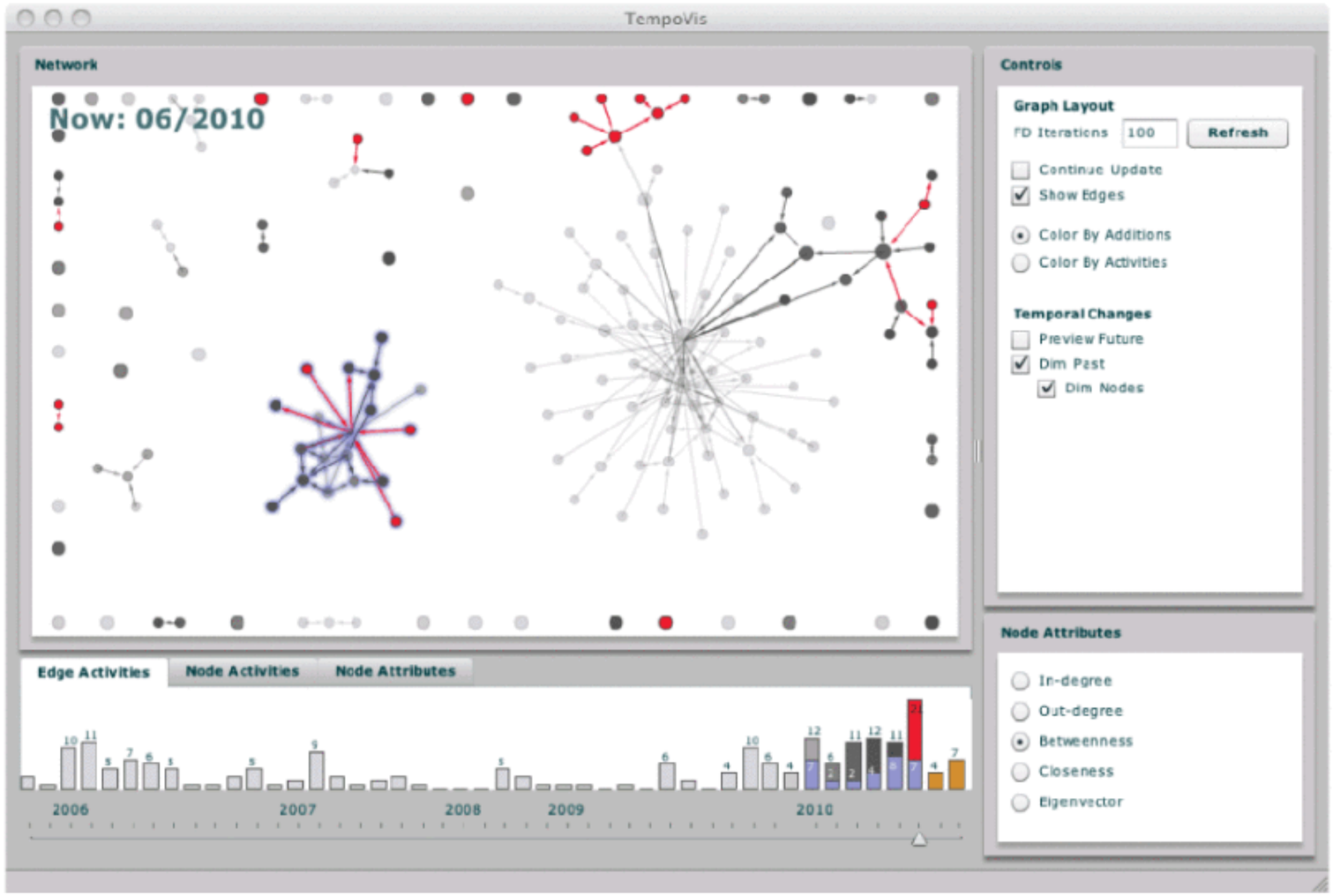
Dynamic Network Visualization

CMSC8280

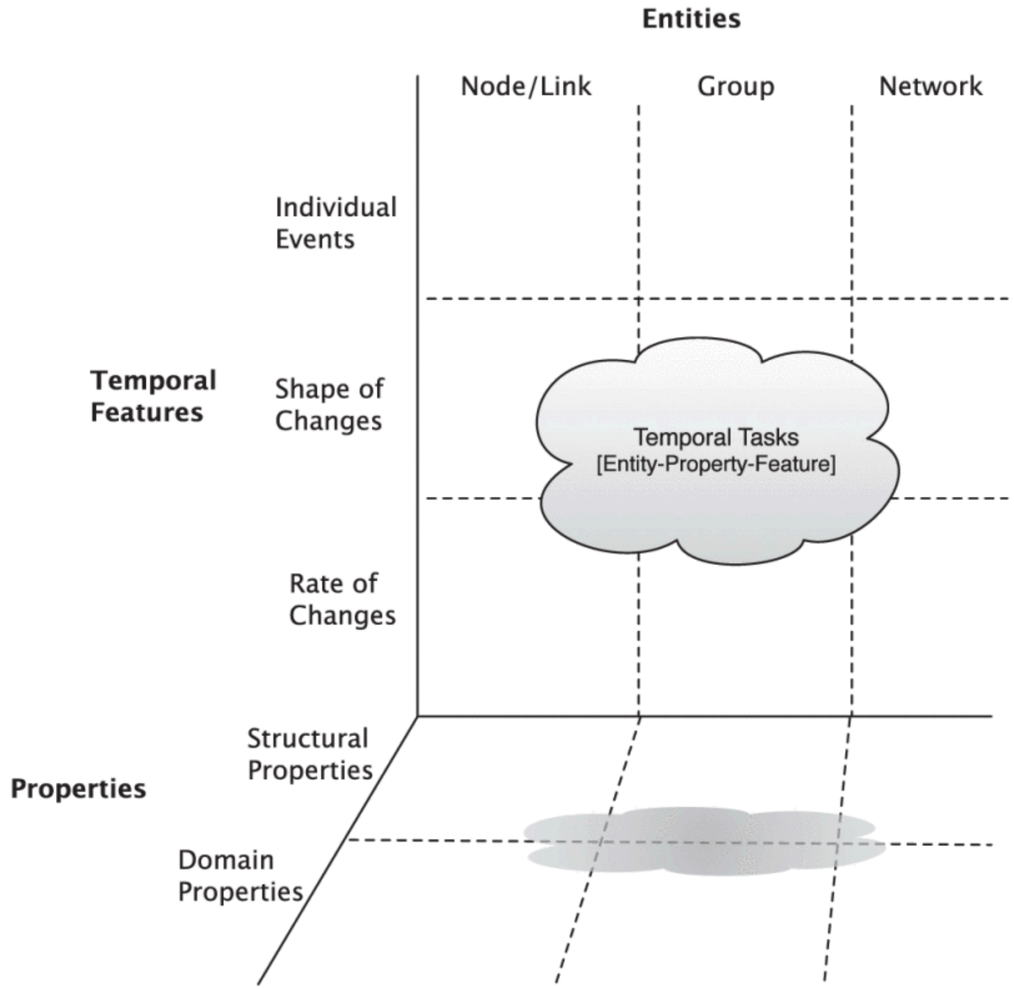
University of Maryland

Tasks in Dynamic Networks



Tasks in Temporal Networks

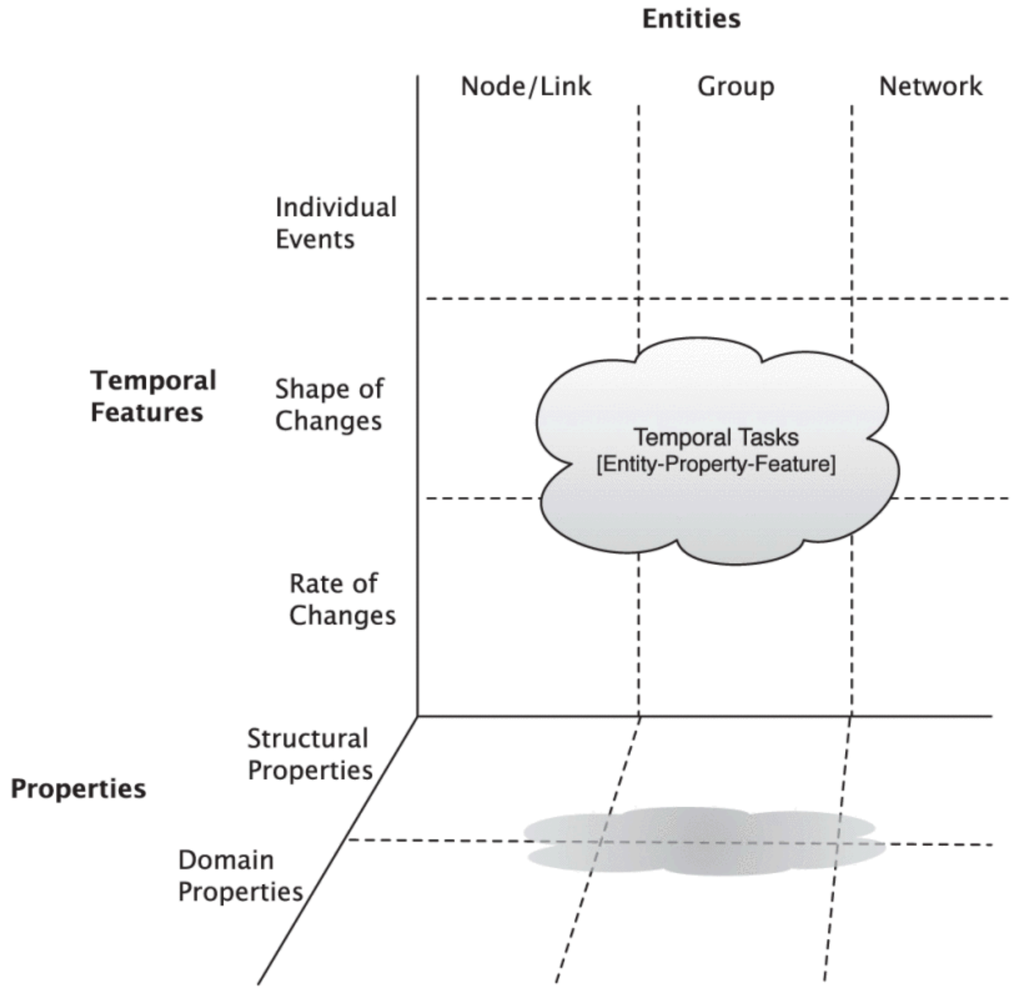
- Entities: We've seen these all semester…
- Properties: Same (degrees, betweenness, etc.)
- Temporal Features: This is new…



[Ahn et al. (2013)]

Tasks in Temporal Networks

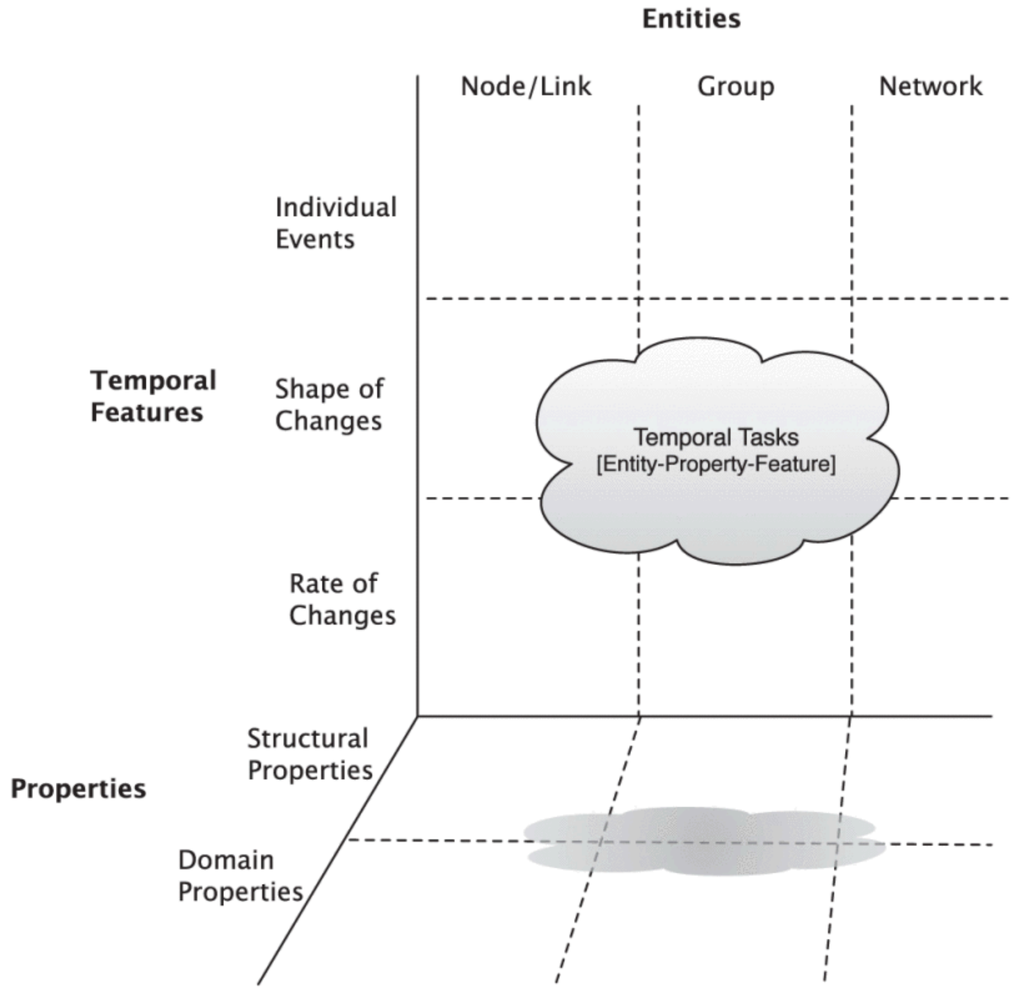
