CS541: Applied Machine Learning

Introduction

Instructor: Deepti Ghadiyaram

Meet the crew!

Prof. Deepti Ghadiyaram
(Instructor)

Dahye Kim
(TF)

Ifreen
(TA)

Instructor’s research journey

→ INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY HYDERABAD

AUSTIN → TEXAS The University of Texas at Austin →

→ facebook AI Research → runway

→ BOSTON UNIVERSITY →

Instructor’s research journey

→ INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY HYDERABAD

- Computer graphics
- Signal processing

AUSTIN → TEXAS The University of Texas at Austin

- Cognitive science, Human visual system.
- Image/video perceptual quality assessment

- Large-scale scene understanding
- Responsible AI

→ facebook AI Research →

- Generative models

runway

→ BOSTON UNIVERSITY

Safety, interpretability, robustness

Today

- Course logistics
- What is machine learning?
- Classification introduction

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Website QR Code

Class website

- Main website [CS541 Applied Machine Learning Spring 2025]

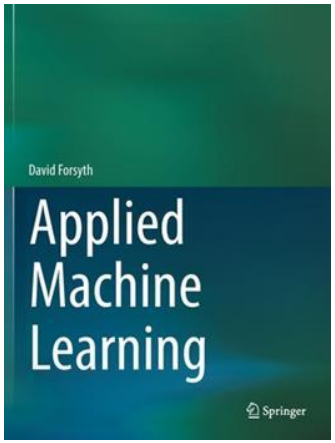
- **Sign up today!** Piazza (Q&A, homework) https://piazza.com/bu/spring2025/cs541
  - Course staff may take up to 2 business days to respond to questions.
  - Come to office hours for quick responses!
  - All communication only via Piazza (private messages / public discussions).

Office Hours

- Deepti's office hours:
  - Tues/ Thurs : 12:45 – 1:45 PM in **CDS 362A**
  - **Sign up here first before you show up during your slot**

- Dahye's office hours:
  - Wed 4:00PM-6:00PM in **CDS 362B**

Textbook



- Required textbook:
  - David Forsyth. Applied Machine Learning; 1st ed.

- Other suggested textbooks
  - Bishop, C. M. Pattern Recognition and Machine Learning. Springer. 2007
  - Ian Goodfellow, Yoshua Bengio, Aaron Courville. Deep Learning.

Problem Sets (35% of grade)

- Bi-weekly problems sets
  - Python coding problems
  - Written math problems
  - Prepare to spend 15+ hours on each
  - Schedule on the website.
- **Late Policy:** 20% penalty per day up to **two days**
  - No special requests
  - Submissions not accepted after two days
- Regrade requests must be submitted 1 week after grades are released

Quizzes (20% of grade)

- Five quizzes
  - (Primarily) multiple choice
  - Timed: must be completed once started with a limited time window for completion
  - 1 week to complete (no late submissions accepted)

Participation (10% of grade)

- Should make a contribution every week such as
  - In-class participation (e.g., via **slido**)
  - Ask questions in class.
  - Respond to other student's questions on Piazza

slido

What word comes to mind when you hear "machine learning"?

ⓘ Start presenting to display the poll results on this slide.

Example Piazza question/responses

One way to ask	What is concept “X”? A: Look at section Z of book and/or lecture Y.
Better way to ask	Regarding concept “X”, what is the role of “Y”? **A: Explanation..** **Key:** Be as specific as possible.

One way to ask	Here are my results (a dump of numbers), do they look right? A: …
Better way to ask	Here are my loss plot, I suspect overfitting. Did anyone in the class see this trend? A: Yes - did you try any regularizers? **Key:** Be as specific as possible.

What questions won't get answered by course staff?

- If they are too vague
- If they have already been asked before.
  - Search before you ask.
- **Be respectful of the course staff's time.**

Labs (20% of grade)

- Hands-on exercises graded based on participation
  - **Bring your laptop** so you can participate
  - Pay attention, be respectful of the instructor
  - Lab materials will be posted to piazza
  - Graded based on **active participation**

- What if you can't make a lab?
  - **Can miss upto 2 labs** throughout the semester.
    - Half credit will be awarded for completing the lab exercise and submitted on gradescope (deadline is the Friday immediately following the lab)

Class Challenge (15% of grade)

Individual end-of-term project

- Based on a real-world problem, hosted as a private challenge on Kaggle or Gradescope
- Goal is to implement a machine learning approach and apply it to the problem
- **Deliverables:**
  - Original code implementing solutions
  - In class presentations.

