



UNIVERSITÀ
DI TORINO

Analisi e Visualizzazione delle Reti Complesse

Final Project

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Scope

- The objective of the final project is to let the students play with a **real-world dataset** applying the **theoretical concepts** and the **practical tools** we have introduced in class.
 - and perhaps exploring something new in autonomy!
- After selecting a topic and datasets, the goal is to present a **narrative through quantitative exploration**.
- The dataset should allow the formalization of the problem using **networks**.
 - networks have to be present, however, other types such as geographical data may also be included.
 - when applicable, it is recommended to explore heterogeneous contexts.
- **[9 credits]** The narrative should contain a **visual exploration** of the domain and the results should be represented in a **data visualization**.
 - **interactive** vs **static**
 - **same domain** vs **different domain**

Organization

- The project can be developed in **groups of maximum 3 students**.
- You have to **register** your project at [this link](#) to specify the group and the topic.
 - **deadline: the end of the course.**
- Groups and topics *should not* be changed after the registration.
 - of course, this could happen for many unpredictable reasons, so in this case, please, reach out and we will find an alternative solution.
- Groups and topics will be presented in the last class of the course. You will be asked to:
 - Prepare a short presentation (5min-8min) explaining the idea and the datasets you intend to use
 - Present to the class your project
 - Receive feedbacks
 - more info will be shared towards the end of the course

What to submit

- A **report** describing the project and its contributions. Generally, it should contain the following sections:
 - Introduction and contextualization
 - What is your project about and why it is worth exploring it
 - Methods
 - What methods did you implement in the analysis and visualization pipelines
 - Results
 - What are the main results and observations you extracted from your analysis
 - Discussion
 - Elaborate on the possible implications of your observations, or why you made some methodological choices over other available alternatives, explore alternative scenarios
 - Conclusions and extensions
 - What did you learn and how this could be extended if you have time?
- This organization is arbitrary and serves as a template to simplify your work.
 - **You are free to use your own structure!**
- We expect **concise yet complete** reports.

What to submit

- The **code** implementing:
 - (a) the network analysis
 - (b) the visualization
- Depending of the type of project it be in the form of:
 - a series of Jupyter notebooks
 - an interactive web app
 - an Observable notebook
 - combinations of them
 - others
- All the material should be packed in an archive and submitted through Moodle **at least 3 days before the exam session.**
- The link will be active at the end of the course.



General rule (probably the most important!)

If you have **any doubt** reach out and we can discuss alternatives that **fit best your case study and project**.

Exam

- The exam is organized in two main parts:
 - **project discussion (40%)**
 - **oral examination (60%)**
 - and remember the 10% bonus for the active participation in class
- **Project discussion:**
 - the group/student presents the project usually with the help of a presentation
 - the presentation is not mandatory, however, it is usually useful to organize the discourse
 - the goal is to show what has been done, the results, the methodology, run a demo if you created an interactive data viz and so on.
 - questions on anything related to the project, the submitted report, the code, will be asked.
 - **all the member of a group must discuss the project in the same session.**
 - Only in specific, motivated cases we can break this rule.

Exam

- **Oral:**
 - the oral part of the exam will test your knowledge of **all the concepts introduced in course**.
 - everything we discussed that has not be marked as optional is a potential candidate for a question.
 - it is possible that a question involves the solution of a **simple exercise** involving theory constructs.
 - a theory question could be practical, e.g., given this networks, compute the betweenness centrality of the nodes
 - each student in a group will be evaluated separately
 - you should expect around 3 questions per candidate
 - this is just an **estimate**, there will be variability

What you can focus on?

- Generic description of the network. Calculate structural measures and plot them whenever it is possible/significant:
 - Distances: average, distribution
 - Degree: average, variance/standard deviation, degree distribution (some fit? Does it follow a power law? If yes, is it in the scale-free regime?)
 - Clustering coefficient
 - Largest connected component size
 - Degree correlation: neutral, assortative, disassortative?
 - Are there communities? Can you properly show them with an appropriate layout? Can you discuss them?
 - Centralities
 - Can you analyze homophily?
- Try to interpret the results of these measures, and comment/discuss results.

What can you focus on?

- Dynamics:
- Once you have studied your network, and you have a general understanding of its structure, you can use it to simulate some dynamic processes, e.g.:
 - Behavioral cascades
 - Diffusion of innovations
 - Epidemics
 - ...
- What could you expect to happen over that network when some of these models is simulated?

What can you focus on?

- Generative models:
 - You might need to create your own artificial random networks for comparison purposes
 - Erdos-Renyi
 - Watts-Strogatz (small-world)
 - Configuration model (degree preserving)
 - Barabasi-Albert (preferential attachment)
 - Stochastic bloc model
- You can use different generative models, to produce comparisons, varying some parameters (e.g., linking probability, number of edges added at each step, degree distributions, and so on)
 - For some comparisons, you may need to preserve some characteristics (e.g., degree distribution). Try to rewire properly your network in order to shuffle your data.
- You can perform on such synthetic networks the analysis that has been proposed in the previous slides, to detect differences
- Try to explain different behaviors

Datasets

- [Stanford Large Network Dataset Collection](#)
- [The KONECT project](#)
- More into the data visualization side:
 - [Awesome public datasets](#)
 - [Kaggle datasets](#)
 - [FiveThirtyEight Datasets](#)
 - [data.gov](#)
 - [AWS Public Data Sets](#)
 - [r/datasets](#)
 - [Google BigQuery Public Datasets](#)



Inspiration for projects

- [MIT course on Networks \(2018\)](#)
- [Network Science course - Ilya Makarov \(2020\)](#)
- [More on the data viz side but still useful - YY Ahn \(2023\)](#)

Q & A 