Visualization and the COVID-19 Pandemic

Scientific Visualization

Professor Eric Shaffer

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What is Visualization? Why do it?

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

- Professor Tamara Munzner

What tasks is visualization used for?

A good question…we need to understand how this tool is best used.

Let's look at some examples and develop some ideas

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Geography of COVID-19

This type of display is called a dashboard

Shows case incidence in geographic regions

You can see change over time

COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)

Geography of COVID-19
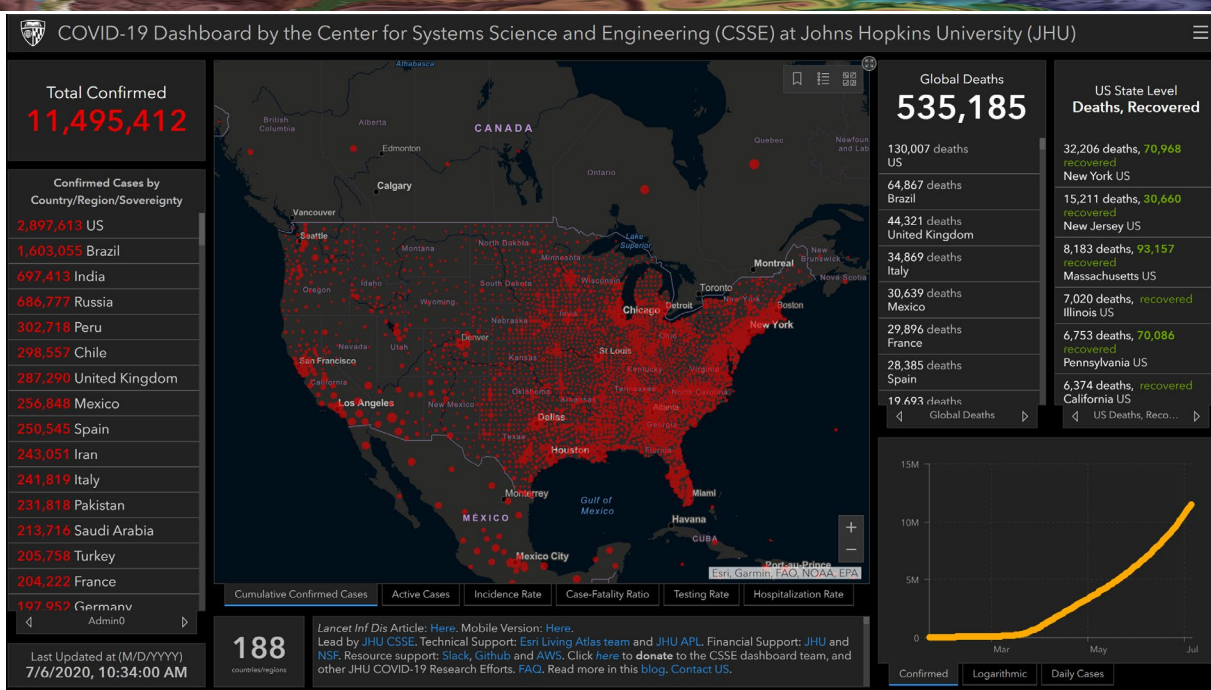
What is the task?

- Reveal patterns

- Explore data and make decisions
  - e.g. resource allocation to different geographic areas
  - e.g. adapting policies to different regions

COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)

