Network Social Science

Network Science Bootcamp 2021
Hong Qu

10 Red Balloons places across the U.S.

DARPA Network Challenge

$40,000 challenge award would be granted to the first team to submit the locations of 10 moored, 8-foot, red weather balloons at 10 previously undisclosed fixed locations in the continental United States. The balloons were to be placed in readily accessible locations visible from nearby roads.

MIT Harnesses Online Crowds to Beat Darpa Balloon Challenge in Just 9 Hours

https://en.wikipedia.org/wiki/DARPA_Network_Challenge

Scale

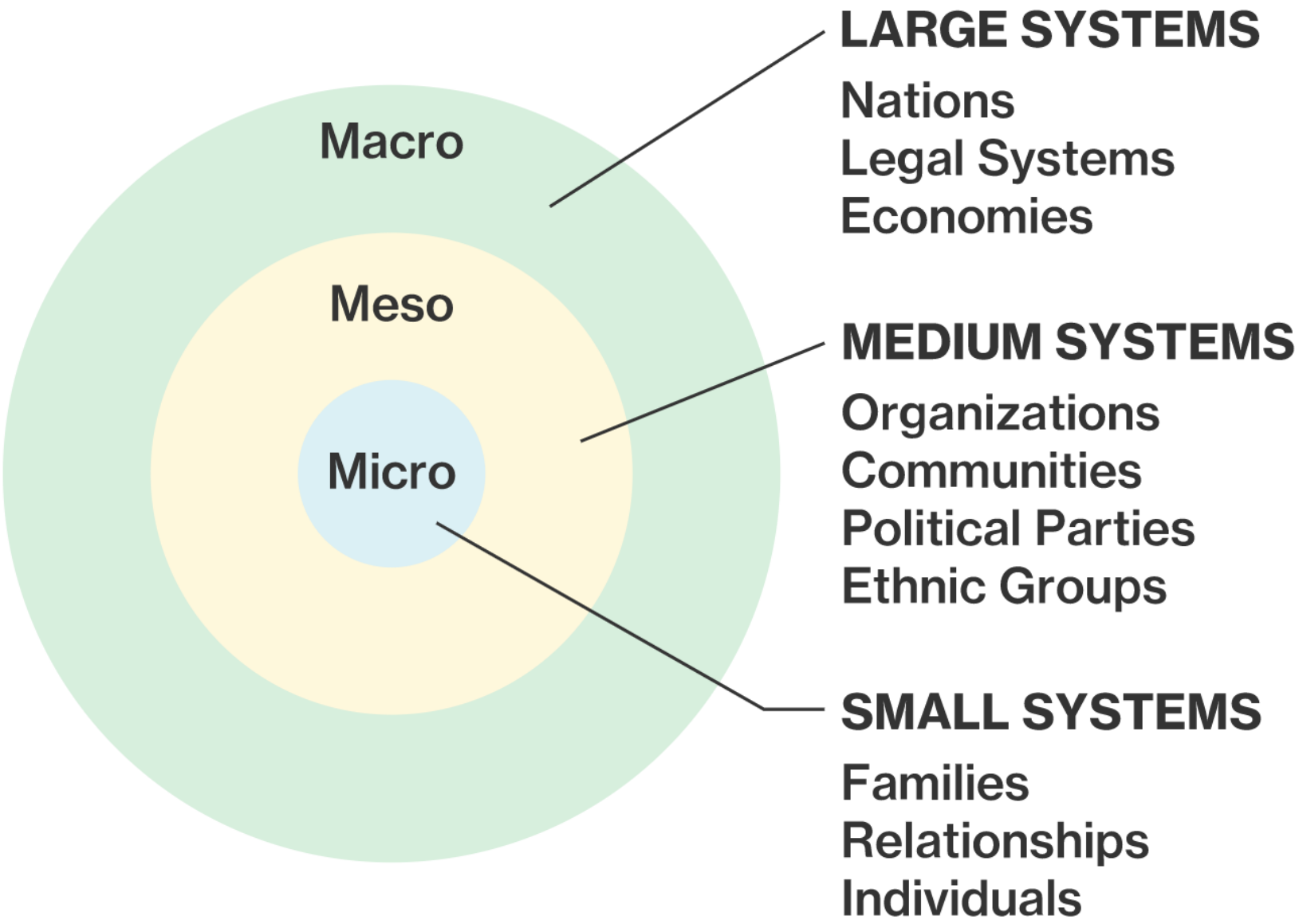
Ego network

Micro

Meso

Macro

Planetary



Networks Exhibit Complexity and Emergence

Models and their Properties

