The Role of Engineers in the 4th Industrial Revolution

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Contents

History of Industrial Revolution

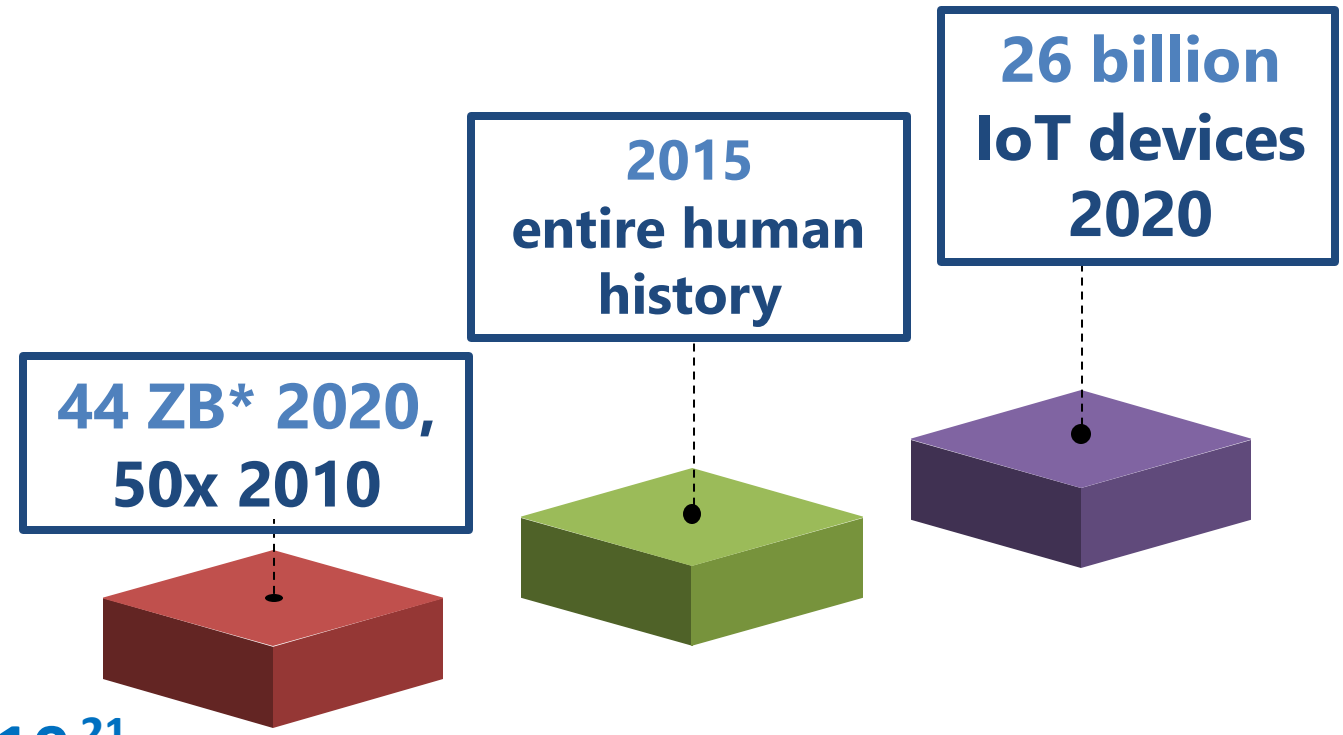
			
1st revolution	**2nd revolution**	**3rd revolution**	**4th revolution**
Late 18th ~ Early 19th century	Late 19th ~ Mid 20th century	second half of 20th century	Early 21st century
Mechanization	**Mass Production**	**Digital revolution**	**AI of Everythings**
Machines replace manual labor (driven by Steam power)	Mass manufacturing using electrical energy	Digital technology using computer and WWW	AI with connected intelligent systems

4th Industrial Revolution

- AI (Artificial Intelligence)/AoE (AI of Everythings)
- Robotics & cyber-physical systems
- IoT (Internet of Things) :
  - smart home, smart city, smart factory, smart farm
- Big Data & Cloud Computing
- Autonomous Vehicles
- Genetic engineering/Biotechnology
- Nano Technology
- ….

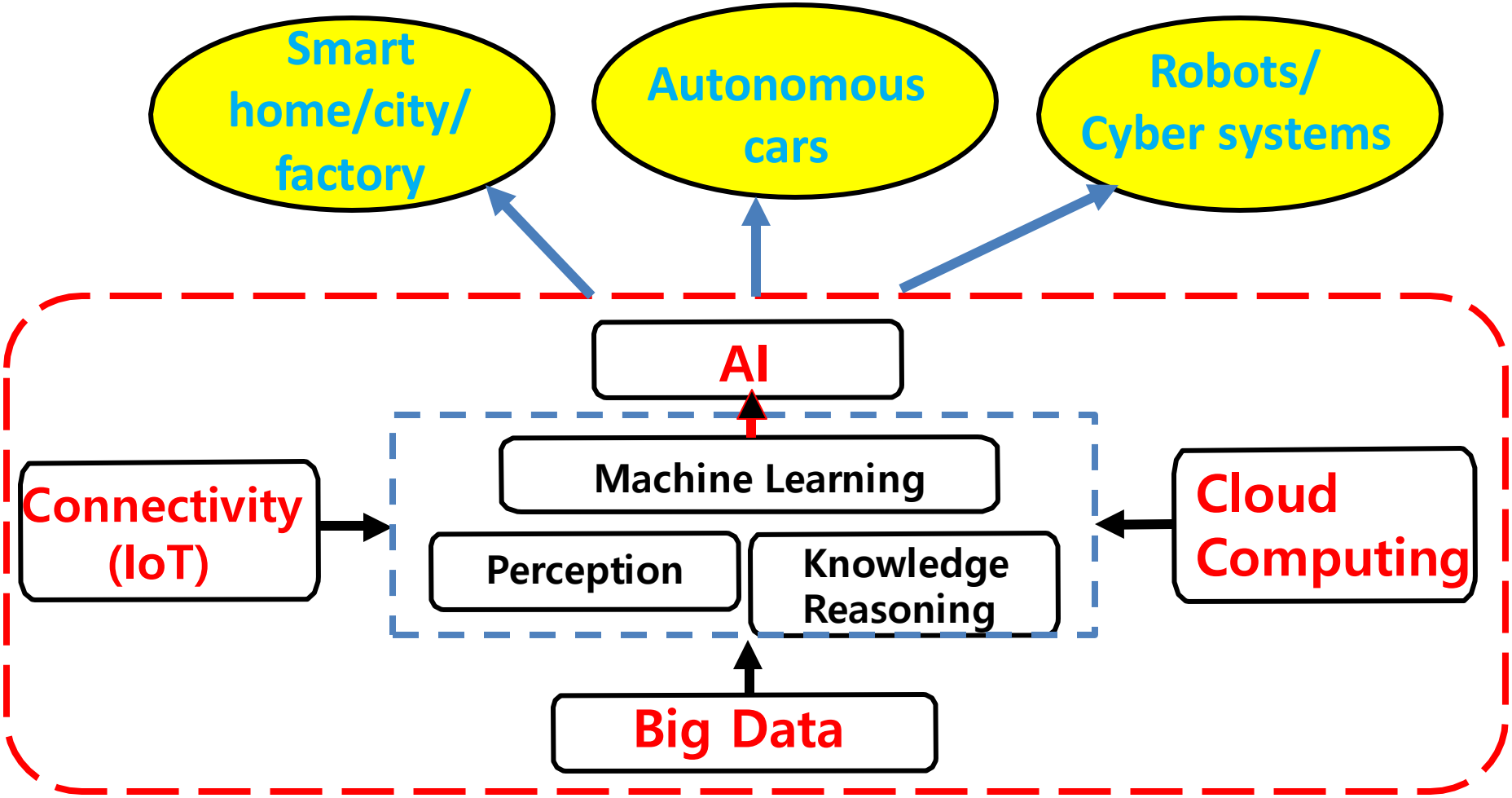
Data volumes driving AI

Only AI has the power to analyze this data to solve grand challenges and problems guiding our future.



