UNIVERSITÄT DORTMUND
FACHBEREICH INFORMATIK

LEHRSTUHL VIII
KÜNSTLICHE INTELLIGENZ

MLnet Report: Training in Europe on Machine Learning

LS-8 Report 17

Katharina Morik
Mario Ellebrecht

Dortmund, 13. April 1995

Universität Dortmund
Fachbereich Informatik

UNI DO

University of Dortmund
Computer Science Department

Forschungsberichte des Lehrstuhls VIII
(Künstliche Intelligenz),
Fachbereich Informatik
der Universität Dortmund

ISSN 0943-4135

Anforderungen bitte richten an:

Universität Dortmund
Fachbereich Informatik
Lehrstuhl VIII
D-44221 Dortmund

Research Reports of Chair VIII
(Aritficial Intelligence),
Computer Science Department
of the University of Dortmund

ISSN 0943-4135

Please direct your requests to:

University of Dortmund
Fachbereich Informatik
Lehrstuhl VIII
D-44221 Dortmund

eMail: reports@ls8.informatik.uni-dortmund.de
ftp to ftp-ai.informatik.uni-dortmund.de
in directory /pub/Reports
WWW: http://www-ai.informatik.uni-dortmund.de

MLnet Report: Training in Europe on Machine Learning

LS-8 Report 17

Katharina Morik
Mario Ellebrecht

Dortmund, 13. April 1995

MLnet Report

Training in Europe on Machine Learning

TABLE OF CONTENTS

Abstract 3
Introduction 3
Teaching ML in Belgium 5
    Belgian Science Organisation 5
    Belgian Situation for ML 5
Teaching ML in France 6
    French Science Organisation 6
    French Situation for ML 6
Teaching ML in Germany 7
    German Science Organization 7
    German Situation for ML 8
Teaching ML in Great Britain 9
    British Science Organization 9
    British Situation for ML 9
Teaching ML in Italy 10
    Italian Science Organization 10
    Italian Situation for ML 11
    Ph.D. Program 12
    Masters 12
Teaching ML in the Netherlands 13
    Science Organization in the Netherlands 13
    Situation for ML in the Netherlands 13
Teaching ML in Portugal 14
    Portuguese Science Organization 14
    Portuguese Situation for ML 14
Teaching ML in Spain 15
    Spanish Science Organization 15
    Spanish Situation for ML..15
Teaching ML in Denmark 16
    Danish Science Organisation 16
Teaching ML in Greece 16
    Greek Science Organisation 16
Teaching ML in Luxemburg 17
    Science Organisation in Luxemburg 17
Teaching ML in Ireland 17
    Irish Science Organisation 17
Teaching ML in Austria and Slovenia 17

Inquiry 18
Results of the inquiry 20
    Computer Science 20
    AI 21
    ML 26
Conclusion 29
A First Tentative Summary 31
Annex A (Questionnaire)
Annex B (Inquiry database)
    Faculties that have answered the questionnaire
    Faculties that have not answered the questionnaire

MLnet Report:
Training in Europe on Machine Learning

Katharina Morik
Universität Dortmund
morik@ls8.informatik.uni-dortmund.de

Mario Ellebrecht
Universität Dortmund
ellebrec@ls8.informatik.uni-dortmund.de

Abstract

Machine learning techniques offer opportunities for a variety of applications and the theory of machine learning investigates problems that are of interest for other fields of computer science (e.g., complexity theory, logic programming, pattern recognition). However, the impacts of machine learning can only be recognized by those who know the techniques and are able to apply them. Hence, teaching machine learning is necessary before this field can diversify computer science. In order to find out, where machine learning is taught in which context and to what extent, MLnet has gathered data from several European countries. In this report, an incomplete overview of the training situation in Europe is given and a questionnaire for obtaining a more complete survey is proposed.

Introduction

Machine learning was one of the first challenges in the field of computer science. Alan Turing claimed that computers must learn and programming should be replaced by teaching. McCarthy proposed systems that were capable of taking advice. In recursion theory learnability was investigated. However, the hardness of learning problems decreased the scientific efforts in machine learning (ML) and artificial intelligence (AI) became more concerned with the fields of natural language processing, knowledge representation, and theorem proving. The practical applications of knowledge-based systems, however, brought the topic to the front again. Building up a knowledge base requires system support. Machine learning offers support to form concept structures, to design rules, and to revise the knowledge base. Meanwhile, results from logic programming and new approaches in complexity theory provided a better basis for machine learning research than the one available in early days of computing. Also the much more powerful computing equipment encouraged researchers to pick up the results from past research and develop new ideas. In the United States of America ML became the hot topic in AI. In Europe, a small but enthusiastic community came into being by the first European Working Session on Learning, organized by Yves Kodratoff at Paris in 1985. Since then, some European or National research projects have investigated theory and practice of ML. These projects have established some expertise in the field of ML, both in the academic and industrial environment. The question now is: in how far is the skill to apply ML disseminated by teaching?

- Do researchers from ML projects teach ML regularly or frequently or only rarely?
- What is the coverage of the ML teaching activities? Is there only one place per country where ML is regularly offered as a course topic or is ML part of the standard curriculum at almost all European universities?
- Are professors who were not involved in ML projects now aware of ML results and incorporate them into their regular courses?

- Is ML taught within AI courses or as a topic in its own right?

- At which level is ML taught (for master students or only for Ph. D. students)?

- Are there specific training activities in industry with respect to ML?

In order to find some answers to these questions, the author started an inquiry at the MLnet meeting at Leuven in 1992. This inquiry has some methodological problems.

- The education systems of European countries are diverse. Notions such as "undergraduate" or "diploma student" do not refer to the same situation (age, prior knowledge, etc.) at different countries.

- The organization of science differs from one European country to another. So, the teaching conditions (who is allowed to teach what where and how long can the person stay at one place) are so disparate that also in this respect English concepts cannot be used easily.

- In several countries research staff is frequently exchanged. Together with the fact that the lecturers of several ML courses are active researchers this means that within one year a flourishing center for ML can become "a desert" with respect to ML teaching.

- ML could be a fashion topic which is taught by regular personnel just one or twice and be disregarded afterwards.

It follows from the lack of a common terminology or a reference structure for education systems -- the first two points -- that it is impossible to design a questionnaire to be filled in by the main nodes of MLnet for their respective countries. No standard questionnaire but a more descriptive text is required for each country. It follows from the ever changing teaching situation -- the last two points -- that a collection of ML courses does not offer an answer to the questions above. A sample of courses could well give a misleading picture of the situation in Europe if not the data are analysed carefully: what is the status of the lecturer, what are the conditions for researchers of this status, is this person planning to continue activities in ML, does the institution continue teaching ML even if this person has moved, etc. For someone who is not familiar with the AI community of the particular country, this is a huge amount of work! The efforts of the analysis of the data would outweigh the benefits of the data collection. Therefore, a more qualitative approach is preferable: for each country, an overview of the teaching situation is given by the respective main node of MLnet. The results of the two statements -- one about the education system and one about the teaching situation -- are then compiled and presented within MLnet.

This report is the compilation of the answers that I have got due to my queries at MLnet meetings (Leuven 1992 and Wien 1993) and various e-mail communications. A second round following this report will help to complete and correct the picture. A second round is necessary, because the situation at each country is not yet completely described (in particular, I have no information about industrial training activities) and some countries are not described at all, namely Luxemburg, Denmark, Ireland, and Greece. This report is intended

- to establish a basis for discussing commonalties and differences of the state of ML teaching at different countries

- to propose a questionnaire to be answered by the main nodes and

- to provoke those whose teaching activities are missing or where the situation of the country is not well described to send me more information.

All comments will be taken into account for the second report.

A final methodological remark concerning MLnet structure could also raise some discussions. As becomes clear from the preceding remarks the procedure that I propose ascribes the role of a national representative to main nodes. We may discuss whether main nodes should serve as distributors within their countries both, from the national community to MLnet and vice versa. This would probably make it necessary that all European countries become involved in MLnet. Moreover, playing this role demands quite a lot of time from the main nodes. Giving an overview of the ML teaching situation in the own country requires to start an inquiry in the own country, triggering colleagues to send me some information about their teaching activities. As main nodes are currently granted in the same way as all other nodes (in particular, no man power -- e.g., student labour -- is financed) their extra work is not acknowledged. Some main nodes may prefer to become regular nodes, be informed and travel to MLnet activities without the burden of extra work. If work load differs, funding should differ, too.

Teaching ML in Belgium

Belgian Science Organisation

The Belgian higher education system comprises a large number of institutions, which are under control of the French or Flemish Communities. The Belgian state only provides the basic framework for recognition of diplomas and similar major issues. Responsibility for higher education is with the Communities. The education institutions are organised and run by the Communities and also by the provinces and communes. In addition to the universities, there are a number of non-university public and private higher education institutions.

The Belgian higher education system of both the Flemish and French Communities offers a multitude of courses and degrees at different levels. In principle, there is a distinction between higher education of the *short* type, higher education of the *long* type at university level and *university* courses. Non-public education institutions must fulfil the legal requirements if they wish to award degrees recognized by the state or claim public funding.

Higher education of the short type is supposed to prepare the student - at an academic level - for a career in industry. Study courses usually take three years and conclude with a diploma. Higher education courses of the long type usually take four to five years, divided into two cycles. This type of education at university level is supposed to promote a view to the practical application of scientific knowledge. Studies conclude with a diploma.

University education comprises a sequence of three cycles, each concluded with a degree that is required for admission the next cycle. The first cycle usually takes two years and is completed with the *Candidat/Kandidaat* diploma., while the second cycle takes another two or three years and is completed with the *Licencié/Licentiaat* degree, which qualifies for the profession. The third cycle is completed with the *Docteur/Doctor* degree and takes at least two years. After another two years, but usually longer, the *Agrégé de l´enseignement supérieur/Geaggregerde voor het hoger onderwijs* degree can be completed.

Belgian Situation for ML

Belgium has four Flemish and four French universities. Only the Katholieke Universiteit Leuven and the Brussels University have specialised courses on ML. At Leuven, Maurice Bruynooghe and Luc De Raedt teach ML. It is one of the centers for inductive logic programming. Students learn the theoretical basis and the programming of ML techniques. Topics of ML are offered regularly to diploma and Ph. D. students.

Antwerp university and Louvain-La-Neuve have an introductory course on AI with a chapter on Knowledge Acquisition and ML including Neural Networks.

Possibly there exists a postgraduate program for industry at Gent university that also covers ML topics.

Teaching ML in France

French Science Organisation

The French higher education system is characterized by the competition between state universities on the one hand and state-run or private elite institutions, the *Grande Ecoles*.. In contrast to the highly selective Ecoles, whose courses have traditionally placed an emphasis on high standards and a close relation to the respective career areas, the universities have to a large degree been able to maintain a leadership in basic research.

Long-term study courses last at least three years and are offered by both universities and Grandes Ecoles. At universities, the courses fall into three successive study cycles. The first two take two years each, while the third on lasts at least one year. Each study section is concluded with an examination and a Diplôme national (e.g. 1. *DEUG*, 2. *Licence*, *Maîtrise*, *MIAGE*, 3. *DESS*, *DEA*), after which studies can be completed. Some universities may offer only the first two cycles to students.

The first study section (*Diplôme d´études univérsitaire générales*) serves the purpose of general education and preparation for the following studies. The minimum amount of studies as fixed by the state is 350 to 550 hours a year. Each year, at least two written exams have to be sat under supervision. The real significance of this first study section is its preparatory and selective function for the following section. The dropout and repeat rate is about 50%. Accompanying course guidance serves students who do not fulfil achievement requirements.

In the second study section (*Licence*, *Maîtrise*, etc.) students have a choice of three different types of study courses and certificates:

1. Students who want to work in research or education traditionally do the Licence exams one year after the DEUG, and after another year the Maîtrise exams.

2. Students aiming at a career in the engineering sector or in industry go for the *Maîtrise de méthodes informatiques appliquées à la gestion.* These study courses are particularly work-intensive.

3. In addition, three-year study courses being completed with the Diplôme d´ingenieur or the Magistére were introduced to compete with the Grand Ecoles. These highly sophisticated courses, to which only 30 to 40 students a time are admitted, combine introduction to peak research with an implementation of its results in practical.

The Grandes Ecoles vary considerably regarding their performance requirements and the standards of education they offer. They have a relatively high degree of freedom in determining the study courses they wish to run and in the award of diplomas. The value of the diplomas depend on the reputation of the Ecole. The degrees of various highly respected Ecoles are approved by the state. As a rule, the study courses last three years, but in certain cases they might take up to five years. The curriculum is designed to begin with multidisciplinary lessons and to focus increasingly on the selected subject in the course of the study programme. The strong orientation on practice is achieved by practical courses and by teachers from industry. The curriculum is very extensive and the workload is very high, but nevertheless the dropout rate remains low.

French Situation for ML

The University Paris-Sud, LAFORIA, the University Nancy I, and the University of Montpellier are offering courses on ML regularly. In general, master students are in the fourth year at university and Ph. D. students start in the fifth year and end in their ninth or even tenth year.

At the University Paris-Sud, special courses on ML are offered regularly. A Ph. D. program does not exist but topics of ML are regularly offered for Ph. D. theses.

At the University Paris VI (LAFORIA), there is a program for Master of Science in AI. About 80 students each year take part in this track. Since 1989, once a year a course on ML and Knowledge Acquisition is offered. The general part (from October to December) covers in 10 hours generalization, induction, ID3. The context is data analysis and information theory. There are also 10 hours on Neural Networks. The specialized part offers to about 10 to 15 students Machine Learning and Knowledge Acquisition in 20 hours. There is also a special course of 20 hours on Neural Networks.

At the University of Nancy I, for students at master level 20 hours on Machine Learning and Knowledge Acquisition are offered. A Ph. D. program for Artificial Intelligence, started 15 years ago, includes 30 hours on Machine Learning and related topics. Neural Networks, Case-Based Reasoning, Pattern and Speech Recognition are also covered.

At Montpellier, courses specialized on ML or Knowledge Acquisition are taught. The courses are either for students being in the fifth year at the university or for those in the fourth year. The courses have a length of 20 hours and are offered once a year. The first course on ML was given 1989. It is possible to write the diploma thesis on a ML topic.