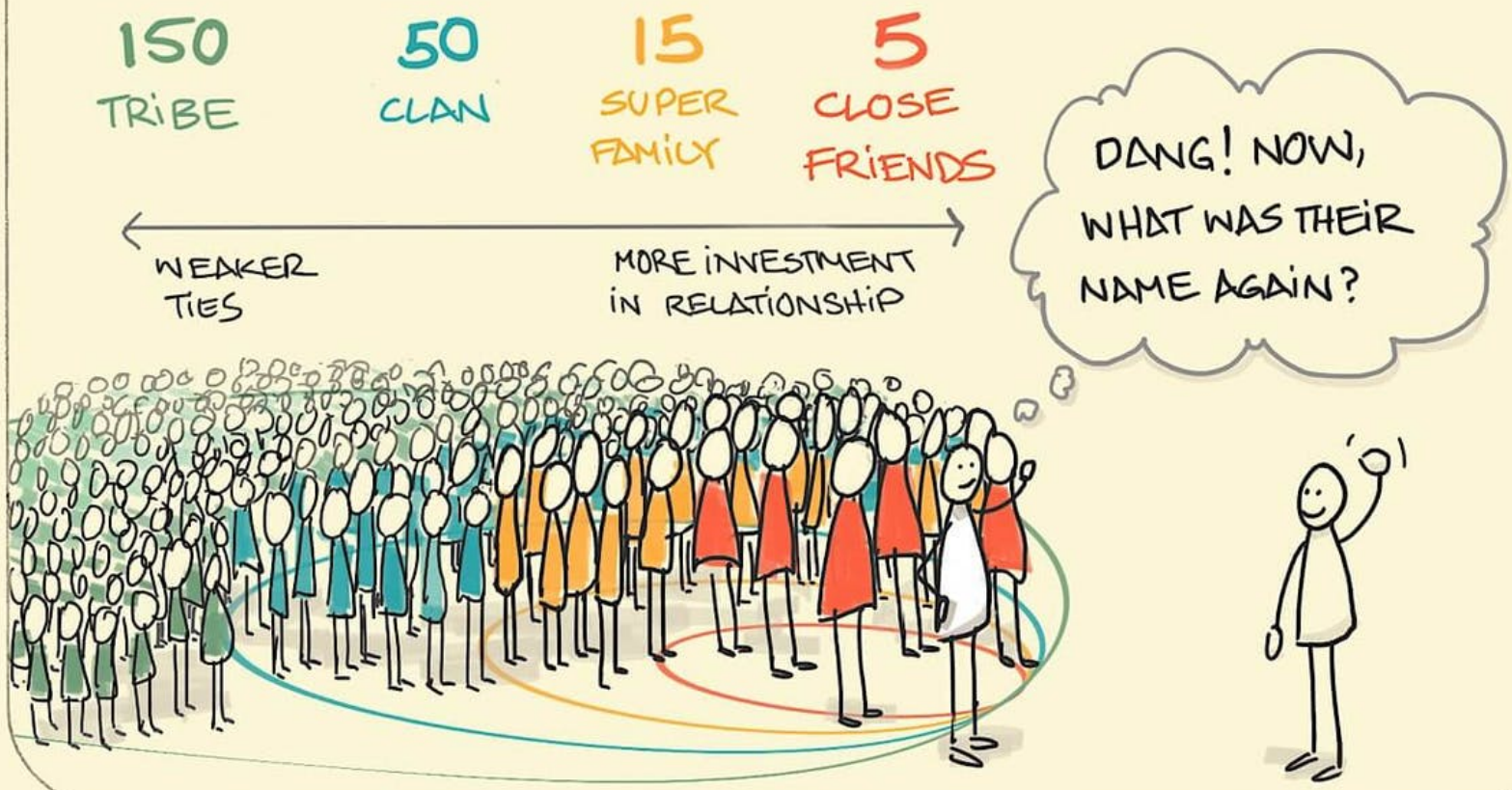
Network	N	L	$\langle k \rangle$	$\langle k_{in}^2 \rangle$	$\langle k_{out}^2 \rangle$	$\langle k^2 \rangle$	γ_{in}	γ_{out}	γ
Internet	192,244	609,066	6.34	-	-	240.1	-	-	3.42*
WWW	325,729	1,497,134	4.60	1546.0	482.4	-	2.00	2.31	-
Power Grid	4,941	6,594	2.67	-	-	10.3	-	-	Exp.
Mobile-Phone Calls	36,595	91,826	2.51	12.0	11.7	-	4.69*	5.01*	-
Email	57,194	103,731	1.81	94.7	1163.9	-	3.43*	2.03*	-
Science Collaboration	23,133	93,437	8.08	-	-	178.2	-	-	3.35*
Actor Network	702,388	29,397,908	83.71	-	-	47,353.7	-	-	2.12*
Citation Network	449,673	4,689,479	10.43	971.5	198.8	-	3.03*	4.00*	-
E. Coli Metabolism	1,039	5,802	5.58	535.7	396.7	-	2.43*	2.90*	-
Protein Interactions	2,018	2,930	2.90	-	-	32.3	-	-	2.89*-

