Doctoral School in Finance and Economics

Course ID (Transportation) Network Analysis

1. Course details

Semester:	2
Credit rating:	1 ECTS /15 TU
Pre-requisite(s):	Probability distributions, fundamentals of graph theory (modelling graphs, terminology), basic programming knowledge (e.g., Python, R)
Lecturer(s):	Anne Lange (anne.lange@uni.lu)
Administrator:	Roswitha Glorieux
Tutor(s):	
Seminar times and rooms:	Block/Semester Course
Tutorial times and rooms:	None
Communications	**It is important that students should regularly read their University e-mails, as important information will be communicated this way.**
Mode of assessment:	Grading: homework/assignment 100%
Examination Periods:	
Course WebPage:	Moodle.uni.lu

2. Aims and objectives

Aims
The course is an introduction to network analysis as it is applied for transportation networks. Most of the methodology roots in social network analysis and has been adapted to transportation networks such as air, rail and public transport networks. The course aims to provide the students with the necessary basis to assess existing studies on transportation network analysis critically as well as conduct their own analyses.
Learning Objectives The student who followed this course . … is aware of common network models in transportation and can interpret research results in the forefront of the modelling choices. . … can calculate metrics that describe node characteristics in networks (e.g. node centralities) as well as metrics to describe the structure of a network as a whole (e.g. degree distribution, network centralizations, communities). . … understands and critically reflects the meaning of metrics and their power in describing specific situations. . … is familiar with necessary software tool to conduct network analyses.

3. Plan of semester

Outline for 5 sessions with 3 TU each, if possible during a timeframe of 4-6 weeks.

Session 1: Introduction (topic, terminology, metrics for centrality, community detection)
Session 2: Exemplary research articles
Session 3: Robustness of transportation networks
Session 4: Software application, graph visualization
Session 5: Replicating a study

4. Course details (by topics)

The following aspects will be introduced or discussed during the course:

- Review on graph terminology, fundamentals on networks
- Network modelling (L- and P-space models)
- Centrality of graphs, its understanding and suitable metrics (e.g. Freeman centralities, Eigenvector centrality, PageRank centrality)
- Local and global transport network efficiency
- Small-world networks, scale-free property
- Community detection within graphs
- Robustness of networks / connectedness of a graph
- Interpretation of graph metrics (e.g. network anomalies)
- Software support (e.g. networkx in Python)

5. Reference list/ Bibliography

The content of the course will be mostly based on:

- WASSERMAN, S. & FAUST, K. 1994. Social Network Analysis: Methods and Applications, Cambridge, Cambridge University Press.
- EASLEY, D. & KLEINBERG, J. 2010. Networks, Crowds, and Markets: Reasoning about a Highly Connected World, Cambridge, Cambridge University Press.
- BORGATTI, S. P. & LI, X. U. N. 2009. On Social Network Analysis in a Supply Chain Context. Journal of Supply Chain Management, 45, 5-22.

Additional reading material:

- BORGATTI, S. P. 2005. Centrality and network flow. Social Networks, 27, 55-71.
- BOWEN, J. T. 2012. A spatial analysis of FedEx and UPS: hubs, spokes, and network structure. Journal of Transport Geography, 24, 419-431.
- DORN, I., LINDENBLATT, A. & ZWEIG, K. A. 2012. The Trilemma of Network Analysis. Proceedings of the 2012 International Conference on Advances in Social Networks Analysis and Mining (ASONAM 2012). IEEE Computer Society.
- GUIMERÁ, R. & AMARAL, L. A. N. 2004. Modeling the world-wide airport network. The European Physical Journal B, 38, 381-385.
- LATORA, V. & MARCHIORI, M. 2002. Is the Boston subway a small-world network? Physica A: Statistical Mechanics and its Applications, 314, 109-113.
- LORDAN, O., SALLAN, J. M., SIMO, P. & GONZALEZ-PRIETO, D. 2014. Robustness of the air transport network. Transportation Research Part E: Logistics and Transportation Review, 68, 155-163.
- REGGIANI, A., NIJKAMP, P. & CENTO, A. 2010. Connectivity and concentration in airline networks: a complexity analysis of Lufthansa's network. European Journal of Information Systems, 19, 449-461.

6. Further information about assessment

Students are expected to prepare some readings for each of the sessions. Details will be communicated to the participants beforehand.

Students will be asked to work with a transportation network dataset themselves in class and at home on their own computers to replicate results from one of the papers discussed earlier in the course.