- Temporal Features of Individual Events
  - Single occurrences: e.g., addition or deletion of an entity
  - Replacement: e.g., edge direction changes
  - Birth or death: e.g., representation of full life-span (as opposed to single occurrence)



[Ahn et al. (2013)]

Tasks in Temporal Networks

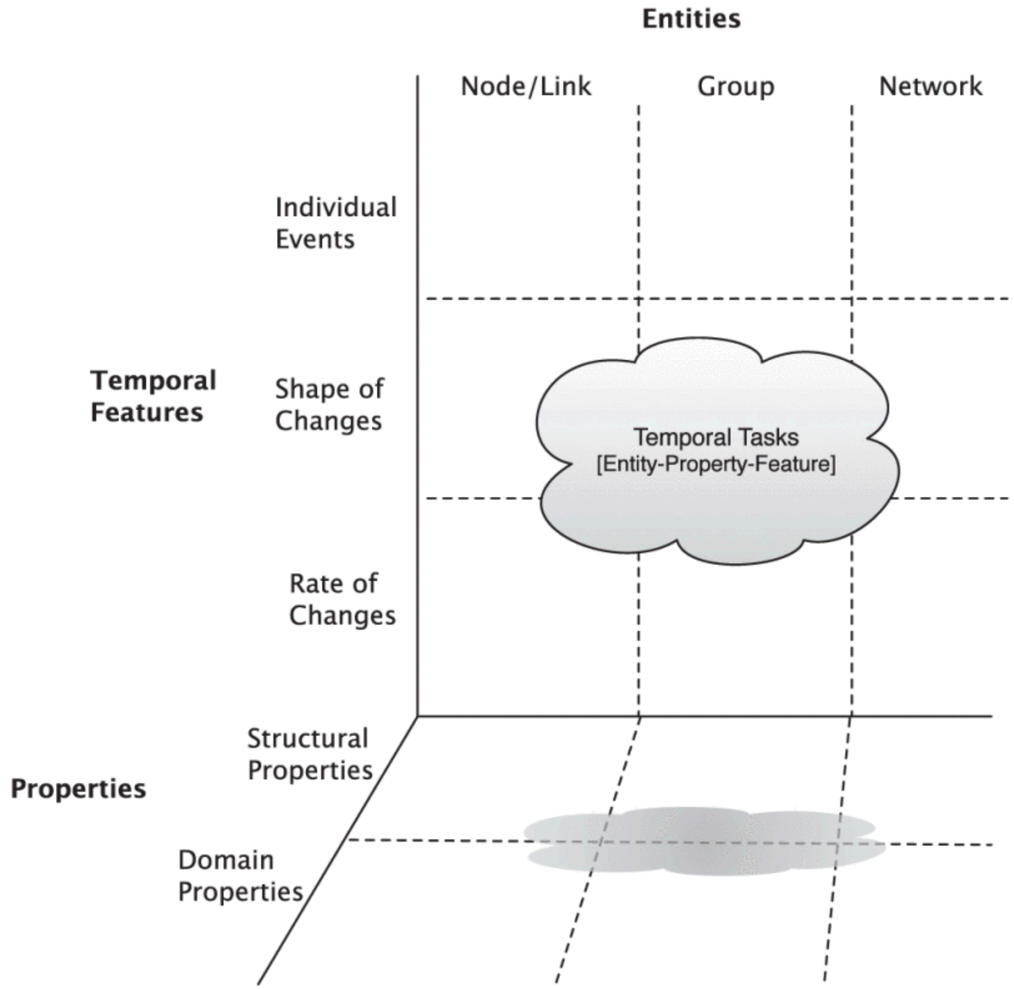
- Temporal Features of Aggregated Events - Shape of Changes
  - Growth or Contraction
  - Convergence or divergence
  - Stability
  - Repetition
  - Peak or Valley



