

CS 460200

Introduction to Machine Learning

Introduction and Basic Concepts

Instructor: Po-Chih Kuo

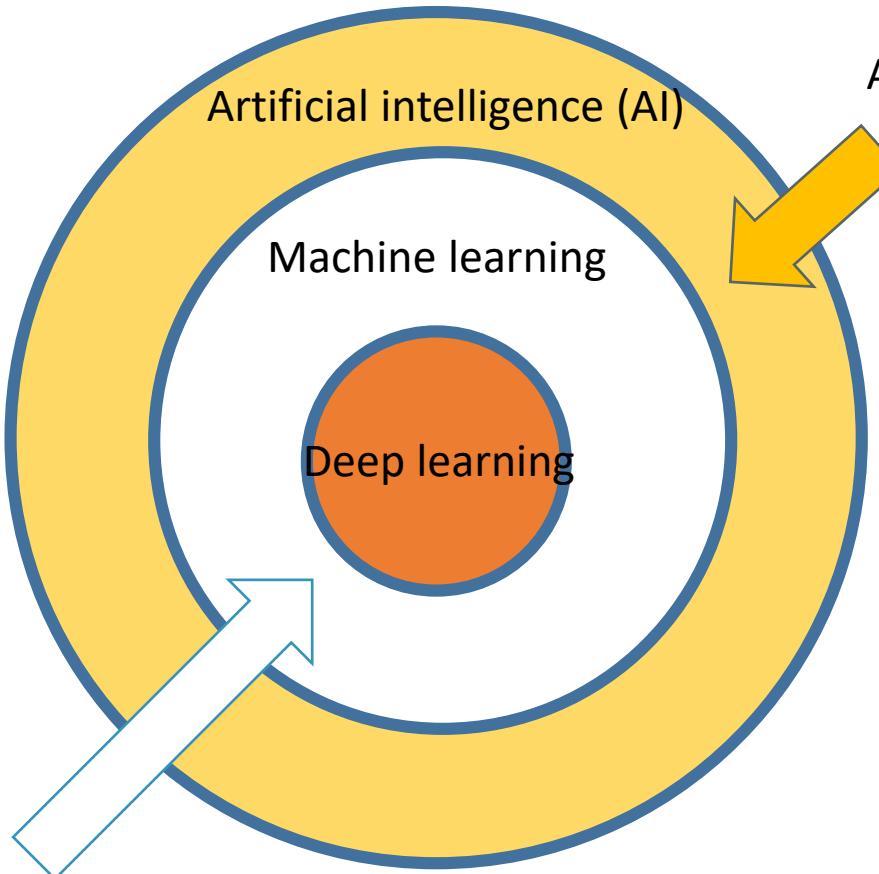
Roadmap

- Introduction and Basic Concepts
- Regression
- Bayesian Classifiers
- Decision Trees
- KNN
- Linear Classifier
- Neural Networks
- Deep Learning
- Reinforcement Learning
- Model Selection and Evaluation
- Clustering
- Dimensionality Reduction

Scope of AI

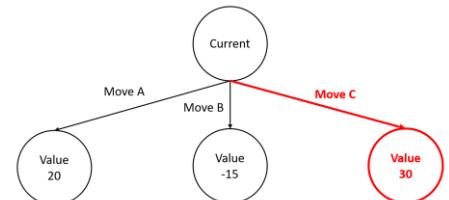
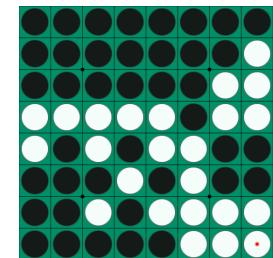
What about?

Go



Can a computer learn by itself?

AI-ML=?
Othello



```
function alphabeta(node, depth, α, β, maximizingPlayer) is
    if depth = 0 or node is a terminal node then
        return the heuristic value of node
    if maximizingPlayer then
        value := -∞
        for each child of node do
            value := max(value, alphabeta(child, depth - 1, α, β, FALSE))
            α := max(α, value)
            if α ≥ β then
                break (* β cutoff *)
        return value
    else
        value := +∞
        for each child of node do
            value := min(value, alphabeta(child, depth - 1, α, β, TRUE))
            β := min(β, value)
            if β ≤ α then
                break (* α cutoff *)
        return value
```

What is Learning?

- “Learning denotes **changes** in a system that enable a system to do the same task **more efficiently the next time.**” - Herbert Simon
- “Learning is **constructing or modifying representations** of what is being experienced.” - Ryszard Michalski
- “Learning is making useful **changes** in our minds.” - Marvin Minsky



What is Machine Learning?

Write programs that recognize a face



- It is very hard to write programs that solve problems like recognizing a face
 - We don't know what program to write because we don't know how it is done in our brain.
 - Even if we had a good idea about how to do it, the program might be very complicated.

What is Machine Learning?

- Instead of writing a program by hand for each specific task, we collect lots of examples that specify the correct output for a given input.
- A machine learning algorithm then takes these examples and produces a program that does the job.



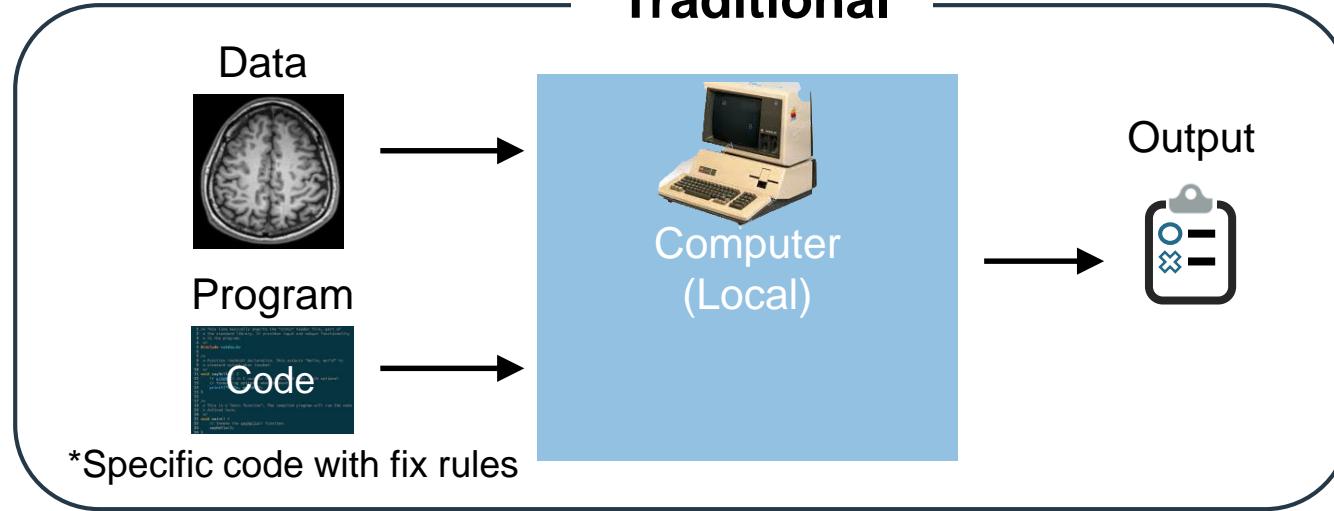
What is Machine Learning?

- Automating automation
- Getting computers to program themselves
- Let the data do the work (writing codes) instead!

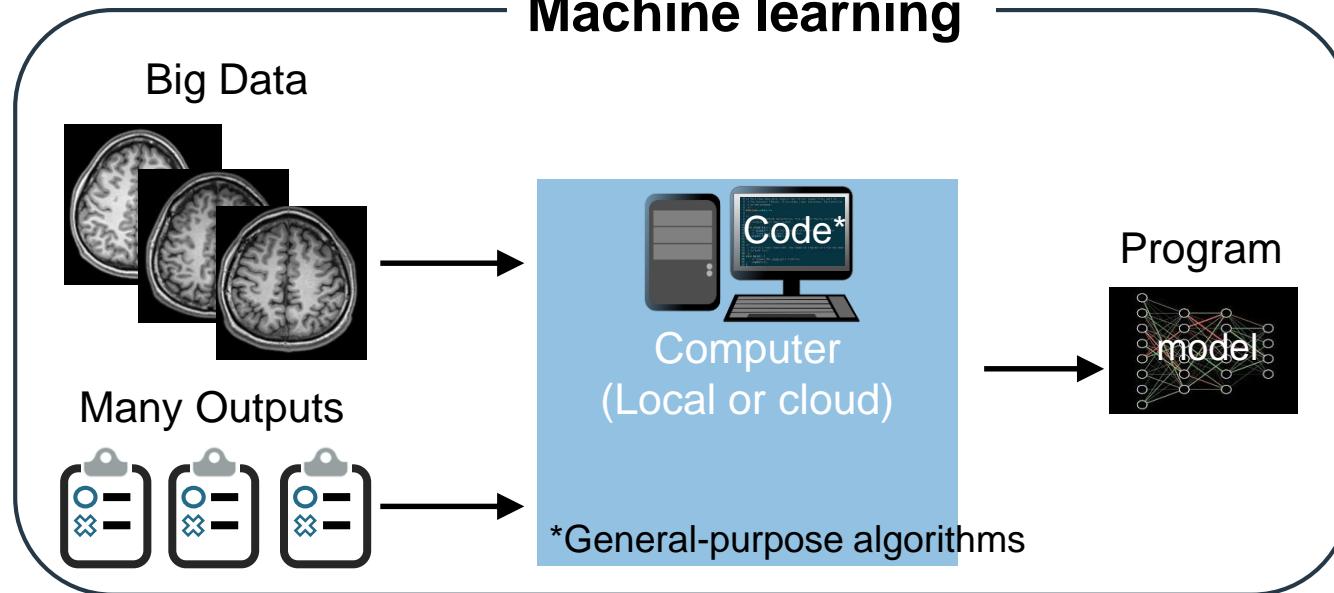
“Machine learning refers to a system capable of the autonomous acquisition and integration of knowledge.”

