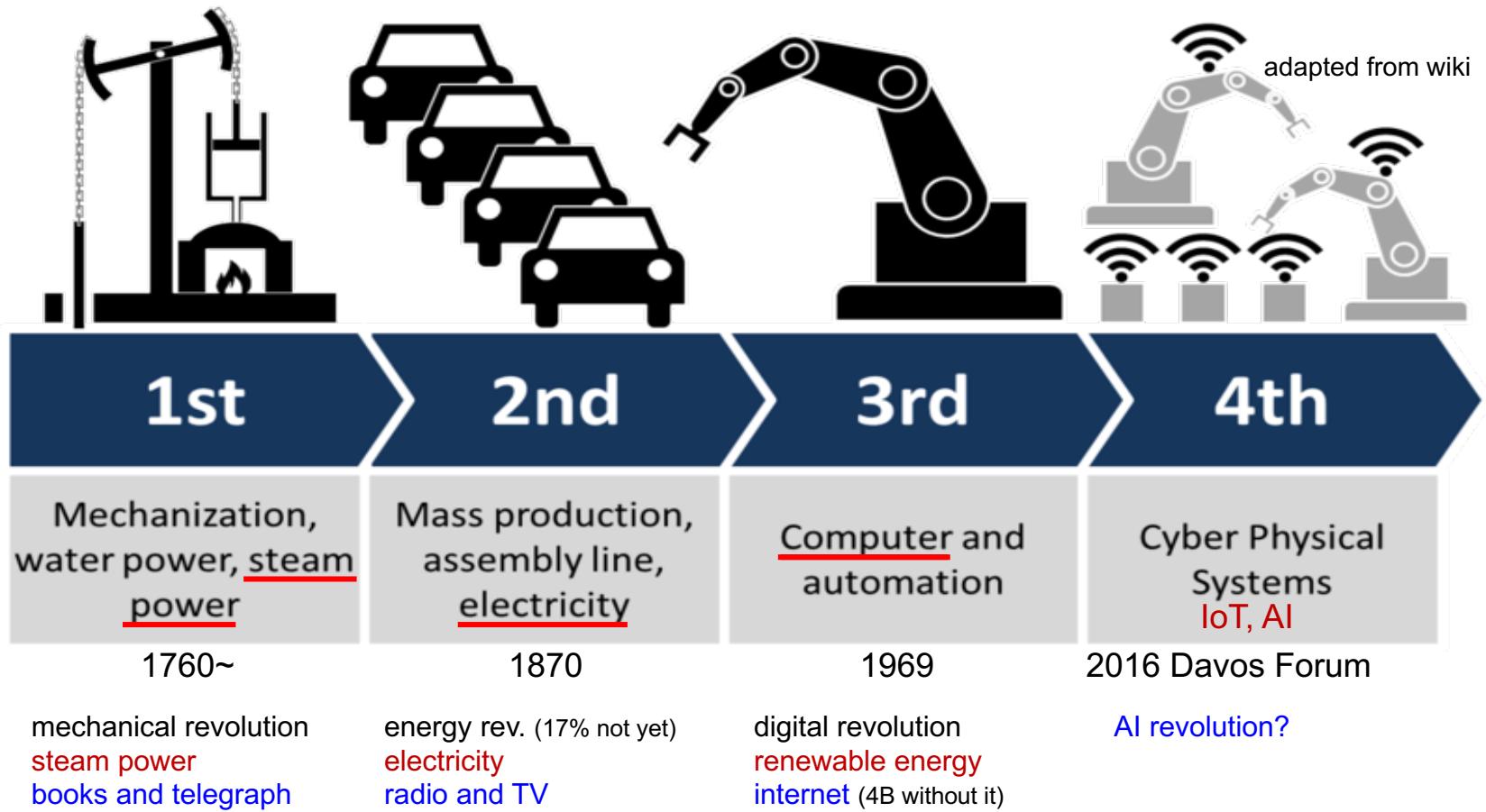


Intro to AI

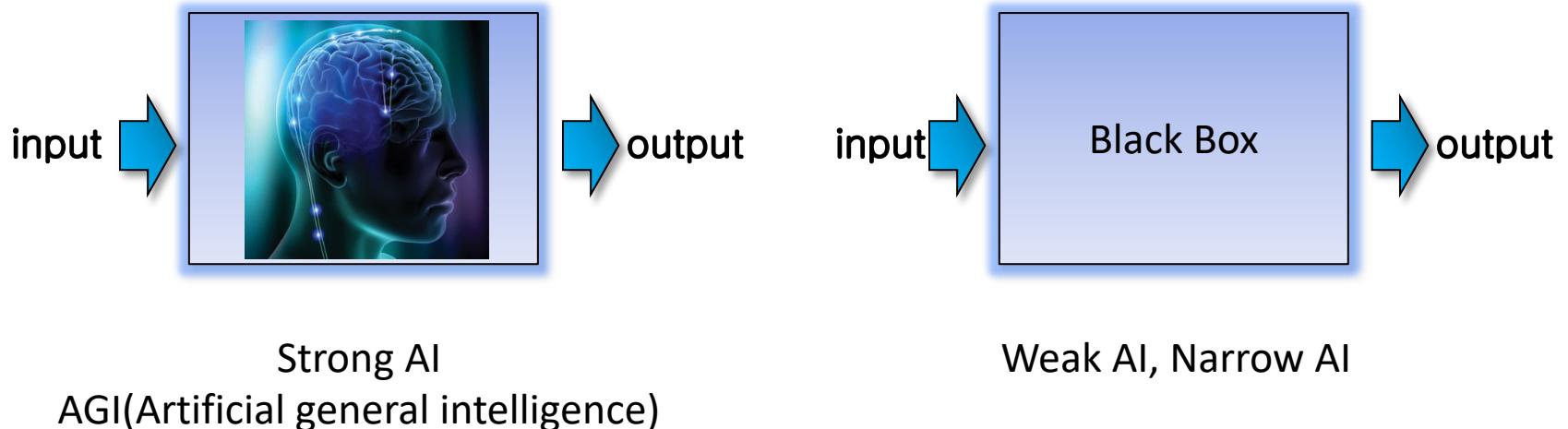
ECE30007 Intro to AI Project

Industrial Revolution



Artificial Intelligence

- Artificial intelligence (AI) is **intelligence** exhibited by machines or software
- **Automation of tasks** that require intelligence
 - Recognition, prediction, learning, natural language processing, planning, reasoning, etc.



AI vs. Conventional SW

- Conventional SW
 - Perform tasks by following **predefined algorithm**
- Artificial intelligence targets
 - **Complex tasks** hard to solve by a fixed procedure
 - Tasks under **changing environment**
 - Decisions under **uncertainty** or **ambiguity**

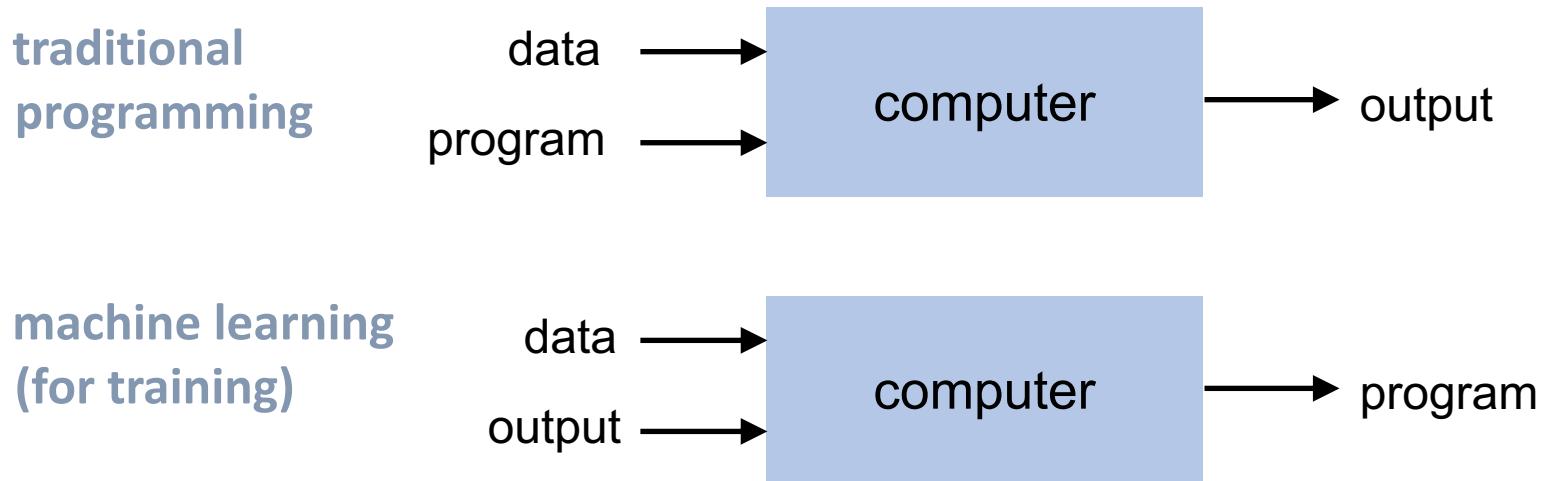


VS.



