DMF Annual Meeting 2018

DMF Annual Meeting 2018 takes place at Department of Mathematics, Aarhus University, June 25–26, 2018.

The first day of the meeting will focus on Mathematics related to Biology and Medicine inspired by the European Mathematical Society who declared 2018 as the Year of Mathematical Biology whereas the second day will focus on questions related to teaching mathematics at the university level briefly.

Mathematical researchers from Danish Universities and a special guest of honor, Michael Reed from Duke University, will give examples from their own research. Michael Reed and 'fagkonsulent for STX' Bodil Bruun will also contribute to the Educational perspectives.

Program for DMF's Annual Meeting 2018

Monday June 25

11:30–12:30	**Lunch**
12:45–13:00	**Welcoming by Steen Thorbjørnsen, president of DMF**
13.00–13.40	**Asger Hobolth(AU): Statistical learning of the mutational processes in cancer.**
13.50–14.30	**Morten Andersen (RUC): Mathematical modeling of blood cancer dynamics.**
14.30–15.00	**Coffee**
15.00–15.40	**Elisenda Feliu (KU) : Algebraic problems in modeling biochemical reaction networks.**
15.50–16.30	**Peter Røgen (DTU): Description and Comparison of Protein 3d-Structures with Emphasis on (Bio-)Topology.**
16.40–17.40	**Michael C. Reed (Duke): Why is mathematical biology so hard?**
18.15–21.00	**Banquet at AU**

Tuesday June 26

09:00–09:40	**Michael C. Reed (Duke): What is the role of biology in the mathematics curriculum?**
09.50–10.30	**Carl Winsløw (KU): Task Design for University Mathematics Education.**
10.30–11.00	**Coffee**
11.00–11.40	**Bettina Dahl Søndergaard (AAU): First year university students' approaches to calculus and their (mis)conceptions and retention of calculus concepts.**
11.50–12.30	**Bodil Bruun (STX): Studenters matematiske færdigheder og kompetencer 2020.**
12.30–13.00	**Closing remarks and sandwiches to-go.**

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Abstracts

Monday June 25

Asger Hobolth: Statistical learning of the mutational processes in cancer

In the last few years I have been involved in a major international effort to enhance our understanding of the mutational processes in human cancer. A particularly popular method is an unsupervised learning method called non-negative matrix factorization (NMF). I will describe NMF and why it is useful. Parameter estimation in the NMF model is a difficult high-dimensional optimization problem. I will compare a number of NMF optimization algorithms: Gradient descent, Majorize-Minimize, Expectation-Maximization, and a procedure based on Cone Projection in convex analysis. A major finding is that a mix-and-match strategy often performs better than running each algorithm in isolation. This is joint work with Astrid Kousholt (Novo Nordisk), Qianyun Guo (Aarhus University) and Jens Ledet Jensen (Aarhus University).

Morten Andersen: Mathematical modelling of blood cancer dynamics

We develop and investigate a mathematical model of the blood cancer type Philadelphia- negative myeloproliferative neoplasms (MPNs) coupled with immune response. The MPNs have a low incidence but a prevalence as lung cancer, since most MPN patients live with the disease for decades although with a high risk of thrombosis and an increased propensity to develop autoimmune and chronic inflammatory diseases. Due to several feedback signals e.g. stem cell niche interaction, and cytokine feedback on the stem cell dynamics, the governing differential equations are nonlinear. Based on time scale separation we then investigate a new reduced model with only two dynamic variables and four algebraic equations which approximate the original model very well. Results of the reduced models comprise a complete mathematical investigation of steady states and their stability. We provide conditions for a globally stable healthy state, MPN state or coexisting state with low number of cancerous cells. The results are compared to clinical data and implications for treatment strategies are discussed.

Elisenda Feliu: Algebraic problems in modeling biochemical reaction networks

Under the law of mass-action, the concentrations of the species of a chemical reaction network are often modelled by means of a system of polynomial ordinary differential equations. The polynomial structure of the system allows us to use techniques that come from algebra and graph theory to study properties of the system, mainly at steady state. This is the basis of the so-called Chemical Reaction Network Theory. In this talk I will start by presenting the formalism of the approach and discuss the questions we would like to address. I will proceed to present some of the results we have recently obtained, mainly focusing on the number of steady states of the system.

Peter Røgen: Description and Comparison of Protein 3d-Structures with Emphasis on (Bio-)Topology

Structure comparison is fundamental for our understanding of proteins and other bio-molecules. Native protein chains describe open (and not closed) curves. Hence, methods from Knot Theory cannot be applied directly to study protein structures. However, protein structures are so folded that ideas and computational efficient methods from or inspired by knot theory are needed to describe and compare them. I will show applications of Reidemeister moves and knot invariants to protein structures.

