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Transforming Places

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EDITORIAL

PLACE AND NARRATIVES

PLACE CONCEPTUALIZATION AND REPRESENTATION

PLACE AND PLANNING

PLACE AND MOVEMENT

WORKSHOP REPORTS

Introduction to the Fourth International Symposium on Platial Information Science

– Editorial –

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The fourth edition of the International Symposium on Platial Information Science (PLATIAL'23) is themed *Transforming Places*. This motto can be read in two ways: as a status describing places in flux, and in imperative form, echoing a proactive human role in changing the physical, social, economic, cultural, and other conditions of our immediate and wider surroundings. Such transformations can affect different geographical parameters and they can take place at different scales. Some processes of place transformation, like urban shrinkage (e.g., Meng and Long, 2022; Wolff and Wiechmann, 2018) and gentrification (e.g., Frank, 2021; Rérat et al., 2010), are spatially confined and affect single cities or neighbourhoods. Others are linked to national or supranational policies or other large-scale processes and thus affect societies as a whole. Examples of the latter are infrastructural changes affecting everyday practices (e.g., Sonea and Westerholt, 2021; Taylor and Pettit, 2020), cultural changes (e.g., Mocnik, 2018; Neff, 2005), to name but a few. As one of the largest post-industrial landscapes in Europe, the German Ruhr has undergone many of the types of transformations outlined above simultaneously. Starting with coal mining in the late Middle Ages and driven by steel milling and other heavy industries during the industrialization of the 19th and 20th centuries, the region was confronted with various, often simultaneous changes that affected economic, cultural, social, political, and other societal domains. These changes continue to this day, slowly transforming the Ruhr from heavy industry and coal to a service-oriented economy. The scale of these changes makes the Ruhr a perfect location for this year's symposium hosted by TU Dortmund University.

The twelve papers presented at the PLATIAL'23 Symposium reflect a broad spectrum of engagement with places and place information. One session is on place and narratives, and it includes three text-related contributions. With a view to better understanding individual and collective nature-related values, Teurlincx et al. (2023) discuss a case study on extracting social, cultural, and ecological perspectives on nature from place descriptions. In a related approach, Steiner et al. (2023) set out a way of extracting sense of place from narratives that involves a novel kind of representation called spatio-textual regions. Williams et al. (2023) close the session with a paper looking at in situ engagements with places by walkers. The latter work connects to the session on place and movement. Kremer and Wagner (2023) present an approach that also focusses on walking, but with an emphasis on providing place-related material in the field. In contrast, Novack et al. (2023) focus on perceptual aspects of physical environments and how these influence the place impressions of walkers. Since movement data usually also implies revealing one's location, Liu et al. (2023) present a location privacy approach. The environments in which we move are often planned. Zhao and Sun (2023) therefore discuss tactics of public engagement in the context of street experiments conducted during the COVID-19 pandemic that produced deliberate changes in street use. Kaminski et al. (2023) also address the issue of participation and presents work that combines participatory GIS with scenario planning, focussing on rural areas. A third planning-oriented contribution by Cobs-Muñoz and Slivinskaya (2023) expand the perspective

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on the teaching of the concept of place in the context of planning degrees. A fourth session offers insights into conceptual aspects of place. Egorova and Bae (2023) discuss the nexus between citizen science and place using the example of urban imaginaries of refugee children. Top et al. (2023) use an analogy-based approach to argue for the interplay between spaces and representations of place paralleling the duality between conceptual extent and intent. Finally, Mocnik (2023) presents the idea of assembling a corpus of place representations to allow for their systematic empirical study.

The symposium also comprises two keynotes, two workshops, and two excursions. The two keynotes were presented by Agnieszka Leszczynski (Western University) and Juliane Czierpka (Ruhr University Bochum). Agnieszka Leszczynski's keynote added an important additional aspect to the symposium: the impact of virtuality and platforms on places. This perspective of digital geography was underpinned by three examples from North American cities, showing how the digital influences the way we perceive, imagine, and use urban spaces. The keynote proposed platforms as a new class of amenities alongside traditional and emplaced amenities. The keynote by Juliane Czierpka took a historiographical perspective and outlined historical developments in the Ruhr and how these have influenced the ways in which people both internally and from the outside understand and mentally represent the area. Thereby, the focus was on the role of women in the deindustrialization of the Ruhr. This talk was complemented by an excursion to Dortmund's North End (in German: 'Nordstadt'), a neighbourhood now dominated by immigrants that initially benefited from the rise of the nearby steel industry and was later greatly affected by its decline. In addition to the keynote lectures, the workshops also offered additional focal points: Slivinskaya and Cobs-Muñoz (2023; both TU Dortmund University) introduced the audience to the Place Standard Tool, which has been developed by a Scottish consortium of public and private actors. Further, Velazco-Londoño (2023; TU Dortmund University) offered a spatial analytical perspective on the study of urban areas. Overall, the symposium programme offered three rich and insightful days that stimulated plenty of platial discussions!

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We are grateful to the two keynote speakers Agnieszka Leszczynski and Juliane Czierpka for their outstanding presentations. We further thank the programme committee members for their reviews and helpful comments: Thomas Blaschke, Susanne Bleisch, Dirk Burghardt, Ekaterina Egorova, Rachel Franklin, Michael F Goodchild, Krzysztof Janowicz, Agnieszka Leszczynski, Grant McKenzie, Mir Abolfazl Mostafavi, Bill Palmer, Alenka Poplin, Simon Scheider, Kathleen E Stewart, Kristin Stock, Thora Tenbrink, Nigel Thrift, and Stephan Winter. We also thank the workshop organizers, all speakers, the local organization team, and, last but not least, the participants for their excellent contributions and lively discussions, which made the PLATIAL'23 Symposium an unforgettable event.

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Capturing Elements of the Nature Futures Framework Through In Situ Place Descriptions: An Empirical Study in Urban Blue Locations

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Human-nature interaction is in constant flux, and capturing the present perceptions and imaginaries of urban nature could facilitate the development of scenarios that ensure positive futures for both nature and humans. This paper explores the feasibility of inferring and operationalizing the three key values of the Nature Futures Framework – Nature for Society, Nature as Culture, and Nature for Nature – through the language in place descriptions and place transformation suggestions, collected in situ in 57 urban blue spaces as part of a pilot citizen science project in the Netherlands. We suggest that cross-pollination between research working towards capturing place facets in natural discourse and the Nature Futures Framework has the potential to provide effective means for a better understanding and visualization of individual and collective nature-related values hold within communities in particular *places*, leading to transformations of urban nature in a way that is beneficial to both humans and nature.

Keywords: urban blue; urban nature; place descriptions; place transformations; Nature Futures Framework

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1 Introduction and Related Work

Geographical Information Science has made significant theoretical and methodological advances in the conceptualization, operationalization, extraction, and representation of platial information. One example is the body of work that has developed an advanced methodological toolkit to capture the richness of place facets through an in-depth analysis of *language* used to describe places. Relying on theories and analytic techniques from cognitive semantics, discourse and text analysis, this line of research leverages diverse types of place-related natural discourse – data collected through in situ free listing and surveys, but also through diverse geographical practices referred to as neogeography (Warf and Sui, 2010), encompassing passive (e.g., social media) and active (e.g., crowdsourcing) forms of Volunteered Geographic Information. This body of work provides valuable insights into a variety of aspects of human-environment relationships: wayfinding and navigation in natural settings, conceptualization of landscape features and the meaning of landscape terms across diverse linguistic and cultural communities, emotions evoked by certain places and activities and place appreciation more

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Table 1: Generic summary overview of the Nature Futures Framework (NFF) value perspectives (cf., Kramer et al., 2023; Pereira et al., 2020, IPBES/TF/SCN/2021/1/2)

NFF perspective	Nature for Nature	Nature for Society	Nature as Culture
Summary description	In which nature has value in and of itself. Nature maintains its ability to function autonomously, and the preservation of nature's diversity and functions is of primary importance	In which nature is primarily valued, and sustainably managed for the benefit of humans	In which humans are perceived as an integral part of nature, where societies, cultures, traditions and faiths are intricately intertwined with nature, and relational values, such as those reflecting cultural identities and ways of life, are dominant
Prevailing value type	intrinsic values	relational values	instrumental values

generally, to name a few examples (Purves et al., 2023; Stock et al., 2019; Tenbrink, 2022; Tenbrink and Williams, 2022).

Linguistically informed analysis of place facets has advanced our understanding of the perception and use of cultural ecosystem services (CES), spanning across disciplines. The linguistic operationalization of CES, such as sense of place in the context of recreation, provides the first key step to the extraction and modelling of the perception and use of cultural ecosystem services across various spatial and temporal scales using verbal data (Egorova, 2021; Kim and Son, 2021; Langemeyer et al., 2023; Wartmann and Purves, 2018). In this paper, we build upon this line of work by exploring place descriptions of urban blue locations from the perspective of Nature Futures Framework values.

The Nature Futures Framework (NFF), proposed by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), is a tool for developing nature-positive scenarios (Pereira et al., 2020). Based on an in-depth analysis of a wide range of visions of positive futures for biodiversity and people, it embraces the diversity of human–nature relationships (Lundquist et al., 2021). As represented in Table 1, the NFF framework comprises three value perspectives that humans can hold towards nature: (1) Nature for Nature (NfN), (2) Nature for Society (NfS), and (3) Nature as Culture (NaC) (Durán et al., 2023; Lundquist et al., 2021). These three value perspectives encompass intrisic (NfN), instrumental (NfS) and relational (NfC) values that people may hold towards nature. To date, the NFF has been successfully applied in dedicated sessions with stakeholders. Importantly, the NFF has been suggested as a tool to sketch futures and aid urban planning for green, sustainable cities that benefit the health of humans and nature alike (Mansur et al., 2022).

While 'urban nature', 'urban blue and green', and 'natural environment' are widely used terms, the conceptual distinctions often remain vague, and the terms appear to be used interchangeably. The classical view that separates and opposes natural and built environments has been contested as irrelevant given the context of the Anthropocene (Ahern, 2016). Hence, the term 'urban nature' emerged, generally referring to natural elements in cities, such as those found in urban blue and green spaces. There is also no clear distinction between urban green and blue spaces since the latter are often encountered amidst green spaces (Smith et al., 2021).

Humans benefit from the presence of urban nature in blue spaces, both in terms of how they experience urban settings (Herzog, 1989) as well as by the ecosystem services provided by nature, such as flood mitigation, food provisioning, and recreation (Keeler et al., 2019). Understanding the values humans give to urban nature in the context of local places and diverse populations that use them is essential for informing nature-positive scenarios by policy-makers. The current applications of the NFF (e.g., Kuiper et al., 2022) are unlikely to capture the full diversity of the population interacting with nature in the real world. Furthermore, they tend to capture broad visions of the future rather than 'small-scale' perceptions and transformation-related imaginaries in particular *places*.

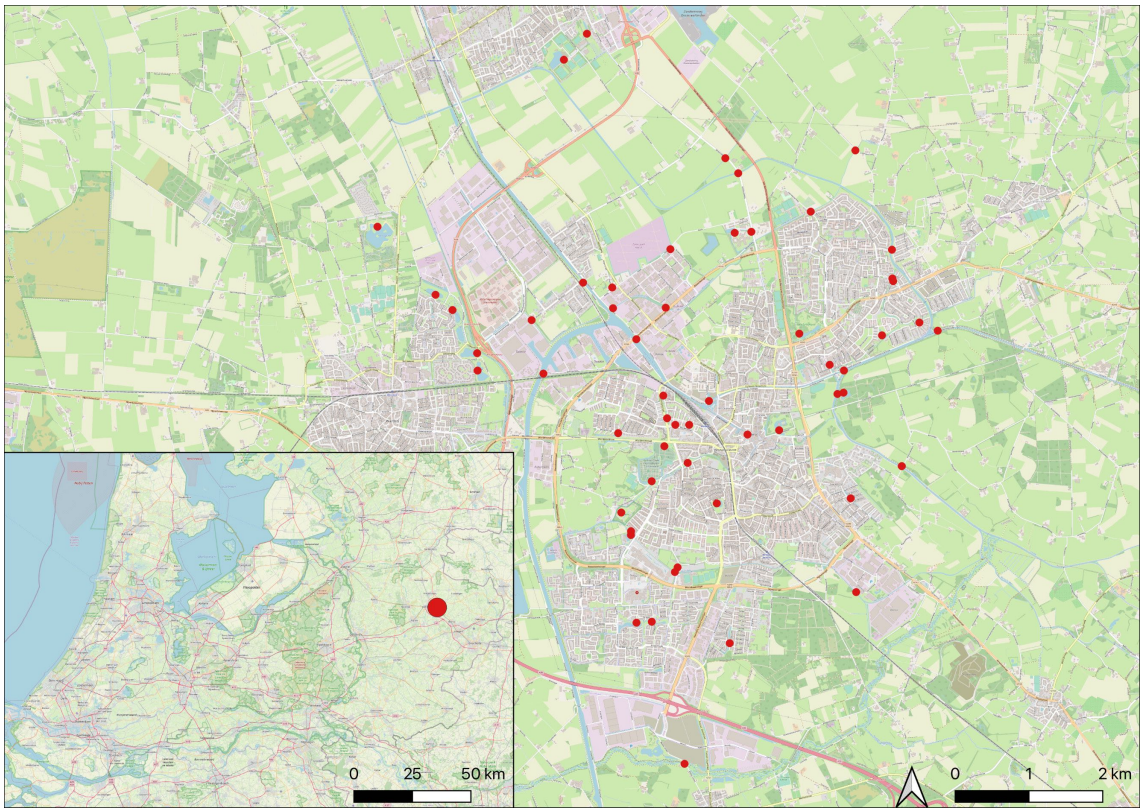

Figure 1: The 57 urban blue locations visited during the *Water Rangers Twente* project in Almelo, the Netherlands

In this study we explore the feasibility of operationalizing and capturing the Nature Futures Framework elements through language in place descriptions in the context of urban nature in urban blue spaces, while simultaneously taking the first steps towards bridging between the two research communities. Research and policy working with the NFF could benefit from the *operationalization of its key constructs through language*, allowing for the leveraging of data collected across various spatial and temporal scales and including views from more diverse sources such as indigenous and local populations (Lahoti et al., 2023). Simultaneously, the research community working on cataloguing the richness with which place is reflected in natural discourse could benefit from the cross-pollination with a future and transformation-oriented framework, and it could engage deeper with *nature-related values of people as a facet* of urban nature places. We explore the feasibility of capturing NFF values in the descriptions of places and suggested place transformations, collected in situ in urban blue places, by addressing the following questions: (1) Can we capture the NFF values through language in the descriptions of places, and in the descriptions of suggested transformations? (2) Can this type of data reveal the directionality of suggested place transformations and the underlying NFF values?

2 Data and Methods

The study uses data collected as part of the citizen science project *Water Rangers Twente*, which ran in the summer of 2022 in Almelo, a city in the Netherlands. The project was developed for the temporarily displaced youth from Ukraine and had several aims, ranging from the contribution to children's place-bonding to the collection of data on the youth perception of urban blue. Grounded in the concept of planetary health, the project focussed on water bodies. On the one hand, participants explored the health of water bodies (e.g., water transparency, and presence of water animals and plants) as part of the national project *Vang de Watermonsters*. On the other, participants investigated and recorded places' attractiveness for visitation. Seventeen children took part in the project, with an average age of 10.6 (SD = 1.9), 11 (64.7%) of them being female. Participants worked in four teams, exploring a total of 57 locations (Figures 1 and 2), filling in 223 individual protocols on place

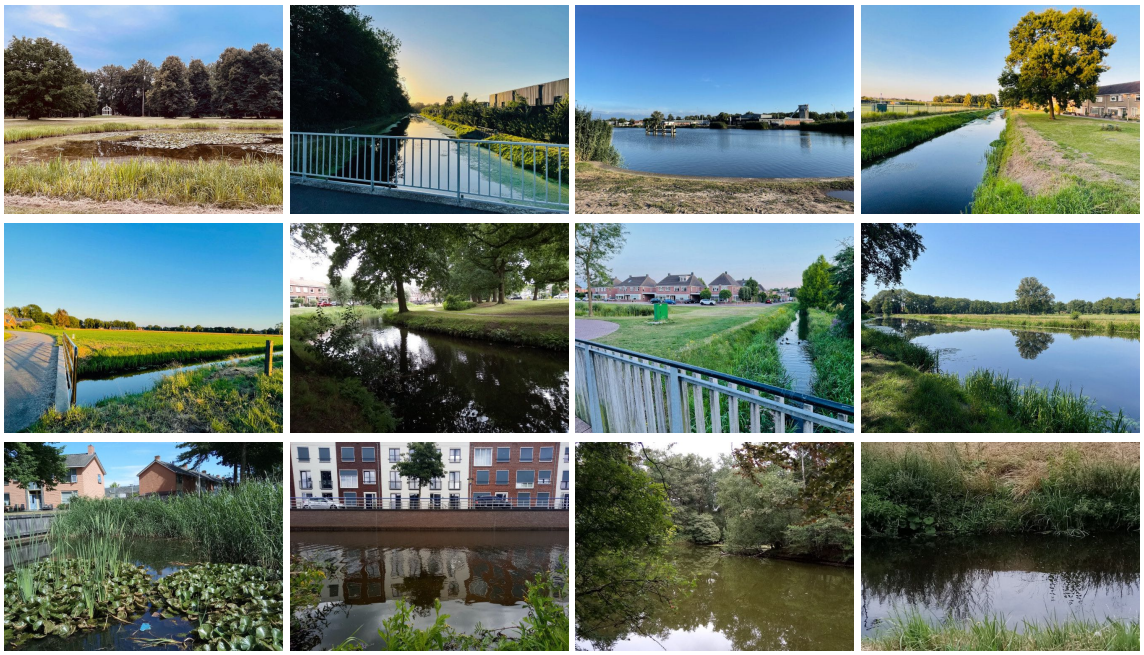

Figure 2: Diversity of places visited during the *Water Rangers Twente* project

attractiveness. This study uses subsections of place attractiveness protocols that included the following instructions and open-ended questions: 'Please describe this place in three words', 'What do you like about this place?' (combined into one dataset for this study, henceforth referred to as 'place descriptions', with a total of 560 entries), 'Which two things would you change?' (henceforth referred to as 'place transformations', with a total of 279 entries). Information from individual protocols was entered into one spreadsheet and translated into English by the project community manager (a native speaker of Ukrainian) and the project PI (the last author in this paper, a native speaker of Russian).

To address RQ 1, we combined the two datasets and compiled a file with unique linguistic expressions in order to reduce the annotation workload. Four authors of this study individually annotated linguistic expressions according to the definitions of the three NFF value perspectives. An additional category 'Other' was introduced to capture concepts that did not belong to any of the NFF elements. A concept could be annotated by multiple categories. We further jointly explored and discussed the key categories of encountered concepts and cases of ambiguity, and developed a draft annotation scheme (the key categories of linguistic expressions and corresponding values are represented in Table 2). Using the said scheme we re-annotated all the data for further analysis. To address RQ 2, we combined data from annotated individual protocols per place (since each place was visited and described by four to five project participants), so that one place-related data entry represented three vectors corresponding to three value perspectives. We further calculated the fraction of each value perspective relative to the total number of value perspectives expressed for each place. For example, for three participants who provided descriptions of a place annotated by the following values (NfS = 1, NfN = 5, NaC = 6), we calculated the sum of all value perspectives represented ($S = 10$) and the individual contributions of each value perspective (NfS = 1/10, NfN = 5/10, NaC = 6/10). With the resulting values summing up to 1, we represent the relative fraction of each value perspective on (three axes) ternary plots. By doing so we correcting for the variation in the number of linguistic expressions and values associated with different places. The procedure was conducted separately for two data subsets – place descriptions, and place transformations.

3 Results

RQ 1. Can we capture the NFF values through language in the descriptions of places, and in the descriptions of suggested transformations? Many linguistic expressions could be mapped onto one of the annotation categories in a relatively straightforward way: 'Nature for Society' (human-actvities around nature, e.g., *swimming*, *fishing*; man-made objects that facilitate the experience of

Table 2: Examples of key categories of the annotation scheme used within this study. Note that place transformations are annotated according to the context, namely, the impact of adding or subtracting the element in a given category, i.e., whether it becomes more suitable for humans to obtain services from nature (Nature for Society; NfS), nature to flourish (Nature for Nature; NfN), or contributes to human-nature relations (Nature as Culture; NaC).

Category	Examples	NfS	NfN	NaC	Other
Human related activities	fishing, swimming, study, reading, recreate	✓			
Emotions, sentiments and quality assessments	beauty, nice, good, fine, aesthetics, motivating, cool, tranquil			✓	
Biota	ducks, flowers, flora, fauna, bees, plants, grass, flies		✓		
Biota related to food provisioning	berries, fish	✓	✓		
Natural objects and elements	lake, sand, field, water		✓		
Constructed objects relating to the experience of or control over nature	bench, built access to the water, bridge, dam, pontoon	✓			
Other constructed objects	house, monument, towers				✓
Sounds	noisy, loud				✓
Size and location-related descriptors	big, small, large, downtown				✓
Litter and pollution	litter, litter bins, polluted, dirty		✓	✓	

nature by humans, e.g., *ascent to the water*, *paths*, *benches for fishing*), 'Nature for Culture' (feelings and sentiments expressing relational value, e.g., *beautiful*, *serene*, *tranquil*, *happy*, *good*, *cool*), 'Other' (man-made objects without clear links to natural values, e.g., *house*, *statue*, *bridge*, various place facets not directly linked to any NFF values, e.g., *long*, *downtown*). The major case of ambiguity related to natural objects (e.g., *lake*, *field*, *sand*, *water*) and biota (*algae*, *duckweed*, *plants*, *thickets*, *toads*, *fleas*, *ducks*). While all four coders annotated such references as 'Nature for Nature' in place descriptions, there was a common agreement that such operationalization is simplistic: biota may, e.g., be mentioned for its benefits (*flowers*) or burden to humans (*nettles, bugs*) rather than its intrinsic value. The role of contextual information – even very primitive, in the form of verbs and adverbs such as *add*/*more* and *remove*/*less* – was clearly seen in the place transformations dataset, where expressions such as *add trees* and *more living creatures in the water* clearly represented the Nature for Nature values, while expressions such as *remove nettle* and *minus reeds* hint at the Nature for Society value perspective. Remarkably, the same concept could appear as both desirable and undesirable across protocols, revealing differences in individual perceptions; examples of such concepts include *duckweed*, *grass*, *water animals*. Other examples of contested concepts that can be reflective of multiple values are *litter* (one of the most frequent terms; can be interpreted as a nuisance to the experience of nature for humans, i.e., Nature for Culture, and also as a threat to nature itself, i.e., Nature for Nature), *berries* (another frequent term; related both to food provisioning, i.e., Nature for Society, but also to habitat for other species, i.e., Nature for Nature).

RQ 2. Can this type of data reveal the directionality of suggested place transformations and the underlying NFF values? Figure 3a illustrates the value perspectives captured in place descriptions of the 57 urban blue locations. While there are some reference to instrumental values (e.g., *one can swim*) and relational values (e.g., *tranquil*, *beautiful*), the average value perspective is skewed towards the intrinsic (Nature for Nature) value. This trend may represent the general cognitive salience of natural objects and biota in urban nature, and an their appreciation in the urban environment. However, it may partially also reflect the priming effect of the water quality measurement activity as well as the annotation bias addressed above (e.g., all references to biota annotated as Nature for Nature in place descriptions). Despite these possible biases, the diversity of places in terms of the NFF value perspectives is rather remarkable given the relatively small geographical area.

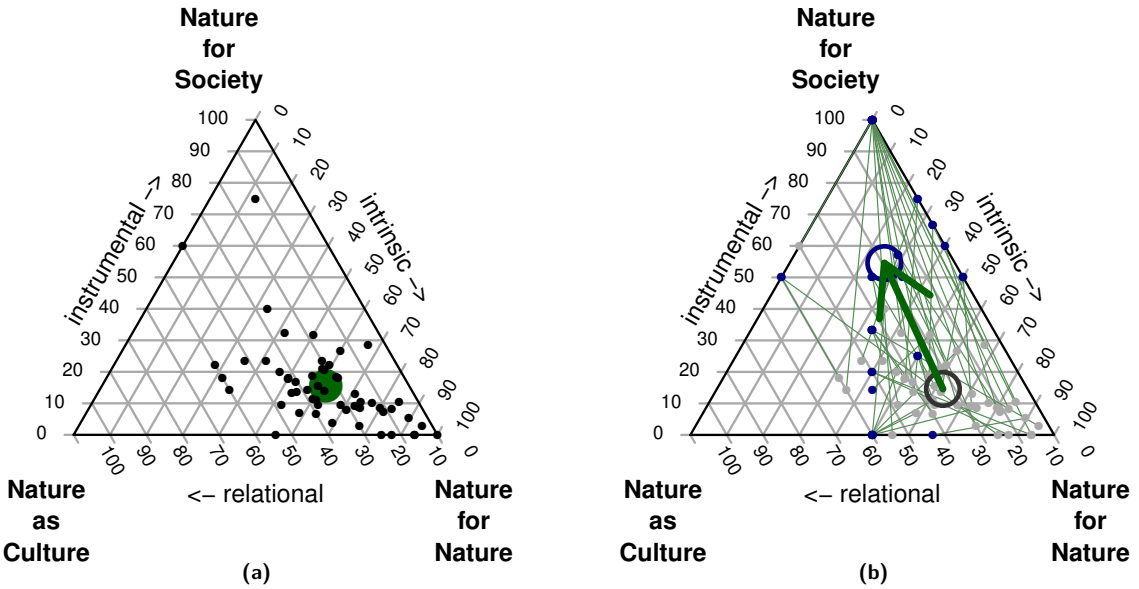

Figure 3: NFF values and transformation of urban blue places in Almelo, the Netherlands. (a) Ternary plot of the NFF value perspectives based on the merged annotations of place descriptions. Black dots represent individual places and the large green dot indicates the mean for all visited places. (b) Ternary plot of the NFF value perspectives based on the merged annotation of place descriptions and place transformation suggestions. Grey dots represent the initial position of places in respect to the NFF value perspectives (same as in Figure 3a), and blue dots represent the position of places in respect to the NFF value perspectives based on the merged annotation of place transformation suggestions. Individual places are connected with green lines. The large green arrow indicates the mean direction of the envisioned transformation, connecting the grey and blue circles representing the mean of initial value perspectives and the envisioned mean change to value perspectives respectively.

Figure 3b illustrates a visible shift towards the Nature for Society, instrumental value perspective. While we encounter a few suggestions that are primarily motivated by the intrinsic value (*add toads*, *more living creatures*, *clean*, and *fence the canal against people so that so that animals feel free without us*), the vast majority of transformation suggestions relate to improving places for human activities: arranging swimming access, reducing nuisance from litter, and creating more favorable conditions for fishing. For example, a site located near the stream Weezebeek (Figure 2, bottom right) falls close to the mean value characterization of across all annotated sites (NfS = 0.16, NfN = 0.59, NaC = 0.25) and its suggested transformation also falls close the the mean value perspective expressed (NfS = 0.5, NfN = 0.25, NaC = 0.25). The site was described by participants as *fine*, *good*, and *motivating* (NaC, relational value) but also had many words reflecting an intrinsic value perspective (NfN: *living creatures*, *transparency*, *snails*, and *few plants* and *few flowers*). The participants suggested adding *benches* and a *gazebo* and cleaning up *litter* reflecting a transformation of the site towards increasing some of its instrumental (NfS) aspects. Through a simple open-ended question on the desired change, we are thus effectively able to visualize the values and the desired futures in the context of the NFF.

4 Conclusion and Future Steps

The presented study is the first step towards capturing the NFF values in the descriptions of places and place transformations. While some of the concepts remain ambiguous without further contextual information, and while this type of data can be considered rather 'thin', it provides an initial insight into diverse local experiences and perceptions of nature and desired changes. As such, it can provide a window into the key concepts shaping communities' mental models in relation to nature (Egorova et al., 2022; Jones et al., 2014), diverse frames of people–nature relations (Willemen et al., 2023), but also into the NFF value perspectives hold by communities in relation to certain urban nature localities, serving as a potential starting point for more focussed and engaged workshops that are currently leveraging

the NFF framework. Importantly, collection of such data today is facilitated not only by social media platforms, but also through the uptake of active crowdsourcing and citizen science, which increasingly engage disadvantaged, marginalized, and indigenous communities (Benyei et al., 2023; Moustard et al., 2021). In the context of citizen science projects with a strong educational element (both *Water Rangers Twente* and *Vang de Watermonsters* introduce participants to the core components of a healthy aquatic ecosystem), simple elicitation of suggested urban blue place transformations prior and following the project can also be used for assessing knowledge acquisition and the potential shift in values towards nature among project participants. In our future steps, we aim to develop and validate the annotation scheme for the NFF values based on the inter-rater reliability test, compile a more representative dataset, and prepare it as a training dataset for the machine learning identification of the NFF values in similar data. We also aim to explore how the three NFF values – intrinsic, instrumental, and relational – map and/or can be integrated with the primitive place facets – geographic, functional, emotive (Hamzei et al., 2020), leading to a more holistic representation of urban nature spots on the one hand, and linking nature futures scenarios to *places* on the other.

Author Contributions

E Egorova and S Teurlincx contributed the main idea and methodology. E Egorova and L Willemen contributed to the data collection. S Teurlincx, R van Halsema, ASM Deffner, and E Egorova contributed to the data annotation (RQ 1). S Teurlincx performed the data analysis (RQ 2). ASM Deffner and S Teurlincx prepared the figures. E Egorova and S Teurlincx contributed to the writing.

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Spatio-Textual Regions: Extracting Sense of Place from Spatial Narratives

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Sense of place is a critical concept underlying the meanings attached to locations and locales in geography and related fields. This concept is often ambiguous and complex when presented in narrative text and challenging to represent and analyse at scale. Mapping a sense of place in this regard requires more than finding geographical coordinates or drawing polygons around toponyms. Our paper develops the concept of a spatio-textual region (STR), a method for identifying platial clusters embedded in spatial narrative texts and explores the potential for mapping the results. We demonstrate the method on an 1857 publication by Thomas Nelson & Sons, a traveller's guide to the Lake District in England. We envision that this method could be employed at scale for generating novel representations of the sense of place embedded in tourist literature, personal journeys, and other spatial narratives.

Keywords: place; narrative; region; Lake District; NLP; visualization

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1 Representing Sense of Place

Sense of place is central to our identity as social creatures, but for all its importance, its definition is complex and multifaceted, and often nebulous and ambiguous. Geographers frequently view 'sense of place' as the third leg of a triad along with location (the coordinates of place), and locale (the physical attributes and activities surrounding these coordinates; Agnew, 1987). Sense of place lacks the precision of the first two attributes. It is 'the experiential and expressive ways places are known, imagined, yearned for, held, remembered, voiced, lived, contested and struggled over' (Feld and Basso, 1996). It exists at various scales, at times simultaneously. It may be positive (joy) or negative (fear; Tuan 1979).

Place has not been extensively considered in a narrative context. Franzosi (2010) discusses how narratives can be analysed quantitatively. He defines narratives as a series of events that make up the story the writer is telling along with evaluations or justifications as to why the events matter. He also notes that narratives consist of both process – what happens – and stasis – what exists. The implication is that a narrative is a series of events that occur in place and in which the place is either fundamental to the event, in which case it is part of process, or forms the background to it as stasis. Despite this, Franzosi does little to identify how place can be analysed as part of the narrative. More recently, Franzosi (2022) presents more detailed consideration of place in narrative largely focussing on place as one of what he terms the '5Ws + H': who, what, when, where, why, and how.

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Rajala et al. (2020) identify four major research needs to improve understanding of sense of place and its capacity in social-ecological research, one of which is central to this project: quantitative methods that can assess place constructs across larger samples and geographical areas. Also important are place ontologies. Ballatore (2016) presents a formalization of place ontologies from the perspective of ontology engineering, rather than philosophical ontology. Acknowledging the cultural dependency of place, he argues that such an ontology should be seen as a module positioned between foundational and domain ontologies whose deployment would increase the interoperability of datasets, particularly in the context of Linked Data. Our larger project both concerns itself with operationalizing these integrated conceptualizations of place and developing scalable methodologies that are widely applicable.

From a GIScience perspective, there have been many calls to improve the handling of place (see, e.g., Bergman and Lally, 2021; Gao, 2022; Purves et al., 2019; Tang and Painho, 2021). Hamzei et al. (2020) provide a review of how place is handled in the GIScience literature. They sub-divide place into a range of geographical and anthropocentric facets. Geographical facets include name, type, and location, while the anthropocentric facets expand sense of place to include the sense or spirit of place, place identity, place meaning, the activities that occur there, and the affordance or purposes that the place can be used for. Many GIScience-based studies have analysed user-generated content to define how place is represented. For example, Bahrehdar and Purves (2018) use tags from Flickr images to characterize places within London, Chesnokova and Purves (2018) use Geograph images to look at the experience of sound in Britain and Ireland, and Karimi et al. (2022) use TripAdvisor to study place in New York. There has been less research exploring place as represented in narratives. Donaldson et al. (2017) explore spatial clusters associated with individual search-terms such as 'beautiful' and 'sublime' in a corpus of writing about the English Lake District, while Paterson and Gregory (2018) use a larger selection of search terms to explore the geographies of poverty as represented in two British newspapers. Meanwhile, cartographers have used a range of techniques to represent sense of place and narrative, including through novel projections, photographic collage, layerings, typography, and annotation (Pearce, 2008; Solnit, 2010). These 'alternative' representations overcome some the conceptual and technical limitations imposed by digital spatial data infrastructures, but they remain challenging to scale and interpret analytically.

A multidisciplinary ESRC-NSF-funded Spatial Narratives project, housed at Lancaster University (UK), is developing ways to address these fundamental problems from computational, analytical, and representational angles. Recognizing that texts offer the most stable and traceable expressions of senses of place, the project uses Natural Language Processing (NLP) with Geographic Information Systems (GIS) to extract platial information corpora of spatial narratives. We aim to draw on and extend work in GIScience on textual processing using geoparsing (Gregory et al., 2015) and machine learning (Karimi et al., 2022) to identify and extract platial information derived from toponyms, geonouns, spatial prepositions, and temporal vocabularies.

