SOAF
SVENSKA OPERATIONSANALYSFÖRENINGEN

SOAK 2017 Programme

Schedule

		Room A35	Room A36
19/10	10.00-11.00	Coffee and registration	
	11.00-11.15	Welcome (Room A35)	
	11.15-12.00	Plenary (Room A35): Anders Arweström Jansson "Two shades of human thinking: Analysis and design of decision support systems for expert users"	
	12.00-12.10	Photo (outside Universitetsklubben)	
	12.10-13.30	Lunch (Universitetsklubben)	
	13.30-15.00	Software and Operational Research	Simulation
	15.00-15.30	Coffee	
	15.30-17.00	Spatial coordination and Dose planning	Economy and Transportation
	17.00-17.30	Subben's checklist revisited (Room A35)	
	17.30-18.00	Mingle (Universitetsklubben)	
	17.30-	Conference dinner (Universitetsklubben)	
20/10	9.00-10.30	Large real-world problems (and reasonable solution times)	Operational research in the public sector
	10.30-11.00	Coffee	
	11.00-11.45	Plenary (Room A35): Jan Frelin "What causes all uncertainty?"	
	11.45-13.00	Lunch (UK)	
	13.00-14.30	Taming uncertainty	Optimization tools
	14.30-15.00	Coffee	

Plenary Sessions

Two shades of human thinking: Analysis and design of decision support systems for expert users

19 October, 11.15-12.00, Room A35

Anders Arweström Jansson, professor at the Department of Information Technology, Division of Visual Information and Interaction, Uppsala University

In this talk, I will present results and experiences from more than fifteen years of research on analysis and design of decision support systems, mainly from the transportation sector but also from intensive care and process industries. I will also put these and other results in the context of the combined research on human judgment and decision making in environments that are complex, dynamic and non-transparent. I will show examples of both good and bad design solutions when it comes decision support systems, and explain why some of them work while others do not. A consistent theme in our research is analysis and design for experienced users: to design for skilled professionals demand a certain amount of discipline when it comes to understanding the expertise necessary for carrying out the work with overall objectives as efficiency, safety, productivity, etc. in mind. I will briefly describe some of the methods we use to analyse and interpret skilled professionals' behaviour and performances, as well as, the design rationales and principles we use as a starting point when we design for expert users. We have come to the conclusion that human judgment and decision making is most appropriately interpreted as two shades of human thinking, and that in order to design for experienced and skilled users we need to recognise complexity and the need for resilience. I will end the talk by putting this conclusion into the context of the recent technological trends with autonomous systems and demands for higher levels of automation.

What causes all uncertainty?

20 October, 11.00-11.45, Room A35

Jan Frelin, Deputy Research Director at FOI

The aim of this talk is to discuss fundamental sources of uncertainty, or unpredictability. Initially I review research by Murray Gell-Mann and Per Bak, who has, with different approaches, have discussed limits to predictability. I then discuss the scope for prediction, and the types of uncertainty that are characteristic of complex systems. Finally, I discuss various methods for addressing uncertainty, and their domains of application.

List of talks

Software and operational research

19 October, 13.30-15.00, Room A35

Design of a Driver Advisory System for Electric Multiple Units based on a Dynamic Programming Approach
Nima Ghaviha, School of Business, Society and Engineering, Mälardalen University

In this talk, we present the application of Dynamic Programming for designing a driver advisory system and discuss the challenges and solutions. We will also present an approach to have a more detailed estimation of power losses in the propulsion system for this optimization purpose. Finally, we will present our driver advisory system with a demo of the application of the system on a real train.

Optimization Models for System Quality and Decisions
Pasqualina Potena, RISE SICS Västerås

Modern software applications are becoming more demanding on non-functional properties (e.g., reliability, performance, security) that determine the user-perceived software quality. This talk is based on our experience in the field of software quality optimization, where we have proposed several models for this goal. A particular emphasis will be given to how quality models can be embedded in optimization models for decisions across multiple lifecycle phases.

Scheduling in Software testing
Patrik Eveborn, Optimal Solutions AB

The talk will be about a project for a customer that performs extensive automated testing of software on expensive hardware. By using optimization techniques for scheduling the tests, the hardware can be shared much more efficiently. At the same time a concept for quality of service for the users has been introduced that also improves precision in response times.
The system is based on Column Generation and is in continuous use. In addition, a module has been built that analyzes and locates redundant hardware, which then can be decommissioned or rebuilt for new purposes.

