Computational Science (Joint Degree)

Vrije Universiteit Amsterdam - Faculteit der Exacte Wetenschappen - M Computational Science (joint degree) - 2016-2017

Computational Science is a joint degree master's programme of University of Amsterdam and VU Amsterdam. Computational Science seeks to explain the complex world we live in using modelling and simulations. By collecting data from various sources and creating computer models, computational scientists can make predictions for problems such as how to influence the flow of traffic, how an epidemic will spread or what the probability is that individuals in society will become addicted to drugs. Further information on the programme (UvA Course Catalogue)

Inhoudsopgave

Optional Courses taught at VU

Vakken:

Naam	Periode	Credits	Code
Algorithms in Sequence Analysis	Periode 2	6.0	X_405050
Behaviour Dynamics in Social Networks	Periode 2	6.0	X_400113
Bioinformatics for Translational Medicine	Periode 5	6.0	X_405092
Computational Intelligence	Periode 2	6.0	XMU_417015
Concurrency and Multithreading	Periode 2	6.0	X_405064
Data Mining Techniques	Periode 5	6.0	X_400108
Distributed Systems	Periode 2	6.0	X_400130
Evolutionary Computing	Periode 1	6.0	X_400111
Experimental Design and Data Analysis	Periode 5	6.0	X_405078
Fundamentals of Bioinformatics	Periode 1	6.0	X_405052
Internet programming	Periode 1	6.0	X_405082
Large Scale Data Engineering	Periode 1	6.0	X_405116
Machine Learning for the Quantified Self	Periode 6	6.0	XM_40012
Parallel Programming Practical	Periode 2+3	6.0	X_400162
Parameter Estimation Applied to Medical and Biological Sciences	Periode 4	6.0	X_432631
Performance of Networked Systems	Periode 4	6.0	X_405105
Programming Large-scale Parallel Systems	Periode 1	6.0	XM_40017
Quantitative Financial Risk Management	Periode 5	6.0	E_FIN_QFRM
The Social Web	Periode 4	6.0	X_405086

Algorithms in Sequence Analysis

Vakcode	X_405050 (405050)
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. J. Heringa

Examinator	prof. dr. J. Heringa
Docent(en)	prof. dr. J. Heringa
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	400

Doel vak
Have you ever wondered how we can track a gene across 3 billion years of evolution? Sequence alignment can be used to compare genes from humans and bacteria, using a dynamic programming algorithm. In this course we focus on
algorithms for biological sequences that can be applied to real scientific problems in biology.

Students will obtain in-depth knowledge about the theory of sequence analysis methods. They will also develop understanding and skills to apply the
algorithms to protein and DNA sequences. We would like to stress that no biological knowledge is required to enter this course.

Goals
- At the end of the course, the student will be aware of the major issues, methodology and available algorithms in sequence analysis.
- At the end of the course, the student will have hands-on experience in tackling biological problems using sequence analysis algorithms and applying the general statistical framework of Hidden Markov Models.
- At the end of the course, the student will be able to implement several of the most important algorithms in sequence analysis.

Inhoud vak
Theory:
- Dynamic programming, database searching, pairwise and multiple alignment, probabilistic methods including hidden markov models, pattern matching, entropy measures, evolutionary models, and phylogeny.

Practical:
- Programming own alignment algorithm based on dynamic programming
- Reverse translation and dynamic programming
- Homology searching and pattern recognition using biological and disease examples
- Multiple alignment of biological sequences
- Entropy-based functional residues prediction
- Programming own implementation of Hidden Markov Models and using it to predict protein domain structure

Onderwijsvorm
13 Lectures: 2 two-hour lectures per week
11 Computer practicals and associated assignments: 2 two-hour hands-on sessions per week

Toetsvorm
The final grade for this course will consist of 50% practical work (see above) and 50% theoretical assessment.
The theoretical assessment will be an oral and/or written exam (depending on number of students).

Literatuur

Course material on bb.vu.nl
Books: Durbin, R., Eddy, S.R., Krogh, A., Mitchison, G.. Biological Sequence Analysis. Cambridge University Press, 1998, 350 pp., ISBN 0521629713.
Recommended reading: Marketa Zvelebil and Jeremy O. Baum Understanding Bioinformatics Garland Science 2008 ISBN-10: 0-8153-4024-9

Vereiste voorkennis
Bachelor in any science discipline (including medicine).
Basic programming skills and an interest in biological problems.

Doelgroep
mAI, mBio, mCS

Overige informatie
Signing up via bb.vu.nl is mandatory.
The course is taught in English.

Behaviour Dynamics in Social Networks

Vakcode	X_400113 (400113)
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. J. Treur
Examinator	prof. dr. J. Treur
Docent(en)	prof. dr. J. Treur
Lesmethode(n)	Hoorcollege, Practicum
Niveau	400

Doel vak
To learn how to identify, specify and predict different types of mental and social processes; to understand how individual and social behaviour emerges from mechanisms known from Cognitive, Affective and Social Neuroscience, and from Cognitive and Social Sciences; to be able to construct network models for mental and social interaction processes; to perform analysis based on these models using Network-Oriented Modeling software tools and empirical data.

