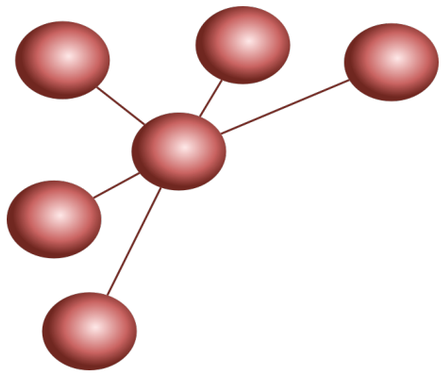

DUBii 2019

Introduction to Network Science
Introduction to Network Biology

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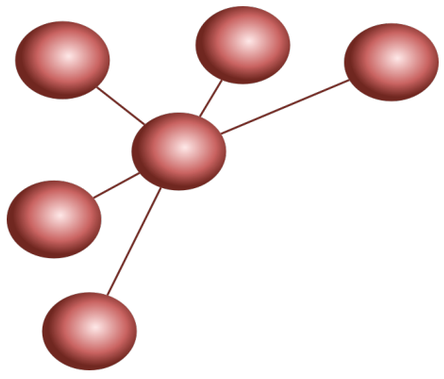
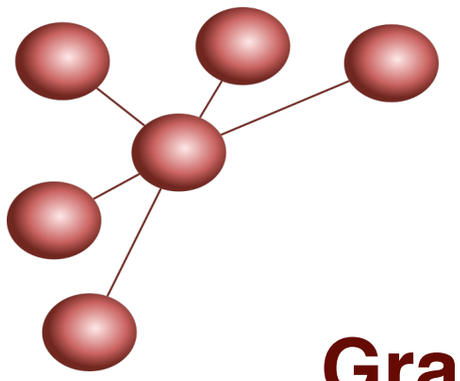
Costas Bouyioukos costas.bouyioukos@univ-paris-diderot.fr



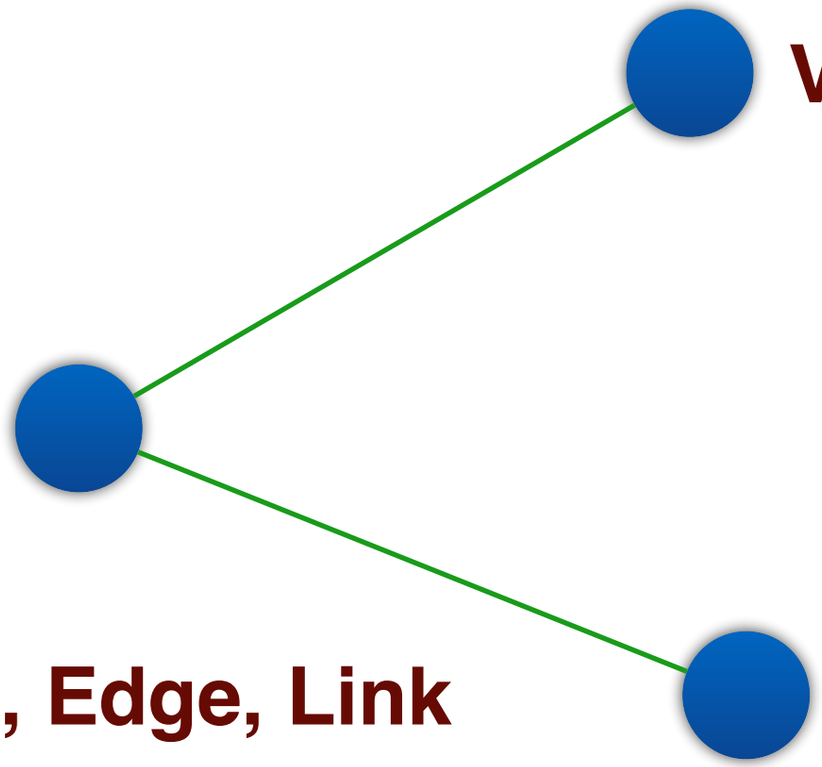
Network Science

- Start 21th century
- Roots on graph theory
- In the context of data production and computer sciences



