

# EE 5104 - Data Science

- **Today**
  - Data Science : Introduction
  - Course Overview

- 
- Turn your video on
  - Check out lecture materials posted in the syllabus
- 

Up-to-date Syllabus: <http://tiny.cc/y3wouz>

# Data Science: Introduction

Young Tae Noh

KENTECH

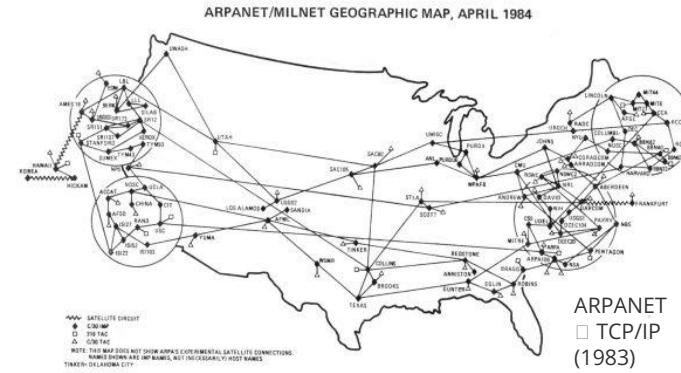
Syllabus URL: <http://tiny.cc/y3wouz>

The majority of slides are borrowed from Prof. Uichin Lee @ KAIST – KSE80

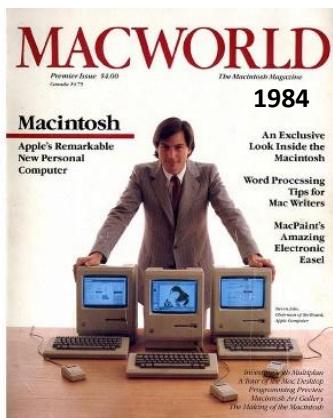
# Computing Trends in Late 1980s



Mainframe computers



Before Internet was widespread

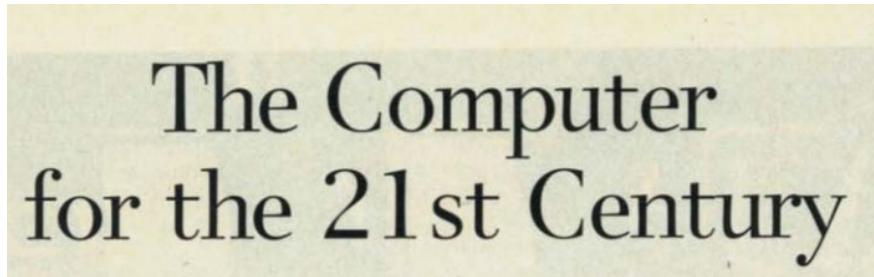


Macintosh had just come out



Cellphones were bulky & expensive

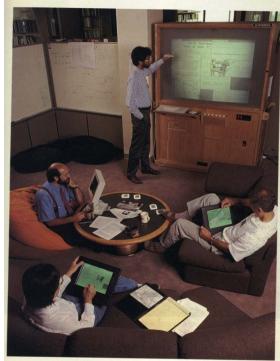
# Computing Trends in Early 1990s



*Specialized elements of hardware and software, connected by wires, radio waves and infrared, will be so ubiquitous that no one will notice their presence*

by Mark Weiser

“Embedding computers into the physical worlds”



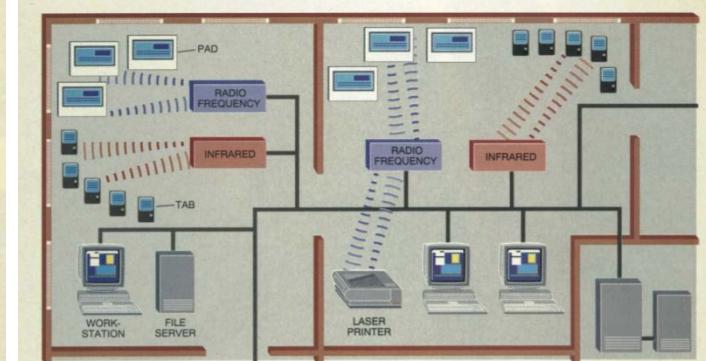
Tabs, Pads, Boards



Badges



Radio



Wireless Networking

# Computing Trends in Early 2000s

COVER FEATURE

Brett  
Warneke  
Matt Last  
Brian  
Liebowitz  
Kristofer S.J.  
Pister  
University of  
California,  
Berkeley

## Smart Dust: Communicating with a Cubic- Millimeter Computer



The Smart Dust project is probing microfabrication technology's limitations to determine whether an autonomous sensing, computing, and communication system can be packed into a cubic-millimeter mote to form the basis of integrated, massively distributed sensor networks.

“Sensors everywhere + wireless networking”



TRSS Node



Crossbow



Ember



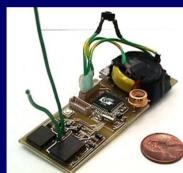
Sensoria



Dust, Inc.

