IOT for an aging population, smart thermometers, smart cities

IOT Freshman Seminar
Tue Octobert 24, 2023

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IOT in the news - October 24, 2023

California suspends GM Cruise self-driving vehicles as 'not safe' for public

Reuters

October 24, 2023 12:32 PM PDT · Updated 28 min ago

Cruise's AVs posed an "an unreasonable risk to public safety," and "are not safe for the public's operation" California's Department of Motor Vehicles (DMV) said in a statement.

… and DMV says Cruise had misrepresented information related to the safety of the autonomous technology

Oct 2. A Cruise **self-driving** vehicles was putting on the brakes but did not avoid striking a pedestrian who had previously been struck by a hit-and-run driver

Big Money

In June, GM CEO Mary Barra reiterated a forecast that Cruise could generate $50 billion a year in annual revenue by 2030, a target the company has not backed away from. The automaker reported on Tuesday that it **lost $723 million on Cruise** during the third quarter.

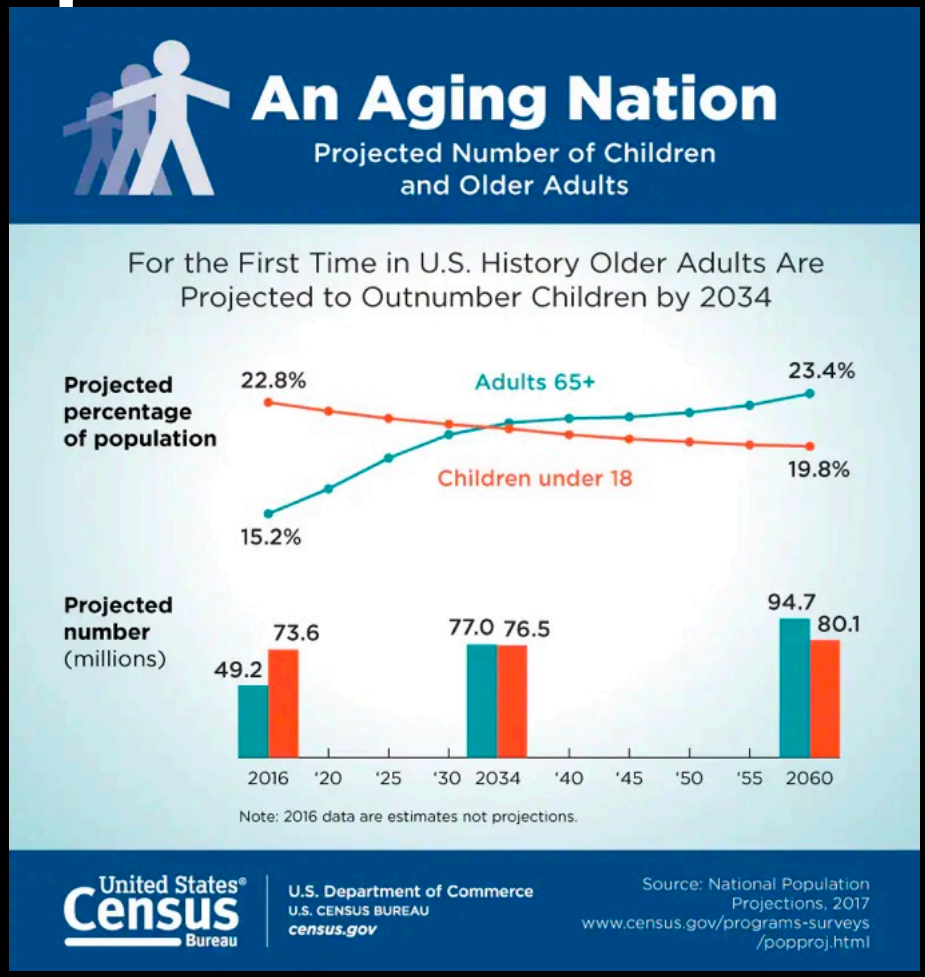
Blitz Capitalism to capture the market
Like Uber/Lyft/Air-BnB

IOT For The Aging Population

Incredibly important

IOT For The Aging Population

- 2030 will be a tipping point
- The number of 65+ adults will **outnumber** children under 18
- At the same time, the ratio of working-adults to adults 65+ will **decrease**
- Do we need to think about how we will care for this 65+ population?



IOT For The Aging Population

Incredibly important

- Our population is aging
- This is in part due to improvements in health care, diet, lifestyle
- There is an increasing need (as a society) to ensure elderly people retain as high a quality of life as possible
- Independence is a big issue, allowing people to “age in place”
- In 2019, the average cost of assisted living in the US is around $4,000 per month—with nursing homes costing more than **double** that
- How can IOT help with this?

IOT For The Aging Population

How can IOT help with this?

- It is simple, can help by using existing **smart home** systems

  Home security cameras for communication with others or for monitoring who is coming and going

  Smart lighting for dark hallways and entryways

  Smart plugs with timers that can ensure devices like space heaters, fans, heating and cooling are on and off at appropriate times of day

  Door sensors to detect if they are opened or closed and how long they are open

  Smart Appliances to ensure the oven is not left on

- Thus, there is a critical need to **make these smart-home systems “just work”**
- Currently, the smart home is a bit disorganized, once it is improved we should see a huge increase in its utility. I would predict an “IOT Version 2.0”

IOT For The Aging Population

What about smart watches and phones?

IOT For The Aging Population

What about smart watches and phones?

- There is sometimes a feeling of “Stigma” when wearing a dedicated alert device. Devices like “Life Alert” and others. Will review life alert later.
- Although smart watches and phones might represent the younger generation, it may be possible to have these devices be adopted by the aging population
- Most smart watches and phones are including more and more “fall alert” software

IOT For The Aging Population

Fall alert on a smart phone/watch

- Settings in software allow calls to be made, emails and text messages to be sent
- These calls can go directly to 911 and email/text is designed for family, friends, caregivers, doctors
- There is some simple logic

  If a fall is detected you have 1 min to call for an emergency or cancel the alert

  If a fall is detected and there is no movement for 1-min (you are unconscious) then the call is automatically made
- Additional medical information can be sent such as existing conditions, prescription drugs, etc
- What are some barriers that may limit the number of older folks using this technology?

