Computational Social Systems week 1

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TU Graz, 10.10.2023

Computational Social Science

Agenda

- Motivation:
  - What is CSS?
  - Historical perspective.
  - Why is it important?
- Topics we will cover in this course
- How this course is organized

Claudia Goldin – receives the prize for her work on uncovered key drivers of gender differences in the labour market.

nature

NEWS | 09 October 2023

Why women earn less than men: Nobel for economic historian who probed pay gap

Claudia Goldin mined 200 years of data to show that greater economic growth did not lead to wage parity, nor to more women in the workplace.

Philip Ball

Claudia Goldin has inspired women and young researchers to be brave and go for the big questions. Credit: BBVA Foundation

What is CSS

“computational social science is an emerging field that **leverages** the capacity to collect and analyze data with an unprecedented **breadth and depth** and **scale**.”

Lazer, et al. ”Computational Social Science." Science (2009)

What is CSS

"**Digital footprints** collected from online communities and networks enable us to **understand human behavior** and social interactions in ways **we could not do before**".

This is an emerging field of study and there is no well-defined agenda. The topics we cover here might be subject to lecturers' knowledge and expertise.

Golder, Scott A., and Michael W. Macy. "Digital footprints: Opportunities and challenges for online social research." Annual Review of Sociology 40 (2014).

Chapter 0

HISTORICAL PERSPECTIVE OF (COMPUTATIONAL) SOCIAL SCIENCE

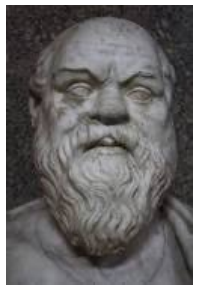
Man as a social animal

Most of the disciplines in SocSci emerged in the 19th century.

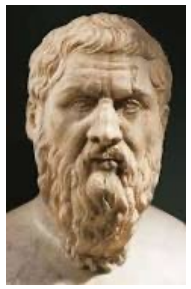
History of SocSci is much older "… already the ancient Greeks…"

Aristotle: "Man is by nature a social animal; an individual who is unsocial naturally and not accidentally is either beneath our notice or more than human. Society is something that precedes the individual. Anyone who either cannot lead the common life or is so self-sufficient as not to need to, and therefore does not partake of society, is either a beast or a god. "

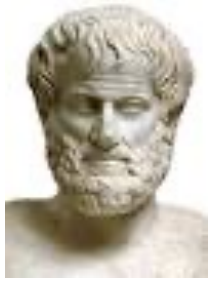
Socratic philosophers laid the fundaments of ethics and political science



Socrates



Plato



Aristotle

Figures from Wikipedia if not mentioned otherwise

Scientific Method

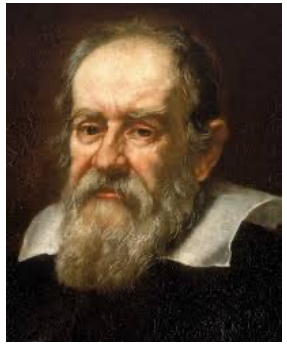
Revolution in natural sciences

Descartes' **rationalism** + F. Bacon, British **empiricists**, Galileo

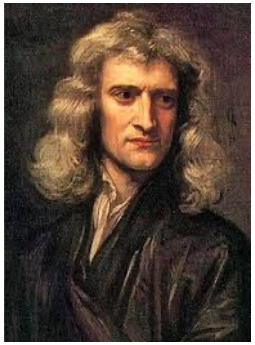
Emergence of the "**scientific method**" in the 17th century (Newton!)

Descartes

F. Bacon



Galileo Galieli



Newton

Observation (measurement) →hypothesis (induction) →consequences (deduction) → experimental/observational test →refinement of hypothesis etc.

Scientific Method: pragmatic steps

Observation (measurement) →hypothesis (induction) →consequences (deduction) → experimental/observational test →refinement of hypothesis etc.

1. Define a question
2. Gather information and resources (observe)
3. Form an explanatory hypothesis
4. Test the hypothesis by performing an experiment and collecting data in a reproducible manner
5. Analyze the data
6. Interpret the data and draw conclusions that serve as a starting point for a new hypothesis
7. Publish results
8. Retest (frequently done by other scientists)

Scientific methods advanced sciences:

amazingly successful, first in physics (mechanics)

Mechanics explained celestial and terrestrial phenomena on the same footing, with unprecedented precision (enabled discovery of new planets)

Soon further branches of physics (thermodynamics, electricity) and chemistry followed with severe consequences on applications (industrial revolution).