**COTS Dust - RF Motes**

- Simple computer
- Cordless phone radio
- Up to 2 year battery life

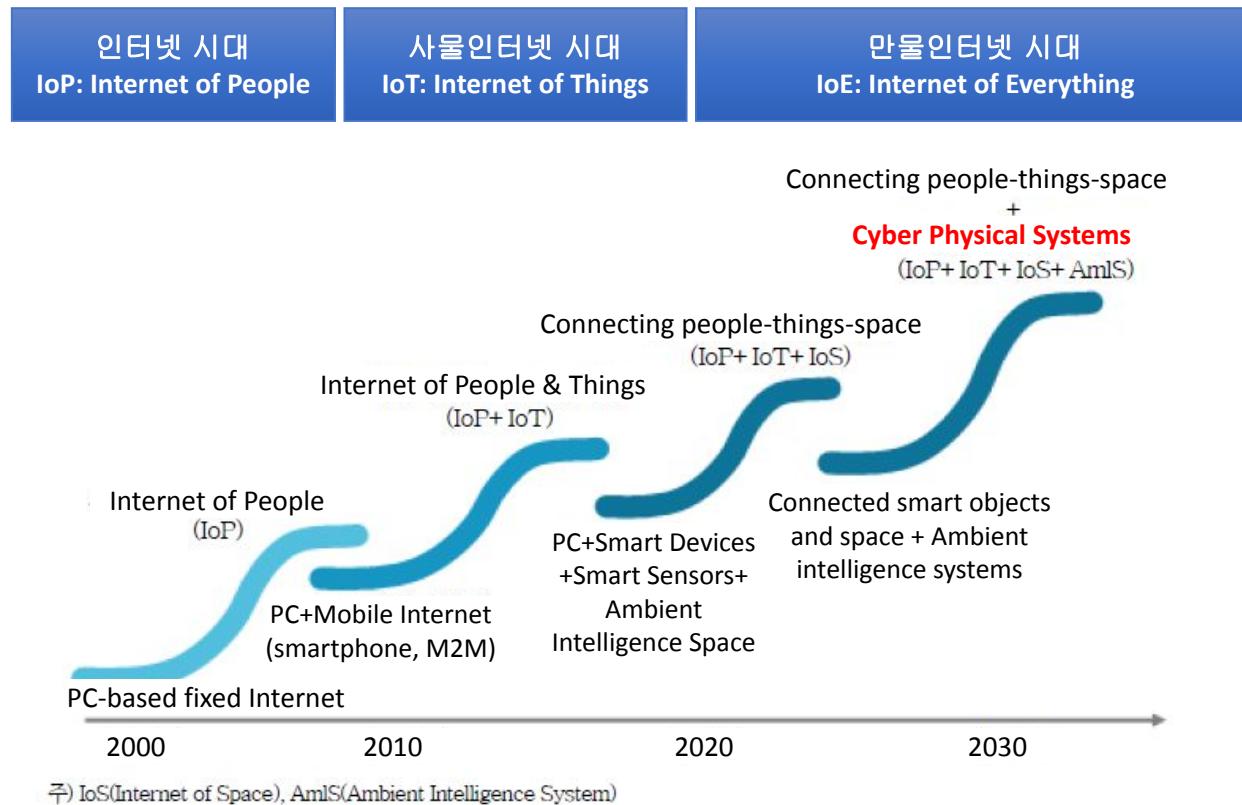


 2 Axis Magnetic Sensor
 2 Axis Accelerometer
 Light Intensity Sensor
 Humidity Sensor
 Pressure Sensor
 Temperature Sensor

SMART DUST

<https://slideplayer.com/slide/5328596/>

# What We Observe



# And Now

1. Devices in diverse “form factors”
2. Sensors everywhere
3. Rich variety of inputs and outputs
4. All wirelessly connected
5. Data-driven intelligence

Computation, communication, and sensing  
all integrated into physical world

# 1. Devices in diverse “form factors”



Smartphones



Activity  
Trackers



Withings, Fitbit, iHealth, Fitbug  
Weight Scales



MonBaby  
Baby  
Monitor



Belkin WeMo  
(smart switch)



Smart Bulb  
(LiFX, Hue)



Nest Learning Thermostat  
(NEST Labs)

## 2. Sensors everywhere



Quantified Self  
self knowledge through numbers

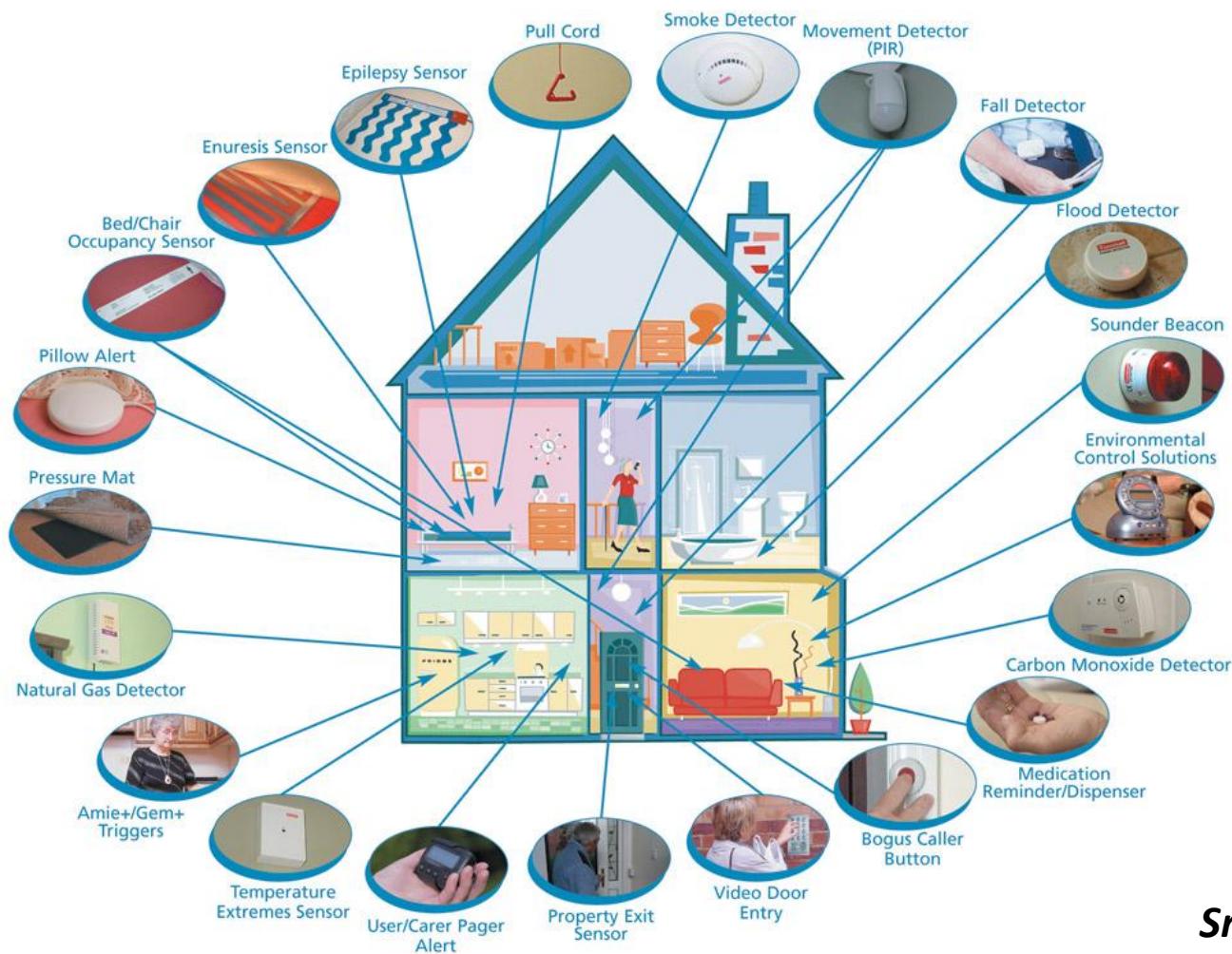
[https://www.ted.com/talks/gary\\_wolf\\_the\\_quantified\\_self](https://www.ted.com/talks/gary_wolf_the_quantified_self)

