Seminarier i tvärvetenskaplig matematik

2016

Fredag 4 november 2016, Göran Bergqvist, MAI, Linköpings universitet

Titel: The higher-order singular value decomposition

Sammanfattning: The singular value decomposition of a matrix is a standard tool in engineering for low-rank approximation and compression of data. When data is given as a multidimensional array or tensor, several generalisations are possible. The most used today in real applications is the so-called higher-order or multilinear singular value decomposition presented by De Lathauwer, De Moor and Vandewalle in 2000. We describe this decomposition and some of its properties regarding computation, low-rank approximation and applications.

Fredag 26 februari 2016, Eric Setterqvist, MAI, Linköpings universitet

Titel: Taut Strings and Real-Time Communication

Sammanfattning: Consider a communication system where a sender produces information which are supposed to be transmitted to a receiver through a channel with time-dependent capacity. At some time instances the channel capacity might be smaller than the amount of information produced by the sender. In order to save part of the information that cannot be transmitted, the sender has a buffer that can store some amount of information for transmitting at later time instances. One typical example in this setting is streaming of video over the Internet.

A problem that arises is how to use the buffer optimally throughout the sending period with respect to the communication quality. To address this problem we introduce the notions of taut strings and invariant φ-minimal sets. With these notions at hand we can, for a wide range of quality metrics, characterize the optimal buffer management strategy and provide algorithms for computing it. Generalization to the case when several pairs of senders and receivers share the channel will also be considered.

2015

Fredag 4 december 2015, Oleg Burdakov, MAI, Linköpings universitet

Titel: On Jacobian matrix approximations and their application in solving nonlinear equation and least-squares problems

Sammanfattning: Our involvement in solving inverse problems in diffuse reflectance spectroscopy and laser Doppler flowmetry stimulated our activity in developing efficient Jacobiam matrix approximations of various types. These inverse problem are constrained nonlinear least squares problems involving a regularization. For solving them, we applied a Broyden-type quasi-Newton approximation of the first derivatives (the Jacobian matrix) of the model with respect to its parameters. Bearing in mind that, for the medical equipment mentioned above, the solution time is a critical parameter, we focused on more efficient Jacobian approximations adopted to solving the related inverse problem. We developed efficient multipoint secant and also interpolation-type approximations of the Jacobian matrix. The numerical experiments show that the new approximations are more accurate than those produced by Broyden's updating formula. This requires less number of iterations for solving the mentioned problem, and as the result, less number of calls of the model which constitutes the major part of the computational time. The aim of this talk is to present our results related to Jacobiam matrix approximations.

Fredag 17 april 2015, Magnus Herberthson, MAI, Linköpings universitet

Titel: Diffusion modeling for magnetic resonance imaging (MRI)

Sammanfattning: Magnetic resonance imaging (MRI), is a technique for e.g. imaging parts of the human body, often for medical purposes. MRI scanners use strong magnetic fields which couple to the dipole moments of water, and by applying oscillating fields, the emitted response reveals the type of tissue under investigation. In the mid-1980s, techniques which also addressed diffusion appeared and they are known as dMRI, diffusion MRI.

To interpret correctly the signals collected from the scanners, a knowledge of the diffusion process within the tissue is important. I will present a way to model such diffusion, which has been developed together with collaborators at IMT, Institutionen för medicinsk teknik.

Fredag 27 februari 2015, Masao Fukushima, Nanzan University, Nagoya, Japan

Titel: Equilibrium Problems under Uncertainty

Sammanfattning: Various equilibrium problems and related problems, such as the complementarity problem (CP), the variational inequality problem (VIP), and the mathematical program with equilibrium constraints (MPEC), have been studied extensively. Since some elements may involve uncertain data in many practical problems, it is undoubtedly important to study those problems under uncertainty. The presence of random factors means, however, that there is no single solution that is applicable to all realizable cases. Therefore, the challenge is to construct a deterministic model that yields a reasonable resolution of such a problem. In this talk, we will first briefly mention some examples from traffic equilibrium and American option pricing, and then present some approaches developed to deal with equilibrium problems under uncertainty, including the stochastic variational inequality problem (SVIP), the stochastic complementarity problem (SCP) and the stochastic mathematical program with equilibrium constraints (SMPEC).