Teaching ML in Germany

German Science Organization

In Germany, education is a matter of the federal states, not of the overall government. Therefore, laws concerning the universities may differ from one federal state to the other. However, the typical career of a scientist consists of being a student, an assistant or researcher, and then becoming a professor.

Studying one main discipline (e.g. computer science) and another secondary discipline (e.g. medicine, linguistics, mathematics) takes about 6 to 8 years depending on whether the student has to earn his or her living. The studies are accomplished by a diploma thesis which itself takes at least 3 months, but regularly 6 to 9 months.

After the diploma, most students become employed by the industry. Those, who want to do research, work in a research project (funded by National or European funding agencies) or become assistants (employee of the university). In both cases, they write their Ph. D. theses while performing the research of the project or while helping in teaching (e.g. tutoring, designing and correcting exercises, teaching programming languages). Some assistants are additionally involved in research projects. Another opportunity is a Ph. D. grant which is much less money but allows one to concentrate on the Ph. D. thesis. At some universities there exist Ph. D. programs where the students get good grants and particular courses are offered for the Ph. D. students. Such a Ph. D. program is funded by the German National Science Foundation (DFG). At Freiburg, there exists one for "Human (and Machine) Learning". Writing a Ph. D. thesis takes about 3 to 5 years, sometimes even longer depending on how demanding the research project is.

After the Ph. D. thesis the scientist has to write a habilitation thesis and do some teaching. This work period (taking again about 5 years time) is funded in almost the same ways as the Ph. D. thesis. Normally, research is then done at another federal state, because scientists are regularly employed no longer than 5 years by the same employer (in academia: the federal state minister for research). As students in the first year at university are about 20 years old[1] , a habilitated scientist is about 34 years old. Then, the scientist is qualified to become a professor which is the only permanent research position at universities. The qualification is only accepted if the scientist gives at least one course a year (about 28 hours) at the university where he (sometimes: she) passed the examination for habilitation. Travel

[1] After school, men have to serve the state either by military or civil service. Women are probably supposed to serve the state by raising children but have (therefore?) no military duty.

costs to the teaching location are not paid. Teaching itself is minimally paid. Positions as professor are publicly announced. The faculty of the university decides in a first round which candidates are put on a list. In the second round, the federal ministry for research selects a candidate from the list. Then, the university and the candidate negotiate about staff (regularly 2 to 3 assistants and a half secretary position go along with a full professor) and equipment. If they cannot come to an agreement, the next candidate from the list starts negotiations. From the first public announcement of a vacant position until the establishment of the candidate as the professor it takes 1 to 2 years, sometimes it takes even 5 years.

Research institutions (German Research institutions (German National Research Center for Computer Science - GMD, German Research Center for Artificial Intelligence - DFKI, Max Planck institutes)) are in principle able to employ scientists for longer than 5 years. The majority of researchers, however, depends on project funds at varying locations.

The most important consequence of this system for our overview is, that active researchers who work in a project have to change frequently so that the expertise that has been built up at one university can rapidly disappear. It may well happen, that during the life-time of a research project, there are seminars on ML each semester, and after the project ML is not even mentioned in the AI lecture. This is particularly so, if the professor himself was not involved in ML but had assistants who wrote the project proposal and performed the investigations.

This (western German) rule is now also applied to the east of Germany. Before, in the German Democratic Republic, scientists used to stay at one place, regularly the one where they had already studied. There were permanent positions without the need to acquire external funds. There is no uniform procedure in which the eastern permanent positions are changed into positions of the western type.

German Situation for ML

The most elaborated subfields of AI in Germany are Natural Language Systems, Theorem Proving and Knowledge Representation, and Computer Vision. These have a long tradition and are at a very high standard. At almost all German computer science faculties, there are regularly courses on AI offered. However, ML is not regularly included, although the situation is currently changing to the better. An AI lecture has about 28 to 56 hours lessons plus 28 hours exercises. AI courses are most often offered to students after their first examination, about their third year at the university.

Special courses on ML are offered regularly at the universities of Dortmund, Kaiserslautern, Leipzig, and will become a regular matter at the Technical University Berlin. Such a seminar or lecture regularly has 28 hours lessons and possibly another 28 hours exercises. At Dortmund, the complexity theoretic approach to ML (within the institute for Theoretical Computer Science) and the AI approach are represented. At Kaiserslautern, case-based reasoning, integrated ML-KA systems and recursion theoretic analysis of learnability is represented. At Leipzig, the recursion theoretic algorithmic learning theory is established. At other universities, assistants offer from time to time a seminar on an ML topic.

At the university of Osnabrück, ML is addressed by seminars in the linguistic department. At the university of Freiburg ML topics are taught at the psychological department and the one for social impact of computer science, mainly in the context of the mentioned Ph. D. program.

At the German Research Center for AI (DFKI), mainly Natural Language Systems and Knowledge Representation are represented. At the German National Research Center for Computer Science (GMD) there was a strong group in ML but the future is unclear as project funds are exceeded. Industrial research laboratories are mainly Mercedes Benz (Ulm), Siemens (Munich), and IBM (Heidelberg). Siemens has decided to concentrate its activities in ML in the USA. In the context of Natural Language Processing, there might be some activities in ML. IBM had some activities in building up knowledge bases in a linguistic context, but is currently not involved in systematic ML research at Heidelberg. Both companies, Siemens and IBM, support their researchers to do teaching, but at the time being I do not know of activities to teach ML. Mercedes Benz still is engaged in ML. The Krupp Research Transfer Institute has developed an ML system and markets it. The Brainware software house at Berlin is involved in several research projects on learning and earn their living by ML applications. I do not know whether they also offer training to the industry with respect to ML.

As a summary, ML has not yet become a standard part of AI lectures and the Computer Science curriculum. However, at some places ML is extensively taught and topics from ML are offered regularly at these places (Dortmund, Kaiserslautern, Leipzig, TU Berlin). At very many universities, seminars have been offered by assistants or researchers. The tendency to include ML into the AI course is upwards.

Teaching ML in Great Britain

British Science Organization

Higher education institutions are classified in two groups since the Further and Higher Educations Acts of 1992: Universities and Colleges/Institutes or Higher Education. The universities are independent, self-governing organizations and are authorized to award their own degrees. The quality of education provided by institutions is closely monitored by the Higher Education Quality Council, which has been established by all the organizations representing degree-awarding institutions.

The number and structures of courses available at higher education institutions in the UK have changed markedly over the past decade and are still doing so. The traditional pattern of a single or joint honours degree lasting three (or four) years still exists, but increasingly courses are becoming geared to specific job opportunities. The principal development has been the introduction of modular courses and also the concept of CATS (credit accumulation and transfer) has become a trend, although this implies great a drawback for the student.

Most higher education institutions offer honours degree courses lasting either three or four years. Successful completion of the courses confers the title *Bachelor of Science (BSc)* upon the holder. Four-year courses often involve one year spent abroad or in industry. Many courses exist, whose duration ranges between one and four years. These include the Diploma of Higher Education and Higher National Diploma (HND). The latter is administered by the Business and Technology Education Council (BTEC). These courses are well-established and nationally respected, and are generally seen as being as tough and rigorous as academic degrees, but with the main focus on the world of work.

Post graduate qualifications include Master´s degrees and PhD. Master´s degrees can be obtained by either study or research, and last one or two years. Doctorates normally take three years of academic research.

British Situation for ML

In Great Britain, ML is taught at the King's College at London, at the Department for Cognitive and Computer Studies of the University of Sussex, and at the University of Aberdeen. At Aberdeen, once a year a course for diploma students offers topics from ML in the context of Knowledge Acquisition. Derek Sleeman together with a tutor is teaching this course called "Applied AI". It takes 12 months to make a diploma in computer science. ML is regularly offered as a topic for the master thesis.

At the King's College at London, Alan Hutchinson is teaching ML topics to students in their third year at university. The course is open for students of Philosophy.

At the University of Sussex, overview courses on AI include introductory ML material. In addition, a ML course for students in their third year is provided, which comprises 10 lectures plus lab sessions and interactive working using an in-house ML toolkit.

Teaching ML in Italy[2]

Italian Science Organization

Until mid seventies the University system in Italy was quite centralized and hierarchical (for many aspects similar to the old German and French system). At that time the only permanent positions were the ones of Professors. Each Professor (usually a man, only occasionally a woman) has his (her) own institute with few (usually one or two) assistants. Courses were given by Professors and sometimes also by assistants or other qualified people (the ones who got Libera Docenza) not necessarily employed by the university. The assignment of a course to an assistant or to a Libero Docente was made on an annual basis. Only one degree was offered by University: the "Laurea" degree which can be achieved after a completion of the curriculum. The number of courses (or credits) and the number of years are determined by a national law and are the same for each university offering that particular degree. National Law prescribes also the titles of the compulsory courses (usually 50- 60% of the total) for each curriculum. There was no Ph.D. program: in the seventies after the laurea one could start a training in the University since some fellowships were offered by the Government. These fellowships last usually four years and the winner has to do research (and also some didactic activity) under the responsibility of a Professor. No final dissertation was required and no academic title was issued. (for many aspects this was a form on internship).

This organization of the university was under pressure during the late seventies so that in 1981 a new law reorganized the University. The current situation includes three kinds of permanent positions:

- Full Professor
- Associate Professor
- Researchers

Even not formally required currently it is almost impossible to get a position as researcher without a Ph.D. title or to have almost completed a Ph.D. program. Two major novelties were:

- creation of Departments and plans for abolishing Institutes
- creation of Ph.D. curricula

However the centralized organization of the Universities was maintained: to get a position of Full or Associate Professor one should be a winner of a national contest where each candidate is examined by a national committee in that particular discipline (e.g. Algebra, Geometry, ..., Computer Science, Computer Engineering, Electronic Engineering, Telecommunications, etc.). The number of new positions as well as the distribution among Universities and scientific areas (such as mathematics, medicine, physics) is decided by the central government under suggestion of a national committee for Universities.

Concerning Ph.D. programs the government used a very cautious approach in authorising universities in opening Ph.D. curricula. In particular many Ph.D. Programs were established by consortia of Universities. The management of the Ph.D. program is centralized; the number of Ph.D. students in each program is decided by the central government on an annual basis. Each winner of the contest for entering a Ph.D. program gets a fellowship from the government (around 7 -8 K ECU) per year and is a full time

[2]The section about teaching ML in Italy was contributed by Piero Terrosso and is presented here almost in the original form.

student. The length of the Ph.D. is fixed for a given program (four years in Computer Science) and the title of Ph.D. is given by a national committee under suggestion of the Ph.D. Program Committee.

Obviously this mechanism is quite rigid and does not encourage to pursue some topics since the national committee could disagree on some areas. In Italy areas such as AI are not always appreciated in the Computer Science academic community.

Italian Situation for ML

In Italy there are two different degrees in the area of Computer Science: the degree in Scienze dell'Informazione (in the following we call it Computer Science) given in the School of Sciences and the one in Ingegneria Informatica (we call it Computer Engineering, even if in some cases it is barely distinguishable from Computer Science) offered in Schools of Engineering. Whereas Computer Science has a relatively long tradition (more than 20 years), Computer Engineering is quite new as an autonomous degree. Until recently, Schools of Engineering offered a degree in Electronic Engineering with a specialization in Computer Engineering.

The most important places for Computer Science are the universities of Pisa, Torino and Milano, even if this degree is offered also at the universities of Udine, Bologna, Genova, Firenze, Roma, L'Aquila, Salerno, Bari and Catania. Among them Udine, Salerno, Bari and Salerno are the oldest ones.

In the current version of the curriculum in Computer Science there is no compulsory course on AI, but many universities offer a course on AI.

At Torino, most students taking the AI course have already followed a course on Logic and a course on Advanced Programming Languages (devoted to logic programming, functional programming and object-oriented). At Torino, the course on AI is quite long (around 100 hours of classroom, students are required to develop an implemented project) and cover classical topics (problem solving, knowledge representation, design of knowledge-based systems, natural language interpretation). The field of ML is covered with about 8 hours of classroom.

A similar situation occurs at Pisa (also at University of Pisa there are courses on Logic and Advanced Programming Languages). With respect to the organization of the AI course it is similar to the one of Torino apart from less emphasis on the design of knowledge-based systems and no classroom on ML.

At the University of Bari, there is a significant tradition on Pattern Recognition. However, in the last few years the area of AI has grown, so that there is a course on AI now similar to the one given at Torino. Moreover there is a specific course in the field of Learning. The title is "Theory of learning" and it covers topics of learning in humans and machines. The core of the course is on symbolic machine learning.

At the university of Udine, there is no specific course on AI (AI specific topics are addressed in other courses), but there is a course devoted to knowledge engineering which covers knowledge acquisition.

At the university of Catania teaching ML has now begun.

At several universities there are courses devoted to topics such as Cybernetics (currently, in most cases, this course covers Neural Networks), Pattern Recognition or Computer Vision. Some of them address the problem of sub-symbolic learning.

With respect to Computer Engineering, there is no compulsory course on AI, but the curriculum foresees two optional courses: AI and KBS. Among the best reputed places for Computer Engineering (Politecnico of Torino, Politecnico of Milano, University of Genova, Pavia, Bologna, Roma and Napoli) only Milano, Pavia, Genova and Roma offer courses on AI. In particular Roma is quite active in AI, but the course on AI provides just a very limited insight into ML (very few hours of classroom). At Genova and Milano AI is strongly related with Robotics and ML is not a major concern..

In conclusion, at the "laurea" level (both Computer Science and Computer Engineering) there is no specific course on ML (apart the case of Bari); there are some on AI, but only few devote some attention to ML. It is worth noticing that courses have to cover broad fields. Specific topics are addressed during the work for a thesis. In order to get a "Laurea" degree the student is required to prepare a written dissertation which takes usually more than one year (equivalent to 8-9 nine months of work full time); most theses involve also the development of software, so that good students are the actual developers of the research prototypes. If we consider the topic of the theses, the relevance of AI and ML is much better than with respect to the course alone.

At the University of Torino around 20% of the students taking a degree in Computer Science (about 200 a year) develop a thesis on AI. Symbolic ML is well present with 10-12 theses per year, topics such as case-based reasoning and genetic algorithms are also covered.

