

BSc & MSc
Computational
Science and
Engineering (CSE)

Annual Report
2020/2021

BSc & MSc CSE

BSc & MSc Computational Science and Engineering

**Annual Report
2020 / 2021**

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ETH Zürich

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or may be downloaded from:

rw.ethz.ch/documents.html

CSE curricula at ETH Zürich on the internet:

rw.ethz.ch

Cover:

Mammal diversity (units of unique species per cell) simulated with Gen3sis / input parameters elevation and temperature

from the Bsc Thesis “Climate Effects on Biodiversity: Numerical Modelling” of the Bsc-CSE student Jonas Mensch, 2021.

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Teaching in BSc and MSc CSE 1

Teaching in Computational Science and Engineering

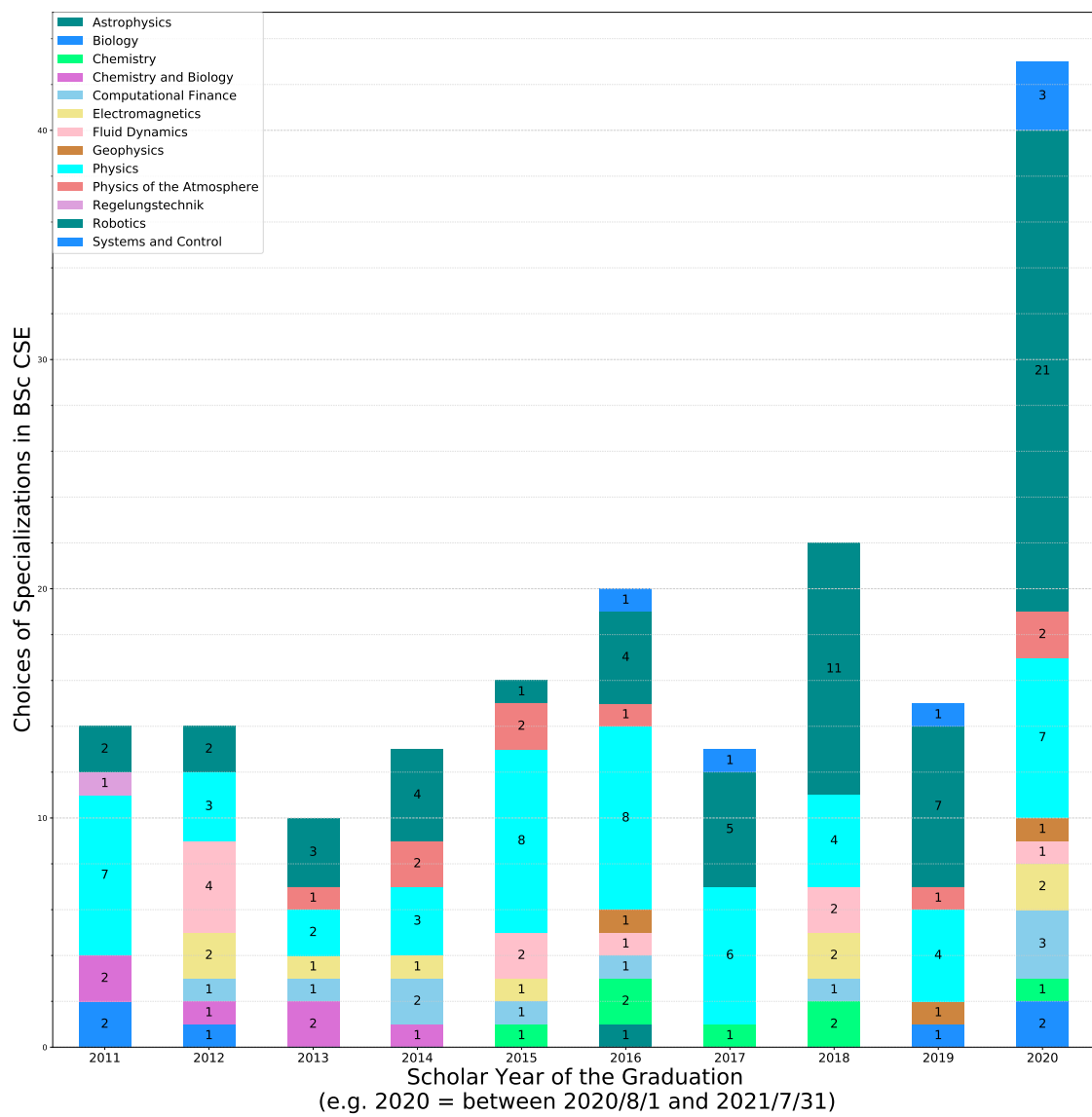
The academic year 2020/21 was again affected by special conditions and restrictions due to the Covid-19 pandemic.

