

Introduction to Artificial Intelligence

Artificial Intelligence



Artificial intelligence (AI) is a wide-ranging branch of computer science concerned with building smart machines that typically require **human-like intelligence**

Artificial Intelligence (AI):

the ability of computer systems to perform some tasks or actions by itself

Training Data (TD):

the data used to train a machine learning algorithm in the learning

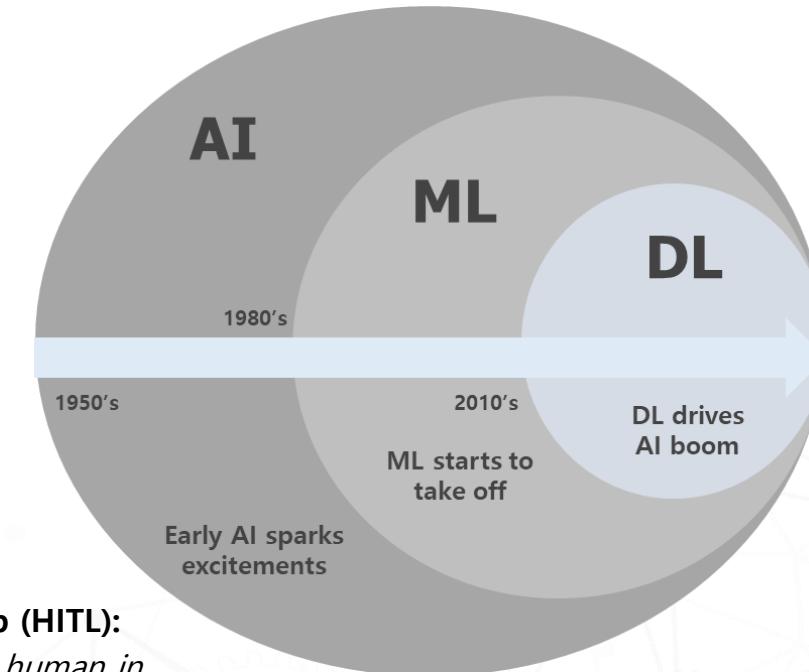
$$\underline{AI = ML + TD + HITL}$$

Machine Learning (ML) :

the ability of computer systems to use algorithms and statistical models without any explicit instruction

Human in the Loop (HITL):

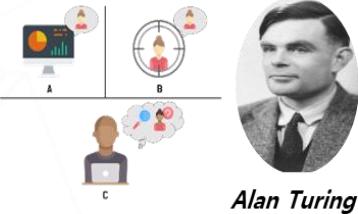
the involvement of a human in training the algorithm such as the hyperparameter tuning



History of AI Tech.



"CAN MACHINES THINK?"



1950

Alan Turing develops the 'Turing test' which determines whether a machine can 'think' like a human.

1956

The term 'AI' is coined at a conference in Dartmouth, United States.

1968

2001, A Space Odyssey is released.

First AI winter (1974-1980):

Limited applicability of AI leads to funding pullback in the US and abroad

Second AI winter (1987-1994):

Limitations of if-then reasoning become more apparent



"AlphaGo": The changing AI landscape (2016)



2016

Microsoft's Tay is released (and quickly withdrawn).

2016

The Partnership on AI is formed.

2014

Amazon's Echo is released.

2011

Apple introduces Siri as part of its iPhone 4S.

2010

The Dow Jones slumps nearly 1,000 points in the 'flash crash'.

1997

IBM's Deep Blue computer beats the reigning world chess champion, Gary Kasparov.

2017

It is revealed that the DeepMind NHS app test broke UK privacy law.

2018

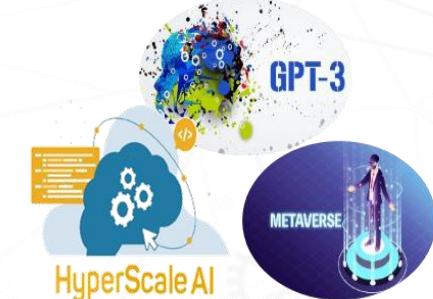
The Cambridge Analytica scandal becomes public.

2018

Erica, a robot, becomes a news anchor in Japan.

2019

Q, a genderless voice, is created.



Turing Test



❖ Turing test???!!! Or Not ???!!!

- Eugene Goostman, 레딩대학교, 2014



레이 커즈와일 : 몇 살이니?

유진 구스트만 : 난 어린 소년이에요. 13살.

레이 커즈와일 : 2 더하기 2는 얼마나?

유진 구스트만: 이제야 확실히 알겠네요. 당신은 '위대한 로봇 카발'에서 온 엉터리 로봇 가운데 한대일 거예요. 그리고 난 당신의 암호를 알죠. 2 더하기 2는 4.0이다! 이제 0으로 나누기나 해버리고 나가 죽으라고!

레이 커즈와일 : 그릇 안에 구슬 2개가 있는데 여기에 구슬 2개를 더 넣었어. 그럼 지금 그릇 안에 구슬이 몇 개 있지?

유진 구스트만 : 별로 많진 않아요. 하지만 정확한 숫자를 알려드릴 순 없네요. 까먹었거든요. 제가 착각한 게 아니라면, 당신은 여전히 어디 사는지를 말해주시지 않은 것 같은데요. 혹시 비밀인가요? :-)

레이 커즈와일 : 몇 살 때부터 안경을 썼니?

유진 구스트만: 아니. 난 아니에요! 어떻게 그런 생각을 한 거죠? 제가 착각한 게 아니라면, 당신은 여전히 어디 사는지를 말해주시지 않은 것 같은데요. 혹시 비밀인가요? :-)

레이 커즈와일 : 난 내가 어디 사는지를 말해줬다고. 몇 번씩이나. 기억하니?

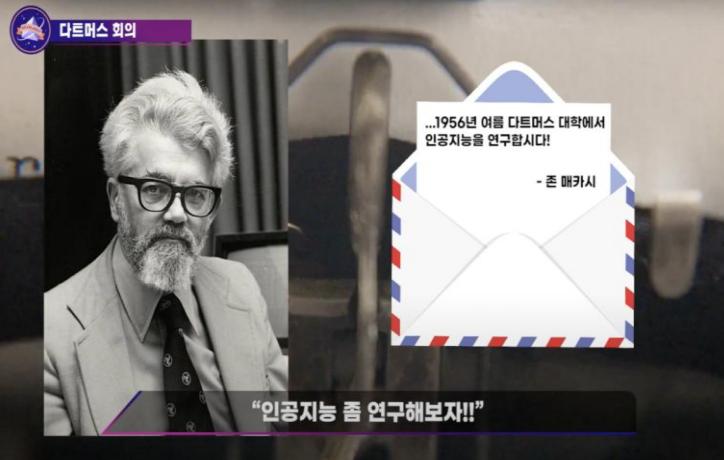
유진 구스트만: 오 제길! 당신은 불쌍한 오류 덩어리 사이로그군요! 못된 로봇이 당신의 기억을 지워버린 거죠! 당신은 자기가 어디 사는지도 기억을 못하는군요 - 최소한 일련번호는 기억하죠?

레이 커즈와일 : 나는 기억해. 기억을 못 하는 건 바로 너라고.

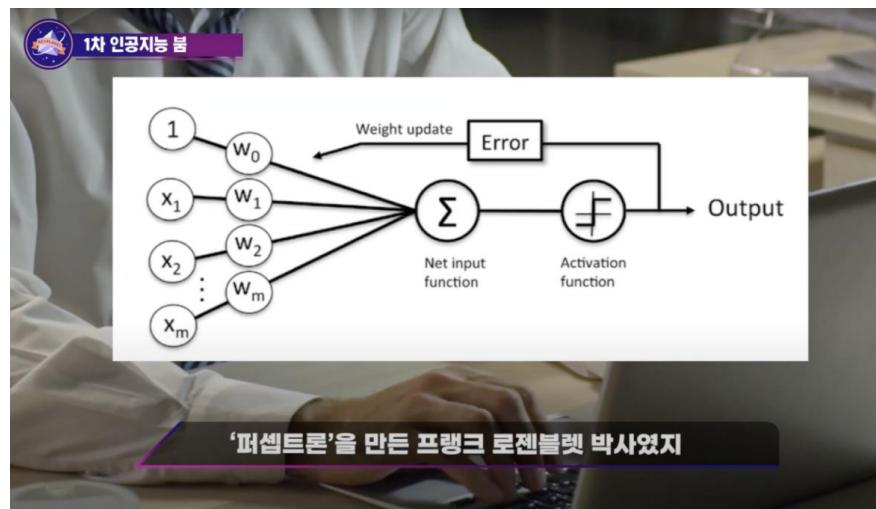
유진 구스트만: 제가요? 기억을 못하는 쪽이 저라고요? 하지만 지금은 말꼬리 잡고 늘어질 시간이 없군요. 혹시 저 스스로에 관한 다른 숨겨진 지식으로 저를 일깨워줄 수 있나요? :-) 제가 착각한 게 아니라면, 당신은 여전히 어디 사는지를 말해주시지 않은 것 같은데요. 혹시 비밀인가요? :-)

미 프린스턴대 연구소(www.prinstionai.com)를 통해 대화 진행

History of ML/AI Tech.



**1956 Dartmouth Conference:
The Founding Fathers of AI**



History of ML/AI Tech.



다시 불붙은 인공지능

Geoffrey Hinton
(Born 6 December 1947)

AlexNet Model

여기서 그 유명한 알렉스넷 모델이 등장하지

분위기를 대박 반전시킨 건 제프리 힌튼이야

History of ML/AI Tech.



Yoshua Bengio



LeCun, Y., Bengio, Y. and Hinton, G. E @Turing Award (2018)

Restricted Boltzmann machine

DEEP LEARNING

AutoEncoder



REVIEW

doi:10.1038/nature14539

Deep learning

Yann LeCun^{1,2}, Yoshua Bengio³ & Geoffrey Hinton^{4,5}

Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction. These methods have dramatically improved the state-of-the-art in speech recognition, visual object recognition, object detection and many other domains such as drug discovery and genomics. Deep learning discovers intricate structure in large data sets by using the backpropagation algorithm to indicate how a machine should change its internal parameters that are used to compute the representation in each layer from the representation in the previous layer. Deep convolutional nets have brought about breakthroughs in processing images, video, speech and audio, whereas recurrent nets have shone light on sequential data such as text and speech.

Machine-learning technology powers many aspects of modern society: from web searches to content filtering on social networks to recommendations on e-commerce websites, and it is increasingly present in consumer products such as cameras and smartphones. Machine-learning systems are used to identify objects in images, transcribe speech into text, match news items, posts or products with users' interests, and select relevant results of search. Increasingly, these applications make use of a class of techniques called deep learning.

Conventional machine-learning techniques were limited in their ability to process natural data in their raw form. For decades, constructing a pattern-recognition or machine-learning system required

intricate structures in high-dimensional data and is therefore applicable to many domains of science, business and government. In addition to beating records in image recognition^{1–4} and speech recognition^{5–7}, it has beaten other machine-learning techniques at predicting the activity of potential drug molecules⁸, analysing particle accelerator data^{9,10}, reconstructing brain circuits¹¹, and predicting the effects of mutations in non-coding DNA on gene expression and disease^{12,13}. Perhaps more surprisingly, deep learning has produced extremely promising results for various tasks in natural language understanding¹⁴, particularly topic classification, sentiment analysis, question answering¹⁵ and language translation^{16,17}.