* ZB = 10^9 TB = 10^{21}

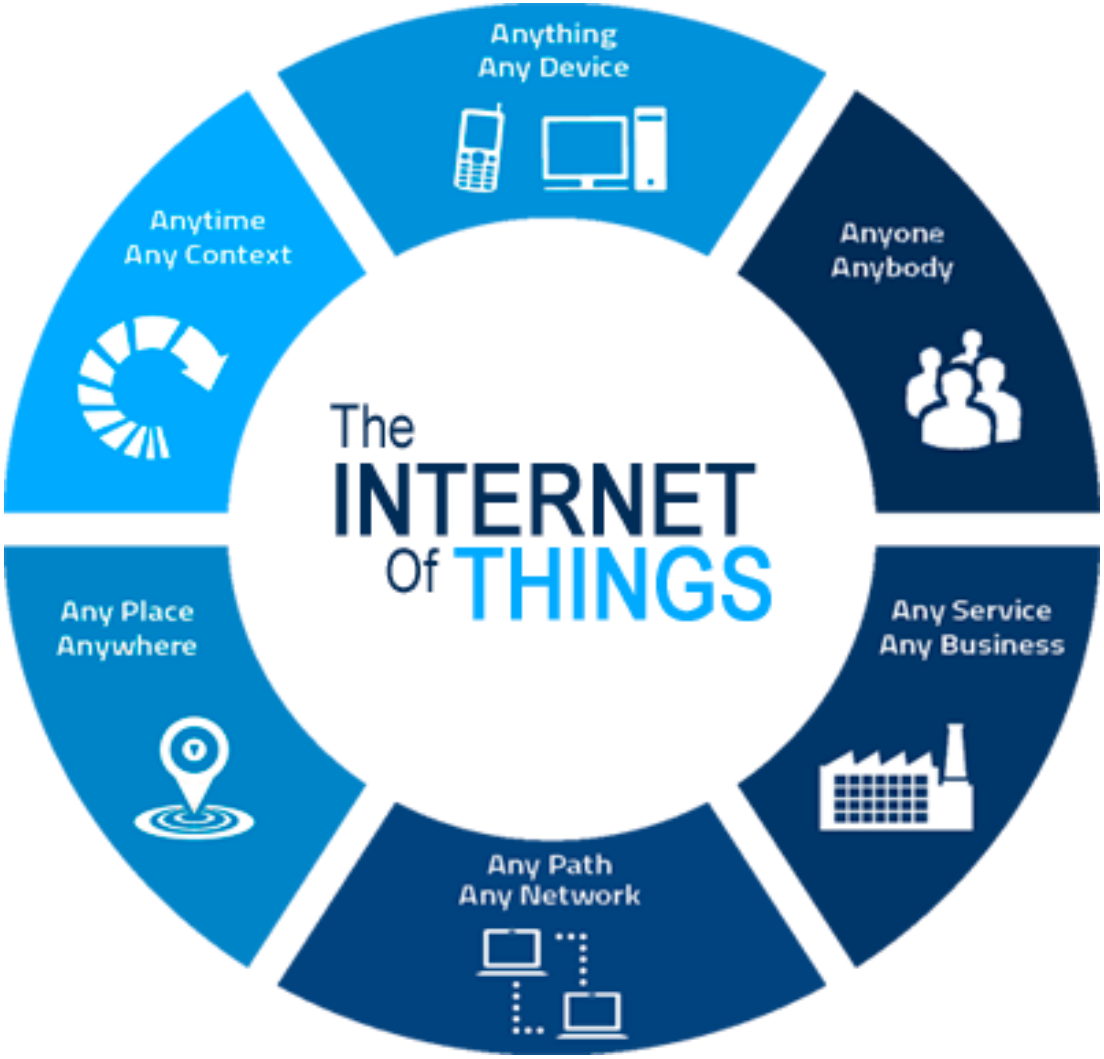
Main IT technologies of 4th revolution



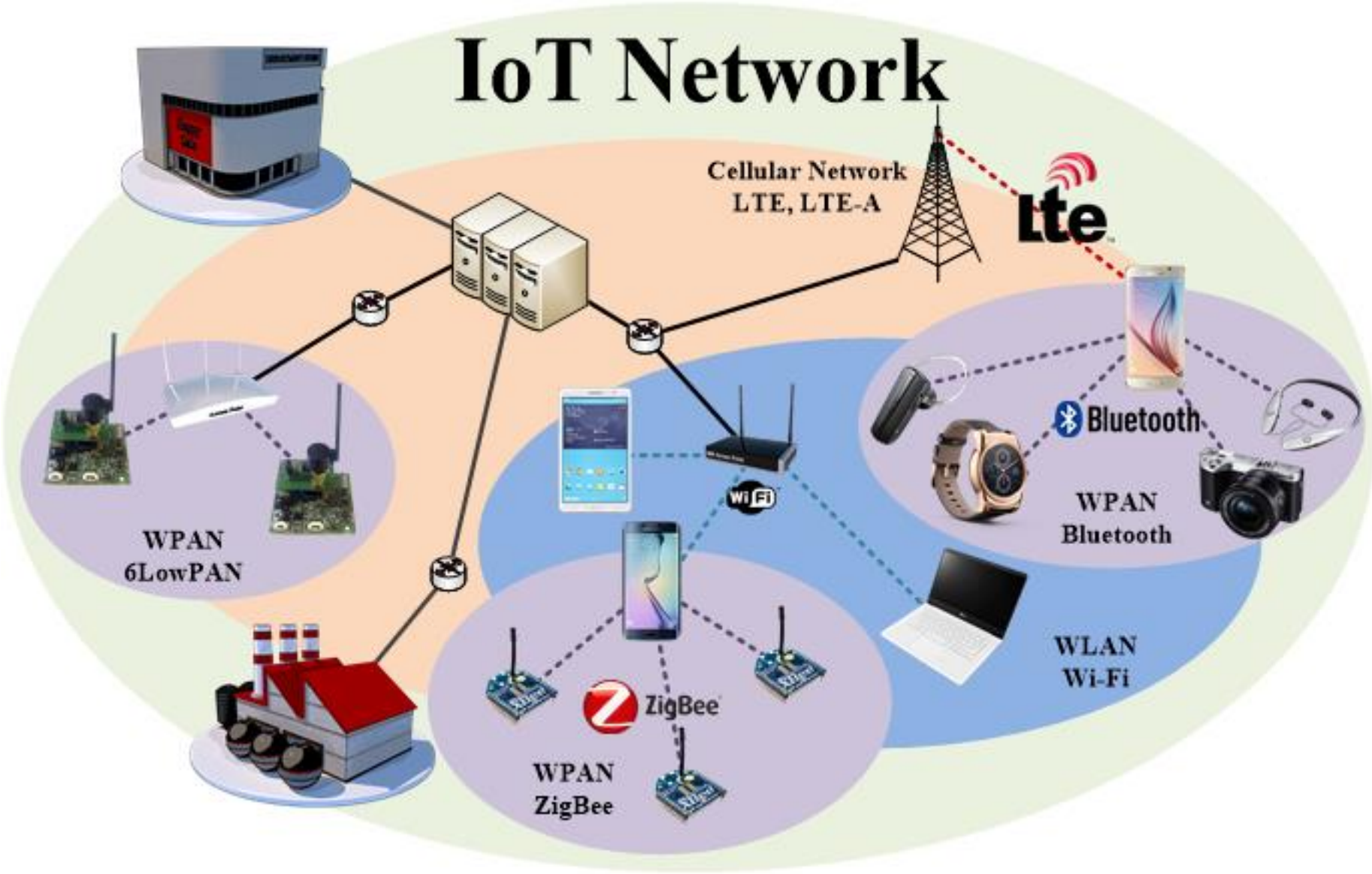
Internet of Things (IoT)

- Every devices & components connected by wire/wireless communication systems

- Keywords:
  - Anything
  - Anyone
  - Any time
  - Any place
  - Any path
  - Any service

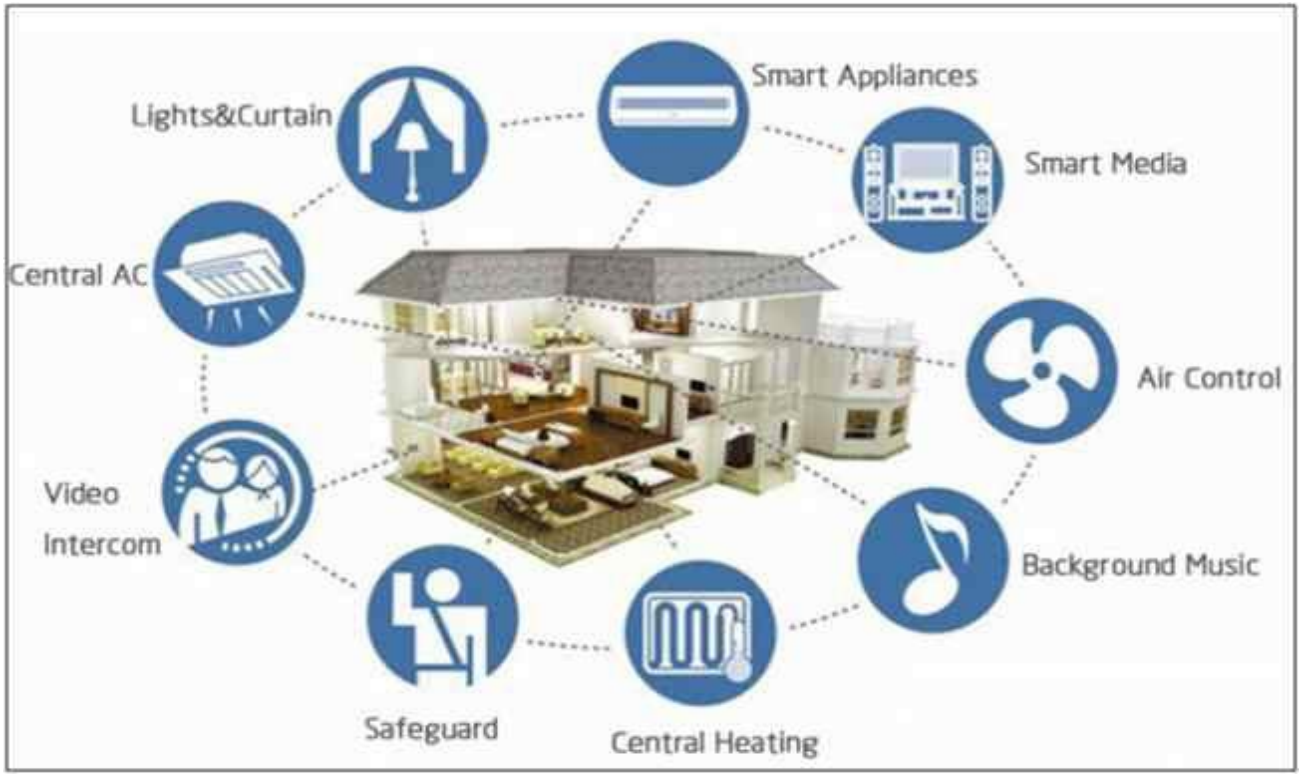


IoT Network


IoT Network
Cellular Network
LTE, LTE-A
Lte
Bluetooth
WPAN
Bluetooth
WPAN
6LowPAN
Wi Fi
WLAN
Wi-Fi
ZigBee
WPAN
ZigBee