Fredag 23 januari 2015, Martin Singull, MAI, Linköpings universitet

Titel: EM-algorithm for the multilinear normal distribution

Sammanfattning: Some recent papers consider estimation of a covariance matrix with Kronecker structure of higher order.

Singull et al. (2012) and Manceur and Dutilleul (2013) extend the estimation procedure for the matrix normal distribution to the multilinear normal distribution of order three and Ohlson et al. (2013) consider the case of higher order tensors of order k. For the multilinear normal distribution of order k, the covariance matrix for a vectorization of the tensor is given by a Kronecker product of k positive definite covariance matrices. The likelihood equations for the multilinear normal distribution are nested, for which no explicit solution exists, hence one can use the so called flip-flop algorithm to find a solution to the k likelihood equations. We will derive a novel expectation maximization (EM) algorithm to compute maximum likelihood estimates in models involving the multilinear normal distribution. It is of great interest to understand the differences and similarities between the flip-flop algorithm and the EM algorithm and also to compare the performance of the two algorithms.

2014

Fredag 5 december 2014, Torkel Glad, ISY, Linköpings universitet

Titel: Modeling of insulin signaling in cells

Sammanfattning: When the insulin level outside a cell changes there will be a series of reactions among proteins in the cell. These reactions can be modeled using ordinary differential equations. Of

particular interest are the mathematical properties associated with responses that have large overshoots.

Fredag 14 november 2014, Claudio Altafini, ISY, Linköpings universitet

Sammanfattning: In this talk I will give an overview of the commonly used "Flux Balance Analysis" framework for modeling genome-wide metabolic networks and discuss some of its standard uses, like the computation of the growth rate as a linear programming problem, or the minimization of the metabolic adjustment that follows a gene knockout as a quadratic programming problem. I will then present the results of our research on describing the effect of drugs and of drug combinatorics on a metabolic network as a bilevel optimization problem.

2013

February 15, Anders Persson, Center for Medical Image Science (CMI)

Anders Persson, director of the Center for Medical Image Science.

Title: Visualization of Quantified Image data - Key to Future?

Abstract: The practice of medical image diagnosis is currently undergoing a fast transformation. Vast amounts of data can be generated in standard examinations and focus is shifting from improving the collection of relevant data for diagnosis to development of effective methods to analyze, visualize, navigate, quantify and interact with medical information. It is now becoming generally accepted in the medical community that one of the most important keys to manage the increasing information work load is the use of 3D, 4D applications and to quantify the data. This talk will take its starting point in state-of-the-art medical visualization and then discuss the need for a research agenda that focuses on the development of the next generation of medical visualization tools, emphasizing the fact that these tools must be based on medical user requirement and work flow studies as well as on new technical developments.

2012

October 12, Ola Friman, Swedish Defence Research Agency (FOI)

Ola Friman received his PhD in medical image analysis from Linköpings universitet in 2003. He then spent 2 years at Harvard Medical School and Massachusetts Institute of Technology, continuing his work in the medical image analysis area. In 2005, he moved to Germany for a position as Head of Image Processing at the Fraunhofer MEVIS research institute. Since 2011, he is back in Linköping as a group leader for the image analysis research at the Swedish Defence Research Agency (FOI). He also has a 'docentur' at the Department of Biomedical Engineering, Linköpings universitet.

Title: Blood Vessel Analysis in 3D and 4D Medical Images

Abstract: This presentation introduces methods for analysing blood vessels and vasculature in 3D and 4D medical images. A brief background on vascular diseases will be given, as well as background on applications in which information about blood vessels is of importance, such as surgical planning. The focus will then be on image analysis methods for measuring, segmenting, visualizing or otherwise extracting relevant information about vessels in CT and MRI images. The lecture will be concluded with examples of current research activities in the area, such as vessel tracking and uncertainty estimation methods.