Summary: Grade Breakdown

Problem sets	35%
Quizzes	20%
Participation	10%
Labs	20%
Class Challenge	15%

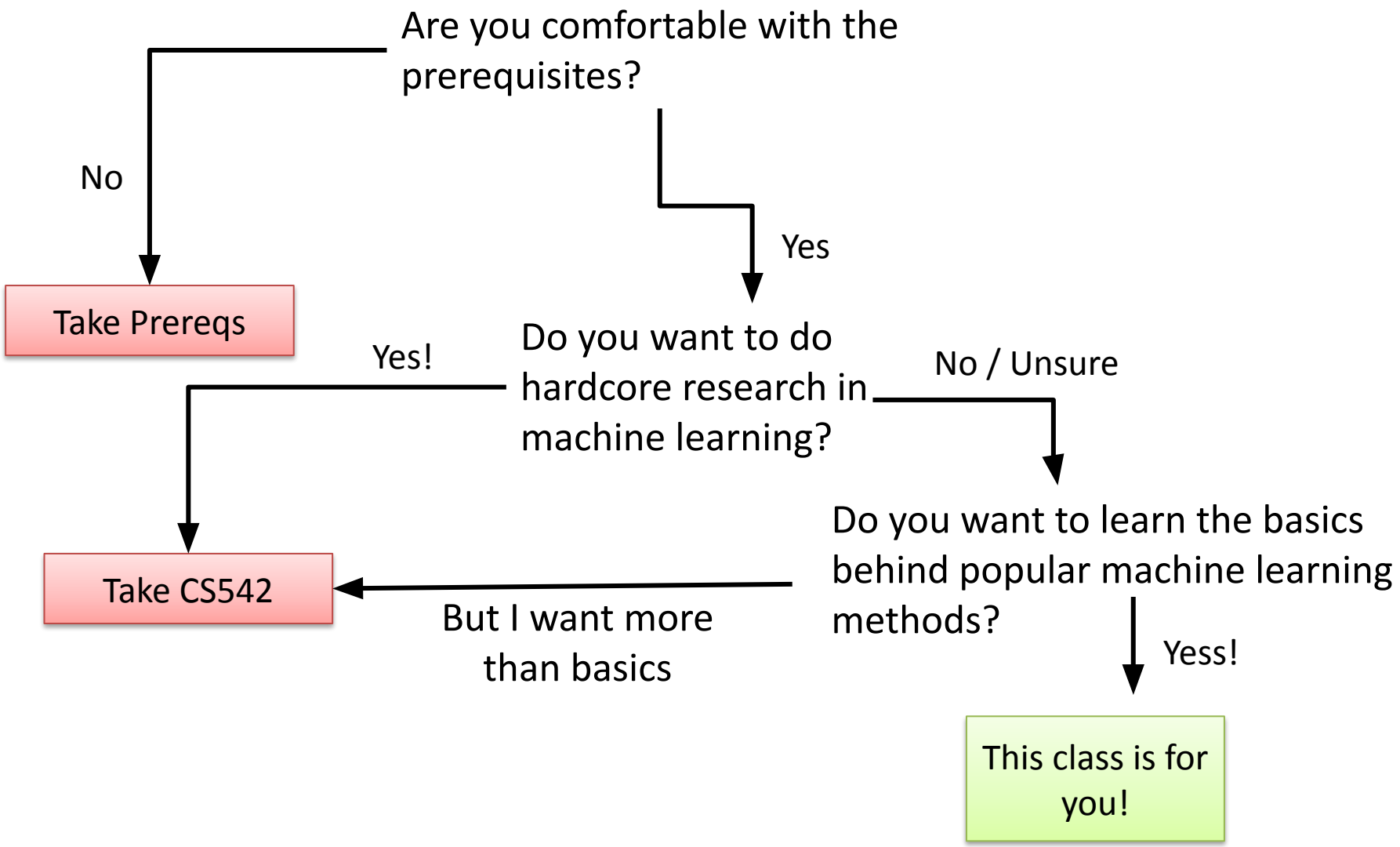
Is this class for you?

		Yes	No
1.	Do you want to do research in machine learning or artificial intelligence?	○	○
2.	Do you want pursue a PhD (especially in machine learning)?	○	○
3.	Do you want to learn *both* the math and the code behind popular machine learning methods?	○	○
4.	Are you comfortable with the prerequisites?	○	○

Alternative Machine Learning Courses

- CAS CS 542 Principals of Machine Learning designed to provide students the background to conduct research in machine learning
  - Math intensive, theoretical.

Is this class for you?



Summary: Is this class for you?

CS542 Principals of Machine Learning and *541 Applied Machine Learning* are alternatives for substantially similar material.

- Your program may only accept one of them for credit towards your degree
- Take CS542 if you want to do machine learning research (i.e., create new machine learning tools)
- Take this course if you want to obtain the background to use machine learning tools effectively.

Course climate

- Some may be more familiar with some topics, some less, and that's ok!
- Please respect each other and listen to each other carefully.
- **It is important to actively participate.**
- No screens (laptops, tablets, phones) during the class.

Course goals

Understand fundamental and popular approaches of machine learning

- Get hands-on experience in coding ML algorithms.
- Maximize your learning experience.
- Have fun!

Academic Policy

- Zero tolerance policy for academic dishonesty.
  - Copying from fellow students
  - Using an LLM to generate code or solving assignments.
- Will be reported directly to the academic conduct committee.
- Detailed academic policy

Today

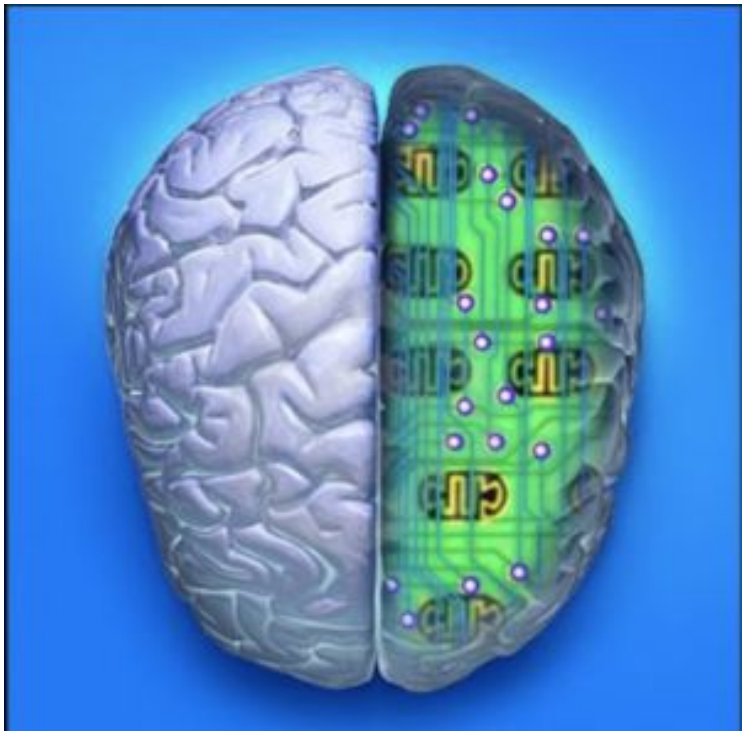
- Course logistics
- **What is machine learning?**
- Classification introduction

slido

What is Machine Learning?

