Summary of course and the final exam

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Syllabus and the final exam

For the written exam, you can bring with you 2 pages (written on both sides) with own notes. See also the exams from the last four years at the specific github address of the course. The written exam counts 1/3 of the final mark. Projects 4 and 5 count 1/3 each for the final mark. For the syllabus, see the official website of the course and the see the discussion below.

Note: The text of the final written exam is in English only, but you can answer in English or Norwegian.

What did I learn in school this year

Our ideal about knowledge on computational science

Does that match the experiences you have made this semester?

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Topics we have covered this year

- Linear algebra and eigenvalue problems. (Lecture notes chapters 6.1-6.5 and 7.1-7.5 and projects 1 and 2).
- Numerical integration, standard methods and Monte Carlo methods (Lecture notes chapters 5.1-5.5 and 11 and project 3).
- Ordinary differential equations (Lecture notes chapter 8 and project 5)
- Partial differential equations (Lecture notes chapter 10 and project 5)
- Monte Carlo methods in physics (Lecture notes chapters 11, 12 and 13, project 4)

Linear algebra and eigenvalue problems, chapters 6.1-6.5 and 7.1-7.5

- Know Gaussian elimination and LU decomposition (project 1)
- How to solve linear equations (project 1)
- How to obtain the inverse and the determinant of a real symmetric matrix
- Cubic spline
- Tridiagonal matrix decomposition (project 1)
- Householder's tridiagonalization technique and finding eigenvalues based on this
- Jacobi's method for finding eigenvalues (project 2)

Numerical integration, standard methods and Monte Carlo methods (5.1-5.5 and 11)

- Trapezoidal, rectangle and Simpson's rules
- Gaussian quadrature, emphasis on Legendre polynomials, but you need to know about other polynomials as well (project 3).
- Brute force Monte Carlo integration (project 3)
- Random numbers (simplest algo, ran0) and probability distribution functions, expectation values
- Improved Monte Carlo integration and importance sampling (project 3).

Monte Carlo methods in physics (Chapters 11, 12 and 13)

- Random walks and Markov chains
- Metropolis algorithm (project 4)
- Applications to statistical physics systems (project 4)

Ordinary differential equations (Chapter 8)

- Euler's method and improved Euler's method, truncation errors (project 5)
- Runge Kutta methods, 2nd and 4th order, truncation errors (project 5)
- Leap-frog and Verlet algoritm (project 5)
- How to implement and solve a second-order differential equation, both linear and non-linear.
- How to make your equations dimensionless.

Partial differential equations, chapter 10

- Set up diffusion, Poisson and wave equations up to 2 spatial dimensions and time
- Set up the mathematical model and algorithms for these equations, with boundary and initial conditions. The stability conditions for the diffusion equation.
- Explicit, implicit and Crank-Nicolson schemes, and how to solve them. Remember that they result in triangular matrices (project 5).
- Diffusion equation in two dimensions.
- How to compute the Laplacian in Poisson's equation.
- How to solve the wave equation in one and two dimensions using an explicit scheme.

Solutions to projects 1-3

Under the project folder at the github address of the course you will find examples of solutions for projects 1, 2 and 3. Special thanks to Ivar, Henrik, Giovanni, Giulio, Mattia and Alessio.

What? Me worry?

Computational science courses at UiO

- FYS3150/4150 Computational Physics I
- FYS4411 Computational Physics II, computational quantum mechanics
- FYS4460 Computational Physics III, computational statistical mechanics
- INF5620 Numerical Methods for Partial Differential Equations
- INF5631 Project on Numerical Methods for Partial Differential Equations
- FYS388 Computational Neuroscience
- STK4520 Laboratory for Finance and Insurance Mathematics
- STK4021 Applied Bayesian Analysis and Numerical Methods
- MAT-INF4130 Numerical Linear Algebra
- MAT-INF4110 Mathematical Optimization
- ECON4240 Equilibrium, welfare and information
- MEK4470 Computational Fluid Mechanics
- MEK4250 Finite Element Methods in Computational Mechanics

New Master of Science program at UiO from Fall 2017

The program aims at offering thesis projects in a variety of fields. The scientists involved in this program can offer thesis topics that cover several disciplines. These are

- Computational mathematics
- Computational mechanics and fluid mechanics
- Computational chemistry
- Computational physics
- Computational materials science
- Computational life science
- Computational informatics
- Image analysis and signal processing
- Computational finance and statistics
- Computational geoscience

The thesis projects will be tailored to the student's needs, wishes and scientific background. The projects can easily incorporate topics from more than one discipline.

The program opens up for flexible backgrounds

While discipline-based master's programs tend to introduce very strict requirements to courses, we believe in adapting a computational thesis topic to the student's background, thereby opening up for students with a wide range of bachelor's degrees. A very heterogeneous student community is thought to be a strength and unique feature of this program.

Best wishes to you all and thanks so much for your efforts this semester