Department of Computer Science

Study Guide 2008-2010

This document is translated from the Finnish study guide for the academic years 2008-2009 and 2009-2010 and is only marginally modified/augmented to express what we have especially in English. Please note that
- Some links point to pages written in Finnish only; we do not have a totally many-lingual web.
- Some special issues, e.g. the language requirements in the degree of a non-Finnish student, have not been expressed in detail.
- **This version is only partially ready; some minor parts may be updated, and some parts are expressed condensed (compared to the Finnish version). In case of any problems, contact your study advisor (fsa[at]cs.helsinki.fi) (or any student councellor).**

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Teacher tutoring contacts (for HOPS tutoring): see http://www.cs.helsinki.fi/opiskelu/hops/.

International student exchange and JOO studies: Head of Studies, N.N.

Web information, e-mail: The department uses **web pages** very extensively for information on both standing and current affairs. The department homepage is at **http://www.cs.helsinki.fi/**, and any useful information on studying at the department is available at http://www.cs.helsinki.fi/en/studies, including info on how to join the e-mail list for students. We recommend the use of the following **service addresses** for e-mail to the department

atk-apu[at]cs.helsinki.fi	help-desk for users of the department's computer systems
tktl-luvat[at]cs.helsinki.fi	user access to the department's systems
opetus[at]cs.helsinki.fi	practical teaching arrangements
hyvaksiluvut[at]cs.helsinki.fi	approval of credits from other institutions
johtaja[at]cs.helsinki.fi	Department Chairman
toimisto[at]cs.helsinki.fi	administration
opintoneuvonta[at]cs.helsinki.fi	student counselling.
opintoesimies[at]cs.helsinki.fi	Head of Studies.

There is a more detailed list of service addresses and detailed instructions at
http://www.cs.helsinki.fi/hallinto/palveluosoitteet.html.

Library

Please see Kumpula Science Library.

Computer science as a discipline and subject for study

Research in computer science focuses on algorithm-based methods and processes, which are used to describe and transform information; their theory, analysis, design, implementation and application are studied. These methods can be implemented as computer programs, which the computer can run 'automatically.' The basic question in computer science is: "What can be automated, and how is it done most efficiently?" This characterisation of this discipline illustrates that, in addition to being an exact method science, computer science is also a constructive and experimental science, where empirical testing plays an important role.

The rapid development in the field of information technology (IT) has made it one of the pivotal sectors in our society, where all functions are increasingly based on IT systems. Nowadays, automatic information processing is closely linked with the areas of business, administration, research and education, where computer skills are essential. Finland has kept up well with this development and Finnish information technology has become a national strength in a short time.

In last few years, the advances in IT have also given rise to new application fields where computer science has formed the methodological core. Examples of such fields are bioinformatics, a combination of biology and computer science, geoinformatics from geography and computer science, and the computational science that has arisen out of the needs of various disciplines such as physics, chemistry, ecology, medicine, behavioural sciences, sociology and economics.

Studies offered by the Department of Computer Science give an excellent competence to work with development and applications in the IT field. In addition to IT experts, the job market is in need of people who are experts in their own fields, while they have good basic skills in IT. One alternative to majoring in computer science, in preparing for duties in the field of IT, is to study the application field as a major subject, while minoring in computer science. There are also multidisciplinary Master's programmes for students who want a wide range of expertise in modern fields like bioinformatics or geoinformatics.

Graduates may work in very different areas of business and administrative computing, in innovative development for the ICT industry, as well as research and education in the IT field. For those interested in research and development, the rapidly growing field of computer science is an attractive alternative; the field offers challenging and significant research problems, leading to solutions that are immediately applied in practice in the industries.

Degree reformation, degree systems

With the reformation of degrees in the whole university, a new degree system was instated on 1 August 2005. Now the transition period of 2005–2008 is over, and all degrees will be finished according to the new degree system.

Degree requirements in computer science have been updated again, starting from the academic year 2008–2009. Besides the new requirements, it is possible to follow the old (2005–2008) requirements until 31 July 2011.

This guide will not describe the old degree requirements; information on those is available in old study guides and on the departmental web pages (degree requirements at

). The rules and practices for transferring from the old systems to the new one are explained at the end of the chapter 'Planning your studies' ('Transferring from an old degree system to a new one') and on the web page http://www.cs.helsinki.fi/tutkinnonuudistus/.

Degrees, sub-programmes, and Master's programmes

The basic degrees of the Computer Science Programme are the Bachelor of Science (BSc) degree consisting of 180 credits and the Master of Science (MSc) degree consisting of 120 credits. The major subject for the Bachelor's and Master's degree is computer science. The contents of the Bachelor's degree are uniform as far as the major subject is concerned, while there are three sub-programmes to select from for the Master's degree (instead of previous six).

In addition, there are two separate Master's programmes at the department:
- The Master's Degree Programme in Bioinformatics, MBI, and
- The International CBU Master's Degree Programme in Information and Communication Technology.

These Master's programmes are carried out in collaboration with other departments and universities. The teaching is given in English and students are accepted through a separate application process. The MBI programme is multidisciplinary, including methods of computer science and statistics and their application to biosciences and medicine. The CBU programme offers advanced computer science studies in either intelligent computing or modern communication technology at the department as well as other Finnish and/or Russian universities.

Full-time students can take a Master's degree in one of the Master's programmes in two years if they have completed the BSc degree. The teaching offered for the Master's programmes at the department can mainly be attended by computer science students, and it is described in the teaching programme for computer science. The descriptions of the Master's programmes are in a separate section of the study guide.

If you are a full-time student, you can complete the Bachelor's degree in three years, and after that, the Master's degree in two years. The post-graduate degrees are the Licentiate of Philosophy (PhLic) and the Doctor of Philosophy (PhD) degrees. The structure of each degree is explained in the section on degree requirements.

Studies in computer science start with the basic module (25 cr) and continue with the intermediate module (61 cr). The planning of studies is supported from the beginning with the course 582507 "LuK-HOPS" that lasts throughout the Bachelor's programme. All students must register for this course at the beginning of their first university semester.

The basic and intermediate modules for the BSc degree contain courses in several sub-programme topics. After completing the BSc degree, students can take the advanced module (80 cr). It is allowed to study some advanced courses before completing the BSc degree but not seminars or Master's thesis. The education for the MSc degree is geared towards expert, development and management jobs in the field or a career in research, and it entails specialisation in accordance with one of the sub-programmes or Master's programmes. The web pages of the sub-programmes contain information on which courses are suitable as optional courses in the advanced module, and how to arrange for course combinations.

The sub-programmes are: algorithms and machine learning, distributed systems and data communications, and software systems. For the MSc degree, students can select sub-programmes

without separate application, as long as they have completed the courses in the degree requirements. At the beginning of the Master's programme, students register for the tutor of each sub-programme in order to start developing their personal study plan (FM-HOPS). Students who have been accepted directly into the MSc degree programme should contact the tutor of their sub-programme to discuss whether they need to complete additional courses before commencing the programme. Students who have not decided on which sub-programme they want to pursue should discuss their study plans and how to find the correct tutor with a student counsellor as soon as possible.

The sub-programme in algorithms and machine learning focuses on the theory and applications of algorithms and artificial intelligence, to find efficient algorithms especially for intelligent systems and to apply these algorithms to biological and other data. The focal area of the sub-programme in distributed systems and data communications is independently operating parallel components of systems and the communication between them. The sub-programme in software systems studies the systematic engineering of large and complex software products, to gain expertise in software engineering, data management, and management of development projects.

The research school

The research school at the Department of Computer Science is meant for students who are interested in pursuing a career in research and development in the fields of computer science or information technology. The research school students aim at a postgraduate degree with the rapid completion of the Bachelor's and Master's degrees as intermediate stages.

The research school does not have separate degree requirements. The purpose of the school is to help students direct their studies towards courses that will be useful in a research career, and to create contacts between students and the research groups at the department (including e.g. presentation of research groups, trainee positions in the research groups, more challenging project work that relates to the research carried out at the department).

The students attending the research school form their own HOPS teacher tutor group, to which they transfer when they have been accepted to the school. At the final stages of their Master's degree, the research school students transfer to one of the research groups or a post-graduate school (HeCSE, ComBi, KIT, SoSE). Students can have their own workspace at the department and borrow a laptop for project work, among other things.

Some 5-10 students are elected for the research school annually in May. The elections are based on student progress and an interview. Students who have done well in their studies may also apply to the school later than in the spring of their first year.

Student counselling

Information about the department, teaching and research is available on the department web server and the notice boards.

The main information about studying at the department is available on the web page http://www.cs.helsinki.fi/en/studies/study-counselling. The most current information about teaching is posted before the start of each term on the web server in the teaching programme for that term. The goals, contents and requirements of each course are presented in the course descriptions on the web page of each course.

The HOPS instructors (teacher tutors) and the student counselling in office A232 (phone 191

51121) will counsel students individually. Please see http://www.cs.helsinki.fi/en/studies/study-counselling for the office hours of the student counsellors. The sub-programme tutors and professors in charge will counsel students in matters pertaining to advanced-module and post-graduate studies. For information on individual courses, please contact the teacher in charge of the course.

