Spring 2022 Syllabus: Complex Networks

## $\begin{array}{c} {\rm Spring~2022~Syllabus} \\ {\bf Complex~Networks} \end{array}$

## Prof. Dr. Dr. Frank Schweitzer

Chair of Systems Design ETH Zurich fschweitzer@ethz.ch

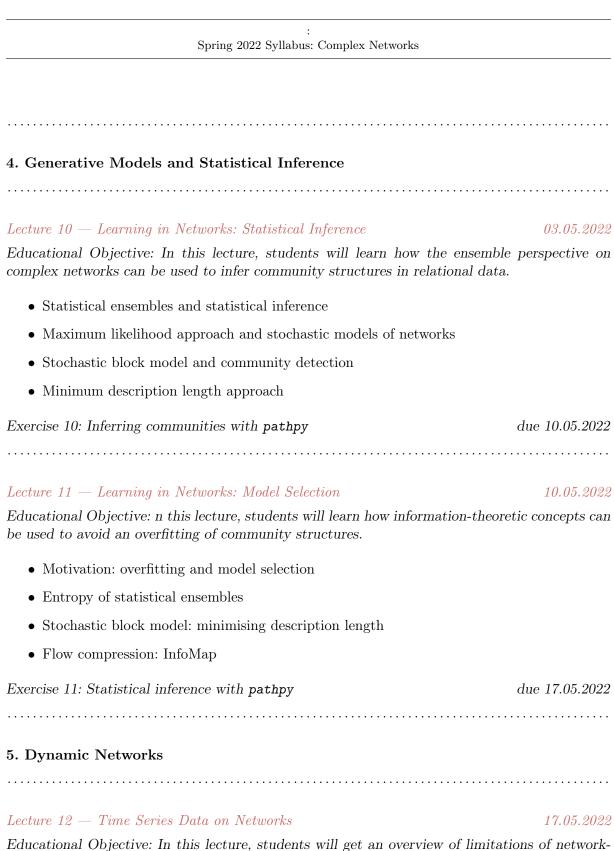
Lecture: Tuesday, 10:15–11:55 (V), ML E 12 Exercise: Tuesday, 09:15–10:00 (U	), ML E 12
Exercises are predominantly programming assignments that can be solved using programs and code skeletons will be provided. During the exercise sessions, stud to present their solutions, which will then be discussed. Sample solutions are p exercise session.	ents are expected rovided after the
1. Introduction to Networks: Basic and Advanced Metrics	
Lecture 01 — Motivation	22.02.2022
Educational Objective: In this lecture, participants will get an overview of the learn the differences between an agent-based modeling and a complex networks	
• Administrative issues and overview of the course	
• Introduction: Agent-based modeling vs. a network approach	
• Motivation: The role of network structures in complex systems	
• Illustrative examples of complex networks in nature, society, economy and	d technology
Exercise 01: Introduction to pathpy and python	due 01.03.2022







Spring 2022 Syllabus: Complex Networks	
3. Dynamical Processes on Complex Networks	
Lecture 08 — Random Walks and Diffusion in Complex Networks	12.04.2022
Educational Objective: In this lecture, students will learn how we networks by means of random walks.	can model diffusion in complex
• Dynamical processes in networks	
• Diffusion processes in networks	
• Random walks as model for diffusion processes	
• Markov chain convergence theorem	
Exercise 08: Simulating diffusion with pathpy	due 26.04.2022
Easter break	19.04.2022
Lecture 09 — Spectral Properties of Complex Networks	26.04.2022
Educational Objective: In this lecture, students will learn how diffusion processes is captured in the eigenvalues of matrix represe of these representations can be used to define feedback centrality	entations and how eigenvectors
• Stationary distributions of random walks	
• Feedback centrality measures	
• Diffusion speed in complex networks	
• Eigenvalue gap of transition matrices	
O O. I	



Educational Objective: In this lecture, students will get an overview of limitations of network based methods for the modeling of time-stamped and sequential relational data.

: Spring 2022 Syllabus: Complex Networks	
• Motivation: Limitations of the network perspective	
<ul> <li>Network evolution and dynamical processes</li> </ul>	
• Temporal networks: Basics	
• A novel perspective on temporal networks	
Exercise 12: Time Series Network Data	due 24.05.2022
6. Finding Patterns in Network	
Lecture 13 — Structure formation in growing networks  Educational Objective: In this lecture, students will learn that feedback	24.05.2022 phenomena in the growth
of networks can lead to the formation of broad degree distributions an	d complex structures.
• growth models for complex networks	
• growth of random networks: uniform attachment	
• feedback in network growth: preferential attachment	
• preferential attachment and node fitness	
Exercise 13: Simulating network growth models	due 31.05.2022
Lecture 14 — Knowledge Discovery with Network Ensembles	31.05.2022
Educational Objective: In this lecture, students will learn how network to model and analyze relational data on complex systems.	rk ensembles can be used
• Generative models of complex networks	
• Exponential Random Graph Models	
• Generalized Hypergeometric Ensemble of Random Graphs	

Session Examination