Welcome meeting for new master students. CS:applied mathematics and risk analysis

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Overview

120 credits altogether (long master):

- 60 credits courses. 60 credits thesis
- Deadline for the master's agreement: December 1st (supervisor(s), course plan, project description).
- Common to choose a special curriculum (10 credits). Typically connected to topics needed in the thesis
- Must have two of
  - FYS-STK 4155(A) Applied Data Analysis and Machine Learning
  - IN4200(S) High performance computing and numerical projects
  - MAT4110(A) Introduction to Numerical Analysis
- Other options at CS besides amra: Chemistry, Mechanics, Physics, Bioinformatics, Astrophysics, Geoscience, Imaging and Biomedical computing...

Topics which may be in focus

Can be mathematically heavy, but can also focus more on the following, when compared to other directions of mathematics.

- algorithms,
- construction and testing of numerical algorithms,
- software development,
- visualization/graphics,
- Signal- and image analysis,
- find useful information in large datasets (risk in a compelx project/portefolio, an oil reservoir in seismic data, a tumor in a medical image),
- simulation of physical phenomena.

Topics which may be in focus

- Formulation of mathematical models,
- Use of heavy computing resources,
- partial differential equations,
- machine learning. pytorch/tensorflow,
- complexity theory.

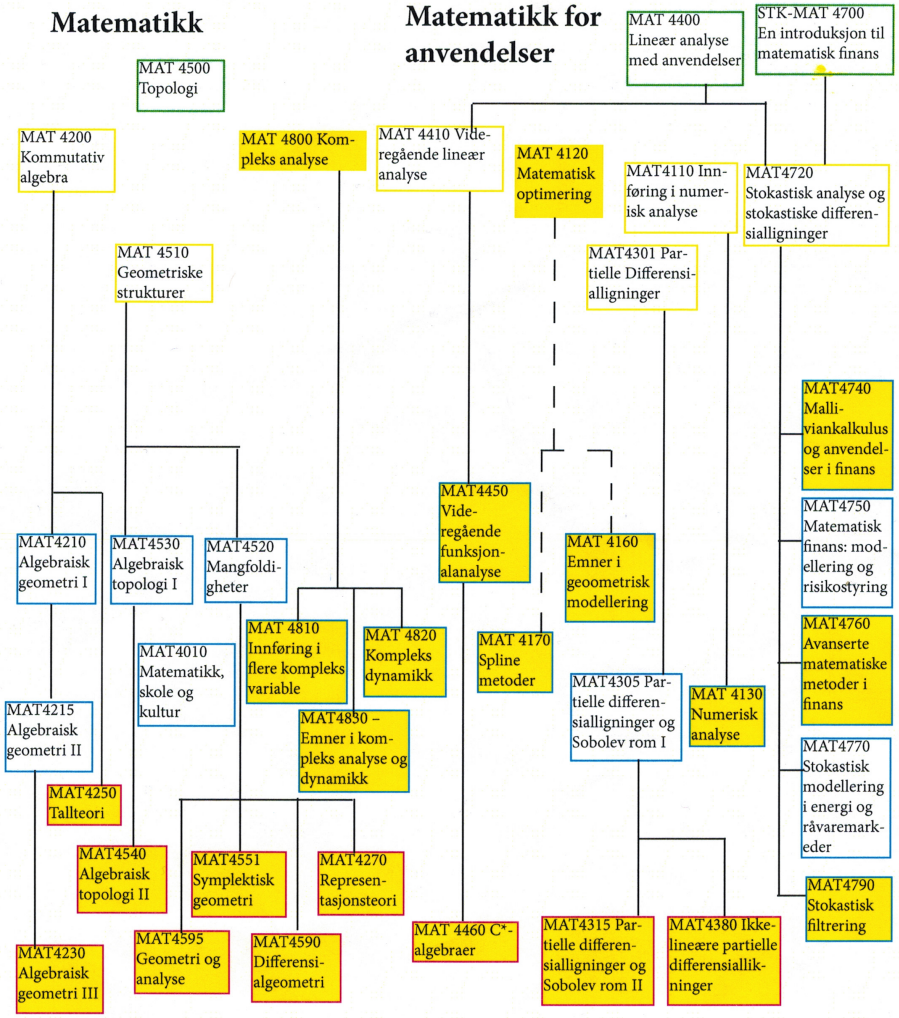
Examples of projects

- Modelling of surfaces in 3D
- Minimal surfaces and 3D printing
- Reconstruction of 3D-models from segments with machine learning
- Recommender systems analysis by compressed sensing
- Stability of adaptive neural networks for image reconstruction.
- Use machine learning for solving partial differential equations.
- Buffering in risk- and reliability analysis
- Numerical analysis of solvers for non-linear ordinary differential equations
- Computational barriers in statistical estimation and reconstruction

Course suggestions mathematics

- MAT4120(A) Mathematical optimization (nårbert)
- MAT4130(S) Numerical Analysis
- MAT4160(S/A) Topics in geometric modelling (nårbert)
- MAT4170(S) Spline methods (nårbert)
- MAT4400(S) Linear analysis with applications
- MAT4410(A) Advanced Linear Analysis
- MAT4450(S) Advanced Functional Analysis (nårbert)
- MAT4500(A) Topology

Course suggestions mathematics



Course suggestions informatics

- IN4190(A) Digital signal processing.