[Ahn et al. (2013)]

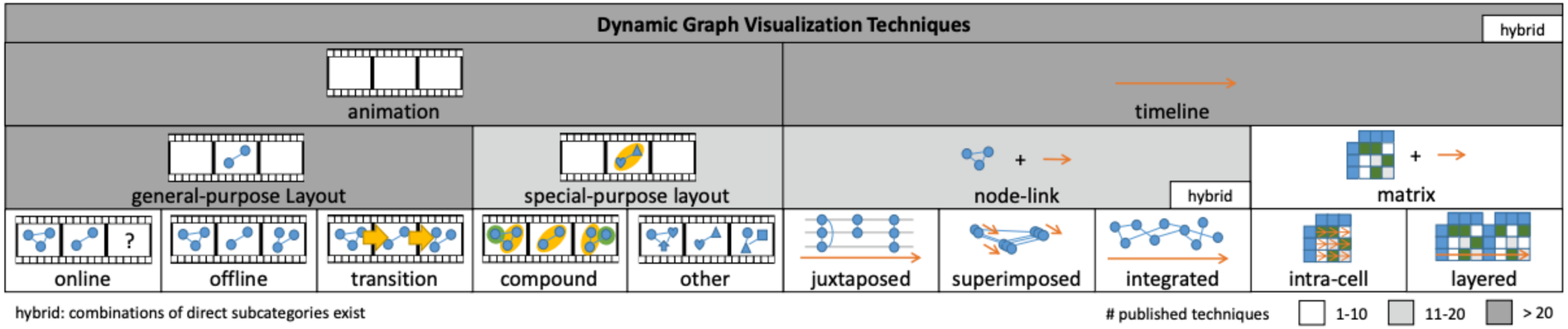
Tasks in Temporal Networks

- Temporal Features of Aggregated Events - Rate of Changes
  - Speed
  - Acceleration



[Ahn et al. (2013)]

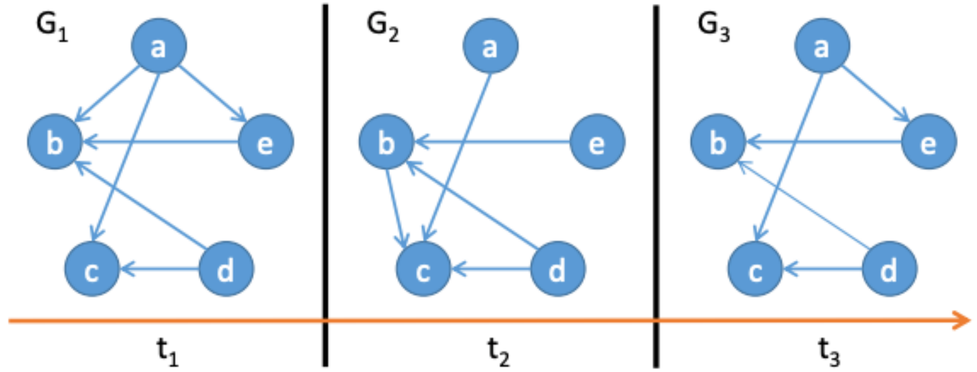
Evolving Graphs



[Beck et al. (2014)]

Evolving Graphs

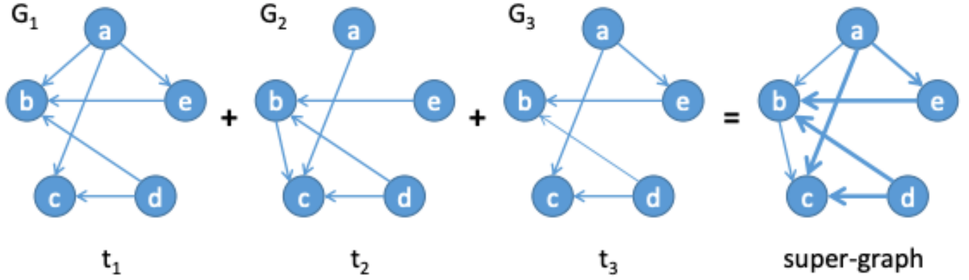
- Starting point: juxtaposed node-link diagram on a timeline



[Beck et al. (2014)]

Evolving Graphs

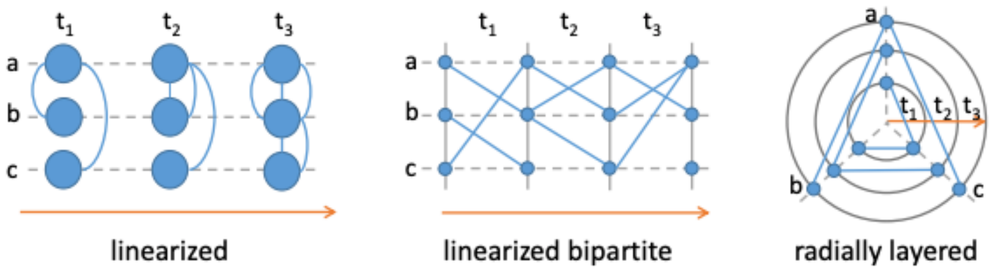
- Super graph: aggregate time on edges



[Beck et al. (2014)]

Evolving Graphs

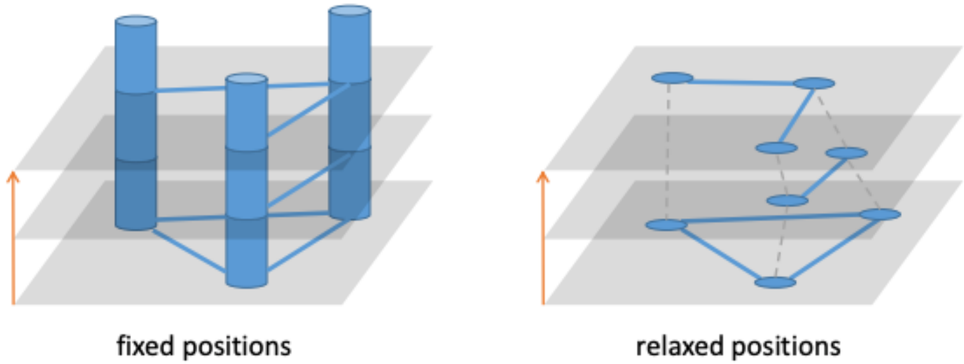
- Addressing scale (somewhat): compact juxtaposition



[Beck et al. (2014)]

Evolving Graphs

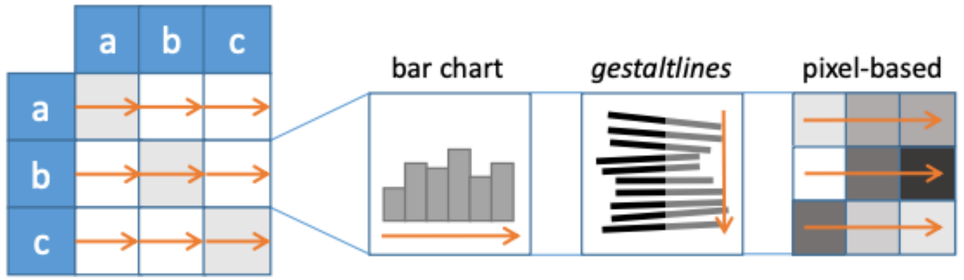
- Superposition, not juxtaposition



[Beck et al. (2014)]

