Data and Society
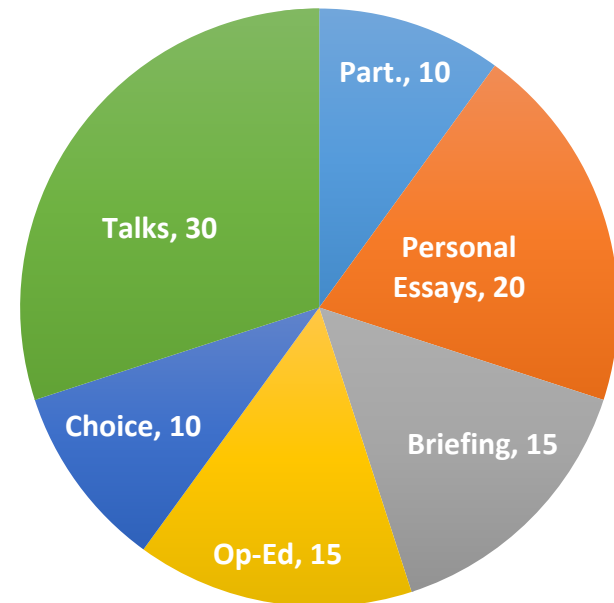## Internet of Things Intro – Lecture 16

3/29/21

Today's Class

- **Personal Essay (Face Recognition) due on April 1 / Instructions in Lecture 1**

- **Last Assignment: April "Choice Assignment" next time**

- Guest speaker Rich Wolski next time

- Lecture / Discussion

- Student Presentations

Op-Ed feedback

- Op-eds are **persuasive arguments**. Not the right format for a topic that most people agree with.

- **Persuasive title, and clear lede and thesis** are important to set the piece off. This is your opener and once you lose your audience, it's hard to get them back.

- Although the piece is persuasive, the **arguments should be justified**. Anecdotes make the piece accessible to the reader but should not be the only arguments.

- **Avoid being too general or too specific.**

- Citations should be **referenced specifically in the text**.

If you didn't quite get this, consider giving it another try (with a different topic) in April's "**Choice Assignment**".

Data doesn't have to be the focus of the op-ed but could be used as part of the justification.

Read before 4/4

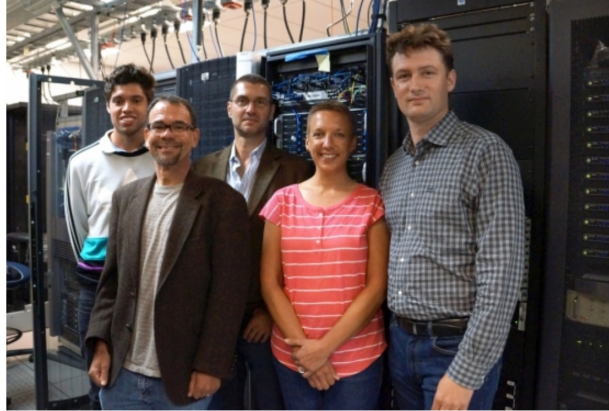- **From Data to Tomato,** UCSB (Rich Wolski's work)
- https://www.news.ucsb.edu/2015/015515/data-tomato

Date	Topic	Speaker	Date	Topic	Speaker
1-25	Introduction	Fran	1-28	The Data-driven World	Fran
2-1	Data and COVID-19	Fran	2-4	Data and Privacy -- Intro	Fran
2-8	Data and Privacy – Differential Privacy	Fran	2-11	Data and Privacy – Anonymity / Briefing Instructions	Fran
2-15	NO CLASS / PRESIDENT'S DAY		2-18	NO CLASS	
2-22	Legal Protections	Ben Wizner	2-25	Data and Discrimination 1	Fran
3-1	Data and Discrimination 2	Fran	3-4	Data and Elections 1	Fran
3-8	Data and Elections 2	Fran	3-11	NO CLASS / WRITING DAY	
3-15	Data and Astronomy (Op-Ed due)	Alyssa Goodman	3-18	Data Science	Fran
3-22	Digital Humanities	Brett Bobley	3-25	Data Stewardship and Preservation	Fran
3-29	Data and the IoT	Fran	4-1	Data and Smart Farms	Rich Wolski
4-5	Data and Self-Driving Cars	Fran	4-8	Data and Ethics 1	Fran
4-12	Data and Ethics 2	Fran	4-15	Cybersecurity	Bruce Schneier
4-19	Data and Dating	Fran	4-22	Digital Rights in the EU and China	Fran
4-26	Tech in the News	Fran	4-29	NO CLASS	Fran
5-3	Wrap-up / Discussion				