- IN5520(A) Digital image analysis
- IN4070(A) Logics
- IN5580(S) Computability theory
- IN4110(A) Problemløsning med høynivå-språk
- IN5270(A) Numerical methods for partial differential equations
- IN4050(S) Introduction to Artificial Intelligence and Machine Learning (overlap with FYS-STK4155)
- IN5400(S) Machine Learning for Image Analysis

AI-related courses

- FYS-STK 4155(A) Applied Data Analysis and Machine Learning
- IN4050(S) Introduction to Artificial Intelligence and Machine Learning (overlap with FYS-STK4155)
- IN5400(S) Machine Learning for Image Analysis

Differential equations/risk analysis

- MAT4301(A) Partial differential equations
- MAT4380 Nonlinear partial differential equations (nårbert)
- MAT4305(S) Partial differential equations and Sobolev spaces I
- MAT4315 Partial differential equations and Sobolev spaces II (nårbert)
- STK-IN4300(A) Statistical learning methods in Data Science
- STK4400 Risk- and reliability analysis (nårbert)
- MAT4720(A) Stochastic analyse and stochastic differential equations
- MAT4770(S) Stochastic modelling in energy and raw material markets

Potential supervisors

- Michael Floater (approximation theory, geometrical modelling, splines, numerical analysis)
- Ulrik Skre Fjordholm (PDE and machine learning)
- Kristina Rognlien Dahl (risk analysis)
- Kenneth Karlsen/Nils Henrik Risebro/Snorre Christiansen (PDE)
- Vegard Antun/Anders Hansen (compressive sensing, machine learning)
- Geir Dahl (optimization)
- Kent-Andre Mardal (Mechanics, machine learning)
- Øyvind Ryan (compressive sensing, wavelets, linear algebra)

Potential external projects

- Sintef (Signe Riemer-Sørensen).
  - Port-Hamiltonian deep learning.
  - Automated graph generation from GPS data. Reducing CO_2 emition at construction sites.
  - Automated movement classification from vibration data.
  - Predictive maintenance on windmill data.
  - Hybrid Modeling and Uncertainty Quantification in Transfer Learning.
- NGI (Norwegian Geotechnical Institute) (Erlend Briseid Storrøsten).
  - Numerical models for avalanches.
  - Tsunami modeling with neural nets.

Note that all external projects must have an internal supervisor from MI!

Resources

- Program page:
  https://www.uio.no/studier/program/computational-science-master/studieretninger/applied-mathematics/index.html
- List of previous thesises, with supervisor:
  https://www.mn.uio.no/math/english/research/groups/cm/complete master-projects.html
- This file:
  https://www.mn.uio.no/math/personer/vit/oyvindry/slides_amra.pd