Deep Learning

Session 1

Course Introduction

Applied Data Science

2024/2025

Course Objectives

- **Learn the theoretical foundations of deep learning**
  - o Explore key concepts such as neural networks, backpropagation, and optimization techniques.

- **Understand the mathematical models behind deep learning**
  - o Understand the mathematical principles, including linear algebra, calculus, and probability, that support neural networks.

- **Implement advanced deep learning algorithms using Python**
  - o Design, code, and optimize algorithms using Python and libraries like PyTorch.

- **Apply deep learning techniques to real-world problems**
  - o Solve complex challenges in domains like computer vision, natural language processing, and predictive analytics.

Classes

- **Thursdays | 16:30 - 18:30**

- **Fridays | 11:00 - 13:00**

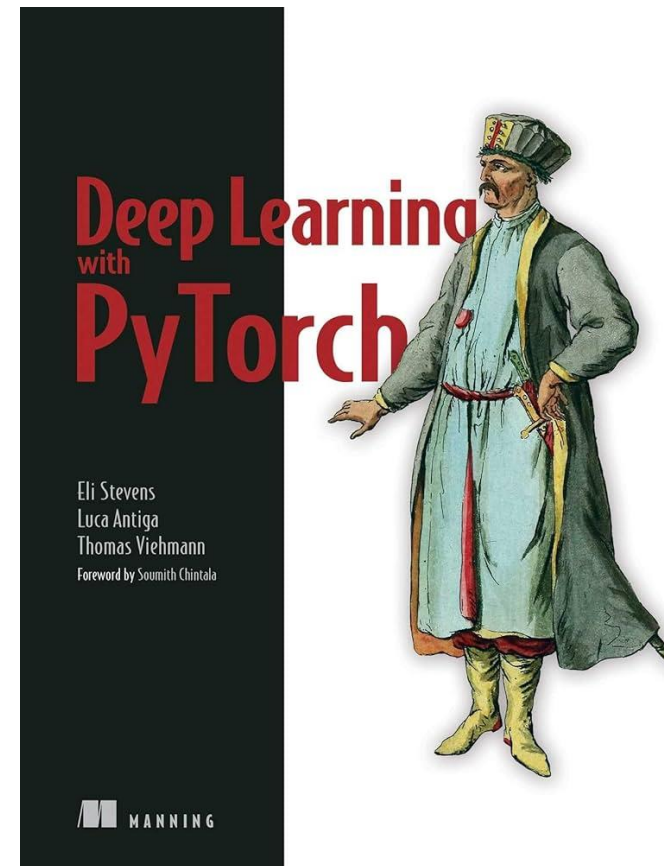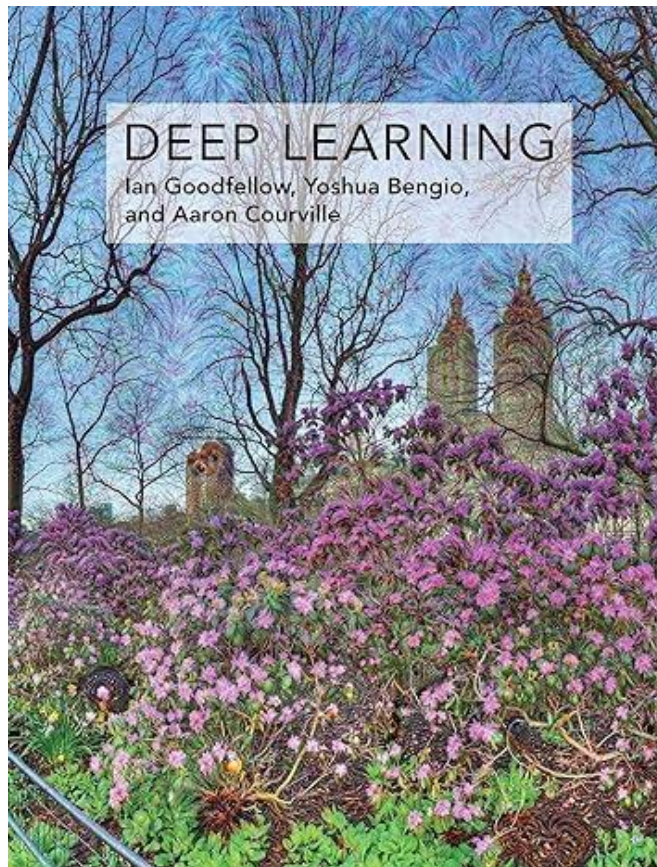- **Theory Session**
  - **Focus**: Foundations of deep learning

- **Hands-On Session**
  - **Focus**: Practical implementation using Python

Evaluation

	% of Final Course Grade
Exam	30%
Lab Assignments	30%
Final Project	40%

Resources

- Both books are available online for free!

Contact

- For all course-related matters you can contact me:

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    OR

    o Jfscorreia95@gmail.com

Deep Learning

- **Artificial Intelligence (AI):** The broadest field focusing on creating machines capable of performing tasks that typically require human intelligence.

- **Machine Learning (ML):** A branch of AI that enables systems to learn and improve from experience without explicit programming.

- **Deep Learning (DL):** A specialized ML technique using neural networks with many layers to model complex patterns in data.