Definition

Graph, Network, Web

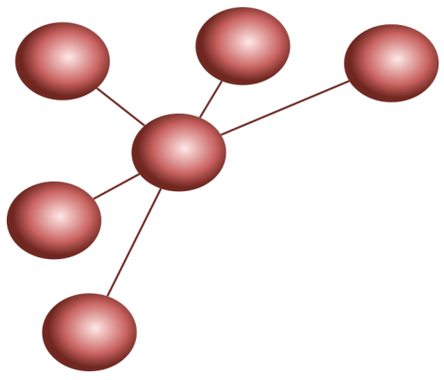


Vertice, Node

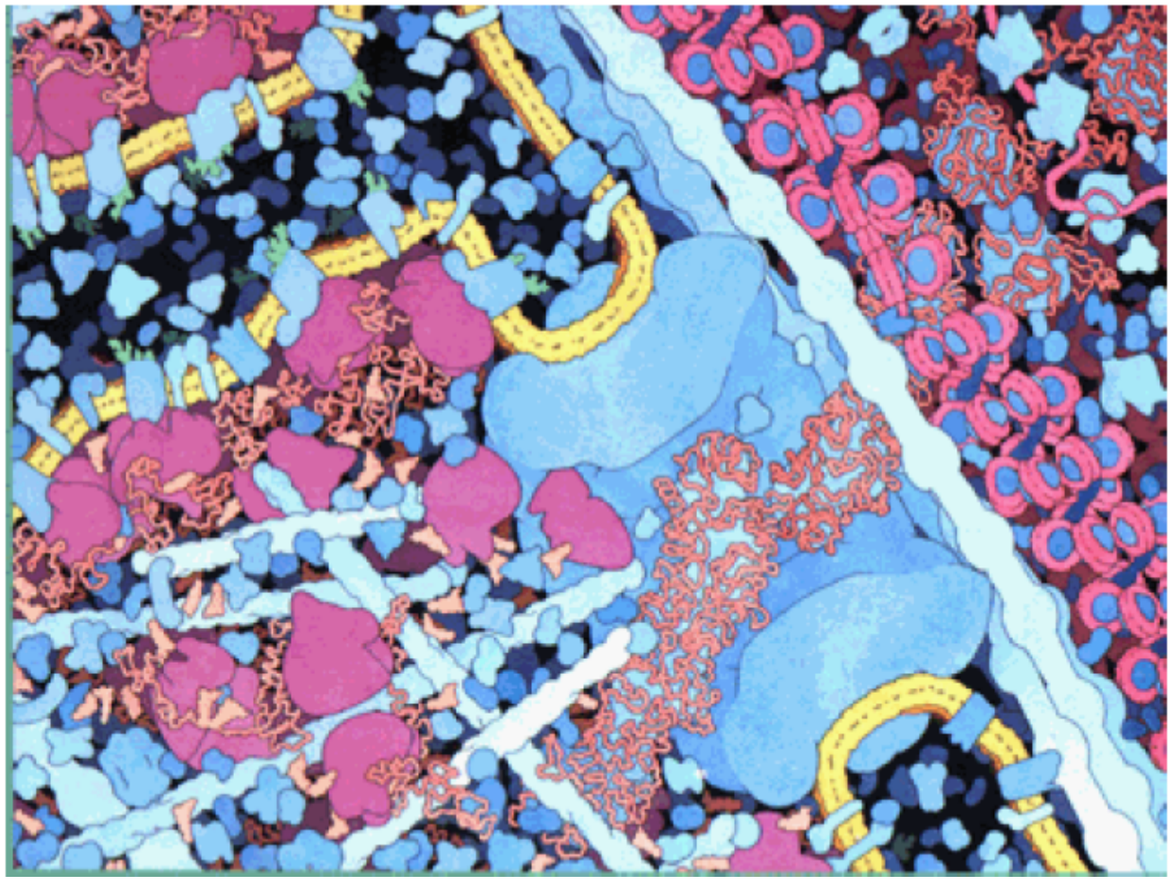
Interaction, Edge, Link

G={V, E}

Topology, Motifs …

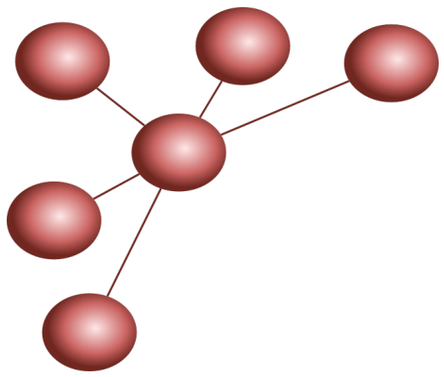


Macromolecules do not act isolated, but interact with each other to perform their functions



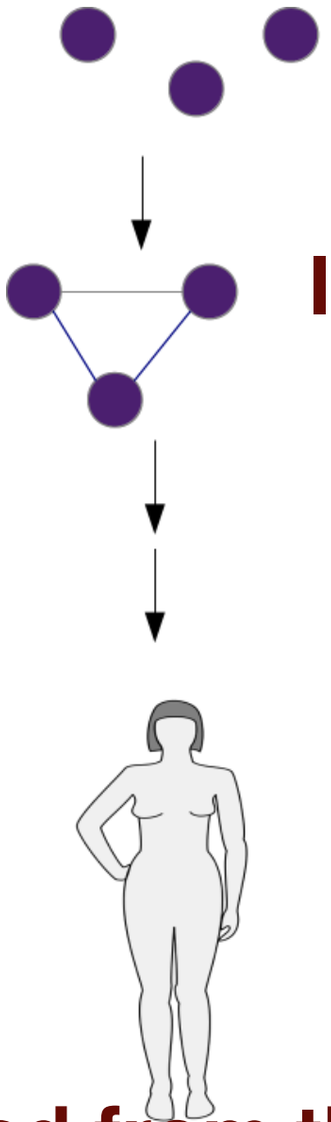
Molecular interactions:
Protein-Protein
Protein-DNA
Protein-RNA
Protein-Lipid
…

Transient, stable, obligatory …



Systems Biology because living organisms are complex systems

Systems component : genes/ proteins

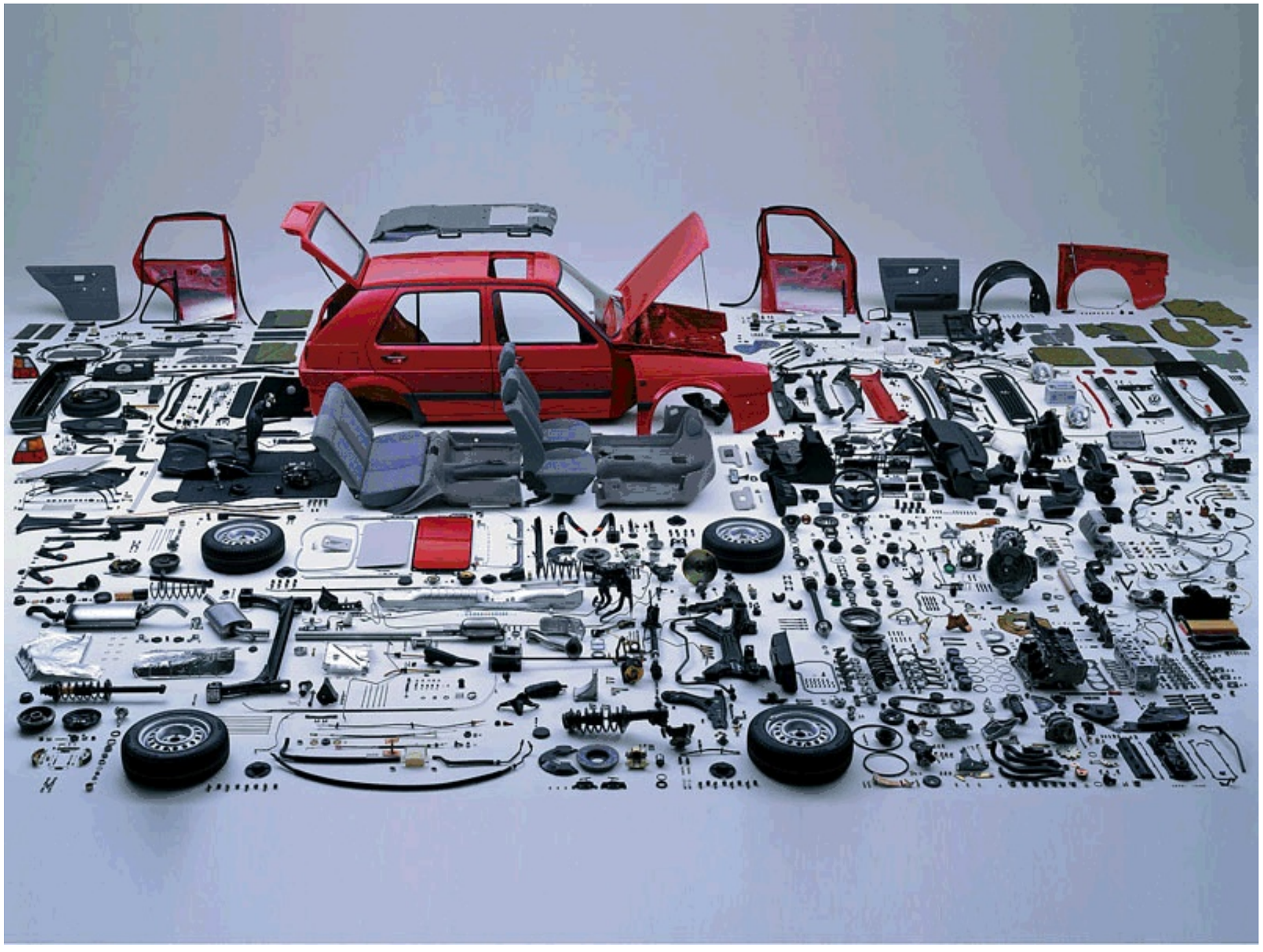


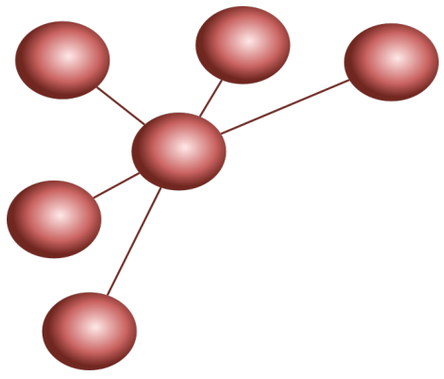
Interaction Networks

Emerging properties : phenotypes

- **Global/collective behavior cannot be deduced from the knowledge on the components**
- **Phenotype does not emerge from isolated biological molecules but from their interactions**