**Elon Musk says Neuralink will be like a ‘Fitbit in your skull with tiny wires’**



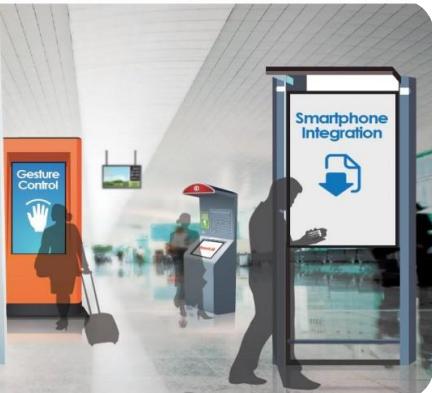
<https://www.digitaltrends.com/news/neuralink-progress-update-2020/>

# 2. Sensors everywhere



**Smart home**

# 3. Rich variety of inputs and outputs



*Digital signage*



*Voice command*



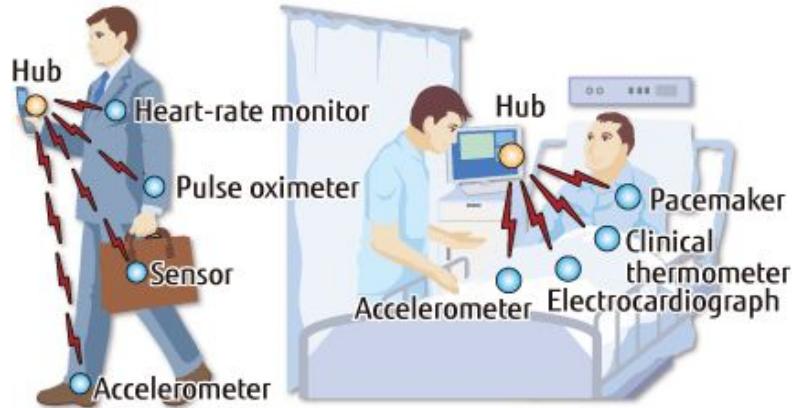
*Physical exertion input*



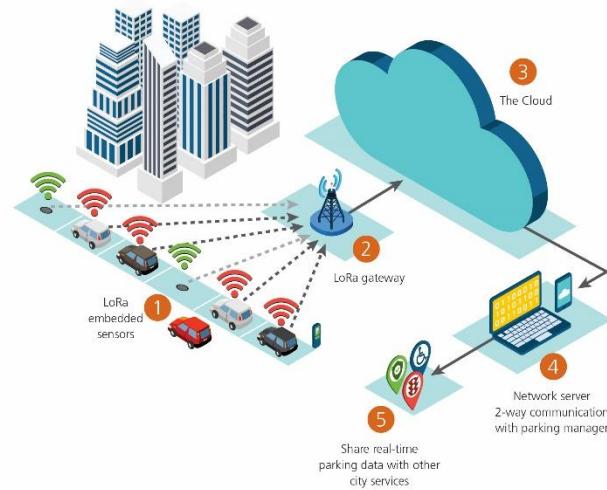
*Minority Report*

*Gesture input*

# 4. All wirelessly connected



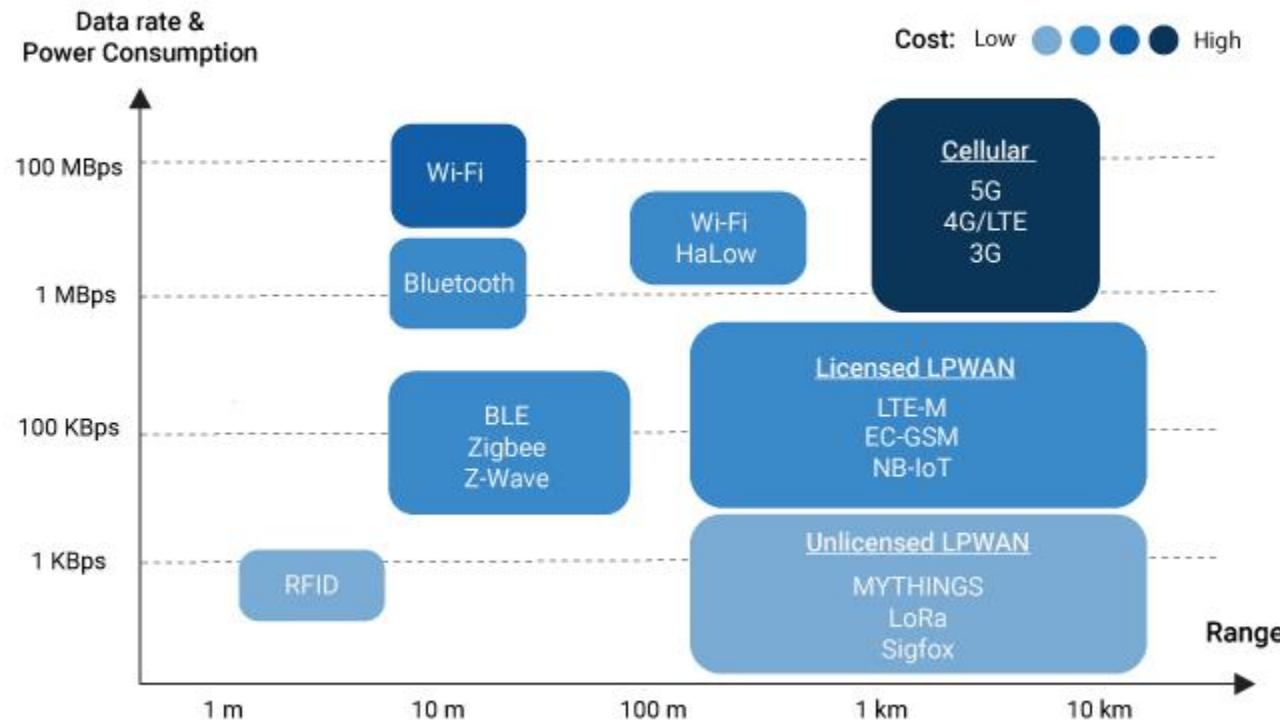
BAN: Body-area networks  
(e.g., Zigbee, Bluetooth)



