Università
della
Svizzera
italiana

**Faculty
of Informatics**

# Plan of studies
Academic year 2015/2016

3-5-8
2015
2016

Faculty of
Informatics

Plan of
studies
3-5-8

Academic
year
2015/2016

# Index

# Preface

# Preface

Mathematics used to be the fundamental discipline of science, as it provides a universal abstract language and a rigid formalism for describing and analysing observed phenomena. But science is undergoing a tremendous change in the 21st century, and informatics is becoming the new backbone of virtually all scientific and technological fields, because our modern data-driven society depends crucially on the ability of managing vast amounts and different kinds of information.

Informatics, the science of information, provides the universal tools for dealing with such data. It not only covers the design of algorithms and data structures for storing, processing, transmitting, and accessing information, but more generally facilitates a modern, digital, and automated approach to problem solving, communication, and collaboration. The enormous impact that informatics has on basically all aspects of human life implies a huge potential for exciting careers not only in the information technology sector, but also in other areas, including economics, health care, aerospace, and entertainment.

The Faculty of Informatics is young and modern. It has gained an international reputation as a high quality centre for research and education in Switzerland. It currently hosts around 200 researchers from all over the world and is engaged in several national and international research projects. It offers a full curriculum that includes Bachelor, Master and PhD programmes. The language of instruction is English, but in the halls you hear many other languages spoken as well. The Faculty continues to grow while keeping an enthusiastic, exciting, and vibrant environment for both students and researchers.

Prof. Dr. Kai Hormann
Dean of the Faculty of Informatics

Faculty of Informatics

# Faculty's governing bodies

The Faculty's governing bodies include: the Faculty Council, the Professors Council, and the Dean's Office.

**Faculty Council**

The highest body of the Faculty is the Faculty Council.

It comprises:
- all tenured professors (full and associate), the assistant professors and adjunct professors of the Faculty;
- one teacher representative (with one- or two-year contract),
- one PhD student representative, one postdoctoral researcher representative and one student representative (Bachelor and Master).

*Full professors:*

| | | |
|---|---|---|
| Antonio Carzaniga | Fabio Crestani | Kai Hormann |
| Mehdi Jazayeri | Rolf Krause | Michele Lanza |
| Michele Parrinello | Fernando Pedone | Mauro Pezzè |
| Jürgen Schmidhuber | Stefan Wolf | |

*Associate professors:*

| | | |
|---|---|---|
| Walter Binder | Michael Bronstein | Matthias Hauswirth |
| Illia Horenko | Marc Langheinrich | Evanthia Papadopoulou |
| Cesare Pautasso | Laura Pozzi | Olaf Schenk |
| Natasha Sharygina | | |

*Assistant professors:*

| | | |
|---|---|---|
| Vittorio Limongelli | Nate Nystrom | Igor Pivkin |
| Robert Soulé | | |

*Adjunct professors:*

| | | |
|---|---|---|
| Luca Maria Gambardella | Carlo Ghezzi | Fabian Kuhn |
| Miroslaw Malek | | |

*Faculty Representatives:*

| | | |
|---|---|---|
| Simone D'Avico (students) | Teseo Schneider (PhDs) | Olga Kaiser (Post-docs) |
| Chiara Francalanci (Teachers) | | |

**Professors Council**
The Professors Council is made up of all tenured professors (full and associate) of the Faculty.

**Dean**
The Dean is elected by the Faculty Council for a two year term, renewable once.
The current Dean is Prof. Kai Hormann.

For the specific duties of each body please refer to the Statute of the Faculty.

## Executive bodies

**Dean:** Prof. Kai Hormann

| | |
|---|---|
| E-mail: dean.inf@usi.ch | Office: SI-105 |
| Phone: +41 (0)58 666 43 27 | Fax: +41 (0)58 666 45 36 |

**Vice-Dean:** Prof. Antonio Carzaniga

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|---|---|
| E-mail: antonio.carzaniga@usi.ch | Office: SI-218 |
| Phone: +41 (0)58 666 46 89 | Fax: +41 (0)58 666 45 36 |

**Vice-Dean:** Prof. Rolf Krause

| | |
|---|---|
| E-mail: rolf.krause@usi.ch | Office: LAB-401 (Level 4) |
| Phone: +41 (0)58 666 43 09 | Fax: +41 (0)58 666 45 36 |

The Dean and Vice-Deans are available for meetings by appointment.





**Dean's Office secretaries:** Elisa Larghi, Janine Caggiano, Laura Heidemann-Tschanz, Danijela Milicevic

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|---|---|
| E-mail: decanato.inf@usi.ch<br>Certificates: www.attestati.lu.usi.ch | Office: SI-120 |
| Phone: +41 (0)58 666 46 90 | Fax: +41 (0)58 666 45 36 |
| Office hours: Monday-Tuesday-Friday: 10.00-11.30 and 14.00-15.30<br>Wednesday-Thursday: 10.00-11.30 | |

**Bachelor's programme Director:** Prof. Laura Pozzi

| | |
|---|---|
| E-mail: bachelor.dir.inf@usi.ch | Office: SI-206 |
| Phone: +41 (0)58 666 43 01 | Fax: +41 (0)58 666 45 36 |

**Master's programmes Director:** Prof. Antonio Carzaniga

| | |
|---|---|
| E-mail: antonio.carzaniga@usi.ch | Office: SI-218 |
| Phone: +41 (0)58 666 46 89 | Fax: +41 (0)58 666 45 36 |

**Master in Informatics:** Prof. Cesare Pautasso

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|---|---|
| E-mail: cesare.pautasso@usi.ch | Office: Via Balestra,<br>Office 305 (Level 3) |
| Phone: +41 (0)58 666 4311 | Fax: +41 (0)58 666 45 36 |

**Master in Computational Science:** Prof. Olaf Schenk

| | |
|---|---|
| E-mail: olaf.schenk@usi.ch | Office: Lab-201 (Level 2) |
| Phone: +41 (0)58 666 4850 | Fax: +41 (0)58 666 45 36 |

**Master in Management & Informatics:** Prof. Mauro Pezzè

| | |
|---|---|
| E-mail: mauro.pezze@usi.ch | Office: Via Balestra,<br>Office 302 (Level 3) |
| Phone: +41 (0)58 666 4658 | Fax: +41 (0)58 666 45 36 |

**PhD programme Director:** Prof. Walter Binder

| | |
|---|---|
| E-mail: phd.dir.inf@usi.ch | Office: SI-204 |
| Phone: +41 (0)58 666 43 03 | Fax: +41 (0)58 666 45 36 |

**PhD programme Director:** Prof. Michael Bronstein

| | |
|---|---|
| E-mail: phd.dir.inf@usi.ch | Office: SI-109 |
| Phone: +41 (0)58 666 41 20 | Fax: +41 (0)58 666 45 36 |

**Faculty Mobility Delegate:** Prof. Natasha Sharygina

| | |
|---|---|
| E-mail: natasha.sharygina@usi.ch<br>URL: www.relint.usi.ch/en | Office: SI-220 |
| Phone: +41 (0)58 666 42 99 | Fax: +41 (0)58 666 45 36 |

**Double degree programme Delegate:** Prof. Mauro Pezzè

| | |
|---|---|
| E-mail: mauro.pezze@usi.ch<br>URL: www.inf.usi.ch/double_master_degree.htm | Office: Via Balestra, Office 302 (Level 3) |
| Phone: +41 (0)58 666 46 58 | Fax: +41 (0)58 666 45 36 |

**Coordinator of Faculty activities/projects and external relations:**
Ing. Mauro Prevostini

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|---|---|
| E-mail: mauro.prevostini@usi.ch | Office: SI-118 |
| Phone: +41 (0)58 666 47 17 | Fax: +41 (0)58 666 45 36 |

The programme directors and delegates are available by appointment.

**Faculty IT responsible:** Ing. Giacomo Toffetti-Carughi
Support research projects for the Faculty members.





# The Faculty of Informatics

Established in 2004 with only 6 professors, we are now a Faculty of 25 professors from many parts of the world. We have gained an international reputation as a high quality research and education center. We host ca. 350 researchers and students, and are engaged in many national and international research projects.

The Faculty features 8 main areas of research, namely: Software Engineering, Computer Systems, Computational Science, Geometric and Visual Computing, Information Systems, Intelligent Systems, Programming Languages, and Theory and Algorithms.

Born as a traditionally flat structure, the Faculty also features some institutes, such as the Advanced Learning and Research Institute (ALaRI), the Institute of Computational Science (ICS), and as partner institute the Dalle Molle Institute for Artificial Intelligence (IDSIA).

The Faculty offers study programmes on all educational levels, including a Bachelor of Science in Informatics, three Master of Science curricula in Informatics, Computational Science, and Management & Informatics (offered jointly with the Faculty of Economics), and a PhD programme.

# Research institutes

### Advanced Learning and Research Institute (ALaRI)

ALaRI is the Advanced Learning and Research Institute established in 1999 at the University of Lugano (Università della Svizzera italiana), with the mission of promoting research and education in Embedded Systems Design. Aware of the real need for a cross-disciplinary approach to education, ALaRI equips students with a unique body of knowledge ranging from electronic engineering to computer science, including interpersonal skills, indispensable in today´s industry, such as team work, complex-project management, and market sensitivity.
The research activities focus on topics of great scientific interest and industrial applicability, based on real-life design issues such as high-level system design, system-on-chip, network-on-chip, wireless communications as well as system properties such as performance, dependability, security and real time.

In view of the evolution of technology, the ever expanding application areas as well as the conditions of the European job market and of the world-wide educational offers, ALaRI is restructuring its educational programme. Consequently, the Master of Science in Embedded Systems Design and the executive Master of Advanced Studies in Embedded Systems Design will not be offered during the academic year 2015/2016, and a new Master of Science in Cyber-Physical and Embedded Systems Design is envisioned to start in the academic year 2016/2017.

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| Director of ALaRI:<br>Prof. Miroslaw Malek<br>Contact person: Ing. Umberto Bondi | Location: Informatics building |
| Address: via Giuseppe Buffi 13,<br>CH-6904 Lugano | Phone: +41 (0)58 666 47 06 / 47 09<br>Fax: +41 (0)58 666 46 47 |
| E-mail: master@alari.ch | URL: www.alari.ch |





### Institute of Computational Science (ICS)

Advanced mathematical Modelling and high performance methods in numerical simulations open new perspectives for science, research and economy. Exploiting the capabilities of modern supercomputers, increasingly complex problems can be tackled – covering a broad spectrum of disciplines, from exact and natural sciences over medicine and biology to economics and social sciences, including bio-medical, environmental, materials, and engineering sciences. The ICS provides a unique research environment, where strong competences in mathematical modelling, numerical simulation and information science come together in an open and application oriented atmosphere.
ICS hosts eight research groups focusing on advanced computing in computational science, high-performance methods for numerical simulation in science, medicine and engineering, computational time series analysis, computational shape analysis, multi-scale and multi-physics models in computational biology, computational modelling of cardiac electrophysiology, and the simulation of biological and physical systems.

Additionally to providing top-level research, it is a main priority of the ICS to offer highest quality education in the area of computational science. A well balanced curriculum in computational science combines the in depht-treatment of topics in applied mathematics, informatics, and high performance computing, with strong connections to application areas as biology, medicine, molecular physics, climate/weather research, geophysics, engineering, fluid dynamics, computer vision, pattern recognition, and finance. Mathematical modelling, discretisation techniques, and state-of-the-art solution methods are part of the curriculum as well as parallel computing and the design and realisation of efficient scientific simulation software. Special emphasis is on the understanding of mathematical and methodological concepts as a universal bridge between the real world processes and the numerical simulations and their application.

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|---|---|
| Director of ICS: Prof. Rolf Krause | Location: LAB Building |
| Address: via Giuseppe Buffi 13,<br>CH-6904 Lugano | Phone: +41 (0)58 666 46 90<br>Fax: +41 (0)58 666 45 36 |
| E-mail: ics@usi.ch | URL: www.ics.usi.ch |

# Partner institutes

### IDSIA (Istituto Dalle Molle di Studi sull'Intelligenza Artificiale)

IDSIA is a non-profit oriented research institute for artificial intelligence, affiliated with both the University of Lugano and SUPSI. IDSIA focuses on machine learning (artificial neural networks, reinforcement learning), optimal rational agents and optimal universal artificial intelligence, operations research, bio-inspired optimisation, complexity theory, and robotics. IDSIA is situated in Manno. In Business Week's "X-Lab Survey" IDSIA was ranked in fourth place in the category "Computer Science – Biologically Inspired", after much larger institutions. IDSIA also ranked in the top 10 of the broader category "Artificial Intelligence". In collaboration with USI, the institute offers some courses of the Master of Science in Informatics.

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| Director:<br>Prof. Carlo Lepori | Phone: +41 (0)58 666 66 60<br>Fax: +41 (0)58 666 66 61 |
| Contact person:<br>Prof. Luca Maria Gambardella | Phone: +41 (0)58 666 66 63<br>Fax: +41 (0)58 666 66 61 |
| Address: IDSIA, Galleria 2, 6928 Manno | |
| E-mail: luca@idsia.ch | URL: www.idsia.ch |





### CSCS (Swiss National Supercomputing Centre)

Founded in 1991, CSCS develops and provides the key supercomputing capabilities required to solve challenging problems in science and/or society. The centre enables world-class research with a scientific user lab that is available to domestic and international researchers through a transparent, peer-reviewed allocation process. CSCS's resources are open to academia, and are available as well to users from industry and the business sector. The centre is operated by ETH Zurich and is located in Lugano.

CSCS and the Università della Svizzera italiana coordinate the Swiss Platform for Advanced Scientific Computing (PASC); a joint effort of all Swiss universities to create a long-term research-driven cooperation network in computational science. The PASC overarching goal is to position Swiss computational sciences in the emerging exascale-era and aims to provide the Swiss scientific community with the tools to make the best use of the new generations of supercomputing machines to solve key problems for science and society. It addresses important scientific research issues in high-performance computing and computational science in different domain sciences through interdisciplinary collaborations between domain scientists, computational scientists, software developers, computing centres and hardware developers.

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| Director: | Prof. Thomas C. Schulthess | |
| Address: | CSCS, Via Trevano 131,<br>6900 Lugano | Phone: +41 (0)91 610 82 11<br>Fax: +41 (0)91 610 82 82 |
| E-mail: | info@cscs.ch | URL: www.cscs.ch |

# USI Presidency, Administration and Services

**Presidency**
President: Prof. Piero Martinoli

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|---|---|
| Secretary: Katya Taddei | Office: VL-205 (via Lambertenghi) |
| E-mail: katya.taddei@usi.ch | Phone: +41 (0)58 666 45 40<br>Fax: +41 (0)58 666 46 47 |

**Administrative services**
The administrative services include the USI secretariat, the faculties' secretariats and the human resources department.

| | |
|---|---|
| General Secretary: Albino Zgraggen | Office: CC-223 (main building) |
| E-mail: albino.zgraggen@usi.ch | Phone: +41 (0)58 666 46 03<br>Fax: +41 (0)58 666 46 47 |

The General Secretary is available for meetings by appointment.

**Front desk (general information and certificates)**

| | |
|---|---|
| Staff: Sébastien Malisia, Mattia Tamò | Office: CC-220 (main building) |
| Phone: +41 (0)58 666 40 00 | Fax: +41 (0)58 666 46 47 |
| E-mail: info@usi.ch | URL: www.attestati.lu.usi.ch |
| Opening hours: Monday-Friday: 10.00-12.00 / 14.00-16.00 | |





**Study Advisory Service and Promotion**

The Study Advisory Service aims at supporting and accompanying students in the choice of a study programme and its subsequent job opportunities. The Study Advisors interact with students, high schools, orientation services, and other universities, and serve as a direct contact point with USI.
For the various presentation activities in Switzerland and abroad, the Study Advisory Service relies on a promoting team formed every year by USI students. A detailed calendar of the Service's events is available under the section Scheduled Orientation Initiatives.

| | |
|---|---|
| Staff: Rosario Maccarrone, Nicole Münger Bandion, Gilda Schertenleib, Stéphanie Biollaz and Claudia Piwecki | Office: CC-303 (main building) |
| Phone: +41 (0)58 666 47 95 / 46 72 | Fax: +41 (0)58 666 47 59 |
| E-mail: studyadvisor@usi.ch | URL: www.orientamento.usi.ch, www.opendays.usi.ch |
| Opening hours: 9.00-12.00 / 13.30-17.30 | |

**International Relations and Study-abroad Office**

The International Relations and Study-abroad Office offers its students and others coming from Switzerland and abroad the following possibilities:
– *The Swiss mobility programme*
– *The Swiss-European Mobility Programme*
– *The International exchange programme*
– *Other programmes: Eurocampus*

The task of the International Relations office is to advise and select outgoing students as well as to accept, assist and welcome incoming (exchange and visiting) students. Therefore, students planning to take part in these programmes should address their enquiries directly to the service. The International Relations Office will then put in place the appropriate administrative procedure, and provide information and advice on various practical matters (e.g. residence permit, insurance, housing, etc.).

| | |
|---|---|
| Staff: Arianna Imberti Dosi | Office: CC-229 (main building) |
| Phone: +41 (0)58 666 46 26 | Fax: +41 (0)58 666 46 47 |
| E-mail: relint@usi.ch | URL: www.relint.usi.ch |
| Opening hours: Monday and Thursday: 9.30-11.30 | |

**Accommodation Service**

The Accommodation Service is a service of our University designed to help students (permanent, exchange and mobility) and assistants in their search for a place to stay. The Service cannot always guarantee full success but wants to provide free one-to-one advice and guidance through practical directions on opportunities and the appropriate channels.

The Accommodation Service can assist students in several ways:
- It runs a database with regularly updated vacancy adverts
- It ensures a timely update (changes, deletions) of all information recorded in the database
- It provides language assistance whenever applicants encounter difficulties in their contacts with letting agents or landlords
- It provides basic information on tenancy laws and general guidelines on housing, procedures, etc.

| | |
|---|---|
| Contact person: Patrizia Bianchi | Office: CC-210 (main building) |
| Phone: +41 (0)58 666 44 89 | Fax: +41 (0)58 666 46 47 |
| E-mail: alloggi@usi.ch | URL: www.alloggi.usi.ch<br>www.facebook.com/usialloggi<br>(Facebook group set up to enable people to share houses or flats) |
| Opening hours: Front desk Monday-Friday: 13.30-15.00 or by appointment | |





**The University Library Services**

The Library provides its services to all visitors interested in the subjects studied at the University. It is open to academic staff members, students and the general public. Most Library collections are available on the shelf, including a wide range of periodical publications. Equally wide are the electronic document collections, which can be also accessed from remote (by academic users only). Among the range of services provided by the Library are the Interlibrary Loan and the Reference Office staff that offers advice and assistance. Individual study areas and computers are also available.

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|---|---|
| Responsible: Davide Dosi<br>Staff: Bruno Benedetti, Nuzio F. Canova, Roberto Maurizio Casagrande, Rita Deiana Brügger, Francesco Meliti, Nadia Moresi Violane Riveiro, Mauro Nidola, Sabrina Piccinini Masiero, Alessio Tutino, Céline Zuber | Location:<br>Biblioteca universitaria di Lugano<br>Via G. Buffi 13<br>CH-6900 Lugano |
| Phone: +41 (0)58 666 45 00 | Fax: +41 (0)58 666 45 09 |
| E-mail: library.lu@usi.ch | URL: www.bul.sbu.usi.ch |
| Opening hours: Monday-Friday: 9.00-22.00 / Saturday: 9.00-12.15<br>Summer time (July-August): 9.00-18.00 | |

**USI online services and resources**

The service offers a set of online resources made available by USI to its students, Faculty and staff.
- Student platform: www.usilu.net
- eCourses platform (Moodle): www.icorsi.ch
- Exam registration and consultation: www.esami.lu.usi.ch
- Email access: www.mail.usi.ch
- FTP access ftp.lu.usi.ch
- USI picture gallery: www.foto.usi.ch
- Corporate design: www.press.usi.ch/corporate-design.htm

**Computer Support Service**

The Lugano Computer Service manages the information system of the entire Lugano campus. In particular, its tasks include:

- Management of all computer equipment;
- Management of the local area network connecting campus buildings, and of the wireless network on campus;
- Management of email, file server, intranet, and other services;
- Management of audio-video infrastructures;
- Consulting services to Faculty members in the educational field;
- Consulting services to administrative personnel for organizational / administrative purposes;
- Selection of suppliers for technical and informatics equipment.