Small World

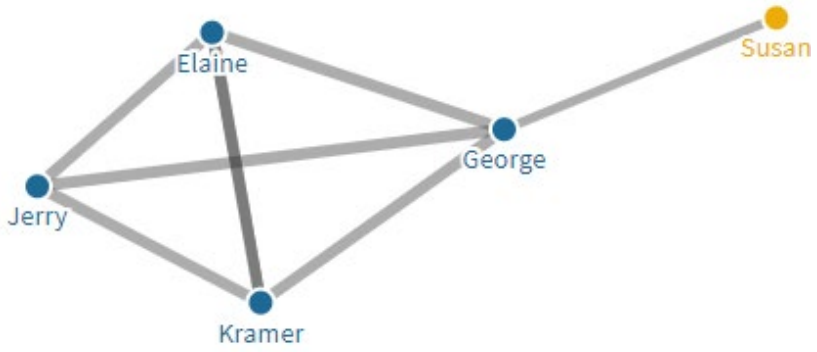
6-degrees of separation
Clustering
Watts-Strogatz model

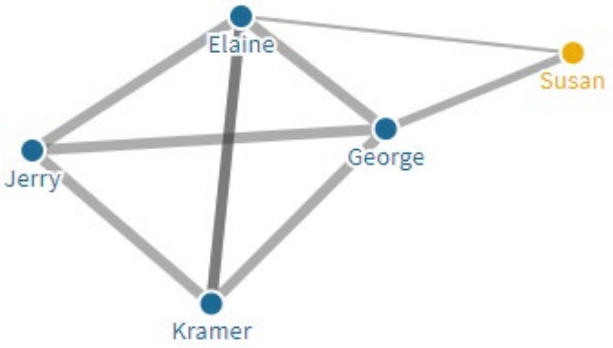
DUNBAR'S NUMBER: 150

TYPICAL NUMBER OF PEOPLE WE CAN KEEP TRACK OF AND CONSIDER PART OF OUR ONGOING SOCIAL NETWORK



sketchplanations





Clustering as explained in Seinfeld

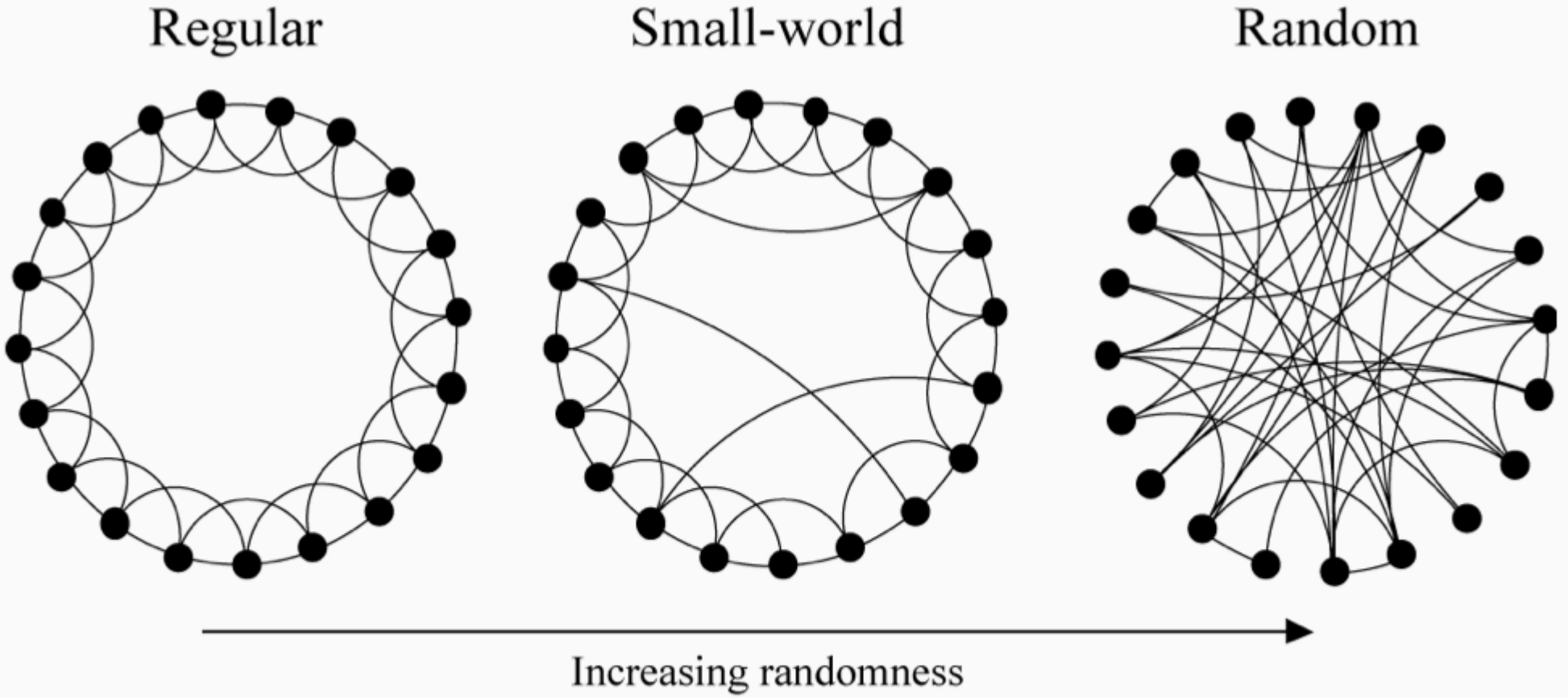
- George has different circles of friends
- Elaine wants to become friends with George's girlfriend Susan
  - killing "independent George"