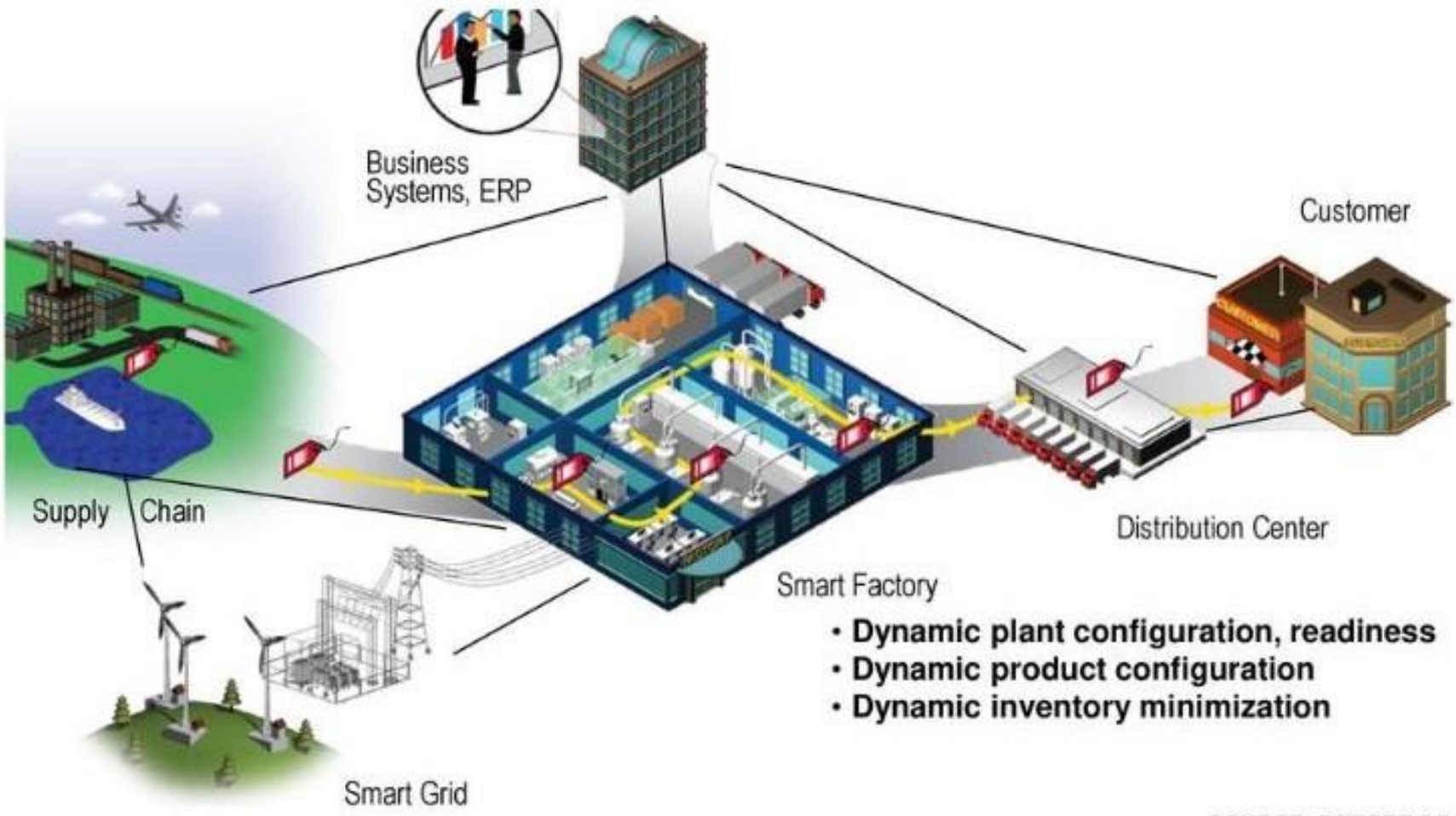
IoT: Smart Home

- Control smart appliances, media, lights, and heating/AC using smart devices such as smartphone and AI speaker
  ➔ Maximize energy efficiency &
  provide convenient living environment
- Security and safety



IoT: Smart Manufacturing

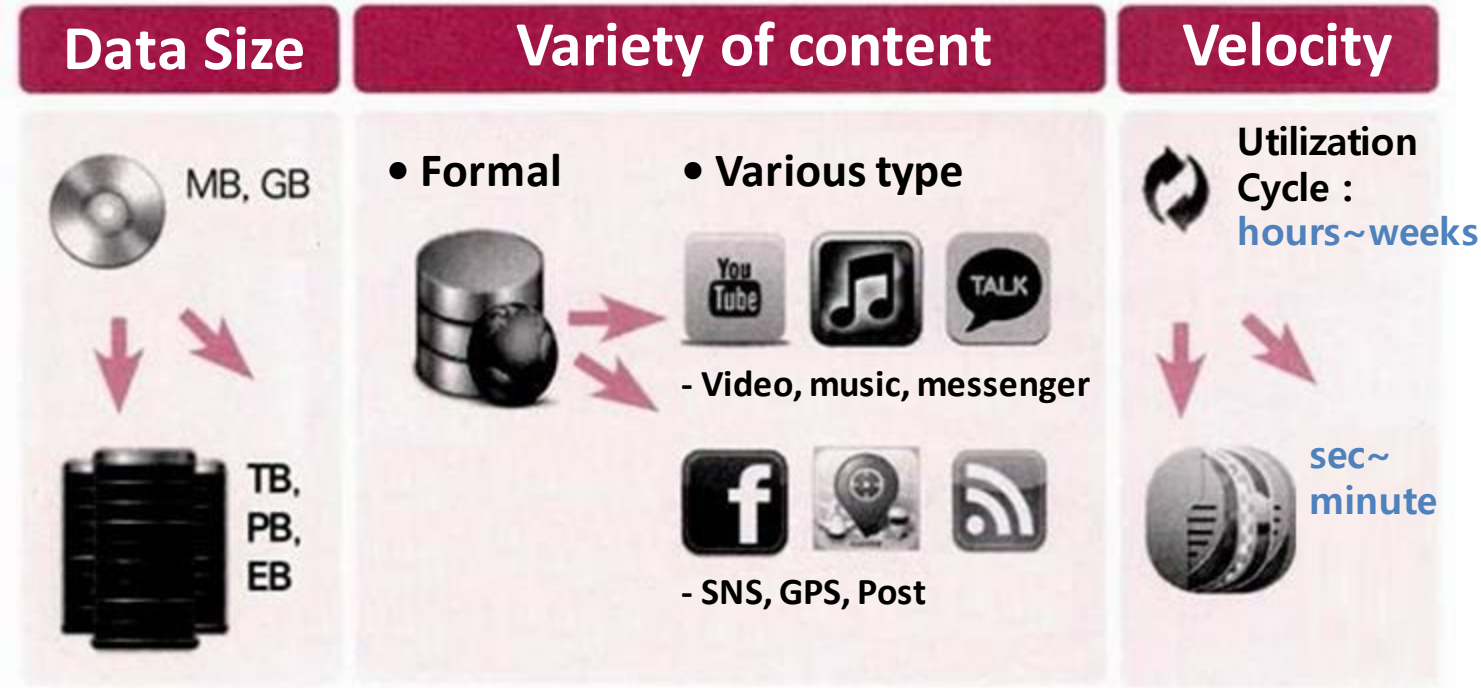
- **Dynamic product/plant/inventory management**



Big Data

* A tool for extracting value from a large amount of data and analyzing the results

- Size : Size of dataset must be large
- Variety : The size and content of the data is different
- Velocity : Real-time processing of data collection, processing, and delivery for incidents



