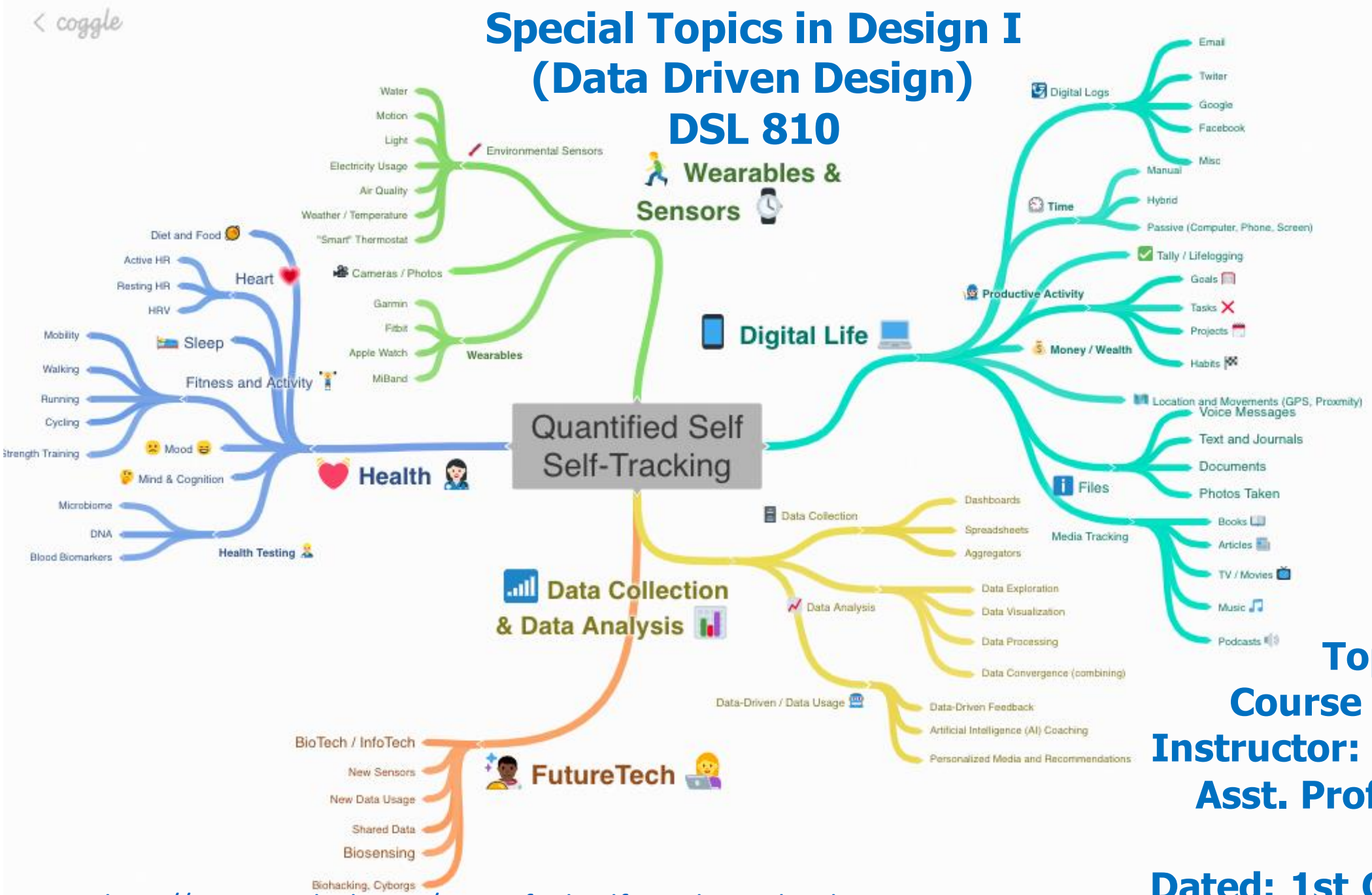
Special Topics in Design I
(Data Driven Design)
DSL 810



Source: http://www.markwk.com/quantified-self-mind-map.html

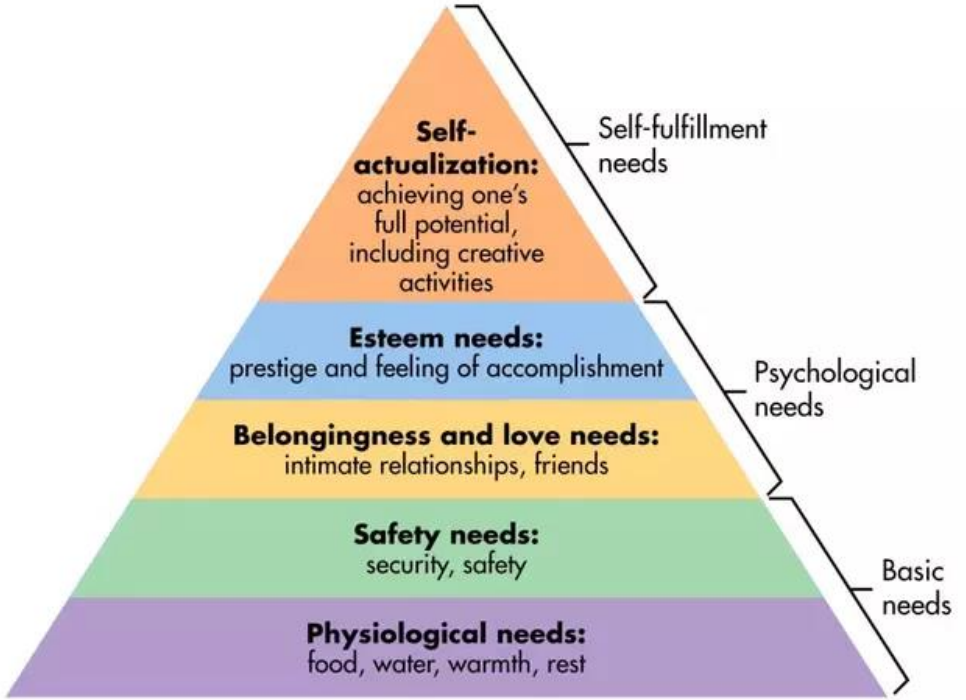
Topic 0
Course Overview
Instructor: Jay Dhariwal, Asst. Prof., IIT Delhi

Dated: 1st October, 2020

My motivation: Health and Wellness

- Health is a state of complete physical, mental and social well-being and it's not just merely the absence of disease or infirmity. (WHO)

Global Wellness Institute



Maslow's hierarchy of needs

Introductions

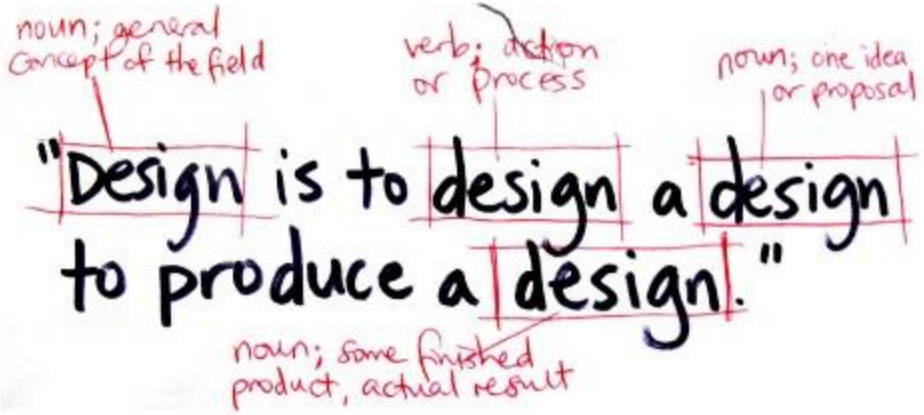
- Myself
- TA: Gulshan Kumar, PhD student, DoD
- TA: George Geo, MDes student, DoD
- Yourself (google form to know your expectations and skills)

Let's decode this topic: Data Driven Design

- What and Why of Design?
- What and Why of Data Science?
- Data Driven Design?

Source of decode image: https://www.daskeyboard.com/blog/decode-our-das-keyboard-holiday-message-and-win/

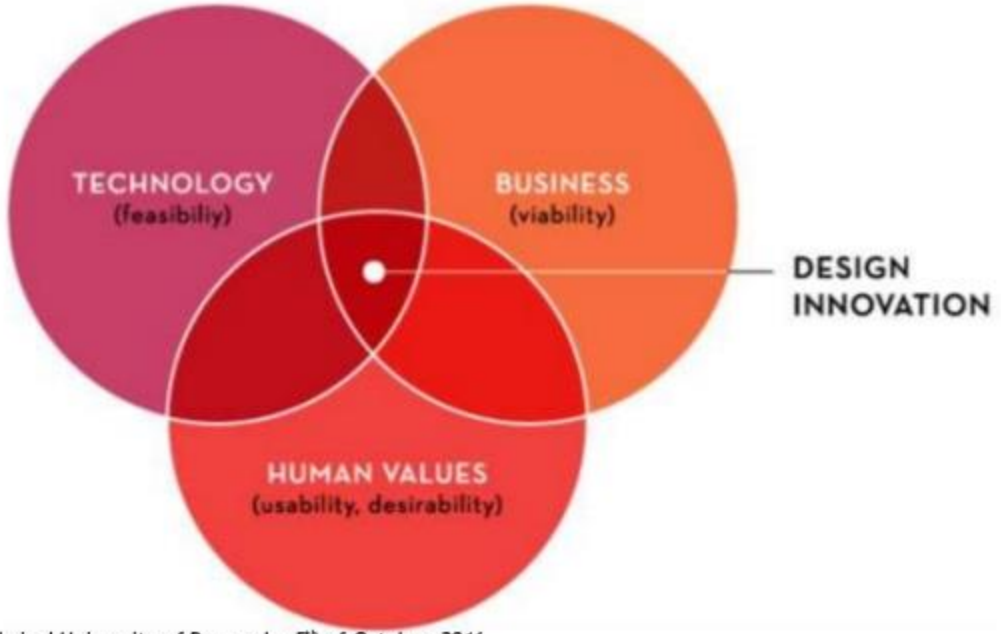
What is Design?



