Lessons from COVID-19: Efficiency vs Resilience

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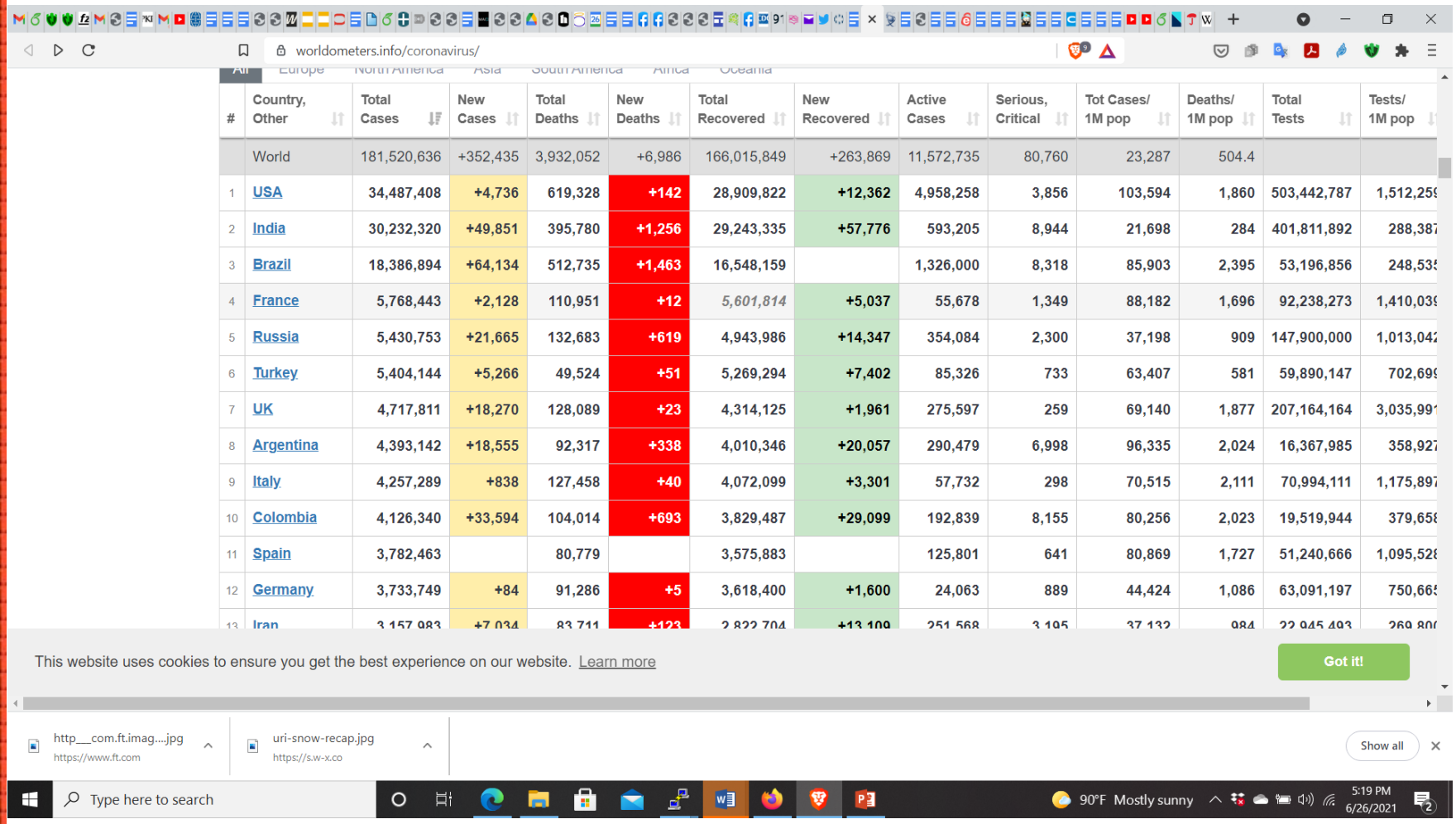
COVID-19: Public-Health Crisis