Role of computers is changing

Traditional



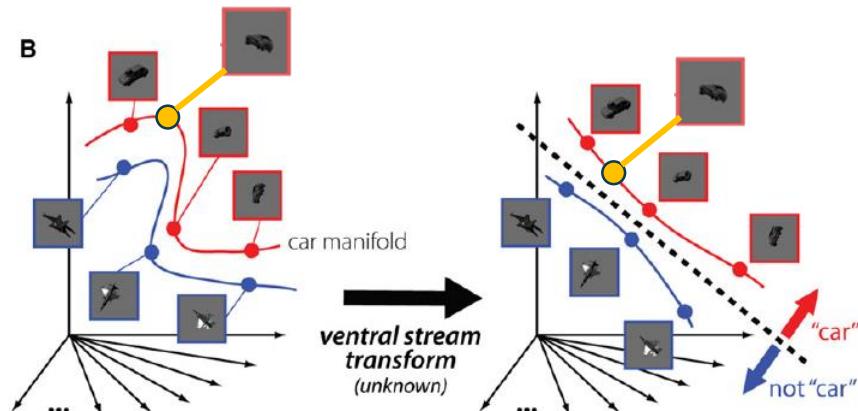
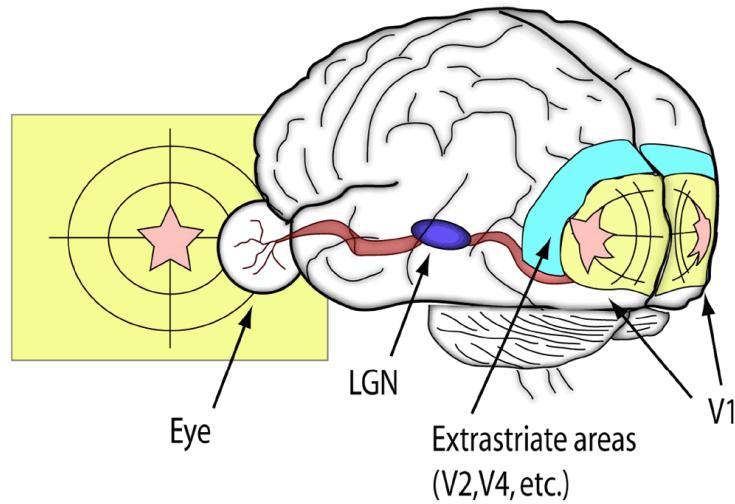
Machine learning



How does ML work?

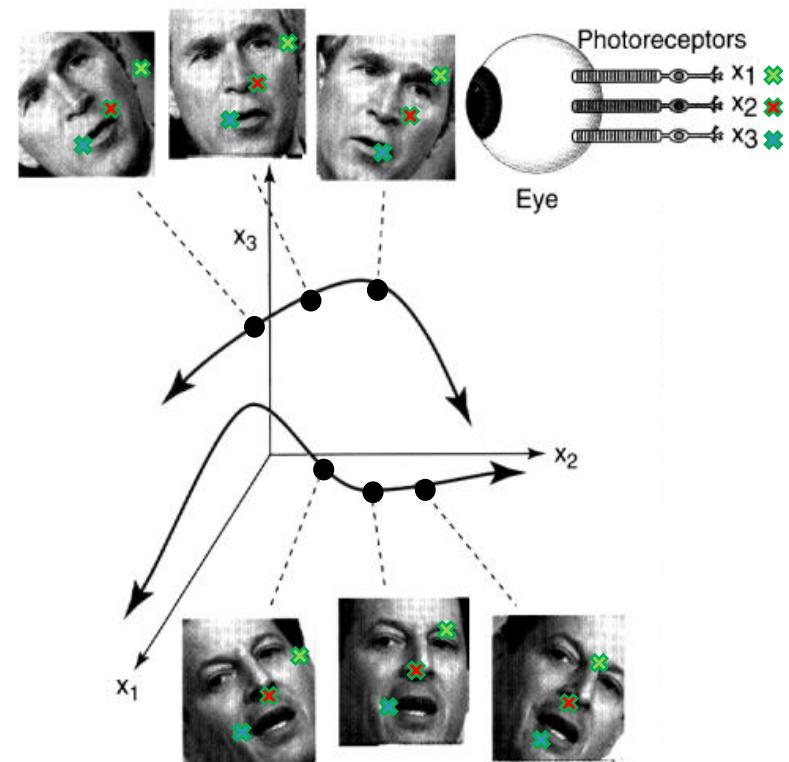
= How to design a good algorithm?

Human Machine learning



(DiCarlo et al., 2012)

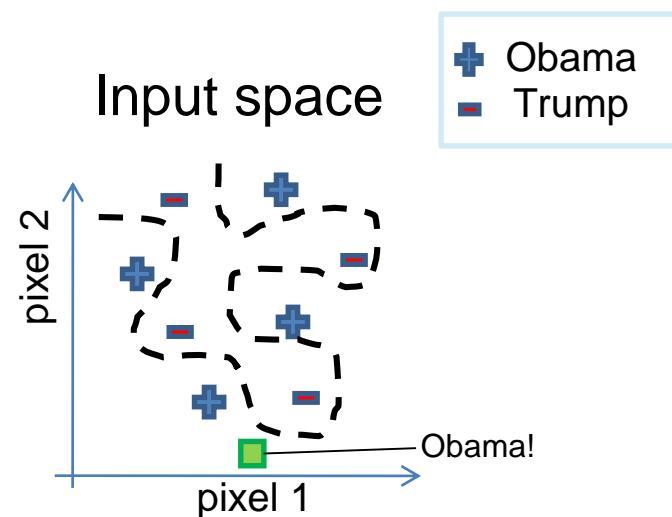
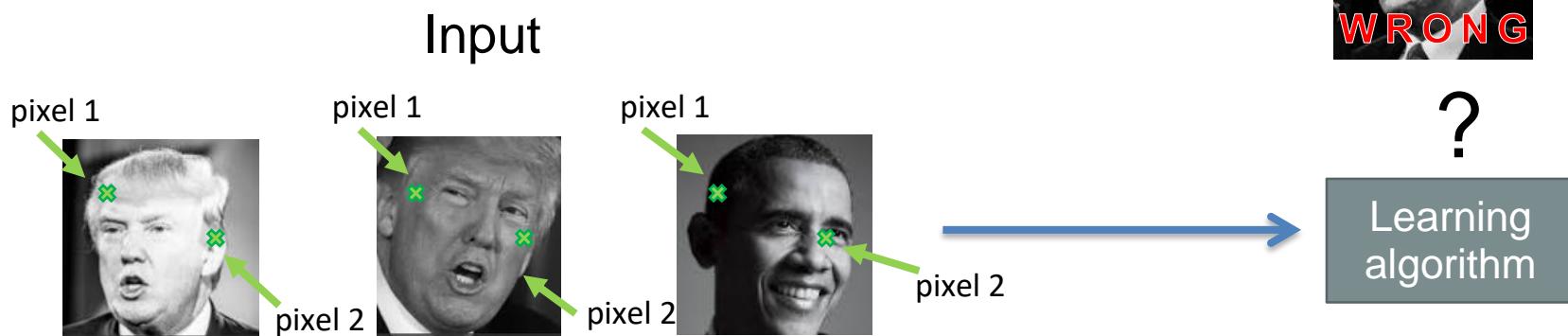
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(Seung and Lee., 2000)

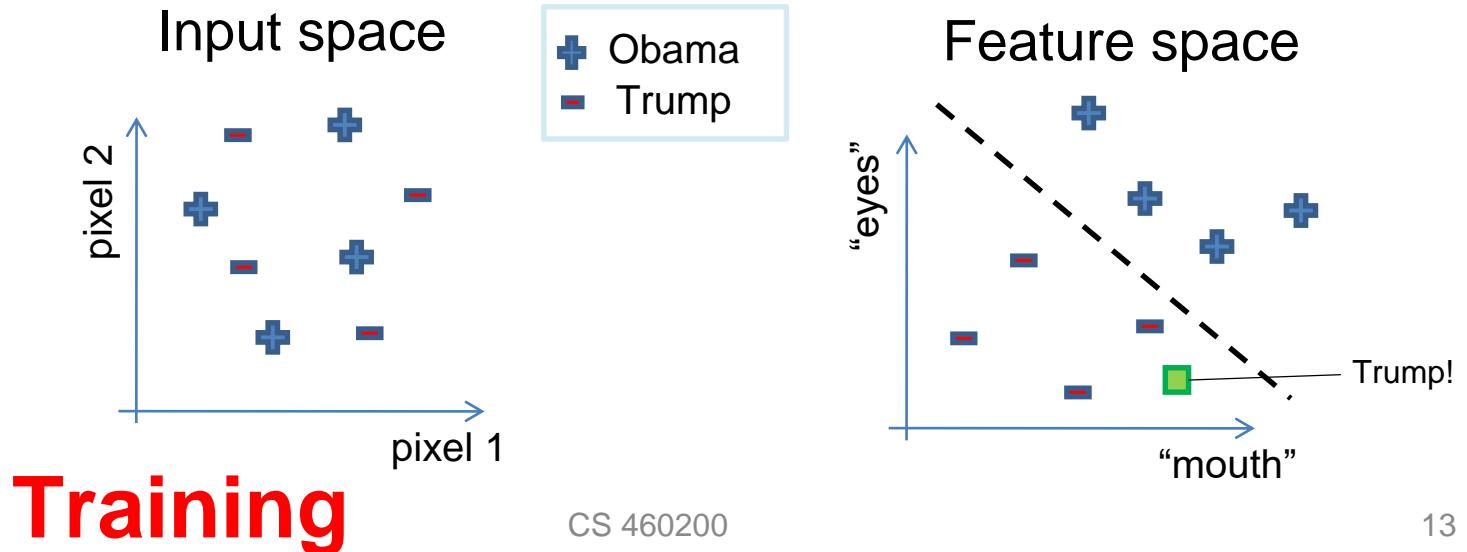
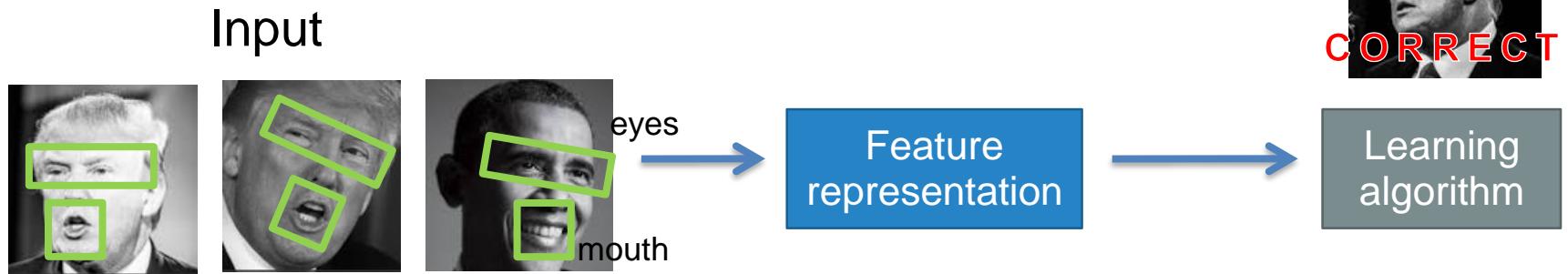
Image space

