

Multilayer Networks Activity

(30 points)

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As you will have to work in teams for the Team Research Project discussed in the syllabus, the first activity of this course provides the teams for the Team Research Project. That is, while learning about multilayer networks, you will produce a multilayer network of the current class, and identify a possible break-down into teams to complete the Team Research Project. This way, while you start to think of multilayer networks for the first time, you have an interest in listening to the various solutions since (1) you thought about the problem as the whole class has the same task, and (2) you will be affected by the created teams for the Team Research Project. Each group for the current project has 15 minutes to convince me that their proposed team breakdown (and reasoning for the team formation) should be the one I will adopt for the classroom.

Description: Research is a major component of this course. Since literature shows the best research is done in teams whose members have diverse backgrounds to integrate the research endeavor [4, 6], students are tasked to partition the class into two teams, so that each team can accomplish the research goals. I provide the class with the list of students in MA4404, and some attributes that help decide what relationships to add between the students. Such an example is shown in Table 1.

Goal: You are tasked with creating a multilayer network (each attribute is captured in a different layer) and partition the MA4404 class into research teams. Ideally, members should complement each other based on the given attributes, and additional information can be collected. The goal is to minimize variability among performance of the teams, rather than to maximize the performance of one team.

Data: Table 1 presents sample data format used to create the class network, which could be augmented by other characteristics as the class sees useful. Each row represents a student, and each column captures the entry of that attribute.

Tasks:

- Describe the methodology of network creation: Identify nodes, edges, and layers. Visualization is optional, use your creativity to explain the network.
- Describe the methodology of team assignment: Describe your methodology for team creation; identify what characteristics were most important in selecting individuals for teams and reasons why.

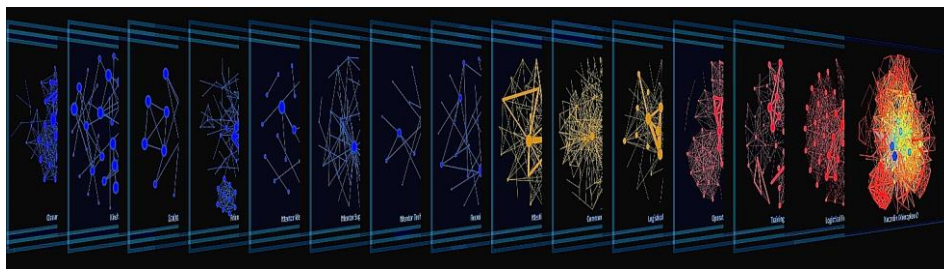
Table 1: Possible data for the Introduction to Networks Project

Name	Major (dual degree with)	Known coding language, Beginner (B) / Intermediate (I)/ Advanced (A)	Military Service	Graduating Month and Year	Other relevant skill(s)	Previous Partners
Student 1	MA	Python (B)	Army	June ' 17	Good speaker	Student, 1, 2
Student 2	CS	Python (A) and R (I)	Navy	Sep ' 17	Good writer	Student 4, 8
...	SE	None	Air Force	Dec ' 17	Visual	...
Student n	OR	R (A)	Marines	Sep ' 17	Detailed	...

- Describe the results: Present your team breakdown and argument(s) for why this distribution of talent meets the goals established for this project. Multiple solutions may be presented if needed.
- Present your conclusions and future work: What did you take away from this task? Provide other attributes you believe could inform these results and why those attributes matter.

An example of such network is shown in Figure 1, a comprehensive review (including temporal networks, networks of networks, interdependent networks) can be found in [2]. Visualization for multilayer networks can be obtained using Pymnet [5] found here <http://people.maths.ox.ac.uk/kivela/mln> library/, Muxviz [3] found here <http://muxviz.net/> or Gephi [1] found at <http://gephi.org/>.

Figure 1: An example of multiplex networks, where each layer captures a different relationships, such as friends, training, classmates, meetings, operations, and so on.



References

- [1] Mathieu Bastian, Sebastien Heymann, Mathieu Jacomy, et al. Gephi: an open source software for exploring and manipulating networks. *Icwsm*, 8:361 – 362, 2009.
- [2] Stefano Boccaletti, Ginestra Bianconi, Regino Criado, Charo I Del Genio, Jesús Gómez-Gardenes, Miguel Romance, Irene Sendina-Nadal, Zhen Wang, and Massimiliano Zanin. The structure and dynamics of multilayer networks. *Physics Reports*, 544(1):1 – 122, 2014.
- [3] Manlio De Domenico, Mason A Porter, and Alex Arenas. Muxviz: a tool for multilayer analysis and visualization of networks. *Journal of Complex Networks*, 3(2):159 – 176, 2015.
- [4] Martin Hoegl and Hans Georg Gemuenden. Teamwork quality and the success of innovative projects: A theoretical concept and empirical evidence. *Organization science*, 12(4):435 – 449, 2001.
- [5] Mikko Kivela. Multilayer networks library for python (pymnet).
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