Important dates

An information session for first-year students majoring in computer science will be held on Wednesday 27 August 2008 at 9-12 in Auditorium B123 (Exactum, ground floor; in Finnish). A corresponding orientation session in English is arranged as a part of the orientation course for international students, on Thursday 28 August, afternoon. The orientation course starts on Tuesday 26 August at 9:00 (University Main building, lecture room 1). In addition, useful general information for new students will be given in the student tutorial groups arranged by the faculty and organized during the orientation course. It is important to participate in these tutorial groups for getting started with your studies and learning about the university community. For majoring undergraduates to set their study process in motion, it is very important to participate in the HOPS work and teacher tutoring from the first meeting on Wed 3 September at 16–18 in Auditorium B123.

There are four periods of teaching:

I   1.9.–19.10.2007
II   27.10.–14.12.2007
III   12.1.–1.3.2008
IV   9.3.–17.5.2008[*)]

[*)] includes Easter week and a two-week intensive period in May; normal teaching programme ends on Friday 3 May.

The following list contains other important dates for the academic year 2007-2008, including more detailed period schedules (exam weeks).

Autumn 2008:

The teaching programme for the autumn term will be published on 11 August.
Registration for I-period courses for major-subject students starts on Thu 21 August at 9.00.
Registration for I-period courses for minor-subject students starts on Fri 22 August at 9.00.
Information session for new majoring students on Wed 27 August at 9-12 in Auditorium B123.
Information session for new minoring students on Thu 28 August at 12-14 in Auditorium CK112.
Information session (in Swedish) for new students on Fri 29 August at 9-10.30 (in lecture hall A129, Chemicum).
Information session (in English) for new students on Thu August, afternoon (as a part of the Orientation course for international students).
Annual registration to the university (presence or absence) should be made before September 1 (the deadline is earlier than before; not for new students).
The office hours for teachers start on Mon 1 September.
Teaching (period I) starts on Monday 1 September.
The course Introduction to Computer Science for first-year majoring students starts on Wed 3 Sept at 12-14 in Auditorium A111. The course contains studies and test for the ICT driving license; the proficiency test for this should be made as soon as possible, preferably before the course, see the course page).

HOPS sessions and teacher tutoring for first-year students start on Wed 3 Sept at 16-18 in Auditorium B123.
The event "Getting started with the Master's thesis" Mon 15 Sept at 16-18 in classroom B222.
Registration for II-period courses for major-subject students starts on Tue 7 Oct at 9.00.
Registration for II-period courses for minor-subject students starts on Wed 8 Oct at 9.00.
Exam week for period I on 13-17 Oct.
"Open doors" day at the department 17 Oct 2007.
Teaching (period II) starts on Monday 27 Oct.
The event "Getting started with the Master's thesis" Mon 3 Nov at 16-18 in classroom B222.
Register for the spring-term software engineering projects 5-20 Nov.
Register for spring-term course in scientific writing 5-20 Nov.
Register for spring-term seminars and courses demanding pre-registration 5-20 Nov.
The teaching programme for the spring term will be published on 1 Dec.
Teaching ends on Fri 5 Dec.
Exam week for period II on 8-10 Dec.
The office hours for teachers end on 14 Dec.

Spring 2009:

The teaching programme for the spring term will be published on 1 Dec 2007.
The office hours for teachers start on Mon 12 Jan.
Registration for III-period courses for major-subject students starts on Wed 7 Jan at 9.00.
Information session for students starting in spring term on Wed 7 Jan at 12-15 in Auditorium B123.
Registration for III-period courses for minor-subject students starts on Tue 9 Jan at 9.00.
Teaching (period III) starts on Mon 12 Jan.
The event "Getting started with the Master's thesis" Mon 19 Jan at 16-18 in classroom D122.
Registration for IV-period courses for major-subject students starts on Tue 17 Feb at 9.00.
Registration for IV-period courses for minor-subject students starts on Wed 18 Feb at 9.00.
Exam week for period III on 23–27 Feb.
Teaching (period IV) starts on Mon 9 Mar.
The event "Getting started with the Master's thesis" Mon 30 Mar at 16-18 in classroom D122.
The teaching programme for the summer term will be published on 31 Mar.
Register for the summer software engineering projects 1–20 Apr.
Easter holiday 9–15 Apr (no teaching, no office hours).
Register for other summer courses from Mon 20 Apr at 9.00.
Teaching ends on Fri 24 Apr (the intensive period on 17 May).
Exam week for period IV on 27 Apr–5 May.
Deadline for applications to research school Mon 11 May.
Register for autumn-term course in scientific writing 5-22 May.
Register for the autumn software engineering projects 5-22 May.
Register for autumn-term seminars and courses demanding pre-registration 5-22 May.
The office hours for teachers end on 29 May.

Summer 2009:

The teaching programme for the summer term will be published on 31 Mar.
Register for the software engineering projects 1–20 Apr.
Register for other summer courses from Mon 20 Apr at 9.00.

Important dates for the academic year 2009–2010 will be expressed on the web pages in spring 2009.

Degree requirements

Students entering the university in 2008 follow these degree requirements. Students who have started before can follow the requirements of 2005–2008 until 31 Jul 2011 or transfer to follow these requirements. The old degree requirements are available in old study guides and on the department web page http://www.cs.helsinki.fi/opiskelu/vaatimukset.html. The degree requirements for students who entered university in 2005 are available in the study guide 2005-2006 and the above-mentioned web page.

BACHELOR OF SCIENCE DEGREE (180 CREDITS)

1.   Major subject studies

584111   BASIC STUDIES IN COMPUTER SCIENCE (25 CREDITS)
582102 Introduction to computer science, 4 cr
581325 Introduction to programming, 5 cr
582103 Advanced course in programming, 4 cr
582104 Software modelling, 4 cr
58160 Programming project, 4 cr
581328 Introduction to databases, 4 cr

584213 INTERMEDIATE STUDIES IN COMPUTER SCIENCE (MAJOR) (61 CREDITS)
58131 Data structures, 8 cr
58161 Data structures project, 4 cr
582203 Database application, 4 cr
581305 Computer systems organization, 4 cr
582202 Introduction to data communication, 4 cr
581332 Concurrent programming, 4 cr
582206 Models of computation, 6 cr
582215 Introduction to computer security, 4 cr
582216 Introduction to artificial intelligence, 4 cr
581259 Software engineering, 4 cr
581260 Software engineering lab, 9 cr
582204 Bachelor's thesis, 6 cr
50036 Maturity test in BSc, 0 cr

2.   Minor subject studies (50 credits)

Basic module in mathematics or method sciences (25 cr) and
basic module in another minor subject, 25 cr
or
modules in mathematics or method sciences (50 cr).

In all cases, the module in method sciences must include at least 10 credits of mathematics and at least 10 credits of statistics.

In any case, the minor subject studies should include the mathematics course Introduction to discrete mathematics.

3. Other studies

Language studies, 10 cr
582505 First language communication, 3 cr
  Second domestic language, 3 cr
  Foreign language, 4 cr

584401 Information and communication technology studies, 5 cr
  582514 ICT driving licence, 3 cr
  581324 Introduction to the use of computers, 1 cr
  582506 Research data retrieval, 1 cr

584402 Internship or vocational orientation, 1-3 cr
  582508 Job market orientation for software engineering project, 1 cr, or
  582509 Professional IT working, 2 cr

582507 Personal study plan and participating in teacher tutoring, 2 cr

582513 Studying techniques, 2 cr

Optional courses so that the extent of the degree, 180 credits, is fulfilled. These may include major or minor subject courses or courses in other subjects.

MASTER OF SCIENCE DEGREE (120 CREDITS)

A Master's degree in computer science can be completed in one of three sub-programmes:
- Algorithms and machine learning
- Distributed systems and data communications
- Software systems

There are two Master's programmes in English offered at the department. Their requirements are presented elsewhere.
- Master's Degree Programme in Bioinformatics
- International CBU Master's Degree Programme in Information and Communication Technology

The requirements for a Master's degree are set according to sub-programme, but they follow a general pattern as described below.

1. Major subject studies

INTERMEDIATE STUDIES

Intermediate courses that can be taken as part of the Bachelor's degree or in addition to the advanced module in the Master's programme are required in the sub-programmes Distributed systems and data communications and in Software systems.

ADVANCED STUDIES (80 CREDITS)

Compulsory courses for sub-programme, 8 cr
Optional advanced courses appropriate for the sub-programme (other than seminars), 26 cr
Seminars, 6 cr
50131 Master's thesis, 40 cr

50039 Maturity test in MSc

2. Minor subject studies

The sub-programme Algorithms and machine learning requires a total of 60 credits of modules in mathematics or method sciences for the Bachelor's and Master's degrees.

3. Other studies

582510 Personal study plan, 1 cr

584403 Advanced internship or vocational orientation studies, at least 2 cr
 582511 Advanced professional IT working, 2-6 cr
 or
 581387 Information technology: Now! (3 cr) or other appropriate course

Optional courses so that the extent of the degree, 120 credits, is fulfilled. These may include major or minor subject courses or courses in other subjects.