worldometers.info/coronavirus/

All | Europe | North America | Asia | South America | Africa | Oceania

#	Country, Other	Total Cases	New Cases	Total Deaths	New Deaths	Total Recovered	New Recovered	Active Cases	Serious, Critical	Tot Cases/ 1M pop	Deaths/ 1M pop	Total Tests	Tests/ 1M pop
	World	181,520,636	+352,435	3,932,052	+6,986	166,015,849	+263,869	11,572,735	80,760	23,287	504.4		
1	USA	34,487,408	+4,736	619,328	+142	28,909,822	+12,362	4,958,258	3,856	103,594	1,860	503,442,787	1,512,25
2	India	30,232,320	+49,851	395,780	+1,256	29,243,335	+57,776	593,205	8,944	21,698	284	401,811,892	288,38
3	Brazil	18,386,894	+64,134	512,735	+1,463	16,548,159		1,326,000	8,318	85,903	2,395	53,196,856	248,53
4	France	5,768,443	+2,128	110,951	+12	*5,601,814*	+5,037	55,678	1,349	88,182	1,696	92,238,273	1,410,03
5	Russia	5,430,753	+21,665	132,683	+619	4,943,986	+14,347	354,084	2,300	37,198	909	147,900,000	1,013,04
6	Turkey	5,404,144	+5,266	49,524	+51	5,269,294	+7,402	85,326	733	63,407	581	59,890,147	702,69
7	UK	4,717,811	+18,270	128,089	+23	4,314,125	+1,961	275,597	259	69,140	1,877	207,164,164	3,035,99
8	Argentina	4,393,142	+18,555	92,317	+338	4,010,346	+20,057	290,479	6,998	96,335	2,024	16,367,985	358,92
9	Italy	4,257,289	+838	127,458	+40	4,072,099	+3,301	57,732	298	70,515	2,111	70,994,111	1,175,89
10	Colombia	4,126,340	+33,594	104,014	+693	3,829,487	+29,099	192,839	8,155	80,256	2,023	19,519,944	379,65
11	Spain	3,782,463		80,779		3,575,883		125,801	641	80,869	1,727	51,240,666	1,095,52
12	Germany	3,733,749	+84	91,286	+5	3,618,400	+1,600	24,063	889	44,424	1,086	63,091,197	750,66
13	Iran	3,157,983	+7,034	83,711	+123	2,822,704	+13,109	251,568	3,195	37,132	984	22,945,493	269,80

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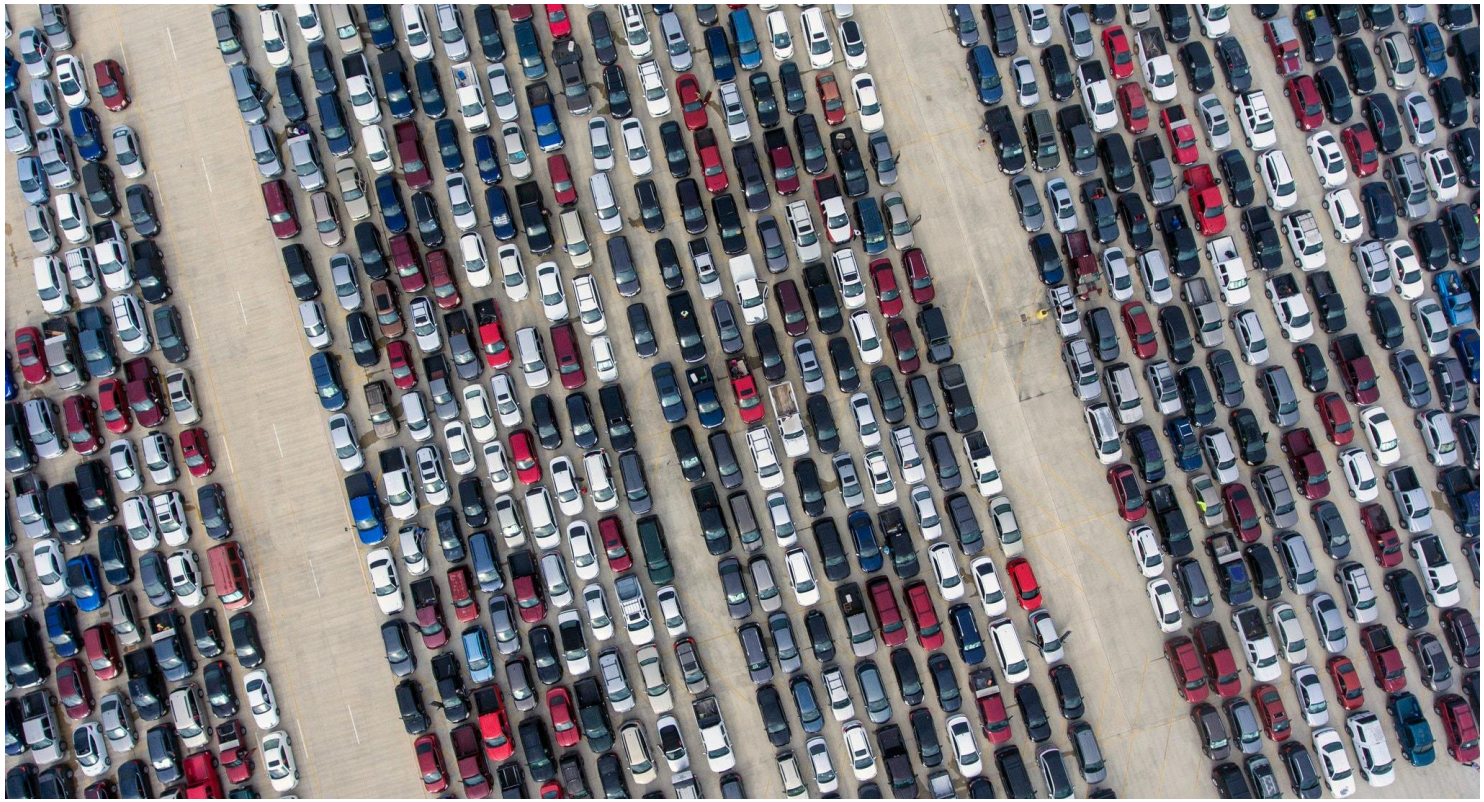
90°F Mostly sunny

