Hypergraphx: a library for higher-order network analysis

Quintino Francesco Lotito[1], Martina Contisciani[2], Caterina De Bacco[2], Leonardo Di Gaetano[3], Luca Gallo[3], Alberto Montresor[1], Federico Musciotto[4], Nicolò Ruggeri[2,5], Federico Battiston[3]

hypergraphx

Lotito, Quintino Francesco, et al.
"Hypergraphx: a library for higher-order network analysis."
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@hgx_team

HGX is a Python library for the analysis of real-world complex systems with group interactions and provides a comprehensive suite of tools and algorithms for constructing, visualizing, and analyzing hypergraphs.

What are higher-order networks?

Systems with non-dyadic interactions are ubiquitous, with examples ranging from cellular networks, drug recombination, structural and functional brain networks, human and animal face-to-face interactions, and collaboration networks.

Higher-order interactions can be naturally described by alternative mathematical structures such as **hypergraphs**, where **hyperedges** connect groups of nodes of arbitrary size.

What tools are implemented?

Data storage & conversion: store higher-order data as hypergraphs; convert to bipartite networks, maximal simplicial complexes, line graphs, dual hypergraphs; add features to hyperedges (e.g., sign, weight, direction, time)
Centrality measures: hyperdegree, spectral approaches.
Motif analysis: exact and approximated algorithms
Community detection: overlapping communities and hyperedge inference; core-periphery organization.
Filtering: statistically validated hyperedges and interacting node groups.
Generators: Erdős-Rényi, scale-free, configuration, and community-based models; activity-driven model for temporal group interactions.
Dynamical processes: synchronization, social contagion, and random walks.
Visualization: visual insights into the higher-order organization of real-world systems

What data is available?

Animal proximity

Human face-to-face interactions

Co-authorship

Votes

E-mail exchange

Gene-disease

Drug associations

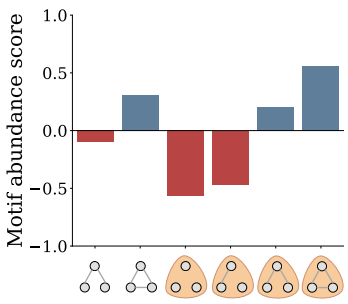
Quick start

Higher-order motif analysis

hypergraphx-motif-analysis-tutorial

```python
import hypergraphx as hgx
from hypergraphx.motifs import compute_motifs
from hypergraphx.readwrite import load_hypergraph
from hypergraphx.viz import plot_motifs

H = load_hypergraph("../test_data/hs/hs.json", file_type="json")
motif_profile = compute_motifs(H, order=3, runs_config_model=5)
plot_motifs(motif_profile)
```

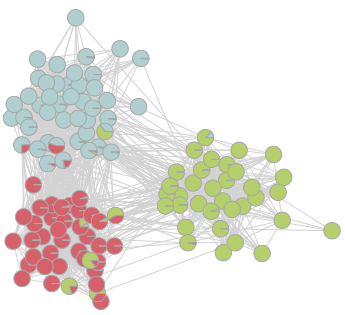


Higher-order communities

hypergraphx-communities-tutorial

```python
import hypergraphx as hgx
from hypergraphx.readwrite import load_hypergraph
from hypergraphx.utils import normalize_array
from hypergraphx.communities.hypergraph_mt.model import HypergraphMT
from hypergraphx.viz import draw_communities

H = load_hypergraph("../test_data/hs/hs.json", file_type="json")
model = HypergraphMT()
u, _, _ = model.fit(H)
u = normalize_array(u, axis=1)
draw_communities(hypergraph=H, u=u, node_size=0.03,
    with_node_labels=False, scale=0.8, opt_dist=1, wedge_width=0.4,
    threshold_group=0., wedge_color='darkgray')
```



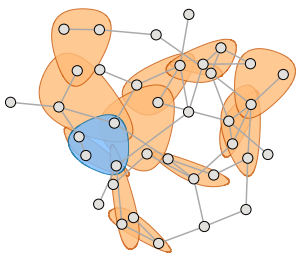
Visualization

hypergraphx-viz-tutorial

```python
import hypergraphx as hgx
from hypergraphx.readwrite.loaders import load_high_school
from hypergraphx.filters import get_svh
from hypergraphx.viz.draw_hypergraph import draw_hypergraph

H = load_high_school("../test_data/hs/hs.json", filter_by_class=
    ['PC*'])
h2 = get_svh(H, approximate_pvalue=True, mp=True)

draw_hypergraph(
    H2, edge_width=1.5, edge_color=SIZE_TWO_COLOR,
    hyperedge_color_by_order=hyperedge_color_by_order,
    hyperedge_facecolor_by_order=hyeperedge_facecolor_by_order,
    hyperedge_alpha=0.8,
    node_size=150, node_color='#E2E0DD', node_facecolor='black',
)
```



1 Department of Information Engineering and Computer Science, University of Trento, Trento, Italy
2 Max Planck Institute for Intelligent Systems, Cyber Valley, Tübingen, Germany
3 Department of Network and Data Science, Central European University, Vienna, Austria
4 Dipartimento di Fisica e Chimica Emilio Segrè, University of Palermo, Palermo, Italy
5 Department of Computer Science, ETH, Zürich, Switzerland

quintino.lotito@unitn.it