IOT For The Aging Population

How can IOT help with this? - What are the considerations and goals?

- This kind of IOT poses a unique set of ethical considerations and concerns
- The decision to install any devices should be made with the consultation and approval of the senior in question
- Primary goal is to make the aging population: safer, more comfortable, and more independent
- Secondary goal is to provide peace of mind to family, friends, and care givers

IOT For The Aging Population

Caring for someone with Alzheimer's in your home

People with advanced Alzheimer's are known to wander off, potentially get lost and inadvertently harm themselves

IOT For The Aging Population

A personalized silver-alert

- A smart home can be set up to monitor these individuals: for their health and safety and the peace of mind of their family (for example, when they have to go to work)
- Includes a number of internet connected “things” that can be remotely monitored and controlled, including:

  Always on video conferencing just to interact and chat

  Cameras to monitor

  Motion detection near entrances/exit and next to car

  Monitoring if doors are open/closed

  GPS tracking of a car

  Monitoring if appliances like ovens or heaters are left on

Friend of mine did this

Was useful so she could go her her father when he randomly drove off

At first he was usually at the golf course

Later he would drive to random destinations and not know how to get home

IOT For The Aging Population

I've fallen and I can't get up!

I do not want to make light of this topic

… but for **historical** purposes …

IOT For The Aging Population

I've fallen and I can't get up!

- This is a **1989** commercial
- "I've fallen, and I can't get up”
- Actually registered as a trademark
- Became a pre-internet “meme” with the phrase on t-shirts, in music, and tv-shows

IOT For The Aging Population

Life Alert

- Through today (2023), Life Alert is expanding its portfolio
- Including: Alert buttons to keep in a bag or pocket, wristbands, and necklaces
- Alert buttons to place in certain locations like the shower.
- **<u>Sadly, many consumer-advocacy groups flag them as predatory</u>**

  Misleading advertising

  High prices

  Aggressive marketing (robo calls, mass mailing)

  Long-term contracts are required and confusing to get out of

They are still at it

https://www.lifealert.com/protectionservices.aspx

IOT For The Aging Population

What is the sensor technology and network architecture?

- The still available “Life Alert” is just a simplified cell phone, pushing a button makes the call and you can speak into the microphone … “I’ve fallen and I can’t get up”.
- Calls get routed to a call center, not directly to 911
- Lots of other companies offering potentially superior products: MobilHelp, MedicalGuardian, OneCallAlert
- $25/month + $10/month for fall detection (up to $50/month)

IOT For The Aging Population

What is the sensor technology and network architecture?

- The company Life Alert does not use sensors, it is just a **button** to make a cell phone call (thus the high per monthly rates)
- Sensor: **Fall alert** uses an accelerometer (you have one in your phone). When you fall, the call center gets called and you have to speak
- Network architecture is not advanced, mostly just have a cell phone chip with a voice/data plan.
- What is the difference between this solution versus using a smart watch/ phone?

The watch/phone can be configured and have much more logic to help in emergencies. Can also provides less stigma, it integrates and becomes natural and invisible

Future: Incorporate all this into the smart-home, phone, smart-watch

Make this IOT system ubiquitous, efficient, optimized

IOT For The Aging Population

Recap

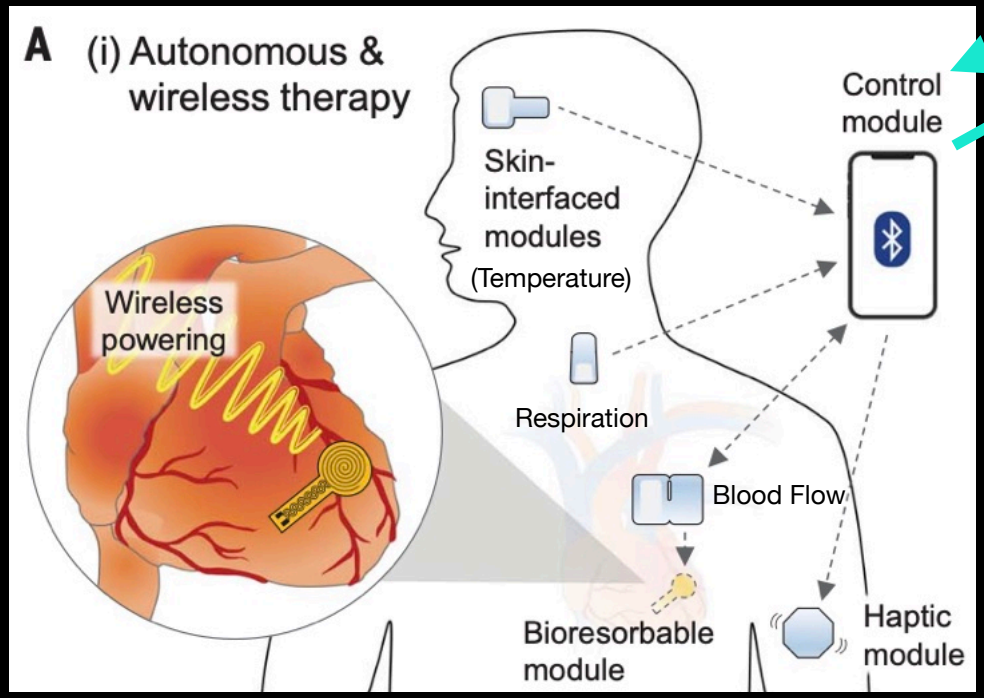
- Will become increasingly important in the next decade(s)
- Unique set of considerations including making user aware of technology monitoring them
- Goal is to provide quality of life, independence, and to “age in place”
- Good thing is, most “smart home” technology is a perfect tool
- Critical need to make the “smart home” just work
- IOT Version 2.0 (we are seeing this with standardization of protocols like **Meta**)