At the University of Pisa around 10% of the students taking a degree in Computer Science (about 250 a year) develop a thesis on AI or a related area. Because of the situation of AI at Pisa many of the theses are related to Logic Programming or Knowledge Representation. No theses on ML.

At the university of Bari about 30 theses for year (out of a total of 180) are devoted to AI; many of them are related to ML

At the University of Udine there is a good number of theses on AI (around 20 per year - that is 25% of the total), no one on ML, some of them on KA.

At the University of Rome (Computer Engineering) there are about 20 theses on AI per year. Almost none of them deals with ML.

Ph.D. Program

In the Ph.D. curricula the relative strength of Computer Science and of AI within Computer Science is apparent. The universities of Pisa, Torino, Milano, Roma offer a Ph.D. in Computer Science whereas other Departments (mainly in the School of Engineering) offer a Ph.D. in Computer Engineering and System Science or Electronics and Computer Science/Engineering. The Ph.D. curriculum of Torino - Milano (courses are shared) offer a course on AI (one out of 8). The course is short (usually 25-30 hours of classroom), but Ph.D. students are additionally required to make independently a study on a specific subject, write a state of the art on the topic and give a seminar.

ML cover 20% of the course. ML topics are addressed also in the independent study. While at Torino symbolic ML is a relevant topic of interest because the baseline of the AI group, at Milano computational learning receives attention mainly because of the interest of professors in Theoretical Computer Science. The Ph.D. curriculum of Pisa does not offer any course on AI (some Ph.D. student addresses topics of AI mainly from the point of view of Logic Programming). The Ph.D. curriculum of Roma does not have any specific course on AI, but there is a number of Ph.D. candidates working on AI.

In conclusion, only at Torino (and partially at Roma) AI plays a relevant role both at the "Laurea" degree level and at Ph.D. level. At Torino ML is the main topic of interest within AI, at Rome not. At the laurea level, among the universities offering AI courses, only Bari devotes specific attention to ML. Theses at the "Laurea" level are the best way for introducing students in a particular topic: ML is pursued especially at Torino and Bari.

Masters

In recent years, some Masters have been created in Italy. Apart MBA given by some universities, Master is not an official degree recognized by the State. In many cases Masters have been created and organized by consortia between one (or more) university and public and private industrial organizations. Usually the number of students (who are already graduated with "Laurea") enrolled in a Master Program is quite limited (20-30), and in many cases they get a fellowship provided by an industrial partner in the consortium. In other cases fellowships are given on funds of CEC or national funds for Innovation. Master programs usually take one year to one year and a half and include a period of work in industry.

The content of the master program usually changes on an annual basis, and in some cases some initiatives have been shut down ore radically changed. To my knowledge, no master program is directly related to the field of AI, however some of them may have a course on AI. For example, at Torino COREP (a consortium centered around Politecnico of Torino) has a Master in Computer Science and Automation and another one in Computer Science and Telecommunication. In both master programs there is a course on AI (particular emphasis is on KBS, only a two-hours seminar on ML).

Teaching ML in the Netherlands

Science Organization in the Netherlands

The system of higher education in the Netherlands is provided by 85 predominantly private *Hogescholen* in addition to the ten state and three private universities. The Hogescholen offer a strongly practical and vocational training, concentrating mainly on applied research work, therefore maintaining direct contact with the economic environment. On the other hand the universities have always pursued independent fundamental academic research and concerned themselves with the academic fostering of future generations.

The universities have strongly contrasting profiles. While the universities at Delft, Eindhoven and Twente are technically oriented, the other universities often place emphasis on arts and social sciences.

At both Hogescholen and universities, a period of four years is allocated to first level studies. Undergraduates may extend this by a further two years without incurring penalties. First level studies lead to a vocational degree, and have two distinct stages.

The first year of study, the *propedeuse*, is a general, preliminary stage with the purpose of introducing the student to, and testing his aptitude for the intended field of study. The *propedeuse* year concludes with a qualifying exam (which can be repeated only once) and is followed by three years of intensive study for the student´s specific qualification. The first two years of the second stage are fairly disciplined, and it is only in the third year that the undergraduate is afforded more freedom of choice and the possibility of more independent work. At the universities, the so-called *doctoraal* studies for natural science lead to the title *doctorandus (drs.)* After completion of intensive specialized studies at the Hogescholen, the title of *baccalaureus (br.)* is awarded.

Upon graduation, most students leave the higher education system. Only a very small number continue with their studies. To gain admission to post-graduate courses, an application to the admissions committee of the respective faculty must be made. The length of study ranges from 1.5 to four years. The second level should offer 10 to 15% of graduates who wish to pursue an academic career the opportunity to complete a doctoral thesis within the framework of a research project. Both university and Hogescholen graduates ca apply for so-called AIO-positions (Assistent in Opleiding). In 1989, there were 3480 AIO-positions, with numbers on the increase. Candidates are selected by the faculty, not the doctoral tutor, which also applies for the funds for the research project. Successful AIO-applicants receive a salary for a maximum period of four years and, where necessary, are also employed on a small scale in teaching.

Situation for ML in the Netherlands

At the Netherlands, AI courses are given at almost all universities with a Computer Science faculty. Some of the courses include topics of ML. Special courses on ML are taught at the university of Amsterdam. At the Department of Social Science Informatics of the University of Amsterdam, there is a regular program to study AI. Within this program, special courses on ML are offered to students in their second and to those in their third year at university. In the third year, students select a subfield of AI as their main interest area. "Knowledge analysis and modelling" is one such area and includes ML. The first course lasts 8 weeks and gives an introduction in basic techniques of ML. The second course lasts

14 weeks and teaches applications of ML to Knowledge Acquisition. The program is open for students of other programs such as Computer Science, Psychology, Social Science Informatics. Logic and Logic Programming is presupposed.

The Department of Social Science Informatics, University of Amsterdam together with the AIO netwerk AI, a network for Ph. D. students in AI, additionally offers a short intensive course on ML. It takes two days and teaches basic techniques of ML.

The Faculty of Mathematics and Computer Science of the University of Amsterdam teaches ML in the context of theoretical computer science. It is offered every other academic year to students in their third year at university. It lasts 8 weeks. The focus is on Computational Learning Theory, in particular Minimal Description Length and Kolmogorov complexity.

Teaching ML in Portugal

Portuguese Science Organization

Higher education in Portugal is organized into two subsystems: university and polytechnic education. The aim of university education is to ensure a solid academic preparation. It also provides the students with technical knowledge, entitling them to engage in professional activities. The aim of polytechnic education is to provide the students with a solid technical knowledge of a higher level and supply them with both practical and theoretical scientific knowledge and its application to professional activities.

Institutions of higher education in Portugal can be tutored exclusively by the Ministry of Education, are dependent on other Ministries or are private and cooperative institutions.

University education grants the Licenciate, Master of Science and Doctorate degrees, while polytechnic education grants the Bachelor's degree and the Diploma of specialized higher studies. The degrees and diplomas conferred by establishments of higher private and cooperative education are equivalent in value and outcoming results to the corresponding degrees and diplomas granted by public institutions.

The two subsystems of higher education are correlative, making it possible for students to transfer from one system to the other. In fact, a student of a course of polytechnic education may request a transfer to a course of university education and vice versa. In the same manner, the holders of a licenciate´s degree acquired through university education have the opportunity to be admitted to courses of specialized advanced studies.

Portuguese Situation for ML

In Portugal, AI and particularly ML is lectured at the Coimbra University and at the University of Porto. Also at the University of Lisboa courses on ML are given from time to time. Ernesto Costa, Pavel Brazdil, and someone from the group of Alfredo Garcao-Steiger are the lecturers. Courses are given at undergraduate level or for diploma students.

Teaching ML in Spain[3]

Spanish Science Organization

In Spain, the universities make up almost all of the higher education sector. Since 1970 there have been only a few, highly specialized disciplines in higher education outside of the universities. Studies at Spanish universities are organised according to the four types of institutions: Facultades and Escuelas Técnicas Superiores (faculties), Escuelas Universitarias (a higher education facility offering three-year courses for degrees with a professional qualification) and Colegios Universitarios (institutions established to relieve the larger universities and often situated in the "Provinces" and at which the first three years of studies at the faculties can be taken).

It is possible to take long-term degree courses, comparable to standard university study, and short-term degree courses at Spanish universities. The Licenciado degree is awarded after five or six year´s study at a faculty. The three-year studies at the Escuelas Universitarias end with the Diplomado degree. Following successful study in the long-term courses, students can add a third study stage to gain the title of *Doctor,* which requires at least two years´ study in doctorate courses and the submission of a doctoral thesis.

Spanish Situation for ML

In Spain, there are 18 Computer Science Schools that offer a 5 years long curriculum in Computer Science (first and second cycle). Studying 5 years is the prerequisite for starting to study within a Ph. D. program. Other Computer Science Schools that offer only a 3 years curriculum (first cycle) do not qualify their students for a scientific career, but are industry oriented. From the 18 places, 10 offer PhD programs in AI. Out of these 10 Computer Science Schools 7 different Computer Science Schools belonging to 6 different Universities provide students with courses on ML. Overall, there are 12 courses distributed as follows:

- 2 courses given at the Computer Science School of the Polytechnical University of Catalonia (Barcelona) in collaboration with CEAB (Blanes).
- 2 courses given at the Polytechnical University of Madrid (in two different schools : Computer Science and Telecommunications)
- 3 courses given at the Computer Science School of San Sebastian (2 of these courses are practically the same under different names given in alternate years)
- 2 courses at the University of Deusto (Computer Science School) of Bilbao (one of them in collaboration with CEAB)
- 2 courses at the University of Granada (Computer Science department)
- 1 course at the Autonomous University of Barcelona in collaboration with CEAB.

All the courses are addressed to graduates in Computer Science or Engineering or Mathematics with a good background in Computer Science. The length of the courses is 20 to 40 hours.

Six of these courses are almost exclusively devoted to Inductive Learning and Similarity-Based Learning (SBL). Four other are more general (SBL, Explanation-Based Learning, Analogical Reasoning, and some notions of Discovery and Connectionist Learning). One course is very specific: Learning of Causal Networks. The main point is that only two courses DO NOT teach ML as stand-alone systems

[3] This section is an edited version of the text provided by Ramon Lopez di Mantaras.

but within the framework of architectures that integrate learning and problem solving (these are courses where CEAB participates). It is very clear that what people teach depends on their research activities: most of the research projects are related to inductive learning with the goal of acquiring knowledge in first generation Expert Systems. Another important remark is that nobody teaches courses entirely devoted to Knowledge Acquisition separately from ML but many ML courses include some Knowledge Acquisition topics.

As a final comment, there are several courses on Robotics that include learning techniques for planning. These courses are given by people that are active in Robotics research.

Teaching ML in Denmark

Danish Science Organisation

For a long time (until 1928), Copenhagen University was the only university in Denmark. The other two universities and another two university centers were founded this century, and have full academic freedom in research and teaching. Besides the universities, the Ministry of Education administers several specialised institutions, which carry out research as well as training of the highest standard within the main fields of study entrusted in each institution. The Minister of Education lays down regulation for admission to studies, study programmes, degrees, staff employment and expulsion of students.

The periods of study are generally rather long, most programmes take five or six years, sometimes even longer. As regulations from the Ministry of Education are general rules for examinations etc., there are additional study and examination regulations determined by the individual institutions.

The *kandidat*-examen is the most common final examination, which takes about six years to finish. Since 1988 a bachelor's degree is introduced. After three years of study in a kandidat-programme and having passed the prescribed examinations, the title B.Sc. may be gained at universities and university-centers.

The university-centers offer one- or two-year project-oriented basic studies as a basis for the major studies on an intermediate or kandidat level.

In 1988, 114,000 students attended courses and programmes in 100 institutions of Danish further and higher education.

Teaching ML in Greece

Greek Science Organisation

The system of higher education in Greece has changed remarkable in the last years. Today, there is a number of universities offering training in the common disciplines. In order to attend, students have to pass examinations at central institutions in Greece. With the poor financial situation of the universities and the strong competition among applicant, it is quite difficult for a student to be admitted to a department of his preference.

Since 1989, postgraduate studies are established at the Master's level and the Doctoral level, but at many departments there do not yet exist study programmes.

Teaching ML in Luxemburg

Science Organisation in Luxemburg

The Luxembourgian higher education system and its courses are specifically oriented on the higher education and study courses systems of the neighbouring countries, in particular Belgium, France, The Netherlands and Germany. It offers a variety of study courses and academic degrees at various levels.

The Institut Supérieur de Technologie offers three-year study courses in applied informatics and several other technical disciplines. Through the impartment of a broad scope of general knowledge, several application and laboratory phases, but without too large a degree of specialization, the courses prepare students for medium-level technical professions in industry, public administration and applied research. On the basis of performance shown at the end of a semester, a *conseil de promotion* decides on whether students should be admitted to the next study section. Before the studies are completed, all students are required to do practical training comprising 16 weeks and in-depth practical training lasting six weeks under the supervision of the practical training agency and in direct cooperation with industry. If studies are completed successfully, the *Diplôme d'ingènieur-technicien* is awarded.

Teaching ML in Ireland

Irish Science Organisation

No Information available.

Teaching ML in Austria and Slovenia

The Ljubljana University in Slovenia regularly offers AI courses (45 hours lectures, 45 hours exercises) and ML is one of the topics. The courses are provided for students in the first year and the fourth year, respectively. There are also special courses on ML (30 hours of lectures) for students in the second year. Ivan Bratko, Nada Lavrac and Igor Kononenko are the lecturers. They also give courses at the Universität für Bildungswissenschaften at Klagenfurt, Austria. These courses are on Knowledge Acquisition (Engineering) and cover a range of ML techniques. They are for students in their third year at the university.

In Austria, the Vienna University (Gerhard Widmer) and the University of Graz (Wolfgang Maass) offer (frequently) courses that cover ML topics.

Inquiry

An inquiry has been carried out by the AI Department of the University of Dortmund in order to obtain an objective view on the situation for ML based on empirical data. For that purpose, a database of addresses has been compiled from various sources with the intention to include all computer science faculties in the EC and some main European universities outside of the EC (at the time the inquiry was carried out).