TEDC - Transform Your Email Strategy With Design Leadership #LitmusLive @pn

// Integrated process

An integrated process: a process that deliberately integrates necessary disciplines



Jaap Daalhuizen · Technical University of Denmark · 5th of October, 2016

- Sciences of the Artificial: Herbert Simon (Nobel Laureate, Economist, Father of AI)
- Breaking silos and working together

Design Thinking at work

airbnb

From near collapse to conquering the market

- Airbnb attributes its market dominance to user-centred design.
- When they about to go bust at $200 revenue per week Airbnb discovered that all of the photos for their listings were low quality and unattractive
- Airbnb decided to replace the amateur photos with high-quality photos and it worked.

> **"Going out to meet customers in the real world is almost always the best way to wrangle their problems and come up with clever solutions"**
>
> Joe Gebbia of Airbnb with First Round.

Image source: https://www.slideshare.net/rajpeddisetty/it-executives-guide-to-design-thinking

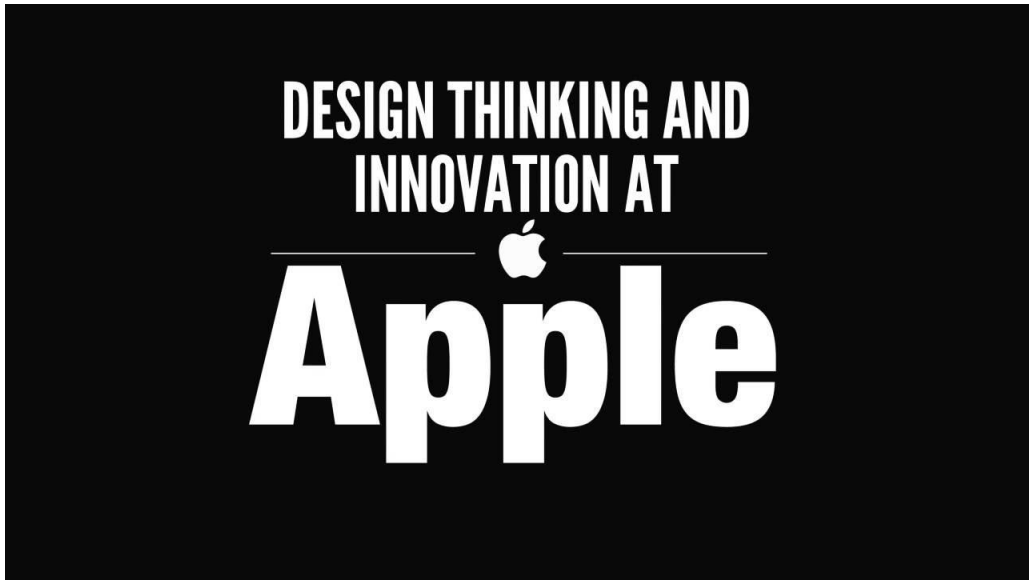
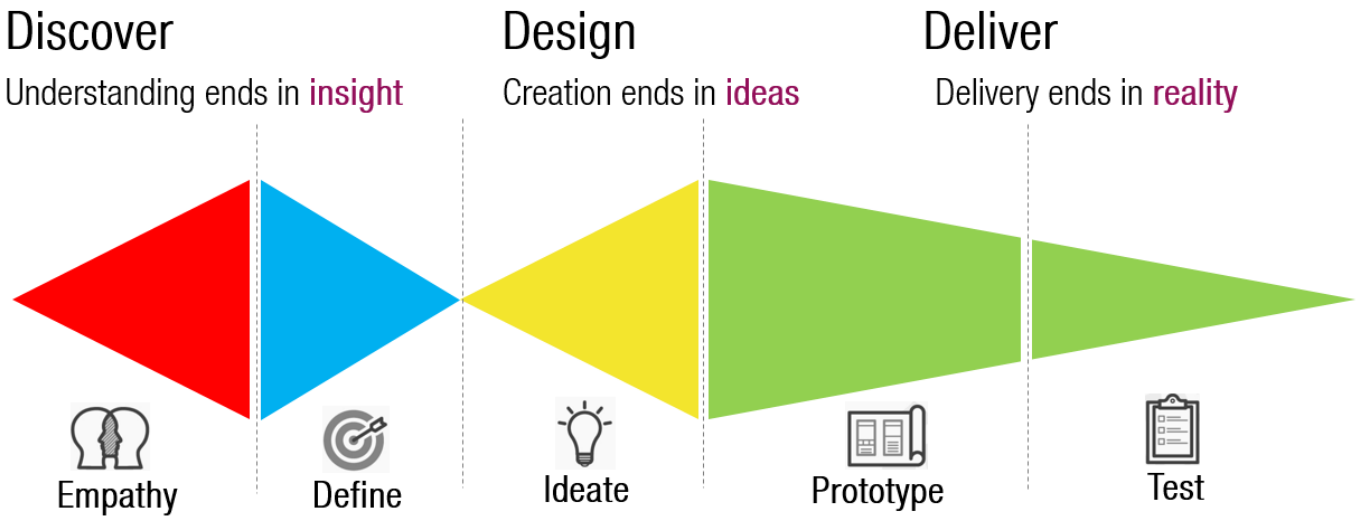


Image source

Image source

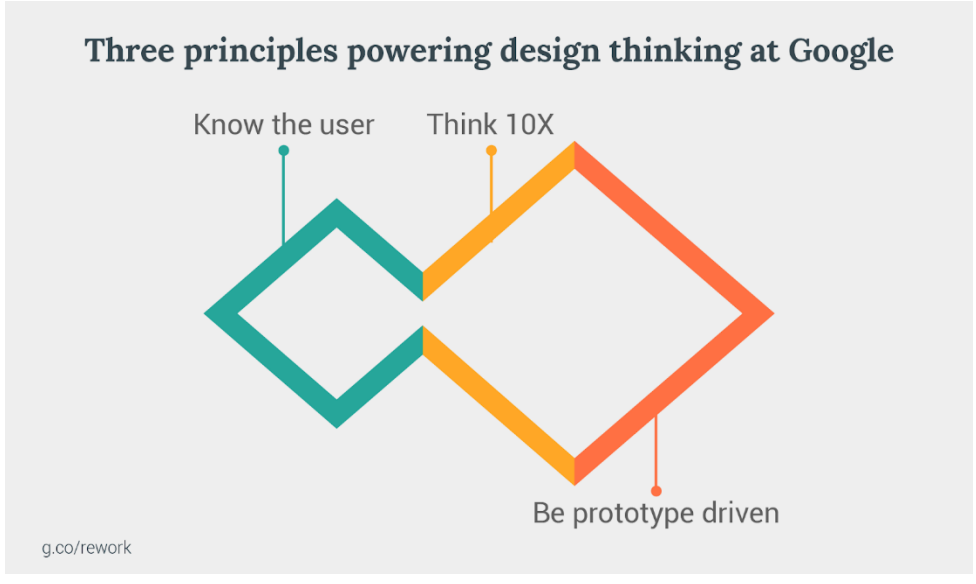
DESIGN THINKING MODEL



Design Thinking is an iterative and non-linear process in which we seek to understand the user, challenge assumptions, and redefine problems in an attempt to identify alternative strategies and solutions that might not be instantly apparent with our initial level of understanding.

