MASTER'S DEGREE PROGRAMME IN BIOINFORMATICS

Department of Computer Science
Department of Mathematics and Statistics
Exactum (Kumpula Campus)
PO Box 68
FI-00014 University of Helsinki
Phone 1911 (switchboard), direct dialling 191 + extension number

Web pages: www.cs.helsinki.fi/mbi

Professor in charge: Juho Rousu
Coordinator: Esa Pitkänen

Bioinformatics as a discipline

Bioinformatics is a new field of science, seeking answers to the questions of life, raised by biology and medicine, with computational means. It is possible to study the infective potential of a virus by modelling its three-dimensional surface structure. The function of genes can be uncovered by a computational study of DNA sequences. The utilization of renewable resources for, e.g. biofuel production can be improved by metabolic modelling. Finally, machine learning can be used to seek cellular mechanisms of cancer from gene expression and metabolomics data.

The analysis of measurement data is of vital importance in modern research into biology and medicine. Understanding such data requires both robust statistical modelling and computationally feasible methods.

In general terms, bioinformatics is computer-aided collecting, processing and analysing of biological and medical information. Mathematics, statistics and computer science methods provide the foundation of bioinformatics, but it is necessary to have a thorough understanding of both the application area and methods. Thus, a bioinformatician often acts as an important mediator between the methodological and biological sciences.

The University of Helsinki (HY) and Helsinki University of Technology (TKK) offer excellent opportunities for bioinformatics studies. Research in bioinformatics at those institutions is of the highest quality in Europe. The universities have extensive contacts to universities and research institutes abroad. This guarantees wide-ranging options for student exchange and post-graduate studies.

Employment of bioinformaticians

Universities and other research institutes employ bioinformaticians in various research positions. Biotechnology companies have also been employing bioinformaticians as specialists in growing numbers. Biological and medical research groups require bioinformaticians for data analysis tasks and development of biodatabases. Furthermore, bioinformatics research groups need more theoretically oriented bioinformaticians for development of new statistical and computational bioinformatics methods. The current state of employment is very good: it has been estimated that the need for bioinformaticians will greatly exceed the number of bioinformaticians currently employed.

Organization

The Master's Degree Programme in Bioinformatics (MBI) is organized jointly by the University of Helsinki and Helsinki University of Technology. At the University of Helsinki, member faculties are the Faculties of Science, Biosciences, Medicine, and Forestry and Agriculture. At Helsinki University of Technology, the programme is organized by the Department of Computer Science and Engineering.

The teaching is given by people working on the cutting edge of bioinformatics research. For instance, people from three research units chosen to be Centres of Excellence by the Academy of Finland have a central role in the development and implementation of the programme.

Degrees

The basic degree offered by the MBI programme is Master of Science (in HY: MSc, filosofian maisteri; in TKK: MSc (Tech), diplomi-insinööri), with bioinformatics as the major subject. The scope of the degree is 120 credits, and requires a suitable Bachelor's level degree as a prerequisite.

The MSc degree consists of a minimum of 70 credits of advanced studies in bioinformatics and a minimum of 40 credits of minor subject studies, including biology, computer science and mathematics. Both the MSc degree and the MSc (Tech) degree have been designed to be as similar as possible. The biological minor subject courses are offered by the Faculties of Biosciences, Medicine as well as Forestry and Agriculture at the University of Helsinki.

The intended time to complete the degree is two years. The detailed structure of the MSc degree is described in the section on degree requirements.

Obtaining the right to study

The right to study is obtained via successful application. The calls for application for the academic year 2008–09 will be published in autumn 2007. Selection protocols, criteria and the schedule will be published on the web pages of the Master's Degree Programme in Bioinformatics (www.cs.helsinki.fi/mbi). Students who are admitted may be expected to complete a maximum of 60 ECTS credits of studies that supplement their prior education. These supplementary studies are not included in the minimum scope (120 ECTS credits) of the Master's degree.

Recommended contents of a Bachelor's Degree

It is recommended that a student considering applying to the MBI programme has a strong background in computer science, mathematics and statistics, ideally so that one of the subjects is the major subject in the Bachelor's degree and at least one of the two others is a minor subject in the Bachelor's degree. A minor in a biological subject is also useful. Taking one of the modules

Basic studies in Genetics (Perinnöllisyystieteen perusopinnot), 25 cr
Basic studies in Genetic Bioinformatics (Geneettisen bioinformatiikan perusteet), 25 cr,

offered by the Faculty of Biosciences is recommended for prospective MBI applicants at the University of Helsinki. Note that the contents of the two modules overlap.