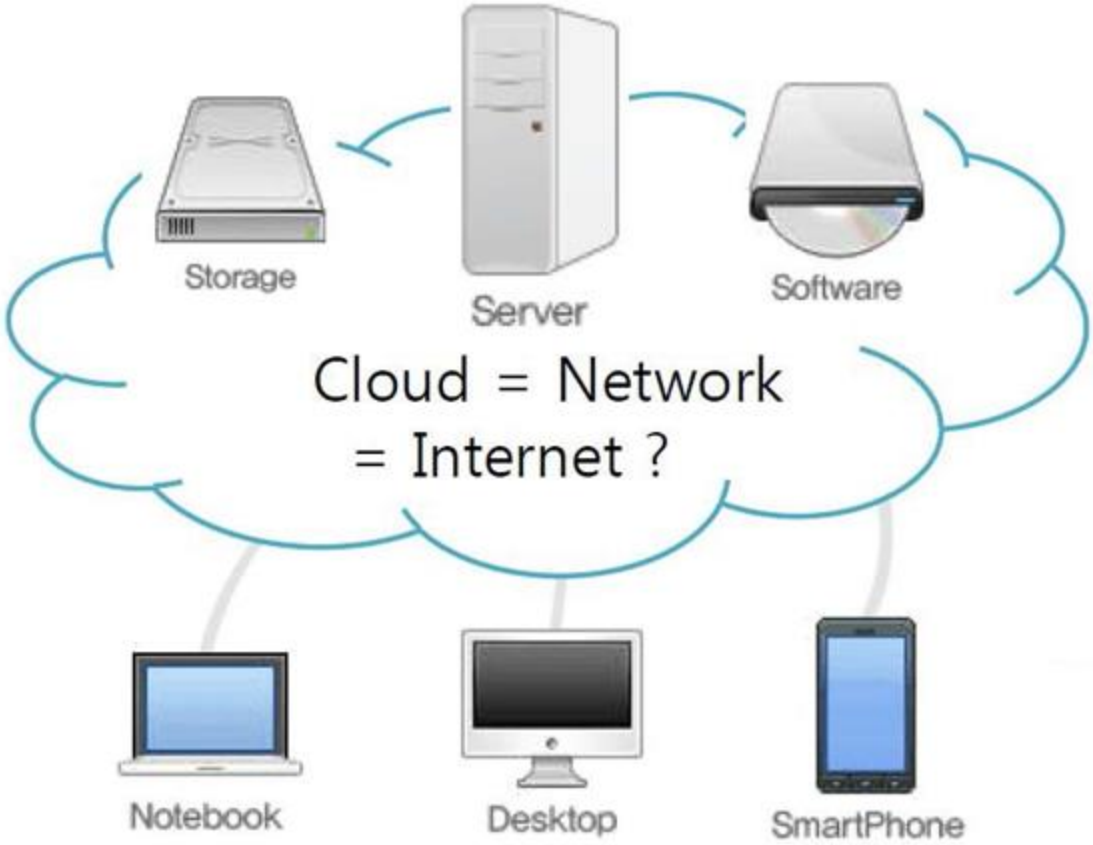
Big Data

- **Human:** **can have a bias in decision making**
- **Big data:** **can overcome bias**
  - Data analysis in decision making is better than intuition
- **Automate Decision Making**
  - The most common applications are bank lending and claims processing decisions

Cloud Computing

Cloud Computing :

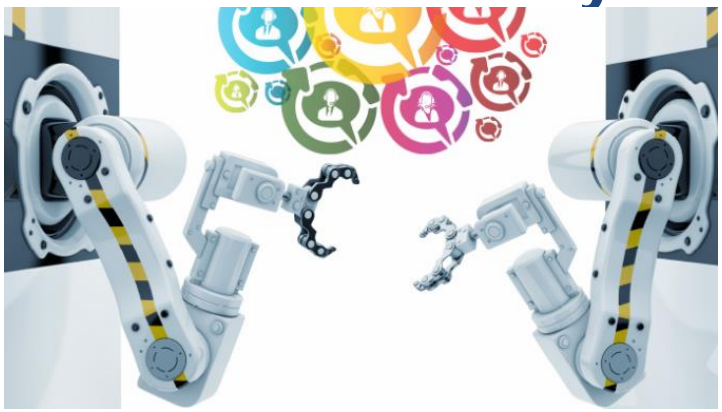
- **IT resources such as computing, storage, software, and networks Services that you borrow and spend on the Internet**



AI (Artificial Intelligence)

- Machines (SW, robots) that think and act like humans
- Machines that learn from data(experience) like humans
- Solve tasks that require intelligence
- Pattern recognition, knowledge acquisition
- Self-improving systems from accumulated data
- Eventually automatic programming

* EXTREME automation, & connectivity



* Cyber-physical systems driven by AI and robots

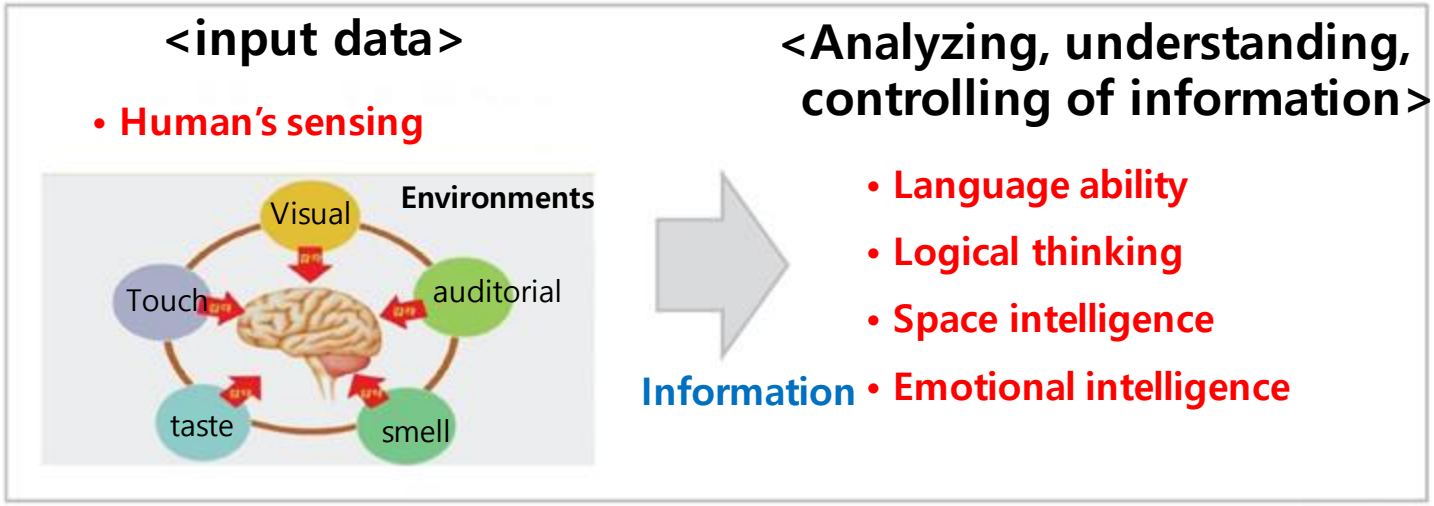
Drivers of Change: Artificial Intelligence

- 2016. March 9~15 : Google Deepmind challenge match
- Alphago(Google Go game AI program) vs Sedol Lee(world Champion)
- Five matches : Alphago won 4 times and Lee won once

Artificial Intelligence (AI)

* **Intelligence :**

- **Ability for analyzing, understanding, and controlling of input data**

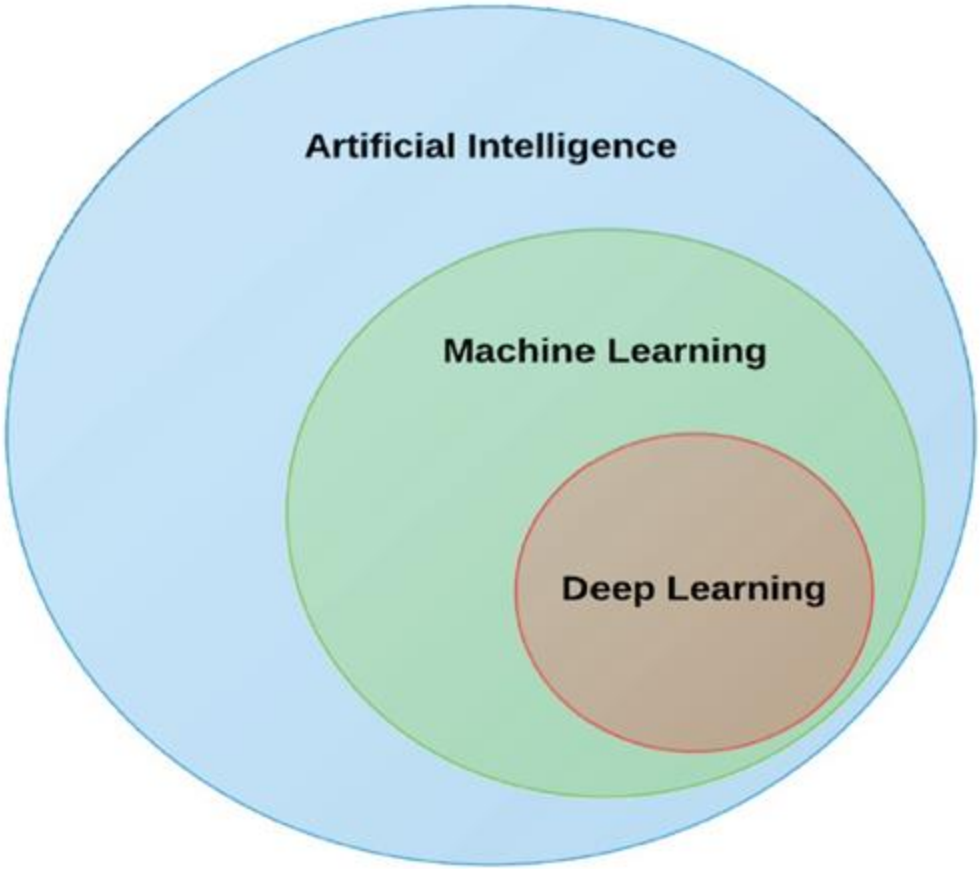


➔ **Mimic human's brain system using neural network (deep learning)**

Artificial Intelligence

* Artificial Intelligence : machine learning

- Intelligence made from machine learning
- Needs deep learning process from a variety of big data