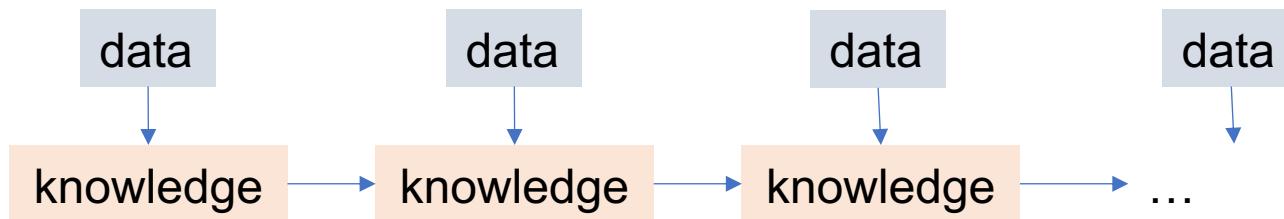
traditional programming vs machine learning

- machine learning generates “program” by training

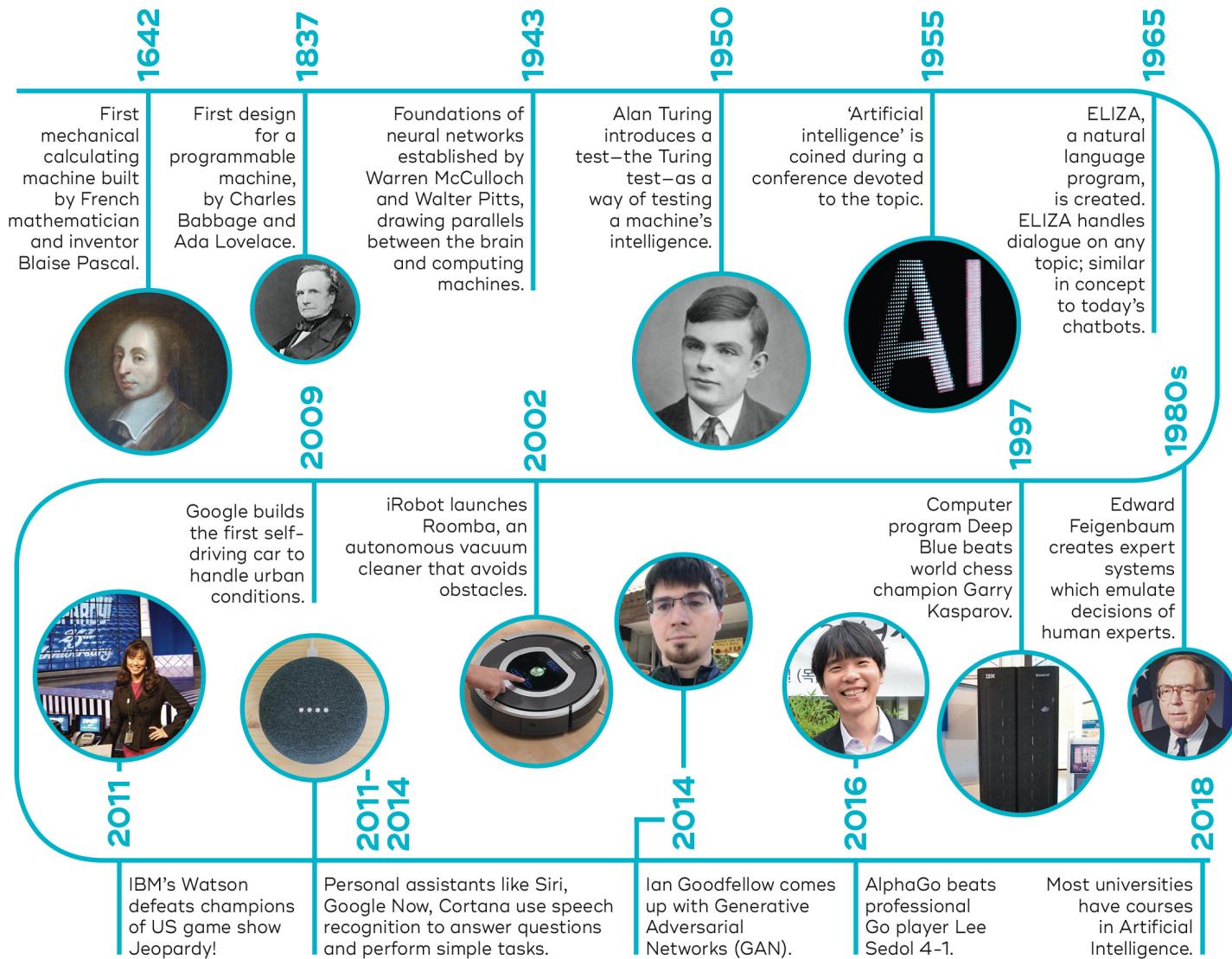


(from P. Domingos's slides)

- source of knowledge is data



History of Artificial Intelligence



Imitation Game (Turing Test) by Alan Turing 1950

Turing test

During the Turing test, the human questioner asks a series of questions to both respondents.

After the specified time, the questioner tries to decide which terminal is operated by the human respondent and which terminal is operated by the computer.

■ QUESTION TO RESPONDENTS ■ ANSWERS TO QUESTIONER

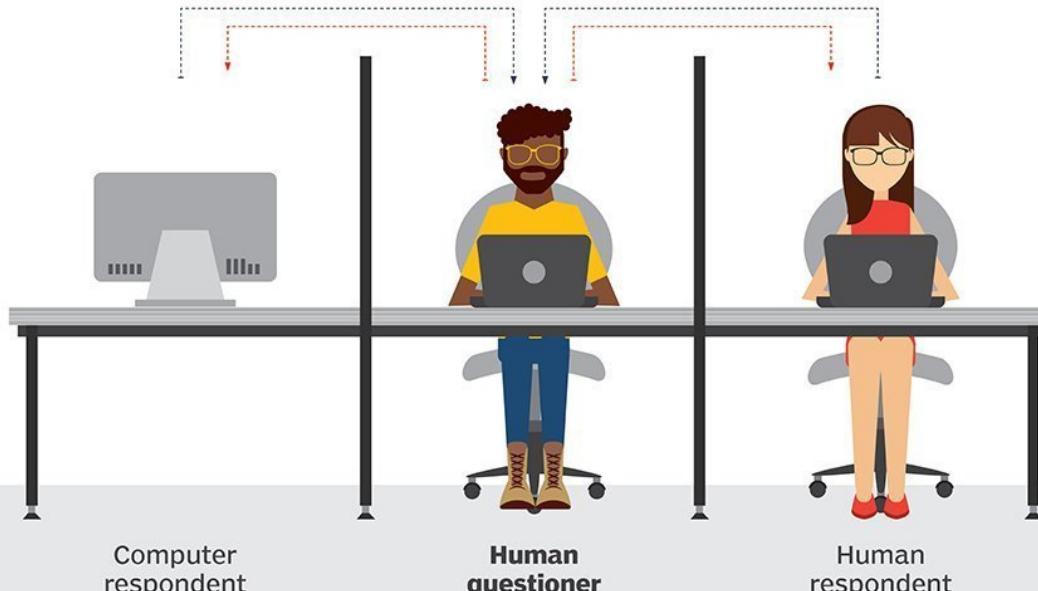
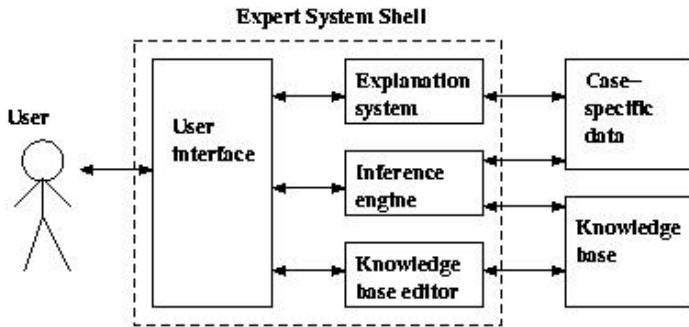


