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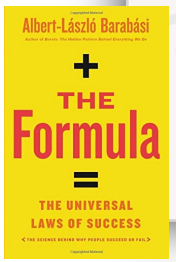
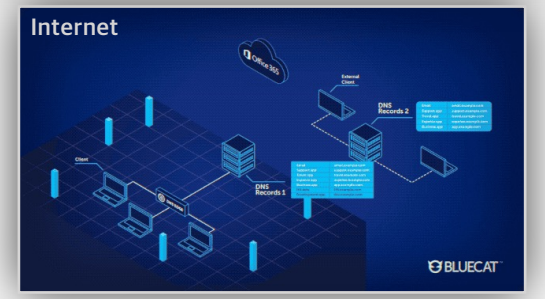
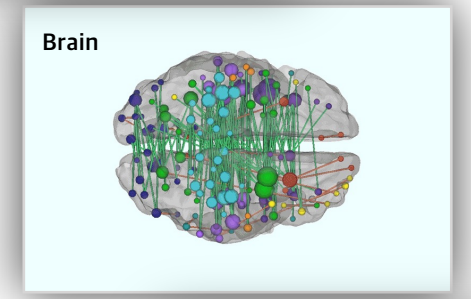
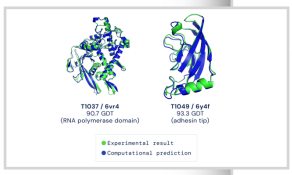
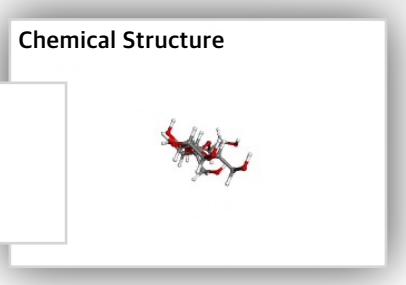
Graph Dynamics are Everywhere

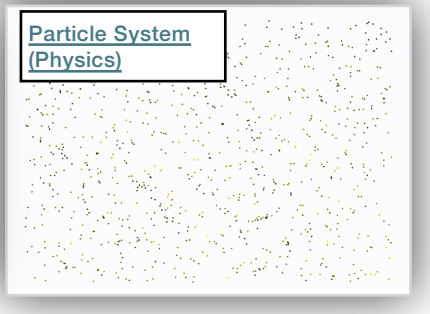








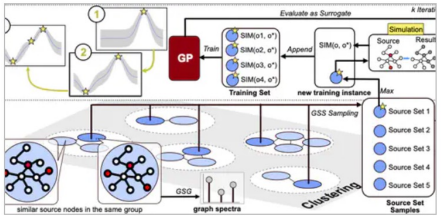




Introduction to the GAI Working Group

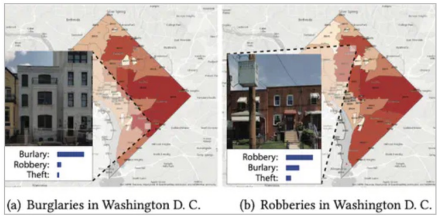
- The **Graph AI** Working Group is dedicated to advancing graph machine learning
  - Focusing on the **dynamic propagation on graph** and their application in various networks.
  - Analyzing the complexities of multiple **interconnected** networked systems

Some previous work



Graph Bayesian Optimization

How to conduct Bayesian optimization over graph problems so as to reduce data use?



Graph Learning on Street Views

Use streetview to predict the crime statistics.

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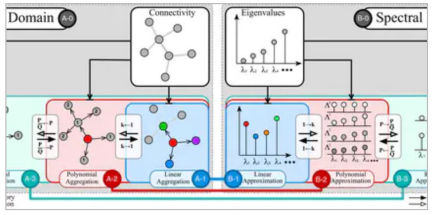
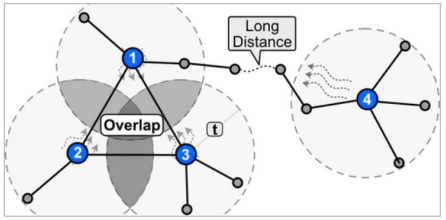


An Unified Framework for Graphs

Is there an unfying framework for all types of graphs, including spectral and spatial, also, directed, higher-order, and dynamic graphs?

