Course syllabus

Simulering
Simulation

EITN95, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED C/D
Date of Decision: 2023-04-18

General Information

Elective for: C4-ks, D4-ns, E4-ks, I4, M4, Pi4
Language of instruction: The course will be given in English on demand

Aim

The purpose of the course is to give an introduction to and ability to perform discrete event simulation, basic optimization approaches, and heuristic methods such as simulated annealing, tabu search and evolutionary algorithms. The course also covers the examination goals of being able to work effectively within different group settings and being able to carry out tasks within given set time frames.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- Have knowledge about different kinds of dynamic models that are used in engineering
- Describe the event-scheduling and the process-oriented approach to writing simulation programs, plan and structure implementation of simulations
- Know how to estimate the accuracy of simulation results and their validity
- Know the basic functions in optimization theory
- Know how to solve linear and integer optimization problems
- Be familiar with the most common heuristic methods for optimization

Competences and skills
For a passing grade the student must

- Write well-structured simulation programs in a general programming language, specifically JAVA
- Estimate the accuracy and reliability of simulation results
- Be able to verify and validate simulation programs
- Know the basic concepts of a Linear Program (LP), convexity, and duality
- Be able to apply the simplex algorithm to linear programming problems
- Know the basic concepts of Integer Program (IP) and the connection between IP and LP
- Be able to apply the branch-and-bound method to IP
- Have a thorough knowledge of the most common heuristic and meta-heuristic methods including local search and its variations, simulated annealing, tabu search and evolutionary algorithms
- Be able to implement heuristic and meta-heuristic methods, and configure the parameters involved in these methods
- Know the concepts of the Monte Carlo method, and be able to implement it for a given optimization problem.
- Work effectively in a group setting
- Work within given set time frames

Judgement and approach
For a passing grade the student must

- Show knowledge of the possibilities and limitations of simulation experiments
- Be able to construct models of systems, implement these in software and investigate the confidence in the results obtained from simulation studies.
- Be able to independently construct models for optimization problems and to apply an optimization package (such as MATLAB or alike) for solving them with full understanding of the solution process and output data
- Be able to choose and apply a heuristic method to solve optimization problems

Contents

In the course we start by studying discrete event simulation. Students learn to write process-oriented and event-scheduling simulation programs in Java. Estimation of accuracy, random number generation, methods for studying rare events, verification and validation are also covered.

Then we proceed to optimization techniques. We study linear programs (LP) and the simplex algorithm. After that we consider integer programming (IP) Mixed Integer Programming (MIP), the relation between IP and LP, and the branch-and-bound method for IP.

Finally, we consider heuristic and meta-heuristic methods for combinatorial optimization problems viewed as optimization through simulation. We explain the local search and its most common variations. We explain the basic meta-heuristics such as simulated annealing, tabu search and evolutionary algorithms. We also illustrate the Monte Carlo techniques.

Students work in groups where they together solve the technical tasks and write reports.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Approved assignments and laboratory exercices gives grade 3. An approved take-home examination is required for grades 4 and 5. For approved

assignments and laboratory exercises, the student has to show the ability to work effectively in a group and equally contribute to the submitted solutions and reports.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0119. **Name:** Home Assignments .
Credits: 6,5. **Grading scale:** TH. **Assessment:** For grade 3, approved home assignments are required. Home Exam is required for grade 4 and 5. **Contents:** Home Assignments
Code: 0219. **Name:** Laboratory Exercices.
Credits: 1. **Grading scale:** UG. **Assessment:** For course completion, passed laboratory work is required.
Contents: Laboratory work

Admission

Assumed prior knowledge: Programming, Basic probability, Statistical methods, Mathematical analysis.
The number of participants is limited to: No
The course overlaps following course/s: ETS060, ETS120, ETS061

Reading list

- Harry Perros: Computer Simulation Techniques: The definitive introduction. 2021. H. Perros, Computer Simulation Techniques: The definitive introduction.
- Michal Pioro: Network Optimization Techniques, Chapter 18 in E. Serpedin, E., Chen, T., and Rajan, D. (eds.): Signal Processing, Communications, and Networking,. CRC Press, 2012, ISBN: 978-1-4398-5513-3.

Contact and other information

Course coordinator: Björn Landfeldt, bjorn.landfeldt@eit.lth.se
Course homepage: http://www.eit.lth.se/course/eitn95