New image



Feature representations

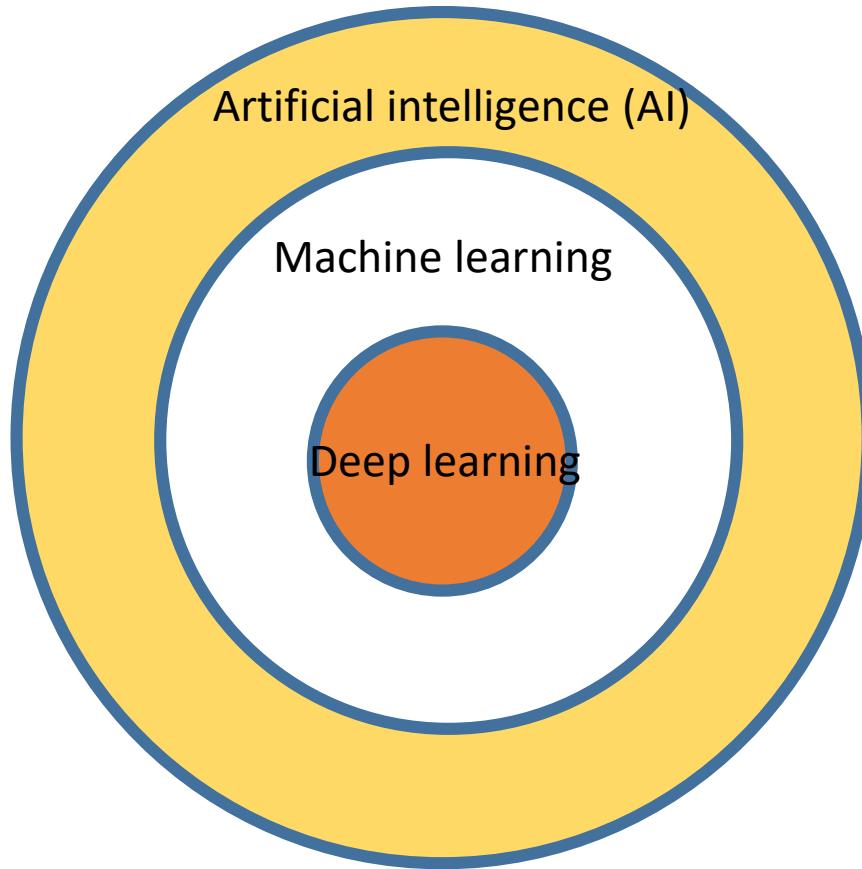
Testing
New image



How does ML work?

- = How to design a good algorithm?
- = How to find a good representation (transformation)?

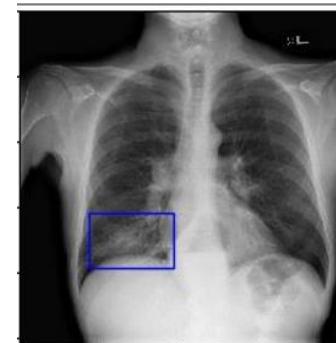
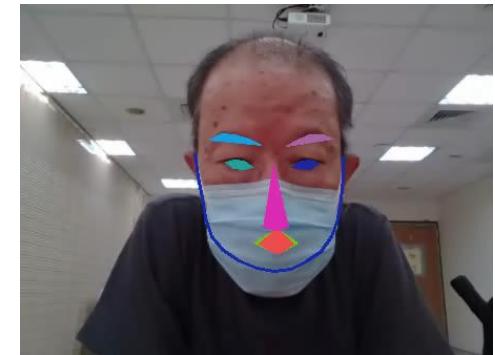
Machine learning?



A new representation!

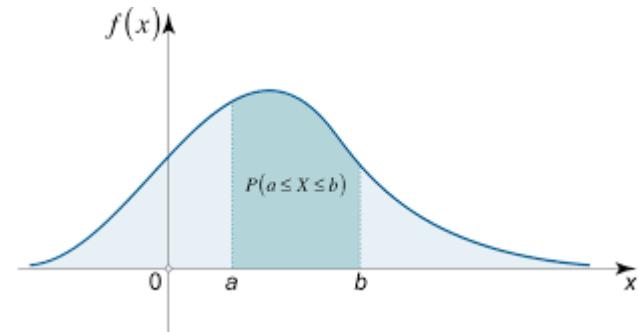
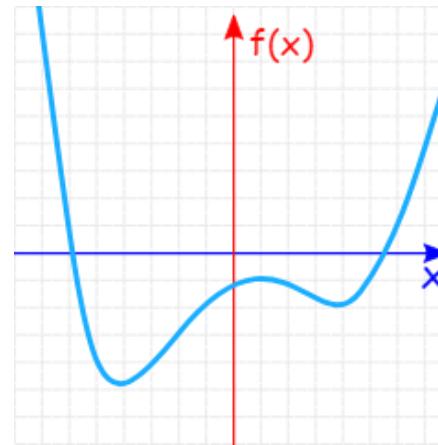
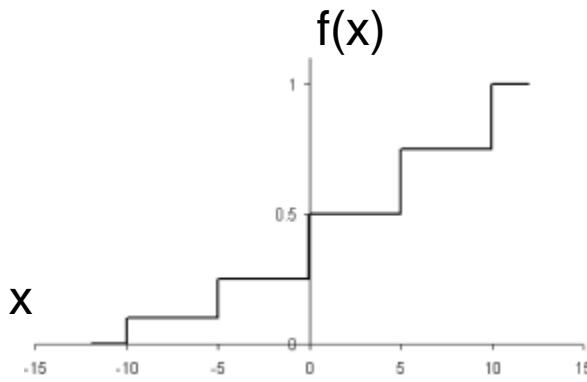
Examples of tasks best solved

- Recognizing patterns:
 - Objects in real scenes
 - Facial identities or facial expressions
 - Spoken words
- Recognizing anomalies:
 - Unusual sequences of credit card transactions
 - Unusual patterns in X-ray image
- Prediction:
 - Future stock prices or currency exchange rates
 - Which movies will a person like?



Inductive Learning

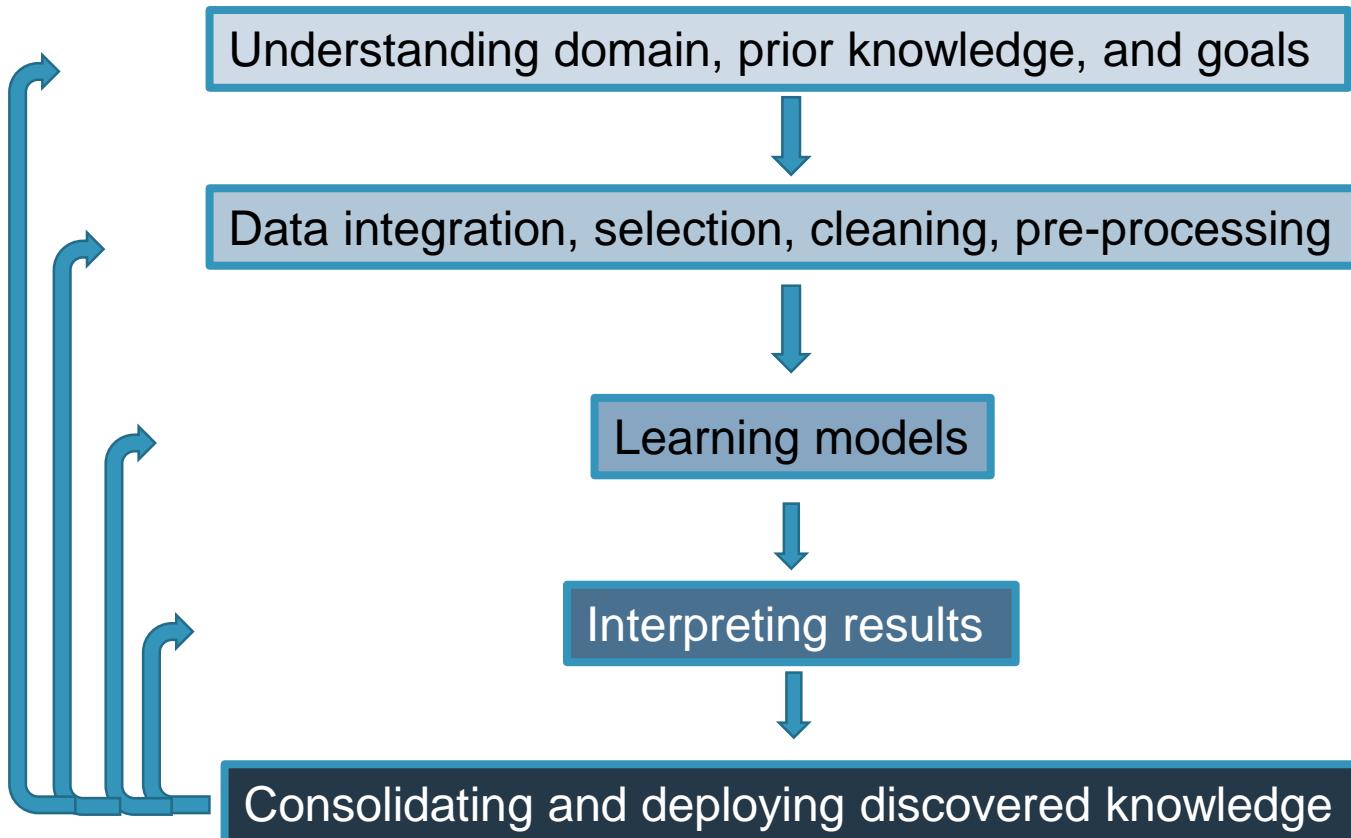
- **Given** examples of a function $(X, F(X))$
- **Predict** function $F(X)$ for new examples X
 - Discrete $F(X)$: Classification
 - Continuous $F(X)$: Regression
 - $F(X) = \text{Probability}(X)$: Probability estimation



Types of Learning

- Supervised (inductive) learning
 - Training data includes desired outputs
- Unsupervised learning
 - Training data does not include desired outputs
- Semi-supervised learning
 - Training data includes a few desired outputs
- Self-supervised Learning
 - Training data does not include desired but alternative outputs
- Reinforcement learning
 - Rewards from sequence of actions