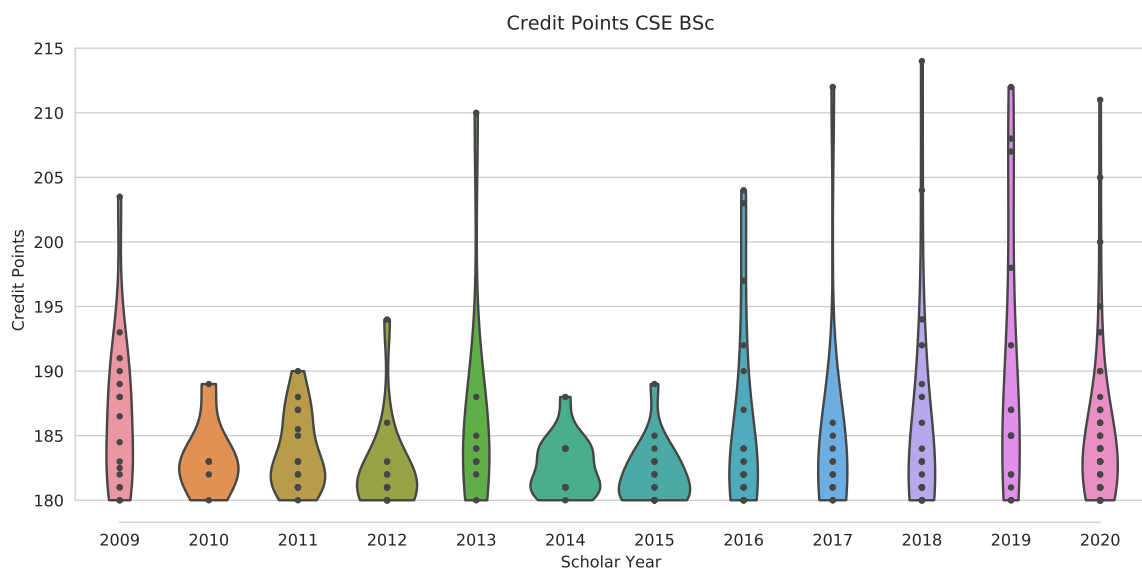
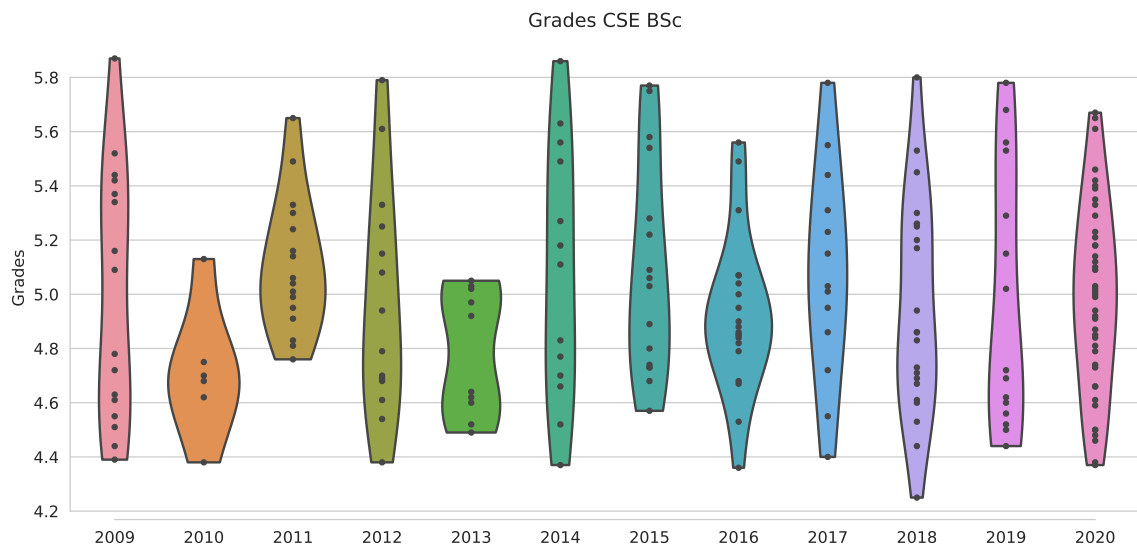
The welcome of the first semester students in BSc and in MSc CSE was conducted as usual in ETH main building, respecting the rules of social distancing. However, the start-of-semester reception in autumn 2021 was offered only for the students in the first semester of the CSE BSc and MSc programs, which made it difficult for the students to become acquainted with more advanced students. Lectures, seminars and Case Studies were again held mainly online. While some students struggled with these conditions, the majority could follow the teaching activities without any problems. The possibility of lively discussions in ZOOM chats during some lectures was a real benefit and the performance of the involved students improved compared to the previous years. Recorded lectures were also very well received and used by the students. From this perspective, the special conditions of the pandemic boosted the evolution of teaching techniques and digitalization across departments and study levels.