DEGREE REQUIREMENTS ACCORDING TO SUB-PROGRAMME

Algorithms and machine learning

1. Major subject studies

584333 ADVANCED STUDIES
Compulsory courses, 8 cr
 582630 Design and analysis of algorithms, 4 cr
 582631 Introduction to machine learning, 4 cr
Optional courses, 26 cr
 One of the following:
  582632 Discrete optimization, 4 cr, and
  582633 Discrete optimization project, 2 cr,
  or
  582634 Data mining, 4 cr, and
  582635 Data mining project, 2 cr
  or
  582636 Probability models, 4 cr, and
  582637 Project in probability models, 2 cr
 Advanced courses in computer science (other than seminars), 20 cr, in accordance with the instructions on the sub-programme web page.
Seminars, 6 cr
50131 Master's thesis, 40 cr
50039 Maturity test in MSc

2. Minor subject studies

A total of 60 credits of modules in mathematics or method sciences for the Bachelor's and Master's degrees.

The module in method sciences must include at least 10 credits of mathematics and at least 10 credits of statistics.

Distributed systems and data communications

1.   Major subject studies

INTERMEDIATE STUDIES

58127 Programming in C, 4 cr (unless included in previous degree)

584334 ADVANCED STUDIES

Compulsory courses, 8 cr
     582640 Operating systems, 4 cr
     582417 Distributed systems, 4 cr
Optional courses, 26 cr
     One of the following:
          582641 Collaboration of autonomous business services, 4 cr
          582498 Internet protocols, 4 cr
          581365 Computer organization II, 4 cr
     Advanced courses in computer science (other than seminars), 22 cr, in accordance with the instructions on the sub-programme web page.
Seminars, 6 cr
50131 Master's thesis, 40 cr
50039 Maturity test in MSc

Software systems

1.   Major subject studies

INTERMEDIATE STUDIES

582482 Database design, 4 cr (unless included in previous degree)

584335 ADVANCED STUDIES

Compulsory courses, 8 cr
     581358 Software architectures, 8 cr
Optional courses, 26 cr
     One of the following:
          581359 Software processes and quality, 4 cr
          582642 Service-oriented software engineering, 4 cr
          582490 Transaction processing, 4 cr
     Advanced courses in computer science (other than seminars), 22 cr, in accordance with the instructions on the sub-programme web page.
Seminars, 6 cr
50131 Master's thesis, 40 cr
50039 Maturity test in MSc

LICENTIATE DEGREE

1. 58090 Ph.Lic. and Ph.D. Studies in Computer Science, 60 cr
     (please see requirements for PhD degree for more details)

2. Licentiate thesis

DEGREE OF DOCTOR OF PHILOSOPHY

1. 58090 Ph.Lic. and Ph.D. Studies in Computer Science, 60 cr
      58271 Studies in the Field of Research, 50 cr
         582710 Postgraduate seminar, 6 cr
         Other contents will be detailed in the study plan.
      58272 General postgraduate studies, 10 cr
         The general postgraduate studies should include studies in philosophy of science
         (582720) and research ethics (582721), general expertise studies (582722), as well as
         international scientific activities (582723). The contents and execution will be
         detailed in the study plan.

2. Doctoral thesis

If postgraduates have some other degree than the MSc in computer science, more than 60 cr may have to be included in their personal study plan.

Computer science studies for minor subject students

584112 BASIC STUDIES IN COMPUTER SCIENCE (MINOR) (25 CREDITS)

582102 Introduction to computer science, 4 cr
581325 Introduction to programming, 5 cr
582104 Software modelling, 4 cr
One of the following options
      582103 Advanced course in programming, 4 cr (or another comparable
      programming course) and
      58160 Programming project, 4 cr
      or
      581328 Introduction to databases, 4 cr and
      582203 Database application, 4 cr
Optional basic or intermediate courses in computer science, 4 cr

584214 INTERMEDIATE STUDIES IN COMPUTER SCIENCE (MINOR) (35 CREDITS)

Compulsory intermediate courses for undergraduates majoring in computer science, 12 cr
Optional basic and intermediate courses in computer science, 23 cr

The minor subject module cannot include the software engineering project or the Bachelor's thesis.

584327 ADVANCED STUDIES IN COMPUTER SCIENCE (MINOR) (60 CREDITS)

The advanced module in computer science can be taken in accordance with the degree requirements for each sub-programme and the module's contents should always be discussed with the professor in charge of the sub-programme. In general, they adhere to the following structure:
      Advanced courses in computer science, 37 cr
      Seminars, 3 cr
      584332 Minor subject thesis in computer science, 20 cr

General instructions and rules

Studies in computer science are mostly based on participation in lectures and exercises, and not so much on learning by reading. Generally, a course will consist of lectures and exercises in different

forms, and assignments are often included. Attending the lectures will show the student where to find the relevant information in the written material. During lab work, the student will learn how to apply the information, either individually or in a group.

The teaching methods are being developed into a more learner-centred approach, and how courses are realised is varied a great deal. Just following lectures will not lead to good results; the individual work of students is pivotal. A course that yields 4 credits, for example, requires a minimum of about 100 hours of work. The basic rule for planning your studies is that **you should schedule some 2 hours of independent work per every classroom or exercise hour**. The number of lectures and other contact teaching per course (and credit) varies. If there are uncommonly few teaching hours in relation to the number of credits a course yields, the portion of independent work is even larger than described above. You should not pack your schedule with all the lectures you can fit into it, but leave sufficient time to complete other tasks and reading that are required for the course.

Many of the courses emphasise teamwork and learning together. Each exercise group will be split into smaller **study circles** that solve problems according to a given schedule. The study circles will meet regularly to discuss principles for solving the exercises and to present solutions. Some other new teaching methods include courses that are strongly based on web material to be used independently and the virtual courses on video arranged in co-operation with other universities (the national virtual university project OSCu).

Working during terms usually slows down studies, and in some cases students never graduate. Especially, the Master's thesis demands full-time concentration of the student, and working on something else during thesis writing is not recommended. On the other hand, summer training (during summer vacation) is recommended for learning practical skills in the IT field.

It is important to take your courses in the correct order, so that you have a good command of the prerequisites for each course before starting on it. Please see the chapters on course interdependencies and the study schedule for more information.

Lecture courses and separate exams

A course usually comprises 4-8 credits (cr). Short courses take one period, longer ones continue into the next period. Each period consists of six weeks of teaching, followed by an exam week.

There are two ways to complete a course: by taking a lecture course or a separate exam. Both require pre-registration according to deadlines and instructions listed on the web pages. When registering for a course, you are usually required to register for an exercise group, i.e. you register for a course by registering for the exercise group.

A lecture course usually consists of lectures and one or two course exams. Each course exam lasts 2.5 hours. There may also be some compulsory or optional exercise sessions, lab work or study circles, which may yield points that affect the final grade. How to complete a course and the schedule for intermediate work will be announced at the beginning of each course, at the latest. Deadlines must be met. For most lecture courses it is possible to attend a separate or resit exam. If a course is mainly completed through exercises done during the course, project work etc, it may not be possible to take a separate exam or even to resit an exam.

Separate exams are formally independent of lecture courses, and the requirements are based on the material in the course description. Separate exams last 3.5 hours, and their requirements are usually those of the last lecture course to have been offered. For separate exams, participation in the lecture course is not usually required. However, for courses where the exercises or lab work is

considered a very important part of the course, it is not possible to take a separate exam, but only a resit exam, where the same course components are required as in the original course exam. The schedule for exams is on the web page http://www.cs.helsinki.fi/en/studies/exam-schedule.

For most students, the exam based on the lecture course is more suitable than taking a separate exam. Usually, even the most thorough independent exercises cannot substitute for the teaching and exercise problems given at a lecture course. Please see course descriptions on the page http://www.cs.helsinki.fi/opiskelu/index.en.html for how to complete a course.

Students can attend lecture courses, i.e. by registering for an exercise group on the basic and intermediate level, at the Department of Computer Science, no more than twice. A registration that has not been cancelled before the course deadline, usually by the end of the first exercise week, is counted as an attempt. The course lecturer may give a third chance, based on a well reasoned petition. Attempts from before Autumn 2002 are not counted when applying this rule.

There are no restrictions on taking separate exams. When planning the order in which to take each course, you must also take into account the prerequisites for each course, in addition to its requirements. Registering for and participating in a separate exam without proper preparation and lacking all the required pre-knowledge is usually fruitless and does not make for sensible planning.

The aim of this rule is not to make life difficult for students, but to enable a reasonable planning of studies. This will also free the department's teaching resources to be used where they are most needed, e.g. for extra exercise groups.

Most courses are graded on the basis of points awarded for different factors that vary according to the course. The grading scale for all courses has six steps (0-5). To gain the lowest passing grade 1/5, the student usually needs c. half of the maximum points, and to gain the highest possible grade 5/5, about 5/6 of the maximum points. Grading may, however, be partitioned more exactly e.g. so that certain parts have to be passed with sufficient points. In this case it is not possible to compensate the failure in one part with good points in other parts but with some additional work or by a new exam.

The courses described in English in the Finnish teaching programme will be lectured in English. Some other courses may be lectured in English, as well, if there are foreign students wanting to participate. Please see Computer Science Courses in English for more information.

Laboratory work

There are three independent exercise courses included in the requirements for the Bachelor's degree. They are called laboratory work (to distinguish between them and the often smaller assignments included in some lecture courses). In laboratory work, students can enhance and apply the knowledge and skills acquired during lecture courses by design and implementation assignments. The work is divided into individual lab courses. Attending lab work requires that the student has completed the corresponding course (or separate exam) before starting the lab course. It is recommended that the lab work be started immediately after completing the required courses.