It is possible to apply to the MBI programme with a major in a biological or medical subject. However, significant minor subject studies in methodological sciences (computer science, mathematics or statistics) are required. The module

Minor Subject Studies in Computer Science, Mathematics and Statistics (Menetelmätieteiden sivuainekokonaisuus), 60 cr,

offered by the Faculty of Science is a recommended minimum for a prospective MBI applicant at the University of Helsinki.

It is recommended that an applicant to the programme would have studied the following subjects: algorithms, biomathematics, computational modelling, databases, discrete mathematics, linear algebra, probability calculus and statistics. In particular, for the students of the University of Helsinki, the following courses of the University of Helsinki are recommended.

Department of Mathematics and Statistics:
Differential equations I (Differentiaaliyhtälöt I)
Introduction to probability (Johdatus todennäköisyyslaskentaan)
Introduction to statistical inference (Johdatus tilastolliseen päättelyyn)
Linear algebra and matrices I+II (Lineaarialgebra ja matriisilaskenta I+II)
Single variable calculus (Analyysin peruskurssi)

Department of Computer Science:
Computational Data Analysis I+II (Laskennallinen data-analyysi I+II)
Data Structures (Tietorakenteet)
Design of Algorithms (Algoritmien suunnittelu)
Introduction to Databases (Tietokantojen perusteet)
Introduction to Programming (Ohjelmoinnin perusteet)
Models of Computation (Laskennan mallit)
Programming in Java (Java-ohjelmointi)

The old Bioinformatics sub-programme in the computer science degree programme

By the introduction of bioinformatics as a major subject, the bioinformatics sub-programme within the computer science degree programme will be phased out. Nevertheless, students that have started their studies before 1 August 2006 have the possibility to choose the bioinformatics sub-programme within the computer science degree programme, and to study according to the 2005–06 requirements. Students who have started their studies before 1 August 2005 also have the right to study according to the 2004–05 requirements which belong to the old study system, permitting that they complete their degree by 31 July 2008.

Student counselling and the personal study plan

Students are required to make a personal study plan (FM-HOPS) as part of their MSc degree, which is approved by the special tutor of the programme and the supervising professor. The personal study plan is to be approved by the end of the first period of the first year of study in the programme. The study plan will be updated when needed as the studies progress.

In particular, it is important that the minor subject studies are planned to complement the previous studies in the Bachelor’s degree, so that the methodological studies and biological studies form a meaningful whole.

Counselling for students is given by the following people:

University Lecturer Esa Pitkänen, special tutor of the programme, computer science (HY)
Professor Elja Arjas, mathematics and statistics (HY)

University Lecturer Päivi Onkamo, minor subject studies in biology (HY)
University Lecturer Outi Monni, minor subject studies in medicine (HY)
Lecturing Researcher Janne Nikkilä (TKK)

More information can be found on the web pages on student counselling:
http://www.cs.helsinki.fi/mbi/counselling/

Degree requirements

Students who have obtained the right to study in the Master's Degree Programme in Bioinformatics in Autumn 2007 will follow these requirements. The old requirements for the bioinformatics subprogramme within the computer science degree programme are available in old study guides. Requirements for TKK can be found in the study programme of TKK.

MASTER OF SCIENCE DEGREE (120 CREDITS)

1. Major subject studies (minimum of 70 credits)

584329 ADVANCED STUDIES IN BIOINFORMATICS (70 CREDITS)
582606 Introduction to bioinformatics, 4 cr
582604 Practical course in biodatabases, 4 cr

Optional advanced courses in bioinformatics (other than seminars), minimum of 16 cr

Seminars, 6 cr

50151 or 57631 Master's thesis, 40 cr, containing
993734 Academic Writing for Students in English-Medium Master’s Degree Programmes 1, 2 cr
993735 Academic Writing for Students in English-Medium Master’s Degree Programmes 2, 2 cr
58307312 Master's thesis seminar, 3 cr
50041 Maturity test

2. Minor subject studies (minimum of 40 credits)

584330 MINOR SUBJECT STUDIES IN BIOINFORMATICS (40 CREDITS)
A minimum of 40 credits of the following subjects, in accordance with an approved personal study plan (FM-HOPS)

- Computer science
- Mathematics and statistics
- Biology, medicine or other suitable subject

3. Other studies (minimum of 2 credits)

Personal study plan (FM-HOPS), 1 cr
Advanced internship or vocational orientation studies, 1–3 cr
Optional courses

An additional requirement is that Bachelor's and Master's degree together must contain

- Studies in biology, medicine or other suitable subjects, minimum of 25 credits
- Studies in mathematics, statistics and computer science, minimum of 60 credits

General study instructions

Bioinformatics studies consist both of lectures and practical work. Major subject studies involve mostly lecture courses, where a lecture course may include practical project work. In minor subject courses in biology, practical work may include either computer classes, laboratory work (wetlab), or both.