Artificial Intelligence (AI)

Machine Learning (ML)
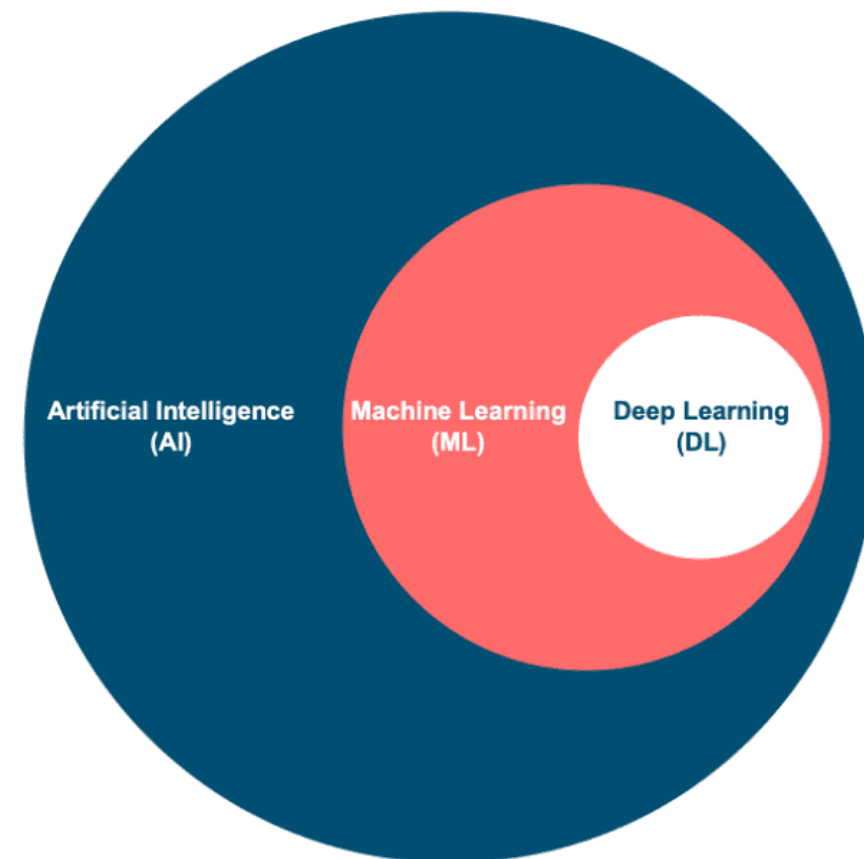
Deep Learning (DL)

Deep Learning: Why now?

1. **Big Data**
   - Larger Datasets
   - Easier Collection and Storage
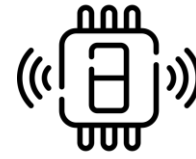
Sensor Data   Public Web

Social Media   Documents

2. **Hardware**
   - Graphics Processing Units (GPUs)
   - Massively Parallelizable
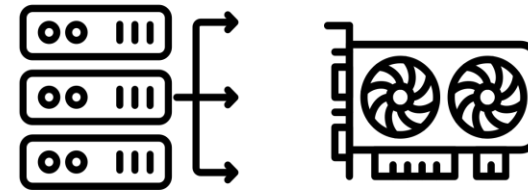
3. **Software**
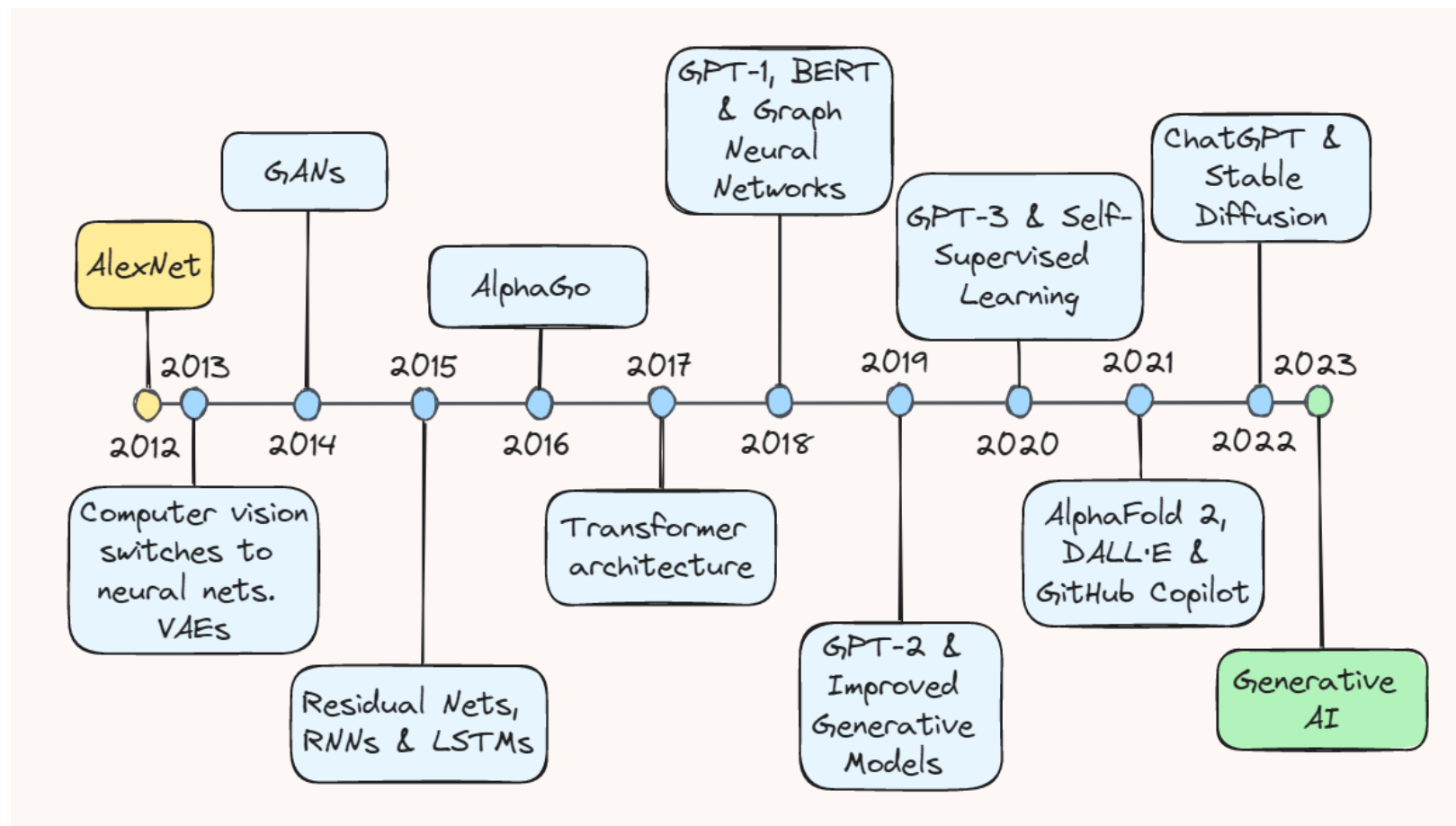   - Improved Techniques
   - New Models
   - Toolboxes