There are three laboratory courses: the Programming project (prerequisite courses are Software modelling and Advanced course in programming), the Database application (prerequisite courses Introduction to programming, Software modelling, and Introduction to databases), and the Data structures project (prerequisites Programming project and Data structures).

Each lab course lasts about 6 weeks, and there are new teams for each period. The course may also be completed during the summer. There will be a joint initial lecture for all the teams of each period in the Programming and Database application projects. At the same time, this is when the teams start working together. The Data structures project starts without a joint initial meeting; the teams meet separately. The work must be completed during the course, which means that at least 15 hours per week should be scheduled for the lab work. If the work is not finished on time, the project will be considered interrupted. **Students who have interrupted their lab work can only retake the course by way of the interrupters' queue.** This means that interrupting lab work may seriously slow down your studies.

Registration for the lab courses is binding. However, if it is more than 48 hours until the start of the course, registrations may be cancelled. It is compulsory to attend the initial lecture (for the Data Structures Project, the team's initial meeting). **If a student who has registered for the course is not present at the first lecture (initial meeting) and has not contacted the person in charge of the project (for the data structures project, the instructor of the group), the student loses his/her place.** Later he or she may register only by way of the waiting list. Any free places on each course are filled from the waiting list during the initial meeting. When the places are filled, new students take precedence over students who have interrupted the course.

Each lab course has its own rules and regulations, which can be seen on the course homepage.

Bachelor's thesis (Scientific writing)

In the course Scientific Writing, students focus on information retrieval and on using scientific source material, as well as written and oral presentations of scientific renderings. The course exercises lead up to the final paper, the thesis (6 cr) completing the Bachelor's degree. In addition, passing of First-language communication (Äidinkielinen viestintä, 3 cr), the ICT course Research data retrieval (1 cr) and the maturity test is connected to this course. The skills and methods taught at this course will also be useful for writing your Master's thesis (pro gradu); at that stage, there will not be any teaching in writing skills.

The course is given each term and is aimed at computer science majors. Students may register for this course when they have completed the compulsory basic and intermediate module lecture courses and laboratory work, except Software engineering and the Software engineering project. It is not recommended to take this course in the same term as the Software engineering project.

The topics of the essays and surveys of the course correspond to the sub-programmes and research areas at the department. Researchers and teachers of the sub-programmes supervise the assignments. When registering, the students may express the subject they are interested in.

The maturity test required for the Bachelor's degree is completed during this course. A second maturity test will be taken for the **Master's degree**, in connection with the Master's thesis. The course exercises should be written in the same language as the mother language test in the matriculation exam (Finnish students).

Seminars

In the new degree requirements, 2 seminars (2 x 3 cr) are included in the Master's degree. A seminar is usually based on presentations and discussions. Each student is required to prepare a report on a given topic, give an oral presentation and actively participate in discussions and other work. Seminars are evaluated on the presentation, on a written report and other participation. Seminars usually meet once a week for a whole semester (two periods). Seminars that follow a

different schedule have the same amount of work. Students are required to be present during at least 3/4 of the regular weekly meetings.

Before the seminar, the whole Bachelor's degree must have completed. Usually only a limited number of students (11-13) may attend a seminar. If more students want to attend, the teacher selects the participants. **Note:** Students register for the Autumn seminars during the previous Spring and the Spring seminars during the previous Autumn.

The seminars described in English in the Finnish teaching programme will be held in English. Some other seminars may be held in English, as well, if there are foreign students wanting to participate. Please see Computer Science Courses in English for more information.

Master's thesis (Pro gradu)

The Master's thesis (called the Pro gradu in Finland) is the final thesis done independently by the students for their MSc degree. The extent of the thesis is 40 credits. The Bachelor's degree and most of the advanced module must be completed before starting on the Master's thesis.

The thesis usually requires at least one semester of concentrated work. Because of the varying nature of the work, it is hard to estimate how long it will take. Students may apply to the department for a Pro gradu grant to support themselves while working on the thesis.

The Master's thesis is usually written on a subject from the same sub-programme as the compulsory advanced-module courses. The subject of the thesis must always be agreed upon with the professor in charge of the sub-programme. For theses that cover many different sub-programmes, the thesis-writer may be required to complete some courses from other sub-programmes before starting to write his or her thesis.

The work is divided into two phases; initiation into the subject field and independent research. During the initiation the research plan is formulated. When the research plan has been approved, this phase is considered complete. There are more instructions on how to write the research plan and on the contents of the thesis in Finnish on the page http://www.cs.helsinki.fi/en/studies/msc/general. To find a suitable thesis topic, you may also want to acquaint yourself with the department's research groups and their work in the chapter 'Planning your studies - Sub-programmes' or on the page http://www.cs.helsinki.fi/en/research/.

Any questions you may still have about embarking on your thesis work may be answered at the event on getting started with your Master's thesis, which is held at the beginning of each period (in Finnish). You will find the dates and times in the chapter "Important deadlines". The seminars often support the thesis work, in some cases, seminars are planned specifically for students at the thesis stadium of some sub-programme, and they can discuss the theme of their theses in their seminar work.

The maturity test should be taken as a separate exam when the Master's thesis has been submitted for evaluation.

Personal study plan (HOPS), teacher tutoring, ETAPPI-tutoring

The aim of teacher tutoring is to help organise your studies and to promote the interaction between students and the department. **Preparing and maintaining a personal study plan as well as attending certain tutoring sessions is a compulsory part of the degree requirements for students majoring in computer science.**

At the beginning of their first autumn, new students register for the course that continues during the whole Bachelor's programme. Students are divided into groups of some 15 members, and each group has an appointed teacher as tutor. In the tutor group, students are given counselling and an individual study plan is made and followed up during the coming years. In addition, the tutor regularly meets students individually. Students who enter university in the spring must contact the HOPS contact person at the beginning of the term. Students in the Master's programme attend a similar programme during their Master's studies.

The successful progress of students is also supported by the **ETAPPI system** that includes three check-points during the BSc programme and two check-points during the MSc programme.

The first check-point occurs in the first spring and the others towards the end of the programme. From the start, students must take into account that students whose progress is found to be delayed at later check-points cannot continue in the programme without drawing up a new study plan for approval. Please see the degree programmes and faculty's instructions for more details.

Registering study modules, grades

Individual course credits are registered automatically, but to have **study modules** (basic, intermediate, advanced and post-graduate modules as well as the modules for other studies and post-graduate studies) registered, students must fill in a separate application.

To have their completed modules registered, students should hand in a copy of the registration records maintained by the university (a transcript) and an application form with a list of the courses that they want to include in the module. The page http://www.cs.helsinki.fi/opiskelu/opintokokonaisuuksien-merkinn-t (In Finnish) contains a list of persons who sign for study modules as well as forms for making the list and detailed instructions.

The study modules for minor subjects (except the method science module and the 25-credit module based on separate studies elsewhere) are registered at the departments of the minor subject according to their own practices.

In addition to the major and minor subject modules required for the Bachelor's or Master's degree, there are some other courses that have to be completed in accordance with the degree requirements. All studies that are not ordered under major subject or minor subject modules are combined into the module 'Bachelor's degree other studies'. The major and minor subject modules must be registered before applying to register the other studies. For the Master's degree, other courses ('Other major-subject studies' and 'Other studies' separately) are usually registered at the same time as the advanced module. At this stage, too, any minor subject modules should be registered before this. The faculty issues diplomas; please see the web pages of the Faculty of Science.

The general rule is that you can include courses and study modules that are seven years old or less. The person who registers the module can approve older grades if there are extenuating circumstances.

The grade (1, 2, 3, 4 or 5) for each study module is computed from the average of the course grades that are included in the module, weighted by the number of credits. However, the weight of the Master's thesis or minor subject thesis when computing the grade of the advanced module is 15 credits. The average is rounded off to the nearest integer; e.g. the average 1.5 will yield the grade 2/5, anything lower 1/5 etc. The grades for modules according to older systems will be computed according to their rules (see old study guides or web pages) and converted to the scale 1-5. If a final

grade for a module completed before 1 August 2005 (date of completion, the registration date has no relevance) turns out different when computed from the original course grades than when computed from the converted grades, the higher grade is registered.

Module grades that have been registered before 1 August 2005 have been transformed to the new scale automatically, regardless of the fact that the grade computed on the basis of original course grades may have been better than the overall registered grade. Students can apply for a redress on the grade from the Head of Studies (basic and intermediate modules) or the professor in charge of a sub-programme (advanced modules), though only as long as the module has not been incorporated into the degree diploma.

The grades for the Master's thesis and the minor subject thesis are converted to numerical grades as follows: l (5), ecl (5), mcl (4), cl (3), nsla (3), lub (2), a (2).

The agreement on flexible study rights (JOO)

The JOO agreement that covers all Finnish universities gives students the right to study subjects not offered at their home universities at other universities. Based on the JOO agreement, you can take courses or more extensive minor subject modules that are to be included in your degree at other universities.

The JOO studies should be chosen so that they support the sub-programme of the Master's programme. The sub-programme is typically chosen at the end of the Bachelor's programme.

To study at another university according to the JOO agreement, please contact that university for more information on how to apply. Some universities use an electronic application system, others use the traditional paper forms. The department's Head of Studies will give the recommendation required in the application. When applying for a recommendation, students have to present a study plan, and the application has to be handed in well in advance before the target university's deadline. There is more information on the JOO agreement in the printed study guide and on the web page http://www.cs.helsinki.fi/en/studies/flexible-study-rights-scheme-joo-department-computer-science.