Lecture courses

A lecture course typically contains lectures and exercises. As a general rule of thumb, a student should study independently for two hours for every lecture and exercise hour on each course. For instance, if the course has four hours of lectures and two hours of exercises per week, the student should study a minimum of 12 hours per week in his or her own time. In addition, attention should be paid to fulfilling the prerequisites before attending the course. Passing a lecture course usually requires completion of a sufficient number of exercises, and passing the course exam. An alternative way to pass a course is by a separate exam.

Laboratory courses (”wetlab”)

Sufficient skills for further biological laboratory work will be provided during the courses Biology for methodological scientists and Measurement techniques for bioinformatics. The student is required to take these courses if he or she has not taken equivalent courses earlier.

Seminars

At least two seminars (6 credits) have to be included in the Master's degree. A seminar usually consists of student presentations and discussion. Seminars usually meet once a week for two periods (a whole semester). Each student is required to give at least one presentation on the topic of the seminar and actively participate in discussions. Passing a seminar involves writing a seminar paper. Grading is based on the oral presentation, participation in discussions and the written paper. Students are required to be present during at least 3/4 of the weekly meetings.

Registration for the courses and examinations

Students register for courses and separate examinations offered by the University of Helsinki according to the registration practices in the department organizing the course. At the Department of Computer Science, the web address of the registration system is http://ilmo.cs.helsinki.fi, and at the Department of Mathematics and Statistics, the address is http://ilmo.cs.helsinki.fi/matematiikka. Students register for courses and separate examinations offered by Helsinki University of Technology with the following registration system: https://webtopi.tkk.fi.

Teaching schedule

Teaching is given in four periods:
I 3 September – 21 October
II 29 October – 16 December
III 14 January – 2 March
IV 10 March – 4 May
Each period consists of six weeks of teaching, followed by an exam week. No teaching will be given during the period breaks 22–28 October and 3–9 March.

Advanced internship

The degree includes an obligatory advanced internship phase. The internship position is intended to be either in a research group or in a company working in a related field. The aim of the internship is to familiarise the student with real-world bioinformatics and with people working with it. The internship position is agreed on with the student counsellor as a part of the study plan. Some available positions for the internship will be announced on the MBI web page: http://www.cs.helsinki.fi/mbi/internship.

Grading

All courses are graded either on the six-step scale 0–5 or the two-step scale fail/pass. The lowest passing grade is 1/5, for which the student usually needs to gain half the maximum points. For the highest grade 5/5, the student usually needs at least 5/6 of the maximum points.

Teaching language

The teaching language in the programme is primarily English. Exceptions are noted in the Teaching programme.

Master's thesis

The Master's thesis is the final thesis done independently by the student for the MSc degree. The extent of the thesis is 40 credits (HY) or 30 credits (TKK). In the Master's Degree Programme in Bioinformatics, the Master's thesis is written during the second year of studies.

The topic of the thesis is agreed upon with a professor of the Programme. Usually the topic is related to research problems of a bioinformatics research group. Ideally, the work involves members from both methodological and application fields. The following list provides the names and some research interests of professors working with methodological bioinformatics. The list serves as a starting point for finding a suitable topic for the Master's thesis.

Biological data fusion: Samuel Kaski, Hannu Toivonen
Biological data mining: Heikki Mannila, Hannu Toivonen
Functional genomics: Liisa Holm, Samuel Kaski, Juho Rousu
Gene expression data analysis: Elja Arjas, Samuel Kaski
Genetic mapping: Elja Arjas, Heikki Mannila, Hannu Toivonen, Esko Ukkonen
Sequence analysis: Heikki Mannila, Esko Ukkonen
Metabolic networks: Juho Rousu, Esko Ukkonen
Structured population dynamics, evolution and natural selection, ecological modelling: Mats Gyllenberg

A more complete list is provided on the web pages of the programme.

The work is divided into three phases. The first phase involves writing a one-page subject proposal where the research question is formulated. During the second phase, a research plan is written. The research plan should already contain most of the literature references of the final thesis. Both the proposal and the research plan must be approved by the instructor of the thesis. Finally, the thesis is written.

While working on the Master's thesis, the student is expected to participate in the Master's thesis seminar on a regular basis and give two presentations, one on the research plan and the other on the (nearly) completed thesis in the seminar.

Additionally, the student must take a course in Scientific writing in English before completing the Master's thesis in accordance with the personal study plan. Suitable courses for fulfilling this requirement are given in the Teaching programme under the section Language courses.