Image source

Image source



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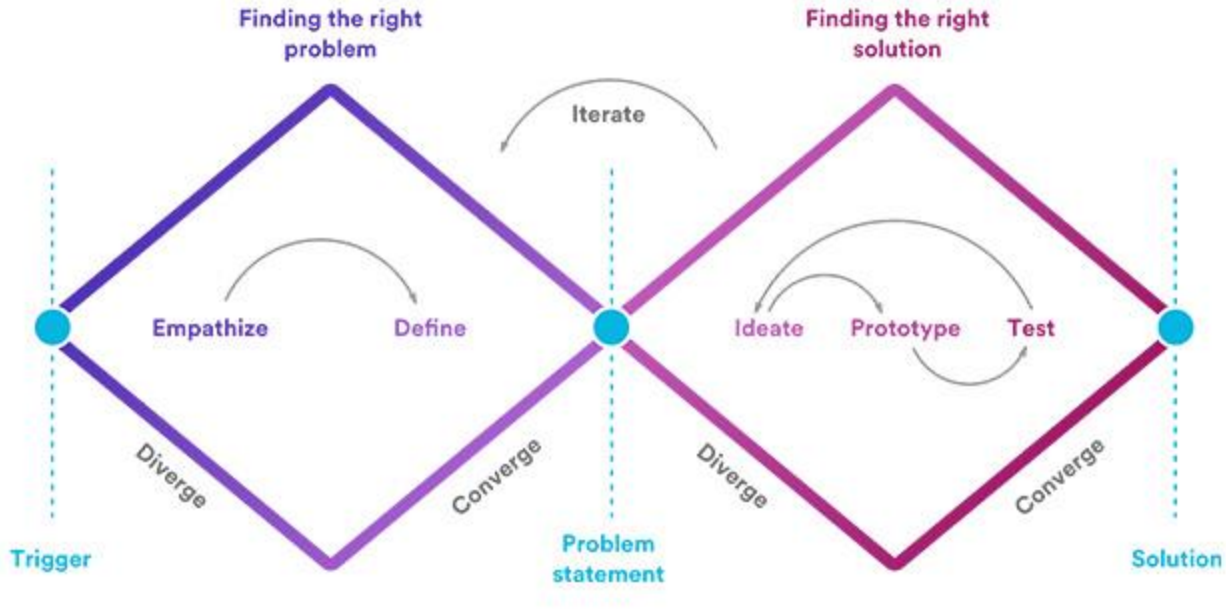
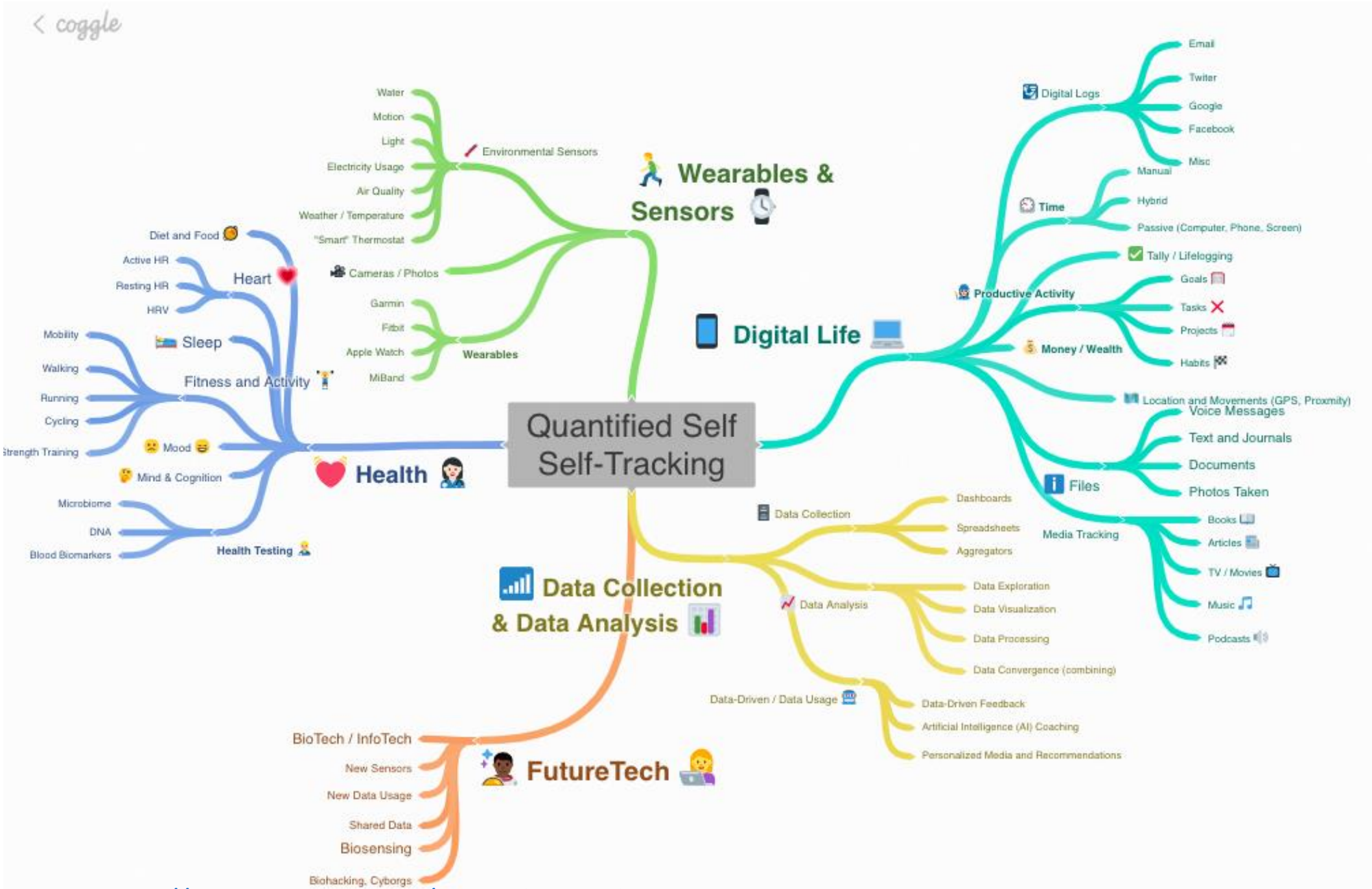


What is Design Thinking process?

Design Thinking - Tim Brown, CEO and President of IDEO

1. Divergent thinking (instead of convergent thinking, exploring possibilities)
2. Integrated, Holistic thinking (instead of analytically to one part of the problem). Work to resolve desirability, feasibility, viability.
3. Design is human-centered, meet needs – instead of starting from technology or business.
4. Can apply to any product or system (digital or physical)
5. Prototyping speeds up the innovation process.
How fast at prototyping?
6. Build movements
OpenIDEO: Social Impact Powered By Design Thinking
7. Design is moving from consuming to creating meaningful, participative experiences
8. Collaboration, trust, playfulness
9. Design every aspect of business
10. ASKING THE RIGHT QUESTION is important.



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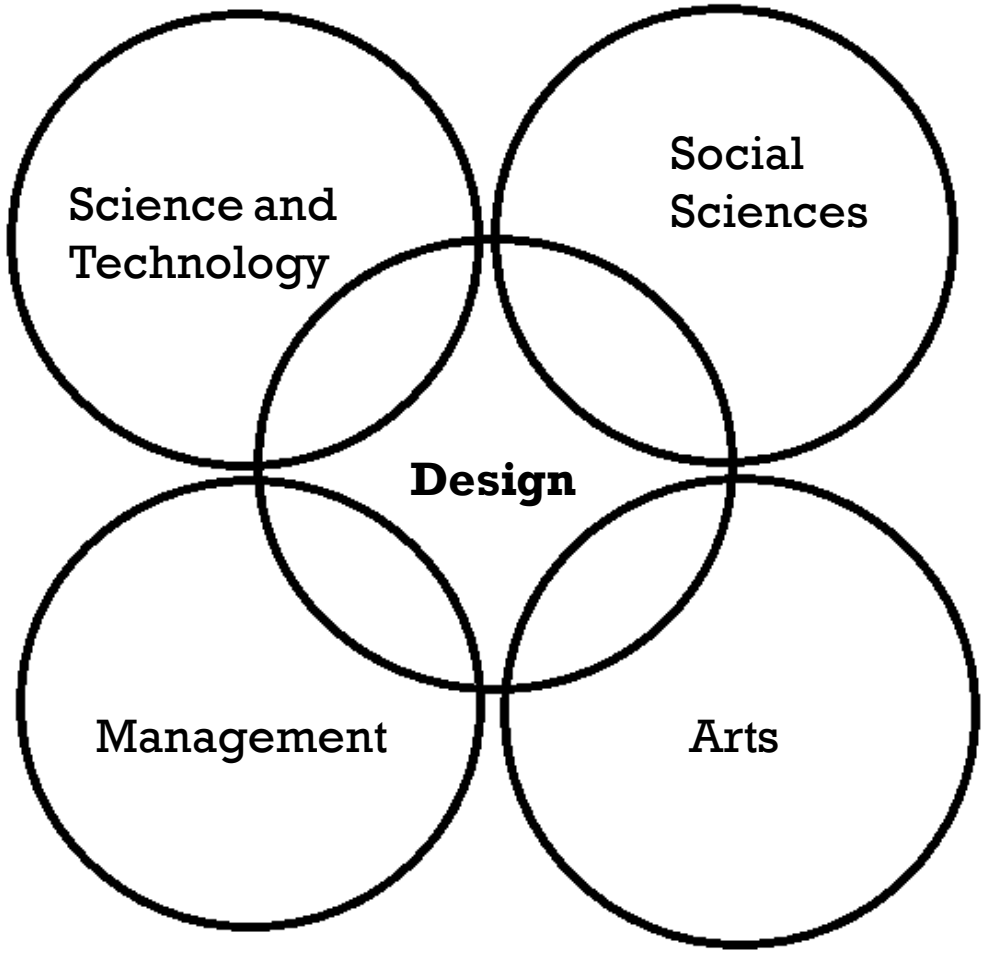
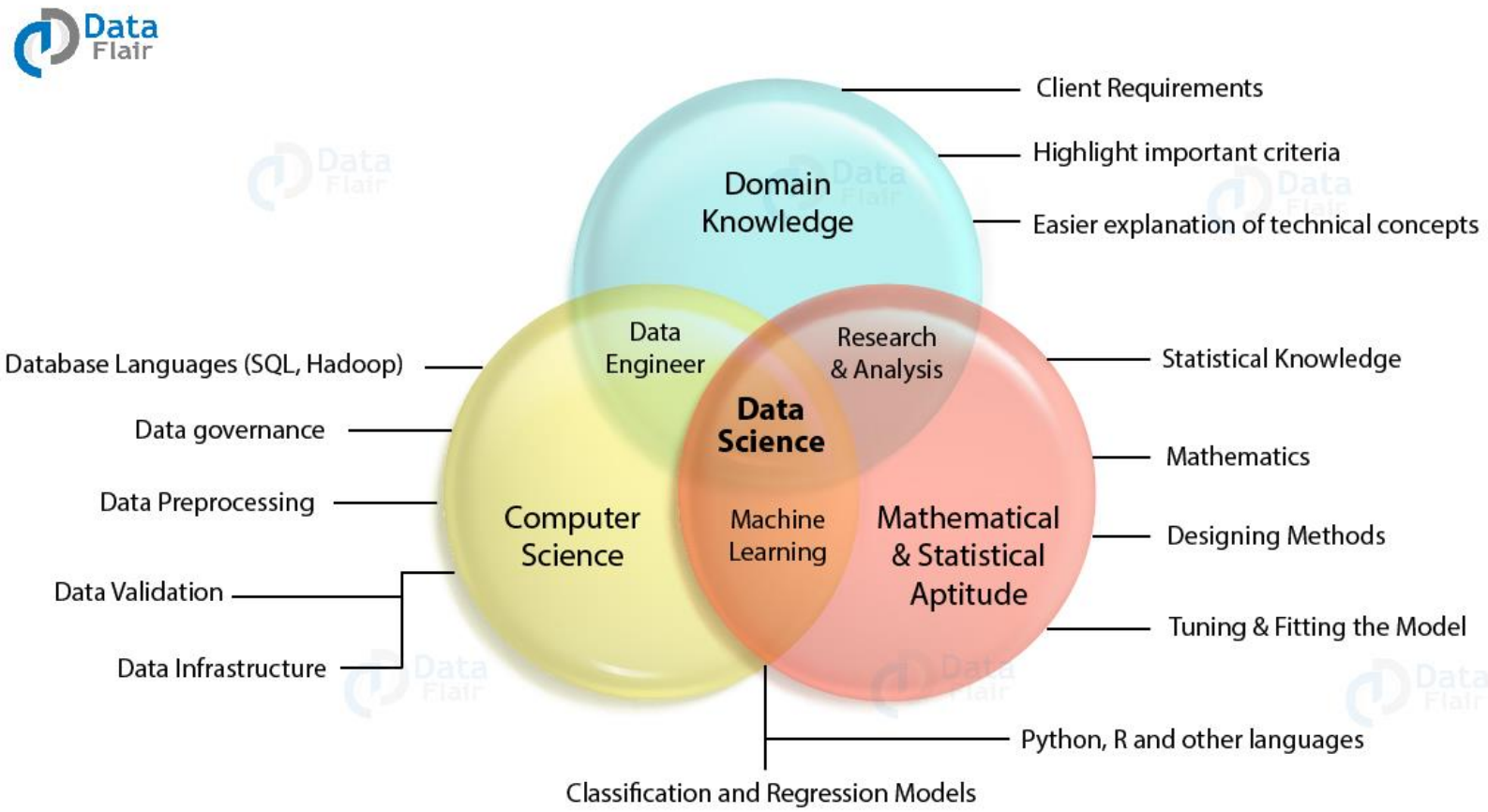