Evolving Graphs

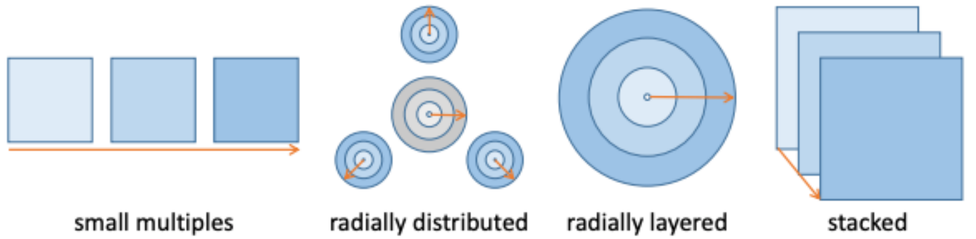
- Encode edge history in each cell of an *adjacency matrix*



[Beck et al. (2014)]

Evolving Graphs

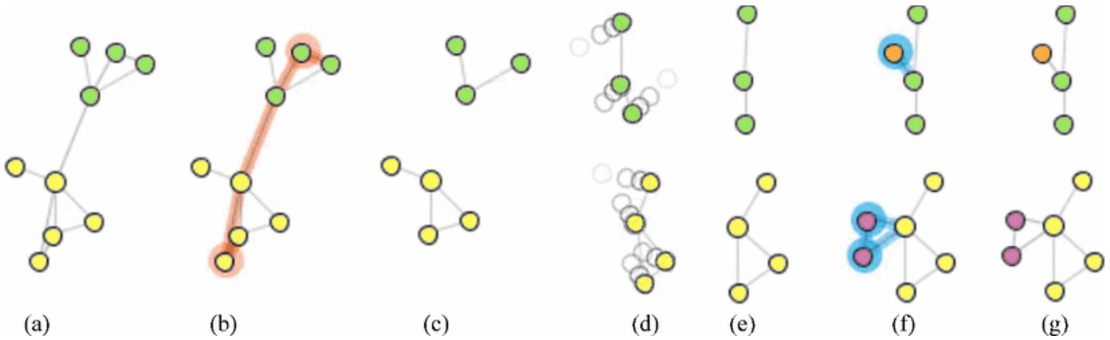
- Layering matrices to represent time

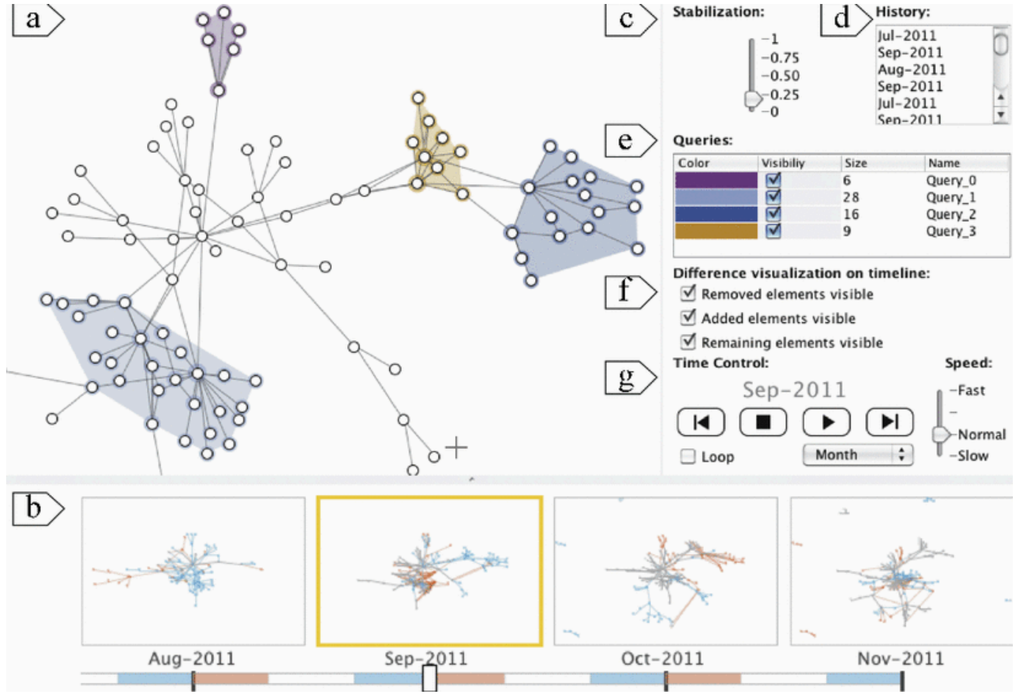


[Beck et al. (2014)]

GraphDiaries

- (Overview) juxtaposition on timeline
- (Detail) animation w/ transition
  - Specific transition design





[Bach et al., (2014)]