A questionnaire (cf. Annex A) has been prepared to meet the requirements to answer the questions formulated at the beginning of this report. The questionnaire was sent out to all 300 faculties (cf. fig 1) in 236 different cities (cf. fig 2) and 14 countries included in the addresses database (cf. Annex B).

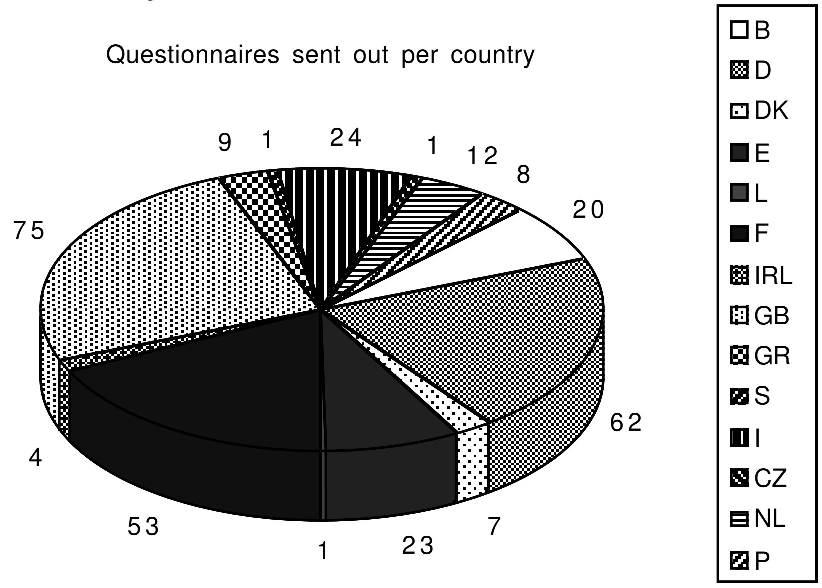


fig 1

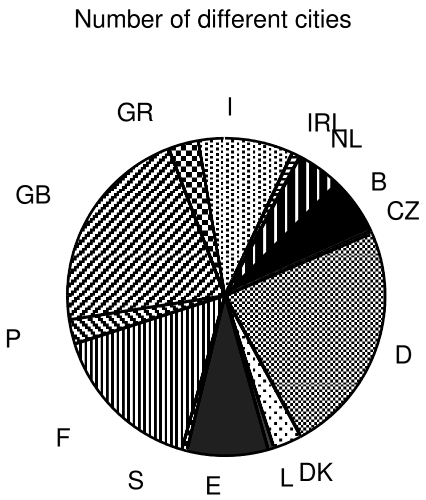


fig 2

Of the 300 questionnaires sent out, 74 were returned, including two from universities which do not offer Computer Science as a regular study topic (cf. fig 3). This corresponds to an overall return quota of about 25% (cf. fig 4).

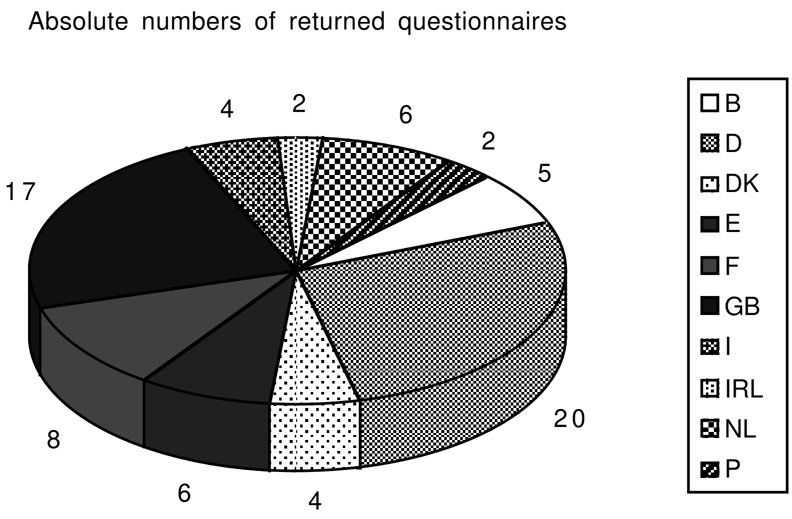


fig 3

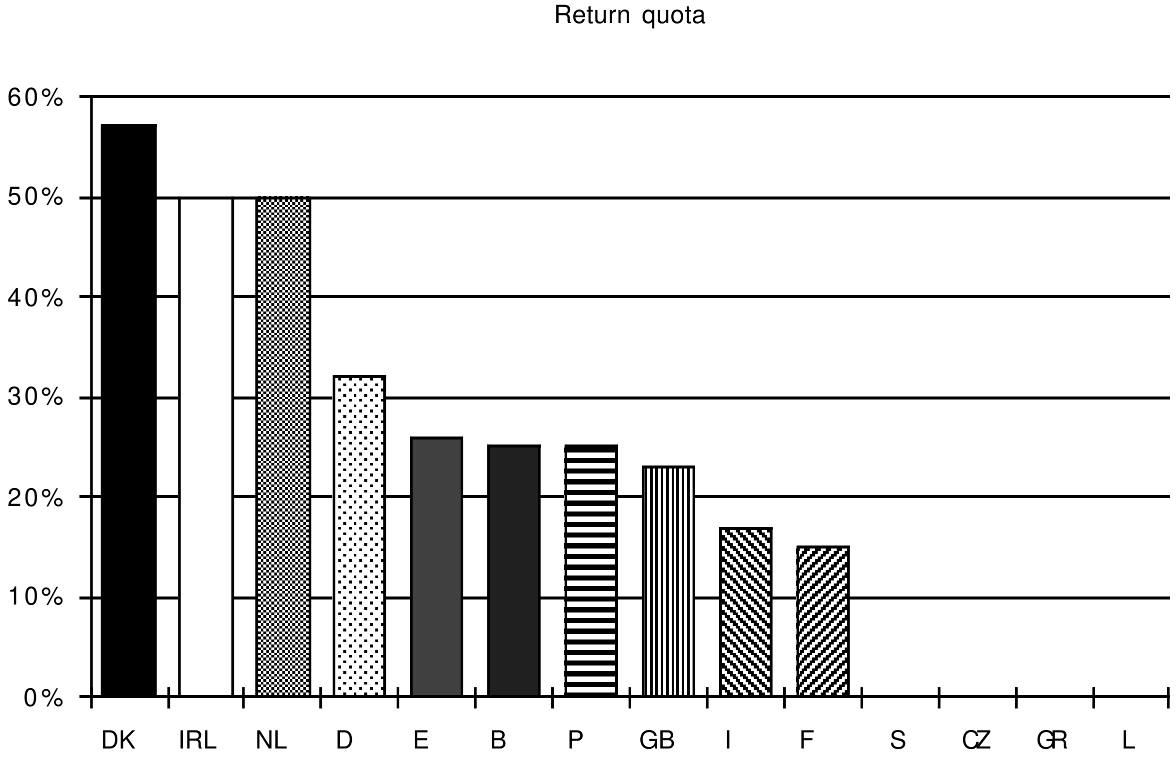


fig 4

Results of the inquiry

Computer Science

To learn about the structure of the different educational systems and the comparability of training and diplomas, two basic questions about the situation regarding Computer Science were asked. As a result, the size of the faculties and the time it takes students to graduate differ enormously (cf. fig 5 and 6)

However, a qualification needs o be made. The German state supposes students to achieve their diploma degree after nine semesters (4.5 years). The answers to the questionnaire fit exactly the prescribed time. Knowing the German situation, however, we must conclude that the answers do not reflect the actual time needed by the majority of students. To tell the truth, German students of Computer Science study about 12 semesters, i.e. they graduate after six years. Hence, the different duration in different countries reflects not only the actual situation, but also the attitude of those answering the questionnaire: they either choose the actual duration or the prescribed duration.

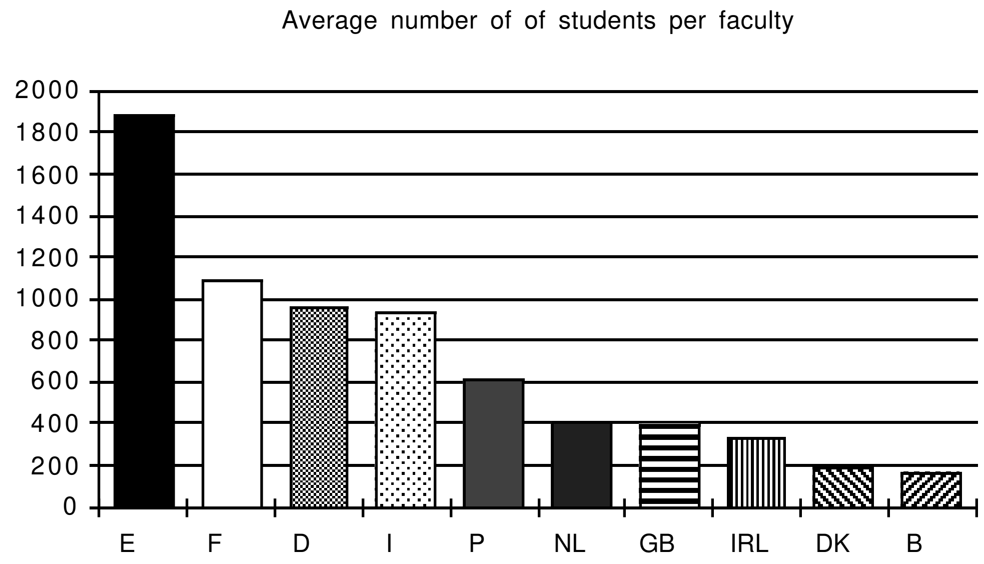


fig 5

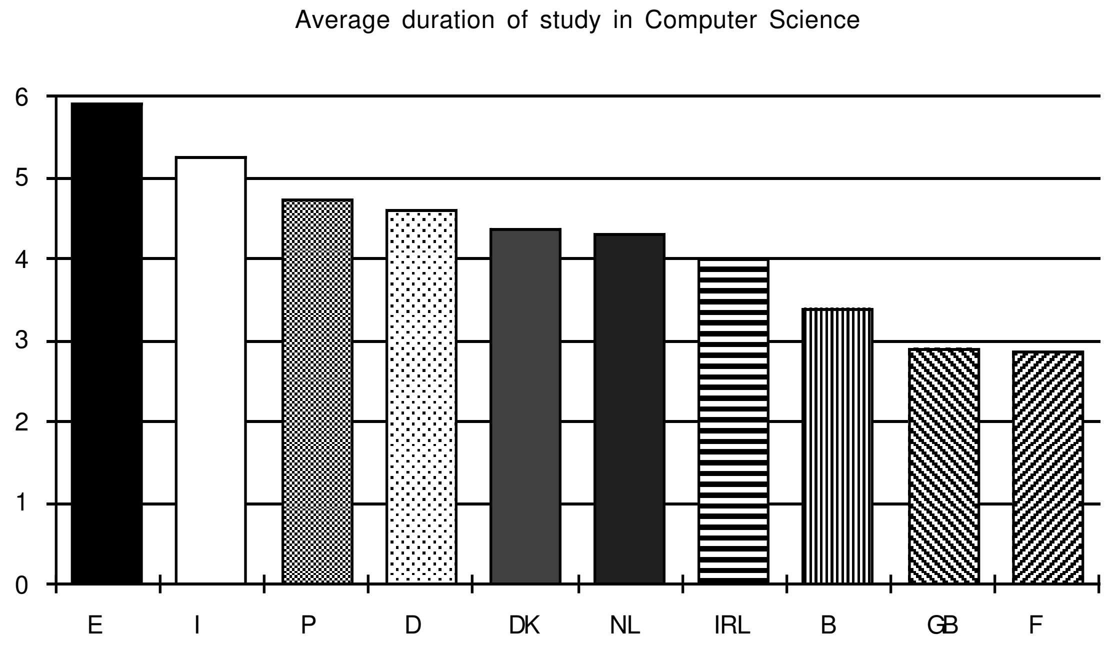


fig 6

AI

The situation in Europe regarding AI can be determined by several data. The average numbers (cf. fig 7) of diploma/master theses per year with an AI topic are quite high and in some countries make up for five percent of all theses (cf. fig 8).

