Computing Across the Disciplines (CAD); a new Center/Department at the University of Oslo

A proposal to the board of the Mat-Nat Fakultetet of the University of Oslo

Establish a center by fall 2018 and as a new department by fall 2021

Why should we focus on Computational Science and Data Science?

- By 2020, it is expected that one of every two jobs in the STEM fields will be in computing (Association for Computing Machinery, 2013)
- Computation is an essential and cross-cutting element of all STEM disciplines
- Computational science has developed into a discipline of its own right
- Computations and the understanding of large data sets will play an even larger role in basically all disciplines of STEM fields, Medicine, the Social Sciences, the Humanities and education
- Students at both undergraduate and graduate level are unprepared to use computational modeling, data science, and high performance computing – skills valued by a very broad range of employers.

Computational science, a cross-disciplinary enterprise
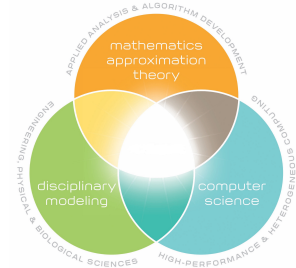
Goals

- Position UiO as a leader in computational science by recruiting faculty whose expertise pertains to large-scale computing and mathematical foundations of data science - both generalists (algorithm/tool developers) and specialists (focused on specific disciplines).
- Develop a comprehensive set of courses and degree programs at both the undergraduate and graduate levels, including minors and graduate certificates, that will give students across the university exposure to practical computational methods, and more generally to the idea of computers as problem-solving tools.
- Facilitate the adoption of computational tools and techniques for both research and education across campus, through education and faculty collaboration. A center and then a department will facilitate the pursuit of these goals!
- Educate the next generation of school teachers and university teachers, with a strong focus on digital competences.

Strengths, Possibilities and Synergies

- Several Centers of excellence in research where Computational Science plays a major role
- Newly established center of excellence in education research
- Newly established Master of Science programs in Computational Science and Data Science
- Several excellent groups in STEM fiels who do Computational Science
- Computational topics are included in all undergraduate STEM programs, possibility to develop a bachelor program in Computational Science
- Several educational prizes and awards related to computational science
- With a center and later a department we have the possibility to really position UiO as the leading Norwegian and perhaps European institution within Computational Science and Data Science
- Lead in the development of computations in Life Science
- Strong links with SIMULA research lab

The Center/Department

- Administratively located under the Mat-Nat college
- Composed of 25-30 FTEs, including some current UiO faculty and when it becomes a department a larger number of new hires (most from ACI).
- Most of these faculty will have joint appointments with other units and/or departmentz at the University of Oslo and SIMULA research laboratory
- Faculty will focus on computational science, data science and large-scale and high-performance computation
- Faculty will be incentivized to engage in cross disciplinary and cross-department/college research collaborations
- Nurturing environment to attract these faculty and pursue large and interdisciplinary grants
- Close ties to SIMULA research laboratory and the HPC center at USIT

Benefits

- Recruitment of new faculty who are incentivized to collaborate across the university both in terms of research and education.
- Opportunities for existing UiO faculty to expand their computation-related capabilities, and to train students to use computational techniques.
- Broad and deep educational opportunities for both undergraduate and graduate students across the university.

Research opportunities

- Research challenges that require computation-oriented multidisciplinary and interdisciplinary approaches.
- Research problems that require "bleeding edge" (e.g., multi-petaflop/petabyte) computational approaches to interpret experimental data and complex data..
- Develop research programs on Quantum Computing, the future of computing. The Wallenberg foundation in Sweden and Chalmers University of technology have funded a project on developing quantum computing technologies with SEK 1 billion. The aim is to position Sweden in a top global top position in quantum technology.
- Center-level funding opportunities (e.g., SFF, Marie Curie etc etc).

More research opportunities

- Simulations of complex quantum mechanical systems using novel algorithms, with applications spanning from quantumchromodynamics on the lattice and subatomic physics, via materials to the equation of state of stars.
- Exploring algorithms from quantum computing in order to solve complicated quantum mechanical problems
- Study complex materials or the DNA using large-scale molecular dynamics simulations
- Using machine learning to solve complicated problems, from neuroscience (our brain), physiology to complicated materials
- Using machine learning to develop new tools for learning
- Computing in Life Science (more text here)
- Computing in the Social Sciences and the Humanities (more text here)

Involved departments and centers of excellence

1. Institute for theoretical Astrophysics and Rosseland Center for Solar Physics: Mats Carlsson and Viggo Hansteen
2. Bioscience: Tom Andersen and Lex Nederbragt
3. Chemistry and Hylleraas Center for Quantum Molecular Sciences: Michele Cascella, Thomas Bondo Pedersen, Trygve Helgaker and Simen Kvaal
4. Geoscience: John Burkhart, Joe Lacasce and Thomas Vikhamar Schuler
5. IFI Bioinformatics: Torbjørn Rognes
6. IFI Imaging and Biomedical Computing (coupling to Simula): Andreas Austeng, Xing Cai, Joakim Sundnes and Simon Funke
7. Math and Mechanics: Karsten Trulsen and Kent-Andre Mardal
8. Math and Computational Finance, Statistics and Risk Analysis: Arne Bang Hansen and Geir Olve Storvik
9. Math and Cmputational Mathematics: Geir Dahl, Ragnar Winther, Knut Mørken, Martin Reimers, Michael Floater
10. Physics and Center of Computing in Science Education: Morten Hjorth-Jensen and Anders Malthe-Sørenssen

Timeline

1. Establish a center called **Center for Computing across Disciplines** by Fall 2018 and co-locate with the new Center for Computing in Science Education
2. Establish a department called **Computational Science** by Fall 2021
3. "New Master of Science Program on Computational Science starts fall 2018":" "
4. "New Master of Science Program on Data Science starts fall 2018":" "
5. Develop a Bachelor program in Computational Science and Data Science?

Role and functioning of Center

More text to come

Role and functioning of Department

More text to come

Centers and Departments at other universities

Universities worldwide with departments that cover computational science and data science and offer educational programs in computational science and data science

Country	Department	Bachelor program	Master program	PhD program

Educational programs at other universities

The Society for Industrial and Applied Mathematics (SIAM) keeps track of graduate programs in computational Science. The list is most likely not complete.

Make extensive table taken from the SIAM survey and make own survey.