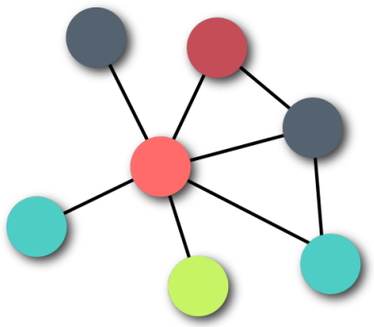
Exemple :



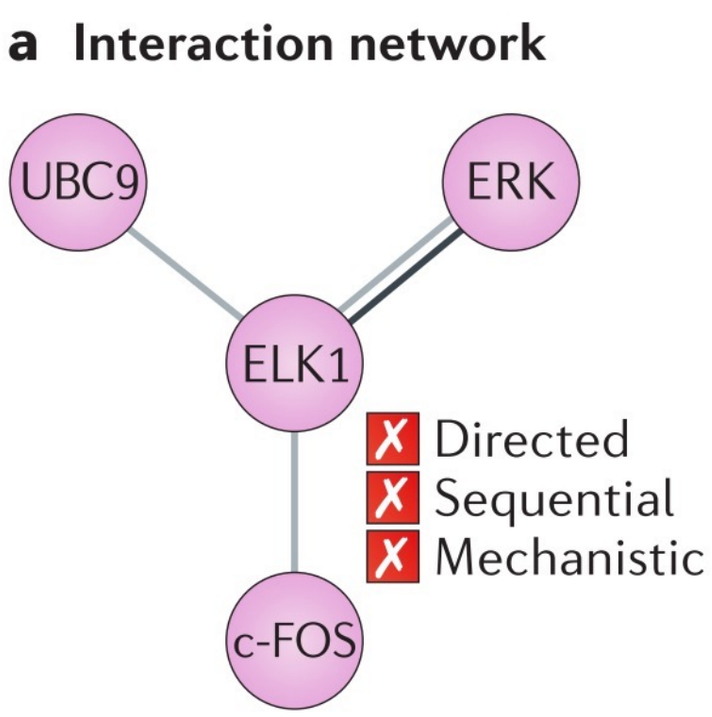


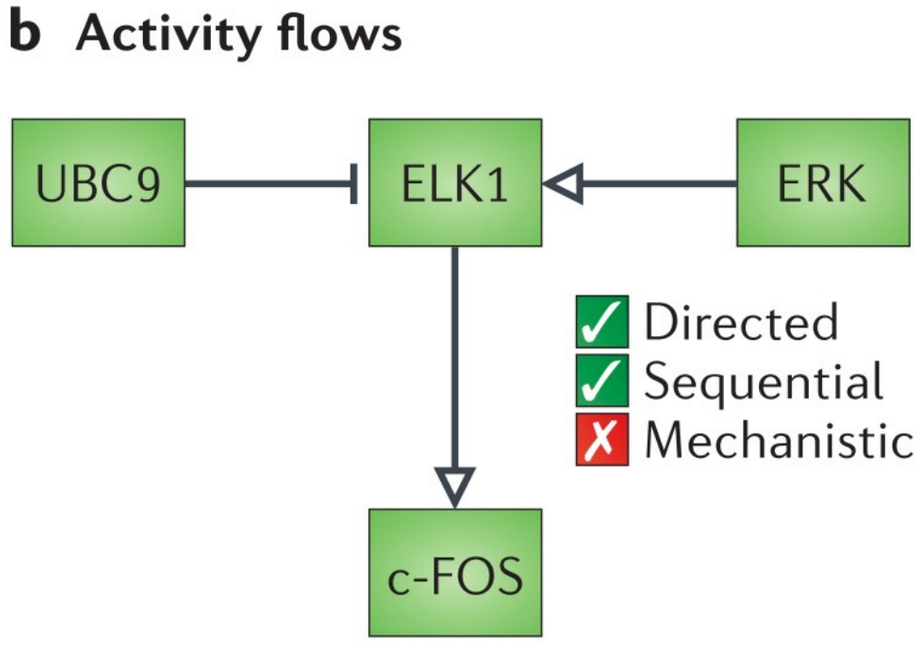
Biological Networks

- From literature, knowledge, curation
- From large-scale interaction experiments
- From inference from large-scale experiments

