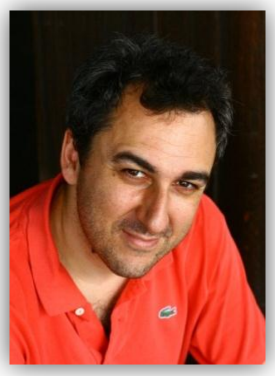
ANNUAL SEMINAR IN OPTIMIZATION AND SYSTEMS ENGINEERING 2013

The Center of Excellence in Optimization and Systems Engineering at Åbo Akademi University organizes a one-day seminar on Friday November 15th in Forum Marinum, Auditorium Ruuma, Linnankatu 72, Turku, Finland.

The plenary speaker, Professor Leo Liberti, currently active at IBM Thomas J. Watson Research Center Yorktown Heights, New York, will hold two lectures connected to symmetry in mathematical programming and distance geometry.



PROF. LEO LIBERTI
Plenary speaker

Leo Liberti has a PhD in optimization from Imperial College London, UK. He was a professor at École Polytechnique (Paris) until 2012, as well as a vice-president of his department, and is currently a researcher at IBM Research. He has published more than 150 research papers on mathematical programming, global and combinatorial optimization, distance geometry, bioinformatics, and industrial systems applications. He is also the author and editor of several books in optimization including "Distance Geometry: Theory, Methods and Applications" coedited with A. Mucherino, C. Lavor and N. Maculan, Springer New York, 2013, and "Global Optimization: from Theory to Implementation" coedited with N. Maculan, Springer Berlin, 2006.

The complete seminar program is given below. In addition to Professor Liberti's lectures, presentations will be given by postgraduate students active within the Center of Excellence in Optimization and Systems Engineering.

The seminar is free (including lunch and coffee) and open to anyone interested.

For registration and more information visit the OSE group's website at www.abo.fi/ose. Deadline for registration is Friday November 8th.

MORNING SESSION

Chair: Professor Tapio Westerlund

10.00 **Professor Tapio Westerlund**
Chairman of the OSE group
Opening statement

10.05 **Professor Leo Liberti**
Symmetry in mathematical programming

10.50 **COFFEE BREAK**

11.15 **Professor Leo Liberti**
Distance constraints in Euclidean geometry

12.00 **LUNCH BREAK**

AFTERNOON SESSION

Chair: Dr Andreas Lundell

13.30 **Mikael Nyberg**
Weather routing – using dynamic programming to win sailing races

13.50 **Johan Pensar**
Marginal pseudo-likelihood: a Bayesian approach for learning the graph structure of a Markov network

14.10 **Anders Skjäl**
Complexity theory for the global optimizer

14.30 **COFFEE BREAK**

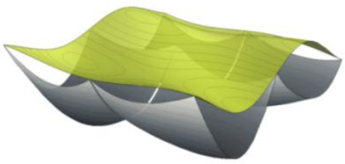
15.00 **Amir Shirdel**
Trend and system identification with orthogonal basis function

15.20 **Axel Nyberg**
Applications of the quadratic assignment problem

15.40 **Otto Nissfolk**
Reformulation of 0-1 quadratic programs

16.00 **Henrik Nyman**
Stratified Gaussian graphical models

PLENARY LECTURES IN OPTIMIZATION



At this year's seminar in Optimization and Systems Engineering, the invited speaker Professor Leo Liberti from IBM Thomas J. Watson Research Center, Yorktown Heights, New York, will hold two lectures connected to OSE research.

Symmetry in mathematical programming

When solving Mathematical Programming (MP) problems using Branch-and-Bound (BB), be they linear or nonlinear, continuous or mixed-integer, the presence of symmetries of the solution set results in BB taking longer than strictly needed, due to the symmetries induced on the BB tree.

I shall illustrate a class of "symmetry breaking" methods based on reformulating the symmetric MPs so that some of the symmetric optima become infeasible. I shall show how to automatically detect MP formulation symmetries by reducing MP to graphs, and how to automatically generate reformulated MPs with (hopefully) fewer symmetric optima.