LPWAN: Low-power wide-area networks  
(e.g., LoRa, NB-IoT)

<https://www.electronicsweekly.com/news/iot-smart-cities-he-long-range-forecast-for-wireless-connectivity-2018-08/>

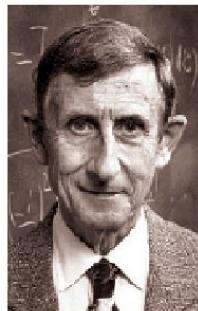
# 4. All wirelessly connected



# 5. Data-driven intelligence

Ubiquitous sensing and data analysis as a new tool

“ New directions in science are launched by new tools much more often than by new concepts. The effect of a concept-driven revolution is to explain old things in new ways. **The effect of a tool-driven revolution is to discover new things that have to be explained.**”



Freeman Dyson (1997) *Imagined Worlds*  
Harvard University Press, Cambridge, MA

# 5. Data-driven intelligence

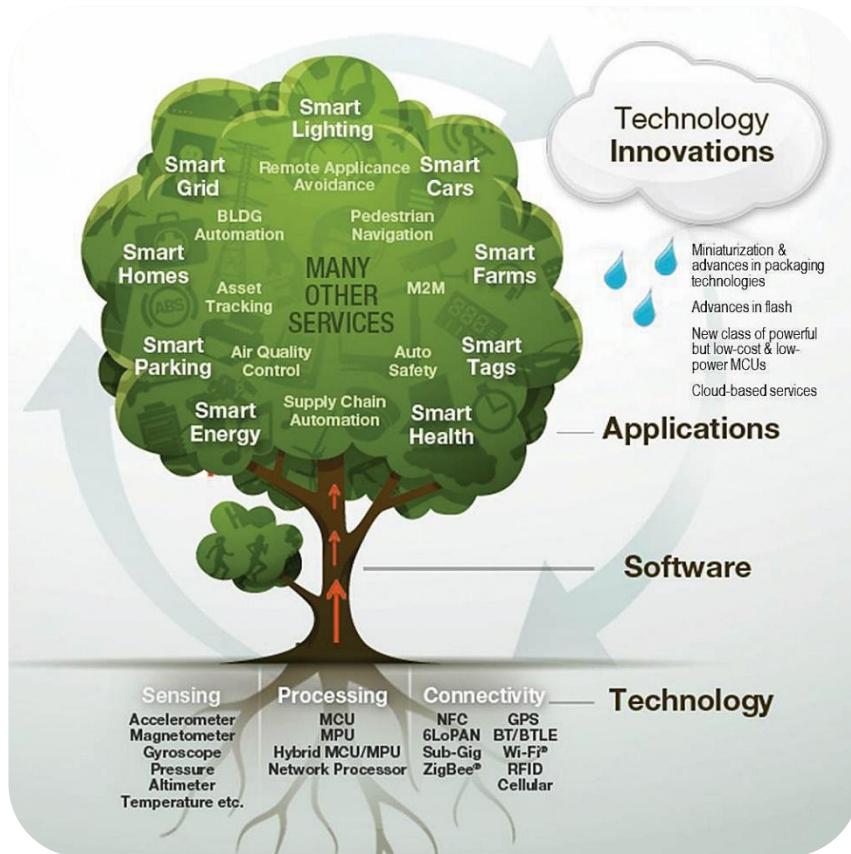
New opportunities for data-driven intelligence with sensor data analysis