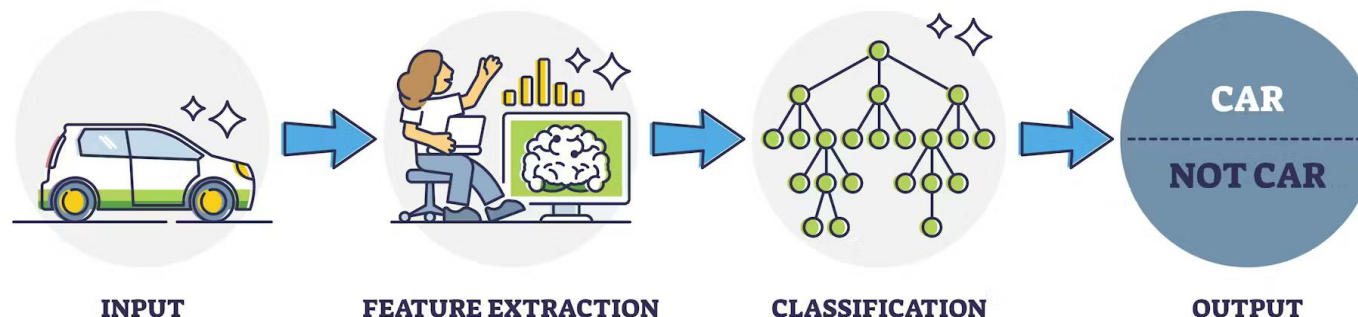TensorFlow

PyTorch

Deep Learning: Timeline

https://www.algotive.ai/blog/machine-learning-what-is-ml-and-how-does-it-work
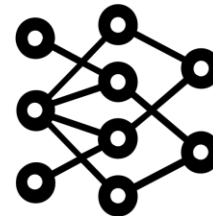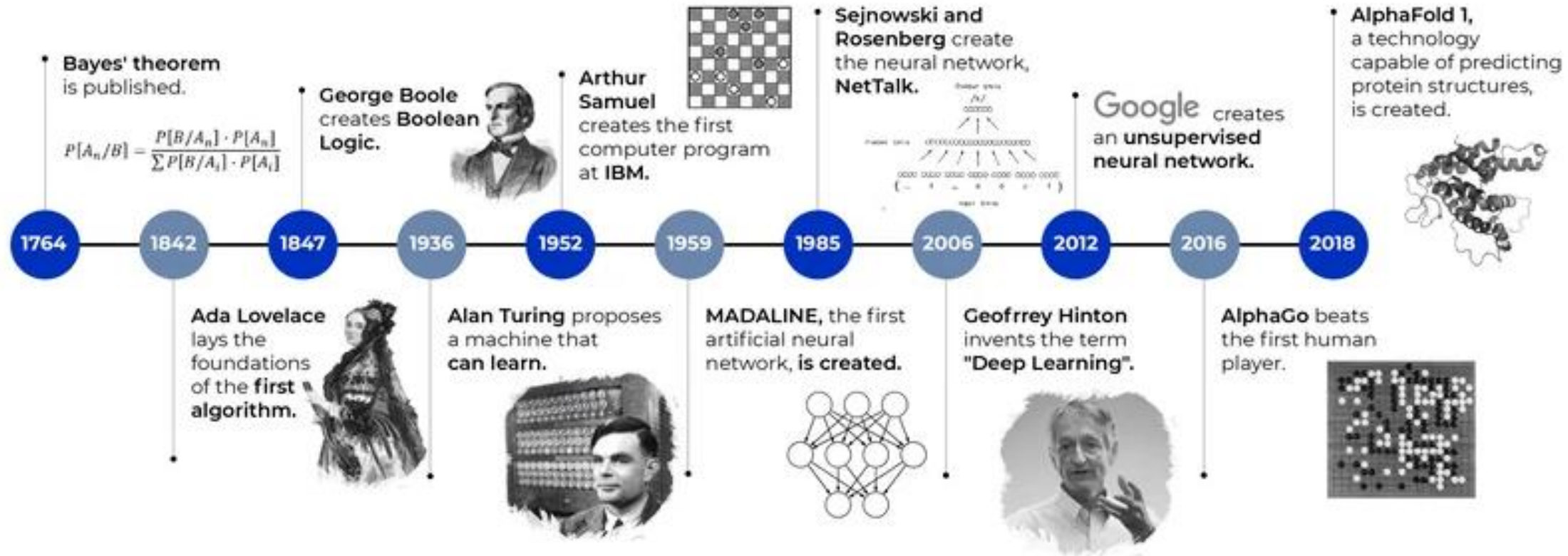
Deep Learning: The Last Decade

