**Course Syllabus**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Title of the course | | Theory Construction and Model Building (offered in English) | | | | | | |
| Title of the Academic Programme | | Bachelor’s Programme 'Sociology and Social Informatics' | | | | | | |
| Type of the course | | Elective | | | | | | |
| Prerequisites | | Sociological Theory, Information Systems, Data Analysis | | | | | | |
| ECTS workload | | 5 | | | | | | |
| Total indicative study hours | | Directed Study | | Self-directed study | | | Total | |
| 70 | | 120 | | | 190 | |
| Course Overview | | The course aimed at equipping students with tools to transform ideas into theories. Building on second-year Sociological Theory, the course will help students interested in computational research, or considering an analytical career in industry to acquire computational thinking mindset, learn to express vague ideas as testable and verifiable models, and understand how to model individual- and collective decisions and outcomes.  The first part of the course deals with tools to model and compare individual decisions and choices. This is a required skill for future analysts, and we will also discuss how to develop it further and where it can be applied.  Then, based on concepts from Sociological Theory and specifically of Analytical Sociology, students will get experience in working with theoretical constructs and relationships in order to generate, adapt and build on theoretical models. The main focus is on the progression from modelling individual and group decision making to the mechanism-based explanation in social science using agent-based models. The course includes a large practical part which covers working with different decision modelling approaches, including decision trees, finite state machines, participatory simulations, and agent-based models.  The course will require a large amount of independent study and will help you to work on your computational and, partially, coding skills. | | | | | | |
| Intended Learning Outcomes (ILO) | | As a result of this course, students will:   * Thoroughly understand the role of theory in sociological research * Understand the link between theorizing and modelling * Generate research ideas * Translate research ideas into formal theories * Appropriately apply decision modelling approaches to research and analytics tasks * Interpret modelling results in sociological terms | | | | | | |
| Teaching and Learning Methods | | Teaching and learning methods include a lecture, seminars, group work, practical home assignments (NetLogo, R, spreadsheets). | | | | | | |
| Content and Structure of the Course | | | | | | | | |
| **№** | **Topic / Course Chapter** | | **Total** | | **Directed Study** | | | **Self-directed Study** |
| **Lectures** | **Seminars** | |
| 1 | Course Intro. Theory, Decisions and Models | | 25 | | 2 |  | | 15 |
| 2 | Individual Decision Making - Optimization, Rationality, Utility, Cognitive Biases. Tools for Modelling Individual Decisions - Tables, Rules, Trees, FSMs | | 23 | |  | 12 | | 15 |
| 3 | Micro-Macro links in Complex Adaptive Systems. What is Agent-Based Model? Introduction to NetLogo - My first ABM | | 23 | |  | 12 | | 15 |
| 4 | Exploring and Extending ABMs - Fire in the Forest. Creating ABM from scratch. Design Principles | | 23 | |  | 8 | | 15 |