Maturity test

The maturity test required for the Master's degree is taken as a separate exam when the Master's thesis has been submitted for evaluation. A new test is required even if the student has taken the test at the Bachelor level. If a Finnish student has previously taken the Bachelor level maturity test in his or her mother tongue, the student may take the Master's level maturity test either in English or in mother tongue. Otherwise, the Finnish student is required to take maturity test in mother tongue. Non-Finnish students take the maturity test in English.

Registration of completed modules

To register the study module Advanced Studies in Bioinformatics, the student should hand in a copy of the transcript of records maintained by the university and an application form with the list of courses that the student wants to include in the module. The application form and contact information of persons who approve the application are available from the Programme webpage.

Bioinformatics as a minor subject

The recommended way to study bioinformatics as a minor subject is to take the Basic module in genetic bioinformatics (25 cr) offered by the Faculty of Bioscience. For details, see the study guide of the Faculty of Biosciences, or contact either Professor Liisa Holm or University Lecturer Päivi Onkamo.

Computer access

The Department of Computer Science and the Department of Mathematics and Statistics provide classrooms with computers that may be used in studies. To access the computers, you need a personal user account. Please see the Study guide sections for Computer Science and Mathematics and Statistics for details.

Post-graduate studies

Post-graduate studies aiming for a Doctor of Philosophy or Licentiate of Philosophy degree are typically pursued in conjunction with research groups working in the field of Bioinformatics.
A list of such groups can be found on the web pages of the Master's programme.

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 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 coordinating 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 cooperation 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 (HY), and

from the general secretary Heikki Lokki (HY) as well as electronically on the web page http://www.cs.helsinki.fi/combi/ or by email to combi@cs.helsinki.fi.

ComBi is a partner programme in Bioinformatics Research and Education Workshop (BREW). BREW aims to introduce PhD students to the work modes of international conferences at an early stage in their PhD work, to bring together PhD students and experienced researchers in an atmosphere of cooperation and inspiration, to establish research contacts across Europe, to be utilized in the student's subsequent research and to contribute to the development of bioinformatics education and to the formation of the research community across Europe. More information on BREW is available on the ComBi web page.

Other related graduate schools

The following list includes graduate schools that offer postgraduate programmes in fields related to bioinformatics in the Helsinki region. Contact information for graduate schools can be found on the MBI web pages.

Biomaterial Graduate School
Clinical Drug Trials Graduate School
Finnish Graduate School in Plant Biology
Finnish Graduate School of Neuroscience
Functional Research in Medicine Graduate School
Graduate School in Computational Methods of Information Technology (ComMIT)
Graduate School in Pharmaceutical Research
Helsinki Biomedical Graduate School
Helsinki Graduate School in Biotechnology and Molecular Biology
Helsinki Graduate School in Computer Science and Engineering (HeCSE)
National Graduate School of Clinical Investigation
The Finnish Graduate School on Applied Bioscience: Bioengineering, Food & Nutrition Environment (ABS)
Viikki Graduate School in Biosciences

Course descriptions

For each term, major subject courses are given first, then the courses recommended for the minor subject in computer science, mathematics and statistics, biology and medicine. An up-to-date list of courses can be found on the following web page: www.cs.helsinki.fi/mbi/courses.

Autumn term 2007

Major subject

T-61.5120 Computational genomics (4-7 cr)
Adjunct Professor Sampsa Hautaniemi, I and II periods, Thu 8-11, TKK, T-building room T5
Algorithms and models for biological sequences. Prerequisites: Basic mathematics courses and basic programming skills, T-106.1220/T-106.250.

582606 Introduction to bioinformatics (4 cr)
University Lecturer Esa Pitkänen, I period (04.09.-12.10.), Tue, Fri 14-16, Exactum C222
This course gives an introduction to the central topics in bioinformatics, and gives a foundation for further courses in the Master's Degree Programme in Bioinformatics. Course book: Deonier R. C.,

Tavare S., Waterman M. S.: Computational Genome Analysis - An Introduction, Springer, 2005.
Course exam: Wed 17th October from 16.00 to 19.00.

57393 Mathematical modelling (10 cr)
Dr. Stefan Geritz, I and II periods (3.9.-21.10., 29.10-16.12.), Mon, Wed 10-12, Exactum B322, Exercises Fri 10-12, Exactum B321
Mathematical modelling is the translation of a problem in the real world into a well formulated mathematical problem. The course offers basic techniques for model formulation and model analysis in population biology, physiology, biomechanics and others. The main focus is on modelling and analysis of dynamical systems using differential equations and difference equations. Prerequisites: Elementary knowledge of differential equations recommended. Course literature: Lecture notes (handed out during the course).

