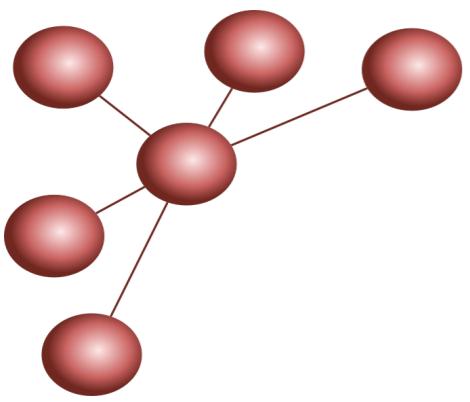


Introduction to Network Science

Introduction to Network Biology

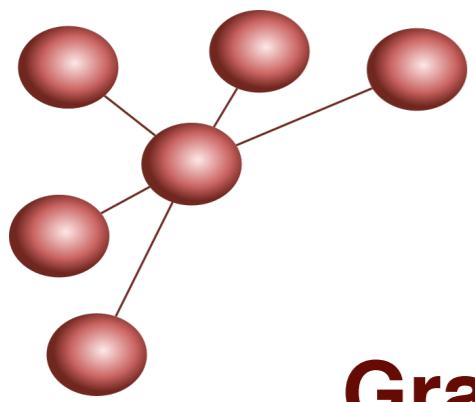
Anaïs Baudot anais.baudot@univ-amu.fr

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



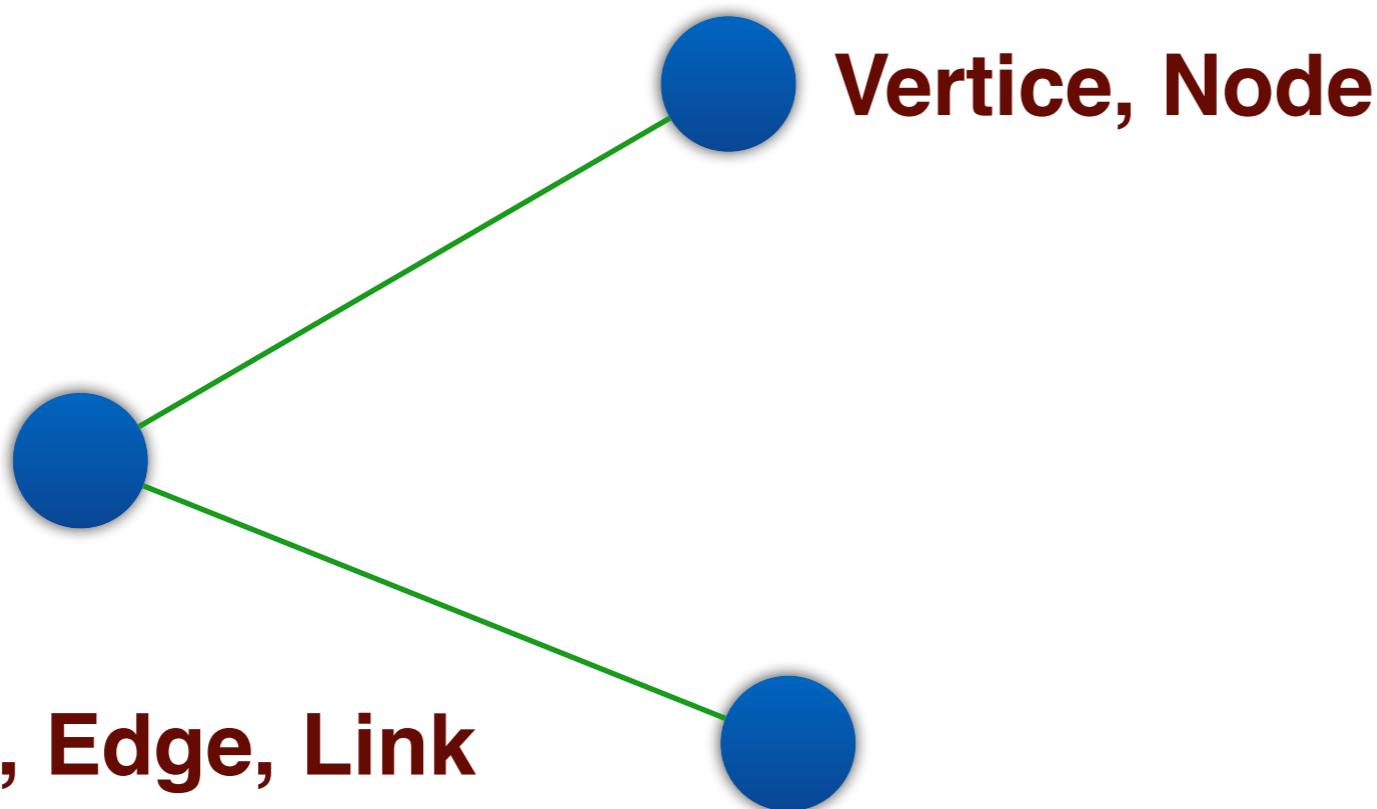
Network Science

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



Definition

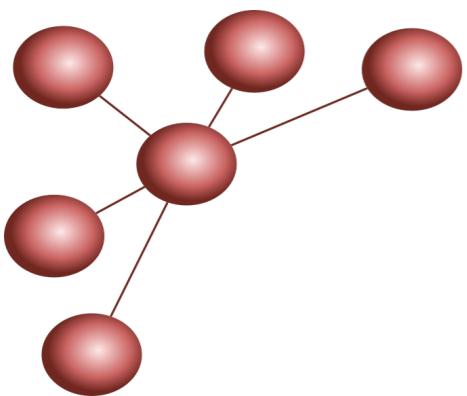
