

Network Analysis

AN INTRODUCTION FOR HUMANISTS

Dr Katarzyna Anna Kapitan
30 January 2025

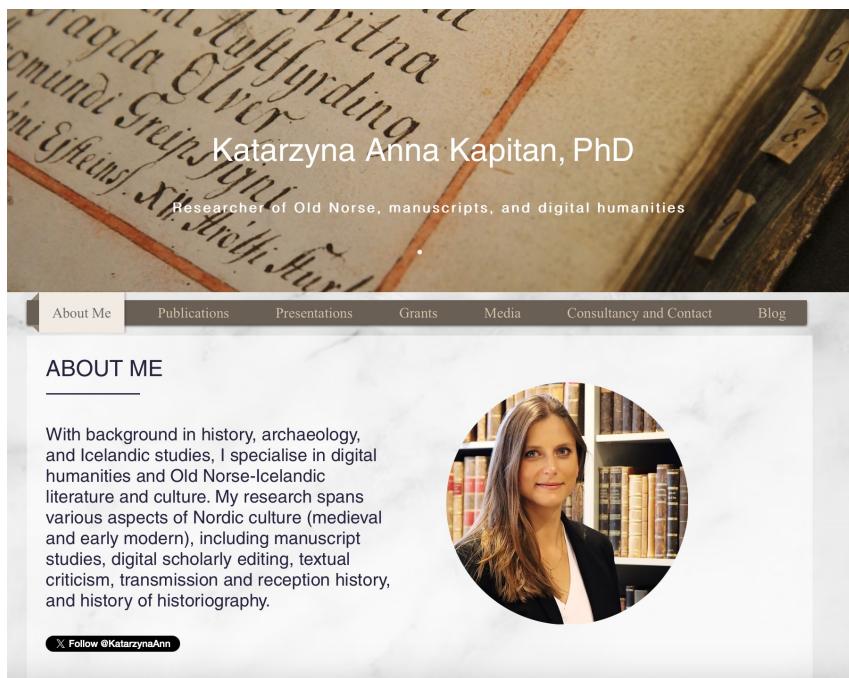
Katarzyna Anna Kapitan, Network Analysis for Humanists,
Paris 2025

Time: Thursdays, 13:00-16:00*

Place: 65 Rue de Richelieu, 75002 Paris

* 13 February: 14:00–17:00

Teacher: Dr Katarzyna Anna Kapitan



The screenshot shows the homepage of Dr. Katarzyna Anna Kapitan's website. At the top, there is a dark purple header with the title "Teacher: Dr Katarzyna Anna Kapitan". Below the header, there is a large image of an open medieval manuscript with Old Norse text. Overlaid on the manuscript image is the text "Katarzyna Anna Kapitan, PhD" and "Researcher of Old Norse, manuscripts, and digital humanities". Below the image is a navigation bar with links: "About Me" (which is highlighted in a light gray box), "Publications", "Presentations", "Grants", "Media", "Consultancy and Contact", and "Blog". Under the "About Me" section, there is a heading "ABOUT ME" followed by a short biography: "With background in history, archaeology, and Icelandic studies, I specialise in digital humanities and Old Norse-Icelandic literature and culture. My research spans various aspects of Nordic culture (medieval and early modern), including manuscript studies, digital scholarly editing, textual criticism, transmission and reception history, and history of historiography." To the right of the biography is a circular profile picture of Dr. Kapitan, a woman with long blonde hair, wearing a black blazer over a white shirt, standing in front of a bookshelf filled with books. At the bottom of the page, there is a small link "Follow @KatarzynaAnn" with a Twitter icon.

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0000-0003-2763-0056

Introductions: Present Your Neighbour

- ▶ Name
- ▶ Current study programme
- ▶ Previous studies
- ▶ Research Interests
- ▶ Free-time activities
- ▶ Why did they choose this course?
- ▶ What are their expectations for this course?

- ▶ This course provides an introduction to network analysis, specifically designed for humanities students.
- ▶ Network analysis offers powerful methods for examining relationships, connections, and structures within cultural, historical, and literary contexts. The course covers both the theoretical foundations of network science and the practical application of network analysis and visualisation tools in humanities research.
- ▶ Students will explore key concepts and methodologies while gaining hands-on experience in mapping social networks in historical archives, analysing character relationships in literature, and tracing intellectual networks in scholarly communication.

- ▶ The course consists of eight sessions, each including a **lecture**, a **seminar**, and a **hands-on session**. Lectures introduce fundamental concepts and methods, while seminars encourage critical engagement with research projects applying network analysis to different types of humanities data. Hands-on sessions provide practical training with tools, such as Gephi and Python libraries for network analysis.
- ▶ By the end of the course, students will be able to critically evaluate network-based approaches, apply network analysis techniques to their research, and interpret visualisations and metrics in meaningful ways.

Core Textbooks

- ▶ Filippo Menczer, Santo Fortunato, Clayton A. Davis, *A First Course in Network Science*, version 3 (Cambridge University Press 2023).
- ▶ Albert-László Barabási, *Network Science* (Cambridge University Press, 2016).
- ▶ Folgert Karsdorp, Mike Kestemont, Allen Riddell, *Humanities Data Analysis: Case Studies with Python* (Princeton University Press, 2021)
- ▶ William Mattingly, *Introduction to Python for Digital Humanities* (2022).