Understanding Exponential Growth
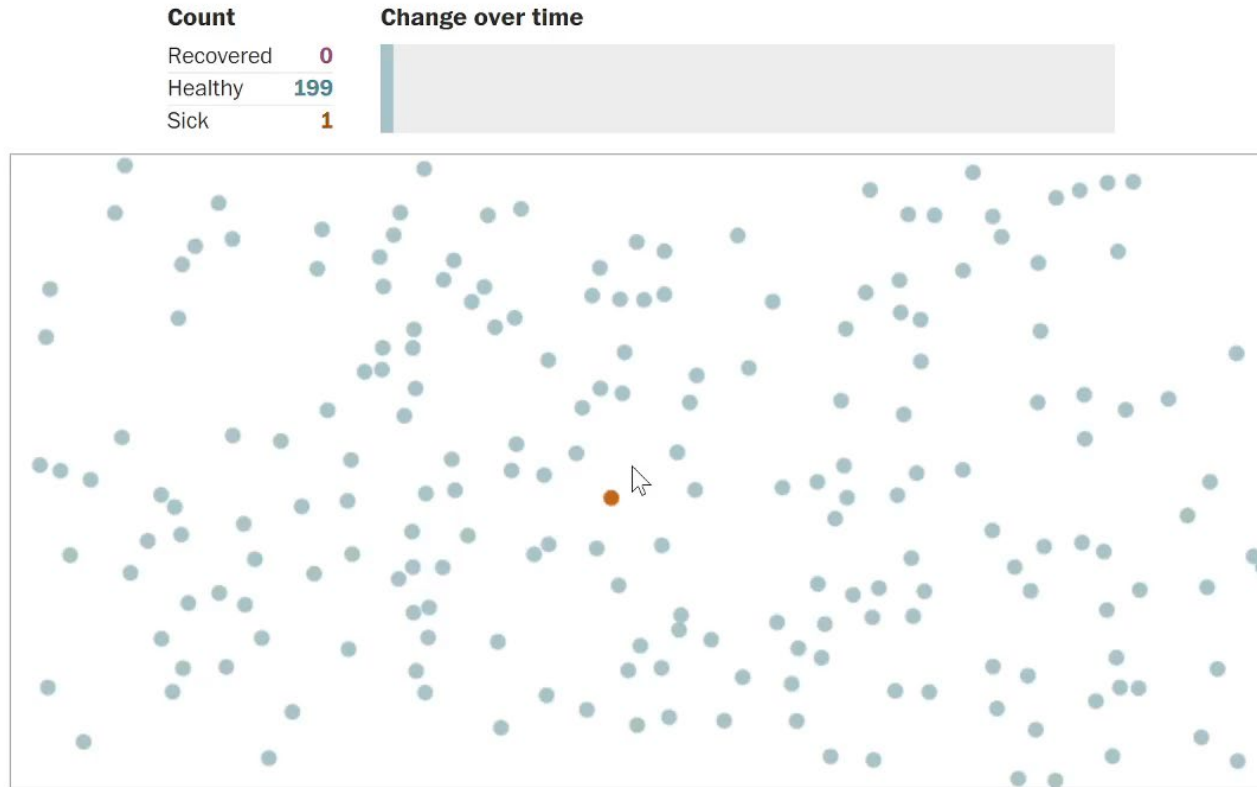
Simulation of disease spread

Why outbreaks like coronavirus spread exponentially, and how to "flatten the curve"
By Harry Stevens, Washington Post, March 14, 2020