PDF Code Slides



Higher-order Relation in Seeds

How remote seeds can implicitly ``interact'' with each other in the influence maximization problem?

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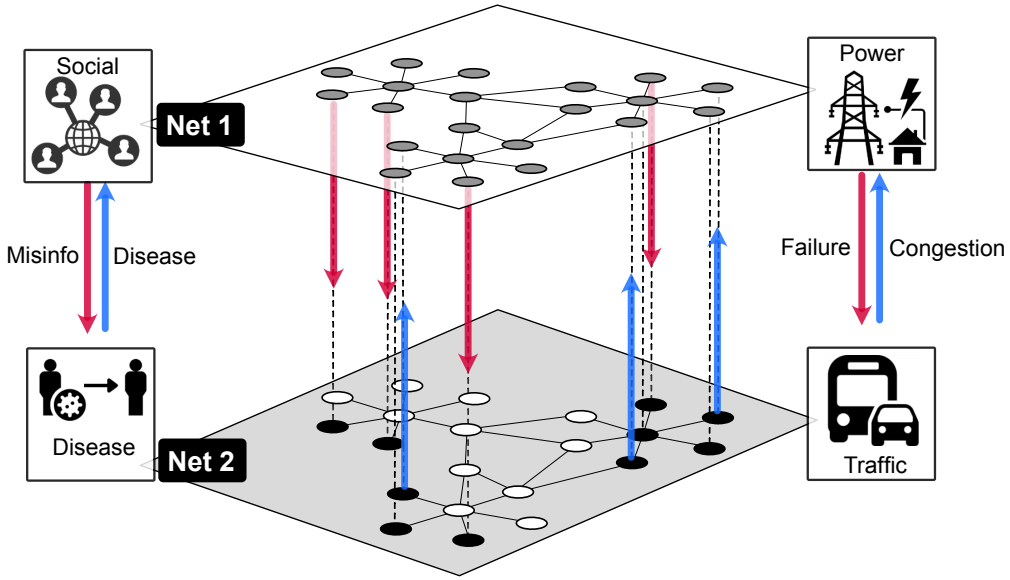
Significance of Graph AI in Multi-Layer Networks

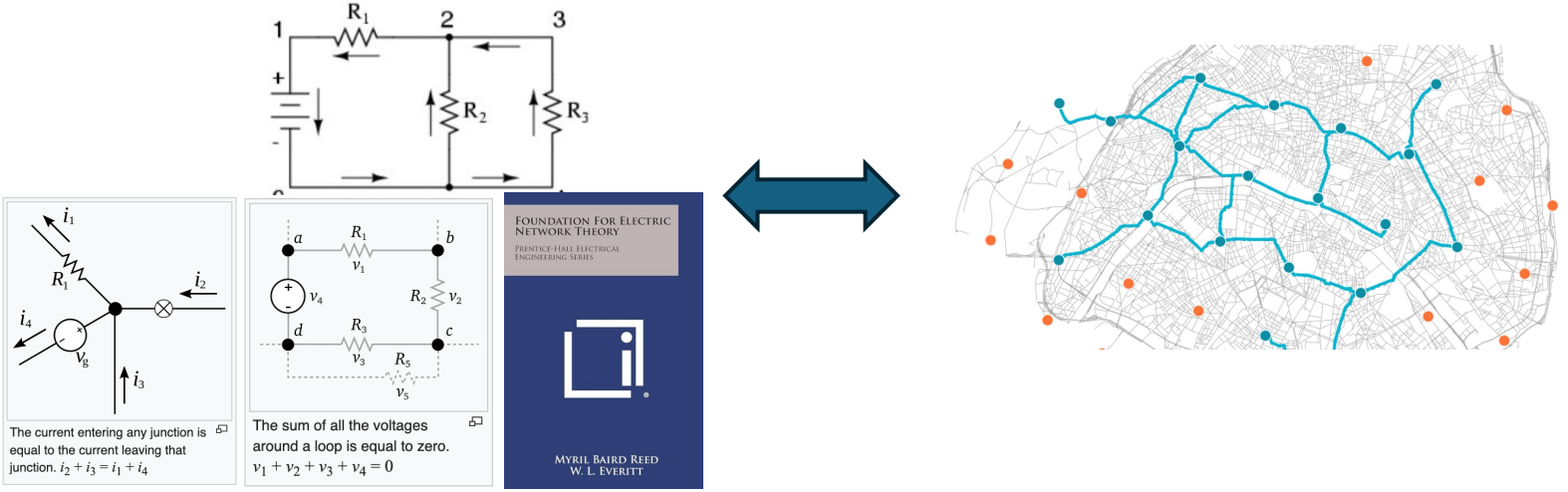
Key Challenges: Multi-layer network complexities