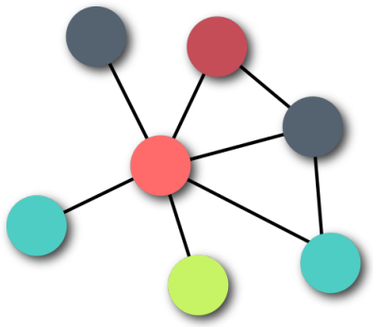


2 main types of networks to represent biological information flow

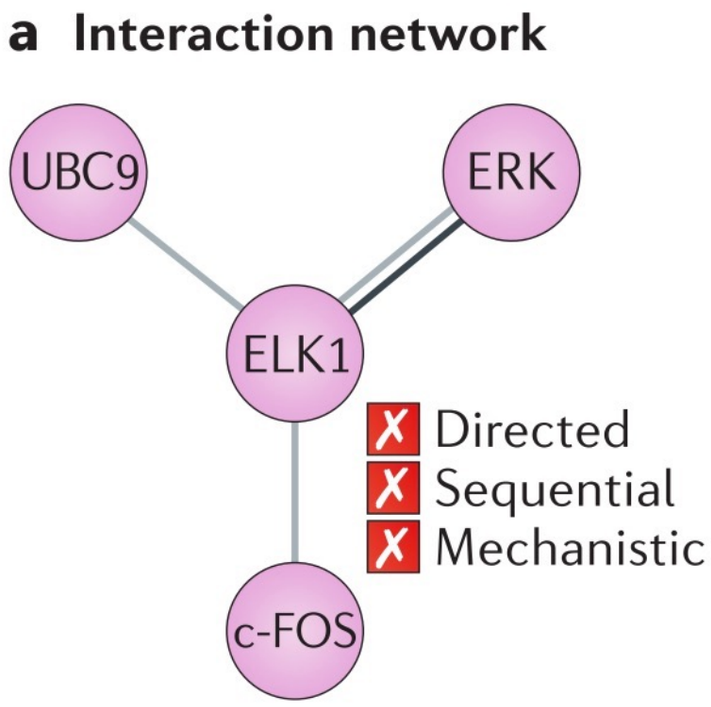




Le Novère et al. 2015

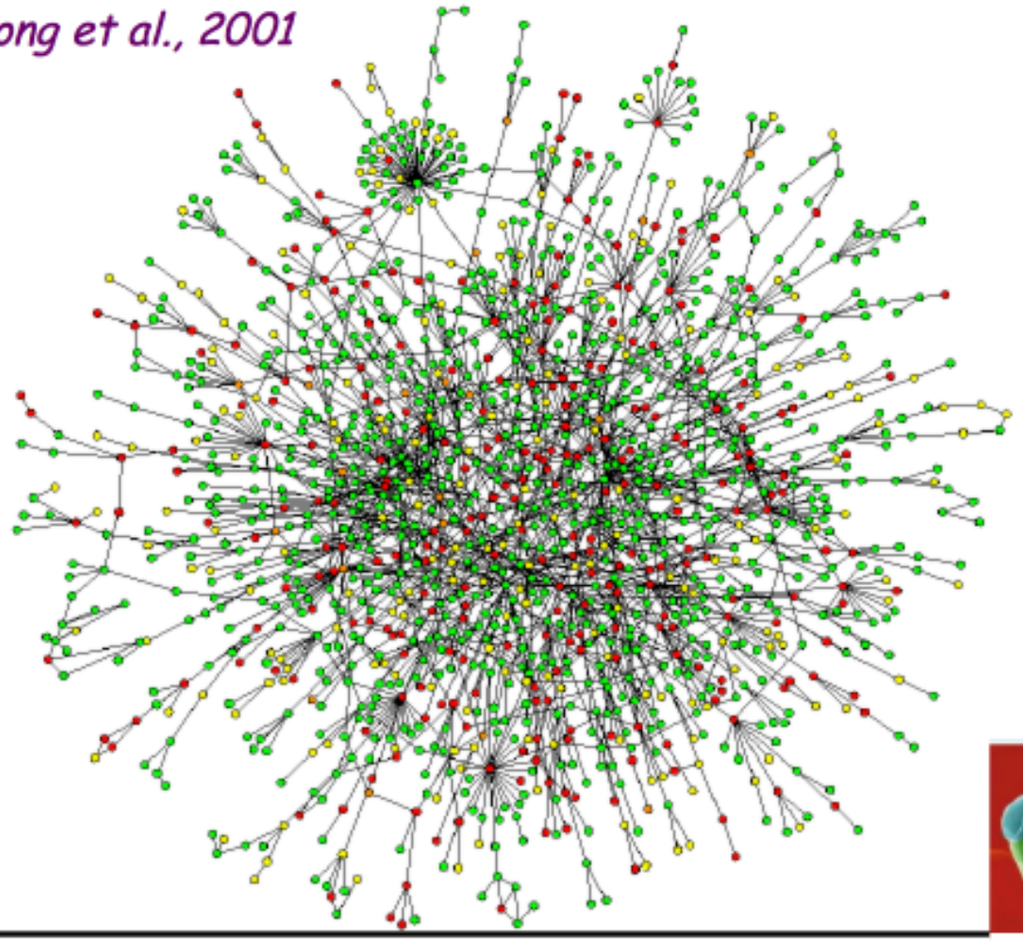


Interaction networks / Interactome

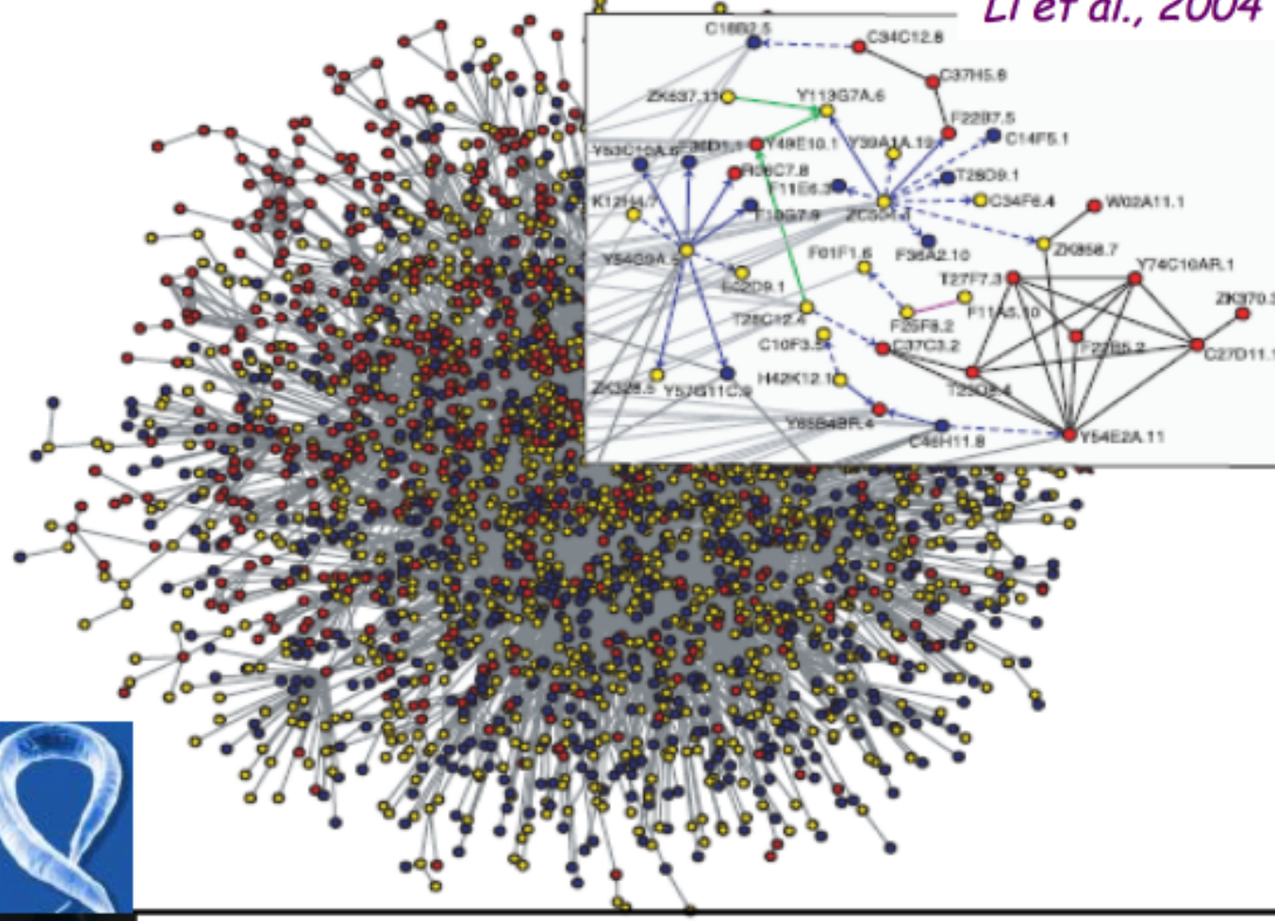


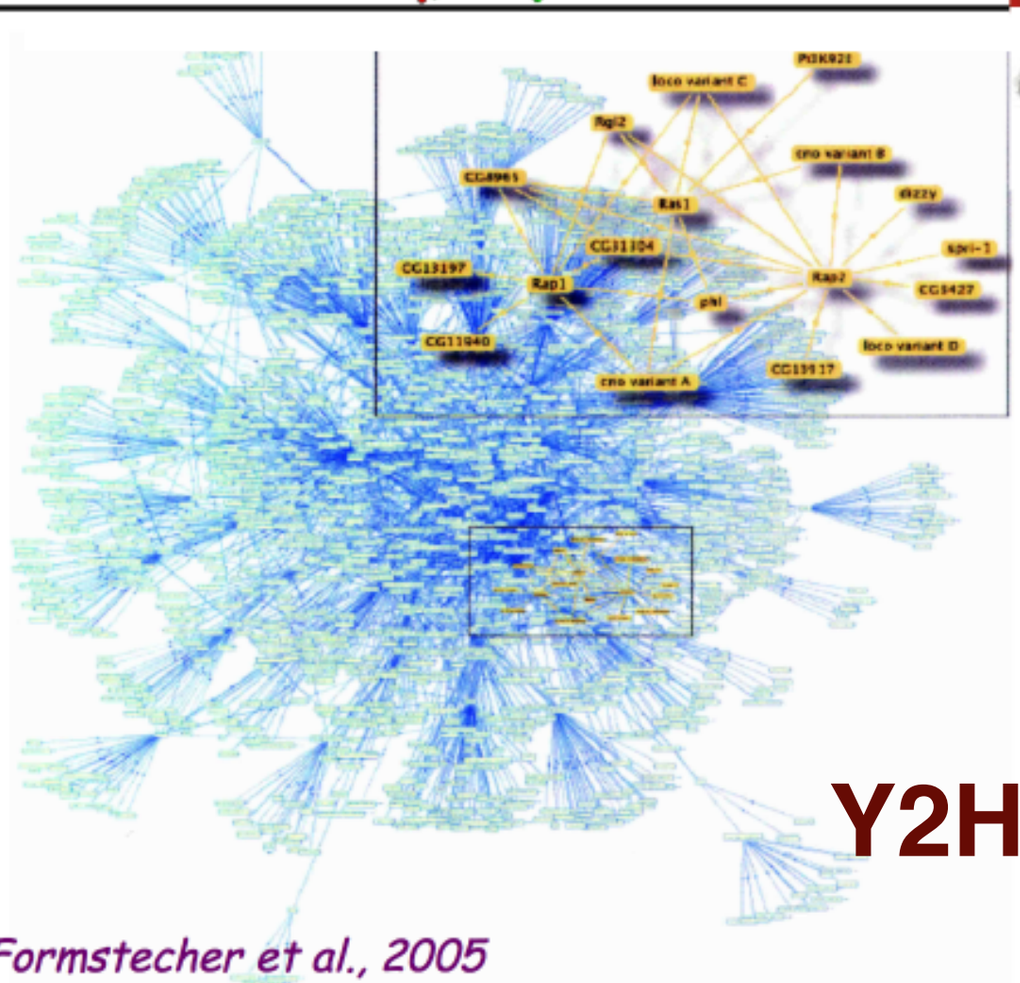
Le Novère et al. 2015