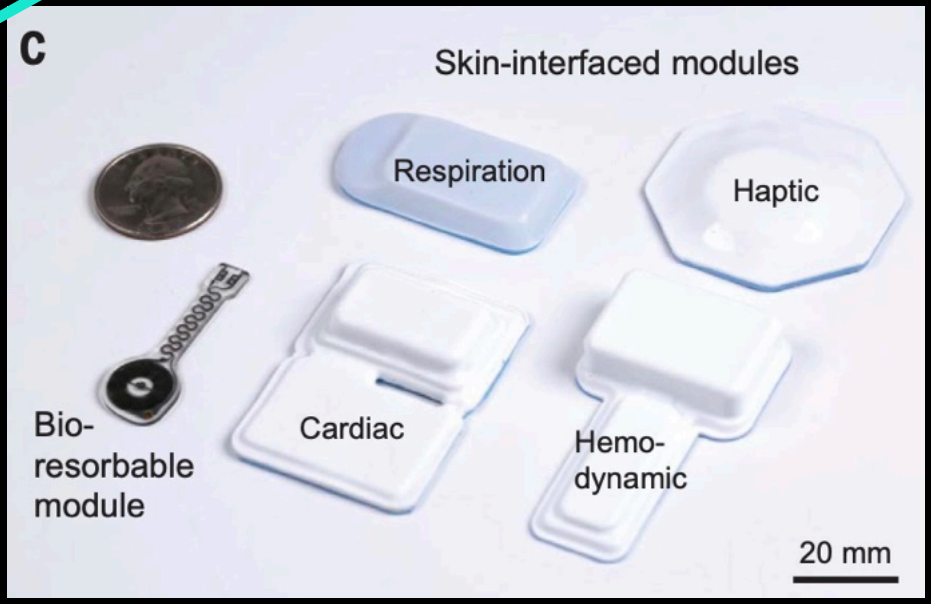
IOT For The Aging Population

Cardiac IOT

Cardiac IOT - Pacemakers

Doctor is in the loop





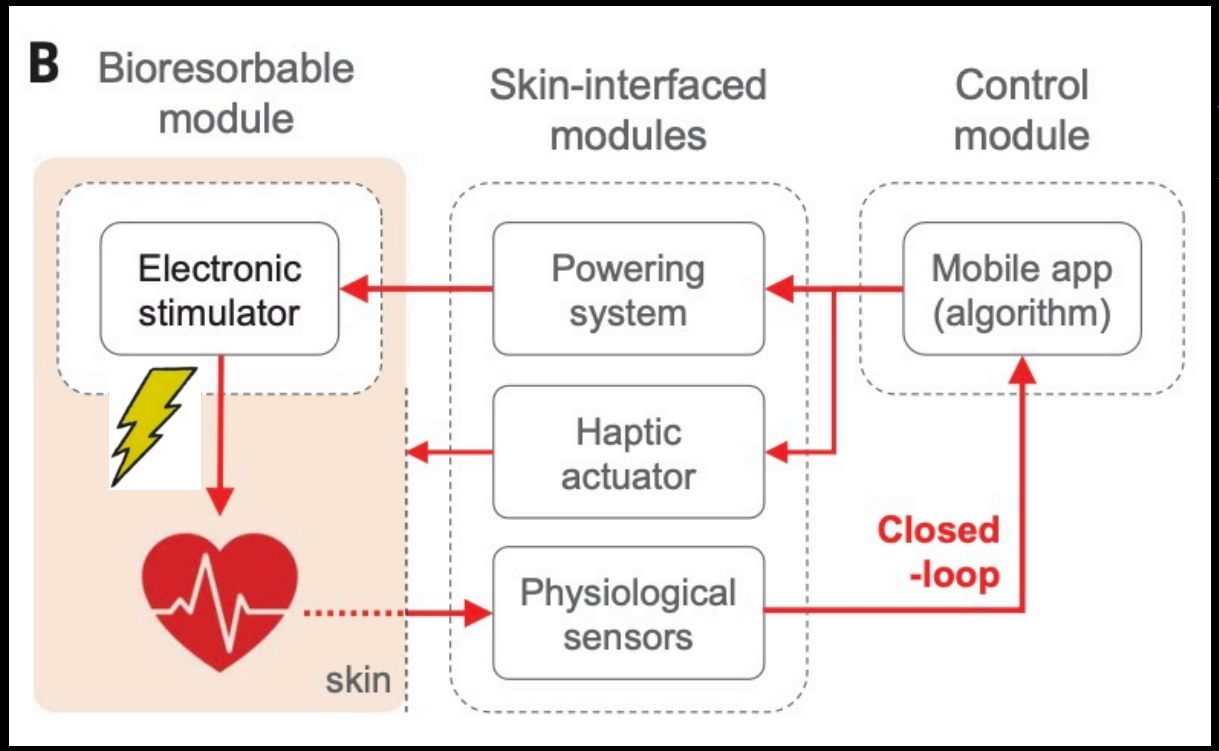
Sensors Can Monitor
- Temperature
- Respiration
- Heart rate and blood O2 levels
- Heart Electrocardiogram (ECK)

Actuators Can Stimulate
- Heart (requires edge computing)
- Give vibration/haptic feedback

Pacemaker is surgically implanted
All other sensor/actuators are soft rubber “patches”

https://www.science.org/doi/10.1126/science.abm1703

Cardiac IOT



Doctor is in the loop

This closed loop monitors heart activity and with **edge computing (phone)** can decide if the heartbeat is irregular and actually **stimulate the heart!!**

Important concept

- **False-Positive**
- **False-Negative**

Smart Watches

Provide most of these measurement (no closed loop)

Oxygen Saturation (SpO2)
Skin Temperature
Heart Rate
Breathing Rate

ECG 

Atrial Fibrillation (AFib, irregular hear rate)
- Can increase the risk of blood clots, stroke, and heart attack
- Adults over 40 have a 1 in 4 risk of developing AFib
- AFib is treatable, smart watches allow early detection

FitBit Overview

https://www.fitbit.com/global/us/technology/health-metrics

FitBit AFib

https://www.fitbit.com/global/us/technology/irregular-rhythm

Smart Thermometers

Can Smart Thermometers Track the Spread of the Coronavirus?

Smart Thermometers

What is “normal” human body temperature?

Smart Thermometers

What is “normal” human body temperature?

