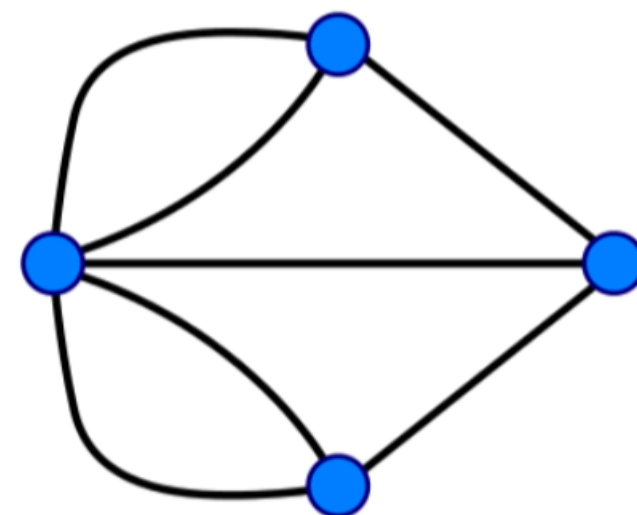
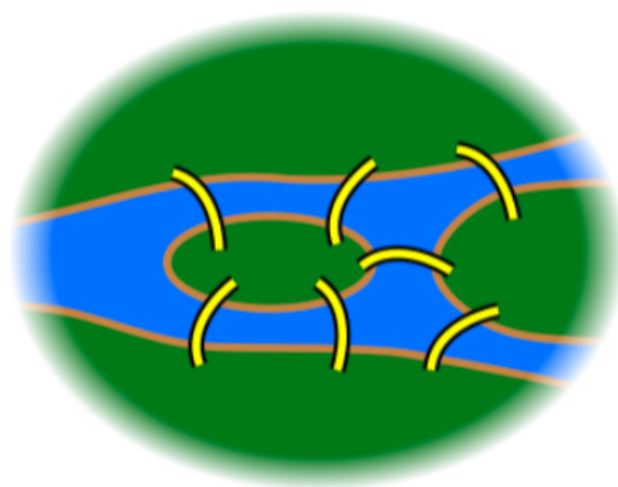
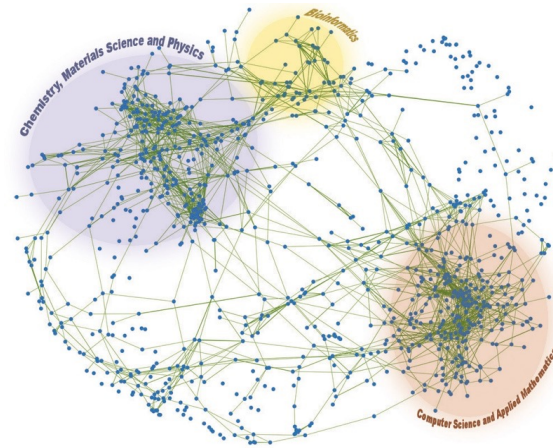


Perspectives

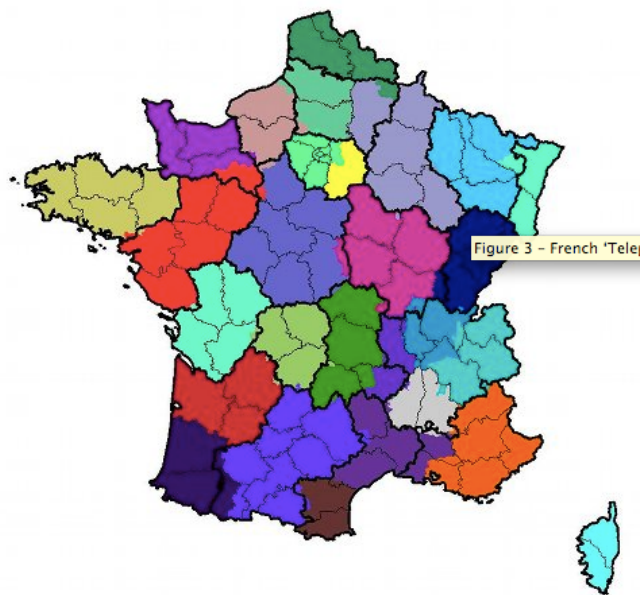
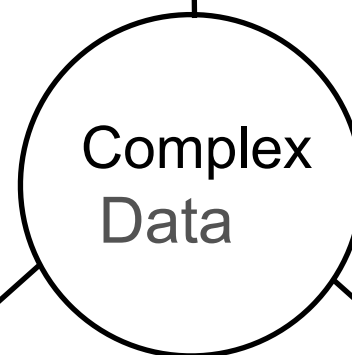
R. Lambiotte
Mathematical Institute
Oxford University