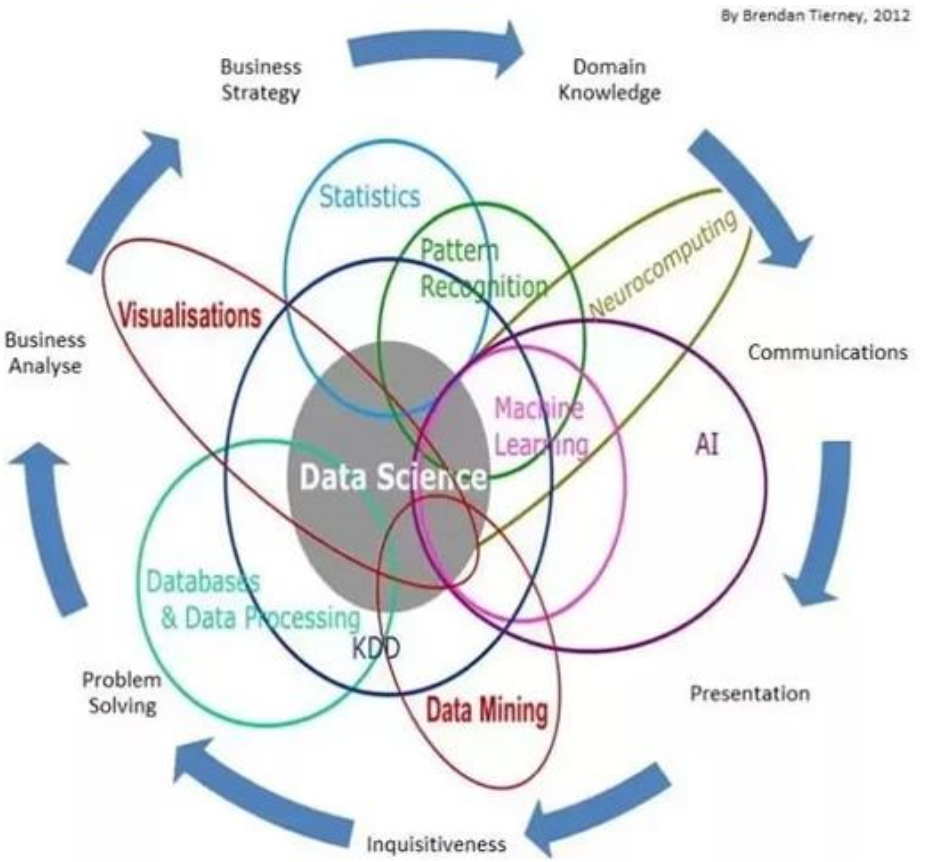
A Vision for Design

To apply design thinking to solve the wicked problems in the society, taking inputs from the sciences and technology, social sciences, management and arts domain as the need may be.

Data Science: understand and analyze actual phenomena with data



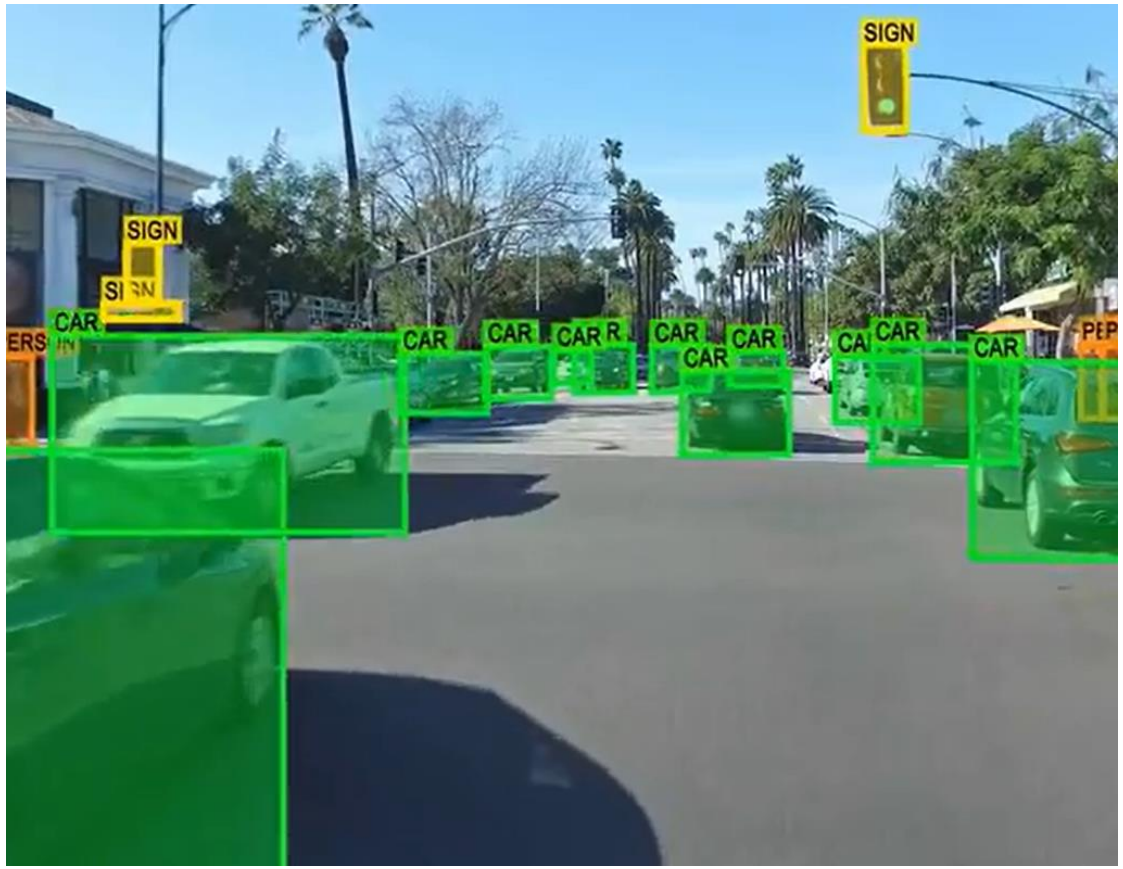
Data Science is multi-disciplinary



https://www.simplilearn.com/data-science-vs-data-analytics-vs-machine-learning-article