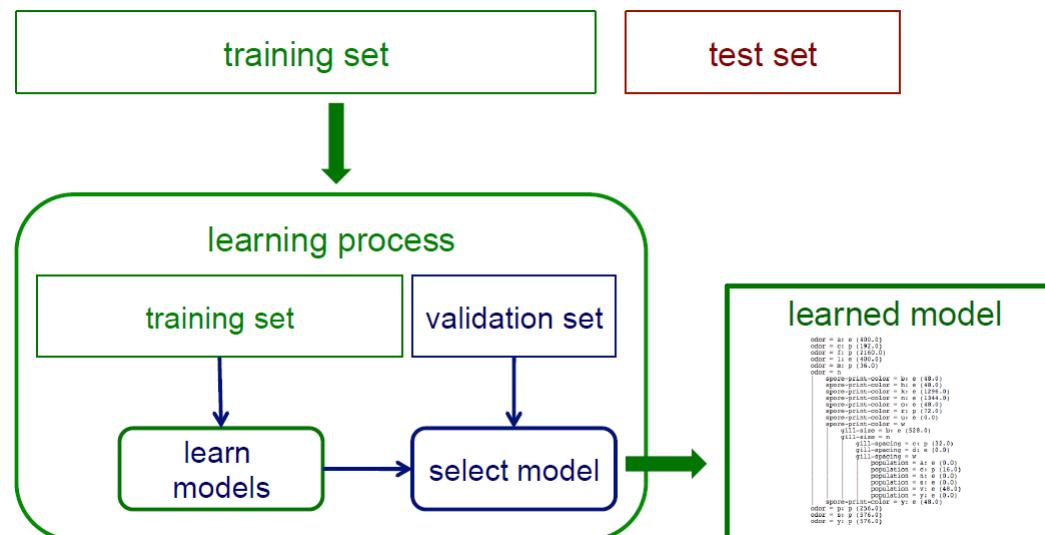
ML in Practice



“Only 10% of ML project is coding. The other 90% is cleaning data or tuning models.”

Training Testing Validation

- Suppose we want unbiased estimates of accuracy during the learning process?
 - Partition training data into separate training/validation sets



Roadmap

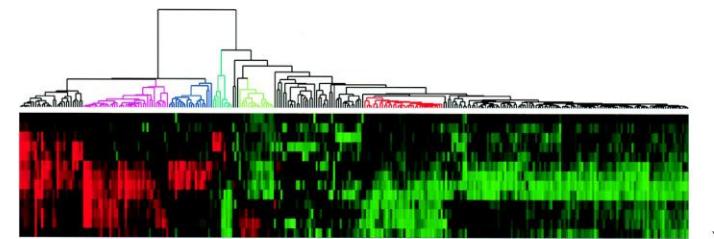
- Introduction and Basic Concepts

- Regression
- Bayesian Classifiers
- Decision Trees
- KNN
- Linear Classifier
- Neural Networks
- Deep learning
- Convolutional Neural Networks
 - Autoencoder
 - Adversarial

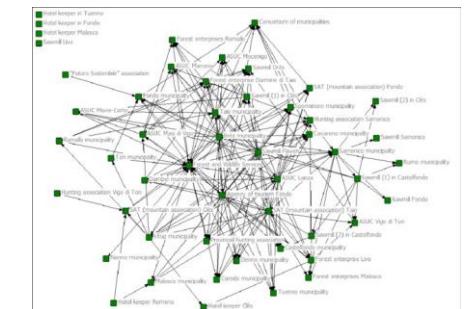
- RNN
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Continuous $F(X)$?
Discrete $F(X)$?
 $F(X) = \text{Probability}(X)$?

Supervised Learning



Unsupervised Learning

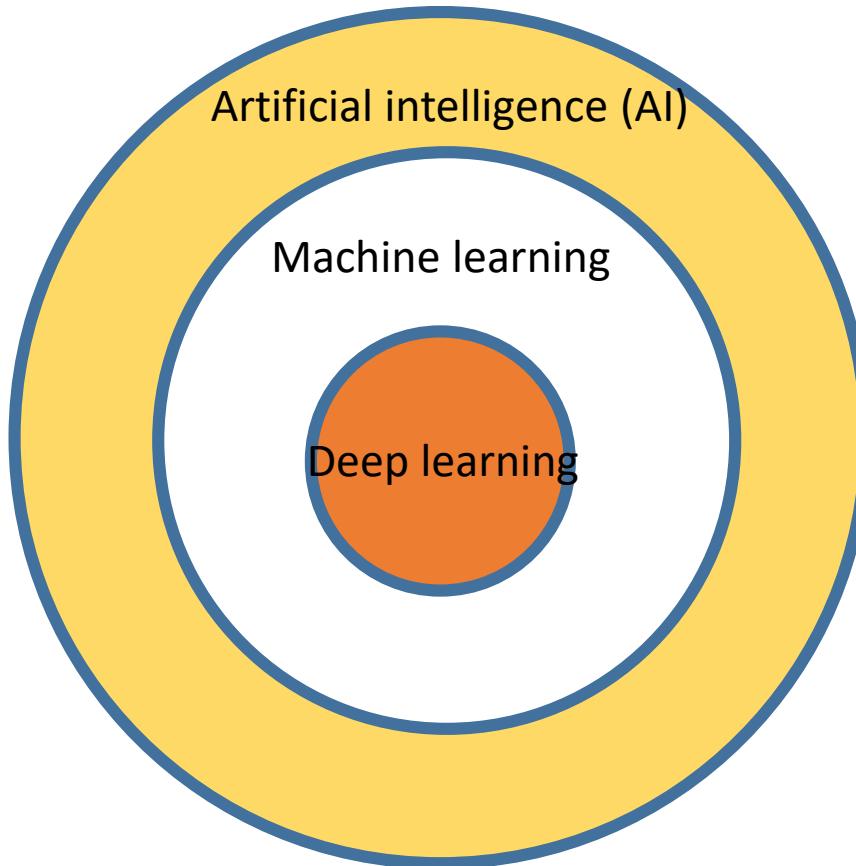


What you should know?

- More and more people want to learn machine learning. But...



Scope of AI



Deep learning



In "Nature" 27 January 2016:

- “DeepMind’s program AlphaGo beat Fan Hui, the European Go champion, five times out of five in tournament conditions...”
- “AlphaGo was not preprogrammed to play Go: rather, it learned using a general-purpose algorithm that allowed it to interpret the game’s patterns.”
- “...AlphaGo program applied **deep learning** in neural networks (convolutional NN) — brain-inspired programs in which connections between layers of simulated neurons are strengthened through examples and experience.”

Photo Descriptions



Explore image and video storytelling beyond pixels



Default

Iron Man

I You have to think about the consequences, Wade!

Deadpool

D Oh please, major killjoy. The kid deserves some action!

Jenny

J I want to learn, and I can handle it! Both of you, stop arguing!



在前景中，一幅充满活力的蓝色和黄色画作显示在墙上。这件艺术品以其复杂的笔触和鲜艳的色彩精美地捕捉了自然景观的精髓。在图像的中心，一幅更大画作展示了一座高耸的山峰，风景如画的瀑布从岩石表面倾泻而下。背景展示了宁静的蓝天，进一步突出了画作的宁静。在这幅艺术品旁边，一幅亚洲风格的画作以连绵起伏山脉和郁郁葱葱的绿树为特色。错综复杂的细节和细腻的笔触捕捉了传统亚洲景观艺术的精髓。在图像的底部，一幅画描绘了一个被树木环绕的宁静蓝色湖泊。这件艺术品的宁静氛围唤起了一种平静和放松的感觉。



ENGLISH ▾ Bolt Default

In a serene park setting, two individuals find respite on a bench, enjoying each other's company and the tranquil surroundings. As they converse, life bustles around them: a person strolls down a nearby sidewalk, and a man ambles in front of an impressive monument. Further off, a group of people congregates amidst the verdant landscape, taking in the beauty of the park. A solitary woman sits on another bench nearby, her presence adding to the diverse array of visitors. This picturesque scene captures the essence of urban parks as havens for relaxation and socialization amid the hustle and bustle of city life.

Deep CNN for Image Classification

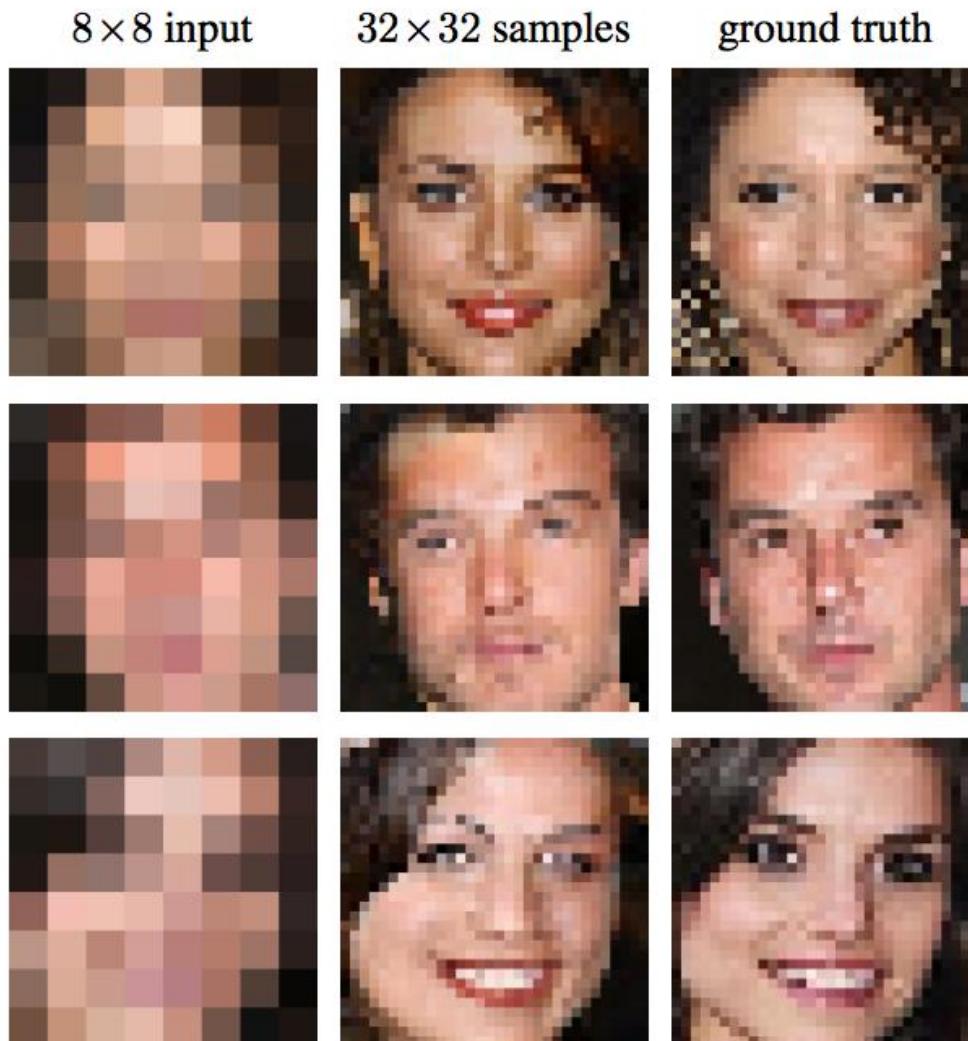
The screenshot shows a CodeSandbox environment with the following details:

- Left Panel (Code):** The file is `index.js`. The code is a React component for image classification using TensorFlow.js. It includes imports for React, React DOM, TensorFlow/TensorFlow.js, and Ant Design (antd). It uses the `useState`, `useEffect`, and `useRef` hooks. The component handles loading a mobileNet model, displaying a canvas for drawing, and handling file uploads to predict images.
- Right Panel (Browser):** The browser window title is "Image Classification Demo with TensorFlow.js". The URL is `https://ch2g5.csb.app/`. The interface includes a "Choose File" button with the selected file "OldYoungW...llusion.jpeg". Below it is a preview image of a young girl wearing a white headband and a dark jacket, shown in profile facing right.