- **Issue 1: real world is a network of networks, however, graph/network in different domain mainly working separately. (Application-wise)**
  - Propose: interaction among multiple network across different domains, such as disease network over human network and rumor over social network



Significance of Graph AI in Multi-Layer Networks

- **Issue 2: the development of graph theories in each domain is independently, ignoring their similarities and transferability (theory-wise)**
  - Propose: unified theoretical framework to cover most of graph research. For instance, the constraints of current flow in electrical networks by voltage and resistance mirrors the dynamics observed in traffic flow, where the gap in volume between adjacent intersections resembles voltage differences, and the limitations on road capacity are analogous to resistance.



Goals and Impact of the Working Group

- **Issue 2: the development of graph theories in each domain is independently, ignoring their similarities and transferability**
  - Successful stories: the history of collaborative endeavors across different fields illustrates the potential for synergy

Flow phenomena span multiple disciplines. Percolation, from Statistical Physics [101], is used in Epidemiology [102] and Computer Science [103]. Diffusion, a Thermodynamics concept [104], is adapted in Biology [105] and Finance [106]. Crowd Dynamics, from Sociology [107], is used in Urban Planning [108]. Network Flow, an Operations Research concept [91], extends to Computer Science [109] and Supply Chain [110]. Convection, initially in Meteorology [111], applies to Geology [112]. Advection, in Atmospheric Sciences [113], applies to Oceanography [114]. Braess Paradox, first found in Traffic Flow [28], is observed in Electrical Networks [115] and Game Theory [116]. This comprehensive set of flow phenomena and their cross-disciplinary applications underscores the interconnectedness of scientific domains and the potential for groundbreaking transdisciplinary study.

Proposal Grant Opportunities

- Opportunities for funding are available across various domains including:
  - Research Infrastructure
    - NSF EPSCOR Track 1 and 2, E-RISE RII.
    - NSF - Community Infrastructure for Research in Computer and Information Science and Engineering (CIRC)
    - NSF Cyberinfrastructure for Sustained Scientific Innovation (CSSI)
    - NSF Civil Infrastructure Systems (CIS)
  - Research Network
    - NSF Research Coordination Networks
    - NSF Accelerating Research through International Network-to-Network Collaborations (AccelNet)
    - NSF GROWING CONVERGENCE RESEARCH (GCR)

GAI WG members

- Members:
  - **Zhiqian Chen**, Assistant Prof., Computer Science & Engineering
    - General Graph/Network, dynamic propagation over graphs
    - Circuit, transportation, social network, epidemiology,
  - **Haifeng Wang**, Assistant Prof., Industrial & Systems Engineering
    - Brain Network
  - **Mohammad Marufuzzaman** , Associate Prof., Industrial & Systems Engineering
    - Logistic Network, supply chain
  - **Megan Ricardson**, Assistant Research Prof., Social Science Research Center
    - Social network
  - **Qingmin Meng**, Associate Prof., GeoScience
    - Geo-spatial network
    - Ecology network
- Inviting more

Planned Activities and Budget

- Upcoming Activities:
  - Preliminary experiments
  - Collaborative research proposals
  - Interactive meetings and seminars

- Budget Breakdown:
  - Experiments: $1,000
  - In-person Seminars: $2,000
  - Virtual Seminars: $600
  - Outreach: $500