Unit Name	Alternative Names	Components	Commander's Rank
Fireteam		4 Soldiers	Staff Sgt
Squad	Section (Cavalry)	4-10 Soldiers	Sgt or Staff Sgt
Platoon		16-40 Soldiers in 2 or more Squads	Lieutenant
Company	Troop (Cavalry), Battery (Artillery)	100-200 Soldiers in 3-5 Platoons	Captain
Battalion	Squadron (Cavalry)	4-6 Companies	Lt. Colonel
Brigade	Group (Logistics or Special Forces)	2-5 Battalions	Colonel
Division		3 or more Brigades	Major General
Corps		2 or more Divisions	Lt. General
Field Army		2 or more Corps	General (or Lt. General)
Army Group		2 or more Field Armies	General

Watts-Strogatz model

Interpolating between a randomized structure close to ER graphs and a regular ring lattice.

Watts-Strogatz model



Liao, Vasilakos & He (2017)

Randomness	Type of Graph	Clustering	Path Length
$p = 0$	Regular	Highly clustered: $\tilde{C} \approx \frac{3}{4}$	High diameter (Long paths): $L \approx \frac{n}{2\bar{k}}$
$p = 1$	Random (~Erdos-Renyi)	Low clustering: $\tilde{C} \approx \frac{\bar{k}}{n}$	Low diameter (Short path lengths): $L \approx \log_{\bar{k}}(n)$

https://chih-ling-hsu.github.io/2020/05/15/watts-strogatz

Community Detection

Karate Club

"The network captures 34 members of a karate club, documenting links between pairs of members who interacted outside the club. During the study a conflict arose between the administrator "John A" and instructor "Mr. Hi" (pseudonyms), which led to the split of the club into two. Half of the members formed a new club around Mr. Hi; members from the other part found a new instructor or gave up karate."