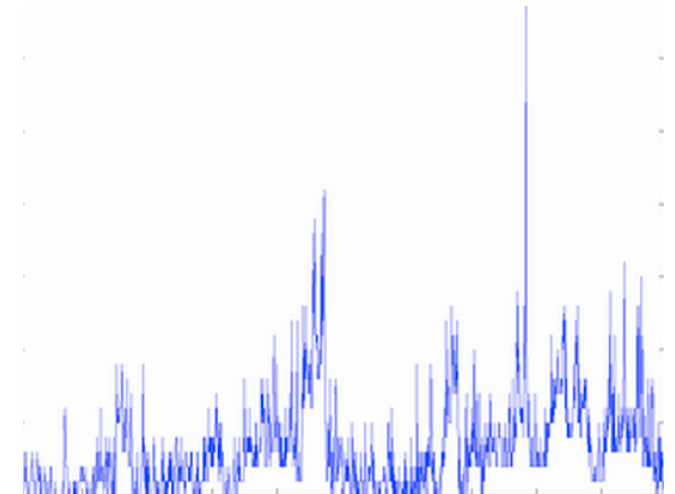
Multiple nature of Complex Data



Relational



Geometric



Temporal

A NetSci 2018 satellite workshop

When Complex Networks meet Complex Data:

Higher-Order Models in Network Science





Basic building blocks are **pairwise** edges

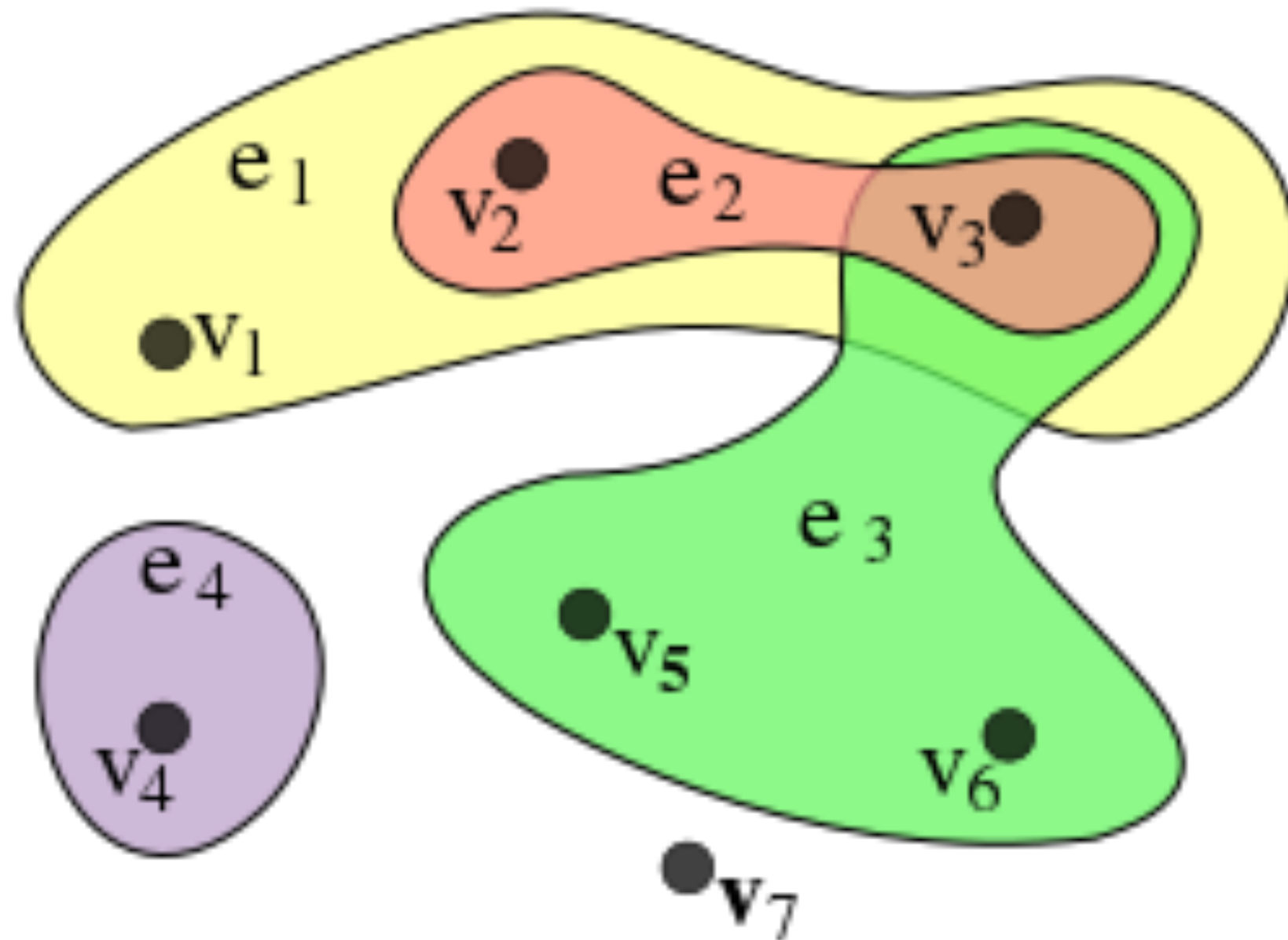
Networks are **constant** in time

Combining incident edges provides paths of