**Motivation**

- Networks are ubiquitous in modern science, engineering, and the humanities.
- Networks modeled with graphs can only represent pairwise interactions, not higher-order relationships.
- Many software libraries for graphs exist: NetworkX, Boost, JUNG, etc.
- Challenge: no libraries for hypergraphs exist that have both data structures and algorithms. This leaves a lot of work to do!

**What Are Hypergraphs?**

**Undirected Hypergraphs**

- Nodes represent complexes (in grey) and standalone proteins (in blue outside of any complexes).

**Directed Hypergraphs**

- Directed hyperedges connect "tail" groups of nodes to "head" groups of nodes.

**halp: Hypergraph Algorithms Package**

- **Features**
  - Open Source: Thoroughly tested Python package publicly-available on GitHub [1]
  - Data Structures: Directed and undirected hypergraph data structures to easily model complex networks
  - Usable Algorithms: Implementations of important and canonical hypergraph algorithms
  - Utilities: Quick extraction of hypergraph properties and statistics + conversion to other formats/structures

**Example Algorithms**

- **B-Visit from s**
- **s-t B-Hyperpath**

**Motivation**

- Cells respond to environmental signals through “signaling pathways”
- Many types of reactions can occur along these paths
- Graphs cannot model these interactions adequately...but hypergraphs can!

**New Algorithm with Application to Biological Networks**

**Cellular Signaling Pathways**

- The biological interpretation of a B-hyperpath is a path from node s to node t that contains all intermediate reactants and products needed to reach t from s
- We developed an algorithm using mixed integer linear programming to find the shortest acyclic B-hyperpath of all possible B-hyperpaths in a directed hypergraph [6]

**Shortest B-Hyperpath Algorithm**

- The algorithms currently implemented in halp span:
  - Connectivity [2]
  - Hypertrees [2]
- These algorithms are illustrated to the right:
  - B-Visit algorithm, for computing B-connectivity
  - s-t B-hyperpath algorithm, for computing a minimal B-connected hyperpath

**References**


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WWW: https://tmmurali.github.io/halp/