https://towardsdatascience.com/ten-years-of-ai-in-review-85decdb2a540

Why Deep Learning over Machine Learning?

https://www.turing.com/kb/ultimate-battle-between-deep-learning-and-machine-learning
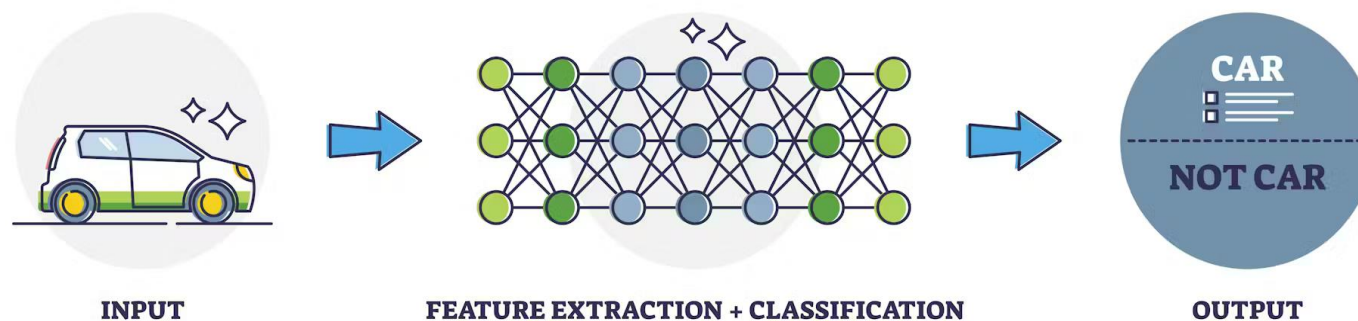
Why Deep Learning over Machine Learning?
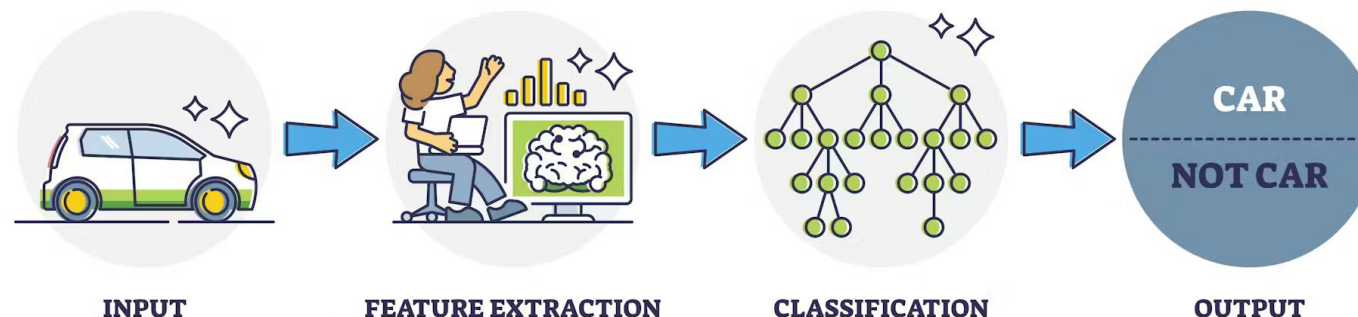
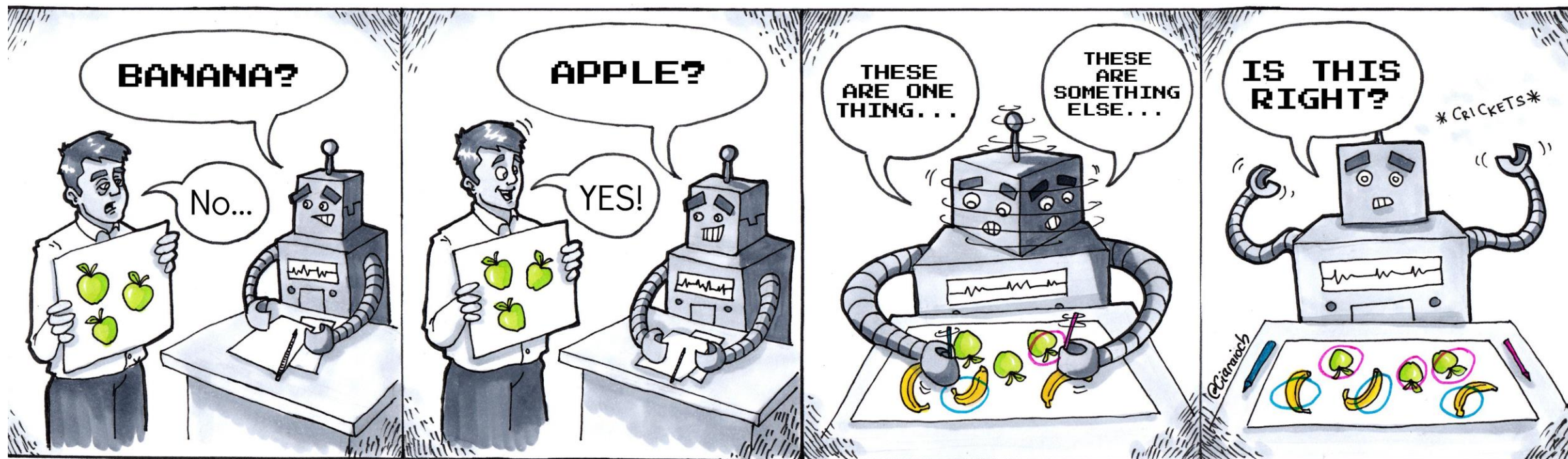**Challenging to hand-craft features!**
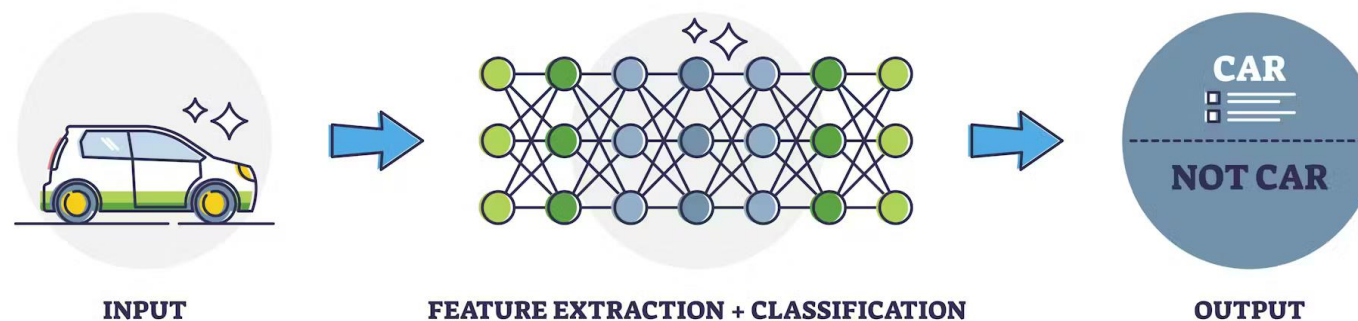
Machine Learning Recap