Understanding Exponential Growth
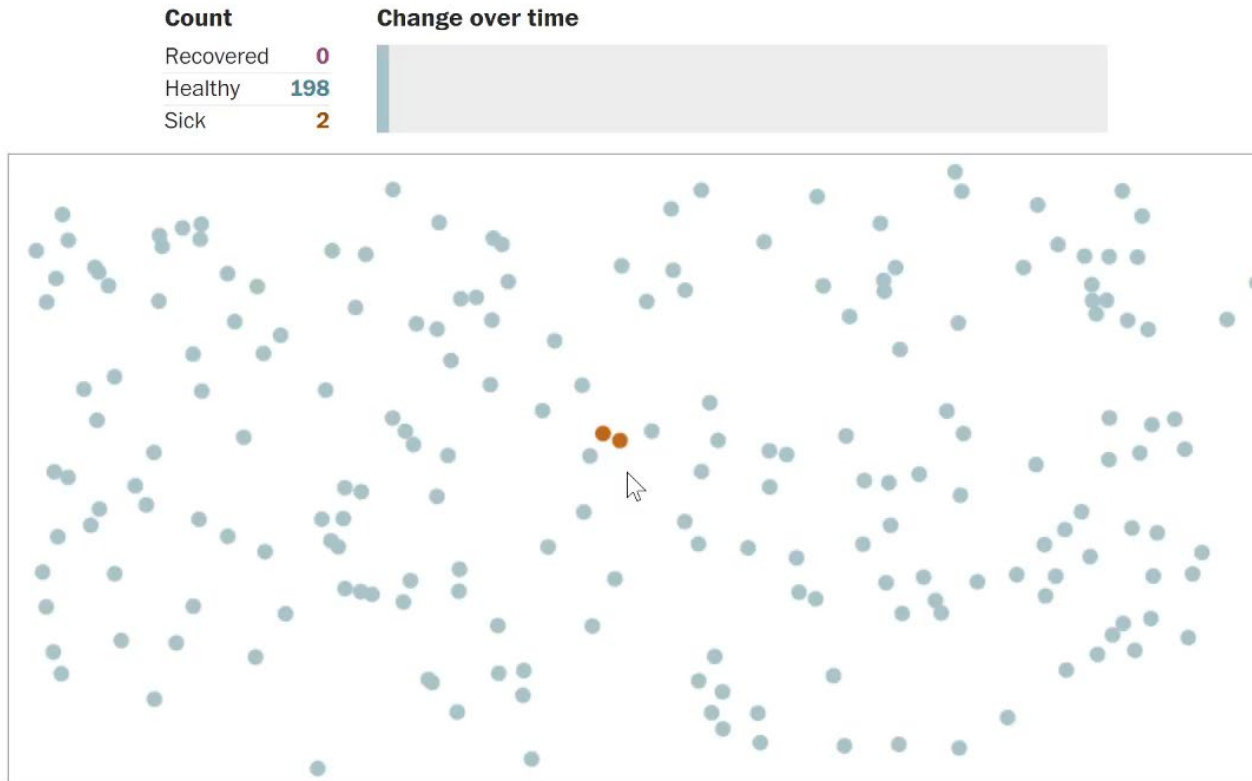
Simulation of disease spread

75% of population uses social distancing

Why outbreaks like coronavirus spread exponentially, and how to "flatten the curve"
By Harry Stevens, Washington Post, March 14, 2020

Understanding Exponential Growth

These visualizations can be used to:

- to explore data and answer questions

- to communicate ideas

- generate hypotheses

- to persuade or inspire

Why outbreaks like coronavirus spread exponentially, and how to "flatten the curve"
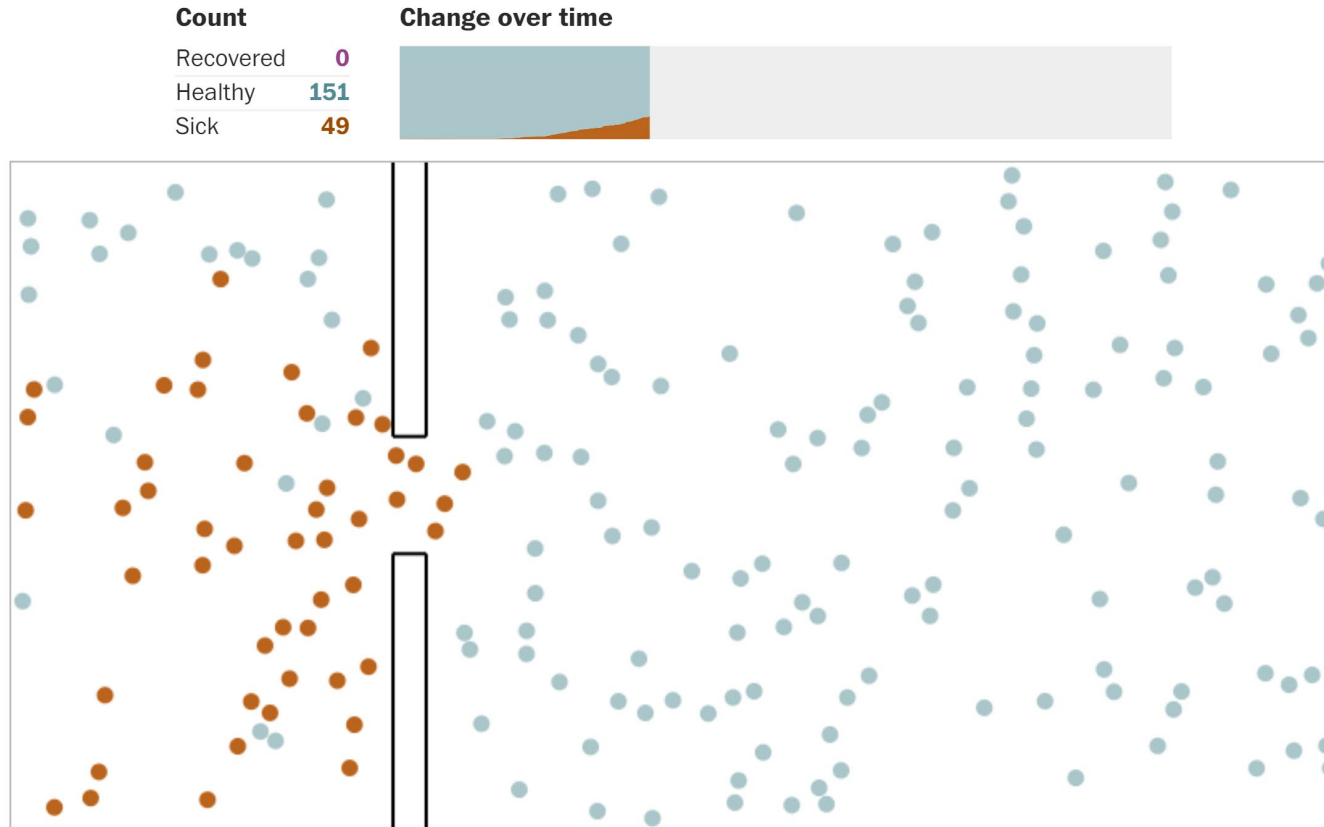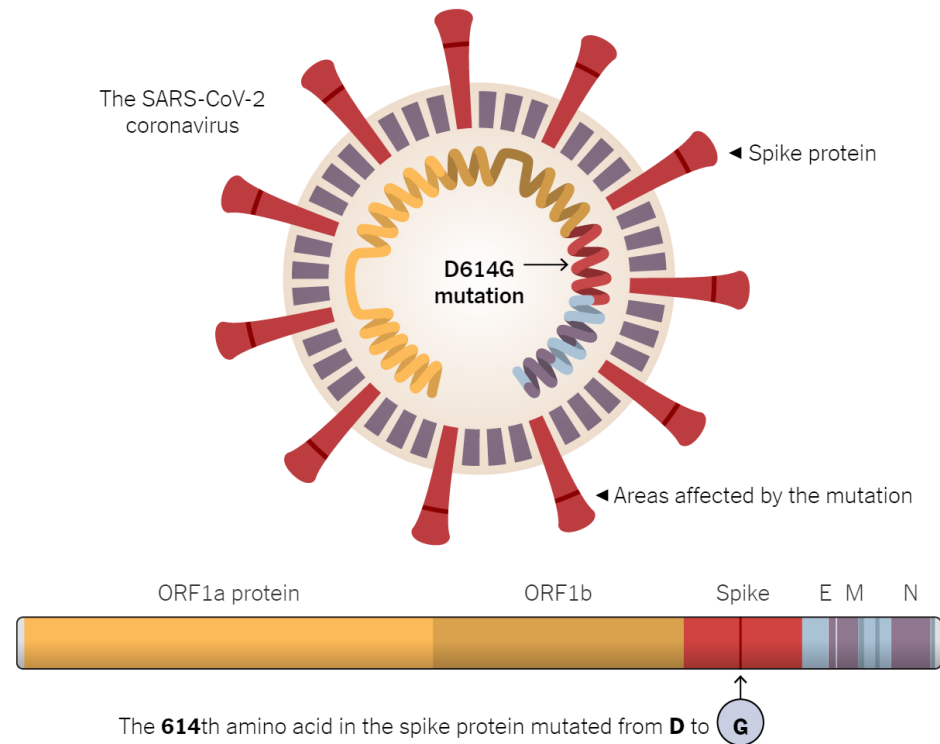By Harry Stevens, Washington Post, March 14, 2020

COVID-19 Protein Structure

The D614G Mutation

A tiny mutation in the coronavirus genome may stabilize the spike proteins that protrude from the virus and allow it to infect more cells — at least in laboratory experiments.