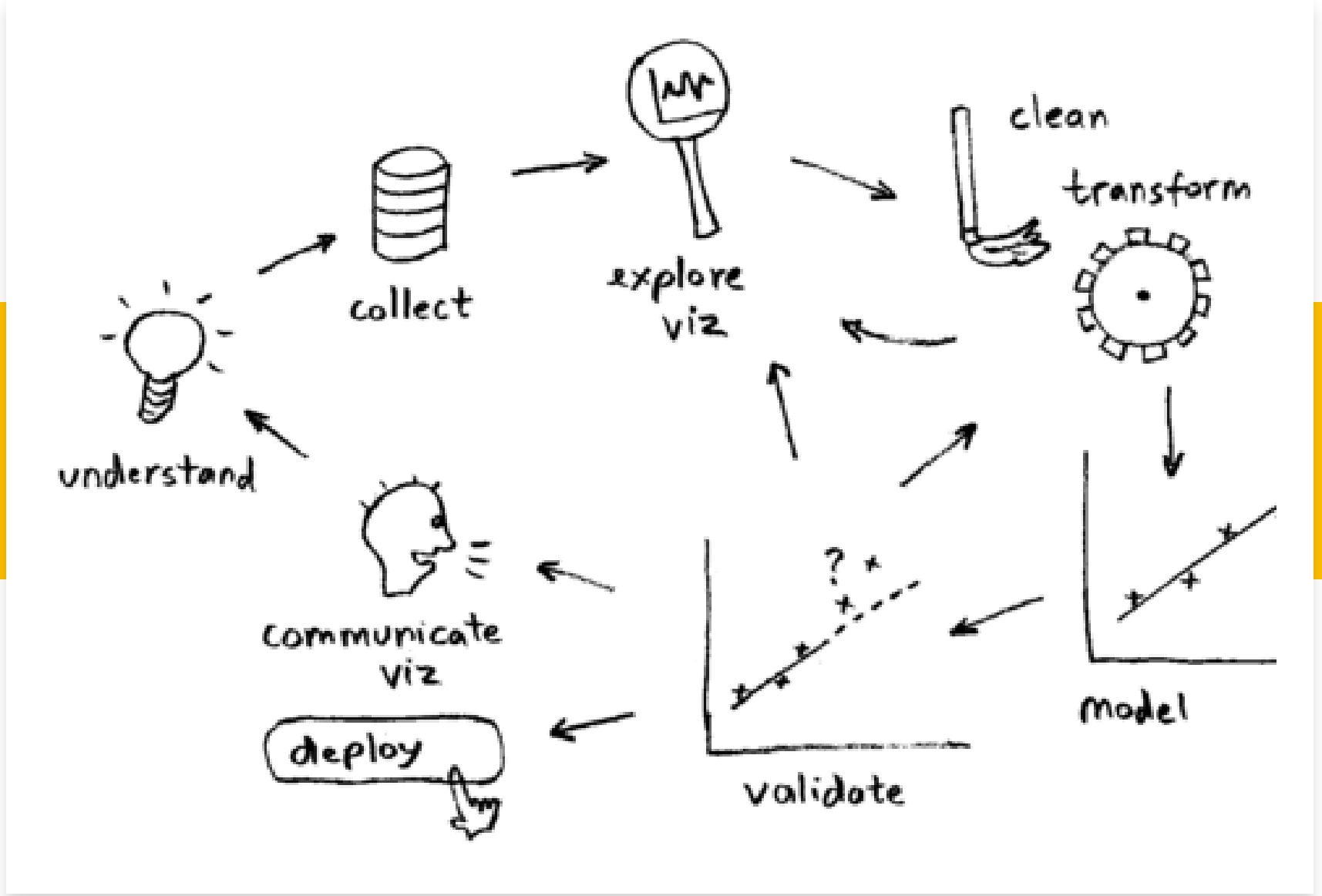
Have you used ML before?

- Siri, Google Assistant, Alexa.
- Amazon suggestions to buy stuff, Film suggestions on Netflix



Why should you care about ML?

- AI vs. ML
- Google's AI AlphaGo Is Beating Humanity At Its Own Games
- Elon Musk's concerns about Artificial Intelligence
- Eric Schimdt: Former Chairman, Alphabet (parent company of Google): Self Driving Cars are the future, AI assisted health care.
- Vinod Khosla about Generative Design (CAD+AI). Bike example



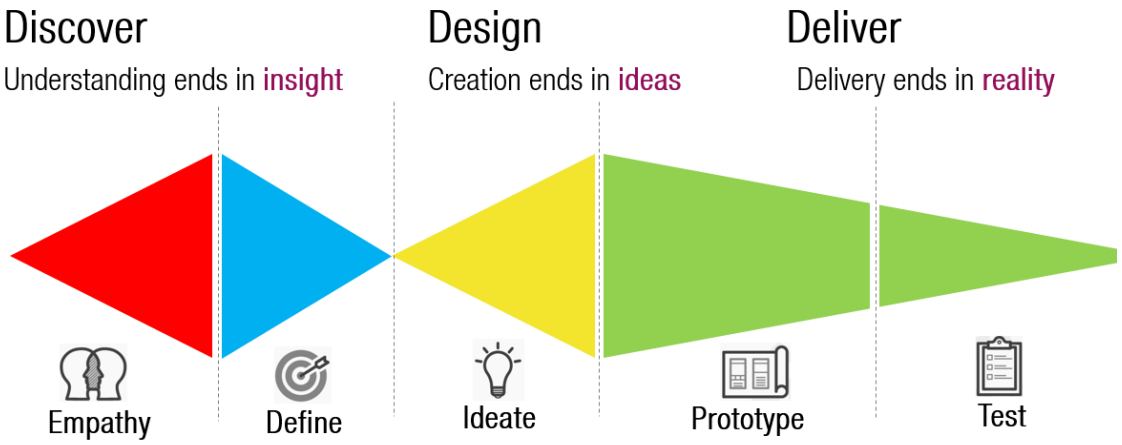
Data science workflow

Source: http://datascience.la/data-science-toolbox-survey-results-surprise-r-and-python-win/

Data Driven Design

- Let's take an example of making an assistive chair for the elderly – Prankur Kataria.

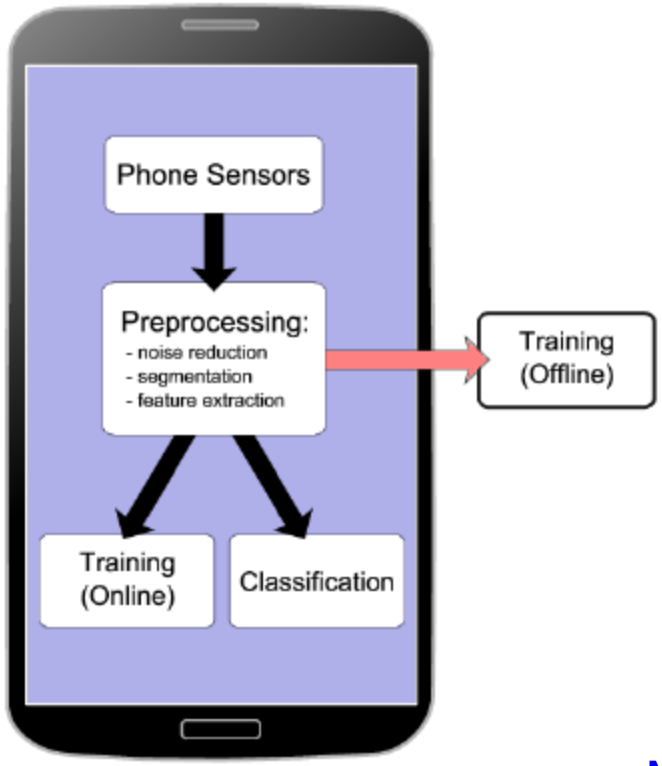
DESIGN THINKING MODEL



Design Thinking is an iterative and non-linear process in which we seek to understand the user, challenge assumptions, and redefine problems in an attempt to identify alternative strategies and solutions that might n be instantly apparent with our initial level of understanding.

- Image source

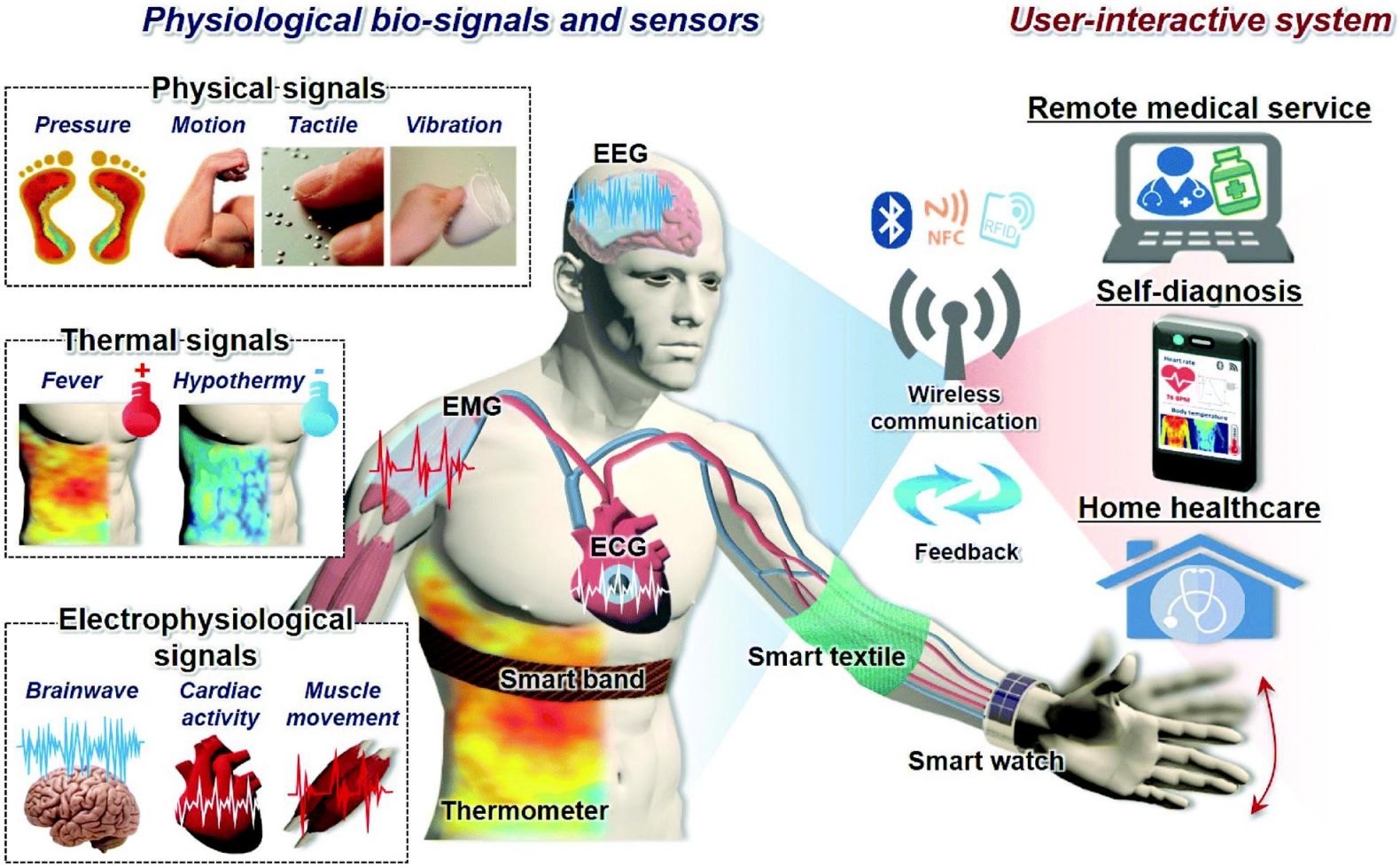
Human activity recognition



doi:10.3390/s150102059

[MATLAB video tutorial]
[Data source]

Wearables for health monitoring



Ha, Minjeong, Seongdong Lim, and Hyunhyub Ko. 2018. "Wearable and Flexible Sensors for User-Interactive Health-Monitoring Devices." Journal of Materials Chemistry B 6 (24): 4043–64. https://doi.org/10.1039/c8tb01063c.