Inhoud vak
This course is a multidisciplinary course, also accessible for students from other disciplines such as Neuroscience, Psychology or Social Sciences. Behaviour dynamics occurs in different forms, contexts and complexity. Complexity can occur in the mental processes within persons or in social interaction processes, or in both. Both types of processes can be adaptive: mental processes can change due to learning, and social interactions can also evolve over time. Theories and findings from Cognitive, Affective and Social Neuroscience and also from Cognitive and Social Sciences are presented and used to get insight in the underlying mechanisms that form a solid scientific basis for modelling of these processes. In the course a Network-Oriented Modeling approach based on temporal-causal networks is used to model both these internal mental processes (as networks of mental states) and social interaction processes (as social networks). During the course several examples are

studied. These examples cover imagination and dreaming by internal simulation, integration of emotions in all kinds of mental and social processes, learning of emotion regulation, ownership and attribution of actions, empathic social responses, empathic joint decision making, development of shared understanding and collective action, and different principles for evolving social networks.
The dynamics of such processes is modeled, simulated and analysed (including verification and validation) in this course using dedicated and easy to use modelling environments for Network-Oriented Modeling;,no programming is needed. In the last few weeks of the course a more ambitious final assignment is addressed, which can be worked out to a paper that may be submitted to an international conference where it could be presented and provide a publication.

Onderwijsvorm
Combinations of lectures and practical assignments.

Toetsvorm
Practical assignments.

Literatuur
Treur, J., Network-Oriented Modeling: Addressing Complexity of Cognitive, Affective and Social Interactions. Series on Understanding Complex Systems, Springer Publishers, October 2016.
URL: http://www.springer.com/gp/book/9783319452111#aboutBook
doi: http://dx.doi.org/10.1007/978-3-319-45213-5
Table of Contents: http://www.few.vu.nl/~treur/cve/Papers/NOMToC.pdf
In digital form free downloadable from the VU.

Aanbevolen voorkennis
Some background in modeling.

Doelgroep
mAI and multidisciplinary master studies from Psychology, Neurology and Social Sciences

Bioinformatics for Translational Medicine

Vakcode	X_405092 ()
Periode	Periode 5
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. S. Abeln
Examinator	dr. S. Abeln
Docent(en)	prof. dr. J. Heringa
Lesmethode(n)	Hoorcollege, Practicum
Niveau	400

Doel vak
Observations from biological high-throughput experiments will allow us to improve diagnosis and give a personalised treatment plan for patients. However, integrating data from several sources and using this data for predictions is non-trivial.

This is a theoretical and practical Bioinformatics course on computational methods for Translational Medicine; we will focus on Bioinformatics algorithms that are used to predict the clinical outcome for patients and analysis methods to obtain deeper understanding of complex diseases, by combining data from various high-throughput experiments such as proteomics, microarrays and next-generation sequencing as well as existing biological databases.

goals
• At the end of the course, students will be aware of Bioinformatics methods that are applicable to the area of Translational Medicine.
• Students should be able to combine these methods to come to a creative solution to get new insights from large scale biological experiments.
• At the end of the course, students will have hands-on experience in handling large biological datasets, and will understand the complexity of the biological data both from high-throughput experiments and existing biological databases.
• The student will become familiar with a few in depth research topics that lie within the expertise area of several (Bioinformatics) researchers at the VU, UvA,AMC, NKI and VUMC.

Inhoud vak
Theory
• Computational analysis of molecular profiling techniques, such as: proteomics, RNA sequencing, exome sequencing, arrayCGH.
• Computational methods include: normalisation, feature selection, classification, read mapping, clustering.
• All data analysis is relevant in a clinical setting, for diagnosis, treatment decisions or biomarker discovery.

Practical:

• Classification Assessment of Tumor Subtypes (CATS): This is a large assignment for which you have to build a classifier that can discriminate different tumor subtypes based on arrayCGH profiles. You need to hand in predictions (class contest), write a paper and give a presentation. Note that this is a group project.

Three small data analysis practicals are also given on:
• Exome sequencing
• RNA sequencing
• Proteomics

Onderwijsvorm
• 13 Lectures (2 two-hour lectures per week)
• 12 computer practicals (2 two-hour sessions per week)

Toetsvorm
The final grade for this course will consist of 65% practical work (see above) and 35% theoretical assessment.

Practical assessment (65&):
• CATS assignment (35%)
• 3 data analysis assignments (30%)

Theoretical assessment: (35%)
• Oral or written exam (depending on number of course students).
• As part of the exam a research paper on a Bioinformatics method needs to be analysed in detail and you need to write a small research proposal based on the paper.

