Universität Zürich[UZH]

UZH Blockchain Center

SocialNetworks
UNIVERSITY RESEARCH PRIORITY PROGRAM

PROF. DR CLAUDIO J. TESSONE

AGENT-BASED MODELLING

FOR BUSINESS, ECONOMICS, INFORMATICS AND SOCIAL SCIENCE

SYLLABUS

SPRING SEMESTER 2020

Network Science / URPP Social Networks
Department of Business Administration (IBW)
University of Zurich, Switzerland

PREAMBLE

Welcome

This course takes place every Spring Semester. You will find all necessary information concerning the course within this Syllabus. From time to time, updates will be communicated on the OLAT Platform and on the Network Science webpage at BWL (http://www.business.uzh.ch/professorships/networkscience.html). Please, check regularly both.

We are very happy to welcome you to our lecture.

Claudio J. Tessone

Quick Overview

Instructor

- Prof. Dr Claudio J. Tessone
  Office AND 4.42, Andreasstrasse 15
  CH-8050 Zürich
  Switzerland

Office hours are by appointment

Phone: +41 44 63 42 918
E-mail: claudio.tessone@business.uzh.ch
Webpage: https://www.business.uzh.ch/professorships/networkscience

Teaching Assistants

- Dr Manuel S. Mariani
  E-mail: **manuel.mariani@business.uzh.ch**

- Caspar Schwarz-Schilling
  E-mail: **caspar.schwarz-schilling@uzh.ch**

Details

Type: Lecture
Target Audience: This course is acknowledged for MA students and is assigned to the „Wahlpflichtbereich" BWL 6.
Frequency: Each fall Semester
AP (ECTS): 6
Language: English

Prerequisites

Fundamental courses in statistics (e.g. Empirical Methods MOEC0021). Solid programming skills (or the willingness to develop this knowledge **prior** to the lecture) are a necessary requirement. The programming language in which the exercises are to be solved is not relevant. We can support you if the code is written in Python, R, etc. Python will be used during the exercises as example.

Content:

A detailed introduction to the most paradigmatic agent-based models with a focus on understanding the aims and applications of this technique.

Grading:

Active participation, multiple choice tests, assignments given in class.

Further information:

https://www.business.uzh.ch/en/professorships/networkscience/teaching

Registration:

Through the registration tools at the University of Zurich.

1. Introduction and Objectives

Agent-based models are routinely applied by companies and organisations to inform managerial and marketing decisions. How to choose the market segments to target in a marketing campaign for a new product, in order to minimise costs and maximise the eventual number of adopters? Which customers are more susceptible to social influence, and which ones are most influential among their peers? How to model and predict their behaviour? How do collective phenomena (such as the widespread adoption of a new technology) emerge in social and economic systems, and can we predict and control them?

Driven by these questions and more, **agent-based models (ABMs)** are fundamental instruments to understand the link between the **micro-level dynamics** (i.e., the local rules of interaction between the units of a complex socio-economic system) and **emergent macro-properties** (i.e., collective properties of the system). Therefore, ABMs revolve around the design and implementation of stylised and parsimonious models that capture specific mechanisms. ABMs differ from standard econometric modelling as they typically do not resort to regressive models to fit observed data.

The course covers topics related to ABMs as variegated as: Product adoption, diffusion of opinions, virus diffusion (in social and computer networks), segregation in society, consensus formation (again in social and computer networks), agent behaviour in financial markets. The common theme is that in all these processes, one can explain the collective behaviour of the system in terms of the local interactions among its units.

The course is highly interactive. All the lectures have both a theoretical and a practical session. In the practice session, the students will develop (in small groups and always supported by the instructors) the models themselves. This will allow them to gain direct experience and familiarity with the concepts taught in the theoretical session and the techniques involved. In this participatory environment, multiple exercises and the creation of visualisations will play an important role.

2. Course Contents

LECTURE 1. **Kickoff**

. Example from Marketing practice: Seeding strategies. Example from social science: Understanding the origins of cultural segregation.
. Micro-behaviour and Macro-properties
. Emergent properties
. What is an Agent-Based Model?
. Control and order parameters
. Introduction to programming techniques

LECTURE 2. **Models of Spreading (i)**

. Diffusion of innovations and product adoption
. Innovators and imitators

. Early versus main market development
. Data-driven parameter estimation

LECTURE 3. **Models of Spreading (ii)**

. Models of epidemics (compartment models)
. Susceptible-infected
. Susceptible-infected-recovered
. *Naïve* dynamic implementation
. Gillespie algorithm

LECTURE 4. **Threshold models and Contagion**

. Gossips
. A simple model for riots
. Complex contagion
. Malware and computer viruses
. Consensus
. Applications to blockchains

LECTURE 5. **Models of Consensus and Social Influence**

. Imitation, herding
. Coordination and anti-coordination
. Voter model
. Ising model
. Majority models

LECTURE 6. **Cellular automata and Self-organised criticallity**

. Social cellular automata
. Conway's Game of Life
. Crowd dynamics
. Traffic dynamics
. Forest-fire model
. Sand-pile model
. Minority games and applications to financial markets

LECTURE 7. **Social Segregation**

. Racial segregation in modern societies
. Schelling model of segregation
. Local proximity
. Bounded neighbourhood

LECTURE 8. **Evolution of Culture**

. Language dynamics
. Axelrod model on the evolution of culture
. Multicultural versus monocultural states

LECTURE 9. **Data-driven modelling and Wrap-up**

. Parameter estimation from agent-level data
. Parameter estimation from system-level data
. The effect of the dynamic rules

3. Course Material

Material Offered

Students have access to OLAT to download the slides presented in class, find relevant material, datasets and literature.
The following procedure is strongly recommended as preparation for the classes.