indirect interaction (aka connectivity)

I. Beyond binary interactions

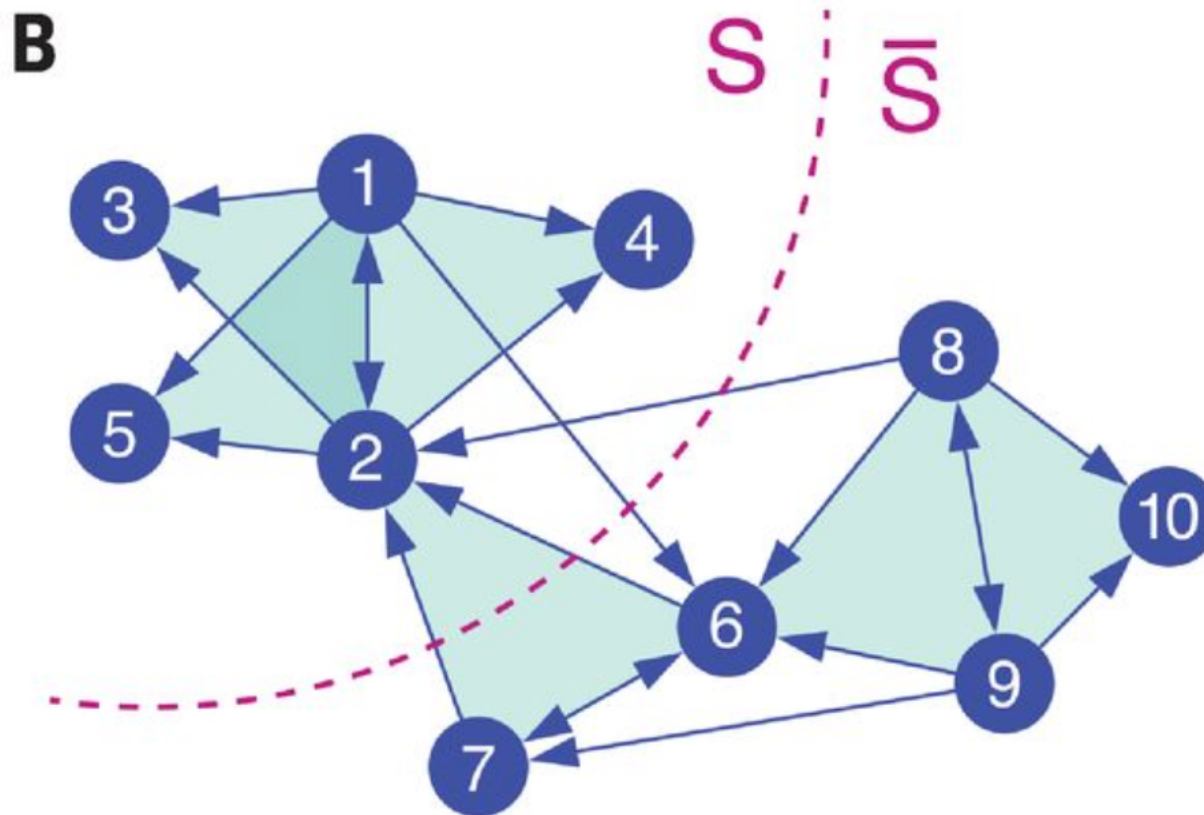
Many datasets intrinsically have non-binary interactions, for instance collaboration networks.