Literatuur
• course material on bb.vu.nl
• Marketa Zvelebil and Jeremy O. Baum Understanding Bioinformatics Garland Science 2008 ISBN-10: 0-8153-4024-9

Aanbevolen voorkennis
An interest in Biological problems.

Doelgroep
mAI, mBio, mCS

Overige informatie
Signing up via bb.vu.nl is mandatory.
The course is taught in English.

• Compulsory course for students in MSc of Bioinformatics.
• Optional course for students with Bachelor Physics, Chemistry, Mathematics, Computer Science, Biology, or Biomedical Sciences.

Computational Intelligence

Vakcode	XMU_417015 ()
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. A.E. Eiben
Examinator	prof. dr. A.E. Eiben
Lesmethode(n)	Hoorcollege
Niveau	400

Inhoud vak
http://studiegids.uva.nl/xmlpages/page/2016-2017/zoek-vak/vak/22870

Overige informatie
This course is offered at the UvA. For more information contact: FNWI Education Service Centre, Science Park 904, servicedesk-esc-science@uva.nl, +31 (0)20 525 7100.
Enrolment via https://m.sis.uva.nl/vakaanmelden is required.

Concurrency and Multithreading

Vakcode	X_405064 (405064)
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen

Coördinator	prof. dr. W.J. Fokkink
Examinator	prof. dr. W.J. Fokkink
Docent(en)	prof. dr. W.J. Fokkink
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	400

Doel vak
This course provides a comprehensive presentation of the foundations and programming principles for multicore computing devices.

Specific learning objectives are:
* To provide insight into fundamental notions of multicore computing and their relation to practice: locks, read-modify-write operations, mutual exclusion, consensus, construction of atomic multi-reader-multi-writer registers, lost wakeups, ABA problem.
* To provide insight into algorithms and frameworks for multicore computing and their application in multi-threaded programs: mutual exclusion algorithms, spin locks, monitors, barriers, AtomicStampedReference class in Java, thread pools in Java, transactional memory.
* Analyzing algoritmes for multicore computing with regard to functionality and performance: linearizability, starvation- and wait-freeness, Amdahl's law, compute efficiency gain of parallelism.
* Mastering elementary datastructures in the context of multicore computing: lists, queues, stacks.
* Programming in multi-threaded Java, and performing experiments with such programs.

Inhoud vak
The course consists of the following topics: Shared memory, mutual exclusion, synchronization operations, concurrent data structures, scheduling, transactional memory, and a multithreaded programming assignment.

Onderwijsvorm
Lectures: 4 hours per week, exercise classes: 4 hours per week.

Toetsvorm
The written exam counts for 65% and the programming assignment for 35% of the final mark.

Both for the written exam and the programming assignment at least a 5.0 must be obtained (and the overall average mark should be at least 5.5).

Only students that achieved at least a 3.0 for their initial programming assignment are offered a resit opportunity for this assignment.

Literatuur
Maurice Herlihy, Nir Shavit, The Art of Multiprocessor Programming, Morgan Kaufmann, 2008.

Aanbevolen voorkennis
Datastructures & Algorithms

Programming in Java

Doelgroep
mAI, mCS, mPDCS

Overige informatie
The homepage of the course is at http://www.cs.vu.nl/~tcs/cm/

The lectures and written exam of the BSc and MSc variant of Concurrency and Multithreading coincide. The difference is that the BSc variant has a smaller programming assignment than the MSc variant.

The MSc variant of this course cannot be followed by students that included the BSc variant in their BSc program.

Data Mining Techniques

Vakcode	X_400108 (400108)
Periode	Periode 5
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. M. Hoogendoorn
Examinator	dr. M. Hoogendoorn
Docent(en)	dr. M. Hoogendoorn
Lesmethode(n)	Hoorcollege
Niveau	500

Doel vak
The aim of the course is that students acquire data mining knowledge and skills that they can apply in a business environment. How the aims are to be achieved: Students will acquire knowledge and skills mainly through the following: an overview of the most common data mining algorithms and techniques (in lectures), a survey of typical and interesting data mining applications, and practical assignments to gain "hands on" experience. The application of skills in a business environment will be simulated through various assignments of the course.

Inhoud vak
The course will provide a survey of basic data mining techniques and their applications for solving real life problems. After a general introduction to Data Mining we will discuss some "classical" algorithms like Naive Bayes, Decision Trees, Association Rules, etc., and some recently discovered methods such as boosting, Support Vector Machines, and co-learning. A number of successful applications of data mining will also be discussed: marketing, fraud detection, text and Web mining, possibly bioinformatics. In addition to lectures, there will be an extensive practical part, where students will experiment with various data mining algorithms and data sets. The grade for the course will be based on these practical assignments (i.e., there will be no final examination).

Onderwijsvorm
Lectures (h) and compulsory practical work (pra). Lectures are planned to be interactive: there will be small questions, one-minute discussions, etc.

