IT University of Copenhagen

Software Architecture

Session #11

Reconstruction (II): Abstraction

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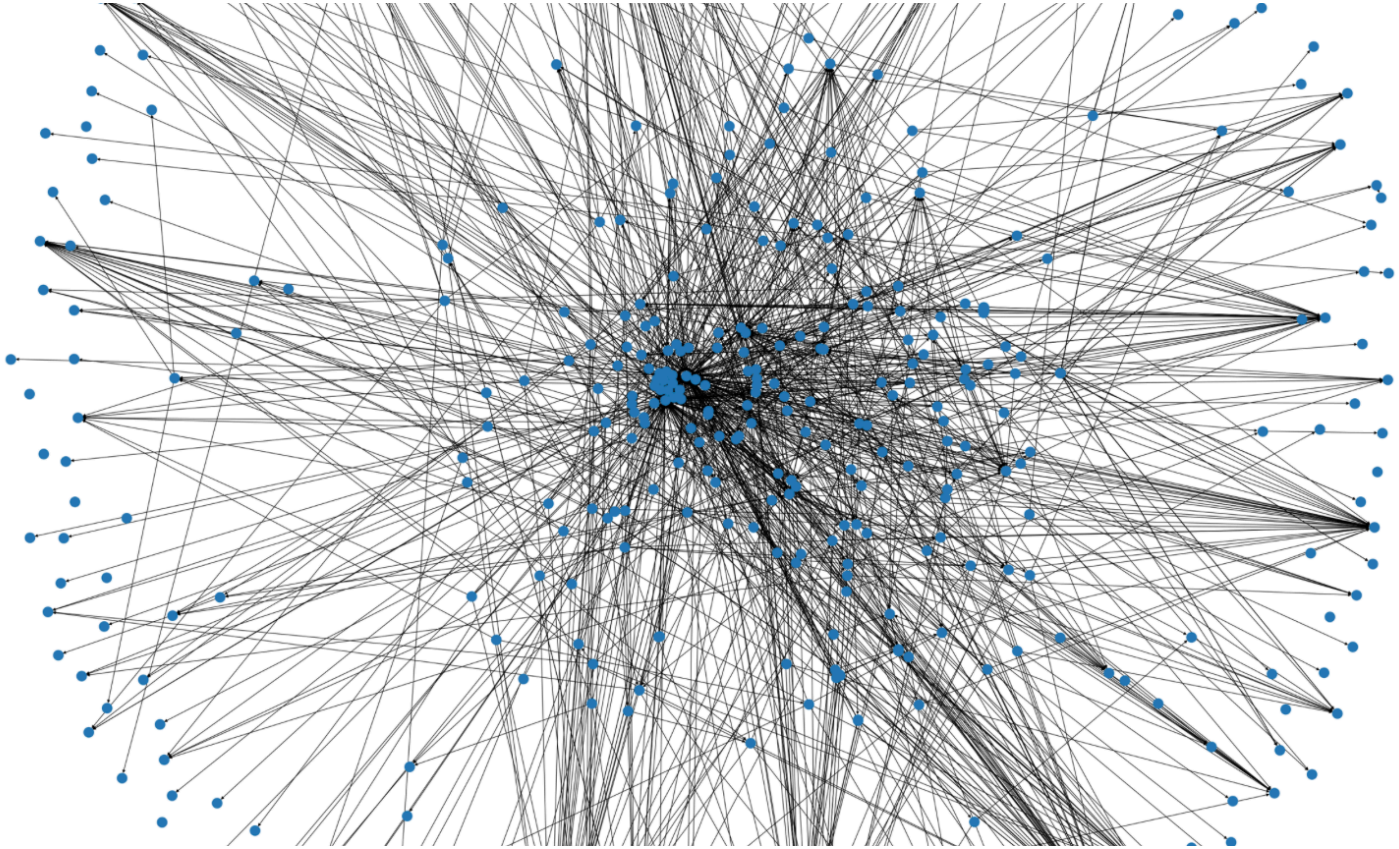
github.com/mircealungu/reconstruction

The *source view* obtained last time



- **System**: Zeeguu-API
- **Source View**: Modules & Dependencies
- **Entities**: .py files in the project
- **Relationships**: import statements between .py files