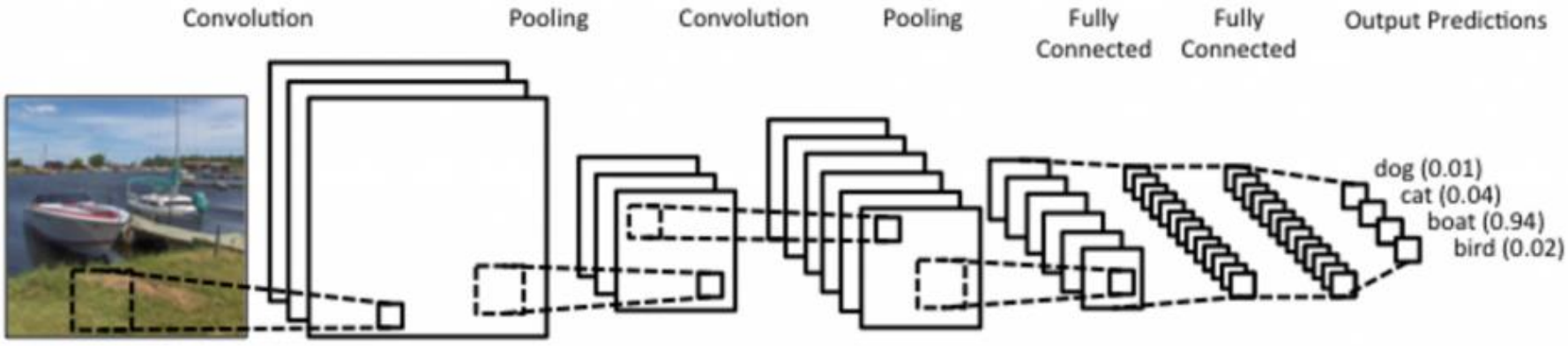
Convolutional Neural Network (CNN):

* Golden standard of Deep learning

- **A class of deep, multi-layer neural network that has successfully been applied to analyze visual image.**

  ➔ identifies semantic objects of certain class(cars, humans,…)

- **Consists of a number of convolutional and subsampling (pooling) layers, followed by fully connected layers.**

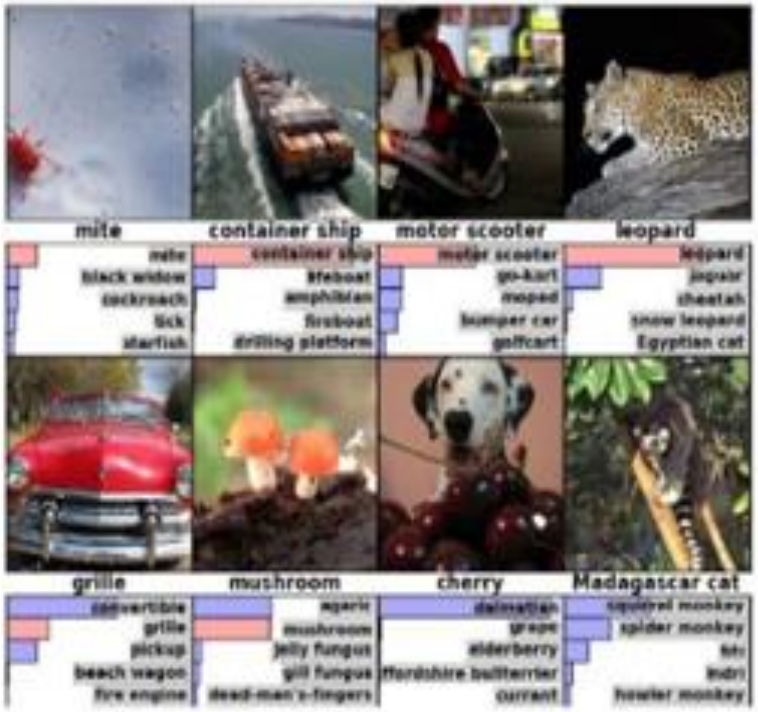


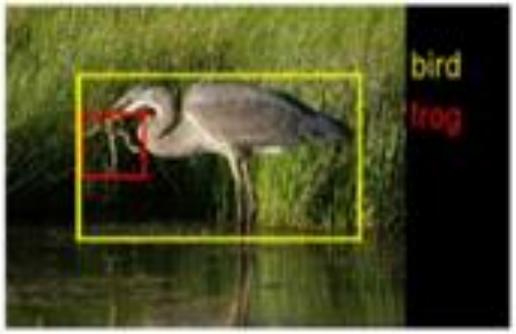
*** Raw pixels ➔ detect edges ➔ simple shapes ➔ high-level features ➔ classifier**

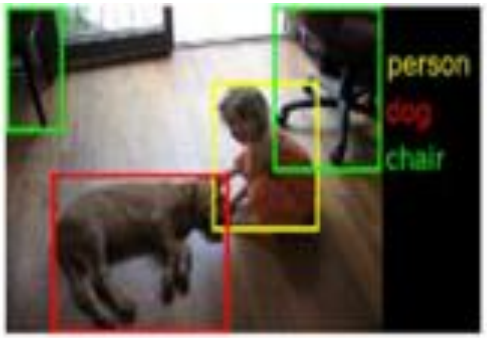
Deep learning: Object recognition

- (At NIPS2012) **Deep learning** in computer vision applications outperforms other methods because of training using a big dataset and high computation capability of multi-core GPUs.

- Advantage: Training using **ImageNet** dataset (1.2M image data)