- General Idea:

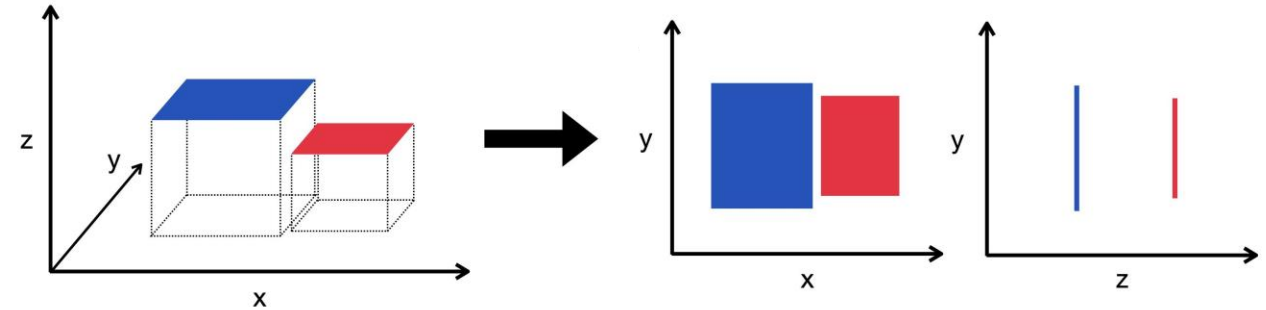**Machine Learning is about turning data into useful insights and predictions with minimal human intervention.**
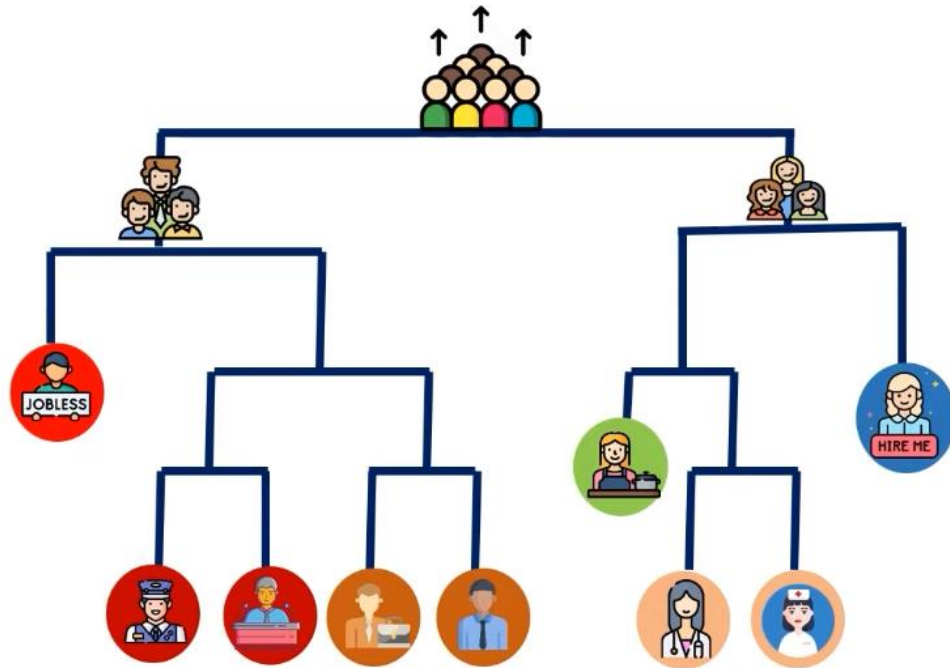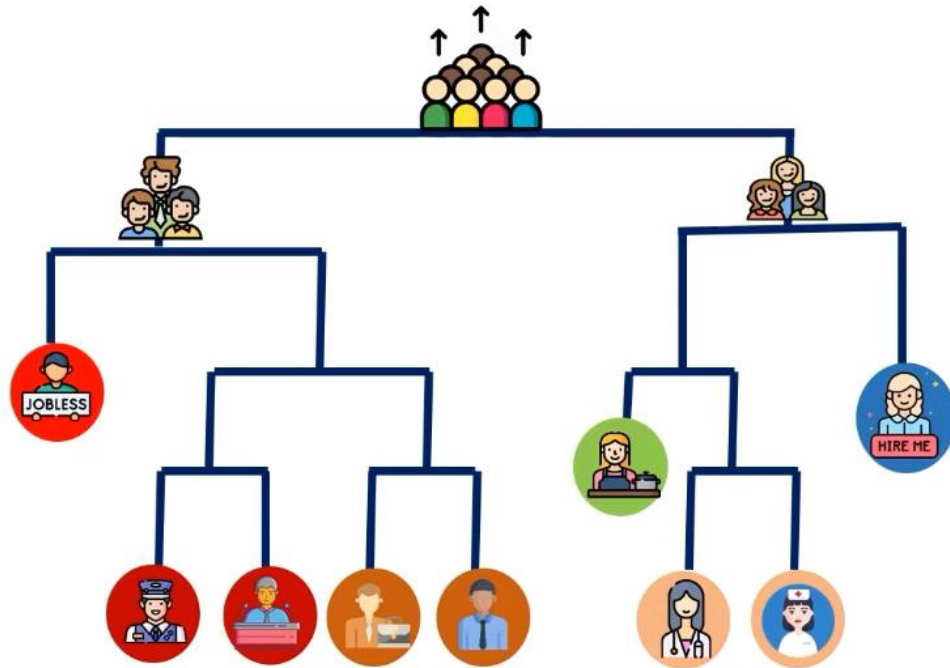
Unsupervised vs Supervised Learning