Lecture

- **The Internet of Things**

The Internet of Things (IoT)

- The IoT deeply interconnected ecosystem of **sensors, cameras, computers, smart systems, connected devices** and other technologies.

- IoT "things"

    - share data

    - work together to make decisions

    - often operate autonomously in the background

The IoT empowers people through technology and technology through intelligence

- Autonomous decision-making

- **Optimization, customization, personalization**

- Monitoring

- **Efficiency**

- Smart systems
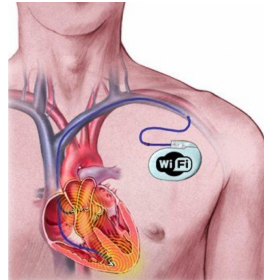
IoT innovation: A perfect storm

- **Technology advances**
  - AI
  - Data science
  - Cloud computing
  - Small scale devices
  - Power solutions
  - Network innovations, etc.

- **Social drivers**
  - Growth of technology as social infrastructure
  - Competition
  - Sparse consumer protections
  - COVID pandemic

- **The "new normal": The IoT as ubiquitous critical infrastructure**
  - Economic impact: $4-$11 trillion by 2025 (McKinsey)
  - Surveillance market: $63.2 billion by 2022 (Stratistics MRC)
  - Almost all vehicles will be self-driving by 2050 (Rand)

IoT → Internet of Everything

- IoT forms the basis for an expanded view of the world (**Internet of Everything**) where **biological** (people, plants, animals), **physical** (planetary, environmental) and **cyber** (data, devices, systems) "entities" as well as **organizing structures and processes** are powered by information and connected by technology.

- This larger connected world forms the basis for the future of society and the planet.

IoT systems: Smart Cities

- Use **real-time data and adaptive systems** can promote health, safety, security, and well-being of citizens

KEEP STREETS CLEAN

Products like the cellular communication enabled Smart Belly trash use real-time data collection and alerts to let municipal services know when a bin needs to be emptied. This information can drastically reduce the number of pick-ups required, and translates into fuel and financial savings for communities service departments. // Visit

STOP DRIVING IN CIRCLES

With the use of installed sensors, mobile apps, and real-time web applications like those provided in Streetline's ParkSight service, cities can optimize revenue, parking space availability and enable citizens to reduce their environmental impact by helping them quickly find an open spot for their cars. // Visit

RECEIVE POLLUTION WARNINGS

The DontFlushMe project by Leif Percifield is an example that combines sensors installed in Combined Sewer Overflows (CSOs) with alerts to local residents so they can avoid polluting local waterways with raw sewage by not flushing their toilets during overflow events. // Visit
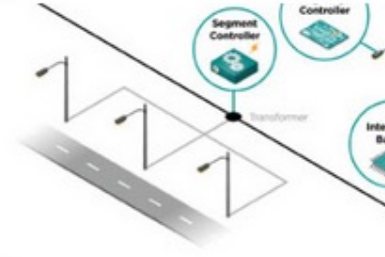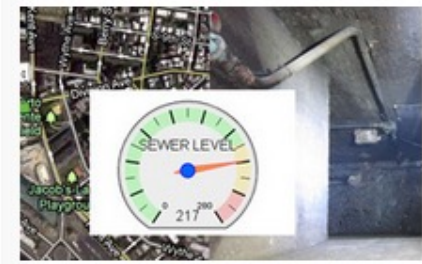

USE ELECTRICITY MORE EFFICIENTLY

The SenseNET system uses battery-powered clamp sensors to quickly measure current on a line, calculate consumption levels, and send that data to a hosted application for analysis. Significant financial and energy resources are saved as the clamps can easily identify meter tampering issues, general malfunctions, and any installation issues in the system. // Visit