Although computational tests show that reformulations may not always succeed in making BB terminate faster, they can be applied very efficiently – so they can be considered an efficient "pre-solving step" to running BB.

Distance constraints in Euclidean geometry

The central problem of Distance Geometry (DG) is an inverse problem: given a weighted undirected graph *V* and an integer *K*, find an embedding of *V* into R^K such that the Euclidean distance between pairs of points corresponding to graph edges is the same as the graph weight.

There are many important applications to this abstract geometric problem: protein conformation, localization of wireless sensor networks, clock synchronization, robotic control, and others.

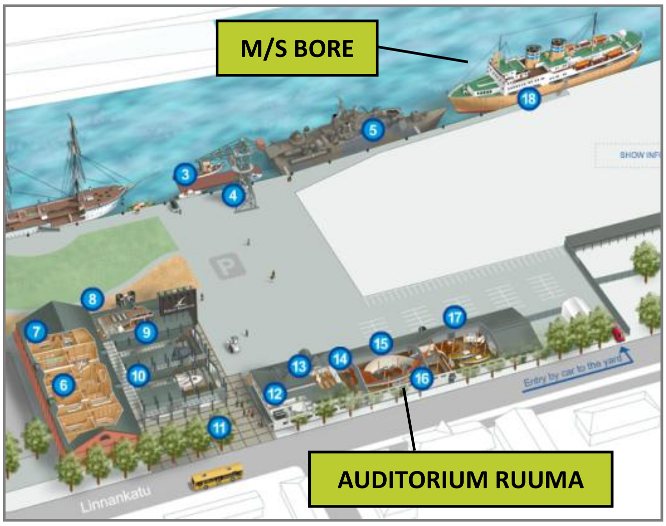
I am going to discuss an efficient algorithms for finding solutions under some density conditions.

ABOUT THE VENUE – FORUM MARINUM

"The Forum Marinum Maritime Centre is a lively and versatile center for maritime activities, comprising a national special maritime museum, and the Finnish Navy Museum."

Forum Marinum is located in a historic environment close to the castle and harbor in Turku (Address: Linnankatu 72). **The lectures will be held in Auditorium Ruuma and the lunch at M/S Bore.**

More information can be found at **www.forum-marinum.fi**



SOURCE: WWW.FORUM-MARINUM.FI

POSTGRADUATE PRESENTATIONS

MIKAEL NYBERG
PhD student

WEATHER ROUTING – USING DYNAMIC PROGRAMMING TO WIN SAILING RACES

Weather routing is an ancient art born long before computers and optimization. Historically weather routing was based on historic data, personal observation and conventional wisdoms. However, development of powerful optimization models combined with accurate weather prediction has changed the landscape of weather routing completely. Today, sophisticated optimization models, often using dynamic programming, are used to find optimal routes in everything from short “around the cans”-races to non-stop around the world ordeals. This talk will be a brief introduction to weather routing; how it works, what data is required and how solutions are used. The problem is solved recursively using dynamic programming techniques to find the fastest route through the network. Furthermore, the evolution of routing algorithms will be discussed. Examples include Volvo Ocean Race Game, the world’s largest virtual regatta with over 178.000 registered boats in 2012.

JOHAN PENSAR
PhD student

MARGINAL PSEUDO-LIKELIHOOD: A BAYESIAN APPROACH FOR LEARNING THE GRAPH STRUCTURE OF A MARKOV NETWORK

Markov networks are used in a wide variety of applications in fields ranging from computer vision to natural language and computational biology. Learning the undirected graph structure of a general Markov network is a hard computational problem. The computation of the generally intractable partition function renders likelihood-based methods ineffective for large-scale models. One approach for circumventing this issue in maximum likelihood-based approaches has been to replace the likelihood function with the pseudo-likelihood. The factorization of the pseudo-likelihood also makes it interesting from a Bayesian perspective. Under certain assumptions, the marginal pseudo-likelihood can be efficiently evaluated through an analytical expression similar to the marginal likelihood for a DAG structure of a Bayesian network.