Explicit modelling of multiple intervals in a constraint generation procedure for multiprocessor scheduling
Emil Karlsson, Department of Mathematics, Linköping University

Multiprocessor scheduling is a well-studied NP-hard optimisation problem that is of interest in a variety of applications. The focus of this presentation is explicit modelling of tasks with multiple intervals. This work extends a constraint generation procedure previously developed for avionics scheduling and we here address a relaxation of the problem that can be considered as a multiprocessor scheduling problem with precedence relations.

Simulation

19 October, 13.30-15.00, Room A36

Medelfältsanalys av kjedjeköer
Alexander Aurell, Department of Mathematics, Royal Institute of Technology, and Göran Svensson, Department of Mathematics, Royal Institute of Technology and Teleopti

Kjedjeköer ger en hög flexibilitet till en relativt låg träningskostnad i flerskill-system, dvs system där en servicestation kan hantera flera typer av ärenden. I en kjedjekö växelverkar servicestationerna indirekt med varandra. Vi använder den interaktionen för att härleda en medelfältsapproximation av ködynamiken, vilken har en lägre komplexitet än orginaldynamiken.

A splitting algorithm for simulation-based optimization problems with categorical variables
Zuzana Nedělková, Department of Mathematical Sciences, Chalmers University of Technology

A splitting algorithm that explores a multidimensional discrete search space and is suitable for optimization problems with simulation-based objective functions will be presented. The splitting rule is based on the representation of a convex relaxation of the search space in terms of a minimum spanning tree and adopts ideas from multilevel coordinate search. The objective function is underestimated on its domain by a convex quadratic function. Our main motivation is the aim to find---for a vehicle and environment specification---a configuration of the tyres such that the energy losses caused by them are minimized.

Predicting the near-future location and status of ambulances using simulation modelling
Tobias Andersson Granberg, Department of Science and Technology, Linköping University

An ambulance dispatcher decides which ambulances to allocate to new calls, and how to relocate ambulances in order to maintain a good coverage. Doing this, it is valuable to have information about where the ambulances are likely to be located in the near future, and if they will be available or busy. We present a simulation model that can be used to predict this, and compare the results to a naïve forecasting model. We also discuss the practical use of the model, including difficulties with user acceptance and system integration challenges.

Implementing simulation in healthcare
Krisjanis Steins, Department of Science and Technology, Linköping University

Despite the growing number of academic publications, simulation appears to be less used in health care than in other application areas and only a small proportion of simulation studies is actually implemented. The talk will discuss the implementation problem and highlight some of that factors that can affect the implementation of simulation in health care.

Spatial coordination and Dose planning

19 October, 15.30-17.00, Room A35

New network optimization techniques for positioning unmanned aerial vehicles as communication relays for surveillance tasks

Oleg Burdakov, Department of Mathematics, Linköping University

Many applications for unmanned aerial vehicles (UAVs) are related to surveillance of distant targets, including search and rescue operations, traffic surveillance and forest fire monitoring as well as law enforcement applications. The sensor information gathered must safely be transmitted continuously from a set of surveillance UAVs to a base station via a set of relay UAVs. In many cases, high uninterrupted bandwidth requires line-of-sight between sender and transmitter to minimize quality degradation. Communication range is typically limited, especially when smaller UAVs are used. To accomplish these ends, relay chains for surveillance of a single target, and relay trees for simultaneous surveillance of multiple targets are created. The spatial placement of these UAVs should take into account the local terrain as well as the location of the base station and targets. The surveillance and communication quality of the placement is to be optimised. We show how to reduce these one- and multi-target problems to network optimization problems characterized by a very large number of nodes and arcs (over one billion). We also present new algorithms developed for effectively solving such problems.