Graph, Network, Web



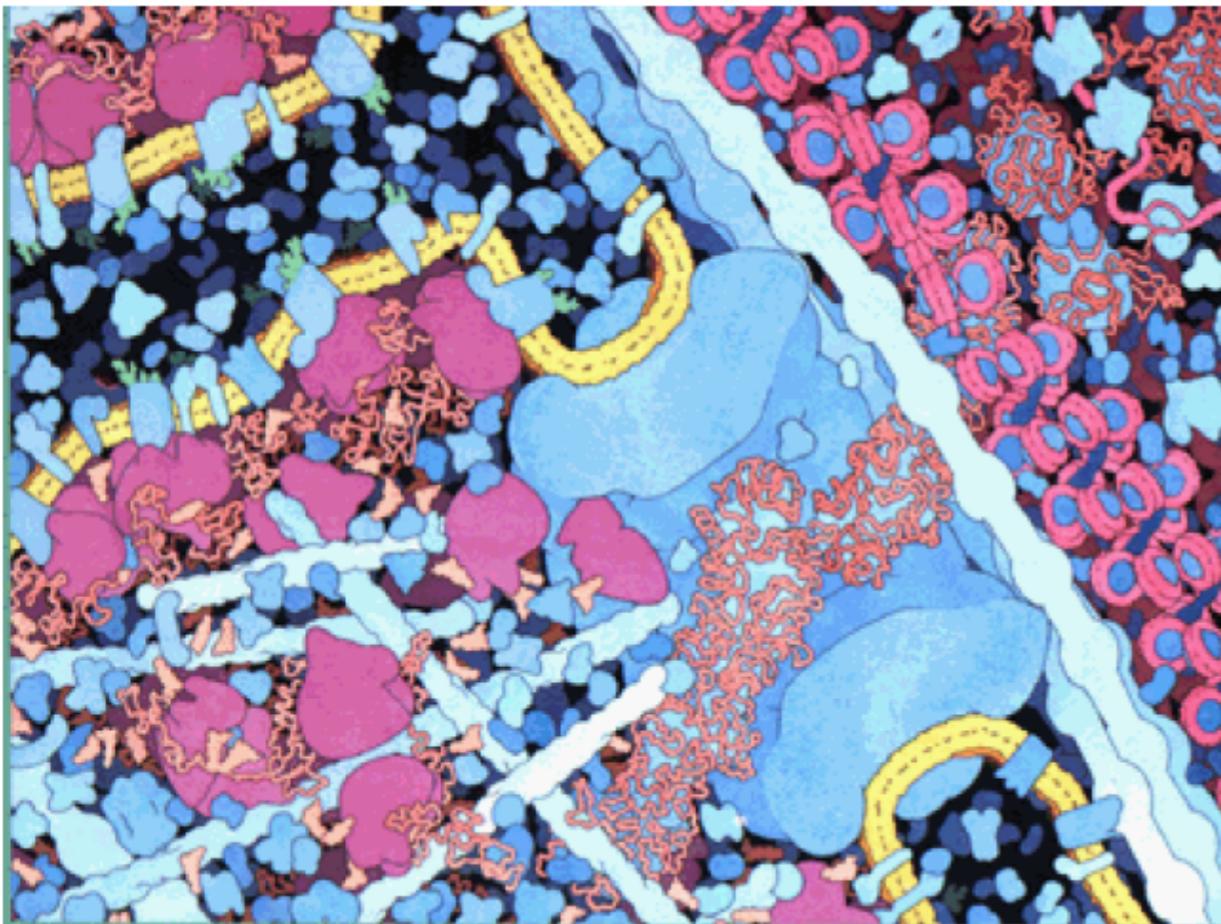
Interaction, Edge, Link

$G=\{V, E\}$

Topology, Motifs ...



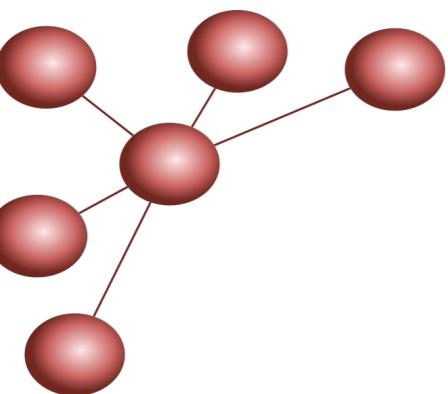
Macromolecules do not act isolated, but interact with each other to perform their functions



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

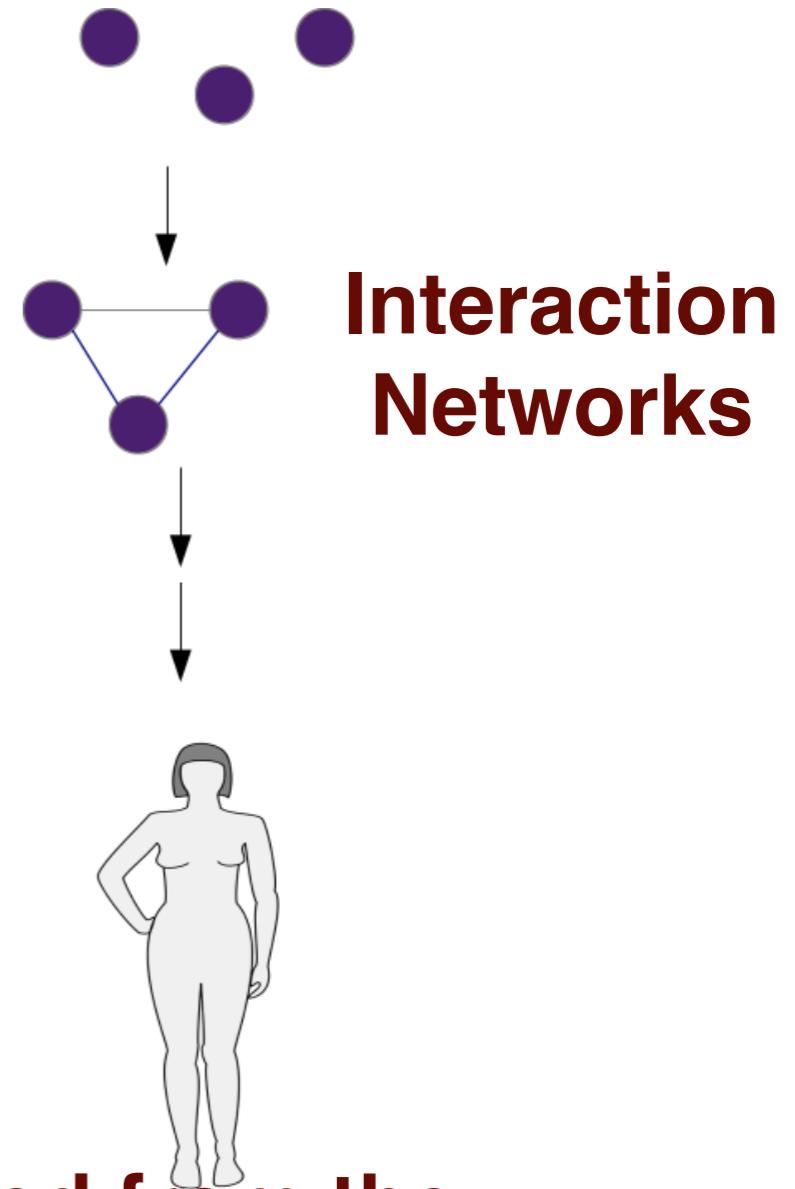
...

Transient, stable, obligatory ...