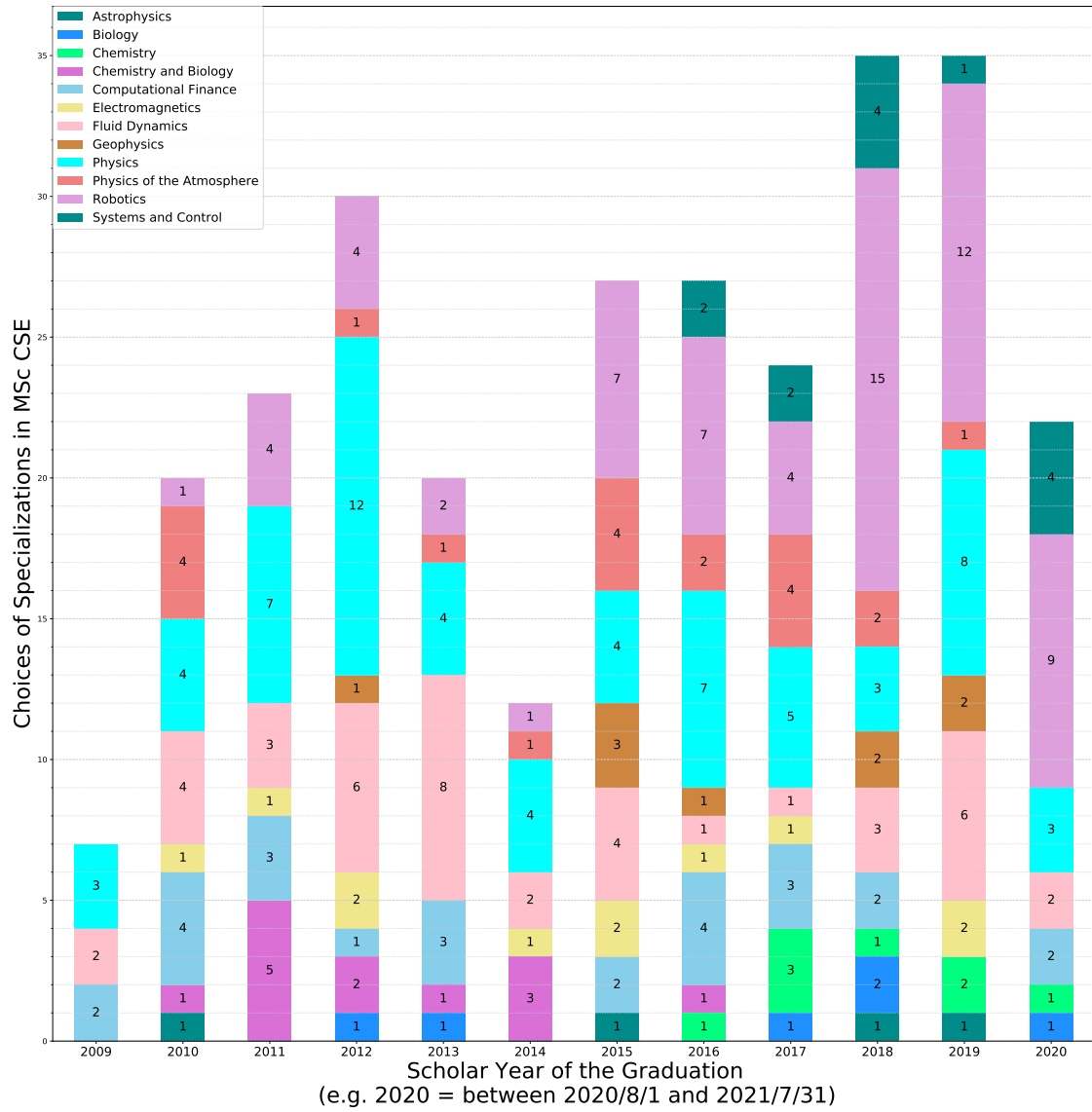
Despite the special conditions, the exam results were normal, in some cases even better than in previous years. In the winter examination session 2021, 85.5% of the 63 participating students passed the first Basisprüfungsblock, 69.2% passed the exam block *G1* and 78.6% passed the block *G2*. The lecture *Design of Parallel and High-Performance Computing* was chosen by 25 students, 96% of them passed. The lecture *High Performance Computing for Science and Engineering I* was chosen by 10 students, 90% of them passed. Popular lectures among the BSc CSE students in Fall 2020 were: *Numerical Modelling in Fortran* (13), *Introduction to Computational Physics* (9) and *Theory of Robotics and Mechatronics* (8). In the *Case Studies Seminar* in Autumn 2020 a number of 41 BSc CSE and 37 MSc CSE students participated with success. The lecture *Advanced Numerical Methods for CSE* in Autumn 2020 was very popular among the MSc CSE students (28). Also popular were *Probabilistic Artificial Intelligence* (12), *Deep Learning* (8) and *Dynamic Programming and Optimal Control* (8).