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Scientific tools evolved in parallel:

Experimental equipment (discipline specific)

Mathematics and Statistics (general)

Galileo: ”The book (of nature) is written in mathematical language” (In the original: Philosophy)

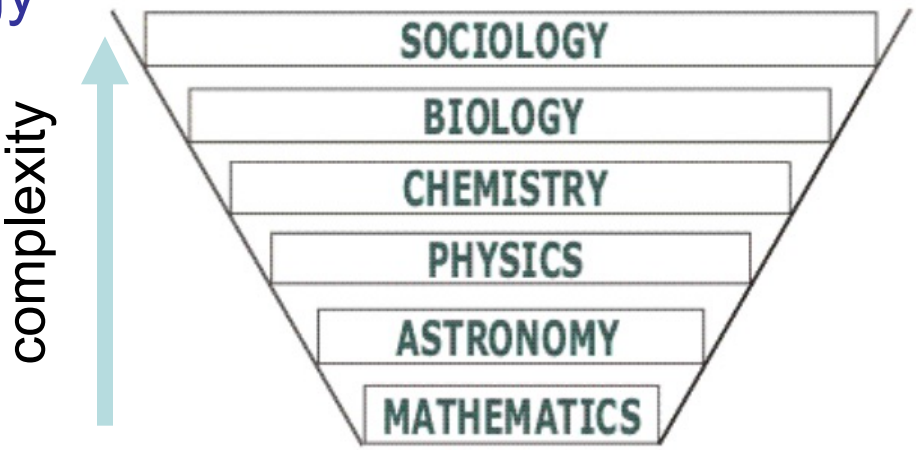
Modern Sociology

Starting from the beginning of the 19th century the success of natural sciences inspired scholars to seek for possibilities to define disciplines (instead of doing just philosophy) to which the ”method of physics” (scientific method) can be applied.

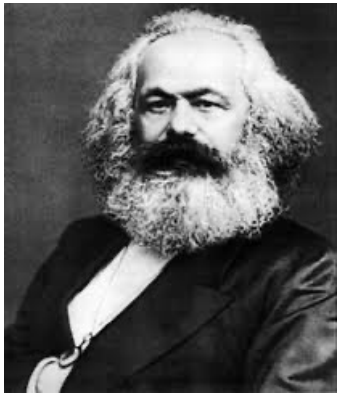
Auguste Comte

Auguste Comte (1798-1857): Sociology

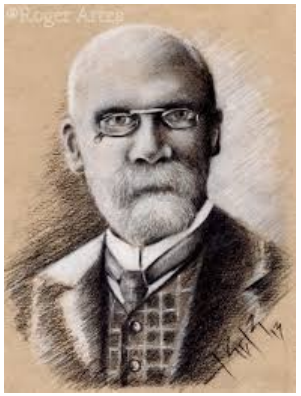
Comte coined the concept of positivism; "positivity", means simply the degree to which the phenomena can be exactly determined. This, as may be readily seen, is also a measure of their relative complexity, since the exactness of a science is in inverse proportion to its complexity.



(Some of the)Founders of modern social sciences



Karl Marx



Emile Durkheim

Max Weber

Social science research methods:

- Qualitative designs emphasize understanding of social phenomena through direct observation, communication with participants, or analysis of texts, and may stress contextual and subjective accuracy over generality.
- Quantitative designs approach social phenomena through quantifiable evidence and often rely on statistical analysis of many cases (or across intentionally designed treatments in an experiment) to establish valid and reliable general claims.
- Mixed-methods

Social Physics

Pierre-Simon Laplace (”applying to the political and moral sciences the method founded upon observation and upon calculus, the method which has served us so well in the natural sciences”)

Marquis de Condercet (“Social mathematics”)

Adolphe Quetelet (“Social physics”)