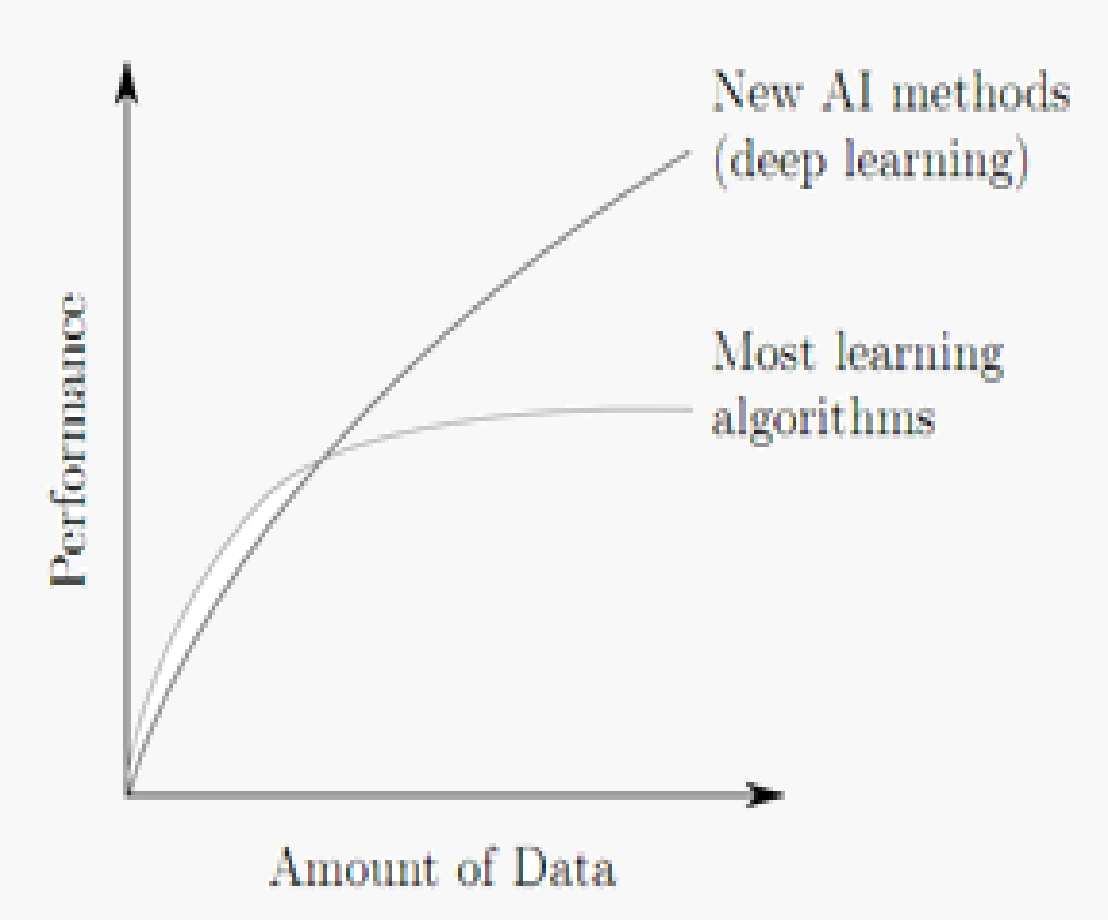




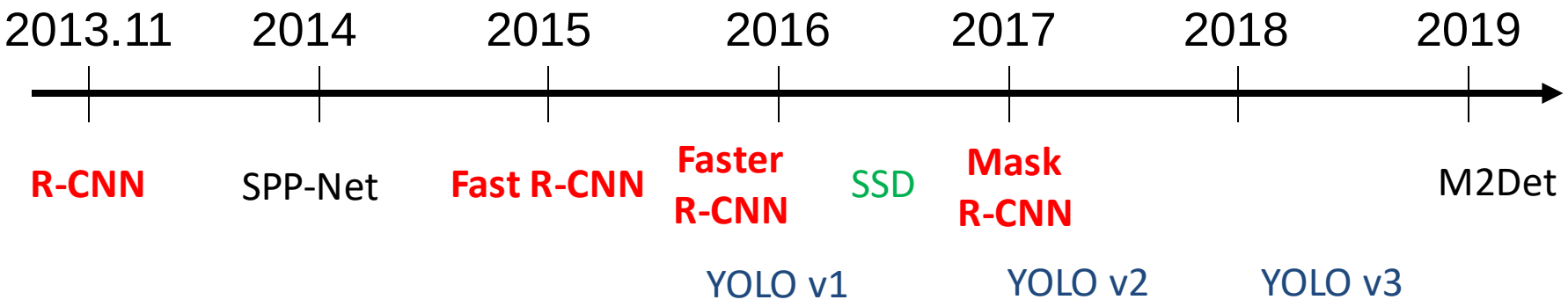
Object recognition by deep learning

- **Detection accuracy by**
  - **Human : 94.90 %**
  - **DL in 2015 : 96.43 %**
  - **DL in 2017 : 97.85 %**

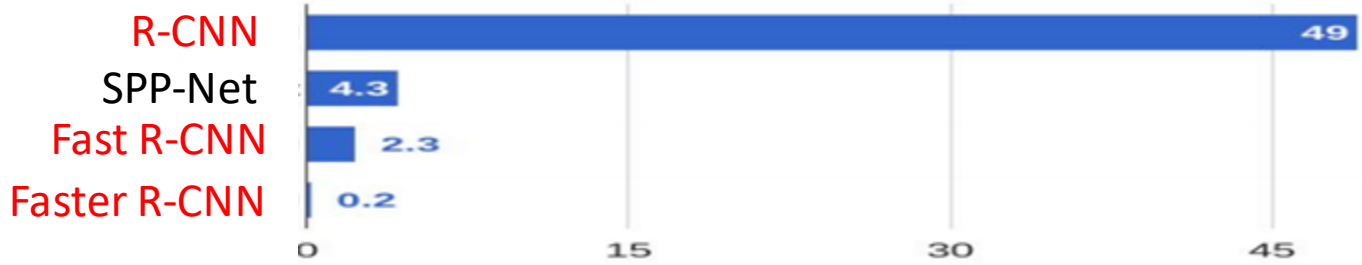
- **In DL method,**
  the more data,
  the better performance.

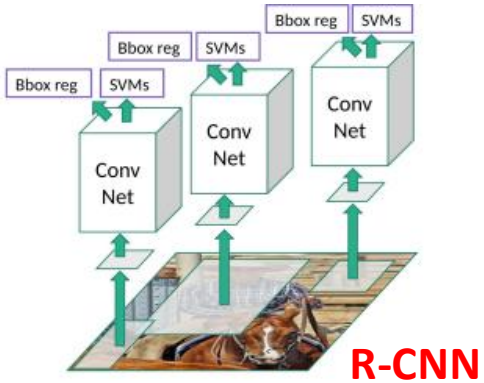


Example: DL-based Object Detection



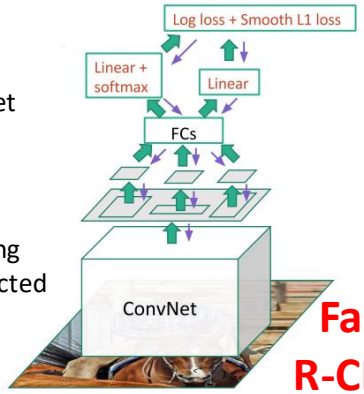
* Progress in test time(sec) for object detection (R-CNN based case)



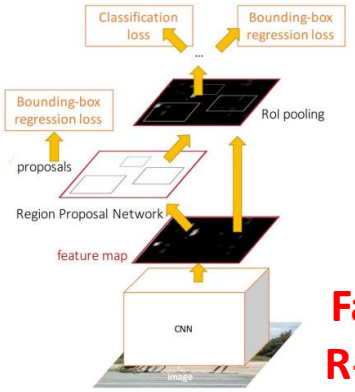


Forward whole image through ConvNet

Insert RoI Pooling and Fully-connected layer



Insert Region Proposal Network (RPN)



Applications of Deep Learning

1. Object detection in image ➔ autonomous cars
2. Image classification/Object segmentation
3. Visual tracking
4. NLP (Natural Language Processing)
5. Machine translation
6. Robotics
7. Art
8. Data analysis and decision-making

   (investment, medical diagnosis, legal issue,…)

Artificial Intelligence (AI)

* Advantages of AI

Automation

➔ **Replace or supplement what people do**

1) Save labor and working time

- Work that follows a defined process

2) 24 hours/365 days working without getting tired

- Factory, Construction, Framing, Driving, ...

3) Always do work without mistakes

- Surveillance/Security, Editing, Medical surgery, etc...

New Service

➔ **Provide a new experience/service**

1) Personal assistant, Personalized service

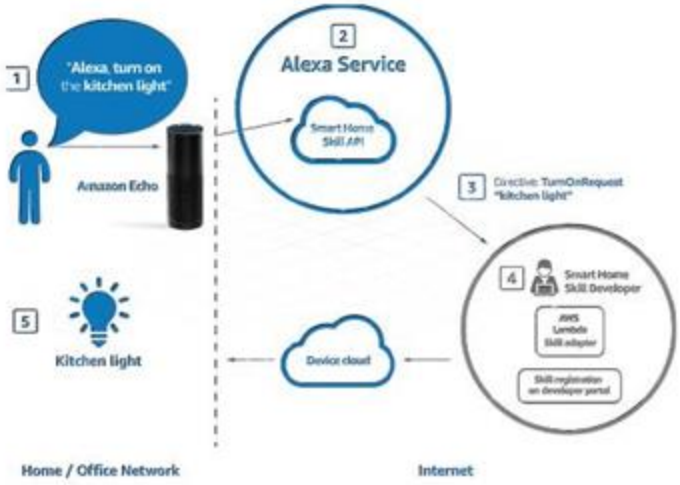
2) Interaction with everythings via IoT

3) Self-learning & Self-creation (music, art, ...)

Artificial Intelligence (AI)

* AI Applications: Smart Home assistant

<Intelligent speaker>



<Home service robots>

Artificial Intelligence (AI)

* AI Applications: Education

<Tablet-based self-study>

<Virtual reality education>

<Robot-based self-study>

<Teacher Robot>

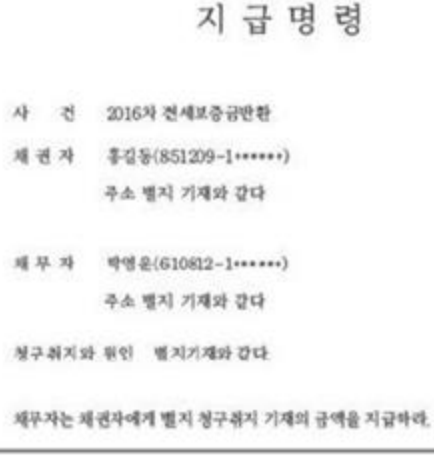
Artificial Intelligence (AI)

* AI Applications: Law

<Legal AI>

<Case Search>

<Writing legal doc.>



<Legal advice>

<Evidence management>

Artificial Intelligence (AI)

* AI Applications: Medical

< Cancer diagnosis>

< Skin cancer diagnosis>

< Heart disease prediction>

< Eye disease examination>

< Patient management>

< Nursing Robot>

< Virtual Nurse>

Artificial Intelligence (AI)

* AI Applications: Creation

<Story telling>

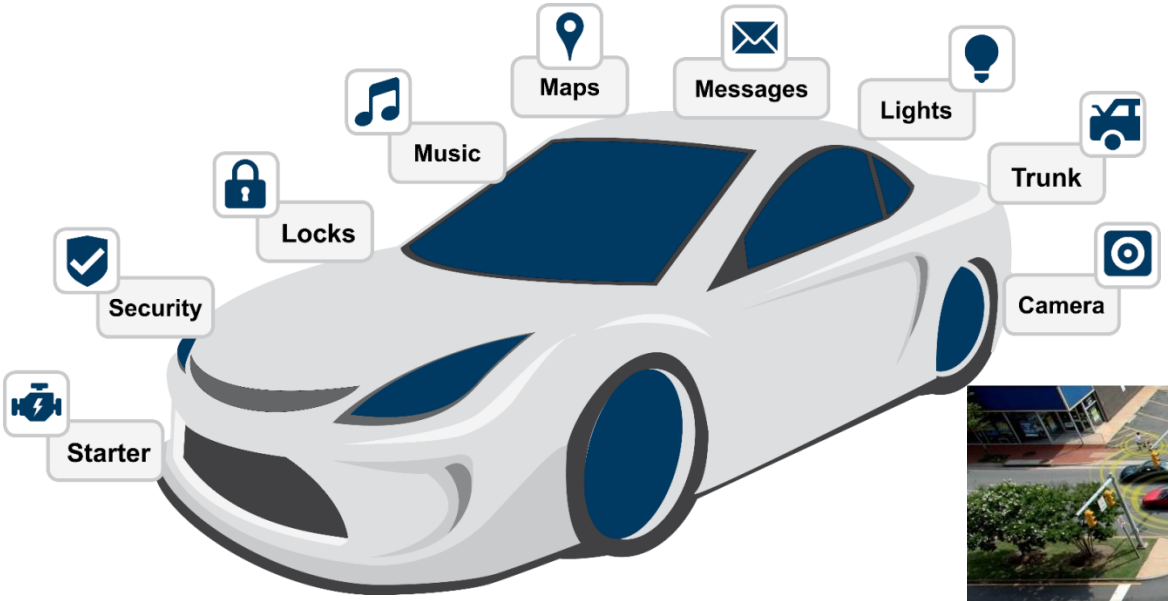
ex) Two sumo players are playing on the dirt floor and the crowd is watching.