Toetsvorm
Practical assignments (i.e. there is no exam). There will be two assignments done in groups of three. There is a possibility to get a grade without doing these assignments: to do a real research project instead (which will most likely to involve more work, but it can also be more rewarding). For the regular assignments the first assignment counts for 40% and the second for 60%. The grade of both assignments needs to be sufficient to pass the course.

Literatuur
Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques (Third Edition). Morgan Kaufmann, January 2011
ISBN 978-0-12-374856-0

Aanbevolen voorkennis
Kansrekening and Statistiek or Algemene Statistiek (knowledge of statistics and probabilities) or equivalent. Recommended: Machine Learning.

Doelgroep
mBA, mCS, mAI, mBio

Distributed Systems

Vakcode	X_400130 (400130)
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. ing. T. Kielmann
Examinator	dr. ing. T. Kielmann
Docent(en)	dr. ing. T. Kielmann
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	400

Doel vak
After taking this course, students will be able to:

- understand the intricacies related to designing and developing a distributed computer system.

- understand the tradeoffs between centralized, distributed, and fully decentralized solutions.

- understand the impact of scalability on performance and fault-tolerance of a distributed system.

- understand the impact of performance and fault tolerance on data consistency.

- understand the peculiarities of process coordination on large scale.

Inhoud vak
It is difficult to imagine a standalone modern computer system: every such system is one way or the other connected through a communication network with other computer systems. A collection of networked computer systems is generally referred to as a distributed (computer) system. As with any computer system, we expect a distributed system to simply work, and often even behave as if it were a single computer system. In other words, we would generally like to see all the issues related to the fact that data, processes, and control are actually distributed across a network hidden behind well-defined and properly implemented interfaces. Unfortunately, life is not that easy.

As it turns out, distributed systems time and again exhibit emergent behavior that is difficult to understand by simply looking at individual components. In fact, many aspects of a distributed system cannot even be confined to a few components, as is easily seen by just considering security.

In this course, we pay attention to the principles from which modern distributed systems are built. Unfortunately, these principles cannot be viewed independently from each other: each one is equally important for understanding why a distributed system behaves the way it does. We will consider the following principles:

- architectures
- processes
- communication
- naming
- coordination
- consistency and replication
- fault tolerance

These principles will be discussed in the context of a few simplifying concepts that have been used to master the complexity of developing distributed systems: objects, files, documents, and events.

Onderwijsvorm
The course is taught as a series of lectures, in combination with exercise classes.

Toetsvorm
Written exam.

Literatuur
This year, we will use a reader. Details about its distribution will be announced via blackboard in due time.

Aanbevolen voorkennis
Students should have taken a standard course on computer networks. Experience with (distributed) programming will be helpful.

Doelgroep
mCS, mPDCS, mSNE (UvA)

Evolutionary Computing

Vakcode	X_400111 (400111)
Periode	Periode 1

Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. A.E. Eiben
Examinator	prof. dr. A.E. Eiben
Docent(en)	prof. dr. A.E. Eiben, J.V. Heinerman MSc
Lesmethode(n)	Hoorcollege
Niveau	400

Doel vak
To learn about computational methods based on Darwinian principles of evolution. To illustrate the usage of such methods as problem solvers and as simulation tools.To gain hands-on
experience in performing experiments.

Inhoud vak
The course is treating various algorithms based on the Darwinian evolution theory. Driven by natural selection (survival of the fittest), an evolution process is being emulated and solutions for a given problem are being "bred". During this course all "dialects" within evolutionary computing are treated (genetic algorithms, evolutiestrategieën, evolutionary programming, genetic programming, and classifier systems). Applications in optimisation, constraint handling, machine learning, and robotics are discussed. Specific subjects handled include:
various genetic structures (representations), selection techniques, sexual and asexual variation operators, (self-)adaptivity. Special attention is paid to methodological aspects, such as algorithm design and tuning. If time
permits, subjects in Artificial Life will be handled. Hands-on-experience is gained by a
compulsory programming assignment.

Onderwijsvorm
Oral lectures and compulsory programming assignment (in teams of 3). Highly motivated students can replace the programming assignment by a special research track under the personal supervision of the lecturer (s).

Toetsvorm
Written exam and pogramming assignment (weighted average).

Literatuur
Eiben, A.E., Smith, J.E., Introduction to Evolutionary Computing. Springer, 2015, 2nd edition, ISBN 978-3-662-44873-1.

Vereiste voorkennis
Programming skills are necessary to do the practical assignment.