Systems Biology because living organisms are complex systems

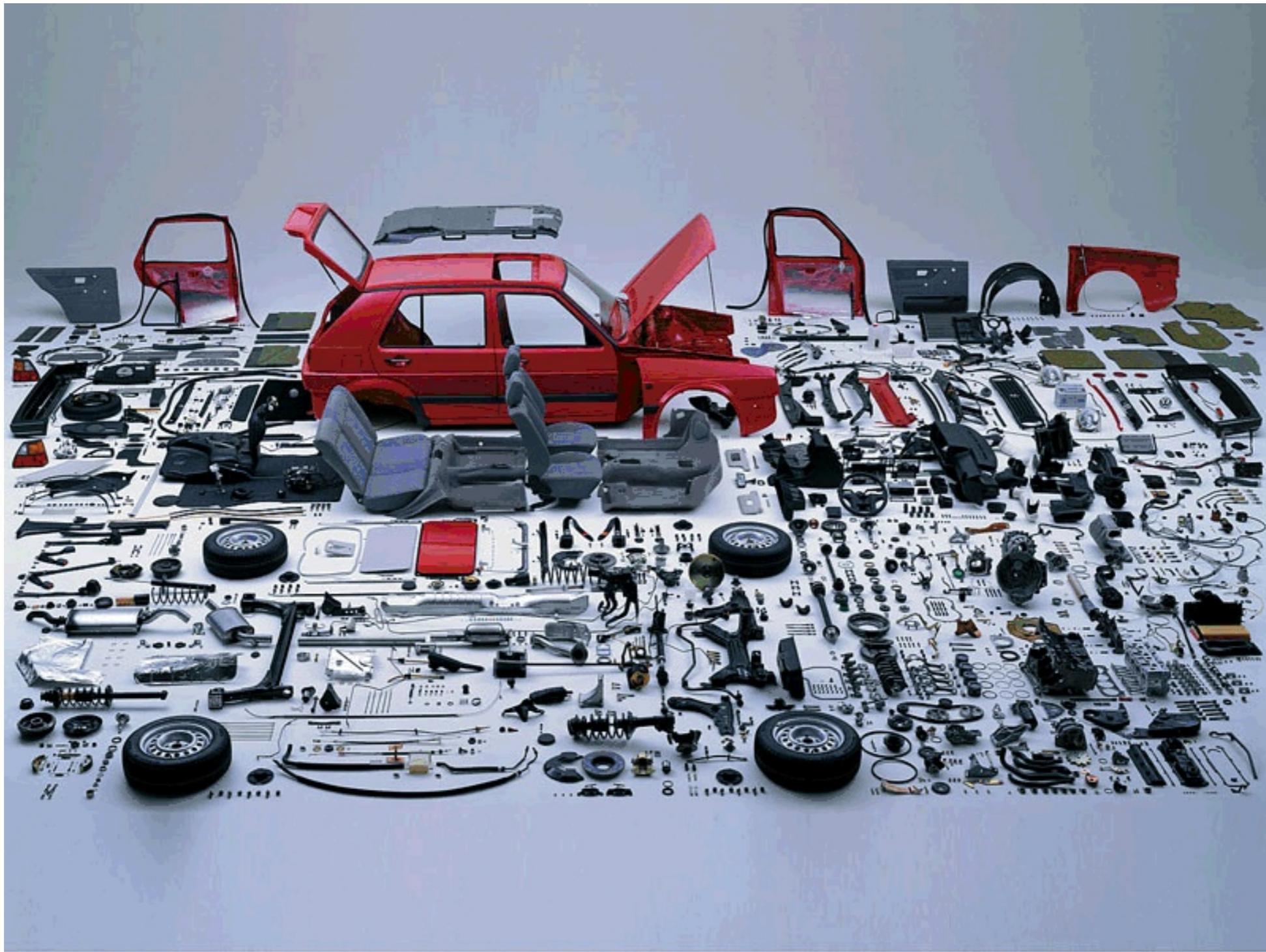
Systems component : genes/
proteins

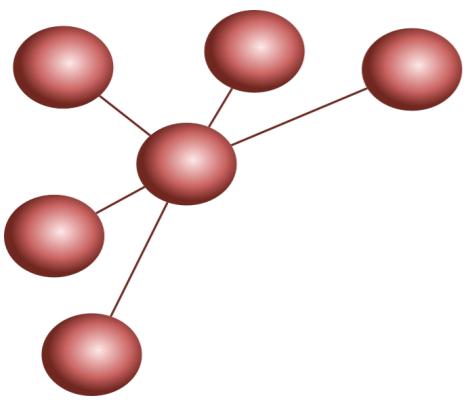


Emerging properties : phenotypes

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

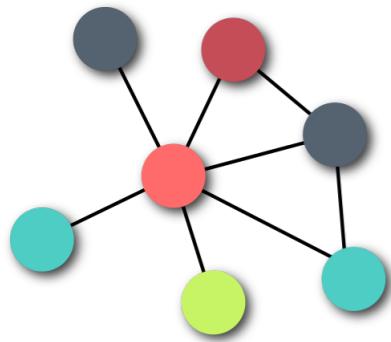
Exemple :