GraphDiaries

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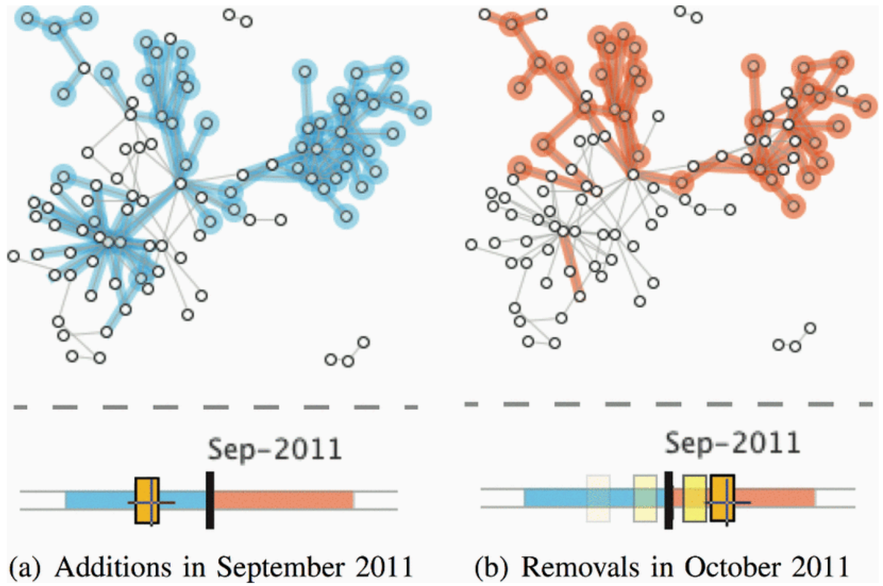
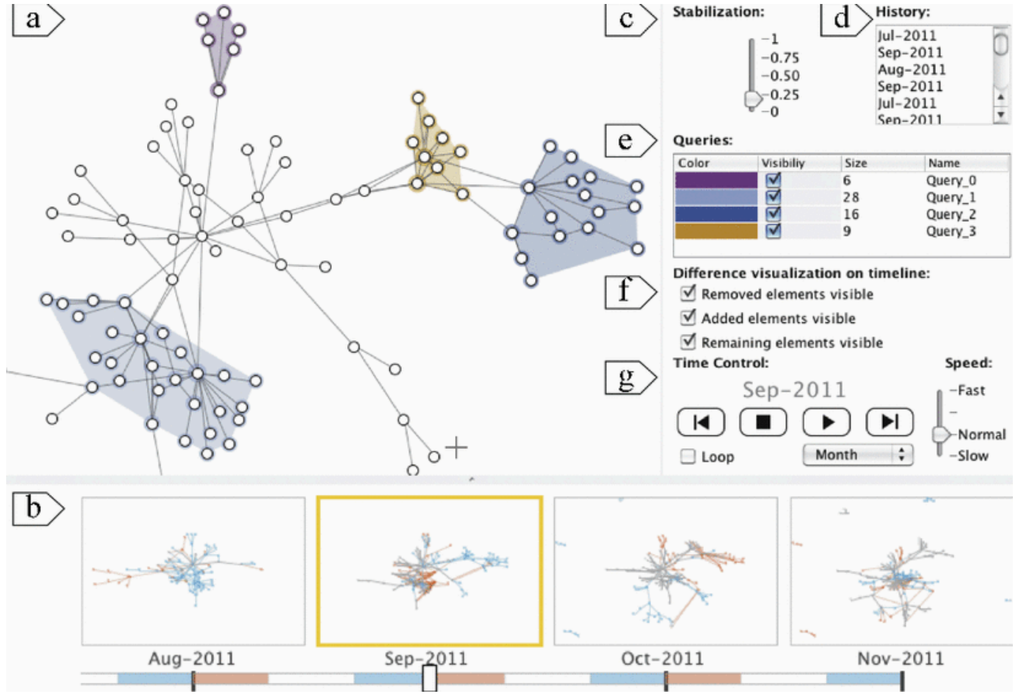
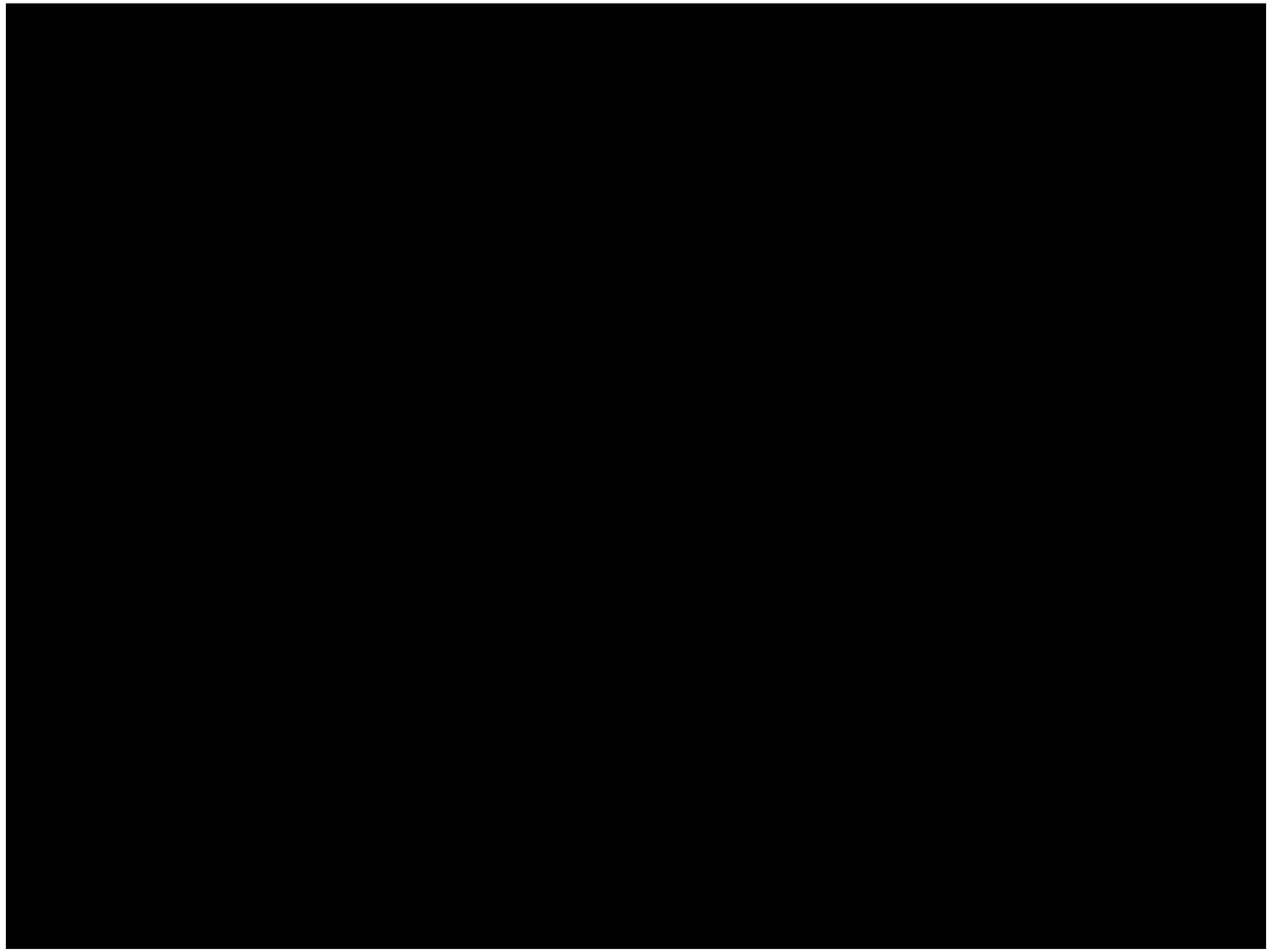




[Bach et al., (2014)]

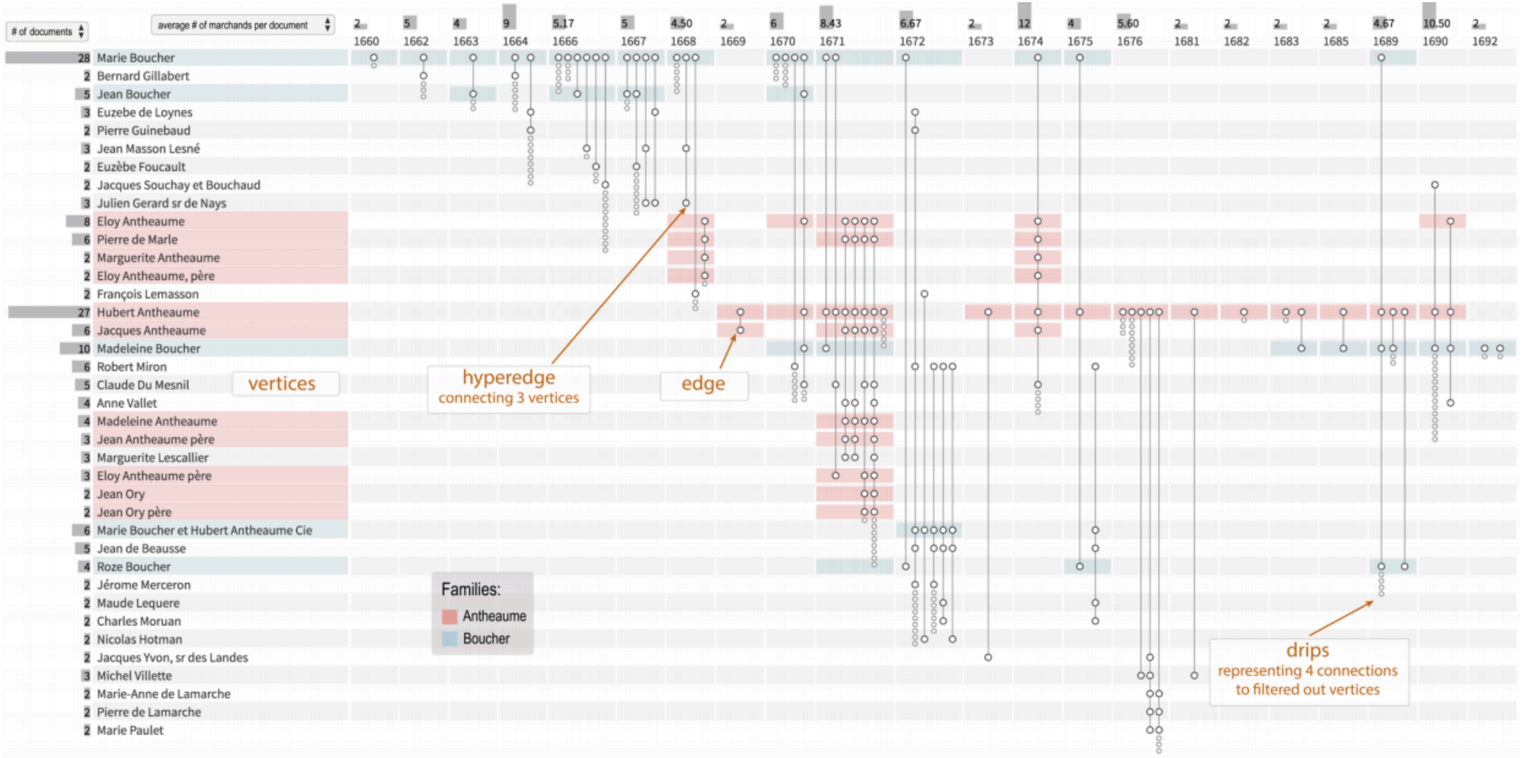
GraphDiaries



[Bach et al., (2014)]

