

Major in Systems and Operations Research

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Aalto-yliopisto
Aalto-universitetet
Aalto University

9.4.2024

Faculty members



Prof. Ahti Salo
Decision & risk analysis



Prof. Philine Schiewe
Public transport optimization



Prof. Kai Virtanen
Defence and military operations



Prof. Risto Lahdelma
Energy systems analysis



Prof. Fabricio Oliveira
Optimization under uncertainty



Prof. Afzal Siddiqui
Power markets & economics

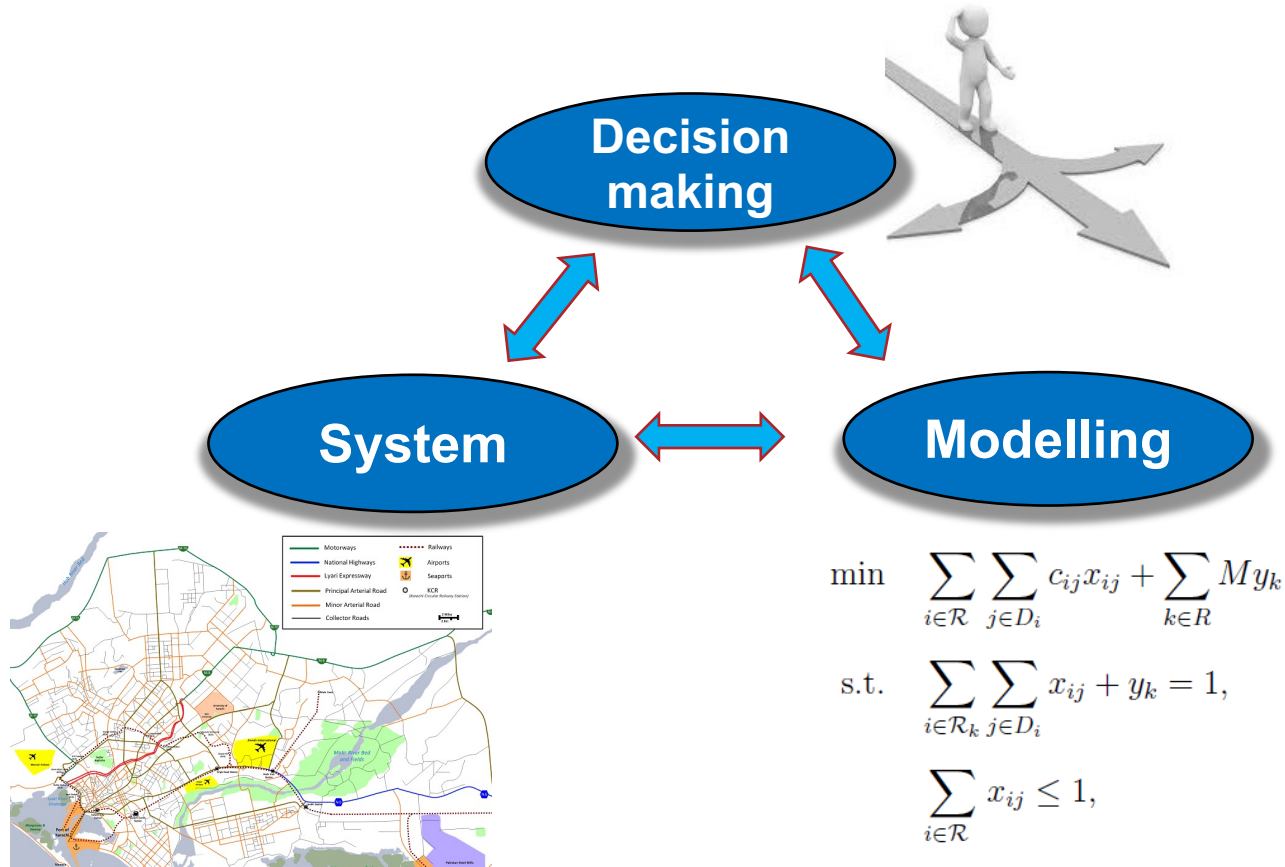


Dr. Fernando Dias
Bioinformatics & optimization



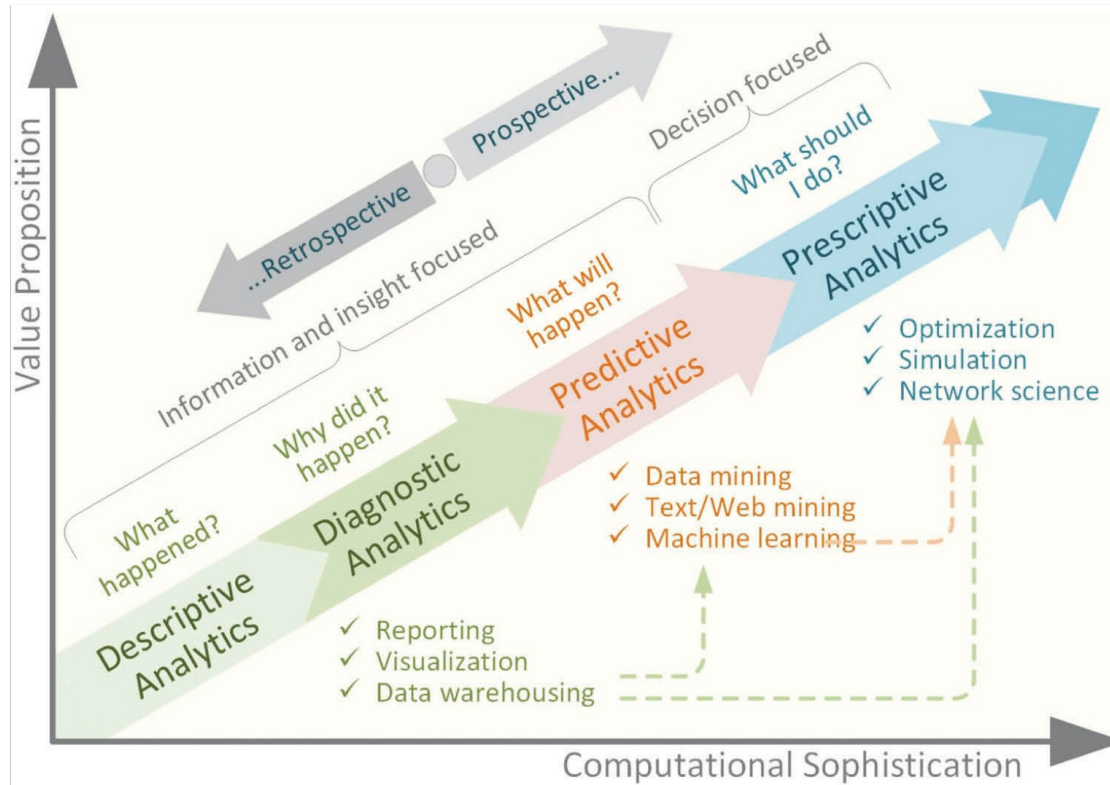
Dr. Tuomas Raivio
Critical infrastructure resilience

Pillars of Operations Research



$$\begin{aligned} \min \quad & \sum_{i \in \mathcal{R}} \sum_{j \in D_i} c_{ij} x_{ij} + \sum_{k \in \mathcal{R}} M y_k \\ \text{s.t.} \quad & \sum_{i \in \mathcal{R}_k} \sum_{j \in D_i} x_{ij} + y_k = 1, \\ & \sum_{i \in \mathcal{R}} x_{ij} \leq 1, \end{aligned}$$

Dimensions of analytics



The objective of the major in Systems and Operations Research is to educate experts who master quantitative methods and have professional skills for solving decision problems arising in the planning and management of complex systems. Core topics in the major are optimization, statistics, forecasting, dynamic systems, simulation, and decision and risk analysis. The major includes hands-on

Overall, the major is founded on a balanced engineering-economic approach which builds on structured problem solving, systems thinking, and mathematical modelling. This approach allows operations research (OR) professionals to optimize the use of limited resources, to improve the efficiency of production and services, and to support decisions in recognition of risks and multiple objectives.

Methods of systems and operations research are used extensively in application areas such as finance, logistics, manufacturing, services, defence, energy, environment, and healthcare. OR is widely known as the scientific discipline for making "Smarter Decisions for a Better World". The rapidly expanding field of analytics employs OR methods to provide data-driven decision support.

Graduates in Systems and Operations Research are in growing demand by firms, consultancies, research institutes, and the public sector. Many start their careers as analysts and then advance to more senior positions and even to top management. The major provides an excellent basis for continued studies and graduates often choose to pursue a doctoral degree.