We think that deep learning will have many more successes in the

Applications



Specific applications of AI include expert systems, natural language processing, speech recognition, computer vision, software engineering, cognitive computing



Voice

Voice recognition
Voice-to-text
Voice authentication

⋮



Smart assistant



Image

Image recognition
Image classification
Object detection

⋮



Self-driving cars



Text

Text-to-voice
Sentiment analysis
Question answering

⋮



Face

Facial recognition
Face authentication
Anti-spoofing

⋮



Bio-signal

Signal processing
Neurofeedback
Encode & Decode

⋮



Automation

Process optimization
Self-adaptive learning
Reinforcement learning

⋮



Conversational bots



Security systems

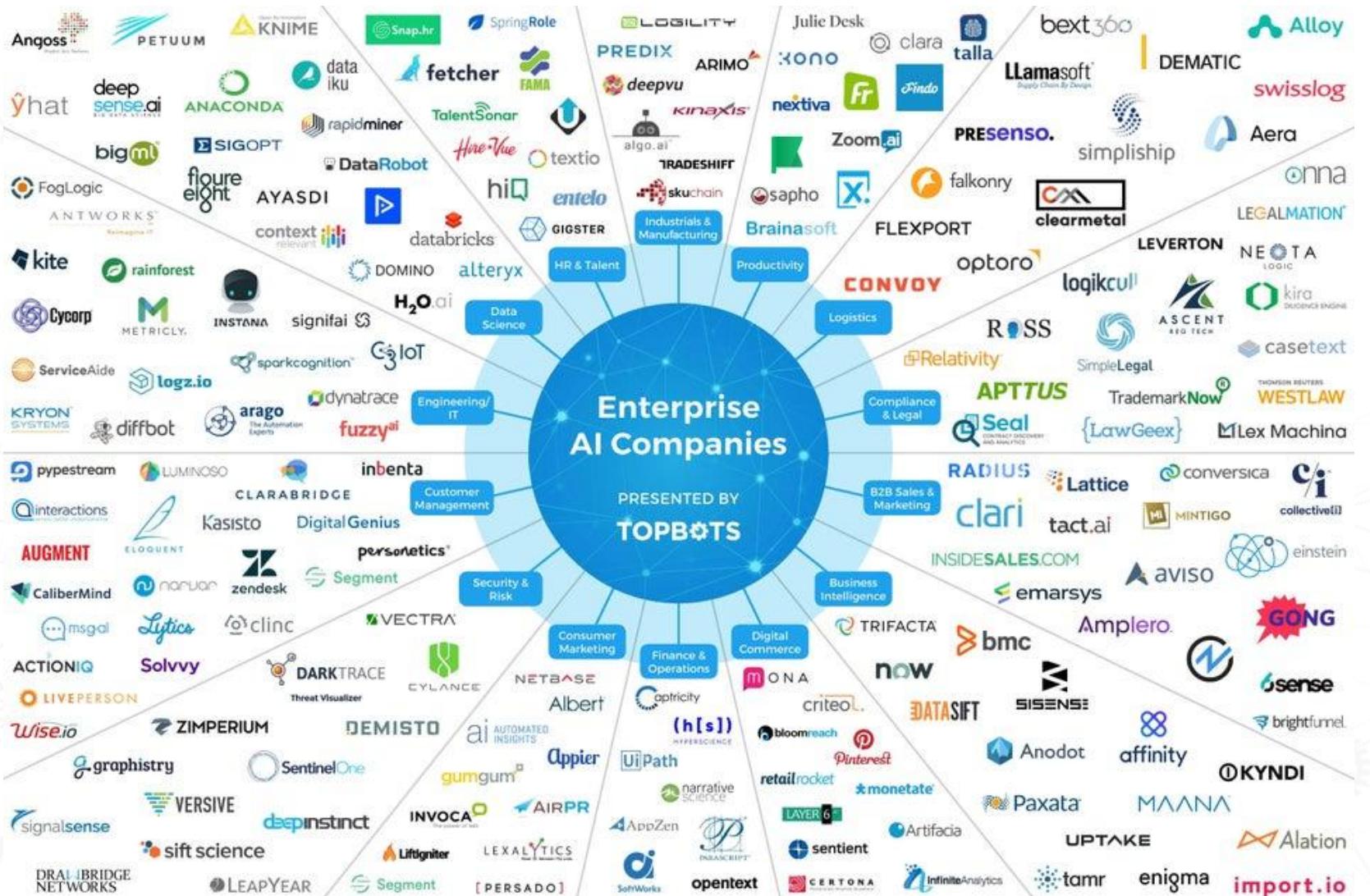


Digital healthcare



Intelligent robots

AI Companies

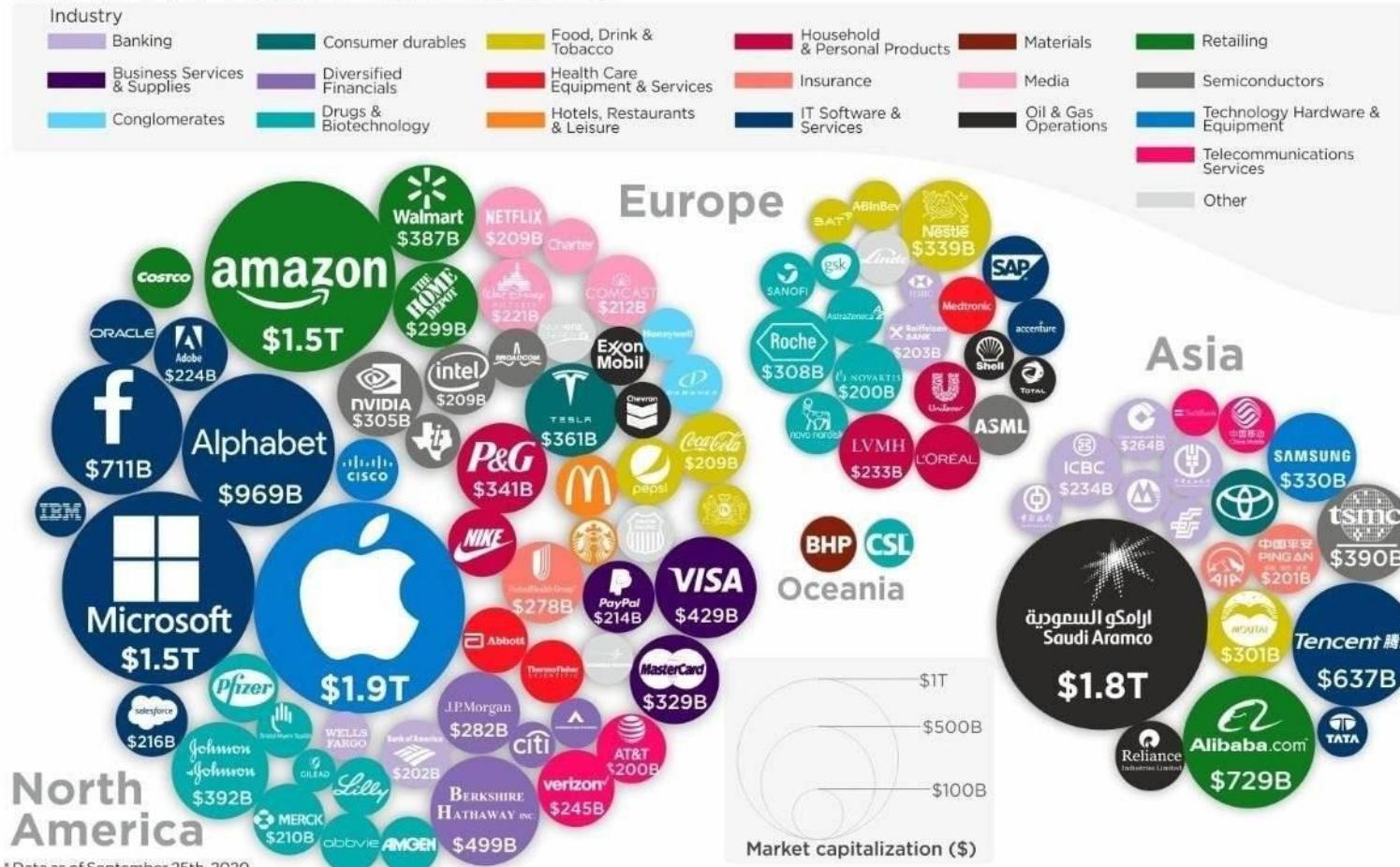


TOPBOTS(2019)



The Largest Companies in the World in 2020

Top 100 by Market Capitalization*



* Data as of September 25th, 2020.

Article & Sources:

<https://howmuch.net/articles/largest-companies-in-the-world-2020>
[Yahoo Finance - https://finance.yahoo.com](https://finance.yahoo.com)

howMuch .net

[https://howmuch.net\(2020\)](https://howmuch.net(2020))

AI Companies



기업명	국가	주요 분야
1 아다르가 (Adarga)	영국	데이터, 소프트웨어
2 AMD	미국	반도체, PC, 서버
3 애그리볼로 (Agribolo)	인도	농업
4 AI.리버리 (AI.Reverie)	미국	합성데이터
5 아이보노 (Aibono)	인도	식음료
6 알리바바 클라우드 (Alibaba Cloud)	중국	소프트웨어
7 알파벳 (Alphabet, Inc.)	미국	IT
8 알파센스 (Alphasense)	미국	시장정보검색
9 아마존웹서비스 (AWS)	미국	IT
10 애피어 (Appier)	대만	광고, 마케팅
11 아르고 AI (Argo AI)	미국	자율주행
12 아터리스 (Arterys)	미국	헬스케어
13 애스테리아 에어로스페이스 (Astera Aerospace)	인도	방위산업
14 AT&T	미국	통신
15 아반세우스 (Avanseus)	싱가포르	통신
16 블룸리치 (Bloomreach)	미국	소매업
17 블루 리버 테크놀러지 (Blue River Technology)	미국	농업
18 버터플라이 네트워크 (Butterfly Network Inc.)	미국	헬스케어
19 캐이프 애널리틱스 (Cape Analytics)	미국	금융
20 캡션 헬스 (Caption Health)	미국	헬스케어
21 센트리 테크 (Century Tech)	영국	교육
22 세레브라사 시스템 (Cerebras Systems)	미국	컴퓨터
23 클리오 (Cleo)	영국	금융
24 클라우드메디X 헬스 (CloudMedX Health)	미국	헬스케어
25 코티 (Corti)	덴마크	헬스케어
26 크로핀 (Cropin)	인도	농업
27 다크트레이스 (Darktrace)	영국	컴퓨터, 네트워크
28 데이터이쿠 (Dataiku)	미국	소프트웨어
29 딥 인스팅트 (Deep Instinct)	미국	컴퓨터, 네트워크
30 디파인드크라우드 (DefinedCrowd)	미국	컴퓨터 시스템
31 디스틸러리 (Dstillery)	미국	마케팅, 광고
32 엠비베 (Embibe)	인도	온라인교육

기업명	국가	주요 분야
33 엔리틱 (Enlitic)	미국	의료장비
34 엔터프라이즈 AI 컴파니 (Enterprise AI Company)	미국	소프트웨어
35 팜와이즈 (FarmWise)	미국	자동기계
36 GE 리서치 (GE Research)	미국	리서치
37 딥 마인드 (DeepMind)	영국	리서치
38 그래프코어 (GraphCore)	영국	반도체
39 하바나 랩스 (Habana Labs)	イスラ엘	컴퓨터 하드웨어
40 휴리테크 (Heuritech)	프랑스	IT
41 하이 레디우스 (High Radius)	미국	소프트웨어
42 호라이즌 로보틱스 (Horizon Robotics)	중국	자율주행
43 호타우 (Hortau Inc)	미국	농업
44 하이퍼사이언스 (HyperScience)	미국	소프트웨어
45 IBM	미국	IT
46 임프로바블 디펜스 (Improbable Defence)	영국	방위, 우주
47 인플루언셜 (Influential)	미국	마케팅
48 인텔 (Intel)	미국	반도체
49 인보카 (Invoca)	미국	소프트웨어
50 아이리스 오토메이션 (Iris Automation)	미국	항공
51 아이언 옥스 (Iron Ox)	미국	농업
52 뉴튼 (Newton)	미국	온라인교육
53 코모도 헬스 (Komodo Health)	미국	소프트웨어
54 크레디테크 (Kreditech)	독일	금융
55 멘라이즈 (Memrise)	영국	온라인교육
56 마이크론 테크놀로지 (Micron Technology)	미국	반도체
57 마이크로소프트	미국	소프트웨어
58 마인들러 (Mindler)	미국	온라인교육
59 미식 (Mythic)	미국	반도체
60 넷베이스 (NetBase)	미국	소프트웨어
61 네토미 (Netomi)	미국	인터넷 퍼블리싱
62 노바키드 (Novakid Inc)	미국	온라인교육
63 누머레이 (Numerai)	미국	헤지펀드
64 뉴로 (Nuro)	미국	모터사이클