Jeong et al., 2001



Li et al., 2004

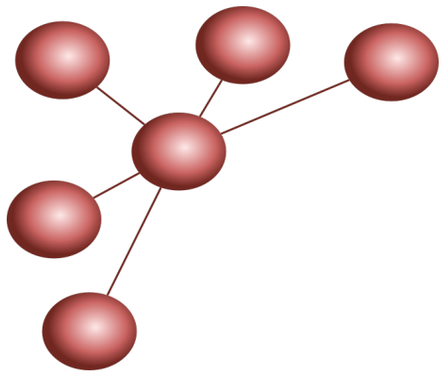




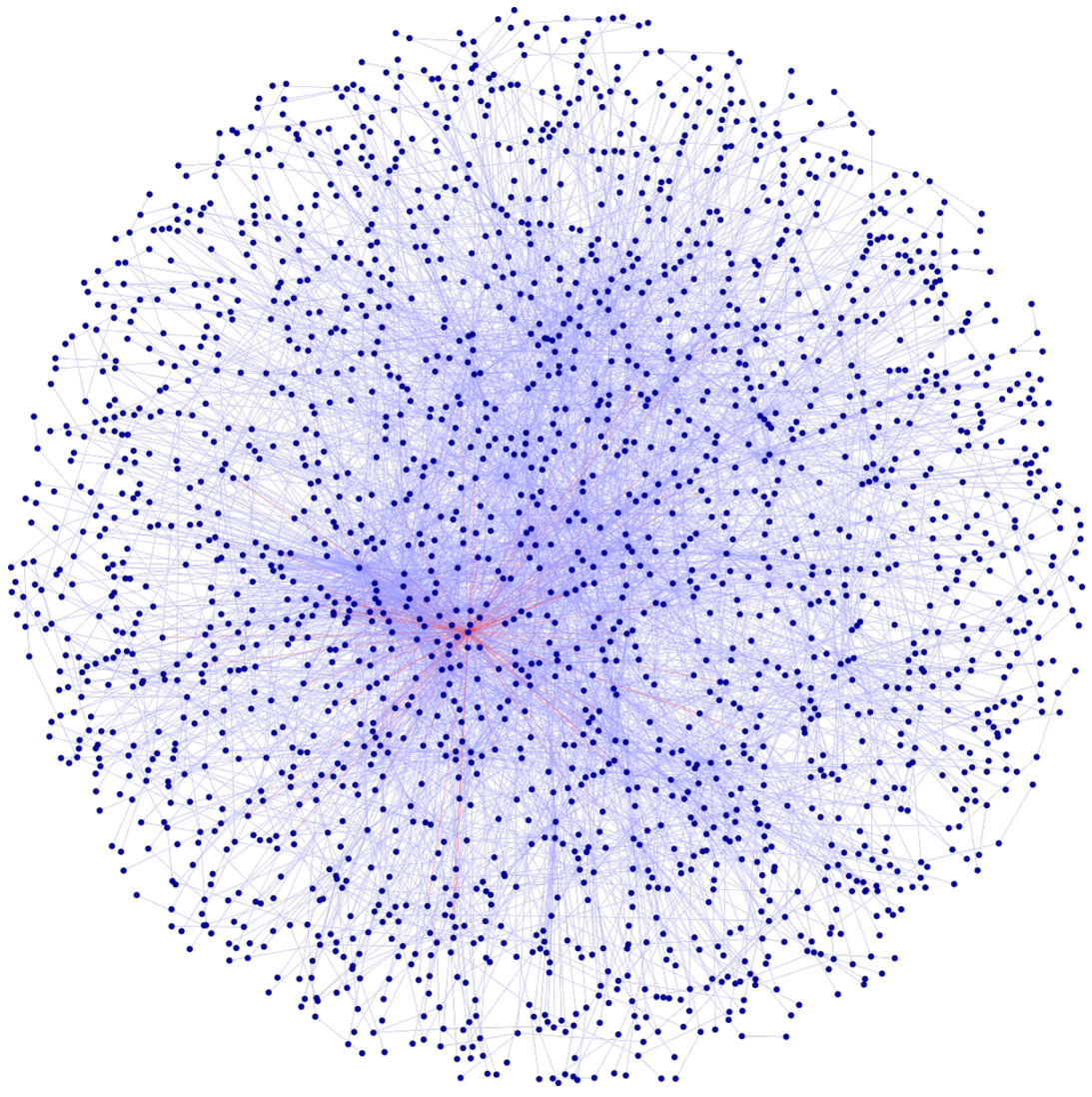
Formstecher et al., 2005

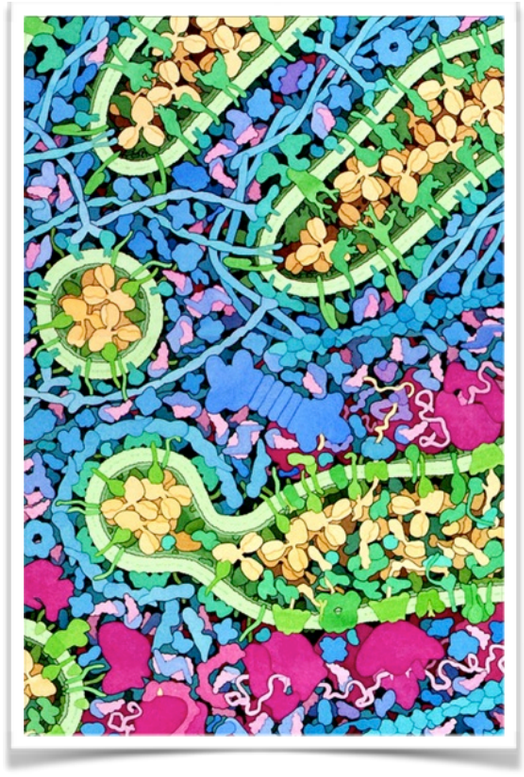
Y2H screens

Rual et al., 2005



Interactomes

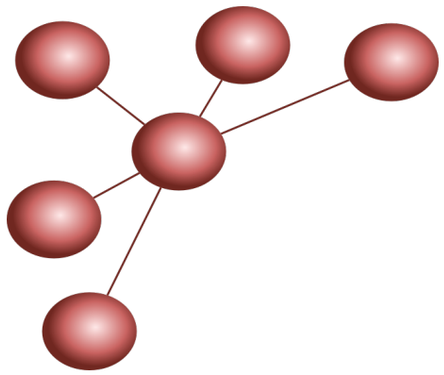




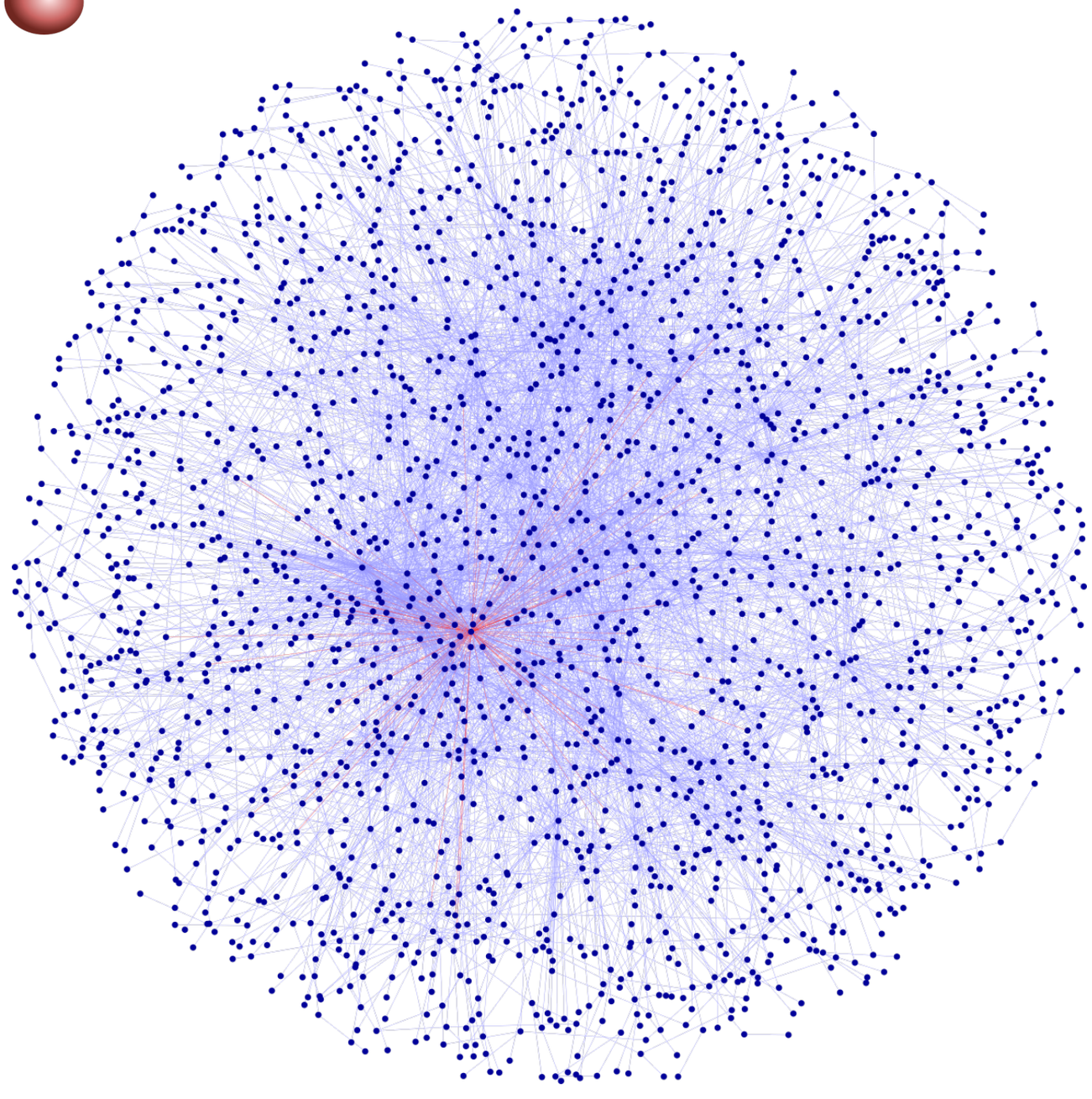