Systems and Operations Research is a compact major

Total 120 ECTS	<u>Major*</u> 40–65 ECTS	<u>Master's thesis</u> 30 ECTS	<u>Minor for compact major</u> 20–25 ECTS	<u>Elective studies**</u> 25–30 ECTS
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* Compact major 40-45 ECTS. Long major 60-65 ECTS. Systems and Operations Research is only offered as a compact major.

Code	Course	ECTS	Period/year
Mandatory courses (20 ECTS)			
MS-E2112	Multivariate Statistical Analysis	5	III-IV/1 (or during BSc)
MS-E2121	Linear Optimization	5	III-IV/1 (or during BSc)
MS-E2132	Laboratory Assignments in Operations Research II	5	I-II/2
MS-E2135	Decision Analysis	5	I-II/1
Seminars (5-12 ECTS)			
Include at least one or both seminars in your major studies:			
MS-E2177	Seminar on Case Studies in Operations Research	5-7	III-V/1 or 2
MS-E2191	Graduate Seminar on Operations Research	5	I-II/2

A?

Specialization studies

Choose sufficiently many courses from the following lists to complete the required 40–45 credits for the major. The second list contains special courses planned for 2024–2026 that might be offered at different periods than indicated below. All other MS-E2XXX courses also qualify, and additional courses may be offered. Check courses.aalto.fi for an updated list.

MS-E2122	Nonlinear Optimization	5	I-II/1 or 2
MS-E2145	Combinatorial Optimization	5	III-IV/1 or 2
MS-E2148	Dynamic Optimization	5	III/1 or 2
MS-E2114	Investment Science	5	I-II/1 or 2 (or during BSc)

Courses on special topics:

MS-E2117	Riskianaly				
MS-E2130	Mathema	MS-E2120	Suomalaisen yhteiskunnan resilienssi**	1–5	I-II/1 or 2
MS-E2150	Discrete I	MS-E2147	Optimization in Public Transport	5	I-II/2
MS-E2155	System D	MS-E2160	Stochastic Programming and Robust Optimization	5	I-II/2
MS-E2107	Independent Research Projects in Systems and Operations Research Analysis			5–8	I, II, III, IV, V/1 or 2



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I N F O R M S

Transactions on Education



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A Seminar for Solving Client Problems in Project Teams

Ahti Salo

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00076 Aalto, Finland, ahti.salo@aalto.fi

We describe the course “Seminar on Case Studies in Operations Research” in which teams of four or five students work on real problems posed by firms and governmental research institutions. In this course, which is taught at Aalto University School of Science, students use operations research to solve these problems and also develop teamwork, communication, and project management skills. Since 2001, the student teams have carried out more than 60 projects of which many have had significant business and societal impacts. We discuss experiences from this course and consider implementation details that have contributed to the attainment of learning objectives.

Key words: collaborative learning; group projects; teaching with projects; team teaching

History: Received: June 2011; accepted: July 2012.

MS-E2177 - Seminar on Case Studies in Operations Research (V) D, Lecture, 12.1.2024-7.6.2024

Project topics for 2024 are proposed by:

1. **Finnish Defence Forces**: Optimal use of mortar systems
2. **Fennia**: Optimal investment strategy for nonlinear life insurance liabilities
3. **Radiation and Nuclear Safety Authority in Finland**: Impact assessment of post-treatment options in radiation therapy
4. **SEB**: Concentration risk of corporate deposits
5. **Inclus**: Simulation models for the risk assessment of construction projects
6. **Inclus**: Uses of generative AI in risk management processes

Previous years' project plans and reports are available under "[Deliverables from previous seminars](#)"

The logo for Fennia, featuring the word "fennia" in a lowercase, green, sans-serif font.The logo for SEB, consisting of the letters "S|E|B" in a bold, black, sans-serif font, with vertical bars separating the letters.The logo for Stuk, featuring a blue stylized icon of three interlocking shapes to the left of the word "stuk" in a bold, blue, sans-serif font. Below "stuk" is the text "SÄTEILYTURVAKESKUS" in a smaller, blue, sans-serif font.The logo for Inclus, featuring the word "inclus" in a bold, black, sans-serif font.