Doelgroep
mBA, mAI, mCS, mPDCS

Experimental Design and Data Analysis

Vakcode	X_405078 ()

Periode	Periode 5
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. E.N. Belitser
Examinator	dr. E.N. Belitser
Docent(en)	dr. E.N. Belitser
Lesmethode(n)	Hoorcollege, Practicum
Niveau	400

Doel vak
In this course the student is acquainted with the most common experimental designs and regression models. Furthermore, nonparametric tests and bootstrap methods are discussed. On completion of this course the student should be able to:
- design experiments and analyse the results according to the design,
- analyse data using the common ANOVA designs,
- analyse data using linear regression or a generalized linear regression model,
- perform basic nonparametric tests,
- perform bootstrap and permutation tests.

Inhoud vak
Regression models try to explain or predict a dependent variable using measured independent variables. Statistical methods are needed if there is random variation in the dependent variables. We will discuss multiple linear regression, analyses of variance (ANOVA), generalized linear regression models. All methods will be illustrated with practical examples. Especially in the case of ANOVA it is necessary that the study is well designed in order to draw sound conclusions from an experiment or survey. In this course a few well known designs (completely randomized, randomized block etc.) and the associated analyses of variance are discussed. The remainder of the course is be dedicated to non-parametric testing methods and bootstrap methods:
- Wilcoxon test for (one and two samples),
- Kolmogorov-Smirnov test (two samples),
- rank correlation tests,
- permutation and bootstrap tests.
All analyses are carried out by using the statistical package R.

Onderwijsvorm
Lectures, computer classes, discussions of the computer assignments.

Toetsvorm
Weekly computer assignments and final assignment. The final grade is based on the written reports of all these assignments.

Literatuur
- Slides of the lectures,
- R manual,
- assignments.

An introductory book on statistics (containing the prerequisite knowledge for this course) is for example
- Statistical reasoning for everyday life, J.O. Bennett, W. Briggs, M.F.Triola.

For more background on the topics in this course, the following books are recommended:
- Linear models with R, by J.J. Faraway (emphasis on the implementation in R);
- Extending the linear model with R, by J.J. Faraway (emphasis on the implementation in R);
- A first course in the design of experiments; a linear models approach, by D.C. Weber and J.H. Skillings (emphasis on the designs, also implementation in SAS).

Vereiste voorkennis
Introductory statistics.

Aanbevolen voorkennis
Probability and statistics courses.

Doelgroep
mAI, mCS

Overige informatie
All assignments are to be solved using the statistical package R (http://www.r-project.org/).

Fundamentals of Bioinformatics

Vakcode	X_405052 (405052)
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. ir. K.A. Feenstra
Examinator	dr. ir. K.A. Feenstra
Docent(en)	dr. ir. K.A. Feenstra
Lesmethode(n)	Hoorcollege, Deeltoets extra zaalcapaciteit, Computerpracticum
Niveau	400

Doel vak
Interested in Bioinformatics?
Or you want to find out how biology can make an exciting application domain?
Or you want to learn how what more you could do with your data, and with less effort? Enter here to start!

Fundamentals of Bioinformatics (FoB) is the starting course of the Bioinformatics master. It aims to give a broad overview of important topics relevant to the field, with a focus on current open problems. Students will be made aware of these open problems during practical sessions that aim to let the student ‘stumble upon’ these problems by themselves. Based on their background, students will be assigned to separate classes where they will be working to fill gaps in their background knowledge in programming and/or biology.

Goals:

• To make the students aware of gaps in their own background knowledge.
• The student will be aware of the major issues, methodology and available algorithms in bioinformatics.
• To work together in a group of diverse backgrounds.
• To gain hands-on experience in scripting and handling basic mathematical equations as a means of solving bioinformatics problems.
• To develop a basic understanding of major concepts in genomics and molecular cell biology that are relevant to current topics in bioinformatics.

Inhoud vak
Theory:
• Evolution, Genomes, Sequences, Blast/PSI-Blast, Semantic Web, Multi-omics, Next-generation Sequencing

Practical:
• Exercises during/in between lectures
• Project in groups to solve a major bioinformatics problem. The groups will be composed to include each of the three major background areas: bioinformatics, biology and computer science. Success of the group project will depend on the level of cooperation!

Onderwijsvorm
• 12 Lectures (two hour lecture in the morning, two days per week)
• 12 Computer practicals (two hour sessions following the morning lectures, two days per week), partially supervised.
• Project work

Toetsvorm
• [30%] Programming or Biology classes
• [30%] Project and group work
• [40%] Oral or written exam (depending on number of course students) to assess:
Exercises
Project results (individual)
Lecture topics

Literatuur
• course material (slides, scientific papers) on bb.vu.nl
• Marketa Zvelebil and Jeremy O. Baum Understanding Bioinformatics Garland Science 2008 ISBN-10: 0-8153-4024-9

Aanbevolen voorkennis
Bachelor in any science discipline (including medicine), or strong programming background.
An interest in algorithmics approaches to biological problems.