LIGHT STREETS MORE EFFECTIVELY

This smart lighting system from Echelon allows a city to intelligently provide the right level of lighting needed by time of day, season, and weather conditions. Cities have shown a reduction in street lighting energy use by up to 30% using solutions like this. // Visit

SHARE YOUR FINDINGS

AirCasting is a platform for recording, mapping, and sharing health and environmental data using your smartphone. Each AirCasting session lets you capture real-world measurements (Sound levels recorded by their phone microphone; Temperature, humidity, carbon monoxide (CO) and nitrogen dioxide (NO2) gas concentrations), and share it via the CrowdMap with your community. // Visit

IoT Systems: Smart Homes

IoT-focused products

- **Remotely monitor and manage** your home / physical environments

- Promote **efficient and cost-effective resource usage**

From
http://postscapes.com/internet-of-things-examples/

HEAT YOUR HOME EFFICIENTLY

Smart thermostats like the Nest use sensors, real-time weather forecasts, and the actual activity in your home during the day to reduce your monthly energy usage by up to 30%, keeping you more comfortable, and offering to save you money on your utility bills. // Visit

MAKE SURE THE OVEN IS OFF

Smart outlets like the WeMo allow you to instantly turn on and off any plugged in device from across the world or just your living room. Save money and conserve energy over time by eliminating standby power, measure and record the power usage of any device, and increase its operating lifespan through more efficient use and scheduling. // Visit

TRACK DOWN THOSE LOST KEYS

You can easily track down those lost keys or cell phone in your house using Bluetooth and other wireless technology devices like the Cobra Tag.. // Visit

LIGHT YOUR HOME IN NEW WAYS

Web enabled lights like the Phillip's Hue can be used as an ambient data displays (Glow red when my bus is 5 minutes away). These multi-functional lights can also help you to reduce electricity use (automatically turn off the lights when no one is in a room) or help to secure your home while you are away by turning your lights on and off. // Visit

AVOID DISASTERS

Using a device like the Ninja Block and its range of add-on sensors you can track if a water pipe has burst in your basement, if there is motion inside your home while you are away, and have it automatically send you a notification by email or text message when it happens. // Visit

KEEP YOUR PLANTS ALIVE

Whether taking care of a small hydroponic system or a large backyard lawn, systems like HarvestGeek with their suite of sensors and web connectivity help save you time and resources by keeping plants fed based on their actual growing needs and conditions while automating much of the labor processes. // Visit

IoT systems: Environmental monitoring and management

IoT-focused products

- Use real-time data and predictive analysis to better **understand and manage ecosystems and natural resources**

MONITOR POLLUTION LEVELS

The Air Quality Egg is a community-led air quality sensing system designed to allow anyone to collect high resolution readings of NO2 and CO concentrations outside of their home using an RF transmitter and ethernet driven base station. The data can then be shared to create a network of readings to be used by the community and general public. // Visit

TRACK WATER

The University of Berkeley's Floating Sensor Network project uses motorized drifters (Outfitted with cell communication, GPS, temperature, and salinity sensors) that can be quickly deployed in response to unanticipated events such as floods to track the movement of water, contaminants, and other conditions in waterways. // Visit

HELP PROTECT WILDLIFE

A project by Ground Labs and Lion Guardians is creating an open source wildlife tracking collar system to safeguard the Maasai herders cattle and protect the last 2000 lions living Southern Kenya. The system consists of a tracking collar that utilizes a GPS/GSM module to locate and track the lions and communicate their coordinates to researchers and Maasai herders via SMS." // Visit

GET AN ADVANCED WARNING

The University of Loughborough's Acoustic Landslide Detector system called ALARMS (Assessment of Landslides using Acoustic Real-time Monitoring Systems), detects high-frequency stress waves produced by soil movement. They can be used to calculate soil movement in real time and send out alerts to communities before an event occurs. // Visit

KNOW THE VARIABLES

Nik Sargent's Bumblebee project sheds light on how the environment influences bees activity patterns and behaviours using sensors (visual, audio, temperature, sunlight, weather) and web technology to monitor and record their daily lives. // Visit