Set of protein-protein interactions detected in an organism

Physical interactions, but physiological interactions ?

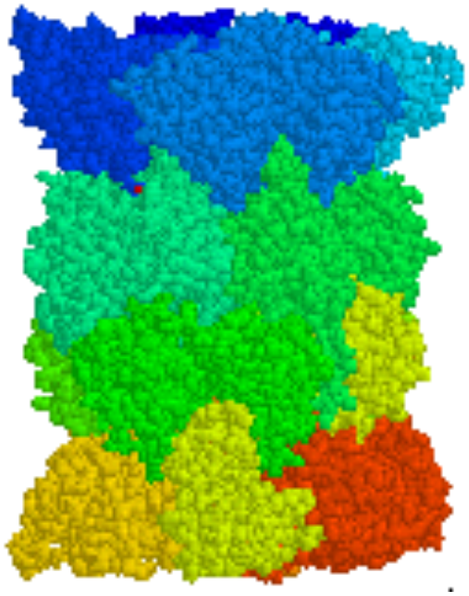
Interactomes are devoid of spatio-temporal information

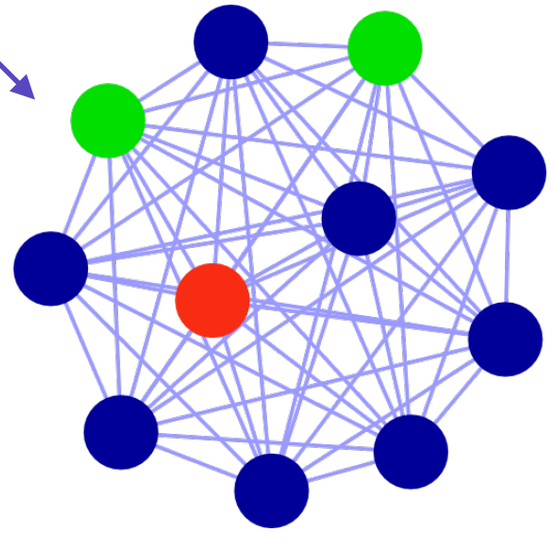


Interactomes



Protein-protein interaction networks





Protein complexes

Interaction databases

Multi-organisms:

- DIP (dip.doe-mbi.ucla.edu)
- IntAct (www.ebi.ac.uk/intact)
- MINT (mint.bio.uniroma2.it/mint)
- BioGRID (www.thebiogrid.org)
- BIND (www.blueprint.org)

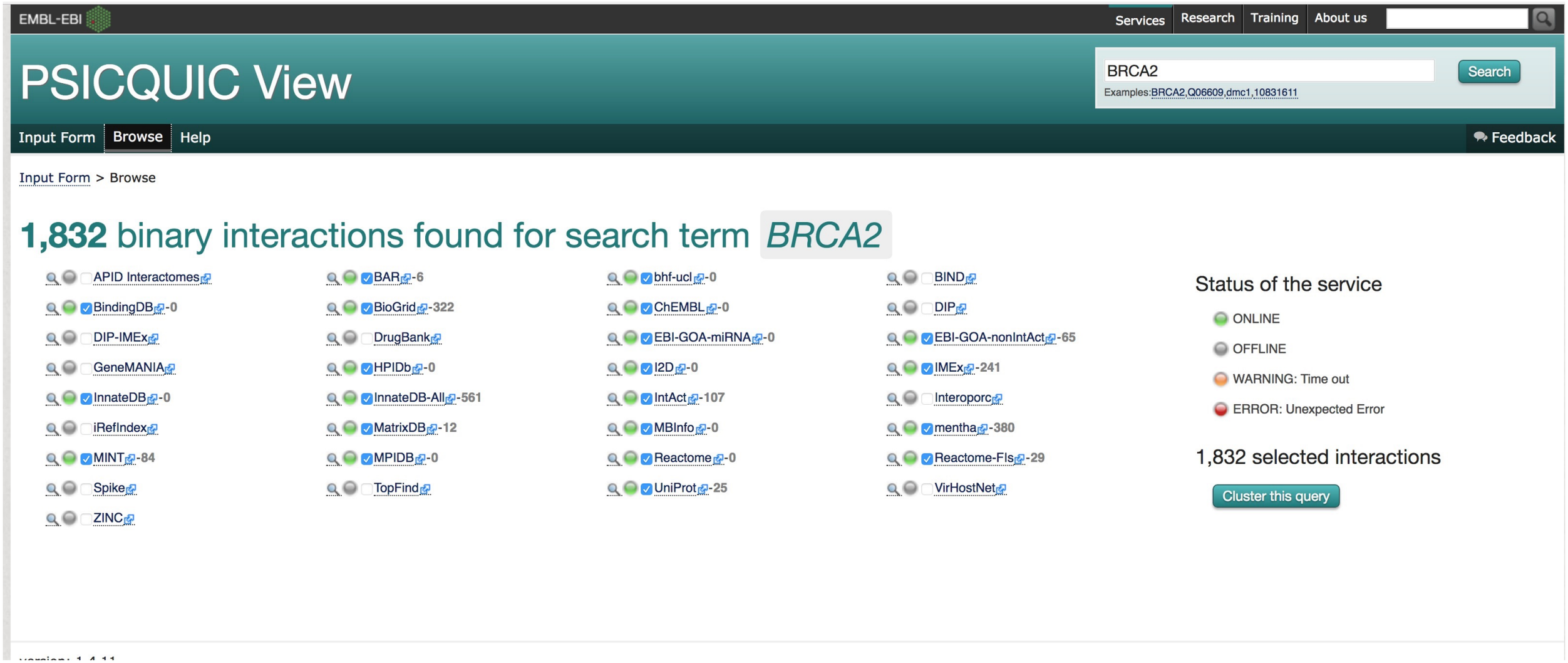
Human

- Reactome-FI

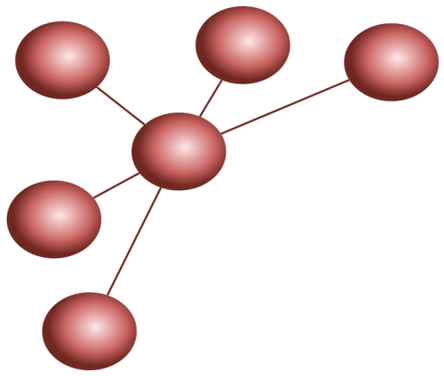
IMEx

International Molecular Exchange Consortium

Psicquic portal

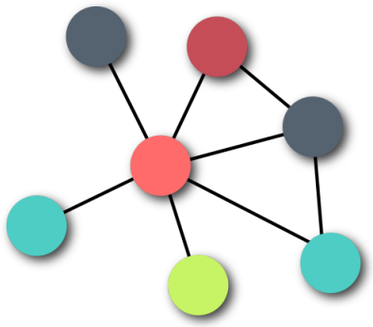


http://www.ebi.ac.uk/Tools/webservices/psicquic/

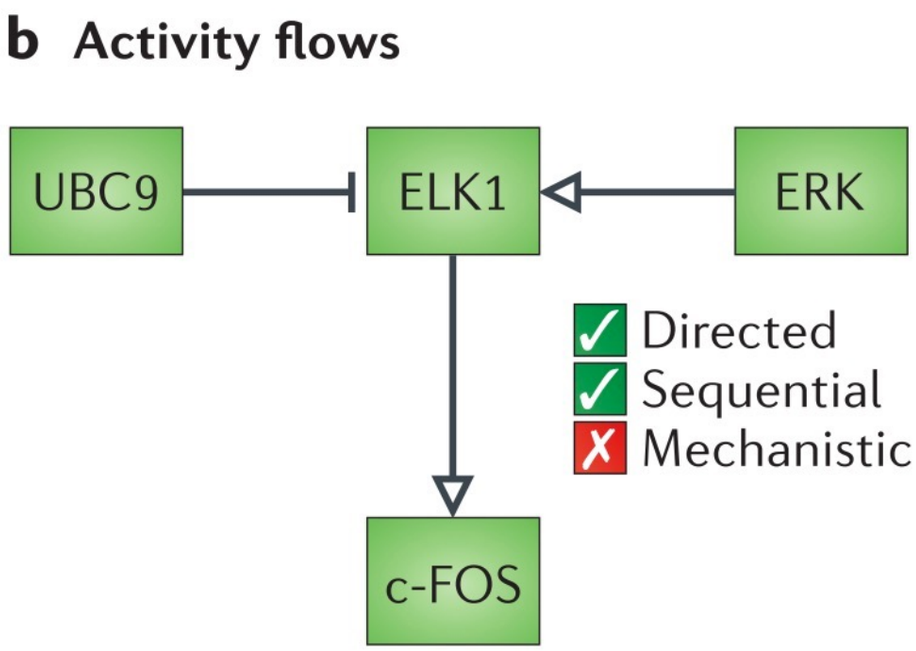


Network inference from -omics data

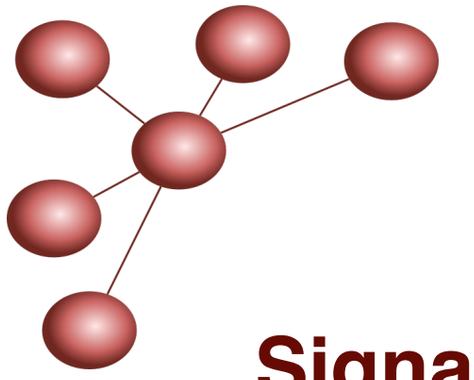
- Co-expression networks from transcriptomics data => Session #2