ILLUSTRATION: GSTUDIO GROUP/ADOBESTOCK

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TechTarget

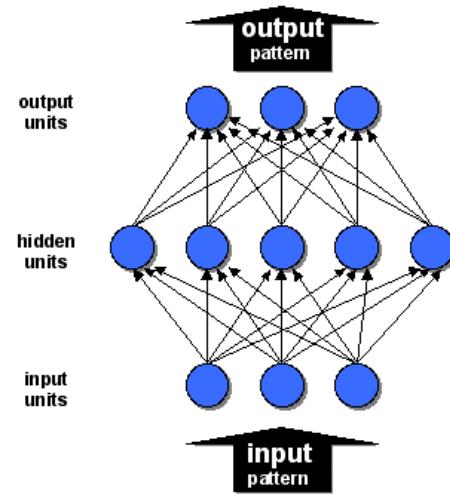
Two Major Approaches to AI

- Knowledge-based approach
 - Rules derived from designer's knowledge
 - **Symbolic AI**
- Ex) IBM Watson



- Data-driven approach (machine learning)
 - Learn from data
 - **Connectionist AI**
- Ex) AlphaGo

Given sufficient training samples,
data-driven approach can be better
than knowledge-based approach



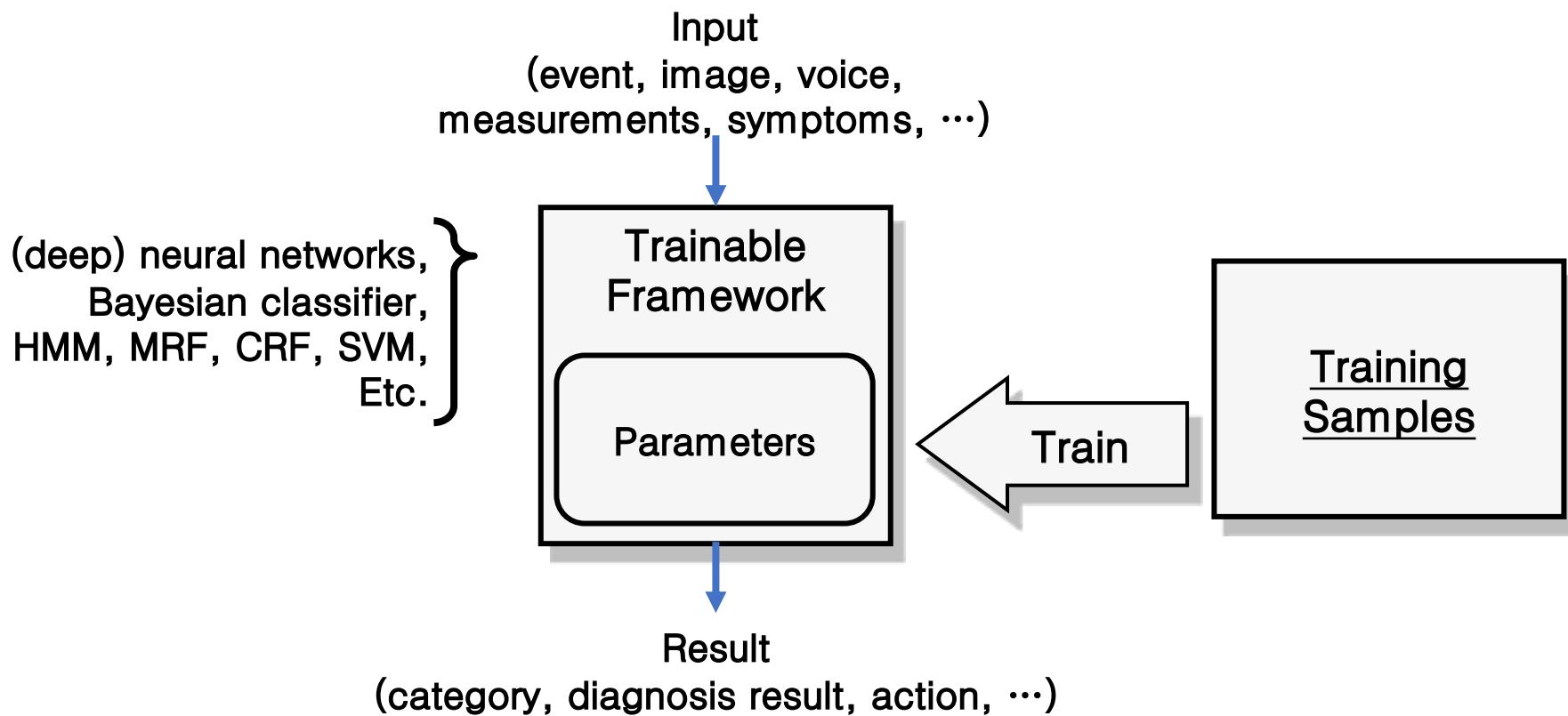
Knowledge-base Approaches

- Trials to formalize and automate “thinking”
- Symbolic, logic-based approach
 - Explicit symbolic representation of knowledge
 - Problem solving with searching/planning
 - Reasoning, inference, proof
- Logic, reasoning: form or operation on knowledge and concepts in abstraction

Ex) “All men are mortal.” + “Socrates is a man.”
→ “Socrates is mortal.”

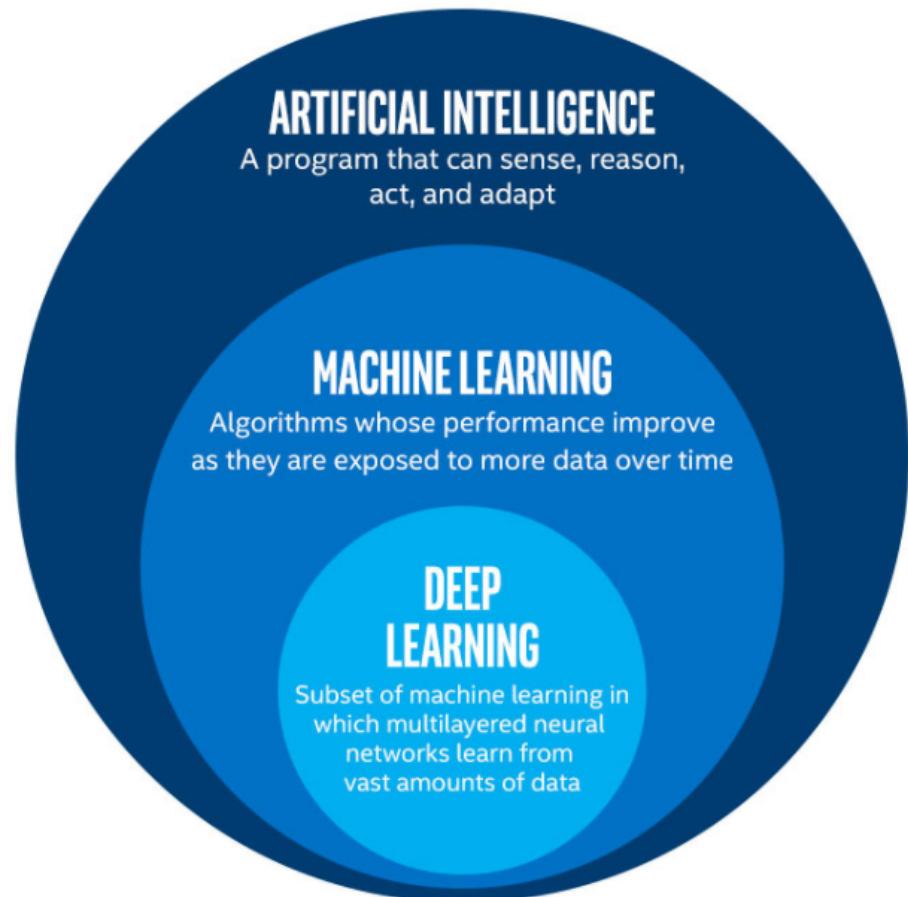
Machine Learning

- Field of study that gives computers the ability to learn without being explicitly programmed.
 - Data-driven approach