- Actually it seems to have gone down 1 degree between 1860 - 2017
- Human body temperature is now is **97.5 degrees Fahrenheit**
- **Lower metabolic rates**. Your body uses energy so all your systems can work the way they should. This creates heat. But people may have lower metabolic rates now because we weigh more than people did centuries ago. The less heat your body makes, the lower your temperature.
- **Population-wide decline in inflammation**
- **Lower rates of infection**. In the 19th century, infections such as tuberculosis, syphilis, and long-term gum disease were more common. As a result, many people had higher body temperatures.
- **Better thermometers**. We may have more accurate thermometers than people did a century ago.

https://www.webmd.com/lung/what-is-a-fever#1

Smart Thermometers

Can Smart Thermometers Track the Spread of the Coronavirus?

- Yes
- One company is Kinsa (many others)
- For a few years they have been able to accurately track the **flu**
- And can do it up to 2 weeks before the Centers for Disease Control and Prevention (CDC)
- Any ideas on why so effective? Compared to the CDC?

Smart Thermometers

Can Smart Thermometers Track the Spread of the Coronavirus?

- Any ideas on why so effective?
- The CDC uses manual reporting from doctors
- Doctors manually fill out patient data directly on the CDC website
- This limits their reporting frequency (fill out reports daily or weekly)
- Patient temperatures are only reported when people are sick enough **to go to a doctor**

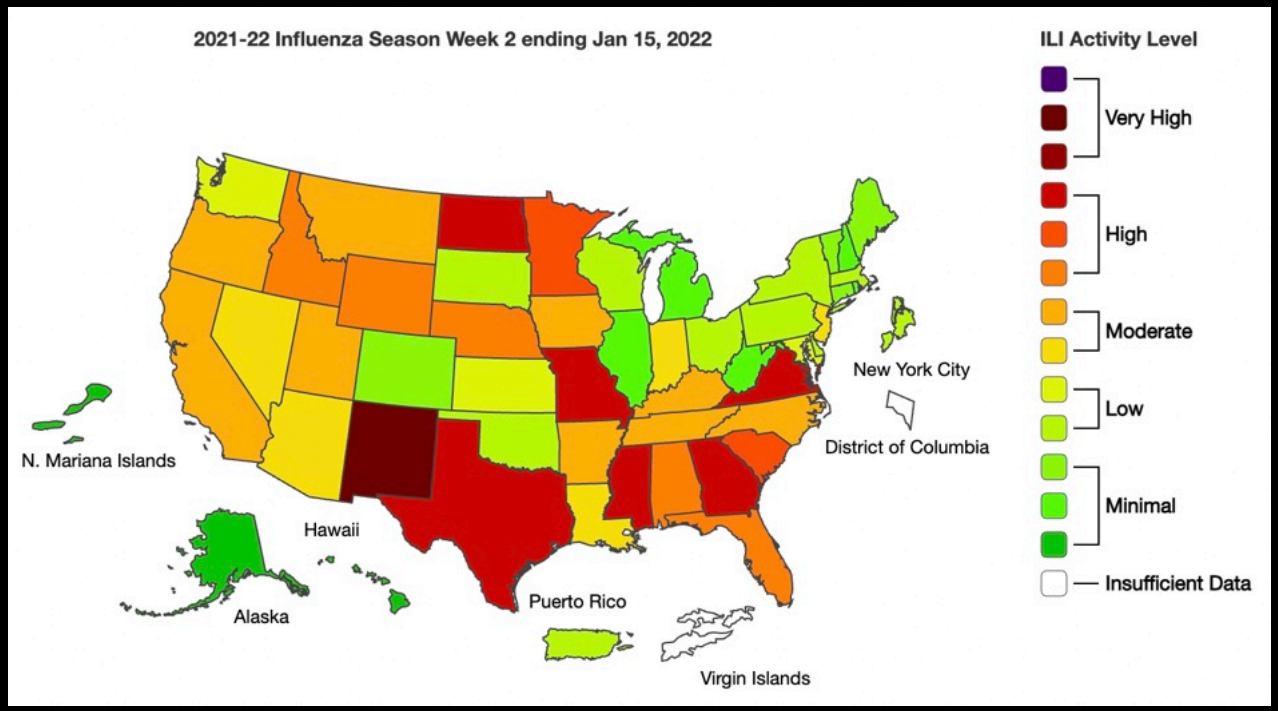
Weekly CDC “Flu View”

CDC provides data once per week

https://www.cdc.gov/flu/weekly/usmap.htm

Week ending Jan 15, 2022

- Manual reporting is inherently slow
- Flu: https://www.cdc.gov/flu/weekly/index.htm
- Covid: https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/



CDC has weekly updates to track the Flu and Covid

Smart Thermometers

Smart Thermometers Provide Automatic And Real-Time Data

- Imagine: millions of homes with smart thermometers
- Each time you feel ill with a fever, you take your temperature
- Thermometer has blue-tooth and sends the temperature reading to your phone
- A cell phone app send the temperature and your zip-code to a cloud server
- This seems secure, most of their code is open source and publicly available.
- They just have 3 pieces of information: (i) Date/time, (ii) your zipcode, and (iii) your temperature
- Automatic aggregate data analysis can be done in real-time and across potentially massive geographic regions

Smart Thermometers

Can Smart Thermometers Track the Spread of the Coronavirus?

- Lets check Davis and Sacramento right now!
- https://healthweather.us/map/california-CA/yolo-county-06113?mode=covid_risk
- https://healthweather.us/map/california-CA/sacramento-county-06067?mode=covid_risk

Smart Thermometers

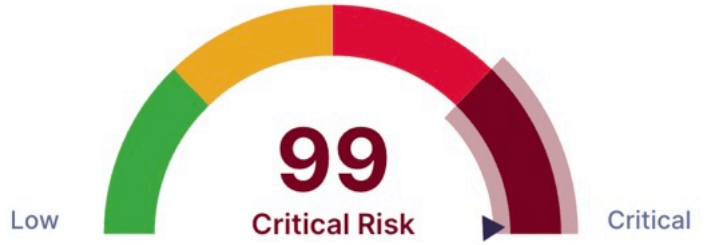
Can Smart Thermometers Track the Spread of the Coronavirus?