What is Machine Learning?

Build algorithms capable of imitating human intelligence.



learn from data

slido

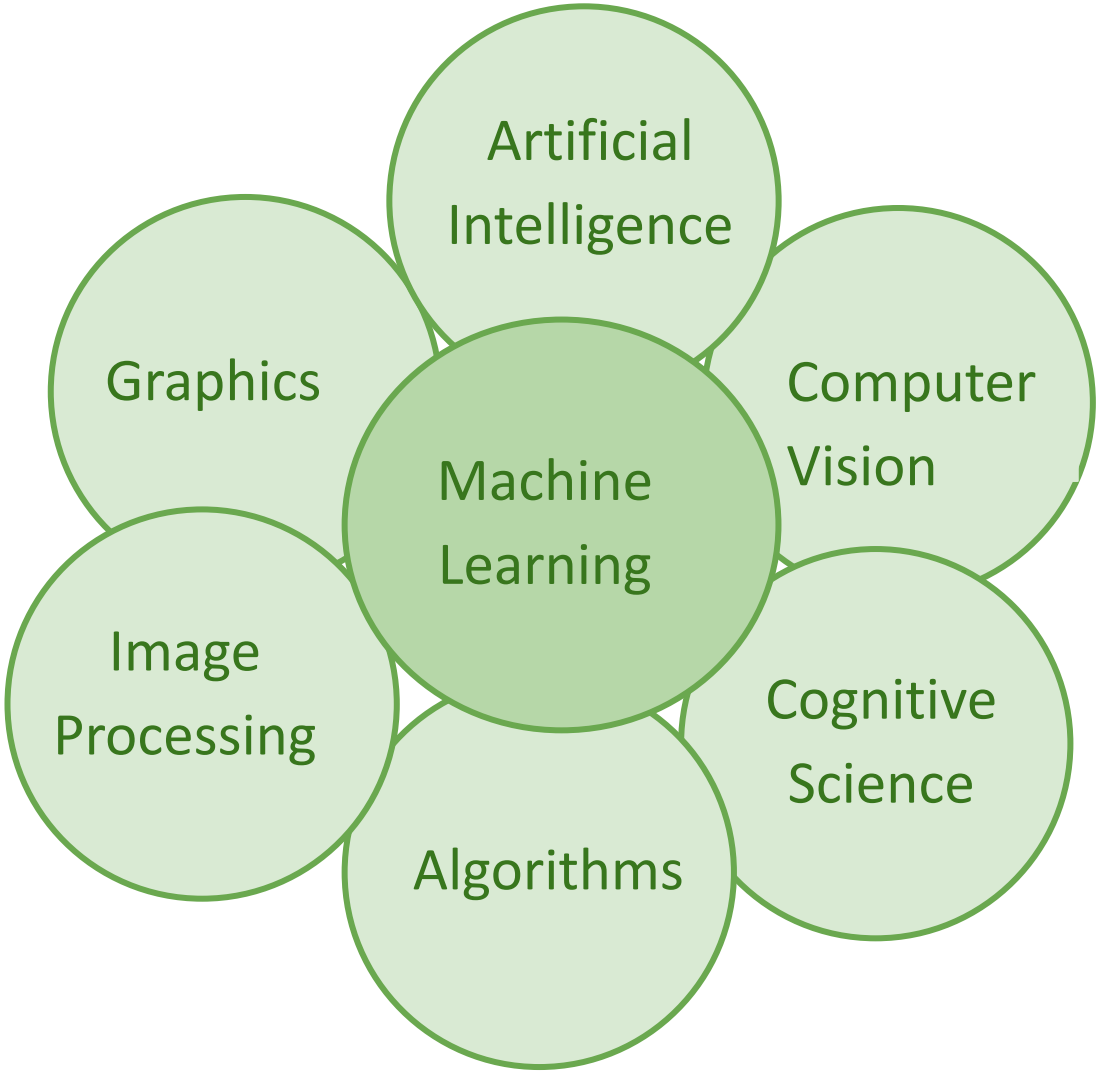
Why do we need Machine Learning?

ⓘ Click **Present with Slido** or install our Chrome extension to activate this poll while presenting.

Machine Learning:
Why do we need it?

- Help automate boring, hard tasks
- Hard to program computer directly to do the task
- Instead, program a computer to **learn** from examples
- Often use “big data” examples.