For this paper, we focus on a narrow but novel approach to analysing extracted toponyms from narratives to demonstrate a potential way to map sense of place. We take for our example *The Corpus of Lake District Writing*, a collection of 80 richly descriptive texts[1] written about the English Lake District over two centuries. In previous work, we have mined this corpus to look at place using individual toponyms and the sense of place found in words in close textual proximity to them (Taylor and Gregory, 2022). These were aggregated to form spatial clusters of toponyms described as, e.g., 'beautiful' or 'sublime' (Cooper et al., 2016) but without regard to narrative context or more complex ideas of sense of place. This approach provided us a foundation on which we build the present analysis.

2 Spatio-Textual Regions

We propose here the concept of a spatio-textual region (STR) to identify cultural regions, or places, described by texts. An STR is a clustered set of toponyms and a contiguous section of text describing those toponyms. Spatial narratives include information about place in several forms: locational and distance metrics, events and material attributes, and sentimental qualities associated with those locations. Thus, an STR is conceived as a spatial and textual frame for Agnew's location, locale, and sense of place characteristics (Agnew, 1987).

Our demonstration of this STR approach begins with a single text by Thomas Nelson & Sons entitled *The English Lakes* (Nelson, 1857), a traveller's guide to the Lake District of around 10,000

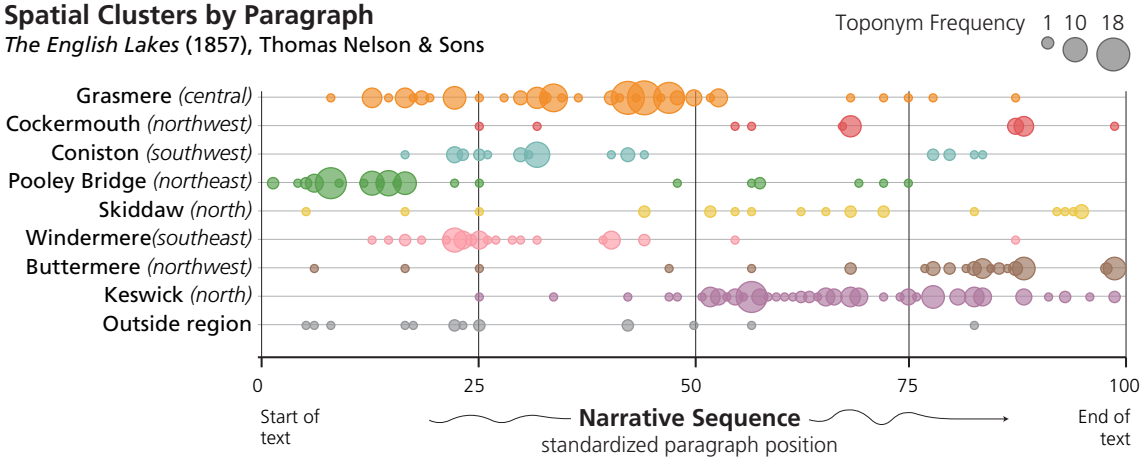

Figure 1: Number of toponyms in each spatial cluster by paragraph. The x-axis shows the standardized paragraph position (0-100%) along the narrative sequence with the first paragraph on the left and last paragraph on the right.

words. Topoynm extraction (geoparsing) is a prerequisite to this method, for which we use tools developed by our project team (Ezeani et al., 2023). Due to the complex nature of geographical names, automated geoparsing is not comprehensive or without error; we acknowledge but do not address these issues in the current work. This proposed approach also has two other key limitations: it is limited to point-based spatial data and is applicable only to corpora comprising a comparable extent and scale.

2.1 Spatial Clustering

After geoparsing a text, the first step in identifying an STR is to apply a spatial clustering algorithm such as k-means clustering to extracted coordinates. For a test case in Nelson, we identified eight major clusters corresponding to generally recognized Lake District areas (Grasmere, Cockermouth, Coniston, Pooley Bridge, Skiddaw, Windermere, Buttermere, and Keswick). Locations beyond the Lake District were excluded from the k-means clustering and allocated to their own separate 'outside region' cluster (Figure 1).

2.2 Textual Clustering

Raw spatial clustering ignores the structure or sequence of the narrative source and thus omits critical information about the unfolding of a platial experience depicted by the author. In the next step, we identify each occurrence of each toponym by paragraph, and allocate it to its spatial cluster (Figure 1), thus illustrating how Nelson's descriptions proceed through the Lake District from the beginning to the end of his text.

The English Lakes starts by using toponyms that are primarily in the northeastern area of the Lake District, around Penrith and Pooley Bridge (green). After 10% of the text, the guide begins to use some toponyms from the central area around Grasmere (orange), while continuing to describe sites in the northeast region. The text then moves to describe the southeastern area around Windermere (pink) and the southwestern area of Coniston (blue), before moving to the north in Keswick (purple) and eventually to the northwest area around Buttermere (brown). Figure 1 also shows that it is unusual to have a section of several paragraphs consisting of toponyms from only one cluster. Some paragraphs contain many toponyms while others have none. Finally, it is not always clear which spatial cluster is the focus, e.g., at a quarter of the way through the text; the guide apparently references toponyms in all major regions of the Lake District.

In practice, textual descriptions that include locations may be near each other geographically or referentially, i.e., by recalling a memory or imagining a distant place. Smoothing helps to define continuous sections of text that refer *primarily* to a particular spatial cluster of locations, even if it contains toponyms from elsewhere. We chose a simple method of giving each toponyms a smoothed

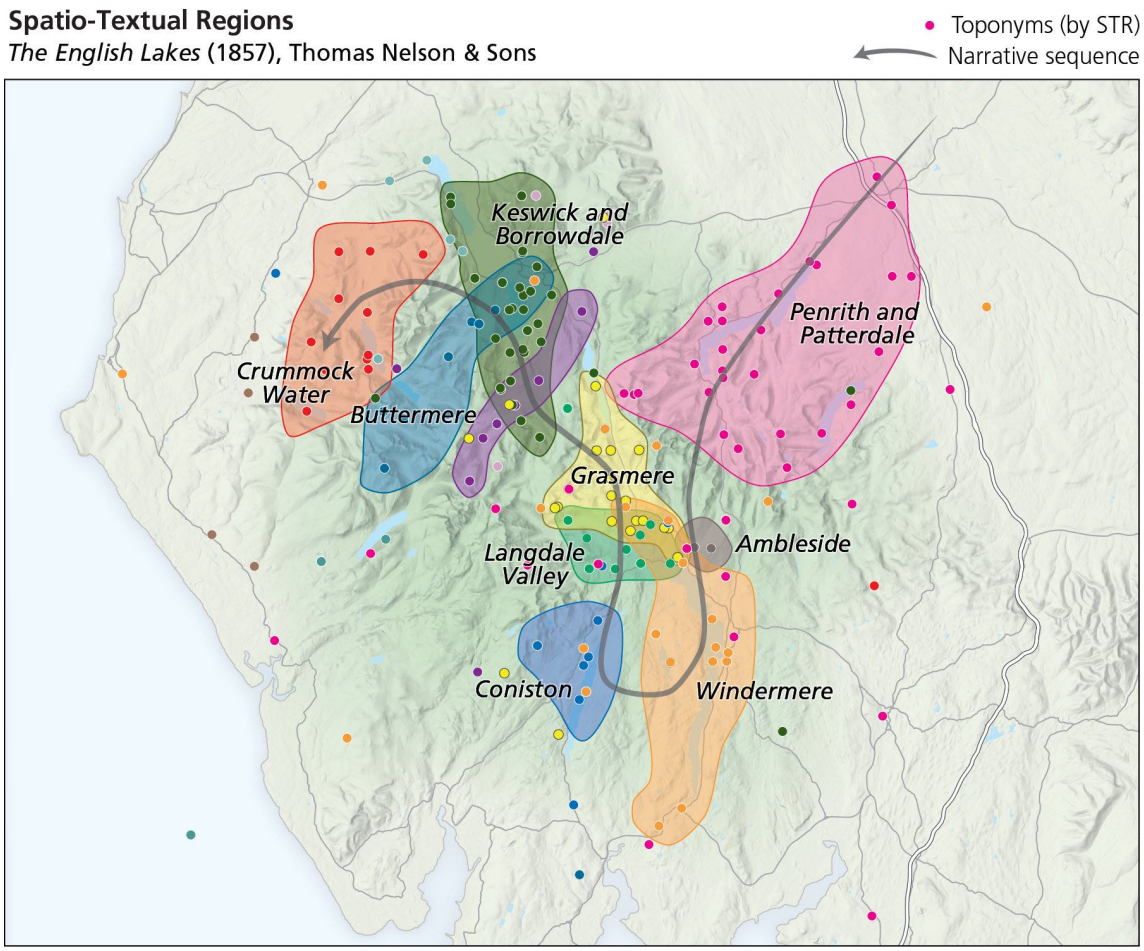

Figure 2: Spatio-textual regions in Nelson's 1857 text. The major STRs are outlined manually to indicate their *approximate* spatial extent.

cluster ID corresponding to the most common spatial cluster among its eight neighbors in the text, and then identifying breaks by comparing smoothed and original cluster IDs.

Spatio-textual regions (STRs) were created by working through the smoothed clusters in textual order. The first toponym, for instance, is allocated to the first STR (in our example, the area around Penrith and Patterdale). For subsequent toponyms a new STR is defined if both the smoothed cluster ID and the original cluster ID for this toponym were different from the smoothed cluster ID of the previous toponym. Finally, we enforce that a new STR cannot be defined mid-paragraph. This allows us to reflect the importance of paragraph structure to textual descriptions and aligns with other paragraph-level textual analysis methods.

2.3 Representing Place

When combined, the spatial and textual clustering approach allows us to map STRs, or *places*, derived from the corpus, thereby combining both locational information with the rich sense of place information embedded in narratives. By mapping the spatial loci and narrative progression of the STRs (Figure 2), distinctive places begin to take shape for Nelson. For example, Windermere emerges as both spatially and narratively distinct from adjacent Ambleside, while other authors may disagree. Overlapping STRs indicate geographical areas that the guide repeatedly returns to, even if only referentially at a distance. Indeed, the guide instructs in the Grasmere area: 'From this walk many charming views may be had of the scenery around Rydal Lake, which is eminently beautiful.'

STRs both define an approximate spatial extent and section of narrative. Once STRs are defined, the narrative can then be examined with sentiment analysis or other textual methods. For this phase of the work, we adopted a basic approach to sentiment evaluation, which relies on a pre-prepared

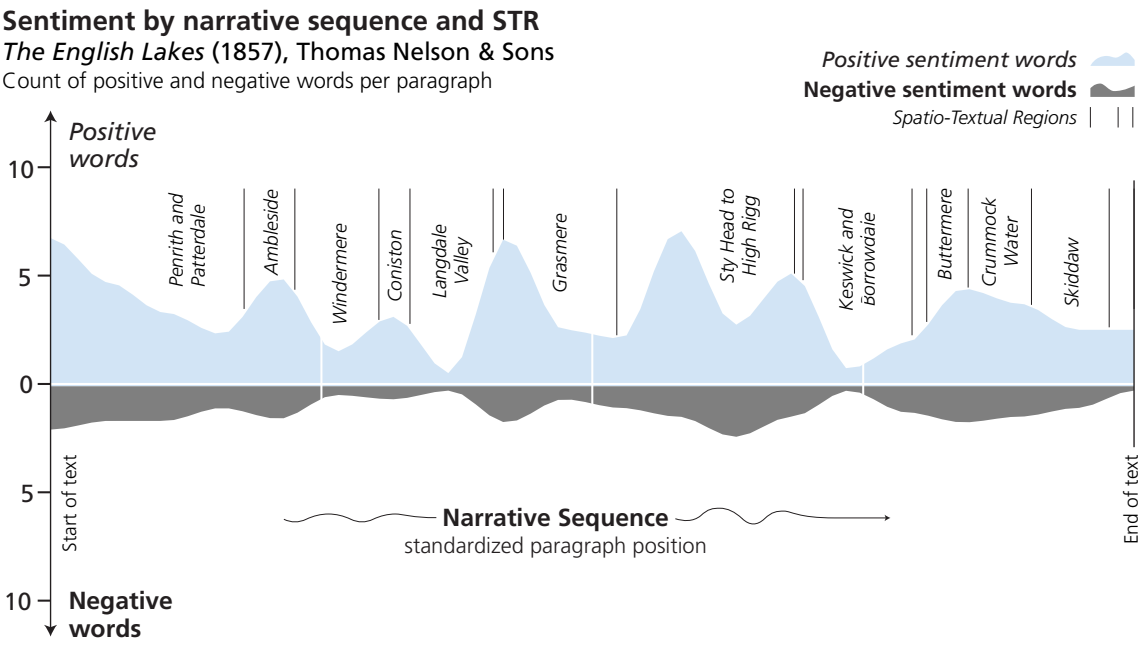

Figure 3: Sentiment by narrative sequence and spatio-textual regions in Nelson's 1857 text. Regions differ in their positive, negative, and total sentiment, with the peak emotions appearing in the central portion of the text (and space, see Figure 2).

sentiment lexicon (Hu and Liu, 2004)[2]. Figure 3 shows the relative strength of positive or negative sentiment by paragraph and each STR in Nelson's text.

This analysis provides a measure of how positively the writer responds to each place by showing the per paragraph density of positive and negative terms (average count of positive and negative words per paragraph). On average, positive words outweigh negative ones by a factor of two, yet there are clear differences in how Nelson responds to different places in different parts of the text. For example, Nelson's description of Ambleside is associated with positive sentiment, while Keswick and Borrowdale are more neutral.

3 Comparative Analysis

We expect the techniques described above can be effective at identifying STRs in a range of travel and other spatial narratives such as those found in the texts of our Lake District corpus. Our larger goal is to generalize these methods to investigate corpus-level patterns. Each author in the Lake District corpus narrates a unique spatial and narrative sequence, defining STRs unique to their perception. A comparative analysis of convergent and divergent STRs across authors thus reveals the varied distinctive regions and itineraries embedded in Lake District texts. We can thus begin to answer the question of whether there is are dominant STRs or sequences of STRs in geospatial or textual terms. Do STRs tend to be consistent across authors? Do texts narrate STRs in a consistent sequence? Do different regions have distinctive sentimental qualities depending on the author?

Figure 4 presents evidence from five texts in the corpus evaluating this approach at a small scale. For demonstration purposes, a single distinctive STR was chosen for its spatial contiguity and distinctive sentimental qualities. Each of these STRs was selected on the basis of a combination of highly distinctive features – both textual and geographical. Notably, across five authors, we see spatially separate STRs emerge, and their descriptions capture the unique sense of place qualities of those places at the time the texts were written, according to the individual perspectives of the five authors. Such a literary map of the Lake District evokes the process of how places are both described and constructed through these texts. One could imagine extending this comparative approach by examining STRs that emerge for a single geographical region across multiple authors, or considering in more depth the sequencing of STRs (e.g., Figure 2) in space and text and the role this may play in accounting for differing experiences of place.

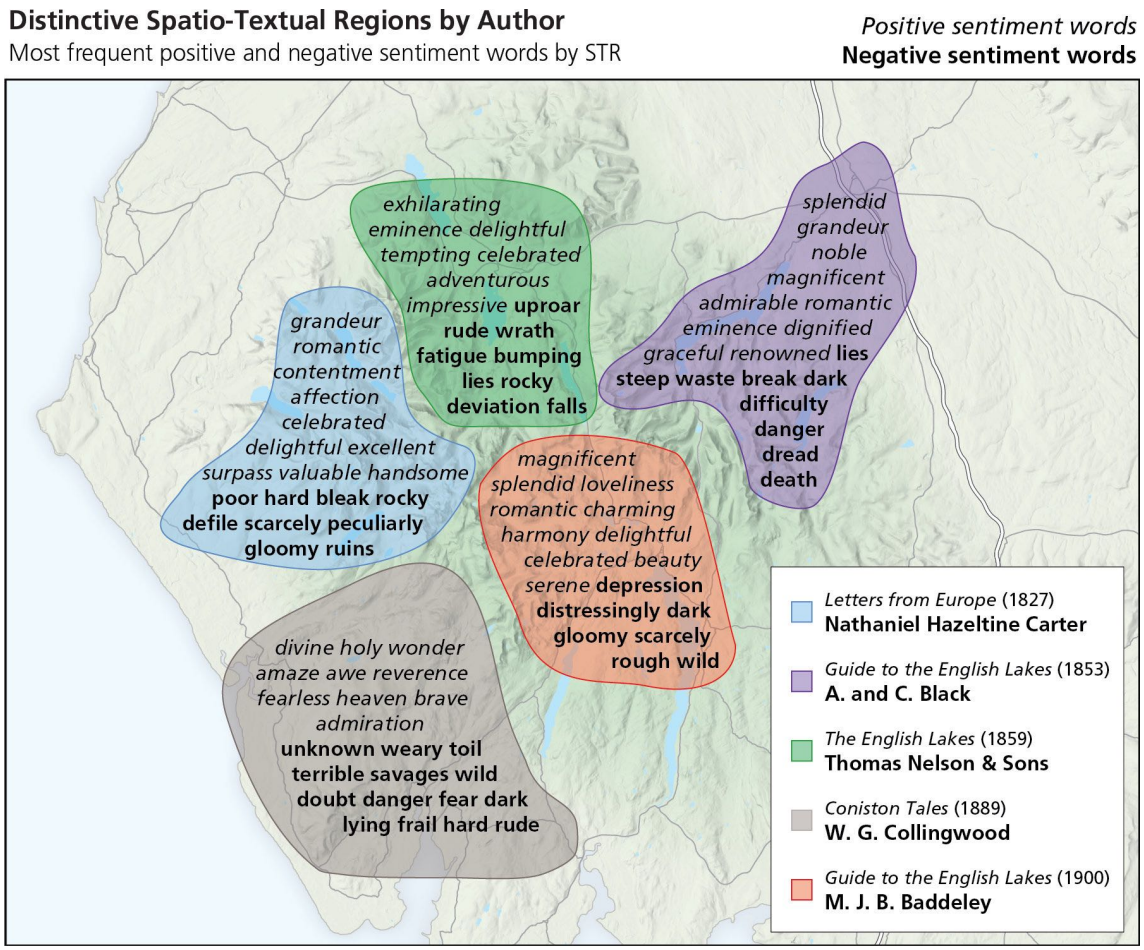

Figure 4: STRs in a comparative perspective: distinctive STRs by author. STRs are defined by choosing one spatially and textually distinct region for each author.

4 Conclusion

This paper reports on initial progress toward a simple but effective method of identifying the spatial and textual extents and qualities of places described in travel narratives. We propose the concept of spatio-textual regions (STRs) and explore their characteristics in a corpus of Lake District travel writing. Within individual texts, the sense of movement through, observation, and experience of place emerges from a combination of textual analysis and geography. The ebb and flow of the sense of place in a narrative can be observed in this example with high and low points of emotional response. When viewed from the perspective of several texts, distinctive STRs can be mapped and contrasted, and the sequential and spatial similarities of STRs can be compared. While limitations to this approach are noted, the research has broader application to other corpora. In our own work, we anticipate applying these methods to an equally rich set of oral testimonies of Holocaust survivors. Using similar methods, it will be possible to explore platial dimensions of memory in this corpus, enriching our understanding both of individual experience and collective patterns forged in this radically different context.

Notes

1. https://github.com/UCREL/LakeDistrictCorpus
2. http://www.cs.uic.edu/~liub/FBS/sentiment-analysis.html

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Author Contributions

I Gregory originated the concept of STR. E Steiner and Z Frank contributed to the concept and text analysis. I Ezeani performed text extraction and sentiment analysis. D Bodenhamer and I Gregory drafted the text, E Steiner and Z Frank finalized the text. E Steiner developed the figures.

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Emerging Platial Narratives and Themes from a Leisure Walking Study

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This article presents the preliminary results of a think-aloud leisure walking study, identifying the key themes and platial narratives. A think-aloud study was conducted to explore what and how leisure walkers engaged with while walking. Our emerging results are presented in the context of an approach to extracting and understanding the platial experience during the study. The early findings suggest that the types of places engaged with while walking and the characteristics of these places are varied, while navigation and wayfinding have an impact on the selected route and the changes that occur during the walk. Our future work will now focus on further analysing these results and using them to improve the recommendation of leisure walking routes.

Keywords: leisure walking; platial information; think-aloud study; route recommendation; mobile geospatial computing

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1 Introduction

Walking for leisure can be considered both a physical activity and an experience where participation in activities and nature are important considerations for walkers (e.g., Ettema and Smajic, 2015). Leisure walking is often a personal and subjective experience, which can explore an individual's connection to place (e.g., Lee and Shen, 2013), but is also influenced by the environment, safety, and the route amenities provided (Brown et al., 2007). The wider context of walking has previously been explored by Chan et al. (2021), finding that the perception of the environment can encourage walking as an activity even with low objective walkability characteristics of the neighbourhood. Previous work has used the think-aloud method and the resulting verbal data to identify how planning and navigation impact wayfinding scenarios in urban routes (Hölscher et al., 2011). Walking routes have traditionally been provided by leaflets and brochures, which usually provide information on access, amenities, and wayfinding (Elliott et al., 2016), while more computational implementations have sought to provide these recommendations using digital technologies. For example, Li et al. (2021) consider how a route recommendation system can use sentiment towards scenery and season to improve the quality of leisure walks, while de Oliveira e Silva et al. (2022) investigate how past travel behaviours from Global Positioning System (GPS) traces can be used to recommend personalized routes. Despite

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current technologies, there are several challenges in understanding the role of place in leisure walking. Therefore, understanding the experiential and platial aspects of leisure walking is important for the curation of improved recommendations that are personal to the user.

The lack of experiential factors used for the recommendation of computational routes provides the impetus for the work reported in this article. We use the concept of platial information described in Mocnik (2022) to understand what users are interested in while leisure walking, to then use a spatial-platial approach to extrapolate rich details from these initial studies (Williams et al., 2022). This article presents the first stage of this process, which focusses on the initial platial information collected through a think-aloud leisure walking study, and presents some emerging themes with a focus on user engagement with place and how this can be represented computationally. These results are provided as a set of themes, with the expectation that future work will continue to analyse and report the full findings of this study.

This article presents some initial and emerging themes from the think-aloud study, with a focus on the platial results of the work. The remainder of this article is presented as follows; Section 2 presents the methodology and describes the study scenario in addition to the software used. The initial and emerging platial results are presented and discussed as themes in Section 3. Finally, Section 4 concludes the article and considers how the remaining results will be analysed in future work.

2 Methodology

To investigate how users engage with leisure walks, a think-aloud verbal protocol study was conducted (Van Someren et al., 1994). The study focussed on what participants attended to while walking. Our study was used to capture a rich understanding of how people engaged with the walk, the characteristics of the walk, and the places of interest formed during the walk. During the study, participants received a GPS tracker to record location, a portable camera to record audio and video, and a prompt sheet to encourage thinking aloud. The think-aloud study allowed a complete set of data to be captured; while audio, video, GPS, and transcriptions allowed researchers to triangulate the results of the study using multiple data sources (Charters, 2003).

2.1 Recruitment

Participants were recruited for the study through social media and snowballing. Participants were allowed to walk as part of a group or individually, and a total of 14 studies were conducted. Participants were able to self-select the route for the walk, with assistance being provided through online recommendations if needed. The study was based on the results of a previous leisure walking survey, which found walks between 31 and 60 minutes to be the most common. Participants were also requested to walk only during daylight hours and to provide a general route plan, which had to be confirmed before the study started.

2.2 Analysis Software

Instead of using traditional technology choices, a contextual Geographical Information System (GIS) was used. The WalkGIS software (Williams et al., 2023) allowed quick analysis of multiple data sources, including plotting the route on a map, transcription support, and a linked timestamp to control the overall system. To support the platial analysis of the information, the GIS also enabled a fuzzy spraycan tool (Evans and Waters, 2007) to be used to represent and display uncertain geographical areas computationally. The research team could then use the tool to extract information about leisure walking experiences where subjective locations or places were discussed. WalkGIS also allowed subjective and vague spatial representations (e.g., Miller, 2006) to be captured within a digital tool, with a timestamp that was linked to the spatial video narrative.

3 Preliminary Themes

The analysis and identification of themes from the think-aloud leisure walking study is a work in progress. The themes reported in this section focus on the platial aspects and places of interest

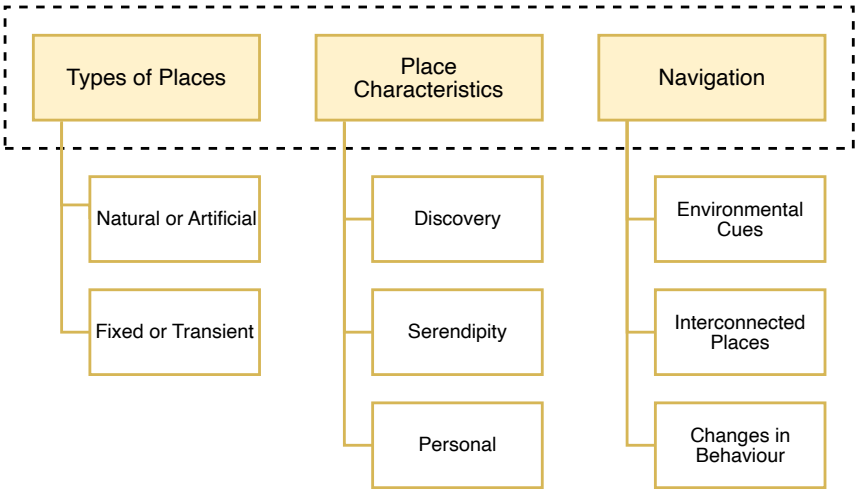

Figure 1: Platial themes identified from the leisure walking study. A diagram presenting the preliminary platial themes identified during the analysis of a think-aloud leisure walking study. The themes present an emerging set of results from the study, and the analysis of these results is ongoing.

identified from the participants' study responses. These form the preliminary themes of the study and were identified from transcriptions, GPS data, and video recordings. Three thematic groups are identified in Figure 1: (1) the types of places that participants spoke about or interacted with during the study, (2) the characteristics of the places identified or the engagements that would occur, and (3) the navigation and wayfinding that the participant did during the walk.

3.1 Types of Places

Participants engaged with a wide array of places or points of interest while walking during the study; some of these included nature, amenities, or the built environment of the walk. Examples of the types of artifacts participants engaged with while walking include houses, signs, trees, and animals. The views or viewpoints of larger collections of artifacts or places were also found to be attended to by participants, which could be performed through either thinking aloud, stopping and looking, or a change of pace while attending to a group of places of interest. Finally, auditory aspects of places were also found to influence leisure walking experiences, such as vehicles on nearby roads or nearby rivers producing background noise.

Natural or Artificial. Leisure walking places were found to be mostly natural or artificial. Natural aspects include trees, signs, hills, and the nature of the environment. Artificial aspects include man-made paths, buildings, and signage. The natural and artificial elements were not classified as generally good or bad by the participants and instead highlight the context of experiential factors that were identified during the walk.

Fixed or Transient. The variability of the types of places was also identified, where the participants would identify the temporal aspects of the places. Some participants identified long-term changes, such as changes in land use over a number of years. Similarly, participants would identify temporal aspects that would change over a day (e.g., the sunlight), or over a more long-term seasonal change. Finally, another identified characteristic of fixed places was determined, which contrasted with transient places because most participants did not explicitly mention changes during the study.

3.2 Place Characteristics

The characteristics of places were also identified from the study, e.g., different places of interest during the walk would have different classifications for the participants. For example, greenspace was often correctly classified as a park or similar green open area, which participants would have a positive acknowledgment of. This positive aspect would not always be the case, and some participants identified the limitations of the places or provided a comparison with other segments of the walk.

Discovery. Discovering new places, walking segments or interesting aspects of a walk was found to be a key element in enjoying the walking experience by participants. This discovery element of the walk was often activated from the planning stage, where participants would leave some aspects of the walk to decide upon arrival. On the contrary, participants were also interested in revisiting areas, whether this was recent or more of a prolonged wait between visits, revisiting previously explored areas in some cases would cause think-aloud utterances of nostalgia from some participants.

Serendipity. The discovery of unexpected but valuable aspects of the walk was a notable theme identified in some of the walks. Serendipity is used as a theme to describe these aspects. Some participants would engage with places on the walk that were unexpected, e.g., the discovery of a new or interesting natural feature as part of the walk. These unexpected aspects are often not represented using traditional mapping tools and are difficult for walkers to predict during the walking experience.

Personal. Existing literature has identified leisure walking as a subjective and personal experience for many walkers, with personal preferences about where to walk, and place attachment being key to these experiences. The preliminary themes of our study identified cases of personal connection to the places where participants walked, with these related to the location or a previous similar experience that occurred. The personal aspect of walking was also highlighted in group walks, as participants would identify and discuss shared experiences or topics of interest.

3.3 Navigation

The final theme identified from these preliminary results is navigation and wayfinding of the participant during the walk. Our early findings suggest that navigation played an important role in the platial aspect of the study during the walking experience. The participants would sometimes locate themselves based on local knowledge of the surrounding area, providing rich details on personal understanding of place. In other cases, participants would use prior experiences, the environment, or signage to support the journey. The participants' think-aloud utterances on the navigational aspects of the walk also provided details on personal navigation choices and factors that determine the desired characteristics of the experience.

Environmental Cues. Participants would sometimes use environmental cues to support navigation and finding directions during the walk, such as rivers, roads, and buildings. Other environmental aspects were supported by noise or the opening and closing of the view of the walker, which participants would sometimes use to confirm the direction of the walk and the current location. Participants also used environmental cues to select which path to take, such as the quality of the path, accessibility of the area, or the natural factors of potential routes.

Interconnected Places. Participants would sometimes connect places as part of the walk, choosing to compromise on the in-between locations of a walk to improve the experience in the future. For this, participants would sometimes break walks into smaller segments to support functional routes between more interesting or engaging parts of the route. This emerging finding highlights how participants value high-quality places of interest along a route and use this to improve the overall experience, even if it means a temporary compromise on the quality of the route.

Changes in Behaviour. Navigation would sometimes change based on the behaviour of the participants, e.g., the participants would sometimes slow down or stop to engage with places of interest along the walk. These changes in behaviour would sometimes have an effect on the overall walk, where participants would identify a new place of interest unknown previously, and would alter the route to include the new aspect as part of the experience. In the context of group walks, participants would also change behaviour by discussing aspects of the place with other group members.

4 Conclusions and Future Work

This article provides a short extract of our emerging platial themes from a think-aloud leisure walking study and presents these preliminary results as a short discussion. Our article has identified three main themes from a platial perspective of our think-aloud study: identifying how the types of place, the characteristics of the place, and the navigation of the route had an influence on the locations and

choices made along a leisure walking route. These results are still in an early stage, and future work will attempt to relate them directly to transcriptions and route segments. Our work will now focus on analysing the themes in full. In addition to extracting platial representations, we hope to analyse the walk for characteristics and other interesting facets which could be used to improve the walking experience.

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The Image of the City by Temporarily Displaced Children: How Place-Based Citizen Science Contributes to Place Discovery

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This study focusses on spatial knowledge acquisition among Ukrainian children, temporarily displaced as a result of a war and newly arrived in the Netherlands. As part of a place-based citizen science project, we conducted two sketch mapping sessions, one before and one after the project, to explore youth's conceptualization of the environment following a three-month residency in the new city, and to assess the impact of a two-week citizen science project on place discovery. Methodologically, we investigate the semiotics of sketch maps supported by individual interviews, and characterize types of knowledge and experiences reflected in the data. The presented work suggests that the sketch map representations capture the physical, emotional, and social contexts of youth's interaction with the new environment, while place-based citizen science provides an opportunity for direct and indirect spatial knowledge acquisition and enrichment of the city image with new meanings, contributing to place discovery.

Keywords: mental mapping; sketch mapping; place discovery; context; residential displacement

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1 Introduction and Related Work

People develop mental maps of diverse environments throughout their entire lives, both from direct (e.g., visiting a place) as well as indirect (e.g., studying a map) environmental experiences (Montello and Freundschuh, 1995). These internal spatial representations encode information used for determining one's location and other spatial relationships, finding one's way between places and communicating spatial knowledge to others (Golledge, 1999). Sketch mapping is a well-established technique that affords a lens into the way people conceptualize and experience their environments, and has a long tradition of being used in two lines of research – investigation of spatial cognition and exploration of the dynamics of human–place relations. The studies in the first line of research are often framed around the concept of familiarity, being based on either the recollections of known environments or environments that have just been explored. Sketch maps are often assessed based on indicators such as completeness and the accuracy of spatial relations, allowing to explore various factors affecting the quality of internal spatial representations and spatial knowledge acquisition – the structure and scale of the environment, sources of knowledge (direct versus indirect), type of experience (e.g., locomotion versus stationary viewing), type of locomotion, the presence of proprioceptive or auditory information as well as individual differences (e.g., skills and personality) in mental mapping abilities (Ishikawa and Montello, 2006; Montello and Freundschuh, 1995; Schwering et al., 2022; Weisberg and Newcombe, 2018). More generally, it has been proposed that spatial knowledge acquisition occurs in stages, proceeding from

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landmark to route and further to survey knowledge (Golledge, 1999). Highlighting the complexity of environments and distortions in our memory and judgments, Tversky (1993) suggests to use a *cognitive collage* metaphor for internal representations of complex environments not known to us in detail (overlays of multiple thematic perspectives of a place), and a *spatial mental model* metaphor for internal representations of less complex and small-scale environments. Studies with children highlight the critical role of movement and repeated encounters with the environment in spatial knowledge acquisition (Herman and Siegel, 1978). Adult-level variations in cognitive mapping are present by age 12 (Nazareth et al., 2018), although some children at the age of 9 to 12 may yet find it difficult to integrate knowledge acquired from different routes (Golledge et al., 1992).