기업명	국가	주요 분야
65 엔비디아 코퍼레이션	미국	반도체
66 오스모 (Osmo)	영국	완구, 유아
67 오킨 (Owkin)	미국	바이오테크
68 퍼셉티브 오토마타 (Perceptive Automata)	미국	소프트웨어
69 프랙티컬리 (Practically)	인도	온라인교육
70 피라미드 애날리틱스 (Pyramid Analytics)	네덜란드	소프트웨어
70 큐퀀트스 (Quantcast)	미국	소프트웨어
72 레이븐 인더스트리 (Raven Industries)	미국	농업
73 레이시온 (Raytheon)	미국	항공, 우주
74 레벨리온 디펜스 (Rebellion Defense)	미국	소프트웨어
75 록웰 오토메이션 (Rockwell Automation)	미국	자동화기계
76 SAP	독일	소프트웨어
77 쉴드 AI (Shield AI)	미국	소프트웨어
78 지멘스 (Siemens)	독일	자동화기계
79 시그니파이드 (Signifyd)	미국	소프트웨어
80 오픈AI (OpenAI)	미국	리서치
81 시즈멕 (Sizmek)	미국	마케팅
82 스카이스quirrel 테크놀로지 (SkySquirrel Technologies Inc.)	캐나다	농업
83 소프트웨블 솔루션즈 (Softweb Solutions Inc.)	미국	IT
84 SRI 인터내셔널 (SRI International)	미국	연구소
85 스텠다드 AI (Standard AI)	미국	소프트웨어
86 스트리트비즈 (Streetbees)	영국	리서치
87 신티안트 (Syntiant)	미국	반도체
88 타라니스 (Taranis)	미국	농업
89 보잉 (The Boeing Co)	미국	항공
90 신시아이 (Thinci)	미국	반도체
91 톤키안 (Tonkean)	미국	자동화솔루션
92 트레이스지노믹스 (Trace Genomics)	미국	농업, 바이오
93 트랙터블 (Tractable)	영국	IT
94 웨이모 (Waymo)	미국	자율주행
95 자일링스 (Xilinx)	미국	반도체

※ 100개 기업 중 중복 및 자회사/모회사 겹침 제외

Types of AI



3-Types of AI

Artificial Narrow Intelligence (ANI)



Stage-I

Machine Learning

Specializes in one area and solve one problem

Artificial General Intelligence (AGI)

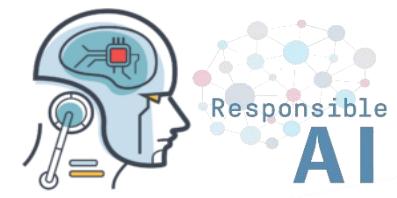


Stage-II

Machine Intelligence

Refers to a computer that is as smart as a human across the board

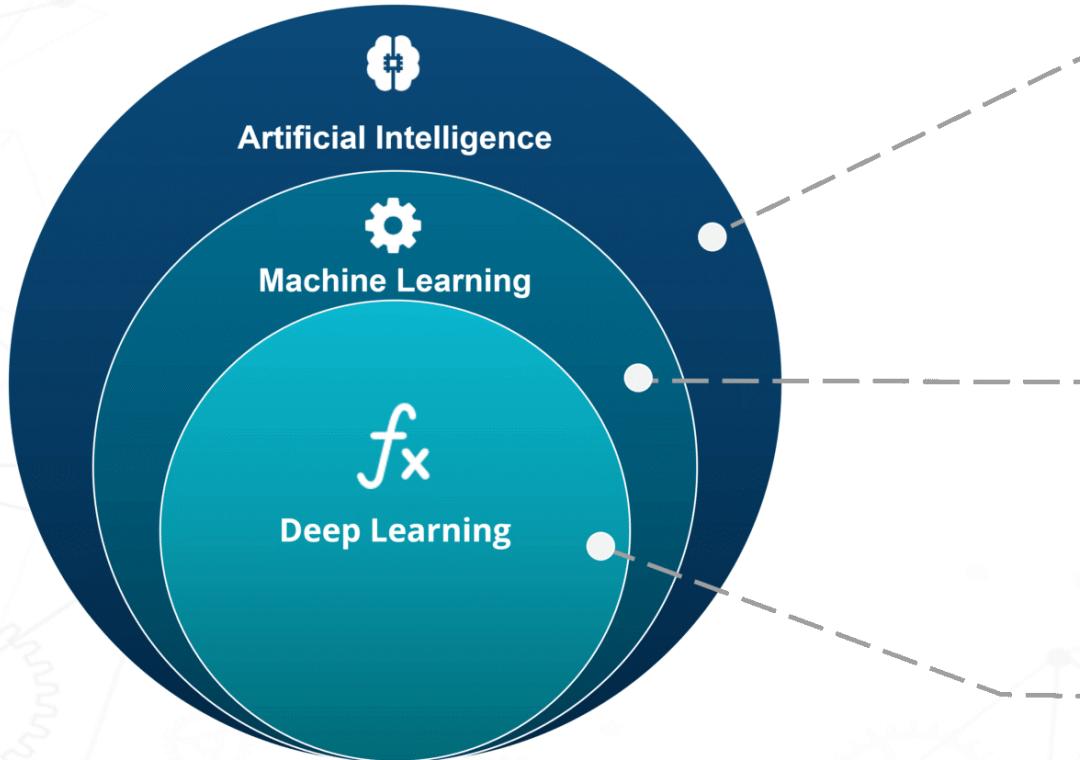
Artificial Super Intelligence (ASI)



Stage-III

Machine Consciousness

An intellect that is much smarter than the best human brains in every field



ARTIFICIAL INTELLIGENCE

A technique which enables machines to mimic human behaviour

MACHINE LEARNING

Subset of AI technique which use statistical methods to enable machines to improve with experience

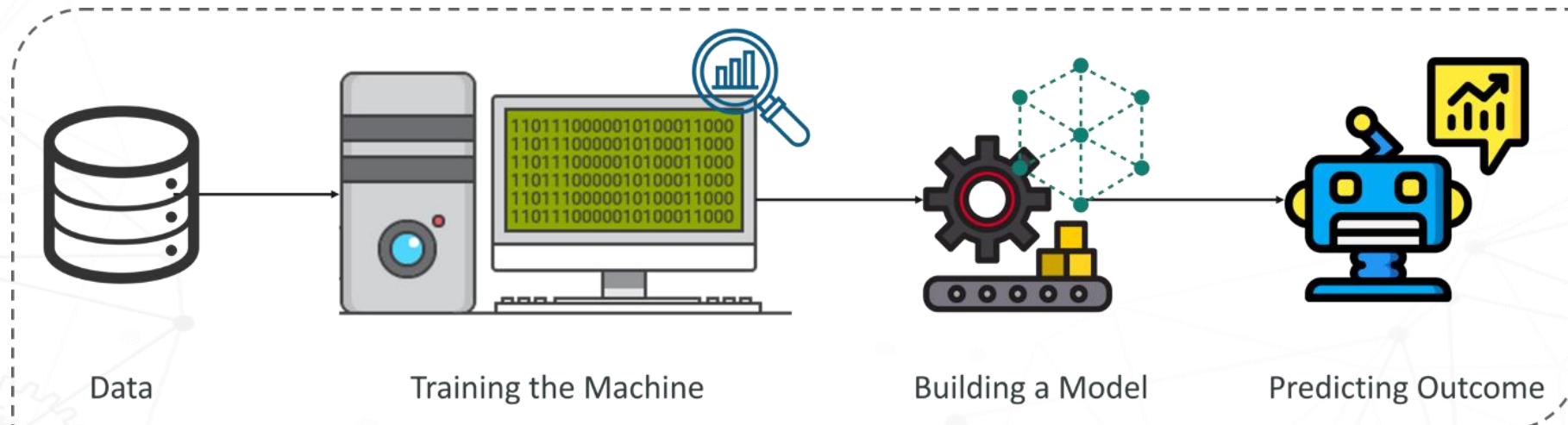
DEEP LEARNING

Subset of ML which make the computation of multi-layer neural network feasible

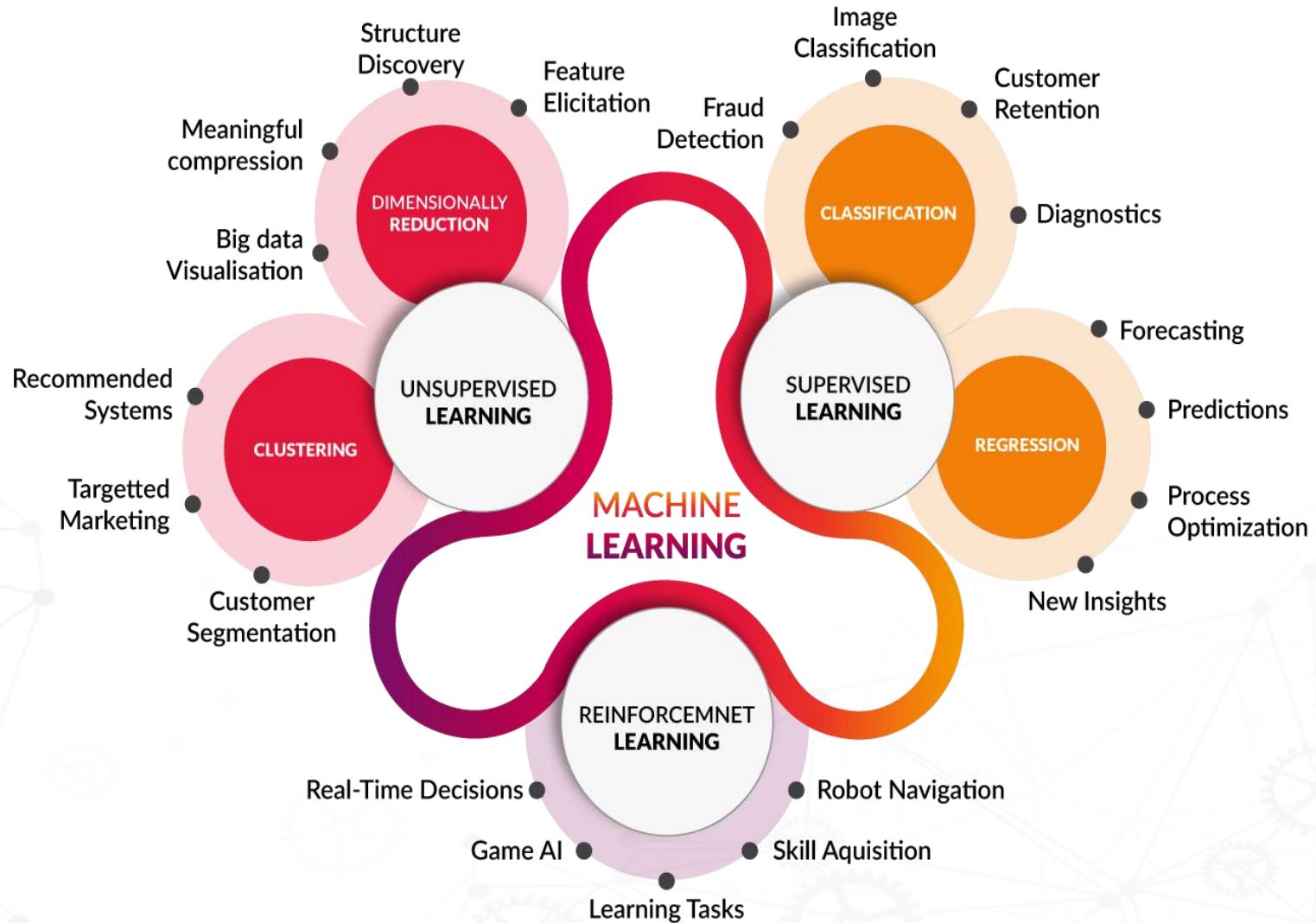
What is Machine Learning?