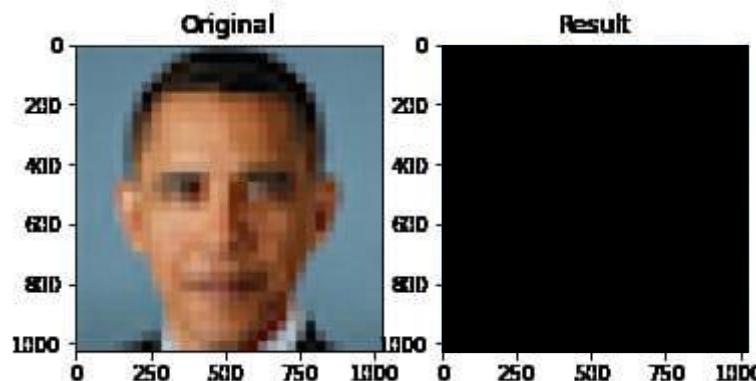
```
js index.js
  1 import { useState, useEffect, useRef } from "react";
  2 import ReactDOM from "react-dom";
  3 import tensorflow/tfjs";
  4 import mobileNet from "@tensorflow-models/mobilenet";
  5 import Spin from "antd";
  6 import "antd/dist/antd.css";
  7
  8 import styles.css;
  9 import TagsContainer from "./Components/TagsContainer";
 10
 11 const ClassificationDemo = () => {
 12   [model, setModel] = useState(null);
 13   [predictions, setPredictions] = useState([]);
 14   [imageUrl, setImageUrl] = useState(null);
 15   [canvasRef] = useRef(null);
 16
 17   useEffect(() => {
 18     const loadModel = async () => {
 19       const model = await mobileNet.load();
 20       setModel(model);
 21     }
 22     loadModel();
 23   }
 24
 25   const handleUploadChange = ({ target }) => {
 26     imageUrl(URL.createObjectURL(target.files[0]));
 27
 28   const drawImageOnCanvas = (image, canvas, ctx) => {
 29     const naturalWidth = image.naturalWidth;
```

<https://codesandbox.io/s/image-classification-demo-with-tensorflowjs-ch2g5>

Pixel Restoration ([Google Brain](#))

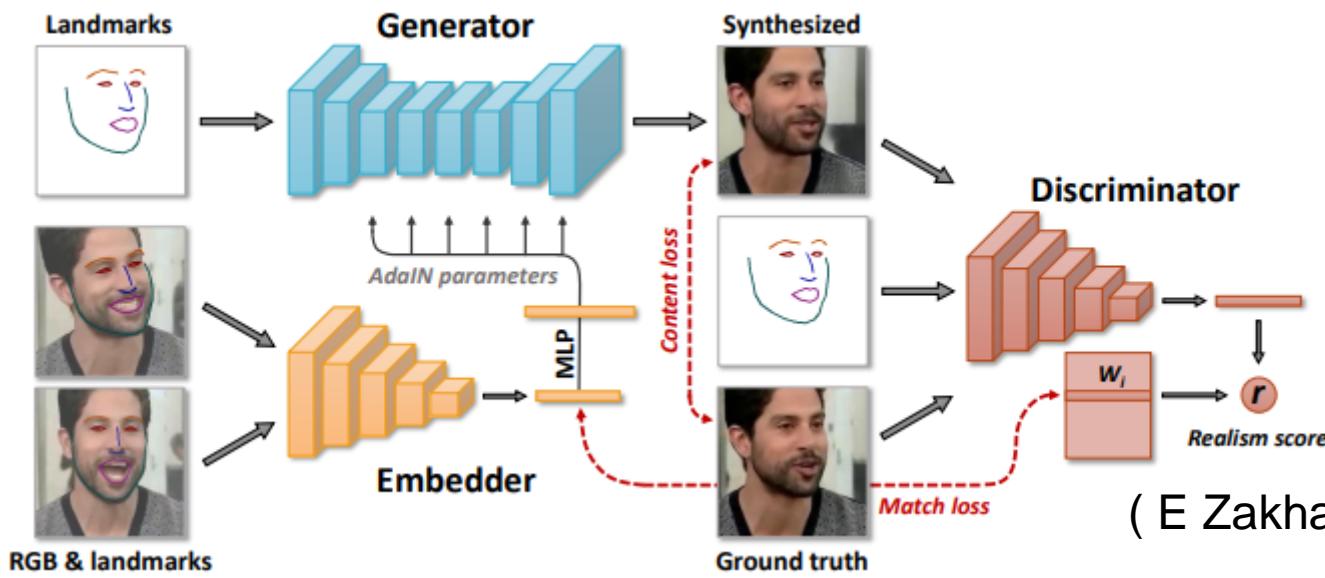
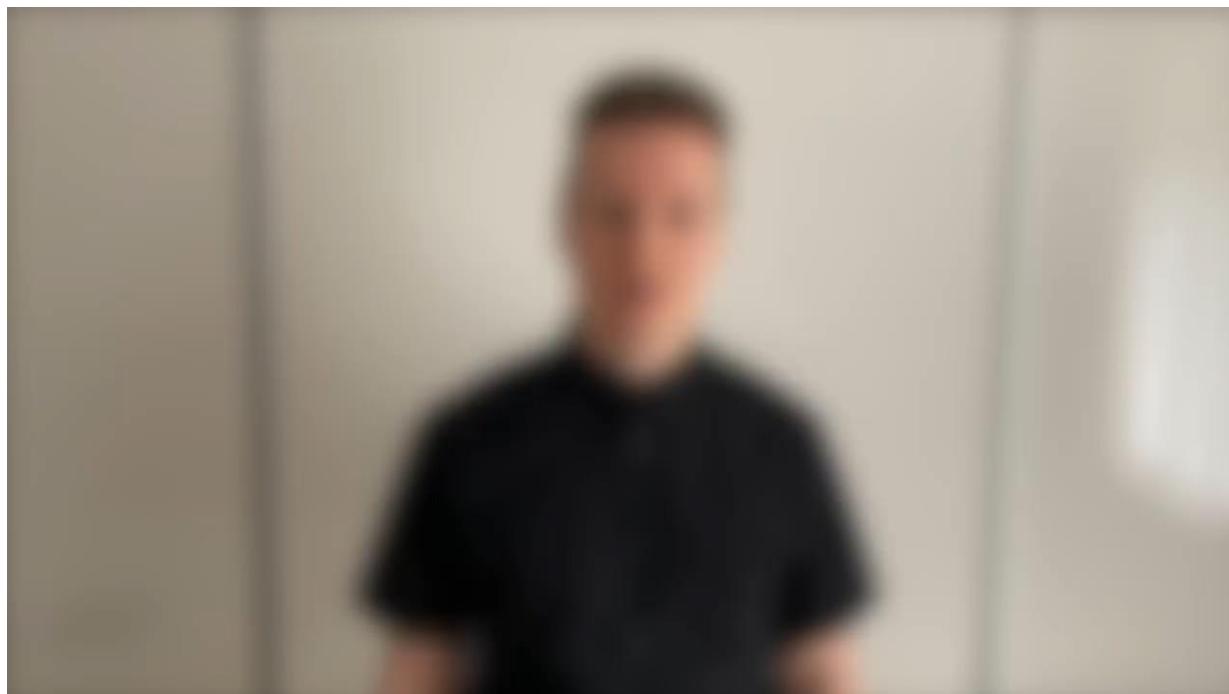


However,



https://github.com/tg-bomze/Face-Depixelizer?fbclid=IwAR2T0XRJMFMS-FjofeSVxz8zguoKj_j2Wy2KXCzljuv80c1YjzuJBe4eesA

Fake video



(E Zakharov · 2019)
29

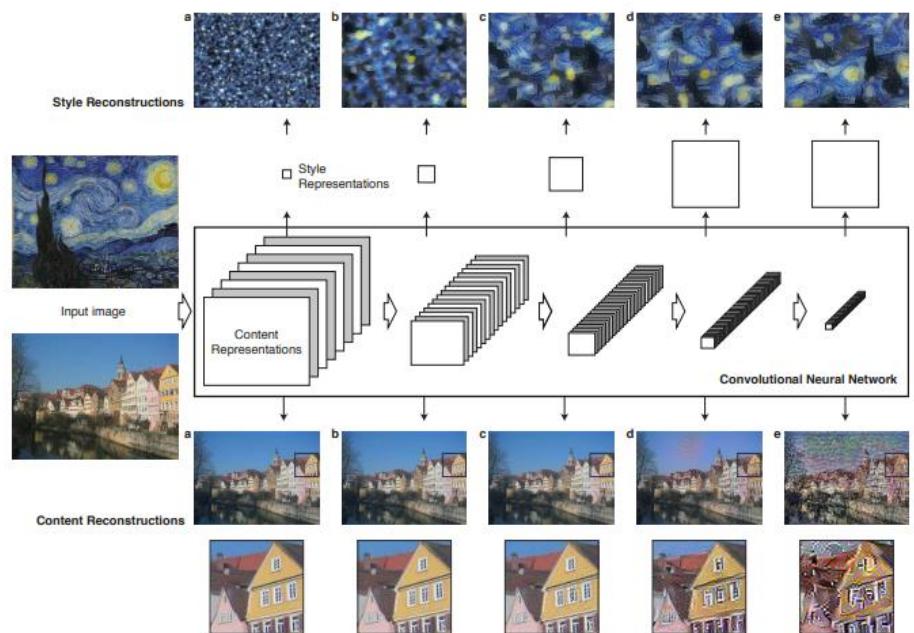
Colorization of Black and White Images (Zhang, 2016)