T-61.5110 Modeling biological networks (5 or 7 cr)
Professor Samuel Kaski, Professor Tommi Jaakkola, 13.8.-17.8.2007, TKK
Models of biological cellular-level networks: gene regulation, signaling, metabolism. Methods for inference of networks from data, and prediction using the models. Mainly probabilistic and machine learning models. Prerequisites: Basic mathematics courses, preferably also T-61.5050. Additional information: The course has two variants, 5 or 7 cr. The longer variant contains exercise work.

582604 Practical course in biodatabases (4 cr)
PhD Petteri Sevon, II period (30.10.-07.12.), Tue, Fri 14-16 Exactum C222
Techniques for accessing and integrating data in biological databases are studied. The course contains project work. Prerequisities: 582606 Introduction to bioinformatics, basics of databases, basic programming skills. Course exam: Tue 11th December from 9.00 to 12.00.

T-61.5080 Signal Processing in Neuroinformatics (5 cr)
Adjunct Professor Ricardo Vigário, I and II periods, Thu 14-16, TKK, T-building room T5
The goal of the seminar is to give an overview of some of the main biomedical signal processing techniques, with clear emphasis to EEG and MEG. There, we should see something about modeling, artifact identification and removal, nonparametric and model-based spectral analysis, segmentation and joint time-frequency analysis. Some closer attention will be given as well to the analysis of event related data. Additional topics include independent component analysis, biorhythms and sleep and synchrony. The material for these extra topics is in the form of several journal papers. Prerequisites: Basic mathematics courses.

T-61.6080 Special course in bioinformatics II (3-7 cr)
Lecturing Researcher Janne Nikkilä, I and II periods, Thu 12-14, TKK, T-building room T5
The purpose of this course is to give postgraduate level knowledge on bioinformatics or a related field. The actual contents of the course vary from year to year. The course can be lectured, or arranged in seminar form.

Statistical methods in genetic epidemiology and gene mapping (6 or 8 cr)
Professor Elja Arjas, I period, Exactum
The course requires reasonable fluency in probability calculus, as well as understanding of the basic ideas underlying statistical inference and testing. It is also helpful, but not an absolute requirement, to have some previous familiarity with the main principles of genetic inheritance, particularly with Mendelian segregation. Course literature: Duncan C. Thomas: Statistical Methods in Genetic Epidemiology, Oxford University Press, 2004.

Seminars

58307308 Seminar: Regulatory networks (3 cr)
PhD Teemu Kivioja, Professor Juho Rousu, I period (07.09.-12.10.) Fri 12-14, Exactum C220, II period (02.11.-07.12.) Fri 12-14 Exactum C220

58307312 Master's thesis seminar
University Lecturer Esa Pitkänen, I and II periods, Mon 16-17, Exactum C220
While working on the Master's thesis, the student is expected to participate in the Master's thesis seminar on a regular basis and give two presentations, one on the research plan and the other on the (nearly) completed thesis in the seminar. The Master's thesis seminar operates throughout the year. Seminar dates in Autumn 2007: 17.9., 22.10., 19.11., 17.12.

Minor subject

399672 Biology for methodological scientists (8 cr)
Adjunct Professor Outi Monni, University Lecturer Päivi Onkamo, I-IV periods, Biomedicum and Viikki
This course gives an introduction to basic concepts and techniques of molecular biology. Particularly, the students will study biological problems that require computational methods to be solved. The course is particularly tailored for students with no previous molecular biology background. The course consists of an exam (Modern Genetic Analysis, Chapters 1-4, 9, 14-16, Eds: Griffiths, Gelbart, Lewontin, Miller, 2nd edition, 2002) and three modules: I Microarrays, II Medical Genetics, and III Developmental Biology. The course is given annually.

52926 Book exam (Genetics) (3 cr)
The genetics book exam is held on the first Tuesday of each month. In addition, an extra exam is held in between periods I and II. Contact University Lecturer Päivi Onkamo for examination material. Enrol for the exam a week before the examination date at the Genetics office. Examination dates:
Autumn 2007. 4.9, 2.10, 23.10, 6.11, 4.12.
Spring 2008. 8.1, 5.2, 4.3., 1.4., 6.5.

57723 Computational methods in statistics (8 or 10 cr)
D.Sc. Petri Koistinen, I and II periods, Tue, Thu 12-14, exercises Mon 12-14, Exactum B120

Elementary Bayesian analysis (9 cr)
Adjunct Professor Aki Vehtari, I and II periods, Exactum

52931 Exercises in protein informatics (5 cr)
Professor Liisa Holm, II period (12-30.11.), Mon-Fri 12-17, Viikki Infocenter, room 138
Practical course where we aim to infer protein function and structure as well as possible from the amino acid sequence. Tools include public web servers. The course contains guided exercises and a group work where a target protein is analyzed. Prerequisite: 53739 Genetic bioinformatics.