Activity flow / Gene Regulatory Networks / Influence Graphs

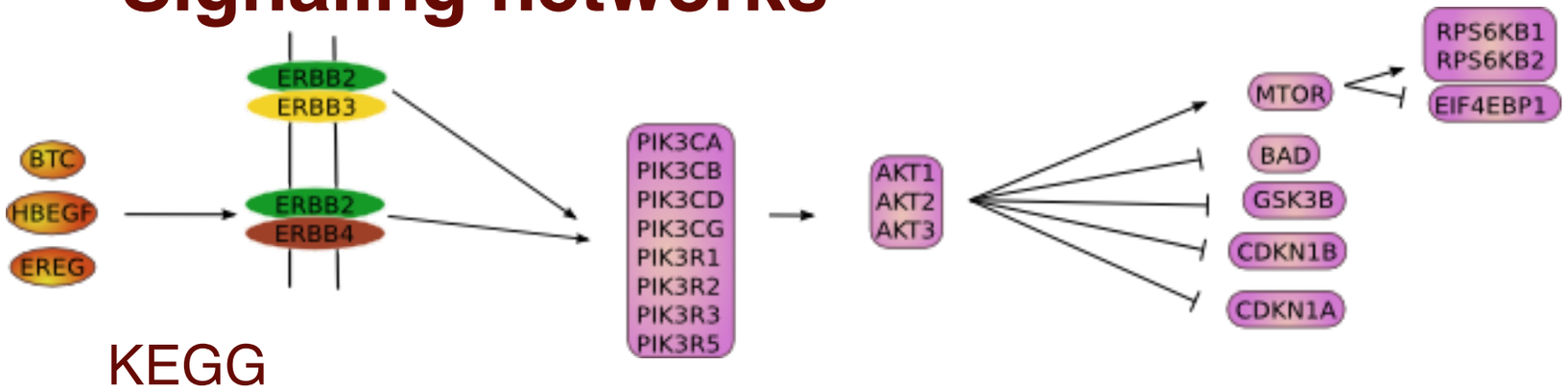


Le Novère et al. 2015



Signaling Networks

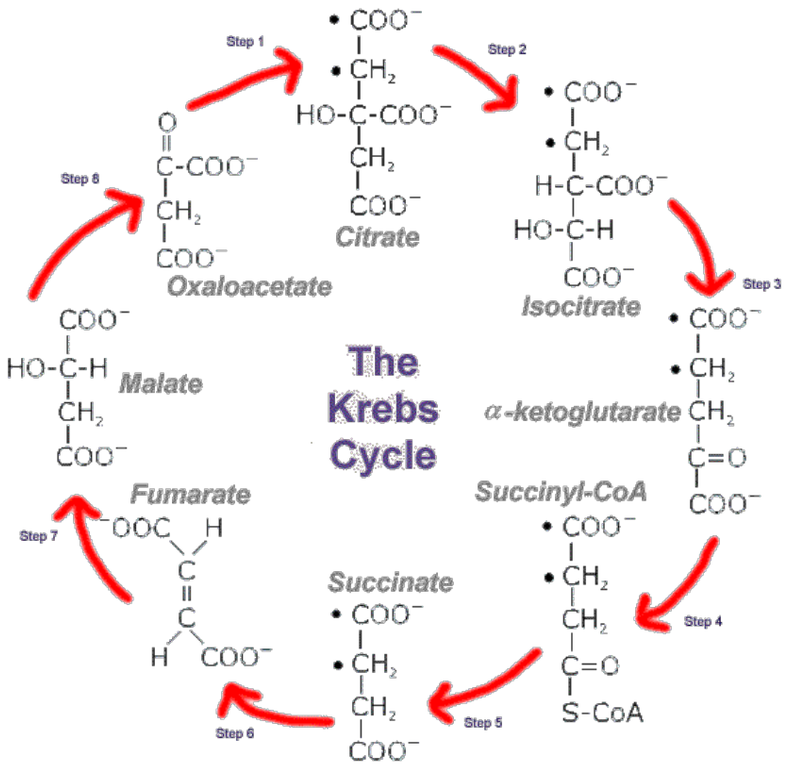
Signaling networks



KEGG

Metabolic networks

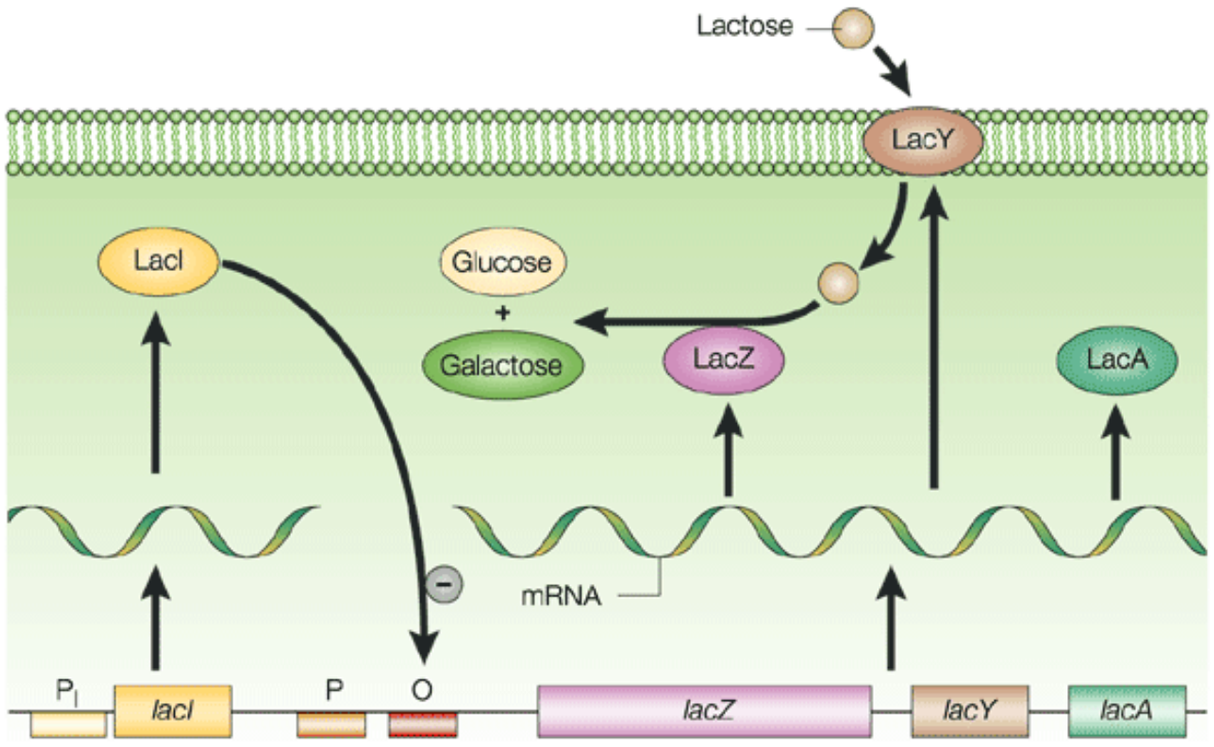
2 types of nodes : enzymes & substrates, reaction directional or bidirectional



Metabolic Cycle

Gene Regulatory Networks

Operon / Regulatory networks



Opéron lactose

Nature Reviews | Genetics

Shuman et al.