STOP THE BLEEDING

Invisible Tracck is a wireless device being used in pilot programs to help combat illegal deforestation taking place in the Amazon. The battery operated devices are installed on select trees and as soon as the logged trees are in transit and able to connect to a mobile network (Up to a 20 mile range), an alert notification with location coordinates is sent to the Brazilian Institute of Environment so they can take action. // Visit

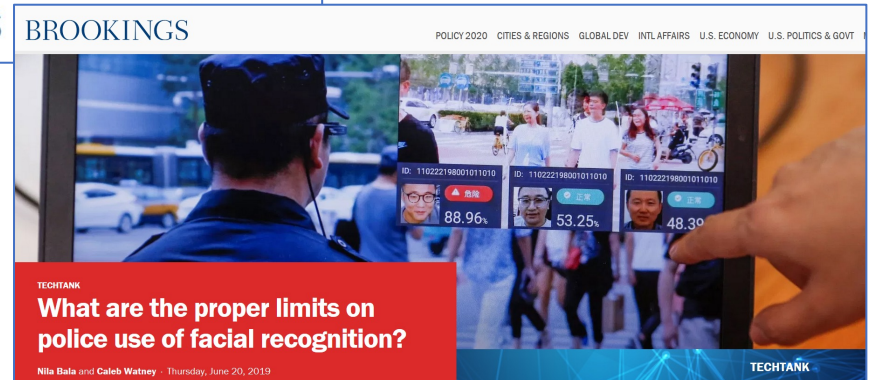# Many benefits of the IoT

Robotic Surgery

Disaster Response

Autonomous Vehicles

Risks of the IoT

Man Hacks Monitor, Screams at Baby Girl
April 28, 2014 / 1:29 PM EDT

Welcome to the Internet of things. Creepy things.

Last week, Fox 19 reported that a man hacked into an internet-enabled baby monitor in a home in Cincinnati, Ohio, and started screaming "Wake up baby!" at a 10-month-old girl.

Uber crash shows 'catastrophic failure' of self-driving technology, experts say

A couple says that Amazon's Alexa recorded a private conversation and randomly sent it to a friend

GOVERNMENT

FDA warns users of cyber vulnerability in pacemaker programmers

Contact tracing by app: life-saving or invasion of privacy?

TECHTANK
What are the proper limits on police use of facial recognition?
Nila Bala and Caleb Watney · Thursday, June 20, 2019

Mitigating risk through social oversight: The IoT's "cultural lag" [Ogburn]

Technological advances →

Social framework, ethical guidelines →

- **Disruptive technologies can have broad societal effects, transforming**
  - *Work opportunities and workforce needs*
  - *National and international priorities*
  - *Economic, cultural, social, and political structures*
  - *Leading sectors and new areas for innovation and impact. Broad ripple effect from both.*

Disruptive technologies -- How did the Industrial Revolution transform the World?

- **Transition to new manufacturing processes in late 18th / early 19th century.**

  - Hand production → machines, new chemical manufacturing, new iron production processes
  - Improved efficiency of water power and the increased use of steam power
  - Wood and bio-fuels → coal
  - England → Western Europe, US

- **Major turning point, almost every aspect of daily life influenced in some way**

Iron Bridge, Shropshire. First bridge constructed from iron. Opened 1781.

Source: Wikipedia

Technological Innovation transformed society during the Industrial Revolution, social oversight followed innovation

- **Economic transformation**
  - Better standard of living
  - Better agricultural practices, housing, food supplies
  - Less expensive clothing and consumer goods

- **Urbanization and life-style changes**
  - Rise of factories and modern cities (and pollution)
  - Change in employment options; over-employment of children

- **Social policy**
  - Child Labor laws
  - Environmental laws
 - Growth in trade unions

Cottonopolis is a name given to the city of [Manchester], in England. It denotes a metropolis of cotton and cotton mills, as inspired by Manchester's status as the international centre of the cotton and textile processing industries during this time.