In another line of work, sketch maps provide rich insights into the dynamics of human–environment relations and illuminate the role of individual and sociocultural factors in the experiences of geographies of everyday life. Following the United Nations Convention on the Rights of the Child and more recent initiatives such as the UNICEF Child-Friendly Cities, there has been a steady growth in research on children's sense of connection to community and place in their local and wider worlds, where sketch maps provide a playful method for working with youth (Freeman et al., 2023; Gillespie, 2010; Kelley et al., 2012; Matthews, 1995; White and Green, 2012). Thus, Gillespie (2010) provides a revealing account of the evidence of psychosocial barriers in the sketch maps of children from a more restricted cultural background (Amish) in comparison to non-Amish children, who enjoy more freedom in exploring the same surroundings in the USA. Freeman et al. (2023) unveil the role of social space as the strongest connector for Pacific Island children's spatial encounters as displayed in their sketch maps. Den Besten (2010) explores the neighbourhood sketch maps by immigrant children in Paris and Berlin, highlighting how '(micro-)geographies of emotions' are intertwined with individual migration histories and access to resources. The sketch maps also reflect the role of extra-curricular education ('reception' classes where youth are introduced to the local cultural phenomena) through the depiction of cultural-architectural symbols of the cities.

The present study leverages sketch maps to explore the conceptualization of a new home city by Ukrainian youth who recently arrived in the Netherlands, contributing to the line of work that explores the role of cultural background and context in place conceptualization – temporal displacement is characterized by a high level of uncertainty and other key challenges associated with residential displacements, such as the interruption of social connections. The study also explores the impact of a place-based citizen science project on spatial knowledge acquisition and the development of emotional ties and meanings, characteristic of the 'place discovered' stage of place bonding, the latter known to contribute to the well-being of refugees (Sampson and Gifford, 2010; Trąbka, 2019). Finally, we provide some insights into the semiotics of sketch maps, which remains a largely scattered area, with Gieseking (2013) being one prominent effort to systematically review the analytic components leveraged in sketch mapping studies. In particular, we address the following questions: (1) Which information is encoded in children's sketch maps, and how?; (2) How do temporarily displaced children conceptualize their new environment after a three-month residence?; and (3) How does a short-term place-based citizen science project contribute to place discovery?

2 Data and Methods

2.1 The 'Water Rangers Twente' Project

The 'Water Rangers Twente' took place in the summer of 2022 in Almelo, a small city located in the Twente region of the Overijssel province, the Netherlands. The project was developed for the temporarily displaced youth from Ukraine and had several aims ranging from education to data collection, including place discovery by newly arrived children. Seventeen children took part in this pilot project, with an average age of 10.6 (SD = 1.9), 11 (64.7%) of them female. All of them arrived in Almelo around three months prior to the start of the project and were living in the same emergency shelter ('Noodopvang' in Dutch), that we will henceforth refer to as participants' home residence.

The core activity of the project represented fieldwork, whereby participants worked in four teams going on bicycle trips to urban blue locations across the city, collecting data on water quality, but also on the attractiveness of visited locations for recreation. Field trips were conducted every day over a two-week period. The teams had an equal amount of fieldwork time, with each team making five trips of four

hours each. At the beginning of a trip, the team leader indicated locations that the team was planning to visit on the map (each team received an A3 paper map of the area, centred on their home residence and scaled 1:20,000), and the accompanying person – the community manager or the project PI – planned the route and led the way. At the end of the trip, teams marked visited locations on the map. On average, three locations were visited per trip. Jointly, the teams explored 57 unique locations during the course of the fieldwork phase. To enhance the entertainment component and encourage the exploration of the geographical area, the project introduced a gamification element, whereby teams collected points for the number of visited locations, travel distances, a balanced geographical distribution of visited locations in relation to the home residence, and geocaching tasks to encourage exploration of new places for recreation.

2.2 Data Collection and Analysis

As part of the study exploring the impact of place-based citizen science on place discovery, we conducted two sketch mapping sessions, one prior ('pre-programme') and one after the programme ('post-programme'). Participants were gathered in the same room and received identical sets of drawing materials. Following basic instructions to work silently and independently, the children were given the following prompt: 'Using the given paper and the drawing materials, draw a map of Almelo based on your understanding. You may include features such as buildings, roads, nature features, neighbourhood areas, and any other places of interest. Please give a name or word label for any specific places, to the best of your understanding. You may leave areas blank or unlabeled if you wish.' Once participants finished sketching, they were provided with the following instruction: 'Now, please use this red pen to draw a heart or star on your favorite locations on the map.'

To better understand the depicted features, we conducted individual interviews on sketch maps with each participant, three days after the second map sketching session. The children were asked for permission to record the interview, and 10-minute semi-structured interviews were conducted by the community manager, who received training on the protocols and procedure. The interview protocol included one open-ended question ('How are these two maps different, and why?') as well as specific questions to clarify ambiguous features ('What is this?'), and through this process, additional labels were separately added to the original maps by the interviewer. As part of the project impact assessment study, we also conducted 45-minute focus groups with each of the four teams, with one of the open-ended questions relating to place discovery: 'How, if in any way, has the project helped you to discover the city?' All seventeen participants took part in the current study. The research procedure and written consent forms for parents and assent forms for the children were approved by the Research Ethics Committee at the Faculty Geo-Information Science and Earth Observation (ITC), University of Twente.

Both sketch maps and transcripts of verbal data (interviews and focus groups) were coded in Maxqda (v. 22.2.1, 2022). In sketch maps, each feature was coded with respect to two aspects: the shape and the label, if any (e.g., 'Shape: ambiguous, Label: none', 'Shape: point, Label: Aktion (name of the store)'). Cases for which the semantics of the feature could not be derived from the shape or the label were marked for clarification during the interviews. Following the interviews, an additional section 'Comment' was added to the dataset, e.g., 'Shape: ambiguous, Label: none, Comment: Big neighbourhood on the map'. Combined together, information on these three aspects helped to define the semantics of the feature (e.g., a neighbourhood or a store). Features were further grouped into four broad categories: built space, green space, blue space, and other. Following Gillespie (2010), we also added an additional level of annotation to capture features reflecting 'recreation' and 'socialization'.

3 Results and Discussion

In what follows, we address the key findings and their discussion in relation to three research questions.

RQ 1. Which information is encoded in children's sketch maps, and how?

To this question, we provide initial insights into the aspects of spatial knowledge and platial experiences and their representation in both pre-programme and post-programme maps.

In many cases, the shape of a depicted feature provided a direct reference to their semantics. The most recognizable features were roads, houses, lakes, and rivers. The semantics of some places could

be derived through objects associated with them (e.g., depiction of fruit and vegetables on top of a house-shaped feature, representing a grocery store), or a combination of objects semantically belonging to one place (e.g., water, sand, chaise lounges, and a sun umbrella to represent a beach; cars and gasoline pumps to represent a gas station). Some children preferred to depict features as points or location icons. The semantics of the feature was then often conveyed through labels or additional symbols (e.g., a cross for a hospital). Many labels were straightforward (e.g., names of the stores), but some represented referential metonymies, with the place being labelled by one of its salient features. Notable examples include 'armchair' for a pond with an armchair dumped into the water, 'rabbits' for a park with a high population of rabbits, and 'litter' for a visibly littered pond. Some labels represented comments reflecting the observation of a place over time, e.g., 'has dried out' next to a pond-shaped feature. Other labels represented elaborated descriptions reflecting experiences with places (e.g., 'the legendary lake with a small island') or their location (e.g., 'a place downtown'). Some features remained ambiguous and would not be identifiable without comments provided during the interviews, such as a rectangle for a football pitch and a curved line for a road (which could also be a river).

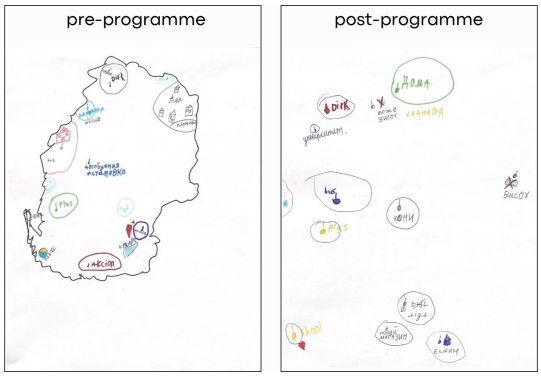
A number of peculiar patterns were observed by the authors and addressed by participants in the interviews. Semantic uncertainty was often represented through question marks or explicit labels 'do not know what this is' or 'some stuff'. Positional uncertainty could be observed through a visible difference in the depiction of semantically similar features within one sketch map. For instance, in one sketch map, we observed three instances of particular roads (drawn in a rather distinguishing manner) as well as multiple curvy lines, drawn in a rather abstract manner and representing the general knowledge of the existence of these features but not their concrete instances. Another interesting pattern referred to drawings of seemingly random objects such as hot air balloons and rabbits. At first glance, such objects lacked a clear denotative content and could be regarded as semiotic noise (Zelianskaia et al., 2020). However, children accounted for including such features as being frequently seen in the area. Indeed, hot air balloons are frequently seen in the skyscape of Twente, while rabbits are frequent visitors in urban parks and gardens. Finally, another peculiar feature – a boundary around the drawn area – represented the participants' awareness of unfamiliar areas and their spatial knowledge gaps (e.g., 'I didn't know what was there [beyond], so I just draw a line').

Examples of further elements that occurred in the participants' sketch maps and invite for further analysis are code-switching between Ukrainian and Dutch in the labelling of places, the use of vernacular toponyms (e.g., one street in one of the sketch maps was labelled 'Pushkin street', which is a non-existent toponym in the area), the depictions of the Ukrainian flag – all hinting at the sketch mapping as a social act of *place-making* and *self-continuity* through the depiction of one's self by means of cultural and linguistic signs, and organization of a 'story' that links the familiar past and the present (Albers et al., 2021). These preliminary insights support the view that sketch maps should be treated as social acts that draw on socially available ways of making sense, 'rather than neutral depictions of an external reality or of an internal cognitive realm' (Van Ommen and Painter, 2005, p. 506).

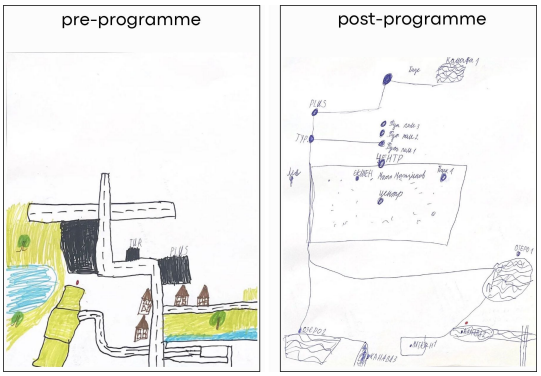
In terms of representation, most of the sketch maps adopted a bird-eye view, but we also encountered a street view depiction of the environment (Figure 1h). We also encountered a collage-like sketch map (Figure 1e), representing three non-integrated routes (to the school and two stores) alongside the detailed depiction of the home residence area, suggesting the co-existence of different types spatial knowledge (Siegel and White, 1975) and supporting the *collage* metaphor for internal spatial representations of large-scale environments (Tversky, 1993). In total, 484 features were identified in the pre and post-programme sketch maps, and the final coding scheme included 56 unique semantic codes. The built environment category had the largest variety of semantic codes and the highest frequency ($n = 320$), followed by urban blue space ($n = 95$), the urban green space ($n = 48$), and features categorized as 'other' ($n = 21$). The number of features included in each sketch map ranged from 4 to 31, with an average of 15.1 ($SD = 6.1$). The average number of features in pre-programme sketch maps was 15.1 ($SD = 5.6$), and in post-programme sketch maps, 15.2 ($SD = 6.7$).

RQ 2. How do temporarily displaced children conceptualize their new environment after a three-month residence?

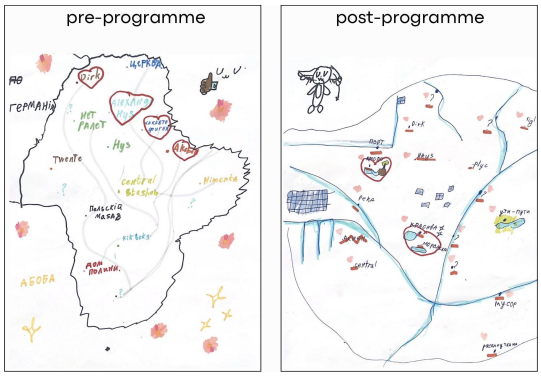
The pre-programme sketch maps showed a high level of agreement between the individual participants' sketch maps, with the home residence being represented in all sketch maps. According to previous



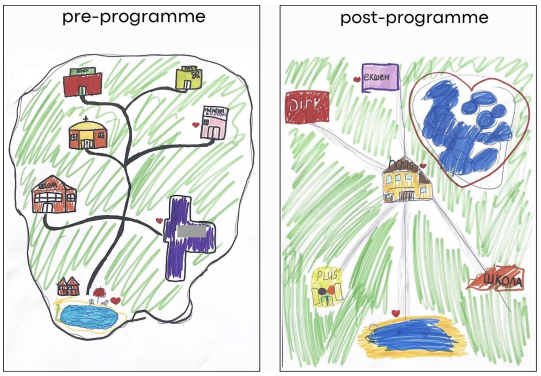
(a) Boundary around the drawn area



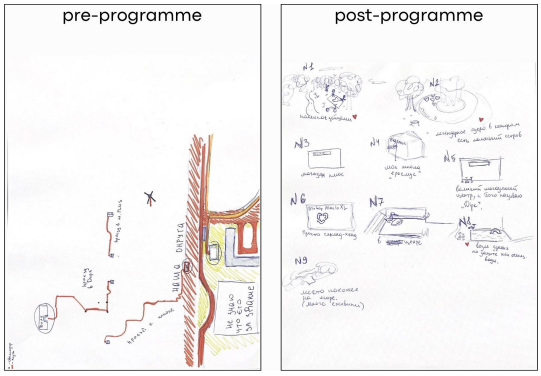
(b) Size of the drawn area



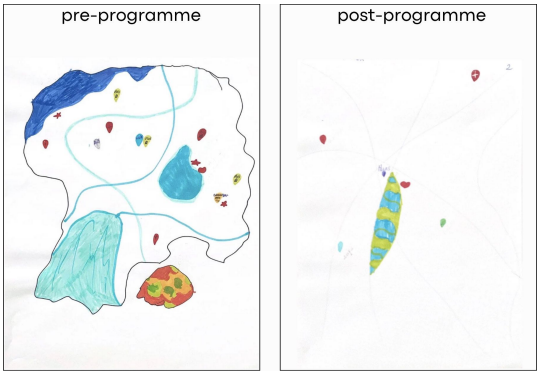
(c) Topological accuracy



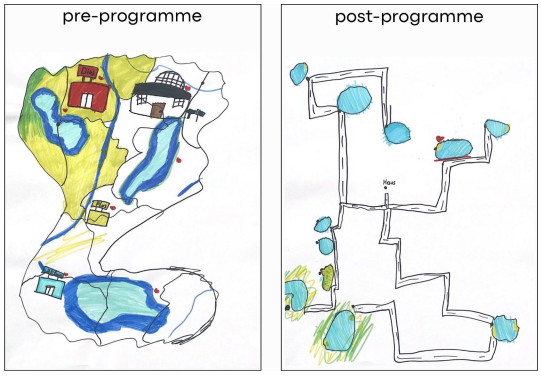
(d) Centring the home



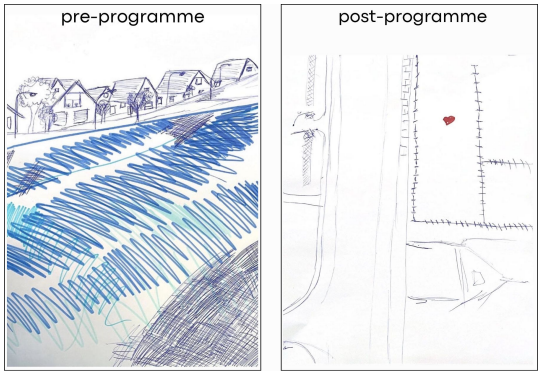
(e) Types of spatial knowledge



(f) Salience of the geocaching activity



(g) Urban blue spaces



(h) Perspective

Figure 1: Examples of pre and post-programme sketch maps drawn by the participants of the study. Each pair of sketch maps demonstrates an example of prominent differences between participants' pre and post-programme maps, captured in the supplementary labels. Where depicted in the original sketch maps, the name and the house number of the home residence have been concealed.

studies, the participants' homes often shape the prominent 'heart' of sketch maps (Gillespie, 2010; Van Ommen and Painter, 2005), suggesting that the current residence place provides a home-like environment for the youth and is associated with positive emotions, which is also supported by the fact that it is often marked as a favourite place in the sketch maps.

Apart from the home residence, the same core features (found within approximately a mile) repeated in many of the maps: a school, nearby grocery stores and supermarkets, a playground, a gas station, a lake with a beach, and a park. Many of these places, especially the stores, were referenced by name. These findings are in line with previous research suggesting that the recently arrived youth feel most at home in places that are close to where they live and go to school. The latter may represent 'safe places' from which recently arrived youth 'venture forth to explore the geographies of their new social and physical environment' (Sampson and Gifford, 2010, p. 121). In the context of newly arrived Ukrainian families, young children might also have limited freedom to explore the area without the supervision of adults, and the area exploration might be embedded into activities such as doing groceries with family members, which would explain the relatively high number of grocery stores and supermarkets represented in sketch maps. The occurrence of the same unique places across the maps might also indicate knowledge exchange about newly discovered places (such as stores and parks) within the community.

While many sketch maps included the same core features, further depicted features reflected the participants' interests and experiences. Thus, recreation places drawn by male participants often included football pitches and a stadium. Several sketch maps made generous use of natural elements such as forests and trees, lakes, rivers, and canals. Examples of places that occurred in one or two sketch maps only and represented more unique, individual experiences included a hospital, a church, a kickboxing club (the participant shared encountering the place by incidence and making a mental note to come back and try out this sport), and a stationery store (the participant shared being a keen drawer). In comparison to research on sketch maps by children who have been residing in their areas (Freeman et al., 2023; Gillespie, 2010), we have encountered little evidence for socialization at this stage, one exception being the depiction of a home of a new local Dutch friend in one of the sketch maps.

There were also notable differences in the geographical area covered and the level of detail. In two sketch maps, the drawn area was confined to the immediate area surrounding the home residence and included meticulous details, such as road marking, a bus stop, a horse stable across the road, small ditches (together with water plants), and a parking lot next to the home residence. One of these sketches adopted a street view, providing a rather artistic and vivid three-dimensional representation of the street where the home residence is located, with street lamps and trees, houses with chimneys and plants in the windows, reflecting the participant's keen observation and close interaction with the immediate environment. Other sketch maps, in contrast, included a much larger geographical area extending to the city centre (e.g., the municipality, the train station, cafes, and shops), with one sketch map including a border with Germany. This diversity might reflect different situations among the newly arrived families, whereby some of them are more mobile (e.g., have a car) and can explore the city with greater convenience; it might also reflect the participants' natural curiousity about the geography of the new environment and its indirect exploration through online maps – as shared during the interview by the participant who included Germany, they had taken time to study the area through Google Maps.

Apart from the home residence, places marked as favourite included schools, a football pitch, a lake with a beach, a stationery shop, a grocery store, a supermarket, a horse stable, and McDonald's. Some of the participants marked multiple places as favourite (sometimes with multiple hearts), with one participant drawing one large heart around the whole depicted area, suggesting a growing place attachment to the new environment.

RQ 3. How does a short-term place-based citizen science project contribute to place discovery?

Comparison of numbers of types of features in pre and post-programme sketch maps revealed a decrease in the number of built environment features, from 69.7% to 62.6%, although it maintained its position as the most prominent category of features. The number of blue space features increased

from 13.3% to 25.9%, while the number of green spaces saw a small decrease, from 11.2% to 8.6%. A two-sample t-test revealed no statistically significant difference in the total number of depicted features per participant across the phases ($t(29.14) = -0.06$, $p = 0.95$). However, a qualitative analysis of sketch maps, supported by the analysis of interviews and focus groups, revealed several patterns reflecting the salience of the experience of participating in the place-based citizen science project, and the acquisition of different types of spatial and platial knowledge.

The boundary around the drawing disappeared in post-programme sketch maps (Figures 1a, d, f, and g) due to the need to represent the newly acquired knowledge – in the words of participants, 'to draw the whole city', 'to make all lakes fit, as well as stores, grass and nature'. The drawn area was often visibly larger and took up more space on the sheet of paper than the pre-programme sketch area (Figure 1b). Some post-programme sketches were characterized by an increased accuracy, both in relation to topology and distances, often as a result of indirect experience, i.e., working with the maps. For example, the sketch map in Figure 1c was drawn by a participant who was responsible for marking visited locations and identifying locations to visit during the following field trip on the paper map of the area. One can easily recognize the large canal with three prominent branches and some other salient features that the team had not visited during field work. In the interview, the participant confirmed remembering some of the elements 'from the map'. In some cases, the place of residence became more centred between the pre and post-programme phases, which may signal more adoption of home, or, again, the role of interaction with the project paper map that was centred on the place of the residence, as in Figure 1d. We have also observed a switch in the map perspective, from a street view to a bird eye view, as represented in Figure 1h.

In general, the post-programme maps reflected various salient experiences during the programme, which supports previous findings on the selectivity of sketch maps (Blades, 1990). Given the focus of the project, it is not surprising that many post-programme sketches included new urban blue spaces, often in an abstract way (e.g., clustered, as in Figure 1d), to show their existence, rather than location. Also roads were prominent in post-programme sketches, as in Figure 1g, reflecting the strong movement-related exploration component of the experience. The positive emotions experience by participants during the exploration of urban blue spaces were also reflected by the marking of such places as new favourites. The most explicit expression of the close interaction with new places and the positive emotions might be the sketch map in Figure 1e. The pre-programme map depicts in detail the area around home residence and three oft-travelled routes (to the school and two stores). The post-programme map lacks the spatial component, depicting instead a set of numbered places. The drawings of the places include vivid details (e.g., lakes, trees, islands, and youths themselves, having a picnic in one of the places, with bicycles parked nearby). Some of the places are marked with rich descriptions (e.g., 'the legendary lake with a small island' and 'the place that looks like a sea, with lots of blackberries'). The salience of the geocaching activity is visible in Figure 1f, where the post-programme map focusses – albeit, almost exclusively – on the water body from the second geocaching activity.

When interpreting reasons for the differences between the maps during the interviews, participants often referred to newly acquired spatial knowledge (e.g., 'Because I got to know the city better') and highlighted which new elements now had to be depicted. During the focus groups, participants often started the discussion of place discovery with urban blue and green spaces. Apart from the latter, participants also mentioned newly discovered landmarks (e.g., 'a place with a beautiful arch') as well as areas ('I have found out there is something behind the school and the store'). One participant found out that the city was not very big in comparison to their home city: 'It takes 20 minutes to get to the outskirts of this city, while it takes 3 hours in [name of their home city].' Participants also felt that active exploration of the city during the project increased their ability to recognize places and use them to navigate and self-orient:

> Q1: I think I started memorizing the routes better, after seeing more of the city – the different places I had never been before, the roads I had not travelled before.
>
> Q2: When we cycled around during this project, we got to see more places, and I can now more or less self-orient in city. If I find myself in some place, I can self-orient, recognize the road, and find the way home.

4 Conclusion

Although childrens' sketch maps may appear to be full of idiosyncrasies and individualistic expressions of the space represented, they allow us to gain a deeper understanding of how children adapt to the challenges of temporal displacement. By observing how geographical features encountered in the world are represented in mental maps as well as how social and emotional context is imprinted on such representations, we gain valuable insights into the ways in which children engage in place discovery through the active observation and exploration of the new environment. Activities such as place-based citizen science enhance spatial route and landmark knowledge, but also provide space for deep interaction with the environment through the multimodal sensing, leading to experiential, embodied knowledge of places. Enriching the youths' image of the city with emotional ties and meanings contributes to place attachment, which is known to have an impact on the well-being of displaced residents. Importantly, such projects contribute to inclusive citizen science and may provide insights that can inform child-friendly urban planning grounded in cultural plurality.

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Author Contributions

E Egorova acquired funding for the 'Water Rangers Twente' project and contributed the main idea of this study. CJ Bae contributed the details about the method. E Egorova performed the data collection. E Egorova and CJ Bae contributed to the data analysis and writing.

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Place Representation as a Prerequisite to Place Communication

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Places can hardly be formally represented in such way that their qualities can be experienced from the representation itself. Places are therefore currently largely inaccessible to formal methods, which is one of the reasons why Platial Information Theories and Platial Information Systems do not yet exist. This paper discusses the possibilities that a shift to a communication perspective offers in terms of a better understanding of platial information. In particular, it argues for the need to create a corpus of place representations to study them empirically. Such a corpus can be expected to facilitate a deeper understanding of the mechanisms that are effective when representing places as well as how place representations can be transformed into other place representations.

Keywords: place; representation; communication; information; pragmatism; corpus

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1 Introduction

There are different types of representation being used for different purposes. Among them are representations that only provide a mere reference, such as place names in the case of places, as well as representations that communicate a sufficient number of aspects of the represented object such that the recipient can develop a more complex idea of it without having access to it him or herself. In the latter case, the object represented, such as a place, is *mediated* (Mocnik, 2023a), as is the case, for instance, with the detailed description of his home in Ulysses by James Joyce (Joyce, 2000), to which the main character, Leopold Bloom, regularly returns and experiences everyday moments of his life. This representation can only be fully understood by humans (as opposed to machines) because only they understand the content of the description and can place it in the context of their own experience. The description of the home in Ulysses is thus a mediating representation in the context of human interpretation. Formal methods, on the other hand, only have access to the words, the sentence structure, and alike, thus only make referencing possible. The bigger picture enriched by and referring to personal experience is, however, omitted.

Geometries can be represented formally, e.g., as points, lines, or polygons (cf., Simple Features; International Organization for Standardization, 2004). Such a representation mediates qualities of the geometry in the sense that a Geographical Information System (GIS) can easily reason with it. Since geometries, potentially enriched with thematic information, can be represented formally without difficulty, it is possible to utilize such representations (or the result of considerations that include them) for enabling communication. For example, we survey footprints of houses and streets as well as city and country boundaries to then import them into a GIS and map them for communication purposes, potentially together with derived information. The use of a such mediating representations seems useful for communication purposes whenever they appear straightforward and effortless in spite of their richness.

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Representations of places, contrary to those of geometries, cannot be mediating in the context of computational interpretations, or only to a very limited extent. In fact, many qualities of places seem to elude formal representation, such as the sense of place (Kyle and Chick, 2007; Tuan, 1977, 1979), the experience of a place (Malpas, 1999), and resulting place attachment (Agnew and Duncan, 1989; Low and Altman, 1992; Tuan, 1977). Even the place ballet is sometimes perceived differently for an existing place than what a representation of the trajectories might convey, such as in terms of the different ways in which paths are travelled and what meaning they have (Seamon, 1979; Seamon and Nordin, 1980). Accordingly, the question arises of how information about places can be systematically investigated and understood with a focus on the qualities of a place. To this end, we will discuss why places are difficult to mediate through formal representations (Section 2) and what alternative possibilities a focus shift towards the communication about places offers (Section 3). Subsequently, references to and representations of places are discussed as building blocks of such communication (Section 4). Finally, the creation of a corpus of place representations is proposed and corresponding challenges and prospects outlined (Section 5).

2 Mediating Places Through Formal Representation

It seems obvious to think of information about places as a direct reflection of platial qualities. If we could formally describe and quantify these qualities, such as the sense of place and the identity of a place, then we could describe the expression of a place through corresponding data. Similar to how a physical system can be described by suitable measurements[1], a place would then be sufficiently well described by these data. The interpretation of the data would in this case yield detailed information about the place and at least partially replace personal experience.

Possible ways of approaching information about places in this way must inevitably face the question of how a corresponding concept of place looks like and how it can be formally construed. For example, vocabularies developed by political instances (e.g., UK Parliament, 2023), approaches related to location-based services (e.g., Antunes et al., 2008), and many further approaches to ontologies of place have been discussed (cf., Ballatore, 2016). A comprehensive answer to the question would be tantamount to formalizing one and potentially even unifying several concepts of place. However, this seems inadequate from the geographical viewpoint, both due to the high complexity inherent in these concepts, which has so far made formalization impossible even within the discipline of geography, and due to partial incommensurabilities (Mocnik, 2022).

Previous statements could be misunderstood in that information about places could not exist. In fact, what is being questioned is merely whether formal perspectives can effectively provide a holistic view and mediation of places. The temperature distribution in a place, where shadows are located, and how many people regularly interact in and with the place can be measured. Corresponding data can be created and kept available, and their interpretation provides some impression of individual properties of the place. However, in most cases, what constitutes the place cannot be captured in this way. In particular, embodied experience cannot be measured and expressed through data, thus rendering a holistic view almost impossible. Formal methods for generating information about places, such as computer-based methods, can therefore only be used to a very limited extent for the mediation of places[2]. Examples of corresponding shortcomings have been discussed, for instance, by Mocnik (2022).

3 Communication Perspective: Transforming Place Descriptions

If we cannot understand how to mediate places by formal methods to the degree necessary for many applications, we may resort to the *communication* about places. In this case, the question of how we communicate a place substitutes the question of what information about it looks like. What seems to be only a small difference – after all, we can understand communication as the transmission of information – leads to a clearly different perspective. This perspective is not characterized by the complete and holistic representation of places by means of data but by the *pragmatic* consideration of generating the desired image of the place in the recipient's mind. What is communicated is solely subordinate to the success of the image conveyed.

There exist numerous and diverse examples of such communication (Mocnik, 2023b). We can link information conveyed through language, images, music, models, and many other forms of representation with our previous personal experience. In this way, successfully communicated images of a place emerge. Even if it still seems unclear how exactly this process is shaped in the context of place, many examples of such communication seem to be effective (Mocnik, 2023b). In many cases, we can infer what constitutes a place from individual facets, mundane habits, and narratives about the place. The idea of portraying a place through the most complete possible description by measurable variables and mediating it in this way is replaced by the success of communication.

The perspective of communication about places builds on the transformation of place representations. The perspective of formal representation to mediate places assumes that we can generate information about places by both examining existing places and planning non-existing or not-yet-existing places. In both cases, we have an influence on which platial qualities we mediate. It is the decision of the person generating the information how to mediate. The communication perspective promoted here, in contrast, considers *what* information *is actually communicated* about places in *existing* examples of communication. The researcher's conscious decision about how to represent by formal methods gives way to the idea of using existing communication, often with unconscious choices, as a blueprint. Accordingly, the communication perspective must focus on how platial information experiences different interpretations between the context of the sender and the context of the receiver in examples of existing communication. An influence of these contexts seems incomprehensible and a transformation of the place description the rule, at least as long as personal experiences and sensations play a role.

The transformation of place descriptions is not only an often undesirable side effect of communication, but it can also be seen as one or even the only possibility to influence communication about places. The information sent could thereby be altered according to suitable formal rules such that it can be interpreted in a meaningful way again. Similar to a search engine, which summarizes web pages in suitable ways and then displays them, and a GIS, which creates an analysis based on existing data and communicates the results with the help of a map, information about places can be altered through transformations in such ways that this change in communication constitutes an added value with respect to some application. For example, high heterogeneity of place descriptions can be an issue when writing a travel guide. If the descriptions are modified such that they represent the places as touristic and such that they are of the 'representation-as a touristic destination' genre (Mocnik, 2023b), then they may be better understood and more useful for the travel guide. Also, by means of suitable transformations, the descriptions could be altered to be better understandable for those who have not yet visited and experienced the place themselves. The focus here, however, is not on the descriptions but on the transformations, which have their origins, similar to communication, in pragmatics.

The question of how a place develops under the influence of climate change is another example of a situation in which transformations play a role. We can describe both the current place and also the still fictitious, future place as it is affected by climate change. However, the latter cannot be experienced in the real world; we can only resort to an estimate extrapolated from our current and past experience. If formal methods of reasoning are to support the understanding of such a future place as well as corresponding possibilities for development, then the (automated) transformation of the current place description appears to be an obvious possibility. The description of the current place would then be transformed into a description of the possible future place. Even if embodied experience, among others, remains hidden from formal methods, the latter can alter its description in such a way that the receiver can well imagine how the place will change under the influence of climate change. It is beneficial here that the receiver can in the ideal case, but in any case if the sender and receiver are identical, refer back to his or her embodied experience. In order to better understand such transformations on the levels of places and of information and to be able to practically name their benefits, it seems indispensable to study many examples of places and their successful representation beforehand.

4 Understanding Reference to and Representation of Places

The communication perspective focusses on what is practically communicated in order to convey places. It is not the representation constructed in the academic context that plays a role here, but the observable mode of communication. The signs used in the communication process can be understood

as representations of places and their qualities too, for instance when the atmosphere of a place is described. In contrast to representations constructed by formal means, however, human communication is potentially based on different premises, employs different forms of representation, and communicates different selections of aspects. Representations and their various forms are thus, in a sense, the building blocks of communication.

Contrary to the idea of formally representing places and their qualities, the context of the sender and receiver plays a decisive role in communication, such as when previous experiences and other previously visited places are taken into account in the interpretation of the communicated signs. However, there has been little research into what exactly this interplay of places, signs, and contexts looks like. A better understanding would presume the empirical analysis of successful communication in order to better understand the mechanisms behind its effect. This particular importance of empirical approaches particularly derives from the fact that the mechanisms to represent are often more complex than the mere referencing of a place, where the communicated sign is assigned a meaning by denotation[3] and for that reason alone becomes a representation.

An example of a more complex representation is the mode of *representation-as*, which combines several more basic modes. In case of representation-as, the representamen denotes some place P while also representing some other 'intermediate' place Q, some of the qualities of which are exemplified by this representation and subsequently imputed onto the very place P (Mocnik, 2023b). These qualities define what the place P is represented as. As an example, a model of the Tower Bridge sold as a souvenir represents London as a touristic destination, because it denotes London and because it represents the place of the Tower Bridge by exemplifying its quality of being touristic through the use of vibrant colours, cheap production quality, and the fact that it is sold in tourist shops. These qualities of the place of the Tower Bridge are then imputed onto London, which is, in consequence, mediated as a touristic place.

5 Discussion and Conclusions

In order to advance the analysis of place representations in accordance with the communication perspective, it is necessary to empirically examine a number of examples. This raises the need to establish a corresponding *reference corpus*[4] that contains semantically prepared examples of place representations. The corpus would be helpful in several respects: (a) the contained representations would be able to serve as reusable examples; (b) the open and permanent accessibility makes possible to reference these representations; and (c) it makes possible the analysis of the structure of the included representations and the identification of commonalities among these. Ideally, the corpus and the communication captured in it can provide indications of how place representations are typically created and transformed in a given context. In this way, the corpus has already (as part of an ongoing research effort to create such a corpus) and will continue to enable and stimulate disciplinary and interdisciplinary research, as it facilitates the intellectual exchange about place representations and their common (and differing) modes of action.