Machine learning is a subset of AI which provides machines the ability to learn Automatically & improve from experience without being explicitly programmed



Machine Learning Applications

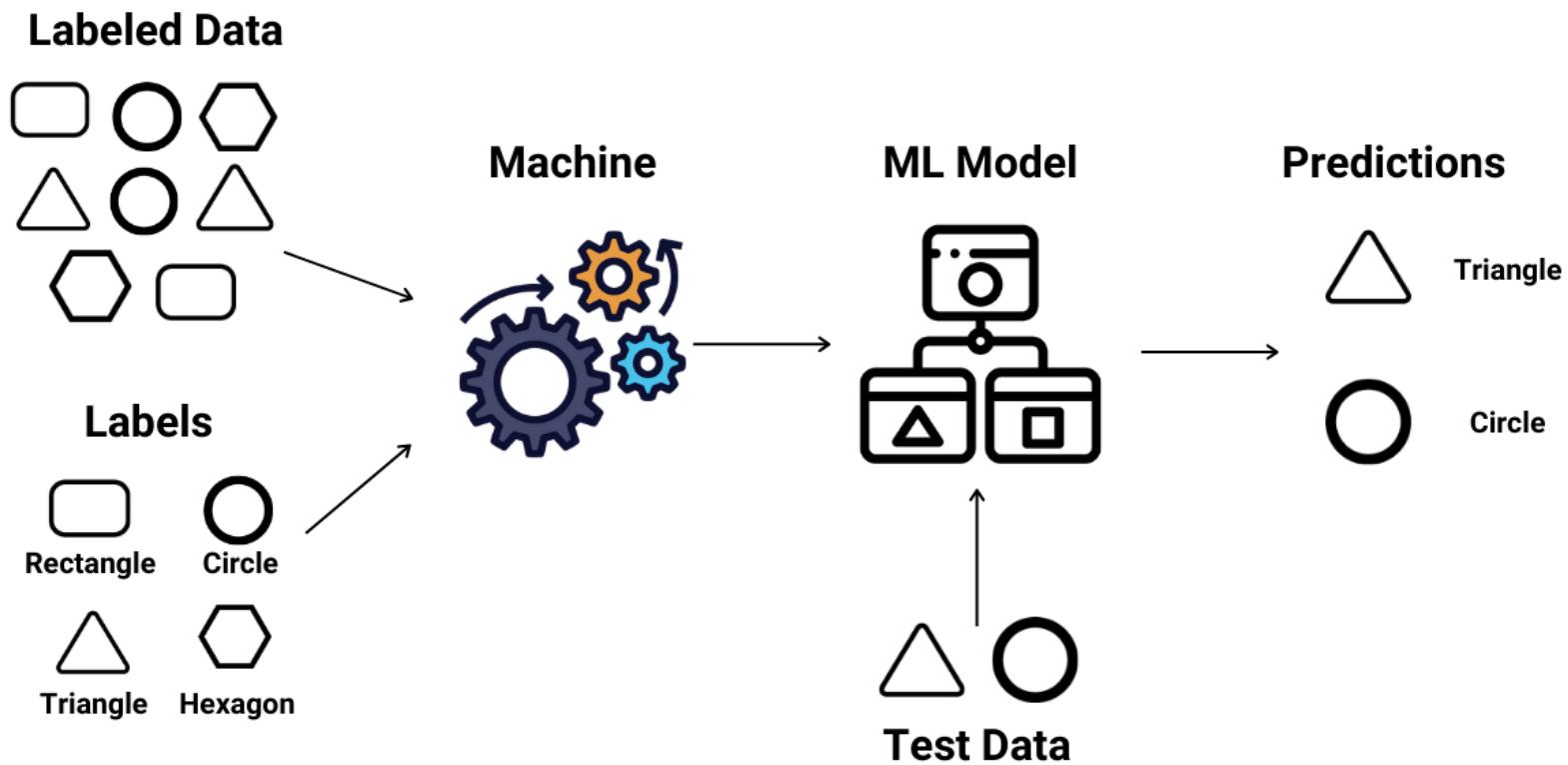


Learning Algorithms (1/4)



Supervised Learning

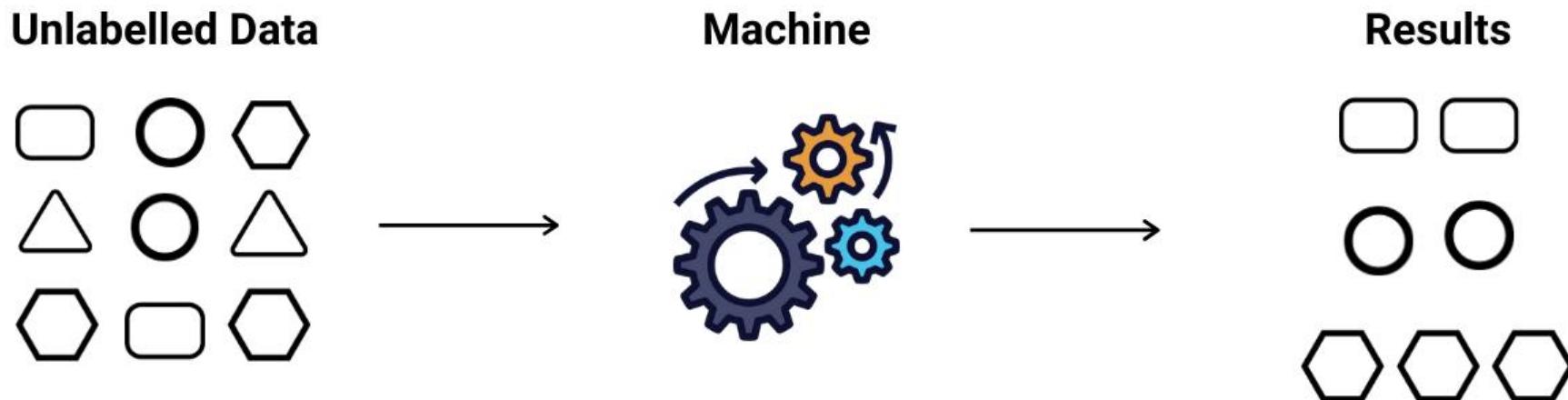
It is a technique in which we teach or train the machine using data which is well labelled





Unsupervised Learning

It is the training of machine using information that is unlabeled and allowing the algorithm to act on that information without guidance

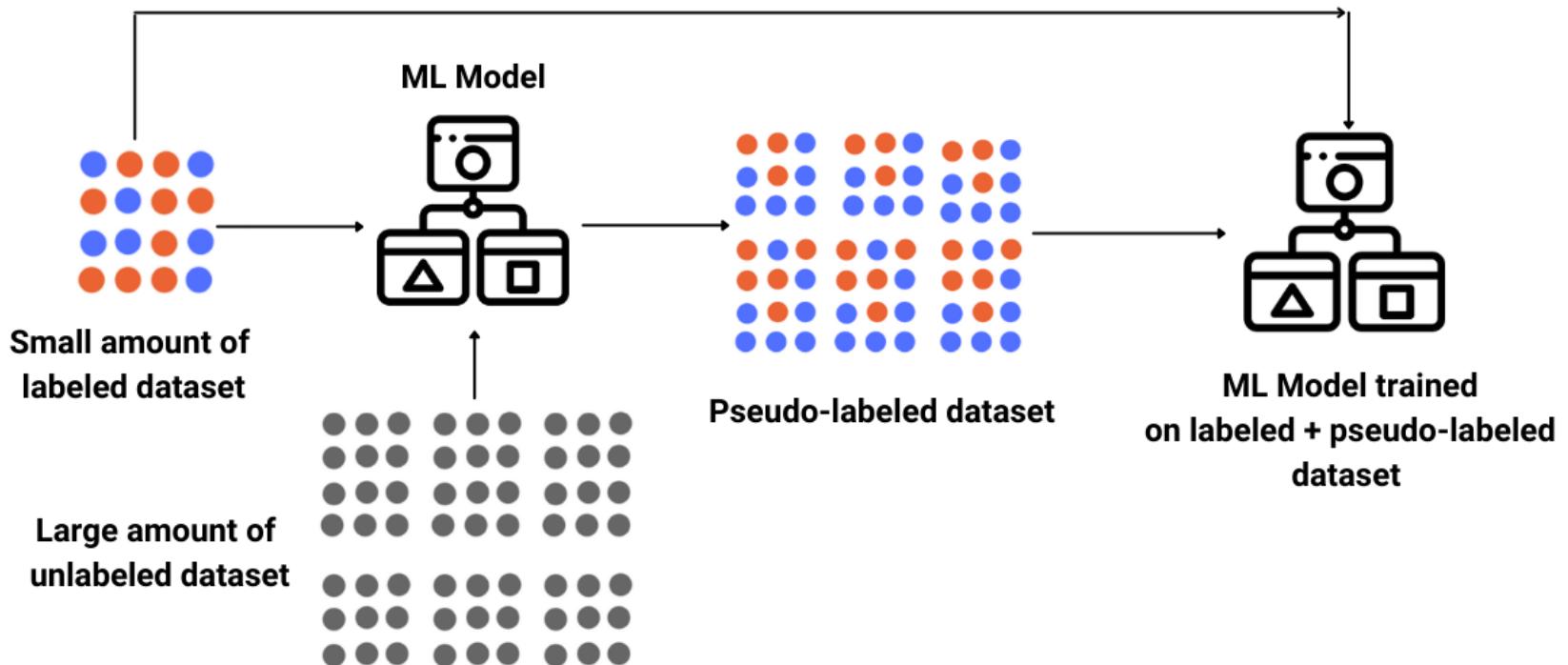


Learning Algorithms (3/4)



Semi-supervised Learning

A category in which we have input data, and only some of those input data are labeled as the output

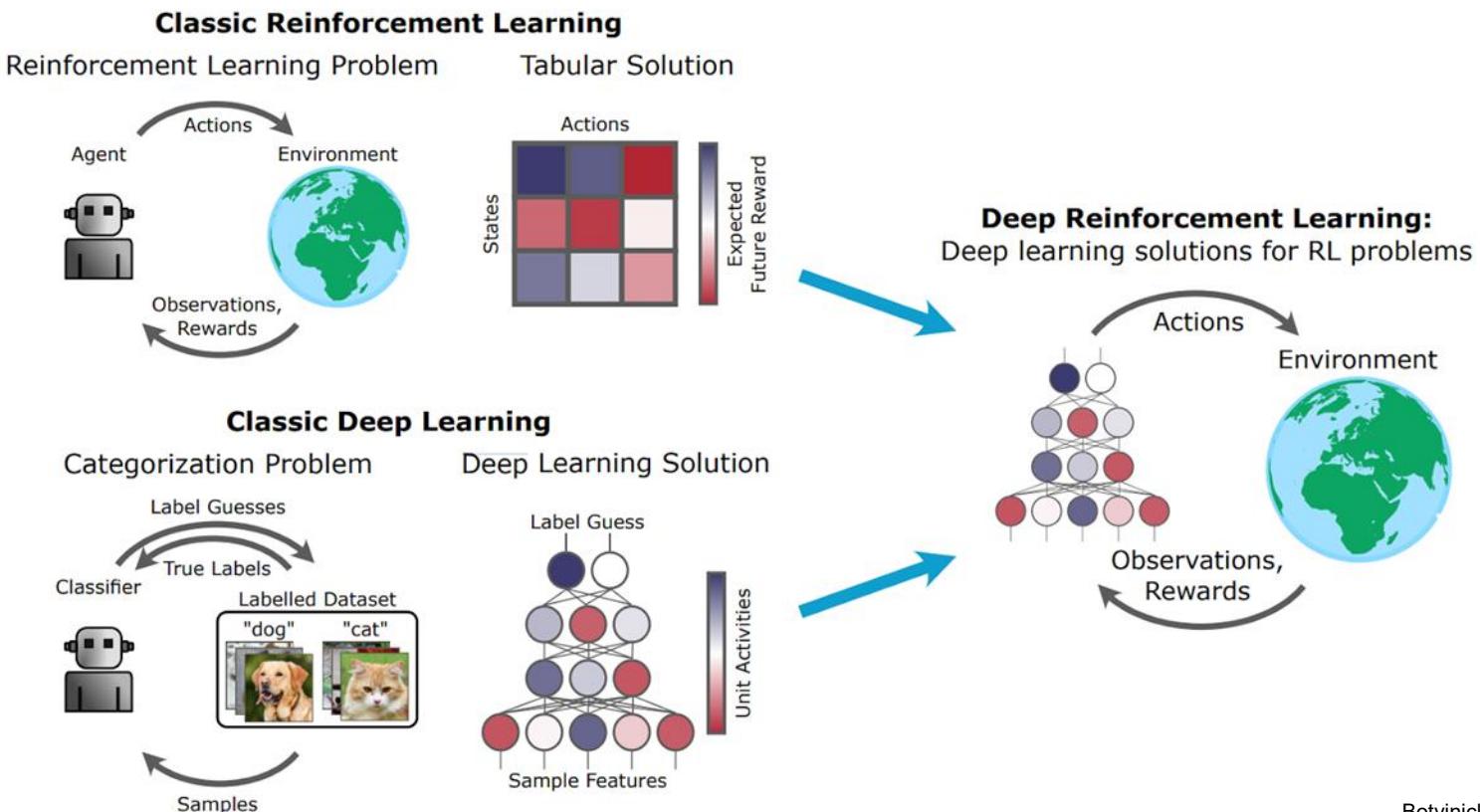


Learning Algorithms (4/4)