Doelgroep
mAI, mBio, mCS, mMNS

Internet programming

Vakcode	X_405082 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen

Coördinator	dr. S. Voulgaris
Examinator	dr. S. Voulgaris
Docent(en)	dr. S. Voulgaris
Lesmethode(n)	Hoorcollege
Niveau	400

Doel vak
Guide the student through the design and development of Network and Web applications.

Inhoud vak
The course discusses the principles for understanding, designing, and developing Internet applications. This includes programming the network (sockets, threads, RPC, RMI), programming the web interface (servlets, PHP, Javascript, AJAX), and setting up secure communication channels. Throughout the course, as well as in the context of the lab assignments, attention is paid to practical issues of applying these concepts.

Onderwijsvorm
Lectures combined with lab assignments

Toetsvorm
Final exam plus lab assignments

Literatuur
Course slides

Vereiste voorkennis
Knowledge of C, Java

Aanbevolen voorkennis
Good knowledge of both C and Java

Doelgroep
mAI, mCS, mPDCS

Large Scale Data Engineering

Vakcode	X_405116 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. P.A. Boncz
Examinator	prof. dr. P.A. Boncz
Docent(en)	prof. dr. P.A. Boncz
Lesmethode(n)	Hoorcollege
Niveau	500

Doel vak
The goal of the course is to gain insight into and experience with algorithms and infrastructures for managing big data.

More information is found on http://event.cwi.nl/lsde

Inhoud vak
This course confronts the students with some data management tasks, where the challenge is that the mere size of this data causes naive solutions, and/or solutions that work only on a single machine, to stop being practical. Solving such tasks requires the computer scientist to have insight in the main factors that underlie algorithm performance (access pattern, hardware latency/bandwidth), as well as possess certain skills and experience in managing large-scale computing infrastructure.

Onderwijsvorm
There are two lectures per week, and requires significant practical work. The practicals are done outside lecture hours, at the discretion of the students who are supported remotely through Skype screen sharing.

Toetsvorm
In the first assignment the students can work either on their own laptops via a prepared VM, or in the cloud using an Amazon EC2 Micro Instance; and there is an online competition between practicum teams for the best result. The second assignment, using a Hadoop Cluster, are done on the SurfSARA Hadoop cluster (90 machines, 720 cores, 1.2PB storage). For this assignment, a report of 5-8 pages must be written. The students also need to read two scientific papers of choice, related to the second assignment, and present these in class. There is no written examn; the grade is based on the two assignments grades, the grade for the in-class presentation and attendance/participation.

Literatuur
scientific papers provided in the course

Vereiste voorkennis
Hadoop environments are consist of Linux machines, so some basic ability in working with these comes in handy. Also, you must have some programming skills in C,C++ or Java.

Aanbevolen voorkennis
Programming proficiency in C/C++ or Java

Doelgroep
mCS, mPDCS

Machine Learning for the Quantified Self

Vakcode	XM_40012 ()
Periode	Periode 6
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. M. Hoogendoorn
Examinator	dr. M. Hoogendoorn
Lesmethode(n)	Hoorcollege, Practicum
Niveau	400

Doel vak
The quantified-self refers to large-scale data collection of a user's behavior and context via a range of sensory devices, including smart phones, smart watches, ambient sensors, etc. These measurements contain a wealth of information that can be extracted by means of machine learning techniques, for instance for the purpose of predictive modeling. In addition, machine learning techniques can be a driver for adaptive systems to support users in a personalized way based on the aforementioned measurements. The type of data does however require specialized machine learning techniques to fully exploit the information contained in the data. Examples of challenges include the temporal nature of the data, the variety in the type of data, the different granularity of various sensors, noise, etcetera. The main aims of this course are to:
* Understand the challenges imposed by quantified-self data upon machine learning techniques.
* Become familiar with machine learning techniques for predictive modeling that are able to cope with these challenges.
* Become familiar with machine learning techniques that drive adaptive feedback and support.
* Understand how different machine learning approaches can be united in a single system.
The student should become familiar with the more theoretical side of the domain and the current state-of-the-art in research. In addition, the student will learn how to apply this knowledge in a practical setting.

Inhoud vak
The course will provide an overview of relevant state-of-the-art machine learning techniques. More in specific, it will address:
• Feature engineering (how do we come from raw data to usable features):
* Identifying (temporal) features
* Unifying time scales
* Handling missing data
• Learning of user patterns:
* Temporal machine learning approaches such as recurrent neural networks, time series analysis
* Similarity-based approaches using time (including dynamic time warping)
* Association rules (including numerical variants)
• Adaptive feedback and support
* Reinforcement learning
* Nearest neighbor approaches
• Integration of the various components.
In addition, a number of real-life applications will be discussed. Next to lectures, there will be an extensive practical part, where students will learn to work with various algorithms and data sets. As a final assignment, the students will develop a mobile-based system which incorporates several techniques treated during the lecture.

Onderwijsvorm
The course will be taught in four weeks. During the first two weeks the emphasis will be on lectures (l) and assignments associated with the material covered in the lectures. These assignments will form the basis for the final assignment, which is a project (pro) to build a data-driven intelligent system for the quantified self.