5:19 PM
6/26/2021

COVID-19: Economic Crisis

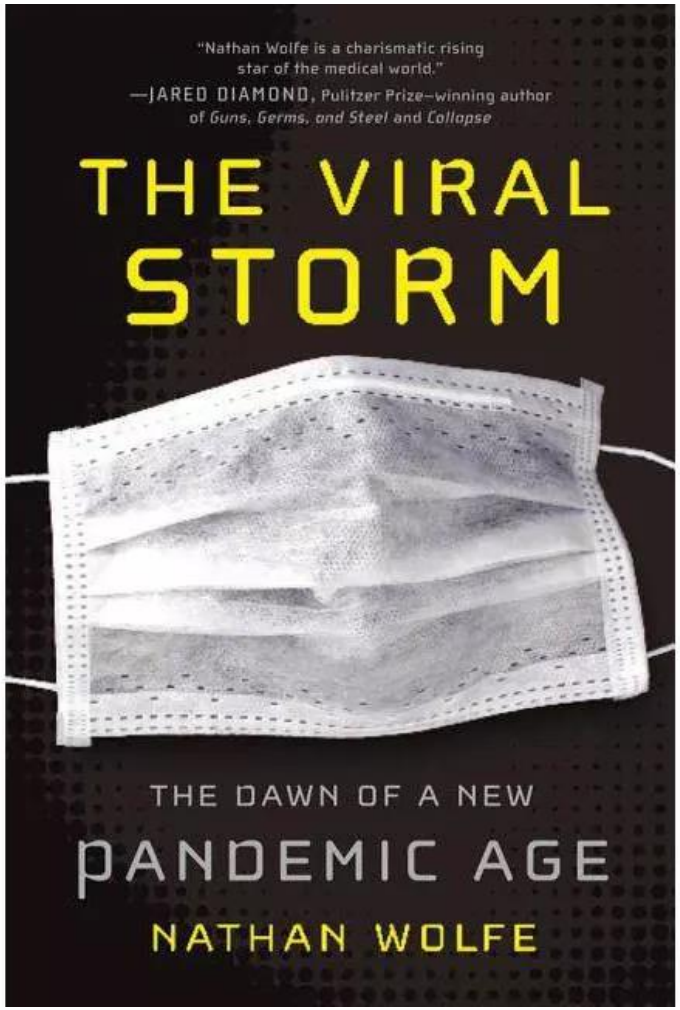
- WaPo, 11/25/'20: "26 million now say they don't have enough to eat, as the pandemic worsens and holidays near."



