Information Theoretical Modeling of Multi-Agent Interactions

Xueyan Niu

School of Industrial Engineering, Purdue University

Background

Addressing many major scientific and engineering challenges requires understanding and characterizing interactions in complex systems.
E.g.

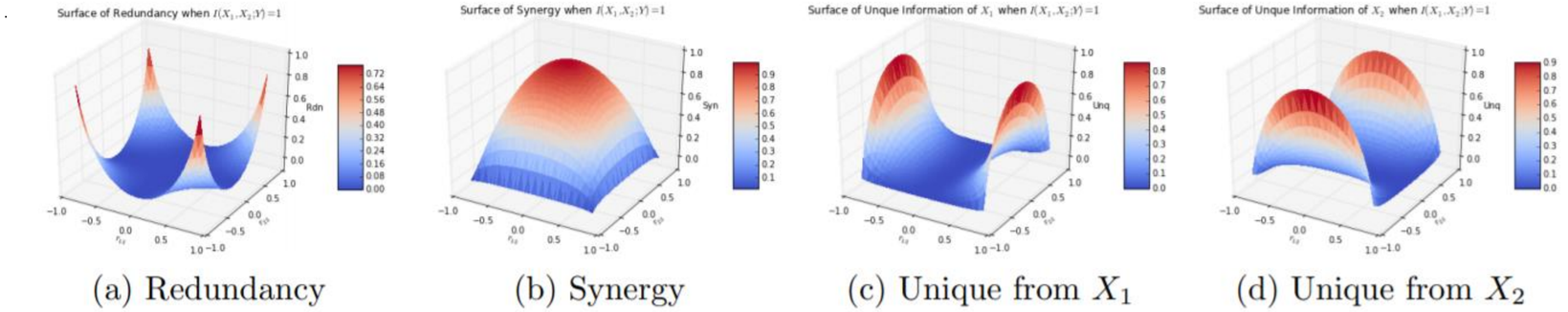
- the risk of heart disease
  - hundreds of genetic variants
- global navigation systems
  - multiple satellites
- deep learning
  - interconnected neurons

Questions

Theoretical characterization of interactions that give rise complex systems.

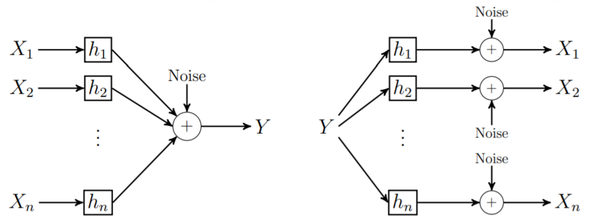
1. Quantifying complex interactions using information theory.
2. Establishing correspondences between information quantities.

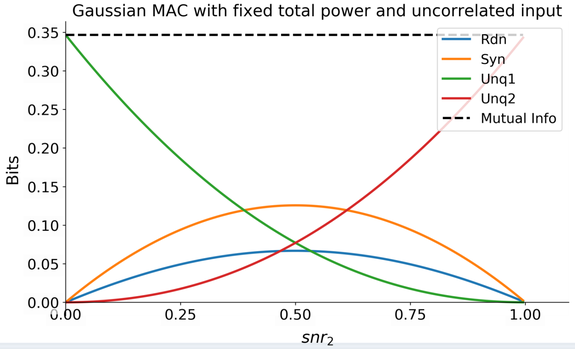
A novel differentiable measure of the complex interactions

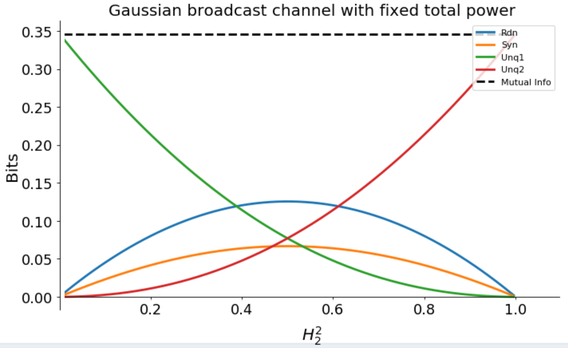


A novel duality between the information measures

in communication channels with many-to-one and one-to-many network topologies.







Method

- Information Theory
- Differential Geometry
- Lattice Theory

Conclusion

My long-term goal is to develop rigorous methodologies for researchers in various domains to analyze and model complex systems.

Reference

[1] X. Niu, and C. J. Quinn. "A measure of synergy, redundancy, and unique information using information geometry." 2019 IEEE International Symposium on Information Theory (ISIT), 2019.

[2] X. Niu, and C. J. Quinn. "Synergy and redundancy duality between Gaussian multiple access and broadcast channels." 2020 International Symposium on Information Theory and Its Applications (ISITA), 2020.