<https://www.youtube.com/watch?v=l2l3e1oNwUU>

# Why now?

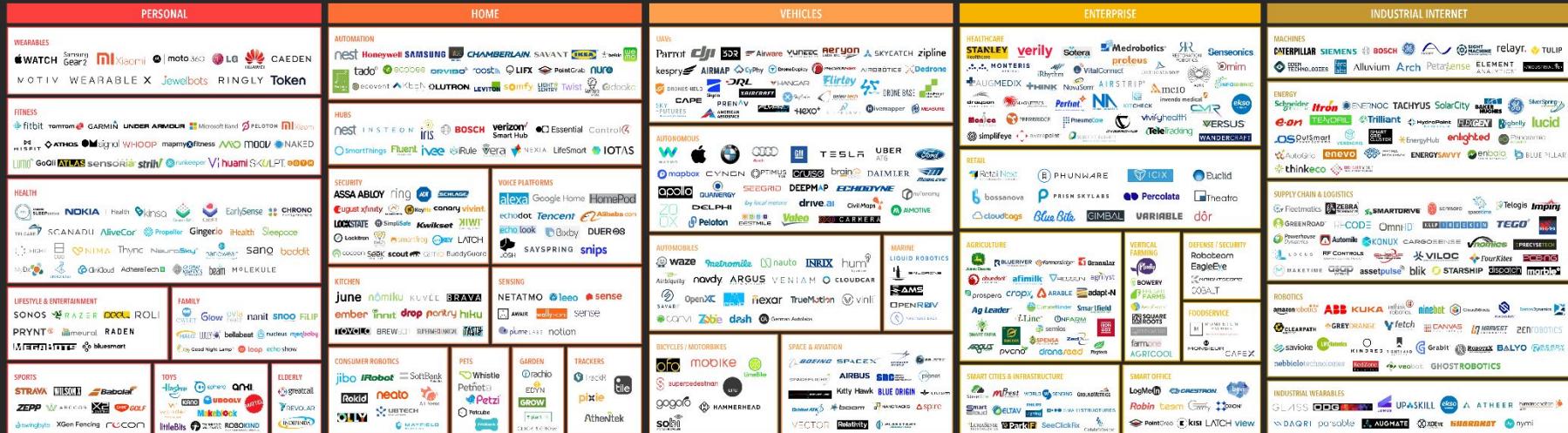
- Ecosystem is ready



Underlying sensing, processing, and networking technology & data availability

# Internet of Things Landscape 2018

## Applications (Verticals)



## Platforms (Horizontals)



## **Building Blocks**



# IoT Applications

PERSONAL		HOME	
<b>WEARABLES</b>	<b>WEARABLES</b>	<b>AUTOMATION</b>	<b>AUTOMATION</b>
apple WATCH Samsung Gear 2 MI Xiaomi moto 360 LG HUAWEI CAEDEN MOTIV WEARABLE X Jewelbots RINGLY Token		nest Honeywell SAMSUNG HUE CHAMBERLAIN SAVANT IKEA belkin weMo tado° ecobee ORVIBO roost LIFX PointGrab nure ecovent KEEN OLUTRON LEVITON somfy LIGHTSENTRY Twist Lumen dealeko	
<b>FITNESS</b>	<b>FITNESS</b>	<b>HUBS</b>	<b>HUBS</b>
fitbit TOMTOM GARMIN UNDER ARMOUR Microsoft Band PELOTON MI Xiaomi MISFIT ATHOS signal WHOOP mapmyfitness MOOV MOOV NAKED Lumi GoQii ATLAS sensöria striiv runkeeper Vi huami SKULPT GGYH		nest INSTEON IRIS BOSCH verizon Smart Hub Essential Control4 SmartThings Fluent ihee iRule Vera NEXIA LifeSmart IOTAS	
<b>HEALTH</b>	<b>HEALTH</b>	<b>SECURITY</b>	<b>VOICE PLATFORMS</b>
SLEEPsense NOKIA Health kinsa ResearchKit CareKit EarlySense CHRONO THERAPEUTICS TEL CARE SCANADU AliveCor Propeller Ginger.io iHealth Sleepace EIGHT cue NIMA Thync NeuroSky nanowear sano beddit MyDx SPARCLABS ClinCloud AdhereTech beam MOLEKULE		ASSA ABLOY ring ADT SCHLAGE August xfinity xfinity KeyMe canary vivint. LOCKSTATE SimpliSafe Kwikset KIWI Lockitron smartfrog Ever LATCH cocoon Seek scout camio BuddyGuard	alexa Google Home HomePod echodot Tencent Alibaba.com echo look Bixby DUEROS JOSH SAYSPRING snips
<b>LIFESTYLE &amp; ENTERTAINMENT</b>	<b>FAMILY</b>	<b>KITCHEN</b>	<b>SENSING</b>
SONOS RAZER DEEL ROLI PRYNT meural RADEN MEETUP bluemart	OWLET Glow ovia health nanit snoo FiLIP HALO LULLY bellabeat nucleus mnbaby Good Night Lamp loop echo show	june nōmiku KUVÉE BRAVA ember innit drop pantry hiku TOVOLA BREWBOT SUPERMECHANICAL TASTY	NETATMO Ileo sense AWAIR wallyHOME sense plumeLABS notion
<b>SPORTS</b>	<b>TOYS</b>	<b>CONSUMER ROBOTICS</b>	<b>PETS</b>
STRAVA WILSON X Babolat ZEPP ARCCOS X2 GAME GOLF swingbyte XGen Fencing Recon	Hasbro sphero ANKI greatcall KANO ubooly Mattel wonder littleBits Makeblock ROBOKIND INDEPENDA	jibo iRobot SoftBank Robotics Rokid neato A.I. Nemo OLLY UBTECH MAYFIELD Petcube Technology Will Save Us	Whistle Petnet Petzi Petcube
		<b>GARDEN</b>	<b>TRACKERS</b>
		iRadio EDYN GROW plantlink Click & GROW	TrackR tile pixie AthenTek

# IoT Applications



# And Now

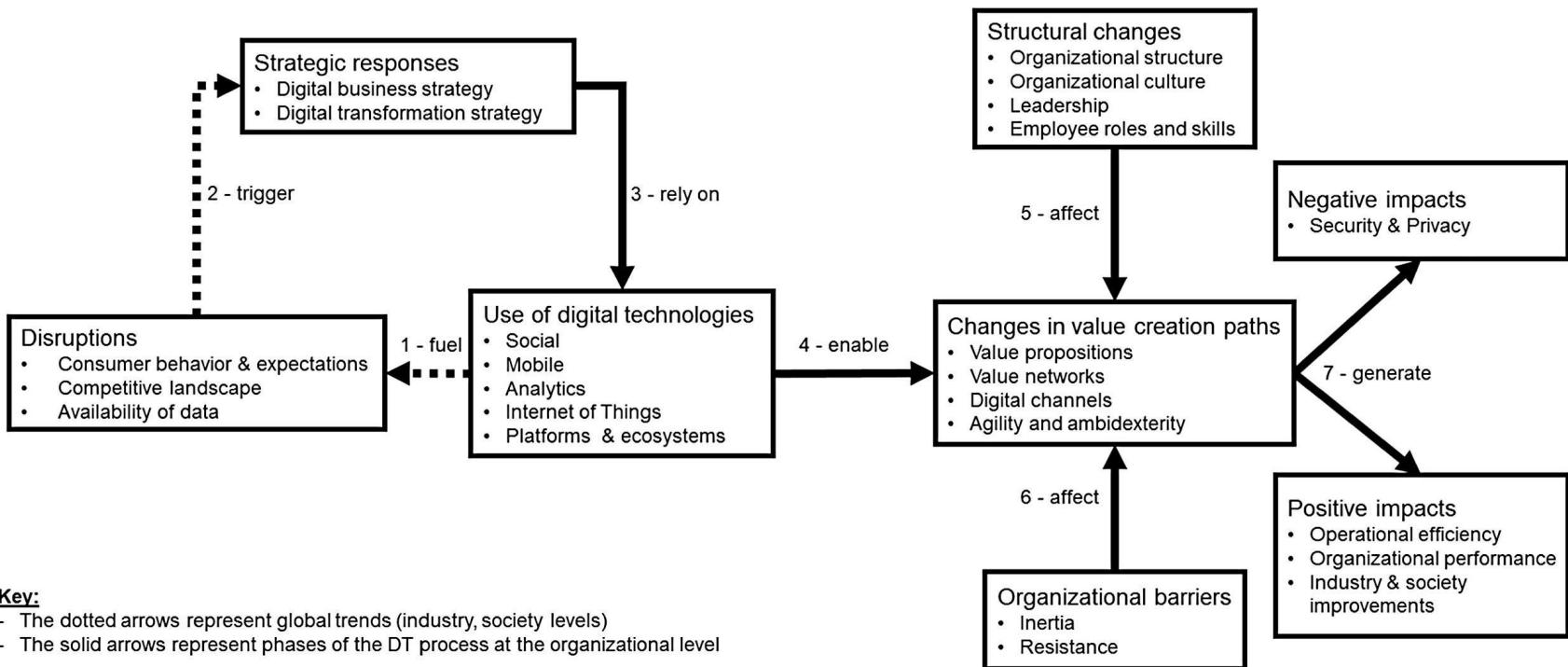
1. Devices in all form factors
2. Sensors everywhere
3. Rich variety of inputs and outputs
4. All wirelessly connected
5. Data-driven intelligence