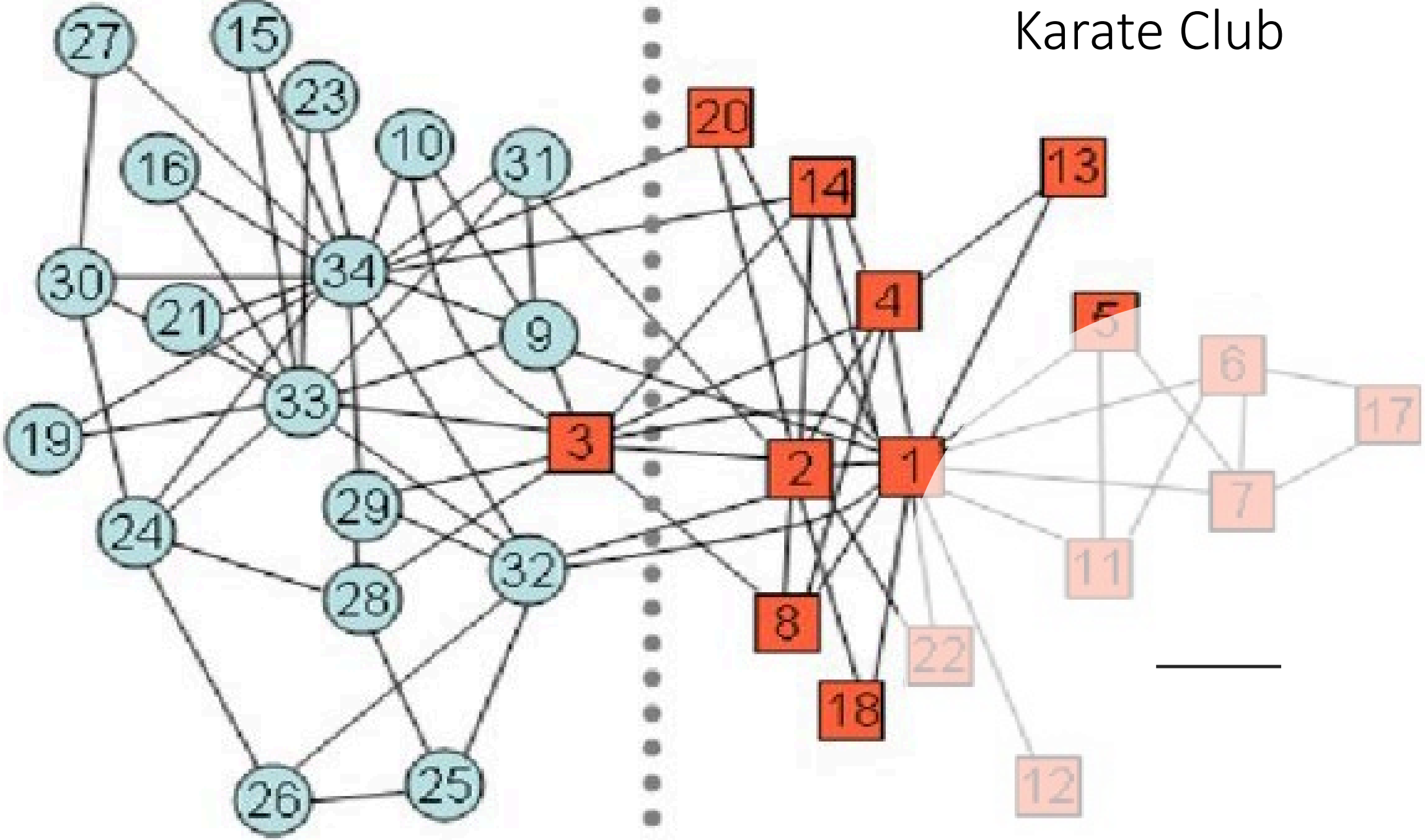
https://en.wikipedia.org/wiki/Zachary%27s_karate_club

https://networkx.org/documentation/stable/auto_examples/graph/plot_karate_club.html

RESULTS OF INITIAL *NETFLOW* RUN

INDIVIDUAL NUMBER	SIDE OF CUT	FACTION	CLUB AFTER FISSION
1	Source	Mr. Hi - Strong	Mr. Hi's
2	Source	Mr. Hi - Strong	Mr. Hi's
3	Source	Mr. Hi - Strong	Mr. Hi's
4	Source	Mr. Hi - Strong	Mr. Hi's
5	Source	Mr. Hi - Strong	Mr. Hi's
6	Source	Mr. Hi - Strong	Mr. Hi's
7	Source	Mr. Hi - Strong	Mr. Hi 's
8	Source	Mr. Hi - Strong	Mr. Hi's
9	Sink	John - Weak	Mr. Hi's
10	Sink	None	Officers'
11	Source	Mr. Hi - Strong	Mr. Hi's
12	Source	Mr. Hi - Strong	Mr. Hi's
13	Source	Mr. Hi - Weak	Mr. Hi's
14	Source	Mr. Hi - Weak	Mr. Hi's
15	Sink	John - Strong	Officers'
16	Sink	John - Weak	Officers'
17	Source	None	Mr. Hi's
18	Source	Mr. Hi - Weak	Mr. Hi's
19	Sink	None	Officers'
20	Source	Mr. Hi - Weak	Mr. Hi's
21	Sink	John - Strong	Officers'
22	Source	Mr. Hi - Weak	Mr. Hi's
23	Sink	John - Strong	Officers'
24	Sink	John - Weak	Officers'
25	Sink	John - Weak	Officers'
26	Sink	John - Strong	Officers'
27	Sink	John - Strong	Officers'
28	Sink	John - Strong	Officers'
29	Sink	John - Strong	Officers'
30	Sink	John - Strong	Officers'
31	Sink	John - Strong	Officers'
32	Sink	John - Strong	Officers'
33	Sink	John - Strong	Officers'
34	Sink	John - Strong	Officers'