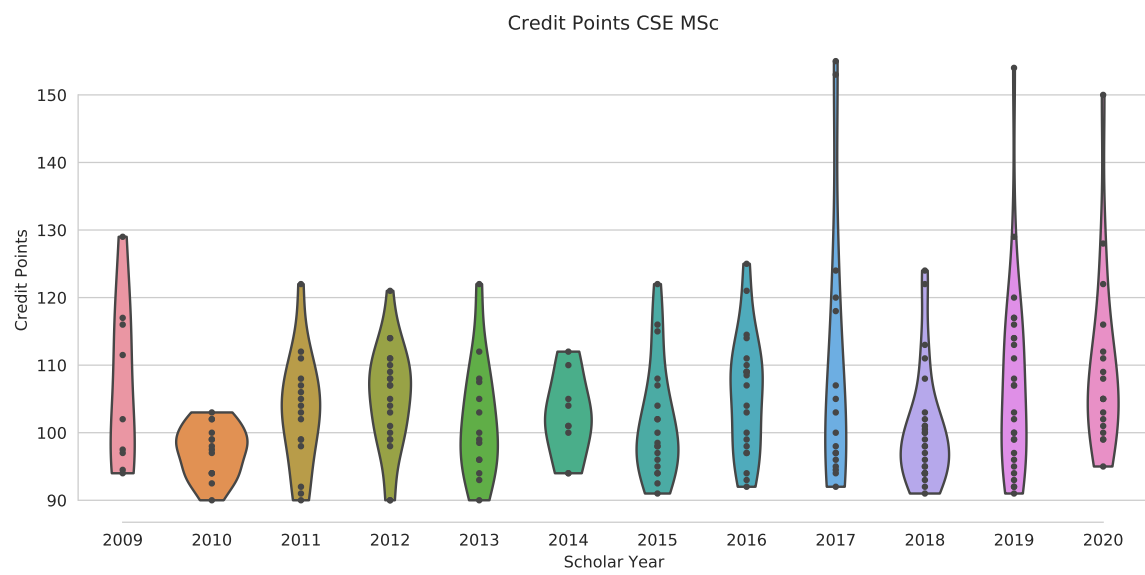
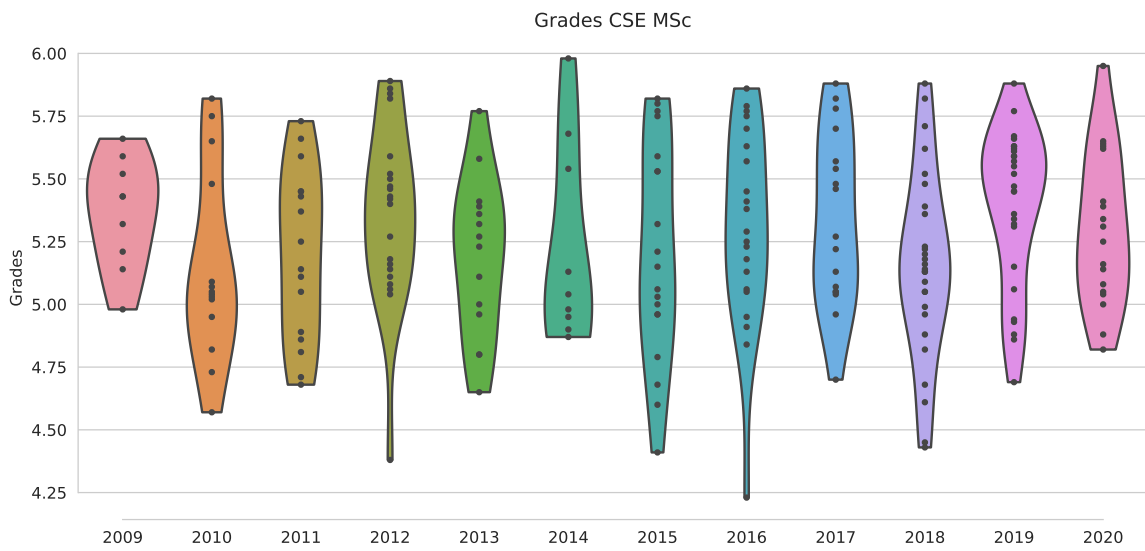
In the summer examination session 2021, 75.4% of the 63 participating students passed the second Basisprüfungsblock, 64% passed the exam *G3* and 60% passed the block *G4*. All of the 26 students attending *High-Performance Computing Lab for CSE* passed, while 8 of the 9 participating students passed *High Performance Computing for Science and Engineering II*. Popular lectures among the BSc CSE students in Spring 2021 were: *Software Engineering* (23) and *Introduction to Machine Learning* (16). The *Case Studies Seminar* Spring 2021 was successfully attended by 37 BSc CSE and 33 MSc students. Popular lectures among the MSc CSE students in Spring 2021 were: *Advanced Systems Lab* (22), *Computational Statistics* (20) *Optimization for Data Science* (11) and *Deep Learning in Scientific Computing* (8).

In each of the two semesters of the academic year 2020/21, grades were awarded to MSc CSE students in about 70 scientific lectures and seminars across all the ETH departments.