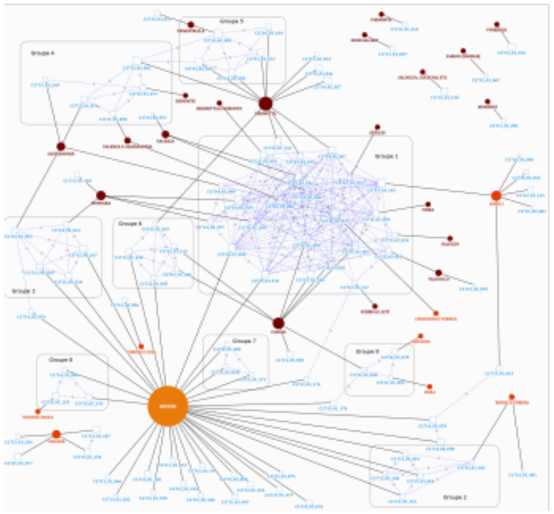
Dynamic Hypergraph

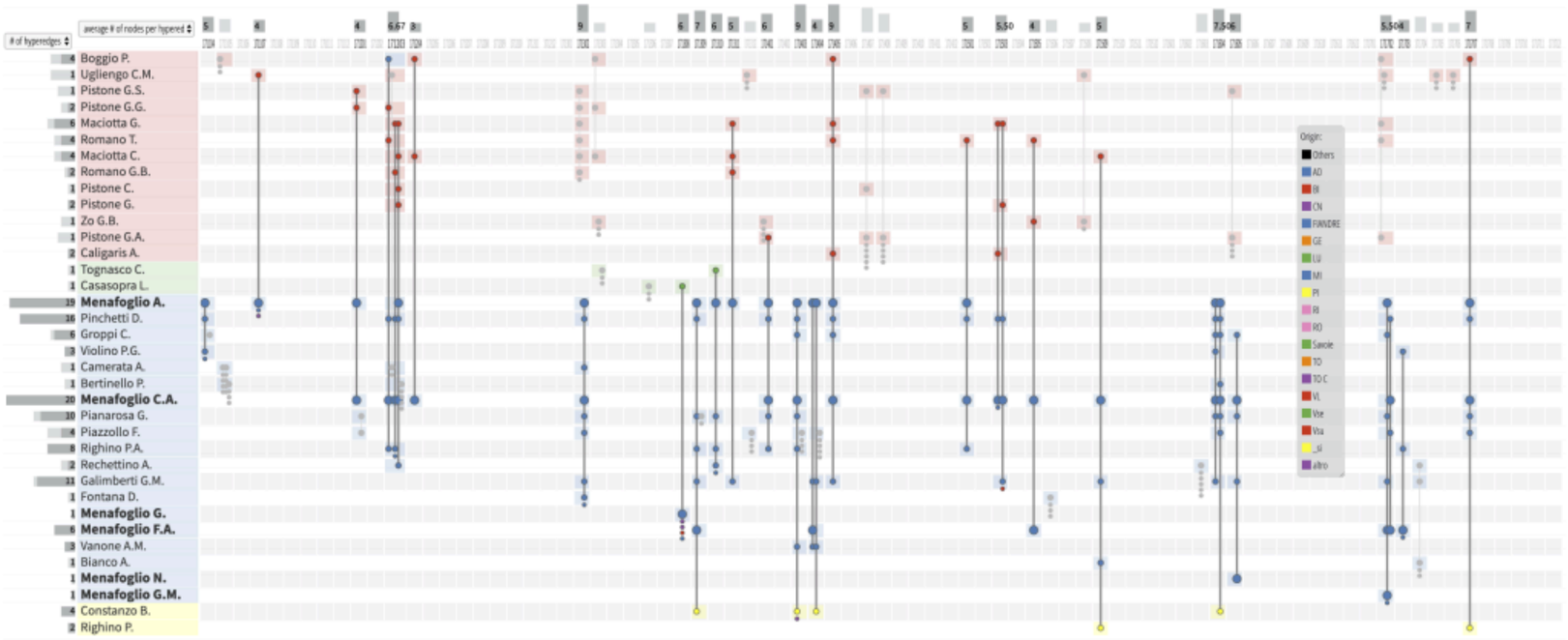
- Juxtaposition on timeline
  - Hypergraphs: edges connect 2+ vertices



[Valdivia et al., (2019)]

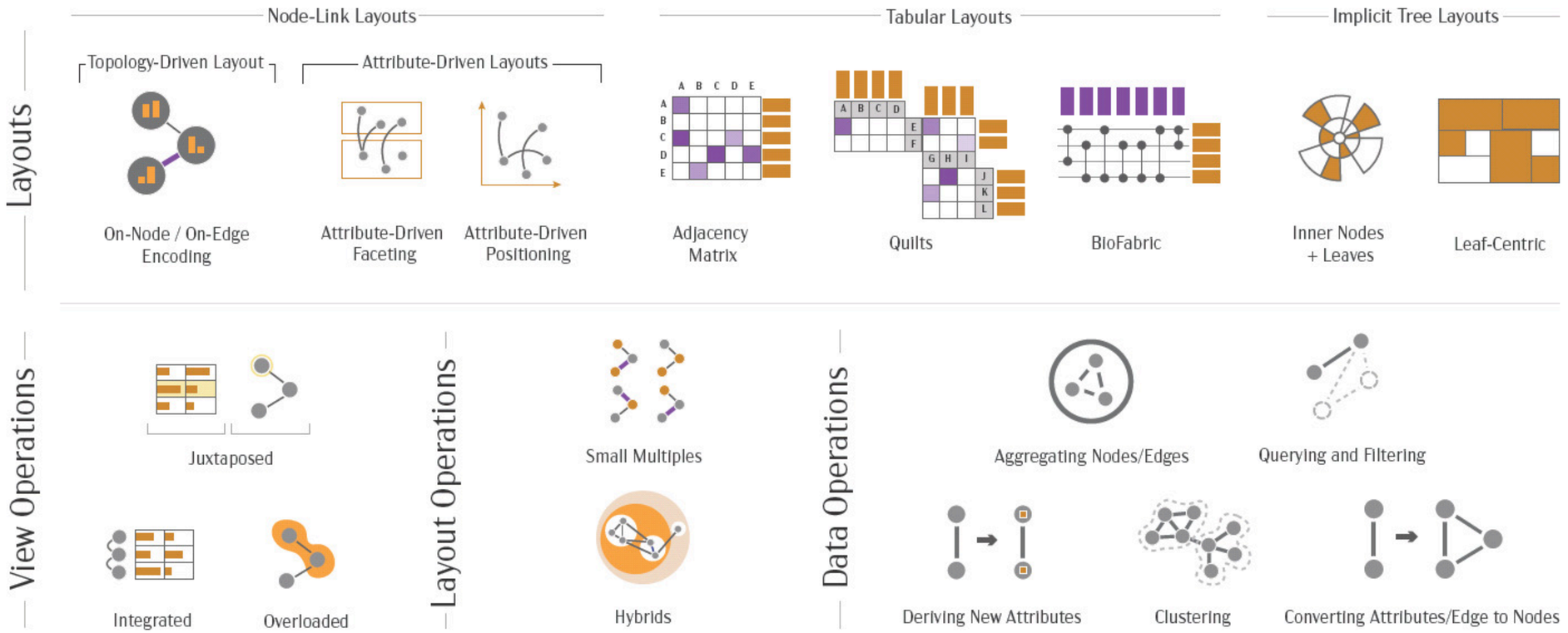
Dynamic Hypergraph





[Valdivia et al., (2019)]