	Date	Lectures
1	30 January	Introduction to Network Thinking
2	6 February	Understanding Network Elements
3	13 February	Small Worlds and Connectivity
4	20 February	Hubs and Influential Nodes
5	13 March	Direction, Weights, and Meaning
6	20 March	Modelling Networks
7	27 March	Identifying Communities
8	3 April	Network Dynamics and Change Over Time

Assessment

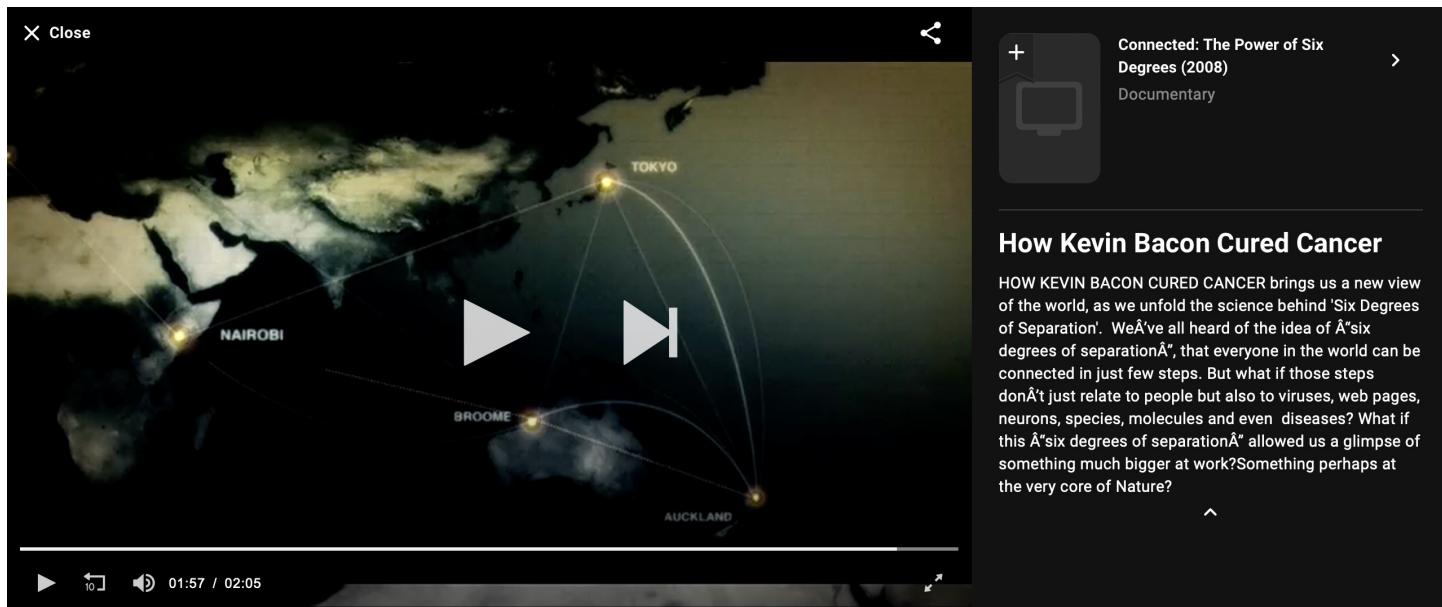
- ▶ Attendance and active participation – 20%
- ▶ Article-review (in-class presentation & written submission) – 30%
- ▶ Final project (in-class project presentation & digital asset submission) – 50%

- ▶ Note: In order to pass the class you need to pass all three grading components (Attendance, Article-review, and Final Project).

Introduction to Network Thinking

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Connected: The Power of Six Degrees



YouTube: <https://www.youtube.com/watch?v=2rzxAyY7D7k>

IMDb: <https://www.imdb.com/title/tt1310375>

Network

- ▶ a complicated system of roads, lines, tubes, etc. that cross each other and are connected to each other
- ▶ a group or system of people or things that are connected to each
- ▶ a group of people who meet, exchange information, etc. for professional or social
- ▶ a number of computers and other devices that are connected together so that equipment and data can be shared

Source: Oxford Academic English Dictionary (<https://www.oxfordlearnersdictionaries.com>)

Networks

What types of networks do you know?