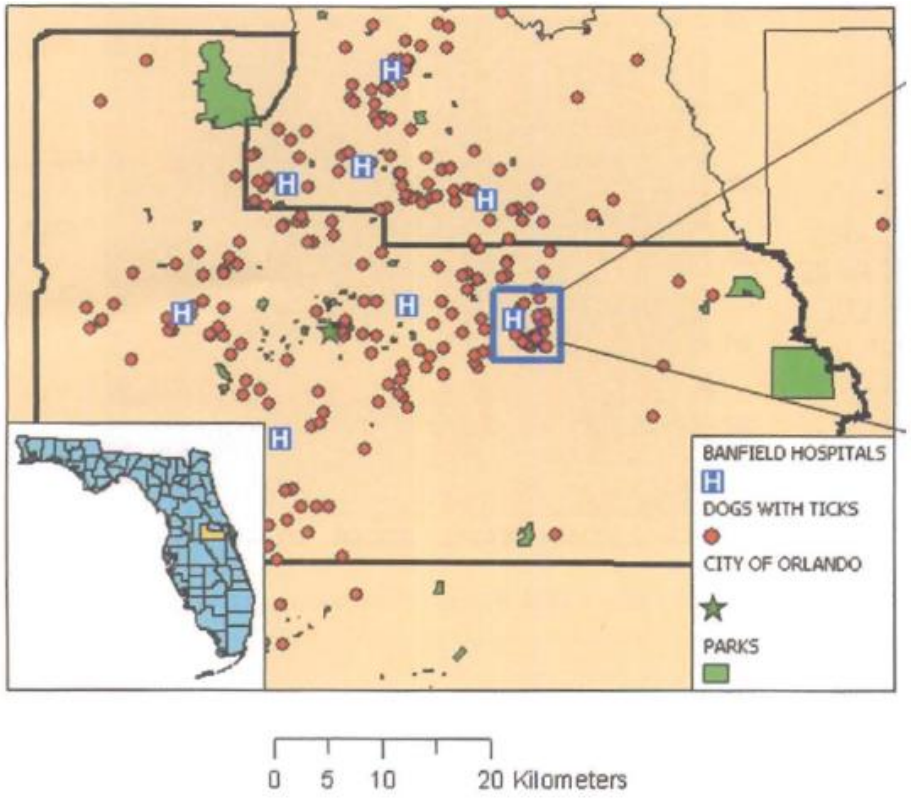
Idea Generation

Prof Ramesh Raskar,
Faculty, MIT Media Lab

Let's decode this topic: Data Driven Design

- What and Why of Design?
- What and Why of Data Science?
- Data Driven Design

Topic 2: Case studies for Project Proposal



- Spatio-temporal clusters for early epidemic detection
- Data Science for COVID-19
- NodeMCU + sensors + ThingSpeak
- Big Data analysis from MIT North Court study
- Machine Learning for Building simulation
- Marta González - Mobile Data for Urban Transformation
- SAS data warehouse data to improve USCG supply chain

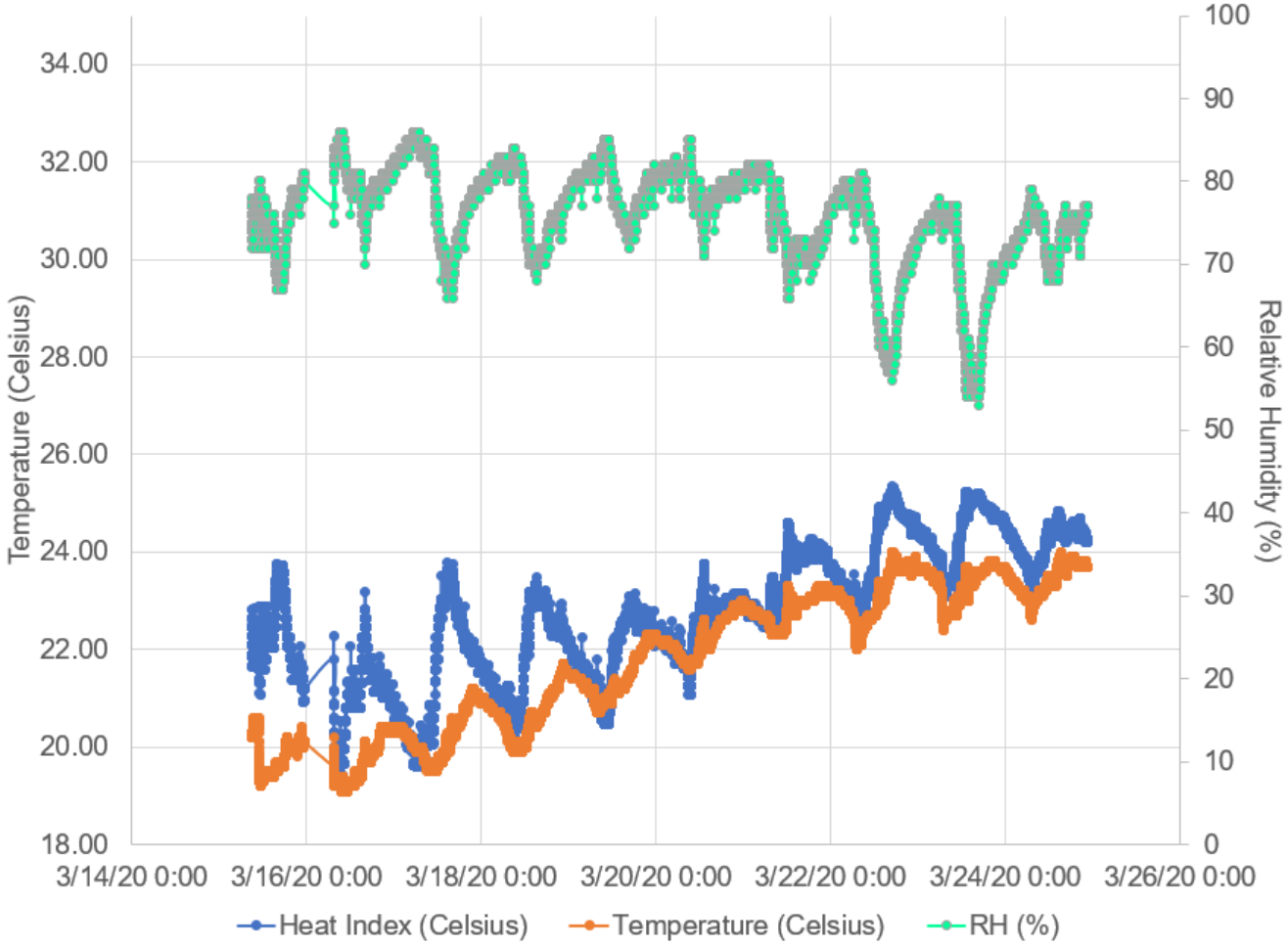
Moore G.E., Ward M.P., **Dhariwal J.**, Wu C.C., Glickman N.W., Lewis H.B., Glickman L.T., 'Development of a national companion animal syndromic surveillance system for bioterrorism', *2nd International Conference on the Applications of GIS and Spatial Analysis to Veterinary Science (GISVET 04), Univ. Guelph, Ontario, Canada*, Durr, P. A. and Martin, S. W., Jun 2004.

Understanding congested travel in urban areas Serdar Çolak, Antonio Lima & Marta C. González *Nature Communications* **volume 7**, Article number: 10793 (2016)

Big Data Analytics: Design of Outdoor Public Spaces

Reinhart C., Dhariwal J. and Gero K., 'Biometeorological indices explain outside dwelling patterns based on Wi-Fi data in support of sustainable urban planning', *Building and Environment*, 126, 2017, 422–430.

Heat Index profile for my room
NodeMCU + DHT11 + ThingSpeak



Observations

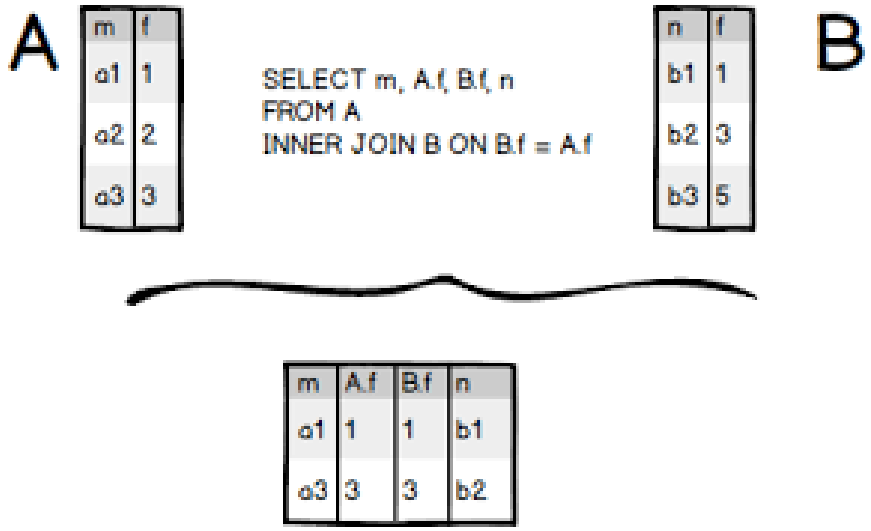
1. 48500 data points
2. T, Rh every 18 sec for 10 days
3. Cyclical pattern
4. Daily Temperature Increase
5. In the context of COVID-19, this analysis helps to know what Temp, Rh to avoid which is conducive for the virus
6. Assignment 5 on thermal comfort