Computation, communication, and sensing  
all integrated into physical world

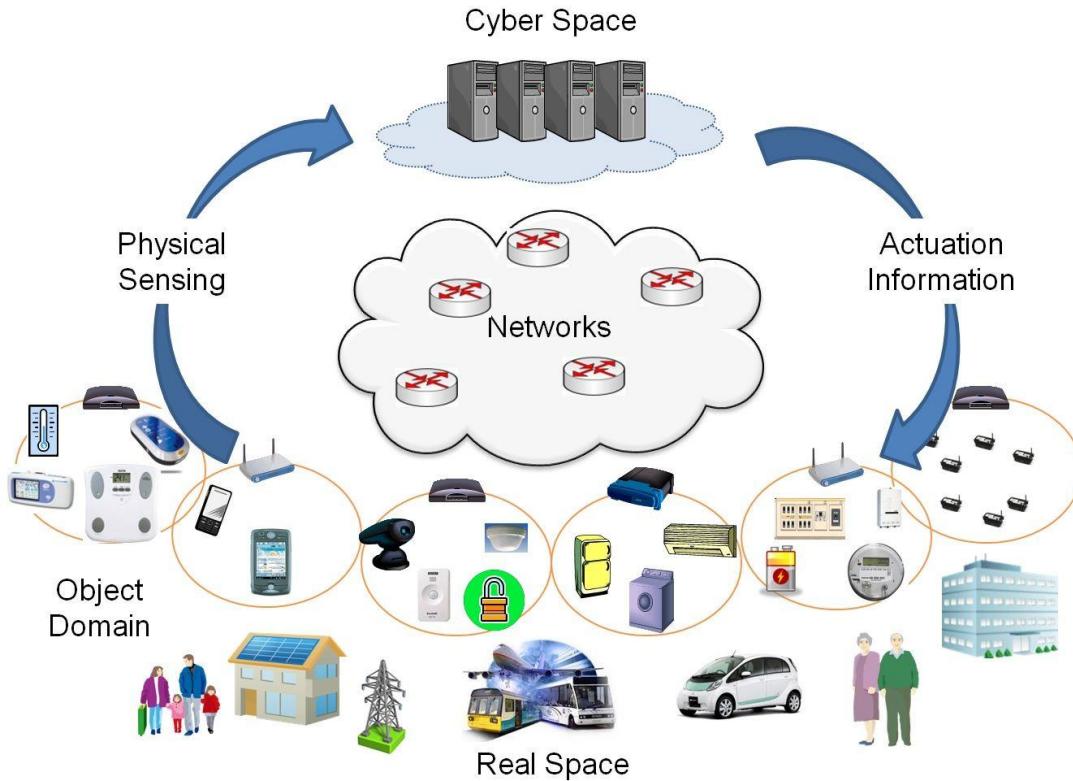
- Digital transformation & cyber physical systems

# Digital Transformation

“a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” (Vial 2019)



# Cyber Physical Systems



1. Devices in all form factors
2. Sensors everywhere
3. Rich variety of inputs and outputs
4. All wirelessly connected
5. Data-driven intelligence

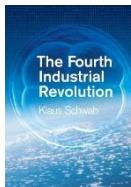
Transformative technologies for managing interconnected systems between its physical assets and computational capabilities

# 4<sup>th</sup> Industrial Revolution Led by **Cyber-physical-systems**



## Navigating the next industrial revolution

Revolution	Year	Information
	1 1784	Steam, water, mechanical production equipment
	2 1870	Division of labour, electricity, mass production
	3 1969	Electronics, IT, automated production
	4 ?	Cyber-physical systems