Relation to other fields

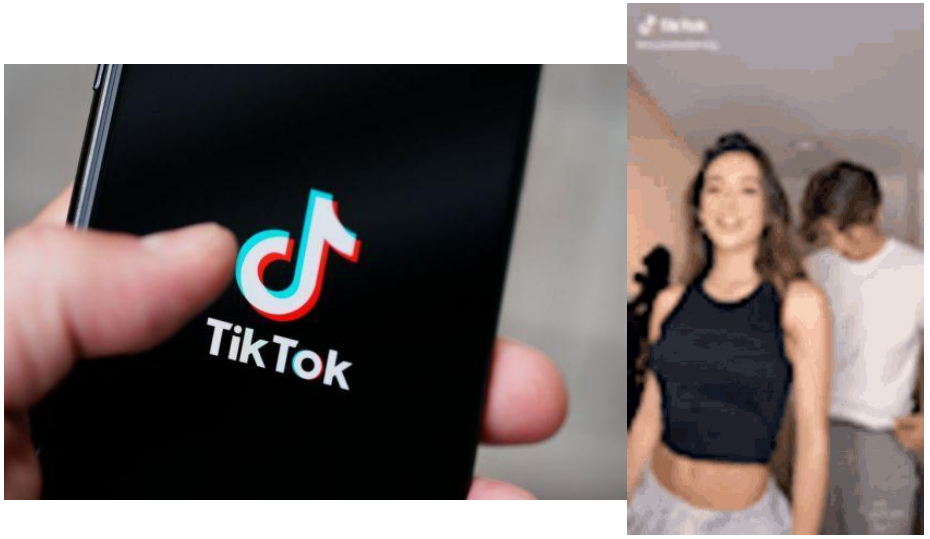


Machine Learning:

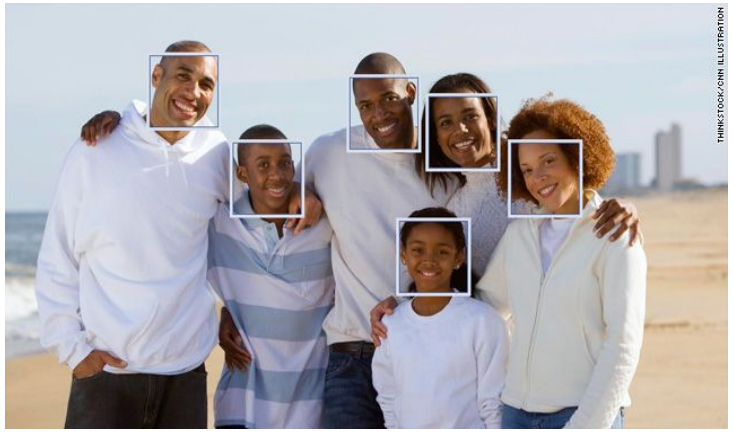
name three ways you used it today!

Machine Learning in Real Life:
social media & entertainment

AI Speakers & assistants



Recommendation algorithm on Tiktok



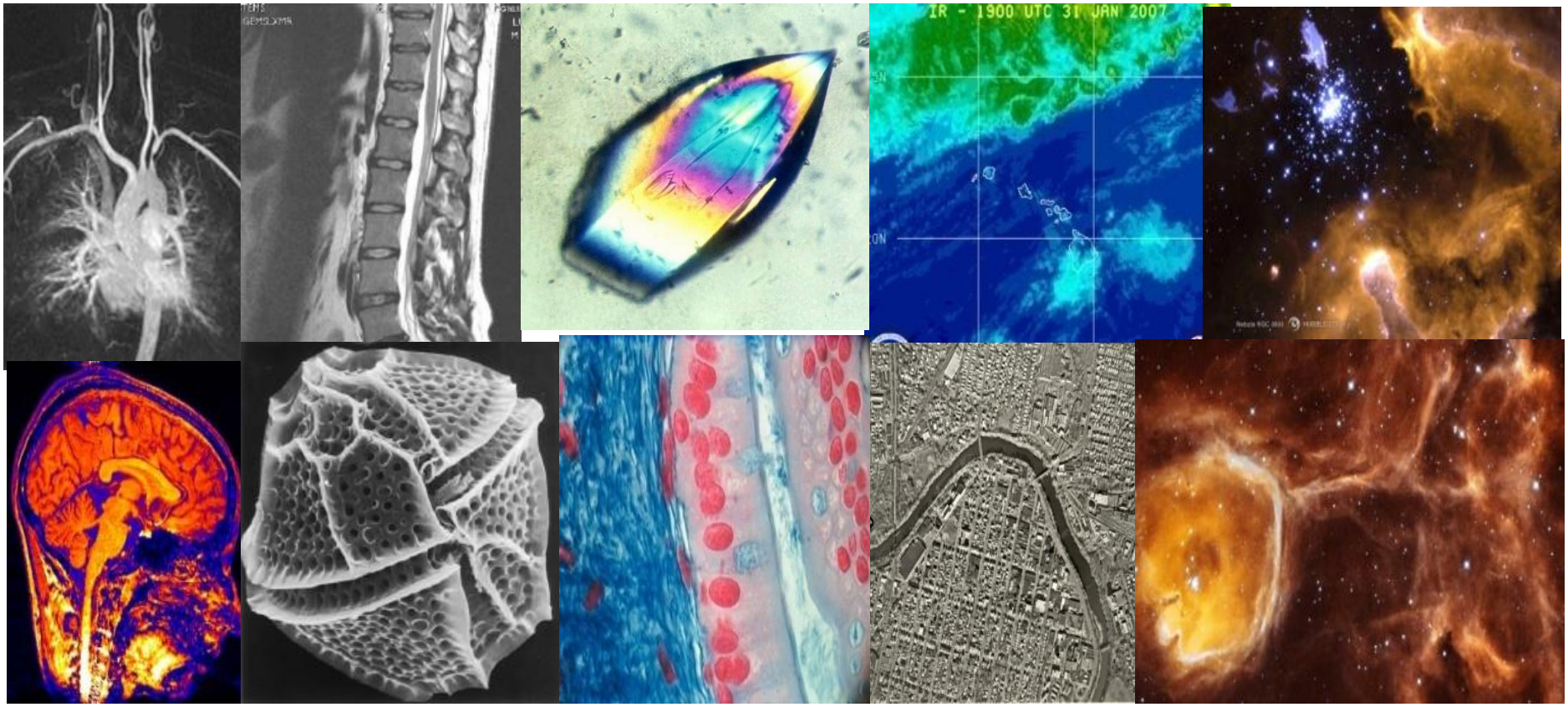
face tagging on social media

Machine Learning in Real Life:
Smart Cars

- Stanford/Google one of the first to develop self-driving cars
- Cars “see” using many sensors: radar, laser, cameras