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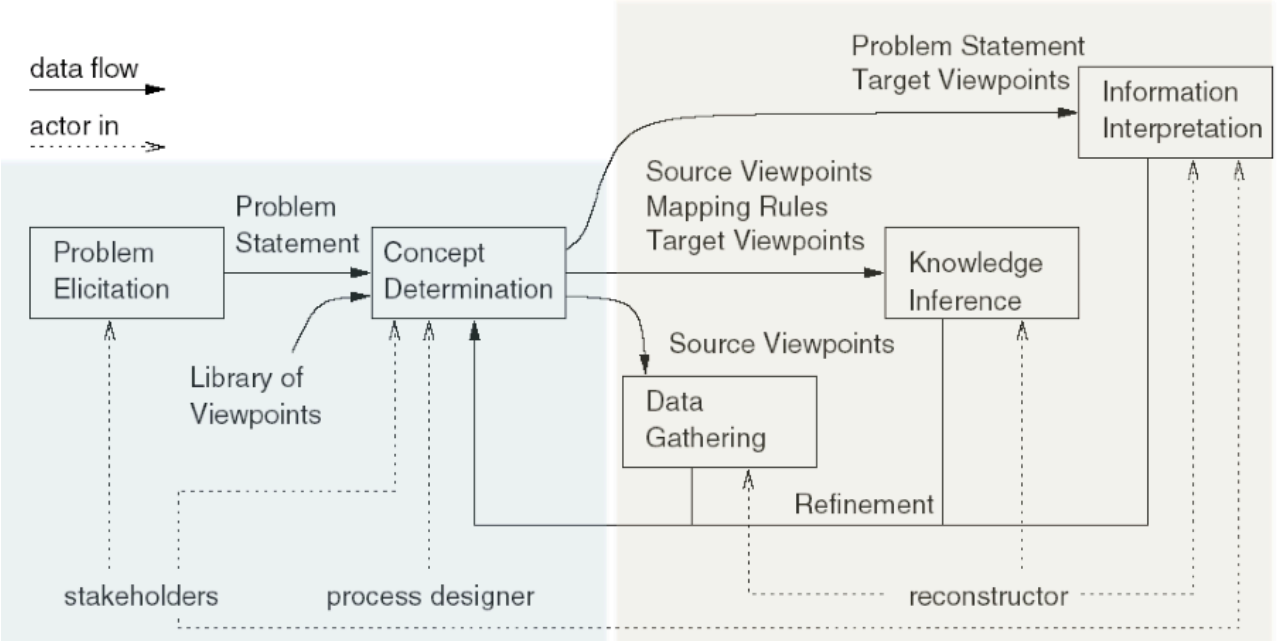
What else can we do here to simplify?

Knowledge Inference / Abstraction

Symphony... (Sec. 6.2): "The reconstructor creates the target view by ...

- **condensing the low-level details** of the source view, and
- **abstracting them** into architectural information.



"[...] domain knowledge is used to **define a map between the source and target view**."

Approach #1: Mapping Using Naming Conventions

[..] **if the mapping contains a rule about using naming conventions to combine classes into modules**, the resulting map lists each class and the module to which it belongs."

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Case Study: **Software Reflexion Models: Bridging the Gap between Design and Implementation**, *Murphy et al.*