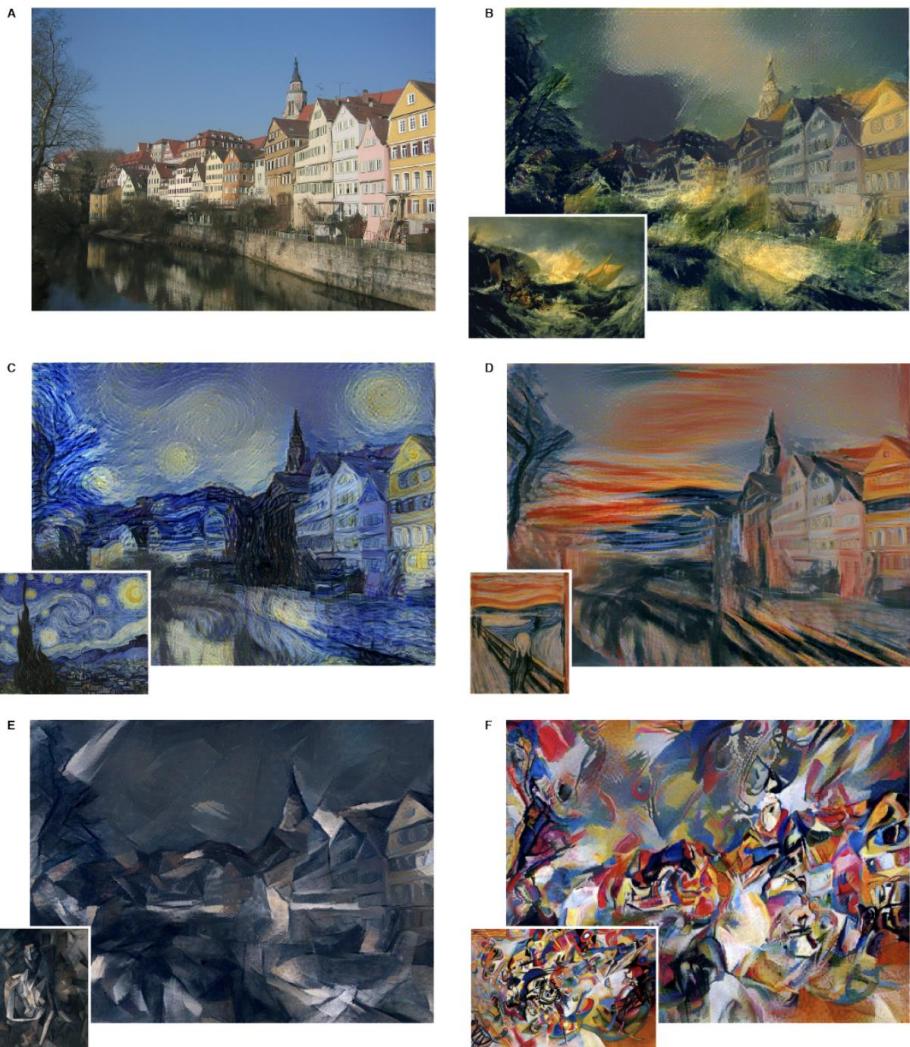
100 year old pictures...

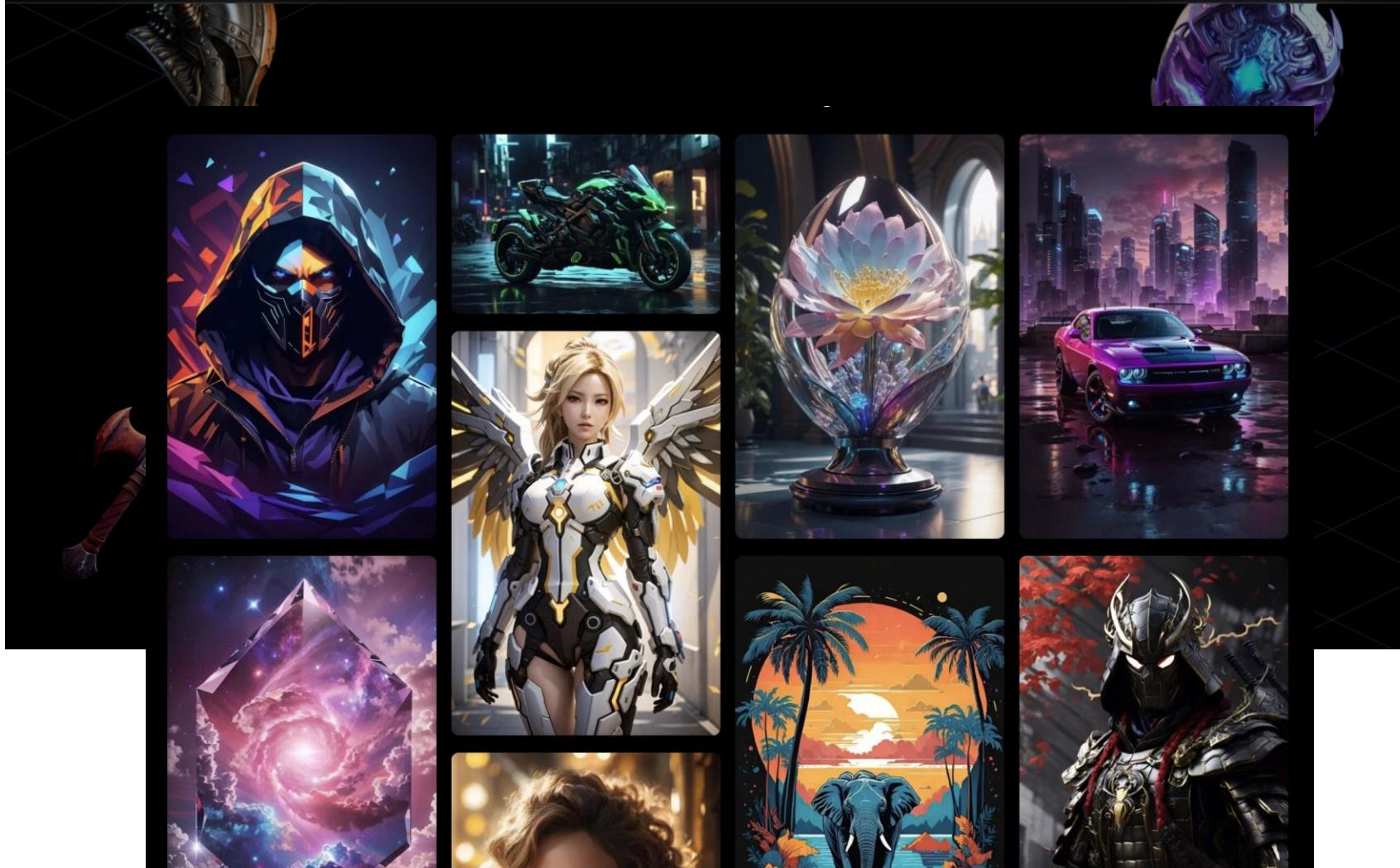


Style Transfer



(Gatys et al., 2015)



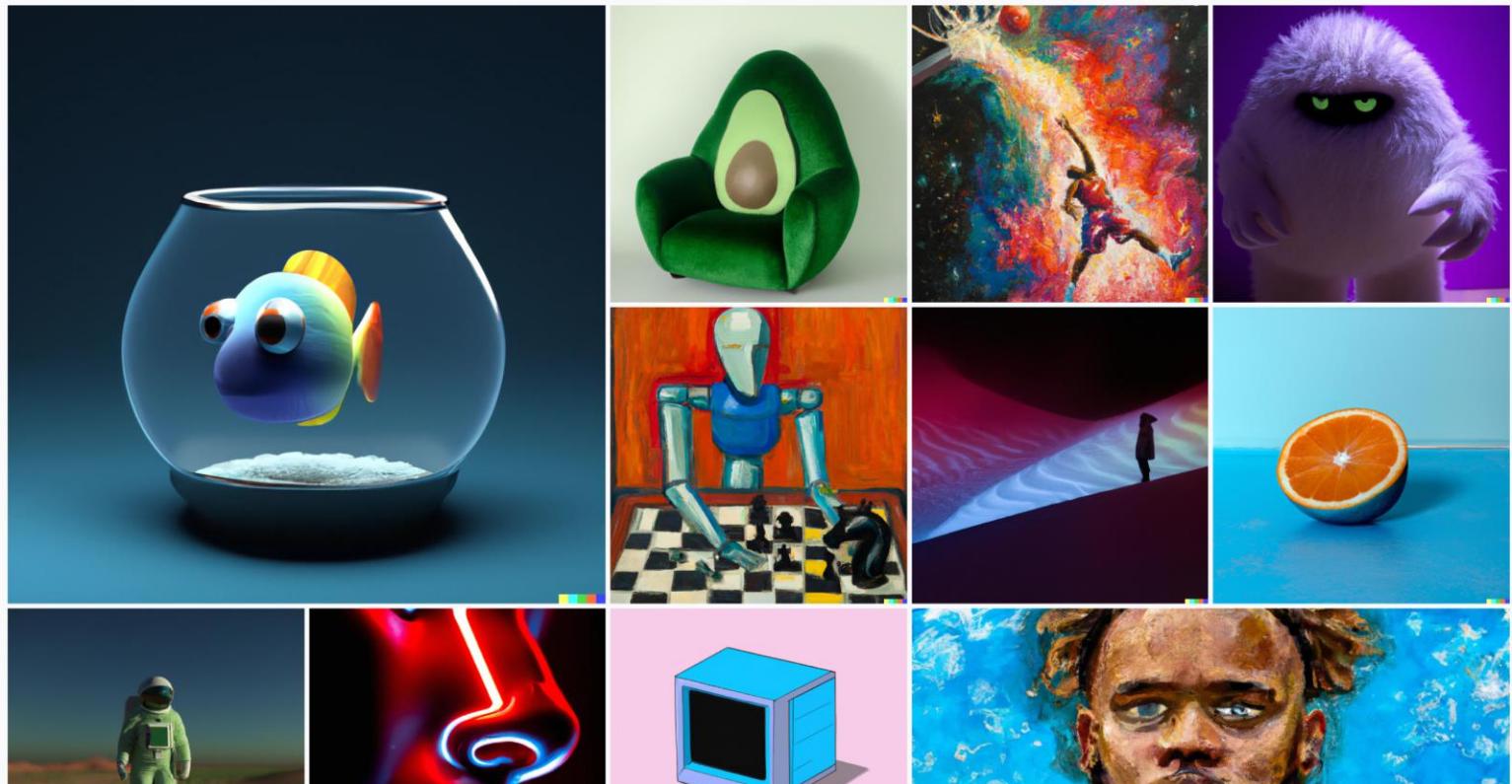




DALL-E History Collections

An Impressionist oil painting of sunflowers in a purple vase...

