IMADA Development Plan

Overview of the department

The Department of Mathematics and Computer Science (IMADA) comprises the research groups Computer Science, Mathematics, Applied Mathematics and the centre Laboratory for Coherent Education and Learning (LSUL). The department has a long history of excellence in research and teaching, and has a unique position merging the subjects of computer science, pure, and applied mathematics, statistics, eScience, and theoretical physics.

IMADA currently has 25 full, associate, and assistant professors, of which

- 12 belong to the Computer Science group, covering the research areas
 - Algorithmics
 - Optimization and heuristics
 - Database systems and Big Data
 - Bioinformatics
 - Chemoinformatics
 - Programming languages and methodologies,
- 11 belong to the Mathematics group, covering the research areas
 - Computational mathematics
 - Computational Quantum Field Theory
 - Modern analysis
 - Statistics
 - History and philosophy of mathematics
 - Discrete mathematics, and
- 2 belong to the centre LSUL, covering the research area of
 - didactics of mathematics and natural sciences.

The department delivers the following degrees entirely:

- Mathematics (BSc and MSc)
- Applied Mathematics (BSc and MSc)
- Computer Science (BSc and MSc)
- Master in Naturfagsundervisning

The department delivers a substantial part of the following degrees:

- Mathematics-Economy (BSc and MSc, joint with the Faculty of Business and Social Sciences)
- Computational Biomedicine (MSc, joint with the Department of Biochemistry and Molecular Biology, starting up in autumn 2016)

Additionally, the department delivers teaching in mathematics, statistics, didactics, and computer science to other degrees throughout the university.

The degrees delivered by IMADA – Mathematics, Applied Mathematics, Computer Science, and Mathematics-Economy – are all of the highest relevance to the region and to country as a whole. The national levels of unemployment for the graduates are extremely low: the K4-7 in 2012 are all below 4% for these degrees, which should be compared to a national average for MSc degrees in Science of 12% in the same year.

The interdisciplinary curriculum in Applied Mathematics is the only of its kind in Denmark, bringing computational mathematics, computer science and statistics together in a context of natural science. The same subjects are brought together in the context of finance and economy for the degree in Mathematics-Economy, supplemented by courses delivered by the Faculty of Business and Social Sciences. The curriculum of the Computer Science degree follows the guidelines of the ACM, and the candidates are highly sought after by both large and small companies in the region. Students of Mathematics get basic training in programming and have the ability to tune their degree in directions ranging from computer science to didactics via both pure and applied mathematics.

Special focus areas and initiatives up to 2020

Teaching

Educating students at SDU with competences of vital relevance to the development of the region and the country is a task that the department is proud to undertake. In addition to our own degrees, we support the rest of the university, providing research-based support teaching of the highest quality within mathematics, statistics and computer science.

Ensuring a sufficient number of tenured staff

In order to maintain our high level of teaching in our own degrees and to support our ambition to provide excellent research-based support teaching for others, the department must have a sufficient number of tenured staff members covering a sufficiently broad variety of subjects within the main areas of mathematics, statistics, eScience and computer science. Comparing the number of degrees and amount of support teaching we deliver with our number of tenured staff members, this issue is seen to currently be very strained. Additionally, ensuring enough time for tenured or tenure track staff members to develop their research is essential for providing a conducive working environment and maintaining a competitive research level. It is also a key aspect when aiming to recruit and retain the strongest talents, both among staff and among students.

Increased student intake and retention

The student intake on our degrees has risen substantially over the last few years. Considering how strongly our graduates are sought after, we wish to increase our student intake even further as well as student retention. We have the same ambition for our MSc degrees, aiming in particular for a higher intake of international students. To these ends, we will

- improve our visibility in student recruitment initiatives;
- demonstrate clear career paths for graduates;
- ensure that our degrees are competitive with respect to the selection of elective courses, possibilities for industrial collaborations and studies abroad.

Make more use of our expertise for the benefit of SDU within teaching

With its unique mixture of expertise within pure and applied mathematics, statistics, eScience and computer science, IMADA is already providing research-based support teaching to many parts of SDU. However, there is both a potential and a need for increased teaching collaborations across the university. We wish to meet this need, by expanding the already existing collaborations and by developing new collaborations with other faculties. In particular, we will

 develop a Master's degree and course packages in Data Analytics to be offered across the entire university.

Research collaborations inside SDU and with OUH

IMADA has a long tradition of applying our competences in collaboration with other research environments at SDU and at Odense University Hospital (OUH). We see particularly strong potential to extend, further develop, and consolidate our ties with other research environments within areas such as

- data analytics, using our expertise in data mining, database systems and distributed computing.
- health, using our expertise in bioinformatics, chemoinformatics, statistics, resource optimization, data management and privacy;
- robotics and drones, using our expertise in optimization, online algorithms, statistics and data processing;
- theoretical physics, using our expertise in numerical analysis, eScience and high-energy physics to create a rich and competitive environment in the intersection of theoretical physics and applied mathematics.