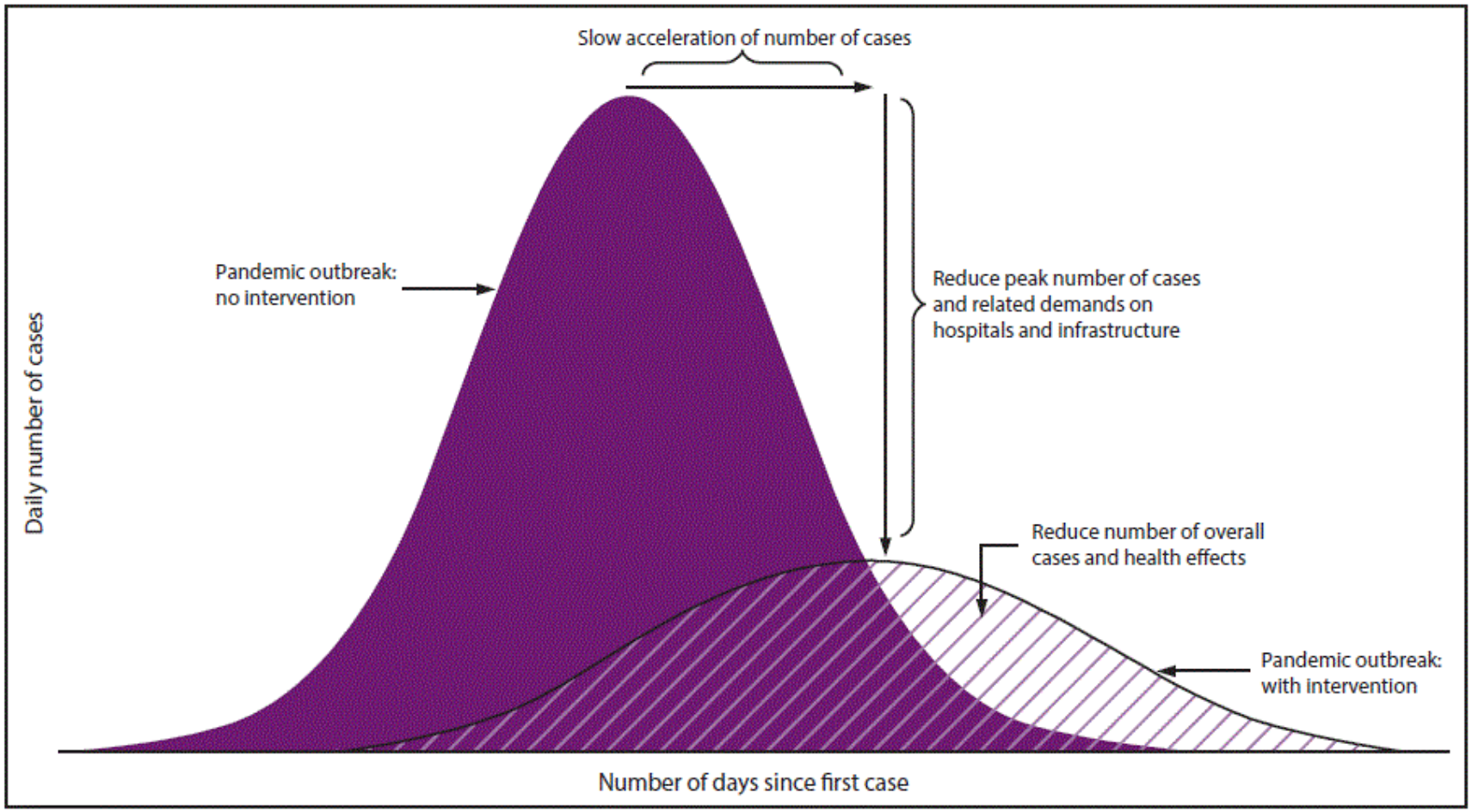
COVID-19: Social Crisis

COVID-19: Political Crisis

Why were we not ready?



March'20: Flattening the Curve



Why Flatten the Curve?

- Many hundreds of thousands of infections will happen — but they don't all have to happen at once!
- MarketWatch, April 2020: "Nurses are wearing garbage bags as they battle coronavirus: '*It's like something out of the Twlight Zone*'"

Resilience vs Efficiency

- William Galston, WSJ, March 2020: *Efficiency Isn't the Only Economic Virtue*
  - *"What if the relentless pursuit of efficiency, which has dominated American business thinking for decades, has made the global economic system more vulnerable to shocks?"*
  - *"Efficiency comes through optimal adaptation to an existing environment, while resilience requires the capacity to adapt to disruptive changes in the environment."*

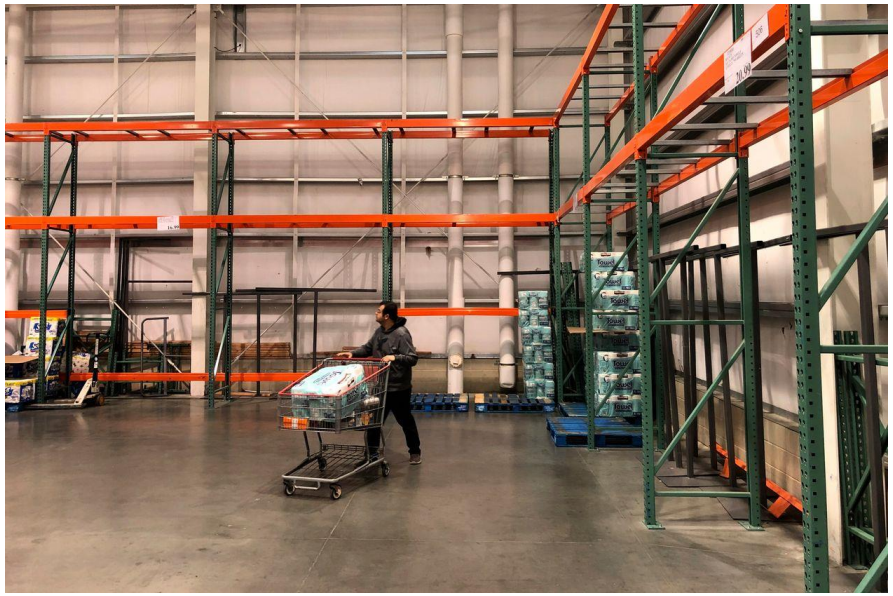
Resilience: ability to recover readily from illness, depression, adversity, or the like

Example: Just-in-Time

- **JIT Manufacturing**: *a methodology aimed primarily at reducing times within the production system as well as response times from suppliers and to customers.*
  - Reduce inventory costs by reducing inventory.
  - Parts should arrive "just in time".
- JIT manufacturing is highly efficient, but assumes *best-case logistics.*
  - *Efficiency at the expense of resilience.*

Why Are There Still Not Enough Paper Towels?

Sharon Terlep +Annie Gasparro, WSJ, Aug. 2020: "Blame lean manufacturing. A decades-long effort to eke out more profit by keeping inventory low left many manufacturers unprepared when Covid-19 struck. And production is unlikely to ramp up significantly any time soon.



Why Did Covid Overwhelm Hospitals?