Credits from other institutions

Based on studies elsewhere (e.g., other universities, in an exchange programme), students may be exempted from some courses with similar contents. In addition, credits taken elsewhere may be accepted instead of optional courses and minor subject studies.

More instructions are available on the web page http://www.cs.helsinki.fi/opiskelu/ohjeet/hyvlukohje.html (in Finnish) and from the foreign student advisor at fsa [at] cs.helsinki.fi. Application forms are available at http://www.helsinki.fi/ml/lomakkeet/index.shtml. The Head of Studies makes the decision on integrating credits from other institutions.

IT work experience as part of the degree

Students with work experience in the field of information technology may be exempted from the compulsory Software engineering project (9 cr). Work-oriented studies included in both the Bachelor's degree (1-3 cr) and the Master's degree (2-6 cr) can be credited too according to certain norms. Please see the page http://www.cs.helsinki.fi/en/studies/credits-work-experience-field-information-technology for more information. Applications are approved by the department's Head of Studies.

International student exchange and work experience

There are different possibilities for foreign exchange studies and internships through agreements on many levels between departments, universities and countries. The main exchange programme is the Erasmus agreement with some universities in EU countries. The university has a number of other exchange agreements with other countries, outside Europe as well. A student exchange or internship position depends mainly on the student's own initiative and long-term planning. The period of exchange varies between a few months and one full academic year. Application deadlines vary according to university and/or exchange programme, and usually occur 6-15 months before the start of the exchange period. Thus, a student who is interested in an exchange position should activate him- or herself from the beginning of the previous autumn term.

Full credit is usually given for studies completed abroad. This is ensured by the study plan that is made before the exchange period. In practice, credits for studies abroad are given after the exchange period, by the same method as any credits from other institutions. International work experience may yield credits in the same way and by the same application method as any work experience in the IT field.

The person in charge of agreements and study plans for international exchange programmes and internships is the department's Head of Studies.

Computer science as minor subject

Rights of admission

All university students have the right to study computer science at the basic level (25 cr) and the intermediate level (30 cr at the most), or the computer science courses in the method sciences minor subject module (55 cr at the most). Larger study modules are available on application, please see http://www.cs.helsinki.fi/opiskelu/sivuaineoikeus.html. Applications are approved by the department's Head of Studies.

Students can apply for admission to the intermediate level when they have completed the basic module in both computer science and their major subject. Students can apply for admission to the advanced level when they have completed the intermediate module in both computer science and their major subject. For admission based on applications, a grade level of at least 3/5 in computer science courses is generally required. In order to attend advanced level courses, the student should have at least the right to study on the intermediate level.

Students in the physical sciences, geology, chemistry or mathematics educational programmes can transfer to degree students in computer science by applying for a transfer from the Faculty of Science. Please contact the department or faculty student counsellors for more information on how to change majors.

Studying

The courses in the basic module and some intermediate courses (projects, software engineering project, Scientific writing) are given each semester.

Which semester's course is intended for major-subject students is noted in the teaching programme. The department may have to limit the number of minor subject students who attend these courses. Minoring students should plan their studies so that they start at the beginning of spring term (period III). In this way, students can complete the basic module in two semesters (spring, the following autumn).

For the computer science courses in the method sciences minor subject module, there are separate rules in the study guide.

Minor subject students have to take into account the prerequisites just like majoring students. The prerequisites are listed in the teaching programme and on the course web pages, as well as in the time-plan for majoring students.

How minoring students can transfer from the old degree systems to the new one is described on the page http://www.cs.helsinki.fi/tutkinnonuudistus (in Finnish).

Planning your studies

In the new degree system, the Bachelor's degree (BSc) and the Master's degree (MSc) are completely separate, i.e. the modules in the Bachelor's degree are not part of the Master's degree as they have been so far. You may include extra courses in the Bachelor's degree, but that does not cut back on the requirements for the Master's degree (except during the transition period, when the extra courses from an old Bachelor's degree may partially be included in the Master's degree). The rules and practices for transferring from the old system to the new one are explained at the end of the chapter 'Planning your studies' ('Transferring from an old degree system to a new one').

The Bachelor's degree includes compulsory minor subject studies (1 or 2, depending on the extent of the module in mathematics or method sciences) , but for the Master's degree this is true only for the sub-programme of algorithms and machine learning, and for Master's programmes. Minor subjects are discussed further below, in connection with the Bachelor's degree.

Studies for the Bachelor's degree (Bsc)

1.   Major subject studies

The major-subject studies include the basic module (25 cr) and the intermediate module (61 cr); the requirements being the same for everyone. Variations are possible by studying extra optional courses. The courses cover all the main areas of computer science, and in addition to lecture courses comprise three projects (Programming project, Data structures project, Database application) and the extensive Software engineering project. In addition, the intermediate module includes the Bachelor's thesis and the maturity test, which are completed as part of the course Scientific writing. The compulsory courses in the basic and intermediate modules should be completed in the order listed in the section 'BSc study schedule'. Students do not have to follow the schedule exactly, but do have to keep in mind the interdependencies shown in the schedule. The course descriptions will give more detail about prerequisites, including for optional intermediate courses and advanced courses.

When planning your optional courses, please consider that two of the MSc sub-programmes require one specific intermediate course: in Distributed systems and data communications, the course Programming in C (4 cr), and in Software systems, the course Database design (4 cr), are required. If you complete these courses as part of your BSc degree, you can take other optional courses instead of them for your MSc degree. When planning optional courses for the basic and intermediate modules, students are in general recommended to consider their sub-programme in the Master's programme, if they have chosen one. On the other hand, it may be useful to enhance the scope of studies by completing courses for another sub-programme.

2.   Minor subject studies

Minor subjects are formed by study modules, not individual courses. The first minor subject should be the mathematics or the method sciences module, with a minimum of an extended basic studies module (30 cr). Students can choose their second minor subject and possible extra minors freely. If students take the extended basic study module of 50 credits or the basic and intermediate modules of 60 credits in their first minor subject, a second minor subject is not necessary. The basic modules of method sciences consist of mathematics and statistics courses; the minimum volume of both subjects is 10 cr. The approved courses are detailed in the presentation of method sciences. The course Introduction to Discrete mathematics (5 cr) is compulsory in all combinations, as it pays special attention to clarifying basic mathematical concepts.

Students should start their studies in mathematics or method sciences during their first year and complete them during their first two years, even if they are taking the extended module. They should also take the first courses in mathematics, **especially the course Introduction to Discrete Mathematics, during their first autumn term**, or their studies will be seriously delayed. Discrete mathematics skills are vital for the course Data structures, which students should take in their first spring term. Mathematical skills are also necessary for some other BSc courses as well as for most MSc sub-programmes. In addition, understanding relevant computer science literature for e.g. research purposes usually requires a basic knowledge of mathematics.

For the MSc degree, students have to take at least 60 cr in modules of mathematics or method sciences for the sub-programme algorithms and machine learning (including the modules in the BSc degree). Students aiming for this MSc sub-programme may benefit from taking these minor subject modules already at the BSc stage.

When choosing minor subjects and optional courses, students should try to combine them with the major subject to make the contents of the degree an integrated whole. For the success of their advanced module, it is to be recommended that computer science students take more than the minimum of mathematics or method sciences as minor subject. Mathematical exact thinking and decision making is also important when solving problems, be they ever so practical. Consequently, the most important courses in mathematics are general courses such as Linear Algebra I and courses in analysis, which also form a basis for other courses in mathematics.

The choice of suitable courses partially depends on which MSc sub-programme students are going to enter. The course Logic I also provides a set of norms for defining programming languages and other systems, and it also provides necessary basic information in the study of databases and artificial intelligence. Probability calculus (e.g. the course Introduction to Probability) is necessary when considering system performance in data communications or distributed systems. The course also provides a basic theory for intelligent and adaptive systems as well for analysis and design of algorithms.

For some sub-programmes, statistics (on its own or as part of the method science module) is considered a very suitable minor subject; please see the descriptions of each sub-programme.

There are recommendations on suitable minor subjects to combine with each sub-programme on the web pages of the sub-programmes. Students may take minor modules in other faculties or even at other universities. Students should note that many departments require the students to fill in applications or take a proficiency test to gain admission to study the subject. Please find this information yourself; the application or proficiency test is often arranged only once a year.

Some examples of minor subjects available at the University of Helsinki:

at the Faculty of Science (in addition to the mathematics and method sciences modules) physics, theoretical physics, geography.

at the Faculty of Biosciences biology (many so-called joint minor subject modules), genetic bioinformatics, genetics, general microbiology, biochemistry;

at the Faculty of Social Sciences (in addition to statistics) economics, social psychology, philosophy, communications, the management minor module;

at the Faculty of Arts theoretical philosophy, general linguistics, language technology (see the description of the language technology network below);

at the Faculty of Behavioural Sciences cognitive science, education, adult education, psychology.

Studies at other universities are possible through the agreement on flexible study opportunities (JOO). The most popular minor subjects have been industrial engineering and management (Helsinki University of Technology, TKK), economics and business (Helsinki School of Economics), and some art subjects (University of Art and Design), as well as the joint programme between HSE and TKK, software business management. Please check the programme books of the universities mentioned for more information about courses and application procedures, and how to integrate your credits from other universities on the web page
http://www.cs.helsinki.fi/en/studies/recognition-credits-other-institutions.