Through this, IMADA will contribute to SDU's abilities for initiating and getting funded interdisciplinary research projects addressing societal challenges.

Collaborations with industry and public partners

Local, regional, and national industry partners and public organizations are showing a strong interest in collaborations with IMADA within, for example, areas such as algorithms, optimization, machine learning, Big Data, modeling and High Performance Computing. We see a rapidly increasing number of requests from SMEs as well as potential for extending collaborations in our ongoing dialogue with larger companies such as Vestas and Danfoss. Recently IMADA has played a key role, in collaboration with the SDU eScience Centre, in successfully organizing the first "Supercomputing Challenge", where companies present problems and work with students and researchers to find efficient solutions. It is planned to repeat the event on a national scale with the support of DelC.

We aim to further explore the potential for collaborations in order to

- increase our visibility to potential industrial partners;
- support ongoing and future collaborations;
- use our expertise to promote the development in the society around us, in particular on a municipal and regional level.

In particular, we see a large potential for contributing to the development of SMEs in our region by offering them our research-based analytical competencies and advanced research tools. For this to work on a larger scale, we envision the establishment of a dedicated technology transfer unit comprising dedicated academically trained employees (for example PhD graduates) as well as access to business development resources. The academic resource persons would be the primary technical contacts to companies performing research-based consulting and mediating contact with relevant researchers at

IMADA for more advanced and possibly research-generating challenges. The unit would closely work with the SDU eScience Centre and Cortex Lab for establishing and maintaining industry contacts and with IDEA for spinning off companies, if the demand arises. The income generated by the unit should contribute primarily to covering its personnel expenses.

Centre for Big Data

Current national and EU funding calls include Big Data as a primary topic, and it is expected that significant funding will continue to be allotted to the area during the coming decade. The ability to adequately handle big data sets is also an increasingly important competition parameter for industry. Big Data is already an area in which IMADA is highly active with research in data stream management and query processing, cloud computing, programming languages for concurrent systems, parallel computing, cryptography, algorithms for external memory and eScience. We have ongoing collaborations with external partners on Big Data topics, both on an academic and commercial level. We also see a strong need for our competences within Big Data at other parts of SDU.

We thus intend to create a Centre for Big Data with the purpose of gathering, solidifying and expanding SDU's competences in Big Data infrastructures and tools at all levels: regional, national and international. This centre will be tightly integrated in the framework of the SDU eScience Centre and its national HPC centre. The Centre for Big Data would have a coordinating role w.r.t. to SDU's involvement in the Big Data Value Association, its visibility in the context of Big Data in Horizon 2020, and Big Data-related degrees at SDU.

The centre would also host the "Data Experimentarium", a university-wide platform for supporting the application of data infrastructure and data analysis tools to problems from industry, public partners, and SDU/OUH research units, in close cooperation with both the proposed new technology transfer unit and Cortex Lab.

Increasing external funding

External funding is an important source of income for the department, providing support for research development, covering costs for equipment, guests and travel, and, in particular, helping to maintain a steady flow of PhD students and postdoctoral researchers. IMADA is prioritizing to increase the amount of external funding through a variety of efforts:

- excellent IMADA researchers are supported and encouraged to apply for traditional research funding from national and EU sources;
- relevant IMADA researchers are participating in interdisciplinary funding applications as part of IMADA's push to increase internal collaboration;
- research-based consulting through the new technology transfer unit is expected to play an increasing role as a source of external funding;
- membership in the Big Data Value Association through the Centre for Big Data is expected to bring long-term benefits in access to EU funding.

Stronger ties between mathematics and computer science

IMADA has a unique position as a department that brings together both mathematics and computer science. Having these two fields together in one department, together with subfields such as applied mathematics, statistics, eScience and theoretical physics, helps to further strengthen the department's expertise despite its rather modest size, and it also provides unique educational possibilities for our students and our ability to offer support teaching.

We wish to strengthen this unique position by promoting existing areas such as graph theory, optimization and combinatorics. We also wish to develop new areas that lie within the intersection of the two areas such as

- error correcting codes,
- cryptology,
- data compression.

We intend to make better use of the expertise that we already have at the department by developing more courses within these areas, in particular on MSc level, and making the supervision possibilities more visible for existing and future students.

Future positions

Based on the focus areas described above, our proposed scientific areas for hirings over the years up to 2020 are the following:

- Data analytics/machine learning/data mining
- Database systems
- Distributed computing
- Security/privacy/cryptology

We suggest no specific time-wise sequencing or prioritizing of these areas, but prefer instead to have broad calls including all areas.