Michael C. Reed: Why is Mathematical Biology So Hard?

Are biology and medicine different from the traditional applications of mathematics? And, anyway, is there new mathematics in it? These questions will form the basis of a discussion about the challenges and opportunities at the interface between mathematics and the biological sciences. Several different physiological systems, ranging from insect respiration to liver toxicology to the neural basis for mood and cognition, will be introduced to illustrate these questions, especially the intellectual challenges. A particular emphasis will be to show how new mathematical questions arise naturally if one really looks at the biology.

Tuesday June 26

Michael C. Reed: What is the role of biology in the mathematics curriculum?

In the U.S.A., mathematical biology is a flourishing branch of mathematics, while 30 years ago mathematical biology was almost unknown. What is the reason for this sea change, and what does it mean for mathematics as a discipline? Currently, most of science is biology, so if you believe that mathematics as a discipline should contribute to science, then mathematics departments must relate to biology and medicine. However, there are good reasons why many mathematicians are uncomfortable on the messy landscape in biology. So, how should mathematics departments and individual mathematicians respond to these changes? And what are the best ways to teach mathematical biology? These issues, which are difficult, will be discussed, focusing on the administrative and pedagogical issues.

Carl Winsløw: Task Design for University Mathematics Education

We present some examples and main notions of task design as a method of intervention based research on the teaching and learning of mathematics at university, with a special focus on the transition from Calculus to Real Analysis, on inquiry oriented and 'research-like' situations in such courses, and on the alignment of tasks used in teaching and assessment. In particular, we emphasize the key role of mathematics itself in such research.

- E. Nardi & C. Winsløw (2018), Select Papers from the first International Network for Didactic Research in University Mathematics (INDRUM) conference. Special Issue of

International Journal of Research in Undergraduate Mathematics Education, Vol. 4, Issue 1, April 2018.

- C. Winsløw, G. Gueudet, R. Hochmut & E. Nardi (2018), Research on University Mathematics Education. In: T. Dreyfus, M. Artigue, D. Potari, S. Prediger & K. Ruthven (Eds.), Developing research in mathematics education – twenty years of communication, cooperation and collaboration in Europe. Oxon, UK: Routledge – New Perspectives on Research in Mathematics Education series, Vol. 1, pp. 60–74.
- C. Winsløw (2018). Analysis teaching and learning. In S. Lerman (Ed), Encyclopedia of Mathematics Education, Springer 2018 (to appear).

Bettina Dahl Søndergaard: First year university students' approaches to calculus and their (mis)conceptions and retention of calculus concepts

In my talk I present some of my research on how first year university students learn, or fail to learn, calculus. The research is done in the USA, Croatia, and Denmark. Some of my research is focused on the students' study and learning approaches, which includes to what extent they seek deep or surface understanding. I also show examples of how students solve calculus tasks and which types of partical understandings occur, including to what extent they apply the concept definitions or just a concept image while solving these tasks. Finally I show some examples of students' long term retention of previous learnt calculus; what is it that they remember?

Bodil Bruun: Studenters matematiske færdigheder og kompetencer 2020

Med gymnasiereformen i 2005 blev fagbekendtgørelser til læreplaner for faget med fokus på matematiske kompetencer og eksperimenterende tilgang i læring af de faglige emner blandt andet med brug af stærke matematiske værktøjsprogrammer. Desuden var der en åbenhed med plads til at udforske faget og tværfaglige emner, hvor elever kunne arbejde problemorienteret med brug af matematik og andre fag. De senere år har vist en udbredt tendens til en mere ensidig tilrettelæggelse med fokus på den skriftlige eksamen, hvilket har betydet, at den frigivne plads i stedet er blevet udnyttet til 'mere af det samme'. Parallelt hermed tog brugen af de matematiske værktøjsprogrammer en uhensigtsmæssig drejning over mod mere instrumentelt arbejde med faget. I 2015 kortlagde Carl Winsløv mfl. fagets status i "Matematikudredningen", som dannede grundlag for nedsættelse af Matematikkommissionen i efteråret 2016. Matematikkommissions anbefalinger er implementeret i de nye læreplaner for faget matematik i alle fire gymnasiale uddannelser (stx, hf, hhx, htx). Oplægget fokuserer på de forandringer, det har medført i læreplanerne, og for de forventninger, vi har til de nye stx-studenters matematiske færdigheder og kompetencer fra sommeren 2020 og frem.