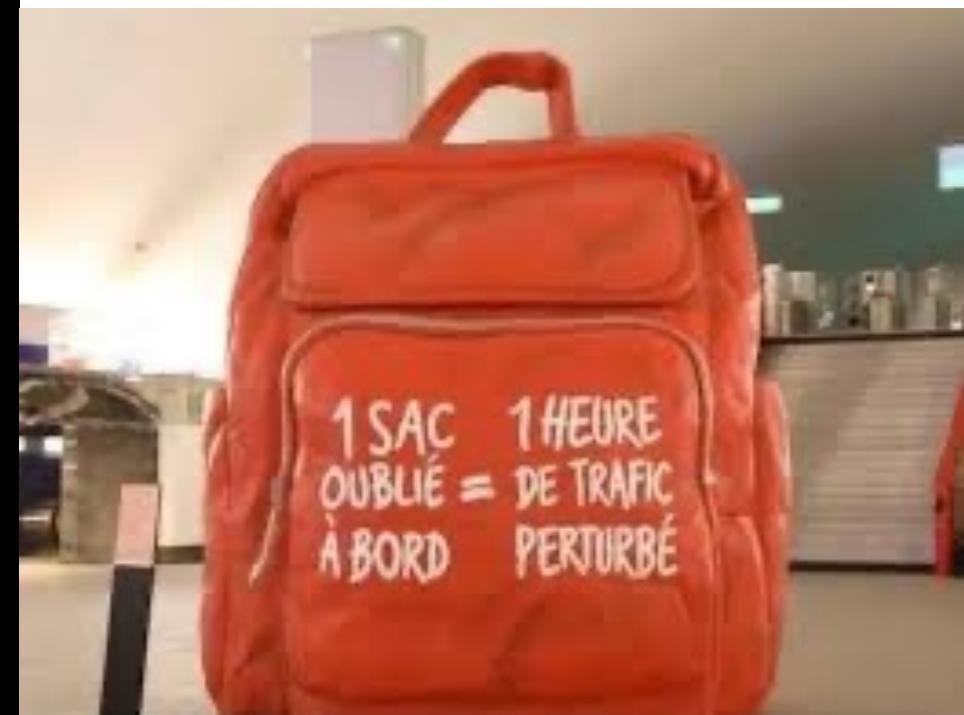
Networks

- ▶ Social networks
- ▶ Communication networks
- ▶ The power grid
- ▶ Trade networks
- ▶ Transportation networks
- ▶ Cellular network
- ▶ Neural network



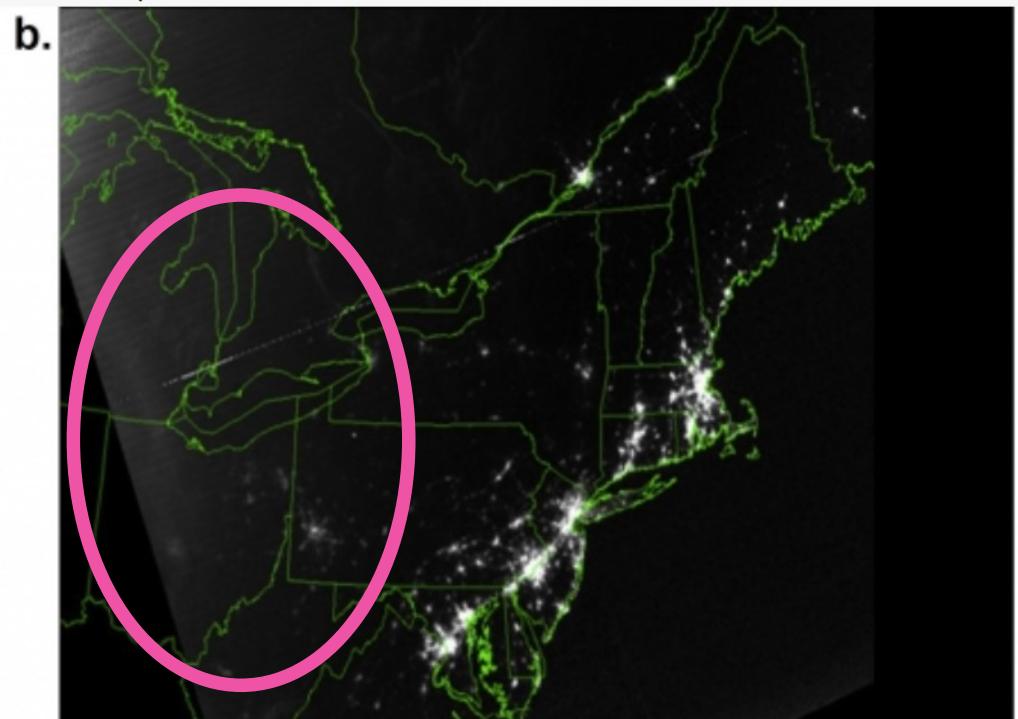
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Network of the metro system in Paris





Toronto, Detroit, Cleveland, Columbus

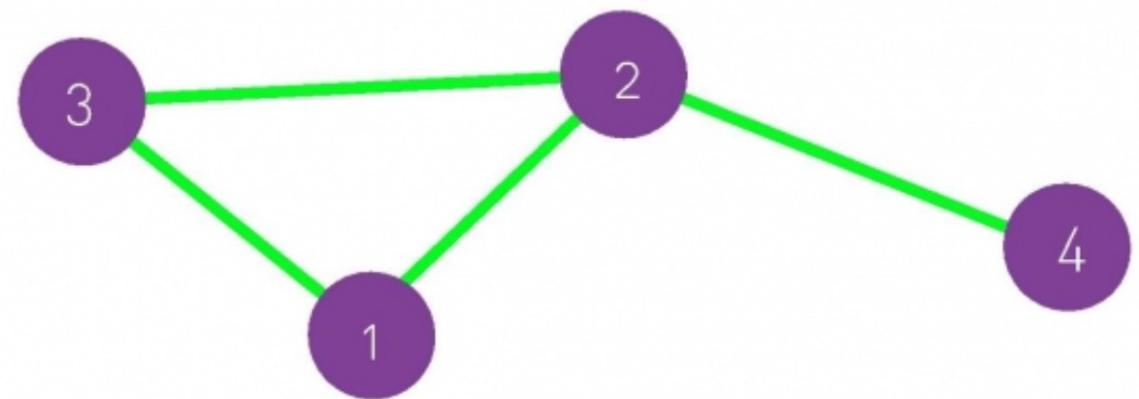
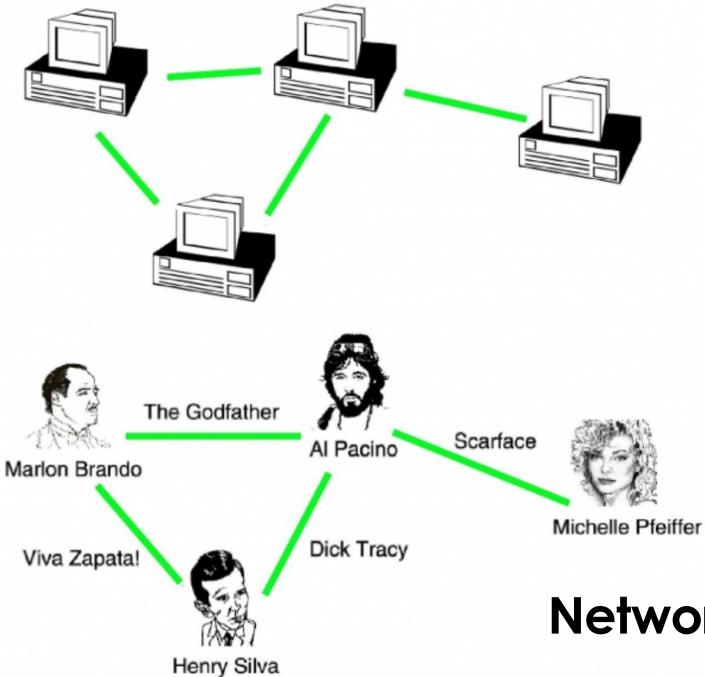