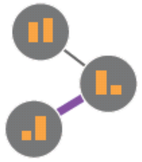
Multivariate Network



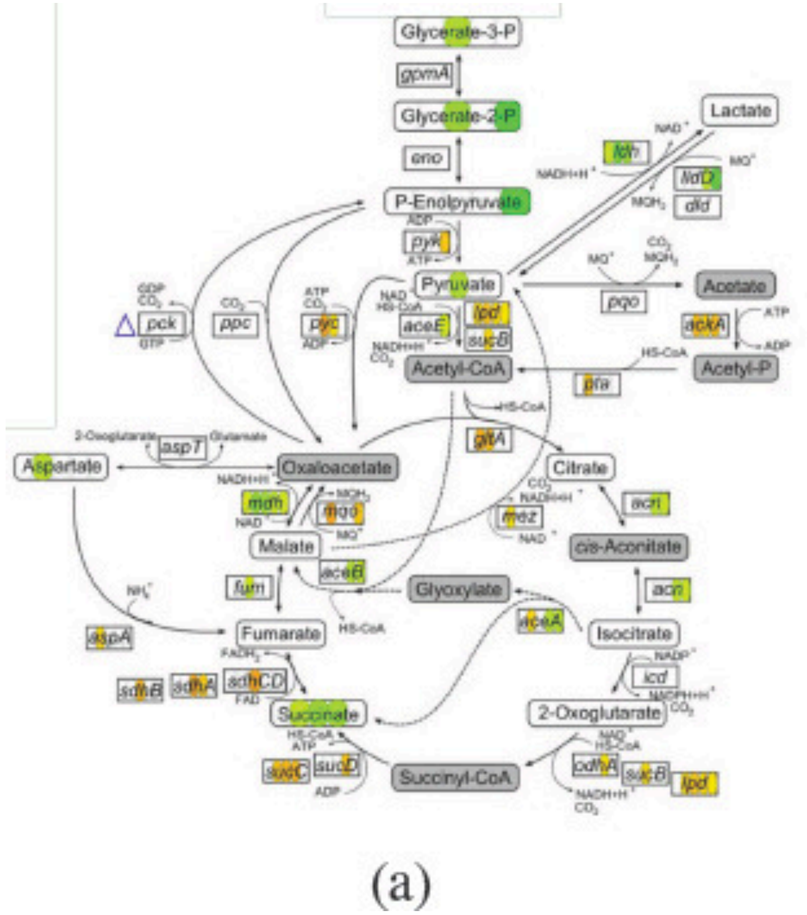
[Nobre et al. (2019)]

Multivariate Network

- On-node encoding



  - E.g., metabolite concentrations

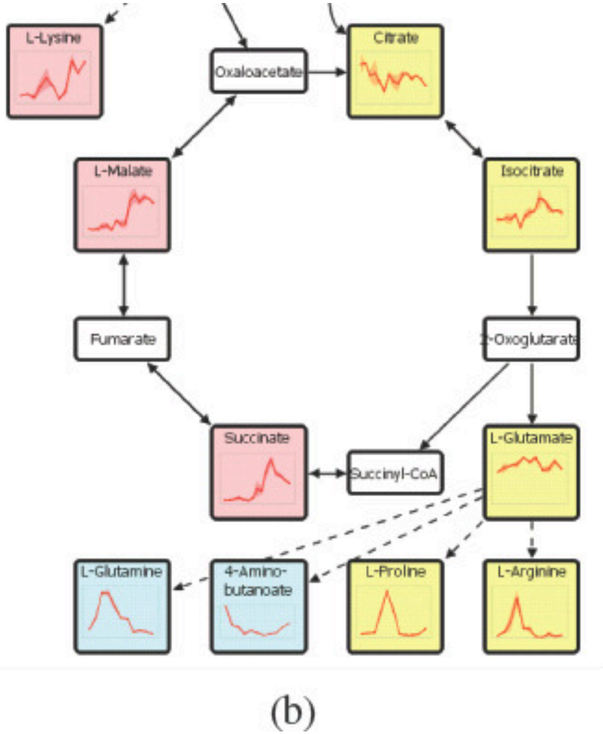


[Nobre et al. (2019)]

Multivariate Network

- On-node encoding

  - E.g., metabolite concentrations over time

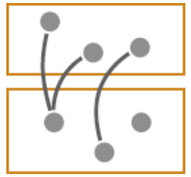


(b)

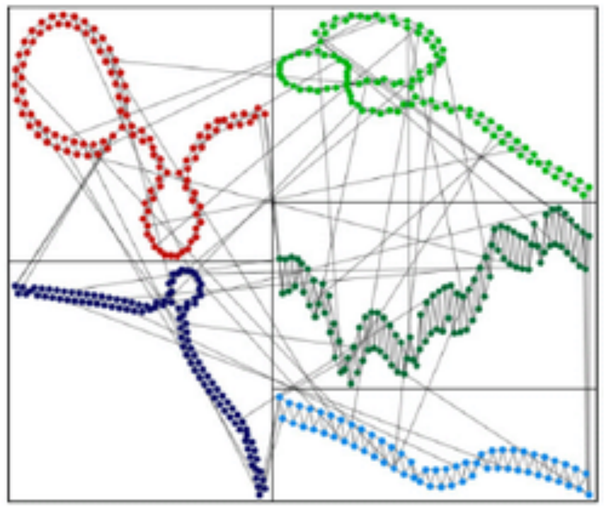
[Nobre et al. (2019)]

Multivariate Network

- Attribute faceting



  - E.g., (hierarchical) cluster membership

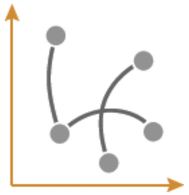


(b)

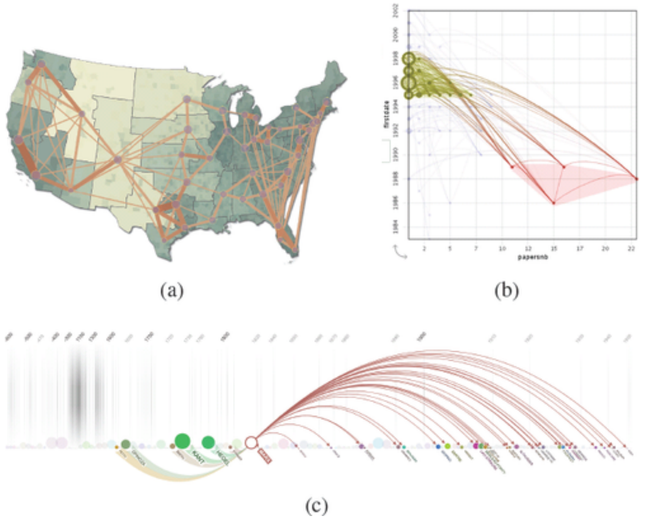
[Nobre et al. (2019)]

Multivariate Network

- Attribute positioning



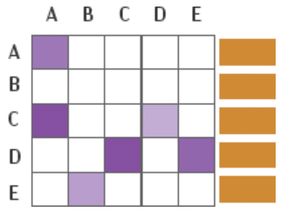
  - E.g., based on continuous attribute value



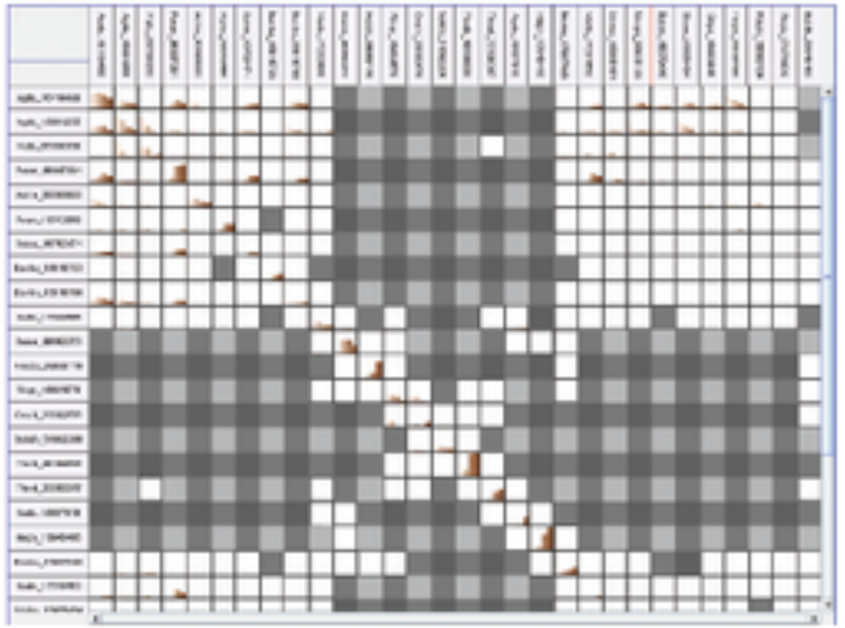
[Nobre et al. (2019)]