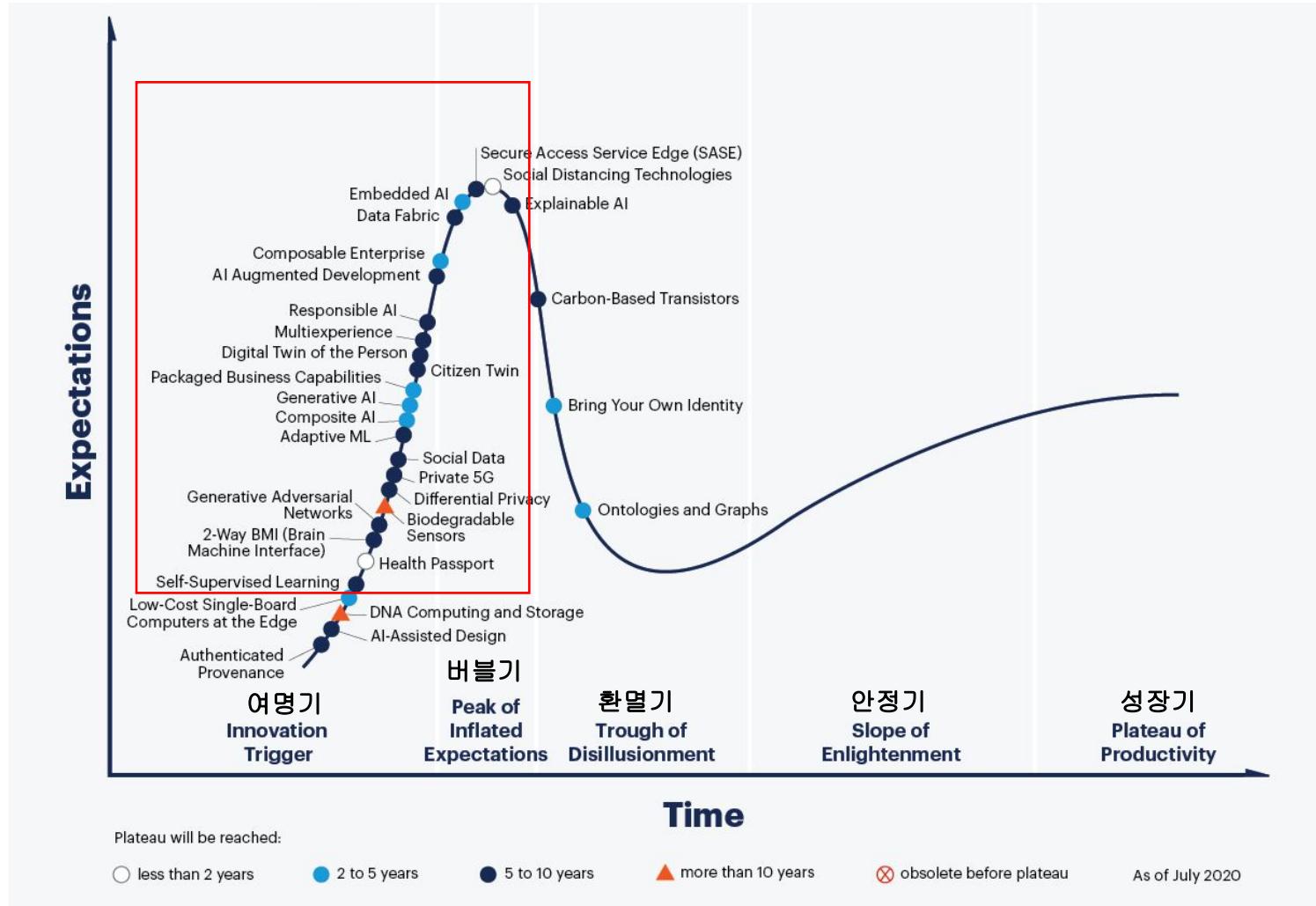


*The Fourth Industrial Revolution, Klaus Schwab, Founder and Executive Chairman World Economic Forum 2016  
The Fourth Industrial Revolution: what it means, how to respond, Klaus Schwab, January 14, 2016*

# Velocity, scope, systems impacts are great!

- Velocity: the speed of current breakthroughs has no historical precedent; exponential growth
- Scope: it is disrupting almost every industry in every country
- Systems impact: the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance

# Hype Cycle for Emerging Technologies 2020



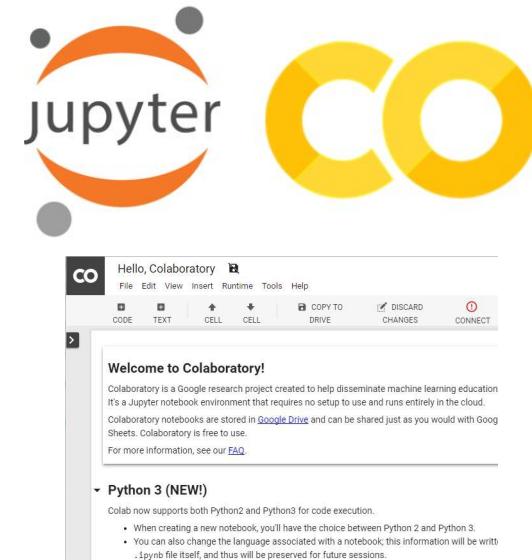
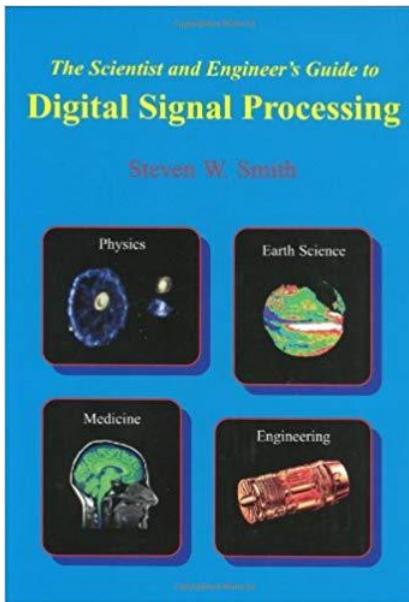
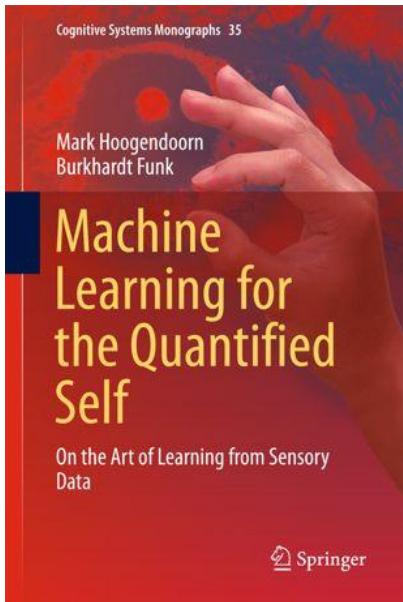
# **Sensor Data Science: Logistics**

Syllabus URL: <http://tiny.cc/y3wouz>

# Goals of this course

- Understand the key concepts of mobile sensor data science that constitute the recent innovations
- Improve complex problem solving skills by learning technical tools and applying those tools to solve real-world sensor data science problems
- Help advance the state-of-the-art sensor data science technologies