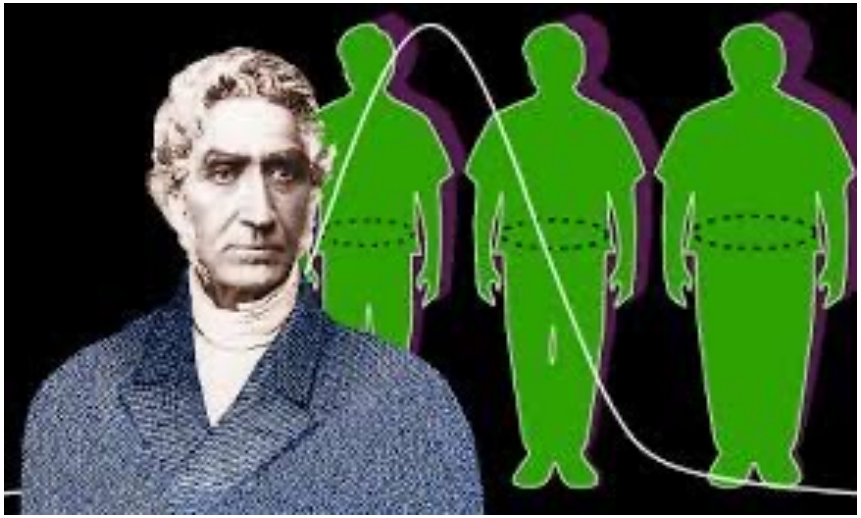
Laplace

Condercet

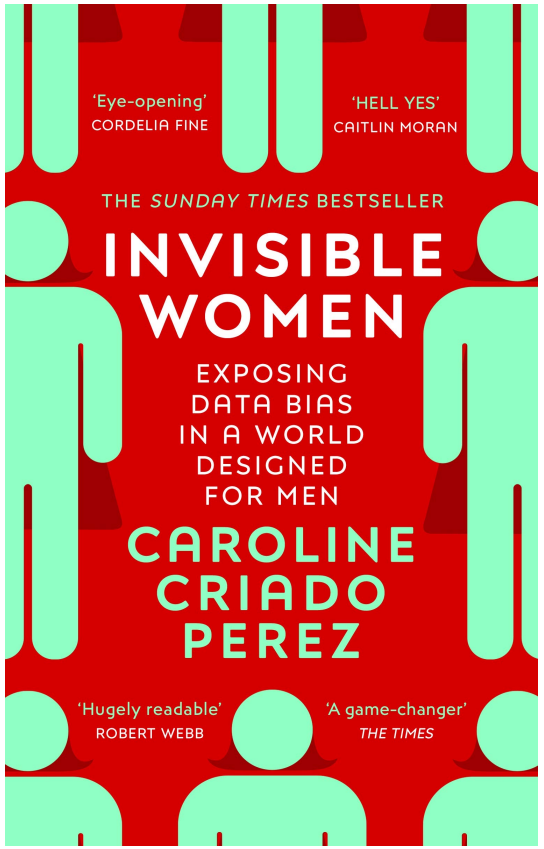
Quetelet

They introduced and promoted statistical methods to Social sciences.

Average man and Social Atomism



Adolphe Quetelet, 1850



Some of these simplifications of social worlds into study of an average man in society can have negative societal consequences.

Statistical Methods: hypothesis testing

Statistical hypothesis testing:

- null model formulation
- comparing empirical statistics with the prediction of the null model
- confidence level (p value, z-score)
- reject null model (in favor of an alternative)

χ^2 test
t-test
etc.

These are statistical tools developed around 1900 and widely used both in natural and social sciences.

Statistics: Need for data

Chapter 1

DATA REVOLUTION

Methods of data collection in SocSci

Interview for the 1950 census. (census.gov)

Classical methods:
-Census
-Archives
-Observation
-**Surveys** (primary source of data)

Question! What are the advantages and disadvantages of this data collection method