Topic 3: Website Design for Course Mgmt

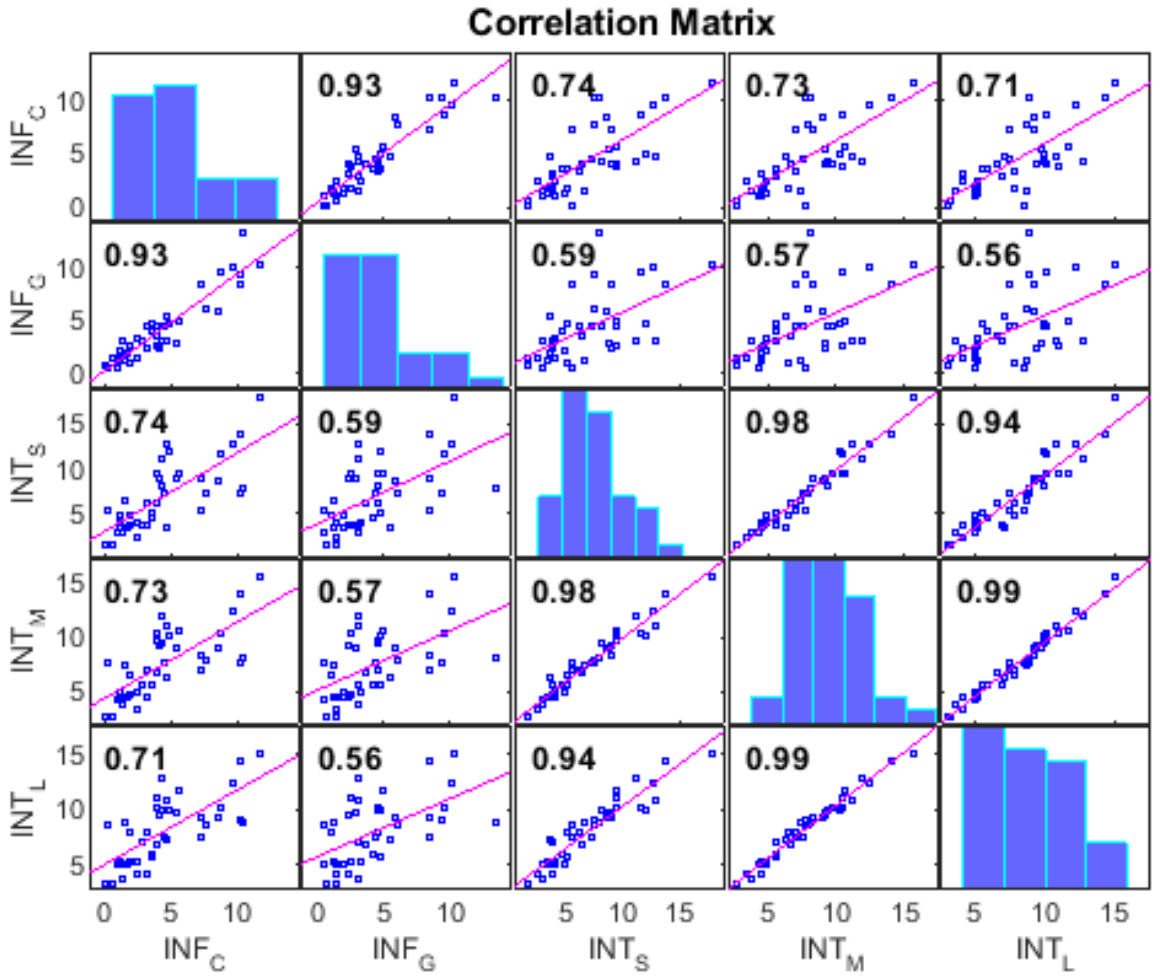
- Portfolio, digital repository for others
- html
- html, css template provided by us Smart Fan
- html, css template of your choice Self stabilizing box
- Anything else (Javascript, Markdown, PHP)
- Image compression, Video editing.

Topic 4: Data preprocessing

- SQL inner join (between tables with fields having unique values - keys)
- SQL queries to filter data
- Avoid duplicates
- Missing values, feature extraction



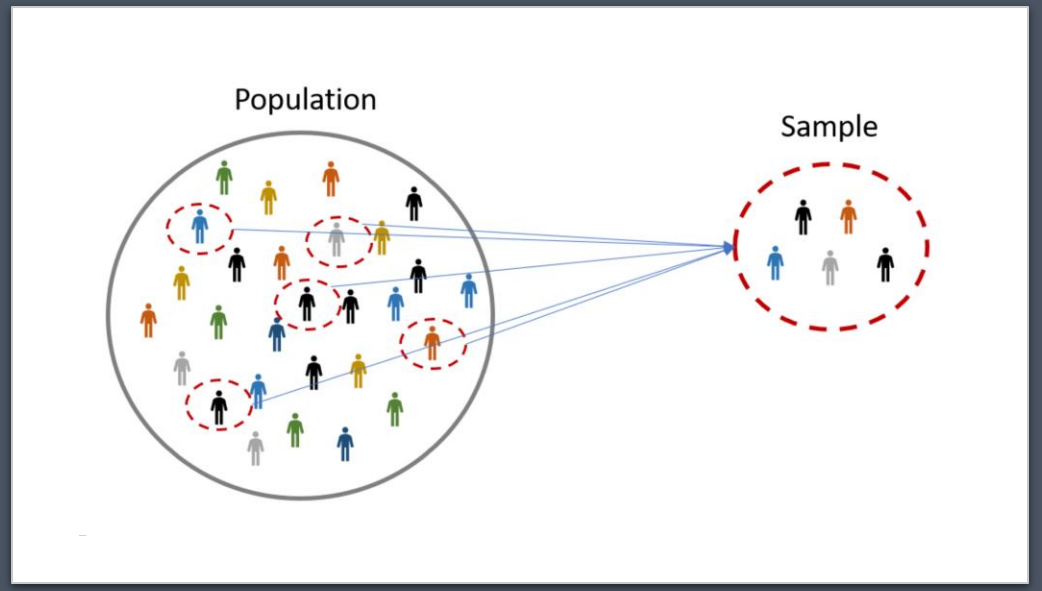
Data visualization

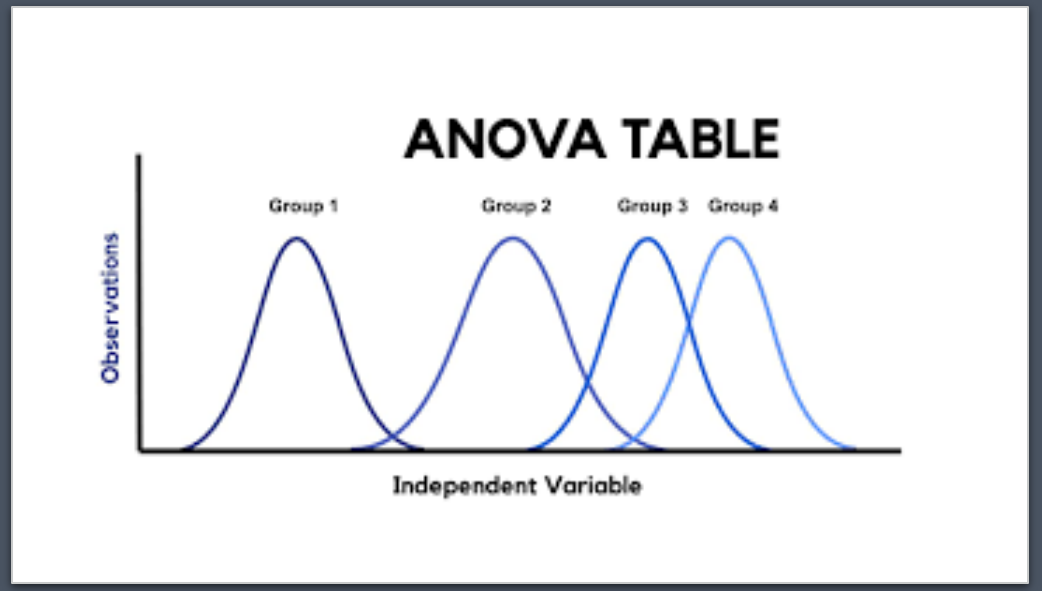


Source: https://in.mathworks.com/help/econ/corrplot.html

Topic 5: Statistical Methods in Design

- Stratified sampling
- Survey methods
- Randomization
- Data normalization
- Statistical distributions for discrete event simulations