Intersection-free cycle time optimization of Multi-robot Stations - Comparing with simulated and industrial estimates of synchronised cycle times

Edvin Åblad, Department of Mathematical Sciences, Chalmers University of Technology and Fraunhofer-Chalmers Centre

The sheet metal assembly is a part of the production process of the automotive industry.
Here, several industrial robots cooperate in a shared workspace to perform tasks, e.g., welds on a car body.
To prevent robot-robot collisions the current approach is to introduce a scheme of synchronization signals, preventing collisions by halting robots in their paths.
This work focuses on another method, which split the workspace into separate partitions, one for each robot. Thus generating intersection-free robot programs.
This method was developed during my master thesis and here I present a new comparison between the two methods, using more accurate estimates of the cycle times.
Due to the time required for accelerating the robots, each signal might add a second to the programme.
As a result, many robot programmes retrieved a reduction in cycle time by optimising them as intersection-free.

Preventing Hot Spots in High Dose-Rate Brachytherapy

Björn Morén, Department of Mathematics, Linköping University

High dose-rate brachytherapy is a method of cancer treatment. Mathematical optimization is being used in the dose planning but there are still steps that are done manually. We look into one of these steps where the aim is to prevent hot spots in the tumour. Hot spots are defined as contiguous volumes where the dose is very high. We construct a novel optimization model that takes the spatiality of the dose into account, in addition to evaluation criteria on an aggregated level.

Automated radiotherapy treatment planning by explicit optimization of plan quality

Lovisa Engberg, Department of Mathematics, Royal Institute of Technology and RaySearch Laboratories AB

Treatment planning is often described as a time-consuming process, where parameters in the underlying non-convex optimization problem need iterative adjustments before satisfactory plan quality is met. An interest to automate the treatment planning process has recently evolved. The purpose of this project is to provide a foundation for automation through a strengthened correlation between objective functions and common measures of plan quality. But the reformulated, now convex, problem is of large scale and requires careful handling.

Economy and Transportation

19 October, 15.30-17.00, Room A36

Kostnads-nytto analys på tågtidtabeller
Victoria Svedberg, RISE SICS and Department of Science and Technology, Linköping University

I detta arbete studerar vi en metod för att undersöka den samhällsekonomiska nyttan av pendel- och regionaltågstrafik med kostnads-nyttoanalys. Ett samhällsekonomiskt värde för pendel- och regionaltågstrafik beräknas genom att med optimering minimera den generaliserade kostnaden och producent kostnaden samtidigt som tidtabellstekniska egenskaper beaktas. Med detta värde kan man sedan jämföra olika spårkapacitetsutnyttjandet från pendel- och regionaltrafik för att få en samhällsekonomiskt maximerad tågtidtabell.

Samhällsekonomisk utvärdering av förändringar i pendeltågstidtabeller
Abderrahman Ait Ali och Jennifer Warg, School of architecture and the build environment, Royal Institute of Technology

I bidraget presenteras en modell för estimering av samhällsekonomiska kostnader för en tågtidtabell. Utifrån en OD-matris genereras antal resenärer per sträcka och tidsenhet. I kombination med tidtabellen i simuleringsverktyget RailSys tilldelas varje resa en tågavgång. Restid, väntetid, bytestid och trängsel i tåget samt operativa parametrar så som tågens körsträcka estimeras för en given, konfliktfri tidtabell. Parametrar används för att beräkna den samhällsekonomiska nyttan för olika tidtabellsalternativ baserad på ASEK:s rekommendationer. I preliminära resultat visades bland annat hur modellen kan användas i olika situationer, till exempel för att prissätta kommersiella tåg som delar nätverket med pendeltåg.

Big data för mer ”vetenskaplig” scenariometodik
Anders Eriksson, Kogma

Scenarier är viktiga verktyg för representation av osäkerhet i många sammanhang. Här ska jag fokusera på scenarier som framställer alternativa ”framtida världar” som underlag för långsiktiga investeringsbeslut. Denna tillämpning ställer stora krav på att scenariouppsättningar ger en så långt möjlig realistisk bild av inom vilka ramar framtiden kan variera. Här menar jag att big data kan vara till hjälp.