The department may approve (register) a minor subject module of 25 credits based on separate courses taken at other universities, if their contents form a comprehensive whole. Any more limited or more extensive studies that do not form a study module according to the specifications of the department where they have been completed can be ordered under optional studies in the degree.

New students are no longer admitted to the software business programme arranged in co-operation with HSE and TKK. A similar module can possibly be taken in future through the JOO agreement, by choosing suitable courses from HSE and TKK. In such cases, a minor-subject module of 25 credits is constituted at the department.

3.   Other studies

The language studies comprise three parts. First-language communication (3 cr) is taken as part of the course Scientific writing. The courses in the other domestic language (3 cr) and foreign language (4 cr) are arranged by the Language Centre. The structure and arrangements for these courses are described on the web pages of the faculty and the Language Centre. Language credits should be completed as soon as possible.

Information and communication technology studies consist of three courses. ICT driving license (3 cr) and Introduction to the use of computers (1 cr) should be taken immediately at the beginning of your first semester. They are connected to the course Introduction to computer science and help learn to use various utility programs at the department's own computer environment efficiently. The course Research data retrieval (1 cr) is part of the course Scientific writing.

The personal study plan (LuK-HOPS) and participation in teacher tutoring (2 cr) are compulsory parts of the degree, and they start at the beginning of the first year and last throughout the

Bachelor's programme. They are registered in the last stages of finishing the BSc thesis and courses, on the basis of active participation and completion of assignments.

Internship or vocational orientation (1-3 cr) is to be completed in connection with the software engineering project (as 1 cr). In addition, professional work experience in the IT field can yield a further 2 credits based on an application. Please see instructions on page http://www.cs.helsinki.fi/en/studies/credits-work-experience-field-information-technology.

Studying techniques (2 cr) is connected to the course Introduction to computer science.

Optional studies can consist of extra computer science courses or other subjects. Any credits that do not combine into a module can be registered as optional studies.

Optional studies useful in the IT field can be found, among others, in the fields of economic and administrational sciences, educational and behavioural sciences, physical sciences and other natural sciences (see above, the section Other minor subjects). Students should choose among these subjects so that the studies support major and other minor subjects, to form a meaningful whole.

Studies for the Master's degree (MSc)

The Master's degree mainly consists of major subject studies (80 cr). It includes a minimum of other compulsory courses (3 cr), and the sub-programme of algorithms and machine learning only has special minor subject requirements. The degree consists of a minimum 120 credits, which may include up to 37 credits of optional courses (depending on the sub-programme and partially on the contents of the BSc degree).

1.   Major subject studies

In addition to the advanced module, two of the sub-programmes include one specific course from the intermediate level. If students have taken these courses for their BSc degree, they can substitute them with any optional courses (computer science or other). The advanced module consists of advanced courses according to sub-programme, two seminars (totalling 6 cr) and optional advanced level courses. The Master's thesis (40 cr) and the maturity test are further requirements for the degree.

2.   Minor subject studies

The volume of 60 cr of modules in mathematics or method sciences is required for the MSc sub-programme on algorithms and machine learning. Some or all required minor subject courses can be taken as part of the BSc degree, in which case students can choose freely the substitute courses.

Students can take extra minor subjects as part of their MSc degree. Some suitable minor subjects are listed above in connection with the BSc degree and on the web pages of the sub-programmes.

3.   Other studies

The personal study plan (FM-HOPS) (1 cr) is made under the tutorage of a tutor dedicated from the beginning of the Masters programme.

The advanced internship or work-orientation can be completed with the course Information Technology: Now! (or other suitable course) or by working in a demanding professional position in the IT field. Students can apply for credits for work experience according to the detailed

instructions on the webpage http://www.cs.helsinki.fi/en/studies/credits-work-experience-field-information-technology.

The optional studies can consist of extra computer science courses or courses from other disciplines. Course credits that do not make up a whole study module are registered as optional studies, but extra credits in computer science are registered as 'Other major-subject studies.' For selecting other courses that fit into the degree, please see the section 'Other studies' in the chapter on the BSc degree.

Sub-programmes

In the new degree system, there are three sub-programmes in the Master's programme for computer science;
- Algorithms and machine learning
- Networking and Services
- Software Systems

The sub-programme of algorithms and machine learning is roughly formed by combining the old sub-programmes of algorithms and intelligent systems, including data mining from the former data management sub-programme. The sub-programme of software systems contains the former software sub-programme and database management topics.

It is not possible to study in sub-programmes of the years before 2005 any more. The sub-programmes valid between 2005–2008 can be used until 31.7.2011. The contents of the former sub-programmes and their degree requirements can be found on their web-pages (via http://www.cs.helsinki/opiskelu/suunta.html) and in the old study guides.

Language technology network

The terms human language technology and natural language processing mean using information technology for linguistic applications and processing natural languages. Some application fields are the use of spoken language for computer user interfaces, computer-aided language education, writing accessories (spell-checkers, grammar checking, etc), data mining and document management, automatic translation, speech recognition and production, interactive network applications, and electronic dictionaries.

The Computer Science Department is a member of the nation-wide language technology education (Kieliteknologian opetus, KIT) network. This network enables extensive and multidiscipline language technology studies in several universities. In addition to the Department of Computer Science, the departments of Linguistics, Cognitive Sciences, Speech Sciences and Translation Studies participate in the network from the University of Helsinki. Language technology is a suitable minor subject for computer science students. Some language technology courses can be included in the advanced computer science module by separate agreement.

The study modules for language technology are co-ordinated at the Helsinki University General Linguistics Dept. The degree requirements and course schedules may be seen on the network's homepages at http://www.ling.helsinki.fi/kit/. To get right to study a minor subject in linguistics, students must pass the course Yleisen kielitieteen peruskurssi (Cyk110/Ctl102) with at least a good grade.

Please contact the research co-ordinator Greger Lindén, for more information (admissions, practical arrangements).

BSc study schedule

Below, a schedule for completing the Bachelor's degree in three years is presented. The schedule is based on a workload of around 30 credits per month. The phrase 'Minor subjects/optional courses' offers flexibility for most semesters, so that e.g. language credits or any possible extra courses in the major subject can be ordered into each student's own programme. Some flexibility is needed in following the schedule: it will be difficult (and useless) to try to find a very small course with 1 or 2 credits to exactly fulfil the credits of a period. The number of credits can be balanced during the term (or even later).

The schedule can be used a basis for your own study plan. When setting up the schedule, students should notice interdependencies between courses, and the times when courses are organised at the department. Students who feel they need to revise their mathematics should take the course 'Matematiikka tutuksi' during period I and the course 'Introduction to computer science' during period III (see alternatives in the schedule). In any case, it is important to take the course 'Introduction to discrete mathematics' in the first semester, or your studies will be delayed.

The courses for the basic module and some of the courses for the intermediate module are given each semester. Most compulsory courses at the intermediate level and optional courses are usually arranged only once per academic year. Optional specialisation courses may be lectured even more seldom. There is an approximate schedule for courses that are repeated on the web page http://www.cs.helsinki.fi/kurssit/toistosuunnitelma.html (in Finnish).

Most compulsory lecture courses and some of the optional courses can be passed by a separate exam each semester and in the summer. The times and dates for separate exams are available at http://www.cs.helsinki.fi/kokeet/. Laboratory courses and the Software Engineering Project may be taken every term including summers.

By taking advantage of summer studies, the students can either choose fewer courses during autumn and spring terms, or try to complete the degree in less time. If this three-year schedule seems too difficult, you can lighten the programme slightly, but please take into consideration the prerequisites and the limitations posed by the teaching programme.

There is a follow-up and support system for the degree programmes called Etappi, with some checkpoints at different stages of the programme. Students who have completed less than 25 credits by the end of the third period in their first year will receive special instruction in connection with their HOPS work. Students who have completed less than 120 credits of their BSc degree after their third year, or who have not completed their degree after four years, may register at the university only after making an acceptable study plan. The study plans are discussed during the HOPS sessions.

Model schedule for BSc degree

1st autumn term, 30 cr

Period I
Start HOPS work (2 cr when finished, 3rd year)
Introduction to computer science, 4 cr (or Matematiikka tutuksi, 5 cr)
Introduction to programming, 5 cr
ICT driving license, 3 cr
Introduction to the use of computers, 1 cr
Studying techniques, 2 cr

Period II
Advanced course in programming, 4 cr
Software modelling, 4 cr
Introduction to discrete mathematics, 5 cr
Minor subjects/optional studies, 2 cr (1 cr)

1st spring term, 30 cr

Period III
Programming project, 4 cr
Data structures, 4 cr (first part)
Computer systems organization, 4 cr
Minor subjects / other studies, 3 cr (or Introduction to computer science, 4 cr)

Period IV
Data structures, 4 cr (second part)
Introduction to databases, 4 cr
Minor subjects/optional studies, 7 cr (6 cr)

2nd autumn term, 30 cr

Period I
Models of computation, 3 cr (first part)
Data structures project, 4 cr
Introduction to artificial intelligence, 4 cr
Minor subjects/optional studies, 4 cr

Period II
Models of computation, 3 cr (second part)
Concurrent programming, 4 cr
Database application, 4 cr
Minor subjects/optional studies, 4 cr

2nd spring term, 30 cr

Period III
Software engineering, 4 cr
Introduction to data communications, 4 cr
Minor subjects/optional studies, 7 cr

Period IV
Introduction to computer security, 4 cr
Minor subjects/optional studies, 11 cr

3rd autumn term, 30 cr

Period I
Software engineering project, 5 cr (first part)
Minor subjects/optional studies, 10 cr

Period II
Software engineering project, 5 cr (second part)
Minor subjects/optional studies, 10 cr

3rd spring term, 30 cr

Period III
Scientific writing, 5 cr (first part)
Minor subjects/optional studies, 10 cr

Period IV
Scientific writing, 5 cr (second part)
Minor subjects/optional studies, 8 cr
HOPS work ends, 2 cr

Interdependencies between courses

There are two kinds of interdependencies; compulsory and recommended ones. The recommended ones specify the amount of pre-knowledge that is needed for a course, and it is the student's own responsibility to meet the requirements. For the compulsory ones, prerequisites are checked at registration and at the start of the course; details are given separately for each course.