Creating a corpus of place representations is complex and time consuming. In order to include the corresponding representations in the corpus, they must first be represented themselves. This requires the development of a suitable framework, including appropriate concepts and definitions as well as vocabularies and methods that reflect these concepts. Subsequently, a meaningful selection of place representations must be made to then represent and included these in the corpus. The intensive analysis that takes place in this process of creating the corpus can already be expected to offer numerous opportunities for significantly improving our understanding of place representations.

The opportunities offered by such a corpus are accompanied by a number of challenges and risks. First of all, the corpus is limited by the fact that only representations of place representations can be included. Access to the place representations is therefore only possible indirectly, which makes some ways of analysis more difficult or even impossible. Beyond this, the diversity of place representations poses further challenges. For example, there is a risk that personal and more intimate place representations are underrepresented because they are less accessible. Also other biases in the representation seem unavoidable while having an impact on the subsequent analysis. In any case, knowledge from a variety of domains is required due to the diversity of existing place representations, but this would also contribute to the strength of the corpus.

Notes

1. This is of course not fully possible in all cases, among others due to Heisenberg's uncertainty principle.
2. This problem applies not only to places, but also to many other things, many of the qualities of which cannot be experienced from simple and formal representations either. Places and corresponding information can, however, in some ways be seen as prototypical for this problem due to their inherent richness and complexity.
3. Denotation is one of the two primary modes to establish reference according to Elgin (e.g., 1983, 2009, 2010) and Goodman (e.g., 1984). An overview can be found in an article by Frigg and Nguyen (2017).
4. The author currently implements such a corpus.

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Exploring the Duality of Space and Place through Formal Geo-Concepts

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Places are initially perceived through the senses, and the fidelity between these senses and their mental representations is imperfect. At the same time, it is impossible to know what platial memories a place name may evoke in the recipient. In contrast, spaces can be reasoned about, but encompass endless continua that cannot be fully comprehended. In this paper, we explore the thesis that the interplay between spaces and place representations parallels the duality between extent, the things a class ranges over, and intent, the range of descriptive qualities of a class. We discuss how a duality may manifest between spaces and representations of senses of places. In doing so, we use definitions from the mathematical basis of Formal Concept Analysis and we introduce the notion of a geo-concept, which is a matching of a space and a place representation. We conclude with a short outlook on implications and directions for future work.

Keywords: place description; spatial information; duality; geographical information; Formal Concept Analysis; geo-concept

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1 Introduction

The recent availability of rich data about places has reinvigorated interest in a problem troubling many geo-information (GI) scientists: what is a place? The problem is particularly prominent because geodata contributed through social media and other sources are predominantly *platial*, while GI-systems are designed to work primarily with spatial data. Translation between platial and spatial data is, to the very least, non-trivial: many places, such as the best spot on the beach or the territory of a nation, have inherently fuzzy and subjective geometric qualities, and for many spaces it is impossible to describe in full the places over which they extend.

The lack of success in integrating place into existing GI-systems – which, due to their dominant focus on spatiality, may as well be called spatial information (SI) systems – has motivated some scholars to pursue a whole new branch of GI, namely that of platial information (PI) systems (Goodchild, 2011; Mocnik, 2022; Purves et al., 2019). The idea is that instead of requiring that place be confined to space, places are first and foremost understood through qualitative representations, such as place names and place descriptions. However, this merely swaps the roles of the initial problem's two participants. How should spaces then be represented in a PI-system? There is a need for an information system that consolidates both the platial and the spatial aspects of geo-information, without one among place and space being subordinate to the other. In order to achieve this, the essence of the relation between representations of place and space must first be understood.

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There seems to be an intrinsic trade-off between place and space. Whenever a place description, which we interpret as being the set, sum, or concatenation of platial qualities, becomes more precise, there are fewer spaces that meet the description and, whenever a space is expanded, there are fewer place descriptions that can truthfully label it. In this essay, we consider the thesis of an order-reversing duality between place representations and spaces. More precisely, we explore whether and how the relation between place representations and spaces corresponds with the duality between formal notions of extent and intent, where extent is that which a class – a collection of things with some aspect or rule of sameness – ranges over, and intent is that which a class is characterized by. This place–space correspondence can be exploited to develop a sophisticated form of GI-systems, composed of concurrently-operable SI and PI systems.

We first expand upon our view of extents and intents, which we base on how they are understood in the theory of formal concept analysis (FCA; Wille, 1992). We do so because FCA offers a precise interpretation of what extents and intents are and an explicit formalization of the relation between them. We then outline our preliminary view on the things that are presented to subjects as place and space and we consider the interplay between extent and intent in conjunction with representations of places and spaces. We end by reflecting on practical implications of our arguments.

During these exercises, we touch on existing literature and philosophical ideas, but we leave a thorough review of the literature, a formalization of our proposed theory, and scrutiny of the latter using the former for future work. Also, we provide examples for many of our statements, but we do not make use of one overarching example. We found that, because of the topic's high level of abstraction, a single comprehensive example could easily be misinterpreted and lead to confusion. Therefore, we opted for multiple smaller examples, which allow to approach the subject matter from multiple viewpoints and thereby a triangulation of the relation between place representations and spaces. Finally, we do not mean to make any definitive claims about places themselves. We are interested in the relations between their representations and spaces, not in their sources. We acknowledge that place and sense of place may not be the same thing, but when we speak of a representation of place, we generally mean a symbol by which a sense of place is represented in communication. The reader may notice that we generally do not mention representations of spaces. This is because we feel that we do not need to represent space in order to specify a duality between notions of space and place. Rather, we claim there is a duality between spaces themselves and qualitative descriptions of places.

2 Conceptualizing Space and Place

The notions of extent and intent are well-established in logic as what a term designates and what it means, respectively. A quintessential example is how the terms *morning star* and *evening star* both designate Venus, even though the terms have different meanings. Extent and intent are generally used as metalogical terms to describe aspects of logic. For instance, extensional and intensional definition are two opposing approaches to imbuing meaning into terms that work by means of, respectively, a list of examples and a list of necessary and sufficient conditions.

In FCA, extents and intents are formalized as the two constituents of concepts. FCA was introduced by Wille (1992) as a structural framework for developing conceptual hierarchies. Through the specification of ordered pairs called *incidences*, a *context* emerges. This context is formalized as a structure (G, M, I), where the incidence relation I is a subset of $G \times M$. Elements in G are referred to as *objects* and elements in M as *attributes*. It should therefore be noted that these terms have specific meaning in relation to FCA. We only intend to refer to notions of FCA if it is clear from context like in this subsection or if we signify them by adding the prefix 'FCA'. For example, an 'object' is not necessarily a 'FCA-object', unless we specify otherwise. Extents are subsets $A \subseteq G$ and intents are subsets $B \subseteq M$. The use of the so-called *derivation* operators $\uparrow$ and $\downarrow$ makes possible to derive extents from intents, and vice versa:

$$A\uparrow = \{m \in M \mid \forall g \in A\colon gIm\} \qquad \text{(extent to intent)}$$

$$B\downarrow = \{g \in G \mid \forall m \in B\colon gIm\} \qquad \text{(intent to extent)}$$

Together, $\uparrow$ and $\downarrow$ form a Galois connection, i.e., $x\uparrow \leq y$ if and only if $x \leq y\downarrow$, where $\leq$ denotes a partial ordering relation. Therefore, it is postulated that if an extent and an intent derive each other, they

form a *concept*. Furthermore, an order is formed through subset relations. If one concept's extent is a subset of another concept's extent and if one concept's intent is a superset of another concept's intent, the former concept may be called a sub-concept of the latter concept, which then is also a super-concept of the former. This sub-concept relation forms a lattice, and more specifically a concept lattice. A key property of a lattice is duality between its two operators $\wedge$ and $\vee$. Formally, this means that the two partial orders are dually-isomorphic. Informally, it means that the structure can be flipped and flipped back, i.e., the order relation can be reversed without loss of information (for more on lattice theory and FCA, see Davey and Priestley, 2002).

FCA is a contextualist framework, meaning it is operated on the supposition that any and all knowledge is context-dependent. Depending on which aspects are taken into account, concepts come into and go out of being. It is also structure-oriented in that symbolic meaning is ignored and conceptual differences are explained in terms of relational discrepancies. Finally, the framework does not allow negation of the incidence relation, which means there can be truth and lack of truth, but no falsehood. FCA is used in a variety of fields, such as ontology engineering, data mining, and chemistry (Poelmans et al., 2013a). Also, multiple extensions have been introduced, such as fuzzy FCA, relational FCA, and pattern structures (PS; Poelmans et al., 2013b). Furthermore, a variety of lattice generation algorithms have been developed, predominantly versions of the InClose and Close-by-One algorithms (Konecny and Krajča, 2021).

In the following subsections, we first draw a parallel between extents and representations of places. Specifically, we argue that representations of place are generalized, which means platial reasoning is comparable to the derivation of intents from extents. We then equate intents to spaces. We argue that spatial partitioning is similar to the derivation of extents from intents. Finally, we consider the correspondence between place representations and spaces, observing that a more precise description of places is accompanied by a reduced list of instances that have these qualities and that, as the list of instances grows, the list of descriptions that apply to all of them shrinks.

2.1 Place and Its Representations

In this subsection we make the case that there is a resemblance between representations of places and extents. According to a popular school of thought, places appear through the senses (Tuan, 1979). Beyond spatial awareness, the overall sense of place connects to some of a place's affordances and restrictions (Jordan et al., 1998), i.e., the ways in which the subject believes they may or may not interact with a place, and some of its memory cues, those things that cause memories of past experiences to resurface. This is at least in part why sense of place is subjective; it manifests in perception dependent on the subject's potential agency and experiential history.

It should be noted that memories of places may also trigger sensation (Tuan, 1979). After all, the memory of a place may bring along past feelings or evoke entirely new ones, like how a tranquil forest in the mind's eye may calm the stressed office worker or how the adult may feel bittersweet melancholy when reminiscing about their childhood home. Evidently, humans have mental faculties that may induce experiential imagination. Even though an imaginative place may be distinguishable from an embodied, real place, the notion of sense of place extends over both the real and the imaginative.

The senses are understood through feelings, but feelings are intangible and ineffable; it is impossible to hold onto them at will or capture their full meaning in the web of language. At most, one may train themselves to respond to their appearance and use labels to signify them. If a mixture of feelings is closest to archetypal happiness, it may be called 'happiness', even if by doing so a slight sense of, e.g., regret slips out of scope. Because of this, where a sense of place only partly represents the place itself, the qualities by which this sense could be described only partly represent this sense of place. In actuality, to say a place is beautiful is to express that a subjective sense of the place has the qualities of a subjective 'beautiful'. Thus, after the initial labeling of the sense of place, there is a trade-off between the fidelity in communication about place between subjects, and the accuracy in the qualification of a sense of place within a subject; general statements more easily find agreement between subjects and specific statements represent more precisely the subject's particular sense of place. Two subjects may agree that a place is beautiful, even when the first is inspired by the lush greenery and the other is moved by the rustic architecture.

In the relation between representations of senses of places and their descriptions, the former act as extents of the latter and the latter as intents of the former. Given a representation of a place, there

is a list of qualities which describe it, and given a single quality, there is a list of representations of places that possess it. We can thus see that qualification of representations of senses of places can be understood as a kind of derivation from extents to intents.

2.2 Space

In this subsection we make the case that there is a resemblance between spaces and intents. Across disciplines, spaces are understood as continua. While in physical reality the continuum is generally assumed to spread across three dimensions, abstract spaces may have fewer (e.g., a two-dimensional cartographic map), more (e.g., in four-dimensional space-time or quantum mechanical state space), or none at all (e.g., function spaces and topological spaces). Regardless of their dimensionality and other axiomatic and theoretic properties, all these models have in common that they appear through relation between objects. Vector space permits notions of magnitude and orientation only with respect to an origin, and metric space centres around the distances between its points. In short, spaces are models formed through relation.

Representations of phenomena can be framed through the emergence of spaces. A cartographic map can be produced not because its underlying model appears at an instant to the mind's eye, but because multiple partial representations can be related to one another one-by-one to construct a greater whole. To say some place x is south of another place y is to express that when starting at y and moving directly away from the North Pole one may reach x. These relational systems may start off simple but can be expanded in principled manners to give rise to more sophisticated reference systems that may even enable quantification. This is, e.g., how metric space gains meaning: due to the combination of how some initial configuration is organized and how a set of axiomatic constraints expand this configuration, a function from all pairs of objects to a set of distances can be defined. Dimensions can also be understood in such terms, since they are generalizations of orders between spatial objects. For instance, the altitude dimension generalizes over the order of things by proximity to the Earth's surface. Axiomatic rules can be applied to expand models of empirical observations. For example, we can apply transitive induction to determine that if x is above y and y is above z, then x should be above z. According to some, places are mereological (Gilmore, 2018). Generally, this means they have a supplemented part-whole relation, which may, e.g., mean that if two spatial regions are disjointed, then they must be parts of a larger region.

So far we have considered the theoretical aspect of spaces, but the emergence of these models may be closely tied to phenomenal reality. For example, one may find that, when interacting with their surroundings, there are two glasses on a table, which may each hold up to 250ml of liquid and each seems half-filled with wine. From this it could be deduced that there must be approximately 250ml of wine on top of the table; a cognitive model of the table's space with an object of 250ml of wine is formed. However, perhaps a third half-filled glass on the table was obscured from view, or after a taste test, one of the glasses turned out to actually contain grape juice. From this, the observer may conclude that the methods they used to rationalize their senses were invalid. They may then adjust their model accordingly, and test again. By doing so, the observer can determine whether their spatial model extends over the specific things they wish to reason about (cf., Scheider and Richter, 2023).

In the relation between spaces and the objects that inhabit them, the first can be intent-to-extent derived from the second, and the second can be extent-to-intent derived from the first. A single space can be partitioned in possibly infinite ways. Conversely, a single object could be incorporated into multiple spatial models. We can thus see that partition of spaces can be understood as a kind of derivation from intents to extents.

2.3 Geo-Concepts

In Section 2.1 we argued that qualifications of places are derivations of intents from extents, and in Section 2.2 we suggested that partitions of spaces are derivations of extents from intents. Of course, the direction of derivation could just be a consequence of whether one were to partition or qualify; we would certainly argue for this to be the case. However, more importantly, it seems that reasoning about places necessitates qualification and the specification of space necessitates partition. This becomes salient when we try to do the opposite: partition of place representations and qualification of space.

Upon partitioning a place description one will find that the parts of a description are less informative than the whole, and therefore apply to more things. The parts of a 'comfortable and affordable' place are 'comfortable' and 'affordable'. However, not all comfortable places are affordable and not all affordable places are comfortable, meaning the set of both comfortable and affordable places is a subset of those that are at least one of the two. In other words, the partitioning of the description would relate to more place instances, not less. We may also consider the place representation itself. Sense of place is instantaneous; each sense of place occurs at an instant. This means the representation of place is discrete because the instance cannot be further specified. It can be argued that instances may share parthood relations, but it is impossible to disentangle these relations at an instant, and even then it may not be enough, since it can be argued that the whole is more than the sum of its parts.

In contrast, spaces are constructed models and their provenances are – or at least can be – theoretically explicit. In other words, we can identify the relations that configure them. However, to qualify them is to ignore their inner structure and view them from a metastructural level. For instance, if a topological space was described as having a distance function, then it would be specified to a metric space. However, a richer description of a space does not change the space's inner structure. If a space is qualified as 'transparent', then everything in it could also be qualified as 'transparent'; after all, if the space would contain opaque things, it would no longer be a transparent whole. This means transparency is not an effective way of discriminating some parts of space from other parts. A qualification of space may put it in contrast to things outside of that space. If an object outside of the transparent space is opaque, we may use opacity to distinguish the space and its parts from the external object. However, this is in general not the purpose of spatial reasoning, which is applied for understanding relations within space, not between spaces.

According to the philosophy of FCA, a pair of an extent and intent may together compose a formal structure called a concept. If we let a place representation be an extent and a space be an intent and – within a given context – the space derives the place representation and the place representation derives the space, we have a concept that is both platial and spatial. For the rest of the discussion, we shall call such concepts *geo-concepts*. If we have a context from which multiple geo-concepts can be generated, we may find that these are partially ordered: some geo-concepts are sub-concepts of other geo-concepts. For example, in some contexts the geo-concept of the province of Utrecht could be considered a sub-concept of the geo-concept of the Netherlands.

However, we find that geo-concepts can come in two forms, namely ones that are either more spatial and less platial, or more platial and less spatial. We shall call these respectively *spatial geo-concepts* and *platial geo-concepts*. A spatial geo-concept is one that has a minimal place representation and a maximal space. This means all qualities to specify the geo-concept's place also apply to all mereological parts of that place. For example, any mereological part of a spatial geo-concept with the FCA-attribute 'prohibited' is also prohibited. We can thus say that not just the overall place but the entire space is prohibited. Conversely, a platial geo-concept is one with a maximal place representation and a minimal space. For instance, if a geo-concept of Paris has the Eiffel tower and Champs-Élysées as qualities, then it excludes all parts of Paris that do not contain these two landmarks. If one were to list all features of Paris, then they would find that only one object in space contains all these features, namely the place of Paris itself. Note, however, that a spatial geo-concept of Paris can also be defined – even in the same context – meaning that Paris can be conceptualized from both spatial and platial points of view.

A duality exists between partitions of space and descriptions of place. If a place description x and a space y form one geo-concept and a place description a and a space b form another, then the description of x yields a if and only if the partition of b yields y. If we let description and partition be represented by respectively the derivation operators $\uparrow$ and $\downarrow$, then we rediscover the Galois connection, i.e., $x\uparrow = a$ if and only if $y = b\downarrow$. In short, we find a co-dependence between place representations and spaces in concept lattices. In a lattice of geo-concepts, for every place there is a space, and for every space there is a place. These spaces and places can be observed or just assumed to exist. In our earlier example of a platial geo-concept of Paris, the perfectly-accurate description of Paris is practically impossible to formulate, so in practice, upon observing a spatial extent of Paris, the existence of a fitting place description is assumed rather than specified. Also, if a place representation of Paris is provided, assuming a fuzzy geometry may often already be enough for effective communication.

Because of the apparent importance of correspondence between space and place description for the formation of geo-concepts, it is worthwhile to consider under what conditions this correspondence may become manifest. In other words, when does a place representation derive a space that in return

again derives the place representation? Or, when does a space derive a place description that in turn derives the initial space? These questions touch upon deep philosophical discussions and relate to dichotomies such as phenomenal versus noumenal, becoming versus being, induction versus deduction, and existence versus essence. However, we limit ourselves to a postulate that if the empirical place and the theoretical space are in agreement, then they amount to a geo-concept. We leave a philosophical grounding of the manifestation of geo-concepts out of scope.

3 Discussion and Conclusion

Geo-analysis requires both options of viewing the data as representations of places and as spaces. In some cases, data should be viewed platially (e.g., to count the number of administrative regions in a country) and sometimes spatially (e.g., to measure the size of each administrative region in a country), but their consolidation has proven difficult. Starting with FCA as a useful framework, where extents and intents form concepts, we have found that place representations and spaces can be combined in geo-concepts. These geo-concepts form a lattice, in which it becomes apparent that the description of place representations and the partition of spaces share a duality, meaning space and place representations are connected in a meaningful way.

The geo-concept seems to draw a bridge between two seemingly opposing views. On one side there are platial traditions, whose adherents are interested in the subjective experience of place, and on the other there are spatial traditions, which are more focussed on the configuration of terrestrial things. Bridging between these two paradigms has seemed – and still seems – like a near impossible task and the emergence of PI-systems that oppose SI-systems is evidence that the paradigms remain disjointed. However, the two views may be harmonized in geo-concepts. The challenge is not to determine whether spatial or platial views prevail for certain research problems, but rather how they should be combined to convert the empirical and the theoretical into conceptual knowledge. PI and SI-systems can be designed such that they work in concurrence, meaning that connections are made between place representations in PI and spaces in SI such that operation on one system informs what changes should be made in another. This could take shape as SI-systems being akin to contemporary GI-systems and PI-systems to classification structures. A result could be that a spatial intersection of two regions implies the assignment of attributes of the places associated to both regions to the intersection value. In other words, it would be possible to automatically derive place classes during spatial operations. Related to this, geometries may not be necessary to represent places. Rather, places could be related to spaces, from which geometric properties can be derived. These properties can be considered as qualities of places, although not essential to them.

After we simplified our notions of the concepts to this level, we realized that the polarity between space and place greatly resembles a dichotomy that has permeated GI-science for decades, namely that of objects versus fields, where objects are discrete spatial entities that may be counted and fields are spatially-continuous functions (Couclelis, 1992). Although the correspondences between sense of place representations and GI-objects, and between spaces and GI-fields is its entire own discussion to be had, there indubitably are commonalities. For example, both objects and places are discrete, while both fields and spaces are continuous. It is possible that our FCA-based approach to understanding space and place may also be applied to understand how objects and fields relate.

This work is still preliminary. We may have oversimplified the notions of space and place, and consequently overgeneralized some of our observations. For example, we mention mereological partitions, but it is not true that all spaces are endowed with a mereology, and we do not consider if and how mereology and FCA correspond. Our goal is not to be meticulous in our formalization, but to share an idea that there may exist a clear mathematical structure for the relation between space and place.

Future work may focus on the philosophical grounding of our interpretations of space and place and on a more rigorous formalization of the concepts. In particular, questions remain about the precedence of space and place (which one comes first?) and the definition of space (what kind of spaces are relatable to places?). Another direction is to provide a proof-of-concept. As of yet, the ideas are only hypothesized, but not implemented in FCA. Finally, it may be interesting to study human cognition to find whether a notion of geo-concepts is used in human reasoning.

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Author Contributions

EJ Top conceived of the main idea and wrote the text. D Romm and G McKenzie provided critical feedback and suggested improvements to the text's structure and contents.

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Scenario Planning and Participatory GIS for Place Research on Rural Transformation

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Several transformations are taking place in rural areas, emphasizing the significance of comprehending the people's perceptions of place. This paper outlines a methodical strategy that integrates participatory GIS and scenario planning workshops to investigate transformations and potential impacts in rural areas. The methodology comprises an open-ended, inductive knowledge process utilized in two workshops. Workshop 1 involves the development and aggregation of driving factors into potential scenarios, whereas Workshop 2 includes the mapping and weighting of scenarios based on the probability of occurrence and strength of impact on the rural area. Although the outcomes are rooted in a relational comprehension of human–environmental factors, a theoretical framework of location-based information is required for further research to entirely understand the mechanisms supporting the emergence of transformative rural areas.

Keywords: scenario analysis; participatory GIS; place; actor and group perception; workshops

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1 Introduction

Crises, such as global warming, can destroy livelihoods, displace people, exacerbate conflicts, and even trigger wars. In the Western world, our growth-driven society is exacerbating socioeconomic crises, such as unemployment and rural exodus, and demographic changes, such as declining birth rates and aging population (Fina et al., 2019; Schröder and Feldhaus, 2010). In addition, some rural areas are undergoing overlapping changes that challenge sustainable spatial planning. To identify these changes, it is critical to understand how people perceive their environment and spatially differentiate their actions (Wardenga, 2002).

The use of scenario analysis is a common and flexible method for predicting possible future developments. Several studies used scenario analysis for strategic spatial planning in business landscapes, natural resources management, agricultural land use, and hazard mitigation (Couture et al., 2021; Pasqualino et al., 2021; Raji et al., 2022). While there are various potential uses for scenario analysis, the integration of people and their environments through the use of geoinformatics is relatively rare. Approaches include the ones presented by Schaffert (2011, 2015) and Haslauer et al. (2012), which incorporate local participation. However, scenario analysis still works with limited space concepts and emphasizes structural factors, while personal experience and perceptions from different stakeholder groups remain a secondary factor. To fully understand a place, it is necessary to comprehend its meaning, which is to some extent embedded in daily personal experiences. Structural factors are related to these experiences, which influence the meaning of place as a perceived phenomenon.

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In this paper, an adapted workflow for scenario analysis is presented, which uses an open inductive and participatory approach. The combination of individual, group-level, and structural patterns not only enables us to make contributions to transformative places regarding spatial development, but also to comprehend these spaces with regards to their future potential impacts.

2 Methodological Approach

To analyse future transformations in rural places, we propose a systematic approach that combines participatory GIS and scenario analysis. Scenario analysis is a predominantly qualitative set of methods for the structured and systematic generation of conceivable future situations known as scenarios. In this regard, we expand the techniques that integrate scenario workshops with GIS (Schaffert, 2015) to include participatory mapping. To incorporate the human–environment concept, we use two workshops (each of two hours' duration) that include a multi-step process consisting of a preparation phase, a workshop phase, and a synthesis phase. The process begins with the problem identification and visualization, which includes defining indicators and conducting GIS analysis of future population changes. Next, stakeholders are selected, and on-site workshops are scheduled with institutional stakeholders. The initial knowledge is adapted and condensed into multiple scenarios in an open inductive approach. The goal of the subsequent scenario workshop is to map and weight the main scenarios based on expert and citizen knowledge in an anonymous approach by using an online mapping tool (Figure 1).

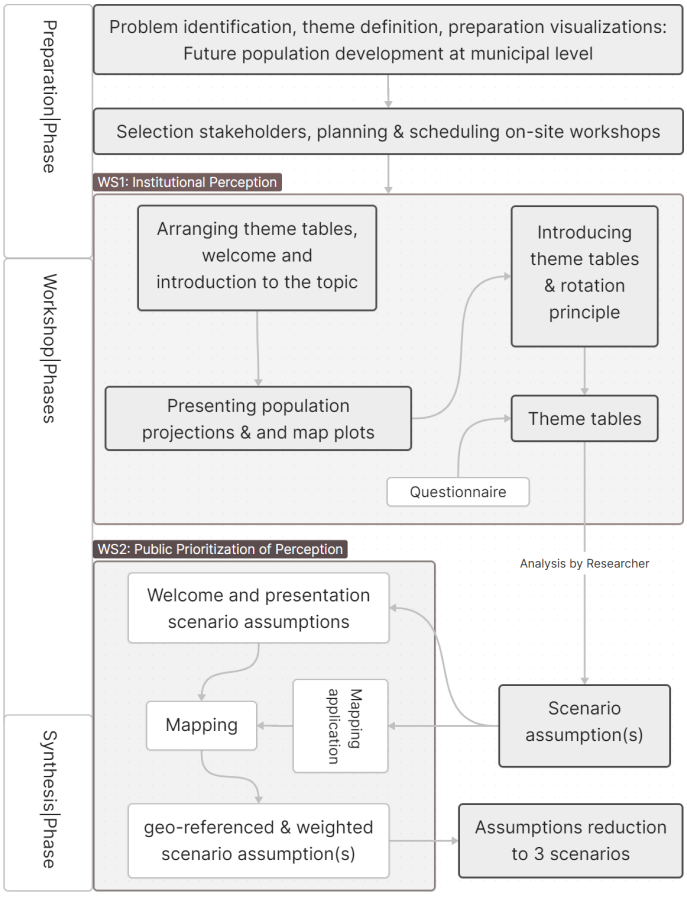
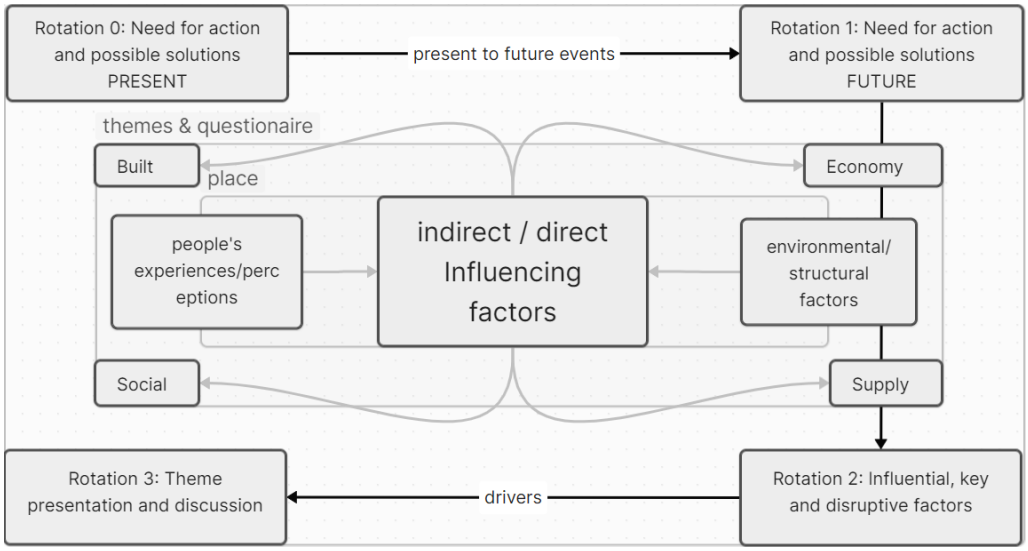
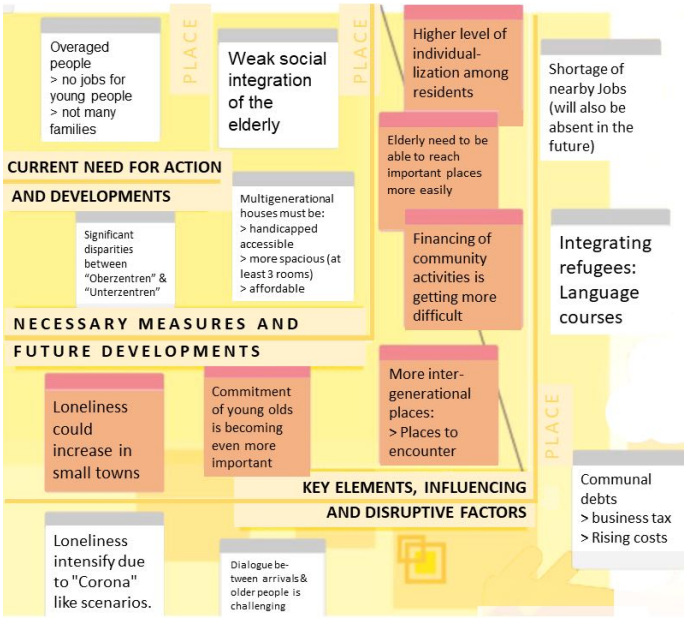


Figure 1: Implementation concept of the presented approach with three successive phases. The preparation phase includes the creation of visualizations and the selection of stakeholders. Then, in the first workshop, participants discuss at topic tables (see Figure 2 for details) to identify current and future scenario drivers. Between workshops, the results are condensed into scenarios, which are presented in the second workshop, where the citizens can map, rank and weight the scenarios (see Figure 3 for details).



(a)



(b)

Figure 2: Theme tables and 10 minutes rotation principle and whiteboard. (a) Participants spread out and rotate to a different table every 10 minutes. In Rotation 0 (R0) they discuss current needs for action and developments, in R1 they discuss necessary measures and future developments and in R2 they discuss relevant influencing factors, key elements, disruptive factors, and possible solutions in relation to their respective topics. (b) An assistant conducts interviews to capture spatial perceptions and records them on a whiteboard as shown in the example for social themes.

2.1 Preparation Phase

The preparation phase involves selecting and assigning stakeholders to expert groups, creating future population development maps, and organizing the workshop. The selection of stakeholders is crucial for understanding the relationship between humans and the environment, as they play a distinctive role as social actors. The socio-spatial interpretation patterns of the stakeholders and their perceptions are influenced by their social position, which is shaped by norms, rules, and resources. To combine different points of view in the synthesis phase while taking into account situational overview, asymmetric knowledge, and social position, it is important to involve different social actors as stakeholder groups in the workshops. In the first workshop, regional political and spatial planning stakeholders will be invited, while the stakeholder groups will be complemented by the general public in the second workshop.

Official statistics can be used to illustrate the current demographic status of the study region and its potential development, and maps showing short, medium, and long-term changes in population characteristics can help to predict future population shifts. The maps are to be presented during the first workshop as an informative foundation for all participants about their region, and to stimulate discussions about current and future impacts on infrastructure needs and public services.

2.2 Workshop Phase

Workshop 1: Institutional Perception. The open-inductive approach aims to engage participants by providing practical experiences and facilitating comprehensive and detailed discussions with the goal of increasing participation. Hence, the initial workshop is divided into two sections: a thematic introduction and a subsequent interactive part. Following an introductory round, the methodology and its applications in spatial planning will be presented by a moderator. Future population maps will be employed to illustrate demographic changes in the region. Next, theme tables will be presented, both in terms of content and as part of the interactive session that follows.

Participants are invited to join one of the theme tables to discuss multiple transformations that are actually and potentially occurring in their rural places, and rotate to another table after 10 minutes. Each table represents one of the four themes based on transformative research studies conducted in rural areas (e.g., Moore et al., 2018; Skinner et al., 2021): built environment, economy, supply, mobility, and social (networks). The 'built' table focusses on factors such as the structural conditions of residential areas, while the 'supply' table deals with the assessment of infrastructure in terms of availability and accessibility. Factors such as mobility options, provision of basic services, health facilities, and barriers are important in this context. The 'social' table includes factors such as loneliness, well-being, social relationships, integration, and health as well as the importance of the places where these factors may occur. The 'economy' table takes into account average income, (un)employment rates, the costs of education, housing, public services, and the financial situation of the municipality. After 10 minutes, the groups rotate from one table (e.g., the 'social' one) to another thematic table (e.g., the 'supply' one) to discuss needs for action and future developments. Then, the participants move on to discuss relevant influencing, key, and disruptive factors (Figure 2b). After a short break, each scientific assistant briefly summarizes the responses of the group and presents them to the audience for discussion, allowing the summaries to be supplemented with additional information.

During the discussion sessions, researchers ask questions related to the topic areas (Table 1) while participants discuss both direct and indirect factors. When conducting spatial planning scenario analyses, direct factors such as ownership structure are often analysed separately from indirect factors such as economic development. Nevertheless, when it comes to a relational understanding of a location, such factors must be open to discussion based on the work or daily experiences of the participants. Furthermore, the scientific staff provides indirect factors such as environmental impacts, climate change, migration, economic crises, and legal situation as a basis for discussion. The participants write their findings on post-it notes during each discussion session, which are then pinned to a whiteboard. The concept of these rotations is shown in Figure 2a.