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| Coordinator: Giovanni Taddei<br>Staff: ing. Cristian Bianchi,<br>ing. Luigi Dota,<br>ing. Marco Greco<br>ing. Flavio Hengge,<br>ing. Riccardo Mantegazzini,<br>ing. Paolo Schmidt,<br>ing. Fulvio Soldini,<br>Svetlana Ivanovic,<br>Federica Boffa | Office: CC-164 (main building) |
| Help Desk Informatics:<br>Phone: +41 (0)58 666 46 10 | Help Desk Audio / Video<br>Phone: +41 (0)58 666 47 10 |
| E-mail: sistema.lu@usi.ch | URL: www.usilu.net |
| Opening hours: Monday-Friday: 8.00-12.00 / 13.00-17.00 | |





**eLab – eLearning Lab**

eLab aims at improving the quality of teaching at USI through the integration of ICT (Information and Communication Technologies). To achieve this goal, eLab provides USI faculties, departments, institutes, teachers, and collaborators with the required infrastructures and services.
eLab's basic services include:

- Management of iCorsi2 (www.icorsi.ch) and assistance for its use. iCorsi2 is an online Learning Management System that allows teachers to share learning materials, engage in discussions with students, communicate information about the courses, manage students' evaluations, etc.
- Management of other eLearning tools and/or assistance on their use;
- Turnitin (www.turnitin.com), anti-plagiarism software;
- MindMeister (www.mindmeister.com), allows to create collaboratively online concept maps and to share them online;
- Prezi (www.prezi.com), for creating presentations;
- Adobe Connect (http://collab.switch.ch), for desktop conferences managed by Switch.

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| Scientific director:<br>Prof. Dr. Lorenzo Cantoni<br>Managing director:<br>Dr. Stefano Tardini<br>Staff: Christian Milani,<br>Elisabetta Decarli-Frick, Anna Picco-Schwendener,<br>Mattia Pera, Yann Cuttaz,<br>Goran Josic,<br>Dr. Riccardo Mazza,<br>Shondel Bervini | Office: CC-139 (main building) |
| Phone: +41 (0)58 666 47 60 | |
| E-mail: info@elearninglab.org | URL: www.elearninglab.org |
| Twitter: www.twitter.com/eLab_USI | |

**Sport Service USI/SUPSI**

Created to raise the awareness of faculty, staff, and students to the importance of sport, this service promotes and organizes various sporting activities and events. The Service organizes regular sports activities, free or at convenient prices.
As member of the Swiss Confederation of University Sports, it collaborates with the sports services of other universities.

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|---|---|
| Responsible: Giorgio Piffaretti<br>Assistants: Dalila Gervasoni, Aniello De Lucia | Office: CC-135 (main building) |
| Phone: +41 (0)58 666 47 97 | Fax: +41 (0)58 666 46 47 |
| E-mail: sport@usi.ch | URL: www.sport.usi.ch |
| Opening hours: Monday 12:00–14:00 Tuesday to Friday: 10:00–14:00 | |

**Career Service**

The University's Career Service aims at fostering exchange and contacts with the professional world, and at acquainting students with the working environment, thus making the transition from the academic world to the work-place easier and more successful.

The Service key activities include:
- Job Data Bank
- Company and career presentations (company self presentations, visiting employers, in-company visits, Mock Interviews, successful applications, …)
- Internship coordination
- Career Forum
- Networking and collaborations with companies (Network USImpresa, Smart recruiting, field projects, partnership agreements)
- One-to-one Career Counselling (CV Reviews, application dossier, career speed dating)
- Publications (Career Success Stories, CV Book, Career newsletter, USI&Carriere Guide, Placement Report)





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|---|---|
| Director: Silvia Invrea<br>Coordinators: Simona Bolis Gelmini, Annelore Denti | Office: CC-303 (main building) |
| Phone: +41 (0)58 666 46 06/46 97 | Fax: +41 (0)58 666 46 47 |
| E-mail: careerservice@usi.ch | URL: www.careerservice.usi.ch |
| Opening hours: Monday-Friday: 9.00-12.30 / 13.30-18.00 | |

**Alumni Service**

The Alumni Service maintains contacts with USI's graduates.
Objectives of the Service are as follows:
- Establish and consolidate a network of contacts among USI's graduates, Faculty and students.
- Create and encourage networking among graduates, companies and institutions.
- Support the professional development and networking of the alumni community
- Promote University development.

To this end the Service supports the Alumni community by organizing a series of thematic meetings (career, networking, educational) dedicated to former students and it ensures that all interested USI alumni are kept up to date with the latest on USI (events, conferences, lectures, graduate training, research, etc.). Among the institutional initiatives the Service maintains an alumni database, publishes the Graduate Yearbook and runs a USI Alumni linkedin group. Furthermore, since 2004, the Alumni service carries out an annual career survey among its graduates.

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|---|---|
| Coordinators: Silvia Invrea | Office: CC-303 (main building) |
| Phone: +41 (0)58 666 46 06/46 97 | Fax: +41 (0)58 666 46 47 |
| E-mail: alumni@usi.ch | URL: www.alumni.usi.ch |
| Opening hours: Monday-Friday: 9.00-12.30 / 13.30-18.00 | |

### Research Service USI/SUPSI

The main objective of the Research Service is to provide support to researchers of USI and SUPSI when developing their research projects and to provide assistance to the organs of both institutions in planning and implementing research strategies. Working closely with the Department of Higher Education of Canton Ticino, the Research Service helps to generate synergies and concerted efforts between the different bodies active in research.
Additionally, the USI-SUPSI research service hosts the Euresearch regional office Lugano. Euresearch is the Swiss network of information on European research and innovation.

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|---|---|---|---|
| Director:<br>Staff: | Dr. Benedetto Lepori<br>Nancy-Lara Millan,<br>Paola Colferai,<br>Valentina Masotti,<br>Martina Pestoni,<br>Maryse Letiembre,<br>Riccardo Cappelletti | Office: | VL-108 (via Lambertenghi) |
| Phone: | +41 (0)58 666 46 14 | Fax: | +41 (0)58 666 46 19 |
| E-mail: | servizio.ricerca@usi.ch | URL: | www.ticinoricerca.ch |

### L'ideatorio

The Ideatorio investigates the relationship between science and society. The Science Center developed in cooperation with the School District of Lugano, offers interactive science exhibitions, science summer camps and a biology laborato- ry for children. Moreover the Ideatorio integrates its activities with Science et Cité, a Swiss foundation created to promote dialogue between science and citizens.





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| Regional Coordinator:<br>Dr. Giovanni Pellegri<br>Staff: | <br><br>Michela Carli,<br>Nicolas Cerclé,<br>Janos Cont,<br>Gilda Giudici,<br>Fabio Meliciani,<br>Cristina Morisoli,<br>Riccardo Rezzonico | Office: | CC-107 (main building) |
| Phone: | +41 (0)58 666 45 20 | Fax: | +41 (0)58 666 46 19 |
| E-mail: | ideatorio@usi.ch | URL: | www.ideatorio.usi.ch |

### AGIRE Foundation

AGIRE is Cantone Ticino's platform for the transfer of technologies and knowledge. It promotes innovation and entrepreneurship in Ticino and it focuses on the support of existing and new companies, in order to create high-skilled jobs and support the economic development of the Cantone Ticino. AGIRE promotes innovative processes that lead to the creation of new products or services, new production systems and new methods of organization and collaboration for a stronger entrepreneurial spirit.

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|---|---|---|---|
| Director:<br>Staff: | Lorenzo Leoni<br>Paolo Orsatti,<br>Roberto Klaus,<br>Fabienne Eggler,<br>Michele Merazzi,<br>Giulia Bottarini | Address: | Tecnopolo Ticino<br>Stabile Suglio,<br>Via Cantonale 2a,<br>CH-6928 Manno |
| Phone: | +41 (0)91 610 27 10 | | |
| E-mail: | info@agire.ch | URL: | www.agire.ch |

## Equal Opportunities Service

The Equal Opportunities Service promotes gender equality and a culture of non-discrimination and better appreciation of difference at Università della Svizzera italiana (USI). Since 2001, the Service has focused on:
– bringing about working and study conditions that are compatible with family life;
– achieving a fairer presence of women and men at all levels of the academic ladder, especially at the tenured-professor rank, promoting and enhancing the career paths of aspiring women academics;
– spreading a culture of equal opportunities and against discrimination.

To alert and inform the academic community to equal opportunities subjects, the Equal Opportunities Service provides advice on issues like maternity, crèches and child-care, on how to adjust study curricula to personal needs, on how to tackle conflicts in the workplace; organizes workshops, events and meetings to alert and inform the academic community on issues relating to equal opportunities; develops publications and statistics on the condition of women.

| | | | |
|---|---|---|---|
| Responsible:<br>Assistant: | Dr. Arianna Carugati-Giugliano<br>Francesca Scalici | Office: | CC-257 (main building) |
| Phone: | +41 (0)58 666 46 12 | Fax: | +41 (0)58 666 46 47 |
| E-mail: | equality@usi.ch | URL: | www.equality.usi.ch |





## Start-up Promotion Centre

Entering the job market after graduation is an important milestone in the life of a student. It is also a real test-bed for the preparation acquired during University years. Today's professional environments, centered on innovation and competition, reward creative and competent professionals who are able to generate work and wealth.
For these reasons, the Board of Trustees for the Lugano Faculties of USI has created the Start-up Promotion Centre: a service helping Swiss and foreign graduates with innovative ideas to develop them into enterprises. The service takes advantage of these universities' scientific, technical and management expertise to assess the feasibility of proposed ideas and projects, supporting their development and realisation. Graduates who intend starting up a business can also request access to the "Incubator" which provides a favorable environment with suitably equipped spaces, infrastructures and common services.

| | | | |
|---|---|---|---|
| Coordinator:<br>lic. rer. pol.Roberto Poretti<br>Contact person at USI:<br>ing. Umberto Bondi<br>Contact person at SUPSI:<br>lic. oec. publ. Alessandro Cavadini<br>Contact person for the Accelerator:<br>dott. ing. Tran Que Dung<br>Collaborator:<br>Oscar Pang | | Office: | CP START UP<br>Via Maderno 24<br>6900 Lugano |
| Phone: | +41 (0)58 666 41 64 | Fax: | +41 (0)58 666 42 25 |
| E-mail: | admin@cpstartup.ch | URL: | www.cpstartup.ch |

## Student associations

Several students associations have been founded within the University. The main objectives are to improve relations between the students and the institution, and of enriching the range of educational and recreational offer during school. The associations are especially concerned with the collection of didactic material, organisation of parties and meetings, cultural and sporting events, and networking among University students and the business world.

The student associations active at USI are:
- AIESEC
- African Students Association Ticino (ASAT)
- Organizzazione Studenti Accademia (OSA)
- DebaTable - USI Debating Club
- EESTEC
- ESN Lugano
- Institute of Electrical and Electronics Engineers (IEEE Student Branch Lugano)
- Iranian Students Association
- L'Unione Studentesca Ticinese (L'USTi)
- L'universo
- Musily
- Student Events Association
- Student Point
- UNIcinema
- United students
- USI Alumni Association
- USI Amnesty International
- USI Coro
- USI MUN (Model United Nations)

URL: http://www.usi.ch/en/associazioni_studentesche.htm





## Media and Communication Service

The USI Media & Communication Service organizes, coordinates and accompanies the communication activities of the Università della Svizzera italiana to inform the press and the general public of the many academic, research, and cultural activities of USI. In cooperation with institutional bodies of the University, the faculties, institutes, services, associations and the academic community (professors, assistants and students) the service aims to achieve these goals:
- Establish an ongoing open and transparent relationship with journalists
- Disclose the main activities and projects USI to the public
- Coordinate and support external communication for the institutions, faculties and research institutes
- Promote information exchange within the University community
- Coordinate and develop the institutional publications of the University
- Foster the coordination of graphic and visual elements of the corporate design

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|---|---|---|---|
| Staff: | Dr. Cristina Elia Ott,<br>Dr. Giovanni Zavaritt,<br>Robin Creti,<br>Dimitri Loringett,<br>Gilda Schertenleib,<br>Barbara Vogt | Office: | VL-204 (via Lambertenghi) |
| Phone: | +41 (0)58 666 47 92 | Fax: | +41 (0)58 666 46 19 |
| E-mail: | press@usi.ch | URL: | www.press.usi.ch |

### Quality Assurance Service

Launched in the autumn of 2003, USI's Quality Assurance Service is responsible for a sound administration of quality assurance within USI, focused mainly on teaching, research, and services to the academic community.

The Service's activities include:
- Collecting and elaborating statistical data on students, assistants, teachers and professors, services and infrastructure.
- Carrying out teaching evaluation.
- Yearly, biannual or targeted surveys on the satisfaction of all USI users: students, academic and administrative staff, researchers, etc.
- Providing support in the institutional review procedures carried out by the President's office.
- Contact and collaboration with the Swiss Federal Statistical Office, which collects data on students and graduates, and manages the Swiss universities statistical systems.
- Collaboration with the Swiss Center of Accreditation and Quality Assurance in Higher Education (OAQ) and be part to the Swiss universities quality network (Q-Netzwerk).
- Providing support to all USI services and faculties with regard to statistics, data analysis, surveys, evaluations and feedbacks, and statistical operations.

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|---|---|---|---|
| Responsible: | Michele Balmelli | Office: | VL-102 (via Lambertenghi) |
| Phone: | +41 (0)58 666 41 99 | Fax: | +41 (0)58 666 46 47 |
| E-mail: | qualita@usi.ch | | |





### Psychological Counselling Service

The Psychological Counselling Service has been created in cooperation with the ATP (Association of Psychologist of Ticino) with the aim of facilitating access to professionals in the field of psychology.
The Psychological Counselling is a way of providing help in a moment of personal struggle.
Emotional distress may come in different forms and degrees, from a short term to a more complicated and long-lasting discomfort. When a disorder or a problem interferes with the daily routine affecting relationships, family, the workplace or school, the person in need can turn to a professional psycholo- gist. Psychological Counselling can focus directly on defining a specific problem, finding possible solutions, making decisions, handling a crisis. Psychological Counselling is covered by the Cassa Malati Complementare (Complementary Healthcare Insurance) if provided by psychotherapists autho- rized by the Canton.

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|---|---|---|---|
| Contact: | Associazione ticinese psicologi (ATP) | Address: | CP 112<br>CH, 6850 Mendrisio Borgo |
| Phone: | +41 (0)79 441 66 04 | | |
| E-mail: | info@psicologi-ticino.ch | URL: | www.psicologi-ticino.ch |

## Other services:

### Copy Center

A Copy Center is available for all printing needs.

| | | | |
|---|---|---|---|
| Responsible: | Ruggero Lai | Office: | CC-121 (main building) |
| Phone: | +41 (0)58 666 45 86 | E-mail: | ruggero.lai@usi.ch |

# Academic calendar

# Academic calendar

The academic year goes from September until June. Courses are held from September until December and from February until June. The semester includes 3 exam sessions (January, June and September).

**Academic Calendar 2015-2016**

***Fall Semester 2015-2016***

| | |
|---|---|
| Formal registration | September 1 – 25, 2015 |
| Classes Begin: | September 14, 2015 |
| Classes End: | December 18, 2015 |
| No classes: | December 8, 2015 (Immaculate Conception) |
| *Exams sessions* | |
| Registration: | November 23 – December 7, 2015 |
| Winter session: | January 18 – February 5, 2016 |

***Spring Semester 2016***

| | |
|---|---|
| Classes Begin: | February 22, 2016 |
| Classes End: | June 3, 2016 |
| Dies academicus: | April 23, 2016 |
| No classes: | March 25 – April 1 2016 (Easter holidays)<br>May 5, 2016 (Ascension)<br>May 16, 2016 (Pentecost Monday)<br>May 26, 2016 (Corpus Domini) |
| *Exams session* | |
| Registration: | May 9 – 23, 2016 |
| Summer session: | June 13 – July 1, 2016 |
| *Autumn Exams session (recovery)* | |
| Registration: | July 25 – August 8, 2016 |
| Exams: | September 5 – 16, 2016 |

Bachelor’s degree programme

# Bachelor's degree programme

## Introduction

The Bachelor of Science in Informatics introduces students to the theory and practice of informatics. It emphasizes theoretical foundations, technology, systems thinking, and soft skills like communication and teamwork.

The curriculum is structured around four areas of learning essential for a truly interdisciplinary education:

**Theory.** The principles and foundations were established in the 20th century. These foundations help the students understand the potential and limits of computing. The theoretical subjects represent a solid basis to conduct sound scientific analysis and design.

**Technology.** Informatics is in permanent and fast-paced evolution, characterized by rapid changes in technology. Students are exposed to the most recent technological advances and learn to cope with technological change and evolution, as well as the impact of technology on society.

**Systems thinking.** Informatics systems today form the foundations of many societal, governmental, and business systems and services. Students learn to view a computer-based system as a component of a larger environment rather than an isolated system.

**Communication and Teamwork.** Information technology projects are intrinsically interdisciplinary. Informatics professionals work in teams to identify complex problems and develop appropriate solutions. Students learn to communicate, to work with others in teams, and to present the results of their work.

The program is based on the European Credit Transfer System (ECTS), which is recognized by all universities in Europe. The three-year Bachelor degree (BSc) is followed by a two-year graduate study programme, leading to a Master degree (MSc). The Faculty offers three Master programmes in Informatics, Computational Science, and Management & Informatics (offered jointly with the Faculty of Economics).

**Mobility**
A student can take part in a mobility or student exchange programme and undertake a semester in another university for a maximum of 30 ECTS in one semester. The student must discuss the choice of host institution and the study plan with the Bachelor director and obtain approval. The mobility period generally lasts one semester; it may be extended, subject to approval of the Bachelor director, to a maximum of two consecutive semesters.

For all information about mobility please consults the International Relations and Study-abroad Office webpage www.relint.usi.ch/en/index.htm.





# Study plan

The Bachelor programme consists of an innovative, project-based, team-oriented curriculum of six semesters (three years) and corresponds to 180 ECTS credits proportionally distributed (30 ECTS for each semester). In the first four semesters, students work on group projects. In the fifth semester students are required to do an internship in industry. In the sixth semester, they work on an individual final project in which they use all the acquired knowledge to solve an interesting problem. The Bachelor students have opportunities for summer internships both at companies and at the university.

***First year***

***Fall semester***

| Course | ECTS | Professors |
|---|---|---|
| Computer Architecture | 6 | Giovanni Ansaloni |
| Discrete Structures | 6 | Stefan Wolf |
| Privatissimum | 3 | Faculty |
| Programming Fundamentals 1 | 6 | Nate Nystrom |
| Software Atelier 1:Fundamental of Informatics | 6 | Michele Lanza, Andrea Mocci |
| Technical English | 3 | Jim Kauffman |
| **Total ECTS** | **30** | |

***Spring semester***

| Course | ECTS | Professors |
|---|---|---|
| Algorithms and Data Structures | 6 | Antonio Carzaniga |
| Calculus | 6 | Michael Bronstein |
| Linear Algebra | 6 | Igor Pivkin |
| Programming Fundamentals 2 | 6 | Matthias Hauswirth |
| Software Atelier 2: Human-Computer Interaction | 6 | Monica Landoni |
| **Total ECTS** | **30** | |

***Second year***

***Fall semester***

| Course | ECTS | Professor |
|---|---|---|
| Automata & Formal Languages | 3 | Laura Pozzi |
| Computer Networking | 6 | Alessandro Margara |
| Probability & Statistics | 6 | Illia Horenko |
| Programming Fundamentals 3 | 6 | Walter Binder |
| Software Atelier 3: The Web | 9 | Cesare Pautasso |
| **Total ECTS** | **30** | |

***Spring semester***

| Course | ECTS | Professor |
|---|---|---|
| Data Management | 6 | Robert Soulé |
| Introduction to Computational Science | 3 | Rolf Krause |
| Operating Systems | 6 | Fernando Pedone |
| Software Atelier 4: Software Engineering Project | 9 | Mauro Pezzè |
| Systems Programming | 6 | Antonio Carzaniga |
| **Total ECTS** | **30** | |

***Third year***

***Fall semester***

| Course | ECTS | Professor |
|---|---|---|
| Algorithms & Data Structures 2 | 3 | Evanthia Papadopoulou |
| Artificial Intelligence | 3 | Luca Maria Gambardella |
| Computer Graphics | 6 | Kai Hormann |
| Information Retrieval | 6 | Fabio Crestani |
| Numerical Computing* | 6 | Olaf Schenk |
| Principle of Economics | 3 | Gianmaria Martini |
| Software Atelier 5: Field Project | 9 | Michele Lanza |
| **Total ECTS** | **30** | |





***Spring semester***

| Course | ECTS | Professor |
|---|---|---|
| Bachelor Project | 18 | Mehdi Jazayeri |
| Languages & Compilers | 6 | Nate Nystrom |
| Optimization Methods* | 6 | Rolf Krause |
| Theory of Computation | 6 | Natasha Sharygina |
| **Total ECTS** | **30** | |

| | |
|---|---|
| **Total ECTS credits** | **180** |

* Electives: can be chosen instead of one of the other courses of the same semester (with the exception of the Field Project Atelier)

Please be aware that slight changes in the study programme may occur.