52714 Human genetics (3 cr)
Professor Jim Schröder, II period (9.10.-29.11.), Tue, Thu 10-12, Viikki Infocenter, auditorium 2

81055 Population and quantitative genetics (3 cr)
Adjunct Professor Helena Korpelainen, II period (30.10.-4.12.), Tue, Thu 12-14 Viikki Infocenter, auditorium 2
The course is lectured in Finnish.

399671 Practical bioinformatics (8 cr)
Adjunct Professor Outi Monni, University Lecturer Päivi Onkamo, I-IV periods, Biomedicum
Practical Bioinformatics approaches various bio-computational analysis methods essential in life sciences from a practical point of view. The course consists of four modules (I-IV; 2 cr each) organized in four different periods. Each module consists of approximately 28 hours of lectures and practical exercises in a computer class. Additionally, the modules will include homework and exam. The course is tailored for undergraduate and graduate students studying biosciences (biology, biochemistry, medicine etc.) and assumes no previous background in bioinformatics or programming. Basic computer skills are required. The course is organized at the Biomedicum Helsinki (Haartmaninkatu 8). A maximum of 25 students will be accepted for the course. The course consists of the following modules: I Unix and Perl programming, II Biodatabases, III Microarray data analysis, IV Gene mapping.

Probability and stochastic processes (9 cr)
Lecturer to be announced, I and II periods, Exactum

Spring term 2008

Major subject

57394 Adaptive dynamics (10 cr)
Dr. Stefan Geritz, III and IV periods, Mon, Wed 10-12, exercises Fri 10-12, Exactum B321
Adaptive dynamics is a mathematical theory that explicitly links population dynamics to long-term evolution driven by mutation and natural selection. It provides methods of model formulation, methods of model analysis and mathematical theorems that relate phenomena on an evolutionary time scale to processes and structures defined in ecological and population dynamical terms. Adaptive dynamics is a new but rapidly developing theory that poses various interesting and mathematically challenging problems. From an applications point of view, a great strength of adaptive dynamics is its capability to model evolution driven by complex ecological interactions. Adaptive dynamics is being applied by a growing number of researchers to a wide variety of concrete ecological-evolutionary problems. Prerequisites: Elementary knowledge of differential equations recommended.

582483 Biological sequence analysis (6 cr)
Professor Esko Ukkonen III period (14.01.-19.02.) Mon, Tue 14-16 Exactum D122
The course covers the basic probabilistic methods for modelling and analysis of biological sequences. Prerequisities: 582606 Introduction to bioinformatics and basics of probability calculus. Course exam: Fri 29th February from 16.00 to 19.00.

T-61.5050 High-throughput bioinformatics (5 or 7 cr)
Lecturing Researcher Janne Nikkilä, III and IV periods, TKK, T-building
The course introduces computational and statistical methods for analyzing modern high-throughput biological data, in particular microarray data, and their use in systems biology. Necessary biological background is reviewed briefly. Requirements: Examination and exercises. Literature: Sorin Draghici, 2003. Data analysis tools for DNA microarrays, Chapman & Hall/CRC, USA. Prerequisites: The basic mathematics courses; and S-114.2510 Computational Systems Biology or equivalent background. The course has two variants, 5 or 7 cr. The longer variant contains exercises.

T-61.5090 Image analysis in neuroinformatics (5 cr)
Adjunct Professor Ricardo Vigário, III and IV periods, TKK, T-building
The goal of the course is to give an overview of some of the main biomedical image processing techniques, with clear emphasis on neuronal data. Topics range from artifact removal and image enhancement to pattern classification and diagnostic decision. Prerequisites: Basic mathematics courses.

582450 Modelling of vision (5 cr)
Adjunct Professor Aapo Hyvärinen, III period (04.02.-20.02.) Mon, Wed 14-16, Exactum C222
The topics are mechanisms and modelling of human perception. The emphasis is on modelling of visual feature extraction, and modelling of object and scene recognition. The course is most suitable to students specializing in bioinformatics or intelligent systems. Prerequisites: calculus, probability calculus, linear algebra. The course continues in Helsinki University of Technology in period IV.

Practical course on phylogenetic analysis (5 or 8 cr)
Adjunct Professor Siru Varvio, IV period, Mon, Tue 14-16, Exactum
The course focus is on phylogenetic inference from DNA-sequences by parsimony, maximum likelihood and bayesian methods and program packages.

T-61.6070 Special course in bioinformatics I (3-7 cr)
Professor Samuel Kaski, Professor Heikki Mannila, III and IV periods, TKK, T-building
The purpose of this course is to give postgraduate level knowledge on bioinformatics or a related field. The actual contents of the course vary from year to year. The course can be lectured, or arranged in seminar form. This course replaces study period T-61.188 Special Course in Bioinformatics I.

