Theoretical Computer Sciences

Sergio Peignier sergio.peignier@insa-lyon.fr

Associate Professor
INSA Lyon
Biosciences department

Table of contents

1. Overview

2. Prerequisites

3. Objectives

4. Complementary sources

Overview

Overview

- **Theoretical Computer Sciences**
- **Applications in biology** (project)
- Two parts:
  - **Part I** Sergio Peignier:
    Graph theory.
  - **Part II** Théotime Grohens:
    Combinatorial algorithms, complexity, ...

Prerequisites

Prerequisites

- Notions of **Computer Sciences**
- **Calculus.**
- Basic **programming skills** (Python, R, ...).

Objectives

General Competencies

- Analyze a system:
  - **Model** a (complex) **system** as a **graph**.
  - **Analyze** and **characterize graphs**
  - **Understand** major **graph models.**
  - **Write mathematical proofs**

- Exploit a real system model:
  - **Implement** a computer **simulation** of a **complex system**, as a **graph**.
  - **Select/Design/implement** algorithms for graphs, **detect tendencies** and **interpret** results.

Specific Competencies

- Model a **complex biological network** as a **graph**
- **Implement/study** it in python using **Networkx**
- **Apply/Choose/implement** graph theory analysis algorithms.

Specific Knowledge

- Basic definitions

  edge, node, graph, undirected, directed, weighted, ...
- Specific graphs (trees, bipartite, ...)
- Graph representations (adjacency matrix, adjacency list)
- Metrics (Rich club coef., degree, clustering coef., ...)
- Graph Traversal Algorithms (DFS, BFS, Djikstra)
- Motifs and Communities.
- Community detection algorithms

  Girvan Newman, Louvain, ...
- NetworkX Python library.

Complementary sources

Complementary sources & References

- Book: Dynamical Process On Complex Networks, Barrat et al.
- Book: Networks, an Introduction M.E.J. Newman,
- Book: Network Science, A.L. Barabási.
- Book: Graph Theory with Applications, J.A. Bondy and U.S.R. Murty.
- Book: Introduction to Algorithms, Cormen et al.
- Book: Graph Theory, R. Diestel.
- Blerina Sinaimeri lecture notes