For the general teaching timetable please refer to:
www.inf.usi.ch/orario_corsi.htm.

## Course descriptions

## Algorithms & Data Structures

| Instructor: | Antonio Carzaniga | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | 2nd |

Algorithms and data structures are fundamental to computer science. They are the essence of computer programs. The performance of any software system depends on the efficiency of its algorithms and data structures, and more generally, the study of algorithms provides insights into the nature of problems. This course provides students with the basic knowledge and skills necessary to design and reason about algorithms, and to understand the purpose as well as the strengths and weaknesses of some of the most fundamental algorithms and data structures. The course covers basic notions of: complexity, asymptotic worst-case and average complexity, big-O notation, complexity classes; general algorithmic strategies, brute force, greedy, divide-and-conquer, and dynamic programming; common algorithms, searching and sorting, elementary graph algorithms, string matching; basic data structures, stacks, queues, linked lists, rooted trees; more advanced data structures, B-trees, heaps, hash tables.





## Algorithms & Data Structures 2

| Instructor: | Evanthia Papadopoulou | ECTS: | 3 |
|---|---|---|---|
| Type: | Lecture | Semester: | 5th |

This course covers a variety of topics on algorithms and data structures, building upon the material of the first year course "Algorithms and Data Structures". Algorithms and data structures are fundamental to computer science and the essence of computer programs. The performance of any software system depends on the efficiency of its algorithms and data structures. This course extends the students' knowledge on fundamental algorithms by focusing on several important topics such as data structures for disjoint sets and union-find, interval trees, graphs and graph algorithms such as shortest paths and matchings, intractability and NP completeness, how to deal with intractability and approximation algorithms.

## Artificial Intelligence

| | | | |
|---|---|---|---|
| **Instructor:** | **Luca Maria Gambardella** | ECTS: | 3 |
| Type: | Lecture | Semester: | 5th |

Reasoning, learning, searching for new information, extracting models from knowledge base systems and adapting to unpredictable situations are key factors in any modern computer system. The goal of this course is to investigate knowledge representation models and algorithms that are useful to reason about facts and situations and are suitable to support advanced search and optimisation strategies other than learning systems. In fact, learning from experience and from errors is a crucial aspect for any intelligent system that has to interact with an external environment. The course moves from simple to complex problems introducing concept such as heuristic search and approximation algorithms. These are important tools to allow the student to theoretically analyze and practically solve real life situations.





## Automata & Formal Languages

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|---|---|---|---|
| **Instructor:** | **Laura Pozzi** | ECTS: | 3 |
| Type: | Lecture | Semester: | 3rd |

The theory of automata and formal languages deals with the problem of modelling computation: what is a computer, and what are its fundamental capabilities? Thus, it constitutes the basis for further studies on the theory of computability and complexity. Additionally, Automata and Formal Languages is a very practical course, as it provides knowledge of the models used in many branches of computer science, from scanners and lexical analysers in compilers, to programs for designing digital circuits, and even in other areas such as linguistics. At the end of this course you will be familiar with models of computations used today, you will understand how they are fundamental to further studies and you will be ready for a more advanced course on the theory of computation.

## Bachelor Project

| | | | |
|---|---|---|---|
| **Instructor:** | **Mehdi Jazayeri** | ECTS: | 18 |
| Type: | Project | Semester: | 6th |

The purpose of the bachelor project is to give the student an opportunity to work independently to develop the solution to a significant (i.e. large) problem. The student must learn and demonstrate both independence and a systematic approach to problem solving. The number of credits is 18 ECTS; that is, the amount of work expected is equivalent to 3 typical bachelor-level courses.

The students are expected to work throughout the semester under the supervision of their project advisor on the substance of the work. The students also meet regularly as a group with the Bachelor Project Coordinator to receive instructions about the purpose and mechanics of implementing a long-term project.

At the end of the semester, the students produce:
- A project report
- A poster and poster presentation
- A product (if applicable) such as an algorithm, a software library, or application.





## Calculus

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|---|---|---|---|
| **Instructor:** | **Michael Bronstein** | ECTS: | 6 |
| Type: | Lecture | Semester: | 2nd |

This course teaches the essentials from real analysis, which are relevant to informatics. It consists of five chapters. After revisiting basic facts about natural numbers, integers, and rational numbers, the first milestone is to understand the concept of real numbers and their properties. We then study sequences and series of real numbers and learn about the idea of convergence. The third chapter introduces real functions in one variable and focuses on the property of continuity and its consequences. Differentiation and integration are covered in the last two chapters. After finishing this course, students possess the mathematical skills required for solving basic problems in a formal and structured way and they will have developed a good understanding of differential and integral calculus. Whenever possible, applications of theoretical concepts are highlighted and part of the homework assignments deal with the implementation of numerical algorithms to practically experience the mathematical concepts.

## Computer Architecture

| **Instructor:** | **Giovanni Ansaloni** | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | 1st |

The class teaches the basic principles of how a computer functions, from the very basic building blocks (transistors and logical gates) to the more complex components (CPU, memory, buses, I/O interfaces). Students learn how one can describe the basic operations in a computer using digital logic, and how these operations can be realized in both hardware and software. Students gradually combine these basic operations into a "microarchitecture" – a software-controlled datapath that connects digital memory with an arithmetic-logical unit – on which one can then build more and more complex "layers" that will finally allow the writing of complex programs in human-readable programming languages. This knowledge not only forms the basis for understanding how something as complex as a modern computer actually works, but is also a pre-requisite for learning about many advanced topics in informatics, such as Hardware/Software Co-Design, System Programming, Compilers, and Operating Systems.





## Computer Graphics

| **Instructor:** | **Kai Hormann** | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | 5th |

This course gives a comprehensive introduction to the theoretical and practical aspects of computer graphics. The first half of this course is devoted to the implementation of a ray-tracer, a method for generating pictures of virtual scenes, which is used for special effects and computer-generated movies. A basic version of such a ray-tracer is developed already in the first week. While learning about the theory of local lighting models, color, homogeneous coordinates, and texture mapping, we keep extending the code until it eventually handles moving objects, shadows, reflections, and refractions. The second half of this course treats the concept of rasterization, an alternative approach to image generation, which is used in games, for example. After implementing our own rasterizer, we learn how to use the OpenGL library and how to program the GPU to achieve special effects. For all programming tasks we provide a framework, so that the students can concentrate on implementing the core methods and algorithm.

## Computer Networking

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|---|---|---|---|
| **Instructor:** | **Alessandro Margara** | ECTS: | 6 |
| Type: | Lecture | Semester: | 3rd |

The focus of the course is on the architecture of the network, its fundamental protocols, and the design principles behind them. The course will follow a top-down approach. Therefore, the first topics covered will be common network-based applications, with a particular focus on the HTTP protocol. We will then look at the two most important transport protocols of the Internet, namely TCP and UDP. In studying TCP we will discuss its provisions for reliability and congestion control. We will then look more closely at the network layer in IP networks. In this section we will study IPv4 as well as IPv6 and its most common extensions. This section of the course will cover the architecture of today's Internet, the basics of interdomain and intradomain routing, and other concepts related to the network layer, such as fragmentation. The course will also review some basic concepts in network and communication security.

## Data Management

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|---|---|---|---|
| **Instructor:** | **Robert Soulé** | ECTS: | 6 |
| Type: | Lecture | Semester: | 4th |

Databases are essential to applications in a wide variety of domains, including finance, health care, commerce, and telecommunications. In fact, most applications that people use on a day-to-day bases are backed by databases. This course provides a practical introduction to database technology. By the end of this course, students will understand the fundamental concepts about database management systems, become familiar with commercial tools for the design and development of database applications, and be exposed to recent trends in database-like storage systems. Topics covered include modeling enterprise data with ER diagrams, the relational model, SQL, XML, logical design with normalization, physical design, query execution, transaction processing, recovery, concurrency, online analytical processing, and NoSQL systems.





## Discrete Structures

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|---|---|---|---|
| **Instructor:** | **Stefan Wolf** | ECTS: | 6 |
| Type: | Lecture | Semester: | 1st |

This course deals with the mathematics of countable structures. Hereby, central themes are modeling, abstraction, simplification, and generalization. The main topics of the course are propositional logic and proofs; sets, relations, and functions; combinatorics (urn models, inclusion-exclusion), graph theory (trees, planar graphs, Euler tours and Hamilton cycles) and some basic number theory (modular calculus, groups, Euler's theorem, RSA).

## Information Retrieval

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|---|---|---|---|
| **Instructor:** | **Fabio Crestani** | ECTS: | 6 |
| Type: | Lecture | Semester: | 5th |

Today more and more information is becoming available in unstructured or poorly structured form. Examples of information of this type are free text, web pages, videos, images, sounds, blog, etc. The goal of this course is to enable the student to understand the fundamentals of information access for unstructured or poorly structured information. In particular, the aim is to assist the student to get an understanding of some of the techniques for the indexing, retrieval, filtering, clustering, and presentation of textual and multimedia information held in digital archives and on the web.

The course complements what the student has learned from a previous course on Database technology.

## Introduction to Computational Science

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|---|---|---|---|
| **Instructor:** | **Rolf Krause** | ECTS: | 3 |
| Type: | Lecture | Semester: | 4th |

Computational Science, i.e. the mathematical modeling and numerical simulation of real world problems in natural and social sciences, engineering, finance, biology, and medicine, is of paramount importance for our modern knowledge and technology driven society. In fact, nowadays, computational science is indispensable in science and industry. Within this course, we will introduce basic and central concepts and techniques of mathematical modeling and numerical simulation and we will show how they can be used to model and simulate model problems and realistic problems. Topics will include condition numbers, numerical solution of linear systems, numerical solution of dynamic problems, and classical interpolation and approximation. Each of the presented numerical methods will be mathematically analyzed, implemented, and tested along an illustrative problem. Thus, the course will not only introduce methods and tools in Computational Science, but it will also create a direct bridge between theory and application.

## Languages & Compilers

| | | | |
|---|---|---|---|
| **Instructor:** | **Nate Nystrom** | ECTS: | 6 |
| Type: | Lecture | Semester: | 6th |

Programming languages allow us to express our intentions to computers and to each other. This course teaches you how to analyze programming languages, focusing on semantics, the meaning of programs in languages. To understand the semantics of a programming language, we take an engineering approach, building interpreters and compilers for the language. We use this approach to understand a variety of constructs in functional and object-oriented languages and to understand how these constructs interact with each other in real-world languages.





## Linear Algebra

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| **Instructor:** | **Igor Pivkin** | ECTS: | 6 |
| Type: | Lecture & Seminar | Semester: | 2nd |

This course gives an introduction to the field of linear algebra. Concepts and techniques from linear algebra are of fundamental importance in many scientific disciplines and provide the "language" for understanding the behavior of linear mappings and linear spaces. Topics covered are linear systems and Gauss method, vector spaces, linear maps and matrices, determinants, eigenvectors and eigenvalues.

## Numerical Computing

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|---|---|---|---|
| **Instructor:** | **Olaf Schenk** | ECTS: | 6 |
| Type: | Lecture | Semester: | 5th |

Numerical computing is an interconnected combination of computer science and mathematics in which we develop and analyze algorithms for solving important problems in science, engineering, medicine, and business – for example, simulating an earthquake , choosing a stock portfolio, or detecting cancer tumors in medical images. The students will learn principles and practices of basic numerical computation. This is a key aspect of scientific computation. This class will cover several topics, including: one-dimensional nonlinear equations; understanding and dealing with sources of error; linear equations and linear least-squares; data fitting; and ordinary differential equations. As much as possible, numerical methods will be presented in the context of real-world applications.

## Operating Systems

| | | | |
|---|---|---|---|
| **Instructor:** | **Fernando Pedone** | ECTS: | 6 |
| Type: | Lecture | Semester: | 4th |

Operating systems are a fundamental part of any computer system and common to virtually every application. This course surveys conceptual design and implementation issues of such complex programs, starting with the most basic notions of operating systems (e.g., the difference between the kernel and user modes, system calls) and evolving to develop key approaches to operating systems design and implementation. The course delves into the four main pillars of operating systems: process management (i.e., concept of process, multithreaded programming, process scheduling, synchronization, and deadlocks), memory management (i.e., memory-management strategies, virtual memory), storage management (i.e., file systems interface and implementation, mass-storage structure, and I/O systems), and operating systems protection and security. In addition to a conceptual view of operating systems, the course exposes students to the implications of some techniques through a hands-on approach.





## Optimization Methods

| | | | |
|---|---|---|---|
| **Instructor:** | **Rolf Krause** | ECTS: | 6 |
| Type: | Lecture | Semester: | 6th |

Optimization is of fundamental importance in virtually all branches of science and technology. As a consequence, optimization methods find their applications in numerous fields, starting from, e.g., network flow and ranging over shape optimization in engineering to optimal control problems. This course provides an introduction into the most important methods and techniques in discrete and continuous optimization. We will present, analyze, implement, and test -along selected problems- methods for discrete and continuous optimization. Particular emphasis will be put on the methodology and the underlying mathematical as well as algorithmic structure. Starting from basic methods as the Simplex method, we will consider different central methods in convex as well as non-convex optimization. This will include optimality conditions, the handling of linear and non-linear constraints, and methods such as interior point methods for convex optimization, Newton's method, Trust-Region methods, and optimal control methods.

## Principles of Economics

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|---|---|---|---|
| **Instructor:** | **Gianmaria Martini** | ECTS: | 3 |
| Type: | Lecture | Semester: | 5th |

The course presents the main concepts of Economics, at an introductory level. It covers both Microeconomics and Macroeconomics issues, related to the economic method, demand and supply, elasticities and their applications, national income, inflation, money, growth, unemplyoment and trade.

## Privatissimum

| | | | |
|---|---|---|---|
| **Instructor:** | **Kai Hormann, Michele Lanza, Vittorio Limongelli, Laura Pozzi, Natasha Sharygina, Stefan Wolf** | ECTS: | 3 |
| Type: | Seminar | Semester: | 1st |

A weekly meeting to discuss university life, science, technology, and society. The course is intended to help the students learn about, and adjust to the heavy and conflicting demands of being a new university student.

## Probability & Statistics

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|---|---|---|---|
| **Instructor:** | **Illia Horenko** | ECTS: | 6 |
| Type: | Lecture | Semester: | 3rd |

We treat the basic notions of discrete combinatorics and probability theory: Bernoulli trial, binomial coefficients, probability spaces, the probability function, random variables, expectation value, variance and covariance. Of central importance are the limit theorems such as the weak law of large numbers and the central limit theorem. These establish the link to statistics: In order to obtain a significant statement from a random sample, what is the necessary size of the sample? And if we have two or more different models that we can fit to the sample then which one is the "best"? And what does "best" means in this context? We discuss estimators and tests. Also based of the notions of probability, we discuss the basics of information theory such as entropy, conditional entropy, and mutual information. Theoretical concepts in the course will be illustrated with real-life examples from finance, climate research and medicine.





## Programming Fundamentals 1

| | | | |
|---|---|---|---|
| **Instructor:** | **Nate Nystrom** | ECTS: | 6 |
| Type: | Lecture & Lab | Semester: | 1st |

This is a first course in programming--applying computation to problem solving. The course is aimed at students with little or no prior programming experience. We'll be using a programming language called Racket, in which we will practice functional programming. But, this is not a course about Racket; it's a course about software construction: designing programs and then translating designs into implementations. Designing software means making wise choices about data structures, algorithms, and program organization. Implementing means more than just writing code: it means making wise decisions about systems and interfaces. By the end of the course, students should be familiar with various programming constructs universal to all languages, they should be able to analyze problems and then create programs to solve them.

## Programming Fundamentals 2

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|---|---|---|---|
| **Instructor:** | **Matthias Hauswirth** | ECTS: | 6 |
| Type: | Lecture & Lab | Semester: | 2nd |

This course teaches how to develop software using an object-oriented approach. It teaches how to structure a problem using the concept of classes, and how to use fields and methods to model state and behavior. The course uses Java as its programming language. It introduces the fundamental concepts of types, dynamic memory allocation, and references. It covers the ideas of collections and iteration to deal with multiple objects, the ideas of inheritance and polymorphism to deal with variability in software, and the idea of exception handling to deal with unexpected situations. It covers principles of design such as coupling and cohesion, encapsulation, and immutability, and it introduces common design patterns. The practical aspects of the course include testing and debugging techniques that help improve the quality of the resulting software.

## Programming Fundamentals 3

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|---|---|---|---|
| **Instructor:** | **Walter Binder** | ECTS: | 6 |
| Type: | Lecture | Semester: | 3rd |

This course teaches concepts and methods of object-oriented programming as well as concurrent programming techniques. In the first part of the course, the object-oriented programming features of Java are presented in detail, covering inclusion polymorphism, dynamic binding, and parametric polymorphism. The course also teaches design by contract, UML, as well as selected design principles and patterns. The second part of the course gives an introduction to concurrent programming in Java. It covers multithreading, safety and liveness hazards, and synchronization. The presented techniques enable the development of scalable Java software that is capable of exploiting modern multicore hardware.

## Software Atelier 1: Fundamentals of Informatics

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|---|---|---|---|
| **Instructor:** | **Michele Lanza and Andrea Mocci** | ECTS: | 6 |
| Type: | Atelier | Semester: | 1st |

The first of the ateliers, which are a crucial part of our Bachelor curriculum is roughly divided into three main pieces. On the one hand the students will obtain first-hand experience with a variety of tools of the trade, such as LaTex, HTML, Versioning (git, SVN), and the shell. Second, the students will be introduced to the history of computer science since its very beginning up to the present day. The third part of the atelier is dedicated to the semester project that the students will do as part of the Programming Fundamentals course.





## Software Atelier 2: Human-Computer Interaction

| | | | |
|---|---|---|---|
| **Instructor:** | **Monica Landoni** | ECTS: | 6 |
| Type: | Atelier | Semester: | 2nd |

This Atelier combines some important ingredients to help students get a better understanding of their future profession as ICT experts. It starts from an introduction to ethics that investigates the many ways and venues ICT can be used maliciously, focuses on responsibilities and proposes ethical solutions. With a renewed awareness of the role ICT plays in everyday life, students can focus on and take a critical approach in assessing what makes an interface usable, used and useful. The course is completed by a practical component: learning how to use Cascading Style Sheets. That provides an additional tool for students to put the theory learned into practice by designing ethical, usable, useful and enjoyable interfaces.

## Software Atelier 3: The Web

| | | | |
|---|---|---|---|
| **Instructor:** | **Cesare Pautasso** | ECTS: | 9 |
| Type: | Atelier | Semester: | 3rd |

The ultimate goal of the Informatics Atelier is to teach the student to become a computing professional. To this end, the atelier gives an introduction to the role of computing and computer scientists in the professional world as well as society in general and provides an environment for the students to learn about and use specific software tools, work with other students in group projects, and effectively present the results of their projects. The emphasis during the Web Atelier in the third semester is on client/server programming, emerging Web technologies and Web design. The Web Atelier will cover the following Web technologies: REST and HTTP, CSS3, HTML5, JSON; students will also learn how to program in JavaScript on the client and on the server-side with Node.JS, the Express framework and Dust templates.

## Software Atelier 4: Software Engineering Project

| Instructor: | Mauro Pezzè | ECTS: | 9 |
|---|---|---|---|
| Type: | Atelier | Semester: | 4th |

Programming skills are essential but not enough to develop large and complex software systems that require the coordination of a team of specialists. Software engineering is about the development of such moderns software systems. The course is about software engineering in practice. Students will learn how to go beyond programming, how to coordinate a team of specialists, how to apply modern methodologies and techniques. Students will experience with state of the art tools to understand the role of automation for developing software systems and coordinate the work of a team.