Yolo County, CA

There is a **critical** risk of illness in Yolo County. **COVID-19** cases are very high and spreading rapidly, while **Influenza (flu)** cases are moderately high and falling.

How does Kinsa calculate illness risk? →

Kinsa's early warning system tracks the spread of illness in real-time and forecasts future outbreaks through a network of millions of smart thermometers.



Exercise extreme caution

75-100 Area Risk: There is uncontrolled spread of severe illness. Protect yourself by avoiding all social contact.

Smart Thermometers

Can Smart Thermometers Track the Spread of the Coronavirus?

Sacramento County, CA

There is a **critical** risk of illness in Sacramento County. **COVID-19** cases are very high and stable, while **Influenza (flu)** cases are moderately high and falling.

How does Kinsa calculate illness risk? →

Kinsa's early warning system tracks the spread of illness in real-time and forecasts future outbreaks through a network of millions of smart thermometers.

Smart Thermometers

Can Smart Thermometers Track the Spread of the Coronavirus?

- Is this good information?
- How do you think people will react to this kind of warning?
- Does this data tell you there is danger?
- How do **you** respond to this?
- Do you “Avoid All Social Contact”
- Good example where IOT merges with our lives and we need to decide how to interpret the information

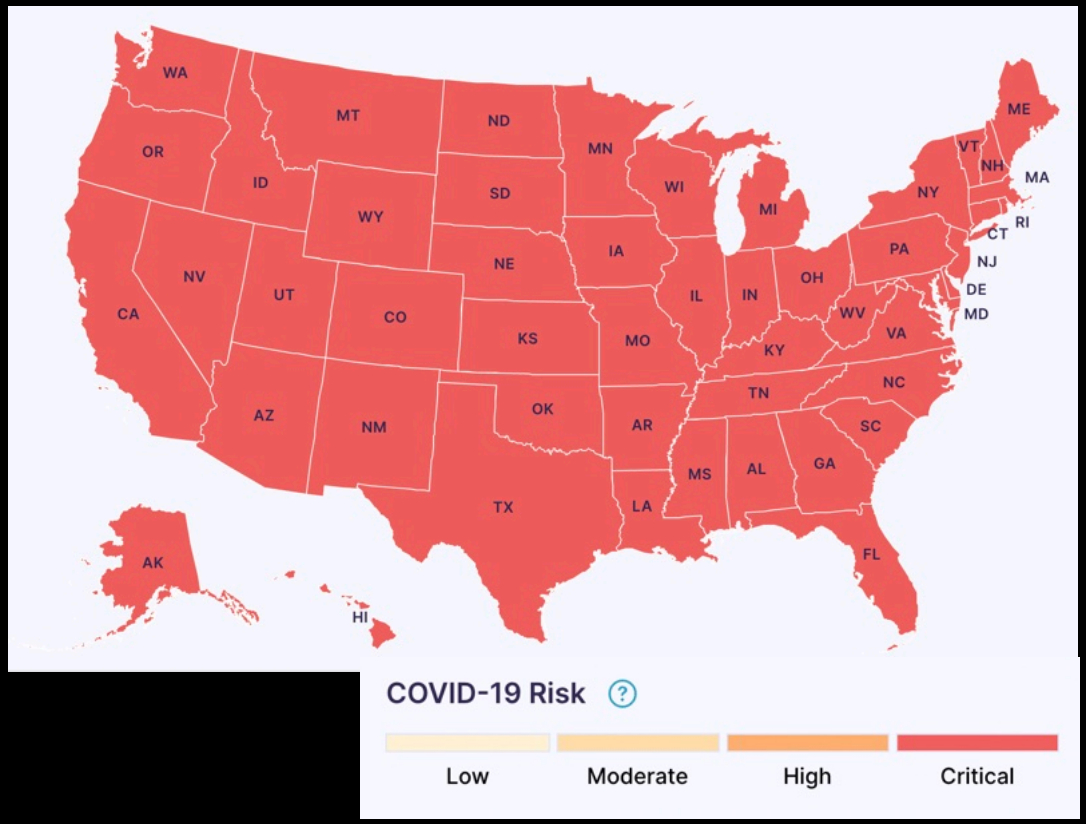
Yolo

Sacramento

Smart Thermometers

Kinsa Covid Risk Map

- Jan 2022, Kinsa is reporting “critical” risk for the entire country.
- This is based on recent temperature readings and their database of what is expected
- Is this useful data?