The resulting **hypergraph** can be transformed into a network by replacing each hyper edge by a clique - not a bijection due to the information loss.

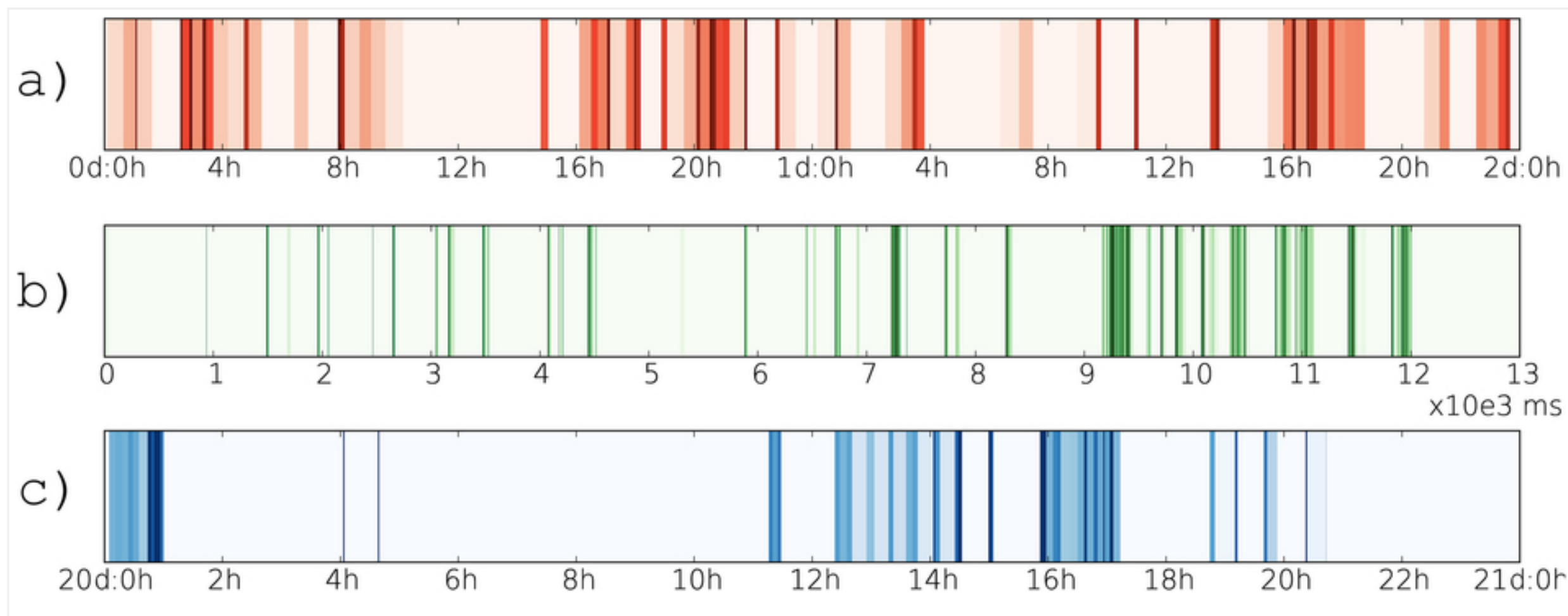


Structure of Multi-body Networks, e.g. seen as hypergraphs

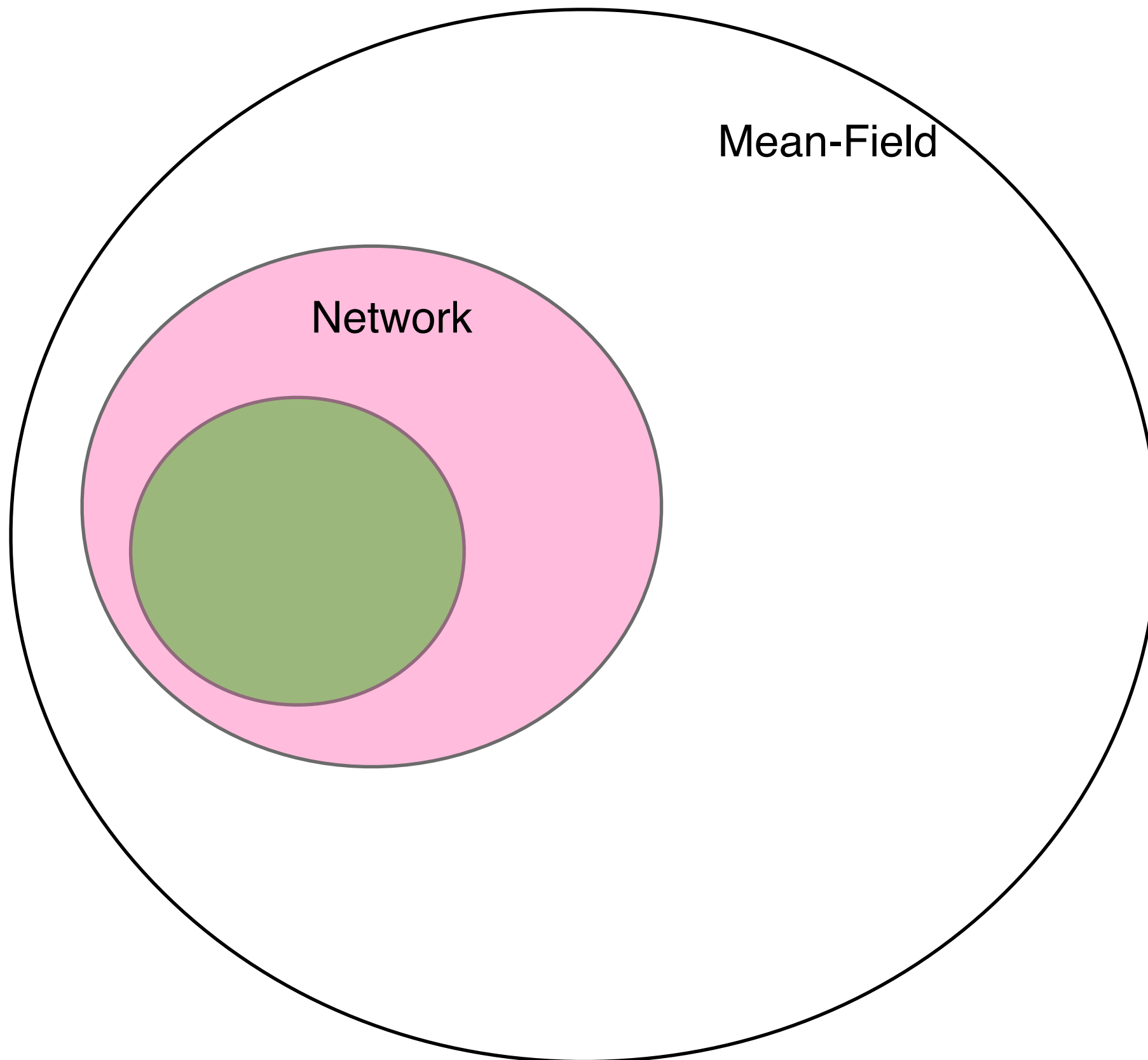
Community structure, clustering, centrality, link prediction, etc.