Karate Club



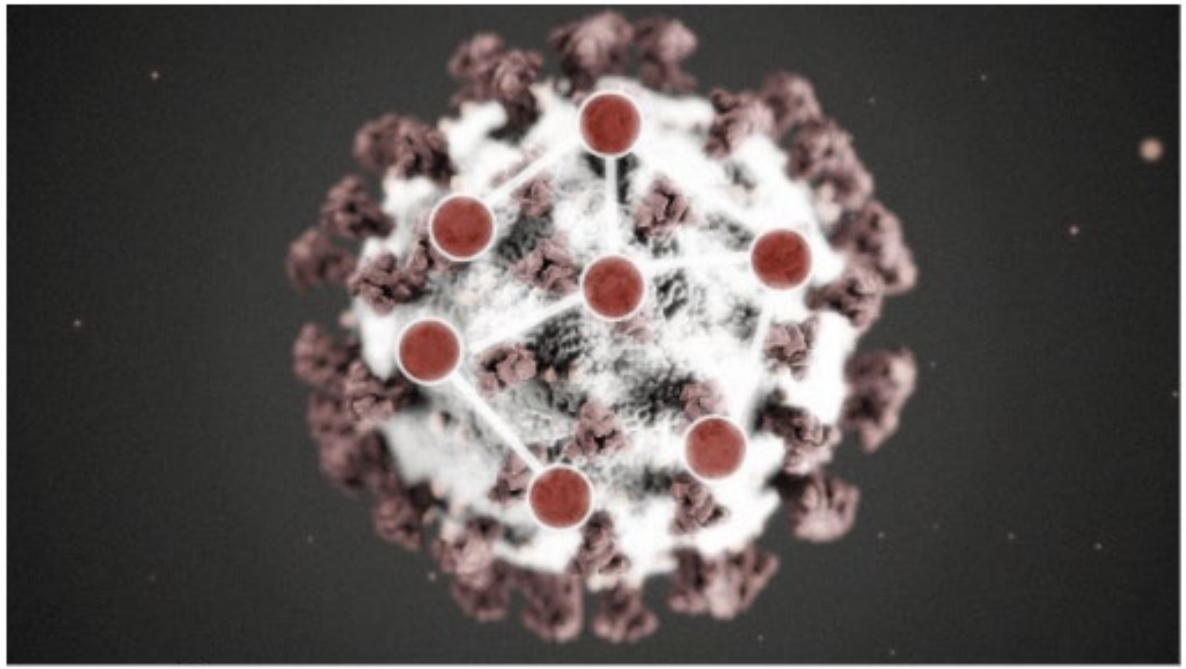
https://www.researchgate.net/publication/225168779_A_Scalable_Multilevel_Algorithm_for_Graph_Clustering_and_Community_Structure_Detection

Pinterest

“Thus, we can think of Pinterest as a giant human curated bipartite graph of 7 billion pins and boards, and over 100 billion edges 1 . We use this bipartite graph of pins and boards to generate recommendations.”

https://medium.com/pinterest-engineering/pinsage-a-new-graph-convolutional-neural-network-for-web-scale-recommender-systems-88795a107f48