## Software Atelier 5: Field Project

| Instructor: | Michele Lanza | ECTS: | 9 |
|---|---|---|---|
| Type: | Atelier | Semester: | 5th |

The Field Project Atelier consists of an internship either within a company or within a research group of the faculty. The goal is for the students to obtain hands-on experience with real world problems. The field project atelier can be done individually or as a group, depending on the given context.





## Systems Programming

| Instructor: | Antonio Carzaniga | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | 4th |

A "system" integrates functionalities and devices at different levels. Examples are information systems consisting of databases and processing modules, a distributed storage system consisting of networked redundant storage devices, an operating system that manages heterogeneous computing resources, and a robotic system made of physical devices, embedded sensors and controllers, as well as complex processing modules. The most common system programming language is C. This course is a practice-oriented introduction to programming in C. The focus is on features of the language and libraries that are particularly useful in programming systems. This includes the memory model, input/output, the network programming interface and other system calls, the organization of a large system programs, including the relevant language features and the build process, symbols and their relations to compilation units and the linker, and an introduction to symbolic debugging.

## Technical English

| | | | |
|---|---|---|---|
| **Instructor:** | **Jim Kauffman** | ECTS: | 3 |
| Type: | Lecture | Semester: | 1st |

This course focuses on improving the four language skills: listening, reading, writing and speaking. In addition, emphasis is given to understanding and using different grammatical structures, as well as expanding and applying vocabulary. Course content includes a variety of technical areas, for example technology, planning, projects, design and careers. Information is provided on how to obtain international language qualifications through either the Cambridge English Language Assessment exams (for example, the First Certificate Exam) or the International English Language Testing System (IELTS). If participants are interested in pursuing these qualifications, some preparation and practice for the exams will be included in the course.

## Theory of Computation

| | | | |
|---|---|---|---|
| **Instructor:** | **Natasha Sharygina** | ECTS: | 6 |
| Type: | Lecture | Semester: | 6th |

The class introduces the fundamental mathematical properties of computer hardware, software, and certain applications thereof. It explores what can and cannot be solved on a computer, how quickly, with how much memory, and on which type of computational model. The class is divided into two major parts: computability theory and complexity theory. Computability theory deals primarily with the question of whether a problem is solvable at all on a computer. Complexity theory considers how efficiently the problem can be solved. Two major aspects are considered: time complexity and space complexity, which respectively address a problem of how many steps does it take to perform a computation, and how much memory is required to perform that computation. The subjects have strong connections with engineering practice. Practical exercises will involve experimentation with various tools.

# Introduction

The Faculty of Informatics offers several Master of Science (MSc) programmes, which culminate with a thesis of the student's choosing:

**Master of Science in Informatics.** The programme prepares students for current and evolving technologies in computer science by deepening their knowledge. Depending on their interest, they can select a broad range of topics and specialize in one of the seven research areas covered by our professors (Computer Systems, Geometric and Visual Computing, Information Systems, Intelligent Systems, Programming Languages, Software Engineering, and Theory and Algorithms). The Faculty proposes moreover the unique opportunity to spend a period of time as study abroad aimed at obtaining a double Master degree in collaboration with the Politecnico di Milano.

**Master of Science in Computational Science.** The Master in CS combines mathematical, informatical and applied courses building deep competences in applied mathematics and computational science with a strong background in informatics and in the development of scientific simulation software.

**Master of Science in Embedded Systems Design.** In view of the evolution of technology, the ever expanding application areas as well as the conditions of the European job market and of the world-wide educational offers, ALaRI is restructuring its educational programme. Consequently, the Master of Science in Embedded Systems Design and the executive Master of Advanced Studies in Embedded Systems Design will not be offered during the academic year 2015-2016, and a new Master of Science in Cyber-Physical and Embedded Systems Design is envisioned to start in the academic year 2016-2017.

**Master of Science in Management and Informatics.** Offered jointly with the Faculty of Economics, this Master is open to students with a Bachelor in Informatics or related disciplines, as well as students with a Bachelor in Economics or related disciplines, and provides necessary tools and skills for understanding complex information technology problems while knowing about the needs and requirements of a modern organization.

All Master programs offer the opportunity for specialization both in terms of professional training and of academic research. The Faculty also offers a very popular PhD program addressed to Master students who want to pursue their study in academic or industrial research.

**Mobility**
A student can take part in a mobility or student exchange program and undertake a study semester in another university for a maximum of 30 ECTS. In this case, the student must discuss the choice of host institution and study plan with the Master director to obtain approval.

For all information about mobility please consults the International Relations and Study-abroad Office webpage http://www.relint.usi.ch/en/index.htm.





# Master of Science in Informatics

## Introduction

**Goals**
The Master of Science in Informatics prepares students for current and emerging technologies in computer science by deepening their theoretical knowledge and sharpening their practical skills. The programme is designed for both Bachelor students who wish to complete their education and professionals seeking to refresh their knowledge and sharpen their skills. The Master combines the study of fundamental aspects of computer science with a practical hands-on approach, preparing professionals for successfully pursuing a career in research and development across any application domain.

**Contents**
The Master of Science in Informatics is characterized by a broad offering of topics and subjects that can be freely combined in a learning path tailored to the needs and interests of each student. At USI, students learn how to understand, design, simulate, and optimize complex software-intensive systems. They master the ability to develop automated solutions, introduce them in different business and application domains, and predict and assess their positive impact in the real-world. Students experience the need for a rigorous approach to guarantee the quality of their work while following the most appropriate software engineering methodologies, techniques and state-of-the-art tools. Students can benefit from the research excellence of our teaching staff by getting involved in ongoing research activities as part of their master thesis project (which can be carried out across the entire second year of the Master).We offer the unique opportunity to obtain a double Master's degree in collaboration with Politecnico di Milano.

**Career Prospects**
Informatics is both the infrastructure and the engine of today's society. In Switzerland, it plays a key role in industry (pharma, manufacturing of machinery, chemistry, etc.) as well as in the service sector (banking, insurance, trade, transport, administration, etc.). The national education and research institutions have acquired a considerable reputation worldwide, in particular in the field of Information Technology. Many IT companies, some of them world leaders, have or are planning to have research and development centres in Switzerland. Considering this, graduates in Informatics have excellent opportunities on the

job market. The demand for well-educated specialists in Informatics is very high and is expected to grow even more. Graduates of the Master of Science in Informatics are prepared to become, for example, a business-savvy software designer for the highly competitive software industry of the 21st century, a system engineer with the skills to design, implement, and maintain reliable, secure, and large distributed systems, or be trained to solve complex problems in interdisciplinary areas like graphics and special effects, intelligent search engines, computer vision and face recognition, or robotics.





# Study plan

The study programme consists of four semesters full-time study (120 ECTS). Up to 90 ECTS of credit can be obtained by following courses offered in the Fall and Spring semesters. As soon as students have obtained 60 ECTS, they can begin their master thesis (30 ECTS). To broaden the student's perspective, up to 12 ECTS can be obtained with elective courses chosen from any other Master programme offered by the Faculty of Informatics, while up to 6 ECTS can be obtained by following any Master course offered at USI.

**Fall Semester's courses**

| Course | ECTS | Professors |
|---|---|---|
| Advanced Compilers | 6 | Robert Soulé |
| Advanced Programming & Design | 6 | Walter Binder |
| Algorithms & Complexity | 6 | Evanthia Papadopoulou |
| Distributed Algorithms | 6 | Fernando Pedone |
| Distributed Systems | 6 | Fernando Pedone |
| Human-Computer Interaction Design | 6 | Monica Landoni |
| Intelligent Systems | 6 | Jürgen Schmidhuber |
| Numerical Algorithms | 3 | Kai Hormann |
| Software Engineering | 6 | Carlo Ghezzi, Andrea Mocci |
| Software Quality | 6 | Mauro Pezzè |
| Software Quality Lab | 3 | Mauro Pezzè |
| Master Thesis | 15 | Faculty |

**Spring Semester's courses**

| Course | ECTS | Professors |
|---|---|---|
| Advanced Computer Architectures | 6 | Laura Pozzi |
| Business Process Modeling, Management and Mining | 3 | Cesare Pautasso |
| Computer Aided Verification | 6 | Natasha Sharygina |
| Computer Vision & Pattern Recognition | 6 | Michael Bronstein |
| Data Analytics | 6 | Fabio Crestani |
| Geometric Algorithms | 6 | Evanthia Papadopoulou |
| Geometry Processing | 6 | Kai Hormann |
| Information & Physics | 3 | Stefan Wolf |
| Information Security | 6 | Marc Langheinrich |
| Massively Parallel Programming | 3 | Nate Nystrom |
| Physical Computing | 6 | Marc Langheinrich |
| Quantum Computing | 6 | Stefan Wolf |
| Robotics | 6 | Gianni Di Caro |
| Software Architecture & Design | 6 | Cesare Pautasso |
| Master Thesis | 15 | Faculty |

For the general teaching timetable please refer to:
www.inf.usi.ch/orario_corsi.htm.

The Scientific Director of the Master of Science in Informatics is Prof. Cesare Pautasso.





**Course descriptions**

## Advanced Compilers

| **Instructor:** | **Robert Soulé** | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |

This course focuses on the design and implementation of compilers. Topics covered include the structure of one-pass and multiple-pass compilers; symbol table management; lexical analysis; traditional and automated parsing techniques; syntax-directed translation and semantic analysis; run-time storage management; intermediate code generation; introduction to optimization; and code generation. This course requires a substantial, semester-long programming project implementing a functional compiler that includes lexical and syntactic analyzers, a type checker, and a code generator.

## Advanced Computer Architectures

| **Instructor:** | **Laura Pozzi** | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |

The course builds on previous knowledge in basic computer architecture, and visits the major techniques devised to get higher performance from a single processor, and, later on, from multi-processors. It describes the concepts of pipelined CPUs, cache architecture and optimization, Instruction-Level parallelism (Superscalar and VLIW architectures), Thread-Level parallelism (fine-grained, coarse-grained, simultaneous multithreading), Data-level parallelism (Vector architectures), and shared-memory multi-processing. The course also includes a project where the Simplescalar and Cacti simulation tools are used to perform design-space exploration, and to understand the tradeoffs that computer architects must consider between performance and cost.





## Advanced Programming & Design

| **Instructor:** | **Walter Binder** | ECTS: | 3 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |

This course teaches concepts and methods of object-oriented and concurrent programming that help create complex software systems that are extensible and scalable. It covers principles of object-oriented programming and design, inclusion polymorphism, single and multiple dispatch, parametric polymorphism, design patterns, functional programming, concurrent programming, and aspect-oriented programming. These concepts are explained in the context of the Java programming language.

## Algorithms & Complexity

| **Instructor:** | **Evanthia Papadopoulou** | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |

Algorithms are fundamental to computer science. They are the essence of computer programs and they lie at the core of any software system. This course will cover fundamental techniques for designing efficient computer algorithms, proving their correctness, and analyzing their performance. The contents include greedy algorithms, divide and conquer algorithms, dynamic programming, network flow, NP completeness and computational intractability, approximation algorithms, and randomized algorithms. Techniques on algorithm design and analyisis will be developed by drawing on problems from across many areas of computer science and related fields.

## Business Process Modeling, Management and Mining

| Instructor: | Cesare Pautasso | ECTS: | 3 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |

Business Process Management combines knowledge from information technology and management sciences and applies it to the automation, analysis, monitoring and improvement of operational business processes within large and small organizations. Without well-designed and well-defined process models, to be reliably and efficiently executed, organizations are unable to compete and will not survive in modern globalized marketplaces. This lecture will introduce the students with notations and methodologies for modeling business processes and support their execution within process-oriented information systems. To do so, students will become familiar with modern technologies for automated workflow management and process mining.

## Computer Aided Verification

| Instructor: | Natasha Sharygina | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |

This course covers fundamental algorithms and modeling techniques for formal verification of computer systems. In particular, it covers topics such as model checking, satisfiability (SAT) solving and satisfiability modulo theories (SMT). These techniques have become essential tools for the design and analysis of both hardware designs and software systems. These methods allow the designer exhaustively check if a system satisfies its specification, or to systematically seek for cases where it fails to do so. The emphasis is on the underlying logical and automata-theoretic concepts, the algorithmic solutions, and heuristics to cope with the high computational complexity. Students will experiment with checking the system correctness by writing formal proofs manually and by applying fully automated verification tools.





## Computer Vision & Pattern Recognition

| Instructor: | Michael Bronstein | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |

The purpose of the course is to introduce basic problems and notions in image processing, computer vision, and patter recognition though a common geometric framework and present some classical, industry-standard and state-of-the-art methods through this framework. The course uses tools from differential geometry, calculus of variations, and numerical optimization to address problems such as image recovery (denoising, impainting, deconvolution), filtering (adaptive diffusion, bilateral and non-local means filters), 3D structure reconstruction (shape from shading, stereo, photometric stereo); and rigid and non-rigid similarity and correspondence (iterative closest point methods, multidimensional scaling, Gromov-Hausdorff distance). The emphasis is made on both formulating a rigorous mathematical model of the problem and developing an efficient numerical method for its solution, with hands-on programming exercises that solve real-world problems.

## Data Analytics

| Instructor: | Fabio Crestani | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |

This is an applied statistics course focusing on data analysis. The course begins with an overview of how to organise, perform, and write-up data analyses. The course starts with a theoretical part on the how to mine very large datasets to get valuable data to analyse. Then it covers some of the most popular and widely used statistical methods to analyse the data, like linear regression, principal components analysis, cross-validation, and p-values. Instead of focusing on mathematical details, the lectures are designed to help you apply these techniques to real data using the R statistical programming language, interpret and visualise the results, and diagnose potential problems in your analysis.

## Distributed Algorithms

| Instructor: | Fernando Pedone | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |

Distributed computing systems arise in a wide range of modern applications. This course surveys the foundations of many distributed computing systems, namely, the distributed algorithms that lie at their core. The course provides the basis for designing distributed algorithms and formally reasoning about their correctness. It addresses issues related to what distributed systems can and cannot do (i.e., impossibility results) in certain system models. The course focuses on three aspects of distributed computing: system models, fundamental problems in distributed computing, and application of distributed algorithms. System models include synchronous versus asynchronous systems, communication models, and failure models. Several fundamental problems are covered, including consensus, atomic broadcast, atomic multicast, atomic commit, and data consistency. Applications of distributed algorithms target various forms of replication techniques.

## Distributed Systems

| Instructor: | Fernando Pedone | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |

Distributed Systems are ubiquitous in modern computer systems. In general, any computing system composed of interconnected autonomous processors is a distributed system. Therefore, understanding how distributed systems are structured is paramount to master modern computer systems. This course is an introduction to distributed systems. It covers basic principles, architectures, and algorithms of distributed systems. The course surveys various aspects of distributed systems, including distributed systems architectures, networking and internetworking, distributed objects and remote invocation, security, distributed file systems, name services, consistency and replication, fault tolerance, and distributed transactions.





## Geometric Algorithms

| Instructor: | Evanthia Papadopoulou | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |

This course is an introduction to computational geometry and its applications. It covers techniques needed in designing and analyzing efficient algorithms for computational problems in discrete geometry such as convex hulls, triangulations, geometric intersections, Voronoi diagrams, Delaunay triangulations, arrangements of lines and hyperplanes, and range searching. Computational geometry is well related to diverse application domains, where geometric algorithms play a fundamental role, such as pattern recognition, image processing, computer graphics, robotics, geographic information systems (GIS), computer-aided design (CAD), information retrieval, computational science, and many others. The course covers general algorithmic techniques, such as plane sweep, divide and conquer, incremental construction, randomization, and approximation, through their application to basic geometric problems.

## Geometry Processing

| Instructor: | Kai Hormann | ECTS: | 6 |
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| Type: | Lecture | Semester: | Spring |

3D geometry is fundamental to many applications, including virtual characters for movies, interactive design of cars and air planes, and complex simulations. This course covers the whole 3D geometry processing pipeline from scanning real objects to printing them. In the first part we review methods for measuring points on the surface of an object and learn how to align the resulting point clouds. We then discuss how to convert this data into a triangle mesh and study different data structures for handling the latter. The second part explains the main processing tasks for 3D geometry, including smoothing, parameterization, remeshing, decimation, and compression of triangle meshes. In the last part, we talk about 3D printing. We not only cover the relevant theory, but also implement all techniques. For all programming tasks we provide a framework, so that you can concentrate on implementing the core methods and algorithms. The whole pipeline will come to life as you apply it to an object of your choice.

## Human-Computer Interaction Design

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|---|---|---|---|
| **Instructor:** | **Monica Landoni** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |

This class aims at familiarising students with both the theory behind the discipline of Human Computer Interaction (HCI) and the practical process of User eXperience (UX) design. Students not only develop an awareness and appreciation of the crucial implications of good interfaces in terms of overall system performance and user satisfaction, but also learn core skills needed in order to identify user requirements, envision interfaces and processes, and evaluate competing design options. Students will work in small teams of 3-5 to drive a design project from start to finish. Core skills are introduced in hands-on classes, interspersed with lectures and discussions about the underlying theory.

## Information & Physics

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|---|---|---|---|
| **Instructor:** | **Stefan Wolf** | ECTS: | 3 |
| Type: | Lecture | Semester: | Spring |

According to the physicist Rolf Landauer, "information is physical." Starting from this insight, we explore topics at the intersection of physics (thermodynamics, quantum theory, relativity) and information (cryptography, Shannon theory, correlations). Examples of subjects are the second law of thermodynamics, the arrow of time, the evolution of life and the second law; quantum non-local correlations, causality, the measurement problem and interpretations of quantum theory (collapse models vs. deterministic models such as many-worlds) and the possibility of experimental tests; the relevance of physics for logic, computation, and cryptography, quantum logic, reversible computing; randomness and the emergence of spacetime from information principles.
After an introductory part by the teacher, the course is carried out as a seminar, where each participant presents a research paper in a talk. No particular background knowledge is required.





## Information Security

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|---|---|---|---|
| **Instructor:** | **Marc Langheinrich** | ECTS: | 6 |
| Type: | Lecture | Semester: | Spring |

This class exposes students to the fundamental concepts of computer security and network security. The growing importance of networks and distributed systems, and their use to support safety-critical applications, has made computer and communication security a central issue for systems today. The class is built on three main parts: security foundations (which includes security terminology, core cryptograhic principles, and secure protocols); applied security (which discusses software security and web security); and privacy (which covers both technical and social aspects of privacy). Students learn to critically assess the security properties of a system and make informed decisions about implementing secure processes.

## Intelligent Systems

| | | | |
|---|---|---|---|
| **Instructor:** | **Jürgen Schmidhuber** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |

Introductory Master's Course to Intelligent Systems (IS) or Artificial Intelligence (AI), taught by award-winning experts of the Swiss AI Lab IDSIA, and USI. The focus is on Machine Learning (ML). According to Computer World (2009), expertise in ML is the top skill sought by IT employers. Today ML is everywhere: search engines use it to improve answers to queries, email programs use it to filter spam, banks use it to predict exchange rates and stock markets, doctors use it to recognize tumors, robots use it to localize themselves and obstacles, video games use it to enhance the player's experience, smartphones use it to recognize objects / faces / gestures / voices / music, etc. After the first few lectures of the basic IS course on ML, IS master students will already know how to train self-learning artificial neural networks to recognize images and handwriting better than any other known method. They will rapidly gain familiarity with state-of-the-art algorithms developed at IDSIA and other AI labs.

## Massively Parallel Programming

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|---|---|---|---|
| **Instructor:** | **Nate Nystrom** | ECTS: | 3 |
| Type: | Lecture | Semester: | Spring |

The ability to program parallel computers productively and efficiently is a critical skill in this era of concurrency. This course provides an introduction to modern parallel systems and their performance characteristics. It covers the fundamentals of parallel data structure design, analysis, and implementation; programming abstractions for concurrency; and techniques for reasoning about the behavior and performance of parallel programs. We study many parallel programs drawn from a variety of application domains and implement programs on a cluster using a modern parallel language, X10.

## Master Thesis

| | | | |
|---|---|---|---|
| **Instructor:** | **Faculty** | ECTS: | 15+15 |
| Type: | Thesis | Semester: | Fall / Spring |

The Master thesis is an academic piece of work, an original contribution to the body of knowledge in informatics. Such a contribution can be theoretical or experimental, but always builds on a solid research effort, and on the use of appropriate concepts, methods, and tools acquired during the Master. Faculty members advise students during their Master's thesis work.