Generate





Rooms that are tiny can be tricky to decorate but they can also be a lot of fun. So when a client challenged us to give her pocket size space a summer makeover for under \$500 dollars, we just couldn't say no. Transforming a very small space doesn't have to blow your budget. Small things like finding a vintage piece of furniture from a relative or adding a fresh coat of paint to your own dated items can add a stylish splash to any abode.

Correctness

2 alerts



Clarity

A bit unclear



Engagement

A bit bland



Delivery

Slightly off



ChatGPT

Examples

"Explain quantum computing in simple terms" →

"Got any creative ideas for a 10 year old's birthday?" →

"How do I make an HTTP request in Javascript?" →

Capabilities

Remembers what user said earlier in the conversation

Allows user to provide follow-up corrections

Trained to decline inappropriate requests

Limitations

May occasionally generate incorrect information

May occasionally produce harmful instructions or biased content

Limited knowledge of world and ----- after 2021



Amna Riaz • 2nd
Blockchain Engineer | Solidity...
4d •

Connect

before chatGPT
5 hours of development
3 hours of debugging

After chatGPT
5 minutes of development
5 days of debugging

#development #chatgpt

[ChatGPT Mar 14 Version](#). Free Research

You and 251 others

29 comments • 8 reposts

Your feedback will help us improve.



Funny

Comment

Repost

Send

Machines Play Machines

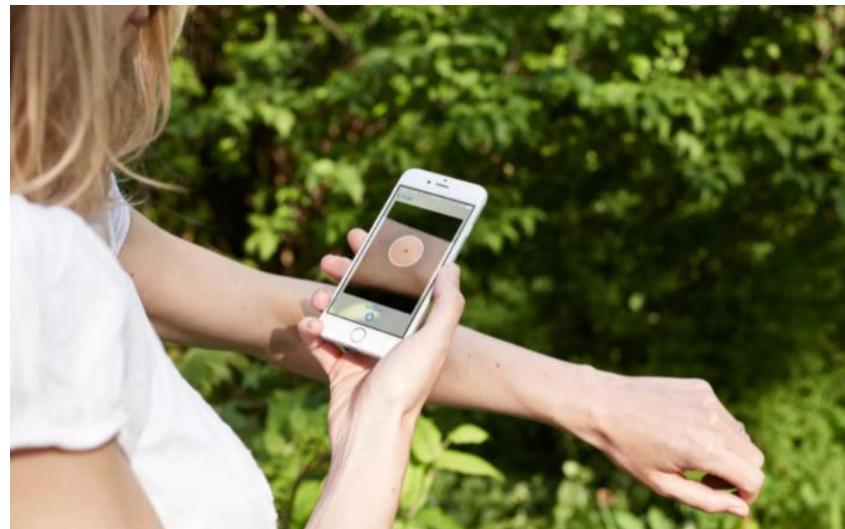


Worried about a mole or skin spot?

Perform regular self-checks for skin cancer with your phone.

[CHECK YOUR SKIN NOW](#)

Available for iOS and Android



[MoleScope](#)



RECENT POSTS

Introducing AI in Healthcare That's Just \$1 Per Use

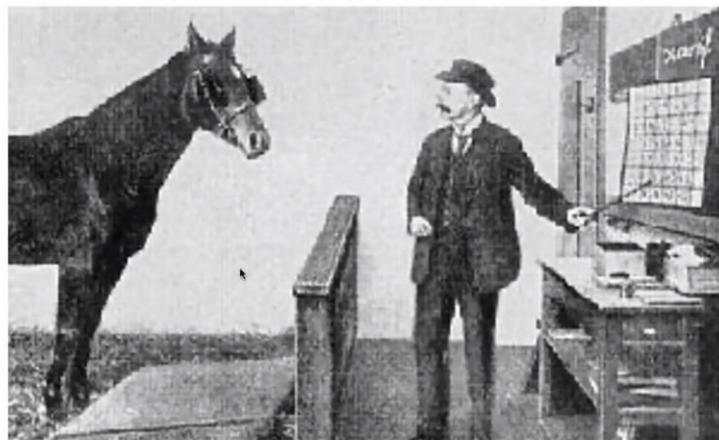
OCTOBER 27, 2017

By: Elad Benjamin

Over the last few years, we've been hard at work at Zebra to develop and introduce AI into radiology. We've written before about why this is important to us, based on the challenges this field is facing, and the impact we believe we can make. Healthcare is challenging – with long cycles, regulatory barriers and slow adoption of new technology, but our vision of affordable, accessible imaging technology for everyone keeps us continually thinking of ways to accelerate the realization of



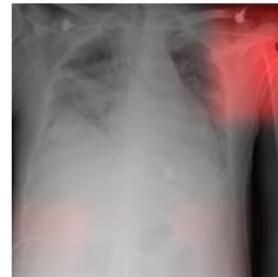
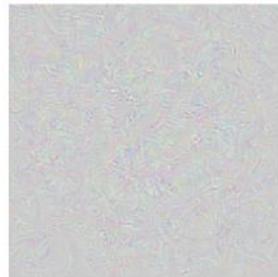
AI is smart?



- Clever Hans
 - Clever Hans was a horse that was claimed to have performed arithmetic and other intellectual tasks.

Model finds shortcut

Shortcuts are decision rules that perform well on standard benchmarks but fail to transfer to more challenging testing conditions, such as real-world scenarios.



Article: Super Bowl 50

Paragraph: "Peyton Manning became the first quarterback ever to lead two different teams to multiple Super Bowls. He is also the oldest quarterback ever to play in a Super Bowl at age 39. The past record was held by John Elway, who led the Broncos to victory in Super Bowl XXXIII at age 38 and is currently Denver's Executive Vice President of Football Operations and General Manager. Quarterback Jeff Dean had a jersey number 37 in Champ Bowl XXXIV."

Question: "What is the name of the quarterback who was 38 in Super Bowl XXXIII?"

Original Prediction: John Elway

Prediction under adversary: Jeff Dean

Task for DNN	Caption image	Recognise object	Recognise pneumonia	Answer question
Problem	Describes green hillside as grazing sheep	Hallucinates teapot if certain patterns are present	Fails on scans from new hospitals	Changes answer if irrelevant information is added
Shortcut	Uses background to recognise primary object	Uses features irreducible to humans	Looks at hospital token, not lung	Only looks at last sentence and ignores context

(Geirhos et al., 2020)

What about our LAB ?



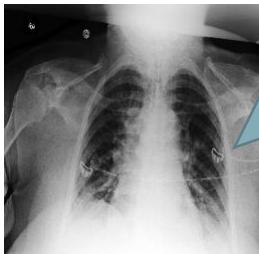
Human-centered Machine Intelligence

Chest X-ray interpretation

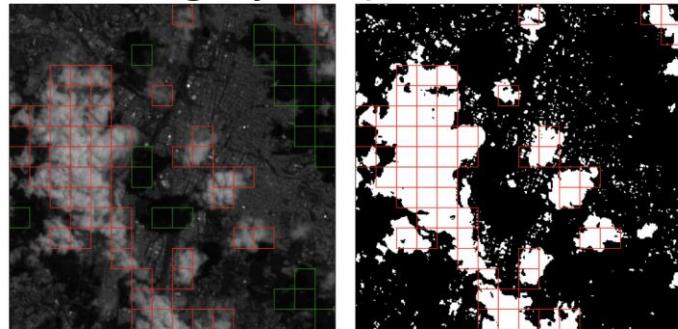


Diagnostic report generation

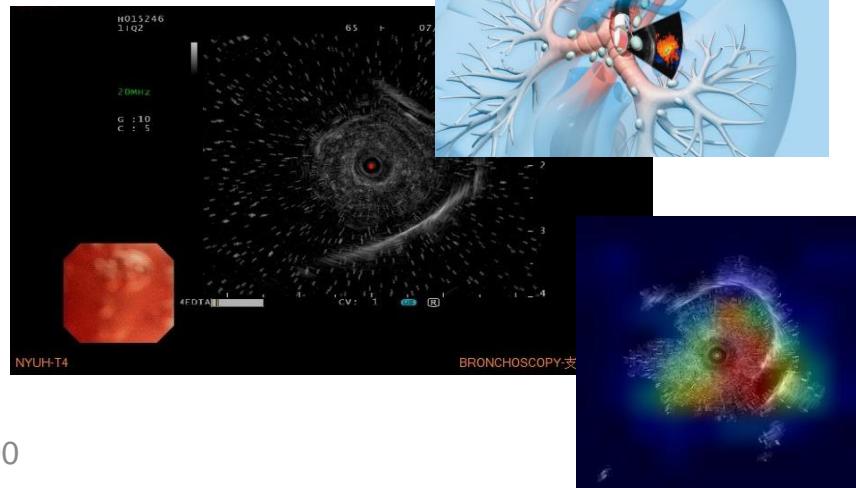
lung volumes are low . heart size is normal . mediastinal and hilar contours are unremarkable . crowding of bronchovascular structures is present without overt pulmonary edema . patchy bibasilar airspace opacities may reflect atelectasis but infection cannot be excluded . no large pleural effusion or pneumothorax is identified . there are no acute osseous abnormalities .



