

Network Science: Concepts and Applications

Homework 1

Objective

The student will explain the basic concepts including: definitions, characteristics and applications.

Instructions

Impact of Network Science

1. Divide the following application fields of Network Science. Each one, research about the Impact of Network Science in the selected field and its application¹:

Field
Technological Networks
Information Networks
Biological Networks
Social Networks
Others

In case of your team size is greater than 4, include additional fields.

Write a summary of your findings (half-page each without images). Additionally, it must include a similar table as the following with the information of **two** networks per assigned field.

Network	Nodes	Links	Directed/Indirected	Number of nodes (N)	Number of links (L)

Don't forget to include references to support your essay information. Include your references in IEEE citation format.

2. Write about a network you are personally interested in (One section per team member). Address the following questions:
 - (a) What are its nodes and links?

¹ Essay can be done in the proposed pairs, but the rest of the Homework must be completed individually.

- (b) How large is it?
 - (c) Can be mapped out? Why?
 - (d) Why do you care about it?
3. Make a brainstorm and answer, what would be the area where network science could have the biggest impact in the next decade? Explain your answer.

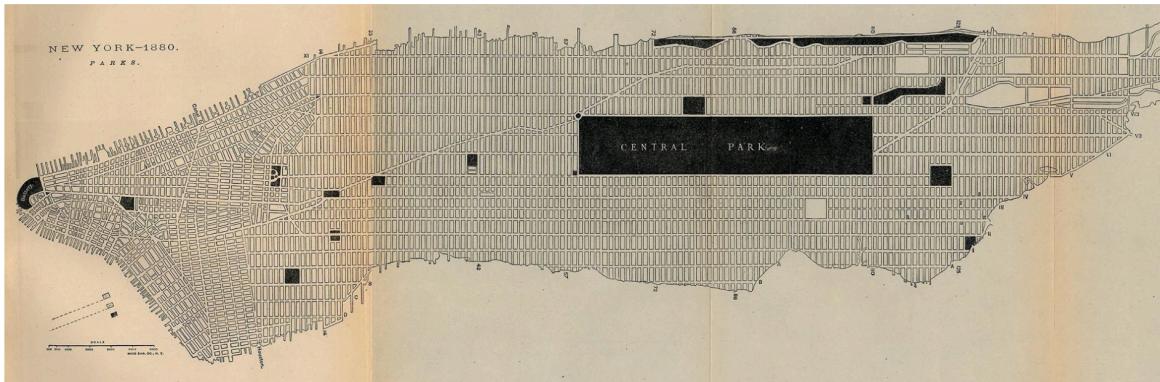
Social Media Networks

4. Discuss some methodologies that can address the grand challenges of Social Network Analysis:
- (a) Big Data Paradox.
 - (b) Obtaining Sufficient Samples.
 - (c) Noise Removal Fallacy.
 - (d) Evaluation Dilemma.

Write a summary of your findings.

5. What marketing opportunities do you think exist in Social Media? Can you outline an example of such an opportunity in given Social Network (Twitter, Facebook, Instagram, Tumblr)?

Network Analysis



Map of New York in 1880. From Report on the Social Statistics of Cities, Compiled by George E. Waring, Jr., United States Census Office, 1886. Image courtesy of University of Texas Libraries.

Figure 1

6. Consider the road map in Figure 1. If one were creating a network representation of traffic patterns, which of the following would be the best choice to make up the links



of the network? (Hint: your answer to the next question may inform your answer to this question, and vice-versa.)

- (a) Pedestrians traveling along the streets.
- (b) Road segments, e.g., 5th Ave. between 12th and 13th streets.
- (c) Entire roads, e.g., 5th Ave.
- (d) Vehicles traveling on the roads.

Justify your answer.

7. Consider the road map in Figure 1. In the network representation of traffic patterns, which of the following would be the best choice to make up the nodes of the network? (Hint: your answer to the previous question may inform your answer to this question, and vice-versa.)