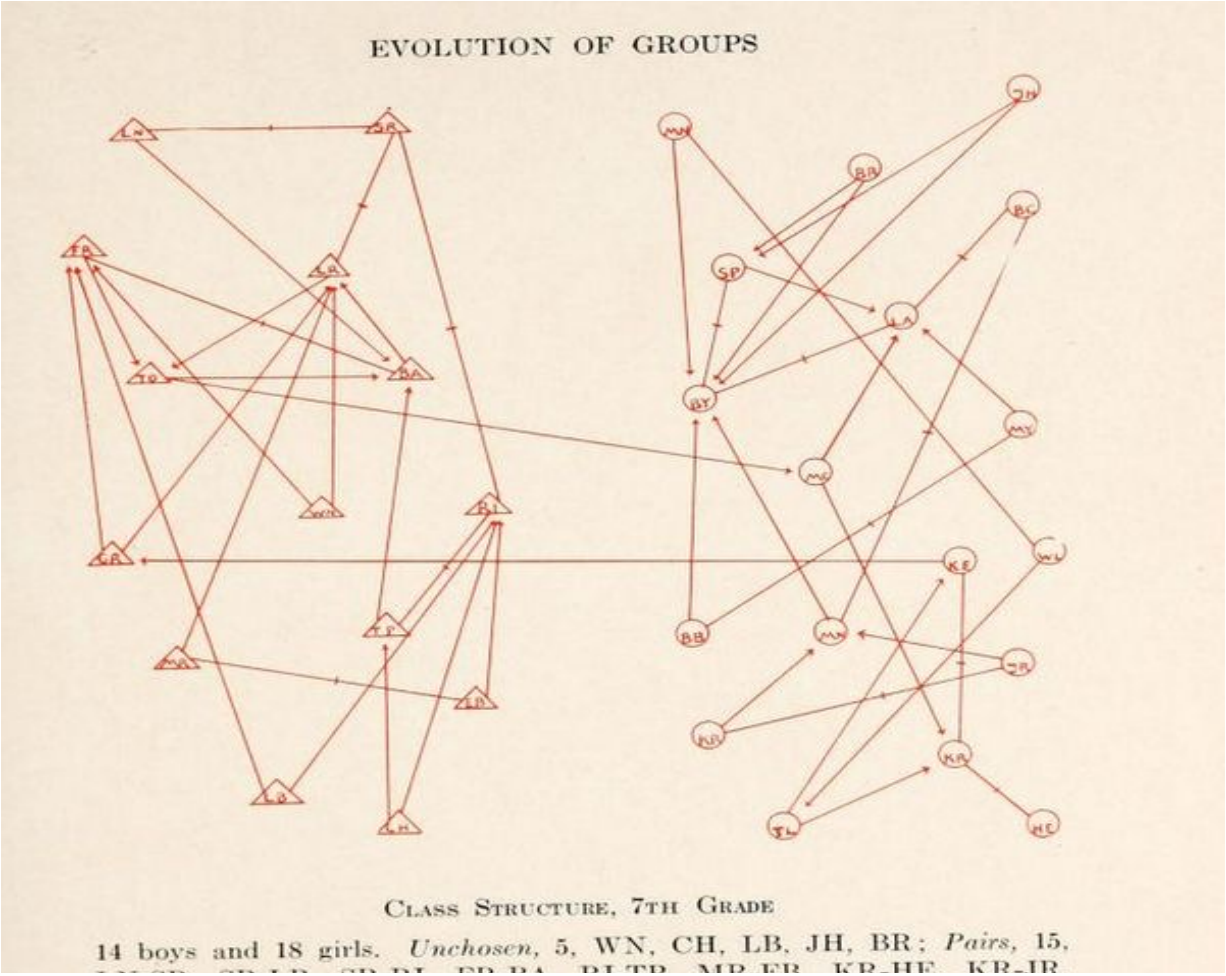
Methods of data collection in SocSci

Interview for the 1950 census. (census.gov)

Classical methods:
-Census
-Archives
-Observation
-**Surveys** (primary source of data)

Advantage of surveys: Targeted questions, targeted groups, possibility of longitudinal studies.

Disadvantages: Large effort, limited size, subjectivity in answers.



Moreno used a sociogram to illustrate social attraction in a school. In this sociogram, boys are illustrated by triangles and girls are illustrated by circles. The directional arrows show attraction. Arrows with centered line are mutual attractions

Moreno, Jacob Levy. "Who shall survive?." (1953).

Found data in the social sciences

There are two general types of found data:

Accretion - a build-up of physical traces

Erosion - the wearing away of material

Question! Can you think of some examples?

Strohmaier, Markus, and Claudia Wagner. "Computational social science for the world wide web." *IEEE Intelligent Systems* 29.5 (2014): 84-88.