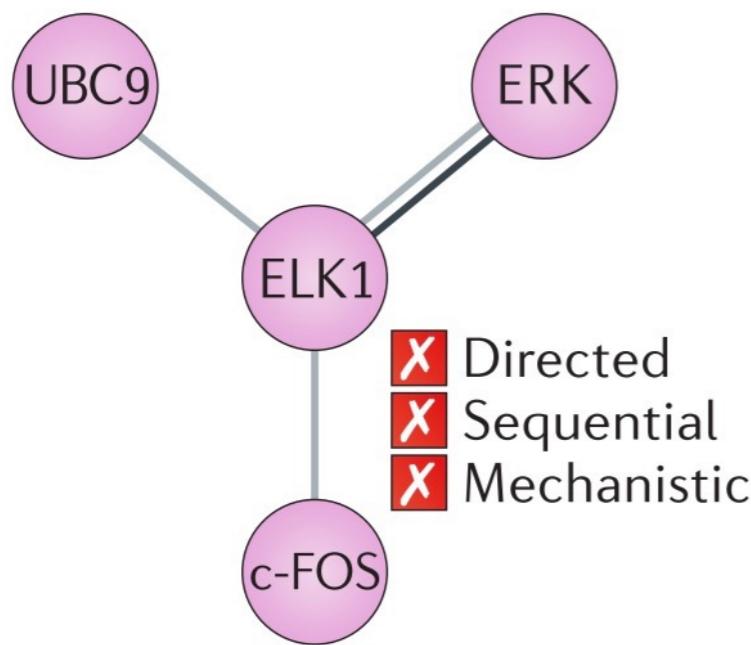
Biological Networks

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

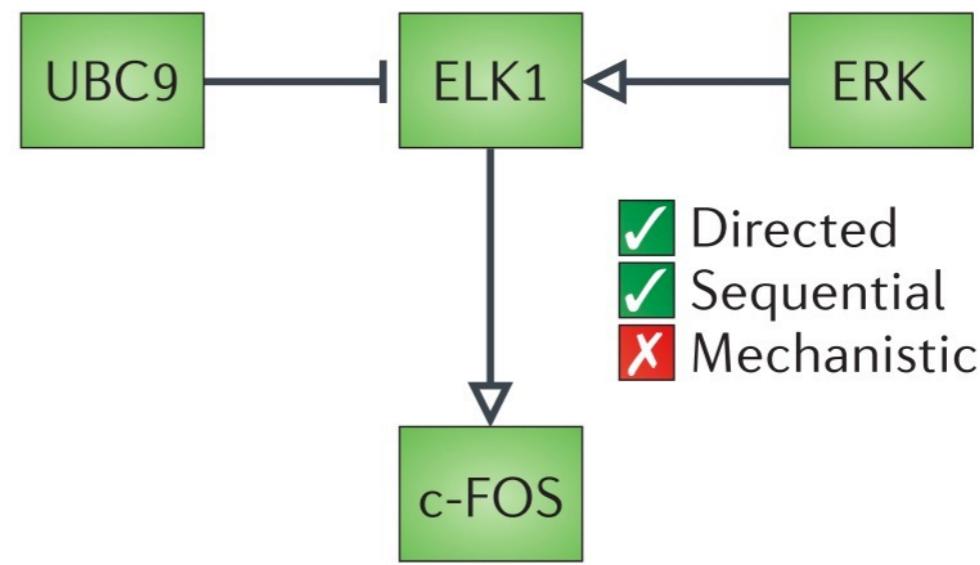


2 main types of networks to represent biological information flow

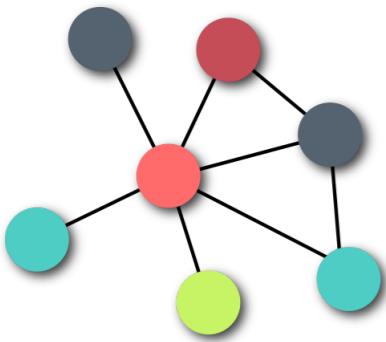
a Interaction network



b Activity flows

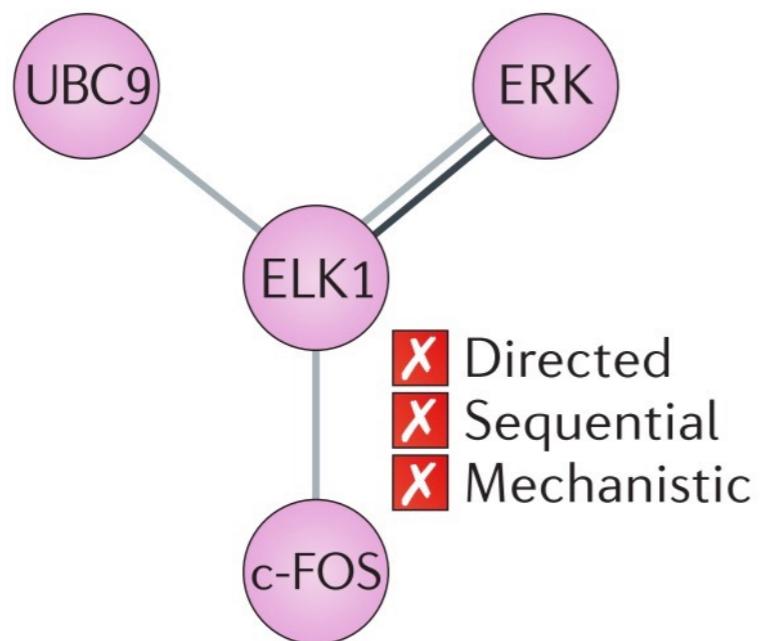


Le Novère et al. 2015



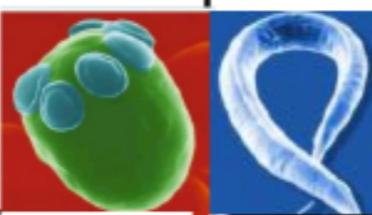
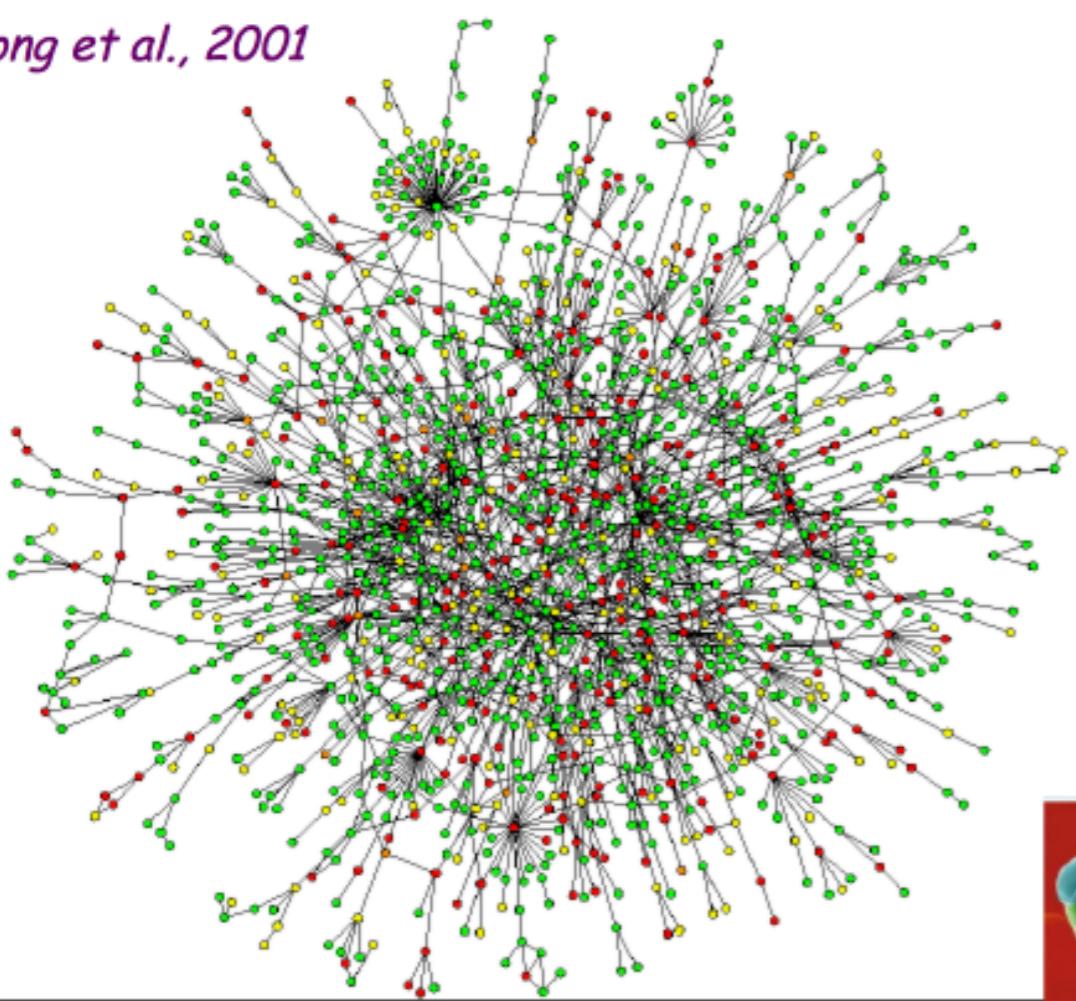
Interaction networks / Interactome