57395 The mathematics of infectious diseases (10 cr)
Professor Mats Gyllenberg, III and IV periods, Tue, Wed 12-14, exercises Thu 10-12, Exactum B120
Prerequisites: Calculus and elementary differential equations. Course literature: O. Diekmann and J.A.P. Heesterbeek: Mathematical Epidemiology of Infectious Diseases: Model Building, Analysis and Interpretation, Chichester: John Wiley (2000), ISBN 0-471-49241-8.

Seminars

58308110 Management of biological databases (3 cr)
PhD Jan Lindström, III period (17.01.-21.02.) Thu 10-12 C220, IV period (13.03.-24.04.) Thu 10-12 Exactum C220

58307312 Master's thesis seminar
University Lecturer Esa Pitkänen, III and IV periods, Mon 16-17, Exactum C221
The seminar continues from Autumn 2007. Seminar dates in Spring 2008: 21.1., 18.2., 24.3., 21.4., 19.5.

Minor subject

399672 Biology for methodological scientists (8 cr)
Course continues from Autumn 2007.

582212 Computational data analysis I (4 cr)

PhD Matti Kääriäinen, Professor Juho Rousu, period III, Wed 12-14, Thu 14-16 Exactum D122
The course covers basic concepts and methods in computational data analysis: model selection problem, learning of classification and regression models and clustering methods. Lectures will be given in Finnish. The course can be taken in English by a separate exam.

582212 Computational data analysis II (4 cr)
D.Sc. Patrik Hoyer, D.Sc. Saara Hyvönen, Professor Jyrki Kivinen, period IV, Wed 12-14, Thu 14-16, Exactum B222.
Component analysis methods, kernel methods, support vector machines, basic methods of probabilistic models. Lectures will be given in Finnish. The course can be taken in English by a separate exam.

52920 Exercises in bioinformatics (5 cr)
University Lecturer Päivi Onkamo, IV period (17-20.3., 25.3.-1.4.), Daily 12-17, Viikki Infocenter room 138

52939 From genomes to gene function (6 cr)
Assistant Elina Helenius, IV period (5-30.5.) Tue-Fri 13-17, Viikki Infocenter lab 1031
Prerequisites: Basic studies in bioinformatics, 52912 Genomes (if not taken previously, needs to be completed during the course).

52746 Genetic analysis (3 cr)
University Lecturer Päivi Onkamo, IV period (lectures: 16-18.4.), Wed-Fri 8-10, Viikki
Lectures will be given in Finnish, one of the exercise groups will be held in English. Course exam: 22.5. 8-12. Prerequisites: basic studies in mathematics and statistics.

52739 Genetic bioinformatics (3 cr)
University Lecturer Päivi Onkamo, III period (14.1.-25.2.) Mon, Wed 10-12, Viikki Biocenter 2, auditorium 1041
Lectures will be given in Finnish.

52912 Genomes (3 cr)
Professor Tapio Palva, IV period (14.4.-19.5.), Mon 12-16, Viikki Biocenter 2, auditorium 1041

812010 Laboratory Course in Plant Molecular Biology (KBIOT401) (5 cr)
Professor Teemu Teeri, Professor Jari Valkonen, III period, Mon-Fri 9-16, Viikki B-building, course lab 176
Construction of cDNA libraries, basics of sequence analysis, use of microarrays for analysis of gene expression and pathogen diagnostics, data analysis by means of bioinformatics, analysis of gene expression using RT-PCR. The course will be given in even years, next time 11.2.-27.2.2008.

399673 Measurement techniques for bioinformatics (6 cr)
Adjunct Professor Outi Monni, III and IV periods, Biomedicum and Viikki
This lab course consists of five different modules and introduces students to the most fundamental molecular biology technologies. These include I Microarrays for gene expression analysis, II Mass Spectrometry for protein profiling, III Genotyping for disease genetics, IV In situ -hybridization and immunohistochemistry for gene expression analysis in tissues, V Cellular imaging using microscopy and imaging software. The course is particularly tailored for students with no previous molecular biology background. Prerequisites: 399672 Biology for methodological scientists

582602 Natural Language Processing (8 cr)
PhD Roman Yangarber, III and IV periods, Tue, Thu 12-14, Exactum B119

Rule-based and statistical linguistic analysis: morphology, part-of-speech tagging, language modeling, name classification, grammars and parsing, shallow syntax/chunking, semantics, word sense disambiguation, and discourse. Applications that combine several levels of analysis, such as information extraction. Exercises, project work, no exam. Prerequisites: Basic programming skills, interest in language or text, Data Structures (Tietorakenteet), Models of Computation (Laskennan mallit).