Data Revolution

Smarter Devices

Michael Franklin, UC Berkeley

Data Revolution

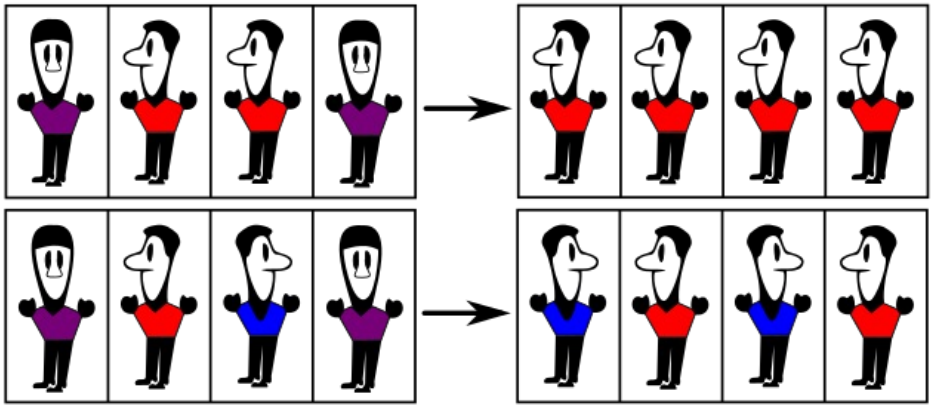
Ubiquitous Connectivity

skype

Michael Franklin, UC Berkeley

Computerization and digital revolution

- Using computer simulations for building social models (Agent-based modeling: ABM)



Example of a sociophysics model inspired from Ising model in statistical physics. Social validation in Sznajd model. If two neighbors agree (top), then their neighbors agree with them. If two neighbors disagree (bottom), their neighbors begin to disagree as well.

Computerization and digital revolution

- Using computer simulations for building social models (Agent-based modeling ABM)
- Using computational powers for handling big data analysis

Found data on the web
Digital footprints

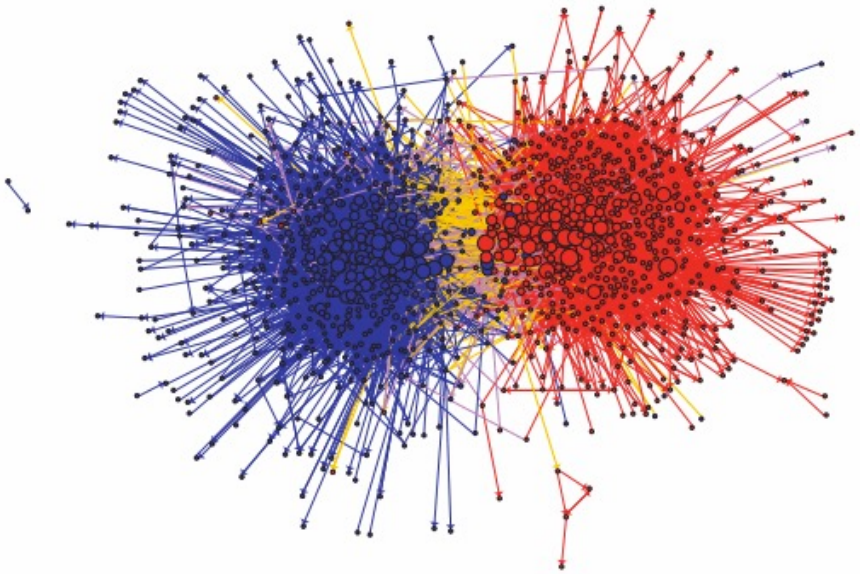
Google

Google Search I'm Feeling Lucky

GPS MotionX

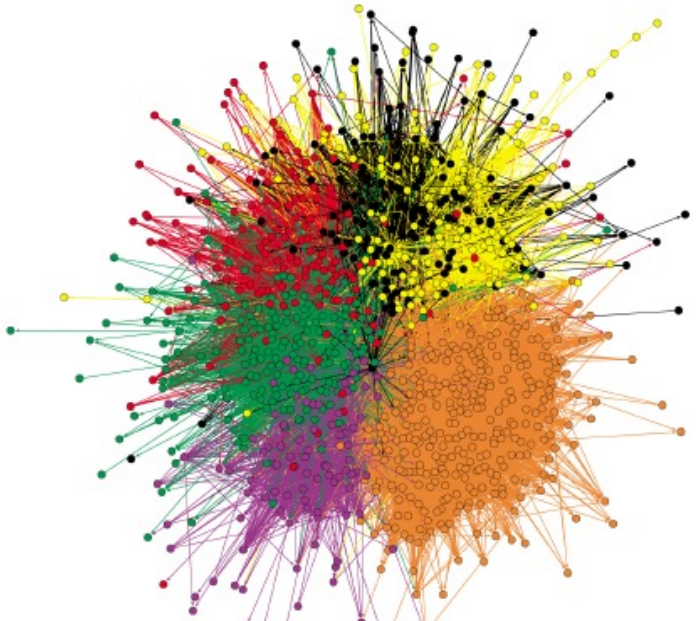
Examples of found data on the web

Polarization in Weblogs
during the US 2004 election



Adamic, Lada A., and Natalie Glance. "The political blogosphere and the 2004 US election: divided they blog." *Proceedings of the 3rd international workshop on Link discovery*. ACM, 2005.