a Interaction network

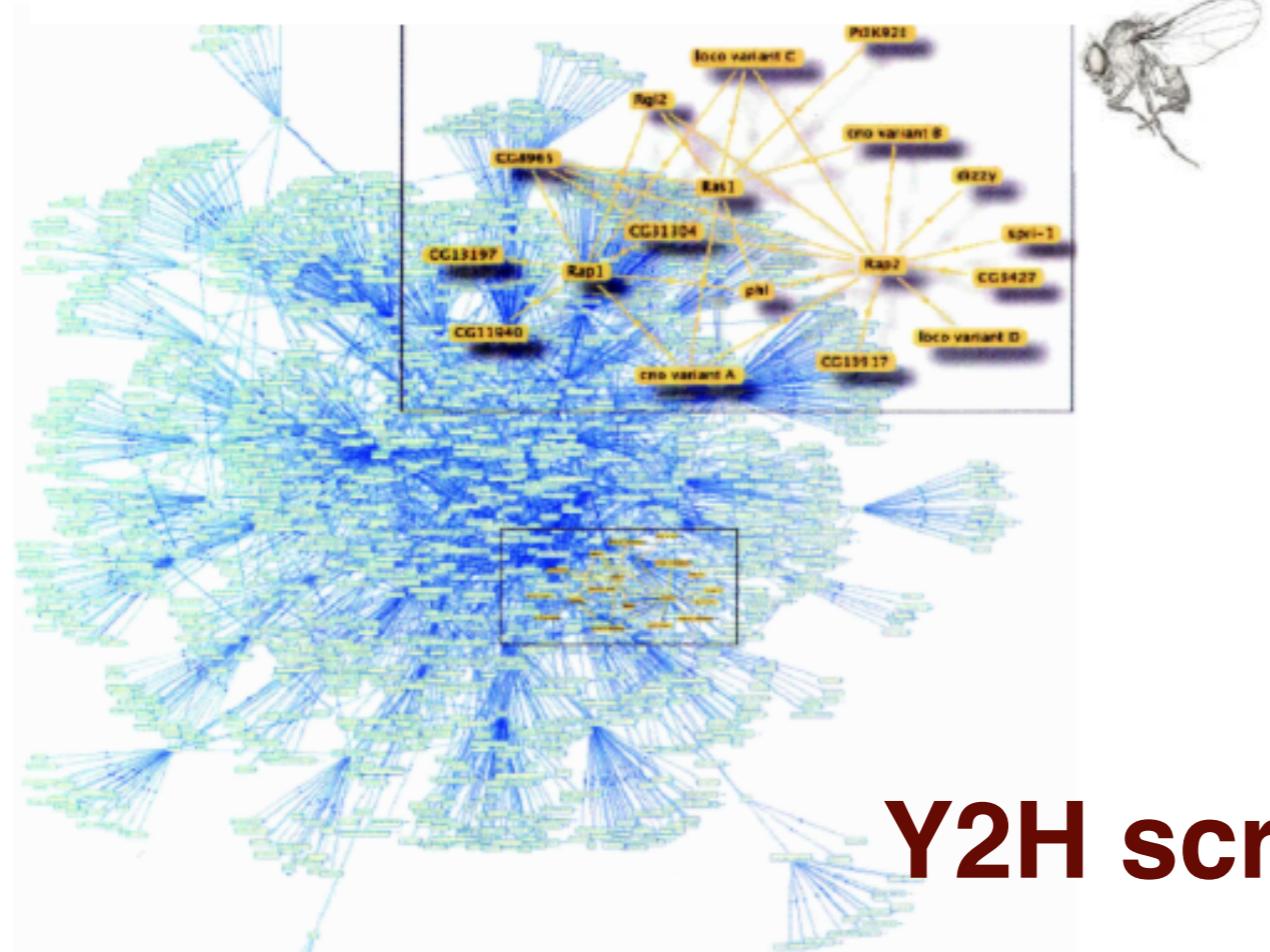
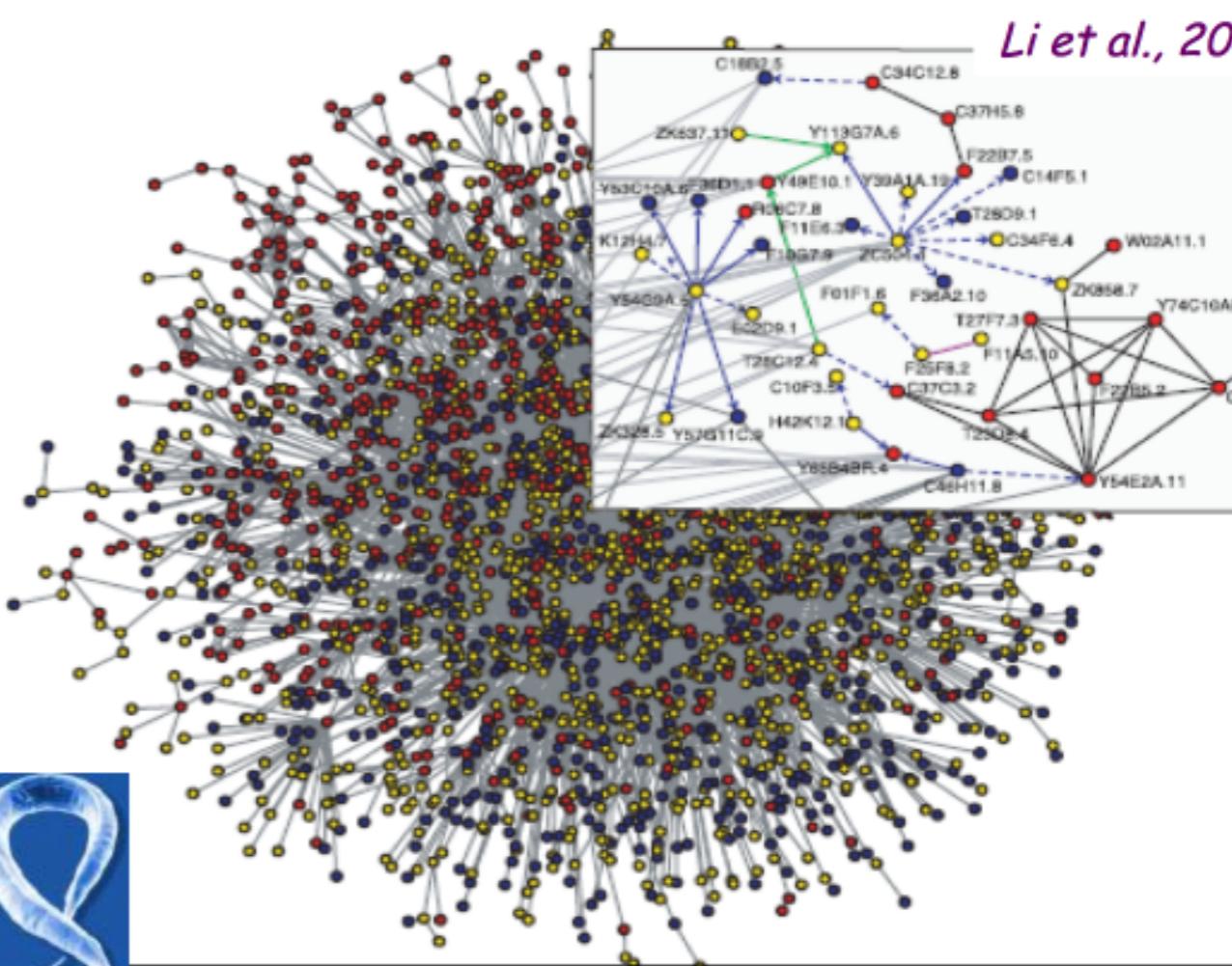