<AI and artist collaboration>

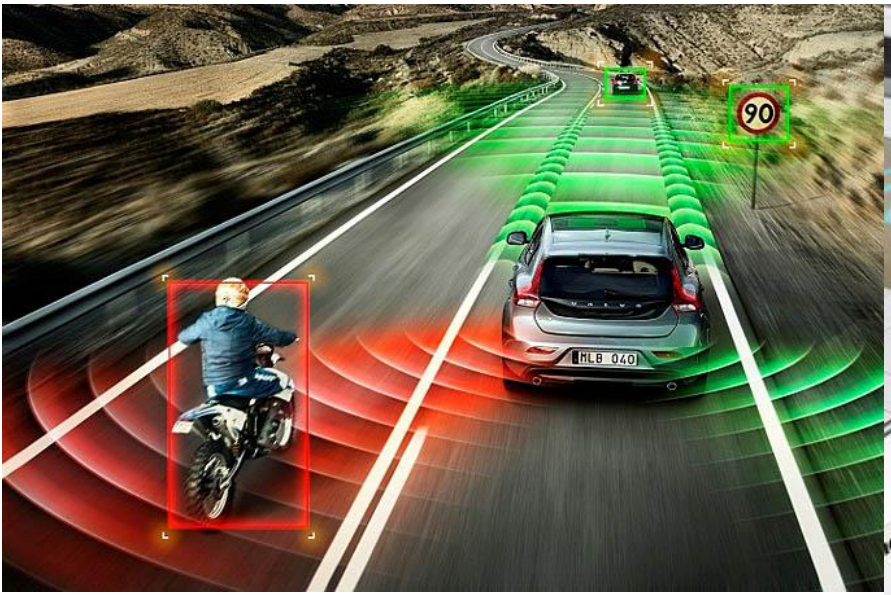
<AI developing AI>

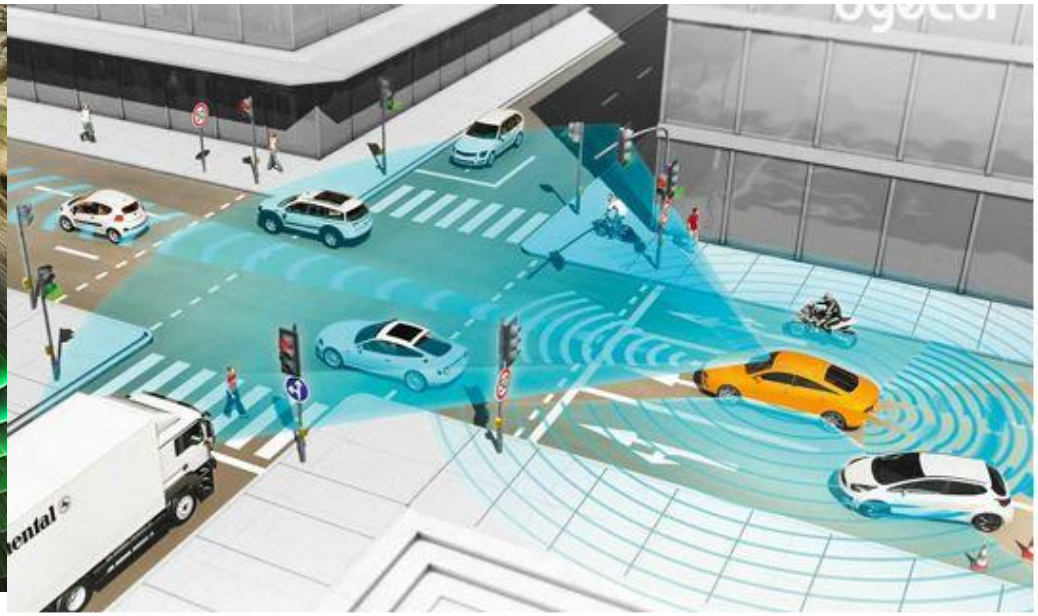
Autonomous Vehicles & Intelligent transportation system

- Intelligent autonomous self-driving
- Safety and security
- Connected with smart city (intelligent transportation system)



Autonomous Vehicles on the road





- Increasing of IT components in AV
  - 35~40% in traditional cars, 75~80% in Electric AV(Tesla, EQ, …)

➔ **Self-driving Cars : IT product!**

➔ IT companies preparing AV: Google, Tesla, Apple, …

➔ Benz, BMW, GM, Ford, Hyundai, Toyoda, Honda,….

Benz F015 AV model

- Test drive in 2013 at real road
- Announce F015 AV model at CES2015
- Commercial AV in 2020~2021

Hyundai AV model (Ionic)

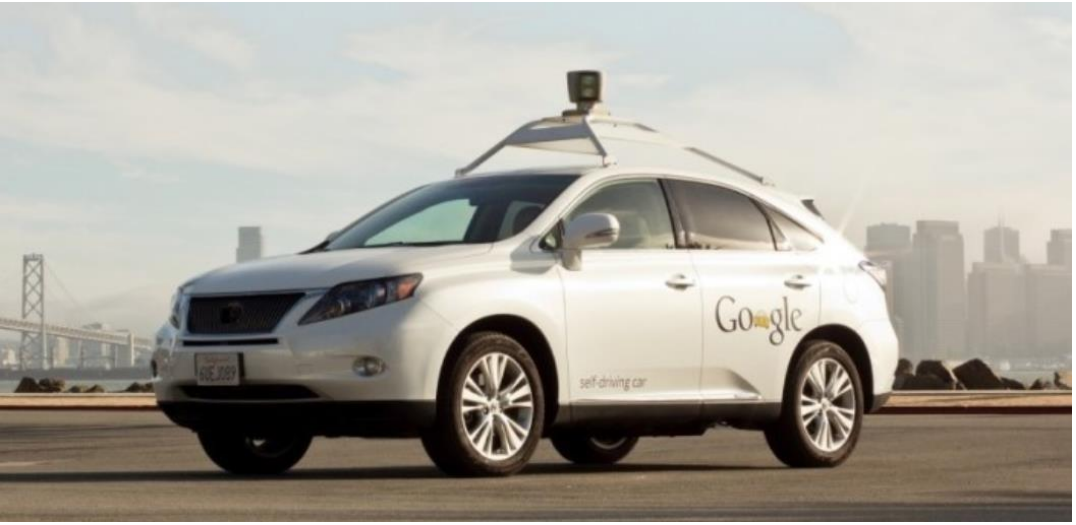
- Test drive at LV (CES2017/CES2018)
- Commercial AV in 2021

- Announced 4B$ joint venture for self-driving cars

  (Sept. 23, 2019)

  ➔ commercial in 2022

Google's first model for AV



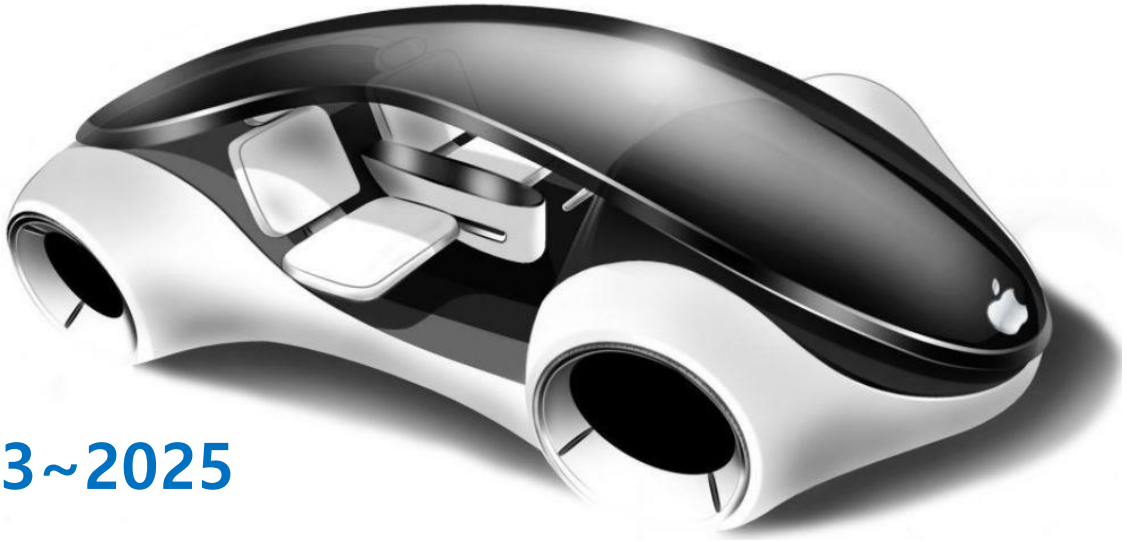
* Starts test driving in 2009
* License from Nevada in 2012
* Driving record of 1.5M miles
  (20 accidents, 1 self-fault)