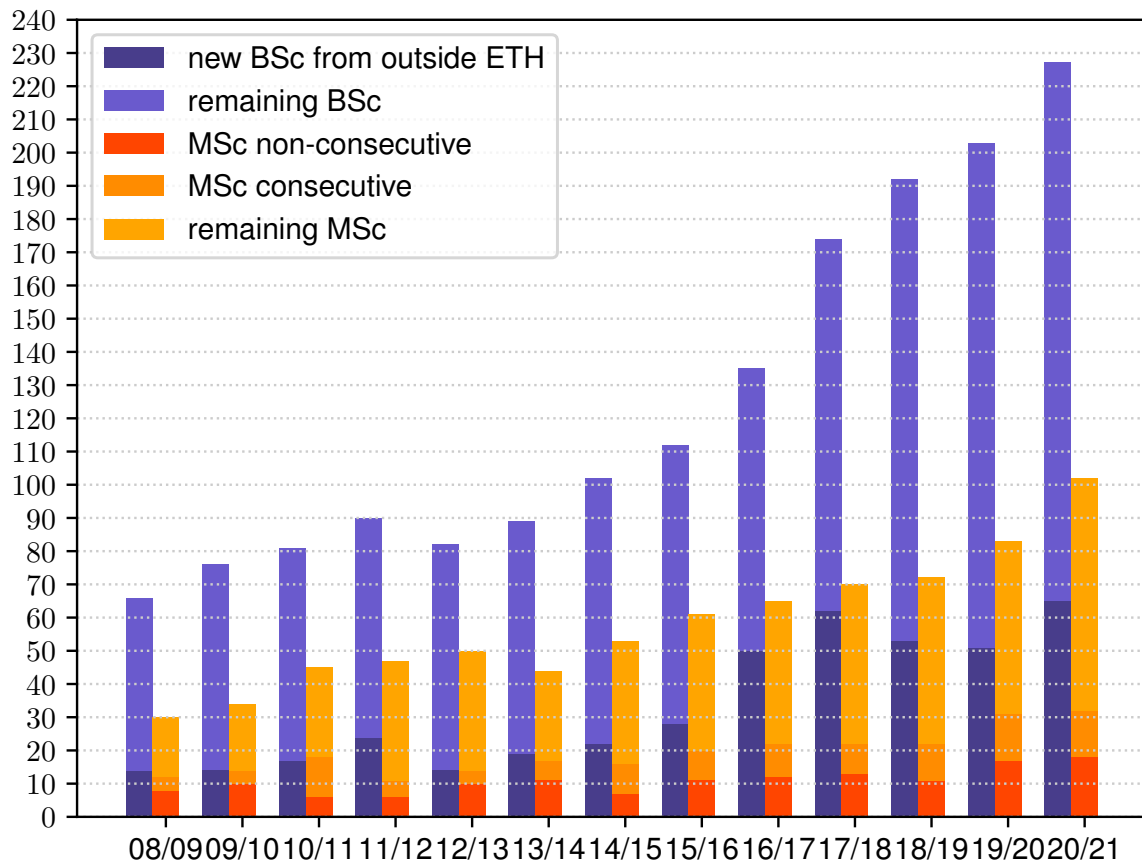






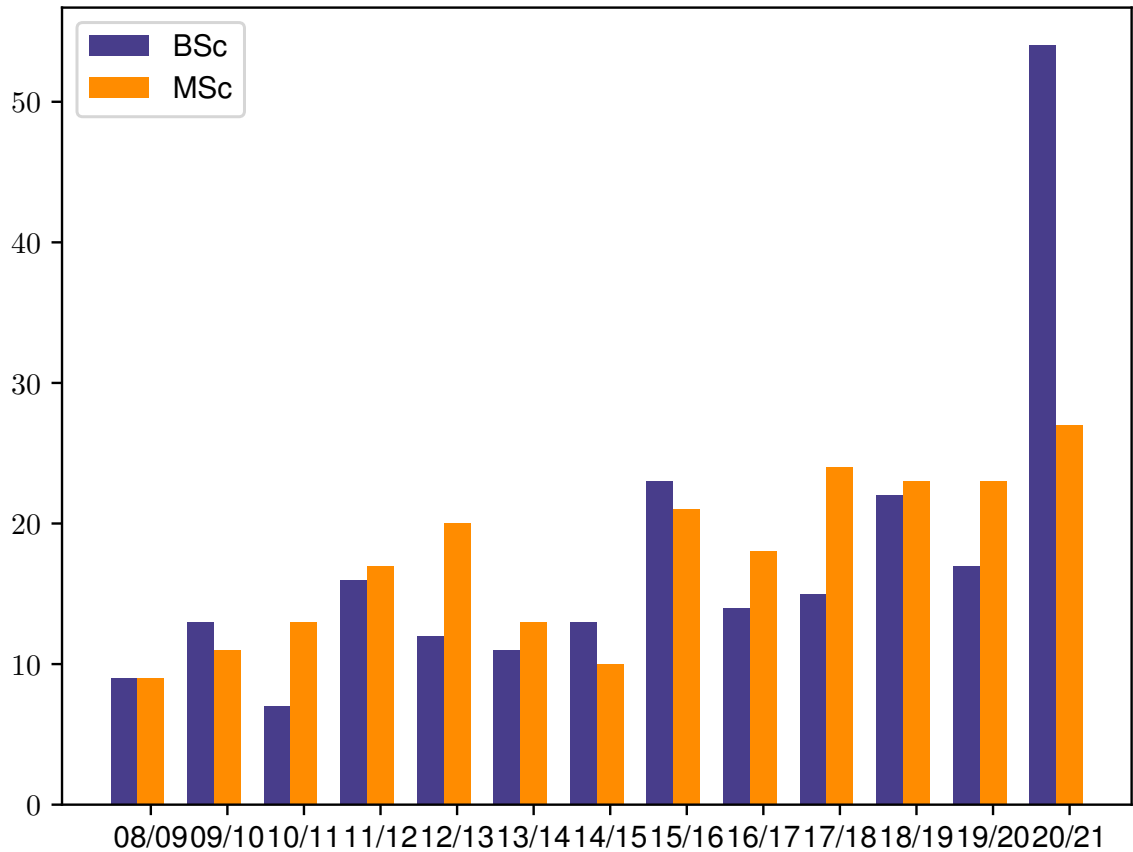
CSE Students and Theses 2

In September 2020, 65 new students started their CSE Bachelor studies in the first semester. From outside CSE 14 students (12 from overseas) entered the CSE Master curriculum. The total number of CSE students enrolled in Fall Term 2020 was 329 (headcount): 227 in the BSc program and 102 in the MSc program.

