CS470: Introduction

Instructor: Seunghoon Hong

Agenda

- Course logistics
- Introduction to AI
- Course preview

Teaching staffs

Instructor:

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Course logistics

- Course materials
    - Course website: KLMS
        - Slides, announcements, assignments, project.
    - Optional textbook: [Goodfellow et al., Deep learning, MIT Press, 2016](#)

Course logistics

- Prerequisites
  - Proficiency in python programming and linear algebra

Course logistics

- Grading policy
  - Attendance (5%)
  - Quiz (10%)
  - Midterm (25%)
  - Programming assignments (30%)
  - Final project (30%)

Assignments

- Programming platform:
    - Google Colab + Pytorch
    - Other libraries such as Tensorflow are also allowed, but not recommended since most course materials will be prepared based on Pytorch

- Late submission
    - Submission deadline: **midnight** at every due date
    - Late submissions are allowed until the **three days** after the on-time deadline with **20% penalty**.
    - You have total two days of grace period.

Final project

Form a team up to 4 people.

Define and solve your own problem

Final project

Define and solve your own problem.

- Solve the **novel task** by applying the existing models
  (e.g. developing a web-service, interactive demo, mobile application, game,
     benchmark, etc.)
- You can use the existing implementations or even the pre-trained models,
  but your **task** (and hopefully evaluation) should be novel and well-defined.
- Detailed grading criteria will be announced shortly, but we encourage the followings:
  - Your task is novel and/or useful and/or fun (yes, it is subjective but will be very generous 😉).
  - The evaluation (or analysis) on your task is comprehensive and convincing.
  - Your approach has technical contributions
    (e.g. non-trivial modifications to the existing model, your own implementation, etc.)

Final project

Deliverables

- **Code**: a link to the Github repository
- **Project report**: 4-page report (in english)

Schedule

- Team setup: 9/11
- Project proposal: 10/16
- Project presentation: 11/30 - 12/9 (4 classes)
- Code and report submission deadline: 12/13

Academic Integrity

- All individual assignment should be completed entirely on your own.
  Discussions between classmates are allowed and encouraged,
  but sharing or seeing other students' solutions is not allowed.

- For team project, you should specify the contributions of each person.
  Contributions should be clear and specific.
  Example: X implemented these functions, Y conducted evaluation on dataset A and B,
          Z performed hyper-parameter tuning on C, D, E, etc.

- Failure to adhere to these policies may lead to serious penalties (e.g. course failure)

Office hour

- Main communication channel: **KLMS Q&A board**
- **TAs**: Wed 6:30 pm - 9:30 pm (via google meet. Link will be shared later)
- **Professor**: by appointment

Introduction to AI

AI in the wild

- Self-driving cars

Waymo Can Finally Bring Truly Driverless Cars to California

The company born as Google's self-driving car project is the first with the right to test human-free cars on public roads in the Golden State.

AI in the wild

- Superhuman performance in games

Not yet but getting closer on ...

IBM Watson (2011, Jeopardy!)

Deepmind AlphaGo (2016, Go)

OpenAI Five (2018, League of Legends)

Deepmind AlphaStar (2018, StarCraft 2)
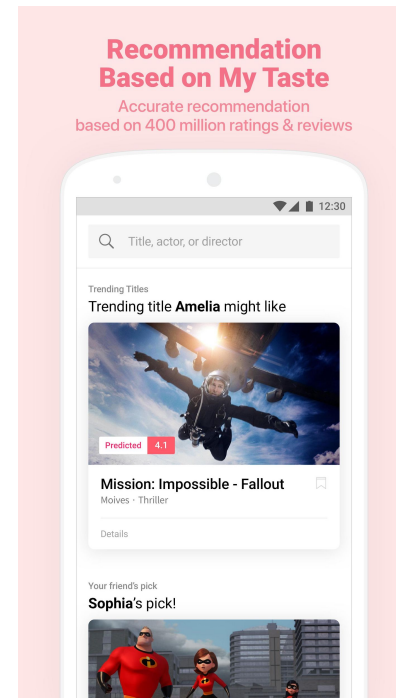
AI in the wild
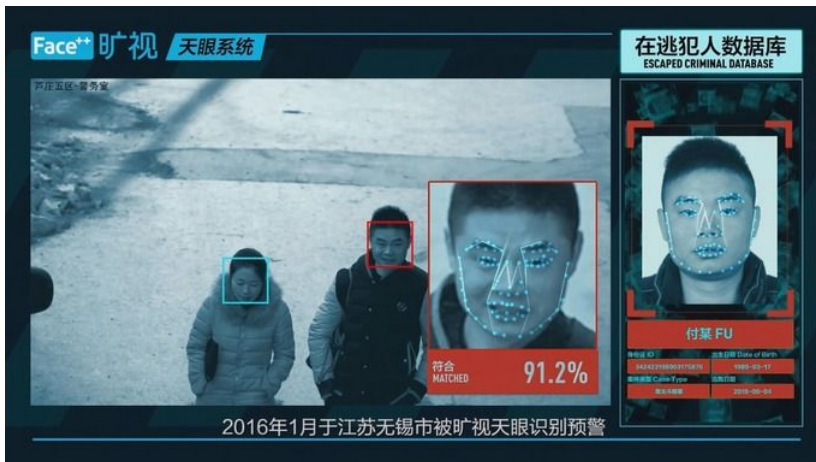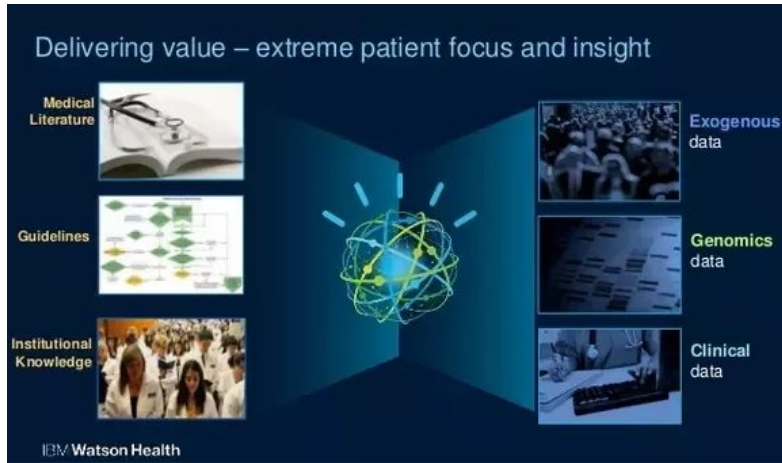
- Recommendations
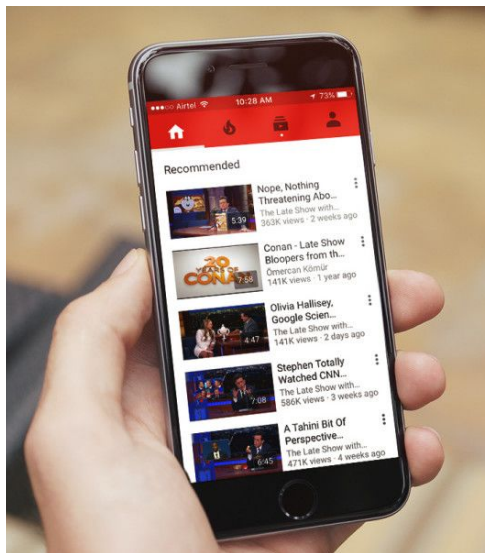
YouTube
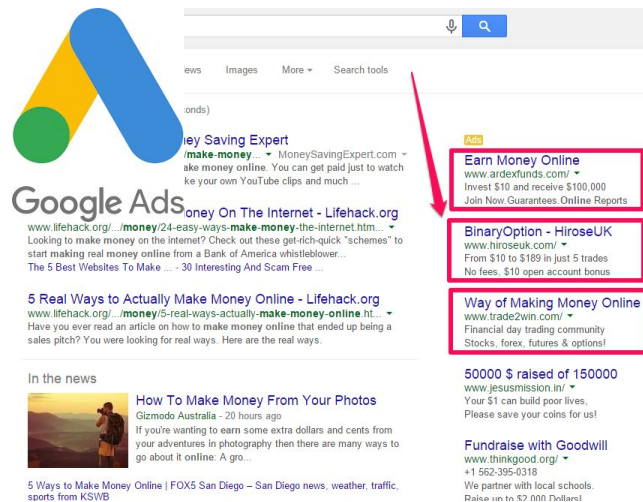
Google Ad