- Waymo project
- Subsidiary in Dec. 2016
- Permit for driverless cars on Oct. 2018 in CA.
- Commercial self-driving car service in Phoenix,AZ area in Dec. 2018

Apple AV model

- Steve Job's dream: "iCar"
- Project "Titan" in 2014
- Official test in 2017 using "Lexus" car with permit

- AV concept car ➔



- Working for new technologies & be launched in 2023~2025

Flying Car (2019)

1) PAL-V: Liberty
   (160km/h, 3500m)
2) Samsonsky: SwitchBlade
   (300km/h, 4000m)
3) Terafusia: Transition
   (160km/h, 2700m)

* Cost ~ $400,000
* Need 100~200m runway

Some companies :

- vertical take-off/landing car in 2020~2022

Influence of 4th Industrial Revolution Tech.

1. AI technology outperforms human functions in many areas

1) Medical examination : Human doctor (86%) vs AI(~90%)
2) Profit in investment : Human investor(6~7%) vs AI(9~10%)
3) Object detection in auto. vehicles : Human(94.5%) vs AI(96.7%)

2. In 2030, a computer reaches human-level intelligence

3. In 2045, computers will exceed the sum of human intelligence

Impact of AI(1)

1. Various technology convergence based on digital revolution & bio-tech.

- Accelerating new combining technologies such as Intelligent robot, IoTs, auto. vehicle, 3D printing, nanotechnology, biotechnology, etc

2. Increase impact of digital platform

- New forms of affiliation and community are increased
- Shorter working hours and universal basic incomes

3. Change in perception of human identity

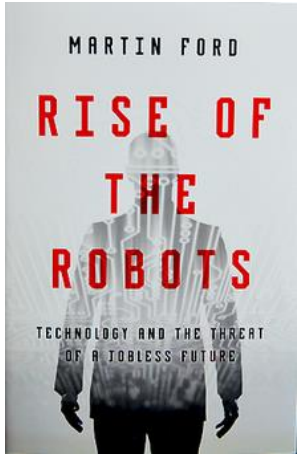
- Privacy Controversy
- Need to redefine moral and ethical boundaries

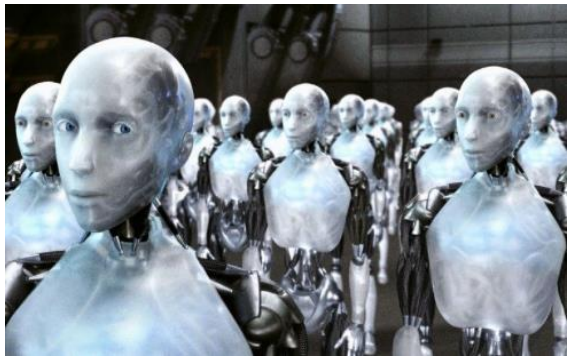
Impact of AI(2) : Negative

Economic, cultural, social,
➔ endless disruption

Labor crisis (Mckinsey)
- 58~60% of jobs automated

Martin Ford:
Rise of the Robots
➔ Accelerates change and threat of jobless future





Elon Musk: AI ➔
existential threat &
calling the demon

Role of IT engineers

1) Main technology of 4th Industrial revolution : AI
   ➔ need to learn about various AI technologies at undergrad. & grad. level

2) Need more intensive R&Ds for deep learning, AI
   ➔ can apply these technologies to every area of our life in a positive way

3) AI-age: expect a lots of problems & crisis
   ➔ important to have good personality, sensitivity, & sound values for making right decision!

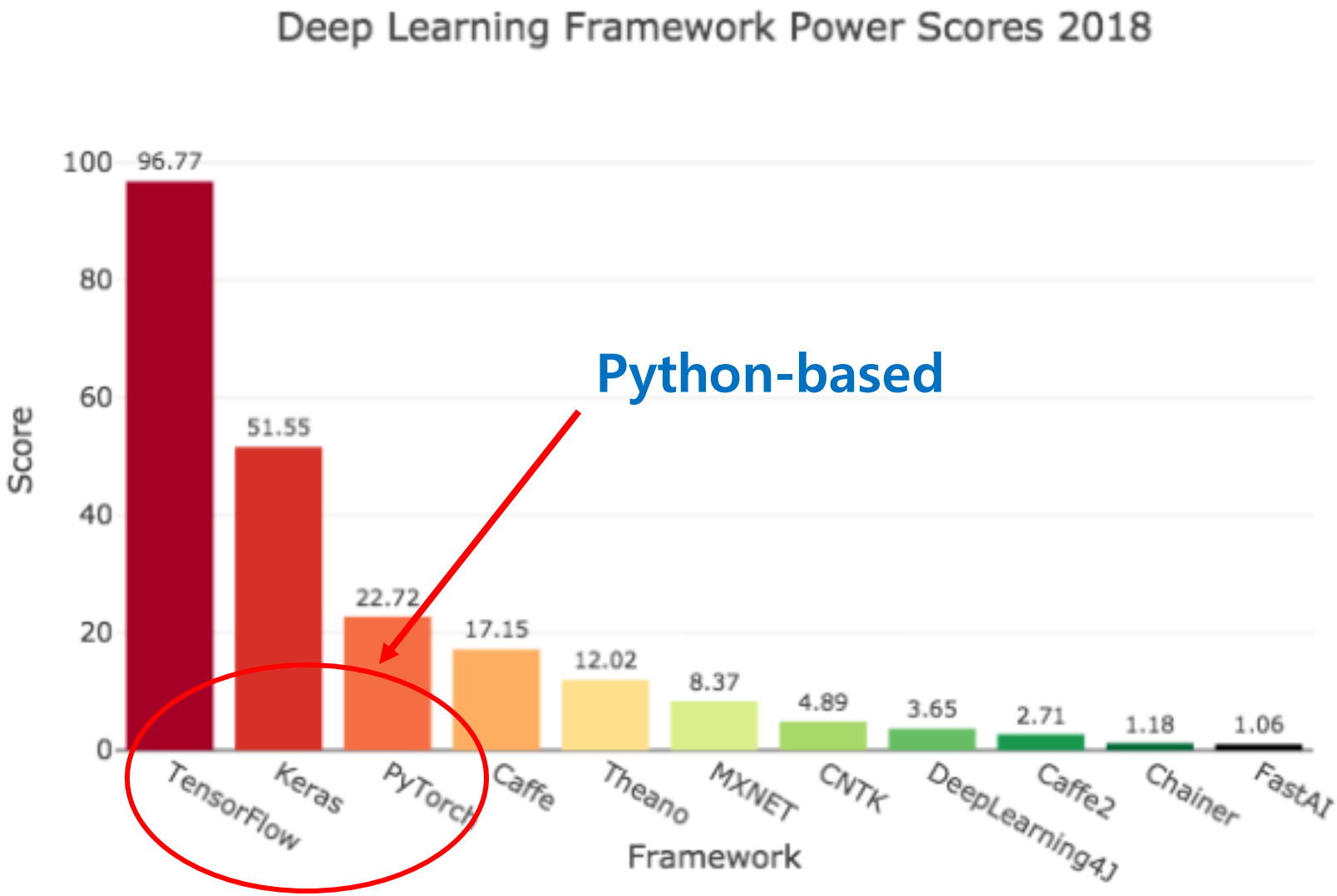
Education for AI at Yonsei U.

1. Undergraduate courses :
   1) Int. to AI (DL) course (Junior/Senior)
      - Python-based
   2) Experimental Lab. for signal processing (Senior)
      - Pytorch (Tensorflow)

2) Graduate courses : 6~8 courses
   - Adv. Deep Learning, Digital Image Processing, Neural Network, Pattern Recognition, Computer Vision, Adv. Signal Processing, ...

3) Ethics & morals as engineer
   - Engineering ethics (grad. course)

DL framework for development



R&D for AI in Korea

1. National R&D funds in AI field

- 100M$/year, 2B$/10 years
- 1~3 professors/researchers, 100K ~ 300K $

2. Support for new AI graduate schools

- 3+2+3 universities
- separate graduate school (at least 7 professors)
- support 2M$ by gov. + matching 2M$ /year

3. Industry R&D funds for AI

- Samsung Science & Technology Foundation (http://www.samsungstf.or.kr)
  (Team: 2~3 professors, 300K~500K $, ~ 5 years)
  (Open to the world) (1st: 2 pages, 2nd: 20 pages)
- Hyundai, LG, SK,...

Terima Kasih!