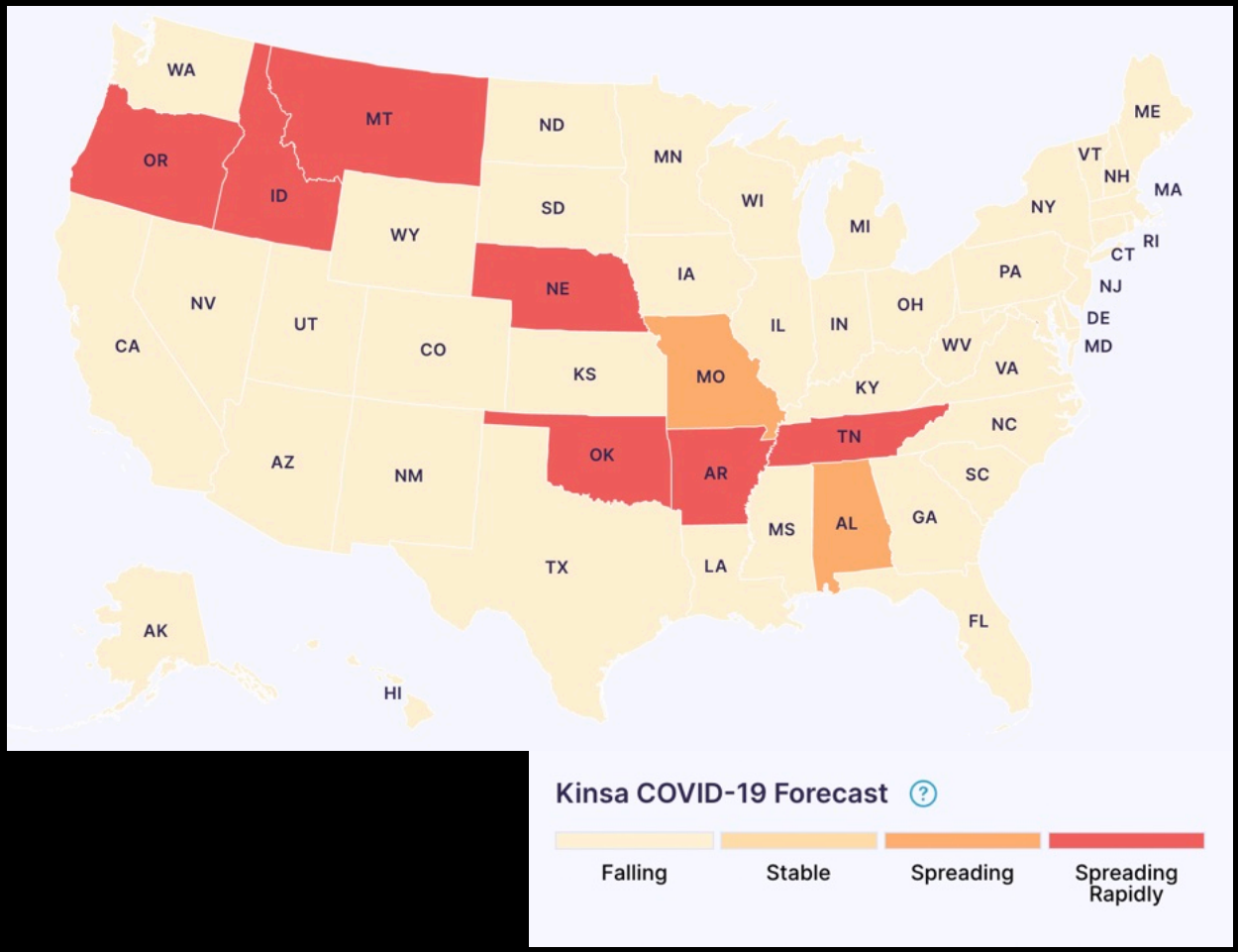


- Jan 24, 2022 and updated daily

Smart Thermometers

Kinsa Covid Forecast

- The Kinsa Covid-19 **forecast** is a bit more informative.
- Tells us that most states that currently have “critical risk” (previous slide) actually have “falling cases”
- The states that are “spreading rapidly” could be informative!



Smart Thermometers

Kinsa Covid Forecast

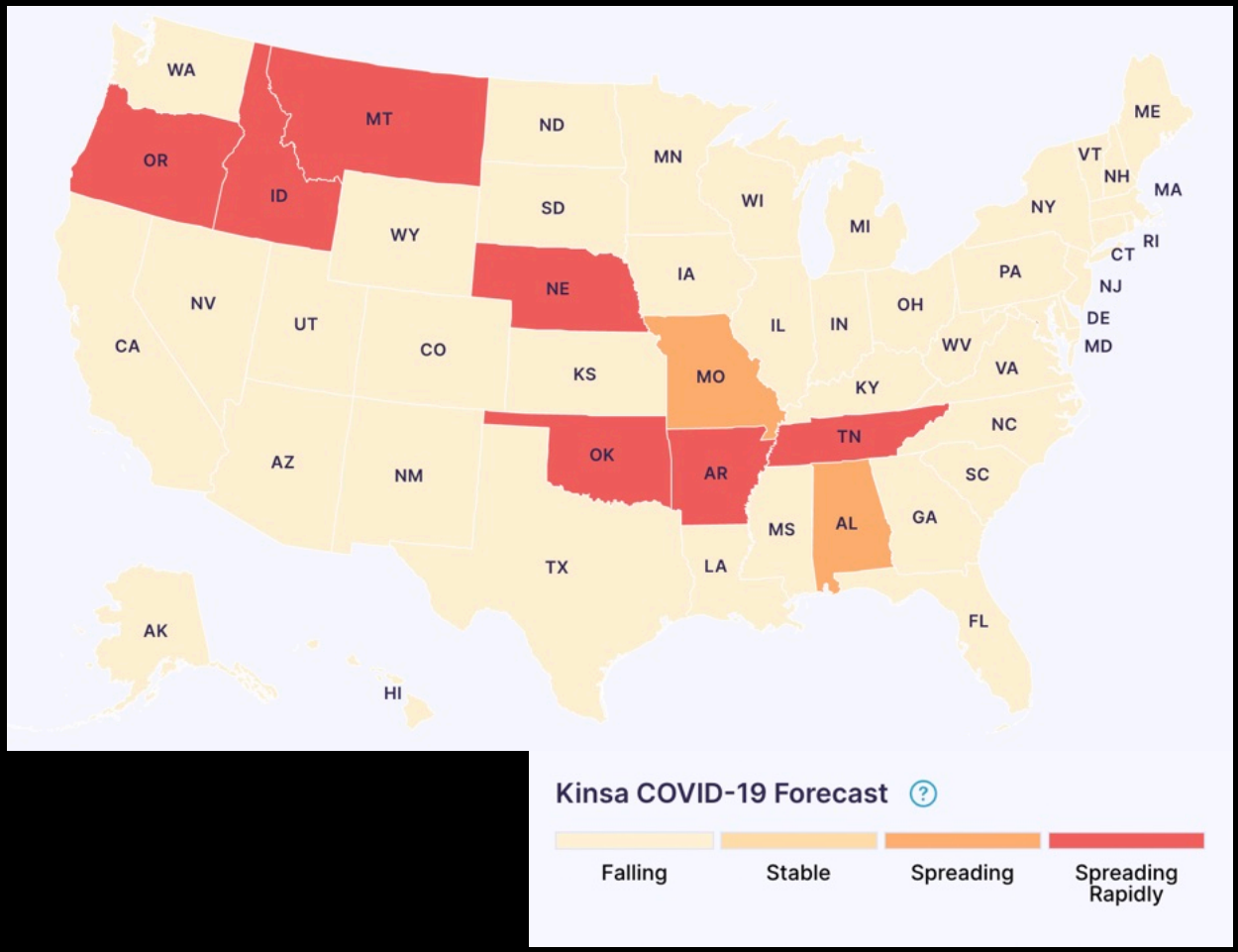
- The “spreading rapidly” states could take action

  Allocate more vaccines

  Allocate more hospital resources

  Impose stricter mask mandates

  Impose more social distancing
- But will they take action?
- Often becomes a political topic!
- **“Data is not neutral”**



Smart Thermometers

What level of IOT are smart thermometers?