Watcha

AI in the wild

● Security

AI in the wild
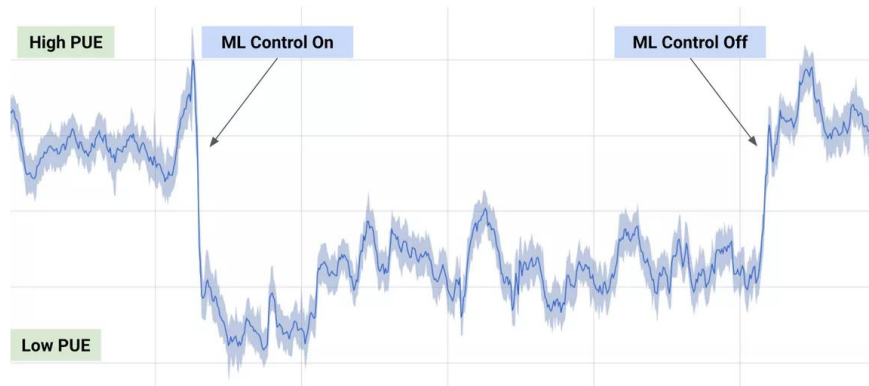
- Healthcare

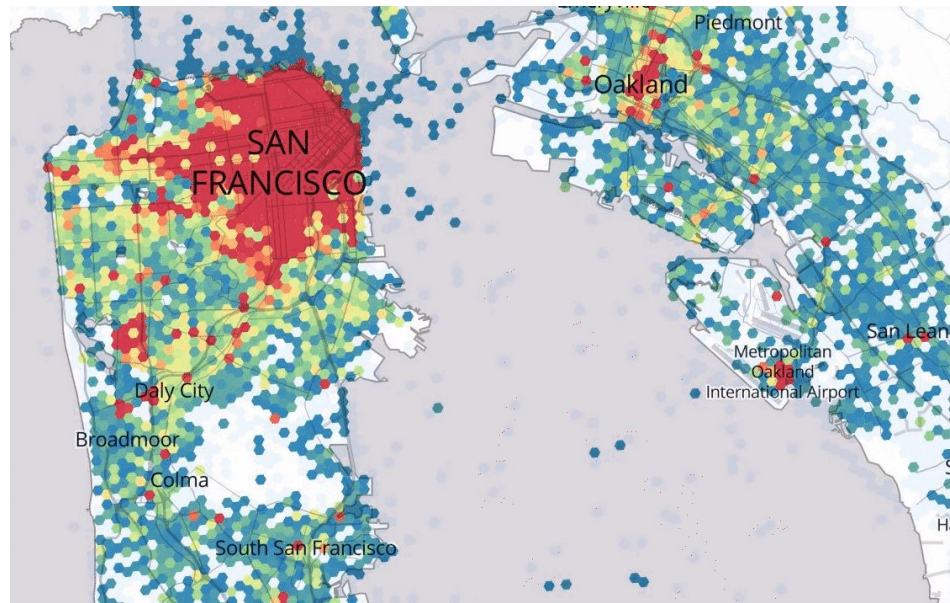IBM Watson Health

Breast cancer diagnosis
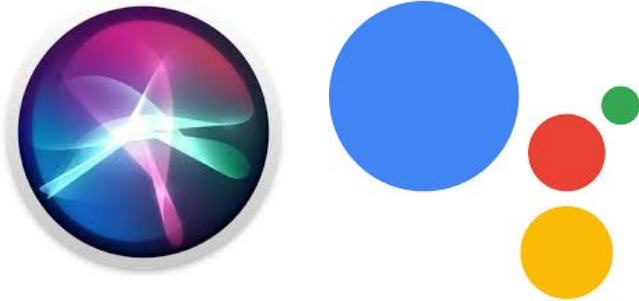
AI in the wild

- Economy

Reducing the energy usage of Google data centers (Deepmind)

Predicting supply/demand in Uber

AI in the wild

- Daily assistance

Virtual assistant
(Apple siri, Google assistance)

Spell checker (grammarly)

There are speculations/hypes on AI

The Atlantic — SUBSCRIBE SEARCH MENU☰

BUSINESS

THE SECOND MACHINE AGE
WORK, PROGRESS AND PROSPERITY IN A TIME OF BRILLIANT TECHNOLOGIES
ERIK BRYNJOLFSSON
ANDREW McAFEE

Technology

Stephen Hawking warns artificial intelligence could end mankind

By Rory Cellan-Jones
Technology correspondent

🕐 2 December 2014 | Technology | 🏳

Stephen Hawking: "Humans, who are limited by slow biological evolution, couldn't compete and would be superseded"

Elon M...
It
"It's definitely...

BY TESS T...

IMAGE: Getty Images

Elon Musk has emerged as a leading voice in speaking out on the potential dangers of artificial intelligence, going so far as to call it the "biggest existential threat" to

Take a Video Tour of Facebook's Frank Gehry-Designed New York City Office

HIT THE ROAD

The advances we'...
humanoid robots, speech recognition and sy...
Jeopardy!-champion computers—are not the...

The objective of this course

- Provide an overview of recent interesting progresses in AI
- Introduce some principles/techniques that has enabled these advances
- Help you understand frontiers/limitations in the current technology
- Hopefully encourage you to find/solve your own problems

So, what is Artificial Intelligence?

What is an intelligence?

- An ability to perceive, reason, act, and learn.

What is an intelligence?

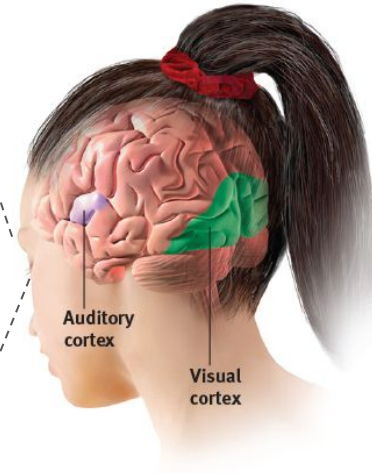- An ability to perceive, reason, act, and learn.

What is an intelligence?