## Numerical Algorithms

| | | | |
|---|---|---|---|
| **Instructor:** | **Kai Hormann** | ECTS: | 3 |
| Type: | Lecture | Semester: | Fall |

This course is about the key numerical algorithms that you should really want to know about. How do TrueType fonts work? What is the secret of Google's success? Why is JPEG compression so efficient? The answers to these questions are clever numerical algorithms, based on Bézier curves, eigenvalues, and the discrete cosine transformation, respectively. We will be able to understand and discuss them once we have gone through some preliminary basics, including Newton's method for finding roots, polynomial interpolation, direct and iterative methods for solving linear systems of equations, and Gaussian quadrature. This course refreshes your basic math skills in calculus and linear algebra and shows how to utilize them for solving several real-world problems, like the ones mentioned earlier. We also provide references to the history of these solutions, going back to Newton, Leibniz, Euler, Gauss and others.

## Physical Computing

| | | | |
|---|---|---|---|
| **Instructor:** | **Marc Langheinrich** | ECTS: | 6 |
| Type: | Lecture | Semester: | Spring |

Physical Computing is about integrating the real world with sensing, communication, and computation. It is about rapidly prototyping devices that can react and interact directly with their environment, rather than being accessed through a keyboard and monitor. The class introduces students to the idea of using small, programmable microcomputers to build self-contained, physical systems that help automate everyday tasks. The course exposes students to basic electronics, microcontroller programming (using the "Processing" language), short-range wireless networking (e.g., Bluetooth), mobile interfaces (smartphones), and embedded sensing. The class centers on Arduino development boards that allow one to rapidly build reactive and/or interactive everyday items, without the need for attaching a Mac or PC to them.

## Quantum Computing

| Instructor: | Stefan Wolf | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |

Followed by an introduction to the basic principles of quantum physics, such as superposition, interference, or entanglement, a variety of subjects are treated: Quantum algorithms, teleportation, quantum communication complexity and "pseudo-telepathy", quantum cryptography, as well as the main concepts of quantum information theory.

## Robotics

| Instructor: | Gianni Di Caro | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |

The course provides an introduction to the field of robotics. The following fundamental issues faced in the design and control of robotic systems will be studied:
- Kinematics and dynamics of locomotion;
- Proprio- and Exteroceptive sensing;State estimation;
- Localization and Mapping;
- Motion planning in mobile and arm robots;
- Navigation;
- Coordination and cooperation in multi-robots.

The course includes theory classes, hands-on classes, and homework. Students will apply the learned concepts through the programming of both simulated and real robots. Students who successfully complete the course will have:
- Acquired practice about robot modeling, programming, and control;
- Gained familiarity with issues and potentialities of robotic applications.





## Software Architecture & Design

| Instructor: | Cesare Pautasso | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |

Architecture is not only necessary as the global blueprint to manage the complexity of large software systems, but should also be seen as the focus of the main design decisions influencing the quality attributes (modularity, maintainability, extensibility, portability, interoperability, reuse, performance) of the resulting system. This class teaches the students to structure complex software systems using components and connectors while keeping track of the rationale behind their design decisions.
Contents: System Decomposition vs. Software Composition; Design Principles: Simplicity, Abstraction, Separation of Concerns, Encapsulation, Information Hiding; Architectural Styles, Patterns and Anti-Patterns: Avoiding Common Design Mistakes; API Design Techniques; 4+1 Architectural Views: Logical, Physical, Process, Development; Model-Driven Engineering; Architectural Decision Modeling

## Software Engineering

| Instructor: | Carlo Ghezzi | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |

Software engineering is the discipline of building software in a methodical way to ensure that the product satisfies its users' needs, is correct (or, more generally, dependable) and maintainable. The course teaches the students how to organize software development projects, how to analyze and specify software requirements, and how to verify software. The course will focus on the use of formal models and methods in software development.
1. Software lifecycle models. Project planning and management. Cost estimation. Standards. Maturity models.
2. Requirements elicitation and specification.
3. Notations and models for formal specification: state machines and Statecharts, Petri nets, declarative descriptions (Alloy).
4. Verification: testing, formal program verification, model checking

The course will be based on lectures and exercise sessions. The students will also be given assignments, which will be presented and discussed in class.

## Software Quality

| | | | |
|---|---|---|---|
| **Instructor:** | **Mauro Pezzè** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |

Avoiding Bugs in software systems by construction is impossible. This course is about methodologies, techniques and tools to check the quality of software systems, identify and remove bugs before software deployment to reduce the possibility of runtime failures. Students will see the many facets of the problem and will learn methodologies, approaches and techniques to check the quality of complex software systems. Students will see the different approaches to testing and analysis and will understand the interplay of testing and analysis within the software development process.

## Software Quality Lab

| | | | |
|---|---|---|---|
| **Instructor:** | **Mauro Pezzè** | ECTS: | 3 |
| Type: | Lab | Semester: | Fall |

Automation is an essential aspect of verification and validation. Many techniques and approaches to software testing and analysis require automation to be practically applicable. The course is about software quality in practice. Students will experience different techniques and tools, will experience the limitations of the different approaches and will understand the requirements of automation. They will become familiar with software verification and validation in practice.





# Master of Science in Computational Science

## Introduction

**Goals**
The Master in Computational Science (MCS) at USI offers the unique opportunity to acquire a focused and in-depth set of knowledge and skills in computer science, mathematics, and scientific computations. It is a unique programme in Switzerland aiming at building deep competences in computer science, mathematics and computational science with a strong connection to applications in natural sciences, life sciences, medicine, and engineering.

**Contents**
The Master in Computational Science (MCS) at USI offers thrilling new perspectives for understanding complex processes in almost all areas of our life – ranging from natural sciences over economy, finance, and social science to life sciences and medicine. Through numerical simulation and mathematical modeling, computational science made possible what was unthinkable only a few years ago: problems that were impossible to test in an experimental setting were made accessible by developing models that can be solved by increasingly powerful supercomputers. The master programme has a unique combination of courses from mathematics and computer science, and additional courses from various applications domains aiming at building deep application-oriented competences in computational science. It has a strong background both in computer science and mathematics and in the development of scientific simulation software. The successful student will acquire strong competences in abstract thinking within a methodology and application -oriented education, which will provide the ability to deal with complex models in various applications areas.
The students' individual choice of elective courses enables them to tailor the focus of their interdisciplinary personal programme - either method-oriented, or computer science-specific. As a result, the programme not only prepares students for current and evolving technologies in computer sciences but will also strongly deepen their knowledge in mathematical and algorithmic methodologies. Along with the mentor, each student will individually set up a study plan for selecting the appropriate elective courses. The mentor will advise and accompany the student through her/his study.

**Career prospects**
The multidisciplinary programme offers a streamlined blend of cutting-edge scientific research and practical application, thus providing an excellent foundation for a corporate, industrial, or academic career. Our students receive a firm grounding in programming, mathematical modeling and numerical simulation. The Master in Computational Science opens the doors to industry in software engineering, environmental engineering, financial services, and chemical and pharmaceutical R&D. It is also a strong asset for a PhD in computational science.

## Study plan

The MCS consists of four semester's full-time study (120 ECTS). It offers courses in numerical mathematics and computer science, together with a wide range of more application-oriented courses. It finishes with a substantial half-year project master's thesis, worth 30 ECTS which can be done in an industrial environment or in a research group. A few selected courses will be taught in block courses by professors from other top-level universities or research centres (e.g., Stanford, ETH Zurich, University of Erlangen, and University of Texas at Austin, CSCS, or ORNL).

***First semester***

| Course | ECTS | Professors |
|---|---|---|
| Deterministic Methods | 6 | Illia Horenko |
| High Performance Computing | 6 | Olaf Schenk |
| Introduction to Partial Differential Equations | 6 | Rolf Krause |
| PDE Software Lab | 3 | Rolf Krause, Drosos Kourounis |
| Numerical Methods for ODEs | 3 | Rolf Krause |
| Numerical Algorithms | 3 | Kai Hormann |
| Software Engineering for Computational Sciences | 3 | Patrick David Sanan |
| **Total ECTS** | **30** | |





***Second semester***

| Course | ECTS | Professors |
|---|---|---|
| Advanced Computer Architectures | 6 | Laura Pozzi |
| Linear and Nonlinear Multiscale Solution Methods | 6 | Rolf Krause |
| Large-Scale Optimization | 3 | Michael Saunders |
| Node-Level Performance Engineering | 3 | Georg Hager, Gerhard Wellein |
| Software Atelier: Supercomputing and Simulations | 6 | Olaf Schenk |
| Stochastic Methods | 6 | Illia Horenko |
| **Total ECTS** | | **30** |

***Third semester***

| Course | ECTS | Professors |
|---|---|---|
| Advanced Discretization Methods | 6 | Igor Pivkin |
| Computational Biology and Drug Design | 6 | Vittorio Limongelli |
| Econometrics | 3 | Patrick Gagliardini |
| Molecular Dynamics and Monte Carlo Methods | 3 | Michele Parrinello, Omar Valsson |
| Project Computational Medicine | 3 | Mark Potse |
| Scientific Visualization | 3 | not offered a.y. 2015-2016 |
| Preparation Master's Thesis | 6 | |
| **Total ECTS** | **30** | |

***Fourth semester***

| Course | ECTS | Professors |
|---|---|---|
| Large-Scale Optimization* | 3 | Michael Saunders |
| Mechanics and thermodynamics** | 6 | Alberto Montina |
| Node-Level Performance Engineering* | 3 | Georg Hager, Gerhard Wellein |
| Master Thesis | 24 | Faculty |
| **Total ECTS credits** | **120** | |

* if not already chosen in the second semester
** elective

Please be aware that slight changes in the study programme may occur.

For the general teaching timetable please refer to:
www.inf.usi.ch/orario_corsi.htm.

The Scientific Director of the Master of Science in Computational Science is Prof. Olaf Schenk.





## Course Descriptions

## Advanced Computer Architectures

| | | | |
|---|---|---|---|
| **Instructor:** | **Laura Pozzi** | ECTS: | 6 |
| Type: | Lecture | Semester: | Spring |

The course description is available at page 80.

## Advanced Discretization Methods

| | | | |
|---|---|---|---|
| **Instructor:** | **Igor Pivkin** | ECTS: | 6 |
| Type: | Lecture | Semester: | 3rd |

The course examines the development and analysis of spectral methods for the solution of time-dependent partial differential equations. Topics include key elements of approximation and stability theory for Fourier and polynomial spectral methods, as well as temporal integration and numerical aspects.





## Computational Biology and Drug Design

| | | | |
|---|---|---|---|
| **Instructor:** | **Vittorio Limongelli** | ECTS: | 6 |
| Type: | Lecture | Semester: | 3rd |

The course provides knowledge to deal with calculations of biological interest. Principles of biology and chemistry are delivered together with a deep understanding of the methods used to compute chemico/physical properties of molecules such as organic and peptidic ligands, proteins and nucleic acids. Standard and advanced computational techniques are described in details and many applications are illustrated. Ligand/protein docking, virtual screening, homology modelling, molecular dynamics, free-energy calculations are some examples.
Great attention is dedicated to the application of these methods in drug design through rational approaches and more automated protocols.

## Deterministic Methods

| | | | |
|---|---|---|---|
| **Instructor:** | **Illia Horenko** | ECTS: | 6 |
| Type: | Lecture | Semester: | 1st |

The course is dedicated to the introduction of the basic concepts necessary for understanding and high performance implementation of deterministic computational algorithms in the area of scientific computing. Concepts, methods and algorithms are always first motivated by application examples from different areas (e.g., robotics/mechanics, data compression, insurance/banking). The recurrent theme of the course is built upon the concept, that those respective computational problems and algorithms can be described from the common optimisational perspective; also the necessary physics background is introduced. Relation is established to the concepts from partial differential equations that are introduced in the other courses of CS Master in the first semester.

## Econometrics

| Instructor: | Patrick Gagliardini | ECTS: | 3 |
|---|---|---|---|
| Type: | Lecture | Semester: | 3rd |

This course aims at introducing students to advanced mathematical methods for modeling and statistical inference in economic analysis. The course builds on the classical foundations of statistics (model specification, parameter estimation, hypothesis testing) and extends the framework to address questions which are of primary importance in econometric analysis, like: How can we estimate the parameters in an equilibrium model for demand and supply of a good? What can we learn from a statistical model which is only an approximation of reality? How can we estimate the parameters of a structural economic model with rational agents optimizing intertemporally their utility? The course is structured in three chapters: (1) Least squares methods (endogeneity, Instrumental Variables, Systems of Simultaneous Equations); (2) Nonlinear regression methods (M-estimators, Pseudo Maximum Likelihood theory); (3) The Generalized Method of Moments (rational expectations models, Euler conditions and orthogonality conditions).

## High-Performance Computing

| Instructor: | Olaf Schenk | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | 1st |

Are you interested in using Europe's faster supercomputers (and getting ECTS credit points for doing so)? Would you like to learn how to write programs for parallel supercomputers, such as a Cray or a cluster of Graphics Processing Units? The course is designed to teach students how to program parallel computers to efficiently solve challenging problems in science and engineering, where very fast computers are required either to perform complex simulations or to analyze enormous datasets. It covers basic principles, architectures, and algorithms of parallel systems. The course is structured in four parts: (i) foundations of parallel systems, (ii) basic parallel algorithm, (iii) parallel programming, and (iv) parallel applications.





## Introduction to Partial Differential Equations

| Instructor: | Rolf Krause | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | 1st |

Many phenomena occurring in real life applications (i.e. physics, finance, biology) are modeled by means of partial differential equations (PDEs) . These mathematical models are sets of differential equations, which describe the essential behavior of a natural or artificial system, in order to forecast and control its evolution The aim of the course is twofold. Firstly, we will give the students an overview on the construction of differential PDEs for basic physical applications. Then, focusing on the arising PDEs, their theoretical mathematical background will be discussed. As the understanding of PDEs is closely connected to understand their physical meaning and the qualitative and quantitative behavior of their solutions, the theoretical investigations will be accompanied by the introduction of numerical schemes, which will allow for the illustrative numerical investigation of PDEs. We will consider elliptic operators (Diffusion), parabolic (heat equation), and hyperbolic (fluid flow, advection).

## Large-Scale Optimization

| | | | |
|---|---|---|---|
| **Instructor:** | **Michael Saunders** | ECTS: | 3 |
| Type: | Lecture | Semester: | 2nd |

Computational science inevitably leads to systems of equations and functions to optimize subject to more equations. The course starts with iterative methods for solving sparse Ax=b and least-squares problems, using the Lanczos process for symmetric systems and the Golub-Kahan bidiagonalization for more general systems. The associated solvers are CG, MINRES, SYMMLQ, LSQR, and LSMR. All methods need minimal storage and are sure to converge. We then study the simplex and reduced-gradient methods for optimization subject to sparse linear constraints (and bounds on the variables), with the LUSOL package providing reliable basis factorization and updates. Interior methods handle bounds differently but still need sparse-matrix methods, as illustrated by PDCO. We then explore augmented Lagrangian methods and SQP methods for handling sparse linear and nonlinear constraints (LANCELOT, MINOS, SQOPT, SNOPT).





## Linear and Nonlinear Multiscale Solution Methods

| | | | |
|---|---|---|---|
| **Instructor:** | **Rolf Krause** | ECTS: | 6 |
| Type: | Lecture | Semester: | 2nd |

In this course, we present the state of the art for linear as well as nonlinear multilevel and multigrid methods. The solution of large linear and nonlinear systems of equations is one of the most important tasks in numerical simulation. Since standard solution methods do not scale optimally , alternative solution strategies have been developed during the last decades. In particular multilevel or multiscale solution strategies have been developed, which are often employed due to their high efficiency. Prominent examples are multilevel or domain decomposition methods for linear elliptic problems, In this course, we start from well known subspace correction methods for linear problems and proceed to more recent developments as are nonlinear multigrid and monotone multigrid. Finally, we will consider (recursive) trust-region methods and their application to minimization problems in computational mechanics. For all methods, we will also discuss their parallelisation.

## Master Thesis

| | | | |
|---|---|---|---|
| **Instructor:** | **Faculty** | ECTS: | 6+24 |
| Type: | Thesis | Semester: | 3rd/4th |

The Master thesis is an academic piece of work, an original contribution to the body of knowledge in applied mathematics and computational science. Such a contribution can be theoretical or experimental, but always builds on a solid research effort, and on the use of appropriate concepts, methods, and tools acquired during the Master. Faculty members advise students during their Master's thesis work.

## Mechanics and thermodynamics

| | | | |
|---|---|---|---|
| **Instructor:** | **Alberto Montina** | ECTS: | 6 |
| Type: | Lecture | Semester: | 3rd |

The course description is available at page 152.

## Molecular Dynamics and Monte Carlo Methods

| | | | |
|---|---|---|---|
| **Instructor:** | **Michele Parinello and Omar Valsson** | ECTS: | 3 |
| Type: | Lecture | Semester: | 3rd |

This course builds up on a previous course into the basics principle of molecular dynamics (Molecular Dynamics, SP 2015). Here we will focus on various advanced techniques in molecular simulations. Some of the subjects covered include Monte Carlo sampling and constant pressure molecular dynamics. We will also discuss the challenges of obtaining proper sampling in molecular simulations and how such challenges can be tackled by employing enhanced sampling algorithms like parallel-tempering and metadynamics. If time permits will we also discuss how to go beyond a classical description of physical system by employing ab initio (i.e. first principle) molecular dynamics.

The techniques and algorithms presented will be motived by considering real-life applications of molecular simulations in various fields of physics and chemistry. Small projects and hands-on examples will be carried out during the course using open source software packages.





## Node-Level Performance Engineering

| | | | |
|---|---|---|---|
| **Instructor:** | **Gerhard Wellein and Georg Hager** | ECTS: | 3 |
| Type: | Lecture | Semester: | 2nd |

Even in scientific computing, code development often lacks a basic understanding of performance bottlenecks and relevant optimization opportunities. Textbook code transformations are applied blindly without a clear goal in mind. This course teaches a structured model-based performance engineering approach on the compute node level. It aims at a deep understanding of how code performance comes about, which hardware bottlenecks apply and how to work around them. The pivotal ingredient of this process is a model which links software requirements with hardware capabilities. Such models are often simple enough to be done with pencil and paper (such as the well-known Roofline model), but they lead to deep insights and strikingly accurate runtime predictions. The lecture starts with simple benchmark kernels and advances to various algorithms from computational science.

## Numerical Algorithms

| | | | |
|---|---|---|---|
| **Instructor:** | **Kai Hormann** | ECTS: | 3 |
| Type: | Lecture | Semester: | 1st |

The course description is available at page 89.

## Numerical Methods for ODEs

| | | | |
|---|---|---|---|
| **Instructor:** | **Rolf Krause** | ECTS: | 3 |
| Type: | Lecture | Semester: | 1st |

Ordinary differential equations (ODEs) and initial value problems (IVP) are ubiquitous in almost all applications arising in computational science. The course will start out with some basic concepts from ODE theory and then continue with the discussion of different explicit and implicit one-step. Performance of different methods for different types of problems will be investigated numerically and the observed behaviour will be explained by mathematical analysis. This will lead to important theoretical concepts like consistency, stability and convergence. In applications, one often wants to employ procedures that automatically refine time-steps in regions where the error is large: Approaches to adaptive step-size control will be discussed and tested. Because IVPs often stem from the semi-discretization of PDEs, in the final part of the course some examples will be analyzed of how spatial and temporal discretization can interact, particularly in problems with wave-like solutions.





## PDE Software Lab

| | | | |
|---|---|---|---|
| **Instructor:** | **Rolf Krause and Drosos Kourounis** | ECTS: | 3 |
| Type: | Lab | Semester: | 1st |

The course "Introduction to Partial Differential Equations" is accompanied by the "Partial Differential Equations Software Lab", which treats the implementation of the underlying numerical methods designed for the solution of partial differential equations (PDEs). The students will learn how to design object-oriented code, implementing all the individual components (mesh, sparse linear algebra, linear solvers, discretization schemes) needed for the discretization and efficient solution of the underlying PDEs.

## Project Computational Medicine

| | | | |
|---|---|---|---|
| **Instructor:** | **Mark Potse** | ECTS: | 3 |
| Type: | Project | Semester: | 3rd |

Numerical simulation plays an important role in the development of biological and medical knowledge as well as in the analysis of medical images and signals. An overview of research in these areas has been given in the second-semester course Computational Medicine.
This course follows up and consists of a research project that is carried out individually and supervised by a TA. A choice of projects will be offered within the research areas that have been treated in the Computational Medicine course. Students will prepare a final report and give a presentation of their work at the end of the semester.