Scenario Assumptions. Before the second workshop, the researchers combine their initial empirical findings to create different scenarios. Analysing data to identify overlaps and interactions between thematic areas is crucial. Combining the current high unemployment rates (economy theme), lack of generational exchange (social), and vacant housing (built), along with a negative future perspective on demographics (key factors), resulted in the scenario named 'Exodus of Young Generation'. Therefore,

Table 1: Questions asked at respective tables. Examples for the theme 'supply'.

Rotation	Questions
0	Do the population forecasts reflect your current expectations?
	How do you evaluate the mobility services and accessibility of everyday facilities (shopping, health services etc.)?
1	What do you think are the main challenges or opportunities for supply and mobility that the municipality might face in the next few years?
	How might demographic changes affect mobility and care in your community?
2	What external factors and trends (political, economic, or environmental) do you see coming to the region and how will they affect mobility and services?
	What would be unlikely, but path-breaking events?

the researchers developed different scenarios based on their empirical findings. During the second scenario workshop, the researchers presented the synergies to the participants, who then used a guiding questionnaire and an online mapping application to prioritize and map them according to their significance. The output was geo-referenced and weighted scenario assumptions.

Workshop 2: Public Prioritization of Perceptions. During the first workshop, institutional participants discuss future developments in an open environment, while in the second workshop, public participants use an online mapping application to ensure anonymity. The aim is to avoid the risk of institutional bias in evaluating future trends due to asymmetric resources, experiences, and social positions of the institutional experts. Participants can access the online application using a QR code that can be scanned on their mobile phones. A scientific assistant provides the QR code. Furthermore, the application is displayed on a screen visible to all attendees. The participants mark points on the OpenStreetMap base map to indicate locations where they see the presented possible scenarios. The pop-up feature permits users to map a scenario to a point (Question 1), identify whether the scenario is related to a current event, a future event, or both (Question 2), rate the level of uncertainty on a scale from 0 to 4 (0 for low, 4 for high; Question 3), and rate the strength of impact on a scale from 0 to 4 (0 for low, 4 for high; Question 4). Finally, participants can provide contextual comments on the transformative site. They are also encouraged to evaluate scenario quality with respect to thematic accuracy or propose a new and different scenario (Figure 3). In the background, a median is calculated for each question, and the sum of uncertainty and impact strength is calculated for each scenario. Each participant has 30 minutes to assign points and scores for each scenario and question. The results are displayed in graphical form below the map in the web client.

3 Synthesis Phase, Conclusion, and Limitations

This workflow allows the utilization of scenario planning as an empirical method to scale the perceptions and future prospects of distinct social groups. Our intention was to make a methodological adjustment that incorporates a notion of place while shifting from spaces seen as positional relationships between material objects to an understanding of spaces as perceived sites of interaction and activity. A vital aspect of this was acknowledging that the social actor and their social group share distinct experiences, objectives, rules, and norms, which entail diverse socio-spatial practices.

Scenario planning is a valuable method for building conceivable future scenarios of places, thereby incorporating personal experience alongside structural factors. We integrate participatory geoinformatics to reduce complex future predictions to a manageable number of possible outcomes. In addition, the use of a participatory web client allows the scenario places to be geo-referenced and made visible for further spatial actions, while ensuring anonymity to include different perspectives on social space in the later analyses. Furthermore, the synthesis workshop provides context for the relationship between direct and indirect drivers in a given place, while the artificial classification of indirect and direct factors is replaced by the prioritization process of already condensed scenarios that are presented in Workshop 2. Moreover, scenarios can be retrieved and mapped, providing a crucial

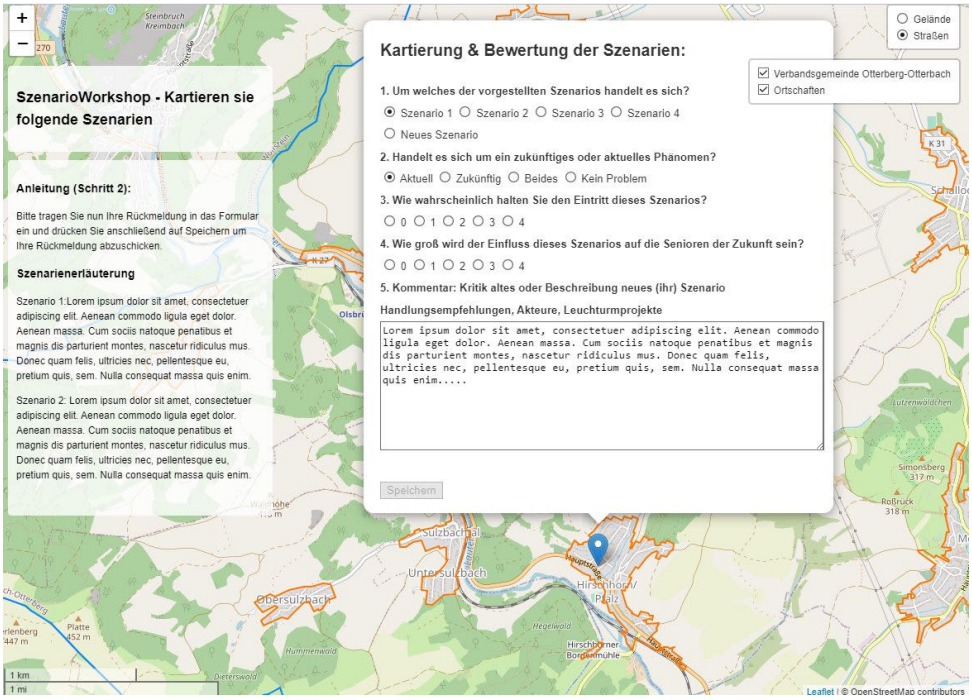


Figure 3: Mapping application. The application is built using Leaflet.js and is connected to a PostGIS database. In Workshop 2, participants evaluate and assign weights to the scenarios identified in Workshop 1. An information window provides descriptions for each scenario. In addition, participants have the opportunity to view the locations where other participants have set points.

understanding of place as a category of sensory perception that individuals use to perceive and classify their environment. Several rural areas are currently undergoing multiple transformations, and a scenario workshop following a multi-stage survey procedure can aid in identifying these changes by utilizing various place perspectives.

However, a theoretical foundation is necessary to fully comprehend place, as even the most sophisticated method is inadequate by itself. The presented workflow enables the integration of the concept of human–environment perception. Nonetheless, the method remains at a descriptive level due to the lack of a thorough elaboration on a comprehensive ontological stance regarding place-based information (Wagner et al., 2020). Moreover, to deconstruct places, it is essential to consider their social, technical, cultural, and powerful (re)production in daily activities (Wardenga, 2002).

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Public Engagement Tactics in COVID-19 Pandemic-Related Street Experiments

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Platial information can reflect through public engagement. Cities worldwide temporarily reallocated street space to serve as public space and active mobility during the COVID-19 Pandemic, known as the pop-up bike lanes, shared streets, and outdoor dining, some of which are still running today. Despite its popularity, few articles have discussed how the government consulted with citizens to convert short-term actions into long-term transformations. We investigated the tactics of the governments to engage with the public through a phenomenological study. Using Mergel's (2013) push–pull-networking tactics framework, we analysed the public engagement practices of the governments in 24 interventions. The data sources include social media data, webpages, official documents, and supplemented with interviews. Despite the lack of public consultation due to the pandemic, government agencies engaged with the public in subsequent development phases. The street intervention locations contribute to the explanation of different public engagement structures and the varied importance of different stakeholders.

Keywords: tactical urbanism; street experiment; platial information; public engagement; people-centric street

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1 Introduction

Street experiment is an intentional and temporary change of street use, regulation, or forms, aimed at transforming streets towards people-centric streets (Bertolini, 2020). Unlike conventional designs that deliver permanent changes, street experiments, a practice of tactical urbanism (Lydon and Garcia, 2015), are meant to be communicative, iterative, and adjustable (Bertolini, 2020; Landgrave-Serrano et al., 2021; Silva, 2016). A known example of street transformation is New York City's Times Square Pedestrianization, in which case the transformation started as a temporary treatment and became permanent upon receiving desirable outcomes (Sadik-Khan and Solomonow, 2017). Through ongoing data and feedback collection, implementers learn and adjust the interventions as they become permanent (Hahn and te Brömmelstroet, 2021).

Tactical urbanism projects are advocated for place-based solutions, but few studies have discussed how this is achieved through ongoing public engagement. The COVID-19 Pandemic-related street experiments are timely for such studies. These temporary interventions took place around the same time, many of which started without public consultation due to emergency and continued to evolve afterwards. Depending on the types (Gregg et al., 2022), these interventions tend to take place in different built environments, ranging from neighbourhood streets to commercial main streets (NACTO, 2020). These interventions may provide insight into varied public engagement processes.

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We studied 24 interventions from 19 cities to understand the public engagement approaches of their government agencies. Three goals and their corresponding tactics were identified in a public sector social media interaction framework: transparency (push), participation (pull), and collaboration (networking; Mergel, 2013). The push tactic means government agencies use public engagement tools for representation and information dissemination. The pull tactic means inviting citizens to provide feedback in order to form a bidirectional communication. The networking tactic means empowering citizen talent and government-citizen collaboration. Although this framework was used to analyse social media interactions, its principles also apply to other forms of public engagements, as it is a contemporary reframing of the *ladder of citizen participation* (Arnstein, 1969). Using document analysis and interviews, we categorized the engagement approaches and tactics of the implementers following the push–pull-networking framework. The result is discussed in relation to place and the continued developments of the interventions.

2 Method

2.1 Case Selection

We selected cases from the Shifting Streets COVID-19 Mobility Dataset (Combs and Pardo, 2021) that satisfy three criteria: (1) they were initiated in major world cities, which term is defined according to the Globalization and World Cities (GaWK) rankings (GaWC, 2020); (2) they were implemented in extensive sizes; and (3) they started during the COVID-19 Pandemic. We included 24 qualified cases that were located in 19 cities and four world regions (Table 1). The emergency responses cover three main types: outdoor patios, shared streets, and bike accommodations (Gregg et al., 2022).

2.2 Data Collection of Platial Information

We conducted desktop research and semi-structured interviews to identify the public engagement approaches of government agencies. The desktop research included API data collection and document collection. To study the social media interactions of an agency, we collected its tweets that included programme keywords and their replies in conversation threads. Twitter was chosen because of its widespread use as an official account. Besides social media, we collected the relevant information of the programme through their websites, meeting recordings, and existing study reports. We traced the programme websites of agencies to evaluate engagement tactics and development trajectories. Finally, we asked key initiators how they communicated with the public regarding the street reallocations.

2.3 Content Analysis

We categorized public engagement tactics in terms of communication channels and interaction intensity. The push tactic is presented in forms of information dissemination through the official webpage, social media platforms, flyers, and signages. The pull tactic is identified when there are surveys, commenting platforms, virtual community meetings, and correspondence by councillors. The networking tactic is reflected in one-on-one neighbour engagements, community events, and community collaborations. Additionally, we used Y(yes)/N(no) to denote whether an approach was established specifically for the intervention. For instance, channels such as social media accounts are pre-existing and thus not designated, whereas online commenting platforms are often set up for the programme. The number of designated approaches reflects the programme's speciality. Programmes that are more intended for experimentation are assumed to have more designated communication channels and are thus more path-deviating and longer-lasting than those that serve only as emergency responses.

3 Result

We identified three public engagement structures: rich push–pull-networking, lean push–pull-networking, and push–pull (Table 1). The rich push–pull-networking structure refers to the use of multiple channels (usually more than three) to cover all three purposes. The lean push–pull-networking structure

Table 1: Case studies and public engagement structures

Case	Main operating agency	Programme types	Status 1 Jan 2023	Tactics struct.*
EU01	Department of Traffic Organization and Technical Traffic Matters, City of Vienna	bike accom.	removed	PP
EU02	Mobility, Public Works and Road Safety, Government of the Brussels-Capital Region	bike accom.	permanent	PP
EU03	Transportation Section, Dublin City Council	bike accom.	ongoing	LPPN
EU04	Municipality of Milan, Agency Mobility Environment and Territory (AMAT)	bike accom.	ongoing	PP
EU05	Municipality of Milan, Agency Mobility Environment and Territory (AMAT)	shared street	ongoing	LPPN
EU06	Department of Roads and Travel, Paris City Hall	bike accom.	permanent	LPPN
EU07	Senate Department for Mobility, Traffic, Climate Protection and the Environment, City of Berlin	bike accom.	ongoing	PP
EU08	Office Area of Urban Ecology, Barcelona City Council	bike accom., shared street	permanent	PP
NA01	Transportation Planning, City of Vancouver	shared street	ongoing	RPPN
NA02	Transportation Planning, City of Vancouver	outdoor patios	ongoing	RPPN
NA03	Chicago Department of Transportation (CDOT)	shared street	ended	LPPN
NA04	Chicago Department of Transportation (CDOT)	outdoor patios	permanent	LPPN
NA05	Denver Department of Transportation & Infrastructure (DOTI)	shared street	permanent	RPPN
NA06	Denver Department of Transportation & Infrastructure (DOTI)	outdoor patios	permanent	RPPN
NA07	Los Angeles Department of Transportation (LADOT)	shared street	ongoing	RPPN
NA08	New York City Department of Transportation (NYCDOT)	shared street	ongoing	RPPN
NA09	New York City Department of Transportation (NYCDOT)	outdoor patios	ongoing	RPPN
NA10	City of Oakland Department of Transportation (OakDOT)	shared street	permanent	RPPN
LA01	District Mobility Secretariat, City of Bogota	bike accom.	permanent	PP
LA02	Ministry of Mobility, Government of Mexico City	bike accom.	permanent	LPPN
EAP01	Department of Transport and Planning, Victoria State Government	bike accom.	ongoing	RPPN
EAP02	Strategy, Planning and Climate Change, Melbourne City Council	bike accom.	paused	RPPN
EAP03	City Sustainability and Strategy, Yarra City Council	bike accom.	ongoing	RPPN
EAP04	Department of Transportation (DOTr), Philippines	bike accom.	permanent	LPPN

*Push–pull (PP), Lean push–pull-networking (LPPN), Rich push–pull-networking (RPPN)

refers to the use of essential channels (usually one or two). The push–pull structure refers to the use of channels to achieve only representation and engagement.

3.1 Rich Push–Pull-Networking Structure

Government agencies adopting the rich push–pull-networking structure treated the interventions as experiments, with room for growth or changes. They maximized channels to reach the public, many of which were designated for the interventions (Table 2). Public feedback collection was an inseparable part of the continuation of their street experiments. For instance, cities deployed designated pushing channels. Webpages were deployed as soon as programmes launched and updated frequently to reflect changes in the intervention locations and policies (NA06, NA08, NA10). While websites can reach a wider audience, place-based notices were still needed to provide more targeted instructions. Flyers and signages were distributed to provide on-site clarifications regarding the traffic arrangements – *'(at the beginning of the project) We basically went and spoke with the businesses, let them know it was coming, and sent people letters and information about the project'* (EAP01).

Common 'pulling' tactics were commenting platforms, online surveys, social media, contact forms, and email. Online portals were suited for feedback collection. In terms of response volumes, the online survey and comments could accommodate up to thousands of replies, reaching a significantly larger number of respondents compared to other means. Online surveys were used for two purposes: the *a*

Table 2: Typical approaches for each tactics structure

Tactics Structure	Exampl. Case	Push	Pull	Networking
Rich push–pull-networking	NA01	Webpage (Y) Flyer and signages (Y)	Social media (N) Mobile Phone App (N) Email (Y) Phone (N) Online commenting platform (N) Online surveys (Y)	Stakeholder and advisory group support (Y)
Lean push–pull-networking	LA02	Webpage (N)	Social media (N) Engagement of business owners (Y)	Civil society groups (N)
Push–pull	EU07	Webpage (N)	Social media (N) Email (N) Phone (N)	

priori survey inviting for collaboration, and the *post hoc* survey for receiving programme feedback (NA07, NA09). To accommodate wide intelligibility, agencies used visual or map surveys to provide richer context and greater clarity (EAP01, EAP02, NA05). A few agencies enhanced transparency by making online comments publicly available, enabling further discussion among citizens (NA09, EAP03). Social media accounts were used to post updates and observe public feedback. Agencies occasionally replied to public responses when they found it necessary.

The networking tactic relied more on communications with targeted groups, such as community leaders, business partners, and local elected officials. Shared streets programmes tended to be collaborations with communities. Taking New York City's *Open Street* as an example, agencies invited interested groups to apply through an online application form, which is a pulling tactic, and then collaborated closely to deliver street experiment programmes. Community partners shared half of the responsibilities in these interventions, including gathering the consent of neighbours as well as the establishing, programming, and maintaining street experiments. In outdoor dining programmes, agencies worked closely with business owners, since its main purpose was economic recovery. The collaboration facilitated the programme to mature and formalize. City staff provided guidance to small business owners, from design drawings to checking for compliances (NA02). The staff also inspected sites to help accommodate special situations (NA09). As the programmes developed, the rules became more stabilized.

The rich push–pull-networking structure helped shaping how the interventions evolve. The agencies were more responsive to public feedback, in forms of policy refinement, design guidelines updates, design changes, or, if the feedback was not satisfactory, the termination of the intervention.

3.2 Lean Push–Pull-Networking Structure

Agencies using a lean push–pull-networking structure adopted fewer and less designated channels (Table 2). For pushing approaches, webpages were used in the form of press releases, usually issued at the beginning of the interventions and major programme updates. The updates were less flexible or frequent compared to those done by rich push–pull-networking agencies. For the pulling tactic, these agencies used fewer channels compared to rich push–pull-networking structure agencies. This would inevitably limit the respondent sources. Online surveys were the common approach (EU03, EAP04), but they have not always been conducted by the agencies directly. Civil society groups helped with *post hoc* surveys and provided policy suggestions (EU06, LA02). Agencies responded to the concerns of citizens through community or stakeholder meetings, but they were held to resolve issues rather than encourage collaboration (EU06, LA02, EAP04). For the networking tactic, agencies consulted targeted groups, such as civil society groups and local elected officials. Instead of intensely engaging with the public directly, they relied on summarized feedback passed through the targeted groups.

Interventions using the Lean push–pull-networking structure were less experimental. They invited feedback but did not sufficiently support development iterations that could lead to adjustments, policy refinement, and innovations. The focus of their engagement tactics was to reassure programme support

and resolve issues. Interventions in this category mostly continued to run beyond the pandemic situation, but few possess potentials for greater impacts.

3.3 Push–Pull Structure

Agencies that adopted the push–pull structure used fewer approaches, some of which do not use designated approaches at all (Table 2). Typically, they made one press release at the beginning of the implementation and lacked continued updates. Some used social media as a source to monitor public feedback (EU08, LA01). Without systematic feedback collection, agencies might obtain biased perceptions, as people may not provide constructive feedback on an online post. More importantly, these agencies did not directly interact with the general public. Some agencies removed interventions after the pandemic period (EU01), while others faced vandalism and difficulties in maintaining the extensive interventions (LA01). These interventions served as one-off installations without intentions for continued testing.

4 Discussion

4.1 Relationship with Place

Public engagement is a process to proactively collect platial information (Mocnik, 2022), data that reflect the feelings of people when they use the transformed street elements. Lofland (1998) defined the public space, parochial space, and private space. The place attachment of people to their neighbouring streets plays a role in how the governments conduct public engagements, who the key stakeholders are, and what feedback to can be expected. Shared streets were often located on neighbourhood streets that are quiet and localized (NA01, NA03, NA05, NA07, NA08, NA10), closer to the definition of parochial space. Residents have a higher sense of ownership over the streets and hence a higher demand for decision-making. These street locations were collectively decided between the government agencies and residents. This process requires governments to engage with citizens through push–pull-networking tactics to understand preferences and subsequent feedback. Non-commercial outdoor patios served as free seating and maintained by the community. These facilities were engaged similarly as the Shared Streets (NA02). In contrast, outdoor patios that were used for commercial activities tend to be located on commercial streets. These locations are public spaces, in which case the voices of business owners and consumers play a bigger role in shaping public feedback. When deciding the permanent development of temporary outdoor patios, the support of business owners was considered with a heavier weight (NA04, NA06, NA09). Furthermore, bike accommodations were implemented based on strategic bike routes, with an emphasis on building a complete network. There would be less room for the collaborative engagement of residents and they tend to be a more top–down process. Due to this reason, few European cases used push–pull structures (EU01, EU02, EU04, EU07, EU08). The decisions of the governments played a bigger role in bike network expansions.

4.2 How Experimental Are These Street Experiments

Agencies that launched rich push–pull-networking structure enhanced public engagement and enabled iterative developments of street experiments. This kind of intervention is closer to the ideals of street experiments, which is to be iterative, adjustable, and innovative (Hahn and te Brömmelstroet, 2021). This structure also helped building a long-term pathway to combine tactical urban changes with strategic planning (Vallance and Edwards, 2021). Vancouver, e.g., has launched its *Slow Street* design guidelines to support longer-term programme development. The temporary structures are continually being used in post-pandemic time. Agencies that launched the lean push–pull-networking structure used public engagements to justify the intervention continuation (or discontinuation). The experiments were one-off rather than iterative. This structure may have contributed to short-term developments of the street experiments (Glaser and Krizek, 2021). Nevertheless, the input may be inadequate to contribute to policy innovation. Chicago's shared streets were discontinued after the second year's programme for the reduced interest received from the public. There were no noticeable lasting design changes in those temporarily changed streets. The push–pull structure is mostly associated with bike

lane developments. Less experimental features were found. Agencies emphasized implementation and problem resolution rather than experimentation. Lacking community collaboration may harm the perception of bike lane safety and usefulness. This study reveals a high proportion of push–pull engagement structures, which confirms the concerns of researchers with lacking public engagement in government-initiated street experiment projects (Combs and Pardo, 2021; Verhulst et al., 2023).

5 Conclusion

In this study, we investigated tactics adopted by the initiating agencies to evaluate user feedback on pandemic-related street experiments. We coded engagement approaches into push/pull/networking tactics and analysed different tactics combinations and their intervention outcomes. We looked at public engagement tactics and instruments used in the pandemic-induced street experiments. As platial information, the public feedback has different importance depending on the intervention locations. Further, the public engagement structure reflected the different degrees of experimentation in these street interventions. Our research contributes to understanding how agencies used temporary street interventions to undergo longer-term street transformations.

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Exploring Place: A Pedagogical Journey in Spatial Planning Using the Place Standard Tool

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This paper presents the pedagogical outcomes of integrating the Place Standard Tool – an open-access survey tool for assessing places – into the learning experience of first-year spatial planning students to approach the concept of place and its connection to their discipline. The study, conducted within a case study in Rozenburg-Rotterdam, the Netherlands, focusses on examining the relationship between spatial dynamics and residents' interactions with their surroundings. Through field trips and a street survey, the students utilized collective mapping and the Place Standard Tool to assess people's perceptions of Rozenburg as a place, examining its challenges, pressures, and opportunities. The paper critically reflects on the methodological and pedagogical aspects of this integration, emphasizing the significance of the platial perspective in spatial planning education. Drawing from a hands-on pedagogical experience, the paper outlines the advantages of adopting the platial approach in the learning process, while also highlighting the challenges of introducing complex and theoretically loaded concepts such as place.

Keywords: place; street survey; teaching; education; learning; interdisciplinary

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1 Introduction

Place encompasses a myriad of perspectives and concerns, intricately interweaving the physical, social, and environmental fabric that shapes communities and influences the interpretation of our surroundings (Mocnik, 2022). However, due to its elusive nature, place challenges pedagogical efforts within the classroom. As educators in spatial planning, our goal was to equip first-year spatial planning students with the necessary tools and understanding to navigate this complex landscape. To fulfill this purpose, we embarked on a transformative pedagogical journey guided by the notion of place, employing multidisciplinary teaching strategies. Our case study was Rozenburg, a former town now situated within the administration of Rotterdam, the Netherlands. With an estimated population of 12,335, Rozenburg now resides amidst Europe's largest port. By engaging with the residents of this distinctive setting, our objective was to enable students to unveil diverse insights and considerations held by the community. This experience broadened our students' outlook and enhanced their understanding of the intricate relationships between individuals and their circumstances, which underlies spatial planning as discipline and practice.

The premise that initiated our pedagogical journey is rooted in Rozenburg's urban and environmental pressures, which affect the everyday life of residents and their relations to their surroundings. The notion of sense of place is then invoked to capture and encompass such relations, both on a practical level of meeting residents' needs by their locale, as well as on the level of deeper personal connections,

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perceptions, sense of identity and belonging, among others. The initial assumption suggested that sense of place of residents might be influenced by urban and environmental pressures undergone by a particular locale. The students set out to test it and unveil the possible ways of such influence on residents' perception of their place. Drawing upon the multidisciplinary discourse surrounding the concept of place, we emphasized the significance of such a platial approach for comprehending spatial dynamics from a planning perspective. By shedding light on the interplay between spatial factors and the interactions of individuals with their surroundings, this exploration offered valuable insights into the multifaceted relationship among place, its inhabitants, and the field of spatial planning.

2 Framework

The pedagogical setting of this experience is anchored in a two-semester study project within the Spatial Planning bachelor programme at TU Dortmund University[1]. The module provides hands-on training in research skills for first-year spatial planning students and fosters a practical understanding of applying knowledge in future practice. This co-supervised self-learning project approached Rozenburg's dynamics, including expanding industries, population factors, and economic activities driving the demand for land. It also addressed pressing issues such as air pollution from port logistics and nearby industrial clusters as well as the impact of the climate crisis and rising water levels.

One of the challenges associated with the pedagogical format was to strike a balance between providing a robust framework to support students and leaving enough room for their independent and creative contributions. The conceptual richness of place, complemented by the suggested methodological framework, facilitated this balance. Students had the flexibility to work within the module framework and to develop their own problem statement. For this matter, they delved into specific pressures encountered in Rozenburg, such as land-intensive industries and ongoing construction projects like the highway tunnel (*Blankenburgverbinding* in Dutch), as well as upgrading mitigation initiatives of the *Green Belt* around Rozenburg. The research question that guided their undertakings forward was formulated as: 'How could urban and environmental pressures be affecting the sense of place of the inhabitants of Rozenburg?'. This question directly reflects the struggles that the students underwent in understanding the inability to have definitive and full-rounded answers regarding place and its perception. In fact, a central goal of our pedagogical process was not only to introduce students to an instrumental approach to place in planning but also to expand their outlook toward a broader discussion on the nature of space in spatial disciplines. Students were encouraged to reflect on a variety of terms employed in spatial and geographical disciplines to refer to what Thrift (2003) called 'the fundamental stuff of geography'. As the author points out, 'space is not just a commonsense external background to human and social action'. Therefore, if we are to take the learning process in spatial disciplines to its roots, we might need to start by reflecting on fundamental concepts, which are accepted to be understood and established to such a degree that obscures them from deep and critical understanding. Thus, the students were encouraged to craft their own stance in the space and place debate, having in mind not only deeper conceptual understanding but also navigating and developing an approach to place tailored to the project's goals and their study in Rozenburg.

Delving into the above-mentioned topics, the students anchored their understanding of place in a human geographical perspective, acknowledging the multidisciplinary reach of the notion of place in social sciences, humanities, psychology, environmental studies, inter alia (Buttimer and Seamon, 2015; Relph, 1976; Tuan, 1977). To better comprehend the concept, the students approached place through the lens of sense of place as a multidimensional concept, comprised of four dimensions – the self, environment, social interaction, and time (Beidler and Morrison, 2016). Unpacking each, they foregrounded the dimension of the self as pivotal for transforming space into place, asserting the central role of the human subjective side to it. Moving further, the tripartite construct of sense of place as consisting of place identity, place attachment, and place dependence (Jorgensen and Stedman, 2001) has been added to the study framework. To reconcile the heterogeneous conceptualizations of dimensions while retaining coherent conceptual support for the study, the students undertook the above tripartite scheme, wherein place attachment is located at the core, and influenced by place identity and place dependence. The main challenge faced by them in such harmonization was to find how these three constructs correspond with social, physical, and environmental aspects of place. It became clear that these constructs are intricately intertwined and could not be disentangled into

simplistic attributions. Proof of the last is reflected in the physical facilities that were solely associated with place dependence. Throughout this process, the students developed an understanding that an individual's experience of place is a holistic phenomenon. It encompasses elements such as the physical and built environment, social interactions, and cultural experiences as well as personal experiences, emotions, and behaviours towards a place, which all together result in a bond between an individual and a place (Nelson et al., 2020).

While adopting such an approach, the students faced the challenge to translate the conceptual premises into operational categories to be applied to the study. For these endeavours, the Place Standard Tool[2] (PST) was proposed as a resource. This place-based tool was developed by a public-private alliance in Scotland known as the Place Standard partners[3]. This participatory assessment resource has been adapted for case studies in various contexts (Gjorgjev et al., 2022; Kleopa et al., 2019; Ocaña et al., 2022), and in our case, it helped to articulate the efforts to understand the fluidity of the concept of place and the inherent subjectivities of sense of place. The tool acted as a catalyst for understanding the perception of place held by Rozenburg's inhabitants across social, physical, and environmental dimensions. The PST provides a 14-dimensional graph framework that sheds light on areas for improvement based on the community's perspective. These dimensions are organized into five major categories: Movement, Space, Resources, Civic, and Stewardship. Movement focusses on safe and sustainable transportation, while Space examines design and usage to promote community engagement. Resources assess accessibility, aiming to reduce inequality. Civic emphasizes building quality and accessibility, and Stewardship involves care, influence, and democratic decision-making. The PST provides a community-friendly framework for assessing the quality and potential for improvement of neighbourhoods while addressing their inequalities, making it a suitable resource for spatial planning practices. The initial way to address the said challenge taken by the group was based on searching for potential links between three broad sub-notions of sense of place – place attachment, place identity, place dependence – and wider categories incorporated into the PST (i.e., Space, Resources, Civic, Stewardship, Movement). The students based their reasoning on such initial assumptions as, e.g., linking place dependence to the availability and wealth of resources provided by place, or attributing a stronger sense of place identity to a higher degree of stewardship towards place. However, such an approach soon revealed itself as rather simplistic and unfeasible to achieve, as it proved impossible to disentangle all interwoven aspects into clear-cut compartments which fit neatly into a general picture of a place, like compatible puzzle pieces. The place asserted itself as a way more complex and dynamic creature, where different facets are feeding into each other, overlapping and sometimes contradicting each other. This realization reinforced the understanding pointed out by Erfani (2022) that a single integrated conceptual framework for sense of place is implausible across all fields, highlighting the need to develop or adapt frameworks for each research case.

3 Methodology as a Journey

This project provided an opportunity for students to approximate the material and social fabric of the site, reflecting on the theoretical and conceptual foundations of planning. An exploratory field trip allowed the students to gain a first-hand impression of Rozenburg and test preliminary findings against the immediate experience on the ground. While filling field observation forms and recording their observations in respective assigned sectors of Rozenburg, the students were asked to adopt a place perspective from their own position as newcomers getting familiar with the site, as familiarity with surroundings builds the first bridge to conceive an area as a distinct and specific place. Synthesizing the gathered observations in a collective mapping exercise, the students had to pin down their heterogeneous impressions to the abstract 2-dimensional surface of the Rozenburg plan, reflecting in the process how location-sensitive some things are and how all-pervasive some others. Based on this first field trip experience and interim conclusions, the students had to face their preconceptions and assumptions, reconsidering the pressures and dynamics in Rozenburg. The fieldwork revealed a different view of the community, challenging the notion of vivid and omnipresent pressures while highlighting the positive aspects of Rozenburg. Despite being affected by some external pressures, Rozenburg's residents seem to enjoy abundant greenery and easy access to water bodies. Therefore, the research evolved and the efforts shifted towards methodological and operational considerations, particularly regarding the adaptation and application of the PST during the second field trip. As reported above, throughout

the learning process the students more and more recognized the complexity of the sense of place phenomenon and the difficulty of categorizing it in a straightforward manner. However, they found that the thematic content of the PST provided a suitable framework for exploring everyday life concerns in Rozenburg. It allowed them to structure conversations and engage with the local community while registering these interactions in a structured fashion, gathering insights that shed light on place attachment, place identity, and place dependence, albeit not in plain fashion. The PST categories did not streamline directly into the three constructs, however, the students were able to elucidate some links across them. For example, resources of place feed not only into place dependence but constitute a part of place identity and attachment as well. Apart from conceptual and methodological considerations, the students worked through practical matters of applying the PST. Before its on-site and online application, the PST underwent a testing process within the university context, leading to further adjustments. One of the challenges faced was transforming the PST into survey sheets that were convenient and intuitive for quick on-the-spot completion. Additionally, a major ordeal arose from the language barrier encountered by German-speaking students in an English-speaking research group working within a Dutch-speaking community. The language barrier was one of the aspects that underscored the significance of being receptive to the local context in a place-based setting and stimulated the students to reflect on the role of cultural differences in general while engaging with places from diverse backgrounds. The PST itself is intended and designed to be applicable across a variety of contexts and locations since it is structured around very general basic categories. In this regard, it is telling that the Dutch adaptation of the PST[4] did not introduce major changes but offered a Dutch translation of the basic framework. However, it is at the level of content and application of the PST where cultural differences are set to play a crucial role. Each conversation held around the PST themes carries unique outlooks, perspectives, and subjective inputs from both residents and researchers. Therefore, careful calibration and great sensitivity are needed in the very process of dialogue, and subsequent interpretation of obtained results. The issue of cultural differences becomes even more pertinent for the comparability of the PST results across different localities and countries. The unified PST graph plotting the numerical scores for categories might compel us to draw conclusions from mere juxtaposition of graphs, which might be erroneous if a larger cultural context is not accounted for.

To ensure comprehensive coverage when applying the PST in their second fieldwork, the students committed to three consecutive days at the central square of Rozenburg, with shifts from 8 am to 9 pm. In addition, individual surveys were randomly distributed in diverse neighbourhoods, inviting residents to take part in the online version of the PST survey. The on-site participant selection followed a random sampling approach, avoiding bias towards specific individuals. This methodology resulted in a statistically significant sample, with well-distributed age groups and genders given the format of the street survey, indicating a low risk of bias. The students successfully collected 343 on-site and 25 online responses, accounting for approximately 2.98% of Rozenburg's population actively involved in the surveying process. Among the participants, 49% identified as female, 50% as male, and 1% as diverse. The surveyed age groups were as follows: 2% aged 0–15, 18% aged 15–25, 29% aged 26–45, 26% aged 46–65, and 23% aged 65+, aligning with the neighbourhood's demographic profile except for the youngest age group of 0–15 due to the lack of autonomy for children to take part in such activities.