ANDERS SKJÄL
PhD student

COMPLEXITY THEORY FOR THE GLOBAL OPTIMIZER

Many texts on global optimization acknowledge hardness results from complexity theory, but few dwell on the implications for deterministic, stochastic and heuristic algorithms. It is common knowledge that many general classes of optimization problems are NP-hard. Convex optimization is the notable exception on the continuous side. For discrete problems the border between easy and hard is less intuitive, but a large reference literature exists. Complexity theory has also clarified the limits of approximation algorithms. In this talk I outline some central concepts from theory and discuss how they relate to optimization algorithms in practice. Some well-known problems and algorithms serve as illustrations.

AMIR SHIRDEL
PhD student

TREND AND SYSTEM IDENTIFICATION WITH ORTHOGONAL BASIS FUNCTION

In experimental system identification, disturbances can affect destructively estimation of system parameters. By using a model structure based on orthogonal Laguerre or Kautz basis function expansions, and sparse optimization with l_1-regularization and iterative re-weighting, we can identify the system parameters and structural disturbances simultaneously. An important property of orthogonal basis function is to cover system delays, reduce the model complexity and by using output error identification, the identified models are more reliable and robust for multistep prediction than other model structures. A model order reduction stage can also give a lower-order system with acceptable performance. In this contribution we present the method and demonstrate it on a simulated example and on real distillation column data. The results show that with the proposed method accurate system models can be identified using experimental data containing unknown trends and outliers.

AXEL NYBERG
PhD student

APPLICATIONS OF THE QUADRATIC ASSIGNMENT PROBLEM

The quadratic assignment problem (QAP) was presented in the literature 1957 by Koopmans and Beckmann as a mathematical model to allocate economic activities to specific locations. Since then, an astonishing number of problems in a number of completely different fields have been solved as QAPs. The problem can be illustrated with two matrices, one corresponding to distances between locations and the other to flows between facilities. The structure of these matrices vary quite drastically between fields of applications and therefore the choice of method is important. This talk will focus on real world examples, as well as a short summary of my work related to solving QAPs.

OTTO NISSFOLK
PhD student

REFORMULATION OF 0-1 QUADRATIC PROGRAMS

Semidefinite programming (SDP) can be used to derive tight convex relaxations of hard optimization problems. 0-1 quadratic programming (QP) problems can be convexified by using SDP to obtain the optimal convexification vector. I will present a new SDP relaxation also utilizing nondiagonal elements in the SDP for lower bounding. The 0-1 QP problems used for testing consist of: (1) Coulomb glass problems, a special type quadratic assignment problem, (2) the taixxxc problems, a type of gray-scale pattern problems and (3) Boolean least squares problems, found in digital communication.

HENRIK NYMAN
PhD student

STRATIFIED GAUSSIAN GRAPHICAL MODELS

Gaussian graphical models represent the backbone of the statistical toolbox for analyzing continuous multivariate systems. However, due to the intrinsic properties of the multivariate normal distribution, use of this model family may hide certain forms of context-specific independence that are natural to consider from an applied perspective. Such independencies have earlier been introduced to generalize discrete graphical models and Bayesian networks into more flexible model families. I will present a class of models that incorporates the idea of context-specific independence to Gaussian graphical models by introducing a stratification of the Euclidean space such that a conditional independence may hold in certain segments but be absent elsewhere.

The Optimization and Systems Engineering group at Åbo Akademi University is an interdisciplinary research group within the Division of Natural Sciences and Technology. Appointed a Center of Excellence within research at the university for the period 2010-2014, the group focuses on theory, methods and algorithms in systems engineering, optimization and statistics, as well as their applications in science and engineering.

For more information please contact Chairman Professor Tapio Westerlund (Process Design and Systems Engineering), Professor Paavo Salminen (Mathematics), Professor Jukka Corander (Statistics), Professor Hannu Toivonen (Industrial Systems Engineering), Dr Andreas Lundell or visit www.abo.fi/ose.