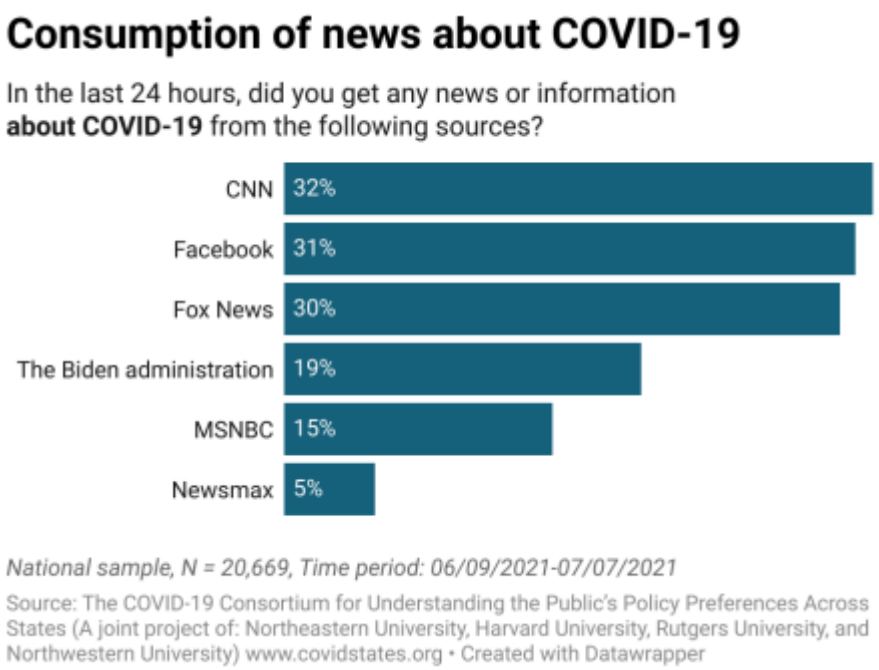
Misinformation

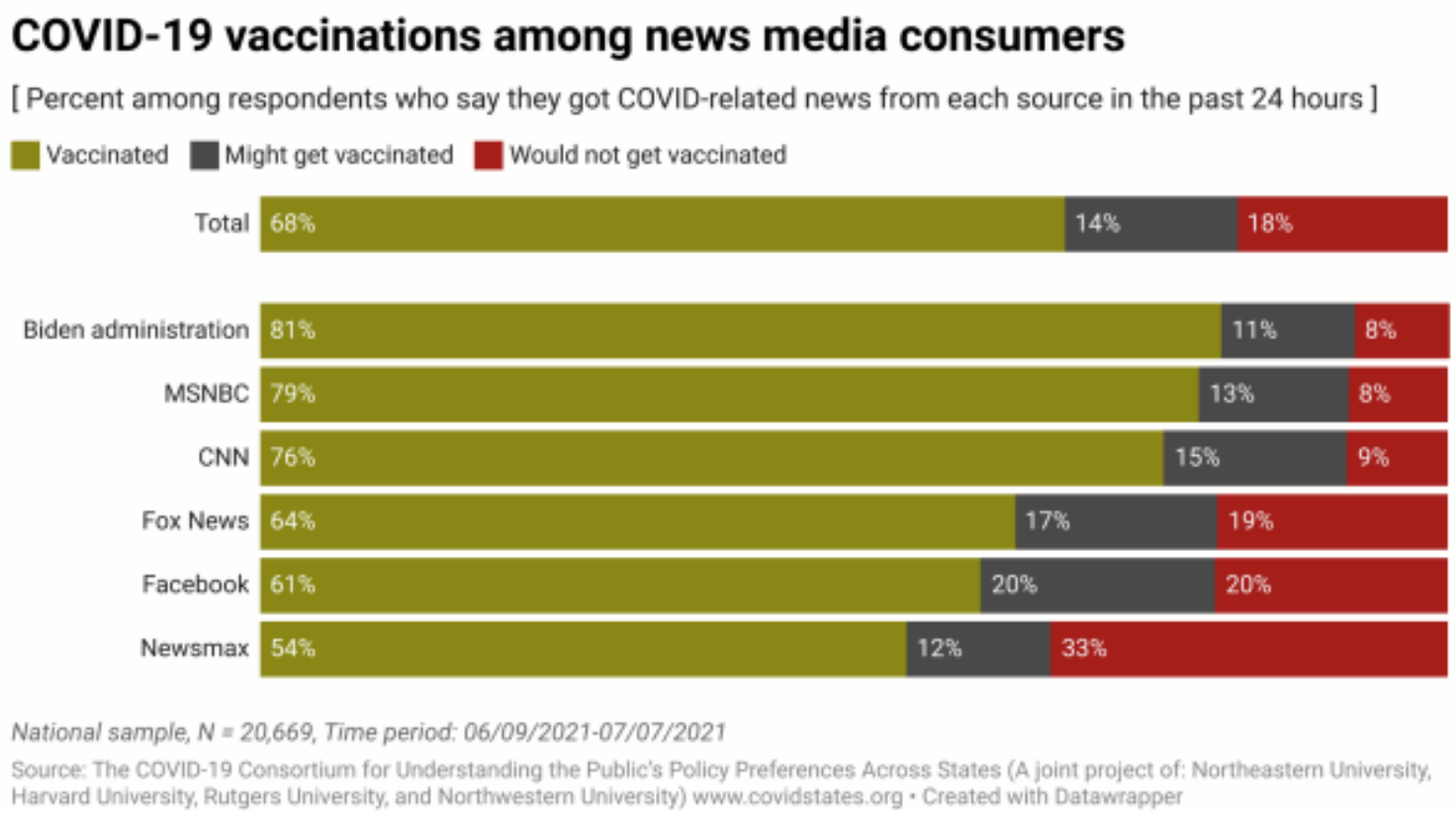


THE COVID STATES PROJECT:
A 50-STATE COVID-19 SURVEY
REPORT #57: SOCIAL MEDIA NEWS CONSUMPTION AND COVID-19 VACCINATION RATES

