Discipline: Operations

1. Language / Sprache

English

2. Title / Titel

Stochastic Models

3. Lecturer / Referent

Prof. Dr. Gudrun P Kiesmüller, TUM Campus Heilbronn, TU München

4. Date and Location / Zeitraum und Veranstaltungsort

Online-Course: 15.3.2021 – 1.4.2021

The course will be offered in electronic form. Participants get screencasts and exercises to study the different topics themselves. Additionally, virtual meetings are organized during the course to discuss the different topics and to support the participants.

5. Course Description / Kursbeschreibung

5.1 Abstract and Learning Objectives / Zusammenfassung und Lernziele

Many real life system are subject to uncertainty and should therefore be modelled with stochastic models. In this course we focus on the theory and the application of three different classes of stochastic models: Discrete Time Markov Chains, Continuous Time Markov Chains, and Markov Decision Processes. 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. Additionally, we discuss methods to derive structural results and to obtain optimal policies.

5.2 Content / Kursinhalt

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, the uniformization method is studied, which enables a transformation of a continuous time Markov Chain in a discrete time Markov Chain.

In the last block of the course Discrete Time Markov Decision Processes are studied. After the introduction of the model, different numerical methods, like the policy iteration or the value iteration, are discussed to obtain optimal decisions. It is also shown how structural properties about the optimal decisions can be obtained

5.3 Schedule (including start and end time / Zeitplan (inkl. Start- und Endzeit)

The course starts with an introductory session on

15.3.2021 10.00-11.00

Regular virtual meetings take place at the following dates and times

17.3.2021 16.00-18.00
19.3.2021 16.00-18.00
22.3.2021 16.00-18.00
24.3.2021 16.00-18.00
26.3.2021 16.00-18.00
29.3.2021 16.00-18.00

During the last meeting each student has to give a short presentation

1.4.2021 10.00-18.00

5.4 Course format / Kursformat

The course consists of three blocks where each block is composed of a series of screencasts, exercises, and scientific papers. Three different types of exercises are offered. The first type of exercises should support students to improve their modelling skills. In order to learn how to apply the models, programming exercises have to be done. Additionally, theoretical exercises are offered to deepen the theoretical knowledge. At the end of each block a scientific paper should be studied such that it can be seen how the knowledge can be applied in research.

6. Preparation and Literature / Vorbereitung und Literaturhinweise

6.1 Prerequisites / Voraussetzungen

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.

6.2 Essential Reading Material / Pflichtlektüre

Each student has to study and present one scientific paper related to the topics discussed in the course. The paper can also be related to the research project of the student. The allocation of the papers is done in the beginning of the course.

6.3 Additional Reading Material / zusätzliche Lektüre

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

Putermann, ML. (2005): Markov Decision Processes – Discrete Stochastic Dynamic Programming, Wiley Series. Chapters 1 -5

6.4 To prepare / Vorarbeiten

Before the virtual meetings, the students must have studied the corresponding screencasts and exercises.

7. Administration

7.1 Max. number of participants / Maximale Teilnehmerzahl

20

7.2 Assignments / Aufgaben

Participants get several small assignments during the course to support the learning process

7.3 Exam / Prüfungsleistung

One presentation and one larger assignment

7.4 Credits / Punkte

6 ECTS

8. Arbeitszeitaufwand / Working Hours

Aufteilung der Arbeitsstunden / Working Hours *(z. B. Vorarbeiten / preparations: 30 h, aktive Mitarbeit / active participation: 100 h, Prüfungsvorbereitung / preparation for exam: 30 h, Prüfung / exam: 20 h …)*	**Stunden**
Studying Screencasts	60
Solving exercises and assignments	60
Active participation in discussions	30
Final exam	30
SUMME	**180 h**
ECTS: 6	