Despite the noticeable construction noises and occasional chemical smells resulting from the neighbourhood's proximity to industrial complexes, the resulting graph (Figure 1) averaging all of the responses exhibits an overall positive sense of place in Rozenburg. The main concerns expressed by the surveyed residents focussed on 'Public Transport' (Movement), 'Housing and Community' (Civic), and 'Influence and Control' (Stewardship). However, it is important to acknowledge that the survey results also revealed positive elements. Respondents expressed satisfaction with 'Traffic and Parking' (Movement), 'Natural Space' (Space), and 'Work and Economy' (Resources). As the project is currently in its final stages, further analysis will be conducted to examine specific areas and data behaviour.

4 Pedagogical Takeaways and Challenges

By incorporating the PST into our pedagogical journey, a comprehensive understanding of the multi-faceted aspects that shape places can be acquired. It helped us to guide a conceptual discussion and envision the scope of the notions of place without losing sight of the discipline that hosts this study project. It allowed students in an early stage of their careers to engage with the local community,

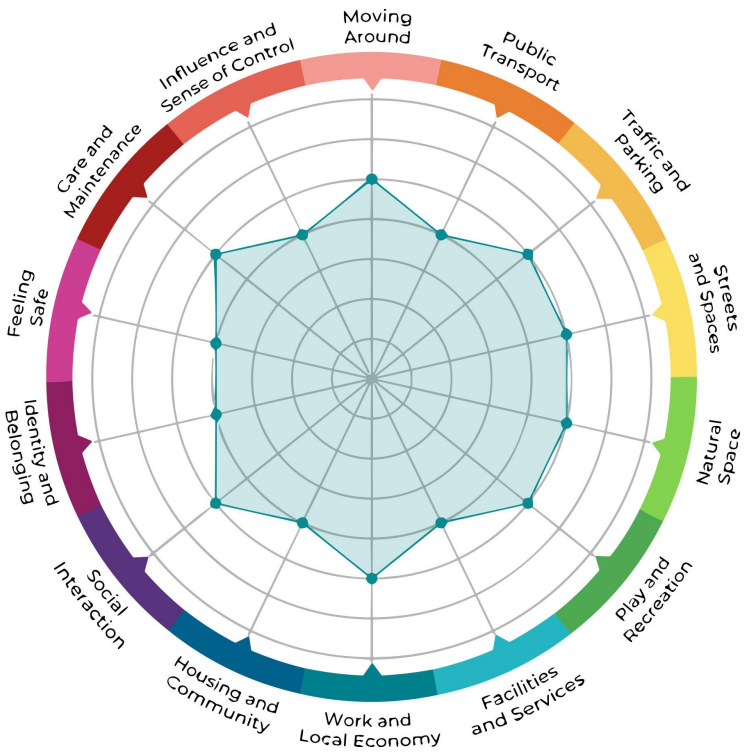

Figure 1: Place Standard Tool resulting graph for average responses in the surveying process in Rozenburg, the Netherlands (Created through http://www.ourplace.scot/tool)

unveil diverse perspectives, and consider the lived experiences and concerns of people. Consequently, the tool becomes a resource for students to evaluate, analyse, and monitor places, identify areas for improvement, and generate well-informed recommendations for spatial planning and development projects. Ultimately, the inclusion of the PST enhances the spatial planning process by incorporating community input and fostering a more inclusive and people-centred approach.

The concept of place offers a potent outlet that harmonizes various spatial considerations with human perspectives. It grounds the dynamics of different scales into distinct and tangible locales while imbuing them with social relations and collective meanings. Within an academic structure, an open and guided research project provides a significant opportunity for students to approach a specific case study as both academic researchers and future planning practitioners. This approach encourages reflection on the theoretical and conceptual foundations of planning while developing practical methods and hands-on approaches in the field. At the same time, the fruitful nature of the platial approach can pose challenges in achieving learning outcomes at the entry level of spatial planning. The concept of place, being open to a nearly infinite number of interpretations and approaches, exceeds the basic premises needed for an empirical case study, thereby charging it with theoretical depth. The latter demands a higher level of comprehension from students, which needs to be developed and nurtured along the way.

5 Conclusions

The journey is yet to be accomplished, as the students are still working on finalizing the research at the time of writing. It can be confidently asserted, however, that the implementation of the platial approach in the module has proven to be a rewarding framework despite the challenges, both conceptual and pedagogical ones, brought by such a complex topic. The complexity and holistic nature of place eludes a straightforward operationalization via rigid and unresponsive methods, which demands thoughtful and careful engagement with it in the classroom settings, and even more so in the future planning practice of students. This approach has not only allowed the execution of a robust empirical case study but also

facilitated the attainment of valuable academic learning outcomes and high-level theoretical knowledge, which is crucial for spatial planning as an academic discipline. Additionally, it has demonstrated its added value by bringing multidisciplinary expertise to the field of spatial planning, both as a practical endeavour and an academic discipline. Moreover, it has provided insights into sociology and social and urban studies, which align closely with the objectives of the platial agenda. The success achieved thus far in this experience can be directly attributed to the dedicated and engaged efforts of our students.

Notes

1. More about the project structure can be found on https://raumplanung.tu-dortmund.de/studium/bachelor-raumplanung/projektstudium/projekte/
2. The Place Standard Tool is of public access through https://www.ourplace.scot/tool
3. More about the Place Standard partners on https://www.ourplace.scot/about-us
4. https://www.pharos.nl/kennisbank/de-leefplekmeter-wat-vind-je-van-je-leefplek/

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Co-creation of Place-Based Content for Field Trips and Public Trails by Geo-Content Management

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While learning about places in classrooms takes large profit of digital geomedia, digital assisted learning on site is still bound to fragmented solutions, as innovative Extended Reality immersions often demand too much resources to be run on average smartphones. In addition, efforts staging digital aided learning experiences on site are still too cumbersome for regular teaching. In an explorative answer to this challenge, we introduce the FAU Geoexplorer, aiming at focussed presentation of geomedia on site supported by an easy to follow content creation process.

Keywords: location-based services; field-trips; geodidactics

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1 Place-Based Tools to Be Used for On-Site Learning

At present, digitally enriching on-site experiences of field trips is limited to the use of fragmented geomedia and apps supporting learning about specific topics. In contrast, generic e-learning platforms with rich support of the content creation process still support place-based content only to a very limited degree. An integrated combination of both, supporting a broad variety of use cases ranging from field trips to public trails or geo-participation is thus highly relevant.

At the Friedrich-Alexander University Erlangen-Nuremberg (FAU), by developing the FAU Geoexplorer we aim at a tool that acts as an overlay platform integrating both (1) the functionality of pre-existing apps and (2) distributed geomedia from different cloud storage locations and is thus able to support the advantages of a didactically structured content creation process as well as blended learning experiences on site.

In this paper, we first introduce our goals in the context of place-based GIS and provide an overview of the requirements derived from previous research in the field of place-based learning. In a second step, we introduce the main interface of the FAU Geoexplorer and present two examples of outdoor experiences staged with it. We report from early evaluations and conclude with remarks about the road ahead.

2 Starting Point and Goals

Beyond the look for interesting places on behavioural data (like home or work location; see Isaacman et al., 2011), Winter et al. (2009) mark a milestone when Geoinformation Science first asked for an appropriate geo-model of the phenomenological concept of place (first stated by Tuan, 1977; for an

D Kremer and A Wagner (2023): *Co-creation of Place-Based Content for Field Trips and Public Trails by Geo-Content Management*. In: R Westerholt and FB Mocnik (eds.), *Proceedings of the 4th International Symposium on Platial Information Science (PLATIAL'23)*, pp. 77–83

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overview, see Cresswell, 2004). Decomposing the methodological singular of (outside) space rooted in early GIS systems, the concept of place differentiates between the mere *location*, the *locale* of spatial arrangements, and the *senses of place* assigned and modified by ongoing social practices (see also Schatzki, 2002; for an overview, see Kremer, 2018). Following this approach in Geoinformation Science, research invested in supplying platial operators to integrate platial data in spatial analysis (Gao et al., 2013) and in locating places from natural speech (Richter et al., 2012; Vasardani et al., 2013).

At the same time, critical digital geographies (Ash et al., 2018) still call for more substantial *transgressions* in using digital spatial representations as *mode of inquiry* (see also Kremer and Walker, 2022). Reflected by the lowercase plural of *gis* in the sense of *geographical imagination systems* (Bergmann and Lally, 2021), Kwan (2002) first introduced the use of multi-modal data to augment common cartographic representations. Combining place-based modelling and analysis in Geoinformation Science with content analysis of multi-modal data, Kremer (2018) introduced a multi-layer model integrating (1) the analysis of individual motion tracks of tourists with (2) the analysis of tourist photos indicating platial attention and (3) the analysis of interview data making sense of the experiences gathered by (1) and (2). Accordingly, Gao (2022) defines places-based GIS as the combination of (1) platial, multi-modal data and associated sense-making, (2) computational models of place, and (3) related functionality for analysis and visualization.

In this context, but quite in contrast to this analytic approach taken above, the social practice of geo-imaginations (conceptually, see Taylor, 2004) becomes a powerful tool in geo-didactics, when on-site experiences are not only augmented with geomedia but also with tasks demanding creativity (Dickel and Keßler, 2019). Consequently, when teaching GIS in school, Schulze et al. (2015) call for a shift from an *expert view* to an *non-expert use of digital geomedia*. Thus, following the definition of Gao (2022), our goal is not to present enhanced computational models of place – we actually rely on POI representations – but to rather foster both the staging and visiting platial on-site experiences in real space with the use of immersive geomedia and tasks demanding for creative imagination.

On-site learning has been long known to provide deeper insights into place-bound patterns and relations (Feulner and Ohl, 2014; Lude et al., 2013). As a result, place-based approaches to learning are not only used in Geography but also in object-related disciplines like Archeology (Verstegen and Kremer, 2023). At the same time, learning to compare platial patterns across different sites is mandatory to identify similarities and dissimilarities (Arends et al., 2011). Offering a simple place-based application mediating these on-site experiences with the use of geomedia combined with a proper content creation pipeline staging the on-site learning experience thus provides a high potential for enhancing the outcome of on-site learning. This covers imagery, audio, and video, but also 3D content for Extended Reality (XR) when important parts of the site have not been preserved or lack public accessibility. The recent call for climate-neutral travel further increases the demand for field trips arranged with the help of XR content (Mühlenberger and Verstegen, 2022; Verstegen et al., 2022).

In response to this demand, we decided to develope a tool supporting mobile location-based learning experiences alone or in small groups. Supporting the content creation process, we provided a separate input form guiding the input process and making content reusable for the needs of different target groups. Our goal in university education is not that students just visit pre-sketched field trips arranged by lecturers. Instead, following the idea of self-organized learning, we taught them how to prepare a field trip in small teams themselves. After mutually visiting the field trips of the other groups, we offered common reflection sessions to discuss the on-site observations amongst the different groups. Because we focus on the co-creation process and on-site presentation of geomedia and do not offer additional geoanalysis, we classify our approach as geo-content management and geo-content delivery, which is in contrast to the concept of mobile Web GIS.

We quickly learned that our approach is also useful in other than just academic settings. The medium-term goal of our project is to provide an application that can be used in academic teaching as well as in school, and to stage public trails from various disciplines. As a proof of concept, in cooperation with the *Metropolregion Nürnberg*, we established digitally assisted public trails in small villages in the region revealing the depth of added value production chains bound to those places. To further support touristic exploration of the trails, we enabled our application for use with QR codes, which will be attached to places in the field and allow for discovering the routes in explorative touristic settings.

3 Setting the Scene: Didactical Considerations

As current approaches are often technology-driven or explorative and lack concepts and evaluations approved by didactics and education sciences (Feulner and Ohl, 2014), we will provide a short introduction on findings in these fields in a first step to then derive related requirements from them (Verstegen and Kremer, 2023).

In contrast to the term place-based learning often used to designate learning about places in the classroom (Aßbichler et al., 2021), we follow the paradigm of mobile, location-based learning to aid learning with mobile devices at a specific place of interest (Feulner and Ohl, 2014). As approaches of self-organized learning (Sembill et al., 2007) lend themselves not only for use in higher education but also in school (Schlieder and Kremer, 2014), the including of students in the co-creation process of setting up a field trip or public trail deepens their understanding of related places. At university, self-organizing can also cover self-scheduled visits alone or in small groups both for identifying suitable places and setting up tasks their fellow students have to solve on site. While mobile, location-based learning provides a high potential for visualizing, contextualizing, and exemplifying on-site content, it poses two challenges: (1) lecturers need special training themselves to stage controlled, yet inspiring and engaging learning experiences (Lude et al., 2013); and (2) reusability is key to compensate for the intense preparation efforts (Feulner and Ohl, 2014).

In an integrated platform, both challenges can be addressed systematically in an integrated manner, as generating, maintaining, and publishing content is a workflow already well supported by learning content management systems (Turnbull et al., 2020). A tool acting as an overlay platform incorporating an easy-to-use workflow model will act as an light-weight content management and content delivery system adapted for the platial domain. It thus reduces both the costs of training students and teachers to compose on-site experiences and increases the reusability of already designed content. In addition, integrating XR content from distributed sources and using functionality from other e-learning apps for on-site assignments further increases the value of mobile place-based learning.

4 Design and Implementation: Geo-Content Management and Geo-Content Delivery

As our platform is designed to guide the content creation process as well as the actual visit, we decided to provide a light-weight solution architecture suitable for different types of media including XR experiences. Designated as overlay tool, it is a design goal to cross-reference and combine other, more specialized apps into a common workflow.

We evaluated a web-based solution as well as native apps on mobile platforms. Native mobile apps usually perform best regarding map frameworks and cached offline content, while web-based solutions allow for a seamless combination with other solutions. After having gathered experiences with a web-based solution for two years now and having identified that a solid offline cache is crucial to be able to offer services also in remote areas without mobile connectivity, we eventually develop a multi-platform solution based on fluttr (Google, 2023) at the moment.

The core ontology of our software (in terms of the core concepts considered; for other usage of the term ontology, see Kremer, 2012) is composed of (1) routes, (2) excursion sites related to specific routes, and (3) pages associated with each excursion site. As digital geomedia can distract from on-site observation, we decomposed the content associated with each site to multiple pages showing one chunk of content at a time. Each page contains a (1) small introducing text, (2) one single piece of media, and (3) a clear task to follow. This step-by-step process reduces the need for special training when working for the first time with the platform – for content creators as well as for visitors. A table of content provides easy access to the input draft at any stage. We currently support a broad range of geomedia including imagery, video, audio, and 3D models, described by appropriate metadata. Content-creation is assisted by a simple markdown editor. Figure 1 provides an impression of the input form.

The presentation layer app is composed of a map that focusses on the current place of interest including a recommended route leading to it and the page-wise visualization of the content associated with the site. The app supports a step-by-step user workflow that guides the visitor along the chosen trail.

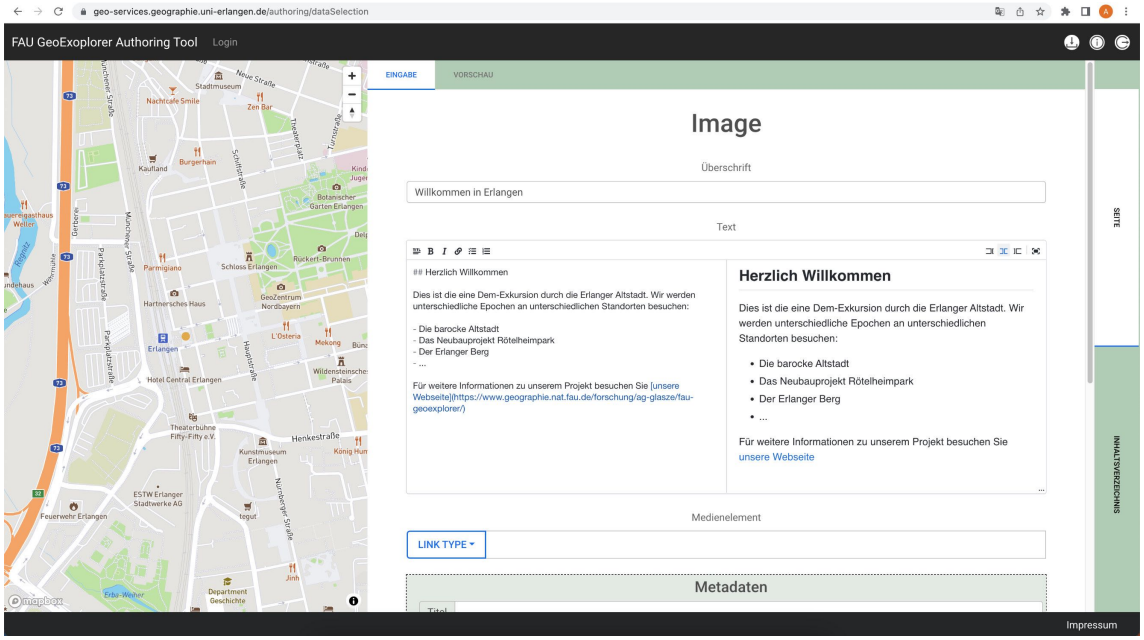


Figure 1: Screenshot of the authoring tool. Example for creating a media page for the content type image partially filled out with markdown content. (Andreas Wagner)

5 Comparing Imagery to On-Site Experiences

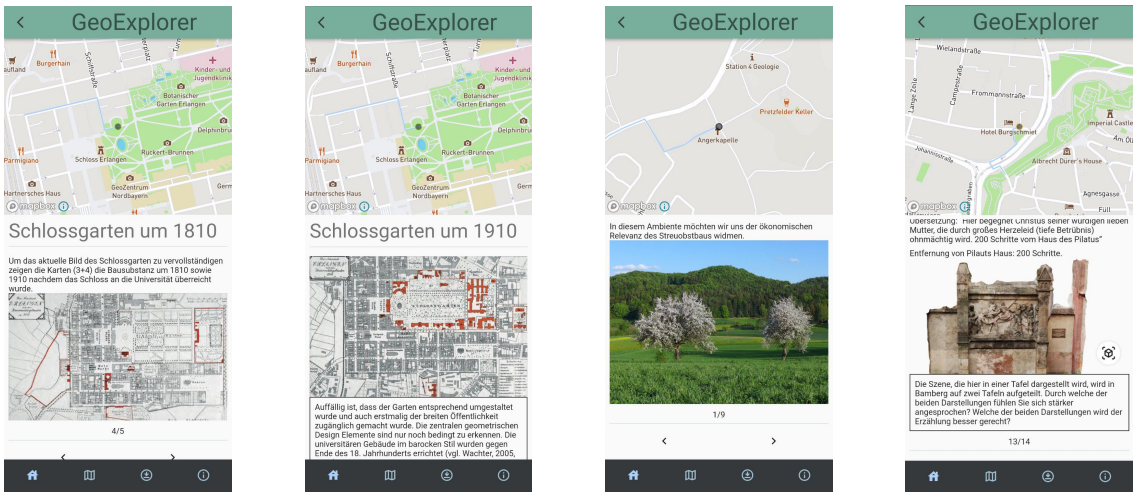
For an illustration of the interface as well as the main use case of our application, we focus on the didactical method of image comparison. Besides historical photographs (Figures 2a and 2b), images can visualize the appearance of specific places during different seasons, or provide the average development of plants for cross-check in heat waves on site. The user could see an image of the cherry blossoom, even if visiting the site in winter (Figure 2c).

This basic method can be further enriched by showing not only images but by also integrating 3D objects. We can briefly illustrate that in the context of Christian Archeology. Stations of the Cross are a series of Christian depictions of Christ carrying the cross from the place of his condemnation in Jerusalem to the place of his crucifixion at Golgota, and finally show the place of his entombment (Sternberg, 2003). The first station of the cross from the world heritage town of Bamberg was digititized by laser scanning and made accessible via the Geoexplorer. This allows for comparison with on-site experiences of a related station of the Cross in Nuremberg and even for projecting similar experieces when no related station was preserved. This experience is augmented best when the 3D object is used to create XR immersions rendering the 3D object on the mobile camera (Figure 2d).

In addition, we offer QR code capability to support entering a public trail on site. Basic information presented on pyhsical information boards in public can be digitally enriched by geomedia and nested into a trail containing other places without physical boards. Following the QR code, tourists are shown the site-specific content in the context of the whole trail and can decide to follow the trail from this point or even walk to the starting point to follow the complete trail.

6 Early Evaluation Results and Road Ahead

First qualitative feedback using the FAU GeoExplorer (Kremer, 2022) pointed at the positive effects of mobile, location-based learning. Students very much liked to go out in the field according to their own schedule and explore places to be represented on our platform. When acting as co-creators, students appreciated most the high motivation gained from working with digital tools in an explorative creation process. Well-known limitations cover the extra effort needed to prepare on-site learning experiences (Lude et al., 2013), which is balanced by increased reusability of content. Other impedi-



(a) Image comparison with a map from 1810

(b) Image comparison with a map from 1910

(c) Image for comparison of a landscape in spring

(d) 3D object with possibility to view in AR

Figure 2: Screenshots from FAU Geoexplorer

ments cover limitations of mobile devices in general, like readability of displays in bright sunshine, low battery runtimes, lack of mobile connectivity in remote areas, and data privacy issues (Feulner, 2021).

After our current work to provide the FAU Geoexplorer as a native app for mobile platforms, we will focus on native integration of simple e-learning tasks and add further support of more detailed geo-visualizations on the map. On top of that we like to support more explorative work with 3D objects, e.g., linked with 360° image spheres. As we are able to attract more and more project partners, we plan to conduct more formal evaluations.

Author Contributions

D Kremer contributed the main idea. A Wagner contributed the details about the technical implementation.

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The Influence of Socio-Demographic Factors on Walkability Perception – Results from a Large-Scale Survey

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Urban sense of community and sense of place are dependent on streetscapes that foster the activity of walking. In this context, a key question is in which ways socio-demographic factors affect how individuals subjectively perceive the walkability of streets. This study addresses this question based on an online survey in which 1440 individuals of different gender, ages, sexual orientations, and immigration backgrounds provided more than 86,000 subjective assessments of street view images from 495 streets in Central London, UK. Statistically significant differences in the average and variance of assessments for most socio-demographic groups comparisons were found. This evidence suggests that theories relating the visually perceived features of the streets to their subjective walkability perception need to account for the influence of the individuals' socio-demographic factors.

Keywords: walkability; perception; street view; user survey

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1 Introduction

Walking is a mobility mode and leisure activity associated with numerous health, environmental, social, and economic benefits. Multiple studies provide evidence that walking promotes mental and physical health, particularly among the elderly (Pae and Akar, 2020). As a fundamental type of active mobility, walking also contributes to achieving more sustainable and environmentally pleasant cities. Furthermore, neighbourhoods and districts tend to be more economically vibrant when services and amenities are accessible by walking (Zhao et al., 2018). Finally, social integration and sense of place are known to be fostered by streets and urban public spaces that support the active movement and interaction of individuals (Koohsari et al., 2023).

To assess the extent to which streets and districts support and encourage walking, researchers and planners have long relied on walkability indices (Guzman et al., 2022). Based on spatial attributes such as the land-use mix, proximity to public transportation, and connectivity of streets, these indices allegedly measure walkability objectively. Although useful, these indices do not take into account the particularity, complexity, and diversity of streets and the fact that the enjoyment of walking is subjectively perceived. The aim of this study is to contribute to the uptake of walking and the design of walking-friendly streets as well as shed light on how the perception of urban spaces is conditioned on socio-demographic factors. Specifically, the following research question is addressed: is the perception of street walkability affected by the individuals' socio-demographic attributes?

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1.1 Related Work

The approach of combining street view imagery with user surveys for investigating how individuals perceive streets has been advanced by a few studies in recent years (Ma et al., 2021; Ramírez et al., 2021; Zhang et al., 2021). In many of these studies, while viewing one or more street view images of a location, participants are asked to rate the degree to which they agree with statements like 'I would feel safe walking this street'. The ratings provided by the participants are then treated as dependent variables estimated by different predictive models based on attributes computed from the street view images. These image attributes are often extracted with convolutional neural networks (Zhao et al., 2017). An appealing advantage of this approach is that, because street view images are available for many cities and areas, city-wide estimations of walkability perception can be generated.

Other related studies have applied discrete choice models (Ben-Akiva and Lerman, 1985) to quantify the participants perception of safety (Ramírez et al., 2021). To train these models, the MIT Place Pulse Google Street View dataset is often used (Naik et al., 2014). Place Pulse was generated from 2010 to 2014 by thousands of volunteers who expressed their preferences in terms of safety, beauty, etc. when shown two images of different streets from 56 cities (Dubey et al., 2016). The over one million pairwise comparisons make up a valuable dataset. Unfortunately though, the volunteers did not provide their demographic characteristics, making it impossible to investigate the influence of factors such as gender, ethnicity, age, etc. Our work differs from the ones above in that (a) the assessed streets are from the same study site; (b) four different walkability aspects are systematically assessed; and (c) ample data on the participants' socio-demographic factors were collected as to enable investigation whether, how, and to what extent these factors affect streetscape walkability perception.

2 Methods

The methodology applied in this work has two components, namely, street view images from Google Street View (GSV) and a user survey in which participants assess these images according to their perceived walkability and answer questions on their socio-demographic attributes.

2.1 Street View Image Collection and Selection

For collecting and selecting the GSV images, the following procedure was undertaken. The geographic coordinates of the middle point from every street segment in Central London, United Kingdom, the study site of this work, was extracted. Also the heading direction of the respective street segment was extracted. These parameters were then used in GSV's API requests that returned, for each street segment, four images in four heading directions differing in 90 degrees: two of which have heading directions along the streets' axes and two of them are orthogonal to it. From now on, we refer to these groups of four images with the same geo-coordinates and different heading directions as 'locations'.

On the group of images from all such locations, attributes were extracted representing the visual stimuli of the streets. Examples of such attributes include the relative area of vegetation, the number of cars, and the number of pedestrians as well as landscape indices such as openness, imageability, and greenness (Zhang et al., 2018). The semantic segmentation model PSPNet (Zhao et al., 2017) and the object detection model TensorFlow (Abadi et al., 2016) were used in this task. Based on these extracted image features, the locations were automatically clustered into five classes. Finally, the 99 locations closest to the centroids of these clusters were selected for participant assessment in the user survey. This procedure ensured that the resulting 495 locations covered the diversity of streetscapes from the study area.

2.2 User Survey

A total of 1440 participants were recruited using Prolific, a platform for recruiting and financially gratifying survey participants. Because Prolific enables the screening of participants based on different criteria, we were able to obtain an almost equal split of males and other genders as well as of heterosexuals and LGBTQIA+. Besides responding to several questions on their socio-demographics, mobility behaviour, and personality traits, each participant evaluated 15 different locations according to four walkability perception aspects, namely, overall enjoyment, sense of safety, social vibrancy, and

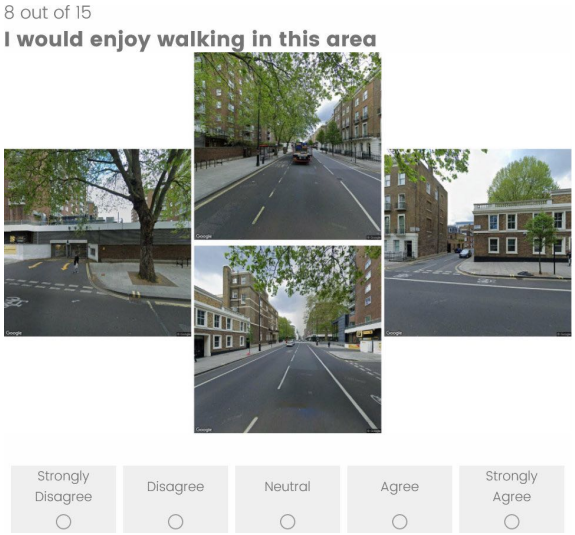

Figure 1: Street Walkability Assessment. An example of visualizations from our survey prompting the participant's rating of street walkability, in this case of the aspect 'enjoyment'.

perceived beauty (aesthetics). Hence, each participant provided 60 assessments on the same group of 15 locations. The assessments were provided through a 5-level Likert scale (Figure 1). The statements provided for assessing the four perception aspects were 'I would enjoy walking in this area', 'I would feel safe walking in this area', 'I think this area is socially vibrant', and 'I think this area is beautiful'. It is important to mention that in the survey the 15 locations were assessed for one perception aspect at a time and that for each aspect the order of the locations was randomized. This was to avoid any bias of leading the participant to provide coherent assessments for the four aspects for a given location. Overall, a total of 86,400 location assessments were obtained.

2.3 Statistical Analysis

To answer the question whether the perception of street walkability is affected by the individuals' socio-demographic attributes, we conducted statistical tests to verify if the average and variance of the ratings are statistically different across the socio-demographic groups. For that, the following sequence of statistical tests was conducted. First, the Shapiro-Wilk test (Shapiro and Wilk, 1965) verified whether each of the datasets being compared are reasonably symmetric about the mean and resemble a normal distribution. If one or both of the ratings discrete distributions, according to the Shapiro-Wilk test, do not resemble a normal distribution (i.e., $p < 0.05$), a conventional permutation test tested the difference of means. In either case, the Levene test (Mandelbrot, 1961) was used to

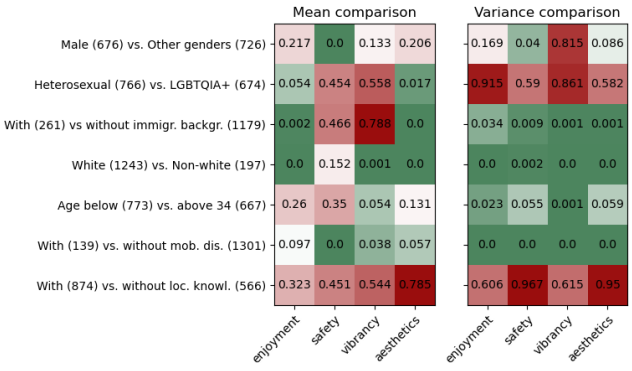

Figure 2: Statistical Comparison of Walkability Perception Ratings. The p-values of the tests compare the average and variance differences of the walkability perception ratings from the main socio-demographic groups. The number of participants belonging to each of these social groups is indicated in parenthesis.

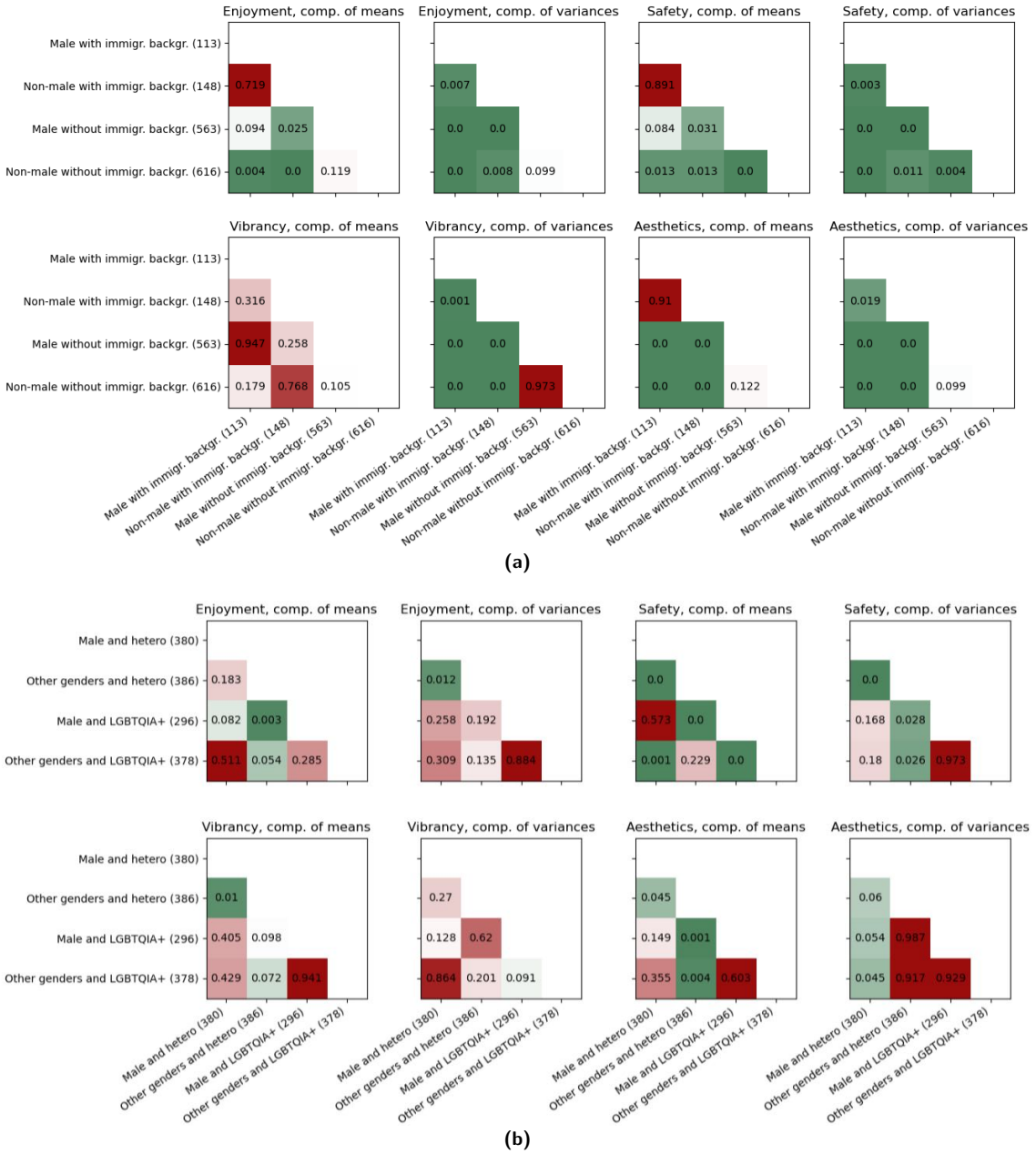

Figure 3: Statistical Comparison of Walkability Perception Assessments. The p-values of the tests compare the average and variance differences of the walkability perception ratings from groups resulting from the combination of socio-demographic factors, i.e., (a) gender and immigration background and (b) gender and sexual orientation. The number of participants belonging to each of these social groups is indicated in parenthesis.

verify the equality of rating variance across any two groups. In case that the variances of the groups are not statistically different, an independent t-test of equal means was conducted. Otherwise, the Welch's t-test of equal means was conducted. If the variances of the ratings from the two groups being compared are statistically equal, a standard independent t-test was applied to test the equality of means from the two distributions. If the variances are not statistically identical, the recommended Welch's t-test (Ruxton, 2006) was used instead. Both tests are two-tailed.