The SARS-CoV-2 coronavirus

D614G mutation

◄ Spike protein

◄ Areas affected by the mutation

ORF1a protein | ORF1b | Spike | E | M | N

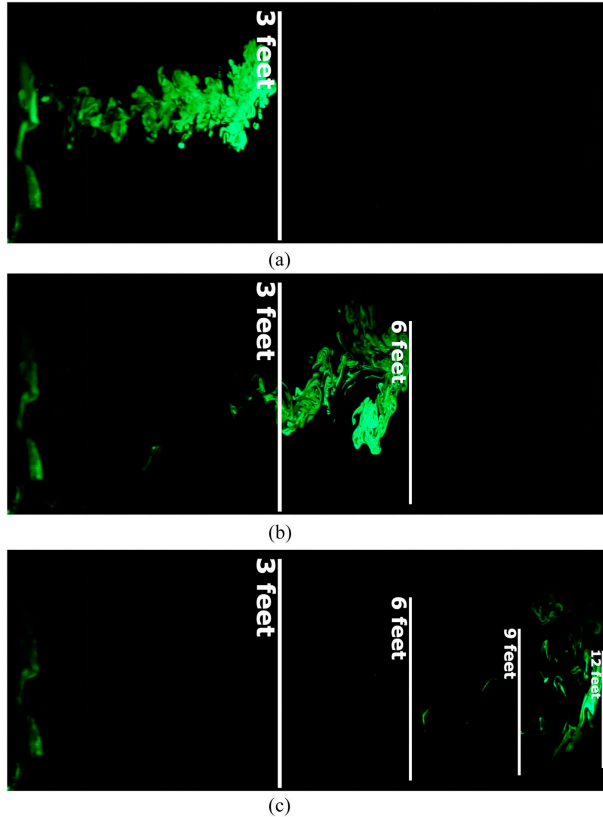The **614**th amino acid in the spike protein mutated from **D** to G

The D614G mutation in the SARS-CoV-2 spike protein reduces S1 shedding and increases infectivity

Lizhou Zhang, Cody B Jackson, Huihui Mou, Amrita Ojha, Erumbi S Rangarajan, Tina Izard, Michael Farzan, Hyeryun Choe1

Visualization used to communicate ideas

Mask Usage and Fluid Dynamics

No mask

High speed photography of a physical experiment
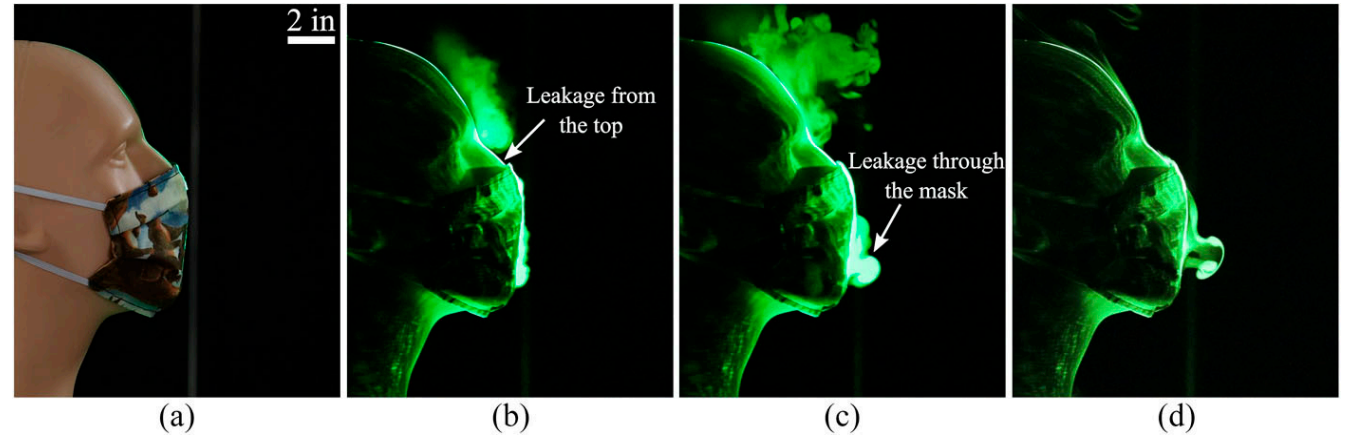
A homemade face mask stitched using two-layers of cotton quilting fabric. Images taken at (b) 0.2 s, (c) 0.47 s, and (d) 1.68 s after the initiation of the emulated cough.

