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Network inference

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Network structures are shaped by evolutionary mechanisms and determine the central aspects of how a system functions. However, differently from systems that are naturally embedded in space, we cannot simply "look" at network in order to extract its most important structural patterns. Instead, we must rely on well-founded algorithmic methods to extract this information from data in an interpretable way. In this lecture, we review a principled approach to this problem based on the elaboration of probabilistic models of network structure, and their statistical inference from empirical data.

We aim to cover the following topics:

- The stochastic block model (SBM) and its variants (degree correction, overlapping groups, etc.)
- Bayesian inference and model selection: Distinguishing structure from noise.
- Generalizing from data: Prediction of missing and spurious links.
- Model extensions: Layered, dynamic SBMs, and generalized models on continuous latent spaces.
- Fundamental limits of inference: The undetectability transition.
- Efficient inference algorithms.
- Network reconstruction from noisy or indirect data.