Russell Gold Terlep +Melanie Evans, WSJ, Sept. 2020: **Why Did Covid Overwhelm Hospitals? A Yearslong Drive for Efficiency!**

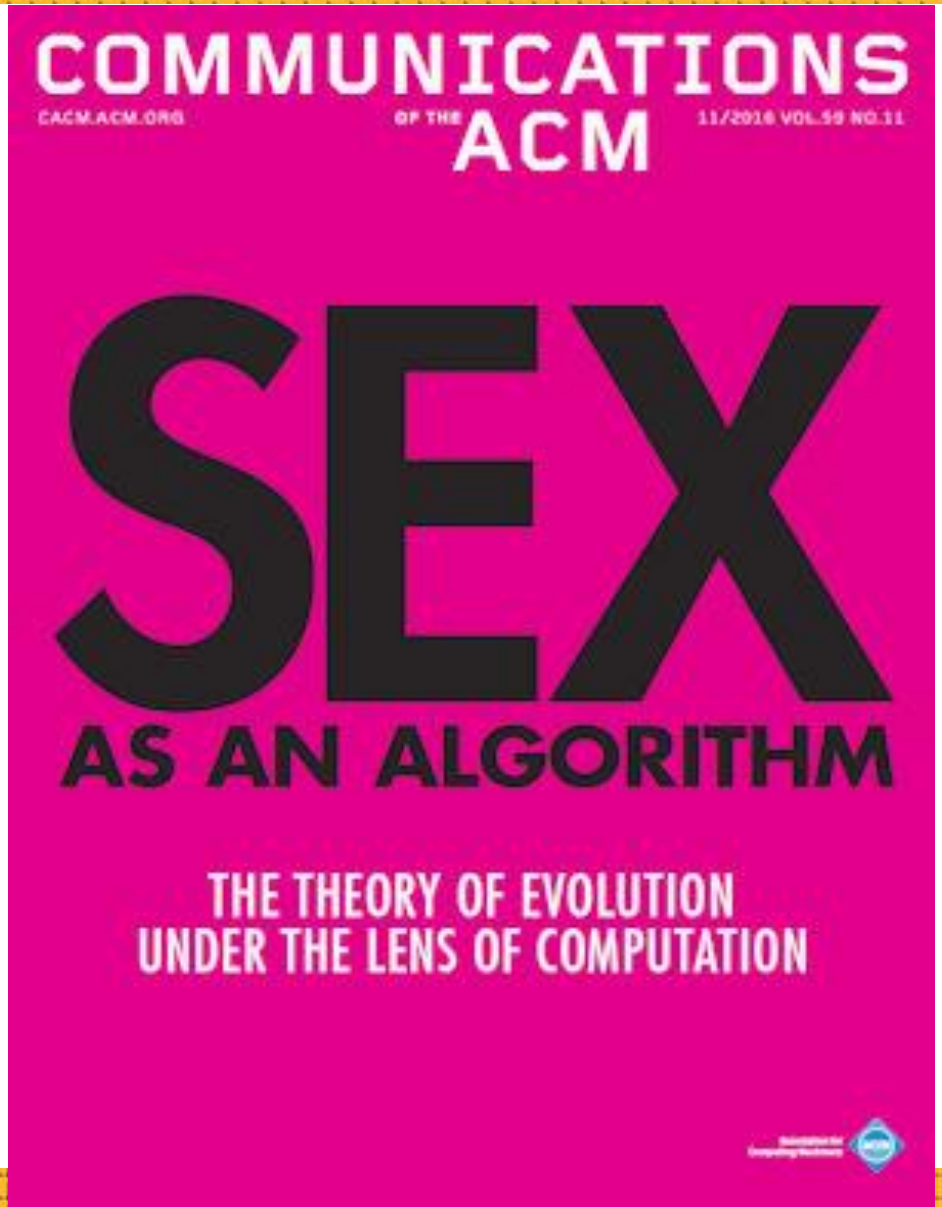
- "Health systems have kept a tight rein on employee numbers and expanded outpatient care, helping their finances but making them less prepared for a medical crisis."

- **Cost-Cutting at America's Nursing Homes Made Covid-19 Even Worse** – "The industry could have done more to stop the virus.", Ben Elgin, BusinessWeek, Oct. 2020
  - WSJ, Nov. 25, 2020: Covid-19 Deaths Top 100,000 in U.S. Long-Term Care Facilities

Resilience vs. Precarity

- ***The Secret Shame of Middle-Class Americans***: *Nearly half of Americans would have trouble finding $400 to pay for an emergency. (The Atlantic, May 2016)*
- ***American Living on the Financial Edge***: *Two-third of Americans would have trouble immediately paying an unanticipated bill of $1,000 (Associated Press, May 2016)*
- *Adam Serwer, The Atlantic, June 2020*: ***It Didn't Have to Be Like This*** *– "The desperation of US workers in the aftermath of the coronavirus was the product of a series of policy decisions and missed opportunities."*

Resilience and Efficiency in Nature



Sex as an Algorithm, I

- A. Livnat and C. Papadimitriou, *CACM*, 11/2016:
  - Computational experience has shown that *Simulated Annealing*, which is a local search—via a sequence of small mutations—for an optimal solution, is, in general, superior computationally to *Genetic Algorithms*, which mimic sexual reproduction and natural selection.
  - Why then has nature chosen sexual reproduction as almost the exclusive reproduction mechanism in animals?