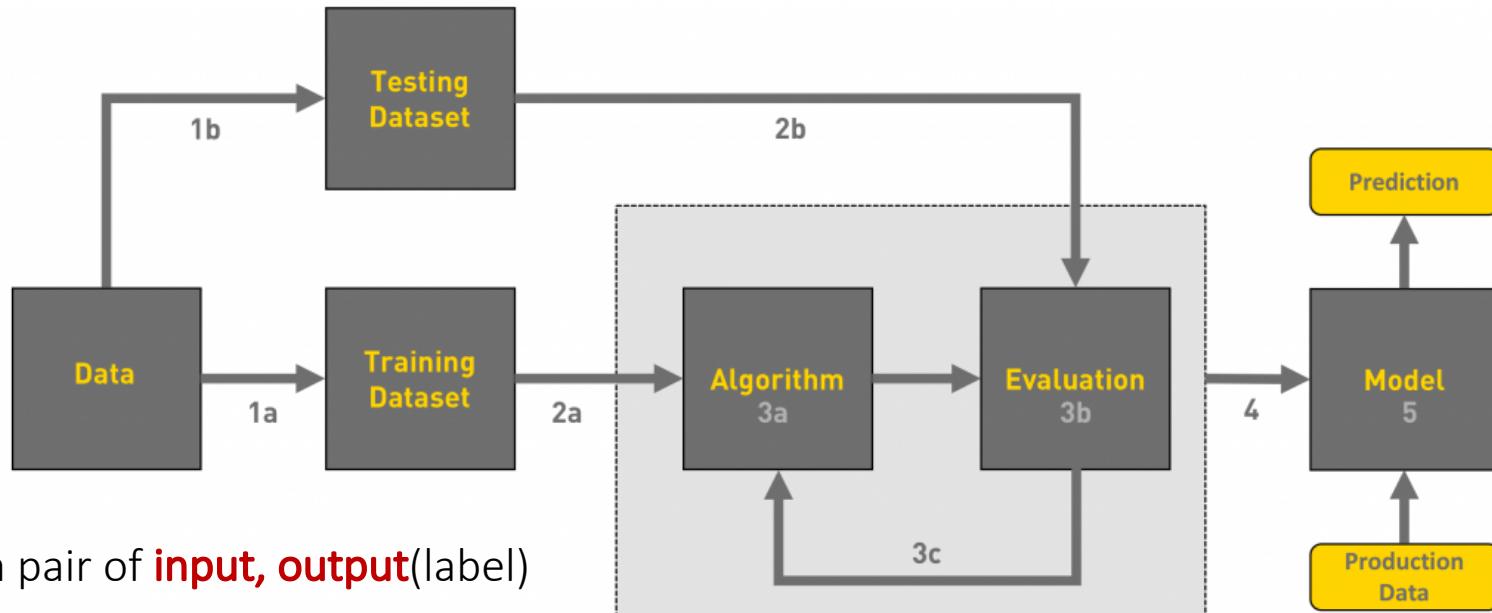
AI, Machine Learning, Deep Learning

- **Artificial intelligence:** **intelligence** exhibited by machines or software
- **Machine learning:** a field of study that gives computers the ability to **learn from data** without being explicitly programmed.
- **Deep learning:** a branch of machine learning based on a set of algorithms that attempt to model **high-level abstractions in data**, mostly, based on **deep neural networks**.



Common ML workflow

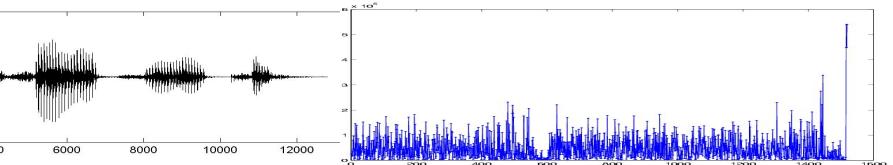
1. Gathering data
2. Data pre-processing
3. Researching the model that will be best for the type of data
4. Training and testing the model
5. Evaluation



data

- a set of values of qualitative or quantitative variables
 - measured from nature, user behavior, industrial process, and so on
 - in many different types

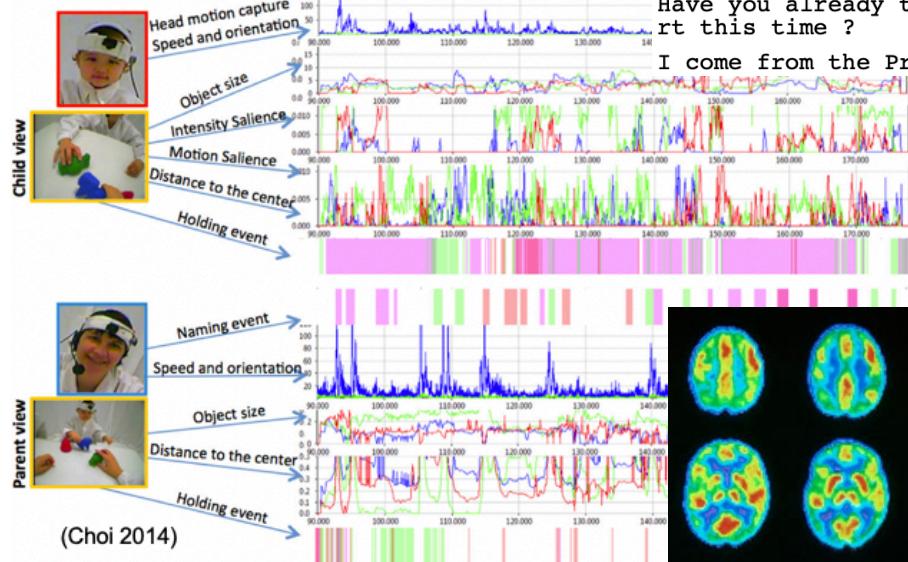
Seoul_l_rate(서울_인구밀도)	house_rate(집_밀도)	dis_park(국립_공원_거리)	dis_highschool(dis_reconst(자연_고등학교_거리))	dis_univ(대학_거리)	dis_hospital
0.03377605	5.84295302	904.695581	318.834795	645.455928	1595.45087
0.03377605	5.84295302	621.870292	225.823377	1268.24651	1363.16371
0.03377605	5.84295302	1328.21769	392.24608	917.420838	1985.36099
0.03377605	5.84295302	1041.90296	446.3249	201.258972	3369.99005
0.03377605	5.84295302	1028.64707	425.626107	665.773405	2615.4826
0.03377605	5.84295302	920.570037	558.978523	569.478505	666.36445
0.03377605	5.84295302	1176.78206	191.057007	805.087601	2321.44444
0.03377605	5.84295302	990.42763	408.293961	730.455581	1528.58338
0.03377605	5.84295302	744.578797	620.704741	378.802143	1086.91683
0.03377605	5.84295302	950.202381	441.57165		



Moreover, the Santa Lucia railway station is just 5 minutes away while other major sights such as the Rialto Bridge and St. Mark's Square can quickly and easily be reached with a 15 to 20 minutes walk.

Have you already thought over how to present this holiday to your sweet heart this time?

I come from the Prievidza region, which has a strong mining tradition.



(Choi 2014)

how do data look?

- structured / unstructured
 - structured data: ex) review rate
 - a matrix (example, dimension) or
 - higher order tensor (example, dimension, time)
 - unstructured data: ex) review comments
- usually, it is messy
 - data cleansing and preparation is crucial and time-consuming process
 - it is crucial in ML to prepare a clean dataset.
 - quality and quantity both matter

Machine Learning Taxonomy

- Supervised Learning
 - Construct a model based on given data and labels (input-output pairs)
 - Ex) classification, regression etc.
- Unsupervised Learning
 - Draw inferences or find patterns from data without labels
 - Ex) Clustering, outlier detection, dimension reduction, autoencoders etc.
- Reinforcement Learning
- Self-supervised Learning

