Markov Chains and Queuing Models

This version: (First official draft)

Course instructors

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Course aims and objectives

Many real life systems are subject to uncertainty and should therefore be modelled with stochastic models. In this course we focus on the theory and the application of two different classes of stochastic models: Discrete Time Markov Chains and Continuous Time Markov Chains. The students should gain knowledge about these models such that they are able to construct these models and apply them to solve real life problems. For illustration we use among others, models of inventory systems, manufacturing systems, maintenance systems, and queuing systems. We show how formulas for performance measures can be derived, and how they can be computed. Further, the students learn numerical methods to obtain solutions, which have to be implemented.
Knowledge about Markov Chains is necessary to understand Markov Decision processes.This course is covering the prior knowledge necessary for the course on Markov Decision Models, including basics about reinforcement learning, that is given in the next semester.

Content

The first block of the course is devoted to Discrete Time Markov Chains. After the introduction of this model class, we study the transient analysis and the long-run analysis of such type of models. We therefore discuss the classification of states and when a Markov Chain is ergodic.

In the second part of the course, Continuous Time Markov Chains are investigated. We discuss the flow rate equation method to obtain the equilibrium distribution and enable a long-run analysis of the Markov Chain. Further, for the transient analysis of a continuous time Markov Chain we introduce the uniformization method.

Application procedure

Prerequisits

Participants should have basic knowledge in probability theory (Random variables, discrete and continuous distribution functions, conditional distributions, moments of random variables). The required prior knowledge includes the topics discussed in the first part (chapter 1 – 7) of the book from Stewart, W.J. (2009): Probability, Markov Chains, Queues, and Simulation, Princeton. Additionally, students should have basic

programming experience.

Application process

PhD Students interested in the course can send an e-mail to office.cdt@mgt.tum.de

Preliminary schedule

20.03.2023: 16.00-17.30: Kick of meeting online

During the kick-off meeting we will discuss the organization of the course and the schedule

The following meetings can be organized hybrid

27.03.2023: 9.30-11.00: Lecture, Discrete Time Markov Chains: Modelling issues

27.03.2023: 11.00-12.30: Exercise, Discrete Time Markov Chains: Modelling issues

27.03.2023: 13.00-15.00: Lecture, Discrete Time Markov Chains: Analysis

27.03.2023: 15.00-17.00: Exercise, Discrete Time Markov Chains: Analysis

03.04.2023: 9.30-11.00: Lecture, Continuous Time Markov Chains: Modelling issues

03.04.2023: 11.00-12.30: Exercise, Continuous Time Markov Chains: Modelling issues

03.04.2023: 13.00-15.00: Lecture, Continuous Time Markov Chains: Analysis

03.04.2023: 15.00-17.00: Exercise, Continuous Time Markov Chains: Analysis

08.05.2023: 10.00-17.00: Presentation of projects

Core readings

Stewart, WJ. (2009): Probability, Markov Chains, Queues, and Simulation, Princeton. Chapter 9

Tijms, HC. (2003): A first course in stochastic models, Wiley. Chapters 3,4,6

Screencasts are available for all lectures!

Assessment

Students have to participate actively in the exercises and have to present a project related to the course topics.

Workload

3 ECTS (22.5 hours lectures, 90 hours total workload)