| 5 | ABM сomponents. Agents and Environments. Analysing ABMs. Verification, Validation and Replication. Extending Schelling’s Segregation model | | 23 | |  | 8 | | 15 |
| 6 | ABM-based Theory Construction and validation. Micro-Macro Link and Sociological Explanation | | 23 | |  | 8 | | 15 |
| 7 | Participatory simulation of interaction and group decision making. Emergence of Friendship | | 25 | |  | 10 | | 15 |
| 8 | Modelling Emergence of Inequality. Advanced Topics - ML, Networks, Maps, Extensions, Reinforcement learning | | 25 | |  | 10 | | 15 |
| **Total study hours** | | | 190 | | 2 | 68 | | 158 |
| Indicative Assessment Methods and Strategy | | * Preparation for Seminars and in-class Participation (30% of the cumulative grade) * Essay I (Individual Decisions) (10% of the cumulative grade) * Test (Basics of Decision Theory and ABM) (20% of the cumulative grade) * Group project (Participatory Simulation Design) (20% of the cumulative grade) * Essay II (ABM Simulation) (20% of the cumulative grade)   Final grade equals to cumulative grade. | | | | | | |
| Readings / Indicative Learning Resources | | Mandatory   * Cioffi-Revilla, Claudio. 2014. Introduction to Computational Social Science: Principles and Applications. 2014 edition. London ; New York: Springer. <https://link.springer.com/book/10.1007%2F978-1-4471-5661-1> * Kochenderfer, Mykel J., Christopher Amato, Girish Chowdhary, Jonathan P. How, Hayley J. Davison Reynolds, Jason R. Thornton, Pedro A. Torres-Carrasquillo, N. Kemal Üre, and John Vian. 2015. Decision Making Under Uncertainty: Theory and Application. 1st ed. The MIT Press. <https://www.frontiersin.org/research-topics/295/decision-making-under-uncertainty> * Wilensky, Uri, and William Rand. 2015. An Introduction to Agent-Based Modeling: Modeling Natural, Social, and Engineered Complex Systems with NetLogo. MIT Press. <https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=3339969>   Optional   * Manzo, Gianluca, ed. 2014. Analytical Sociology: Actions and Networks. 1 edition. Hoboken: Wiley. <https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=1650830> * Schlüter, Maja, Andres Baeza, Gunnar Dressler, Karin Frank, Jürgen Groeneveld, Wander Jager, Marco A. Janssen, et al. 2017. ‘A Framework for Mapping and Comparing Behavioural Theories in Models of Social-Ecological Systems’. Ecological Economics 131 (January): 21–35. <https://proxylibrary.hse.ru:2054/science/article/pii/S0921800915306133?via%3Dihub> | | | | | | |
| Indicative Self- Study Strategies | | **Type** | | | | **+/–** | | **Hours** |
| Reading for seminars / tutorials (lecture materials, mandatory and optional resources) | | | | + | | 40 |
| Assignments for seminars / tutorials / labs | | | | + | | 60 |
| E-learning / distance learning (MOOC / LMS) | | | | - | |  |
| Fieldwork | | | | - | |  |
| Project work | | | | + | | 58 |
| Other (please specify) | | | | - | |  |
| Preparation for the exam | | | | - | |  |
| Academic Support for the Course | | Academic support for the course is provided via e-mail and Dropbox. In 2018-19 some materials are planned to be delivered in blended mode. | | | | | | |
| Facilities, Equipment and Software | | A computer class with NetLogo, R, MS Excel | | | | | | |
| Course Instructor | | Sr. Lecturer Ilya Musabirov, Lecturer Viktor Karepin | | | | | | |