North American Blackout - 45 million people without power in USA and 10 million in Canada

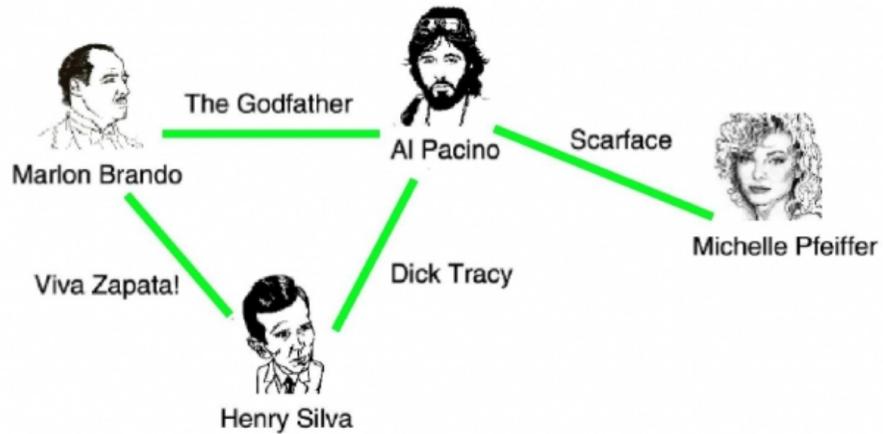
- a. Satellite Image of Northeast United States and Southeast Canada on 13 August 2003 at 9:29 pm
- b. The same but 5 hour later.

Source: Barabási, Network Science (<https://networksciencebook.com>)

Networks & Graphs



Networks & Graphs



N , represents the number of components in the system (number of nodes).

L , represents the total number of interactions between the nodes (number of links).

$$N = 4$$

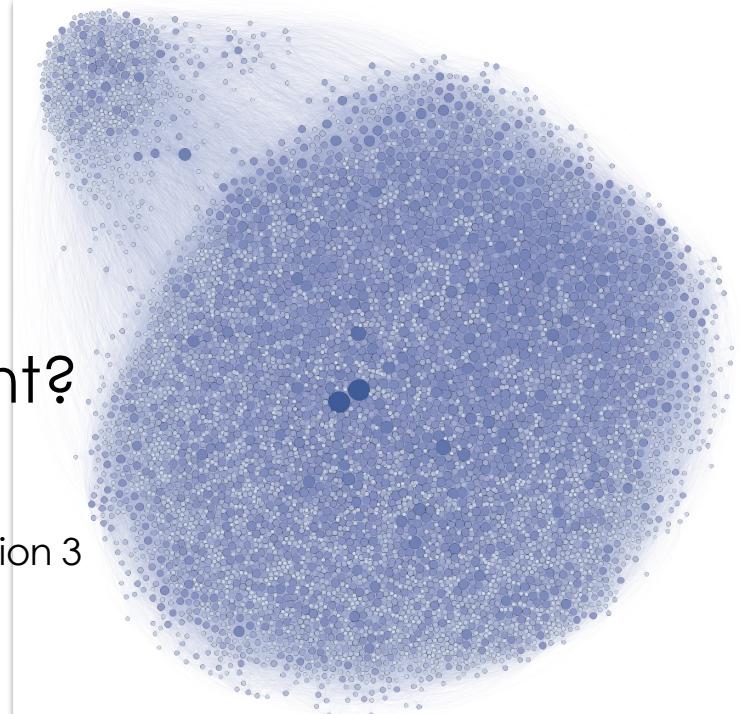
$$L = 4$$

Source: Barabási, Network Science
(<https://networksciencebook.com>)

Facebook Users @ Northwestern University

- ▶ What do nodes represent?
- ▶ What do links represent?
- ▶ What do the two groups might represent?