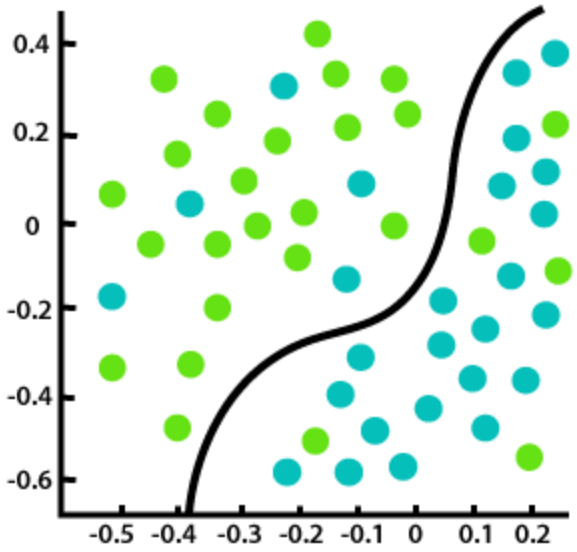




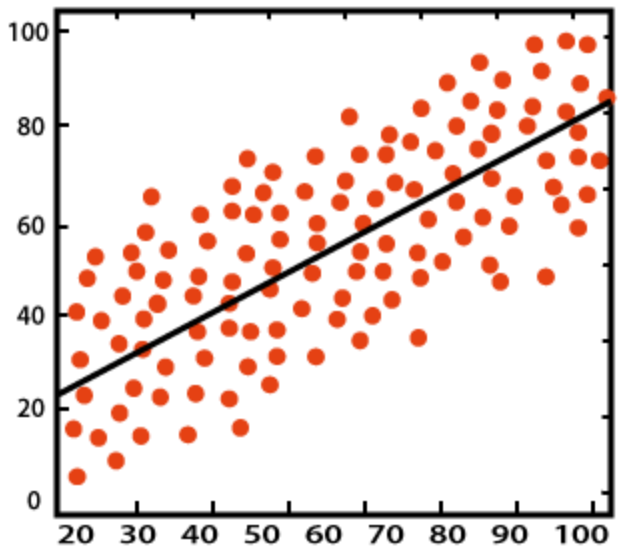
- Source: https://www.omniconvert.com/what-is/sample-size/
- https://estamatica.net/anova-table-with-spss/

Topic 6 and 7:
Regression and Classification

- Getting excited about it – real world examples
- MATLAB cloud login



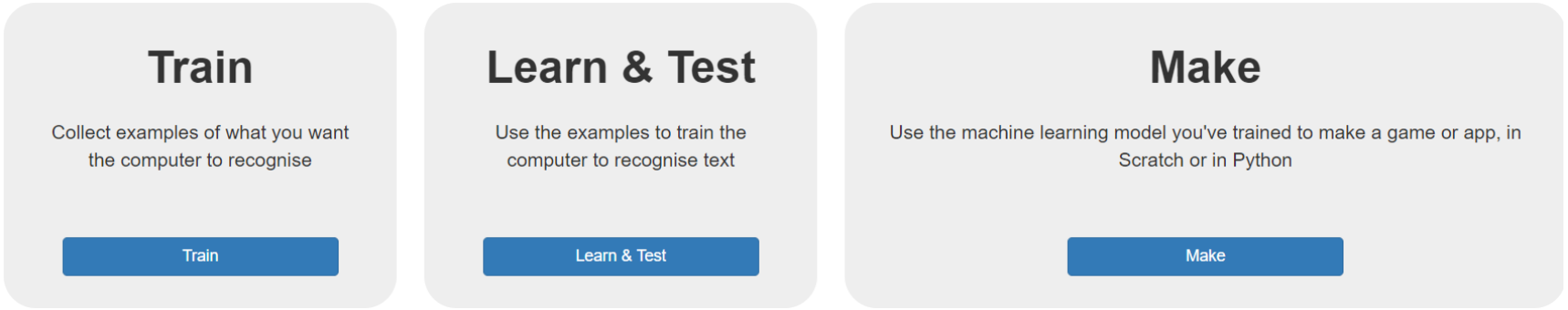
Classification



Regression

1) Estimating the spread of COVID-19 based on meteorological factors using regression
2) Predicting a medical condition based on risk factors using classification
3) Estimating the fitness of a person through human activity recognition data collected from the smart phone sensors via classification
4) Using Wi-Fi data to predict occupant behavior using big data analytics
5) Sentiment analysis for amazon reviews data, facebook comments data, twitter data

[Classification vs. Regression]



Source: https://machinelearningforkids.co.uk/

Introduction to ML

- Google's AI AlphaGo Is Beating Humanity At Its Own Games
- Elon Musk on AI
- Eric Schimdt: AI assisted health care, Self driving cars
- Vinod Khosla: Generative Design
- Machine learning for optimization

Topic 8: Data Science with R/Python

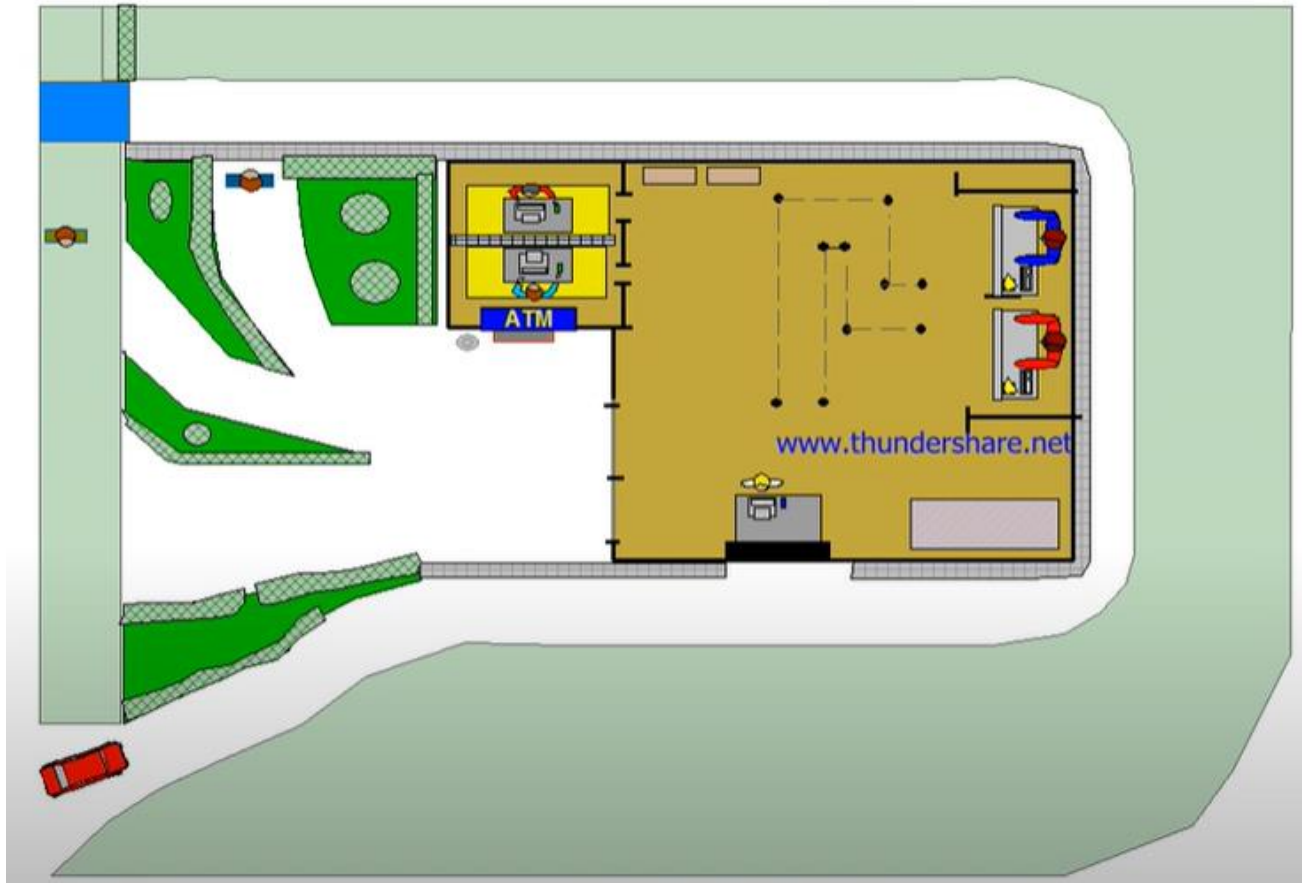
- Free and open source
- edX course on Data Science: R Basics
- Another course on R Basics
- Machine Learning in R step-by-step
- Post resources for Python

Topic 9: Digital Prototyping

- html+css+javascript website
- MIT App Inventor
- Thunkable for mobile app making
- ml5.js

Topic 10: Wildcard week

- Choose any topic – unsupervised learning, a machine learning technique, a research paper
- System Design: discrete event simulations

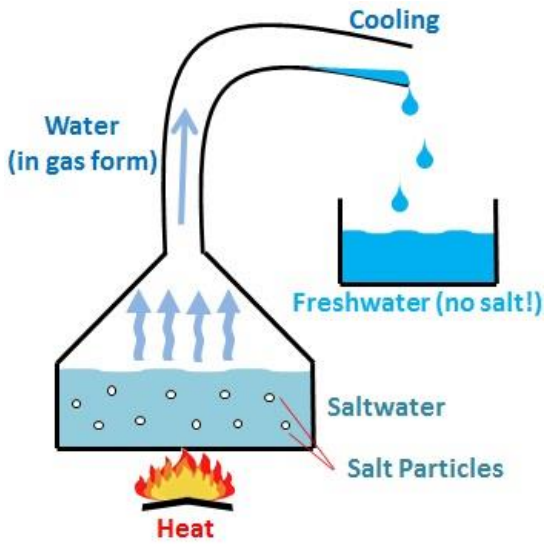


Source: https://www.youtube.com/watch?v=lEDEB94wuE0

One science, science for impact

Anti-disciplinary

First principles method

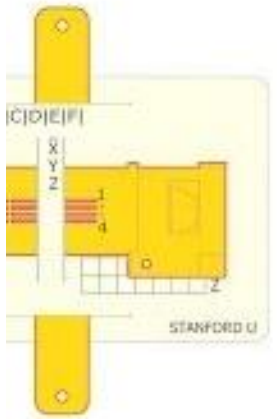


Water filter – plant xylem

Waste-water treatment

Biology, Chemical engineering, Mechanical engineering, Nano-technology

Examples of One Science: SOLVE water



Science for impact

Logistics

- Course schedule and evaluation
- WhatsApp group
- Course Website, Slides
- Windows OS (Mac?)

DSL 810: Data Driven Design

Class schedule

Project Development

Student Pages

Teaching Assistants

Spring 2020 (Prototyping in IoT)

Autumn 2019 (Prototyping in IoT)