Overview of classes

On the webpage an overview of all classes given by our team can be found. Develop an idea of the classes and how they best fit into your personal agenda. Keep in mind that agent-based modelling classes are only offered once a year.

Syllabus

For each course, a detailed syllabus exists with all details concerning that specific course. This is your guideline for the class and a MUST read. You'll find everything in here concerning the grading of the course, the agenda, the planned topics and much more...
The main materials used in this course are:

The Slides

The slides presented and discussed in class are available in a digital format. You can download the slides to each class. The slides do not completely cover the entire Syllabus; therefore, it is necessary to participate in the class. All slides will be distributed after each module.
All our slides follow our detailed standardised slide format. All presentations in the classroom also have to follow this format.

4. Reading

Bibliography

Required readings:

- ✓ N. Gilbert. *Agent-Based Models* (2007, Sage Publications, London)
- ✓ Miller, John H., and Scott E. Page. *Complex adaptive systems: An introduction to computational models of social life* (2009, Princeton University Press)

Recommended readings:

- ✓ T.C. Schelling. *Micromotives and Macrobehavior* (1978, Norton, New York)
- ✓ M. Granovetter. *Society and Economy: Framework and Principles* (2017, Harvard University Press)

Related scientific journals

- ✓ *American Economic Review*

- ✓ *Econometrica*
- ✓ *American Journal of Sociology*
- ✓ *Proceedings of the National Academy of Science*
- ✓ *Philosophical Transactions of the Royal Society B*
- ✓ *Physical Review E*
- ✓ *Physical Review Letters*
- ✓ *Journal of Artificial Societies and Social Simulation*
- ✓ *Scientific Reports*
- ✓ *PLOS ONE*

5. Application Procedure

Please enrol to the course using the usual UZH planning tools. In case of doubts, contact the instructor of the booking service of the Faculty

E-Mail: modulbuchung@oec.uzh.ch

6. Evaluation

There is no final written exam on the subjects taught during the course. We believe this is a subject whose depth can be best learnt by doing: Therefore, there are extensive practice sessions where the students get in-depth exercises on the main topics in the area.

6.1 Active participation in class

Credits are awarded for thoughtful and active participation in class and in exercise discussions throughout the course. Credits will be given for knowledge of readings, cogent articulation of arguments and comments, and contribution to case discussion. Participation will be evaluated for quality as well as consistency. Attending the class and the exercises regularly and on time is an indication of professionalism and will also improve your participation grade.

6.2 Exercise sessions

We strongly recommend that you participate in all exercise sessions, do the readings and follow our instructions. The conduct of this course is based on student inquiry, experience, opinion and reflection related to the readings and other assignments. Exercises (i.e. gaining practical experience with agent-based modelling and the difficulties that may emerge) are a fundamental part of the course.

6.3 Final project

Students will form groups and select a topic of their interest. Then they will develop a project in the area of the course. This will give them the opportunity to have practical experience on all the research cycle: from inception to result analysis. This work will have a large impact on the grades.

7. Academic Fraud

The Code of Honour of the University of Zurich applies to all work in this course and will be strictly enforced. The intent of the Honour Code in this course is to ensure that each student claims and receives credits for his/her own efforts. Violations to this are considered academic fraud.

Definition

Academic fraud is an act by a student, which may result in a false academic evaluation of that student or of another student. Plagiarism is understood as the use or imitation of another people's work, either wholly or partially, without acknowledging the source and the author. In principle, plagiarism is an infringement of copyright law. Short passages from another author may be quoted.
All documents you will hand-in are going to be checked by software and manually for plagiarism. Documents with a score above 10% are going to be intensively validated and in suspicious cases we hand-out penalties for fraud behaviour.

8. Administrative Comments

8.1 Students with disabilities

Any student with a documented disability needing academic adjustment or accommodation is requested to speak with the instructors during the first two days of class. All discussion will remain confidential. Students with disabilities will need to also contact the directors of the Faculty.

8.2 Getting in contact with me

E-mails should be short and to the point. Before sending an email, make clear that email is the appropriate instrument for your task. In some situations, a telephone call is much easier and more personal. Or just ask me in class.

8.3 Registration cards

Right in the beginning of the class you will receive a Word file that we ask you to fill-out. In this file we ask you to add a personal picture and personal address information. Each information is kept confidential and is only accessible to our team. The reasons for doing this are 1) we would like to learn your names by pictures, 2) we use pictures later on if you ask reference letters to better remind ourselves, and 3) we need your contact information for the administration. Delivering these files is of course voluntary. However, we would highly appreciate your cooperation on this. Many thanks in advance.

8.4 Name cards

Please use name cards regularly in class throughout the term so I can learn your names. I usually have large numbers of students across my class, so this will make it easier for me. If you will use name cards, I assume you do not care if I know who you are.

8.5 Sound-emitting devices

It is expected that you turn off/mute all devices that emit sounds and noises that may interrupt the class (e.g., notebook, mobile phones, watch alarms). If an occasion arises in which you may need to receive a phone call, please inform me before the class. If you leave a class to answer a call without previously notification, you will not be allowed to return to class.

8.6 Laptops and calculators

Laptops and programmable calculators are needed in for the sole purpose of supporting the individual learning process.