- Is sensor data stored locally?
- Is sensor data sent to the cloud?
- Is there cloud computation?
- Is a thing controlled remotely after some cloud computing?
- Did this kind of data exist before this IOT system?

IOT LEVE	FEATURES	EXAMPLES
6	New features not included in levels 1-5	Novel insight derived from big data cloud computing
5	Remote data is processed and resulting information is sent back to things that take action	Shared Rideables “Smart” Home To Control Devices
4	Remote data is processed and resulting information is sent back to things	Maps, Uber
3	Thing that transmits data to a remote server on the internet for processing	“Smart” Thermometer to track Covid outbreaks
2	Thing that transmits data to a local server	Agricultural sensor
1	Thing that collects sensory data and stores it locally	Wildlife camera, Monitoring a jet engine

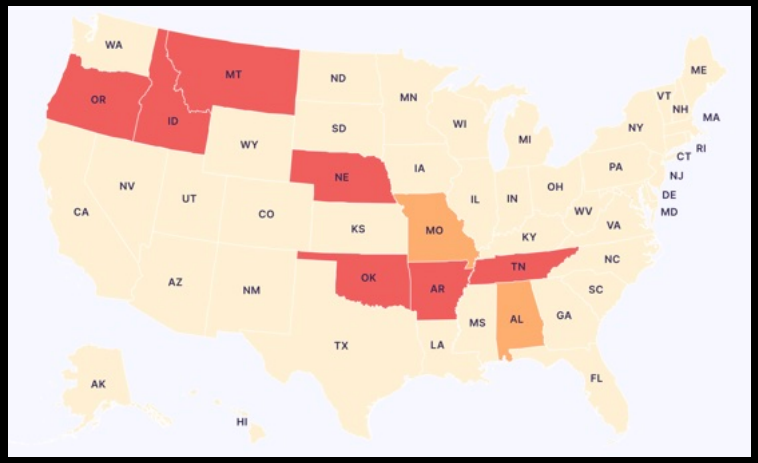
Smart Thermometers

What level of IOT are smart thermometers?

- Interesting new dataset from millions of individuals taking their temperature across the US
- Kinsa has been collecting this data for about 10 years
- They are beginning to be able to make a “Flu Forecast” similar to a weather forecast

  They can do this because they have historical data to compare and contrast with current (todays) data.

- Once we are past Covid and back to baseline, this forecast should be able to predict new outbreaks
- If we act early, this may be an effective health-care IOT



Smart Cities

What IOT “Things” Make A Smart City?

Smart Cities

What IOT “Things” Make A Smart City?

- **Sensors** distributed around a city that measure a number of parameters and report them to the cloud

Smart Cities

What kind of sensors - Public Utilities

- Electric/Gas/Water meters that:

  report usage automatically

  report possible leaks or failures
- Increases efficiency
- Reduces error (hopefully)
- Allows users to see their real time data
- Will we be able to see all our neighbors usage on a map?

Smart Cities

What kind of sensors - Street Lights

- For **night-time lighting** could sense movement and adjust brightness. Like when you walk into a room and lights come on (not really IOT)
- For **traffic lights**, can dynamically adjust their timing:

  Based on current traffic density

  Based on current pedestrian activity

  Special cases for people with reduced mobility, first-responders, delivery trucks, etc

  Has this been implemented?

Smart Cities

What kind of sensors - Environmental Monitoring

- Sensors to monitor temperature, humidity, air quality, noise levels

  Can be done on a block by block basis

  Hypothesis is that the quality (from bad to good) of all these measures could correlate with income level and race on a block by block basis

- Given this data, the city could re-distribute their money and resources to areas with low quality measurements.
- Has this hypothesis been tested?
- For example, in Sacramento the density of trees (and thus shade) determines **ground temperature**. Does this correlate with income per neighborhood?
- Can the national weather service (NWS) temperature give you this answer? Or do you need more local measurements?

Smart Cities

Barcelona is a case study

Smart Cities

Barcelona is a case study - Fab Lab

- Barcelona's ***Fabrication Laboratory*** (Fab Lab)
- Lots more than just IOT https://fablabbcn.org/
- One of a network of 1,200 workshops around the world that allow people to test out new designs and ideas, and build products and new technology using a range of cutting-edge tools
- Labs share their designs online so that something built in Boston can be replicated in a lab in Shenzhen
- With the help of some EU money, the lab built low-cost, easy-to-use sensors that can **detect air pollution, noise levels, humidity and temperature**.
- "This was not only about being part of a scientific project but about enabling political action," said Tomas Diez, who runs the lab.

What are they really doing?

Experimenting with socializing data in order to promote new cooperative approaches to solving common urban problems like **too much noise**

https://www.bbc.com/news/technology-41015486

Smart Cities

Barcelona - Can Get Very Noisy

- Of course car, truck, bus, and **scooter traffic**
- But also crowds of people hanging out
- Residents placed sensors on their balconies
- Were able to demonstrate that night-time noise levels - with peaks of 100 decibels - were far higher than World Health Organization (WHO) recommendations.
- Armed with this information, the residents went to the city council, pressing them to rethink the use of the plaza.
- So what was the outcome?

Smart Cities

Barcelona - Outcome

- Police now move people on at 11:00 PM.
- Garbage trucks, which had previously cleared up when the partygoers left in the early hours, have been rescheduled for the morning
- Steps and stoops that provided seating for gatherers have now been filled with plant boxes.
- What do you think of this outcome?

