## Complex Networks I

## Plan of the lectures

## Introduction

Networks: basic definitions
III. Models
IV. Community Detection

## Peferences

- Evolution of networks S.N. Dorogovtsev, J.F.F. Mendes, Adv. Phys. 51, 1079 (2002), cond-mat/0106144
- Statistical mechanics of complex networks Reka Albert, Albert-Laszlo Barabasi Reviews of Modern Physics 74, 47 (2002), cond-mat/0106096
- The structure and function of complex networks M. E. J. Newman, SIAM Review 45, 167-256 (2003), mat/0303516
- Complex networks: structure and dynamics
S. Boccaletti, V. Latora, Y. Moreno, M. Chavez, D.-U. Hwang Physics Reports 424, 175-308 (2006)


## What is a network

Network=set of nodes joined by links

very abstract representation

convenient to describe many different systems

## Some examples

|  | Nodes | Links |
| :--- | :--- | :--- |
| Social networks | Individuals | Social relations |
| Internet | Routers <br> AS | Cables <br> Commercial agreements |
| WWW | Webpages | Hyperlinks |
| Protein interaction <br> networks | Proteins | Chemical reactions |

and many more (email, P2P, foodwebs, transport....)

## Two main classes

Natural systems:
Biological networks: genes, proteins...
Foodwebs
Social networks

Infrastructure networks:
Virtual: web, email, P2P
Physical: Internet, power grids, transport...


## GENOME

protein-gene interactions

## PROTEOME

protein-protein interactions

# METABOLISM 

## Bio-chemical reactions

## Metabolic Network

## Protein Interactions

Nodes: metabolites
Links:chemical reactions


Nodes: proteins
Links: interactions


## Regulatory Network

Nodes: T. F. and target genes
Directed Links: Regulatory interactions

## Protein Interactions

Nodes: proteins
Undirected Links: interactions


## Scientific collaboration network

Nodes: scientists
Links: co-authored papers

Weights: depending on
-number of co-authored papers
-number of authors of each paper
-number of citations...

## Actors collaboration network

Nodes: actors
Links: co-starred movies

IMDh Internet Movie Database


## World airport network



## complete IATA database

- $V=3100$ airports
- $E=\underline{17182}$ weighted edges
- $w_{i j}$ \#seats I (time scale)
$>99 \%$ of total traffic


## Networks characteristics

Networks: of very different origins


Do they have anything in common? Possibility to find common properties?
the abstract character of the graph representation and graph theory allow to answer....