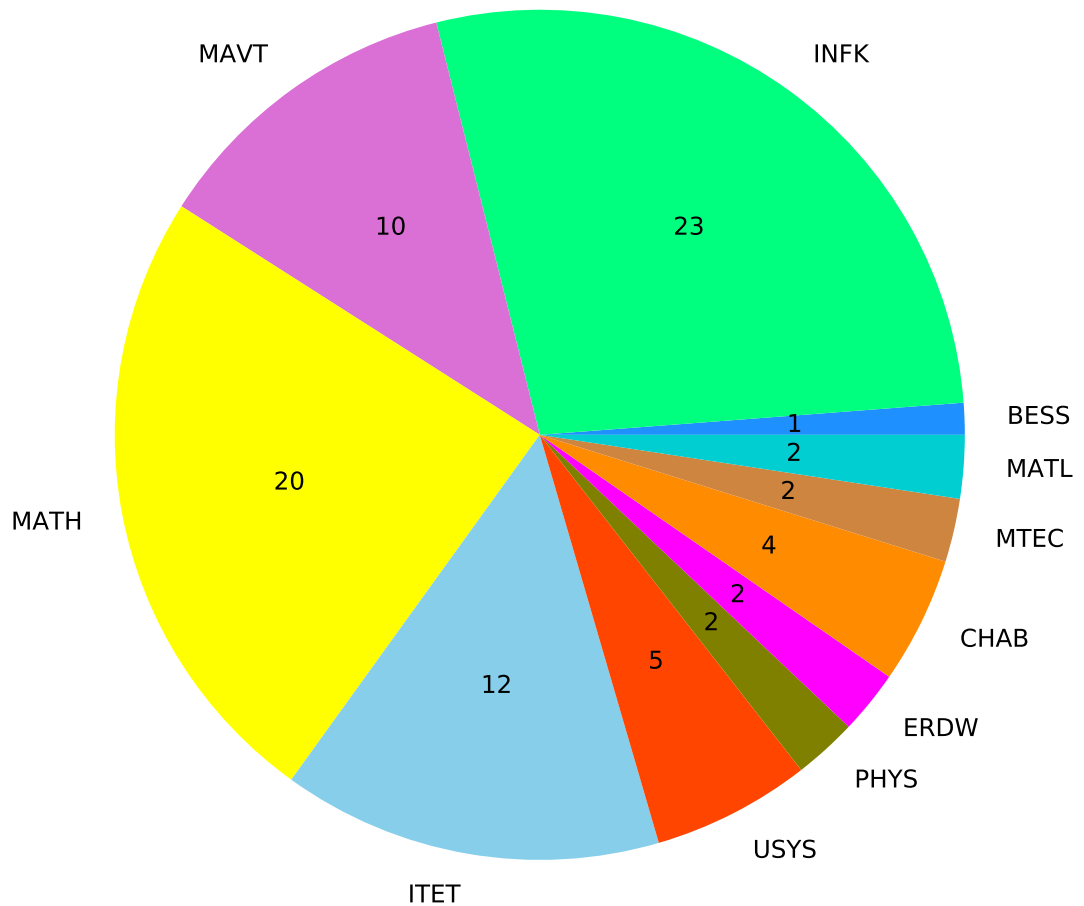


Number of CSE students in the curriculum; dark = number of new students

In the past academic year 81 students have successfully finished a CSE curriculum, 54 Bachelor students and 27 Master students, and have received a CSE degree, some with very good grades. In the following list we give the name of the student, the title of the Bachelor/Master/Term thesis and the name and the department of the advisor. The Willi Studer Preis 2021 for the best CSE Master Diploma in the past academic year was awarded to Thomas Etterlin.



Number of CSE graduates



In the academic year 2020-2021 there were written a total of 83 semester, Bsc and MSc theses in CSE. The diagram above shows that the supervision of these works is spread over 12 departments of ETH, while some of them seem to attract more students than others. The most popular departments this year was D-INFK with 23 theses, D-MATH with 20 theses and D-ITET with 10 theses.

BSc Theses

Sebastian Balzer

Improved MALDI-TOF based antimicrobial phenotype prediction through phylogenetic structure

(Karsten Borgwardt, D-BESS)

Roger Lorenz Barton

3D Modeling in Virtual Reality

(Olga Sorkine Hornung, D-INFK)

Noah Andrés Baumann

A GPU implementation of the Stillinger-Weber potential

(Petros Koumoutsakos, D-MAVT)

Matthias Simon Busenhardt

Human-Guided Robotic Assembly

(Stelian Coros, D-INFK)

Tobia Luis Clagluna

Exploring reduced data exchange in domain and pipeline parallel CNNs

(Torsten Hoefler, D-INFK)

Mark Otto Frey

Edge Detection on Mobile Devices

(Marco Hutter, D-MAVT)

Konrad Otto Handrick

Offloading serverless with sPIN

(Torsten Hoefler, D-MATH)

Richard Andrew Harpur

Online System Identification for Online Feedback Optimization Controllers

(Florian Dörfler, D-ITET)

Angelina Lucy Heusler

High-dimensional Quasi-Monte Carlo Integration

(Christoph Schwab, D-MATH)

Wiktor Jan Hoffmann

Isolating the Non-linearity of the European Climate-Change Response

(Christoph Schär, D-USYS)

Beat Peter Hubmann

Simulating Raman spectra - A CP2K-based implementation and its application to defective graphene nanoribbons

(Carlo Pignedoli, EMPA and Vasile Gradinaru, D-MATH)

Alain Hügli

Evaluating the impact of variable LET on hypoxia-guided treatment planning for NSCLC patients

(John Lomax, D-PHYS)

Felix Julius Elias Illes

Deep Learning for Text Attribute Transfer on Auto Encoder Models

(Roger Wattenhofer, D-ITET)

Lukas Joss

Development and application of standardized evaluation metrics for climate models

(Christoph Schär, D-USYS)

Fabian Urs Kistler

Numerical seismo-hydro-mechanical modeling of subduction-induced seismicity on super-Earths

(Gerya Taras, D-ERDW)

Bjarne Kölle

Numerical relaxation of mesodynamics equations for finite temperature molecular statics

(Dennis Kochmann, D-MAVT)

Leonard Peter Knirsch

Implementation of molecular dynamics algorithms for automated reaction network exploration

(Markus Reiher, D-CHAB)

Tom Niklaus Lausberg

An Efficient Streamfunction-Vorticity Solver for the Simulation of Viscous Fluids

(Markus Hans Gross, D-INFK)

Pavel Lenskii

Efficient multi-dimensional (C)WENO reconstruction

(Roger Käppeli, D-MATH SAM)

Josefine Leuenberger

Plastic rod bending

(Stelian Coros, D-INFK)

David Leonard Lichtenstein
Pan-Tilt-Zoom Camera Calibration for Offline Soccer Video Analysis
(Marc Pollefeys, D-INFK)

Alexander Frederik Morgenroth
Robustness of Adversarially Trained DNNs against Adversarial Deformations
(Rima Alaifari, D-MATH)

Jonas Patrik Mensch
Climate Effects on Biodiversity: Numerical Modelling
(Taras Gerya, D-ERDW)

Yannick Alexander Niedermayer
Extending Kernel Based Regression to Predict Hessian Data for Potential Energy Surfaces"
(Jeremy Richardson, D-CHAB)

Xiaohe Niu
Principles of Animation Applied to Robotics - Animating a Cube Using OpenGL
(Stelian Coros, D-INFK)

Safira Leandra Liora Piasko
On Reducing Numerical Dissipation of Euler Equations with Discrete Exterior Calculus
(Markus Gross, D-INFK)