**Аnnex 1**

**Course Content**

**Topic 1 - Course Intro. Theory, Decisions and Models:**

1. Course Intro. Theory, Decisions and Models

When we study decision making; What is ABM in principle; Agent-Based Models vs. Other Modeling Forms; When is ABM the most beneficial; Trade-offs of ABM

**Topic 2 - Individual Decision Making - Optimization, Rationality, Utility, Cognitive Biases. Tools for Modelling Individual Decisions - Tables, Rules, Trees, FSMs**:

1. Individual Decision Making - Optimization, Rationality, Utility, Cognitive Biases

Theories of decision making; Models of cognition; Rationality and bounded rationality; Ways to compute utility: decisions under risk, the decision under uncertainty, marginal utility, relative utility; Ways to implement cognitive biases in modelling

1. Tools for Modelling Individual Decisions - Tables, Rules, Trees, FSMs

Ways to represent and compute individual decision making and its’ outcomes

**Topic 3 - Micro-Macro links in Complex Adaptive Systems. What is Agent-Based Model? Introduction to NetLogo - My first ABM**:

1. Micro-Meso and Micro-Macro links in Complex Systems

A transition of agent behaviour from the individual level to a level of groups, and farther to macro level of the community; Middle-range theory.

1. What is ABM? Introduction to NetLogo - My first ABM

Introduction to NetLogo; First look at Agent-Based Models and its' basic elements; The interface; Basic syntax

**Topic 4 - Exploring and Extending ABMs - Fire in the Forest. Creating ABM from scratch. Design Principles:**

1. Exploring and Extending ABMs - Fire in the Forest

How to find and explore others' NetLogo models; Practice with reading the info tab in NetLogo models; Exploring the forest fire model; Expanding the forest fire model: 1. add the probability of spreading fire, 2. add wind (the probability of spreading fire in different directions is different)

1. Creating ABM from scratch. Design Principles

A brief introduction to the algorithm of creating Agent-Based model: 1. Motivation, stating the research questions, 2. Formulation of conceptual, formal models, 3. Implementation, operationalization and writing code, 4. Debugging, veriﬁcation and validation, 6. Analysis; Detailed;

**Topic 5 - ABM сomponents. Agents and Environments. Analysing ABMs. Verification, Validation and Replication. Extending Schelling’s Segregation model:**

1. Components of ABM. Agents and Environments

Detailed descriptions of a variety of ways how we can design a model and implement it in code in different manners: 1. Agents (agents’ properties, types of agents, behaviour, collections of agents, the granularity, agent’s cognition), 2. Environments (spatial environments, networks, GIS), 3. Interactions, 4. Scheduling

1. Analysing ABM. Verification, Validation and Replication

How to add analytical graphs to the User Interface; Types of Measurements; The necessity of multiple runs in ABM (stochasticity); Extracting the raw data from ABM runs; Statistical analysis of the Spread of Disease model; Special cases: 1. Network analysis, 2. Environmental and GIS data; Sensitivity Analysis and Robustness, Macrovalidation vs. Microvalidation

1. Project presentations

Presentations of students’ proposals of group project assignments

**Topic 6 - ABM-based Theory Construction and validation. Micro-Macro Link and Sociological Explanation:**

1. ABM-based Theory Construction and validation

How to construct and verify theories with ABM

1. Micro-Macro Link and Sociological Explanation

Theories of (individual) micro-behaviour transition to macro-outcomes

1. Models of interaction and group decision making. Group Biases.

Simulations of the group decision-making process; Agent-based modelling meets Game Theory; Modelling group biases in NetLogo

**Topic 7 - Participatory simulation of interaction and group decision making. The emergence of Friendship:**

1. Participatory simulation of interaction and group decision making

Introduction to simulations with a few human-driven agents; HubNet extension for NetLogo

1. Emergence of Friendship

Mechanisms of friendship formation: Transitivity, Reciprocity and Homophily

**Topic 8 - Modelling Emergence of Inequality. Advanced Topics - ML, Networks, Maps, Extensions, Reinforcement learning:**

1. Advanced Topics - ML, Networks, Maps, Extensions, Reinforcement learning

Participatory Simulations and extraction of rules from Participatory Simulations (HubNet); Integration of advanced data sources and output; Geographic Information Systems (GIS) Toolkits; Social Network Analysis (SNA) Toolkits

1. Extending models

In-class practice with extending and analysing ABMs

1. Modelling Emergence of Inequality

Models of inequality in artificial and social systems

1. Project presentations

Final presentations of group project assignments

**Annex 2**

**Assessment Methods** **and Criteria**

**Assessment Methods**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Types of Assessment** | **Forms of Assessment** | **Modules** | | | |
| **1** | **2** | **3** | **4** |
| Formative Assessment | Test |  |  | \* |  |
| Essay |  |  | \* | \* |
| Project |  |  |  | \* |
| In-class Participation |  |  | \* | \* |

**Assessment Criteria**

**In-class Participation**

|  |  |
| --- | --- |
| **Grades** | **Assessment Criteria** |
| «Excellent» (8-10) | A critical analysis which demonstrates original thinking and shows strong evidence of preparatory research and broad background knowledge. Active participation in classroom activity; able to ask related questions. |
| «Good» (6-7) | Shows strong evidence of preparatory research and broad background knowledge. Excellent oral expression. Might make minor mistakes. |
| «Satisfactory» (4-5) | Satisfactory overall, showing a fair knowledge of the topic, a reasonable standard of expression. Some hesitation in answering follow-up questions and/or gives incomplete or partly irrelevant answers. |
| «Fail» (0-3) | Limited evidence of relevant knowledge and an attempt to address the topic.  Unable to offer relevant information or opinion in answer to follow-up questions. |