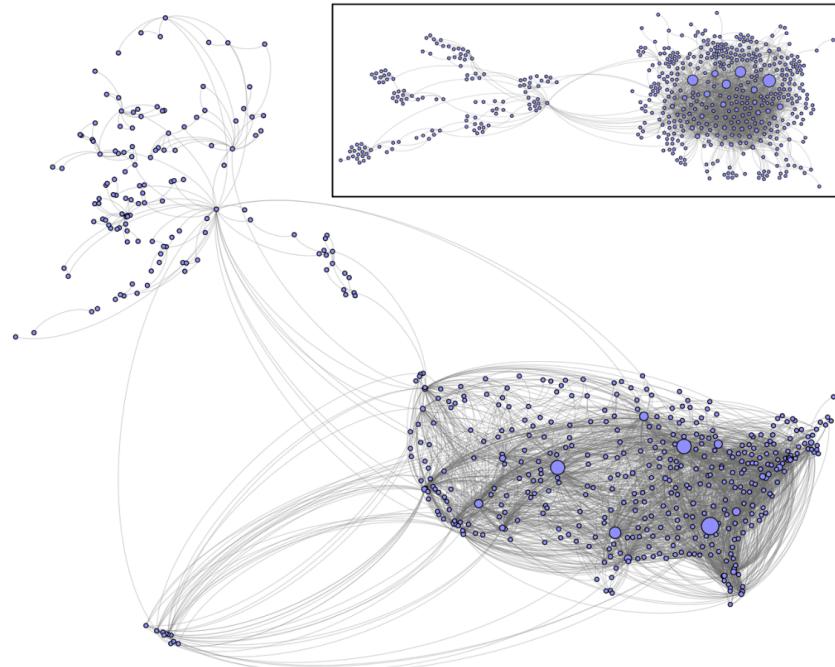
- (a) City blocks, e.g., the block between 5th-6th avenues and 12th-13th streets.
- (b) Street intersections, e.g., 5th Ave. and 12th St.
- (c) Pedestrians moving along the streets.
- (d) Vehicles traveling on the roads.

Justify your answer.

8. Compare the US air transportation network in Figure 2 with the Manhattan road map in Figure 1. The air transportation network displays a distinguishing feature that the Manhattan road network lacks. What is this key characteristic?

- (a) Singleton nodes with no links.
- (b) Multiple routes between nodes.
- (c) Nodes with more than one connected link.
- (d) Hub nodes with many links.

Justify your answers.



The US air transportation network (flight data from OpenFlights.org). Nodes are positioned according to the geographic coordinates of the corresponding airports, so that we can make out the shape of the continental United States, Alaska, and Hawaii. Note that the map projection makes Alaska appear bigger than its actual size due to its latitude. The airport hubs with most connections (e.g., Atlanta, Chicago, Denver) are clearly recognizable. The inset maps the same network, but with a different "force-directed" layout, discussed in Section 1.10.

Figure 2.



Homework Submission

Submit your Homework as a unique PDF document.

Deadline

- May 17th, 2021 at 23:59 hrs.

Recommended Books

- Newman (2018) Networks. The empirical study of Networks. UK: Oxford University Press.
- Barabási (2016) Network Science. USA.
- Menczer, Fortunato and Davis (2020) A First Course in Network Science.

Grading Scheme

Rubric

Results	Excellent	Good	Fair	Needs Improvement
Essay				
Essay is logically organized and well-structured.	10 pts	7.5 pts	5.0 pts	2.5 pts
Information is properly cited.	5.0 pts	3.75 pts	2.5 pts	1.25 pts
The student describes the importance of Network Science in the assigned field.	20 pts	15 pts	10 pts	5 pts
The student includes applications of Network Science in the assigned field.	20 pts	15 pts	10 pts	5 pts

Check list

	✓	X
Question 2	10 pts	
Description		
Nodes and links		
Size		
Mapping (Answer and Justification).		
Importance		
Question 3	5 pts	
Question 4	10 pts	
Challenge 1		
Challenge 2		
Challenge 3		
Challenge 4		
Question 5	5 pts	
Question 6	5 pts	
Question 7	5 pts	
Question 8	5 pts	

*Partial credit can be assigned to each question if the answer is too general or not well supported (as necessary).