3 Results

Figure 2 shows the p-values of the tests comparing the average and variance differences of the walkability perception ratings from 14 main socio-demographic groups. The lower the p-values, the stronger the statistical difference between the social groups. Aligned with findings from Ramírez et al. (2021), males have different average ratings than participants of other genders. Mobility disability and ethnicity are factors that affect the perception of all four walkability aspects. Surprisingly, on the other hand, is that local knowledge has not been found to influence the people's perception. This might be explained by the low probability that the participants know and nurture an emotional relationship with any of the fifteen locations assessed by each of them. Immigration background and sexual orientation seem only to affect the perceived enjoyment of walking and the overall aesthetics of the streets. Figure 3 shows the p-values of the tests comparing the average and variance differences of the walkability perception ratings from groups resulting from the combination of two socio-demographic factors. It can be seen that gender and immigration background affect more the perception of walkability than gender and sexual orientation, especially with respect to the vibrancy and enjoyment aspects.

4 Conclusion and Outlook

This work presents statistical evidence that the subjective perception of street walkability aspects varies significantly across individuals of different socio-demographic factors. Theories relating the visually perceived street features to the subjective perception of their walkability need therefore to account for the influence of the individuals socio-demographic characteristics. In our future work we intend to investigate more deeply rating differences across social groups made of other combinations of socio-demographic factors.

Another research front to be explored relates to how socio-demographic groups, walkability perception rating, and streetscape feature content and disposition correlate. Proxies for the latter can be extracted by means of image interpretation techniques as demonstrated by the works in Section 1.1. We hope that the highlighted correlations between image content and the varied perception by different groups will further contribute to our theoretical understanding of the topic. Furthermore, it can lead to the design and implementation of more accurate predictive models of walkability perception based on now abundant street view imagery.

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Here Is Not There: Measuring Entailment-Based Trajectory Similarity for Location-Privacy Protection and Beyond

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While the paths humans take play out in social as well as physical space, measures to describe and compare their trajectories are carried out in abstract, typically Euclidean, space. When these measures are applied to trajectories of actual individuals in an application area, alterations that are inconsequential in abstract space may suddenly become problematic once overlaid with geographical reality. In this work, we present a different view on trajectory similarity by introducing a measure that utilizes logical entailment. This is an *inferential* perspective that considers facts as triple statements deduced from the social and environmental context, in which the travel takes place, and their practical implications. We suggest a formalization of entailment-based trajectory similarity, measured as the overlapping proportion of facts, which are spatial relation statements in our case study. With the proposed measure, we evaluate LSTM-TrajGAN, a privacy-preserving trajectory-generation model. The entailment-based model evaluation reveals potential consequences of disregarding the rich structure of geographical space (e.g., miscalculated insurance risk due to regional shifts in our toy example). Our work highlights the advantage of applying logical entailment to trajectory-similarity reasoning for location-privacy protection and beyond.

Keywords: trajectory similarity; location-privacy protection; logical entailment; model evaluation; space and place

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1 Introduction

Analysing trajectories as a means to study human mobility is not new (Long and Nelson, 2013; Miller et al., 2019). What is new, however, is that such trajectories are now widely available at an unprecedented spatial, temporal, and thematic resolution for individuals (Demšar et al., 2021; Siła-Nowicka et al., 2016; Xu et al., 2022). Over the past few years, this has fueled a rapidly growing marketplace for private companies to sell, buy, and utilize trajectory data for a wide variety of downstream tasks such as insurance assessment, health monitoring, predictive policing, and autonomous vehicle navigation.

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Whether the goal is to mine or learn from trajectories, most research relies on a common set of trajectory similarity measures. Such measures include spatial and spatiotemporal techniques (Magdy et al., 2015). For instance, Fréchet distance (Alt and Godau, 1995) is a common spatial similarity measure, while Dynamic Time Warping (Berndt and Clifford, 1994) falls under the spatiotemporal category. These measures often imply geometry-first thinking (Janowicz et al., 2022) at the expense of place-based context. Another category is semantic-aware measures where a third, thematic component is included, namely attribute labels associated with a trajectory *fix* (Hu et al., 2013). These measures can be applied to semantic trajectories (Parent et al., 2013). Matching or comparing attribute labels is performed using edit distance (Chen and Ng, 2004), Jaccard coefficient (Jaccard, 1901), and so forth.

As with all similarity measures, what matters from a theoretical perspective is that formal properties of trajectory similarity have to be matched to the task at hand. For example, Fréchet distance will be favored over Hausdorff distance (Hausdorff, 1914) if the curvature of the trajectories plays a bigger role in assessing their similarity, while the Jaccard coefficient will be used if thematic knowledge (e.g., place types) is prioritized in the comparison. Therefore, the entire process of finding a suitable trajectory similarity measure requires a detailed understanding of existing measures as well as deep domain knowledge of the application area. Even a small mismatch between measures and application areas can have substantial consequences. This is especially important because results from trajectory analysis are used further downstream as data features for a variety of automated, machine learning-based tasks.

2 Why Use Logical Entailment to Measure Trajectory Similarity?

While humans move through physical and social space, trajectory similarity is usually characterized in abstract, typically Euclidean space. This is done largely in order to (1) simplify trajectory representation and similarity computation; (2) develop measures that are domain agnostic, thereby improving their reusability; and (3) reduce the amount of auxiliary data required. However, mobility, from a domain perspective, does *not* happen in abstract space. Oversimplifying trajectory representation and ignoring geographical context can be problematic if mischaracterizing these attributes has real-world consequences.

Put differently, the properties of these measures can have unintended implications when applied to automated decision making regarding real-life geographical space. While some representational and computational simplifications are unavoidable, two major developments encourage us to rethink how to assess similarity. First, we no longer live in a data-poor environment with scarce computational resources. Secondly, the increasingly common usage of data features – such as similarity scores – to set policies, evaluate behaviours, and influence other aspects of social life, has far-reaching and often non-transparent consequences. This is even more important in the case of methods to protect personal location privacy before downstream data mining. To give an intuitive example, a privacy-preserving trajectory-generation model creates synthetic trajectories to protect individual privacy while supporting business analytics, e.g., for insurance companies. To prove that such synthetic trajectories can be used as proxies for real movement data, we need to demonstrate a high similarity between the synthetic and real trajectories. A suitable synthetic trajectory should resemble an individual's real movement patterns without revealing privacy-sensitive details, if not necessary for the application:

$$\mathrm{hd}(t,t') = \max_{(x_i,y_i)\in t} \left\{ \min_{(x'_i,y'_i)\in t'} \mathrm{d}\left((x_i,y_i),(x'_i,y'_i)\right) \right\} \tag{1}$$

Figure 1 shows two different trajectories, t and t', in geographical space using a place-based representation based on New York City (NYC) community districts from NYC Open Data[1]. The trajectory t is defined as an ordered set of fixes represented by n tuples $\{(x_1,y_1),(x_2,y_2),\ldots,(x_n,y_n)\}$, and its synthetic trajectory t' is defined as $\{(x'_1,y'_1),(x'_2,y'_2),\ldots,(x'_n,y'_n)\}$. Each tuple encodes a location in two-dimensional Euclidean space. While the two trajectories are geometrically similar according to their Hausdorff distance as shown in Equation 1, they pass through a slightly different set of community districts. This small shift may have large consequences in certain contexts. Insurance companies, e.g., may consider regional factors (e.g., neighbourhood crime rates) about where we live and travel when establishing premiums. They may associate a higher crime rate with a higher risk of vandalism and, consequently,

Figure 1: Two trajectories t and t′ overlaid on NYC community districts

charge drivers who visit these regions more for car insurance. Arbitrarily higher or lower fees may result as artifacts of a location privacy-preserving algorithm that alters the type of neighbourhood – with a higher or lower crime rate – a driver is believed to have visited. In NYC, crime rates are reported by community district, which are used here as the areal unit to illustrate an example presented in Section 4. This illustrates how a slight shift in Euclidean space, e.g., 50 meters to the east or west, may nudge a fix across a boundary and into a different geographical region, consequently changing the set of valid *entailed* statements about that fix.

We suggest approaching trajectory analysis by measuring trajectory similarity in terms of entailment, i.e., by the overlap between the sets of all possible inferences deduced from two trajectories. We then consider two trajectories to be similar if they generate the same or a highly overlapping set of entailment-based statements. This perspective is different from most previous work, because it is *inferential* and based on the logical consequence of traveling through actual semantically rich places. Similarity assessment, then, depends on three components: (1) the *terminology* component (TBox), i.e., a set of axioms specifying the classes and relationships within a domain of interest (Figure 2 as an example); (2) the *assertion* component (ABox), i.e., the set of statements about the world, expressed by using the terminology provided; and (3) the *entailment regime*, i.e., the set of rules to be executed over the ABox and TBox to derive inferences.

Next we will introduce how trajectory similarity can be measured via logical entailment. Then, we discuss the measure in the context of privacy-preserving trajectory generation. More concretely, we use the pre-trained version[2] (including trajectory datasets) of LSTM-TrajGAN (Rao et al., 2020) to showcase the impact of considering entailment in model evaluation.

3 Similarity as the Overlap of Entailed Statements

Given two trajectories t and t' (from Section 2) and a set of inferential rules, we can derive statements about trajectory fixes from existing contextual knowledge via logical entailment. For the sake of simplicity, in this work we only consider spatial relation statements that can be inferred by a qualitative spatial calculus, e.g., the Region Connection Calculus (Randell et al., 1992). Each statement has a

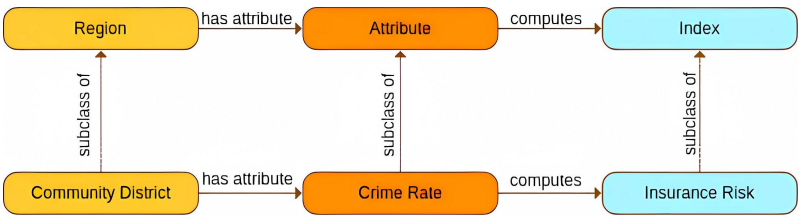

Figure 2: An example TBox involving NYC community districts in the domain of insurance risk estimation

triple form consisting of a subject s, a predicate p, and an object o, such as

$$\langle s\text{: BronxCommunityDistrict1}, p\text{: touches}, o\text{: BronxCommunityDistrict3}\rangle.$$

Such a statement and its inverse relation statement, in the example case

$$\langle s\text{: BronxCommunityDistrict3}, p\text{: touches}, o\text{: BronxCommunityDistrict1}\rangle,$$

will be used in measuring similarity if a trajectory fix `tf` is located in `BronxCommunityDistrict1`, represented as

$$\langle s\text{: tf}, p\text{: within}, o\text{: BronxCommunityDistrict1}\rangle,$$

In this way, a trajectory crossing `BronxCommunityDistrict1` is not counted as entirely dissimilar to a trajectory crossing `BronxCommunityDistrict3`. Lastly, no equal-relation or disjoint-relation statement is included in the similarity comparison.

Given a ruleset, the set of statements derived from logical entailment over a trajectory t (or t') is the union of all such statements inferred from all its fixes. A Jaccard coefficient applied on discrete sets can be used to compute the entailment-based similarity between t and t' based on the overlapping portion of their statements. We propose the measure

$$J(e,e') = \frac{|e \cap e'|}{|e \cup e'|} \tag{2}$$

where $J(e,e')$ is the entailment-based trajectory similarity, and e and e' represent respective statement sets derived from t and t'. We consider statements as *atomic* so that they are not decomposed into subjects, predicates, and objects to compare their similarities. Comparing statement sets is made possible because statements are fully materialized.

4 Evaluation Results

Table 1 first shows 10 sample trajectory pairs, along with their directed Hausdorff distance, entailment-based similarity, and insurance risk deviation. From the table, we observe that the Hausdorff distance (in kilometres) is within the range of $[0.78, 1.74]$, which indicates geometric similarity at an acceptable and stable level. However, our entailment-based similarity shows otherwise, i.e., less than 0.5 for all trajectory pairs.

Assume that an insurance company uses trajectory data to assess insurance risk in 2019. To estimate the insurance risk, we use standardized crime rate data from the 2019 NYC community district profile[3]. We then average crime rates of all community districts that a person crossed to estimate the

Table 1: Ground-truth and synthetic trajectories. The table includes a comparison between Hausdorff distance and entailment-based similarity of the first 10 pairs of ground-truth and synthetic trajectories. The toy example *insurance risk deviation* shows the difference in risk – artificially higher or artificially lower – calculated by a hypothetical insurance company using the synthetic trajectory rather than the ground-truth trajectory.

Trajectory pair ID	Hausdorff distance [km]	Entailment-based similarity	Insurance risk deviation
126	1.38	0.38	3.06
131	1.74	0.38	2.19
133	1.31	0.39	0.74
135	1.63	0.43	3.92
143	0.78	0.47	0.11
144	0.83	0.37	-0.05
170	1.17	0.45	1.43
177	0.63	0.46	0.22
286	1.61	0.43	0.79
289	1.13	0.47	3.42

corresponding insurance risk. The last column of Table 1 shows the deviation of insurance risk if using synthetic trajectories instead of real ones. While the exact deviation values will depend on the context of the parameters being characterized – in our case, using crime rate as a proxy for insurance risk – this toy example demonstrates that geometrically similar trajectories can give rise to unanticipated deviations in insurance risk. Therefore, using synthetic trajectories derived from LSTM-TrajGAN may lead to unreasonable insurance rates, caused by small shifts of trajectory fixes from one region to another. Lastly, we find that among 884 synthetic trajectories there are 417 trajectories containing fixes outside the community district data layer. Lacking crime rate data for those fixes, those synthetic trajectories cannot be evaluated adequately against the others.

5 Here Is Not There

While current methods ignore whether a user's fix is shifted into one neighbourhood or another, using entailment-based measures gives us a way to incorporate a *platial* perspective, or the idea that where a trajectory takes place in physical reality matters. While our example in this work is purely topological for simplicity, semantically rich assertions (e.g., social vulnerability) available in all these places could be included in Equation 2 without any modification.

The concept of trajectory similarity based on logical entailment has implications for the dilemma in protecting an individual's location privacy, i.e., how to protect privacy while preserving the utility of their data. In this work, we demonstrate that the importance of utility cannot be overlooked because human-centric downstream tasks are concerned with place-based context, which requires more attention in future work on location-privacy protection. As choosing the kind of places that matters to a downstream task often introduces a modifiable areal unit problem (Fotheringham and Wong, 1991), the usage of the TBox in measuring entailment-based similarity helps deal with it by pre-defining the relationship between places and tasks.

When computing entailment-based trajectory similarity, the statements considered for similarity reasoning depend on the actual rule set used to infer them. An example of such inferential rules is the transitivity of spatial containment. The more expressive the entailment regime used, the more statements will be entailed and materialized, influencing both the similarity score and the computational complexity of our measure.

6 Conclusions

In this work, we present a logical-entailment view of trajectory similarity. This inferential perspective leads us to compare facts that can be deduced from a place-based context. To compute entailment-based similarity, we measure the overlap of ABox statements and use spatial relation statements as an example. By evaluating the utility of a privacy-preserving trajectory-generation model, LSTM-TrajGAN, we demonstrate how the proposed similarity measure can reveal what is hidden by geometry-based measures operating on an abstract Cartesian plane, and how its usage increases awareness of the application area. In the future, we plan to use large-scale mobility datasets to determine the relevance of a statement to a trajectory based on TF–IDF (Salton and Buckley, 1988) and create local knowledge graphs to support inferences with the help of geo-enrichment services. Also, while in our study we use qualitative spatial calculi, we will explore how to generalize the proposed measure to other calculi, e.g., place-type hierarchies to compute place type-based trajectory similarity, or Allen's interval algebra (Allen, 1983) for temporal reasoning to compute order-constrained trajectory similarity. To sum up, our work demonstrates that measures that fail to take into account actual places and their social context may lead to unintended consequences in an era of massive utilization of machine learning-based recommendations.

Notes

1. https://opendata.cityofnewyork.us
2. https://github.com/GeoDS/LSTM-TrajGAN
3. https://communityprofiles.planning.nyc.gov

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Unveiling Place Perspectives with the Place Standard Tool

– Workshop Report –

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This report presents the outcomes of the workshop titled 'Unveiling Place Perspectives with the Place Standard Tool' held at the Fourth International Symposium on Platial Information Science (PLATIAL'23), which took place on 19–21 September 2023 in Dortmund, Germany. The workshop convened participants from diverse locations and disciplinary backgrounds during the symposium. Using the open-access participatory instrument known as the Place Standard Tool as a framework, the event provided a dynamic platform for engaging discussions and reflections. The tool offers a guideline around 14 major themes, which encompass our place experience. It has been widely adopted and implemented in a variety of contexts, and the workshop has built on its expertise to facilitate dialogue around a place that was selected as a workshop site. The participants conducted an exploratory walk and completed an evaluation of place, sharing their results in a final discussion. The workshop successfully unveiled diverse place perspectives, affirming efficacy of the Place Standard Tool as a versatile instrument for open conversations about place. The hands-on format, fostering informal exchanges, seamlessly aligned with the symposium's broader objectives of nurturing platial discourse and expanding it towards new disciplines and fields.

Keywords: Place Standard Tool; street survey; interdisciplinary dialogue; participation; place evaluation; spatial planning

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1 Introduction

The discourse surrounding place is inherently complex and interdisciplinary, presenting both an asset and a challenge. Place, as a subject, holds significance in extensive theoretical discussions and practical applications, spanning across geography, planning, as well as social and urban studies. The advent of emerging fields, driven by advancements in geoinformatics and widespread digitization, contributes to new approaches and innovative perspectives to this dialogue (Purves et al., 2019; Wagner et al., 2020). Even within such disciplines as cognitive science, or specialized domains like artificial intelligence and robotics, there are valuable insights into our perception, spatial orientation, and relationship with the environment. In the realm of practice, engagement with place takes various forms, including place-making initiatives, tactical urbanism, and grassroots activities. It serves as a powerful tool for community involvement, quality-of-life assessments, well-being evaluations, and the scrutiny of design projects and policy implementations from a participatory standpoint. This rich and heterogeneous landscape, while enabling inclusive and diverse discussion from various perspectives, simultaneously requires concerted efforts toward establishing common grounds for meaningful dialogues across different disciplines and approaches.

L Slivinskaya and V Cobs-Muñoz (2023): *Unveiling Place Perspectives with the Place Standard Tool*. In: R Westerholt and FB Mocnik (eds.), *Proceedings of the 4th International Symposium on Platial Information Science (PLATIAL'23)*, pp. 99–106

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PLATIAL'23 Fourth International Symposium on Platial Information Science (PLATIAL'23)
Dortmund, Germany; 19–21 September 2023

The motivation behind the workshop 'Unveiling Place Perspectives with the Place Standard Tool' stemmed from the recognition of this intricate landscape, aiming to provide a platform for dialogue among the participants of the 'PLATIAL'23: International Symposium on Platial Information Science'. Leveraging their shared interest in place and multifaceted expertise, the workshop aimed to facilitate a rich exchange of ideas, perspectives, and motivations by engaging with the adapted Place Standard Tool (PST). The tool offers a structured framework for holistic discussions about place, with a measurable view across diverse dimensions (Kleopa et al., 2022). Beyond being a profiling tool, it stimulates inclusive dialogues among stakeholders, facilitating the identification of community assets, challenges, and shared priorities (Gjorgjev et al., 2020; Horgan and Dimitrijević, 2019). This flexible tool, adapted for case studies in various contexts (see Cobs-Muñoz and Slivinskaya, 2023), engages communities through surveys, focus groups, walkabouts, and diverse settings (Kleopa et al., 2022). Originating from the Scottish Government, the PST consists of 14 themes, each assessing different aspects such as housing, green spaces, and public transport, among many others. It serves as a versatile instrument, promoting consistent assessments of new and existing places to ensure equitable access to high-quality environments (Place Standard partners, 2022). The tool prompts methodical discussions, considering physical and social elements, and identifies areas for improvement alongside existing assets (Gjorgjev et al., 2020; Horgan and Dimitrijević, 2019).

In the workshop, we explored the PST's methodology and its applicability in different settings. In the following sections, we explore the workshop's objectives and design, its implementation, the results and discussion, and a critical reflection and conclusions. The workshop was designed with three main sections: an introduction to the PST-adapted approach, an exploratory walk, and a results discussion, each contributing to a comprehensive exploration of place perspectives and the efficacy of the PST.

2 Workshop Objectives and Design

The workshop sought to reflect on the gap between theoretical discourse and practical approaches to place by fostering a dynamic conversation among participants from diverse backgrounds and disciplinary affiliations. In recognizing the significance of this interdisciplinary exercise, the hands-on format of our workshop became instrumental. Much of its success hinged on informal discussions and peer exchanges throughout its duration. As we delve into the workshop's objectives and design, it is crucial to acknowledge the main guiding principle: the diversity of approaches and perspectives on place must be recognized, accepted, and embraced. This principle guided us in setting the workshop objective to establish common grounds enabling meaningful interdisciplinary exchange among participants. The emphasis was on engaging partakers actively, fostering a collaborative dialogue, and exploring diverse perspectives on place. These objectives align seamlessly with the broader discourse on place presented in the introductory section of this report. The interdisciplinary nature of the workshop's objectives acknowledges the theoretical complexity of place, while the practical emphasis resonates with the applied aspects discussed in the theoretical discourse.

Given the above guiding principle and objectives, the workshop framework included an introduction to the PST, followed by an exploratory walk, a final results discussion, and the collective transfer of individual results into a common PST radar chart. Central to this design was the adaptation of the PST, a framework designed to structure conversations around place among stakeholders with varying knowledge and attitudes. The guidelines of Place Standard partners (2022) for a workshop state the following:

> 'The Place Standard tool can help you to find out what people think and feel about their place and to identify the strengths of an area. [...] You might also want to arrange a walk-about of your place during your workshop [...].'

This statement resonates with the workshop's and symposium's objectives and design. This made possible the adoption of these open access guidelines, including a street survey sheet, for the purposes of the workshop and modifying it in a context-appropriate way for the place selected as a workshop case study. The selection of the case study had to conform to a number of requirements. First, since the notion of place presupposes a certain level of familiarity with the area in question, all participants had to have a chance to visit the place. Secondly, in order to foster a good conversation within a short time,

such place must have a strong character easily graspable by participants on a short visit. Dortmund Hauptbahnhof (in short: Dortmund Hbf, which is the major one of Dortmund's train stations), and its surroundings seemed to be a suitable site within walking distance to meet the above requirements. Aptly, it also fitted into the symposium theme 'Transforming places', as the station building has been undergoing a massive, long-lasting reconstruction at the time the workshop took place. The area of the site was not delineated by strict borders or paths on purpose (e.g., following the adjacent streets or landmark buildings), as the nature of place evades such limits. The participants were free to walk around the station as far as time and their sense of the area allowed. This setting naturally limited the place to a walkable-sized site around the station building and adjacent spaces, including interior passages and the building itself.

With Dortmund Hbf selected as our case study, providing a tangible and character-rich setting, our focus turned to a structured evaluation facilitated by the PST. This conversation-oriented tool became pivotal in our approach to understanding and reflecting on the quality of the chosen location. The PST includes 14 themes that address different elements of place. For each theme, there is a leading question and a series of prompts. The themes and their leading questions are as follows:

(1) Moving around: How easy is it to move around and get to where I want to go?
(2) Public transport: What is public transport like in my place?
(3) Traffic and parking: How do traffic and parking affect how I move around my place?
(4) Streets and spaces: What are the buildings, streets and public spaces like in my place?
(5) Natural space: How easy is it for me to regularly enjoy natural space?
(6) Play and recreation: How good are the spaces and opportunities for play and recreation in my place?
(7) Facilities and services: How well do facilities and services in my place meet my needs?
(8) Work and local economy: How active is the local economy in my place and are there good opportunities for work, volunteering and training?
(9) Housing and community: How well do the homes in my place meet the needs of my community?
(10) Social interaction: How good is the range of opportunities which allow me to meet and spend time with other people?
(11) Identity and belonging: To what extent does my place have a positive identity that supports a strong sense of belonging?
(12) Feeling safe: How safe does my place make me feel?
(13) Care and maintenance: How well is my place looked after and cared for?
(14) Influence and sense of control: When things happen in my place how well am I listened to and included in decision-making?

The same themes and the street survey sheet template provided by Place Standard partners (2023) were used (Figure 1), excluding their introductory section as it was approached in the first section of the execution of the workshop. The discussion section of the workshop was designed to share results and transfer individual evaluations to a common PST graph. The individual results lead to a conversation around the highest and lowest evaluation points and answering the question 'If you have a chance to change one thing about the site so that it becomes a better place, what would it be?'

3 Workshop Implementation

The workshop was open to all the participants of the symposium. It followed a paper presentation session where the work from Cobs-Muñoz and Slivinskaya (2023) was offered. The said presentation offered a glimpse of what can be expected from working with the PST with a similar adaptation but in different contexts. This, in particular, set an interest among participants working with participatory methods themselves who joined the workshop. In total, eleven people took part in the activity. Accordingly, the workshop was executed following the previously mentioned structure. It started with an introduction to the PST, explaining its conceptual underpinnings and providing practical instructions. Then, the participants were taken on an exploratory walk around Dortmund Hbf (Figure 2), the main site of the workshop, to conduct the PST evaluation with the help of the provided survey sheets. Subsequently, upon return to the venue, the participants shared their reflections on defining, understanding, and conceptualizing place from their disciplinary or practical viewpoints.

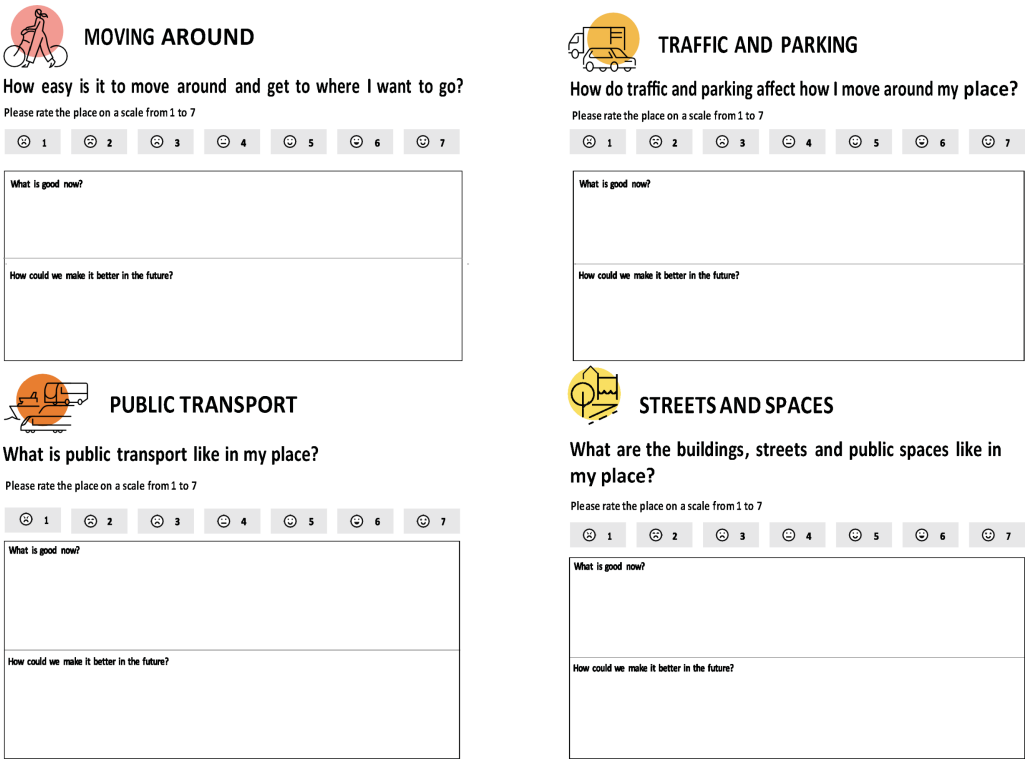

Figure 1: Extract from the Place Standard Tool survey sheet used in the workshop. Example themes for 'moving around', 'public transport', 'traffic and parking', and 'streets and spaces'. Adapted from Place Standard partners (2023)

Figure 2: Exploratory walk towards Dortmund Hbf. Photo by Uwe Grützner, TU Dortmund University

The introduction guided the participants through the street survey form and discussed two key elements in order to establish a common ground for place conversation. First, we discussed the importance of place as a constituent of our daily life in the city. The main takeaway of the said process was that place serves as an umbrella term that encompasses the essential needs that structure urban life. These include not only practical functions, such as moving around or using public facilities, but also such high-order needs as identity, belonging, and sense of community, which are no less essential for our well-being. The second key element addressed general principles for assessing places. The notion of place as we used it for this workshop originates from a humanistic geographical school of thought (Cresswell, 2014; Relph, 1976; Tuan, 1979). As such, it is rooted in the human perspective. It recognizes the individual and subjective nature of our place experience. Accordingly, any attempt at evaluation of such experience will necessarily be of a subjective and individual nature for all participants. At the same time, the PST is aimed at looking into a collective inter-subjective assessment of place, which requires shared premises and criteria agreed by participants. The participants were invited to think of their place in an inclusive and future-oriented manner so as to project a prospective vision of a better place for all. Such perspective demanded an empathetic stance and encouraged the participants to reflect on the diversity and open nature of place in providing quality of life for all.

Following the introduction, the participants, guided by the workshop facilitator, set off to the site, Dortmund Hbf. The participants were encouraged to fill in the PST forms on the go and finalize them at the end of the walk at the plaza in front of the station. Observing the participants spreading around the area, it was noticeable how their tactics of exploring the place differed. Some stopped by and lingered frequently, while others walked briskly to cover the most distance and see the place from all sides. The planned 40 minutes on the site passed quickly, and the participants gathered around to pen down their impressions and notes on the forms. Some were focussed on filling in their forms, while others had already entered conversations about particular observations or content of certain themes. This heterogeneous behaviour gave the first hints of the success of the dynamics, as the participants easily engaged with the place in different ways but following the same framework. Back at the nearby symposium venue, the participants were asked to transfer their PST graphs onto an A0-format poster with a blank PST graph (radar chart) to visualize the resulting group evaluation of place. The discussion about place started while the participants were drawing and passing over text markers around the poster, justifying the reliance on hands-on tools for the workshop. Upon completion of the common PST graph, the wrapping-up discussion, led by the workshop facilitator, started. The participants were asked to comment on their highest and lowest evaluation points and give a brief answer to the question: 'If you have a chance to change one thing about the site so that it becomes a better place, what would it be?' The highlights and results of the discussion will be presented in the following section.

4 Results and Discussion

As anticipated, the discussion revealed the subjective and the shared, the individual and the collective in a resulting snapshot of impressions about place captured by the collective final PST radar chart (Figure 3). Shared opinions complemented by insightful and variegated individual observations all added up into a multilayered picture of place as seen by the workshop participants. Out of this rich polyphonic discussion and pictorial collective result, a number of reflections can be made on the nature of place as a complex notion and the nature of tools that we use to access and learn about places.

In the context of the collective PST radar chart (Figure 3), the average value registered at 4.0 out of 7.0. In an initial approach, three themes emerged with values around 5.0, leaning towards an overall positive appreciation of place: public transport (average: 5.1), facilities and services (average: 5.1), and streets and spaces (average: 5.0). These results underscore the transport-centric nature of the explored location and its robust connectivity. According to Place Standard partners (2023), commendable public transport is characterized by its affordability, reliability, and well-connectedness. This attribute not only diminishes reliance on cars but also promotes environmentally friendly and health-conscious modes of transportation. Similarly, the theme of streets and spaces contributes to crafting an appealing place where people relish spending time. Particularly in a locale like Dortmund Hbf, distinctive streets and spaces play a crucial role in aiding navigation. Likewise, easily accessible local facilities and services (as reflected in the positive assessment of the respective theme) contribute to fostering independent, healthy, and fulfilling lives.

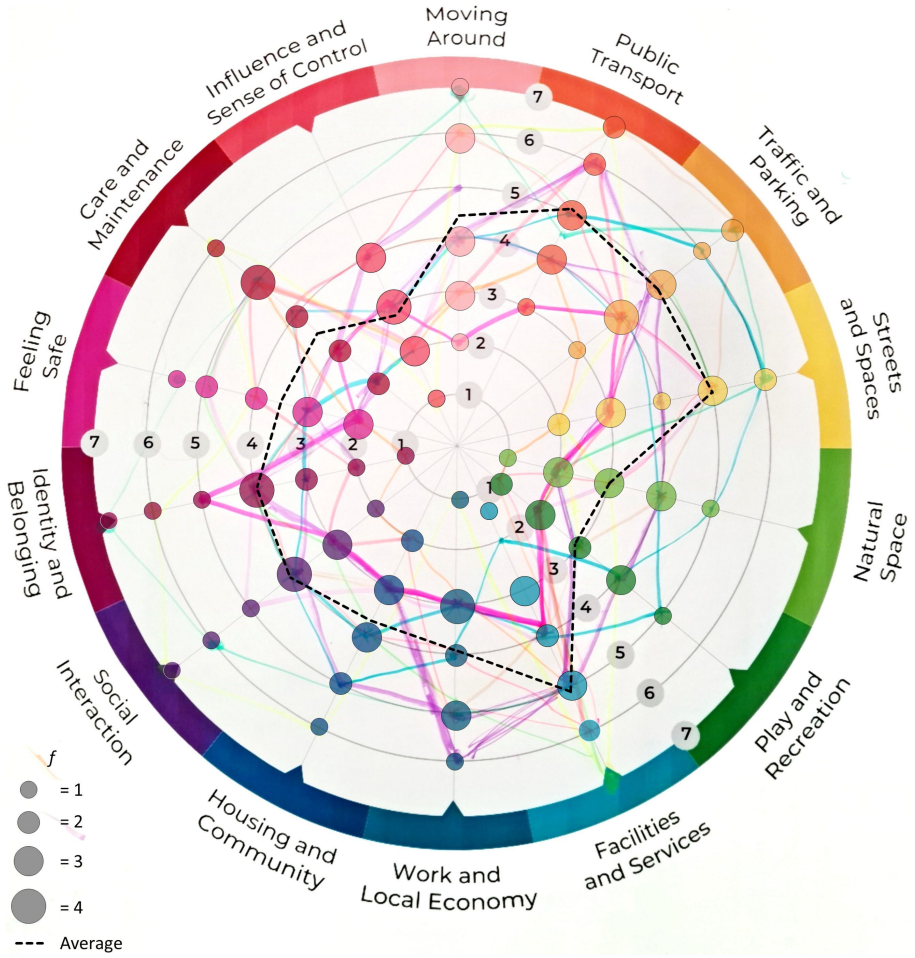

Figure 3: Final result depicted as a collective PST radar chart. The visualization is frequency-based.