Visualizing the effectiveness of face masks in obstructing respiratory jets

Siddhartha Verma, Manhar Dhanak, and John Frankenfield, Physics of Fluids 32:6

Mask Usage and Fluid Dynamics
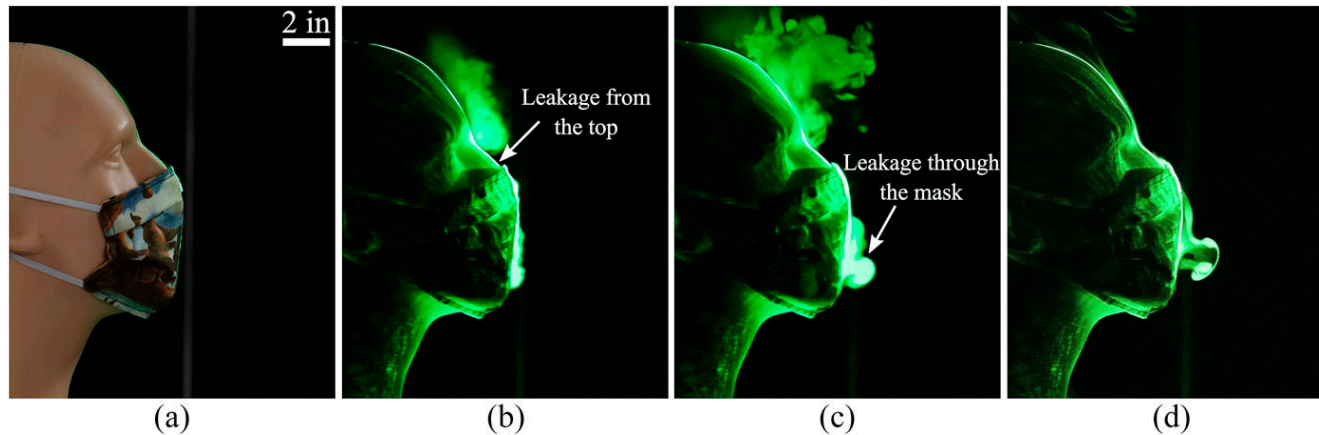
Visualization used to answer questions...which if any masks effectively contain respiratory jets?

Visualization used to communicate and persuade... homemade masks can significantly reduce the spread of a respiratory jet.

Visualizing the effectiveness of face masks in obstructing respiratory jets

Siddhartha Verma, Manhar Dhanak, and John Frankenfield, Physics of Fluids 32:6

CT Scans

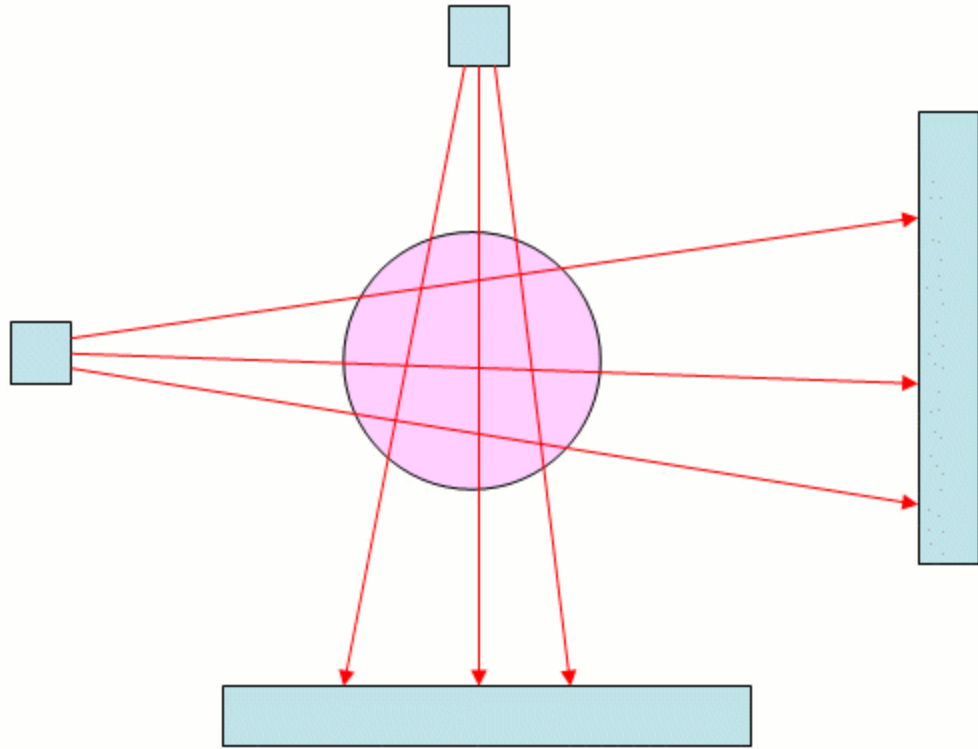A computerized tomography (**CT**) **scan** uses X-rays to generate a series of 2D images that record the observed tissue density.