Le Novère et al. 2015

Jeong et al., 2001

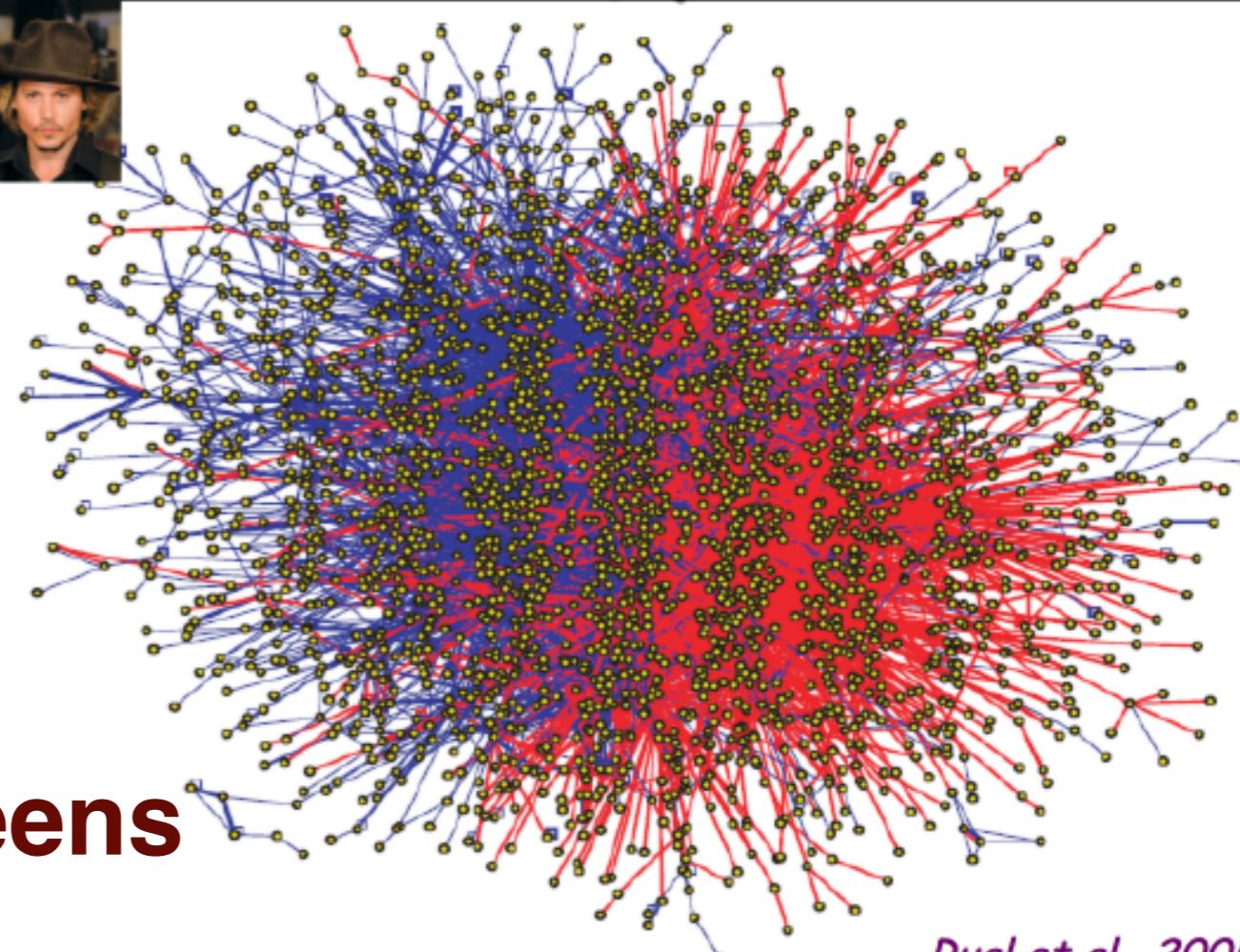


Li et al., 2004

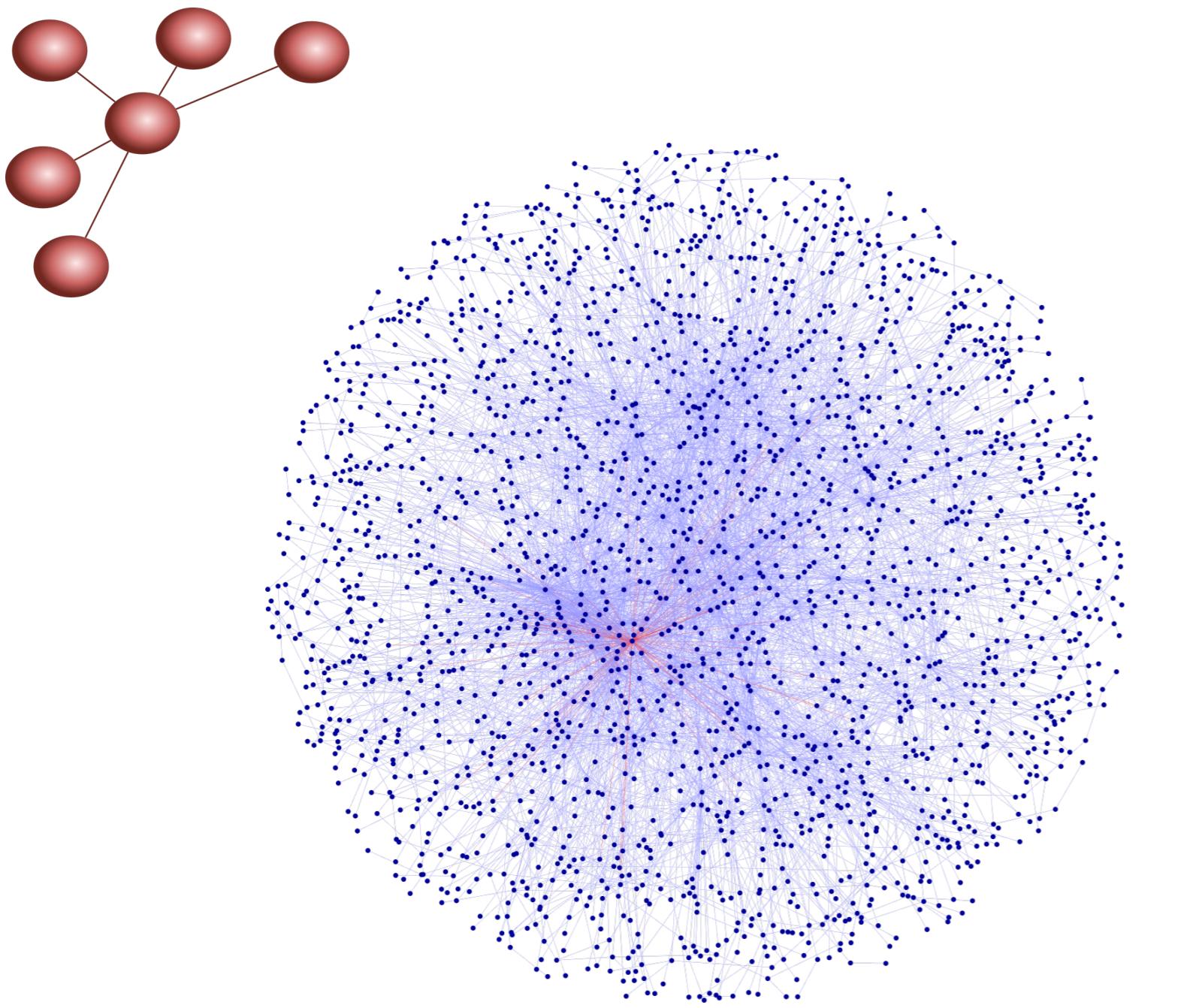


Y2H screens

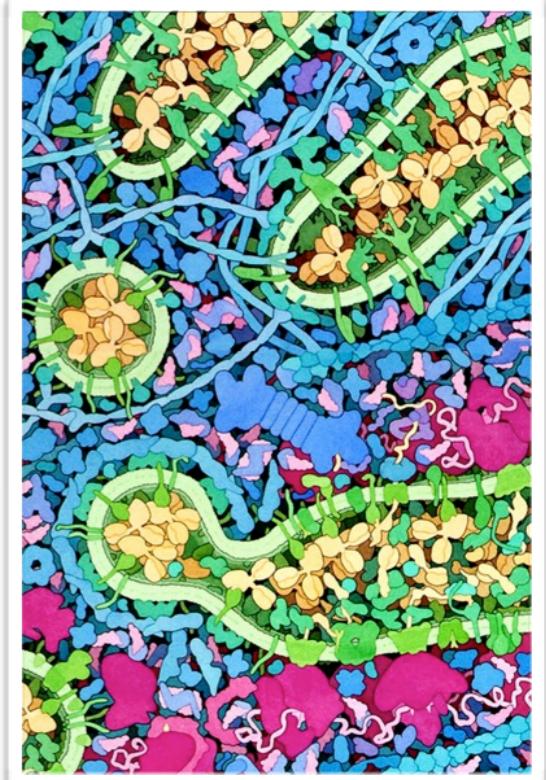
Formstecher et al., 2005



Rual et al., 2005



Interactomes

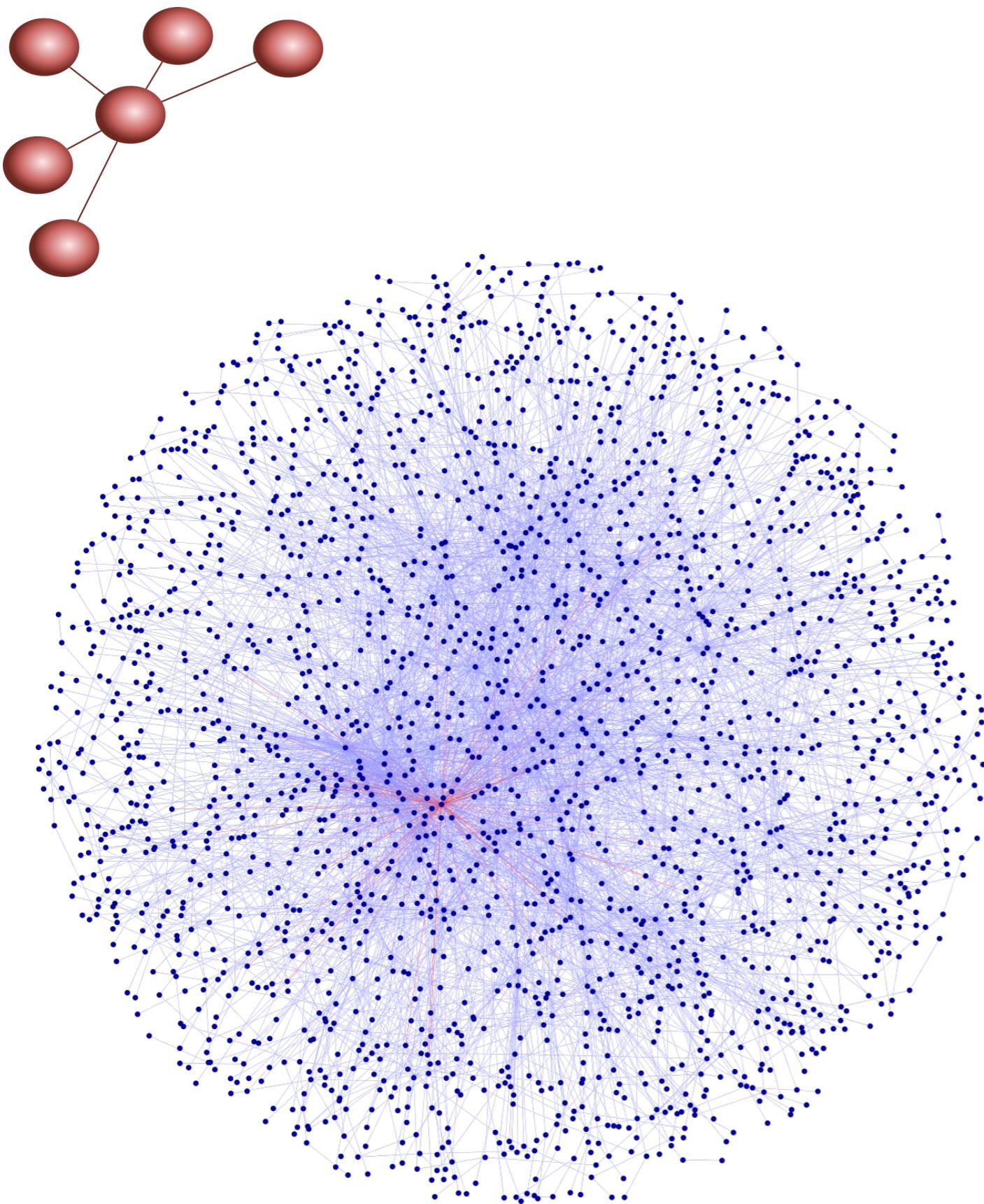


Set of protein-protein interactions detected in an organism

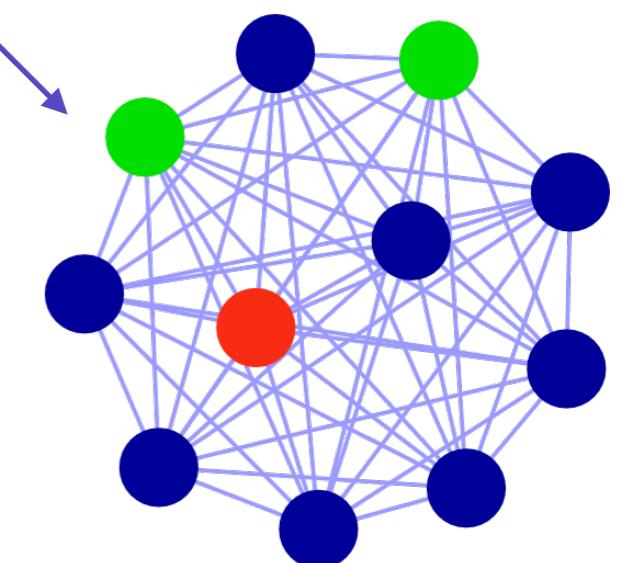
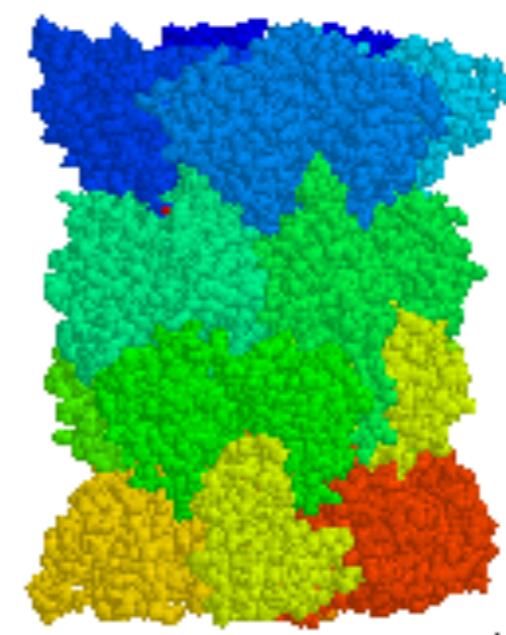
Physical interactions, but physiological interactions ?

Interactomes are devoid of spatio-temporal information

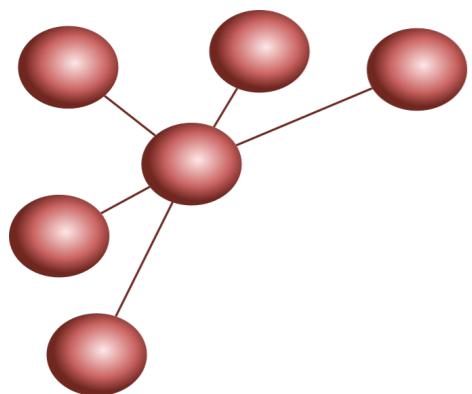
Interactomes



**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)

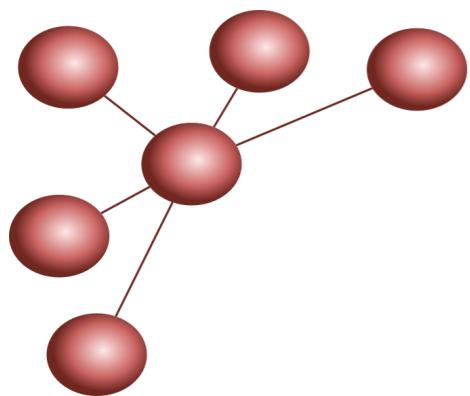
BioGRID (www.thebiogrid.org)

BIND (www.blueprint.org)

International