Energiminimala godstransporter från ett nationellt systemperspektiv
Jenny Karlsson, VTI

För att uppnå högt satta mål för energieffektivisering i transportsektorn krävs en effektiv energi- och transportpolitik. För att lyckas behövs bättre metoder för utvärdering av effekter av åtgärder. Idag finns modeller för analys av godsflöden på transportsystemnivå som bygger på kostnadsminimering, t.ex. den svenska godsmodellen Samgods som används och drivs av Trafikverket. Det finns även metoder för utvärdering av energieffektiviteten för specifika godstransporter från A till B. Det saknas dock metoder för analyser av energi och CO_2 på systemnivå. Huvudsyftet med denna studie är att utveckla en metod för optimering och analys av godsflöden på transportsystemnivå med avseende på energi och CO_2 genom att integrera energiberäkningar med Samgods-modellen. I projektet analyseras olika scenarier för det svenska godstransportsystemet samt den maximala energieffektiviseringspotentialen på systemnivå för Sverige.

Subben's checklist revisited

19 October, 17.00-17.30, Room A35

"Subben's checklist" revisited - A partial description of the development of quantitative OR papers over a period of 25 years

Michael Patriksson, Department of Mathematical Sciences, Chalmers University of Technology

The talk investigates some of the historical developments of one classic scientific journal in the domain of quantitative OR – namely the journal Operations Research – over the 25-year period 1981–2006. As such this paper, and the journal in question, represents one attempt to analyze – also in more generality – how research production has evolved, and evolves, over time.
The talk traces some general developments of the journal over time, such as (a) the fact that the historical overviews (or, literature surveys) in the articles, as well as the list of references, somewhat counter-intuitively shrink over time, while (b) the motivating and modelling parts grow. We also attempt to characterize in some detail the appearance and character, over time, of the most cited, as well as the least cited, papers, over the years studied. In particular we find that many of the ill-cited papers are quite imbalanced; for example, some of them include one main section only.
We have also analysed the articles' utilization of important "buzz words" representing the constitutive parts of an OR journal paper, based on "Subben's checklist" (Larsson & Patriksson, 2014; 2016). Based on a word count of these buzz words we conclude through a citation study, using a collection of either highly or ill-cited papers, that there is a quite strong positive correlation between a journal paper being highly cited and its degree of utilization of this checklist.

Large real-world problems (and reasonable solution times)

20 October, 09.00-10.30, Room A35

A self-adaptive placement heuristic for a highly constrained real-world container loading problem
Jonas Olsson, Department of Mathematics, Linköping University

We present a new heuristic approach for loading packages into containers, and the development of a decision support system based on this heuristic. The problem at hand stems from a real-world industrial setting and is characterized by highly heterogeneous problem instances, both regarding the properties of the individual items and the selection of items to be packed into a container. Further, the problem is highly constrained and rich with respect to practical considerations that need to be taken into account.
Our approach is a two-level metaheuristic. It is composed of a greedy-type constructive placement heuristic and a genetic algorithm. The latter is used to tune the objective function for the former in order to optimize its outcome with respect to the quality of a complete load plan.
The developed heuristic has been implemented in a decision support system, which has been used regularly for over a year to date. Although this heuristic has been developed for a specific application, its overall design should be generally applicable to other intractable optimization problems.

Integrating Railway Timetabling with Locomotive Assignment and Routing:
Jawad Elomari, RISE SICS Västerås

In railway tactical planning, several problems are often solved sequentially where the solution of one problem serves as an input to another, for example: timetabling, platform assignment, locomotive assignment, and locomotive routing. Often so, a solution of an upstream problem may cause a downstream problem to become infeasible, in which case the planner iteratively revisits both problems to find a feasible compromise. Integrating the problems into a single mathematical model helps overcome such situations, but it is challenging due to the model size; for example, Caprara et al. (2006) considered timetabling with a simplified version of station capacity of a real-life Italian railways case; a constraint that is usually discarded. Optimal solutions were hard to obtain, but feasible ones were found heuristically and satisfied the capacity requirements. More importantly, such solutions showed a decrease of 9% in profit and an increase of 15% in service cancelation, compared to the model that assumed infinite capacity (i.e. solutions were more realistic to apply). Motivated by a real-life case in the iron ore corridor along Sweden and Norway, we propose integrating the locomotive assignment and routing problems with timetabling under station capacity restrictions. Within our scope, locomotive assignment is the determination of
engine profiles required to transport cargo from one point to the other, and station capacity is the number of tracks available and their lengths. We will use binary-encoding to reduce the number of binary variables needed to model disjunctive constraints in the integrated model; hence, enabling standard solvers to find high quality solutions for larger instances, without having to customize, or redesign, the search algorithm.