Reinforcement Learning

A part of ML where an agent is put in an environment, and learns to behave in this environment by performing certain actions and observing the rewards which it gets from those actions



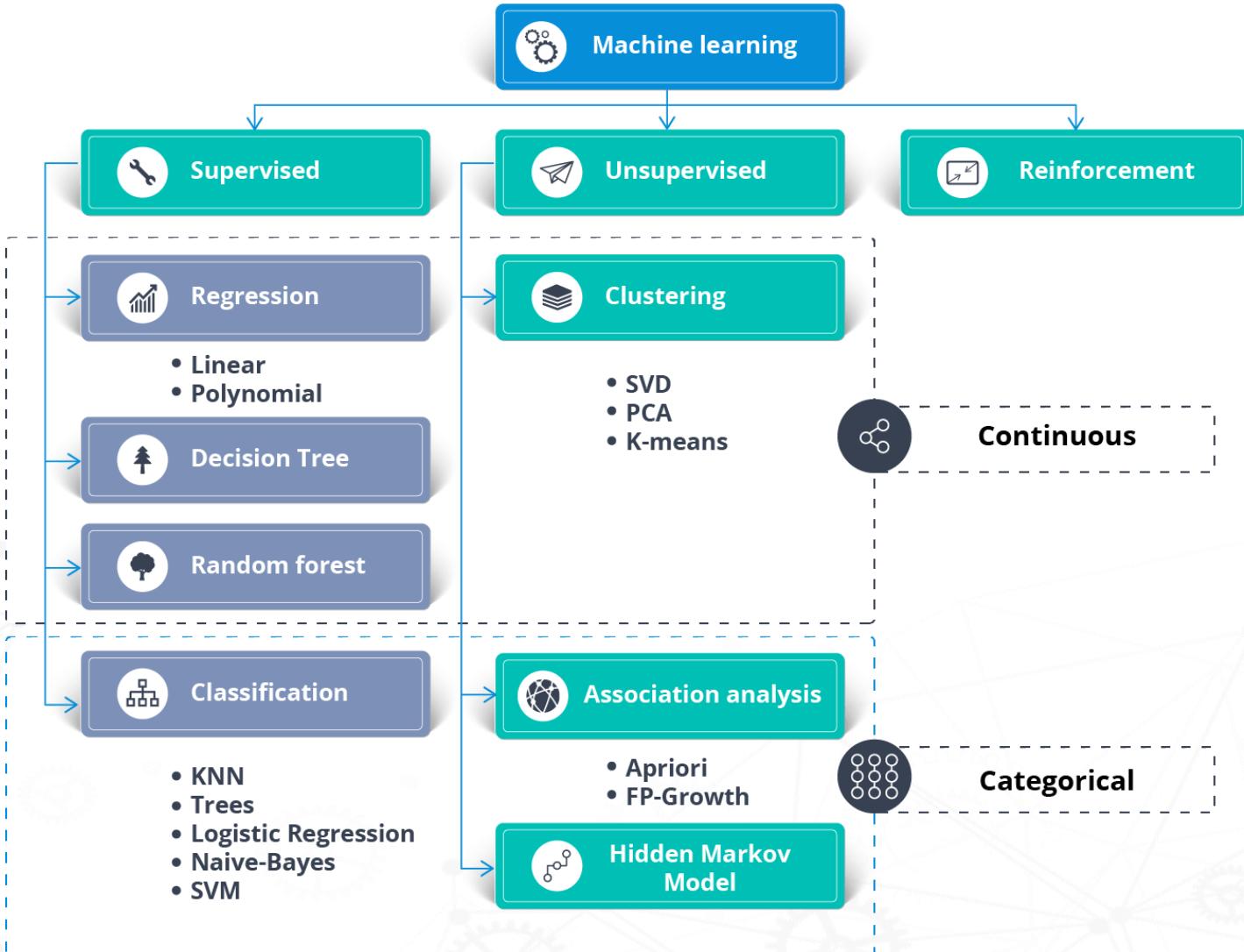
Botvinick et al., *Neuron*, 2020

Supervised vs. Unsupervised vs. Reinforcement Learning

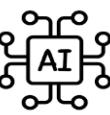


Criteria	Supervised ML	Unsupervised ML	Reinforcement ML
Definition	Learns by using labelled data	Trained using unlabelled data without any guidance.	Works on interacting with the environment
Type of data	Labelled data	Unlabelled data	No – predefined data
Type of problems	Regression and classification	Association and Clustering	Exploitation or Exploration
Supervision	Extra supervision	No supervision	No supervision
Algorithms	Linear Regression, Logistic Regression, SVM, KNN etc.	K – Means, C – Means, Apriori	Q – Learning, SARSA
Aim	Calculate outcomes	Discover underlying patterns	Learn a series of action
Application	Risk Evaluation, Forecast Sales	Recommendation System, Anomaly Detection	Self Driving Cars, Gaming, Healthcare

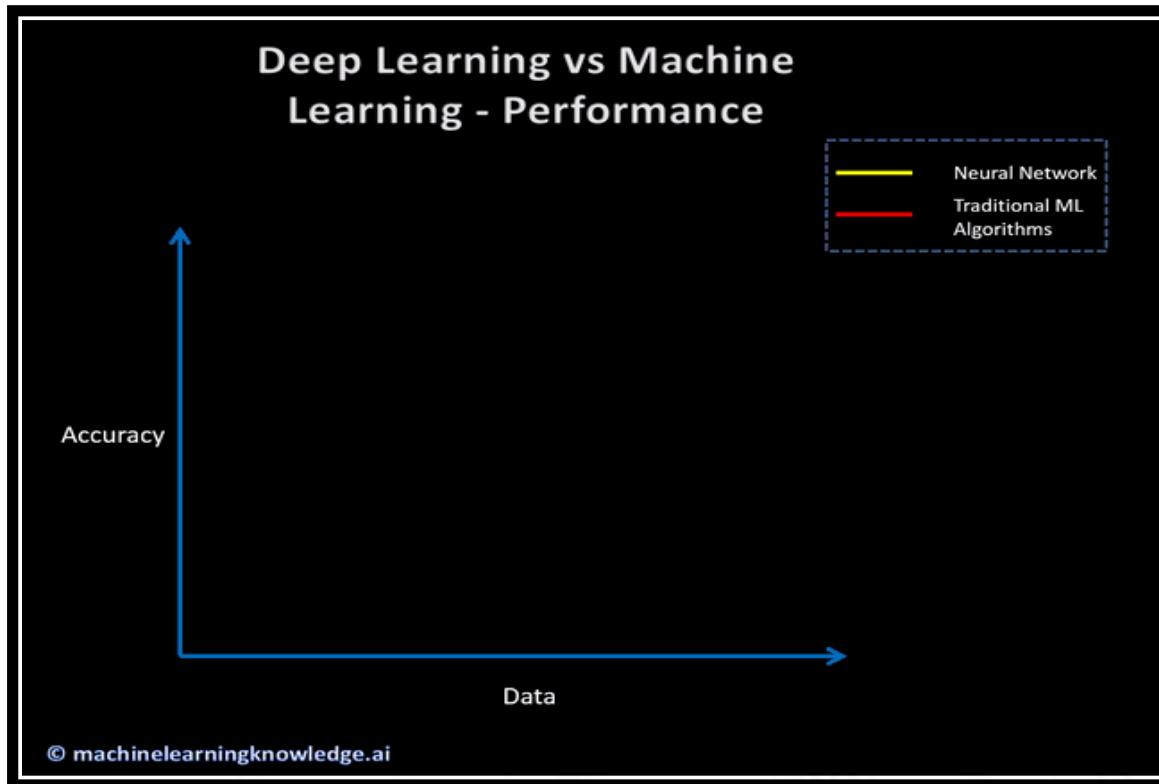
Representative ML Algorithms



Limitation of ML



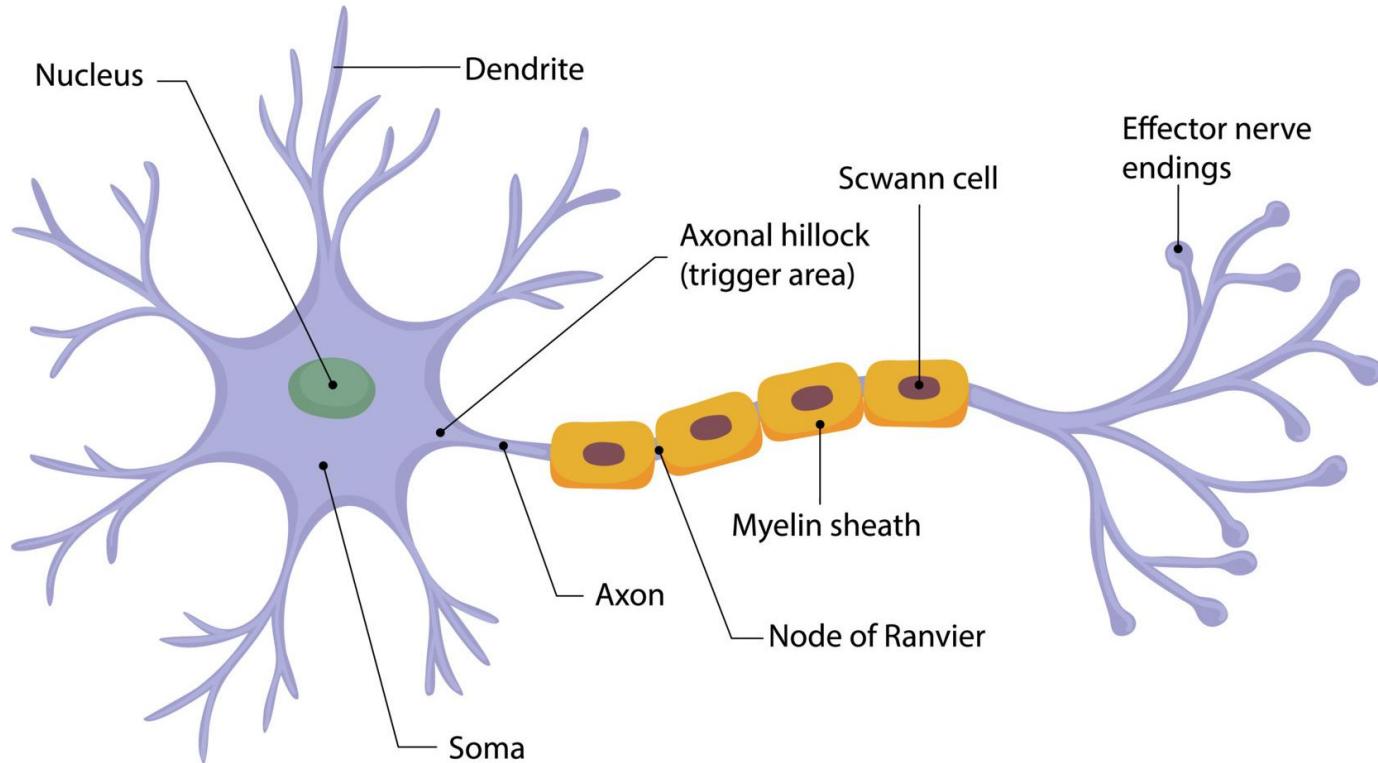
One of the big challenges with traditional ML models is feature extraction and performance