Molecular
Exchange
Consortium

Human

Reactome-FI



Psicquic portal

EMBL-EBI

Services Research Training About us

PSICQUIC View

BRCA2 Examples:BRCA2,Q06609,dmc1,10831611

Search

Input Form Browse Help Feedback

Input Form > Browse

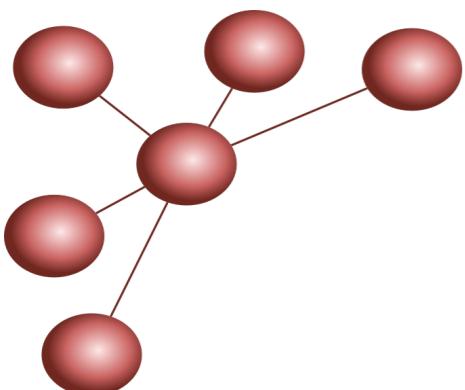
1,832 binary interactions found for search term *BRCA2*

APID Interactomes	BAR -6	bhf-ucl -0	BIND	Status of the service
BindingDB -0	BioGrid -322	ChEMBL -0	DIP	ONLINE
DIP-IMEx	DrugBank	EBI-GOA-miRNA -0	EBI-GOA-nonIntAct -65	OFFLINE
GeneMANIA	HPIDb -0	I2D -0	IMEx -241	WARNING: Time out
InnateDB -0	InnateDB-All -561	IntAct -107	Interoporc	ERROR: Unexpected Error
iRefIndex	MatrixDB -12	MBInfo -0	mentha -380	
MINT -84	MPIDB -0	Reactome -0	Reactome-Fls -29	
Spike	TopFind	UniProt -25	VirHostNet	
ZINC				