Illustration by @Ciaraioch

Types of Unsupervised Learning Tasks
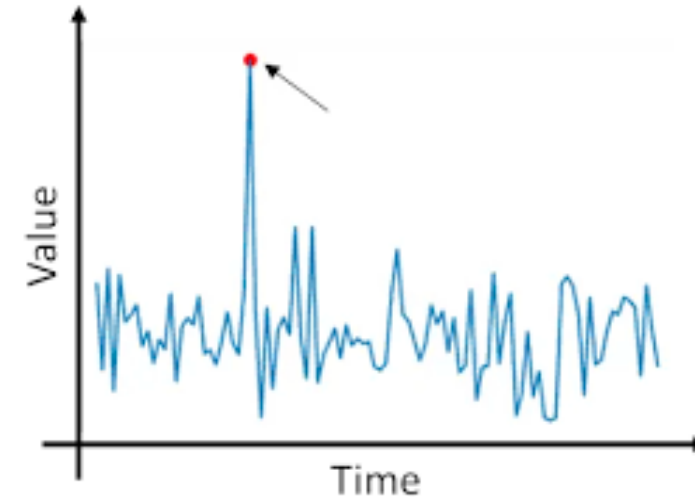
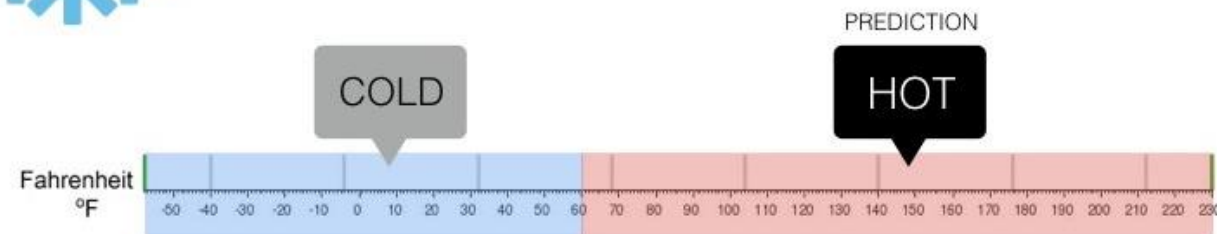# Types of Unsupervised Learning Tasks
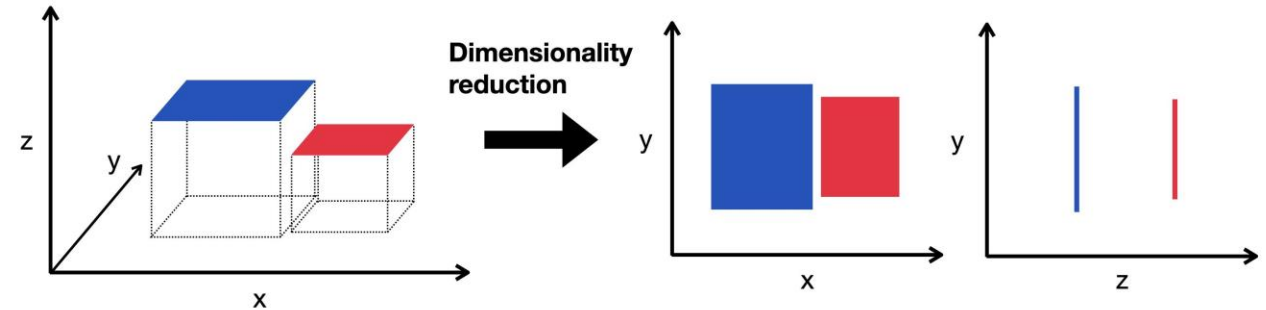
Dimensionality Reduction