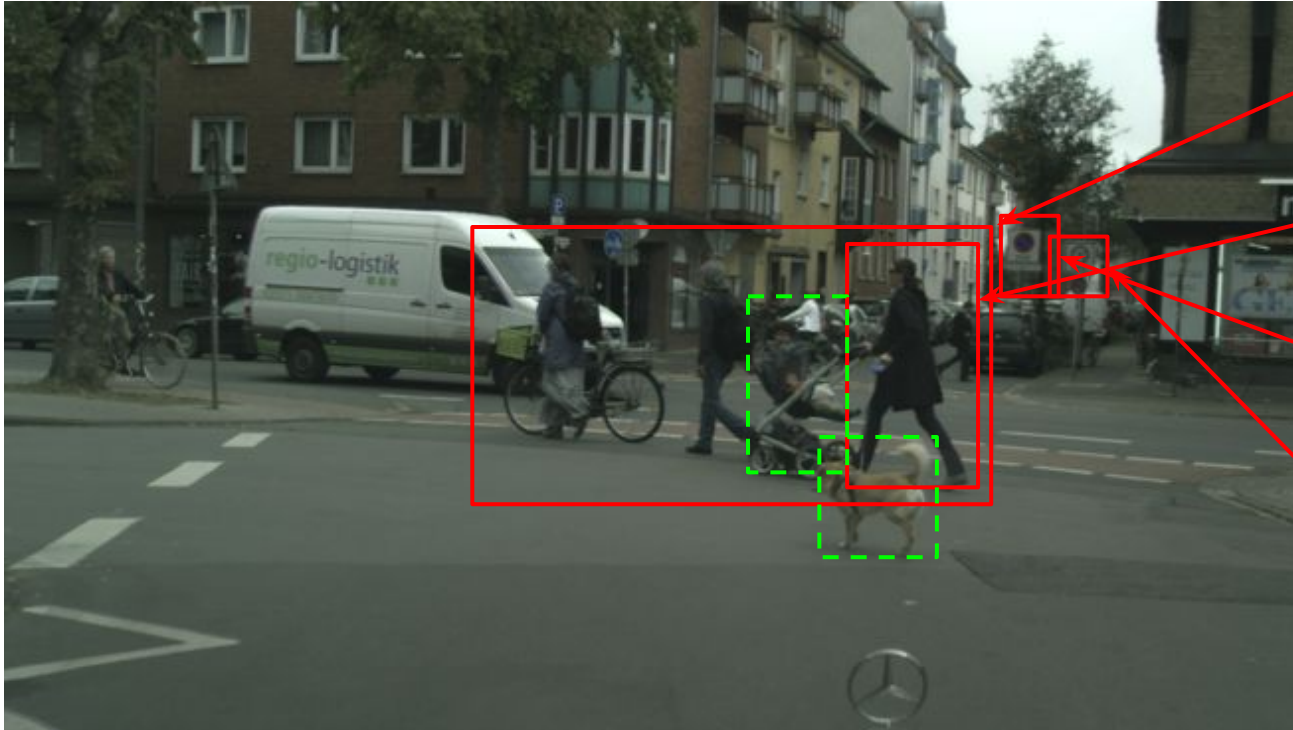- An ability to **perceive**, reason, act, and learn.

Observe the scene through your visual cortex

What is an intelligence?

- An ability to perceive, **reason**, act, and learn.

There are people crossing the road

This woman may walk slowly due to her companions

Maybe we should not enter this area

speed limit is 30mph

What is an intelligence?

- An ability to perceive, reason, **act**, and learn.

Let's make a left turn!

What is an intelligence?

- An ability to perceive, reason, act, and **learn**.

Ok. It was a wrong direction. I should have turned right.

The goal of AI

- Modeling the *components of intelligence* using computable functions

The goal of AI

- Modeling the *components of intelligence* using computable functions

Perception

convert the observation into a machine-understandable form

$$x$$

The goal of AI

- Modeling the *components of intelligence* using computable functions

Perception

convert the observation into a
machine-understandable form

x

Action

define decisions
to achieve the task

$$\begin{bmatrix} \text{Turn right} \\ \text{Turn left} \\ \text{Go forward} \\ \text{Go backward} \\ \text{Stop} \end{bmatrix}$$

y

The goal of AI

- Modeling the *components of intelligence* using computable functions

Perception

convert the observation into a
machine-understandable form

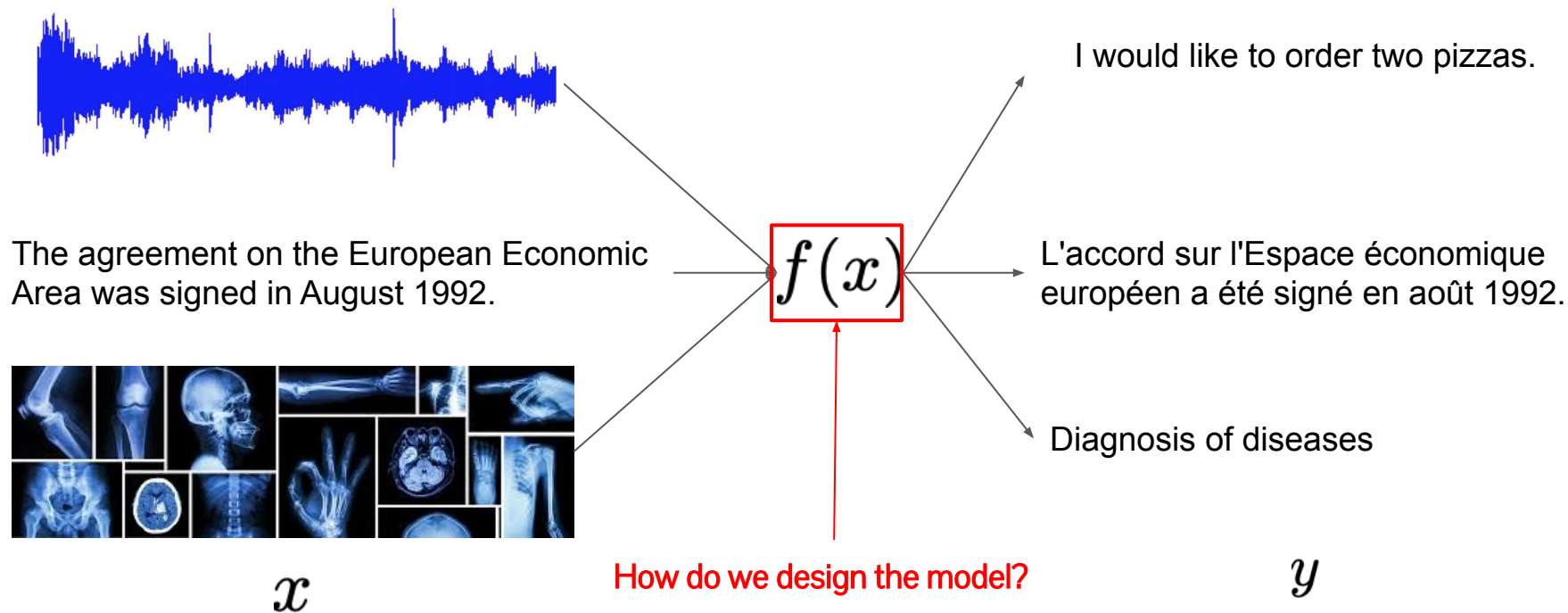**Reason**

design a mapping
between data and output

Action

define decisions
to achieve the task

$$f(x)$$

$$\begin{bmatrix} \text{Turn right} \\ \text{Turn left} \\ \text{Go forward} \\ \text{Go backward} \\ \text{Stop} \end{bmatrix}$$

$$x$$

$$y$$

The goal of AI

- Modeling the *components of intelligence* using computable functions

I would like to order two pizzas.