1,832 selected interactions

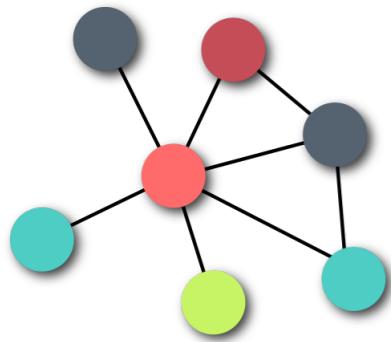
Cluster this query

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



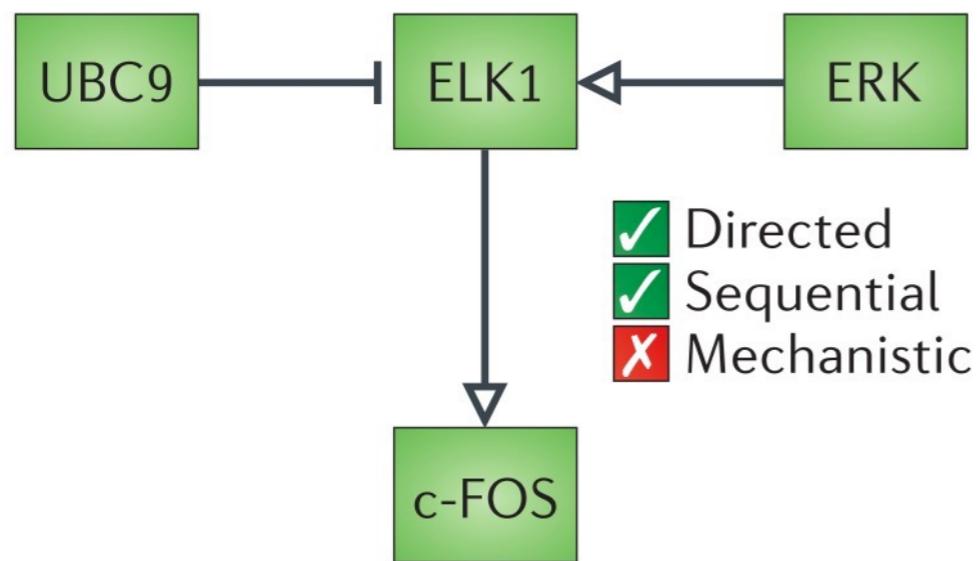
Network inference from -omics data

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

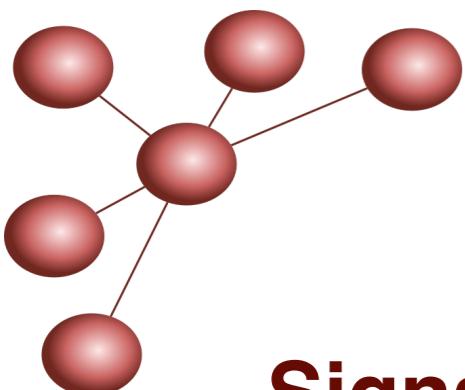


Activity flow / Gene Regulatory Networks / Influence Graphs

b Activity flows

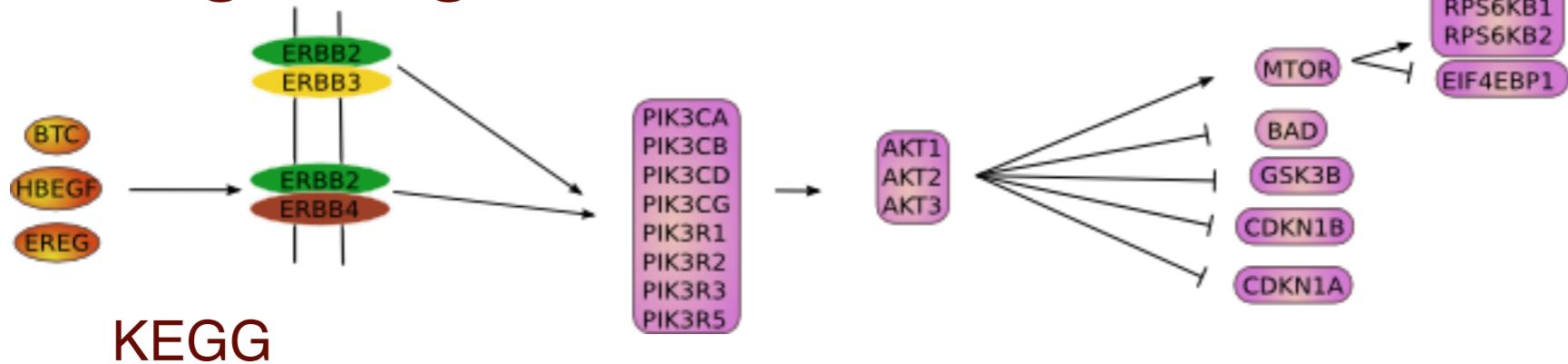


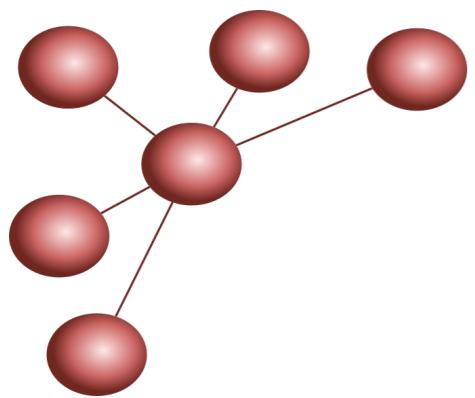
Le Novère et al. 2015



Signaling Networks

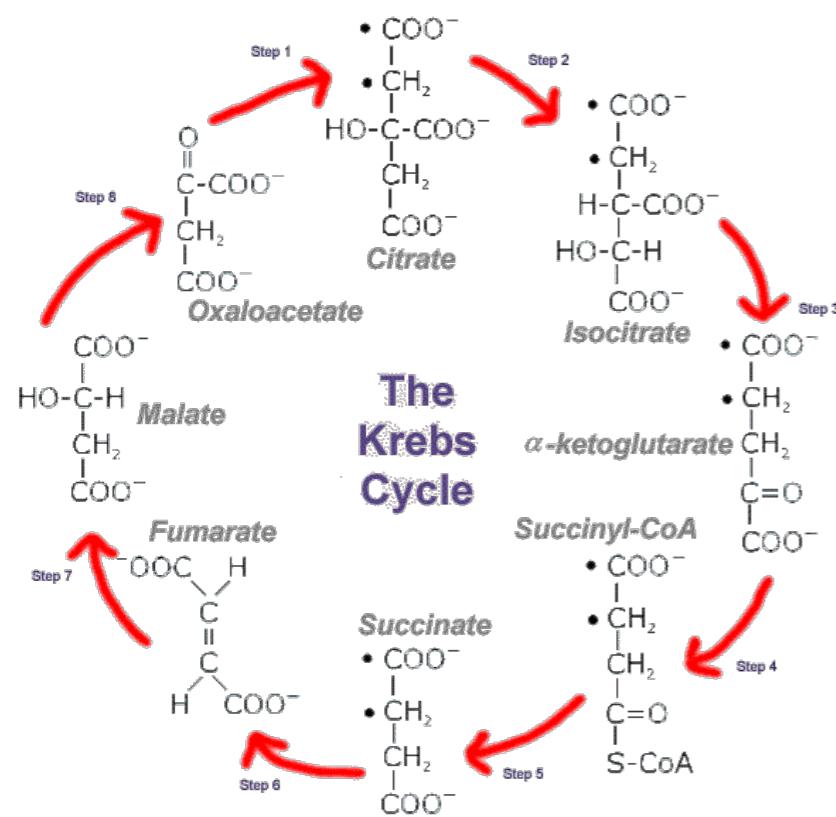
Signaling networks



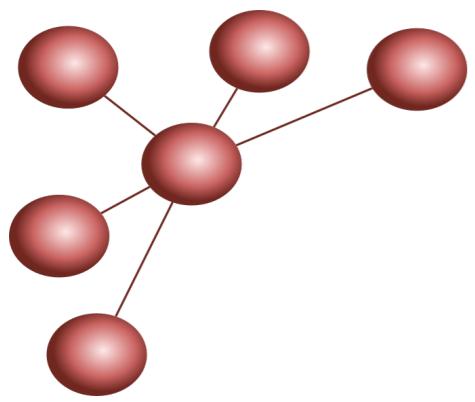


Metabolic networks

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



Metabolic Cycle



Gene Regulatory Networks

Operon / Regulatory networks