Optimization of routes for a fleet of plug-in hybrid vehicles
Ann-Brith Strömberg, Department of Mathematical Sciences, Chalmers University of Technology

We study the hybrid-VRP, i.e., to route a homogeneous fleet of plug-in hybrid vehicles, having a limited load capacity and being subject to time windows for delivery. Recharging of the vehicles'

batteries are optional and can be done only at special recharging sites. The hybrid-VRP is modelled as a mixed binary linear program and solved using column generation (CG). We have also developed dominance criteria in order to improve the dynamic programming algorithm used to solve the ESPPRCs. Our tests show that the most cost-efficient routes in hybrid-VRPs may differ substantially from those of traditional VRPs. As compared with conventional branch-and-cut methods, the solution times are considerably reduced by the CG approach combined with our dominance criteria.

Large-scale integration of wind power into the European electricity system
Caroline Granfeldt, Department of Mathematical Sciences, Chalmers University of Technology

In order to sufficiently decrease greenhouse gas emissions, the future electricity system will most likely need to consist of a large share of variable renewable energy sources, such as wind and solar power. A realistic modeling of such a system must include a fine discretization of time, in order to be able to capture the large and fast variations from these production resources. There is, however, a conflict between having a high temporal resolution and simultaneously maintaining reasonable solution times. For large problem instances, the current, traditional, energy models typically favors the last. In a collaboration with the division for Energy Technology at Chalmers, I consider an optimization model with some typical characteristics for this problem, such as technology investments and dispatch. In my talk, I will discuss this model and possible decomposition methods to be able to increase the temporal resolution on larger problem instances.

Operational research in the public sector

20 October, 09.00-10.30, Room A36

Optimization for snow removal
Kaj Holmberg, Department of Mathematics, Linköping University

We describe the current state of our research on optimization of snow removal. It concerns complicated routing of vehicles, and includes arc routing approaches as well as mixed-integer formulations and heuristics.

Decision Support for Public Service Obligation in Air Transportation
Alan Kinene, Department of Science and Technology, Linköping University

Sweden adopts a subsidy scheme known as Public Service Obligations (PSOs) to achieve equitable accessibility to Stockholm and to health centres, for the whole population. We develop, econometric, analytical and optimisation models which can assist the decision-making concerning which flight routes to subsidize. The optimisation model identifies the optimal PSO route network for the desired PSO standards. The decision support also includes an interface, where the produced results are visualized in the form of an accessibility map. In addition to the applicability of the results, we will also talk about the availability of data to be used, and problems faced when making operations analysis using the available data in the Swedish air transport. The presentation will also include our views on how to solve some of the problems faced for example creating a more comprehensive database.

Hälsoekonomiska utfallsmått i modellering av prehospitalt ambulanstransportsystem
Nicklas Ennab Vogel, Department of Medical and Health Sciences, Linköping University

Akut ischemisk stroke är ett tidskritiskt och ofta livshotande tillstånd som leder till försämrad hälsa och livskvalitet för drabbade personer. I Sverige insjuknar årligen drygt 20 000 personer i stroke. Ambulansens transporttider har en betydande inverkan på patienters tillgång till och hälsoutfall av medicinska behandlingar samt överlevnadsprognos.
Optimeringsmodeller kan stödja planering av ambulanstransporter för patienter med misstänkt stroke eller andra livshotande hälsotillstånd.
Presentationen beskriver planeringsproblemet med fokus på inkorporation av kostnadseffektivitetsmått.

Utvärdering av kostnadsdrivare inom bussbranschen i Sverige
Helene Lidestam, VTI
Kostnaderna för svensk kollektivtrafik har ökat betydligt de senaste åren. Syftet med aktuell studie är att testa och utvärdera vikten av nio tidigare identifierade kostnadsdrivarna för kollektivtrafik. Data har samlats inom genom enkäter och fokusgrupper. En enkät med kvantitativ betygsskala skickades till personer som arbetar antingen hos bussoperatörerna eller hos de regionala kollektivtrafikmyndigheterna (RKM) och som har djup kunskap om offentlig upphandling av busstrafik i Sverige. Resultaten visar att detaljerade krav på bussar och trafikflödets utseende (peak-tider) är de kostnadsdrivare som anses vara de som påverkar kostnaderna mest. Dessa faktorer är problematiska eftersom de också är de svåraste faktorerna att förändra.