The agreement on the European Economic Area was signed in August 1992.

$f(x)$

L'accord sur l'Espace économique européen a été signé en août 1992.

Diagnosis of diseases

x

How do we design the model?

y

AI and ML

ARTIFICIAL INTELLIGENCE

Any technique that enables computers to mimic human behavior

AI and ML

ARTIFICIAL INTELLIGENCE

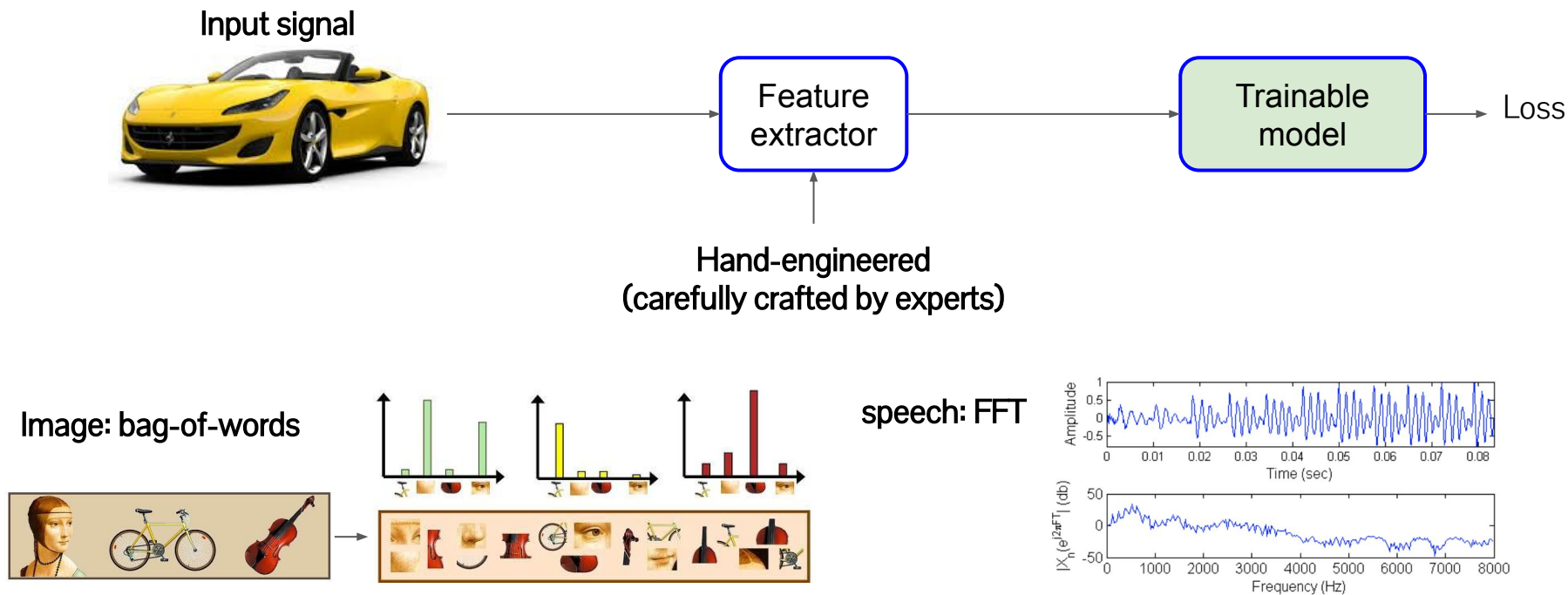Any technique that enables computers to mimic human behavior

MACHINE LEARNING
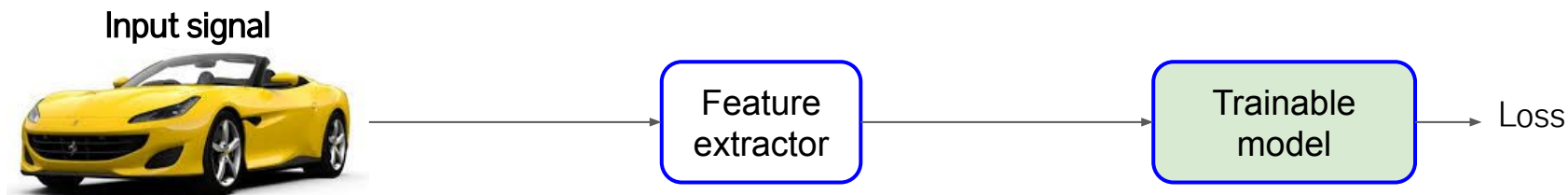
Ability to learn without explicitly being programmed
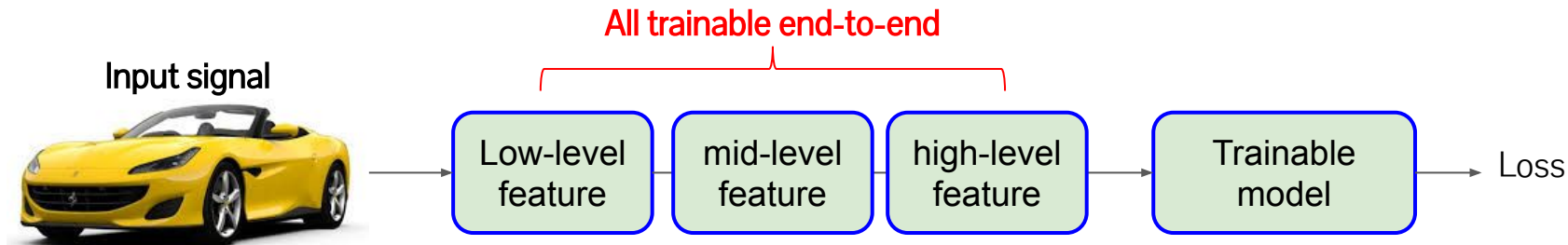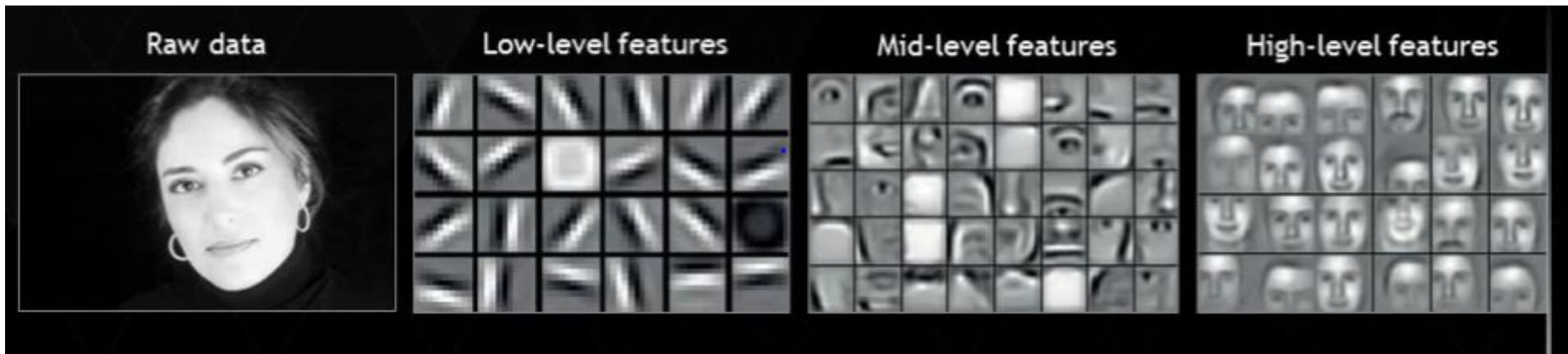
ML workflow