Multivariate Network

- Adjacency Matrix



  - Node attributes on margin
  - Edge attributes on cells

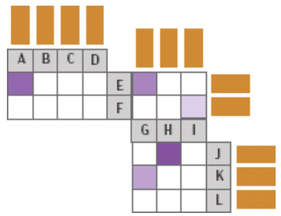


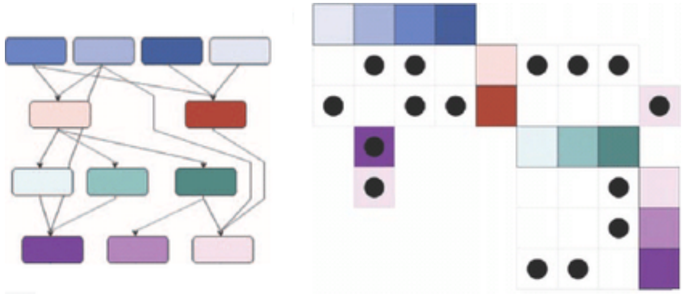
(b)

[Nobre et al. (2019)]

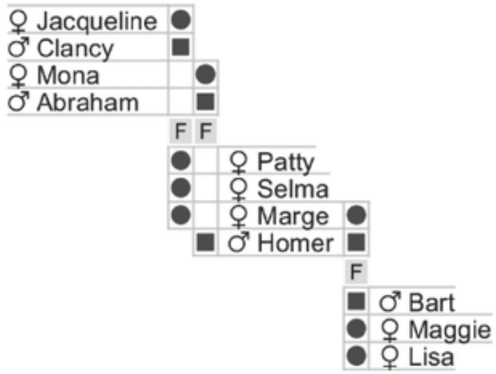
Multivariate Network

- Quilts
  - Appropriate for layered networks
  - Node/Edge attributes as before





(a)

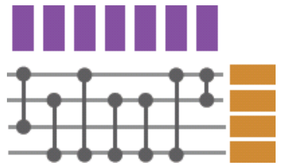


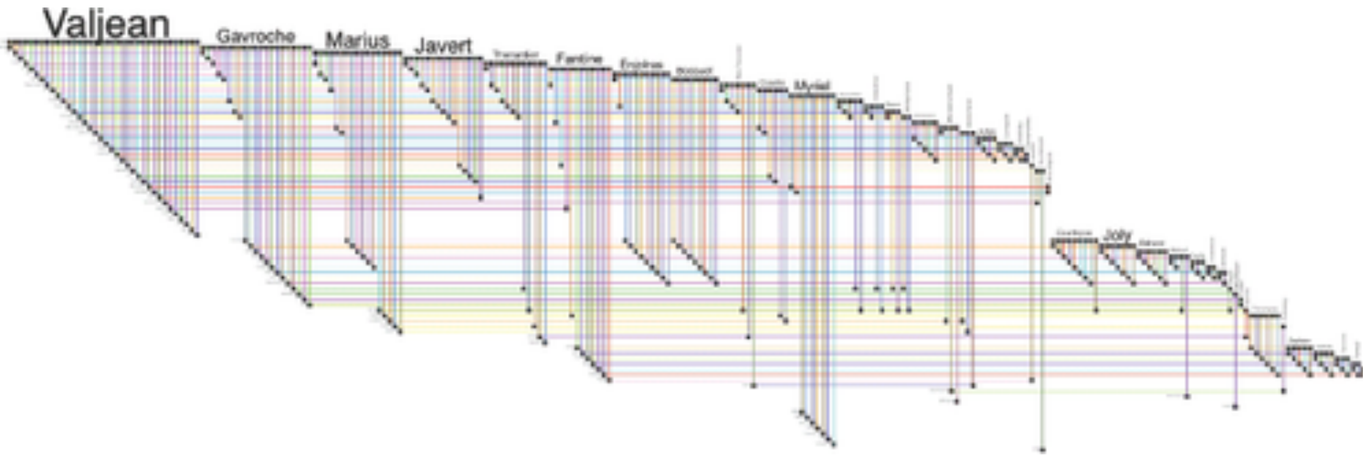
(b)

[Nobre et al. (2019)]

Multivariate Network

- BioFabric
  - Nodes as rows
  - Edges as columns



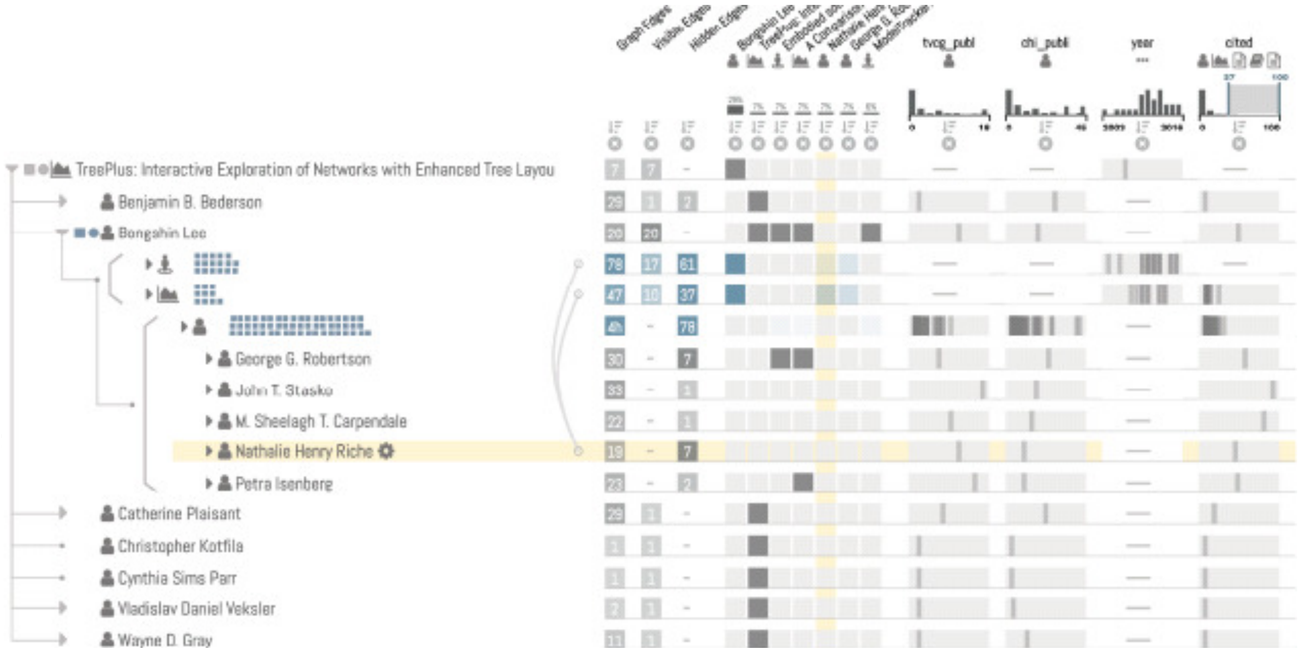


[Nobre et al. (2019)]

Multivariate Network

- Querying and Filtering

  - Query-first approaches
  - Subnetwork shown from point of view of node(s) of interest



[Nobre et al. (2019)]

Summary

- Temporal analysis
  - Encode time (juxtaposition), animate (remember memory is not great)
  - Distinguish events
- Encoding node/edge properties
  - Temporal: on-node sparklines
  - Matrix layouts very helpful

References

- Ahn, et al. (2013). A task taxonomy for network evolution analysis. IEEE TVCG. https://ieeexplore.ieee.org/abstract/document/6620874

- Beck, et al. (2014). The state of the art in visualizing dynamic graphs. EuroVis ’14. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.679.5703&rep=rep1&type=pdf

- Valdivia, et al. (2019). Analyzing dynamic hyper graphs with parallel aggregated ordered hypergraph visualization. IEEE TVCG. https://ieeexplore.ieee.org/document/8789484

- Bach et al. (2014). GraphDiaries: animated transitions and temporal navigation for dynamic networks.

- Nobre, et al. (2019). The state of the art in visualizing multivariate networks. Computer Graphics Forum. https://onlinelibrary.wiley.com/doi/full/10.1111/cgf.13728?casa_token=J3IFPzzQ5iIAAAAA%3Aeajae_y9-fxddRENRt49GXk58_oRaybfmWabXRjw0P_690LmFvMfnFcxjHRARIRneo1NjyG98qBjB8_y