Conversely, themes with average values of 3.0 or lower include natural space (average: 3.0), play and recreation (average: 2.8), and influence and sense of control (average: 2.8). As per Place Standard partners (2023), well-maintained natural spaces bring a multitude of benefits, encompassing improved health and well-being, support for wildlife, flood reduction, and enhanced air quality. However, in an environment dominated by concrete, such as Dortmund Hbf, the lower valuation of this theme aligns with expectations. Similarly, the low averages in the play and recreation theme highlight the potential for improvement in the quality of life and health and well-being of the community. Adequate spaces for play, catering to various age groups, are pivotal for personal development and the enjoyment of leisure, cultural, and sporting activities. The theme of influence and sense of control, averaging 2.8, indicate room for enhancing community engagement and empowerment. Effective decision-making involvement can contribute to building stronger communities and improving the overall quality of the place, fostering a sense of positivity among residents.

The most notable characteristic made apparent during the discussion lay in the difference between local participants, who were already familiar with the place and local context, and symposium guests from elsewhere. The notion of place includes the dimension of time to it (Beidler and Morrison, 2016), albeit not always explicitly. The PST provides a snapshot of place as per the moment of its assessment. It also projects a future vision of a better place based on such assessment, thus adding another time dimension. However, the very notion of place already contains a temporary dimension to it as per definition, as it presupposes such notions as attachment, sense of belonging, and meanings, all of which require time and duration to form (Low and Altman, 1992). In this way, it would seem apparent to expect that locals would know their place better and thus be more precise in their assessment. However, non-local participants, in fact, shared some insightful observations, which were drawn from their own experience. This revealed that our experience of places is accumulated and enriched throughout time

across locations, and we are able to see and read new places through the lenses of our former place knowledge. This also suggests that our knowledge of place does not account only for thick descriptions of locales but contains underlying invariant structures of place experience that manifest across our encounters with familiar and new places.

A key observation that emerged throughout the wrapping-up discussion concerned the subjective nature of our place experience and the similarly subjective nature of any assessments. Such subjectivity appears not only in regard to more complex notions, which necessarily involve affective components (e.g., sense of community or feeling safe) but also in regard to seemingly neutral themes such as public transport or traffic. Whereas the participants shared some factual observations (e.g., availability of parking), their assessment differed, as illustrated by the spiking differences in the resulting common PST graph. This proved that public spaces that can be functional from one point of view could be assessed by others as rather dysfunctional based on individual needs, attitudes, preferences, and other subjective factors. At the same time, as again illustrated by the common PST graph, some patterns evidencing collective impressions also emerged, allowing for a broader picture of the place beyond individual views. In fact, upon sharing their results and commenting on the lowest and the highest points, many participants received supporting voices expressing agreement or solidarity. Contrasting impressions did not spark argumentative debates as to whose vision of place is more valid or correct. Instead, the unalike comments were appreciated by the group as they revealed more facets of place from varied perspectives. This reasserted the value of place as a multifaceted and open notion emerging out of personal experience, as well as social interactions.

The workshop discussions also highlighted the open-ended framework character of the PST as a tool. Fourteen themes covering a broad range of place-related topics are open for interpretation from those who use the tool or analyse its results, as there is no fixed content to any of them. The themes and subdivided categories outline the most general topics, and those often overlap (e.g., 'moving around', 'public transport', and 'traffic and parking' categories are rather difficult to compartmentalize in a precise way). In this manner, the PST has to accommodate possible variations and diverse interpretations without compromizing overall coherence and needed shared understanding. The answers given by the participants illustrated this feature of the PST very well. For some, influence and sense of control had to do with the lack of public participation in the current redesign of the station, while for others, it was severely compromized by regular delays of trains in a way that station users have no control over how much time they have to spend while taking trains there. Such different readings, however, did not obstruct the dialogue but were taken as an added value to it, attesting to the relevance of the PST if employed as designed, recognizing its character.

5 Critical Reflection and Conclusions

The workshop encountered challenges due to the tight two-and-a-half-hour schedule within the comprehensive symposium programme. This required a focussed and curated approach, with hands-on support to quickly familiarize participants with the Place Standard Tool (PST). Another constraint was the deliberate omission of detailed socio-economic, historical, and current contextual information about the workshop area. This decision aimed to prioritize a rich exchange of perspectives over exhaustive site understanding, focussing on acquainting participants with the PST's conceptual framework and practical application through a specific real-life example. Despite these challenges, the workshop was successfully executed within the time frame. This curated approach, coupled with hands-on support, efficiently familiarized participants with the tool.

The strategic emphasis on learning about the PST's conceptual framework and practical application served the workshop's goal of gathering diverse impressions for reflective analysis. The speculative nature of the workshop's discussions, grounded in hypothetical premises, did not compromise the validity of the results. Instead, it aligned with the workshop's objective, contributing to the success of unveiling diverse place perspectives. The lively discussions reaffirmed the PST's efficacy as a versatile instrument, providing a structured framework for open conversations about place. The hands-on format, encouraging informal exchanges, seamlessly aligned with the symposium's broader objectives of nurturing platial discourse. Positive participants' feedback indicated contentment and interest in integrating the PST into future research, showcasing the workshop's success in fostering interdisciplinary dialogue and advancing our understanding of the intricate fabric of place.

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Automating a Quantitative Representation of Urban Form: Integrating Built Environment Analyses as Input for Studies Relating Tangible and Intangible Dimensions of Places

– Workshop Report –

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To study the effects of urban environments on intangible dimensions of places, such as place attachment, in terms of their urban planning principles requires for spatial configurations and patterns in the urban form to be identified in a systematic and reliable way, ensuring comparability and allowing the evaluation of different approaches to urban design. Built environments are traditionally broken down into constituent structures, often analysed in parallel, if not independently, to understand urban scenarios. As a results, the interrelationships between the structures as coexisting aspects are lost and, with it, part of the complex character of the urban scenarios. A methodological approach to automate urban analyses of tangible aspects and integrate the results into a quantitative representation of physical and design patterns of places was presented in a workshop held during the Fourth International Symposium on Platial Information Science (PLATIAL'23) with the aim of gathering expert opinions and evaluate the methodology. Through the contributions and discussions, the strong need to consolidate a model to describe urban scenarios through the simultaneous consideration of multiple tangible aspects was identified. Likewise, the potential of the approach for exploring the interdisciplinary character of places and possible benefits of integrating different analysis and data gathering techniques was regarded during the workshop as positive.

Keywords: workshop; methodology; automatization; urban analysis; spatial configurations; place

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1 Introduction

Within the interdisciplinary field of environmental psychology, the concept of place attachment has been defined as pertaining to the emotional bonds between inhabitants and the contexts in which they carry out their lives, usually referring to a positive association with said places and thus indicative of place quality or of environments exhibiting quality of living conditions (Moulay et al., 2018). Such relations between people and places had been initially considered in the literature to derive from emotional/symbolic and functional bonds, corresponding to the concepts of place identity and place dependence, as sub-dimensions of place attachment (Stedman, 2003; Williams et al., 1992). This model has been subsequently complemented with further dimensions as, e. g., social bonding as representative of the social dimension of places (Luo et al., 2016) or regarded as influenced by familiarity, or cultural backgrounds and contexts (Low and Altman, 1992; Ujang and Zakariya, 2015).

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Parallel to this psychological dimension by which places can be regarded phenomenologically from the perception and cognition of their inhabitants and users, permanent processes of creation and transformation of places signify constant changes to these environments. Among the numerous ways in which cities continuously transform themselves, urban development projects (i.e., urban design projects) can be one of the most clear-cut modes in which urban environments are established or redefined, be them in the form of new urban areas or urban redevelopment projects, changing the contexts in which human life occurs under clear guidelines deriving from the design process. Such undertakings are directly creating or transforming places every time the resulting form of the urban context becomes 'alive' through the use given by its residents and users, for every environment becomes a 'place' when its spatiality and components, be them built or natural, are understood in terms of the relations, interactions, meanings, and experiences that humans have with them (Jenkins, 2004; Relph, 1976). Simultaneously, the character and qualities of the places originating from the physical environments produced by these processes of transformation are related to the guidelines and principles shaping their design. The success or failure of these new or transformed urban contexts as places can be thus said to be, even when not entirely, a result of the urban design principles implemented, of the focus or consideration given by its conception to different aspects of the urban reality, and also a consequence of its omissions or the neglect of given dimensions of urban life. The critique raised, e.g., in the German public discussion of the last decade against processes of city production, development, and intervention of urban areas, especially those produced by the real estate sector as a mean for economical production, refers not only to the physical characteristics or spatial configuration of said developments but also to their inability to provide liveable environments and to respond to current and future-oriented guidelines to urban life, to an evolving concept of urbanity, and to the central role of cities in shaping contemporary societies (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2022; Deutsche Akademie für Städtebau und Landesplanung, 2014).

In this sense, an evaluation of the quality of the urban places that have resulted from different urban design approaches requires the analysis of non-tangible dimensions, as allowed, e.g., by the concept of place attachment, against the backdrop of the urban design patterns that can be read from the already resulting physical environment produced by the conception. Such an approach aiming to establish what features of the urban context promote positive feelings of bonding between people and places warrants the analysis of these two dimensions on already established and functioning neighbourhoods, in which such relations have already come to fruition. Here, the perspective of a 'reverse urbanism' approach, as suggested by Noyman et al. (2019), by which human behavioural patterns are used to evidence 'the success rates of highly performative urban places' and provide strong foundation for urban design, planning, and decision-making practices, is appeal to. But the need for 'sufficient input for "soft" psychological model parts and factors' (Vogelbacher et al., 2019) becomes essential. For this purpose, a systematic translation of urban design (i.e., spatial) configurations into quantitative data accounting multiple factors could serve as overarching yet deep representation of that tangible dimension and allow an understanding of the urban form without omitting its complexity. This quantitative description can then be analysed against intangible aspects of place in following steps of analysis. The automatization of these urban form analyses and the linking of their results to certain spatial components of the environment could simplify their integration into a coherent and multifaceted blueprint of urban areas, ensure comparability between case studies, and facilitate further research on the field.

A methodological approach aiming to automate different quantitative analyses of urban environments in terms of spatial configurations and urban design features, which would allow for the integration and simultaneous consideration of different dimensions of urban areas, has been put forward as discussion topic for a workshop carried out in the context of the Fourth International Symposium on Platial Information Science (PLATIAL'23) with the objective of gathering expert opinions on the methodology presented as well as valuable insights regarding further subjects, dimensions, and methods of analysis that could be included to this approach. The method itself, as well as the results of the workshop, are presented in the following pages of this report.

2 Methodological Approach

The complexity of urban environments arising from the multitude of interacting systems and factors, as well as from their constantly evolving nature, has traditionally been approached by means of its dissection in composing systems or layers, each of them representing different aspects of urban life and

the infrastructures that support them. Still, the cognition of urban surroundings by its inhabitants and users does not usually involve such differentiation. Urban reality is usually perceived as a mixture of all these interacting systems, wherein similarities and differences between places and their patterns can be recognized, while the particularities that makes these out can remain hard to pin-point. Familiar and contrasting situations are more easily identifiable for someone comparing places from the point of view of their own experience. In this sense, the inspection and focus on certain dimensions and aspects of places becomes highly relevant for the analysis of urban environments. With it, the depth and detail with which the world is observed can be intensified, but at the same time the comprehension of a given built environment in its integrating nature is bound to be left out. The contribution that current advances on computational techniques and capacity provide to the simultaneous examination of different aspects of urban form allows for this complexity to be approached systematically with increasingly more accessible resources. Bringing into view many systems at the same time while retaining their intricacy can be a daunting task, especially using traditional approaches. 'It may seem that these nondiscursive properties are elusive, or impossible to quantify, but the patterns are no less real for their complexity, and also there to be found by the machine' (Hanna, 2022). The field of urban analytics has made use of new forms of data as well as innovative computational approaches throughout the last decades to allow a closer look into these urban processes (Malleson et al., 2022).

Current technologies that have been intensely leveraged in this field have allowed for more aspects of urban reality to be brought into focus with increasing scopes of application and depth. They have allowed for previously existing methods of urban analysis to be carried out in greater extends, e.g., increasing the scales of analysis, the comprehensiveness of their application, and extend of variables considered. They have also allowed for other sources of information to be tapped and utilized more effectively as they could have before. At the same time, they have allowed for new methods of analysis to be developed, expanding the ways urban reality can be probed. Yet, the isolation of certain aspects of urban environments to evaluate their possible relations with aspects of urban life and the behaviour of people remains as the usual approach to exploring the interrelationships between tangible and intangible dimensions of places. With them, particular linkages between aspects of environment and behaviour can be thoroughly investigated, but the effect to which other unobserved factors can influence these interactions is left out of the scope of analysis.

The methodology being considered here seeks to approach the analysis of built environments as the sum of several of these different aspects. The automatization of (traditional or innovative) urban analyses and their integration into an inclusive image of urban neighbourhoods in terms of their tangible structures would allow for spatial configurations to be identifiable in terms of quantitative data. The aim is to reduce the complexity of urban environments for the purpose of exploring and understanding them, without overlooking the multiplicity of factors involved or exploring particular relationships in isolation. This integrative picture of built urban contexts that retains the inherit interrelations within their structures can be seen as a translation of the urban design principles applied to their conception and development, as these have materialized in the resulting urban environment, i.e., in the urban reality. To this effect, the approach integrates different quantitative analysis methods and transposes their results to the cartographic representation of the urban area to retain the spatial relations between them. Data on each analysis performed is stored in relation to different spatial components of the urban structure (buildings, plots, streets, and blocks) to serve as a multi-level, multi-dimensional depiction of the spatial configurations, which can be accessed throughout different scales of inspection depending on the requirements of further analyses relating intangible aspects of places. In this sense, this methodological approach is to be regarded as a part of a broader study relating the perception of urban places to their built form, through which the latter can be explored and described. Nevertheless, the application of this integrative method can be expanded to other purposes, as a mean to examine built environments in their complexity, for which the automatization of the process and accessibility to tools and sources of information becomes relevant.

Dimensions of Analysis. Starting from traditional methods of urban analysis, the following aspects of urban environments are considered within the scope of this methodology. An analysis of the built structure follows on the basis of aspects such as density, building typologies, and spatial arrangements such as street configurations, edges, barriers, and sightlines. In terms of uses and functions, the identification of land uses as pertaining to formal determinations, as well as the particular activities carried out in buildings, is complemented with the functions of open spaces and the structures they form, such as networks of public spaces and green spaces. The mobility dimension is overlayed to the

analysis of open spaces, considering not only the analysis of street networks in terms of their hierarchy and types, but also in terms of distribution, accessibility, and centrality-integration (space index). The analysis of modes of transportation complements this network analysis and allows for further aspects particular to each system (pedestrian, cycling, motorized, and public transport) to be also integrated (walkability, quality of infrastructures, restrictions, parking, frequencies, etc.).

Beyond these traditional layers of analysis of urban structures, the integration of innovative methods of analysis and data collection, which could provide further insights into the built environment, is seen as a possible way to expand the scope of the approach. To that effect, some methods have already been tentatively identified, such as multivariate density analysis, e.g., spacematrix (Berhauser Pont and Haupt, 2021); visibility analyses like 2D/3D isovist fields analysis (Wu et al., 2023); volume index/openness analysis (Zhao et al., 2020); and the use of geo-referenced data scraping. Techniques for mapping pedestrian behaviour using public GPS tracks or agent-based modelling (Malleson et al., 2022), as well as the analysis of traffic information, could complement mobility infrastructure analyses. Furthermore, remote sensing and image recognition techniques could provide a closer look at surface distribution patterns in streetscapes (Hamim et al., 2023) or the distribution of vegetation, and it could facilitate the surveying of design aspects in façades. However, the inclusion of these methods in the approach needs to be further evaluated and was also subject of discussion in the corresponding workshop.

Tools and Data Sources. Aiming towards the replicability of the approach, the selection of tools and data sources focusses on the use of accessible tools and information that, to the extent possible, are publicly available or can be freely used. For this purpose, QGIS, as an open-source geographic information system, is used as the main platform for integrating information from different sources, performing and automating spatial analyses, and spatially referencing the results of the different analyses. Within it, the model designer interface (Processing Modeler) is used as an entry-level mean for the automatization of the analyses, allowing the programming of complex processes though a graphical interface and facilitating the implementation of the methodology by users not qualified in programming languages. Geocoding functions integrated to QGIS that make use of readily accessible geodata (Nominatim) are used within the approach to translate semantic information like addresses and names of place to geo-referenced locations. The functionality of the software can also be further expanded by the use of open-source extensions, through which the integration of certain urban analysis can be achieved. Extensions like OSM Downloader or QNEAT3 (QGIS Network Analysis Toolbox) have been integrated so far.

Regarding data sources, the accessibility to information is ensured by the use of publicly-available data. In the German context, where the case studies of this study take place, basic cartographic information and geodata on a variety of topics can be accessed publicly and, depending on the state, without cost. This provides a reliable source of information that ensures to some extend the replicability and comparability of the studies, given that the standards for the geodata infrastructure (layers, fields, data-types, and metadata) are coordinated at the federal level through the GDI-DE (Geodateninfrastruktur Deutschland) and the implementation of the INSPIRE guidelines for the creation of infrastructure for spatial information in the European Union. The available information includes vector data (e.g., cadastre information, formal development plans, and UTM-tiles) and raster data (e.g., digital elevation model, digital orthophotos, and satellite image data), or 3D information (3D building models LoD2). Furthermore, open-source geodata from OpenStreetMap is also used as an important source to complement the cartographic information and geodata available through the official channels. Both sources can be subject of inconsistencies and missing information. For this reason, they are used simultaneously under the consideration of principles of availability and compatibility that arise from the automatization of the analyses, but that are applied retroactively and systematically throughout the process.

Projected Outcomes. The results of the different analyses are to be compiled at the building, plot, street, and block level as to be able to relate them to one another spatially. This information is stored within the different objects (areas and buildings) in the form of scores (continuous data) or types (categorical data) depending on the corresponding evaluation criteria for each analysis. Considered together, these different results are intended to provide a quantitative description of the spatial configurations of a given urban context that can be dynamically computed in relation to a particular place (e.g., residence) or sequences of places (e.g., path to work) for different respondents.

This allows for the information on the built environment to be matched not only generally to the place as a whole but to be regarded from the perspective of the inhabitants as individuals relating to their environment. When considered in relation to the broader urban area (e.g., at the neighbourhood level), the computation of the spatial configurations, participating structures, and the results of their evaluations can provide an overview that will allow the comparison of different study areas in terms of the statistical analysis of the measurements for each aspect integrated to the methodology. Further, on the basis of qualitative methods applied according to the aims of the overarching study (e.g., relating place attachment to built environment), the performance of the different case studies will also be comparable against the backdrop of their spatial configurations, i.e., of their urban design guidelines.

3 The Workshop

Within the framework of PLATIAL'23, one of the workshops carried out, titled 'Automatization of Spatial Analyses of Urban Areas', served the purpose of evaluating the methodological approach presented above and to gather expert opinions on the implementation and methods of analysis considered. The main question posed to the participants to introduce the topic and prompt the subsequent discussion read: 'How to automate spatial analyses to streamline a quantitative representation of the urban form, such that it can be used as input for further research into urban form and intangible aspects of place?'. The main objectives, as stated during the workshop, were to discuss the possibilities and challenges for the automatization of traditional and innovative urban analysis processes, to explore the scope of application of the generated data as features of geospatial components, and to discuss the potential and limits of using this approach as groundwork for further urban studies.

First, the topic was introduced to the participants, including the presentation of the current state of the development of the workflow in QGIS and its application in a particular case study, located around the neighbourhood of Phoenix See in Dortmund. The active participation of the attendees was structured in two phases. In the first part, named 'Exploring the Approach', the group was divided into two smaller subgroups with no more than ten participants to facilitate the discussion. The aim of this first phase was to prime the participants into pondering about the application of this method from their own research perspectives and to propose analysis methods and application scenarios for this methodology. For this, the discussion within the groups was divided into two sub-phases, correspondingly named 'Further Analyses' and 'Possible Applications'. Before starting, participants were given a handout containing questions to help guide the discussion in each sub-phase and where they should also document their contributions and thoughts in each subject. The discussion in each sub-phase followed the following structure: In the first 20 minutes, using the Think-Pair-Share moderation technique, participants were asked to first reflect by themselves on the questions at hand and then to discuss their thoughts with a neighbouring attendee, to finally share their contributions to the group. In the last 10 minutes foreseen for each sub-phase, with the help of a voluntary co-moderator, the group was asked to write down keywords summarizing their contributions on cards and to organize them in a whiteboard. In the case of the first sub-phase, contributions were to be evaluated through a low-hanging fruit analysis and placed accordingly on the whiteboard, following the corresponding diagram. Contributions to the second sub-phase were to be grouped by topics according to categories defined on the go by the participants. For the first sub-phase, under the title 'Further Analyses', the guiding question provided posed was 'What other types of analysis can be integrated to this approach?'. The work sheet invited the participants to share ideas regarding further features of urban environments to be considered for the analysis, (innovative) methods of urban/spatial analysis to be implemented, and sources of information/tools required. For the second sub-phase, titled 'Possible Applications', the main question on the work sheet read: 'How can these new layers of information be used as input data for further interdisciplinary research on places?'. Participants were inquired on aspects of place that could be explored with the approach, relevant data or relationships between parameters, and advantages and disadvantages that may come with applying the approach on the research topics suggested.

The whole group was brought back together for the second phase of the workshop after a short break. In this second part, the results of the first phase were presented by the co-moderators and a general evaluation was carried out with the objective of gathering the opinions of the participants regarding the overall conception, structure, and applicability of the methodological approach in its entirety. The evaluation was conducted through a series of general questions on the advantages,

disadvantages, suggestions, and concerns that the participants had identified when working on the topics of the first phase. This section was moderated using Mentimeter, an online platform with which the participants could respond to the questions through their mobile devices and afterwards see all answers offered by the group through the projector in the room and allowing the evaluation to take place at a steady pace and within the time available. After collecting the answers for each question, a short time was also allotted to 'up-vote' answers from other participants, which allowed a certain consensus on the commentaries to be expressed by the group, helping the author to identify focus points within the answers. At the end of the workshop, the participants were asked to share their concluding comments and thoughts on the topic. This gave them the opportunity to speak openly and express their opinions outside the framework provided by the assessment questions.

3.1 Responses and Contributions

During the first phase of the workshop, 12 participants documented their contributions in the provided work sheets. Through these, several suggestions were provided concerning the methods of analysis that could be integrated into the methodology, as well as possible application scenarios of this approach for further research, corresponding to the topics of the first and second sub-phases. The results of these sessions are summarized in the following paragraphs.

First Sub-Phase: Further Analysis. On the topic of further analyses that could be incorporated into the methodology valuable contributions were provided by the participants on all the guiding questions. The features of the urban environment suggested for consideration can be grouped under the following categories: environmental factors, such as micro-climate, weather, air quality, sound/noise levels, light pollution, daylight/shadows, wind, and smells; street furniture, like lighting elements, benches, planters/vegetation, electricity boxes, trash cans, and drinking fountains; mobility-related features, mainly those on or relating to sidewalks, like bike/scooter/car parking spaces, and bike lanes; features of the built environment, such as specific elements, like city gardening areas, ground surfaces, and façade elements (sequence of openings and façade rhythm); but also properties of the environment, such as building quality, mixture of uses, design glitches, urban thresholds and the porosity and transparency of structures; evolving aspects of place, like the history of the place, its development through time, architectural styles present, and maintenance status of buildings or areas; and lastly, experiential aspects of place, such as the feelings experienced by users (e.g., feeling of safety), local and global perceptions, and digital geographies (e.g., Curbspace).

The following methods of data collection and analysis were suggested by the participants to approach the aforementioned features of places: crowdsourcing for experiential aspects of place; remote sensing techniques, i.e., object detection, for streetscape elements and other built environment features; social sensing for social environments and local/global perceptions; simulations techniques, e.g., ENVI-met, for environmental aspects like micro-climate, wind speed, or solar radiation; VR experiences for digitally testing/exploring experiential aspects of place; machine learning techniques, e.g., GeoAI, for predictive analyses of local/global perceptions (casual reasoning) or for processing information from development plans; space index techniques, e.g.centrality/betweenness, for analysing mobility networks; as well as sentiment analysis, for processing information gathered in participation process. Finally, a series of analysis methods that were highly discussed in both groups and that could be referred to as 'sensescapes', aimed at approaching different types of sensory information that could be also mapped and included in the methodology. The analysis of these 'smooth' scapes included, e.g., the mapping of soundscapes, smellscapes, tastescapes, and stressscapes. These could be regarded independently or in terms of co-occurrences, i.e., of overlapping situations regarding more than one of these dimensions, possibly pointing towards (positive or negative) points of interest in urban places.

Possible sources of information suggested by the participants included: sensor data (recording devices, drones, lidar, thermometers, air quality; IoT sensors); imagery (photography, satellite images, 360° photos, e.g., Google Street View); CCTV footage (safety); surveys/interviews; natural language descriptions; mapathons (participatory mapping sessions); XPlan-GML data (XPlanung data format for legally binding development plans in the German context); thematic maps (e.g., municipal noise maps, lighting concepts, monument register, depth maps); as well as publicly-available cadastral and cartographic data. At the end of the session, the participants evaluated the discussed approaches in terms of cost-benefit by placing cards with keywords regarding the methods of gathering and analysing data on a low-hanging-fruit diagram (Figure 1).

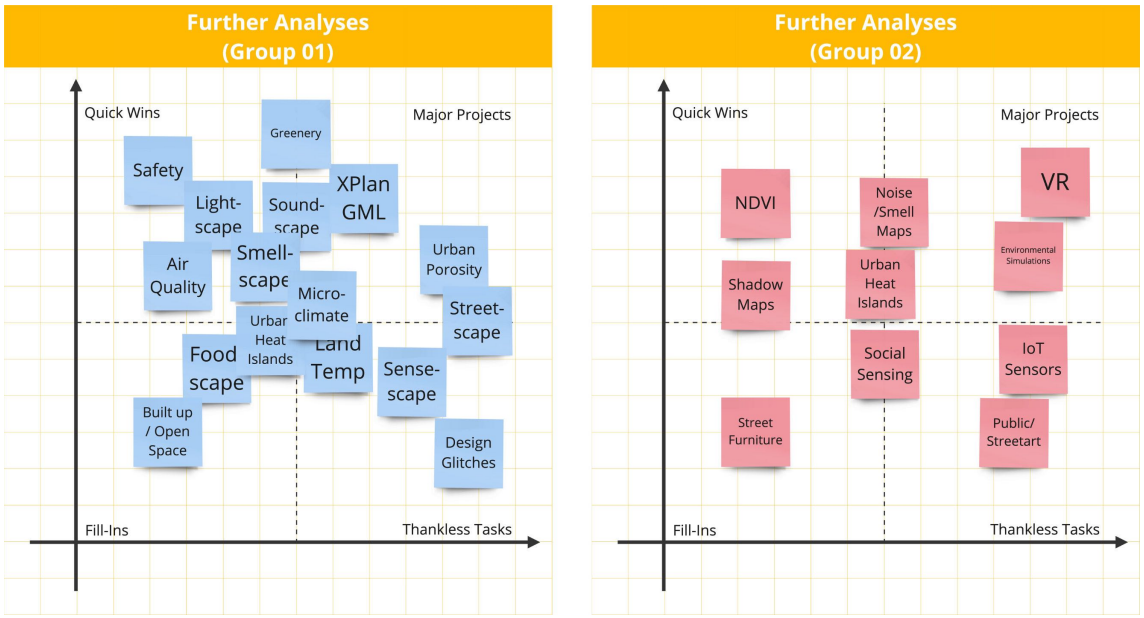

Figure 1: Low-Hanging-Tree Analysis. The contributions of the participants on the topic 'Further Analyses' of Phase 01a, based on the photographic documentation of the workshop whiteboards.

Second Sub-Phase: Possible Applications. The second half of the initial phase was affected by time constraints resulting from very active discussions during the first half. Nevertheless, some of the participants were able to document their thoughts on the possible research scenarios in which this methodology could be applied, the aspects of place that could be explored through it, relevant data, and parameters the possible relationship of which could be studied and the advantages and disadvantages of the application of this approach.

Some of the possible applications suggested included, e.g., studying physical well-being and the feeling of comfort when moving through places, for which possible relations between demographic data and cycling infrastructure could be studied within an urban area. Here, the need for accurate sensor data and possible issues with data protection were expressed as concerns, as well as possible misalignments between the subjective feelings and the objective situation. The exploration of possible relations between street furniture and mobility patterns was also proposed, whereby the location of these elements regarding surrounding building typologies could also be analysed. For this approach, the participant saw as advantages of the method the possibility to integrate innovative data sources and new analysis methods but considered that it could be difficult to implement and deemed it not cost-effective. Another participant suggested two possible research applications: to explore how unique the experiences of inhabitants are, and to study the impact of seasons on places. For these, the analysis of possible relations between parameters like a neighbourhood's calculated walkability and the actual experience of users (e.g., children) regarding distances to daily goals, or between green spaces and changes in temperature across the year, could be explored. Advantages identified for these research approaches are the capacity to model reality more closely and the possibility to test and measure the impact of changes on places, while the overflow of options and possibilities and the risk of overconfidence in the model were identified as disadvantages. The exploration of the concept of vitality in urban places was also suggested as a possible field of application, where a reported sense of vitality could be analysed against parameters like micro-climate (environmental comfort), safety, local community, and mixture of uses. For this approach, the participant identified as disadvantages of the method the possibility that it may not be accessible (user-friendly) for some researchers, that some events are unpredictable, and that the model may be based too much on physical aspects. The speed and replicability of the method in other contexts were regarded as advantages. Another suggestion was the exploration of spatial extent, accessibility, and the integration of places with other surrounding places, as research approaches where this method could be implemented. While considering that the approach offers to deliver much information on places, the participant expressed concerns regarding the complexity of data acquisition as well as questioning how well the method can capture what makes places.

3.2 Evaluation of the Approach

As mentioned before, once the teams had presented the results of the first session to the whole group, the second phase of the workshop focussed on evaluating the method presented as a whole, i.e., as a methodological approach for automating and merging quantitative data that can represent tangible dimensions of built environments and its use as input for exploring possible relationships with intangible aspects of places. In that sense, the feedback goes beyond the advantages and disadvantages previously reported, for it no longer referred to the application of the methodology to explore a specific topic. The contributions of the participants to the different questions posed have been summarized and are presented following the level of agreement shown by the whole group, as allowed by the up-voting function of the Mentimeter platform used.

The participants identified as positive aspects of the approach the possibility to visualize complex relationships between people and places, allowing to explore interdisciplinary aspects effectively through the automation of analyses and enriching the information available by aggregating it with other data. The possibility to identify ideas or relations that are not immediately evident and to test and measure the impact of changes were also pointed out as advantages. As shortcomings or disadvantages the attendees highlighted the need for time and effort by the process of data acquisition, while also pointing out the difficulty of creating datasets including subjective data that is hard to grasp, even more if the research topic requires it on a large scale. Additionally, some participants considered the method to be too focused on physical aspects of places, while others warned about the amount of data required and the obfuscation, possible biases, and omissions that can arise from taking too many aspects into consideration simultaneously. Possible issues with data availability and data protection were also indicated. When asked about recommendations for the approach, in terms of possibilities for improvement, the participants were somehow divided between the inclusion or non-inclusion of surveys into the methodology, thus voting equally on both suggestions. It was also suggested that the scope of the research should be narrowed down and the data sources selected more carefully. Moreover, the recommendation to remain enthusiastic about the approach was also highlighted by the group. Finally, the participants responded to potential challenges and concerns that they may foresee by the application of the method. Here, the group emphasized caution regarding correlations between parameters that may arise when researching their relationships. They also pointed out the scale of the project regarding available resources and expertise, warned about possible errors due to outdated datasets, and addressed how decision-making processes can remain independent of analysis results.

4 Conclusions

The workshop allowed a great opportunity to gather expert insights and opinions on the methodology being presented for the purpose of exploring relations between tangible and intangible aspects of urban places. Through their contributions and suggestions, the participants have shared similar concerns on issues that had previously been identified by the author during the conception of this methodological approach, mainly possible difficulties with the interpretation of relationships identified between aspects of these two dimensions, and technical, organisational, and even theoretical issues that may arise given the scope and integration of a considerable number of analysis and parameters. Nevertheless, the opportunities and benefits that this approach may provide have also been expressed by the participants of the workshop, amongt which its potential for exploring the interdisciplinary character of places, the aim to leverage traditional and innovative data gathering techniques and analysis methods, and the possibility to integrate existing and new datasets can be emphasized.

During the discussions and the joint exploration of the approach, it has become evident that the role of the different aspects of a place to be incorporated and analysed needs to be more clearly defined. Furthermore, the need to develop a strong framework through which these different parameters can be combined into, and interpreted as, meaningful spatial configurations has also been recognized. Through it, the traces of the urban design guidelines behind (contemporary) urban development projects can be discerned in the realized urban environment. This is particularly important not only for the validity of the methodology but above all for the intended goal of approaching the complexity of urban environments and evaluating their qualities and attributes against the background of the residents' perceptions of places.

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