- Traditional pattern recognition

Input signal

Feature extractor → Trainable model → Loss

Hand-engineered
(carefully crafted by experts)

Image: bag-of-words

speech: FFT

ML workflow

- Traditional pattern recognition

Input signal

```
┌──────────┐        ┌──────────┐
│ Feature  │        │ Trainable│
│extractor │───────▶│  model   │───────▶ Loss
└──────────┘        └──────────┘
```

- Deep learning

All trainable end-to-end

Input signal

```
┌──────────┐  ┌──────────┐  ┌──────────┐     ┌──────────┐
│Low-level │  │mid-level │  │high-level│     │ Trainable│
│ feature  │  │ feature  │  │ feature  │────▶│  model   │───▶ Loss
└──────────┘  └──────────┘  └──────────┘     └──────────┘
```

Preview: deep learning representations

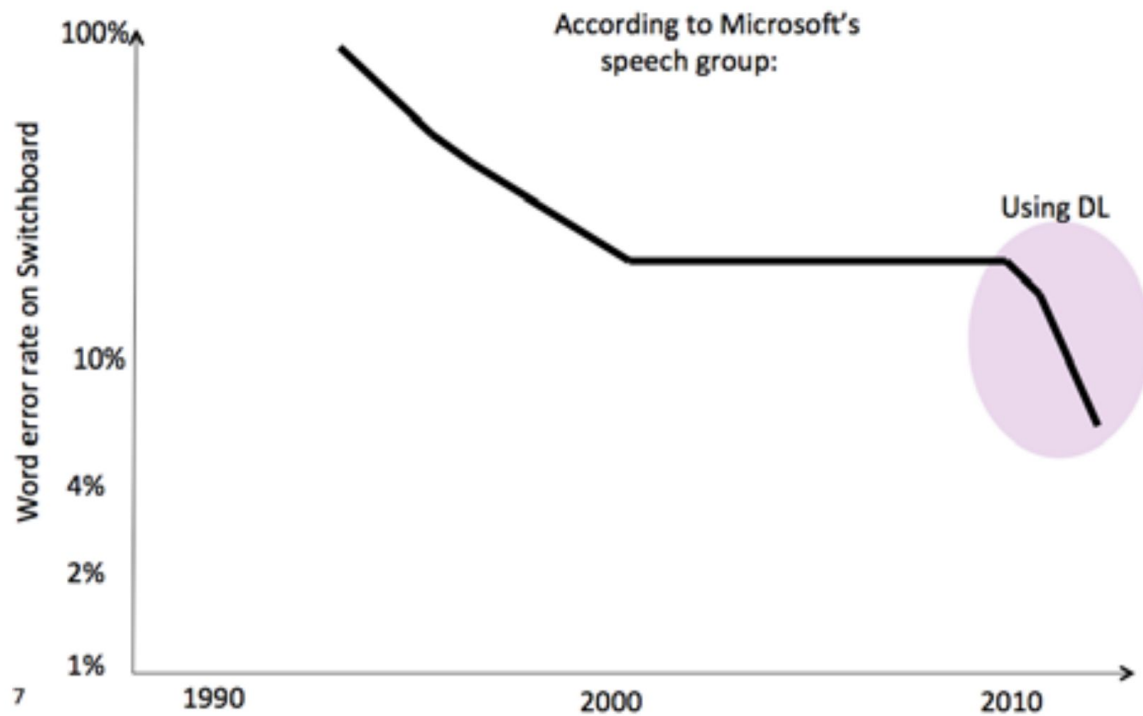| Raw data | Low-level features | Mid-level features | High-level features |