May 25, Olof Dahlqvist Leinhard, CMIV

Olof Dahlqvist Leinhard Olof Dahlqvist Leinhard is a researcher at the center for medical image science and Visualization (CMIV) at Linköping University. He is a physicist with a research focus on

development of quantitative Magnetic Resonance Imaging (MRI) methods, medical image analysis and application of new imaging methods in clinical research projects. At the seminar a research project with focus on development of new methods for acquisition and analysis of whole body high resolution fat/water separated MRI will be presented.

Specific areas covered in the seminar:

- 3D phase field unwrapping of MR-images using the inverse gradient method
- Bias field estimation from sparsely sampled data using multi-scale adaptive normalized averaging
- Whole body non-rigid registration for automatic atlas-based segmentation allowing manual correction of segmentation results.
- Clinical projects: Whole body fat and muscle tissue segmentation.

April 20, Thomas Schön, ISY

Thomas Schön was born in Sweden in 1977. He received the the Ph.D. degree in Automatic Control in Feb. 2006, the M.Sc. degree in Applied Physics and Electrical Engineering in Feb. 2001 and the B.Sc. degree in Business Administration and Economics in Feb. 2001, all from Linköping University, Linköping, Sweden. He has held visiting positions at the University of Cambridge (UK) and the University of Newcastle (Australia). His research interests are mainly within the areas of signal processing, machine learning and system identification, with applications mainly to the automotive and aerospace industry. He is currently an Associate Professor at Linköping University.

Title: Computational methods for estimation of nonlinear dynamical systems

Abstract: This talk will provide an overview of some of the speaker's current research activities in the areas of nonlinear system identification and sensor fusion. The key enabler allowing us to successfully solve hard nonlinear system identification problems is the so called Sequential Monte Carlo (SMC) method, where the popular particle filter is one notable member. It will be shown how to compute both Maximum Likelihood (ML) and Bayesian estimates. ML estimates are computed using the Expectation Maximisation algorithm invoking a particle smoother, solving the inherent nonlinear state smoothing problem. The Bayesian estimates are computed using recently developed so called Particle MCMC (PMCMC) methods. The second part of the talk will introduce several successful applications of sensor fusion. Sensor fusion refers to the problem of computing state estimates using measurements from several different, often complementary, sensors. The applications involve; indoor pose estimation of a human body (using inertial sensors and ultra-wideband), pose estimation of a helicopter using a map (using inertial sensors and a camera), vehicle motion estimation (using inertial sensors and an infrared camera) and finally real-time pose estimation of a helicopter (using inertial sensors and a camera) and autonomous landing of the helicopter.

March 30, Gunnar Cedersund, IKE, IMT

Gunnar Cedersund is a theoretical physicist, who did his Ph.D. on systems biology within control engineering departments (ISY and S2-Chalmers), and which now leads a joint experimental/theoretical group at IKE and IMT together with Peter Strålfors. The research field systems biology is concerned with the usage of mathematical modeling: to analyse data and to keep track of complex reasonings. Gunnar's research has more specifically been centered around ordinary differential equations, in particular identification of unique predictions despite unidentifiability and over-parametrization, parameter optimization, model reduction, and multi-level modelling. Gunnar is

also starting up a systems biology centre here in Linköping, comprising some 15 research groups, world-leading guest professors, and regular international workshops.

January 27, Fredrik Elinder, LiU

Fredrik Elinder got his PhD in Neurophysiology 1994 at Karolinska Institutet and became professor of Molecular Neurobiology 2004 at Linköping University. His research focus today is on the exploration of voltage-gated ion channels at all levels from the molecule to the system. The work includes electrophysiology, molecular biology, biochemistry, biophysical calculations and computer simulations.

Title: Modelling electrical activity in the brain and the heart

Abstract: Voltage-gated ion channels are key players underlying electrical activity in the brain and the heart. In this presentation, I will talk about how ion channels can be modelled, how action potentials in neurons and heart cells calculated, and how the propagation in a neuron can be investigated. Furthermore pharmacological effects on the ion channels will be explored with computer models.