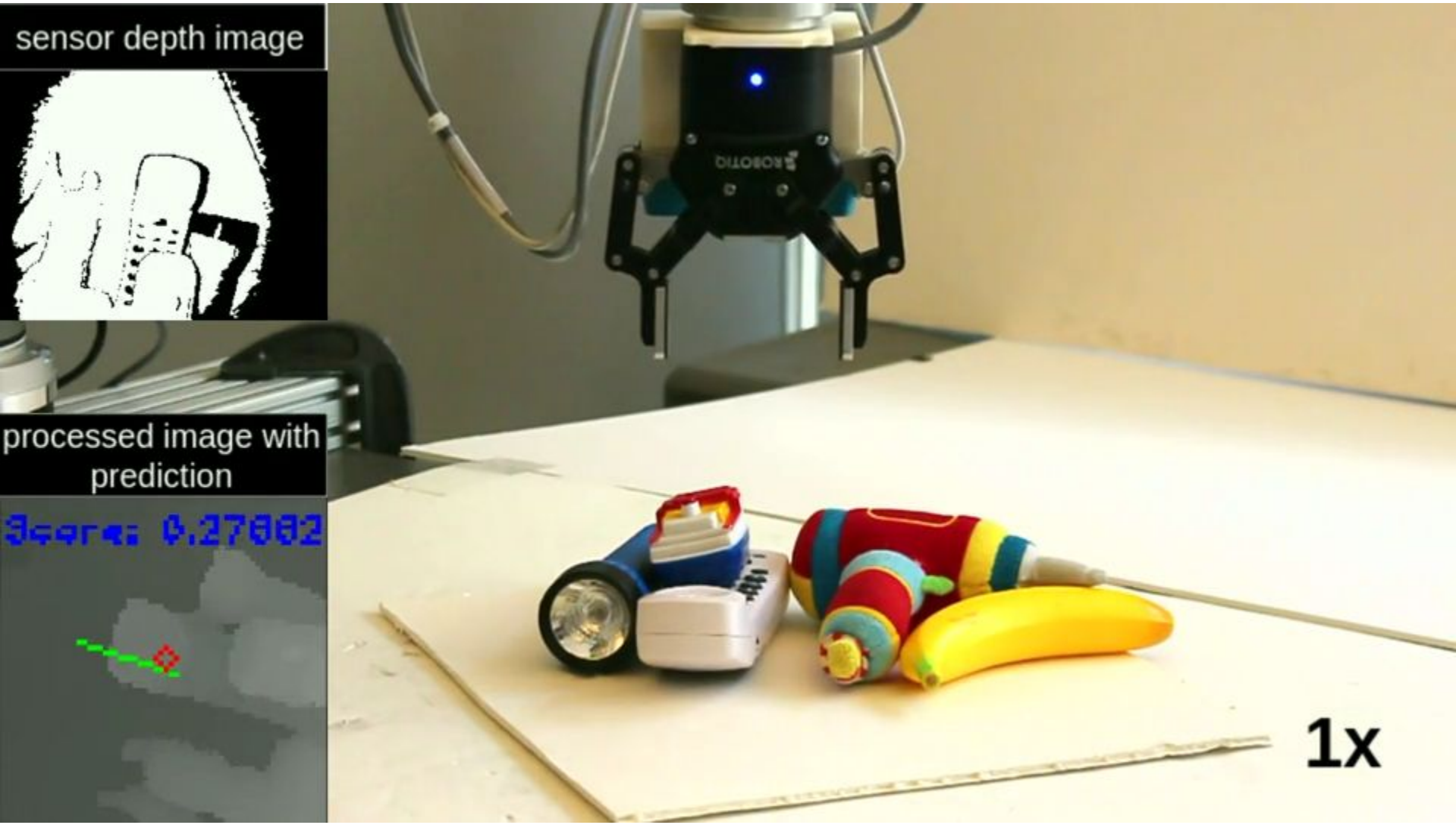
Machine Learning in Real Life:

