UNIVERSITY OF MINNESOTA

Minnesota Robotics Institute

ROB 8970 **ROBOTICS COLLOQUIUM** **FALL 2025**

Class Report – Lecture 4 (09/26/2025)

Speaker : Prof. Donatello Materassi

Apurv Kushwaha
kushw022@umn.edu

Prof. Materassi presented a deeply theoretical yet application based lecture on learning the *input-output structure of networks from observational data*. He showed how the time series data from fields such as genomics, financial markets, and social networks can be used to reconstruct hidden interconnections. The lecture focused on models based on transfer functions, Wiener filtering, and graphical models, showing how tools like minimum spanning trees, conditional independence, and Granger causality can help recover both the *skeleton and orientation* of complex networks. Professor discussed key challenges, such as distinguishing correlation from causation, handling feedback loops, and making reliable inferences with noisy or incomplete data. He concluded by stressing the trade-offs between assumptions, computational complexity, and the reliability of reconstruction.

Questions

- How can these network reconstruction methods be applied to complicate robotic systems that involve multiple sensors and actuators that are intensively coupled?

Comments

- The lecture connected rigorous mathematical tools with real world examples (genes, finance, social networks), making overall concepts easier to catch.
- The section on ***correlation is not causation*** and ***Simpson's paradox*** was very memorable and explained why graphs are essential in causal reasoning.
- The integration of Granger causality with graphical separation concepts showed how classical and modern approaches can complete each other.

What I Liked

- I liked the clear explanation of Wiener filtering as a tool for defining distances between signals and reconstructing tree structures.
- The application to real stock market data, clustering industries without labels, was a great demonstration of the theory's power.

Areas for Improvement

- The lecture included many very complicated mathematical elements and moved quite fast, making it very hard to grasp everything fro me.
- A stronger tie to robotics specific examples (For example : Multi Sensor systems) would make the applications more relatable from a robotics point of view.

Overall Assessment

This lecture offered a rigorous and interesting look into the problem of reconstructing networks from observational time-series data. Prof. Materassi connected theory and practice by showing how tools like Wiener filtering, Granger causality, and conditional independence can reveal hidden structures in complex systems. The emphasis on correlation v/s causation, robustness to real-world noise, and the trade-offs between structure, dynamics, and algorithmic complexity gave an abstract yet comprehensive picture of the field. While being highly technical, the talk was both insightful and interesting, encouraging students to think about how to uncover and validate hidden connections in robotics and beyond.