**Project Work - Participatory Simulation Design**

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| --- | --- |
| **Grades** | **Assessment Criteria** |
| «Excellent» (8-10) | A well-structured, analytical presentation of project work. Shows strong evidence and broad background knowledge. In a group presentation, all members contribute equally and each contribution builds on the previous one clearly; Answers to follow-up questions reveal a good range and depth of knowledge beyond that covered in the presentation and show confidence in a discussion. |
| «Good» (6-7) | Clearly organized analysis, showing evidence of a good overall knowledge of the topic. The presenter of the project work highlights key points and responds to follow up questions appropriately. In group presentations, there is evidence that the group has met to discuss the topic and is presenting the results of that discussion, in the order previously agreed. |
| «Satisfactory» (4-5) | Takes a very basic approach to the topic, using broadly appropriate material but lacking focus. The presentation of project work is largely unstructured, and some points are irrelevant to the topic. Knowledge of the topic is limited and there may be evidence of a basic misunderstanding. In a group presentation, most of the work is done by one or two students and the individual contributions do not add up. Students are unable to maintain discussion. Project and presentation or discussion have some discrepancy in key aspects. |
| «Fail» (0-3) | Fails to demonstrate any appropriate knowledge, or/and NetLogo model does not start without errors. |

**Written Assignment - Essays I-II**

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| --- | --- |
| **Grades** | **Assessment Criteria** |
| «Excellent» (8-10) | Has a clear argument, which addresses the topic and responds effectively to all aspects of the task. Fully satisfies all the requirements of the task; rare minor errors occur; a well structured, analytical paper; references to background |
| «Good» (6-7) | Responds to most aspects of the topic with a clear, explicit argument. Covers the requirements of the task; may produce occasional errors. |
| «Satisfactory» (4-5) | Generally addresses the task; the format may be inappropriate in places; display little evidence of (depending on the assignment): independent thought and critical judgement include a partial superficial coverage of the key issues, lack critical analysis, may make frequent errors. |
| «Fail» (0-3) | Fails to demonstrate any appropriate knowledge. |

**Written Assignment - Test**

|  |  |
| --- | --- |
| **Grades** | **Assessment Criteria** |
| «Excellent» (8-10) | Has a clear argument, which addresses the topic and responds effectively to all aspects of the task. Fully satisfies all the requirements of the task; rare minor errors occur; Shows a clear understanding of the topic, able to implement knowledge and combine them with original thinking. |
| «Good» (6-7) | Responds to most aspects of the topic with a clear, explicit argument. Covers the requirements of the task; may produce occasional errors. |
| «Satisfactory» (4-5) | Generally addresses the task; the format may be inappropriate in places; display little evidence of (depending on the assignment): independent thought and critical judgement include a partial superficial coverage of the key issues, lack critical analysis, may make frequent errors. |
| «Fail» (0-3) | Fails to demonstrate any appropriate knowledge. |

# Individual decision (Essay I)

You have to write a short paper on the decision models you developed for the last class. You can continue to expand the case, that you started on the seminar in groups, but now finish them individually.

You have to choose some theories, that are relevant to your case. Discuss key assumption for each of them. Find other papers for implementation in your field, and/or explain why possible to use it, and quote them.

The text should contain:

1. Hypothesis

2. A framework of decision models you have to choose 3-4

3. conceptual map/diagram for each of them

4. operationalizations of the variables

5. Comparison

6. Conclusion (which one is better)

Your essay should ~500-1000 words.

## Essay assignment (Essay II)

You have read “Explaining Social Change: An Analytical Approach” by Peter Hedström, where he described the idea of mechanism-based explanation and DBO model. In the article, he gave some examples of action- and interaction-related mechanisms (See Figure 3.)

Choose any social phenomena, which was not mentioned in the article, and try to come up with a mechanism-based explanation, using DBO vocabulary, and going through a “long way” of Coleman’s boat.