Engraving by Edward Goodall (1795-1870), original title *Manchester, from Kersal Moor* after a painting of W. Wylde. Wikipedia (cropped from original)

Fast forward to the present

- IoT devices everywhere and increasingly used for everything

- Opportunities for technological innovation, social controls, new approaches to business, entertainment, communication, research, governance, manufacturing, management, etc. etc.
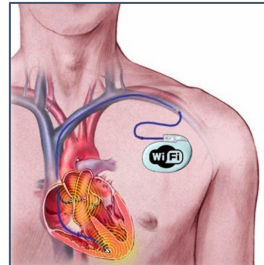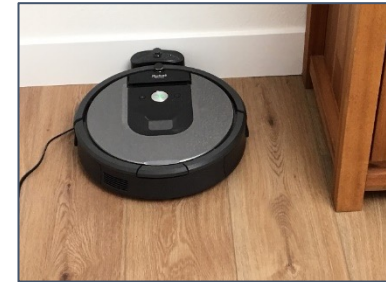
How we build and manage the IoT matters

- Technical architectures have societal implications

- Social controls must be embedded in technology

- **Many trade-offs to consider –** promoting the common good is a holistic exercise
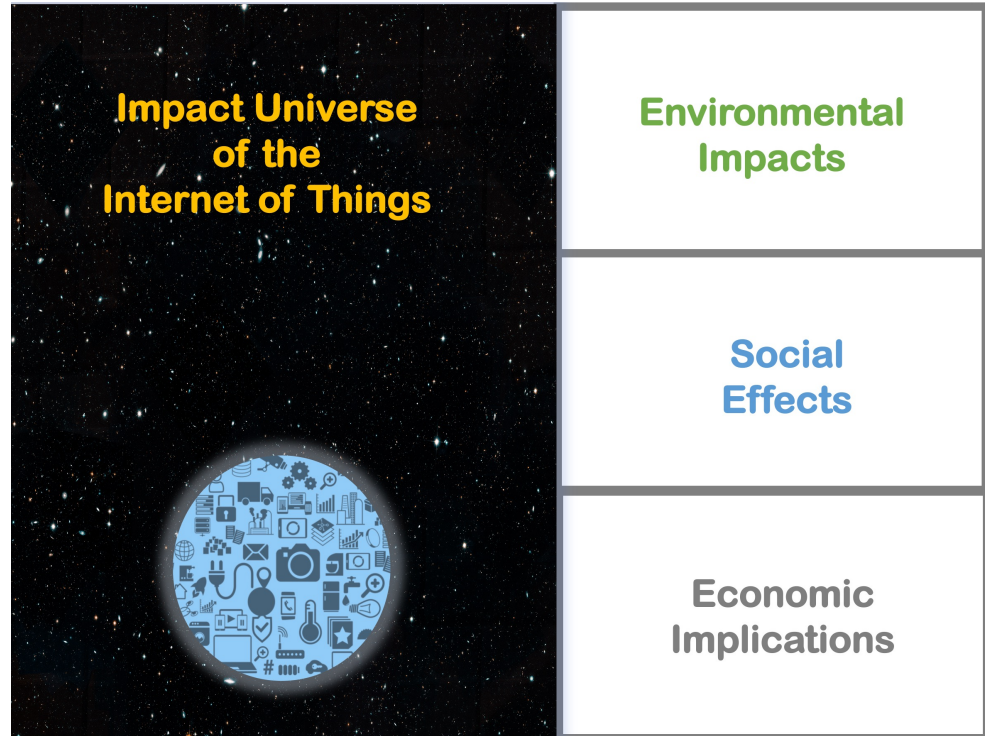
Researchers / Developers: Many challenges / opportunities in developing the IoT

- **Infrastructure challenges:**

    - How do we operate IoT devices in environments where there is no / limited power, or no / limited bandwidth?

    - How do we determine which devices / systems should have the greatest priority? What about emergency situations?

    - How much of the IoT can we run using renewable energy?

- **What protections should be implemented?**

    - Privacy? Security? Safety? Ethical decision-making? Climate protections?

    - How do we architect systems to support public protections

- **Which ethics?**

    - How do we promote ethical decision-making in autonomous systems?

    - How do we ensure safe, unbiased outcomes?

- **Whose data?**

    - Who has the right to access, share, use, control data collected from IoT devices and systems?

    - How do we handle data curation, metadata, interoperability, workflows, retention?

- **Who is liable?**

    - Who is responsible when IoT systems have negative outcomes?

    - Who is liable?

    - What legal framework do we need to assign blame or determine causality?