Sex as an Algorithm, II

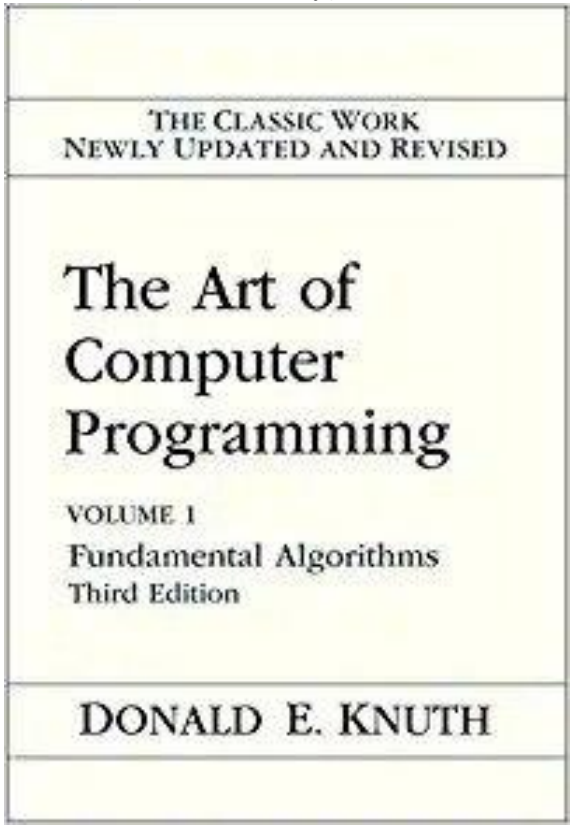
- A. Livnat and C. Papadimitriou, *CACM*, 2016:
  - Sex as an algorithm offers advantages other than good performance in terms of approximating the optimum solution.
  - In particular, sexual reproduction favors genes that work well with a greater diversity of other genes, and this makes the species more adaptable to disruptive environmental changes, that is to say, *more* ***resilient***.

Efficiency & Resilience as Optimization

- **Efficiency**: Short-term optimization
- **Resilience**: Long-term optimization
- Nature prefers long-term to short-term optimization
  - Why? ***Survival***!
  - **Example**: Dinosaurs -- "It's not the strongest of the species that survives, nor the most intelligent. It is the one that is most adaptable to change."--Darwin

Efficiency vs Resilience in Computing

- Wikipedia: "In computer science, the ***analysis of algorithms*** is the process of finding the **computational complexity** of algorithms—the amount of time, storage, or other resources needed to execute them."
  - It's all about ***efficiency***!



Example: PageRank

- PageRank is an algorithm used by Google Search to rank web pages in their search engine results. PageRank was named after Larry Page, one of the founders of Google. PageRank is a way of measuring the importance of website pages.
- PageRank works by counting the number and quality of links to a page to determine a rough estimate of how important the website is. The underlying assumption is that more important websites are likely to receive more links from other websites.

Search-Engine Optimization

- ***Search engine optimization*** (SEO) is the process of growing the quality and quantity of website traffic by increasing the visibility of a website or a web page to users of a web search engine.
- In other words: PageRank ***is not resilient***.
- Today:
  - The PageRank patent has expired.
  - Google's search-result-ranking algorithm is a trade secret.

Friction in Computing

- MYV, *CACM*, 2013: "Our discipline is dedicated to ***reducing friction***. Latency must be eliminated, bandwidth must increase, and ubiquity should be universal. Our goal is to reduce the friction of computing and communication as much as possible."
- Meta's CEO Mark Zuckerberg speaks of "***frictionless sharing***" as a goal!
- We now know that the "utopia" of frictionless sharing leads to filter bubbles, fake news and extreme content.

The Flash Crash

- On 5/6/'10, 2:45 P.M., the U.S. stock market declined steeply, with the DJIA plunging about 600 points in five minutes. U.S. SEC and CFTC identified high-frequency trading as the cause of the crash.
- Proponents of high-frequency trading say it helps make the markets more "liquid."
- Thomas Peterffy, a high-frequency trading pioneer: "*Today's drive for speed has absolutely no social value.*"
- E. Budish, P. Cramton, J. Shim, 2015: "*The high-frequency-trading arms race is a symptom of flawed market design.*"

Frictionful Computing

- Imagine a mechanical engineer who declares that her goal is to eliminate *all* friction, period. We would view this as ***insane***.
- The world cannot function without friction. The goal should be to have the right amount of friction, in the right place, in the right time.
- Yet computer science seems committed to the total elimination of friction in computing.
- **Plea**: *Welcome back friction in computing*!