1. Briefly describe the phenomenon you chose, start and end points on the macro level
2. Describe what is individual-level action
3. Provide desire-only, belief-only and opportunity-only based explanations of action where possible
4. How “desires”, “beliefs” and “opportunities” are connected with each other and with “action” in your example? Describe and draw the scheme (or choose an appropriate one from Figure 3).
5. How many individual actors are included in your explanation?
6. What is the link between the individual and the social (collective)? Describe emergent outcomes which might appear on macro level
7. What ideas from Schelling’s notion of micromotives and macrobehavior you can use in your model and how?

Your essay should ~1000-1200 words.

## Project

You should create a model for a chosen phenomenon. (you can continue to develop a phenomenon, that you described in essay II) Create a scope for a model, describe agents (at least 3 in the model), draw a finite state model for each of your agents. Define agent’s behaviour. Specify the environment, it's characteristics. Specify the time step and its meaning in terms of the phenomenon. Motivate chosen input parameters and outcome measures of the model. Provide info for a model, including a brief description of the main idea. Guide how to use it, with describing output monitors, input switches, buttons and other controls. On project presentation, you do not have to run your model, but it should start without error. You have to present:

* Background of phenomenon
* Research hypothesis
* Describe your model, its parts
* Analysis of models output
* Any future work and model development

Be ready to participate in a discussion regarding your model and presentation.

You can choose any phenomenon you want, but it’s necessary to discuss it with a teacher before submitting. However, if you are no able to choose, the topic will be given randomly from the following list.

1. Evaluation of trust
2. Crowd Behaviour
3. Traffic jams
4. Homophily in the network
5. Matthew effect
6. Crowd wisdom
7. Power of weak ties
8. Prisoner dilemma
9. Transitivity in the social network

**Recommendations for students about the organization of self-study**

Self-study is organized in order to:

* Systemize theoretical knowledge received at lectures;
* Extending theoretical knowledge;
* Learn how to use legal, regulatory, referential information and professional literature;
* Development of cognitive and soft skills: creativity and self-sufficiency;
* Enhancing critical thinking and personal development skills;
* Development of research skills;
* Obtaining skills of efficient independent professional activities.

Self-study, which is not included into a course syllabus, but aimed at extending knowledge about the subject, is up to the student’s own initiative. A teacher recommends relevant resources for self-study, defines relevant methods for self-study and demonstrates students’ past experiences. Tasks for self-study and its content can vary depending on individual characteristics of a student. Self-study can be arranged individually or in groups both offline and online depending on the objectives, topics and difficulty degree. Assessment of self-study is made in the framework of teaching load for seminars or tests.

In order to show the outcomes of self-study it is recommended:

* Make a plan for 3-5 presentation which will include topic, how the self-study was organized, main conclusions and suggestions and its rationale and importance.
* Supply the presentation with illustrations. It should be defined by an actual task of the teacher.

**Recommendations for essay**

An essay is a written self-study on a topic offered by the teacher or by the student him/herself approved by teacher. The topic for essay includes development of skills for critical thinking and written argumentation of ideas. An essay should include clear statement of a research problem; include an analysis of the problem by using concepts and analytical tools within the subject that generalize the point of view of the author.

Essay structure:

1. *Introduction and formulation of a research question.*

2.*Body of the essay* and theoretical foundation of selected problem and argumentation of a research question.

3. *Conclusion* and argumentative summary about the research question and possibilities for further use or development.

**Special conditions for organization of learning process for students with special needs**

The following types of comprehension of learning information (including e-learning and distance learning) can be offered to students with disabilities (by their written request) in accordance with their individual psychophysical characteristics:

1. *for persons with vision disorders:* a printed text in enlarged font; an electronic document; audios (transferring of learning materials into the audio); an individual advising with an assistance of a sign language interpreter; individual assignments and advising.
2. *for persons with hearing disorders: a* printed text; an electronic document; video materials with subtitles; an individual advising with an assistance of a sign language interpreter; individual assignments and advising.
3. *for persons with muscle-skeleton disorders: a* printed text; an electronic document; audios; individual assignments and advising.