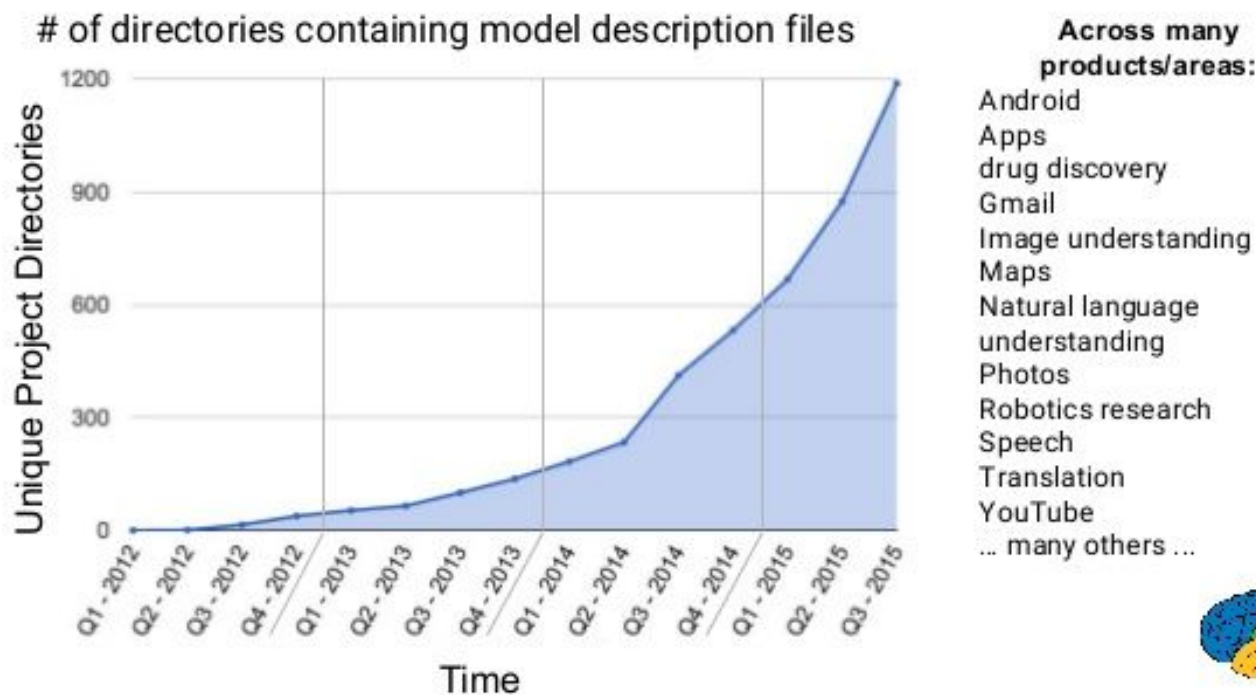# DL revolutionized ML

Top 5 classification error on ImageNet
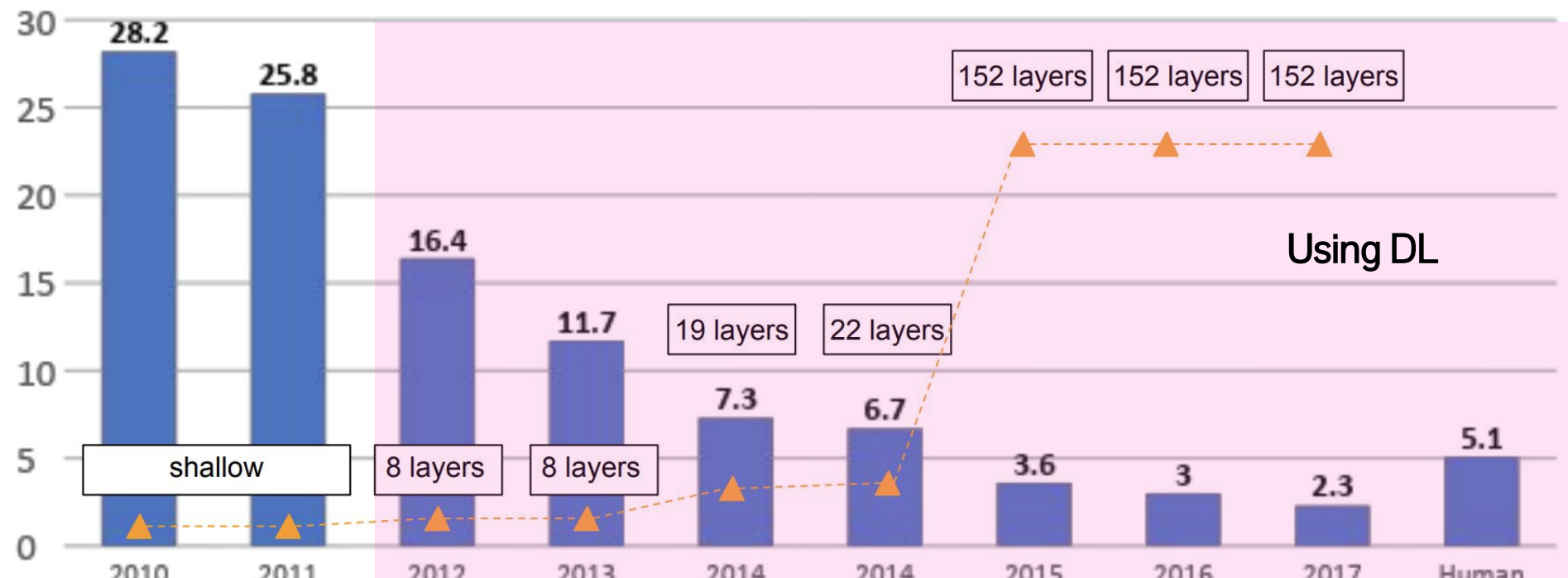
DL revolutionized ML

- Speech recognition over time

DL revolutionized ML

Growing Use of Deep Learning at Google

of directories containing model description files

Across many products/areas:
Android
Apps
drug discovery
Gmail
Image understanding
Maps
Natural language understanding
Photos
Robotics research
Speech
Translation
YouTube
… many others …

Course overview

Convolutional
Neural Networks (CNN)

Recurrent
Neural Networks (RNN)

Deep generative models

Reinforcement
Learning (RL)

Course overview

- Image classification
- Object detection
- Semantic segmentation
- Pose estimation
- Visualization
- Style transfer
- Adversarial attacks

- Text classification
- Sentiment analysis
- Machine translation
- Sketch synthesis
- Image captioning
- Visual question answering

- Image generation
- Text generation
- Text-to-image synthesis
- Img-to-img translation
- Unpaired img-to-img translation
- Interactive drawing

- Search algorithms
- Markov decision processes
- Reinforcement learning

Convolutional
Neural Networks (CNN)

Recurrent
Neural Networks (RNN)

Deep generative models

Reinforcement
Learning (RL)

Preview of the selected applications

Visual understanding

- Image classification

Person,
Elephant,
Sky,
Field,
…

Visual understanding

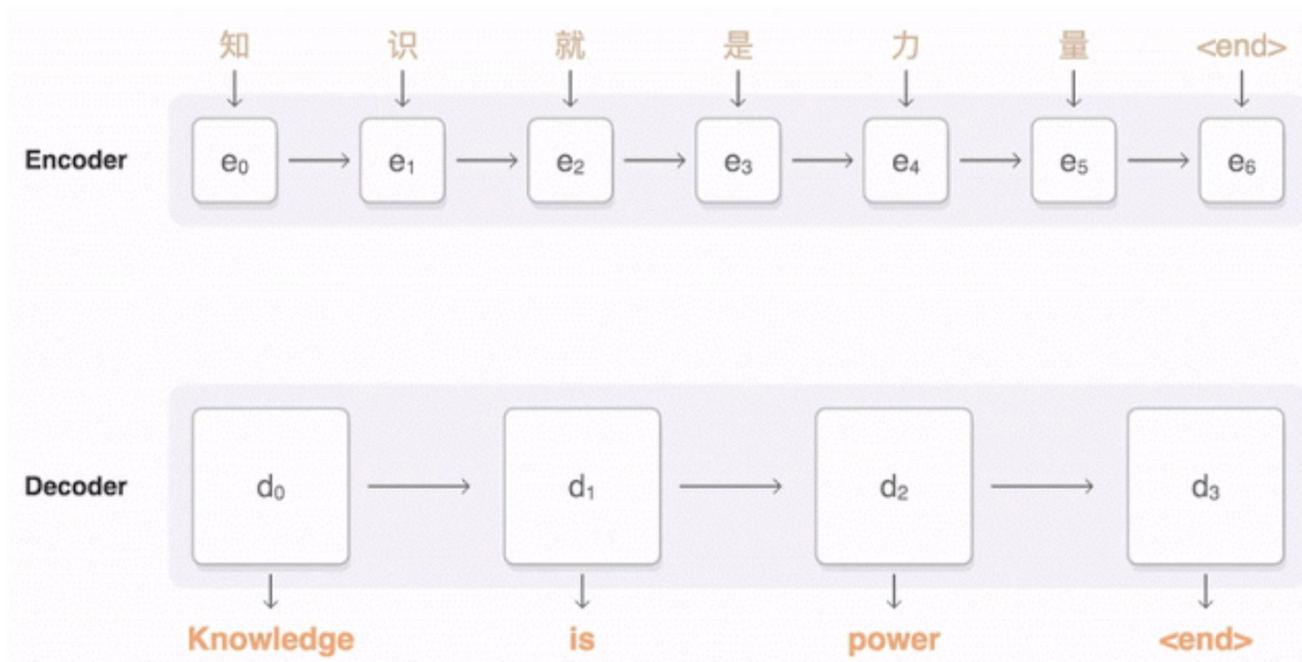- Object detection
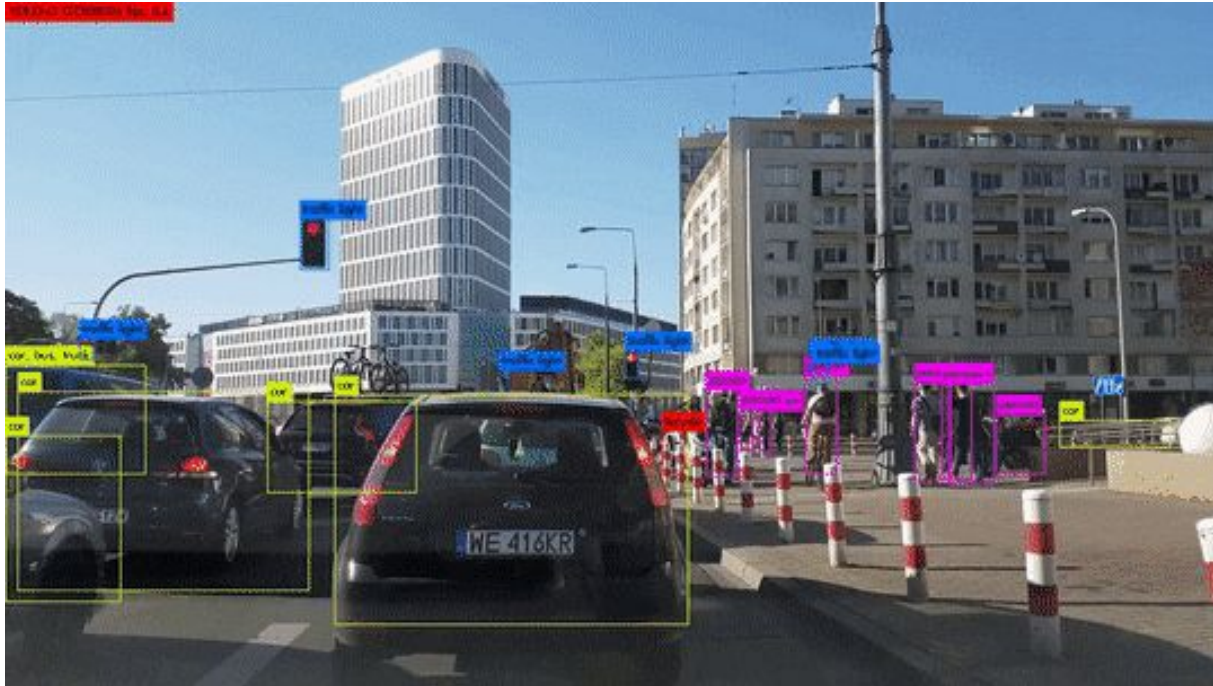
Visual understanding