Polarization on Twitter
during the German 2013 election



H. Lietz, C. Wagner, A. Bleier, and M. Strohmaier. When politicians talk: Assessing online conversational practices of political parties on twitter. In International AAAI Conference on Weblogs and Social Media (ICWSM2014), Ann Arbor, MI, USA, June 2-4, 2014.

New opportunities – new challenges

”Until now, social science has struggled to obtain tools that do more than scratch the surface of some of its questions. These range from identifying the driving forces behind violence, to the factors influencing how ideas, attitudes and prejudices spread through human populations. The available tools have largely remained in a time warp, consisting of analyses of national censuses, small-scale surveys, or lone researchers with a notebook observing interactions within small groups.

Being able to automatically and remotely obtain massive amounts of continuous data opens up unprecedented opportunities for social scientists to study organizations and entire communities or populations.”

NATURE Vol 449, 11 October 2007

Using Big Data makes possible to study questions on empirical basis, which had been earlier impossible to deal with:

- Large-scale structure of the society
- Temporal patterns of communication
- Multi-scale dynamics of human mobility
- Mechanism of disease spreading
- Social contagion (rumors, innovations)
- Quantifying cultural changes
- Patterns of success, creativity
- Filtering fake news and identifying echo chambers
- Urban planning, traffic and well-being in cities
- Crime categorization and pattern identification
- etc.

Many of these problems have immediate relation to applications.

Complexity

Is it enough to have Big Data and good computers?

Wire Magazine

Complexity

Is it enough to have Big Data and good computers?

Some think: Yes!