II. Temporal dimension

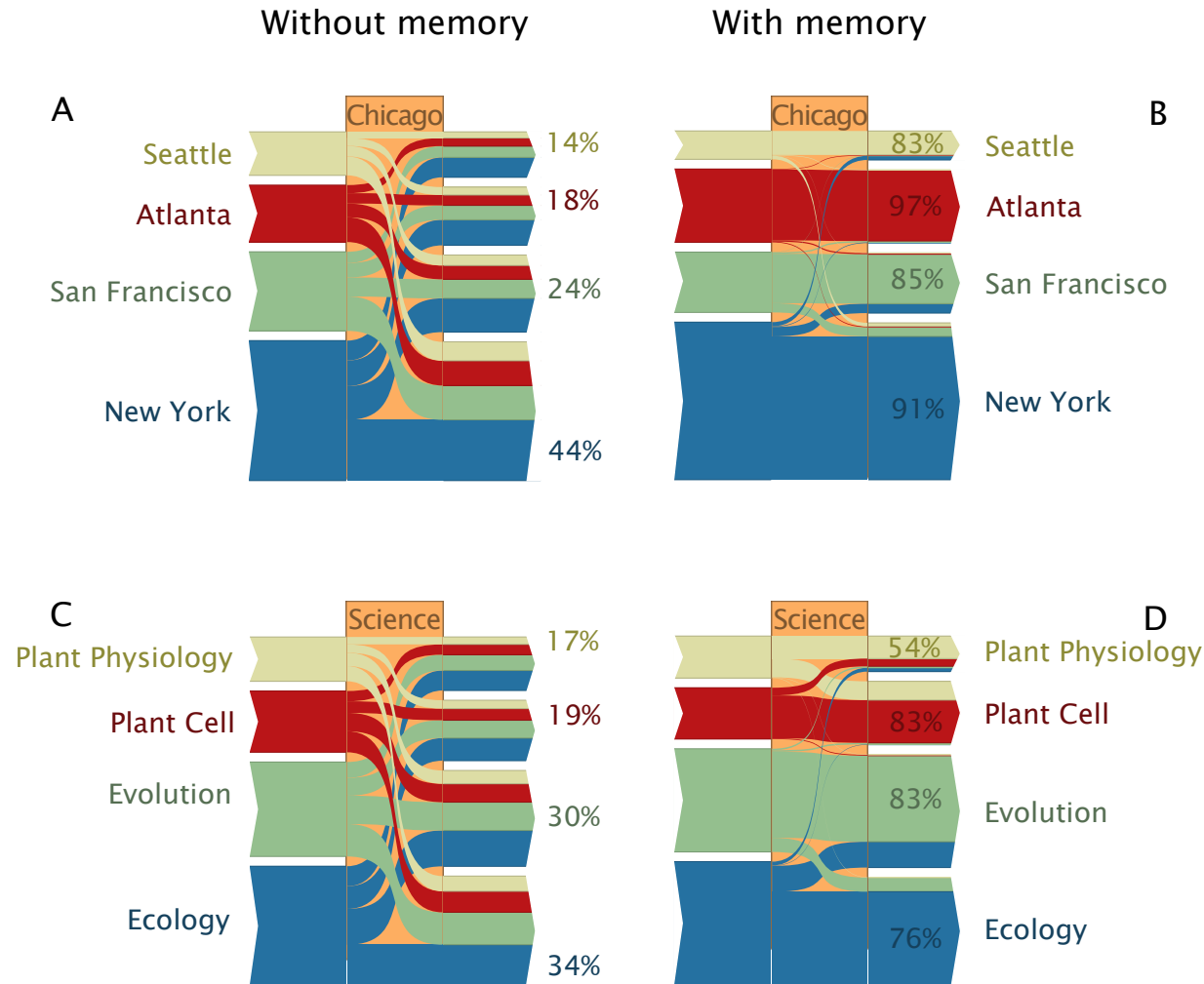


III. Constraining indirect paths



Higher-order dynamics and overlapping communities

Where you go to depends on where you come from
Mathematics of pathways instead of edges

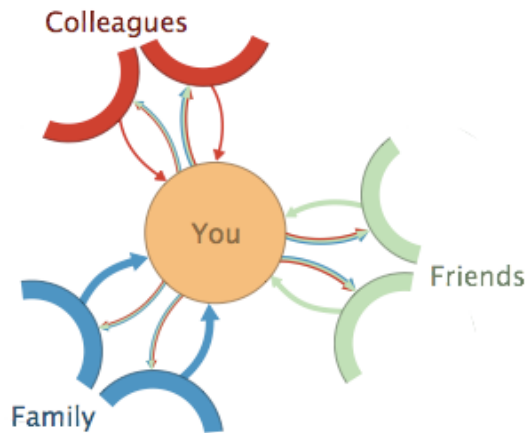


Memory in network flows and its effects on community detection, ranking, and spreading, Martin Rosvall, Alcides V. Esquivel, Andrea Lancichinetti, Jevin D. West, Renaud Lambiotte, Nature Communications, 2015

Higher-order dynamics and overlapping communities

Where information goes to depends on where it comes from
Mathematics of pathways instead of edges

Without memory



With memory