Clustering
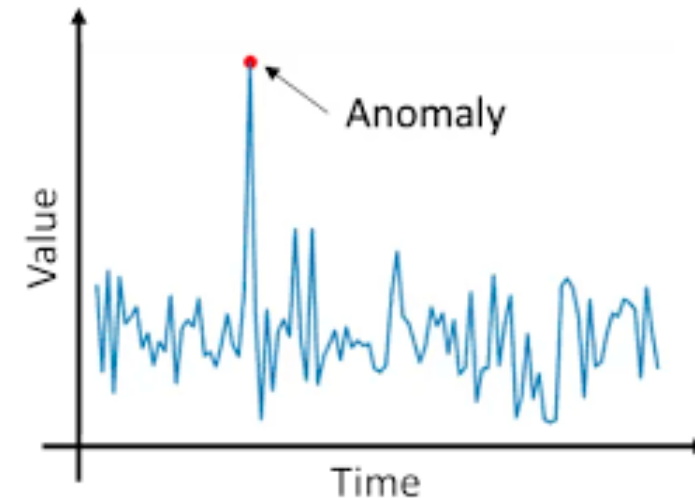
Anomaly Detection

Types of Supervised Learning

Types of Supervised Learning

Data Types

- **Audio**

Data Types

- Audio

- **Images**

Data Types

- Audio

- Images

- **Video**

A Sequence of Video Frames

time

x

y

Blob of connected pixels

Data Types

- Audio

- Images

- Video

- **Text**

The cat sat on the mat

The: [0 1 0 0 0 0 0]

cat: [0 0 1 0 0 0 0]

sat: [0 0 0 1 0 0 0]

on: [0 0 0 0 1 0 0]

the: [0 0 0 0 0 1 0]

mat: [0 0 0 0 0 0 1]

Are you going to be on campus anytime tomorrow? Let me know if you want to have a meeting tomorrow afternoon, instead of Friday afternoon.

1	afternoon
1	are
1	be
0	best
0	go
0	gone
0	monday
1	to
⋮	⋮
1	tomorrow
0	tuesday
1	you
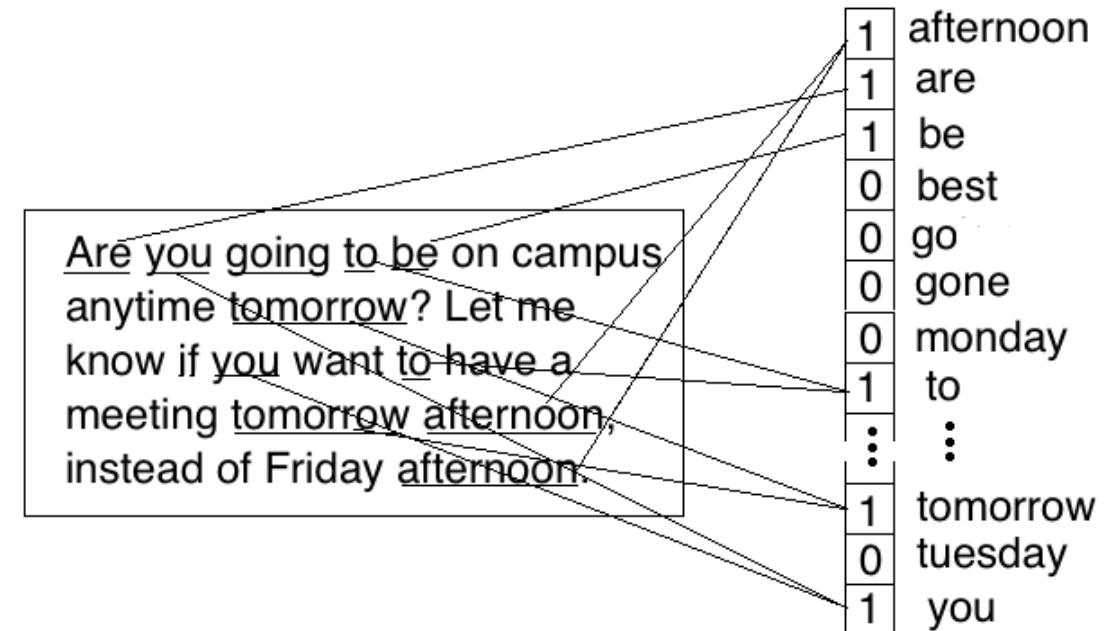
Data Types

- Audio

- Images

- Video

- Text

- **Multi-Modal (combinations of the above)**

Kitten

A kitten or kitty is a juvenile domesticated cat. A feline litter usually consists of two to five kittens. To survive, kittens need the care of their mother for the first several weeks of their life. Kittens are highly social animals and spend most of their waking hours playing and interacting with available companions.