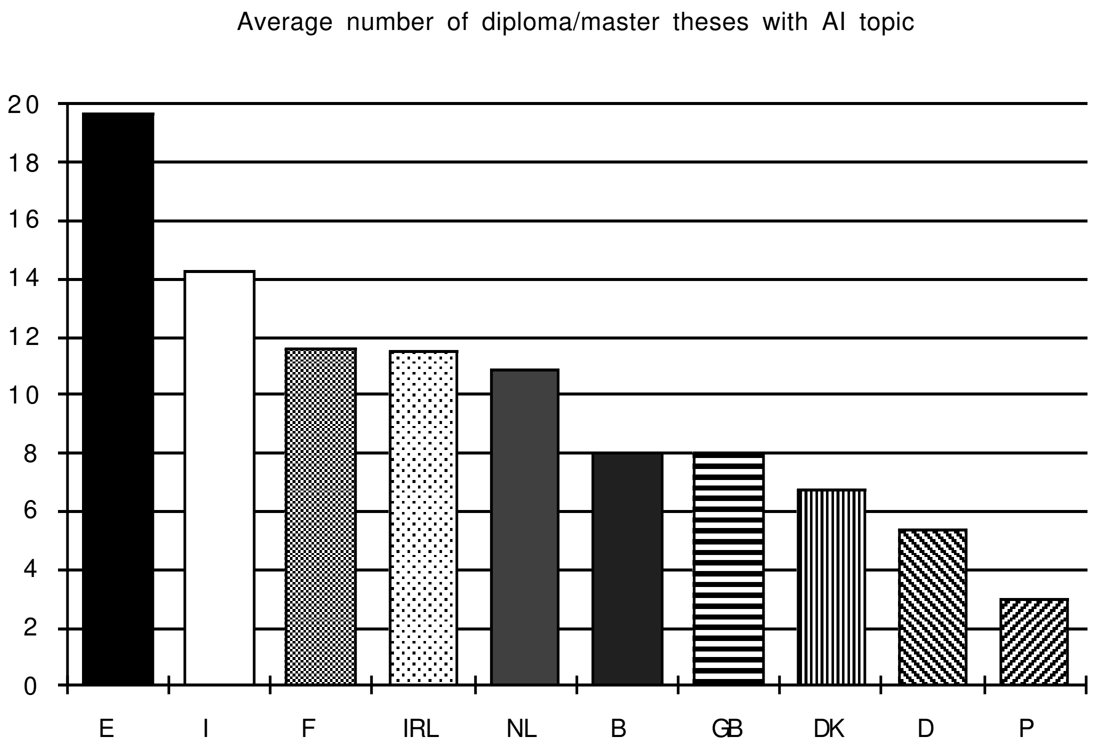


fig 7

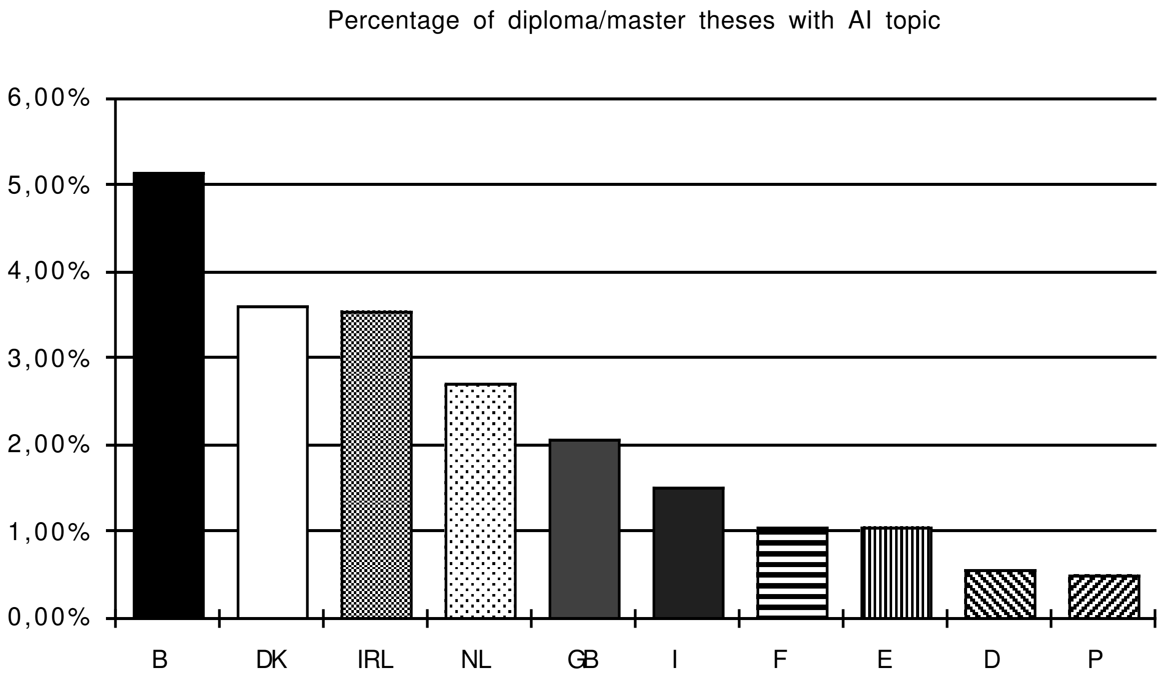


fig 8

AI courses are offered by the most Computer Science faculties (cf. fig 9), in most countries by all.

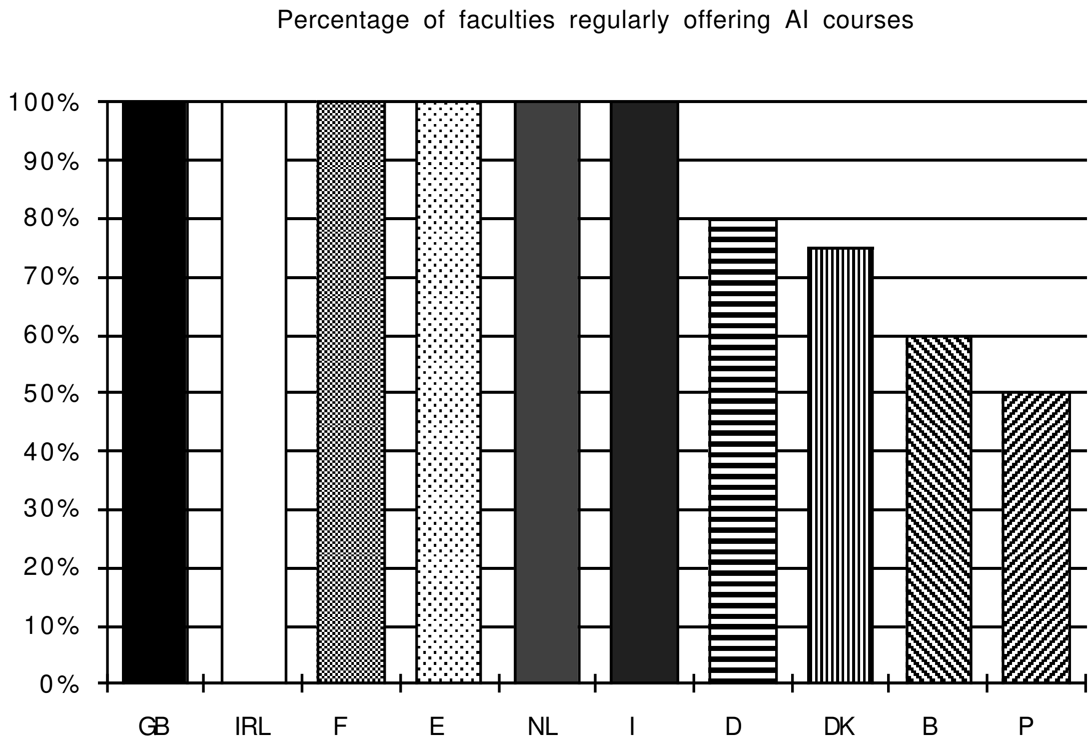


fig 9

Faculties offering a Ph.D. program in AI are numerous in some countries (cf. fig 10), but in other countries they are the exception (cf. fig 11).

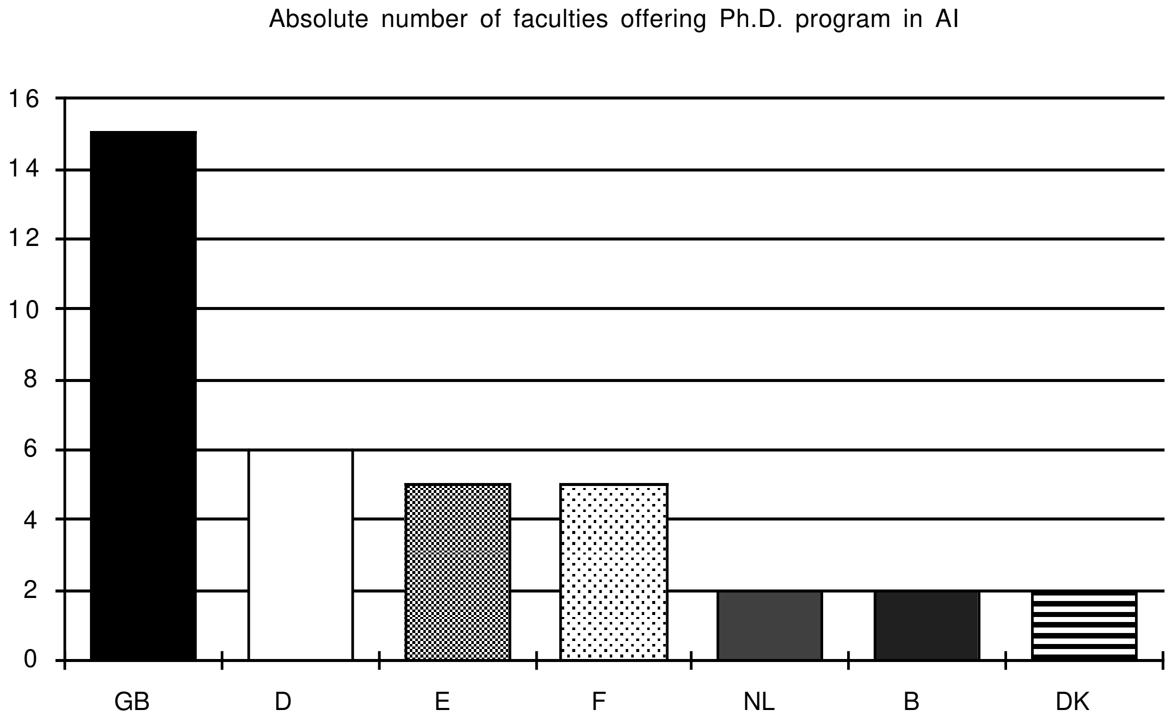


fig 10

Percentage of faculties offering Ph.D. program in AI

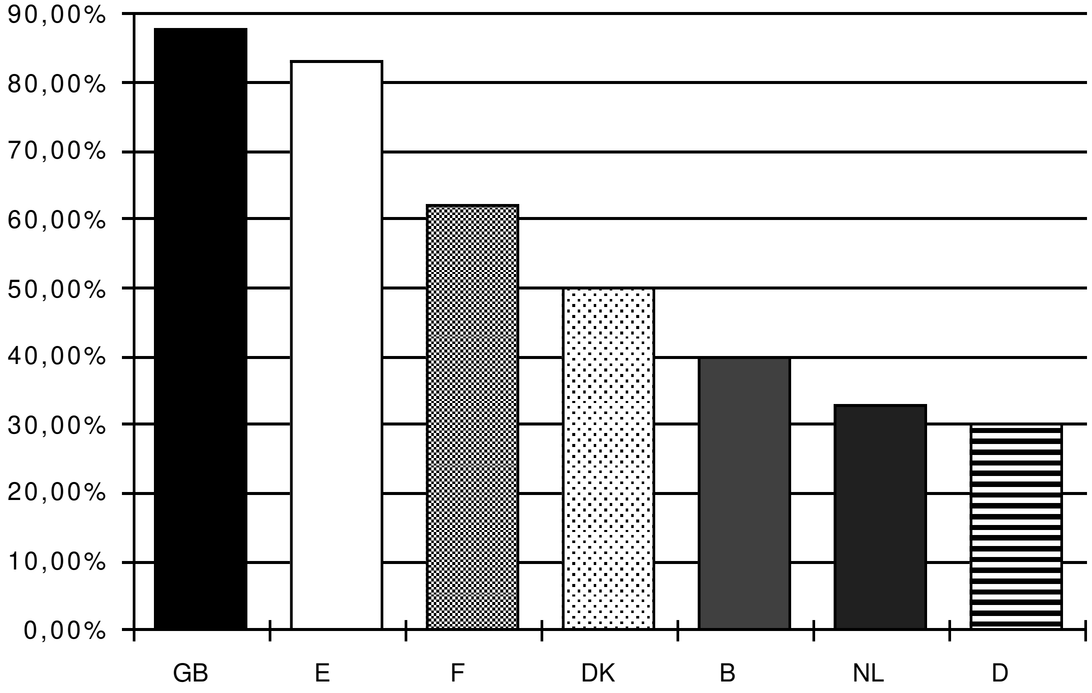


fig 11

Regular AI courses, held by permanent faculty staff, are common (cf. fig 12).

Faculties with AI courses regularly held by permanent staff

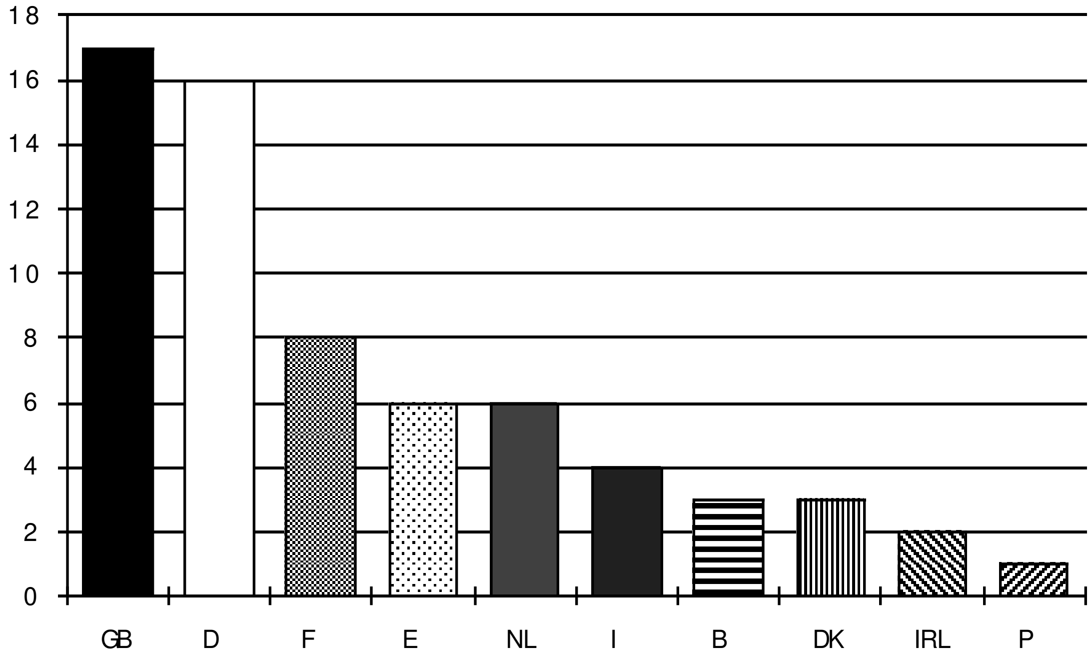


fig 12

There is a great difference among the countries with regard to their AI curriculum and its structure. While an introductory course including exercises (cf. fig 13 and 14) and later on a specialised course is common and a regular part of the curriculum (cf. fig 15), some countries only require their students to visit more AI courses if they are specialising in AI (cf. fig 16).