## Software Atelier: Supercomputing and Simulations

| **Instructor:** | **Olaf Schenk** | ECTS: | 6 |
|---|---|---|---|
| Type: | Atelier | Semester: | 2nd |

The software atelier on supercomputing and simulations presents advanced topics in parallel computing and numerical simulation for prospective computational/software engineers. There will be several programming assignments to acquaint students with basic issues in memory locality and parallelism needed for high performance. Most of the grade will be based on a final project (in which students are encouraged to work in small interdisciplinary teams), which could involve parallelizing an interesting application, or developing or evaluating a novel parallel computing tool. Students are expected to have identified a likely project by mid semester, so that they can begin working on it. We will provide many suggestions of possible projects as the class proceeds.

## Software Engineering for Computational Science

| **Instructor:** | **Patrick David Sanan** | ECTS: | 3 |
|---|---|---|---|
| Type: | Lecture | Semester: | 1st |

Software Engineering for Computational Science introduces essential skills and tools required to write, maintain, and share software. The use of terminals, unix utilities, text editors, compilers, and debuggers is introduced. C++ is introduced and used for most examples and assignments. The proper use of version control and other best practices are introduced early and used throughout the course. Assignments center around the ongoing development of a small scientific application.





## Stochastic Methods

| **Instructor:** | **Illia Horenko** | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | 2nd |

Many of the real-life applications (e.g., in banking/insurance, mechanics, medicine, etc.) can be only approached, modelled and computed as stochastic (or random) processes. The aim of this course is to introduce the most essential mathematical concepts and computational methods from the area of stochastic and random processes. Besides of gaining the theoretical and practical background in the areas of stochastic calculus, random processes and uncertainty quantification, the participants will gain practical skills by doing supervised short research projects from real-life applications. The recurrent theme of the course is in establishing a joint stochastic/statistic perspective for various computational methods and algorithms from computational science, machine learning and informatics.

# Master of Science in Management and Informatics

## Introduction

**Goals and contents**
The Master of Science in Management & Informatics, offered jointly by the Faculty of Informatics and by the Faculty of Economics, has been designed to provide graduates from a wide variety of backgrounds (informatics, economics, mathematics, business, engineering, etc.) with the necessary tools and skills for understanding complex information technology (IT) problems while, at the same time, knowing about the needs and requirements of a modern organization. The shortage of professionals who can interface these two sides is apparent in many companies and leads to extra costs, development of less efficient systems, and general misunderstandings between the technical and organizational parts of a company. The purpose of the degree is to offer a solution to this problem, and to educate professionals who can take responsibility for the interface between these two sides of an organization.
This Master offers a balanced combination of courses that cover the necessary background in management as well as the fundamental aspects of current and evolving information technologies. Moreover, the programme provides students with a specialized knowledge in topics at the interface between management and informatics such as enterprise resource planning. Since English is the unique teaching language, graduates are well-prepared to work in international companies. Moreover, the interdisciplinary approach of this Master provides a general skill to work across traditional areas.

**Career prospects**
This unique cross-discipline programme combines USI's world-leading expertise both in Management and in Informatics and offers exciting career prospects that range from project management to consulting. The programme has been designed to provide graduates who come with a wide variety of backgrounds with the necessary tools and skills for understanding complex information technology (IT) problems while, at the same time, knowing about the needs and requirements of a modern organization.
On the one hand, graduates from this Master will have sufficient knowledge in informatics to be able to interact with the IT department of an organization. This includes a profound understanding of the technical issues involved, the evaluation of technical proposals, and the ability to articulate possible





solutions to the organization or customer. On the other hand, they also understand the tactical and strategic use of IT to enhance the efficiency of an organization and know how to explain the requirement of the users in terms that can be understood by the IT department or client.
The primary labour market for the graduates of the programme is found in medium to large companies as well as the public sector, both in Switzerland and abroad. Most companies struggle with integrating IT in the organization and there is a great need for people who can be the interface between the technical and organizational parts of a company. Potential job profiles range from project management to consulting and include areas such as evaluating the benefit and managing the introduction of a new technology into an organization, designing and implementing small and large scale IT systems, and consulting companies and customers regarding the requirements and the limitations of IT systems.

## Study plan

This full time programme stretches over two years. It allows students to personalize their study curricula according to their interests. The basic knowledge is acquired in the first two semesters. Students who obtained a Bachelor's degree in informatics or a related field (mathematics, engineering, physics, etc.) enter the programme in the Informatics track and follow a set of courses that provide them with a fundamental insight into the management disciplines. In contrast, the Management track is tailored for students with a background in economics or management and teaches the basic aspects of informatics. In addition, all students attend mandatory courses that cover the interface between management and informatics. The third and fourth semester are dedicated to specialized courses and electives that can be chosen according to the students' preference. Moreover, the students participate in a practical field project, which is done in groups for a real company, and conclude their studies by writing a substantial master's thesis.

*First semester*

| Course | ECTS | Professors |
|---|---|---|
| **Core courses (12 ECTS)** | | |
| Enterprise Resource Planning | 6 | Chiara Francalanci |
| Enterprise Resource Planning Lab | 3 | Cinzia Cappiello |
| Project Management | 3 | Paulo Gonçalves |
| **Informatics track (18 ECTS)** | | |
| Accounting | 6 | Stefano Calciolari |
| Corporate Strategy | 6 | Erik Larsen, Matteo Prato |
| Strategic Marketing | 6 | Ivan Snehota, Albert Caruana |
| **Management track (18 ECTS)** | | |
| Fundamentals of Informatics | 6 | Natasha Sharygina |
| Introduction to Programming | 6 | Walter Binder |
| Probability & Statistics | 6 | Illia Horenko |
| **Total ECTS** | **30** | |

*Second semester*

| Course | ECTS | Professors |
|---|---|---|
| **Core courses (12 ECTS)** | | |
| Business Intelligence and Application | 6 | Piero Fraternali, Davide Martinenghi |
| Business Process Modeling, Management and Mining | 3 | Cesare Pautasso |
| Operations Management | 3 | Paulo Gonçalves |
| **Informatics track (6 ECTS)** | | |
| Decision Making | 3 | Dirk Martignoni |
| Entrepreneurship: Theory and Practice | 3 | Gianluca Colombo |
| **Management track (6 ECTS)** | | |
| Databases | 6 | Fabio Crestani |





| **Elective courses (12 ECTS)** | | |
|---|---|---|
| Consumer Behavior (ECO) | 6 | Andreina Mandelli |
| Human Resources Management (ECO) | 3 | Luca Solari |
| Innovation (ECO) | 3 | Natasha Vijay Munshi |
| International Business (ECO) | 3 | Francesco Ciabuschi |
| Mergers and Acquisitions (ECO) | 3 | Gianluca Colombo, Carmine Garzia |
| Service Marketing (ECO) | 3 | Andreina Mandelli |
| Writing Business Plans (ECO) | 3 | Gianluca Colombo |
| Data Analytics (INF) | 6 | Fabio Crestani |
| Information Security (INF) | 6 | Marc Langheinrich |
| Software Architecture and Design (INF) | 6 | Cesare Pautasso |
| Physical Computing (INF) | 6 | Marc Langheinrich |
| Robotics (INF) | 6 | Gianni Di Caro |
| **Total ECTS** | **30** | |

*Third semester*

| Course | ECTS | Professors |
|---|---|---|
| **Core courses (6 ECTS)** | | |
| Six Sigma | 6 | Paolo Rossetti |
| **Capstone Work (12 ECTS)** | | |
| Field Project | 12 | Mauro Pezzè |
| **Elective courses (12 ECTS)** | | |
| Business Dynamics (ECO) | 3 | John Morecroft, Erik Larsen |
| Digital Marketing (ECO) | 3 | Reto Hofstetter |
| Global Market Strategies (ECO) | 3 | Pooya Tavakoly |
| Organizational Design & Change (ECO) | 3 | Alessandro Lomi, Francesca Pallotti |
| Organizations and Social Networks (ECO) | 3 | Alessando Lomi |
| Distributed Systems (INF) | 6 | Fernando Pedone |
| Human-Computer Interaction Design (INF) | 6 | Monica Landoni |
| Intelligent Systems (INF) | 6 | Jürgen Schmidhuber |
| Software Engineering (INF) | 6 | Carlo Ghezzi, Andrea Mocci |
| Software Quality (INF) | 6 | Mauro Pezzè |
| Software Quality Lab (INF) | 6 | Mauro Pezzè |
| **Total ECTS** | **30** | |

*Fourth semester*

| Course | ECTS | Professors |
|---|---|---|
| **Capstone Work (18 ECTS)** | | |
| Master Thesis | 18 | Faculty |
| **Elective courses (12 ECTS)** | | |
| Consumer Behavior* (ECO) | 6 | Andreina Mandelli |
| Human Resources Management* (ECO) | 3 | Luca Solari |
| Innovation* (ECO) | 3 | Natasha Vijay Munshi |
| International Business* (ECO) | 3 | Francesco Ciabuschi |
| Mergers and Acquisitions* (ECO) | 3 | Gianluca Colombo, Carmine Garzia |
| Service Marketing* (ECO) | 3 | Andreina Mandelli |
| Writing Business Plans* (ECO) | 3 | Gianluca Colombo |
| Data Analytics* (INF) | 6 | Fabio Crestani |
| Information Security* (INF) | 6 | Marc Langheinrich |
| Software Architecture and Design (INF) | 6 | Cesare Pautasso |
| Physical Computing* (INF) | 6 | Marc Langheinrich |
| Robotics* (INF) | 6 | Gianni Di Caro |
| **Total ECTS** | **30** | |
| **Total ECTS credits** | **120** | |

*if not already chosen in the second semester

Please be aware that slight changes in the study programme may occur.

For the general teaching timetable please refer to:
www.inf.usi.ch/orario_corsi.htm.

The Scientific Directors for this Master are Prof. Mauro Pezzè, USI-INF and Prof. Nikolaus Beck, USI-ECO.





## Course descriptions

## Accounting

| | | | |
|---|---|---|---|
| **Instructor:** | **Stefano Calciolari** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |
| Track: | Informatics | Offered by: | Faculty of Economics |

Future managers need a solid basis for using accounting information and performance measurement in their careers in manufacturing, marketing and sales, finance, communication, human resources, information systems or other areas of management.
This course thus aims to explore the role of accounting information, management accounting and performance measurement systems in supporting managers in their business decisions and in their day-to-day activities, to perform their duties effectively and to foster their companies' success. In fact, it is widely acknowledged that the survival of any firm depends on its capabilities to generate winning strategic ideas, to motivate its managers to implement strategies, and to create stakeholders´ trust. In these respects, accounting and performance measurement systems play a crucial role. On the one hand, financial statements and reporting systems serve to record and communicate actual performance to both managers and stakeholders in a way that fosters learning from experience, enables redirecting ineffective behaviours and supports the generation of stakeholders´ trust. On the other hand, through strategic planning, programming and budgeting, performance targets are set, coherently with strategic and organizational choices, and used to motivate and evaluate managers´ accountability.





## Business Dynamics

| | | | |
|---|---|---|---|
| **Instructor:** | **Erik Larsen, John Morecroft** | ECTS: | 3 |
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Economics |

Business Dynamics helps participants learn to use system dynamics tools and techniques so that they can begin to develop a dynamic view of strategy. Participants are taken through every phase from strategy development to implementation. Teaching will include methods ranging from traditional lectures to workshops and case studies. Frequent group work sessions will offer plenty of opportunities for learning from peers as well. By the end of the course, students will have a better understanding of the complexities of dynamic strategy and will be familiar with the best and latest tools for strategy design and implementation.
The course content covers feedback mapping, archetypes, and building and using simulation models. The emphasis will be on developing the skills to create simulation models of business situations to help managers make better decisions when faced with uncertainty. Material will be distributed when needed.

## Business Intelligence and Application

| | | | |
|---|---|---|---|
| **Instructor:** | **Piero Fraternali, Davide Martinenghi** | ECTS: | 6 |
| Type: | Lecture | Semester: | Spring |
| Track: | Core course | Offered by: | Faculty of Informatics |

The course develops a working knowledge of the principles, architectures, and tools for Enterprise Information Management and Business Intelligence. It addresses enterprise data integration and knowledge management, data mining and business intelligence. It gives an outlook on emerging data architectures, with focus on social network structures.

It also presents agile and model-driven enterprise application development, using OMGs Model Driven Architecture. The notion of model is illustrated, with different modeling languages (E-R and IFML).

Course outline:
Data management architectures. OLAP and OLTP. Data warehouse architecture and design. Data Mining: clustering, classification, association rules. Random networks, small-world networks, centrality measures. Enterprise Application Development. Model Driven Engineering, OMG's MDA. Entity-Relationship. Interaction Flow Modeling Language (IFML). Web/SOA application building with WebRatio.

The evaluation consists of a written exam and of a project assignment.





## Business Process Modeling, Management and Mining

| | | | |
|---|---|---|---|
| **Instructor:** | **Cesare Pautasso** | ECTS: | 3 |
| Type: | Lecture | Semester: | Spring |
| Track: | Core course | Offered by: | Faculty of Informatics |

The course description is available at page 82.

## Consumer Behavior

| | | | |
|---|---|---|---|
| **Instructor:** | **Andreina Mandelli** | ECTS: | 6 |
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Economics |

The starting point for this course is that consumers define themselves by what they buy, and, vice versa, they buy based on how they define themselves. We build on cognitive and social psychology to understand better the processes underlying this conundrum. We do this primarily to influence what consumers buy, so as to make informed decisions as marketers in a business (for profit) context. The emphasis is on linking deep theoretical insight with practical application, and as such the course provides both the tools and the context for exercising these tools.

## Corporate Strategy

| | | | |
|---|---|---|---|
| **Instructor:** | **Erik Larsen, Matteo Prato** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |
| Track: | Informatics | Offered by: | Faculty of Economics |

This course focuses on business strategy, examining issues central to long and short-term competitive position. We will explore a variety of conceptual frameworks and models to analyse and gain insight into how to achieve or sustain competitive advantage. This journey starts by analysing the impact of the internal context (resources and capabilities) on firm performance and subsequently analysing the external environment influence on a firm´s performance. After covering both the external and internal perspectives, we bring these concepts together to discuss firm level competitive advantage. This first part of the course focuses on single business or business unit strategy and will take up the first ten weeks. The final weeks explore corporate or multi-business strategy and international strategy.

Some of the central questions for the course are:
- How and why do firms differ?
- Why are some firms more successful than their competitors? Is this advantage sustainable or short-lived and why?
- What makes a particular industry attractive?
- What determines success in corporate diversification?
- What determines success or failure in international competition?

For each of the topics covered, you will get an overview of the current thinking and practice in the application of the concepts. By the end of the course you will be able to assess and successfully analyse ill-structured strategic problems by selecting and effectively applying the appropriate tools and frameworks. The class uses variety of teaching methods including lecturing, video, group work, games and presentations.





## Data Analytics

| | | | |
|---|---|---|---|
| **Instructor:** | **Fabio Crestani** | ECTS: | 6 |
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 83.

## Databases

| | | | |
|---|---|---|---|
| **Instructor:** | **Fabio Crestani** | ECTS: | 6 |
| Type: | Lecture | Semester: | Spring |
| Track: | Management | Offered by: | Faculty of Informatics |

The course covers all the classical topics related to databases, starting from the general concepts of information and data, to the specifics of a relational database management system, with SQL and QBE. It will also deal with the most general notions of database design, both from a theoretical and practical perspective. However, the course will take a more practical approach rather than a theoretical one, aimed at teaching the fundamentals of DBMS and data base design using a large set of examples and applications. In fact, a data base design project will be assigned to students in order to expose them to realistic database applications. No prerequisite knowledge of databases is required, but a basic understanding of data structures and algorithms is assumed. One of the main the themes of the course will be showing connections and relationships between databases and other informatics and economics topics, like business intelligence, statistics, data analytics and information retrieval.

## Decision Making

| Instructor: | Dirk Martignoni | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |
| Track: | Informatics | Offered by: | Faculty of Economics |

The course is a general introduction to modeling in the social sciences and to decision making. Main topics include individual decision making under risk and uncertainty, learning, and diffusion. The teaching method will be a mix of lectures and class exercises. The class requires a basic knowledge of mathematics.

## Digital Marketing

| Instructor: | Reto Hofstetter | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Economics |

This course is designed as an introduction to the rapidly evolving world of marketing in new media. It blends conceptual frameworks and theory with an applied perspective. The topics of the course include marketing strategies related to digital marketing, planning of digital marketing activities, monitoring of digital marketing activities and metrics, online advertising, consumer engagement and online communities, and basic social network insight and analytics. The objectives of this lecture will be met through lectures, text readings, practical exercises, and in-class discussions.





## Distributed Systems

| Instructor: | Fernando Pedone | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 84.

## Enterprise Resource Planning

| Instructor: | Chiara Francalanci | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |
| Track: | Core course | Offered by: | Faculty of Informatics |

The main objective of this course is to provide a functional map of Enterprise Resource Planning (ERP) systems, by distinguishing core and extended functionalities. The course explains how information systems have evolved over time and how ERPs represent the result of a continuous and still ongoing functional integration process. The course starts by reviewing the literature of the information perspective of organisational theory. This literature provides a framework to understand the organisational change caused by ERP projects. Then, the course discusses the core functional areas of ERP systems: accounting&finance, operations, and management&control. Extended ERP functional areas are also explained, including customer relationship management (CRM), supply chain management (SCM), Web Information systems (WIS), work force management systems (WFM), business intelligence (BI), social media, and mobile ERP applications. Numerous case studies are discussed in class.

## Enterprise Resource Planning Lab

| **Instructor:** | **Cinzia Cappiello** | ECTS: | 3 |
|---|---|---|---|
| Type: | Lab | Semester: | Fall |
| Track: | Core course | Offered by: | Faculty of Informatics |

The course will present a general methodology for designing and deploying ERP systems. The methodology will cover requirements analysis, sourcing strategies (including outsourcing, cloud and as-a-service solutions), technology-based cost estimation, software and suppliers' selection and management, and related change management issues, including opportunities and issues raised by Enterprise 2.0 developments. Case studies will be discussed in class with the goal of practicing the methodological guidelines provided during lectures.

The course will be based on lectures and exercise sessions.





## Entrepreneurship: Theory and Practice

| **Instructor:** | **Gianluca Colombo** | ECTS: | 3 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |
| Track: | Informatics | Offered by: | Faculty of Economics |

This course is addressed to students interested in exploring the challenges of entrepreneurship, both in SMEs and in larger organizations. The course will provide an insight into the entrepreneurial process and in particular:
– The challenges of getting into business;
– The challenges of booshing the business;
– The challenges of deciding whether to re-invest or exit;
– The challenges of keeping the entrepreneurial spirit in large organizations.

The course is based on lectures, class workshops, case discussions and guest speaker conferences.
The overall objective of this course is to make the students aware of the opportunities offered by an entrepreneurial career, but also of the requirements of such a career, in terms of personal preparation and process orientation.

## Field Project

| **Instructor:** | **Mauro Pezzè** | ECTS: | 12 |
|---|---|---|---|
| Type: | Project | Semester: | Fall |
| Track: | Capstone Work | Offered by: | Faculty of Informatics |

The field project is an important chance to learn some key aspects of company organizations and to acquire teamwork skills. It consists of a consultancy study conducted by a group of four to five students under the supervision of a tutor (typically a professor of the relevant master track). The study is a field activity conducted on the premises of a company (the "client"), i.e., the team will be based at the client's location and collaborate with the client. The tutor assists the team in managing contact with the client, developing the project, and preparing the final report. During the field project, students attend several "research laboratories" where they exchange information on their experience with other students and tutors in the program, and receive input on methods and presentation skills. The project is evaluated by the tutor based on the quality of the final report, the satisfaction of the client, and the results of the team.





## Fundamentals of Informatics

| **Instructor:** | **Natasha Sharygina** | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |
| Track: | Management | Offered by: | Faculty of Informatics |

The course gives an introduction into the main theoretical topics in Computer Science. The goal of the course is to acquire basic knowledge on the mathematical basis of Informatics, such as Logic and Discrete Mathematics, as well as of the important notions and concepts of Algorithmics, Computability, and Complexity theory.

