VHB-ProDok
Verband der Hochschullehrerinnen und Hochschullehrer
für Betriebswirtschaft e. V.
Syllabus

Discipline: Operations Management/Operations Research

1. Language

English

2. Title

Machine Learning and Prescriptive Analytics in Operations Management

3. Lecturer

Dr. Richard Pibernik, Chair of Logistics and Quantitative Methods, Julius-Maximilians-Universität Würzburg, Germany

Dr. Christoph M. Flath, Chair of Information Systems and Business Analytics,

Dr. Nikolai Stein, Postdoc at Julius-Maximilians-Universität Würzburg, Germany

4. Date and Location

Würzburg, October 4-7, 2022

5. Course Description

5.1 Abstract and Learning Objectives

Recently, data-driven prescriptive analytics approaches have received considerable attention in Operations Management (OM) research and have been shown to achieve superior performance compared to conventional approaches that have been used in the past. These data-driven approaches leverage extensive company data (including auxiliary data, such as data on promotions, processes, weather, calendar events, clickstreams, etc.) and use a mix of machine learning and optimization techniques to directly output prescriptions for important OM problems in production, inventory, capacity, transportation, and revenue management. From a practical perspective, they promise better performance and automation of decision making processes.

This course provides a thorough and hands-on introduction to this new field, discusses recent developments in research, methodological and practical limitations, and develops an outlook on the future of this new discipline. We will review recent publications, provide a critical view on current research methods and standards, introduce participants to good practices of data-driven OM research, and discuss research and publication strategies.

The theory parts are complemented by hands-on lab sessions leveraging a Python package for data-driven OM, developed at the organizers' institutions.[1]

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[1] Philippi et al., (2021). ddop: A python package for data-driven operations management. Journal of Open Source Software, 6(66), 3429.

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Syllabus

5.2 Content / Kursinhalt

The course will cover the following topics:

- Fundamentals of data-driven prescriptive analytics in OM

- Implementation and evaluation of data-driven approaches

- Data-driven inventory, capacity and transportation management

- Research standards in data-driven OM research

- Future developments in data-driven OM

- Discussion of a future research agenda

5.3 Tentative Schedule (including start and end time)

Day 1: Hands-on experience – lab sessions and exercises

Day 2: The future of data-driven OM
- Current and future use of Machine Learning in OM
- End-to-End data-driven approaches
- Deep Reinforcement Learning in OM
- Synthetic data generation and evaluation

Day 3: Standards for data-driven OM research
- Evaluation of research standards in selected papers
- Identification of shortfalls in current research
- Robust evaluation strategies
- Replicability and reproducibility of studies
- Explainability of prescriptive analytics approaches for OM

Day 4: Research agenda and further applications
- Paper presentations and discussions
- Research strategy, paper development, target journals
- Paper clinic

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Syllabus

Tuesday, October 4	Wednesday, October 5	Thursday, October 6	Friday, October 7
Introduction & Lab Sessions	*The future of Data-driven OM*	*Standards for Data-driven OM research*	*Research agenda and further applications*
9 am - 10:30 pm Introduction (Flath/Pibernik) 11-12.30: Lab: Data-driven Newsvendor	9 am - 12:30 pm The Future of Machine Learning in OM (Pibernik)	9 am - 12:30 pm Standards for Data-driven Research (I)- Learning from "not so great" practice examples - "The Big Data Newsvendor" (Participant Presentation) - "The Deep Learning Newsvendor" (Participant Presentation)	9 am - 12:30 pm Subgradient Boosting (Participant presentation) Explainability in Practical Applications - SHAP (Participant Presentation) Paper development, research strategy, target journals
Lunch Break	Lunch Break	Lunch Break	Lunch Break
1:30 pm - 5:30 pm Lab and Team exercises: Data-driven Newsvendor	1:30 pm - 5:30 pm Deep Reinforcement Learning in Inventory Management (Participant Presentation) Synthetic Data Generation for OM problems (Buttler/Stein)	1:30 pm - 5:30 pm Standards for Data-driven Research (II) - Replicability, Reproducibility - Benchmarking - Explainability	1:30 pm - 5:30 pm Paper Clinic – Development of Research Ideas and their Implementation Joint development of Paper proposals
Social activity: Wine Tasting	Social activity: "Würzburger Nachtwächter"	Social activity: TBD	

5.4 Course format

The course will comprise lectures and presentations addressing the fundamental theories and applications of the different topics described above, as well as the presentation and discussion of important research papers by the participants. Lab sessions will complement the presentations and discussions.

To make this short course productive, each participant is required to study the fundamental literature (see below) and to prepare at least one presentation of a research paper (either individually or in a team of two, depending on the number of participants).

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Syllabus

6. Preparation and Literature

6.1 Prerequisites

Solid quantitative knowledge in operations management (basic inventory models, basic statistics, economic analysis, fundamentals of optimization). Some basic programming skills are beneficial.

6.2 Essential Reading Material
- Bertsimas/Kallus (2020): From Predictive to Prescriptive Analytics. Management Science 66(3):1025-1044.
- Ban/Rudin (2019): The Big Data Newsvendor: Practical Insights from Machine Learning. Operations Research 67(1):90-108.
- Notz/Pibernik (2022): Prescriptive Analytics for Flexible Capacity Management. Management Science 68(3):1756-1775.
- Elmachtoub/Grigas (2022) Smart "Predict, then Optimize". Management Science 68(1):9-26.

6.3 Additional Reading Material

Will be distributed prior to the course.

6.4 To prepare

Participants must work through the essential reading material (see 6.2) and must present one research paper during the course (see 1.8).

7. Administration

7.1 Max. number of participants

The number of participants is limited to 20.

7.2 Assignments

Participants will have to present at least one research paper (see 1.8).

In addition, all participants must provide a written report of approximately 15-20 pages in which they review the relevant literature pertaining to the research paper they were assigned, describe the most important research findings of the paper, and outline future research directions.

7.3 Exam

The final grade will be composed of the grade for the paper presentation (weight: 1/3), and the written report (2/3).

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Syllabus

7.4 Credits

The course corresponds to a scope of 6 ECTS.

8. Working Hours

Tasks	Hours
- *Self-study (essential reading material listed in 6.2)* - *Preparation of presentation* - *Preparation of written report* *On-site course*	*64* *32* *52* *32*
SUM	**180 h**