2011

December 9, Robert Forchheimer, ISY

Robert Forchheimer is professor at the division of Information Coding at ISY. His main research area for nearly three decades has been Image and Video Coding aiming at highly compressed data rates for transmission and storage. In parallel he was involved in packet radio networking and optical computing. More recently he has published works in areas such as optical networks, organic electronics and systems biology. The talk will introduce and highlight specific issues from some of these areas.

November 11, Tomas Strömberg, IMT

Tomas Strömberg is professor at the Department of Biomedical Engineering (IMT) at LiU. His research concerns biomedical optics, i.e. the interaction between light and tissue. Measurement modalities are denoted diffuse light spectroscopy where broadband light is illuminating a tissue via an optical fiber and backsacattered diffuse light is recorded by other fiber (-s) at some distance from the source. Fibers are incorporated in a plastic probe with well defined geometry. We also utilize Laser Doppler Flowmetry, where a laser source of a single wavelength interacts with tissue in a similar probe. These two modalitities can be modeled using light transport theory in highly scattering media, where the interaction depends on scattering and absorbing properties of tissue. Tissue may be skin that has a clear layered structure. Analytical solutions of light transport is impossible in a realistic geometry. Instead we use Monte Carlo methods and statistical sampling of photon trajectories to simulate light transport. Simulations are time consuming, but may be reduced using symmetry properties and ways to accelerate calculations. The talk will present the background of the research and focus on the algorithm development.

October 13, Eric G. Larsson, ISY

Erik G. Larsson is professor of Communication Systems at ISY. In his talk, he will give a background to multiple-antenna (MIMO) technology for wireless communications and describe some of the opportunities and challenges that arise when scaling up MIMO technology to use very large arrays.

May 12, Fredrik Gustavsson

Fredrik Gustavsson is professor in sensor informatics at the Department of Electrical Engineering, LiU. The talk will describe a couple of entrepreneurial initiatives for spinning off research results into new companies. The common theme in these is a business model of licensing patent protected

mathematical algorithms for embedded systems in consumer products such as cars, music studio equipment and smart-phones.

March 24, Igor Zozoulenko

Igor Zozoulenko is professor in mathematical physics at Linköping University (ITN). In his lecture he will talk about the latest Nobel Prize in physics which was awarded "for groundbreaking experiments regarding the two-dimensional material graphene". Being just a one atom thick, graphene is the first truly two-dimensional material ever produced in laboratory. It has exceptional electronic, optical, and mechanical properties strikingly different from those of conventional semiconductors and metals, and is considered by many as the future material for photonics and electronics.

February 24, Jonas Stålhand

Jonas Stålhand obtained his PhD in 2005 in Engineering Mechancis with a thesis on the mechanical modelling of human arteries. In this talk, he will give an introduction to mechanical modelling of the cardiovascular system and discuss some of the unique problems associated with this field.

January 27, Per-Erik Forssén

Per-Erik Forssén obtained his PhD in 2004 in computer vision. During 2006 and 2007 he was a postdoc at the University of British Columbia in Canada, working on robot vision and machine learning. He is currently assistant professor (LiU Foass) at Linköping University. This lecture describes one of his current projects which studies high-quality image stabilisation for cellphones.

2010

December 2, Eric Setterqvist

Title of the talk: Challenges and experiences in solar energy innovation

Eric Setterqvist is the chairman of the board of the company Global Sun Engineering AB, Luleå. In 2005 Eric Setterqvist wrote his master's thesis in mathematics (part of it was published in Proceedings of AMS) and then founded with some other students of the university the company which uses innovations for producing inexpensive solar energy.

November 18, Larsgunnar Nilsson

Larsgunnar Nilsson is a professor (chair) in Solid Mechanics at Linköping university and also president of Engineering Research Nordic AB, Linköping.

October 21, Fredrik Berntsson

Title of the talk: The finite element method.

Fredrik Berntsson obtained his PhD in 2001 in scientific computing and gave a course on the finite element method in Rwanda (2008) and at MAI (2010). In his talk he will give introduction to the finite element method from both a mathematical and a computational point of view. He will also discuss the contents of the courses that he has given to students.