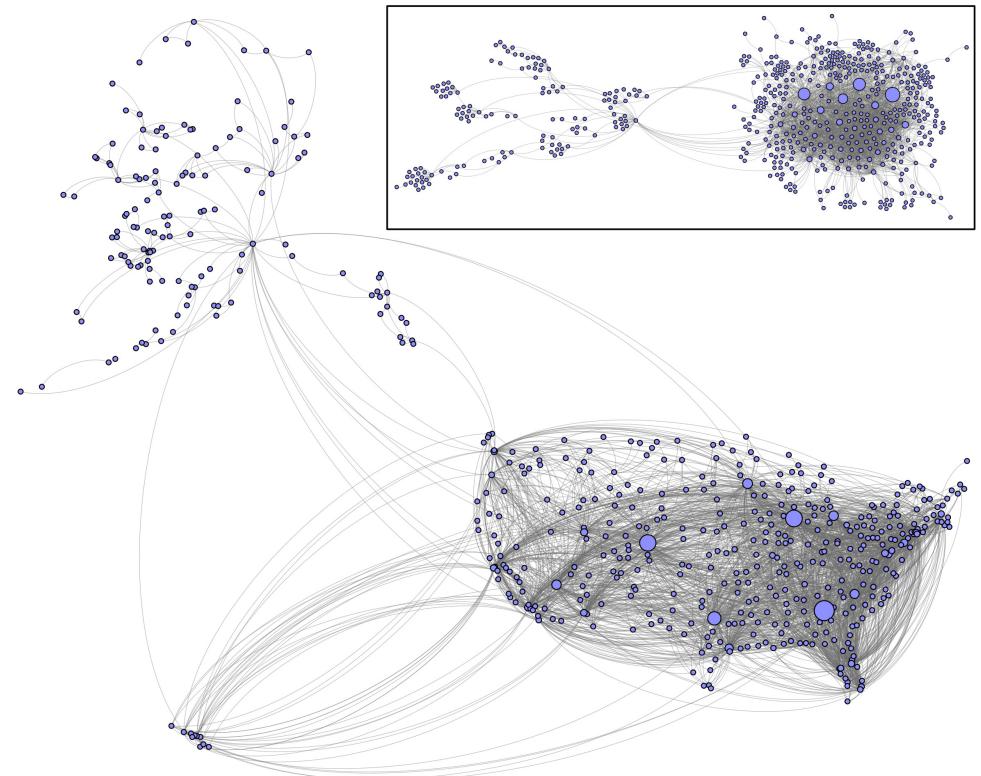
Source: Menczer, Fortunato, Davis, *A First Course in Network Science*, version 3 (Cambridge University Press 2023)



US Air Transportation Network

- ▶ What do nodes represent?
 - ▶ What do links represent?
 - ▶ What do the two layouts represent?
-
- ▶ **Source:** Menczer, Fortunato, Davis, *A First Course in Network Science*, version 3 (Cambridge University Press 2023).

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Network Science

- ▶ 'A key discovery of network science is that the architecture of networks emerging in various domains of science, nature, and technology are similar to each other, a consequence of being governed by the **same organizing principles**. Consequently, we can use a common set of mathematical tools to explore these systems'

Source: Barabási, Network Science (<https://networksciencebook.com>)

Network Science

- ▶ An academic field which studies complex networks such as telecommunication networks, computer networks, biological networks, cognitive and semantic networks, and social networks, considering distinct **elements** or actors [...] and the **connections** between the elements or actors...

Source: Wikipedia

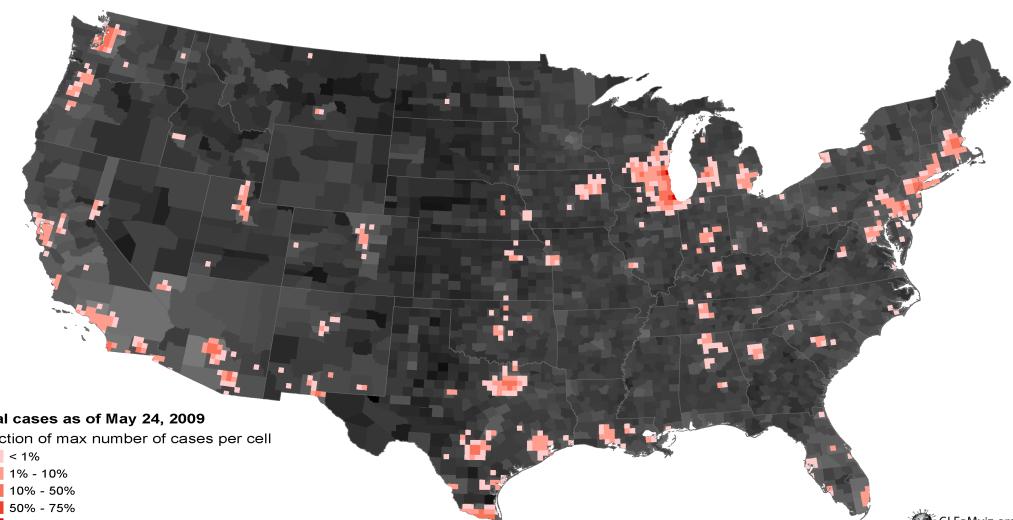
The Characteristics of Network Science

- ▶ Interdisciplinary
- ▶ Empirical and Data Driven
- ▶ Quantitative and Mathematical
- ▶ Computational