Contents:
- Mathematical Basis
- Propositional Logic
- Discrete Mathematics
- Algorithmics
- Asymptotic Runtime Analysis
- Divide-and-Conquer
- Finite Automata
- Computability
- Turing-Machines and Church Thesis
- Undecidable Problems
- Complexity
- P, NP, NP-Complete

## Global Market Strategies

| | | | |
|---|---|---|---|
| **Instructor:** | **Pooya Tavakoly** | ECTS: | 3 |
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Economics |

The course is aimed at enhancing student's abilities to develop strategies for competing in the global business environment. During the course, students will develop the analytical skills necessary for a leadership role by cultivating the ability to make insightful recommendations about how businesses do and can compete globally.





## Human Resources Management

| | | | |
|---|---|---|---|
| **Instructor:** | **Luca Solari** | ECTS: | 3 |
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Economics |

People are the most critical economic asset of any successful organization, and this is especially true in service-intensive sectors such as tourism. Gaining a position of sustainable competitive advantage requires implementing effective systems for resourcing (getting people in the right places to do the right things), developing, and engaging human resources. Even though managers generally recognize the importance of managing human resources effectively, they often fail to do so. This course aims to provide students with the knowledge and analytical tools needed to design HR management systems that generate competitive value.
The course has three main learning objectives. The first is to understand the role of HR in strategy implementation, that is, we address the question of how managers can develop HR practices that produce the competencies and behaviors needed to implement a firm's strategic goals. The second objective is to examine the main HR levers through which such systems operate, e.g., recruiting, selection, training, performance appraisal, compensation and incentives. The third objective of the course it to provide a summary and integration, illustrating how firms have succeeded or failed at realizing the potential inherent in their human resources.
To integrate conceptual and applied material about HR, we will use a series of didactical case studies. Each case will provide an opportunity to apply the conceptual tools discussed in class to concrete, real-life situations and problems. To guide your analysis and case preparation, we will include a set of study questions for each case.

## Human-Computer Interaction Design

| | | | |
|---|---|---|---|
| **Instructor:** | **Monica Landoni** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 86.

## Information Security

| | | | |
|---|---|---|---|
| **Instructor:** | **Marc Langheinrich** | ECTS: | 6 |
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 87.





## Innovation

| | | | |
|---|---|---|---|
| **Instructor:** | **Natasha Vijay Munshi** | ECTS: | 3 |
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Economics |

Today´s world is one of rapid change -technological, social, economic and political. Organisations, large or small, must respond to these changes in order to survive. The most successful organisations, however, are those which exploit and even create change. This course will expose students to a mix of approaches and techniques that promote innovative thinking and entrepreneurial behavior in organisations. The course examines how patterns of change in technologies and industries create both opportunities and threats for existing firms and entrepreneurs. Theoretical models and actual examples emphasize how technological and organisational systems are key components of an ´entrepreneurial mindset´. Furthermore, the course focuses on tactics and strategies that encourage innovation and entrepreneurship within (and between) organisations. Cases and articles highlight critical success factors for both new and established firms, and also how inter-organisational activities shape markets and opportunities.

## Intelligent Systems

| | | | |
|---|---|---|---|
| **Instructor:** | **Jürgen Schmidhuber** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 87.

# International Business

| **Instructor:** | **Francesco Ciabuschi** | ECTS: | 3 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Economics |

This course aims to form students' knowledge in the area of International Business. Specifically students will develop capabilities to identify, frame and understand problems related to the management of international operations. Throughout the course issues are discussed in both theoretical and practical terms to stimulate students to relate models and concepts with practical situations.

By the end of the course the students will be able to:
- discuss implications of globalization and cultural differences
- understand the implications of operating across national borders
- compare different internationalization processes
- describe how firms operate in different markets
- analyze different international strategies and organizational structures
- evaluate and criticize different leadership and control models
- describe the specificity of different functions and units within the international firm
- understand the basis for the competitive advantage of international firms

Course relevance
Today firms are increasingly facing challenging tasks at international level: On one side the environment is increasingly globalized, following the disintegration of regional markets, the expansion of international trade and the internet, and on the other firms keep growing in their geographical and business scope fuelling competition. Therefore, the international manager is required to be flexible, to have a broad understanding of what is changing in the environment and within the firm, to develop always new abilities and to fit into new roles.

This course deals specifically with the following topics:
- Globalization & Regionalization
- Cultural differences
- Internationalization process
- Market entry decisions
- Organizational structures





- International strategies
- Control of foreign operations
- International HRM
- Transnational knowledge and innovation management
- Subsidiaries and HQs role

Throughout the course students will be encouraged to adopt different perspectives to nurture critical thinking and to form an overarching understanding of the phenomenon studied.

## Introduction to Programming

| | | | |
|---|---|---|---|
| **Instructor:** | **Walter Binder** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |
| Track: | Management | Offered by: | Faculty of Informatics |

This course – aimed at students without prior programming experience – gives an introduction to programming with the Java programming language. It explains fundamental approaches to algorithmic problem solving. Students learn about declarative problem specification and procedural problem solving. The course focuses on procedural programming, but introduces also the basic concepts of object-oriented programming. It covers the software development phases of problem specification, software design, programming, testing, and debugging.





## Master Thesis

| | | | |
|---|---|---|---|
| **Instructor:** | **Faculty** | ECTS: | 18 |
| Type: | Thesis | Semester: | Spring |
| Track: | Informatics and Management | Offered by: | Faculty of Informatics and Economics |

The master thesis is an individual project that aims to explore a specific aspect that requires both informatics and economics skills. It can be a conceptual investigation or an experimental work, and shall provide a solid contribution to the field. The master thesis is a unique opportunity to learn how to conduct a thorough investigation and improve individual research as well as presentation skills.
The thesis can be started in the third semester as soon as the student has acquired at least 60 ECTS and shall be conducted under the supervision of an advisor, typically a professor of the master program. Theses may also be conducted in collaboration with external institutions, in which case they may be co-advised by an external advisor.

## Mergers and Acquisitions

| | | | |
|---|---|---|---|
| **Instructor:** | **Gianluca Colombo, Carmine Garzia** | ECTS: | 3 |
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Economics |

The course in centered on the strategic management of M&A. The course will address the following issues.
– Strategic analysis to support M&A decisions and process.
– Structure and management of an M&A deal.
– Strategic challenges of post merger integration process.

The course is based on case discussion and in-class assignment.

## Operations Management

| | | | |
|---|---|---|---|
| **Instructor:** | **Paulo Gonçalves** | ECTS: | 3 |
| Type: | Lecture | Semester: | Spring |
| Track: | Core course | Offered by: | Faculty of Economics |

This course addresses the management of operations in manufacturing and service organizations. Our objective is to introduce students to concepts and techniques related to the design, planning, control, and improvement of manufacturing and service operations. Managing operations effectively requires both strategic and tactical skills and is one of the most critical aspects of an organization. Effective and efficient utilization of resources by an organization determines its success in the long run and operations management is a means to achieve this end. This is especially true today, when we see that significant competitive advantages accrue to firms that manage their operations effectively. The course covers topics in the areas of process analysis, inventory management, demand forecasting, capacity management, and supply chain management. While the primary objective of this course is to familiarize students with the basic concepts, techniques, methods, and applications of operations management, it will provide students with an understanding of operations and the role that they play within an organization.

## Organizational Design & Change

| | | | |
|---|---|---|---|
| **Instructor:** | **Alessandro Lomi, Francesca Pallotti** | ECTS: | 3 |
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Economics |

The course is aimed at introducing students to main topics in Organizational Theory, Organization Design, and Organizational Change. The class will be highly interactive, with case discussions, in-class debates, and organizational simulation games.





## Organizations and Social Networks

| | | | |
|---|---|---|---|
| **Instructor:** | **Alessandro Lomi** | ECTS: | 3 |
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Economics |

This course introduces the conceptual and practical tools that define the field of social network analysis. Some of the main analytical areas discussed include blockmodeling, multidimensional scaling, community detection, and statistical testing of network hypotheses. Substantive topics covered include how networks affect attitudes, preferences and behavior of people in organizations. By the end of the course, students acquire the basic skills needed to map out networks of social, economic and communication relations, diagnose features of networks that might help or hinder individual or team performance, and be able to recognize and describe the main features of network structure. Contemporary network research is unique in that its methodological tools derive directly from practical as well as theoretical concerns. For this reason, class time is allocated equally to methodological and substantive issues, with each substantive topic tied to specific analytical strategies. The course is based on a mix of lectures, workshops, hands-on computer exercises, and interactive examples of analysis of actual and simulated network data.

## Physical Computing

| | | | |
|---|---|---|---|
| **Instructor:** | **Marc Langheinrich** | ECTS: | 6 |
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 89.

## Probability and Statistics

| | | | |
|---|---|---|---|
| **Instructor:** | **Illia Horenko** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |
| Track: | Management | Offered by: | Faculty of Informatics |

The course description is available at page 64.





## Project Management

| | | | |
|---|---|---|---|
| **Instructor:** | **Paulo Gonçalves** | ECTS: | 3 |
| Type: | Lecture | Semester: | Fall |
| Track: | Core Course | Offered by: | Faculty of Informatics |

Why do so many projects fail? Why do so many others fail to produce lasting results? Why do so many projects suffer from cost and time overruns? How can firms identify and design high-leverage policies to improve project performance?
Due to high cost and time overruns of most projects, however, many organisations struggle to meet customer needs and market potential. Effective project management can provide managers with the appropriate methods and tools to improve their projects. In this course, we will cover three important aspects of project management:

- The theory, methods and quantitative tools used to effectively plan, organise, and control projects;
- Efficient management methods revealed through practice and research; and
- Hands-on, practical project management knowledge from optimisation and simulation exercises.
- Topics.
- Work Breakdown Structure (WBS)
- Critical Path Method (CPM)
- Linear and Integer Programming
- Design Structure Matrix (DSM)
- Critical Chain Method, Theory of Constraints (TOC)
- Program Evaluation and Review Technique (PERT)
- Earned Value Management (EVM)
- Project Risk Management
- System Dynamics, Causal Diagramming , Stock-and-Flow Mapping.

## Robotics

| Instructor: | Gianni Di Caro | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 90.

## Service Marketing

| Instructor: | Andreina Mandelli | ECTS: | 3 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Communications |

More than half of the GDP of developed economies originates in the service sectors. Furthermore, most businesses contain elements of service. The production process and the market relationships for services differ in several aspects from those for tangible goods. That poses some specific problems in marketing and management of services that will be exposed and discussed in this course.

The course revolves around three main themes:
– peculiarities of service processes;
– managing service quality and relationships;
– organisational aspects of marketing in service companies.

Students will be expected to actively participate in discussions of case studies as well as to carry out field work and present the results.





## Six Sigma

| Instructor: | Paolo Rossetti | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Fall |
| Track: | Core course | Offered by: | Faculty of Informatics |

Six Sigma is a methodology and a collection of a plenty of useful tools driven by understanding the customers needs and the disciplined use of facts, data, and statistical analysis to improve and reinvent organizational processes. We will learn goals and key principles for Lean Six Sigma business excellence and explore the Lean Six Sigma huge list of tools. The goal of this course is: to build your understanding of process improvement methods; to develop skills and some initial practice using the Six Sigma tools; to discuss and receive initial overview on how to use new skills and tools in your working life. After the initial overview we will dive into core concepts and principles that guide the planning and delivery of a Lean Six Sigma Project. Six Sigma has a very wide collection of tools that can be used in the different phases of a Lean Six Sigma project. We will review most of them according to the use made in the different phases: D (Define) M (Measure) A (Analyze) I (Improve) C (Control).

## Software Architecture & Design

| Instructor: | Cesare Pautasso | ECTS: | 6 |
|---|---|---|---|
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 91.

## Software Engineering

| | | | |
|---|---|---|---|
| **Instructor:** | **Carlo Ghezzi** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 91.

## Software Quality

| | | | |
|---|---|---|---|
| **Instructor:** | **Mauro Pezzè** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 92.

## Software Quality Lab

| | | | |
|---|---|---|---|
| **Instructor:** | **Mauro Pezzè** | ECTS: | 3 |
| Type: | Lab | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Informatics |

The course description is available at page 92.





## Strategic Marketing

| | | | |
|---|---|---|---|
| **Instructor:** | **Ivan Snehota, Albert Caruana** | ECTS: | 6 |
| Type: | Lecture | Semester: | Fall |
| Track: | Elective course | Offered by: | Faculty of Communications |

Strategic Marketing seeks to build a strategic framework of integrating business objectives, strategies, positioning and activities necessary for effective marketing implementation. The marketplace is in a constant state of change and it is critical that marketers understand the changes taking place and are able to develop marketing activities to pursue opportunities and minimize threats.

## Writing Business Plans

| | | | |
|---|---|---|---|
| **Instructor:** | **Gianluca Colombo** | ECTS: | 3 |
| Type: | Lecture | Semester: | Spring |
| Track: | Elective course | Offered by: | Faculty of Economics |

This course offers participants the opportunity to learn to develop and evaluate business plans. The course is built on the knowledge already acquired by a student of the Master in Management and it simulates an entrepreneurial experience. Students are required to develop business plans for two different start-ups: one for a manufacturing company and the other in a services company.

PhD programme

# PhD programme

## Introduction

The PhD programme of the Faculty of Informatics at the Università della Svizzera italiana promotes the development of professionals interested in academic or industrial research. A successful PhD student will gain a broad knowledge and understanding of the general field of informatics, as well as an in-depth specialisation in an area of interest.
Working with one or more members of the Faculty, who serve as the student's advisors, the student will learn the methods and practical skills to conduct research, and will contribute original, useful, and scientifically valid ideas in their chosen area of interest. PhD students are also encouraged to explore other areas and to interact and collaborate with other students and professors within the Faculty as well as in the broader research community.

At present the Faculty awards the following qualifications: PhD in Informatics and PhD in Computational Science.

Most students in the PhD programme are supported as assistants. The support covers tuition and provides a stipend. Responsibilities of assistants include both teaching and research duties. Generally students receive support as long as funds are available and the student is making adequate progress through the programme (as described in the regulations).

The PhD programme is governed by regulations adopted by the Faculty: www.inf.usi.ch/regolamenti_tutti.htm

In order to be admitted, the applicant must have completed a Masters degree in computer science, informatics, or a closely related field prior to joining the programme (but not necessarily prior to applying to the programme).

For more information regarding the admission to the programme:
www.inf.usi.ch/dottorato_regolamenti.htm

PhD programme Directors: Prof. Walter Binder, Prof. Michael Bronstein.
The PhD directors are available for meetings by appointment.
E-mail: phd.dir.inf@usi.ch

# Study plan

The Faculty of Informatics offers PhD courses to students pursuing a PhD at the Faculty. The course Introduction to Doctoral Studies is mandatory for first year PhD students.
Master courses may be cross-listed as PhD courses (for PhD students such courses may have a different value in ECTS from the one associated to the Master course).

### *Fall Semester's courses*

| Course | ECTS | Professors |
|---|---|---|
| Advanced Discretization Methods | 4 | Igor Pivkin |
| Computational Biology and Drug Design | 4 | Vittorio Limongelli |
| Deterministic Methods | 4 | Illia Horenko |
| High-Performance Computing | 4 | Olaf Schenk |
| Intelligent Systems | 4 | Jürgen Schmidhuber |
| Introduction to Doctoral Studies | 2 | Faculty |
| Introduction to Partial Differential Equations | 4 | Rolf Krause |
| Molecular Dynamics and Monte Carlo Methods | 2 | Michele Parrinello, Omar Valsson |
| Numerical Algorithms | 2 | Kai Hormann |
| Numerical Methods for ODEs | 2 | Rolf Krause |
| PDE Software Lab | 2 | Rolf Krause, Drosos Kourounis |
| Research Policy and Grant Proposal Writing | 3 | Benedetto Lepori |
| Software Engineering | 4 | Carlo Ghezzi, Andrea Mocci |
| Software Quality | 4 | Mauro Pezzè |
| Software Quality Lab | 2 | Mauro Pezzè |
| Topics in Computational Chemistry | 3 | Emanuel Karl Peter |





### *Spring Semester's courses*

| Course | ECTS | Professors |
|---|---|---|
| Business Process Modeling, Management and Mining | 4 | Cesare Pautasso |
| Computer Aided Verification | 4 | Natasha Sharygina |
| Computer Vision & Pattern Recognition | 4 | Michael Bronstein |
| Data Analytics | 4 | Fabio Crestani |
| Geometry Processing | 4 | Kai Hormann |
| Information & Physics | 2 | Stefan Wolf |
| Introduction to Computational Geometry | 4 | Evanthia Papadopoulou |
| Large-Scale Optimization | 2 | Michael Saunders |
| Linear and Nonlinear Multiscale Solution Methods | 4 | Rolf Krause |
| Mechanics and Thermodynamics | 4 | Alberto Montina |
| Node-Level Performance Engineering | 2 | Georg Hager, Gerhard Wellein |
| Physical Computing | 4 | Marc Langheinrich |
| Quantum Computing | 4 | Stefan Wolf |
| Robotics | 4 | Gianni Di Caro |
| Software Architecture & Design | 4 | Cesare Pautasso |
| Software Atelier: Supercomputing and Simulations | 4 | Olaf Schenk |
| Stochastic Methods | 4 | Illia Horenko |

## Course descriptions

## Introduction to Doctoral Studies

| **Instructor:** | **Faculty** | ECTS: | 2 |
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| Type: | Lecture | Semester: | Spring |

This course provides PhD students at the beginning of their doctoral studies with the necessary background. Specifically the course features an overview of the PhD program, and a number of lectures, seminars, and panels addressing a number of aspects pertaining to PhD-level research, such as:
– the nature of PhD research
– teaching assistance
– research ethics
– presentation strategies
– publication strategies

## Mechanics and thermodynamics

| **Instructor:** | **Alberto Montina** | ECTS: | 4 |
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| Type: | Lecture | Semester: | Spring |

This course presents the basic laws and concepts of classical mechanics. After an introduction of kinematics and the operational definitions of mass and force, we discuss the three laws of Newton and their consequences, such as conservation of momentum and energy in presence of conservative forces. Then, we deal with linear oscillations of coupled particles, central forces, constrained dynamics as well as rigid body dynamics. This will take us to the Lagrangian and Hamiltonian formalism. In the Hamiltonian formalism, we present Liouville's theorem, which has a fundamental role in statistical mechanics. After a presentation of continuum mechanics and fluidodynamics, which concludes the part on classical mechanics, we introduce the basic concepts of thermodynamics. The course requires a knownledge of mathematical analysis and linear algebra.





## Research Policy and Grant Proposal Writing

| **Instructor:** | **Benedetto Lepori** | ECTS: | 3 |
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| Type: | Lecture | Semester: | Fall |

This course will provide to PhD students information and competences concerning the overall framework of the Swiss research policy and research system, as well as on the interaction with funding agencies and procedures for project submission and proposal writing. These competences are increasingly becoming an essential part of researcher's training, helping her to interact with its policy and funding environment. More precisely, the course will deal with the following topics:
– the goals and organisation of the Swiss research policy and the structure of the Swiss research system.
– the features of the most important funding instruments available, including Swiss National Science Foundation, European Union, Swiss Innovation Agency.
– the procedures for project submission and how to write grant proposal taking into account the requirements and goals of each funding agency.

The courses is structured in six face-to-face lectures, presentations of relevant papers on the topic by individual PhD students and a practical work consisting in the analysis of a project proposal dealing with its structure, presentation and argumentation strategy.

## Topics in Computational Chemistry

| **Instructor:** | **Emanuel Karl Peter** | ECTS: | 3 |
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| Type: | Lecture | Semester: | Fall |

Computational chemistry as a part of theoretical physics spans from quantum-computations to simulations on the level of classical mechanics. Its applications range from the computation of properties of materials at extreme conditions, pharmaceutical modeling of drug molecules in medicinal chemistry to protein folding simulations. Additionally, the computation and prediction of properties of synthetic, medical and biological materials is of emerging interest in industry and research in general. This course will give a short overview over quantum physics, and then will go over to introduce the Hartree-Fock formalism. As a next step, modern quantum chemistry methods will be introduced, i.e. the density functional theory, the molecular orbital- and the valence bond formalism. Finally, recent publications from this wide field will be discussed with the students in relation to the different methods presented before.

For the other course descriptions please refer to pages 80-92 and 98-109.