Toetsvorm
Written exam (E) (50%) and practical assignments (A) (50%). For both parts the grade needs to be sufficient to obtain a final grade. For the

practical assignments the final assignment counts for 60% while the smaller assignments associated with the lectures count for 40% in total.

Literatuur
Papers and reader, made available via blackboard.

Aanbevolen voorkennis
Programming experience.

Doelgroep
XM_AI, XM_BA, XM_CS

Overige informatie
Lecturer:
Dr.M. Hoogendoorn

Parallel Programming Practical

Vakcode	X_400162 (400162)
Periode	Periode 2+3
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. ir. H.E. Bal
Examinator	prof. dr. ir. H.E. Bal
Docent(en)	prof. dr. ir. H.E. Bal
Lesmethode(n)	Hoorcollege
Niveau	500

Doel vak
Obtain practical experience with parallel programming using different programming systems.

Inhoud vak
During this practical, several parallel programs have to be written, using different programming environments, including Java, MPI, and Chapel. The programs must be tested on a parallel machine of the faculty (see http://www.cs.vu.nl/das4) and the performance (speedups) of the programs must be measured, analyzed, and, whenever necessary, optimized. A brief report must be written that presents for each problem the implementation approach taken and discusses the outcomes of the experiments conducted.

Onderwijsvorm
Practical computer work; students work on their own; there is one (kickoff) meeting and supervision from PhD students.

Toetsvorm
Practical computer work, final report.

Vereiste voorkennis
Knowledge of parallel programming in Java/Ibis, MPI, and Chapel (as taught in the Parallel Programming course) is required, as well as practical experience with C and Java.

Doelgroep
Masters Computer Science, PDCS, AI, and Computational Science

Overige informatie
Students can do this course either in Period 2 or in Period 3.
It is not possible to submit assignments in both periods.

Lecturers:
prof. dr. ir. H.E. Bal
Dr. C. Grelck

Parameter Estimation Applied to Medical and Biological Sciences

Vakcode	X_432631 (432631)
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. J.C. de Munck
Examinator	dr. J.C. de Munck
Docent(en)	dr. J.C. de Munck
Lesmethode(n)	Hoorcollege, Practicum
Niveau	500

Doel vak
The course treats the theory of parameter estimation problems in general, but the theory is illustrated extensively by examples from medical and biological sciences and brain imaging (fMRI and MEG/EEG) in particular. Linear and non-linear regression analysis is treated, as well as confidence intervals and significance testing. The goal of the course is to provide insight into the theory of parameter estimation and to develop a critical attitude towards its application and interpretation in order to avoid inconsistent and improper use of the theory.

Inhoud vak
Linear-non linear parameter models, basic matrix-vector algebra,maximum likelihood principle, correlated-uncorrelated noise, OLS, GLS, data outliers, nuisance parameters, linear (time invariant) filters, t-test, F-test, confidence intervals, fMRI data model, missing data, MEG/EEG source localisation. These topics are treated in the form of a series of lectures alternated with exercises.

Extra topics: L1 en L2 norms.

Onderwijsvorm
Lecture and MatLab exercises.

Toetsvorm

Written exam plus bonus point for critical review of scientific paper.

Literatuur
A syllabus and slides will be provided by the lecturer.

Aanbevolen voorkennis
Some Matlab experience is recommended.

Doelgroep
mMNS

Performance of Networked Systems

Vakcode	X_405105 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. R.D. van der Mei
Examinator	prof. dr. R.D. van der Mei
Docent(en)	dr. ing. T. Kielmann, prof. dr. R.D. van der Mei
Lesmethode(n)	Hoorcollege
Niveau	400

Doel vak
Students will acquire basic knowledge of:
• performance aspects of networked systems, consisting of servers, services, and clients
• performance engineering principles and methods,
• quantitative models for predicting and optimizing the performance of networked systems,
• quantitative models for planning capacity of networked systems.
Students will gain experience in engineering and planning performance of networked systems, and will learn how to tackle practical performance problems arising in the ICT industry.

Inhoud vak
Over the past few decades, information and communication technology (ICT) has become ubiquitous and globally interconnected. As a consequence, our information and communication systems are expected to process huge amounts of (digital) information, which puts a tremendous burden on our ICT infrastructure. At the same time, our modern society has become largely dependent on the well-functioning of our ICT systems; large-scale system failures and perceivable Quality of Service (QoS) degradation may completely disrupt our daily lives and have huge impact on our economy.

Motivated by this, the course will focus on performance-related issues of networked systems. In the first part, we study capacity planning and modeling for server systems and networks. In the second part, we study the client side of performance while focusing on web applications for both desktop and mobile devices. We address questions like:

- How can we design and engineer networked systems for performance?
- How can we plan server capacity in networked systems?