Schedule for MSc degree programme

The extent of the MSc programme (120 cr) equals two years of full-time studies. Students who have been accepted directly to an MSc programme can be required to take complementary courses in addition to the 120 credits. Further, the degree requirements of two sub-programmes contain one intermediate course in addition to the advanced ones. MSc courses are intended to be taken just after students have completed their BSc degree (and any possible complementary courses). However, it is possible to take a limited amount (30 cr) of advanced courses in the major subject before completing the BSc degree. However, the BSc degree (and required complementary courses) has to be completed before attending seminars or starting to write the Master's thesis.

It is usually best to take the compulsory advanced courses for a sub-programme before taking optional courses. The intermediate course required for two of the sub-programmes should be taken at the beginning of the Master's programme, unless it was included in the BSc degree. Some sub-programmes list more detailed prerequisites on their web pages. Students should complete the majority of the advanced lecture courses and one of the seminars during their first year, so that they have the necessary background information to start work on their Master's thesis during the second autumn term. Any credits needed to complete the credit amount of the degree (extra advanced courses, optional other courses) can be placed into the schedule as you see best.

The exact schedule of studies depends on the sub-programme and the studying profile within the sub-programme. The following sketch is intended to help schedule studies:

1st autumn term, 30 cr
Start work for FM-HOPS (1 cr on 2nd year)
Compulsory or optional advanced studies, 16 cr
Other studies, 14 cr

1st spring term, 30 cr
Compulsory or optional advanced studies, 12 cr
A seminar, 3 cr
Other studies, 15 cr

2nd autumn term, 29 cr
Optional advanced studies, 6 cr
A seminar, 3 cr
Work-oriented studies, 2 cr
MSc thesis, 10 cr (first part)
Other studies, 8 cr

2nd spring term, 31 cr
MSc thesis, 30 cr (main part)
FM-HOPS (ready), 1 cr

"Other studies" above means any studies needed beyond the compulsory advanced studies. Possible complementary studies make the schedule longer.

According to the new degree system, students who have completed less than 80 credits of their MSc degree after their second year, or who have not completed their degree after three years, may register at the university only after making an acceptable study plan. The study plans are discussed during the HOPS sessions.

Transferring from the old degree system to the new one

Students who have entered the university before 1 August 2005 have been transferred to the new degree system by 1 August at the latest. They - as well as the students who have started between 2005 and 2008 - follow either the degree requirements for 2005-2008 or the requirements of this study guide. The former requirements can be followed until 31 July 2011 only.

Some CS courses of the old requirements will not be arranged any more but can be substituted by some new ones. The detailed instructions of substitutions can be found at http://www.cs.helsinki.fi/tutkinnonuudistus/ (in Finnish; contact your study adviser).

The old minor subject modules are suitable for the new degree system if they answer to the new requirements on contents and scope. A module in mathematics or method science that has been completed before 1 August 2005 can be incorporated in the new degree; in such cases, the course Introduction to discrete mathematics is not required, but can be substituted by some other mathematics course.

A module of 15 cu or less (old credits; "half module") that has been registered in the old system can be registered as a minor subject module in the new system only if it converts into at least 25 credits. Naturally, such a small module can be used as part of the quota for other (optional) courses.

Post-graduate studies

Due to the information technology boom, there is a shortage of people with a postgraduate degree in computer science in both universities and the business world. To meet this shortage of researchers, the universities have started different programmes, like research schools, research institutes and centres of excellence. In addition, IT businesses have invested heavily in R&D by establishing their own research centres, among other things. This makes the situation very favourable for research and postgraduate studies in computer science.

The goal of a post-graduate degree in computer science is to gain deeper knowledge of some sub-field of computer science and the ability to attain new scientific insights in it. Post-graduate studies are usually based on the MSc degree, on the topic of the Master's thesis. We try to steer MSc

students who seem like promising post-graduates towards such subjects that will make a good basis for postgraduate studies.

If they want to continue as post-graduates, undergraduates are well advised to contact the department research group conducting research in their field of interest when choosing the topic for their Master's thesis, at the latest. The group can offer support in many forms, such as scientific expertise, discussions and innovation, as well as international contacts. Belonging to a research group will make it easier to finance your studies, too, often at the stage of writing your Master's thesis. The fields of research and project groups are presented on the page http://www.cs.helsinki.fi/en/research/. Contact person for post-graduate studies: research coordinator Greger Lindén..

The goal of the post-graduate studies may be the Licentiate degree, and/or the Doctor of Philosophy (PhD) degree. A central part of the studies is the independent writing of a licentiate or doctoral thesis. Licentiate research should show that the student is well acquainted with the research field, and that s/he is able to perform independent work in writing scientific texts and performing scientific work. In the doctoral degree, the requirements for the thesis are on a higher level: the thesis should show academic maturity and contain internationally significant new knowledge.

Post-graduates are recommended to aim at the doctoral degree. Usually, a preliminary version of the doctoral thesis can then be accepted as a licentiate thesis. The doctoral thesis may also be developed from the licentiate thesis, if the topic is suitable. In most cases, students should aim at internationally publishable results as soon as they have achieved certain basic skills. Results may be published as journal and conference articles even before the thesis is finished, and it is possible to have a collection of such articles assembled into a thesis. The other possible form of a thesis is a monograph that presents the research as a whole.

Formally, students register for post-graduate studies by agreeing on the topic of the thesis with the professor in charge of the intended research area (the final topic will be found during the research), and on major and minor subject studies. These plans will then be filled into a special form for post-graduate studies. Every student will also be assigned a personal supervisor, who will be in charge of the progress of the thesis work and will ensure the high scientific level of research. If you study full-time, it is possible to complete your licentiate in 2-3 years and a doctorate in four years after completing your Master's degree.

The courses included in the post-graduate degree have to be graded at least 3/5. It is recommended to complete any minor-subject courses in the post-graduate study plan at an early stage.

A great part of the post-graduate students belong to some graduate school. The graduate schools organise post-graduate courses, and offer some positions for full-time post-graduate researchers. The department participates in four post-graduate schools and a large network of research schools (see below). It is also possible to fund your post-graduate studies by working in one of the department's research projects or as a teacher. Furthermore, it is possible to carry out your post-graduate studies alongside a research and development job at an IT company or research institution, although this kind of arrangement has proven to be very strenuous.

The Helsinki Graduate School in Computer Science and Engineering: HeCSE

The Helsinki Graduate School in Computer Science and Engineering (Hecse) is a post-graduate programme in computer science and engineering jointly offered by the Helsinki University of

Technology (TKK) and the University of Helsinki (UH). The Department of Computer Science co-ordinates this collaboration with some computer science labs and research units at TKK. Teaching is organised both at the University of Helsinki and at the Helsinki University of Technology. Hecse focuses on some main concepts and methods of its field. They are important both in scientific research and the applications in the IT industry. There are some 50 PhD students in Hecse, and the school funds the work of 20 of them. Applications are usually due in autumn. Please contact the leader of the graduate school, Professor Hannu Toivonen, or the co-ordinator, Greger Lindén, see the web page http://www.cs.helsinki.fi/hecse/, or send mail to hecse-admin [at] cs.helsinki.fi, for more information on the graduate school, application deadlines and funding.

The Graduate School in Computational Biology, Bioinformatics, and Biometry: ComBi

The Graduate School in Computational Biology, Bioinformatics, and Biometry (ComBi) is a post-graduate programme jointly offered by the Universities of Helsinki, Tampere and Turku as well as the Helsinki University of Technology. The school was established at the beginning of 1998, and the Department of Computer Science at the University of Helsinki is the co-ordinating institution. The research goal of ComBi is to develop computational, mathematical, and statistical methods and models for natural sciences. The thesis projects are carried out in close co-operation with one or more research groups in the application fields (such as biochemistry, molecular biology, genetics and biotechnology, ecology, research into evolution and systematics, geography and economics). More information including activities, application deadlines, funding of studies, etc. may be acquired from the director of the graduate school, Academy Professor Heikki Mannila, and from the general secretary Heikki Lokki as well as electronically on the web page http://www.cs.helsinki.fi/combi/ or by email to combi [at] cs.helsinki.fi.

National graduate school for language technology (KIT)

The KIT post-graduate school is a national, multi-disciplinarian language-technology school that allows its participants to take part in post-graduate schools in the other Scandinavian and the Baltic countries. Please see the page http://www.ling.helsinki.fi//kit/tutkijakoulu/ for more information and application deadlines (in Finnish).