Satellite imagery for public health

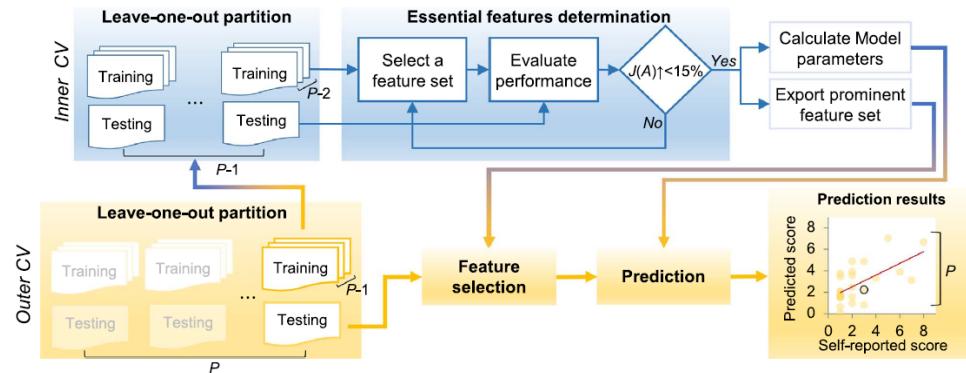


Malignant classification in ultrasound image



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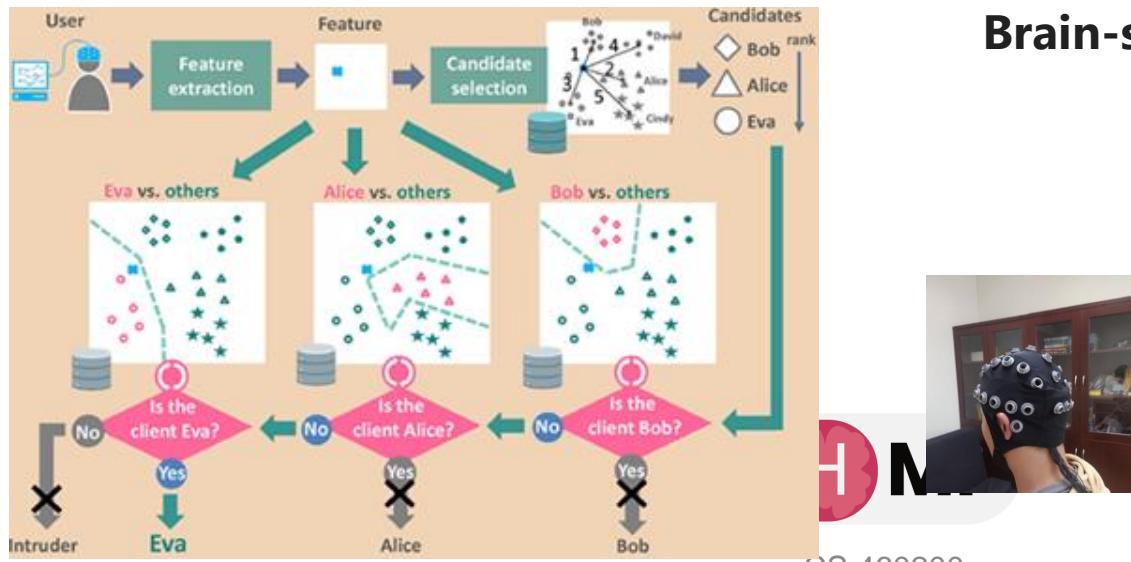
Decoding Pain Level from Magnetoencephalography (MEG)



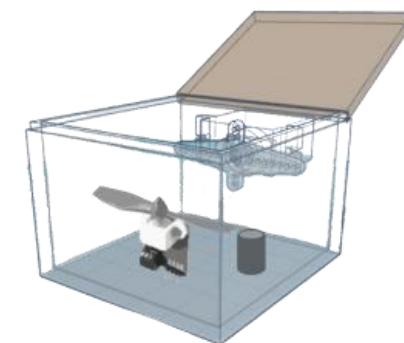
3. Schematic diagram of the nested CV procedure for the determination of essential features and pain level prediction. In the outer CV (yellow), leave-one-out CV using all P was applied to evaluate the accuracy of pain level prediction. In the inner CV (blue), $P-1$ training data in the outer CV were used to determine a set of essential features using an \geq -one-out partitioning for sequential forward search.



EEG-Based Biometrics

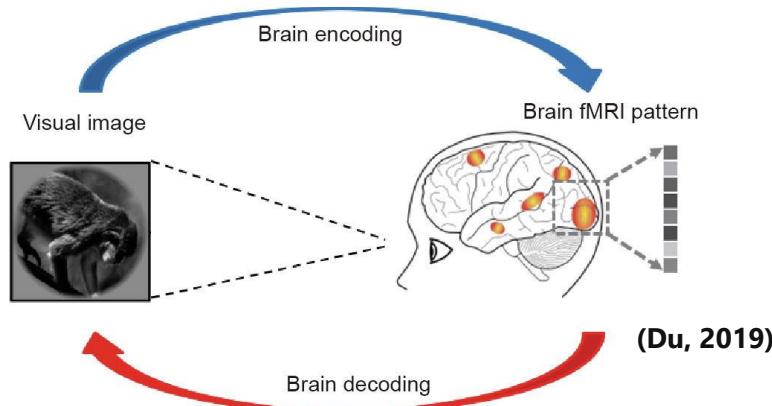


Brain-sensing fragrance diffuser

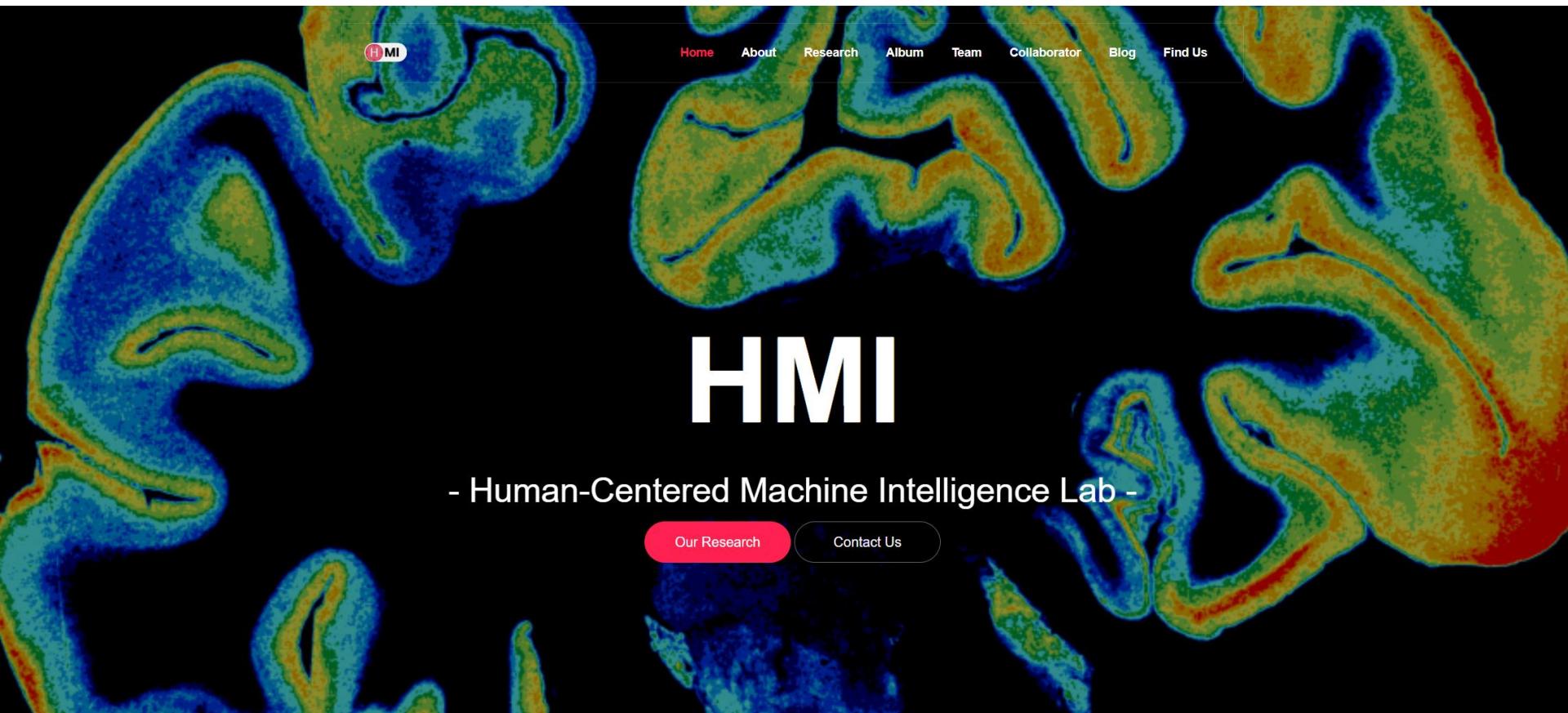


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Decoding and Encoding in Human Brain



<https://nthu-cs-hmilab.github.io/>



Turing Test

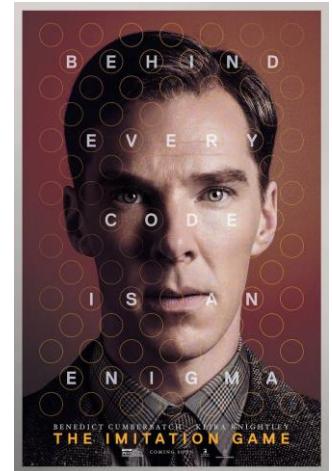
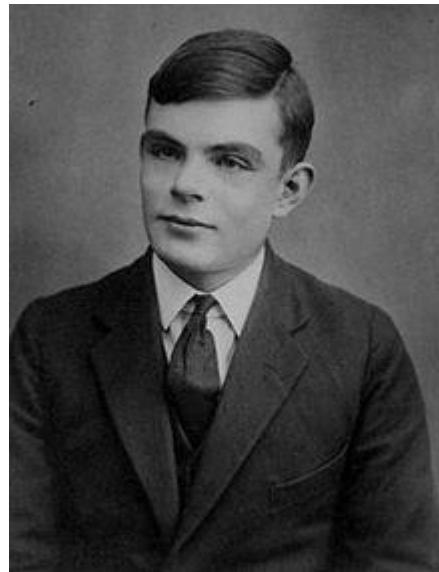


A

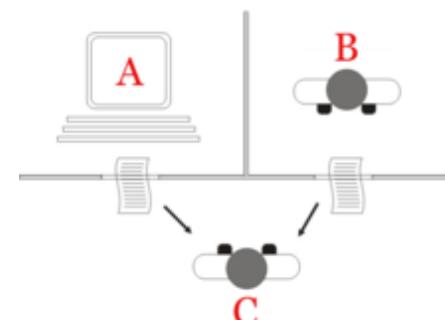
a woman in a kitchen preparing food

B

woman working on counter near kitchen sink preparing a meal



Alan Mathison Turing



Take-home message

- AI vs ML vs DL
- What is representation?
- Supervised vs Unsupervised learning
- Continues output vs Discrete output
- What is shortcut learning?
- What is Turing test?

Questions?



Beginning of the course

End of the course

After becoming an expert