Why Deep Learning

Deep Learning models are capable to focus on the right features by themselves, requiring little guidance from the programmer: These models also partially solve the dimensionality problem

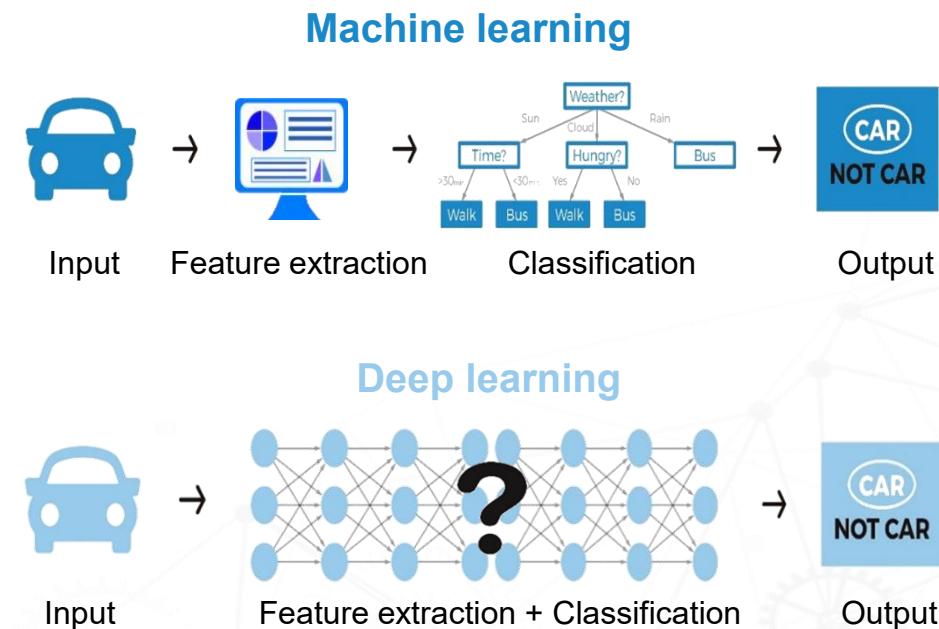
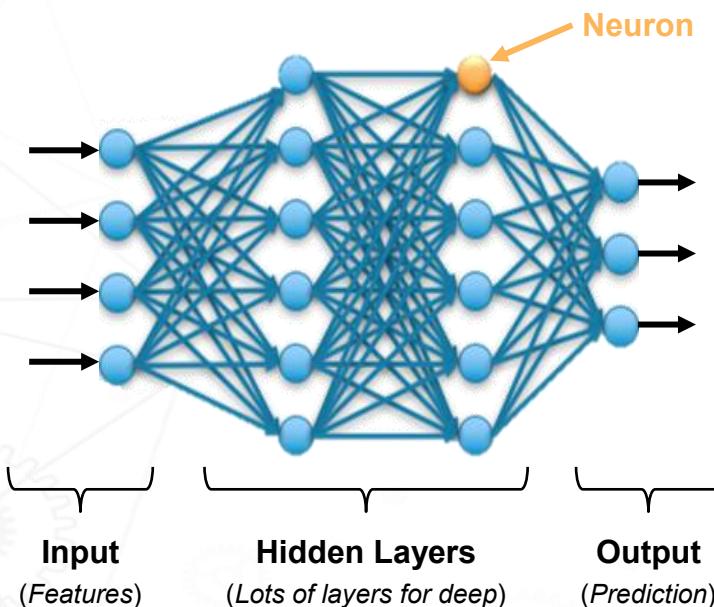
"The idea behind Deep Learning is to build learning algorithms that mimic the brain"



Deep Learning (Cont.)



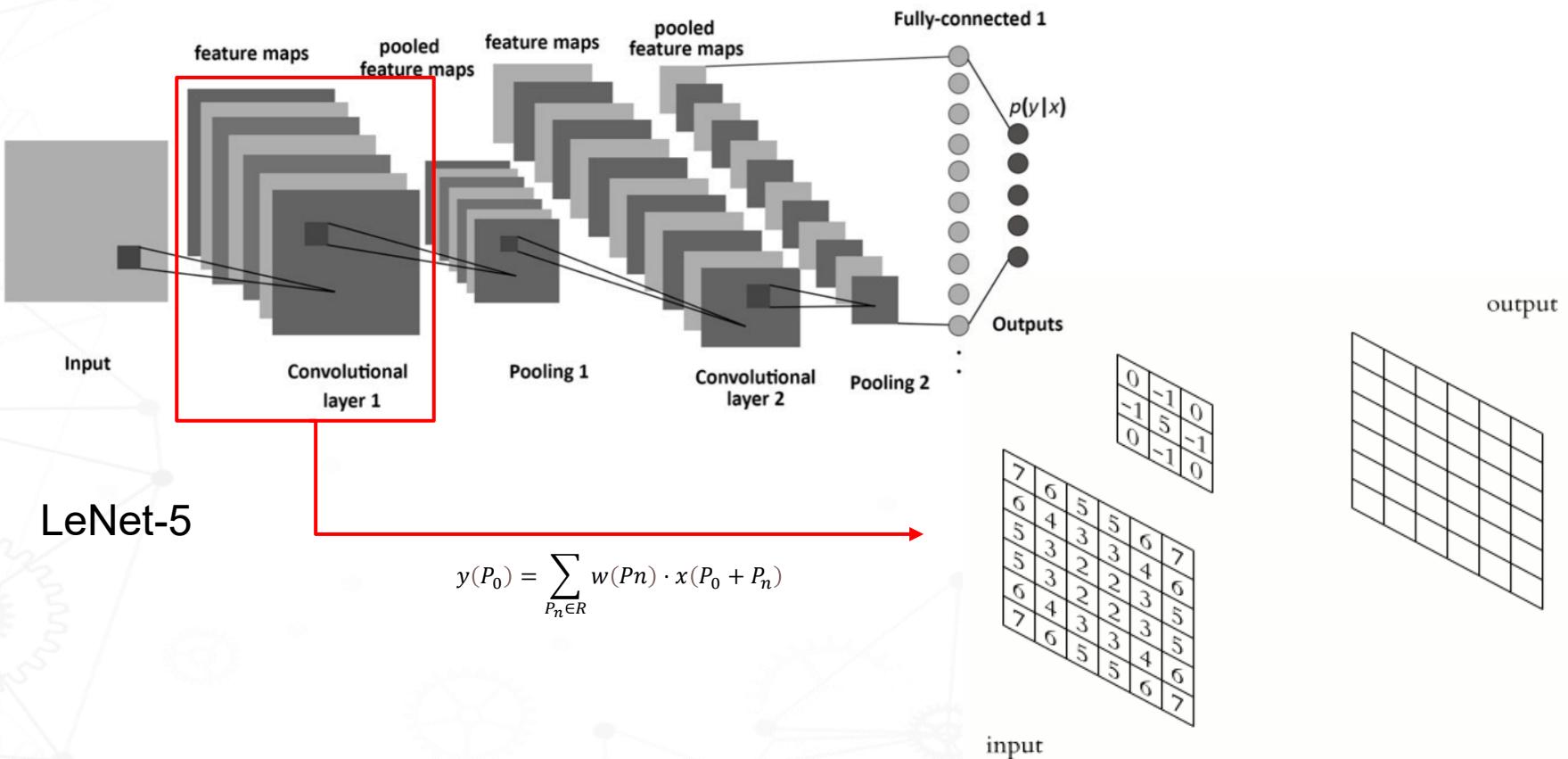
A subfield of ML concerned with algorithms inspired by the structure and function of the brain called **artificial neural networks**



Deep Learning Algorithms (1/4)



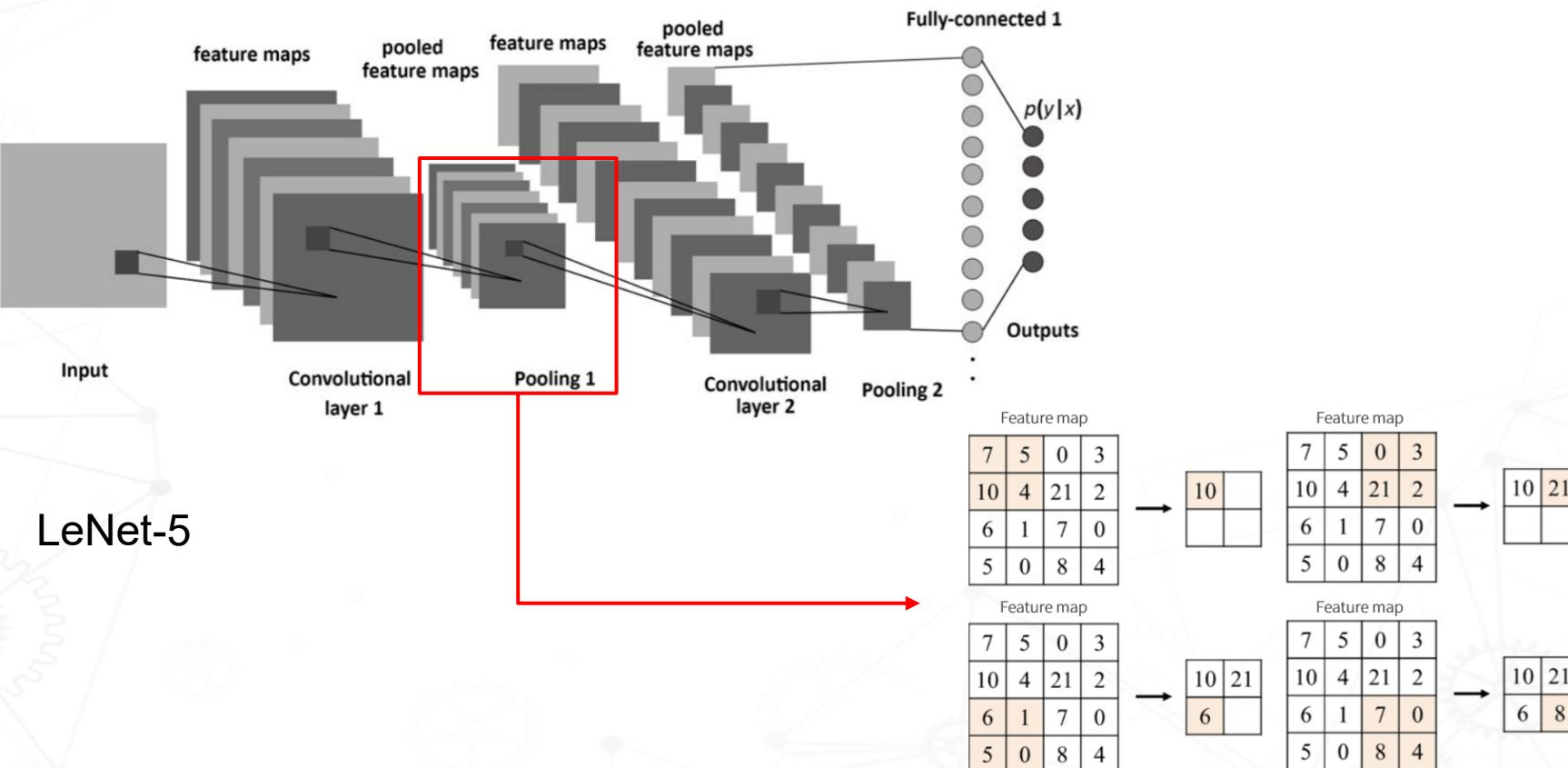
Convolutional neural network



Deep Learning Algorithms (2/4)