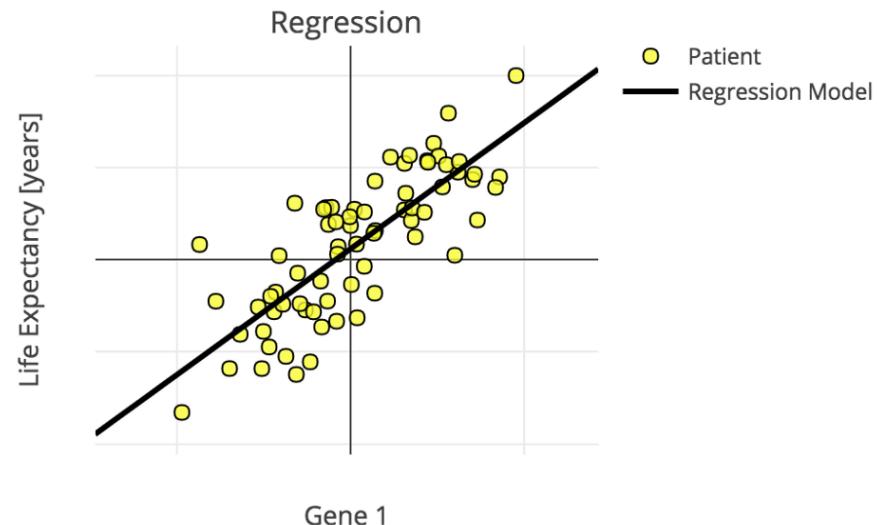
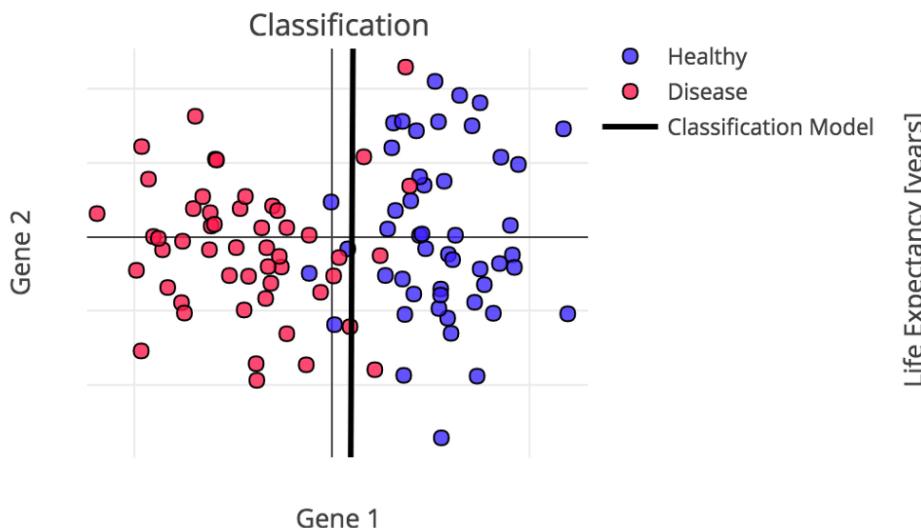
Machine Learning Taxonomy (supervised)

Classification

- inputs are divided into two or more classes, and the learner must produce a model that assigns unseen inputs to one or more (multi-label classification) of these classes.

Regression

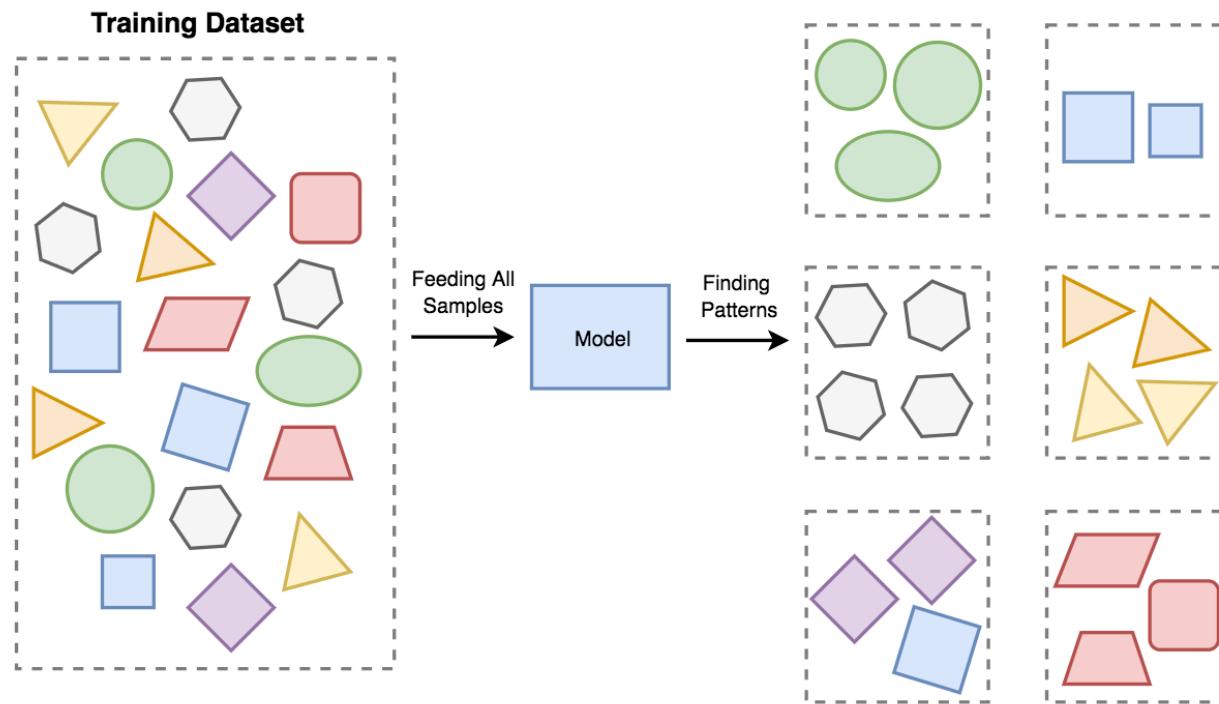
- the outputs are continuous rather than discrete.



Machine Learning Taxonomy (unsupervised)

Clustering

- a set of inputs is to be divided into groups. Unlike in classification, the groups are not known beforehand.

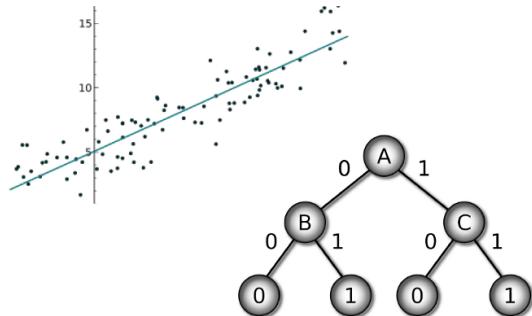


Models

Classification	Regression	Clustering
<ul style="list-style-type: none">• K-Nearest Neighbor• Naive Bayes• Decision Trees/Random Forest• Support Vector Machine• Logistic Regression• Neural Networks	<ul style="list-style-type: none">• Linear Regression• Support Vector Regression• Decision Tress/Random Forest• Gaussian Progresses Regression• Ensemble Methods• Neural Networks	<ul style="list-style-type: none">• Gaussian mixtures• K-Means Clustering• Boosting• Hierarchical Clustering• K-Means Clustering• Spectral Clustering• Neural Networks

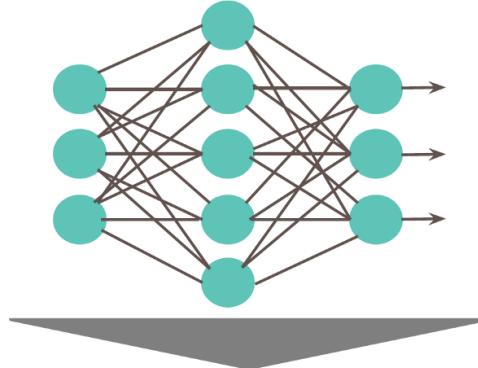
Lin. regression / decision trees:

Decision mechanism can be easily explained



Neural networks:

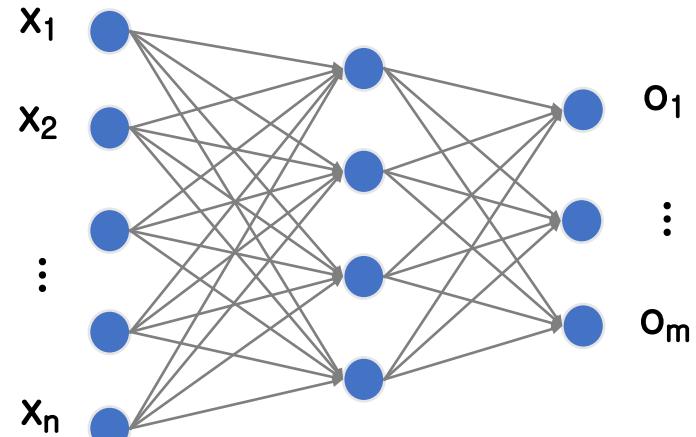
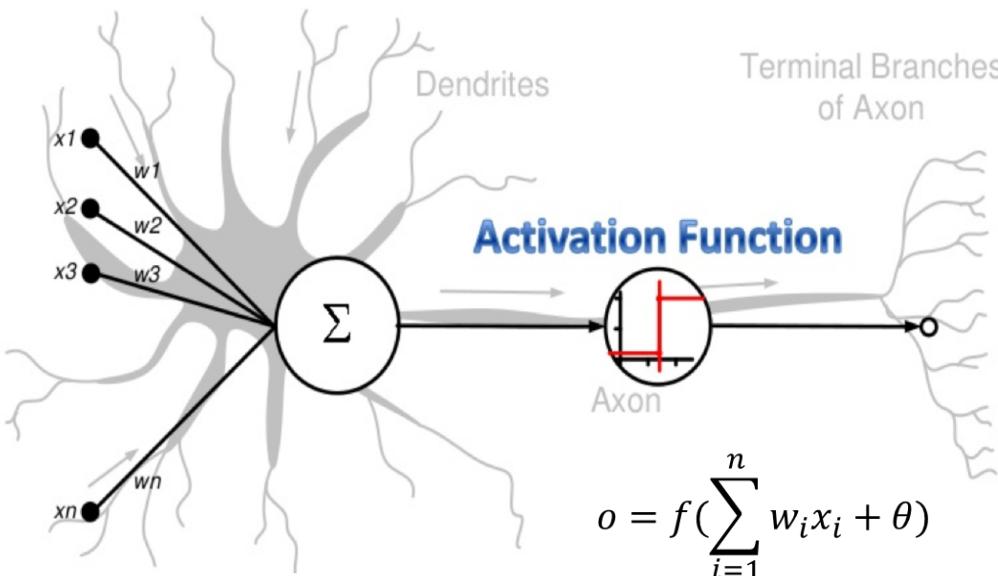
Complex systems that are hard to understand!



Often **100m+** parameters....

Artificial Neural Networks

- **Artificial neural network**: a mathematical model inspired by biological neural networks.
 - Mapping between vectors or sequences
 - Classification, regression, prediction, diagnosis, etc.
 - Learns probabilistic density
 - Sample generation, transform, restoration, etc.



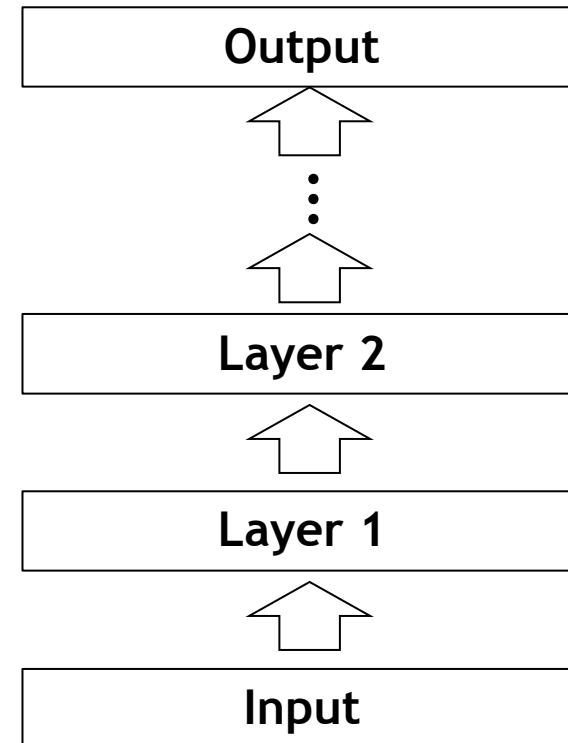
Deep Learning

- A branch of machine learning to model **high-level abstractions in data**, mostly, based on **deep networks**.

- Each layer combines input features to produce high-level features.

$$o = f\left(\sum_{i=1}^n w_i x_i + \theta\right)$$

- A neural network with many layers can learn high-level features.



AI in our life



Image sources: <https://www.ansys.com/blog/challenges-level-5-autonomous-vehicles>

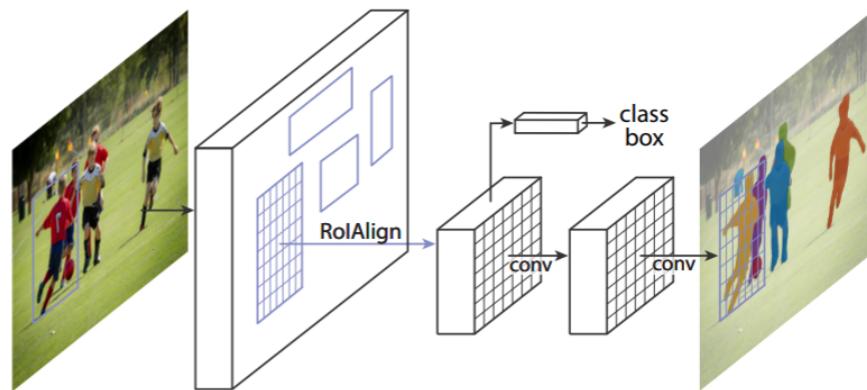
<https://www.uber.com/blog/pennsylvania/new-wheels/>

<https://www.pocket-lint.com/phones/buyers-guides/120309-best-smartphones-and-flagship-mobile-phones-to-buy>