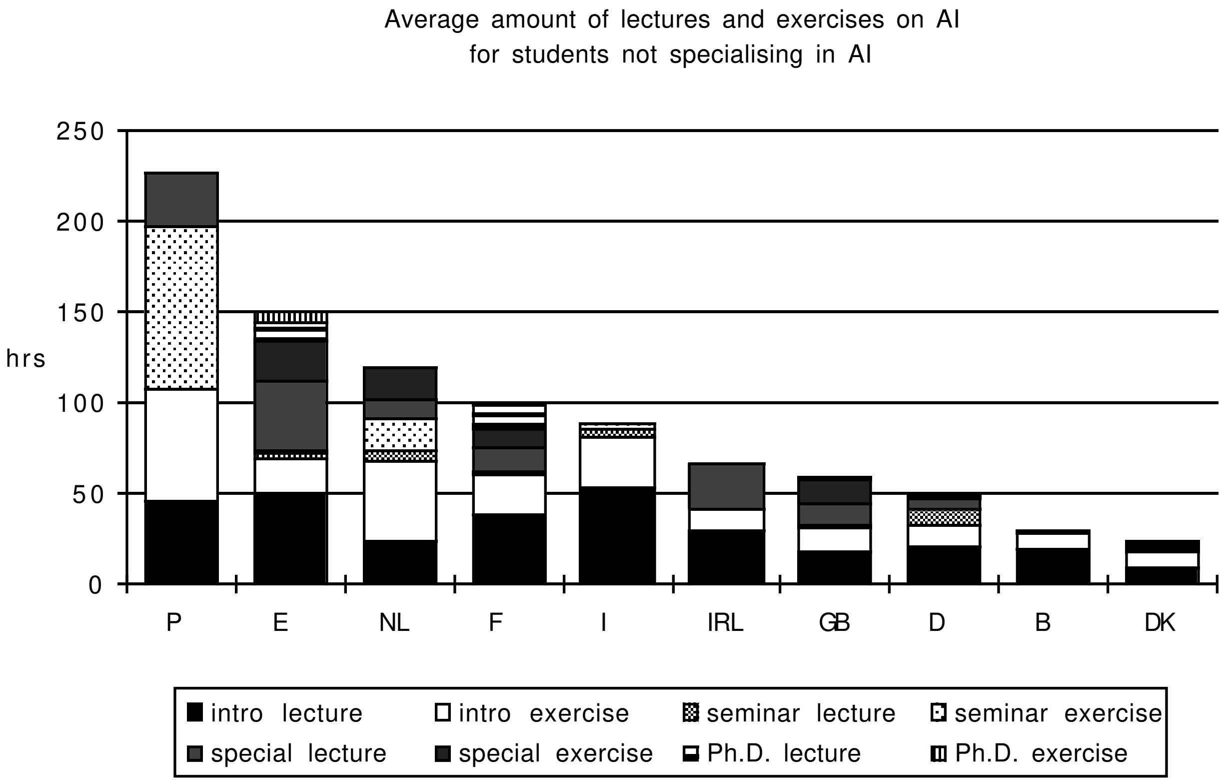


fig 13

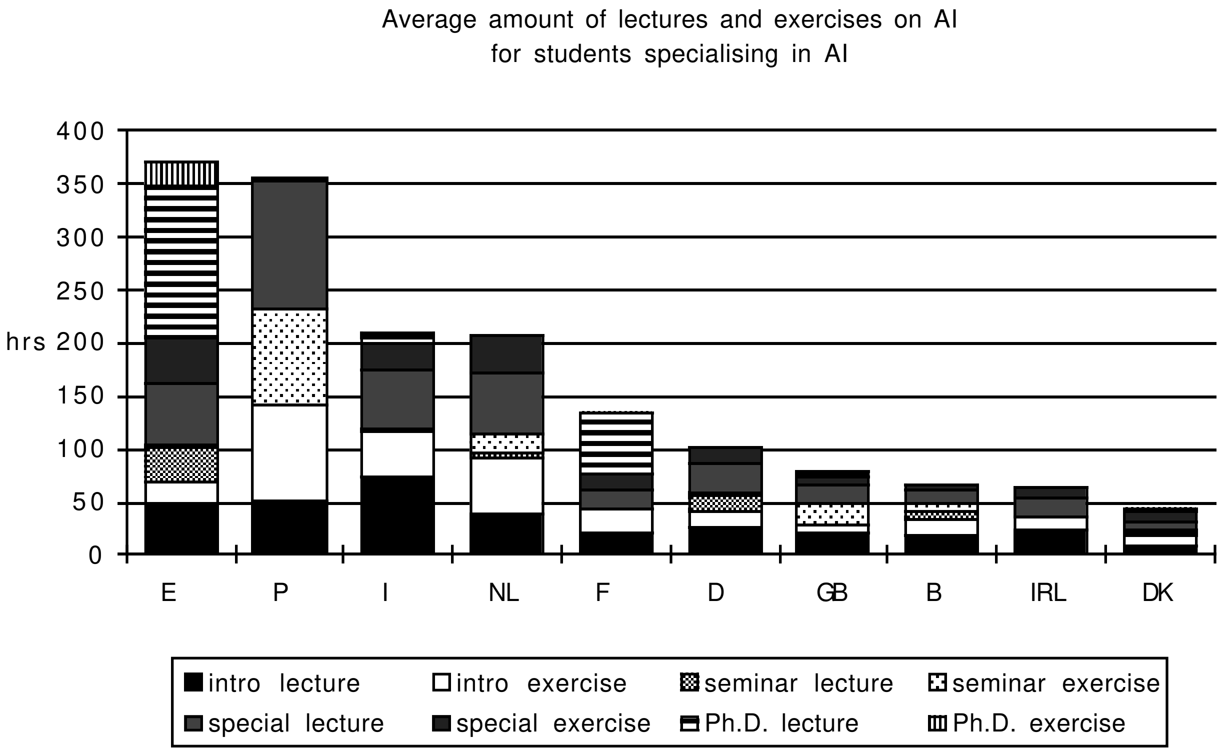
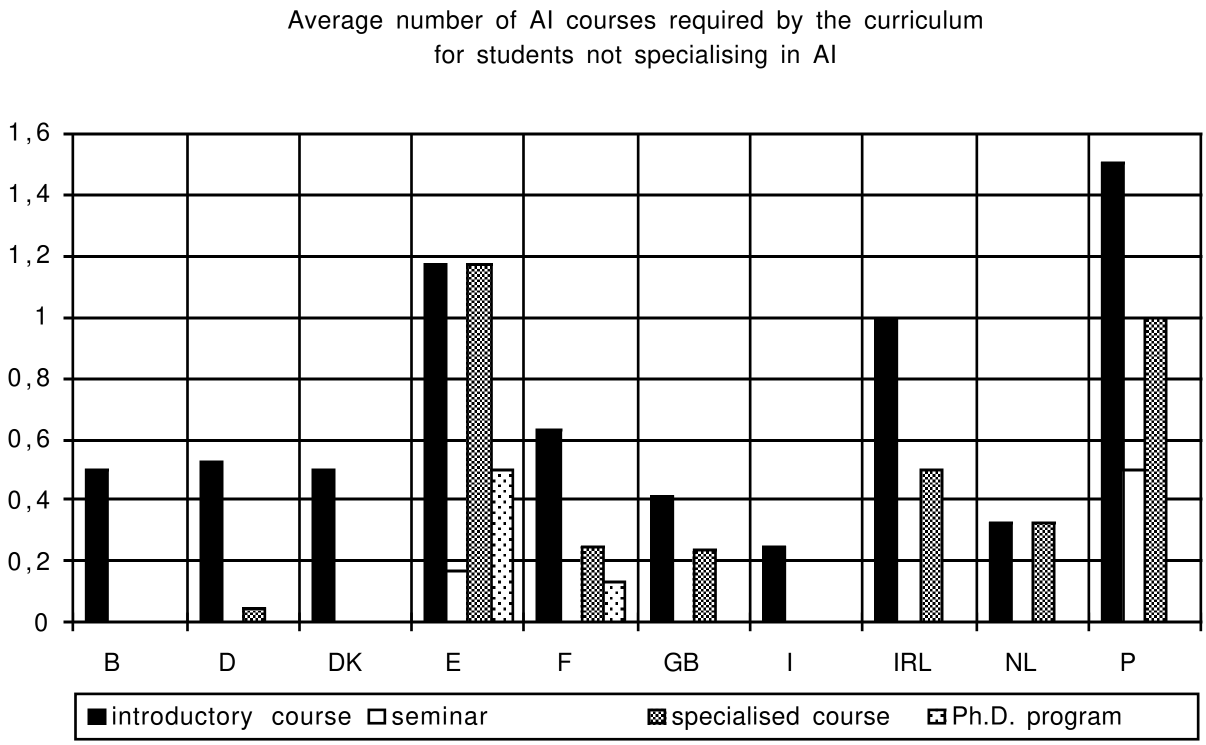
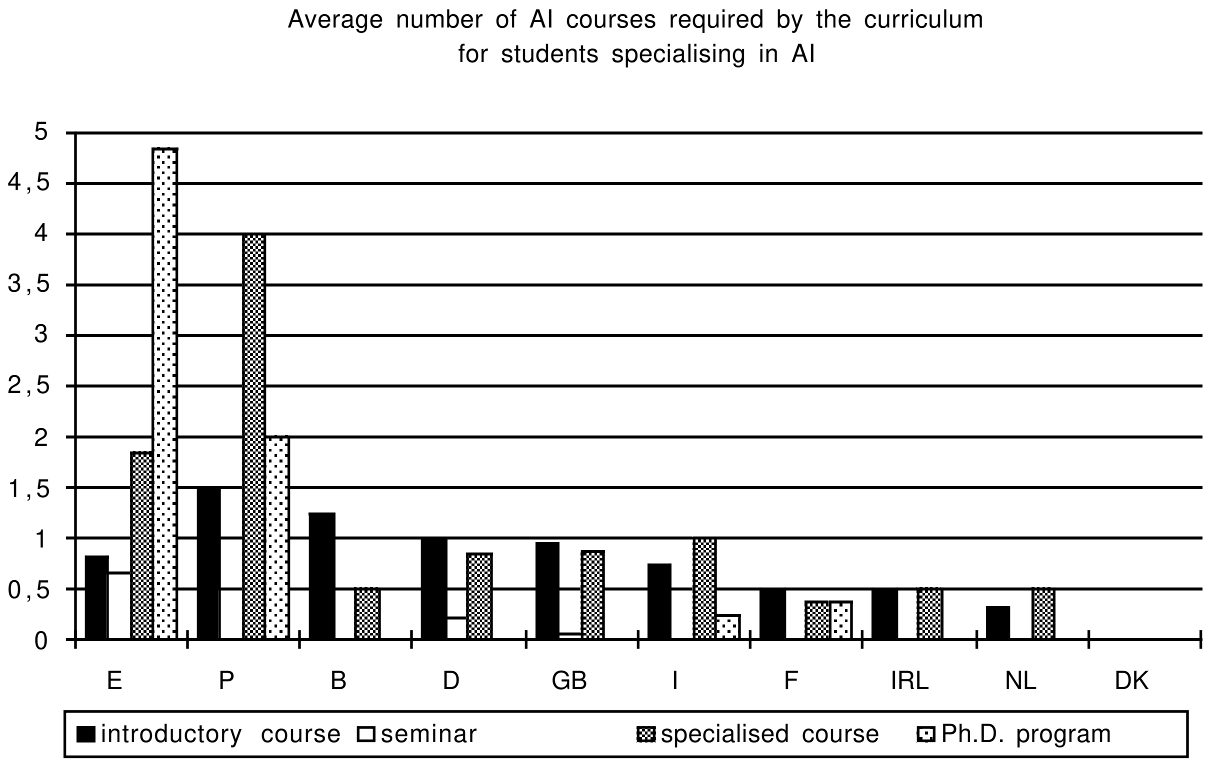


fig 14


Average number of AI courses required by the curriculum
for students not specialising in AI
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
B
D
DK
E
F
GB
I
IRL
NL
P
introductory course
seminar
specialised course
Ph.D. program
fig 15


Average number of AI courses required by the curriculum
for students specialising in AI
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
E
P
B
D
GB
I
F
IRL
NL
DK
introductory course
seminar
specialised course
Ph.D. program
fig 16

In most countries, AI is not introduced to students before the second year of study (cf. fig 17).

country	intro course	special course	Ph.D. program
NL	2,20	3,00	6,00
GB	2,25	2,92	4,09
D	2,69	3,31	5,13
F	2,71	3,57	3,60
B	3,33	4,00	5,33
DK	3,33	4,50	3,67
IRL	3,00	4,00	0,00
P	3,00	1,00	1,00
E	3,17	4,17	6,00
I	4,00	4,00	0,00

fig 17

As a summary, the situation for AI in the European countries is quite good. AI is a regular part of Computer Science training at most universities, and to a satisfying degree.

ML

Compared to AI, the numbers of theses with an ML topic are quite low (cf. fig 18 and 19). Especially Ph.D. theses are rare at European universities.