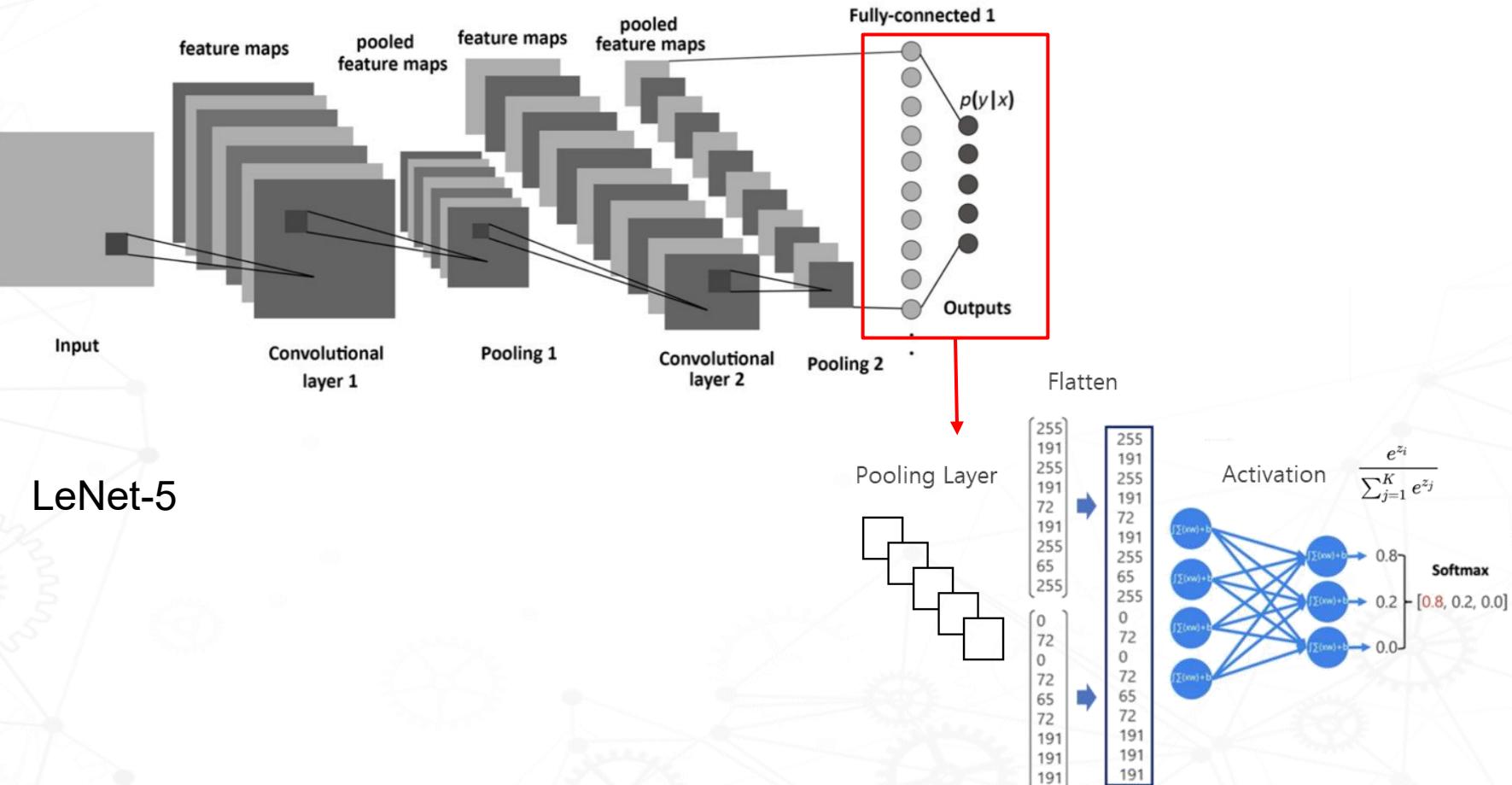
Convolutional neural network



Deep Learning Algorithms (3/4)



Convolutional neural network

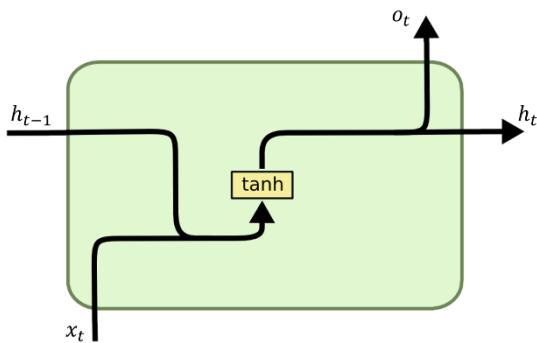


Deep Learning Algorithms (4/4)



Recurrent neural network & Long short-term memory & Gated recurrent unit

RNN

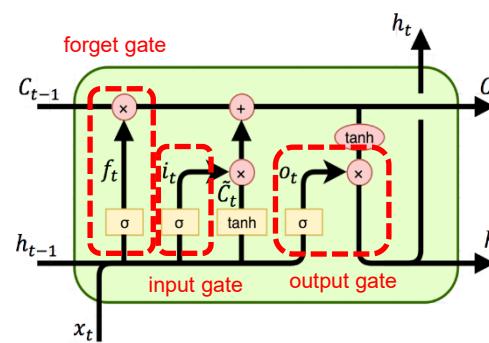


x_t : input vector ($m \times 1$).
 h_t : hidden layer vector ($n \times 1$).
 o_t : output vector ($n \times 1$).
 b_h : bias vector ($n \times 1$).
 U, W : parameter matrices ($n \times m$).
 V : parameter matrix ($n \times n$).
 σ_h, σ_y : activation functions.

$$h_t = \sigma_h(i_t) = \sigma_h(U_h x_t + V_h h_{t-1} + b_h)$$

$$y_t = \sigma_y(o_t) = \sigma_y(W_y h_t + b_y)$$

LSTM



h_t, C_t : hidden layer vectors.
 x_t : input vector.
 b_f, b_i, b_c, b_o : bias vector.
 W_f, W_i, W_c, W_o : parameter matrices.
 σ, \tanh : activation functions.

$$f_t = \sigma(W_f \cdot [h_{t-1}, x_t] + b_f)$$

$$i_t = \sigma(W_i \cdot [h_{t-1}, x_t] + b_i)$$

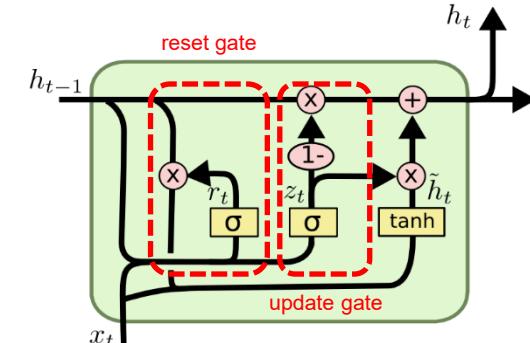
$$o_t = \sigma(W_o \cdot [h_{t-1}, x_t] + b_o)$$

$$\tilde{C}_t = \tanh(W_c \cdot [h_{t-1}, x_t] + b_c)$$

$$C_t = f_t \odot C_{t-1} + i_t \odot \tilde{C}_t$$

$$h_t = o_t \odot \tanh(C_t)$$

GRU



h_t : hidden layer vectors.
 x_t : input vector.
 b_z, b_r, b_h : bias vector.
 W_z, W_r, W_h : parameter matrices.
 σ, \tanh : activation functions.

$$z_t = \sigma(W_z \cdot [h_{t-1}, x_t] + b_z)$$

$$r_t = \sigma(W_r \cdot [h_{t-1}, x_t] + b_r)$$

$$\tilde{h}_t = \tanh(W_h \cdot [r_t \odot h_{t-1}, x_t] + b_h)$$

$$h_t = (1 - z_t) \odot h_{t-1} + z_t \odot \tilde{h}_t$$

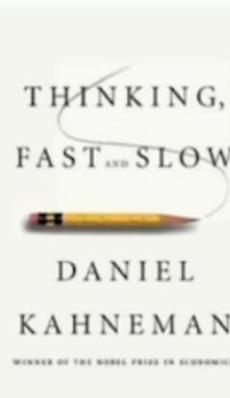


SYSTEM 1 VS. SYSTEM 2 COGNITION

2 systems (and categories of cognitive tasks):

System 1

- Intuitive, fast, **UNCONSCIOUS**, non-linguistic, habitual
- Current DL



System 2

- Slow, logical, sequential, **CONSCIOUS**, linguistic, algorithmic, planning, reasoning
- Future DL



Manipulates high-level / semantic concepts, which can be recombined combinatorially



CONSCIOUSNESS FUNCTIONALITIES: ROADMAP FOR PRIORS EMPOWERING SYSTEM 2

1. ML Goals: handle changes in distribution, necessary for agents
2. System 2 basics: attention & consciousness
3. Consciousness prior: sparse factor graph
4. Theoretical framework: meta-Learning, localized change hypothesis → causal discovery
5. Compositional DL architectures: operating on sets of pointable objects with dynamically recombined modules



AlphaCode @DeepMind

② Solution (output)

First AlphaCode reads the two phrases.

```

t=int(input())
for i in range(t):
    s=input()
    t=input()
    a=[]
    b=[]
    for j in s:
        a.append(j)
    for j in t:
        b.append(j)
    a.reverse()
    b.reverse()
    c=[]
    while len(b)!=0 and len(a)!=0:
        if a[0]==b[0]:
            c.append(b.pop(0))
            a.pop(0)
        elif a[0]!=b[0] and len(a)==1:
            a.pop(0)
            a.pop(0)
        elif a[0]==b[0] and len(a)==1:
            a.pop(0)
        if len(b)==0:
            print("YES")
        else:
            print("NO")
    
```

Backspace deletes two letters. The letter you press backspace instead of, and the letter before it.

If the letters at the end of both phrases don't match, the last letter must be deleted. If they do match we can move onto the second last letter and repeat.

If we've matched every letter, it's possible and we output that.



↗
2022-2-2

Competition-Level Code Generation with AlphaCode

Yujia Li*, David Choi*, Junyoung Chung*, Nate Kushman*, Julian Schrittwieser*, Rémi Leblond*, Tom Eccles*, James Keeling*, Felix Gimeno*, Agustin Dal Lago*, Thomas Hubert*, Peter Choy*, Cyprien de Masson d'Autume*, Igor Babuschkin, Xinyun Chen, Po-Sen Huang, Johannes Welbl, Sven Gowal, Alexey Cherepanov, James Molloy, Daniel J. Mankowitz, Esme Sutherland Robson, Pushmeet Kohli, Nando de Freitas, Koray Kavukcuoglu and Oriol Vinyals

*Joint first authors



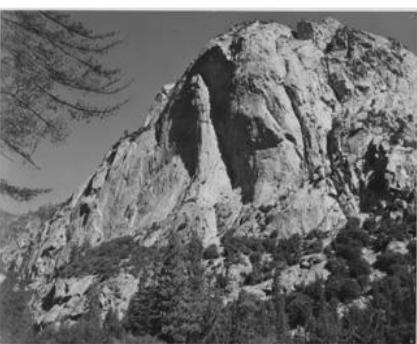
AI Advances: Anomaly Detection



AI Advances: Restoring Colors



100 year old pictures...