<https://www.smarty.ai/blog/tao/smart-speakers/>

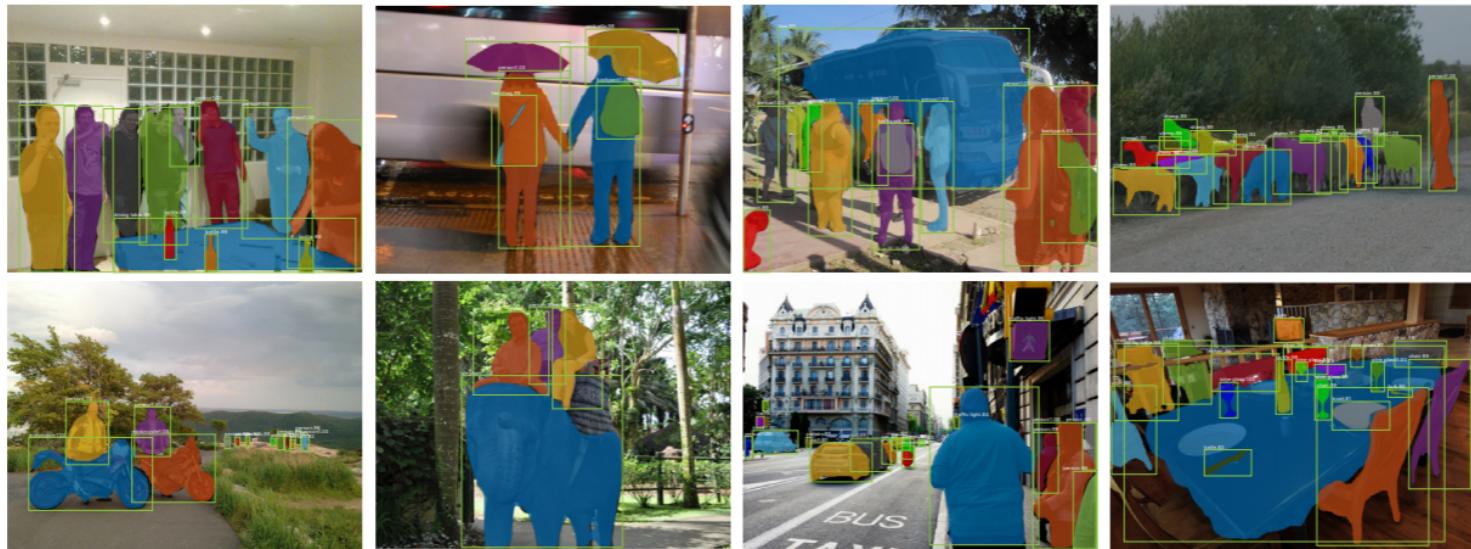
<https://9to5google.com/guides/nest/>

AI in our life



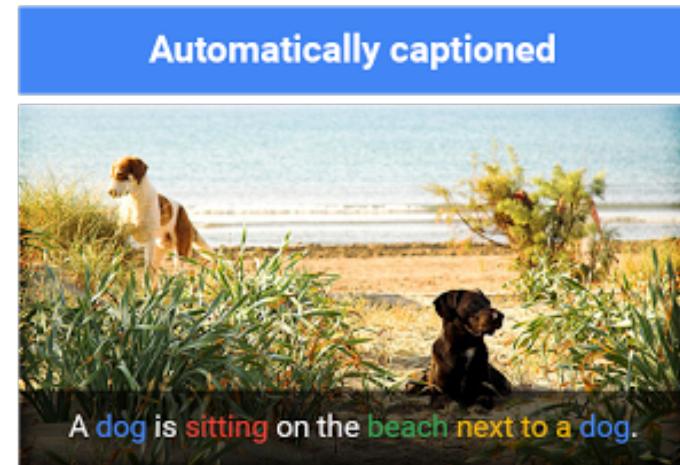
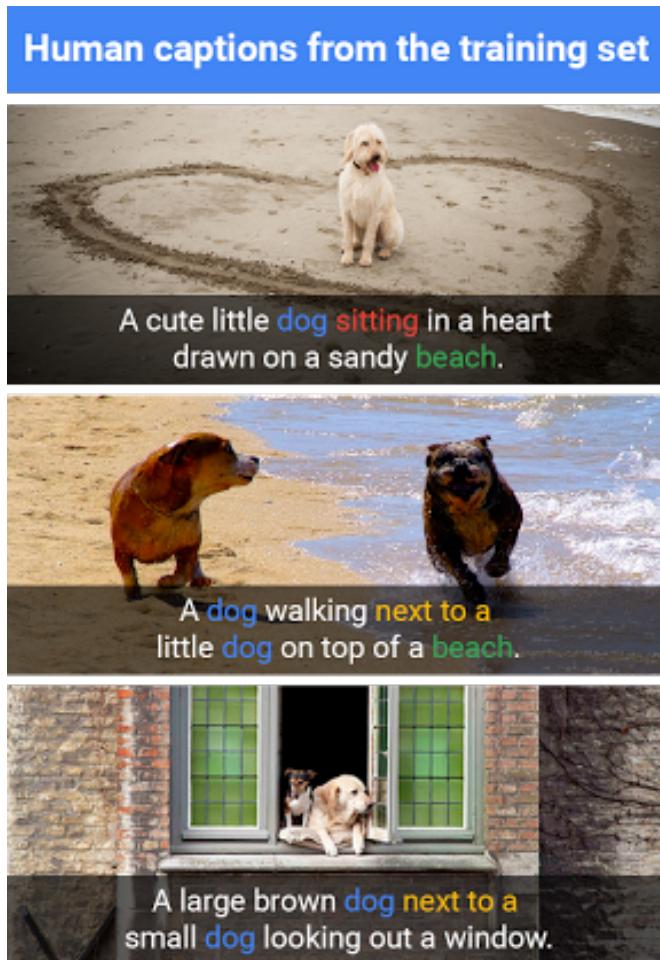
He, et.al., "Mask R-CNN," 2017

Figure 1. The **Mask R-CNN** framework for instance segmentation.



AI in our life

- Image Caption Generation



AI in our life

- Image-to-Image Translation

<https://affinelayer.com/pixsrv/>

Image-to-Image Translation with Conditional Adversarial Nets

Phillip Isola

Jun-Yan Zhu

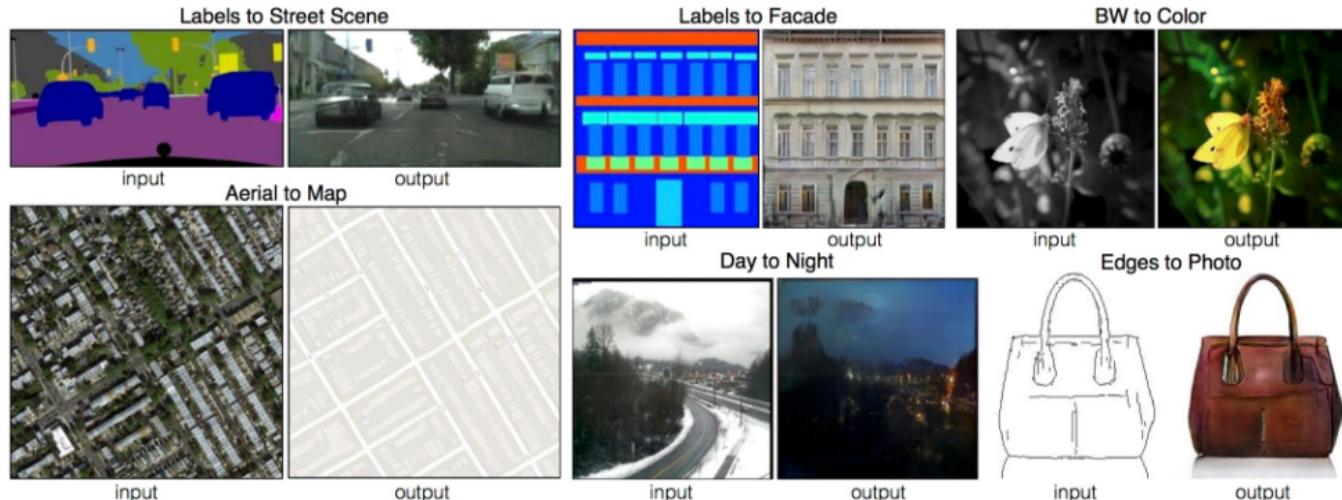
Tinghui Zhou

Alexei A. Efros

University of California, Berkeley
In CVPR 2017

[Paper]

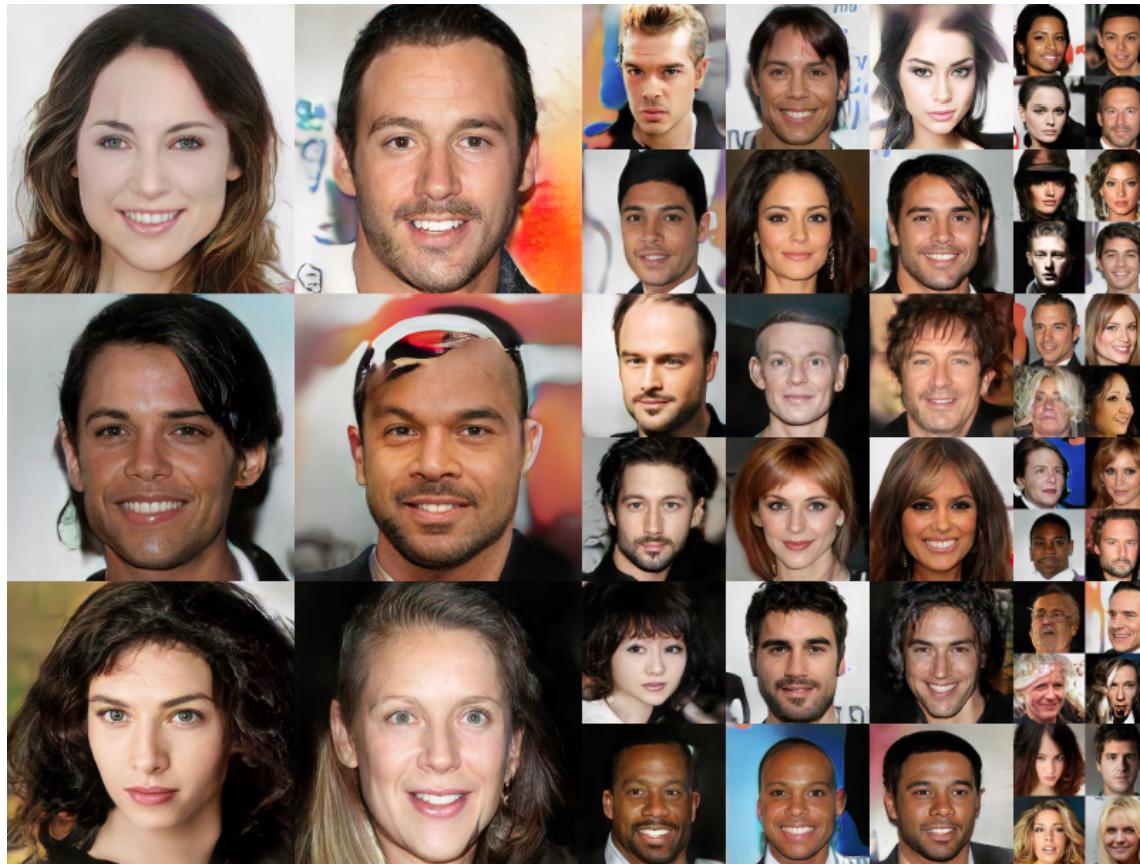
[GitHub]



Example results on several *image-to-image* translation problems. In each case we use the same architecture and objective, simply training on different data.