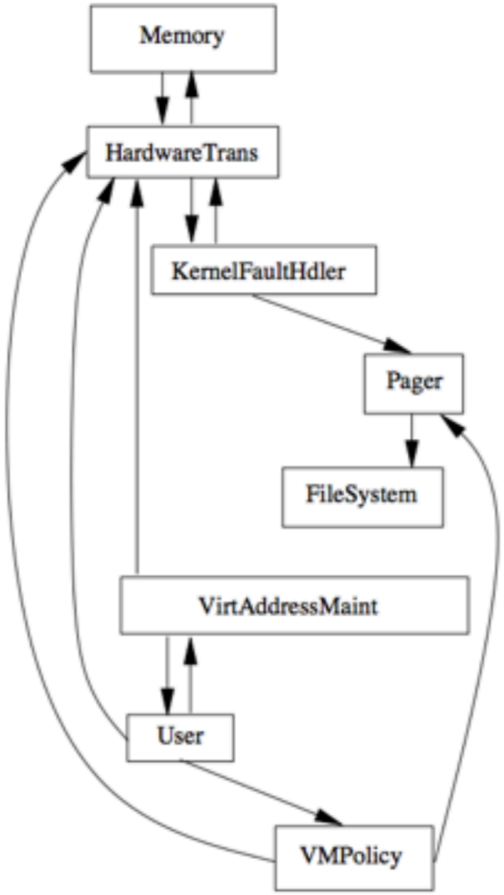
- Ask Linux maintainers to

  1. draw dependencies between subsystems (*as-expected* architecture)
  2. provide mappings from file names to subsystems

- Recover the *as-implemented module view*

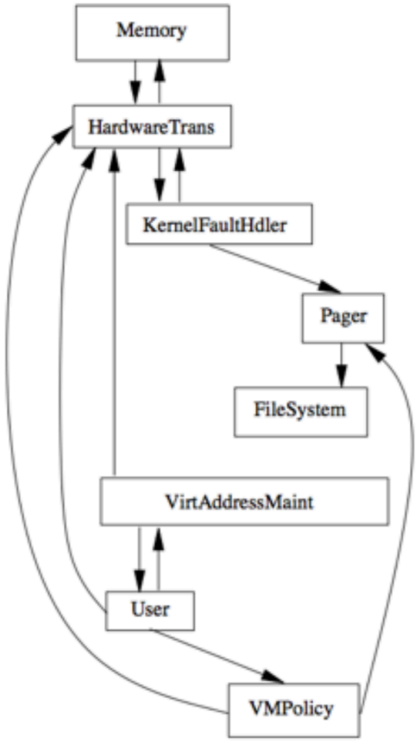
- Compare the *as-implemented* architecture with the *as-expected* architecture

Step 1.a. Maintainers draw dependencies between subsystems



From: Software Reflexion Models: Bridging the Gap ...