The Graduate School on Software Systems and Engineering SoSE

SoSE (Graduate School on Software Systems and Engineering) is a national post-graduate school focusing on software engineering. The school is co-ordinated by Tampere University of Technology. Please contact Professor Jukka Paakki, or see the web page http://www.cs.tut.fi/~sose/ for more information on activities and application dates.

Network of Finnish Graduate Schools in Information Technology (Figsit)

The Finnish network of post-graduate schools, Figsit, is an informal collaboration forum for post-graduate schools in computer science and information technology around the country. In addition to HeCSE, other members are Comas (Jyväskylä), ECSE (eastern Finland), Infotech (Oulu), TISE (Tampere) and TuCS (Turku). All the post-graduate courses are open to network members, and they are announced on a centralized web page. The network arranges an annual international summer school as well as other events for peer support for students and teachers, as well as networking

support. Please see the network web page http://www.cs.helsinki.fi/figsit/ or contact the leader of the HeCSE, Professor Hannu Toivonen, or the co-ordinator, Greger Lindén (e-mail hecse [at] cs.helsinki.fi), for more information on the graduate school, application deadlines and funding.

Helsinki Institute for Information Technology HIIT

The Helsinki Institute for Information Technology HIIT is the joint research institute of the University of Helsinki and the Helsinki University of Technology. Its goal is to enforce the strategic research in the field of computer science, as well as improving the co-operation between the University of Helsinki and Helsinki University of Technology. HIIT is divided into two units; the Advanced Research Unit that strongly co-operates with the industries is led by Professor Martti Mäntylä, and mostly operates in the Helsinki University of Technology facilities, and the Basic Research Unit, headed by Professor Esko Ukkonen. The Basic Research Unit mostly operates at the Department of Computer Science in Kumpula, Helsinki, but part of it operates at the HUT facilities in Otaniemi. HIIT carries out high-classed research in the field of computer science, in close co-operation with other disciplines and with representatives of industrial application areas. The operations at HIIT are divided into the following research programmes: algorithmic data analysis, future Internet, network society, and probabilistic adaptive systems. Please see the webpage http://www.hiit.fi/, or e-mail Esko.Ukkonen [at] cs.helsinki.fi for more information.

Teaching

The teaching programme for the whole academic year (times for lecture classes and seminars) can be found at http://www.cs.helsinki.fi/opinnot/opetusohjelma/. The same page contains links to detailed teaching programmes for semesters, including times for group sessions: the programme for autumn semester 2008 will be published by 11 August, for spring 2009 by 1 December, and for summer 2009 by 31 March. The teaching programme for the academic year 2009–2010 will be published before summer 2009 and the detailed programmes using the same annual schedule as above.

Final planning of studies should be made using the detailed teaching programmes. The times and dates for course and separate exams are available at http://www.cs.helsinki.fi/en/studies/exam-schedule. There may be minor updates compared to the teaching programme for the whole year.

Registration

Students register for lecture courses and separate exams through the department's own registration system on the web (see http://www.cs.helsinki.fi/opiskelu/ohjeet/ilmoittautuminen-en.html), i.e. not through the OODI system. Registering for a course means registering for exercise sessions, study circles and other activities arranged as part of the course, as well as for the course exam; there is no separate registration for course exams.

Binding registrations for exercise groups start a week before the start of term for periods I and III, and three weeks before the start of the period for periods II and IV; please see "Important dates" for more details. Students have to register for lecture courses during the first week of lectures, at the latest. For separate exams, students have to register on the Monday of the previous week at the latest. The chapter 'Lecture courses and separate exams' details the restrictions on registering for a basic or intermediate course that has been interrupted twice before. When registering, please note the prerequisites for each course.

Students should register for the Software Engineering project, Scientific Writing and seminars during the preceding term, see "Important dates."

Students should also register for laboratory courses through the registration system. Students who have interrupted their laboratory work may register only by way of the list of "interrupters" to that course. You may register for exercise groups up until the first lecture (the initial group meeting for the course Data Structure Project). **Students must attend the first group meeting of the group they have registered for, otherwise they lose their place in the group to another student.**

Computer access

To have access to the department's computers, you need a personal user account from the department (the university user account is not enough). New major subject students are given a new account on the basis of their registration with the university, but you have to activate it according to the instructions. Other students should apply for a user account separately. Instructions at http://www.cs.helsinki.fi/en/compfac/user-accounts.

Classrooms

Most teaching is arranged in Exactum at the Kumpula campus. Auditoriums A111 and B123 are on the first floor and Auditorium CK112 on the ground floor. The first letter of the room code (A, B, C, D) shows in which block it is, and the first number on which floor (K1 = ground floor).

Course descriptions

There are short descriptions of the courses in the teaching programme. Only the most important prerequisites are mentioned. The section 'Model schedule for BSc degree' describes the interdependencies between compulsory basic and intermediate courses. Before attending advanced courses, students should have completed most intermediate courses and especially any courses that are important for their sub-programme. The web pages of the sub-programmes contain more detailed information. Please also keep in mind that you have to complete your BSc degree before certain studies (especially seminars and the thesis) in your Master's programme.

More detailed descriptions of the contents, prerequisites and how to complete courses are available (mainly in Finnish, partially in English) through the course list at http://www.cs.helsinki.fi/opiskelu/. The detailed **learning goals** of the courses are also available on the web pages. For further information on general course routines, please see the section 'General instructions and rules' The importance of the **course literature** varies; the course webpage gives detailed information on whether it is recommended or compulsory reading. If the description contains the notation 'no separate exam,' it means that you cannot take the course without attending the instruction sessions. Details are varied.

Computer science courses in English

Most courses are given in Finnish. Some advanced (Master level) courses are offered in English, taught by foreign visitors at the department or by native Finns. Bachelor level courses will be lectured in Finnish but we have prepared to offer an exercise group in English for some courses during the term indicated below. Most examinations can be taken in English if so requested. The examination material will be available in English in such cases. Please contact the teacher responsible for the course two weeks in advance.

All the information here is preliminary. For detailed, up-to-date information please refer to the departmental bulletin boards at the beginning of each semester, the web page or contact the Departmental Student Counselling Office, room A232 (2nd floor), Department of Computer Science, Gustaf Hällströmin katu 2b, phone 191 51121.

At least the following courses are **offered in English (lectures, exercise groups etc.)** this academic year. The volume of each course is expressed as ECTS credits (cr). The schedule and descriptions of the contents can be found in the main study programme, some pages earlier, and on the web page of the course.

AUTUMN 2008

Courses (Master's level)
582481 Causal Analysis (4 - 6 cr)
582615 Peer-to-Peer Networks (4 cr)
582483 Biological Sequence Analysis (6 cr)
582606 Introduction to Bioinformatics (4 cr)

Seminars (Master's level)
58308302 Seminar: Neuroinformatics (3 cr)
58308301 Seminar: Text Mining (3 op)
58308305 Seminar: Future Internet and Other Hot Topics in Networking (3 cr)
58309106 Seminar: Machine Learning in Bioinformatics (3 cr)

SPRING 2009

Courses (Master's level)
582639 Computational Geometry (3 cr)
582638 Unsupervised Machine Learning (4 - 6 cr)
582605 Metabolic Modeling (4 cr)
582604 Practical Course in Biodatabases (4 cr)

Seminars (Master's level)
58309105 Seminar: Peer-to-Peer Systems (3 cr)

The following courses will be **lectured in Finnish** but we have prepared to offer **an exercise group in English** during the term indicated below:

AUTUMN 2008

581324 Introduction to the use of computers, 1 cr
582102 Introduction to computer science, 4 cr
581325 Introduction to programming, 5 cr
581326 Advanced course in programming, 4 cr
582101 Software modelling, 4 cr
582206 Models of computation, 6 cr
581332 Concurrent programming, 4 cr
582203 Database application, 4 cr
58161 Data structures project, 4 cr

SPRING 2009

581324 Introduction to the use of computers, 1 cr
581328 Introduction to databases, 4 cr
58131 Data structures, 8 cr
58160 Programming project, 4 cr
581305 Computer systems organization, 4 cr
581259 Software engineering, 4 cr
58110 Scientific writing, 10 cr (only for students majoring in CS)
582202 Introduction to data communication, 4 cr

Descriptions of these courses (including the schedule) will be available on their web pages.
An exercise group in English or some other advice might be available according to demand for
other courses, especially in sub-programme Distributed systems and data communication. It is
possible to take the course User Interfaces (582201) in English by special arrangements (a separate
exam) only.

Foreign Student Advisor
Dept of Computer Science
PO Box 68 (Gustaf Hällströmin katu 2b)
FI–00014 University of Helsinki
Finland
fax. +358 9 191 51120
E-mail: fsa[at]cs.Helsinki.fi
www.cs.helsinki.fi/en/studies/study-counselling

Teachers
Teachers can be contacted during their office hours, possibly at other times when agreed upon, or by
e-mail. The teachers' offices are located at the Department of Computer Science (Exactum,
Kumpula campus). Office hours will be held from 1 September 2008 to 14 December 2008 in the
autumn term and from 12 January 2009 to 31 May 2009 in the spring term. The exact schedules will
be available at the start of the semester on the web page http://www.cs.helsinki.fi/henkilosto/henkil-
kunnan-vastaanottoajat and by the office of each teacher, and possibly on their home pages.