Medical and Scientific Data



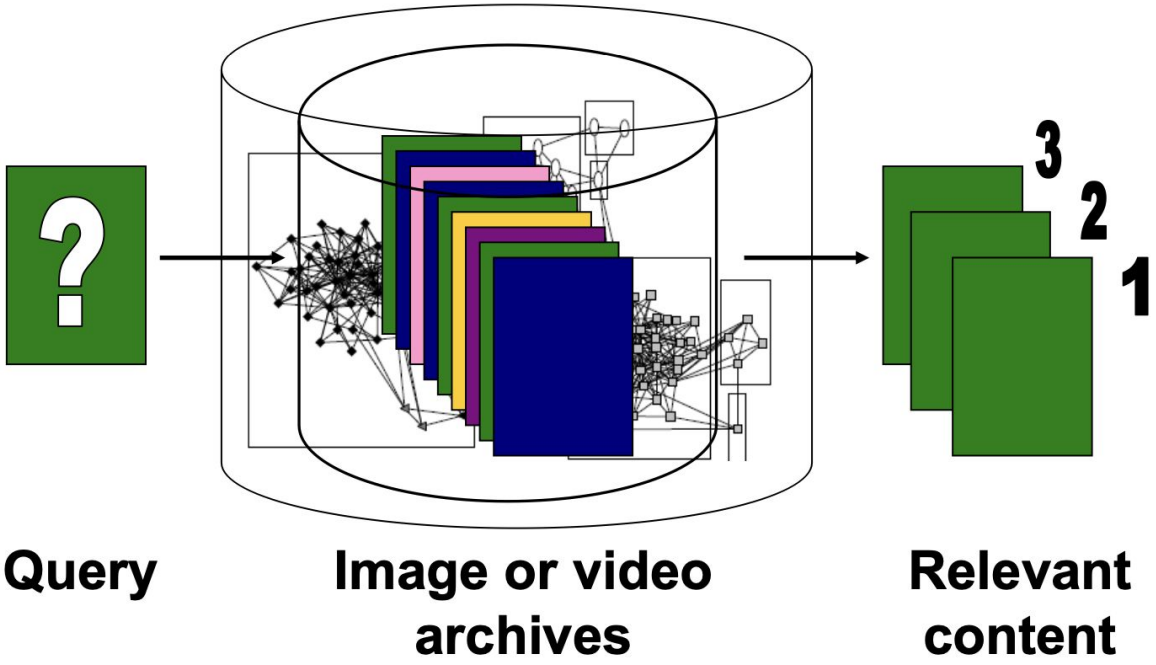
- Healthcare, medical image analysis
- Climate and geography
- Biology
- Astronomy.

Machine Learning in Real Life:
Robotics



Vierreck, Ten Pas, Saenko, Platt. Learning a Visuomotor Controller for Real World Robotic Grasping… CORL17

Machine Learning in Real Life: Search and data organization



Sample applications: Shop for products visually.

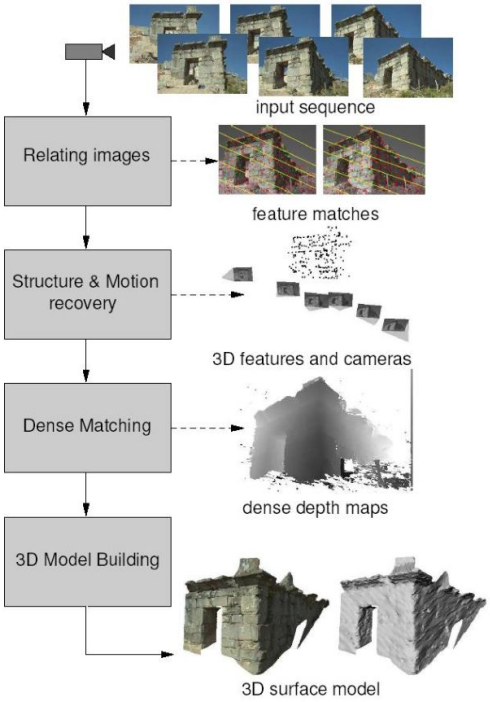
Slide credit: Kristen Grauman

Machine Learning in Real Life: Measurement

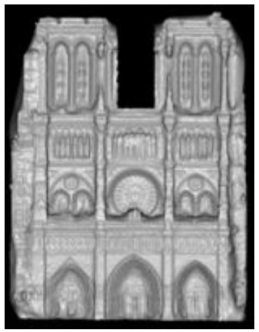
Real-time stereo

Pollefeys et al.