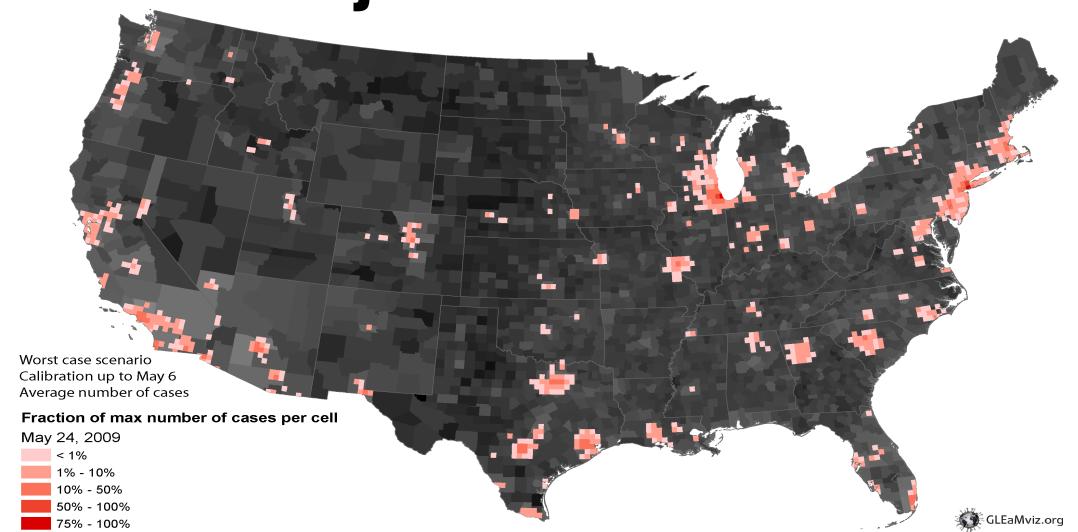
Source: Barabási, Network Science (<https://networksciencebook.com>)

Real Life Applications: Epidemics

Real



Projected



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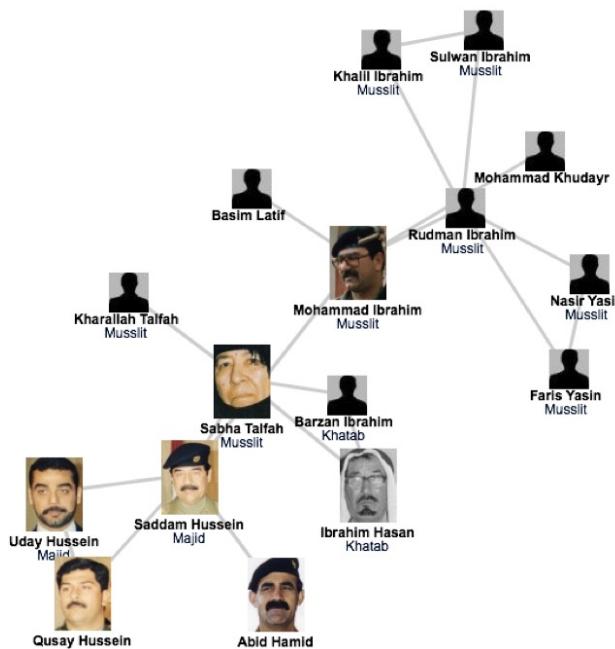
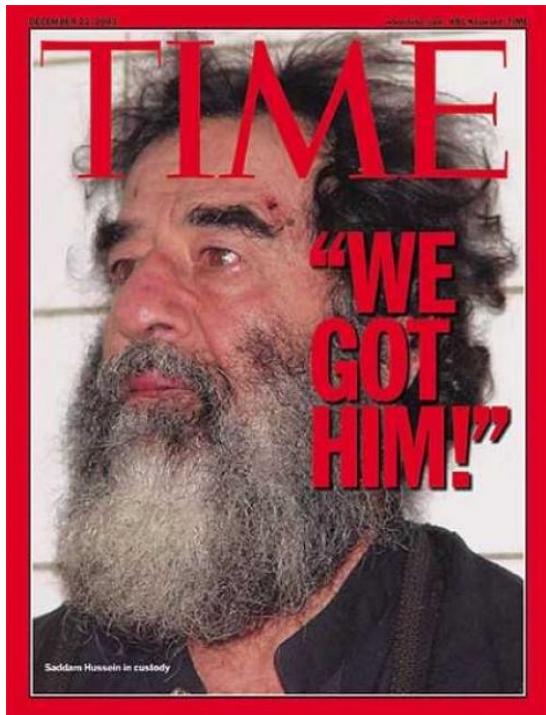
Source: Barabási, Network Science
(<https://networksciencebook.com>)

Real Life Applications: Management



Source: Barabási, Network Science
(<https://networksciencebook.com>)