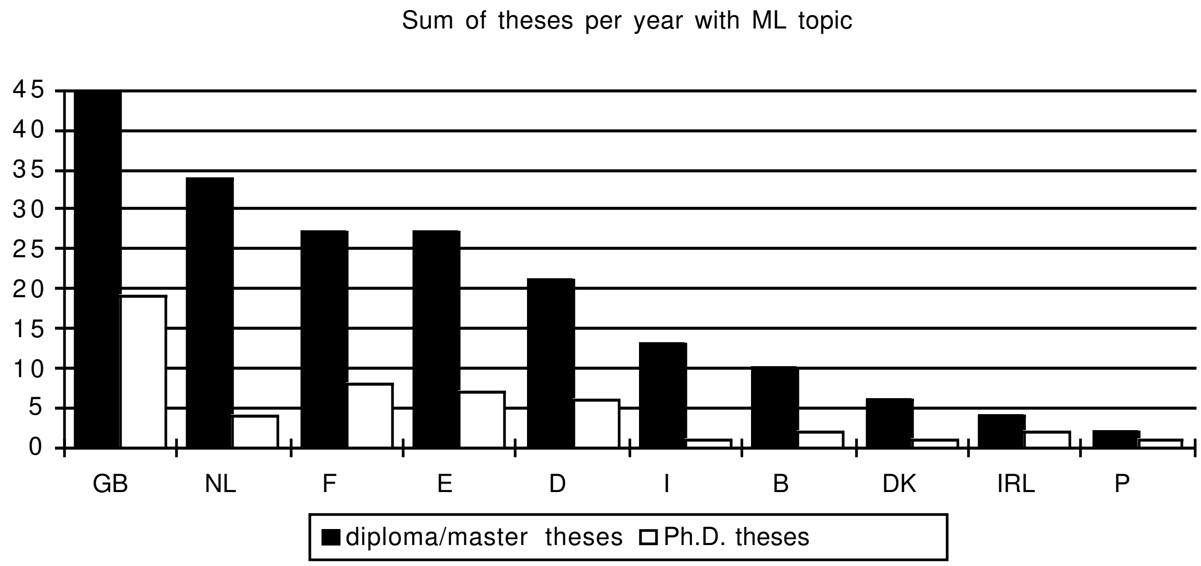


fig 18

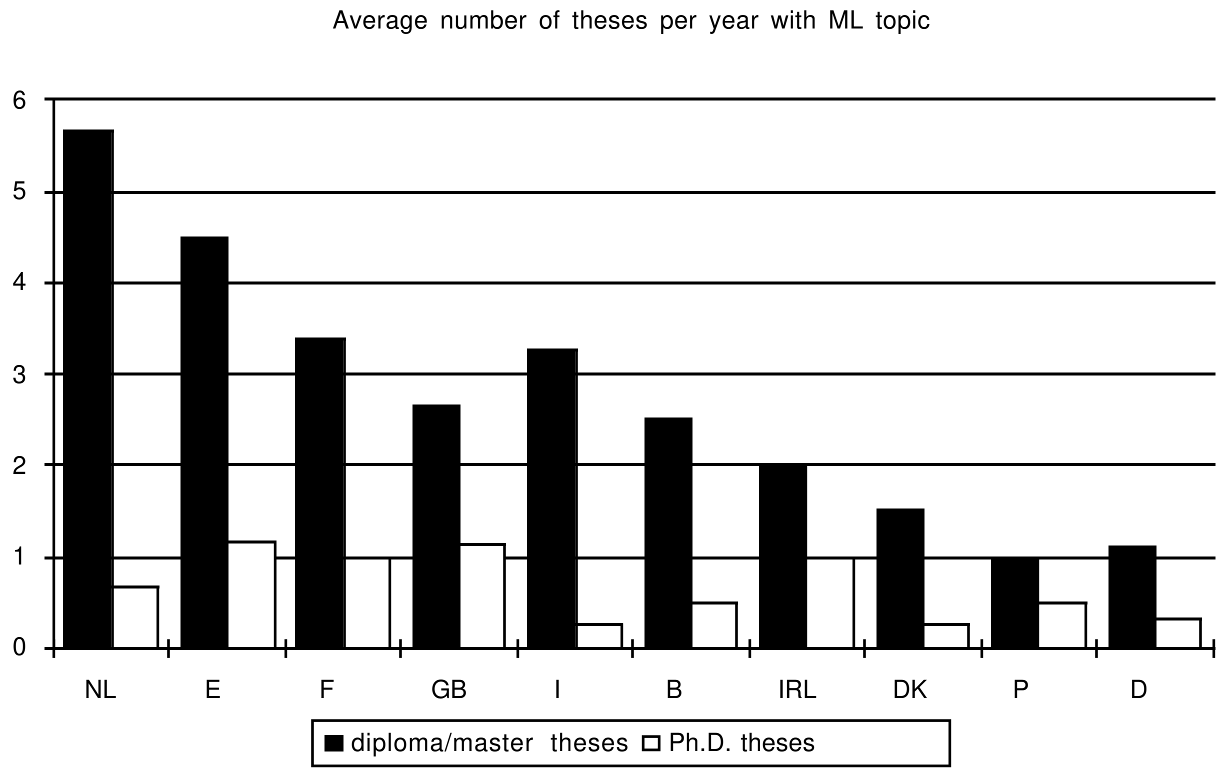


fig 19

Nevertheless, quite a number of faculties state, that ML is a regular topic of theses there (cf. fig 20). In some countries these are even the majority (cf. fig 21).

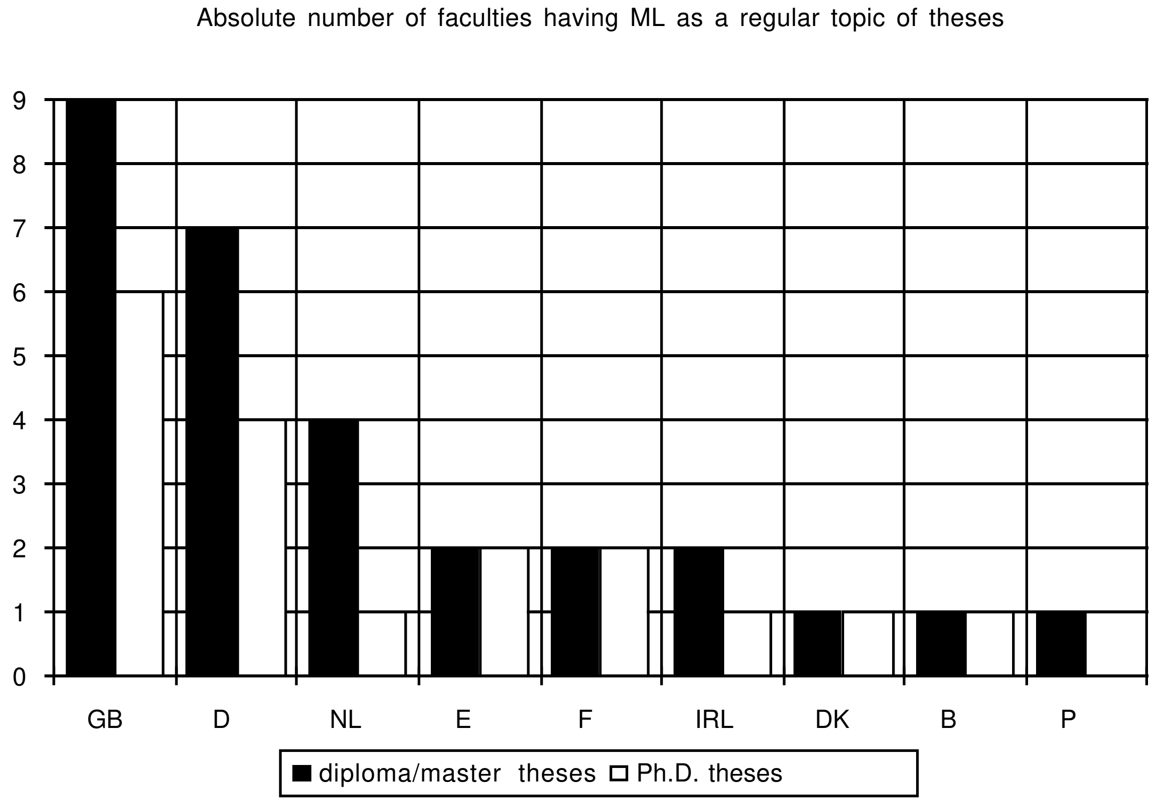


fig 20

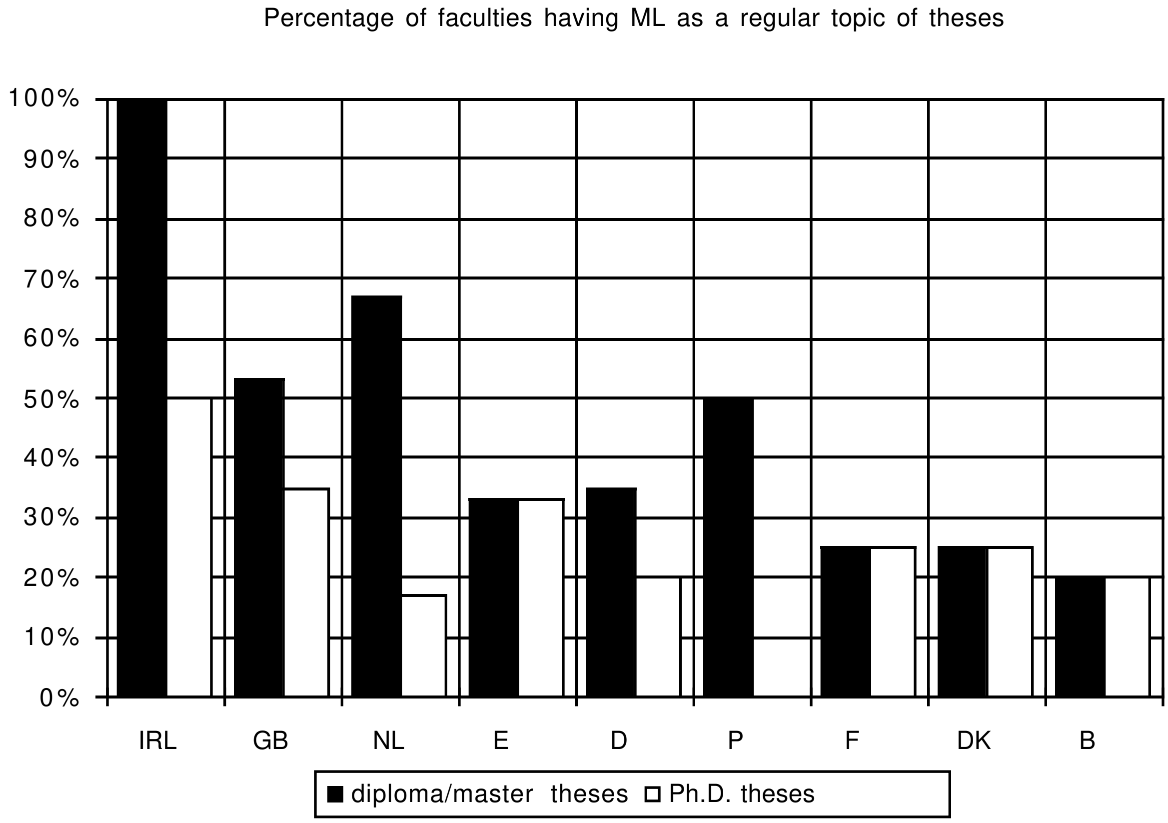


fig 21

Fig 22 shows the most frequent research topics

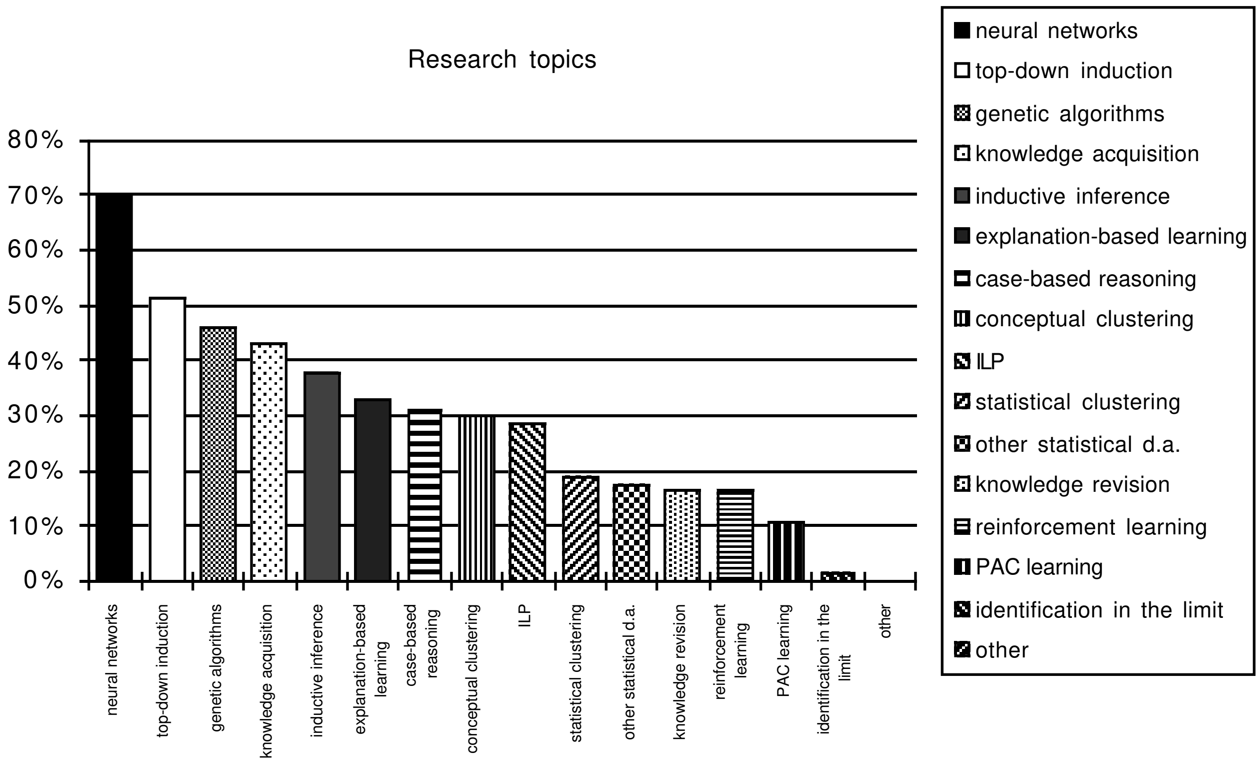


fig 22

It can be clearly seen that in nearly all countries ML has not yet won a firm place within the curriculum. Where ML is taught at a significant level, it is mostly done in seminars or in a lecture in its own right (cf. fig 23).