Structure from motion



Multi-view stereo for community photo collections

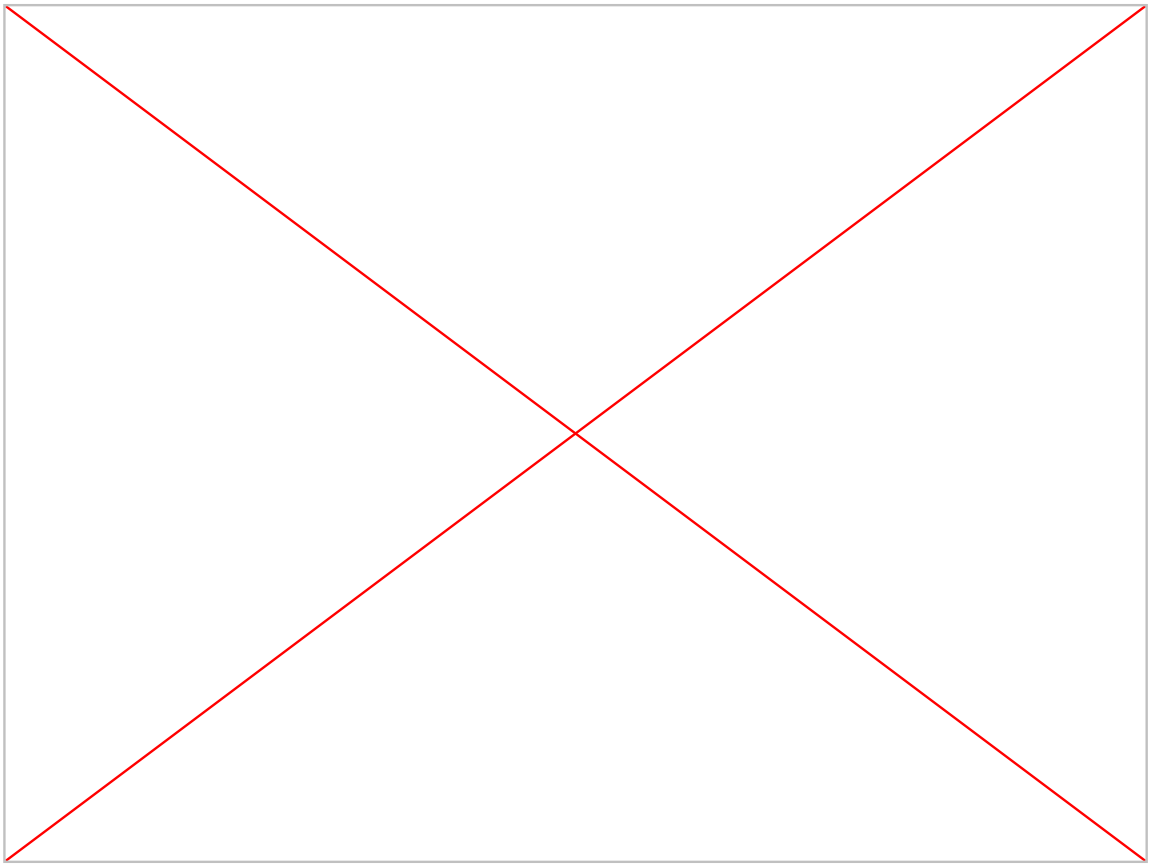


Goesele et al.

Sample applications: Build virtual immersive worlds, self-driving cars

Slide credit: L.Lazebnik

Machine Learning in Real Life: Generation



Sample applications: automatic media creation, generative art, etc.

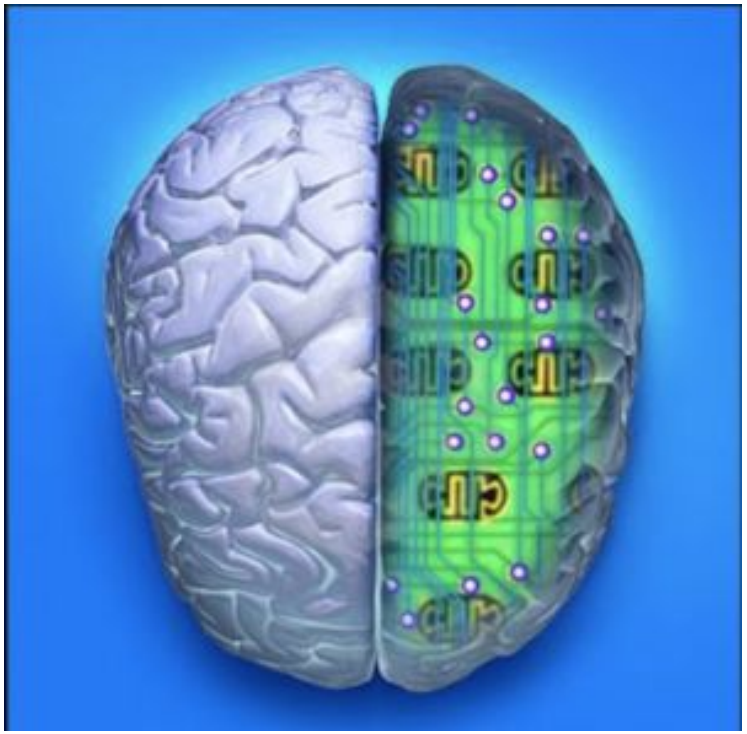
Gen2 by Runway: (Text to video)

Machine Learning in Real Life: Computational Finance

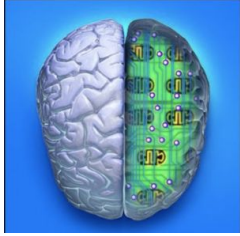
- Predict stock price, cash flows, financing programs, optimize pricing for merchants, fraud detection, etc.

What is Machine Learning?

Build algorithms capable of imitating human intelligence.

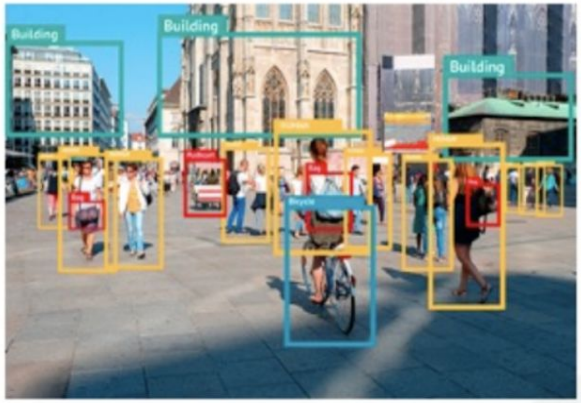


learn from data



So much progress!