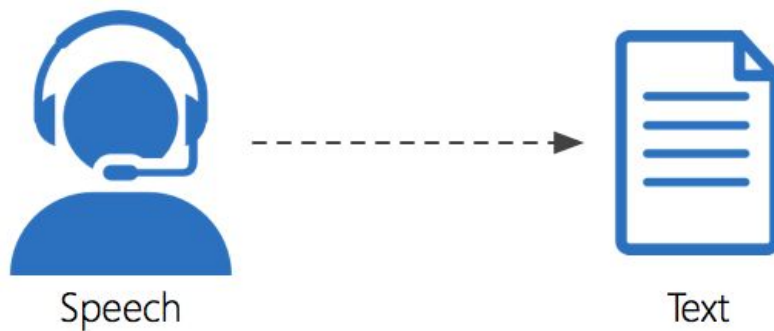- Semantic segmentation

Visual understanding

- Pose estimation

Language understanding

- Machine translation

Audio understanding

- Speech recognition
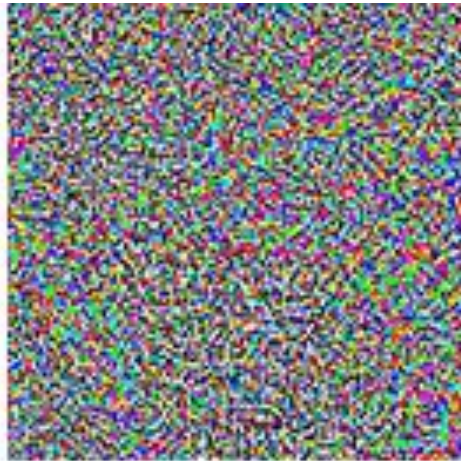

Speech → Text

Understanding neural network
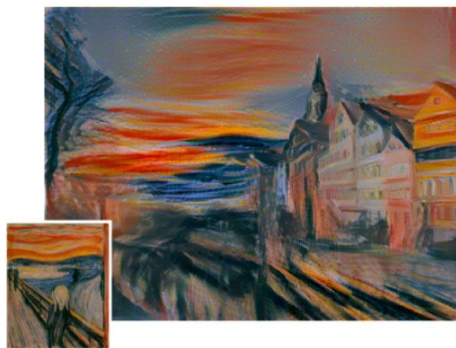
- Adversarial attack
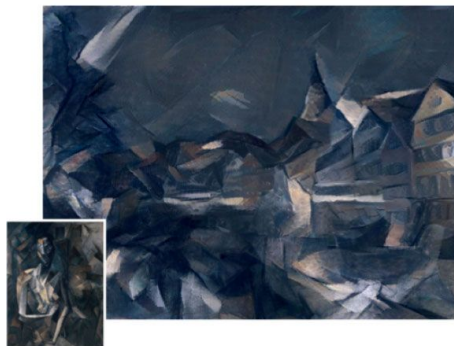

"panda"
57.7% confidence

$+ \epsilon$

$=$

"gibbon"
99.3% confidence

Understanding neural network

- Style transfer

Generative modeling

- Generating images

Generative modeling

- Generating text

SYSTEM PROMPT (HUMAN-WRITTEN)	*Miley Cyrus was caught shoplifting from Abercrombie and Fitch on Hollywood Boulevard today.*
MODEL COMPLETION (MACHINE-WRITTEN, SECOND TRY)	The 19-year-old singer was caught on camera being escorted out of the store by security guards.
	The singer was wearing a black hoodie with the label 'Blurred Lines' on the front and 'Fashion Police' on the back.
	Scroll down for video
	Shoplifting: Miley Cyrus was caught shoplifting from Abercrombie and Fitch on Hollywood Boulevard today (pictured)
	The singer was wearing a black hoodie with the label 'Blurred Lines' on the front and 'Fashion Police' on the back
	The singer was also wearing a pair of black-rimmed glasses, a black jacket, black jeans and black sandals.
	She was carrying a pair of black and white striped gloves and a small black bag.