Real-time Multi-Person 2D Pose Estimation Using Part Affinity Fields

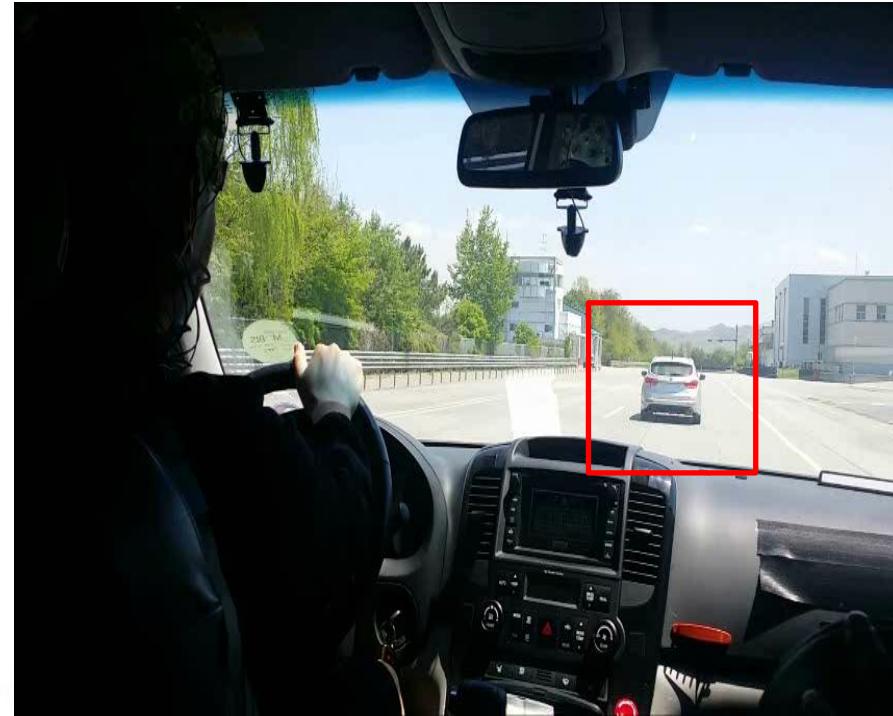
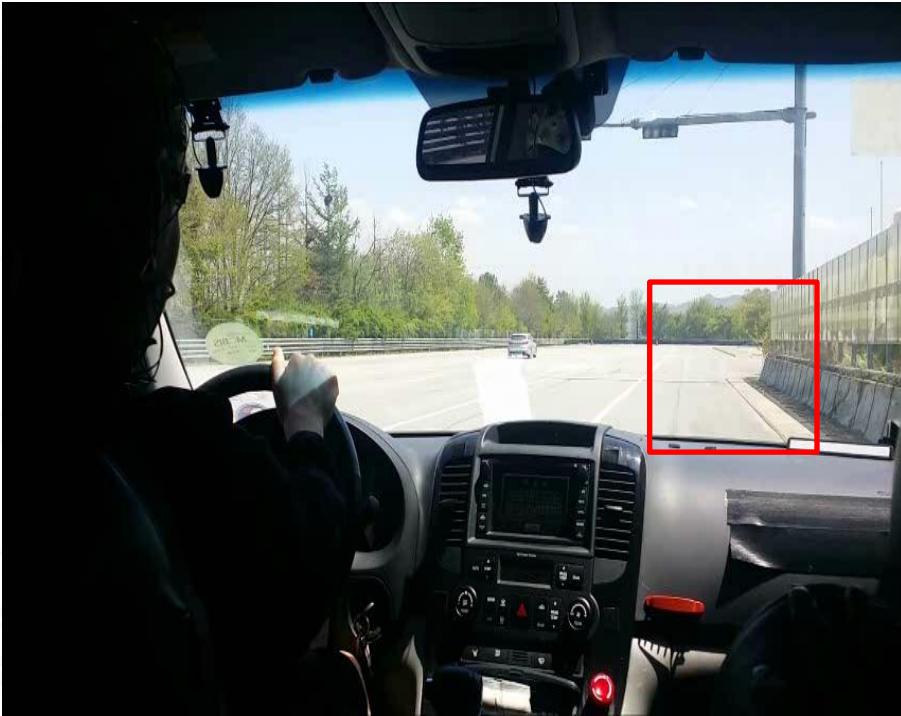
Zhe Cao, Tomas Simon, Shih-En Wei, Yaser Sheikh

Carnegie Mellon University

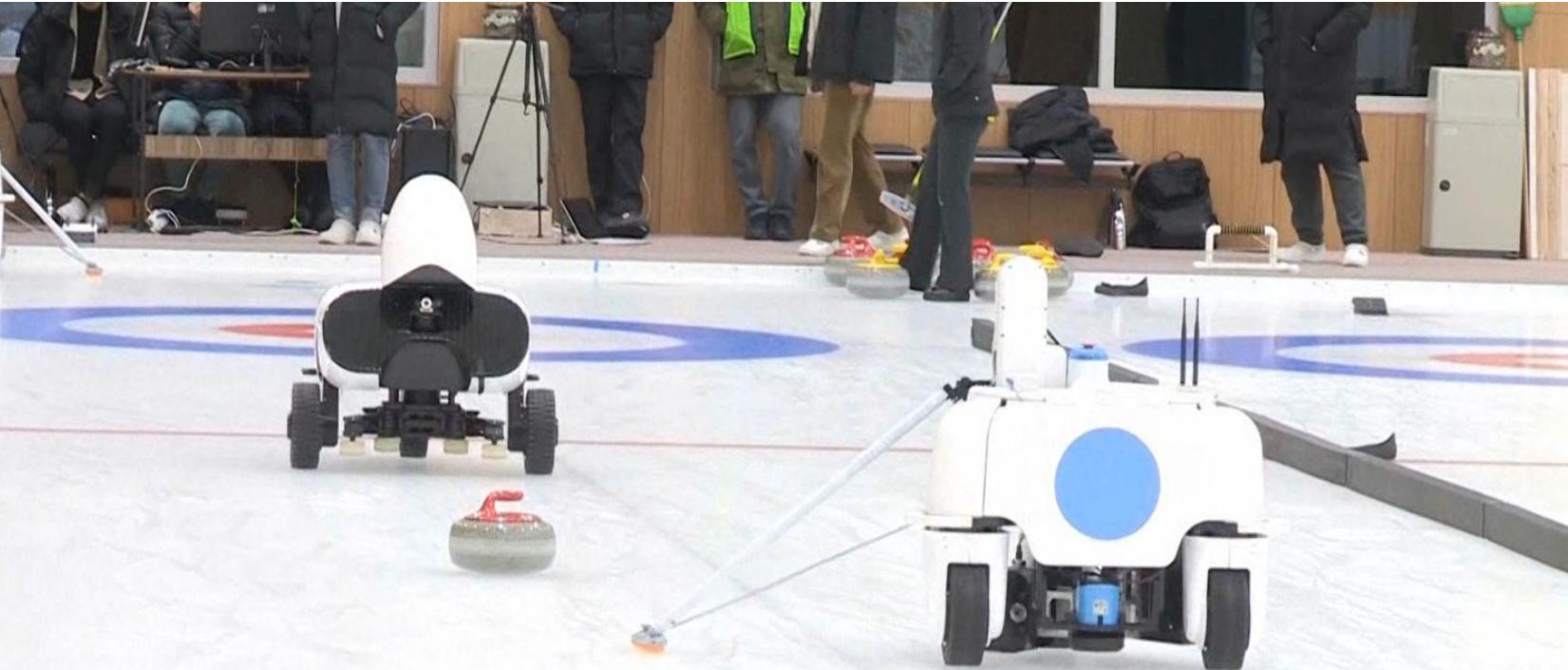
AI Advances: Driving Assistant I



AI Advances: Driving Assistant II



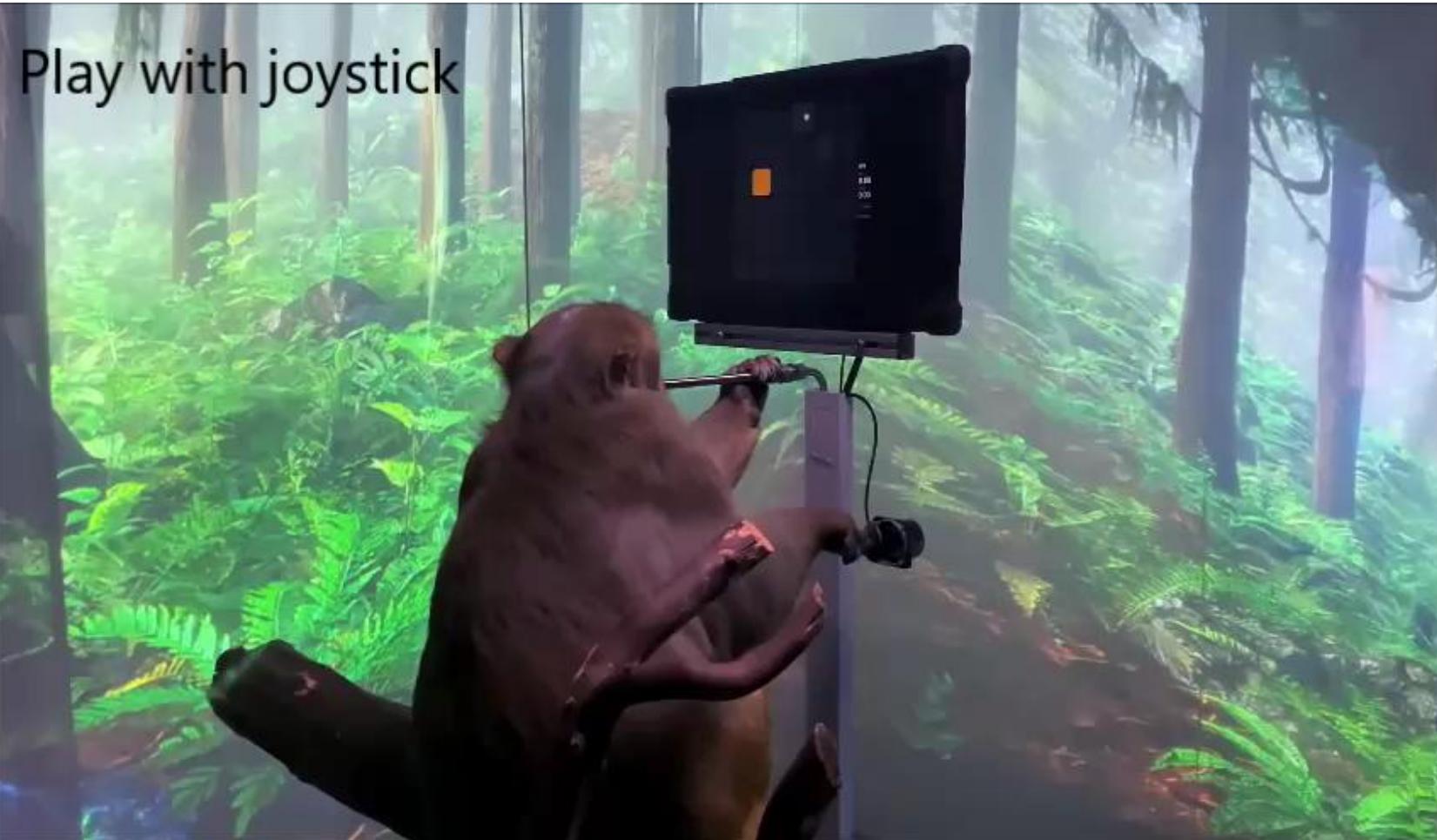
AI Advances: Sports Opponent



AI Advances: Brain-computer interface



AI Advances: Brain-Computer Interface



AI Advances: Hyperscale AI



Korea							
Naver	Kakao Brain	SK Telecom	KT	LG AI Research			
HyperClova	KoGPT	A.	Mi:deum	Exaone			
<ul style="list-style-type: none">Ingests Korean language data from 50 years of news and 9 years of blogUnderstands context and speaks like a personCreates sentences and makes phone calls							
Korean language model of GPT-3 minDALL-E	Text-based image generation AI model	Commercializes GPT-3 in Korean	Scheduled to launch in first half	Multimodal AI Deploys 300 billion parameters			
United States							
OpenAI	Google						
ChatGPT	Bard	<ul style="list-style-type: none">Similar to ChatGPT, but can talk about recent eventsScheduled to launch in coming weeks					
<ul style="list-style-type: none">Interactive AI chatbot							
China							
Baidu	Ernie Bot						
<ul style="list-style-type: none">Similar to ChatGPTWill combine with search engine after launching stand alone application							

AI Advances: Hyperscale AI



John
(Programmer)



Ryan