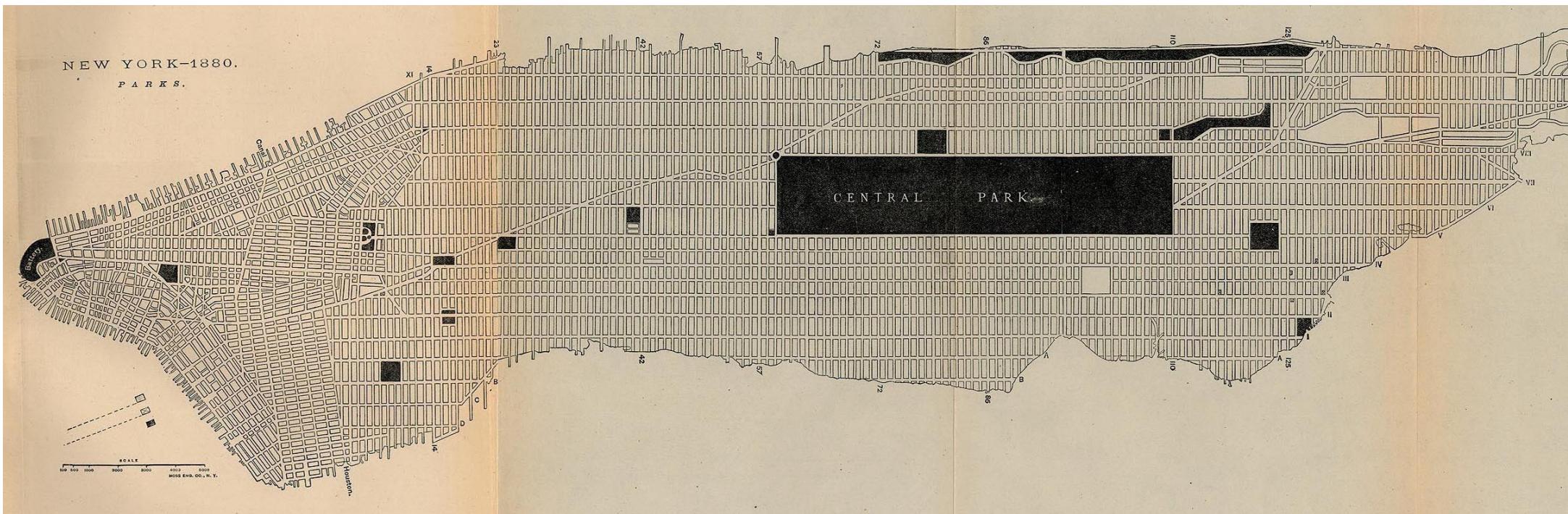
Real Life Applications: Security



Operation Red
Dawn
2003

Source: Barabási, Network Science
(<https://networksciencebook.com>)

What are the nodes and links of the network represented in this street map?



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.

Source: Menczer, Fortunato, Davis, *A First Course in Network Science*, version 3 (Cambridge University Press 2023)..

Seminar

Applications of Network Analysis in the Humanities



	Date	Seminars
1	30 January	Topic Selection
2	6 February	Networks & History
3	13 February	Networks & Literature
4	20 February	Networks & Scholarly Communication
5	13 March	Networks & Manuscript Studies
6	20 March	Networks & Linguistics
7	27 March	Networks & Social Relations
8	3 April	Project Presentations & Closing Discussion

Required Readings

- ▶ Each week **three** required readings
- ▶ Everyone prepares for a class discussion by **reading all three** of them before the class
- ▶ One person prepares a presentation on one of these three articles and leads a discussion on this article (Article Analysis)

Article Analysis - Task

- ▶ Choose one article from the seminar reading list.
- ▶ Read the entire article once without looking at the schema.
- ▶ Try to fill in the schema based on your first reading.
- ▶ Read the article again with the schema, analyse its contents, identify relevant passages.
- ▶ Fill in the schema by writing short answers to all 15 questions.
- ▶ Send the completed schema to Katarzyna (deadline: Tue, 23:59).
- ▶ Prepare a presentation on the article (min 10 and max 15 minutes) and present it in class. **Note:** I recommend using a slideshow to illustrate your presentation. You can time your presentation with slides in programs such as Keynote and PowerPoint.

Article Analysis – Schema

What is the purpose of the study?

- ▶ Write down the exact statement in which the authors describe their aim. Use quotation marks around the exact wording and indicate the page number.
- ▶ Describe the purpose of the study in your own words.
- ▶ What gap in scholarship were the authors trying to fill with their study?

What are the major findings of the study?

- ▶ Note down the major findings of the study. Use quotation marks around the exact wording and indicate the page number.
- ▶ Describe the findings in your own words.



How did the authors conduct their research?

- ▶ Briefly summarize and explain, in your own words, the methodology and the main steps the authors took to conduct their study. How is the data modelled and analysed.
- ▶ Describe the limitations of this approach as discussed by the authors.
- ▶ Is the data and/or code used in the study accessible? If not, is there explanation why?

How reliable are the results?

- ▶ Do the authors suggest any problems with the study that could lead to unreliable results?
- ▶ Do you see any problems with the results? Explain why or why not.

Based on your analysis, are the claims made in this article accurate?

- ▶ Do the conclusions drawn by the authors make sense to you? Are the conclusions too broad or too narrow based on what was actually done in the study?
- ▶ Based on the accuracy of the methodology and the reliability of the results as described above, do you think the conclusions can be trusted? Why?

What is the importance/relevance of this scientific work?

- ▶ Summarise, in your own words, the significant contributions of the work presented in this journal article, as reported by the authors.

How would you summarise this article?

- ▶ Write a one-sentence summary for each section of the article. They should form a cohesive paragraph.

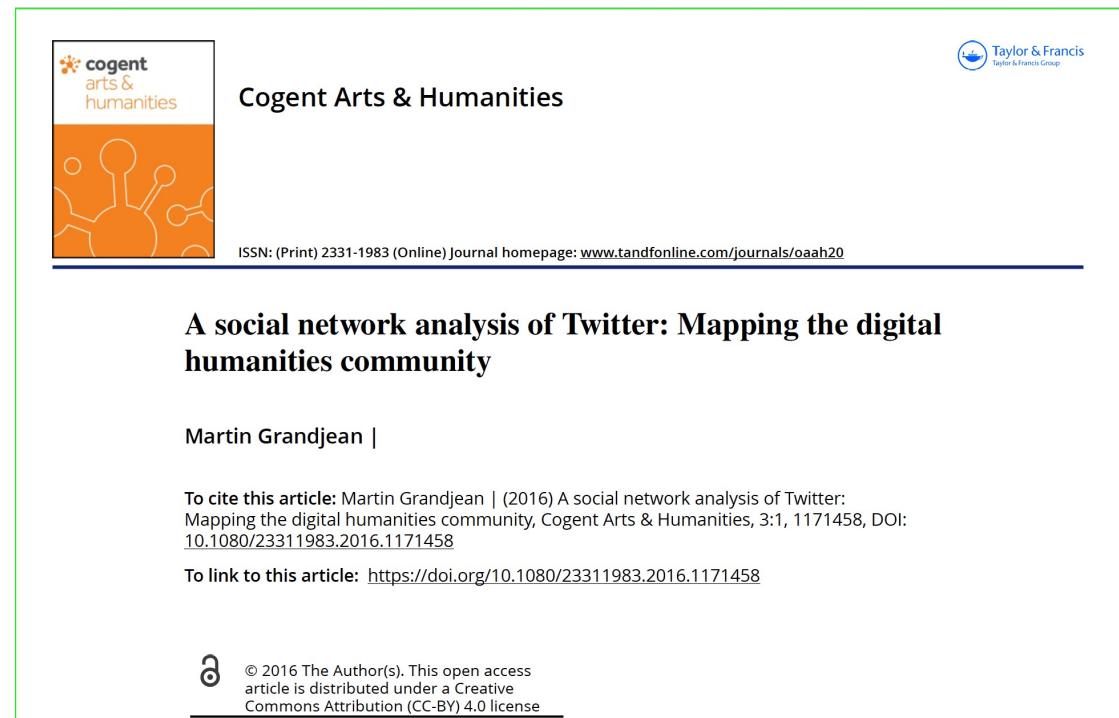
Which topics for discussion arise from this article?