Maxime Raafat
Implicit Cut-Cells Implementation for Sub-Grid Liquids Simulation
(Markus Gross, D-INFK)

Marcel Dyrk Saaro
Pan-Tilt-Zoom Camera Calibration for Offline Soccer Video Analysis
(Sebastian Kozerke, D-ITET)

Joshua Sammet
Predictive Activity Change To Map An Area Of Interest
(Benjamin Grewe, D-INFK / Disney Research)

Manuel Schneider
A Comparison of Different Methods Used in Multiple Testing
(Marloes Maathius, D-MATH)

Ernst Florian Schweizer
The Robo-Investors from Graham-Doddsville – Applying Machine Learning to the Investment Choices of Warren Buffett
(Didier Sornette, D-MTEC)

Vsevolod Semenov
Smart Vote
(Roger Wattenhofer, D-ITET)

Pascal Sommer
Incremental Structure from Motion with Known Vertical Direction
(Marc Pollefeys, D-INFK)

Davide Dimitry Staub
Simulation of Micron-scale Robots
(Stelian Coros, D-INFK)

Alexis Stockinger
On the Reduction of Deep ReLU Networks
(Josef Teichmann, D-MATH)

Jan Christoph Stratmann
Tracking Objects using Radar Point Clouds
(Roland Siegwart, D-MAVT)

Michal Grzegorz Sudwoj
Rust programming language in the high-performance computing environment
(Roger Käppeli, D-MATH SAM)

Robin Paul Vogtlans
Calibration of stochastic volatility models using different neural network approaches
(Patrick Cheridito, D-MATH)

Daniel Widmer
Implicit shape representations for analytically differentiable contact dynamics
(Stelian Coros, D-INFK)

Manuel Winkler
High-order well-balanced finite difference schemes based on equilibrium flux reconstruction
(Roger Käppeli, D-MATH)

Robin Alexander Worreby
Mean-field Hubbard model implementation and application to carbon-based nanostructures
(Ralf Hiptmair, D-MATH)

MSc Theses

Genming Bai

Physics informed Neural Networks for approximating high-order PDEs

(Mishra Siddhartha, D-MATH)

Tim Bernhard

Evaluating Methods to Reduce the Computational Run Time of Simulations to Determine Equilibrium Shear Moduli of Polymer Networks

(Andrei Gusev, D-MATL)

Philipp Jonathan Bomatter

Contextual Reasoning in Vision

(Roland Siegwart, D-MAVT)

Yukun Dai

Visual Coarse Relocation for AR Navigation Apps

(Marc Pollefeys, D-INFK)

Stefano D'Apollito

Learning Interpretable GAN Conditional Space of Emotions for facial expression manipulation

(Luc Van Gool, D-ITET)

Francesco Forcher

Uncertainty quantification of Hamiltonian maps using intrusive polynomial chaos expansion

(Andreas Adelmann, PSI)

Clemens Giuliani

Variational Simulation of Quantum Circuits with Entangled-Plaquette States

(Renato Renner, D-PHYS)

Gwendolyn Haller

Transport simulation of single and multidomain ferroelectric HfO₂ - an ab-initio study

(Mathieu Luisier, D-ITET)

Cyrill Cédric Hedinger

Visual Tracking of Scanned Objects

(Roland Siegwart, D-MAVT)

Liaowang Huang

Partition of unity method based Wave-Ray Multigrid

(Ralf Hiptmair, D-MATH)

Luca Lavarini
Data - Centric Fusion and Automated Cost Analysis
(Torsten Höfler, D-INFK)

Anastasios PAPAGEORGIOU
Deep Learning techniques for disease diagnosis
(Georg Von Krogh, D-MTEC)

Cosima Luna Ruzzo
Analyzing components of a 4D flow framework for fetal cardiac MRI
(Sebastian Kozerzke , D-ITET)

Yannick Olivier Schaffner
Community-Centric Clique Listing
(Torsten Hoeffler, D-INFK)

Leonardo Schwarz
Adaptive brain-like neural networks for control of robotic limbs in brain-inspired hardware
(Indiveri Giacomo, D-ITET)

Ramy Tanios
Physics Informed Neural Networks in Computational Finance: High Dimensional Forward and Inverse Option Pricing
(Siddhartha Mishra, D-MATH)

Niclas Vödisch
Optimizing the Beam Distribution of a Low-Resolution LiDAR for 3D Localization
(Luc Van Gool, D-ITET)

Krispin Wandel
Simultaneous Topology and Form Finding
(Stelian Coros, D-INFK)

Semester Theses

Tim Bernhard

Implementing Finite Element Simulations Including Vertex Rotations
(Andrei Gusev, D-MATL)

Andrej Blaser

"Ray Path Correction for Ultrasound Image Reconstruction
(Orcun Göksel, D-ITET)

Andrej Blaser

The title of my semester thesis is: Eccelerating of electron photon scattering with GPUs
(Mathieu Luisier, D-ITET)

Robert Severin Blass

Coupling Oasis LMF with CLIMADA
(David BRESCH, D-USYS)

Fabrice Angelo Dal Farra

Bubble dynamics simulations with the Boundary Integral Method
(Outi Supponen, D-MAVT)

Philipp Egg

Automatic Reconstruction of Non-Existing Building Elements in Digital Building Models
(Roland Siegwart, D-MAVT)

Daniil Emtsev

De novo drug design using protein structural information and Generative neural network models
(Gisbert Schneider, D-CHAB)

Gwendolyn Simone Haller

Comparison of splitting schemes for the simulation of the dynamics of polymer solution with nonlinear effects
(Vasile Gradinaru, D-MATH)

