Course syllabus «Network Analysis: Statistical Approaches»

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Programme Academic Council
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Number of credits	4
Contact hours	48
Self-study hours	104
Course	1,2
Educational format	Without use of online course

I. Goals and Results of Mastering the Discipline; Prerequisites

This course is an advanced network analysis course, designed for MASNA students who are familiar with concepts and basic techniques of network analysis in applied context. The course provides an advanced view of major theoretical concepts and methodological techniques used in creating complex network-analytic models, with hands-on experience of developing various models used to answer specific research and applied problems. In addition, this course will provide ample opportunities to include network concepts in students' master theses work.

The main goal of the class is to help students, who are already familiar with network theory and methods, to use the integrated systems thinking approach to create theoretically driven, methodologically sound research projects. The ultimate outcome of the class is the completed project proposal for a study, which can later be completed as a full-scale research project.

As a result, students should:

Know:

- the basic principles of network modeling and lay the foundation for future learning in the area.
- the major network modeling programs
- the basic principles behind working with all types of data for building network-based models

Be able to:

- identify a model that is appropriate for a research problem
- develop and code the appropriate model to answer the stated research question
- work with major network modeling programs, especially R, so that they can use them and interpret their output.
- develop and/or foster critical reviewing skills of published empirical research using applied statistical methods.
- to criticize constructively and determine existing issues with applied network mdoelsin published work

Have:

- an understanding of the advantages and disadvantages of various network amodels, and demonstrate how they relate to other methods of analysis
- a working knowledge of the different ways to analyze the network data.

Basic knowledge of introductory network statistics are required for this course.

The basics of this discipline should be used in the following courses and activities:
•Advanced network models
•all other program related courses

The course is strongly related and complementary to other compulsory courses provided in the first year (e.g. Applied Linear Models II, Contemporary Data Analysis) and sets a crucial pre-requisite for later courses and research projects as well as for the master thesis. The course gives students an important foundation to develop and conduct their own research as well as to evaluate research of others.

II. Content of the Course

Please note: each session will span over several class meetings due to complexity of each topic.

SESSION ONE: Models of social influence

This session will focus on how to use network variables as inputs (predictors), explaining variance in some non-network variable(s). The models covered will include basic linear modeling and factor analysis, and will focus on the empirical meaning of network characteristics such as centrality.

SESSION TWO: Exponential Random Graph Models

The topics covered in this session will focus on exponential random graph models, with extentions to temporal (TERMG) and separable TERMG (STERGM). Another topic in this session is on ERGM for ego networks.

SESSION THREE: Longitudinal models

The session will go over the theoretical and analytic specifications of longitudinal modeling, SIENA.

SESSION FOUR: Diffusion models

This sessions builds the understanding of diffusion through network, including modeling the spread of a single product (threshold models, influence maximization problem) and diffusion models in the presence of competition (algorithmic and game-theoretical aspects, extensions of the basic threshold and cascade models, study of equilibrium behavior).

SESSION FIVE: Community detection models

This session covers the basics of local analysis (dyads, triads), extending it to blockmodels, clustering, spinglass algorithm, exploratory graph analysis, and social community detection.

III. Grading

Course grade will be completed as follows:

Course Element	% Towards Final Grade
Course Projects (3, varied points)	60%
In-class labs	40%
Total	100%

If the final grade is non-integer, it is rounded according to algebraic rules. If has a half (.5) at the end, we are rounding upward. Rounding of cumulative grades and other rounding issues are performed according to the HSE rules.

IV. Grading Tools

This class contains several assignments that test student knowledge and understanding throughout the course.

In-class Labs

There will be a lab assignment in almost every seminar, depending on our progress. Seminar labs should help you with the task of mastering network modeling. You are required to submit your completed seminar work (with all questions answered).

Projects

In addition to seminars, I will also assign some datasets for independent explorations. I call these assignments "projects," because they will come with very little in terms of specific instructions. It will be up to you which models to build, so these assignments are not unlike real-life projects that you will face in your career. However, you are welcome to work in groups.

V. Resources

5.1 Main Literature

1. Dehmer, Matthias, and Subhash C. Basak. Statistical and Machine Learning Approaches for Network Analysis, John Wiley & Sons, Incorporated, 2012. ProQuest Ebook Central, URL https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=894394.
2. Mesbahi, Mehran, and Magnus Egerstedt. Graph Theoretic Methods in Multiagent Networks, Princeton University Press, 2010. ProQuest Ebook Central, URL https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=548754.
3. Exponential Random Graph Models for Social Networks : Theory, Methods, and Applications, edited by Dean Lusher, et al., Cambridge University Press, 2012. ProQuest Ebook Central, URL https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=1057451.

4. Alhajj, Reda, and Jon Rokne. Encyclopedia of social network analysis and mining. Springer Publishing Company, Incorporated, 2018. URL https://link.springer.com/referencework/10.1007/978-1-4939-7131-2. Springer Link.
5. De Nooy, Wouter, Andrej Mrvar, and Vladimir Batagelj. Exploratory social network analysis with Pajek. Cambridge University Press, 2005. URL https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=237594&query=Exploratory+social+network+analysis+with+Pajek. Proquest.

5.2 Additional Literature

1. Models and Methods in Social Network Analysis, edited by Peter J. Carrington, John Scott, and Stanley Wasserman. Cambridge University Press, 2005. ProQuest Ebook Central. URL https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=228772#. Proquest
2. Luke, Douglas A. A user's guide to network analysis in R. London, England: Springer, 2015. URL https://link.springer.com/book/10.1007/978-3-319-23883-8. Springer Link.
3. Kolaczyk, Eric D., and Gábor Csárdi. Statistical analysis of network data with R. Vol. 65. New York: Springer, 2014. URL https://link.springer.com/book/10.1007/978-1-4939-0983-4. Springer Link.
4. Lazega, Emmanuel, and Tom AB Snijders, eds. Multilevel network analysis for the social sciences: theory, methods and applications. Vol. 12. Springer, 2015. URL https://link.springer.com/book/10.1007%2F978-3-319-24520-1 Springer Link.
5. Kadry, Seifedine, and Mohammed Z. Al-Taie. Social Network Analysis : An Introduction with an Extensive Implementation to a Large-Scale Online Network Using Pajek, Bentham Science Publishers, 2014. ProQuest Ebook Central. URL https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=1610031#. Proquest.
6. Newman MEJ. Networks : An Introduction. Oxford: OUP Oxford; 2010. URL http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=458550. Ebsco.

5.3 Software

№ п/п	Name	Access conditions
1.	MicrosoftWindows 7 Professional RUS MicrosoftWindows 10 MicrosoftWindows 8.1 Professional RUS	*From the university's internal network (contract)*
2.	Microsoft Office Professional Plus 2010	*From the university's internal network (contract)*
3.	R, R studio	*Open access. URL: https://www.r-project.org/*

5.3 Material and technical support

Classrooms for lectures on the discipline provide for the use and demonstration of thematic illustrations corresponding to the program of the discipline, consisting of:

- PC with Internet access (operating system, office software, antivirus software);
- multimedia projector with remote control.