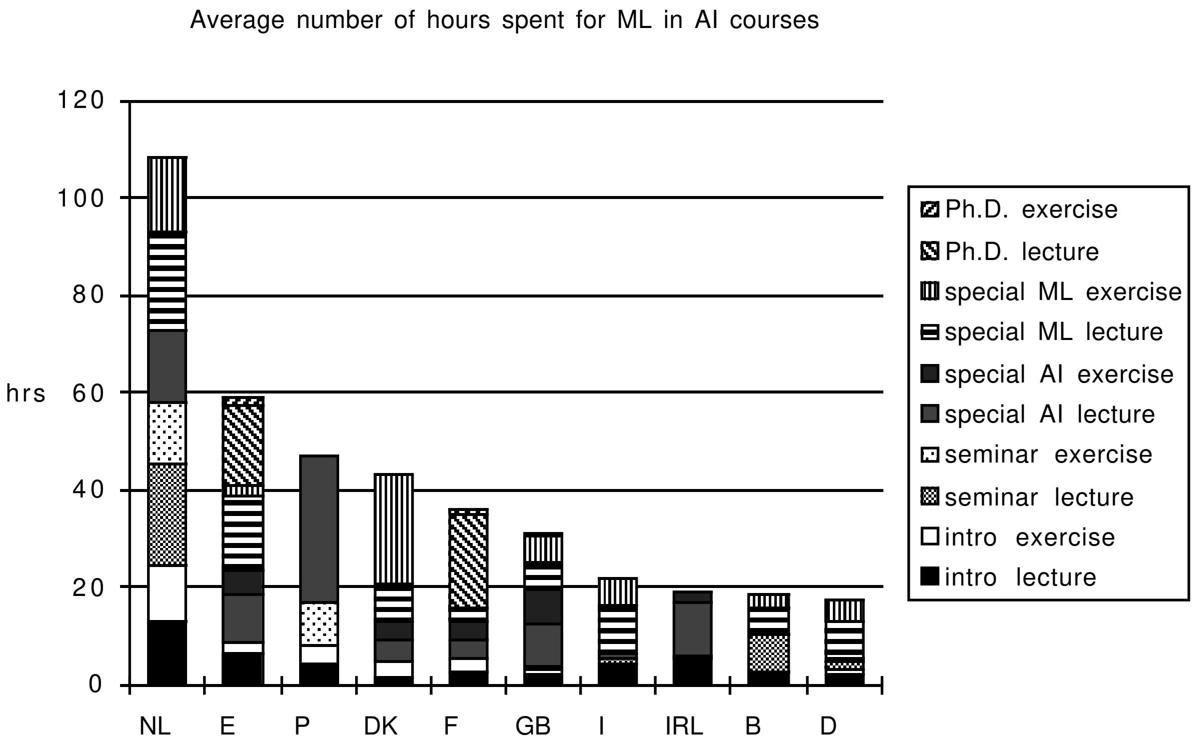


fig 23

Conclusion

It is not widespread that non-permanent staff like researchers or Ph.D. students hold ML courses (cf. fig 24).

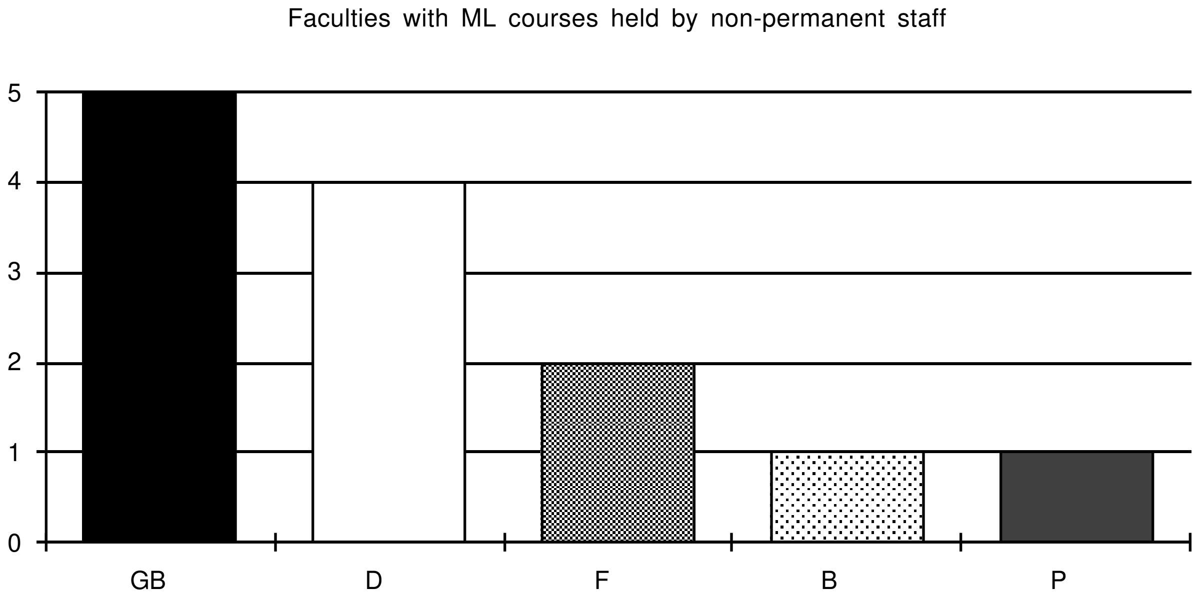


fig 24

In a summary, the situation for ML in Europe is heterogeneous. In some centers of excellence within a number of countries, ML is a standard part of training and research (cf. fig 25), but in general, ML is not recognised as an indisputable field. Sometimes up to 50% of the faculties within a country do not teach ML at all (cf. fig 26).

Average number of hours spent for ML in special interest course

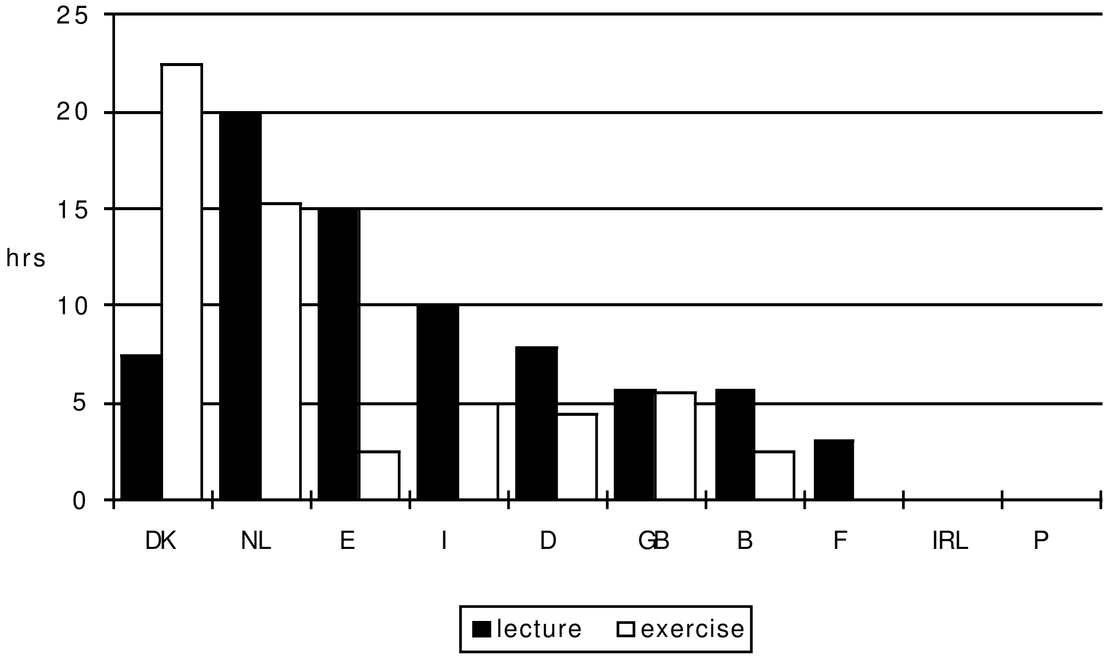


fig 25

Percentage of faculties not offering in ML in any AI course

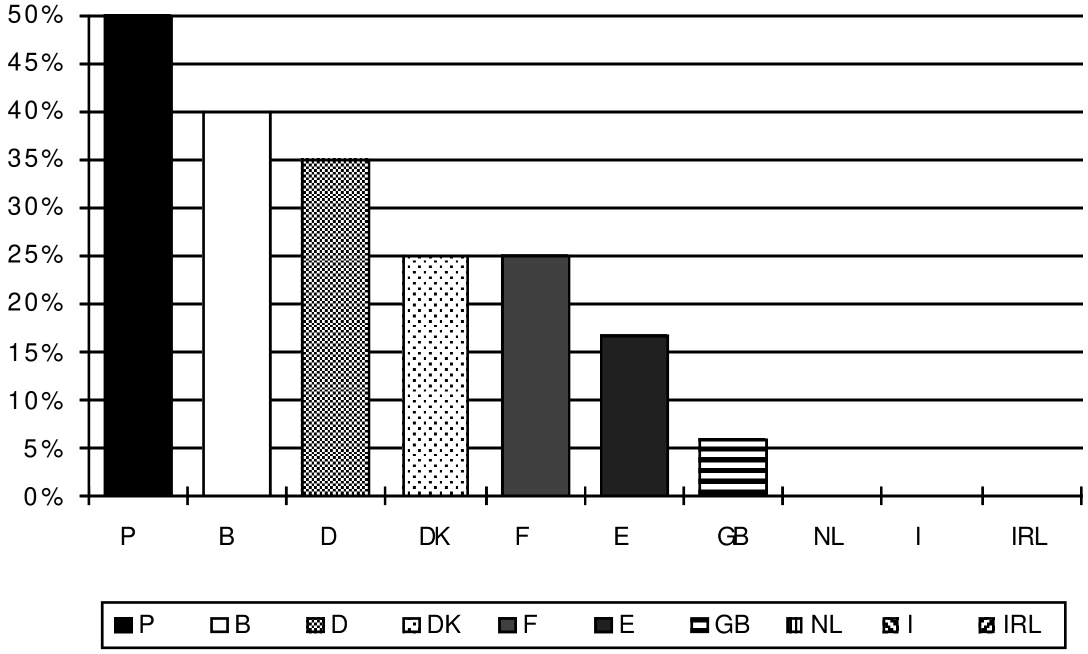


fig 26

A First Tentative Summary

Regarding the questions mentioned at the beginning of this document, tentative answers can now be stated on the basis of the inquiry.

- ML has not yet become a standard topic of Computer Science but has achieved attention within AI courses - be them taught within the Computer Science department or within a department of social sciences.
- As a topic in its own right, ML is taught at some universities per country which can be viewed as "centers of excellence" concerning ML.
- ML topics to diploma and Ph.D. students are offered at several places - namely the centers of excellence produce a high number of theses on ML topics.

It is still unclear whether teaching ML at other places is a temporary matter due to the high attention US scientists pay to ML or whether ML will take its way into the standard curriculum of AI.

Annex A
(Questionnaire)

Prof. Dr. Katharina Morik • Lehrstuhl VIII (AI) • Fachbereich Informatik • Universität Dortmund • Germany

Computer Science

1 How many students study computer science at your faculty?

About ☐☐☐☐ students

2 How many years do students - on an average - study computer science at your faculty?

About ☐☐.☐ years

Artificial Intelligence (AI)

3 Does your faculty regularly offer AI courses which are held by professors/assistants in permanent position?

Yes ☐ No ☐

4 Does your faculty offer a Ph.D. program in AI?

Yes ☐ No ☐

5 How many diploma/master theses per year are concerned with AI topics?

About ☐☐☐ theses

6 In which year of study do students usually take the respective AI courses?
(please check the year the several courses begin)

year of study	start of introductory course	start of specialised course	start of Ph.D. program
first year			
second year			
third year			
fourth year			
fifth year			
later (please indicate the year)			

please check

7 How many hours does a student of computer science, who is not specialising in AI spend in an AI course? Please enter an average number or a probable range

type of course	lecture (hours)	exercise (hours)	courses required by the curriculum (number)
introductory course			
seminar			
special interest course			
course in Ph.D. program (not majoring in AI)			

please enter number

8 How many hours does a student of computer science, who is specialising in AI spend in an AI course? Please enter an average number or a probable range

type of course	lecture (hours)	exercise (hours)	courses required by the curriculum (number)
introductory course			
seminar			
special interest course			
Ph.D. program in AI			

please enter number

Machine Learning (ML)

9 How many hours are spent for ML in AI courses?
Please enter an average number or a probable range
If ML is not a regular topic, please indicate nil

type of course	lecture (hours)	exercise (hours)
introductory course		
seminar		
special interest course in AI		
special interest course in ML		
Ph.D. program in AI		

please enter number

10 Which main topics of ML are taught?
(multiple checking possible, we do not propose any structure of the field of ML here, but merely name frequent topics)

please check

	top-down induction of decision trees		reinforcement learning		knowledge revision
	conceptual clustering		case-based reasoning		inductive inference
	explanation-based learning		neural networks		PAC learning
	inductive logic programming		statistical clustering		identification in the limit
	genetic algorithms		other data analysis from statistics		knowledge acquisition
	others (please name)				

11 Are there ML courses because of research projects held by non-permanent personnel? (e.g. researchers, Ph.D. students)

Yes ☐ No ☐

12 Is ML a regular topic of diploma/master theses?

Yes ☐ No ☐

13 How many diploma/master theses a year are concerned with an ML topic?

About ☐☐☐ theses

14 Is ML a regular topic of Ph.D. theses?

Yes ☐ No ☐

15 How many Ph.D. theses a year are concerned with an ML topic?

About ☐☐☐ Ph.D. theses

16 Finally, please fill in your faculty's/department's address, the name of the person handling ML related affairs and ways to contact you as available.

Name ☐

Address ☐

Tel./Fax ☐

E-Mail ☐

Thank you very much for supporting our project by spending the time to answer this questionnaire.

Annex B
(Inquiry database)

The following pages contain all data from the inquiry database. There are two parts: the first one features the faculties that have returned the questionnaire, including mailing and return date and all statistical data. The second part contains all other faculties that have not submitted any data.
An effort has been made to put the mass of data into readable shape. On the head of every page there are the titles of the different fields of the datasets listed below. The following abbreviations are used:

no.	Database reference number
nc.	Faculty not concerned by the inquiry?; dataset is not used in statistical analysis if field is J
cc.	European country code
pz.	Number for the postal zone within the state

In the first part, the numbers refer to the questions on the questionnaire. Tables (i.e. questions 7, 8, 9 and 10) appear almost in the same form as they do in the questionnaire. The table for question 6 has been converted to show the year of start of the different AI courses (from left to right in the questionnaire) one below the other.