Langwen Huang

Improving the performance of a domain-specific language compiler
(Oliver Fuhrer, D-USYS)

Beat Peter Hubmann

De-Skewing LiDAR point clouds based on GPS-aided visual-inertial system data
(Davide Scarmuzza, D-MAVT)

Fabian Patrick Lyck
Point-Line Structure-from-Motion in COLMAP
(Marc Pollefeys, D-INFK)

Nils Knobloch
Named Entity Recognition with Transformers in the Medical Domain
(Fan Yang , D-INFK)

Valerie Desiree Kulka
Time adaptive conservative finite volume method for the Navier-Stokes Equations
(Patrick Jenny, D-MAVT)

Philipp Helmuth Lindenberger
Pixel-Perfect Structure-from-Motion with Featuremetric Refinement
(Marc Pollefeys, D-INFK)

Ankur Sanjiv Magdum
PDE constrained optimisation with deep learning
(Siddhartha Mishra, D-MATH)

Anton Maksimov
Hierarchical Variational Inference for Federated Learning
(Joachim Buhmann, D-INFK)

Christian Timo Mitsch
Hypersphere Utilization of Local Patch Descriptors
(Marc Pollefeys, D-INFK)

Silvia Manuela Nauer
Reducing Numerical Dissipation of Euler Equations for Computer Graphics
(Markus Gross, D-INFK)

David Florian Ochsner
Markov Chain Monte Carlo for Inverse Problems
(Siddhartha Mishra, D-MATH)

Michael Prasthofer
On operator Deep Learning and applications to nonlinear PDEs
(Siddhartha Mishra, D-MATH)

Tobias Rohner
Exploring the Accuracy/Resource Trade-off in Quantum Circuits
(Torsten Höfler, D-INFK)

Leonardo Schwarz
Towards fast and programmable graph mining
(Torsten Hoefler, D-INFK)

Athina Sotiropoulou
Graph Neural Networks for generating Molecular Dynamics Fingerprints
(Sereina Riniker, D-CHAB)

Mikael Stelio
Application of a DSL to Weather and Climate Modeling
(Oliver Fuhrer, D-USYS)

Alexis Sébatien Dominik Stockinger
On the Reduction of Deep ReLU Networks part 2
(Josef Teichmann, D-MATH)

Martin Carl Christian Tschechne
Normalized Attention Reinforcement Learning
(Roger Wattenhofer, D-ITET)

Wouter Rens Tonnon
High-Order Finite Volume Methods in Orthogonal Curvilinear Coordinates
(Roger Kaeppli, D-MATH)

Nikolaos Tselepidis
Two-Level K-FAC Preconditioning for Deep Learning
(Thomas Hofmann, D-INFK)

Ajaykumar Unagar
Class-Incremental learning for tissue classification
(Orcun Göksel, D-ITET)

Robin Paul Vogtland
Uncertainty of Implied Volatility Surfaces via Bayesian Neural Networks
(Josef Teichmann, D-MATH)

Luohong Wu
A Model Predictive Controller for Quadrupedal Locomotion
(Stelian Coros, D-INFK)

Tianwei Yu
Deep Learning for Model Order Reduction
(Siddhartha Mishra, D-MATH)

CSE Case Studies Seminar 3

The CSE Case Studies Seminar takes place each semester on Thursdays, 16 - 18 hours. Speakers from ETH, from other universities as well as from industry are invited to give a 2×45 minutes talk on an applied topic. The idea is to show the students a case study of an application problem containing the problem setting, the modelling, the mathematical approach and the simulation on a computer. In addition, such a case study should show what is going on in the field of CSE and what are the job perspectives for a CSE engineer. The seminars of the past academic year are given in the two following lists. The pandemic situation at the end of 2020 made the CSE Case Studies Seminar in Fall 2020 to be entirely online, while starting in a hybrid mode.

Case Studies Seminar HS20

- 24.09.20 Anatole von Lilienfeld
Faculty of Physics, University of Vienna
Quantum Machine Learning

- 22.10.20 Jen Jen Chung
Autonomous Systems Lab, D-MAVT
Modelling and Simulation for Intelligent Robots in the Home and in the Field

- 12.11.20 Katarina Knezovic
Hitachi ABB Power Grids Research, Dättwil
Modelling and Simulation of Optimal Power Flows

- 03.12.20 Philipp Weiss, Valentin Giddey
Fluid Dynamics, D-MAVT
Numerical Investigation and Modeling of Turbulent Dispersed Two-phase Flows

- 17.12.20 Christian Kühnlein
European Centre for Medium-Range Weather Forecasts, Reading, UK
Semi-implicit Integration of Compressible Equations in IFS-FVM for Numerical Weather Prediction

The pandemic situation at the start of 2021 made the CSE Case Studies Seminar in Spring 2021 to be entirely online.

Case Studies Seminar FS21

- 25.02.21 Sebastian Sippel, Lukas Brunner
Climate Physics, D-USYS
Integrating Climate Models and Observations for Enhanced Climate System Understanding
- 04.03.21 Florentin Reiter
Quantum Electronics, D-PHYS
Quantum Computing Driven by Noise
- 22.04.21 Martin Frey
Silicon Engineering Group, Synopsys Inc, Zürich
Modeling Electronic Transport in Nanoscale Semiconductor Devices
- 06.05.21 Manuel Guizar Sicaïros
Paul Scherrer Institut (PSI), Villigen
X-ray Micro- and Nano-Tomography, Basic Principles and Applications in Synchrotron Light Sources
- 20.05.21 Markus Reiher
Physical Chemistry, D-CHAB
Recent and Future Directions for Computational Chemistry

**Computational Science
and Engineering (CSE)**

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