Security Last

A view from the security trenches: *"First, somebody builds a thing. And it's super useful. Then eventually somebody else comes along and finds a vulnerability. Then security becomes a part of the engineering process. Just like we need to make sure our code doesn't have bugs that make it crash, we also need to make sure that our code doesn't have bugs that can be exploited for bad purposes. Turn the crank for enough years, and eventually security gets better."*

TechRepublic, 12/'20: "A survey of nearly 1,200 FOSS contributors found security to be low on developers' list of priorities."

The State of Cyberinsecurity

- So here we are, 75 years into the computer age and after four ACM Turing Awards in the area of cryptography (**but none in cybersecurity**), and we still do not seem to know how to build secure information systems.
- The risk is no longer merely about compromised privacy. We must worry now about the **integrity of vital infrastructure** components – NYT 5/9/'20: "*Major pipeline forced to close by cyberattack.*"
- And yet, *the computing community marches forward with* ***no special sense of urgency***.

Cyber Libertarianism

- Over the past 100 years, the amount of vehicle miles traveled has been steadily increasing, but fatalities with respect to vehicle miles traveled have been decreasing.
- U.S. Congress established the National Transportation Safety Board in 1926. Why is there no National Cyber Security Board?
- Cyber libertarianism is a common attitude in the tech community: "*regulation stifles innovation*".
- Tech has not been able to address the cybersecurity situation on its own; IMHO, it is time to get governments involved.

Back to Economic Efficiency

- The relentless pursuit of efficiency prevented us from investing in getting ready for a pandemic, in spite of many warnings over the past several years, and pushed us to develop a global supply chain that is quite far from being resilient.
- Feb. 27, 2020: President Trump defends huge cuts to the CDC's budget by saying the government can hire more doctors "when we need them" during crises.
  - *The Trump Administration shut down CDC's Vaccine Safety Office in 2019.*

Economic Efficiency

- ***Economic efficiency*** means goods and factors of production are distributed or allocated to their most valuable uses and waste is minimized.
- Free-market advocates argue that through individual self-interest and freedom of production as well as consumption, economic efficiency is achieved and the best interest of society, as a whole, are fulfilled.
  - Dani Rodrik, 5/'21: "Economists tend to be enamored of the power of markets to promote overall economic prosperity."
- Does efficiency guarantee optimality?

"First Welfare Theorem"

FWT: Under certain assumptions, a free market will tend toward a competitive, Pareto-optimal equilibrium.

In other words: Free markets produce economic efficiency.

Question: How well does such an equilibrium serve the best interest of society?

Price of Anarchy

- Koutsoupias+Papadimitriou, 1999: Use the ratio between the worst possible Nash equilibrium and the social optimum as a measure of the "price of anarchy" in free markets.
  - *The price of anarchy can be arbitrarily high, depending on the complexity of the system.*

- **In other words**: *Economic efficiency does not guarantee the best interests of society, as a whole, are fulfilled!*

Reaching Equilibria

- Daskalakis, Goldberg, and Papadimitriou, 2005: How long it takes until economic agents converge to an equilibrium?
  - *There are systems in which convergence to mixed Nash equilibria can take an exceedingly long time.*
- Markets are very unlikely ever to be in an equilibrium, because the underlying variables, such as prices, supply, and demand are very likely to change during slow convergence.
  - The Economist, 2/'21: "*There has been too much focus on equilibrium.*"
- **So**: *No efficiency and no optimality*!

Greed is Good?

- In the 1987 movie Wall Street, Michael Douglas as Gordon Gekko gives a speech where he said, "*Greed, for lack of a better word, is good*!"
  - **Argument:** Adam Smith's "Invisible Hand"
- **But**: Every senior CS students knows that greedy algorithms get stuck in local optima. A systemic intervention is needed to drive them out of such optima.
- **Question**: How do we get out of the "local optimum" of cyber insecurity? ***Market failure***!

Free Trade

- David Ricardo, 1817: *If two countries capable of producing two commodities engage in free trade, then each country will increase its overall consumption by exporting the good for which it has a comparative advantage while importing the other good.*
  - Bloomberg, 1/22: *"Europe sleepwalked into an energy crisis that could last years."*
  - **And**: *"Taiwanese companies supply 63 percent of global semiconductors, compared with 12 percent by U.S. manufacturers."*
- Free trade is efficient, but not resilient!

COVID-19: What Did Work?