- **Research implications**

    - How do we study the IoT?

    - How do we do open science on the IoT?

    - How do we do reproducible research on the IoT?

IoT Governance – who makes the rules?

IoT is largely decentralized and without a global governing authority, what is needed to ensure that the IoT promotes the common good?

According to the **World Governance Index** (based on the UN Millennium Declaration), critical themes for governance span key areas.

WGI Theme		IoT Areas Where Governance Structures Needed
Peace and Security	→	IoT Security, Trust, Safety, Crime prevention
Democracy and Rule of Law	→	Legal framework for determining appropriate and inappropriate behavior, liability, accountability, responsibility
Human Rights and Participation	→	IoT "Bill of Rights"? Framework for promoting equality, penalizing discrimination, and reducing the digital divide
Human development	→	Digital ethics, use of technology to advance / actualize its participants and contribute to common good
Sustainable development	→	Architectures, standards, policy, infrastructure, etc. to promote minimize environmental risks and promote sustainable growth

Francine Berman

IoT Players – promoting the public interest in the IoT requires action from every sector

Government should take the lead in protecting the public

- **Regulation of the private sector** with respect to consumer protections, personal data protections, safety and security standards, ethical guidelines

- **Clarity** on responsibility, liability, accountability

Citizens should

- **Ask before you buy** (privacy, security, safety, protections)

- **Provide feedback** (respond to requests for comment on policy)

- Ask public officials, candidates what their stand on technology are and **vote your preferences**

Businesses should

- **Focus on responsible design**
  - Public interest - focused design – architected to support public protections
  - Environmentally-focused design – longer lifespans, SW vs. hardware upgrades, sustainable materials

- **Focus on responsible practice**
  - Development of sustainable supply chains and sources
  - Explainability, risk mitigation

- **Provide transparency about the risks and benefits** of products, what constitutes safe use, what happens to personal data

Higher education should

- Develop **Public Interest Technology courses, internships and programs** in higher ed to increase technology literacy and societal strategies that promote the common good

Presentations

Upcoming Presentations

April 1

- "**Smart farms are hackable farms**," IEEE Spectrum, https://spectrum.ieee.org/riskfactor/telecom/security/cybersecurity-report-how-smart-farming-can-be-hacked

- "**Farms are going to need different kinds of robots**," BBC News, https://www.bbc.com/news/business-56195288

April 5

- "**Your self driving car isn't ready. Smarter roads might change that**," CNN Business, https://www.cnn.com/2021/03/05/cars/cavnue-self-driving-lanes/index.html

- "**Waymo simulated real world crashes to prove its self-driving cars can prevent deaths**", The Verge, https://www.theverge.com/2021/3/8/22315361/waymo-autonomous-vehicle-simulation-car-crash-deaths

April 8

- "**Vaccine passports pose ethical thicket for Biden Administration**," Politico, https://www.politico.com/news/2021/03/17/vaccine-passports-ethics-biden-administration-476384

- "'**This is bigger than just Tinmit': How Google tried to silence a critic and ignited a movement**". Fast Company, https://www.fastcompany.com/90608471/timnit-gebru-google-ai-ethics-equitable-tech-movement

Need Volunteers – 4/12

- "**What a gambling app knows about you**", New York Times, https://www.nytimes.com/2021/03/24/technology/gambling-apps-tracking-sky-bet.html (Ishita P.)

- "**Can computer algorithms learn to fight wars ethically?**", Washington Post, https://www.washingtonpost.com/magazine/2021/02/17/pentagon-funds-killer-robots-but-ethics-are-under-debate/?no_nav=true&tid=a_classic-iphone (Jin H.)

Today's Presentations

- "**Animal Planet**", New York Times, https://www.nytimes.com/interactive/2021/01/12/magazine/animal-tracking-icarus.html?referringSource=articleShare (Julian C.)

- "**Ring and Nest helped normalize American surveillance and turned us into a nation of voyeurs**", Washington Post, (Hannah L.) https://www.washingtonpost.com/technology/2020/02/18/ring-nest-surveillance-doorbell-camera/?utm_campaign=wp_post_most&utm_medium=email&utm_source=newsletter&wpisrc=nl_most