399671 Practical bioinformatics (8 cr)
Adjunct Professor Outi Monni, University Lecturer Päivi Onkamo, I-IV periods, Biomedicum
The course continues from Autumn 2007.

Software tools (6 cr)
D.Sc. Petri Koistinen, III period, Exactum C128
Course contents: R, Matlab, WinBUGS

Language courses

993734 Academic Writing for Students in English-Medium Master's Degree Programmes 1 (2 cr)
University Lecturer Kari K. Pitkänen, III-IV period, Exactum
CEF Level: B2-C1
Target group: Students in English-Medium Master's Degree Programmes
Aim: The aim of this course is for students to achieve a high level of academic English required for completing study-related academic texts (e.g.theses, reports, essays, academic articles).
Contents: This course is intended for students who are currently writing seminar essays, reports, thesis and articles as part of their studies. The course consists of: 1. class input sessions focusing on diverse topics such as the structure of texts, sequence and cohesion, mechanical problems and avoiding plagiarism; and 2. independent writing assignments related to each student's studies. Knowledge of the mechanics of writing in English is given as well as instruction on how to write and lots of hands-on practice of writing. Students who complete this course have the option to continue with a follow-up course.
Material: teacher's and students' own material
Evaluation: Continuous assessment based on contact teaching (24 hrs) and independent work. (Pass/Fail)

993735 Academic Writing for Students in English-Medium Master's Degree Programmes 2 (2 cr)
University Lecturer Kari K. Pitkänen, I-IV periods (see below), Exactum
CEF Level: B2-C1
Target group: Students in English-Medium Master's Degree Programmes who are currently writing the thesis – and have completed Academic Writing for Students in English-Medium Master's Degree Programmes 1 (993734).
Aim: The aim is to improve the student's academic writing skills and provide consultation, feedback and language support for writing a high quality thesis in English. The focus is on editing draft versions of the thesis based on the feedback received during the consultation sessions.
Material: students' own material (draft versions of the chapters and sections of the thesis).
Evaluation: Continuous assessment based on writing assignments, editing and active participation in consultation sessions. (Pass/Fail)

Teachers

Please contact teachers during their office hours. Contact information and office hours are available at http://www.cs.helsinki.fi/mbi/people.

Arjas, Elja, PhD, Professor, HY
Geritz, Stefan, PhD, University Lecturer, HY
Gyllenberg, Mats, D.Sc. (Tech.), Professor, HY
Hautaniemi, Sampsa, D.Sc. (Tech.), Adjunct Professor, HY and TKK
Helenius, Elina, MSc, Assistant, HY
Holm, Liisa, PhD, Professor, HY
Hoyer, Patrik, D.Sc. (Tech.), HY
Hyvönen, Saara, D.Sc. (Tech.), HY
Hyvärinen, Aapo, PhD, Adjunct Professor, Senior Research Scientist, HY
Kaski, Samuel, D.Sc. (Tech.), Professor, TKK
Kivinen, Jyrki, PhD, Professor, HY
Kivioja, Teemu, PhD, HY
Koistinen, Petri, D.Sc. (Tech.), HY
Korpelainen, Helena, PhD, Adjunct Professor, University Lecturer, HY
Kääriäinen, Matti, PhD, HY
Lindström, Jan, PhD, HY
Mannila, Heikki, PhD, Academy Professor, HIIT and TKK
Mäkinen, Veli, PhD, Postdoctoral Fellow, HY
Monni, Outi, PhD, Adjunct Professor, HY
Nikkilä, Janne, D.Sc. (Tech.), Lecturing Researcher, TKK
Niklander-Teeri, Viola, PhD, Adjunct Professor, HY
Onkamo, Päivi, PhD, Adjunct Professor, University Lecturer, HY
Palva, Tapio, PhD, Professor, HY
Pitkänen, Esa, MSc, University Lecturer, Coordinator, HY
Pitkänen, Kari K., PhD, University Lecturer, Language Centre, HY
Rousu, Juho, PhD, Adjunct Professor, Professor, HY
Schröder, Jim, PhD, Professor, HY
Sevon, Petteri, PhD, HY
Teeri, Teemu, PhD, Professor, HY
Toivonen, Hannu, PhD, Professor, HY
Ukkonen, Esko, PhD, Professor, Research Director of HIIT, HY
Valkonen, Jari, D.Sc. (Agr. & For.), Academy Professor, HY
Varvio, Sirkka-Liisa, PhD, Adjunct Professor, HY
Vehtari, Aki, D.Sc. (Tech.), Adjunct Professor, TKK and HY
Vigario, Ricardo, D.Sc. (Tech.), Adjunct Professor, TKK
Yangarber, Roman, PhD, HY