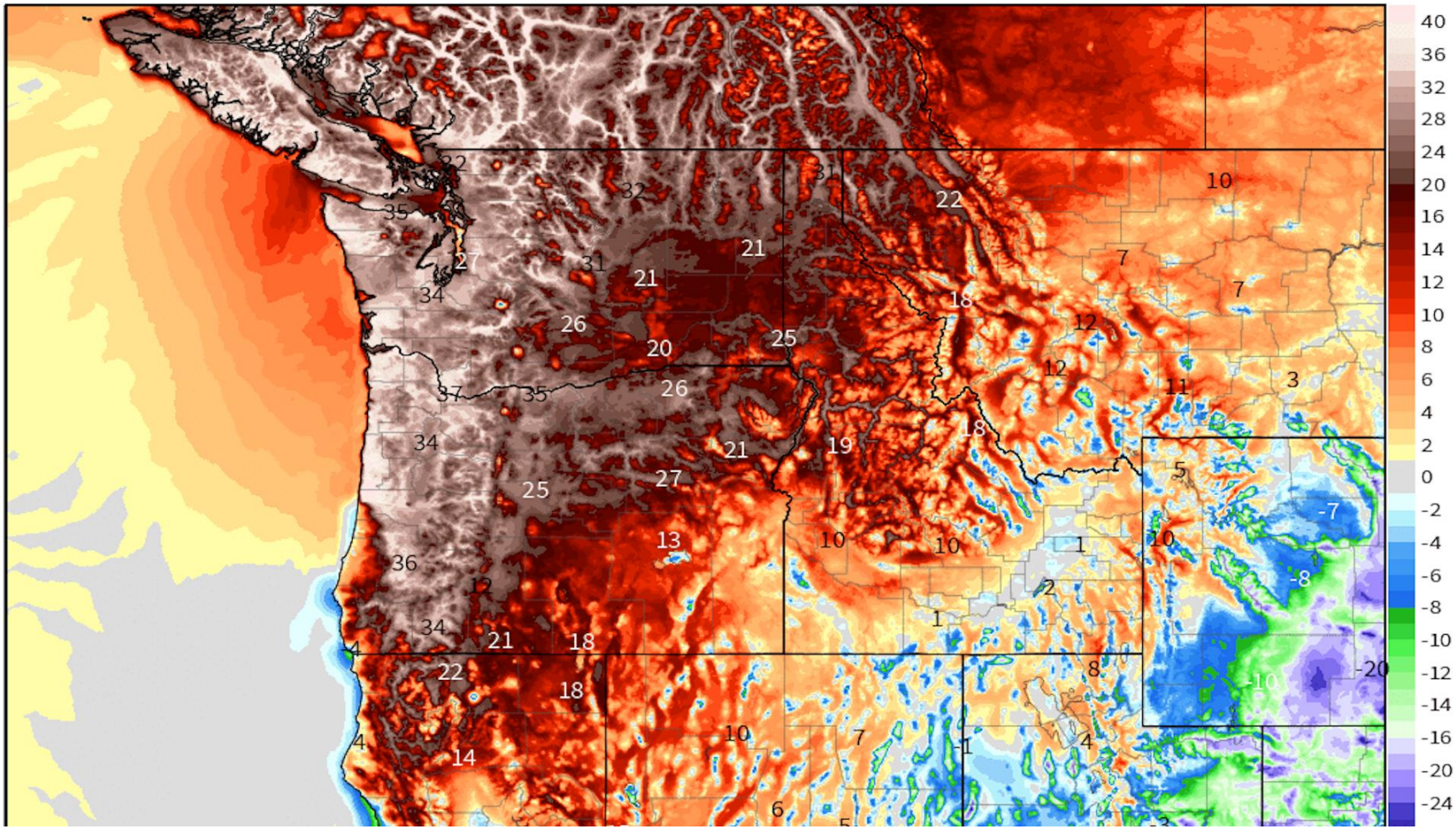
- *The Internet saved the world!*
  - We are working from home, shopping from home, teaching from home, learning from home, seeing doctors from home.
- **Key design principle**: Redundancy!
  - Background: error-correcting codes – 1947, reliable organisms – 1956.
- **After 2008**: bank stress tests
  - Redundancy of capital
- **But**: Redundancy is not efficient!

In Summary

- **Resilience** is a fundamental, but under-appreciated, societal need.
- Both computing and economics need to increase their focus on resilience.
- Markets/people are bad at preparing for *low-probability or very long-term events* (e.g., people have to be forced to buy insurance) – ***societal action required***.
- Adam Tooze, NY Times, 9/21: *What if the Coronavirus Crisis Is Just a Trial Run?*

Pacific Northwest bakes under once-in-a-millennium heat dome

- 6/21: Nearly 500 dead in British Columbia amid historic heat wave



Climate change has gotten deadly

- 7/21, WaPo: The emergency department at Oregon Health Sciences University had rarely been this busy, even during the worst stages of the covid-19 pandemic.
  - "The system was overwhelmed," said Mary Tanski, chair of OHSU's department of emergency medicine, of the towering heat dome that toppled temperature records across the Northwest this week.

Who Will We Be When This Is All Over?

- Fareed Zakaria, WaPo, 10/'20: "The pandemic upended the present. But it's given us a chance to remake the future."
- Matt Simon, Wired, 12/'20: "The Covid-19 pandemic has brought incalculable suffering and trauma. But it also offers ways for people—and even societies—to change for the better."

- MYV: How will AC be different than BC?
  - Wired, 7/'20: "*From the fallen Champlain Tower to climate change, humans haven't yet learned to avoid catastrophes they know are coming.*"

Digital Humanism

- Ada Lovelace, 1843: "I wish to add my mite towards expounding & interpreting the Almighty, & his laws & works, ***for the most effective use of mankind***."