

# **METHODS AND MODELS OF APPLIED RESEARCH**

Number of credits: 4 ECTS

Course period: half semester / 4 classes (2 lecture + 2 seminars) per week

Language of Instruction: English

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## **Course description**

The course is aimed to give its participants basic knowledge about numerical methods that use random numbers to compute quantities of interest, generate artificial datasets with either pre-specified parameters or mimicking original (empirical) data sets, providing sensitivity analysis for this type of data sets and by this giving evidence on the usefulness/effectiveness of the quantitative (econometric) instruments used by researchers. Furthermore, participants will have an opportunity to learn more about application of random numbers in economic modeling (agent-based modeling) and evolutionary optimization methods being applied to different areas.

Participants will apply the methods themselves using econometric software (the lecture will be based on R) at the end of each day of the course. They are encouraged to bring and use their own datasets, but there will also be datasets provided by the lecturer.

## **Prerequisites**

Knowledge of linear algebra is a prerequisite. Some basic knowledge of programming is not required but desirable.

## **Course outline**

Week 1.

Lecture 1 - Introduction to Monte Carlo methods, Software introduction

Lecture 2. Probability review and random number generation

Practice 1. First exercises. Independent work.

Week 2.

Lecture 3-4. Sampling from different distributions.

Practice 2. Independent work.

Week 3.

Lecture 5. Artificial dataset construction and data resampling.

Practice 3. Related exercises. Independent work

Week 4.

Lecture 6. Optimization by Monte Carlo methods: heuristic optimization.

Lecture 7. Discrete and continuous applications.

Practice 4. Related exercises. Independent work

Week 5.

Lecture 8. Introduction to agent-based modeling.

Lecture 9. Basic and more advanced examples

Practice 5. Related exercises. Independent work

Week 6.

Seminar 1-6. Group presentations on the topic chosen followed by discussions

Final evaluation

### **Assignments**

A list of exercises will be distributed in the class

### **Examination**

A PowerPoint (or Prezi, or OpenOffice) presentation of 15-20 slides prepared by a working group (depending on the number of students in the class but not more than three students in a group) on one of the issues covered in the course using literature from a pre-specified list of references. The presentation will be followed by a Q and A session. Each presenter is expected to demonstrate understanding of the topic, appraise aftermath of implementing random numbers to the question of interest and express critical thinking with regard to potential weaknesses in the paper or its further extensions.

### **Course evaluation**

20% active participation in practical exercises

80% group project

### **Core reading**

- 1) Савин И.В., Пушкарев А.А. Методы Монте-Карло в экономических исследованиях) (учебное пособие) электронный Екатеринбург. Изд-во Уральский университет, 2015 – 93 с.

- 2) Gilli, M., D. Maringer and P. Winker (2008). Applications of heuristics in finance. In: Handbook On Information Technology in Finance (D. Seese, C. Weinhardt and F. Schlottman, Eds.). pp. 635–653. International Handbooks on Information Systems. Springer, Germany.
- 3) Robert C. P. and Casella, G. Introducing Monte Carlo Methods with R. Springer, New York, 2010
- 4) Winker P. (2001) Optimization Heuristics in Econometrics: Applications of Threshold Accepting. Wiley. Chichester

### **Recommended reading**

- 1) Blueschke D., Blueschke-Nikolaeva V. and I. Savin (2013) New insights into optimal control of nonlinear dynamic econometric models: application of a heuristic approach, *Journal of Economic Dynamics and Control* 37(4): 821-837
- 2) Gilli M. and E. Schumann (2014) Optimization cultures. *WIREs Computational Statistics* 6(5): 352-358
- 3) Gilli M. and P. Winker (2009) Heuristic optimization methods in econometrics. In: *Handbook of Computational Econometrics* (D.A. Belsley and E. Kontoghiorghes, Eds.) pp. 81-119. Wiley. Chichester
- 4) Savin I. and P. Winker, Heuristic optimization methods for dynamic panel data model selection. Application on the Russian innovative performance, *Computational Economics*, 39(4): 337-363