- Kinda crappy outcome for the Barcelona street culture.
- Novel result is that a network of IOT sensors (installed by citizens) were able to provide the raw data showing it was just too loud and the city actually changed their policies
- Residents were codifying something already known: their square is very noisy

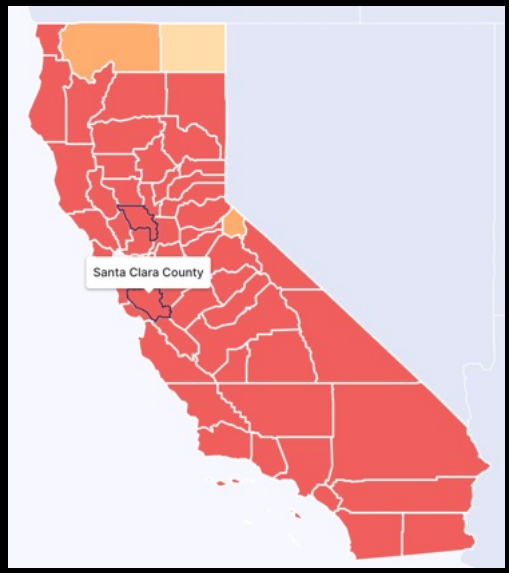
Is Data Neutral

Barcelona - Smart City - Decisions that shape data

- Does data like local noise levels live in a neutral vacuum - not connected to a community?
- The methods used (impersonal by a company or personal by individuals)
- How it gets interpreted (who does the interpretation)
- What gets overlooked (some things can be intentionally overlooked)
- The context in which it is generated, and by whom (again, by citizens)
- What to do as a result?
- The noise data was no longer a pin on a map, it was a shared community concern. Got neighbors out and talking about their shared experience
- Or does this kind of data encourage “not-in-my-backyard” (NIMBY) behavior?

Is Data Neutral

Barcelona - Smart City - Decisions that shape data



- How does this citizen generated **noise** data compare to other datasets?

  Smart Thermometer Covid maps

  CDC Covid maps

- Is the COVID data creating citizen collaboration and sharing?
- Is it causing local governments to take action?
- Are these actions by the government always perceived as the right thing? Like a mask mandate.
- All this depends on local politics, my opinion is covid data is somehow impersonal and most communities are not coming together around it
- Could we have a covid map of all the **“infected” houses on your block**? Would that. be good?

Conclusion

Could we make fine grained maps?

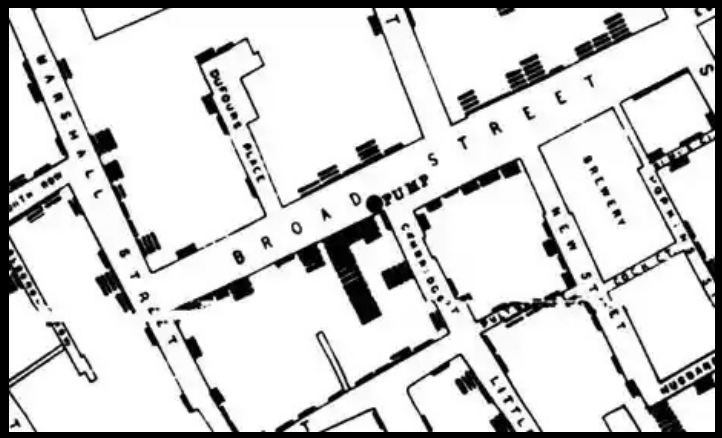
- Could we make detailed maps from house to house of …

  Noise or pollution or temperature they experience

- But what about maps of

  Energy usage, Residents temperatures, Residents covid status?

- Currently, that would be really bad !!!
- How could we arrive at a society where this might be useful?
- I have no idea if we can?

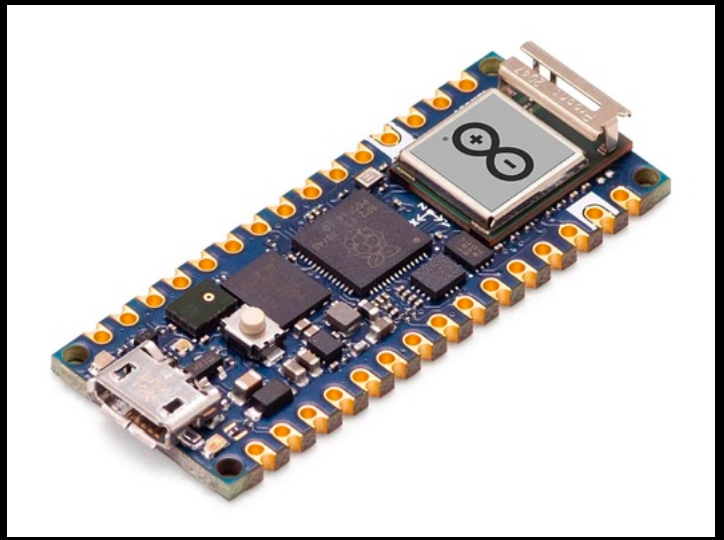


- John Snow mapped Cholera outbreak in London (1854)

Next Class - Building an IOT

- **Need 3 volunteers** to bring a laptop (macOS or Windows) with a USB port.

  So we can power our arduino nano micrmontrollers



IOT Fail - 2014

Hacking smart devices to send spam emails

IOT Fail - 2014

Hacking smart devices to send 750,000 spam emails

- Over 100,000 home “smart things” were hacked to send spam email
- This included routers, media centers, televisions, and even kitchen appliances like a fridge
- Personal computers can be unknowingly compromised to form robot-like "botnets" that can be used to launch large-scale cyberattacks.
- Cyber criminals have begun to commandeer home routers, smart appliances and other components of the Internet of Things(IoT) and transform them into "thingbots" to carry out the same type of malicious activity.
- Note: Only 25% of emails came from “things”, 75% was from traditional computers
- This was possible because email is often included as a feature of a smart thing.
- Even the Huzzah32 we will be using can send email

IOT Fail - 2014

Hacking smart devices to send 750,000 spam emails

- Although individuals who had their “things” hacked did not exactly suffer
- This lack of IOT security enabled a massive and completely untrackable spam email campaign
- We are all familiar with “Security updates” on our phones and laptops, right?
- But what about security updates for your “smart” toaster or fridge?
- Right now this is not common but we might want to change this

Conclusion

- IOT for our aging population could be super useful
- IOT for tracking the Flu or Covid is here
- Smart cities are often talked about - their real power is when date becomes a commodity for a community. Can be empowering
-