- ▶ Write three open-ended questions (not yes/no questions) and/or discussion points that you want to explore in class with your colleagues.

Case study for today

- ▶ Martin Grandjean (2016) 'A social network analysis of Twitter: Mapping the digital humanities community'
<https://shs.hal.science/hal-01517493>
- ▶ **Reading_2025_01_30.pdf on GitHub**

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The screenshot shows a journal article page from Cogent Arts & Humanities. At the top right is the Taylor & Francis logo. Below it, the journal title "Cogent Arts & Humanities" is displayed next to its logo, which features a stylized orange graphic. A horizontal line separates this from the article details. The article title is "A social network analysis of Twitter: Mapping the digital humanities community" by Martin Grandjean. Below the title is a short bio for the author. Further down, there is citation information: "To cite this article: Martin Grandjean | (2016) A social network analysis of Twitter: Mapping the digital humanities community, Cogent Arts & Humanities, 3:1, 1171458, DOI: 10.1080/23311983.2016.1171458" and a link to the article: "To link to this article: <https://doi.org/10.1080/23311983.2016.1171458>". At the bottom left is a Creative Commons Attribution (CC-BY) 4.0 license logo, and at the bottom center is the copyright notice: "© 2016 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license".

Lab

Hands-on session

Final Project

- ▶ The goal of our lab sessions is to allow you to test your NA skills with a small real-life example, which will inform your final project, for which
 - ▶ You will formulate your research question
 - ▶ You will collect and model your data
 - ▶ You will analyse the structure and properties of your network
 - ▶ You will prepare visualisations of your network
 - ▶ You will present what you've done in class [Session 8]
 - ▶ You will write a short essay describing your project and submit it together with the digital asset one month after the course is over.
- ▶ **Do you have an idea for a small project? If not, I do.**

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Course GitHub

- ▶ https://github.com/KAKDH/ENC_HN_NA/
- ▶ Clone it
- ▶ Sync at least once a week before the class

- ▶ **How to clone and sync? See:** <https://docs.github.com/en/get-started/using-git/getting-changes-from-a-remote-repository>

Software

- ▶ We will be using Python and the NetworkX module.
You can follow one or both of two approaches:
 - ▶ Use free services to run Jupyter notebooks in the cloud, e.g., Google Colab (colab.research.google.com), Binder (mybinder.org), Kaggle Kernels (www.kaggle.com/kernels), Datalore (datalore.io), etc.
 - ▶ Run Python locally on your laptop with Jupyter notebooks. We recommend installing the Anaconda Python 3 distribution (www.anaconda.com/distribution). This option requires that you are comfortable with managing software packages.

Software

- ▶ Be advised that each cloud-based notebook service has pros and cons and we cannot test them all in class. You may have to try more than one solution, read documentation, and/or seek support from the providers to install packages.
- ▶ Local Python installations can present issues, especially on Windows machines. Packages are system dependent. Instructors may be unable to provide support.
- ▶ **By following this class, you agree to work independently to find solutions that work on your machine.**

Source: Filippo Menczer, Santo Fortunato, Clayton A. Davis, *A First Course in Network Science*, version 3
Katarzyna Anna Kapłan, *Network Analysis for Humanists*,
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Create your first Network with NetworkX

► Install:

- **Matplotlib** (a comprehensive library for creating static, animated, and interactive visualizations; <https://matplotlib.org/stable/>; Hunter JD (2007) "Matplotlib: A 2D Graphics Environment", *Computing in Science & Engineering*, vol. 9, no. 3, pp. 90-95)
- **NetworkX** (a package for the creation, manipulation, and study of the structure, dynamics, and functions of complex networks; <https://networkx.org>; Hagberg A, Schult DA, Swart PJ (2008), "Exploring network structure, dynamics, and function using NetworkX", in *Proceedings of the 7th Python in Science Conference (SciPy2008)*, G  el Varoquaux, Travis Vaught, and Jarrod Millman (Eds). (Pasadena, CA USA), pp. 11-15).

Exercises

- ▶ https://github.com/KAKDH/ENC_HN_NA/blob/main/labs/Lab1.ipynb
- ▶ Follow all steps in **Exercise 1** and make sure you understand what is happening, feel free to annotate your copy of the notebook further.
- ▶ Move to **Exercise 2** and reproduce this Actor network in NetworkX