Deep Learning Applications

- **Spam Detection**

Deep Learning Applications

- **Recognition**

(Face)

(Speech)

(Fraud)

Deep Learning Applications

- **Robotics**
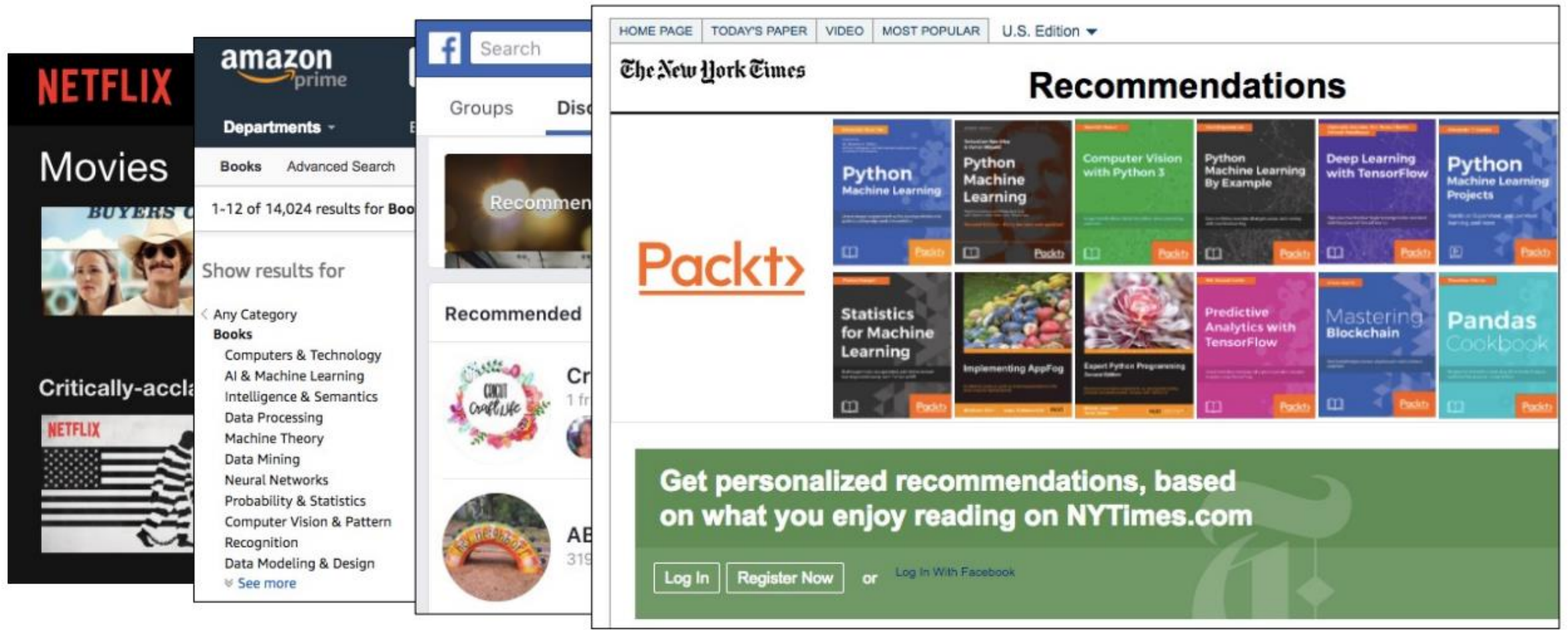

(Self-driving Vehicles)

(Medical Surgery)

(Manufacturing)

Deep Learning Applications
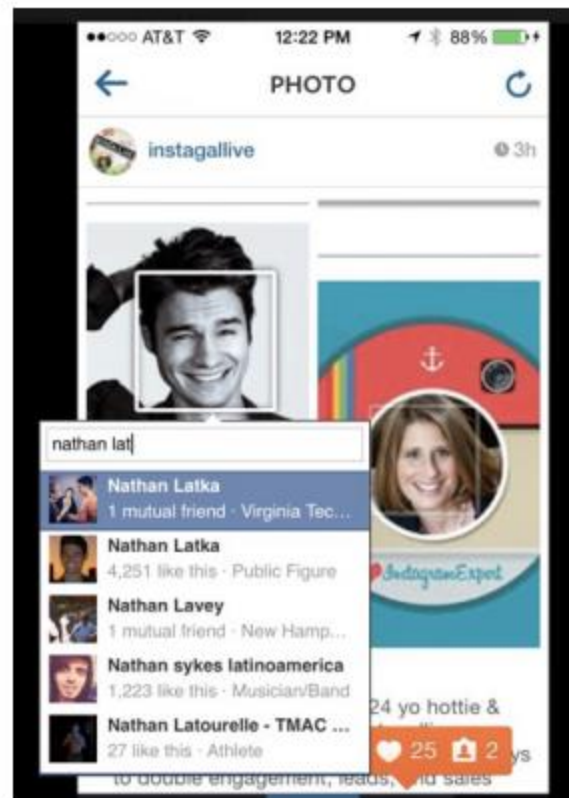
- **Recommendation Systems**

Deep Learning Applications

- **Computer Vision Systems**

e.g., self-driving vehicle on Mars

e.g., recognizing people

e.g., shopping without a cashier

Deep Learning Applications

- **Home Virtual Assistants**

e.g., Amazon's Echo with Alexa

e.g., Google Home