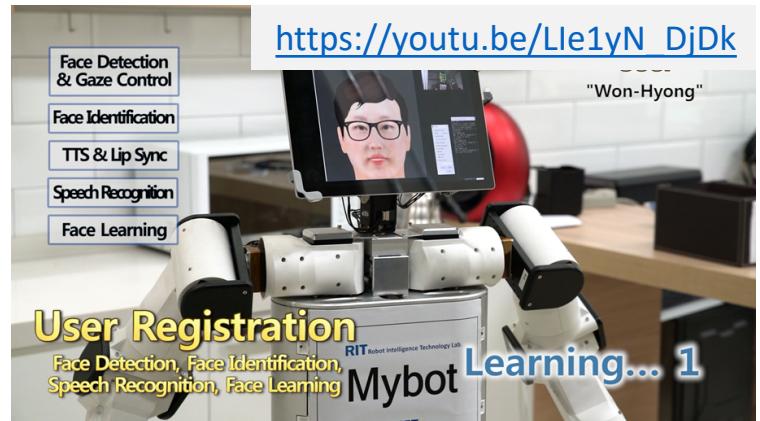
AI in our life

- Image Synthesis



AI in our life

- Robot interaction



AI in our life

Brain-Computer Interface: Drone control

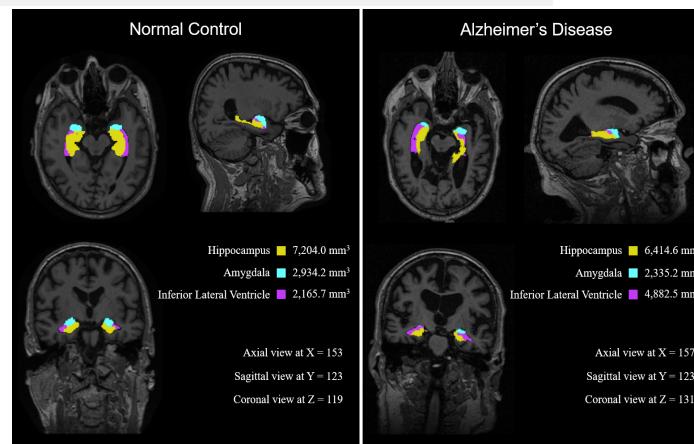
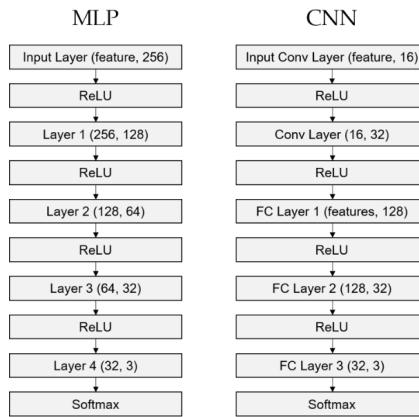


https://www.youtube.com/watch?v=_OoKIE38nhs



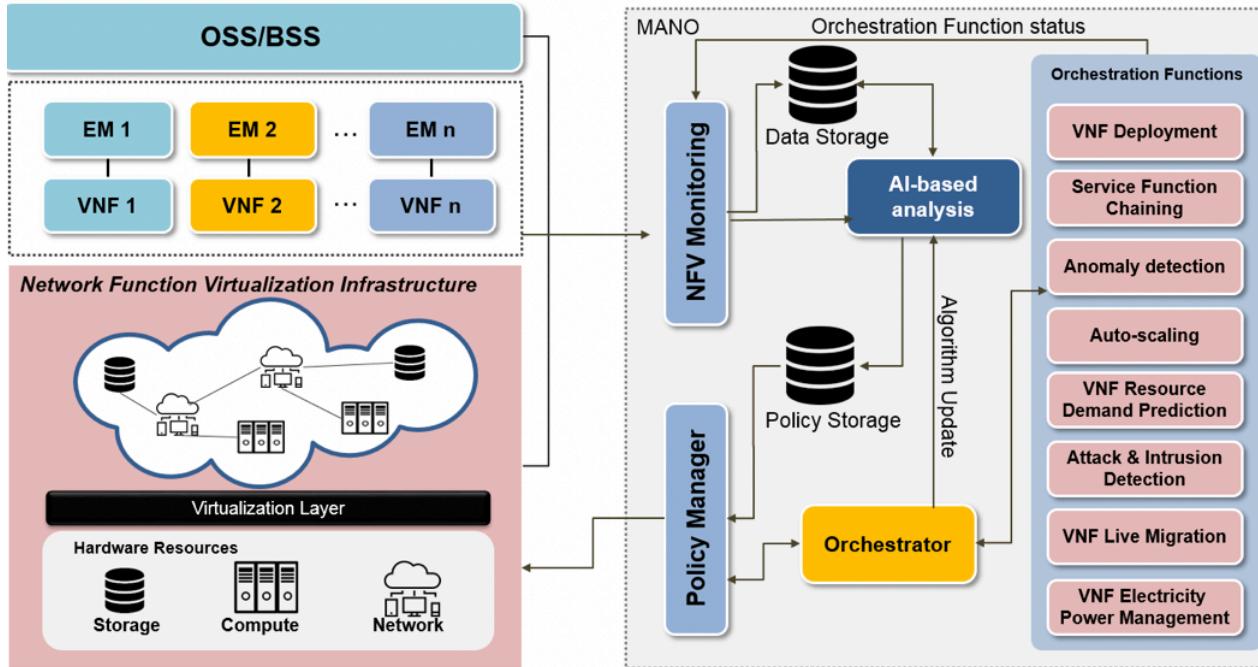
Brain-Computer Interface: Robot arm control

Medical AI for Dementia Diagnosis and Biomarker Detection

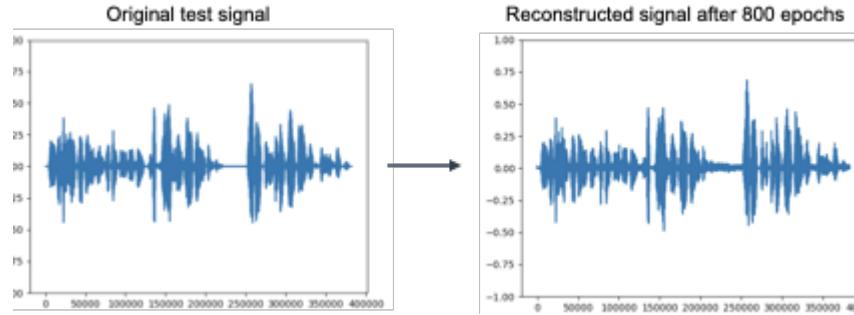


AI in our life

Artificial intelligence to manage virtual network functions



Audio Compression with Recurrent Neural Networks



Limitation of recent AI

- Possible errors and bias
 - As human makes errors, AI can make errors too.
 - Usually, it is evaluated based on public data (which may be biased).
 - Real world is huge, complex and changes.
 - Limited data, label and knowledge.
- Challenges
 - Massive data, computational resource and energy
 - Good experience and insights to domains
 - Understanding of a given problem, phenomena, environment
 - How to design and model domains and problems.
 - How to generalize AI.
 - How to explain results, performance, learning mechanism etc.

Artificial Intelligence vs. Human Intelligence

- Human
 - Learning from even small examples or experiences
 - Good generalization, transferring experience/internal model
 - Relatively human decision can be explained or understandable.
- Current AI is not a strong AI or AGI
 - It is just pretending as if it thinks.
 - No thought, mind, consciousness, emotion, ego in it.
- But AI is a very useful tool
 - Cost-effective, and good for huge data, service, system.
 - Can make up for traditional systems(or service).
 - Thus, Human with AI than Human vs. AI.

Student activity: Project sketch

- Please recall the contents given by today's lecture and imagine the feasible areas that AI can be employed.
- Please sketch what you want to make.
- Then write and draw things on your power point slides.
- Time Plan
 - 10min Idea sketch
 - 20min Group discussion (choose the best item)
 - 30min Presentation by each group
 - Each student should submit his/her idea sketch.