Step 1.b. Maintainers provide mappings from file names to subsystems



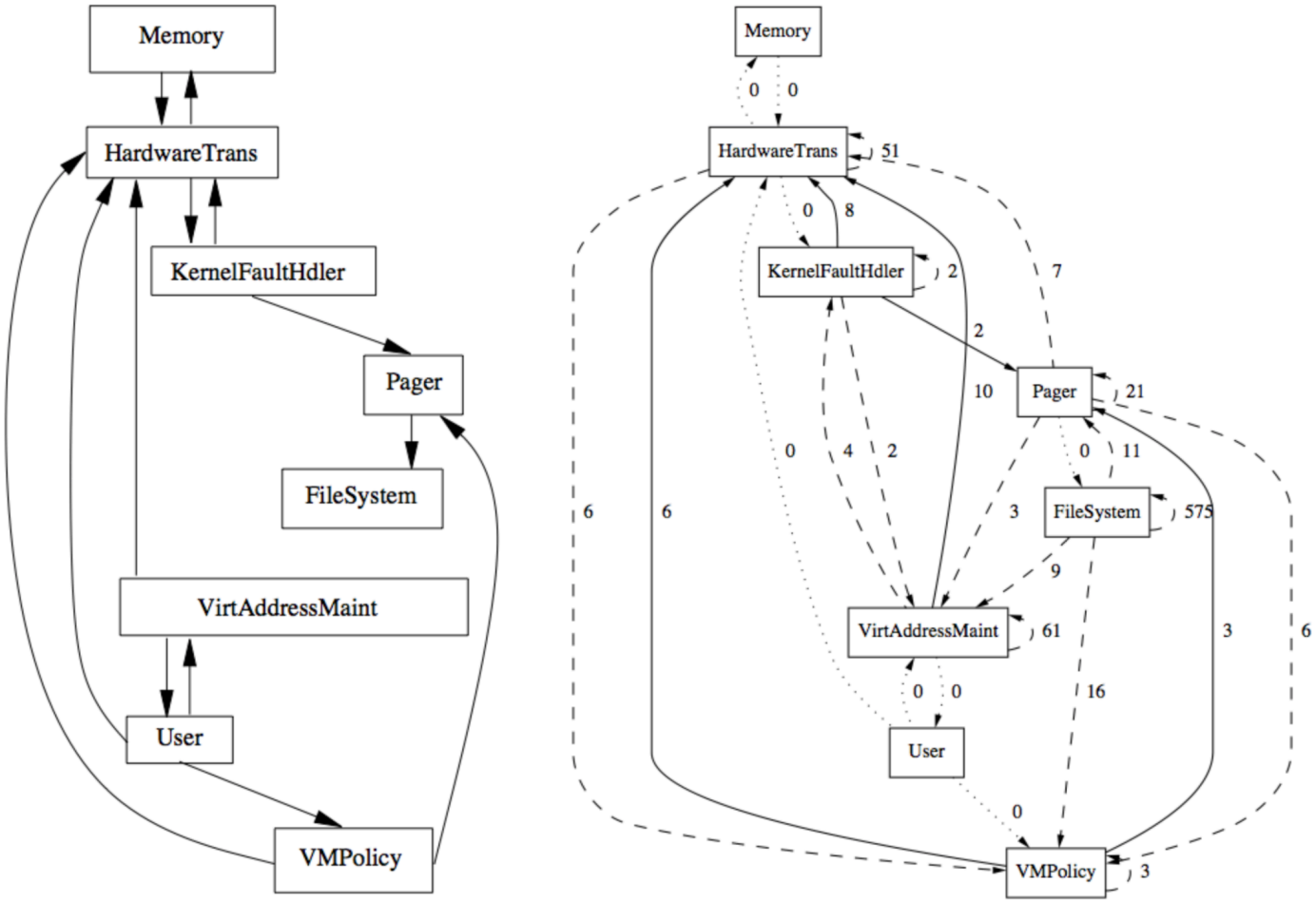
The Mapping

```
file= .*pager.*        mapTo=Pager
file= vm_map.*         mapTo=VirtAddressMaint
file=vm_fault\.c       mapTo=KernelFaultHandler
dir=[un]fs             mapTo=FileSystem
dir=sparc/mem.*]       mapTo=Memory
file=pmap.*            mapTo=HardwareTrans
file=vm_pageout\.c     mapTo=VMPolicy
```

Provided by the developers

From: Software Reflexion Models: Bridging the Gap…

Step 2. Comparing the As-Implemented and the As-Expected Dependencies



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Reflexion Model

= an architectural viewpoint that indicates **where the source model and high-level model differ**

1. Convergences
2. Divergences
3. Absences

Obtaining it is an **iterative process**

```
Repeat
1. Define/Update high-level model of interest
2. Extract a source model
3. Define/Update declarative mapping between high- level model and source model
4. Reflexion model computed by system
5. Interpret the software reflexion model.
Until “happy”
```

From: Software Reflexion Models: Bridging the Gap ...

Approach #2: Using the Folder Hierarchy for Aggregation

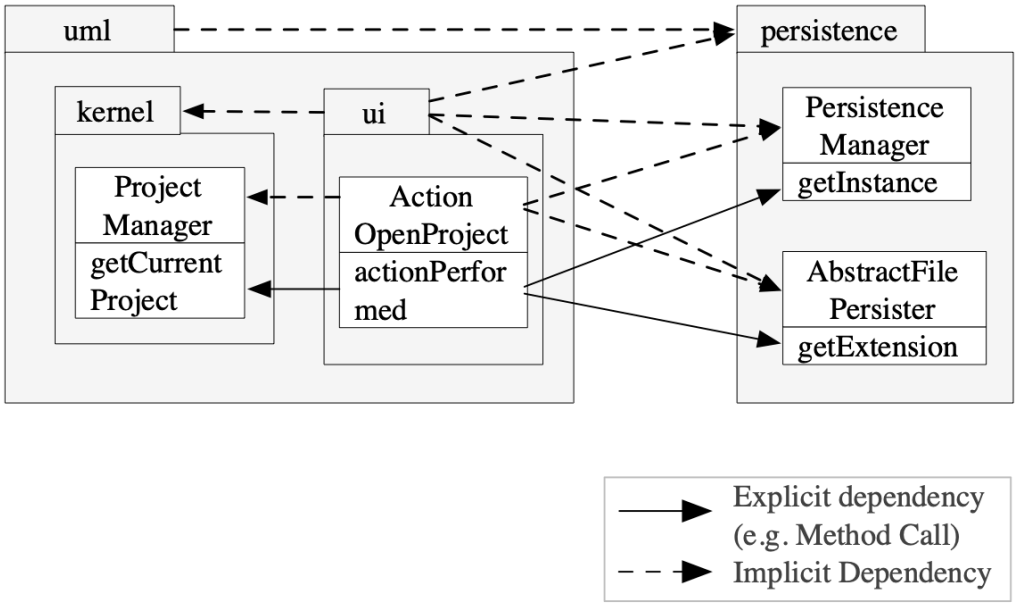
Developers hierarchically organize files in folders. *Let us use that!*