CHRIS ANDERSON SCIENCE 06.23.08 12:00 PM

THE END OF THEORY: THE DATA DELUGE MAKES THE SCIENTIFIC METHOD OBSOLETE

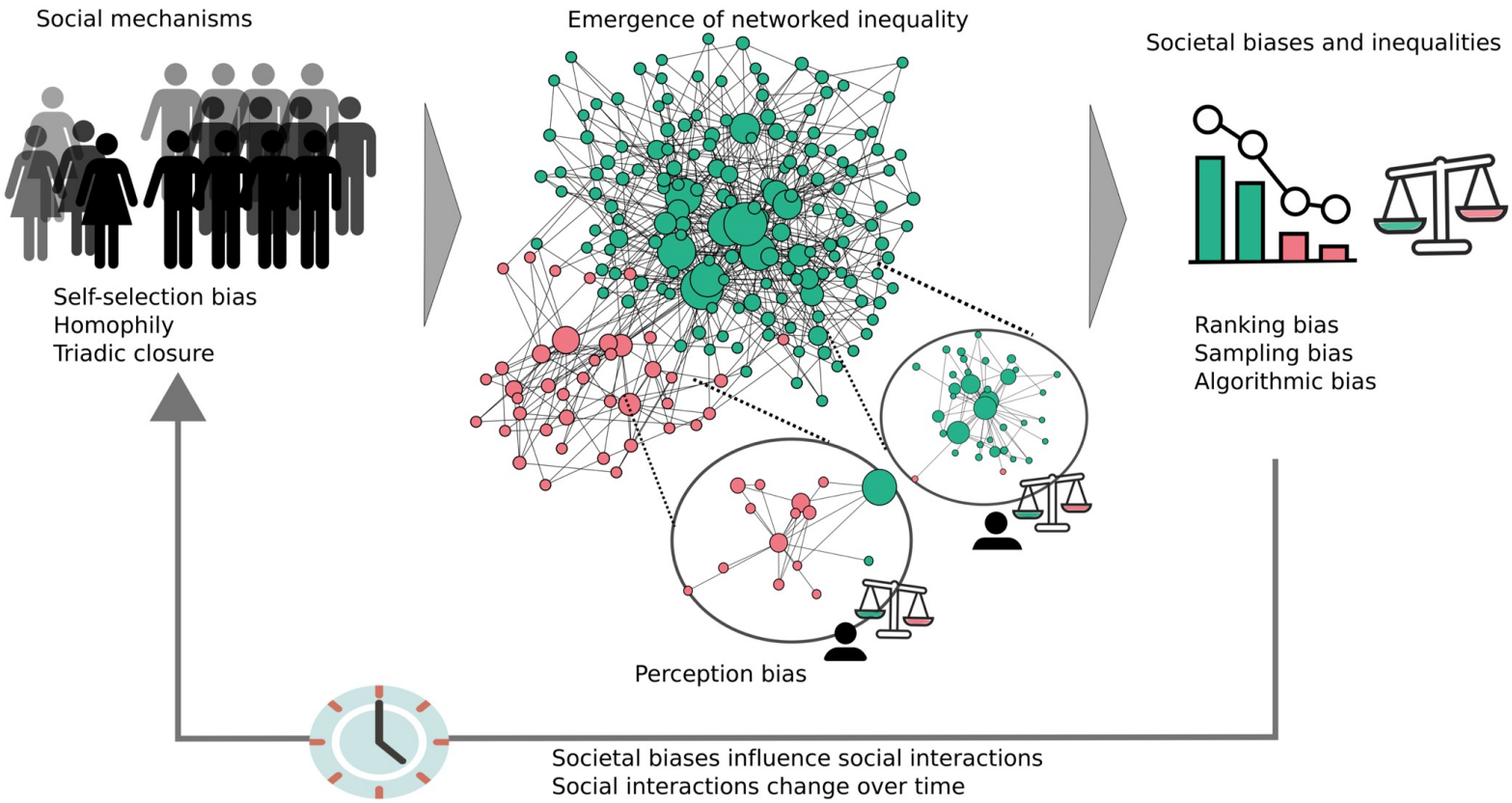
Wire Magazine

We think: No!

For many reasons:

- Hypothesis formation is an important creative step
- Data is not enough!
- Many systems show unexpected, emergent behavior: **complexity**

Human society as a complex system



Minorities in networks and algorithms, Karimi, Oliveira, Strohmaier. arXiv:2206.07113

Human society as a complex system

Question to answer until next week!
What is a complex system and what are its properties?
Is society a complex system?

Complex Systems: A Survey

M. E. J. Newman

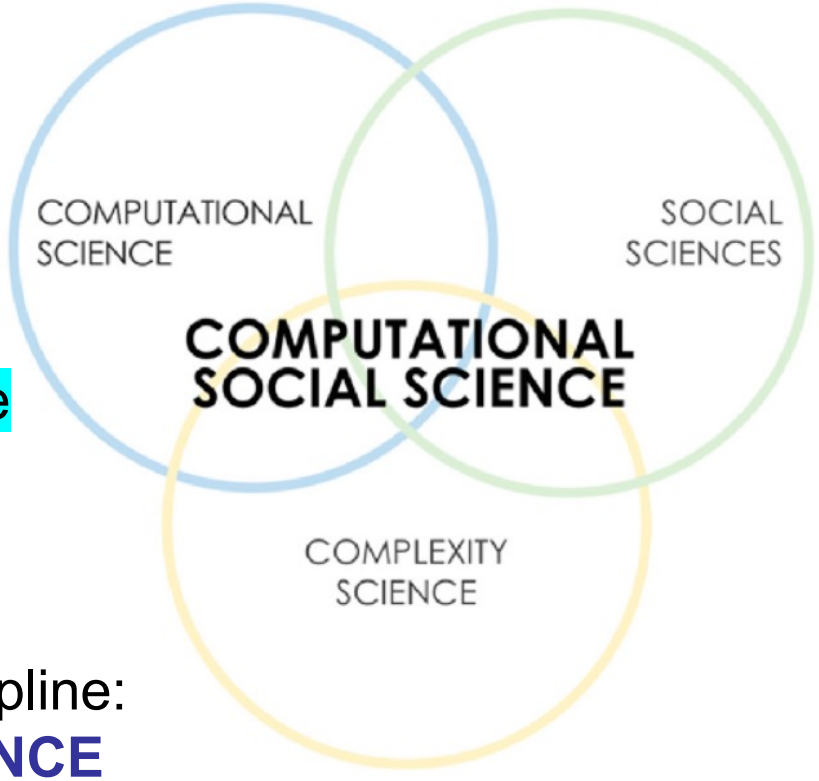
Department of Physics, University of Michigan, Ann Arbor, MI 48109 and
Center for the Study of Complex Systems, University of Michigan, Ann Arbor, MI 48109

A complex system is a system composed of many interacting parts, often called agents, which displays collective behavior that does not follow trivially from the behaviors of the individual parts. Examples include condensed matter systems, ecosystems, stock markets and economies, biological evolution, and indeed the whole of human society. Substantial progress has been made in the quantitative understanding of complex systems, particularly since the 1980s, using a combination of basic theory, much of it derived from physics, and computer simulation. The subject is a broad one, drawing on techniques and ideas from a wide range of areas. Here I give a survey of the main themes and methods of complex systems science and an annotated bibliography of resources, ranging from classic papers to recent books and reviews.