Exchange and internship possibilities

- Industrial/ business MSc thesis worker positions



Career opportunities

Our MSc alumni have *two* main career paths

- **Business/ industry/ government placements**
- **Doctoral studies towards a research career**

An exceptional alumni network



Operations Research Analysts

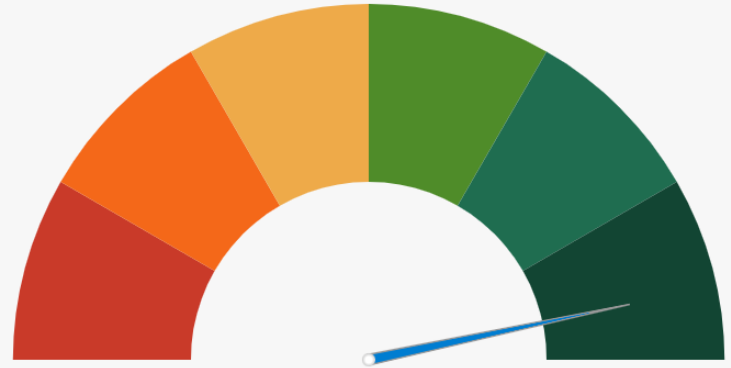
What do they do?

Formulate and apply mathematical modeling and other optimizing methods to develop and interpret information that assists management with decisionmaking, policy formulation, or other managerial functions. May collect and analyze data and develop decision support software, services, or products. May develop and supply optimal time, cost, or logistics networks for program evaluation, review, or implementation.

Also known as:

Advanced Analytics Associate, Analytical Strategist, Decision Analyst, Operations Research Analyst, Optimization Analyst

Projected Growth Rate i



Much faster than average

Employment of Operations Research Analysts is projected to grow 25 percent from 2018 to 2028, much faster than average compared to all occupations.

Research @ SAL

The Systems Analysis Lab
employs researchers
(doctoral students)

A career path for those interested
in scientific training

D.Sc. (Tech.) opens doors for
research and academic position

Summer job opportunities as
research assistants

Key research areas

1. Operations research in defense
2. Energy and climate change policies
3. Risk analysis of safety critical systems
4. Transportation systems and logistics
5. Environmental decision making
6. Innovation and technology strategies



Doctoral careers



Anna Repo
Natural Resources
Institute Finland
(Luke)



Juuso Liesiö
Aalto BIZ



Tuomas Lahtinen
Director, Data & AI
Consulting, Loihde



Vilma Virasjoki
Fingrid

inclus

Inclus erikoistuu yhteisen ymmärryksen rakentamiseen: työkalumme auttavat tunnistamaan, ymmärtämään, visualisoimaan ja hallitsemaan riskejä läpi organisaation avainprosessien. Inclusin asiantuntemus on lähtöisin rauhanvälityksestä, jossa olemme olleet rakentamassa ratkaisuja 15:llä maailman vaikeimmalla konfliktialueella. Inclusin taustalla olevia menetelmiä on kehitetty yhteistyössä Aalto yliopiston systeemianalyysin laboratorion kanssa.



DI Juha Törmänen
Teknologiajohtaja
Inclus

Inclusin osaamiseen ja fasilitointiin luotettiin presidentti Sauli Niinistön isännöimissä ja Risto Siilasmaan johtamissa talousryhmän Kultaranta-keskusteluissa 2020, missä arvioitiin COVID-19:ta vaikutuksia talouteen. Keskusteluun, mielipiteiden esittämiseen ja tuloksien esittämiseen käytettävä aika oli rajattua, mutta Inclus tarjosi alustan jolla saatiin kerättyä, järjestettyä ja arvioitua keskusteluissa esitetyt riskit niiden lyhyt- ja pitkävaikutteisten vaikutusten ja vakavuuden perusteella. Lisäksi arvioitiin myös riskien ratkaisuehdotuksia.

<https://www.inclus.com/>



Dr Kimmo Soramäki

Founder and CEO

Network Topology, System Mechanics
and Behavioral Dynamics in Interbank
Payment Systems

Aalto University publication series

DOCTORAL DISSERTATIONS 75/2012



FNA's technology enables decision makers and business analysts to easily uncover hidden connections, access and understand complex networks and create dashboards & simulations.

Discover

Uncover hidden connections and anomalies in large, complex datasets, and then visualize and monitor them via interactive dashboards.



Optimize

Enhance and configure systems and networks for optimal performance using proven and proprietary algorithms.



Simulate

Deploy simulations to predict the impact of stress events within systems and networks.



<https://www.fna.fi/>

<http://ada2024.aalto.fi/>

2024 INFORMS Advances in Decision Analysis Conference

ADA 2024 | July 10-12, 2024 | Helsinki-Espoo, Finland

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Welcome

The fifth 2024 INFORMS Advances in Decision Analysis Conference will be held July 10-12, 2024 at Aalto University, Helsinki-Espoo, Finland