1. Aggregate nodes
2. Aggregate dependencies
3. Show the aggregated dependencies & nodes

Advantages

1. Works for most languages & most systems!
2. Can be used in a MSc thesis :) (e.g. topic1, topic2)

Approach #2 - Example from ArgoUML



Two types of dependencies:

1. Explicit
2. Implicit

From: Evolutionary and Collaborative Software Architecture Recovery with Softwarenaut, by Lungu et al.

Approach #2 - Basic Implementation in Python

👨‍💻 Code: Basic Abstraction

Complementary Tool: Software Metrics

A software metric is a **measure of software characteristics** which are measurable or countable

Types of metrics:

1. Product - measure the resulting product, e.g. source code
2. Process - measure the process, e.g. frequency of change

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Remember the def of architecture: **"[...] modules, their properties, and the relationships between them"**

A: Metrics can express these "properties".

Product metrics

For **Files/Methods**

- **Cyclomatic Complexity** (aggregated from file level)
  - CYCLO - Cyclomatic Complexity (wiki)
    - number of linearly independent code paths through source code (functions of the number of branches)
    - often used in quality: too much complexity is a bad thing
    - hidden partially by polymorphism

For **Modules**

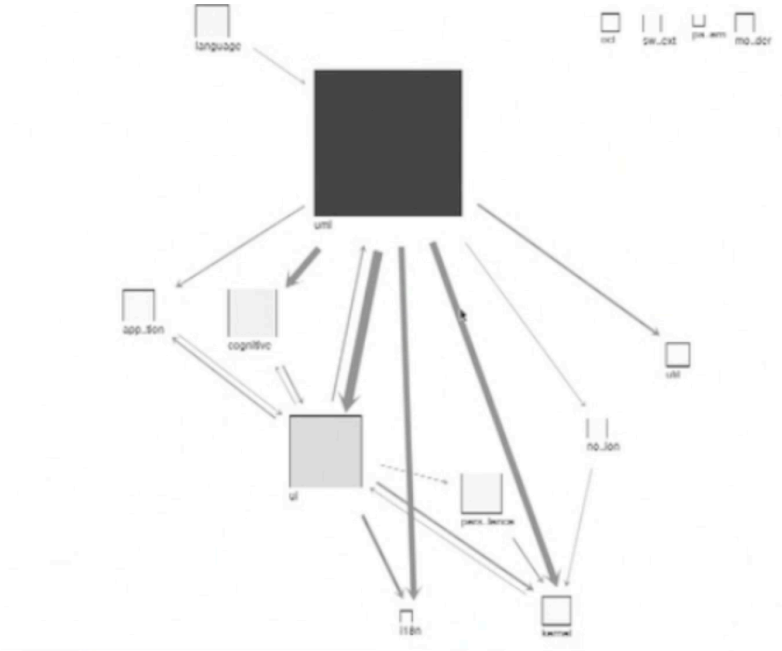
- **Size** (Aggregated from file level)
  - LOC - lines of code
  - NOM - number of methods

For **Dependencies**

- **Total count** of explicit low-level dependencies
- **Number of distinct** explicit low-level dependencies

Augmenting Recovered Views with Metrics

Useful in top-down interactive exploration, e.g. Softwarenaut (video, paper)



e.g., Augmeting nodes and dependencies with metrics in ArgoUML packages with a *polymetric view*

👨‍💻 Coding Assignment: Compute size metrics, and map them on the nodes in your module view at the end of the Abstraction notebook