Taming uncertainty

20 October, 13.00-14.30, Room A35

Optimal maintenance of wind power plants
Quanjiang Yu, Department of Mathematical Sciences, Chalmers University of Technology

Wind power as a kind of clean energy is available in abundance, it's renewable, and it produces almost no greenhouse gas emissions during operation. The area of wind turbine operations & maintenance represents a growing segment and business opportunity in the wind energy industry. The goal of my project is to develop an app using a mathematical optimization model to indicate to the maintenance personnel---who are on site---those components which have the highest probabilities of failing within a short time span. So far I have built a new maintenance model which can generate short time maintenance schedule.

Mot storskaliga utvärderingar av derivatprissättningsmetoder
Pontus Söderbäck, Department of Management and Engineering, Linköping University

Praktiskt användbar marknadsinformation kan extraheras genom mätningar av finansiella derivatpriser. Mätningarna kräver kalibrering av metoderna till marknadspriser, vilket ger upphov till icke-konvexa inversa problem som har flera lokala optima. Hur storskaliga numeriska tester kan användas som underlag till statistiska tester i jämförelse mellan olika metoder kommer också beröras.

Emergency Event Forecasting
Niki Matinrad, Department of Science and Technology, Linköping University

One aim for emergency medical services is to provide quick and efficient medical treatment and transportation to out-of-hospital patients. To achieve this, proper resource management is necessary, and a key factor is to have information about the expected demand for service. In this study, a forecasting model for daily medical emergencies is presented. In order to achieve high precision, influencing variables such as socio-economic aspects and population distribution are taken into account. Furthermore, the model should be able to incorporate real-time data such as weather forecasts and road and traffic conditions, if such data is available.

Säkerhetslagerbestämning med simulering – en jämförelse med analytisk metod
Fredrik Persson, Department of Management and Engineering, Linköping University

Ett företag säljer stora och dyra maskiner med intermittent efterfrågan (sällan och i små volymer). Leveransledtiden är lång och hela maskinen tillverkas efter att kunden beställt maskinen. Nu börjar en marknad öppnas där samma maskiner efterfrågas men mycket kortare ledtid och frågan att hålla ett spekulationslager (säkerhetslager) har aktualiserats. Maskinen är dessutom dyr och binder mycket kapital – bestämningen av en säkerhetslagernivå måste därför vara korrekt beräknad med realistiska antaganden. Studien jämför en analytisk beräkningsmetod av säkerhetslager för intermittent efterfrågan genom att prognostisera efterfrågevolymen med Crostons metod med en simuleringslösning av exakt det aktuella fallet. Simulering visar sig överlägsen då säkerhetslagerbestämningen vilar på vissa, i detta fallet, felaktiga antaganden.

Optimization Tools

20 October, 13.00-14.30, Room A36

Latest Optimization Trends in Practice
Kostja Siefen, Gurobi Optimization

Mathematical optimization methods play an important role in the growing Prescriptive Analytics market. They allow to determine optimal plans for possible future scenarios based on forecasting methods.
The Gurobi Optimizer can be used as both a decision-making assistant, to help guide the choices of a skilled expert, or as a fully automated tool to make decisions with no human intervention.
We present an overview of the latest advances in features and performance with Gurobi 7.5, give an introduction to modeling using Python and the ability to solve models in the cloud.

Creating Optimization-based solutions easily: FICO Xpress Insight
Juan-Manuel García, FICO

General purpose solvers for optimization problems have been around for nearly three decades. Tools and languages for helping OR scientists build such models exist since long ago too. This presentation will describe a third type of optimization software: Xpress Insight, a platform for deploying user-ready applications based on Optimization. FICO Xpress Insight (formerly FICO Optimization Modeler) enables organizations to rapidly deploy optimization models as powerful applications. It lets teams work in a collaborative environment with interactive visualization and an interface designed for end users to work with models in easy-to-understand terms and account for trade-offs and sensitivities implicit in the real problem.