New tools needed. No single discipline is able to cope with the problems:
Multidisciplinarity is a must

Main contributing disciplines:

- Sociology
- Economics
- Psychology
- Computer Science/Data Science
- Physics/Complexity Science
- Network Science
- Math/Statistics



Resulting in an emerging new discipline:
COMPUTATIONAL SOCIAL SCIENCE

TOPICS WE COVER IN THIS COURSE

Course topics overview

- Class 1: Introduction to CSS
- Class 2: Social psychology and social impact
- Class 3: Collective intelligence (guest)
- Class 4: Social behavior and trends (guest)
- Class 5: Social media sentiment analysis (guest)
- Class 6: Social networks
- Class 7: Measuring polarization (guest)
- Class 8: Dynamics on social networks
- Class 9: Animal behavior and collective behavior (guest)
- Class 10: Computational inequality
- Class 11: Algorithms, inequalities and fairness (guest)

COURSE LOGISTICS

Course team

- Instructors:
  - Fariba Karimi
  - Petar Jercic

- For general, course- or assignment-related questions, please use TeachCenter or approach Petar

Fariba Karimi

I am a computational social scientist with a background in complex systems.

- Professor of Data Science at the Dept. of Computer Science TU Graz, Austria

- Group leader at Complexity Science Hub Institute, Vienna, Austria

http://www.frbkrm.com

Interested in understanding social phenomena and inequalities using complex systems methods and data science.

Petar Jerčić

A computational social scientist with a background in computer sicence.

Postdoctoral researcher at computer science department at Tu Graz.

My primary focus is on developing innovative healthcare applications that leverage human physiology and emotions, and to achieve this, I use Data Science, Computational Modeling, and System Architecture to support decision-making and regulate emotions in individuals.

Complexity Science Hub Vienna

Research institute:

- Complexity science, economics, statistical physics

Network Inequality Research group:

- Interested in investigating structural inequalities in social systems and algorithms
- Computational Social Science

Interesting topics for projects, Master thesis:

- If you are interested in the topics of this course, it is likely that you are interested in doing a project / a thesis with us!
  Contact us to discuss opportunities!

Course Organization and Logistics

- ***Lectures***
  *Tuesdays **11:00-12:30***

  Light lunch together ~ 30 min (bring your sandwich)

  *Tutorials **13:00 – 14:00***

- Slides etc:
  Will be shared in Teach Center before the lecture starts

Policies

- **Course documents**: Assignment descriptions and lecture notes will be made available.
- **Deadlines**: Home assignments need to be handed in on the day of the deadline.
- **Plagiarism**: By submitting home assignments, you agree that your work will be checked for plagiarism.

If you submit plagiarized code on any home assignment, you will not be able to complete this course this year and have to repeat next year.

Questions?

Raise them **NOW**!

Home assignment

Pick your favorite topic and a relevant high-quality paper in CSS and write a 2-page summary about that paper; including: what you like about the paper and what you learn by reading that paper.

Deadline: FRI Oct 20, 2023 @ 15:00

Further read

- Computational Social Science, Lazer et al., Science (2009)
- Computational social science: Making the links, Nature pages 448–450 (2012)

- Manifesto of computational social science, The European Physical Journal Special Topics (2012)

- 5 perspective about Computational social science, Nature special issue (2021)

Slides based on the following resources

Yoram M Kalman. Unobtrusive Methods for Social Science Research - A Neglected Methodological Approach in the Social Sciences (slides)

Christine Hine (2011). Internet Research and Unobtrusive Methods. *Social Research Update*, *61*, 1-4.

Michelle O'Brien (2010). Unobtrusive Research Methods – An Interpretative Essay.

CSS lecture course, Strohmaier and Wagner (2017)

CSS lecture course, Gerardo Iñiguez, CEU (2019)