# Faculty - Full professors

**Kai Hormann**
Kai Hormann is a full professor in the Faculty of Informatics at USI. He received a PhD in computer science from the University of Erlangen in 2002 and spent two years as a postdoctoral research fellow at Caltech in Pasadena and the CNR in Pisa, before joining Clausthal University of Technology as an assistant professor in 2004. During the winter term 2007/2008 he visited Freie Universität Berlin as a BMS substitute professor and came to Lugano as an associate professor in 2009. His research interests are focussed on the mathematical foundations of geometry processing algorithms and their applications in computer graphics and related fields. In particular, he is working on generalized barycentric coordinates, subdivision of curves and surfaces, barycentric rational interpolation, and dynamic geometry processing. Professor Hormann has published over 60 peer-reviewed papers and is an associate editor of Computer Aided Geometric Design, Computers & Graphics, and the Dolomites Research Notes on Approximation.

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**Antonio Carzaniga**
Antonio Carzaniga joined the Faculty of Informatics at USI when the Faculty was founded in 2004. From 2001 to 2007 he was also an assistant research professor in the Department of Computer Science at the University of Colorado at Boulder, USA. Antonio received the Laurea degree in electronics engineering and the Ph.D. degree in computer science from Politecnico di Milano, Italy. Antonio is a curious researcher. His primary research interests are in the areas of distributed systems and software engineering, specifically in content-based networking, information-centric networking, distributed publish/subscribe systems, middleware, software adaptability and automatic fault tolerance, and testing. He also conducted research in software configuration management and code mobility. Antonio is also a dedicated and passionate teacher. He has developed and taught a number of courses in the Faculty of Informatics at USI, including Algorithms and Data Structures and Computer Networking.

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**Fabio Crestani**
Fabio Crestani is a Full Professor at USI since 2007. Previously he was Professor (2000-06) at the University of Strathclyde (UK) and Assistant Professor (1992-97) at the University of Padua (Italy). In between he was Research Fellow at the University of Glasgow (UK), at the International Computer Science Institute in Berkeley (USA), and at the Rutherford Appleton Laboratory (UK). Recently he received a Chair of Excellence at the University Carlos III in Madrid (2011-12), a Visiting Scholarship at Yahoo! Labs (2014), and a Visiting Professorship at the UPMF in Grenoble (2015).
Fabio holds a degree in Statistics and Economics from the University of Padua (Italy) and a MSc and PhD in Computing Science from the University of Glasgow (UK). He leads the local Information Retrieval and Text Mining group (see http://www.ir.inf.unisi.ch/ for details).

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**Mehdi Jazayeri**
Mehdi Jazayeri is the founding dean of the Faculty of Informatics and professor of computer science at the University of Lugano, Switzerland. Before coming to Lugano, he held the chair of distributed systems at the Technical University of Vienna where he led the Distributed Systems Group. He spent many years in software research and development at several Silicon Valley companies, including ten years at Hewlett-Packard Laboratories in Palo Alto, California.
He is a coauthor of several books, including Programming Language Concepts, (John Wiley, 3rd edition, 1998), Fundamentals of Software Engineering, (Prentice-Hall, 2nd edition, 2002), and Software Architecture for Product Families (Addison-Wesley, 2000). He is a Fellow of the IEEE. He is a member of ACM, Swiss, German, and Austrian Computer Societies. He has received an Influential Educator Award from ACM (2012) and a Distinguished Educator Award from IEEE (2013).
He received his education at MIT (1971), and Case Western Reserve University (1973, 1975).

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**Rolf Krause**
Rolf Krause is chair of advanced scientific computing and the director of the institute of computational science in the Faculty of Informatics.
From 2003 to 2009, he was professor at the University of Bonn. During that time he spent a sabbatical at UC San Diego (USA) and Columbia University New York (USA). In 2002 he was on a Postdoctoral research visit at the Courant Institute (NYU, New York). He holds a Diploma and a PhD (2000) in Mathematics from the FU Berlin (Germany). His research focuses on numerical simulation and mathematical modeling in the life sciences, in particular medicine, and for engineering applications. A focal point of his work is the development and implementation of parallel simulation-methods, which show excellent performance also in real world applications. He is associate editor of the SIAM Journal on Scientific Computing (SISC).

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**Michele Lanza**
Michele Lanza is full professor at the Faculty of Informatics of the University of Lugano, Switzerland, which he co-founded in 2004. His doctoral dissertation, completed in 2003 at the University of Bern, received the Denert award for best thesis in software engineering of 2003. Prof. Lanza received the Credit Suisse Award for best teaching in 2007 and 2009.
At the University of Lugano Prof. Lanza leads the REVEAL research group, working in the areas of software visualization, evolution, and analytics. He authored more than enough articles and the book "Object-Oriented Metrics in Practice". Prof. Lanza is involved in a number of scientific communities, and has served on close to a 100 program committees.
He likes (software) visualization, universal design, and when it comes to programming he thinks it's nothing but Smalltalk.

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**Michele Parrinello**
Michele Parrinello is currently Professor at ETH Zurich, and the Università della Svizzera Italiana Lugano, Switzerland. He is known for his many technical innovations in the field of atomistic simulations and for a wealth of interdisciplinary applications ranging from materials science to chemistry and biology. For his work he has been awarded the 2011 Prix Benoist and many others prizes and honorary degrees. He is a member of numerous academies and learned societies, including the National Academy of Science, the British Royal Society and the Italian Accademia Nazionale dei Lincei. He is the author of more than 600 papers and his work is highly cited.

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**Fernando Pedone**
Fernando Pedone is a full professor in the Faculty of Informatics at the University of Lugano (USI), Switzerland, and has been also affiliated with Cornell University, EPFL, and Hewlett-Packard Laboratories (HP Labs). He received the Ph.D. degree from EPFL in 1999. His research interests include the theory and practice of distributed systems and distributed data management systems. Fernando Pedone has authored more than 100 scientific papers and 6 patents. He is co-editor of the book "Replication: theory and practice", Springer 2010.

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**Mauro Pezzè**
Mauro Pezzè is a professor of software engineering at the Faculty of Informatics of USI. Mauro Pezzè is serving as associate editor of IEEE Transactions on Software Engineering since 2013 and has served as associate editor of ACM Transactions on Software Engineering and Methodology from 2006 to 2012. He has been program co-chair of the International Conference on Software Engineering (ICSE 2012), general chair (2013) and program chair (2006) of the ACM SIGSOFT International Symposium on Software Testing and Analysis (ISSTA), program chair of the International Conference on Fundamental Approaches to Software Engineering (ETAPS-FASE 2003). Pezzè's research interests are in software engineering and in particular in the areas of software testing and analysis and self-healing and autonomic systems. He is the co-author of more than 100 papers appeared in the top journals and in the proceedings of the main conferences in software engineering and of a book on Software Testing and Analysis together with Michal Young.


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**Jürgen Schmidhuber**
Since age 15 or so, Prof. Jürgen Schmidhuber's main scientific ambition has been to build an optimal scientist through self-improving Artificial Intelligence, then retire. His AI team has won nine international competitions in machine learning and pattern recognition (more than any other AI research group worldwide) and six independent best paper/best video awards, achieved the world's first superhuman visual classification results, and established the field of mathematically rigorous universal AI and optimal universal problem solvers. His formal theory of creativity & curiosity & fun explains art, science, music, and humor. He generalized algorithmic information theory and the many-worlds theory of physics. Many famous leading companies are now using the machine learning techniques developed in his group at the Swiss AI Lab IDSIA (a Business Week Top 10 AI Lab) & USI & SUPSI. He published 333 peer-reviewed papers, and is recipient of the 2013 Helmholtz Award of the International Neural Networks Society.


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**Stefan Wolf**
Stefan Wolf has joined USI's Informatics Faculty in 2011. Born in Schaffhausen, Switzerland, he received a Dipl. Math. ETH, followed by a Ph.D. in Computer Science in the field of Informatiion-Theoretic Cryptography from ETH Zurich under the supervision of Professor Ueli Maurer. After a postdoc at McGill University, Montreal, he was Assistant Professor at University of Waterloo, Ontario, and Université de Montréal, Quebec. From 2005 to 2011, he was a Swiss National Science Foundation (SNF) Professor for Quantum Information at the Computer Science Department of ETH Zurich. His research domain lies in the fields of cryptography, information theory, quantum information processing; he is interested in both the engineering as well as the natural-philosophical aspects of the connection between physics and information.


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## Associate professors

**Walter Binder**
Walter Binder is an associate professor in the Faculty of Informatics, University of Lugano, Switzerland. He holds an MSc, a PhD, and a Venia Docendi from the Vienna University of Technology, Austria. Before joining the University of Lugano, he was post-doctoral researcher in the Artificial Intelligence Laboratory, École Polytechnique Fédérale de Lausanne, Switzerland. His main interests are in the areas of program analysis, virtual machines, parallel programming, and Cloud computing.

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**Michael Bronstein**
Michael Bronstein received the Ph.D. in computer science (2007) from the Technion in Israel. His main research interests are geometric methods in computer vision, pattern recognition, and computer graphics. Prof. Bronstein's research was featured in international news and recognized by several awards, including the prestigious ERC grant (2012). He has served on program committees of major conferences in his field and was keynote speaker in numerous international symposia. Prof. Bronstein is also actively involved in technology transfer and consulting. His start-up track record includes Novafora (2004-2009 as co-founder and VP of video technology) and Invision (2009-2012 as one of principle technologists). Since the acquisition of Invision by Intel in 2012, Michael has also served as a Research Scientist at Intel, where he was one of the key algorithm developers for the RealSense 3D sensor.

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**Matthias Hauswirth**
After an apprenticeship as an "Elektroniker" in Thun, Matthias Hauswirth received an "Informatik Ing. HTL" from Ingenieurschule Biel and later a Masters and a PhD from the University of Colorado at Boulder. During his studies he spent several summers as an intern at Microsoft Research and at the IBM T. J. Watson Research Center. Right after his graduation, in Fall 2005, he joined the Faculty of Informatics here at USI.
Matthias is interested in the area between programming languages, runtime systems, and software engineering, with a focus on the efficiency of software, its users, and its developers. He loves to help students learn, and he is interested in finding approaches to increase the efficiency and the effectiveness of teaching informatics.

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**Illia Horenko**
Illia Horenko is an associate professor in the Faculty of Informatics and the Institute of Computational Science of the University of Lugano. He received a Ph.D. in applied mathematics from the Free University (FU) of Berlin in 2004 and spent several years as a postdoctoral research fellow at the Biocomputing Group and Climate Research Group at the FU Berlin, before joining the faculty of mathematics and computer science of the FU Berlin as an assistant professor in 2008.
His research interests are focused on the development and practical implementation of data analysis algorithms and time series analysis approaches. Published applications of the methods developed by I. Horenko include problems from climate research, economics, biophysics, engineering and sociology. Prof. Horenko has published over 40 papers in the professional literature. He was a co-organizer of several big scientific programs and is a frequent reviewer for international funding agencies and the top journals in his field.

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**Marc Langheinrich**
Prof. Langheinrich received his PhD (Dr. sc. ETH) on the topic of "Privacy in Ubiquitous Computing" from the ETH Zurich, Switzerland, in 2005. He has published extensively on both privacy and usability of ubiquitous and pervasive computing systems, and is a regular program committee member of various conferences and workshops in the areas of pervasive computing, security and privacy, and usability. Marc is an Associate Editor in Chief of IEEE Pervasive Computing Magazine, an Area Editor on Elsevier's "Personal and Mobile Computing" Journal, and a Steering Committee member of the UbiComp and IoT conference series. In 1997, Marc spent a year as a Fulbright Scholar at the University of Washington, Seattle, where he also completed his thesis work in the fields of information retrieval and software agents. From 1997 to 1999 he lived in Tokyo, Japan, where he worked at NEC Research on projects involving personalization and electronic commerce. Prof. Langheinrich joined USI in 2008.

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**Evanthia Papadopoulou**
Evanthia Papadopoulou is an associate professor of computer science at the Università della Svizzera italiana. From 1996 to 2008 she was a research staff member at the IBM T.J. Watson research center, Yorktown Heights NY, USA. She had also been a Faculty member in the department of computer science at the Athens University of Economics and Business. She holds a BS degree in mathematics from University of Athens, an MS in computer science from University of Illinois at Chicago, and a Ph.D. in computer science from Northwestern University, USA, December 1995.
Her research interests include the design and analysis of discrete algorithms, computational geometry and its applications, software and implementation of geometric algorithms, data structures, and algorithmic aspects of VLSI computer-aided design. For her work on "Voronoi diagram based VLSI Critical Area Analysis", she received the IBM outstanding innovation award, August 2006, and a rating of Technical Accomplishment for IBM Research, December 2006.

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**Cesare Pautasso**
Cesare Pautasso is associate professor at the USI Faculty of Informatics. Previously he was a researcher at the IBM Zurich Research Lab and a senior researcher at ETH Zurich, where he earned his PhD in 2004. His research group is interested in interdisciplinary research around all aspects of the architecture, design and engineering of next-generation Web information systems, focusing on building experimental systems to explore the intersection of model-driven software composition techniques, business process modelling languages, and autonomic/Cloud computing. He is an active member of IEEE and ACM, where he has participated in more than 100 international conference/workshop program committees. He edits the IEEE Software Insights department. He was the general chair of the 9th European Conference on Web Services held in Lugano in 2011. He regularly referees for Swiss, EU and International funding agencies. Since 2010 he is an advisory board member of EnterpriseWeb. You can follow him on twitter @pautasso

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**Laura Pozzi**
Laura Pozzi joined the Faculty of Informatics at USI as Assistant Professor in 2005, and she is now an Associate Professor. Before landing at USI, Laura was a postdoctoral researcher in the Processor Architecture Laboratory of EPFL, a research engineer with STMicroelectronics in the Silicon Valley in California, and an Industrial Visitor at UC Berkeley. Laura holds a Master (1996) and a Ph.D. degree (2000) in Computer Engineering from Politecnico di Milano, Italy. Her research interests include embedded processor customization, compiler techniques for customizable processors, coarse-grain reconfigurable fabrics, and in general application-mapping onto unconventional architectures. Laura currently teaches three courses at USI: Privatissimum, Automata and Formal Languages in the Bachelor, Advanced Computer Architectures in the Master.

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**Olaf Schenk**
Olaf Schenk is a professor at the Institute of Computational Science within the Department of Informatics at the Universita della Svizzera italiana, Switzerland. He graduated in Applied Mathematics from Karlsruhe Institute of Technology (KIT), Germany, and earned his PhD in 2001 from the Department of Information Technology and Electrical Engineering of ETH Zurich and a venia legendi from the Department of Mathematics and Computer Science from the University of Basel in 2009. He conducts research in applied algorithms, computational science, and software tools for high-performance scientific computing. Olaf Schenk is a member of the Society for Industrial and Applied Mathematics (SIAM), the Association for Computing Machinery (ACM) and the Institute for Electrical and Electronic Engineers (IEEE). He is a recipient of an IBM faculty award (2008) and two leadership computing awards from the U.S. Department of Energy (2012, 2013). He serves on the editorial board of the SIAM Journal for Scientific Computing.

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**Natasha Sharygina**
Prof. Sharygina's research focuses on improving the program development process through formal methods of specification and verification. In particular, her interests lie in automated formal verification with a specific focus on software/hardware model checking, information security, static analysis, abstract interpretation and decision procedures. Prof. Sharygina received a Ph.D. degree from the University of Texas at Austin, USA in 2002. Her professional experience includes consulting at Bell Labs, Lucent Technologies Computing Sciences Research in 2000-2001 and a research faculty position at Carnegie Mellon University, SEI in 2002-2005. Prof. Sharygina directs the USI Formal Verification and Security group (www.verify.inf.usi.ch) whose work resulted in award-winning theoretical frameworks and practical tools to enable sound and scalable verification of industrial-size systems.

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## Assistant professors

**Vittorio Limongelli**
Professor Limongelli took his Master Degree in Chemistry and Pharmaceutical Technology at University of Napoli "Federico II" (Italy) in 2004 and took at the same university his PhD degree in 2007. During those years, his research was focused on standard computational methodologies (e. g. molecular docking, homology modeling) applied to the study of systems of biopharmaceutical interest. In 2007 he was visiting PhD first at University of Bologna (Italy) and then at ETH Zurich (Switzerland). Here he did his PostDoc working in the field of enhanced sampling simulations used to study rare events in biosystems with a special focus on molecular binding processes. In December 2010 he got a permanent position as Researcher at the University of Naples "Federico II" (Italy) and in 2014 he got the qualification to function as Associate Professor in Italian Universities. In 2015 he moved back to Switzerland as Senior Assistant Professor at USI Lugano (Switzerland). More information can be found on his website.

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**Nate Nystrom**
Nate Nystrom is an Assistant Professor in the Faculty of Informatics at the University of Lugano, Switzerland. His research interests include programming languages, compilers, tools, and methodologies for constructing safe, secure, and efficient systems. Prior to his current position, he was an Assistant Professor in the Department of Computer Science and Engineering at the University of Texas at Arlington and was a postdoctoral researcher at IBM T.J. Watson Research Center in Hawthorne, NY. Nystrom received his Ph.D. in Computer Science from Cornell University in 2007. He also holds B.S. and M.S. degrees in Computer Science from Purdue University and an M.S. in Computer Science from Cornell.

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**Igor Pivkin**
Igor Pivkin received his B.Sc. and M.Sc. degrees in Mathematics from Novosibirsk State University, Russia, M.Sc. degree in Computer Science and Ph.D. in Applied Mathematics from Brown University, USA. Before coming to Lugano, he was a Postdoctoral Associate in the Department of Materials Science and Engineering at Massachusetts Institute of Technology, USA. The research interests of Igor Pivkin lie in the area of multiscale/multiphysics modeling, corresponding numerical methods and parallel large-scale simulations of biological and physical systems. Specific areas include biophysics, cellular and molecular biomechanics, stochastic multiscale modeling, and coarse-grained molecular simulations.

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**Robert Soulé**
Robert Soulé is an assistant professor at the University of Lugano. His research interests are in distributed systems, networking, and applied programming languages. His recent work has focused on software-defined networks, data center modeling, and graph database query processing. He is the recipient of the Best Paper award at ACM DEBS 2012 and a Google Faculty Research Award 2015. Prior to joining the University of Lugano, he was a postdoctoral associate at Cornell University. He received his PhD from New York University in 2012, and his BA from Brown University in 1999. For two years, he was a research co-op in the Data Intensive Systems and Analytics Group at IBM T. J. Watson Research Center.

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# Adjunct professors

**Luca Maria Gambardella**
Luca Maria Gambardella is director of IDSIA, Dalle Molle Institute for Artificial Intelligence, a joint research institute between USI and SUPSI in Manno. He is Professor at SUPSI (Algorithms course) and Adjunct Professor at the Informatics Faculty at USI (Artificial Intelligence course). He is leading the Intelligent Systems Master Research Unit at SUPSI. His major research interests are in the area of optimization, swarm robotics and multi-agent learning, applied to academic and real-world problems. In particular, he has invented influential and frequently cited Ant Colony Optimization algorithms for combinatorial optimization problems. He is leading projects for the Swiss NSF, Swiss CTI, EU Commission and Industries. To date (June 2014) he has published more than 250 publications. According to Google scholar his h-index is 50 and his articles have received more than 25800 citations. He is president of the Swiss Operations Research Society and president of the Euro Excellence In Practice Award 2015.

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**Fabian Kuhn**
Fabian Kuhn is a full professor at the University of Freiburg, Germany and an adjunct professor at the USI Università della Svizzera italiana. He obtained his PhD from ETH Zurich in 2005. After the dissertation, Fabian Kuhn spent his postdoctoral years at Microsoft Research Silicon Valley, at ETH Zurich, and at MIT. In 2009, he joined the USI Università della Svizzera italiana in Switzerland as an assistant professor. Fabian Kuhn moved to Freiburg in spring 2012.

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**Carlo Ghezzi**
Carlo Ghezzi is an ACM Fellow, an IEEE Fellow, a member of the European Academy and of the Italian Academy of Sciences. He received the ACM SIGSOFT Distinguished Service Award. He is the current President of Informatics Europe.
He is a regular member of the program committee of flagship conferences in the software engineering field, such as the ICSE and ESEC/FSE, for which he also served as Program and General Chair.
He has been the Editor in Chief of the ACM Trans. on Software Engineering and Methodology and is currently an Associate Editor of the Communications of the ACM, IEEE Trans. on Software Engineering, Science of Computer Programming, Computing, and Service Oriented Computing and Applications.
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# Course Index

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