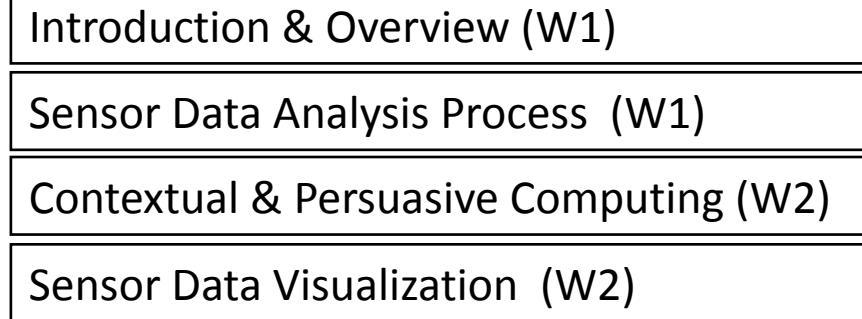
# Topics in this course



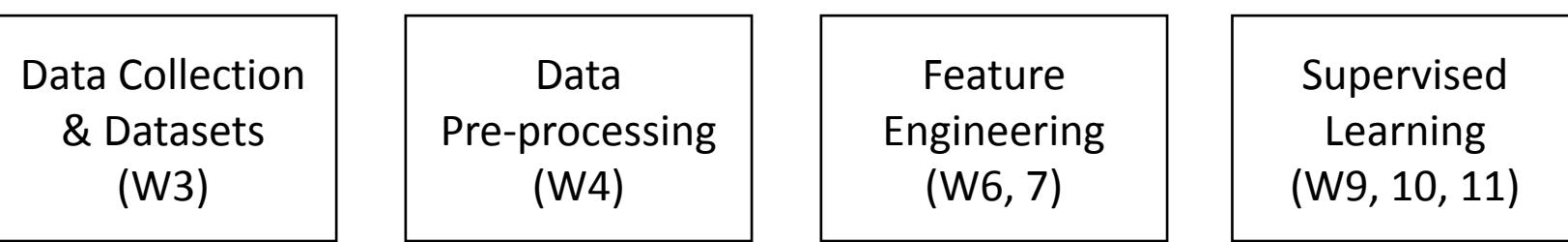
Learning

In-class Practice

## Basics



## Sensor Data Science Pipeline



K-EmoCon  
K-EmoPhone

Noise, missing values  
Anomaly, reduction

Digital signal proc.  
Feature extraction

Traditional learning  
Deep models  
Evaluation techniques

## Advanced Topics

## Applications

Active & Interactive ML (W12)

Emotion & Personality (W5)

Interpretable ML (W13)

Activity & Machine Monitoring (W14)

Causal Analysis (W14)

Interruptibility & Productivity (W15)

# Communications Tools

**LMS @ KENTECH**

- Homework
- Project

**Piazza**  
(sign-up link)

- Q&A
- Critiques

Q&A must be done through Piazza!  
(please, refrain from using emails)

# Teaching Assistants

- Kevin (Head TA)

# Logistics

- Lecture materials:
  - Google Doc Syllabus: <http://tiny.cc/y3wouz>
- In-class discussion:
  - Discussing the topics of the week (e.g., based on summaries/critiques)
  - Group activities
  - Programming/prototyping exercises

# Logistics

- Grading policy
  - Participation: 10%
  - Mid-term: 30%
  - Homework: 30%
  - Project/Final exam: 30%

# Logistics: Participation (10%)

- Class Participation (in-class & piazza)
  - Online class attendance
  - Ask or answer questions
  - Help your classmates (e.g., answering questions or tutoring)
- Lecture note annotation & improvement
  - Provide additional explanation & leave comments to the slides
  - Goal is to improve current lecture materials for 2022 Class!
  - Starting week 2, TA(s) will share assignments

# Logistics: Homework (30%)

- Homework

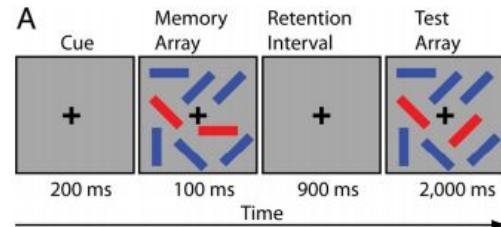
- Mostly based on in-class co-lab practices
- Homework is given to make sure that you run the code and can modify the code (help to check whether you really understood what you have learned)
- You must do your homework to do the term project because you will use the same code for your term project
- Homework will take less than a few hours (goal is to check that you correctly understood what you learned/practice)
- Must submit within a week
- There will be 10 assignments (3% per assignment)

# Logistics: Term-Project (30%)

- Must use K-EmoCon or K-EmoPhone dataset (or both)
- Possible term-project topics will be released by September, but you can propose your own topics
- Possible directions:
  - Replicating existing research papers by using K-EmoCon or K-EmoPhone
  - Improving existing research papers by applying recent techniques
  - Solving new problems by using K-EmoCon or K-EmoPhone
  - Deepening our understanding of K-EmoCon and K-EmoPhone datasets

# Multitasking and Learning

- Distraction & divided attention: texting while driving?
- Multitaskers are inferior in cognitive control: filtering irrelevant info and task switching (Ophir et al., 2009)
- Lower scores (w/ laptop use) of the user and nearby users (secondhand smoking) (Cepeda et al. 2013)



# Personal Technology Use Guidelines

## “Appropriate Use”

- When students bring personal devices such as laptops, tablets, and smartphones to the classroom or class lab, they should appropriately use them
- Communication devices will need to be on silent during the lecture
- Using devices for interacting on sites such as Facebook and Instagram, or playing online games is not an appropriate in-class use of technology
- Sending or receiving text messages, instant messages, or making or receiving phone calls in class can cause significant distractions to the teacher and fellow students
- Personal devices in the classroom are to be used for class purposes only
- Your in-class participation scores will be deducted if you use your devices inappropriately

*Original statements from Bayless, Clipson, Wilson (2013). Faculty Perceptions and Policies of Students' Use of Personal Technology in the Classroom, Business Communication and Legal Studies*