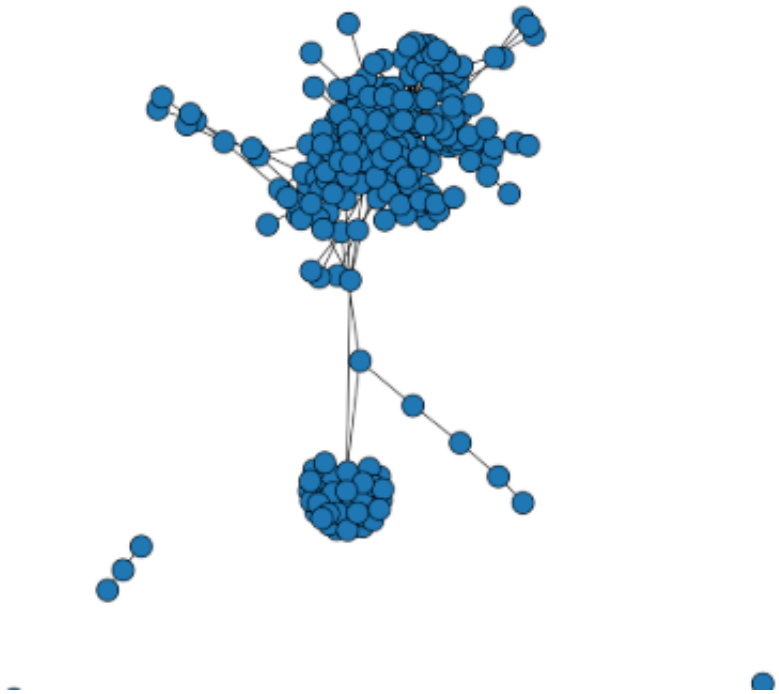
Approach #3 (research!): Keep Only the Most Essential Elements Based on Network Analysis

e.g. Paper: Ranking software artifacts. by Perin, Renggli, and Ressia

- Use the PageRank algorithm of Google
- Abstracts by filtering out the less relevant nodes

Consider trying it out in your project if you're interested in network analysis!

`networkx` supports various methods of network analysis, e.g. centrality, HITS, pagerank

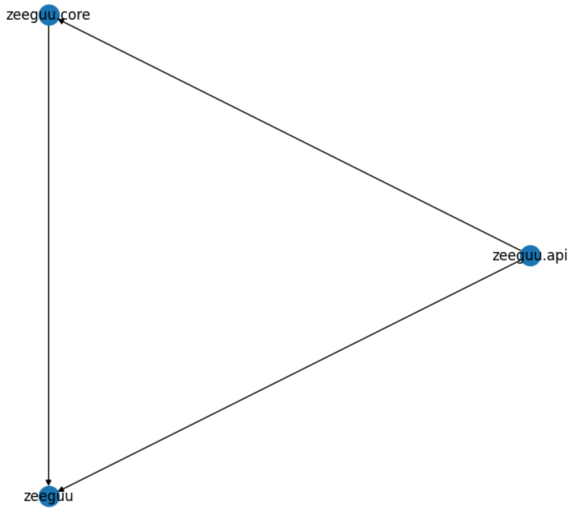


Importance of Dependencies

To tell a story we need subjects and actions

To tell the story of a module view we need

- subjects - the modules in the view
- actions - the meanings of the dependencies



In your project aim to describe also the reason for the dependencies (at least the most essential ones)

To Think About

- Mapping metrics on visualizations helps make sense of the data
- Semi-automatic (~*automation with human in the loop*) solutions are always required in Architecture Reconstruction
- The difference between the views recovered today and a hand-drawn UML diagram?
    - what we created today is always telling the truth (*live diagrams*)
    - but, **maybe not all the truth?**

Personalizing your Project

- Can you complete the implementation of the import extractor with the missing part?
- Can you visualize also dependency metrics with networkx? E.g. a stronger dependency as a thicker arrow?
- Consider using `pyvis` instead of `networkx` -- it has much nicer visualizations!
- Consider exporting the data from networkx into specialized graph visualization tools

To Do: start working on your project! Don't leave it all for the last moment!