These images are then combined to create a 3D data set detailing the observed internal structures.

CT Scans

Used to generate hypotheses ...how does Covid-19 affect the respiratory system.

Used to answer questions...to develop a diagnosis.

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Visualization: Purpose

Some tasks for which visualization is used:

- to explore data and answer questions

- to communicate ideas

- find/reveal patterns and generate hypotheses
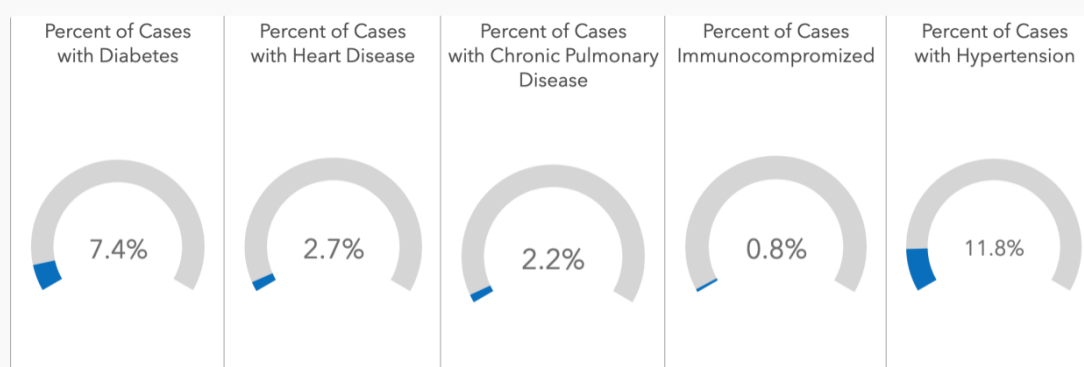
- to persuade or inspire

...surely other reasons as well

The ubiquity of visualizations during the Covid-19 pandemic shows their value.

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Misleading Visualizations

Visualization is notorious in its ability to mislead

- Sometimes intentionally…a sub-category of the "persuade" task

Percent of Cases with Diabetes	Percent of Cases with Heart Disease	Percent of Cases with Chronic Pulmonary Disease	Percent of Cases Immunocompromized	Percent of Cases with Hypertension
7.4%	2.7%	2.2%	0.8%	11.8%

The graphic above, from this page, shows the rate of different preexisting health conditions in patients confirmed to have Covid-19. Because all of these percentages are so low—and they're depicted on a scale that goes up to 100%—it seems like having another condition like hypertension isn't a big deal.

How bad Covid-19 data visualizations mislead the public
June 25, 2020, Quartz, By Katherine Ellen Foley

Using percentages and unordered arcs gives the impression that few people are at risk…may not be true.

Images impart a great deal of information

Great care is required to ensure the information conveyed is accurate

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Insight and Numbers and Pictures

"The purpose of computation is insight, not numbers."

- Professor R.W. Hamming

"The purpose of visualization is insight, not pictures."

- Professor Tamara Munzner

Corollary: Do not use visualization to accomplish a task better done without it.

For example…finding if the number 519 occurs in a list of numbers

Hamming received his Ph.D. from the University of Illinois at Urbana-Champaign in 1942

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