- How can web applications improve performance across wired and wireless networks?

Onderwijsvorm
Classroom lectures and practical homework assignments.

Toetsvorm
The assessment will be based on both homework assignments and a written exam.

Literatuur
Textbook, supplemented with a reader on Stochastic Performance Modelling.

High Performance Browser Networking, Ilya Grigorik, O-Reilly, 2013.

Vereiste voorkennis
The students should have basic knowledge of computer networks.

Doelgroep
mBA, mCS, mPDCS, mEct

Programming Large-scale Parallel Systems

Vakcode	XM_40017 ()
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. ir. H.E. Bal
Examinator	prof. dr. ir. H.E. Bal
Docent(en)	prof. dr. ir. H.E. Bal
Lesmethode(n)	Hoorcollege
Niveau	400

Doel vak
You will
- be introduced to the domain of High Performance Computing (HPC)
- learn about design methods for parallel algorithms
- compare different parallel computer architectures
- analyze performance of network topologies
- develop basic familiarity with a range of parallel programming constructs,
environments and languages
- gain insight into some selected parallel applications

Inhoud vak
This lecture discusses how programs can be written that run in parallel on a large number of processors, with the main goal of reducing execution
time. The class has a brief introduction into parallel computing systems (architectures). The focus of the class, however, is on programming methods, languages, and applications. Both traditional techniques (like MPI message passing) and more advanced techniques like parallel object-oriented approaches from the Java ecosystem or dedicated HPC programing

languages (like Cray's high productivity language Chapel) will be discussed. Several parallel applications are discussed, including nearest-neighbor stencil computations, N-body simulations and search algorithms.

Onderwijsvorm
Lectures (4 hours per week), given by prof.dr.ir. Henri Bal (VU) and Dr Clemens Grelck (UvA). There is a separate Parallel Programming Practical (6 ECTS) in P2 and P3 whose aim is to complement the contents of this course with practical skills and experience. That course makes heavy use of our state-of-the-art DAS research cluster.

Toetsvorm
Written exam

Literatuur
Papers will be made available on Blackboard

Doelgroep
mAI, mBIO, mCS, mPDCS, m Computational Science

Overige informatie
Lecturers:
prof.dr.ir. Henri Bal (VU)
Dr. Clemens Grelck (UvA)

Quantitative Financial Risk Management

Vakcode	E_FIN_QFRM (60422110)
Periode	Periode 5
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Economische Wet. en Bedrijfsk.
Coördinator	dr. S.A. Borovkova
Examinator	dr. S.A. Borovkova
Docent(en)	dr. S.A. Borovkova, dr. A. van Haastrecht
Lesmethode(n)	Hoorcollege
Niveau	400

Doel vak
Deep understanding and ability to implement modern quantitative risk measurement and management techniques, in the areas of market, credit, operational and liquidity risk.

Inhoud vak
The lecturers are Dr. S. Borovkova, an expert on derivatives, risk management and energy markets, and Dr. A.van Haastrecht, Senior Risk Manager of ING Insurance. In this course we will examine various types of financial risks facing corporations and financial institutions, such as market, credit and operational risks. The course will encompass both theoretical and applied aspects of risk management. This course will give you a solid fundamental for measurement and management of financial risks, knowledge of newest quantitative methods and the ability to apply your knowledge in corporate environment. The lectures are complemented by practical assignments designed to maximally match actual risk

management applications in banking environment. For this course you need a strong quantitative focus and affiliation with statistics and probability as well as (some) affiliation with finance, or an intention to learn necessary concepts and vocabulary.

Onderwijsvorm
Lectures (6 hours per week)

Toetsvorm
2 practical assignments and written exam

Literatuur
Embrechts, Frey and McNeal "Quantitative Risk Management"
Counterparty Credit Risk by Brigo, Morini and Palaviccini

Aanbevolen voorkennis
Introductory statistics and probability, implementation skills (Excel, Matlab, Eviews or any other computer package)

The Social Web

Vakcode	X_405086 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. D. Ceolin
Examinator	dr. D. Ceolin
Docent(en)	dr. D. Ceolin
Lesmethode(n)	Hoorcollege, Computerpracticum
Niveau	400

Doel vak
In this course the students will learn theory and methods concerning communication and interaction in a Web context. The focus is on distributed user data and devices in the context of the Social Web.

Inhoud vak
This course will cover theory, methods and techniques for:

- personalization for Web applications
- Web user & context modelling
- user-generated content and metadata
- multi-device interaction
- usage of social-web data

Onderwijsvorm
- lectures
- practical sessions
- assignments including final paper

Toetsvorm
Weighted average of group assignments and final individual paper

Literatuur
- course lecture slides
- selected articles, videos and Web links for each lecture

Aanbevolen voorkennis
Basic programming skills

Doelgroep
VU: mIS
UvA: master Information Studies - Human-Centered Multimedia
mCS
mAI