https://osf.io/uvqbs/

Social Media News Consumption and Vaccination Rates





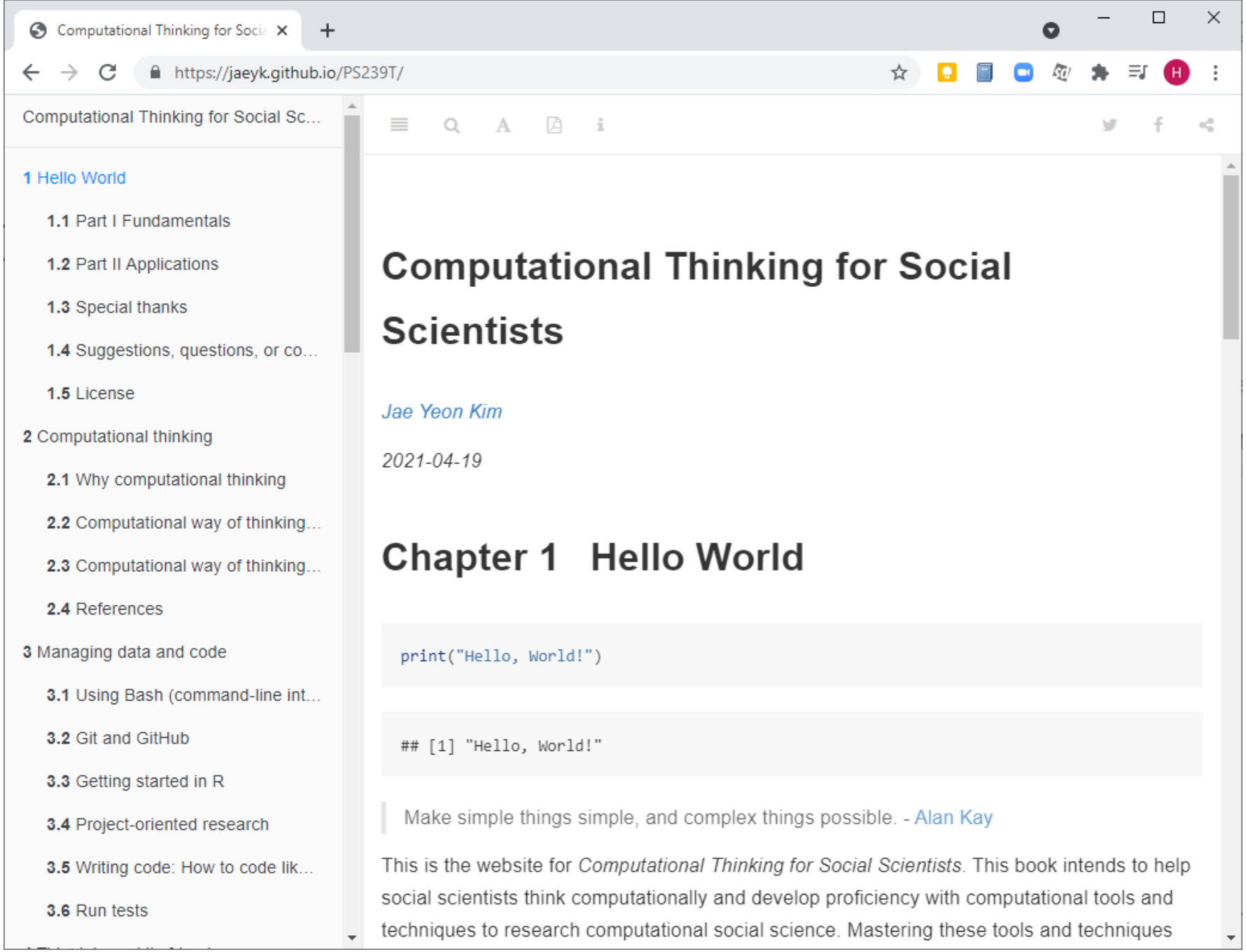
https://osf.io/uvqbs/

Why no one really knows how bad Facebook's vaccine misinformation problem is

The Covid States Project put out a report in late July showing that Facebook news consumers were less likely to get vaccinated than Fox News viewers. Facebook promptly attacked the study's methodology. A company spokesperson told Gizmodo that the results were "sensationalized" and "overstated," in part because they relied on self-reported survey data over a short time window. Instead, Facebook argued, researchers should have used better data, like people's actual reliance on the social network for news over self-reported survey data — data that only Facebook can access.

https://www.vox.com/22622070/facebook-data-covid-19-vaccine-misinformation-researchers-access-nyu-academics

https://www.axios.com/vaccine-hesitancy-misinformation-cba20e80-6871-4ddb-9405-feaa21be77d3.html



https://jaeyk.github.io/PS239T/