Generative modeling
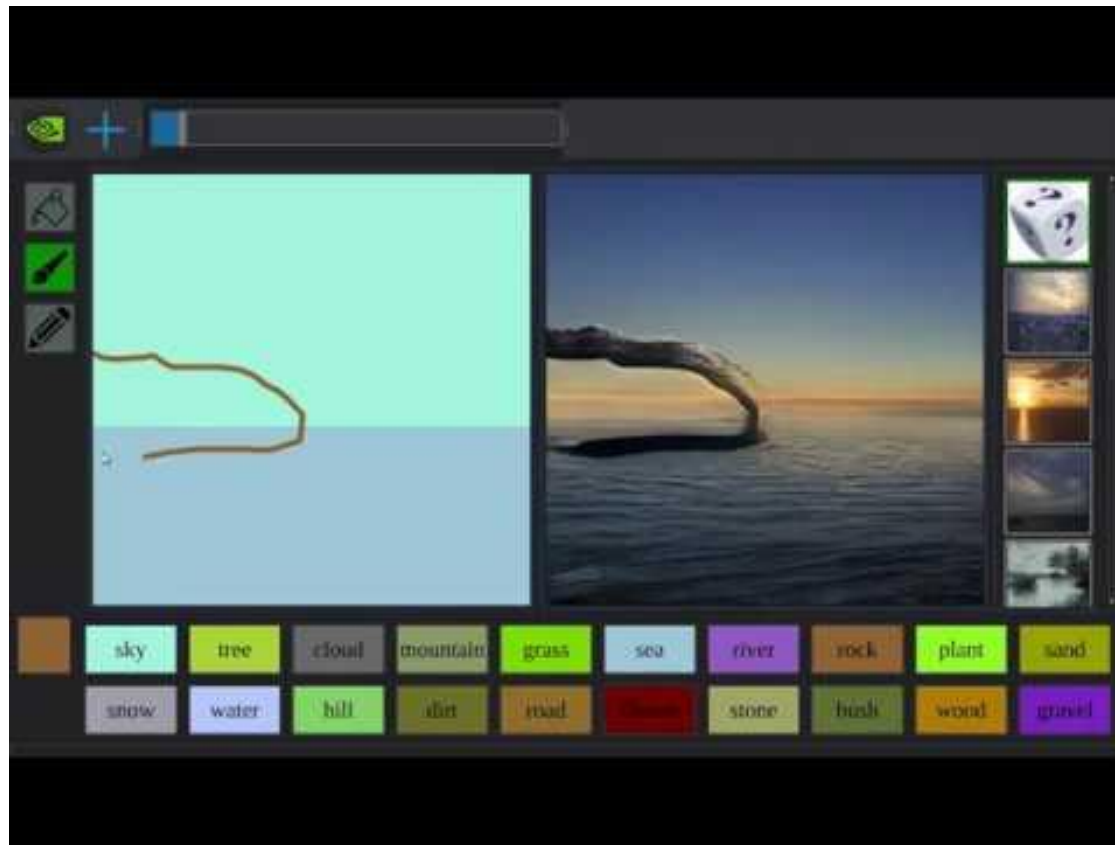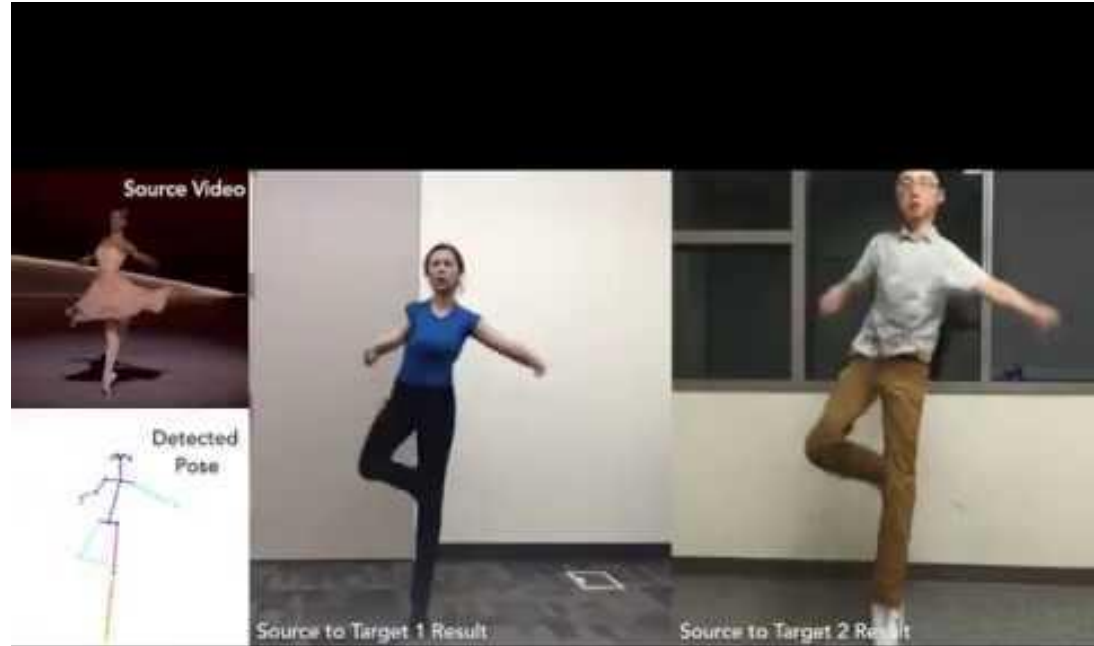
- Generating audio signals

Conditional generative modeling
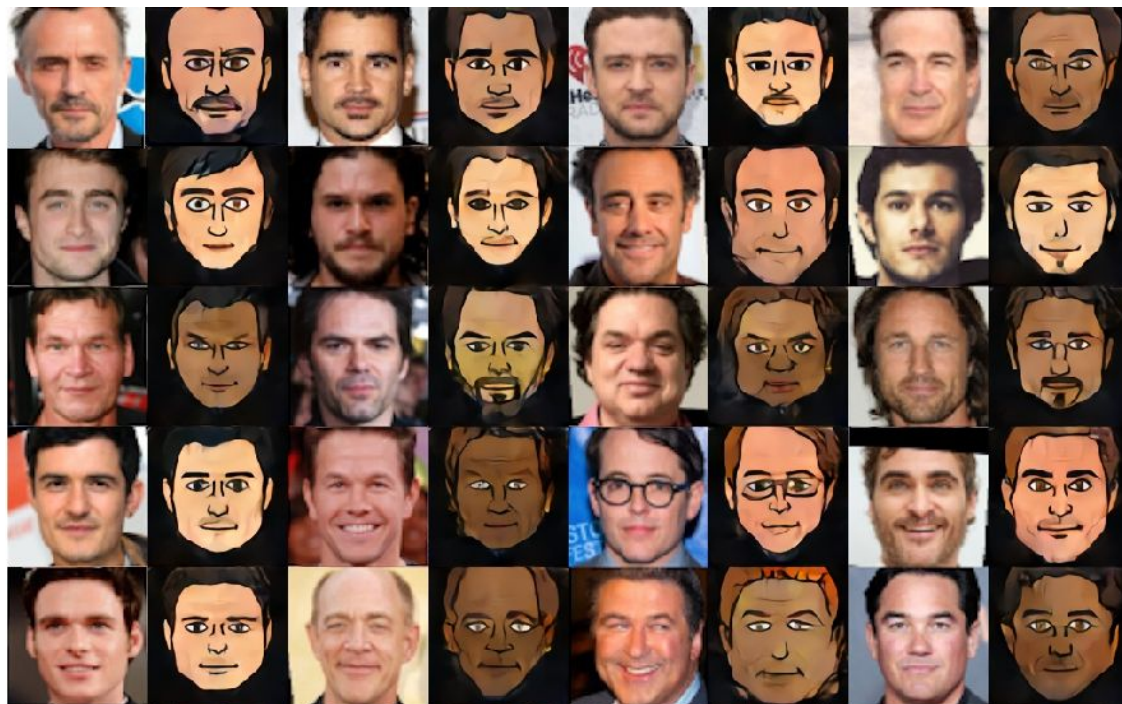
- Interactive generation

Unsupervised conditional generative modeling

- Motion transfer

Unsupervised conditional generative modeling

- Image translation from unpaired data

Next

- Neural network basics

Any questions?