Scene planning



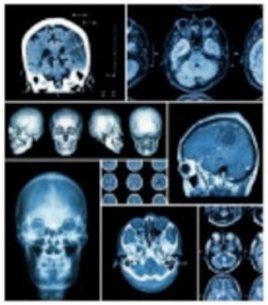
Robot-assisted surgery

Drug discovery

Autonomous vehicles

Facial recognition

Robotics



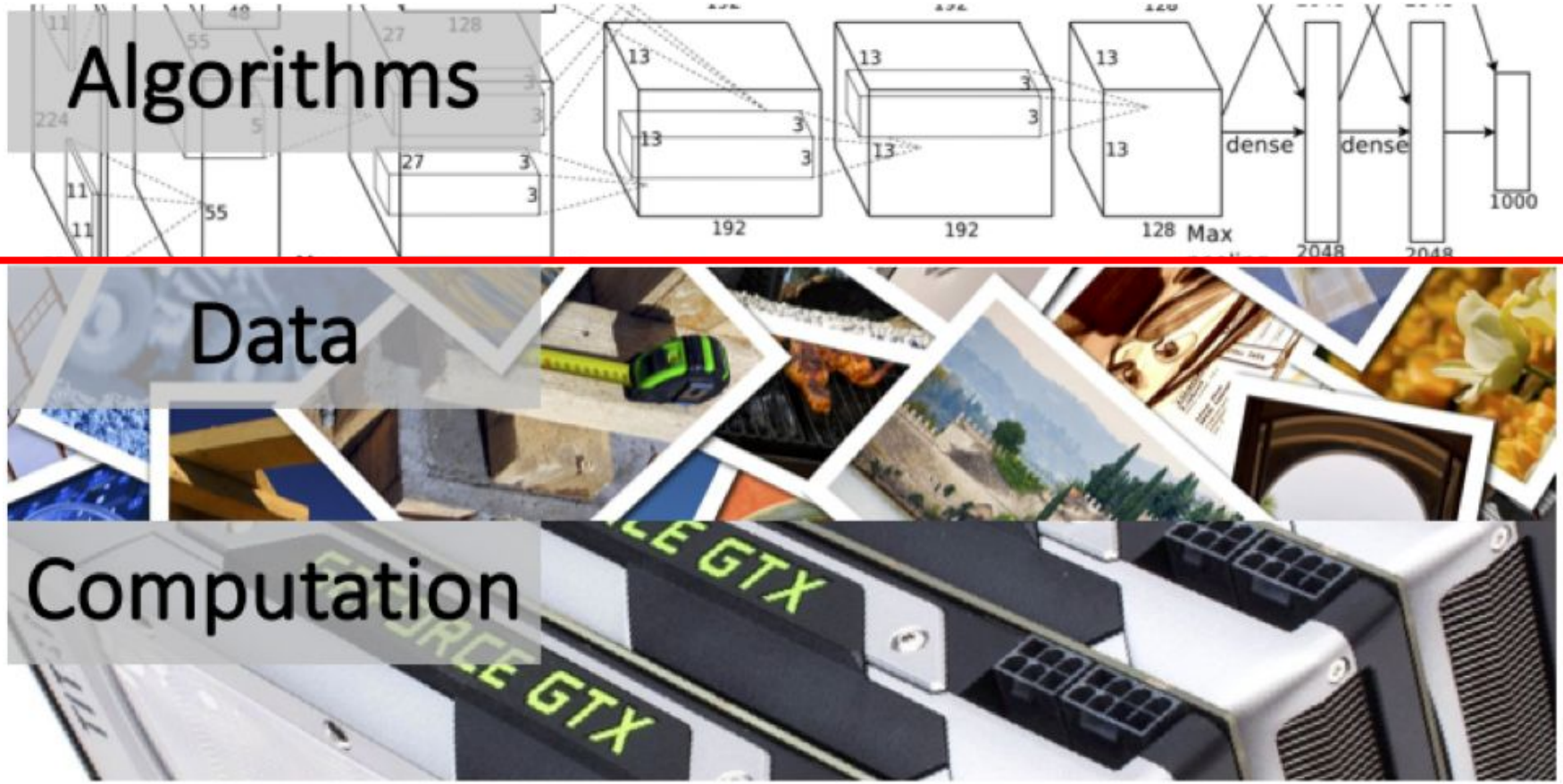
Diagnostics

Slide credit: MIT191

What helped us get here?

Slide credit: Justin Johnson

What helped us get here?



Slide credit: Justin Johnson

Types of learning

Supervised

Unsupervised

Reinforcement

Supervised Learning

- Given a training set consisting of **inputs** and **outputs**, learn to map novel, unseen inputs to outputs

- The novel inputs are called a test set

Training set	Used to learn an algorithm *f*	Set of images
Input	Some attributes of underlying data	Image features
Output	A property we want to predict.	Cat / not cat?

Categorical

Supervised Learning

- Given a training set consisting of **inputs** and **outputs**, learn to map novel, unseen inputs to outputs

- The novel inputs are called a test set

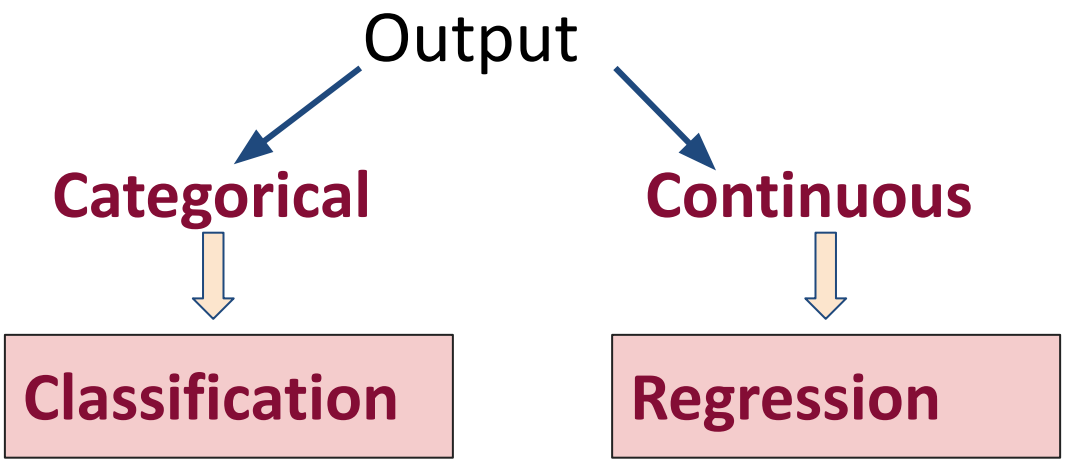
Training set	Used to learn an algorithm *f*	Financial data
Input	Some attributes of underlying data	Market info
Output	A property we want to predict.	Stock price

Continuous

Supervised Learning

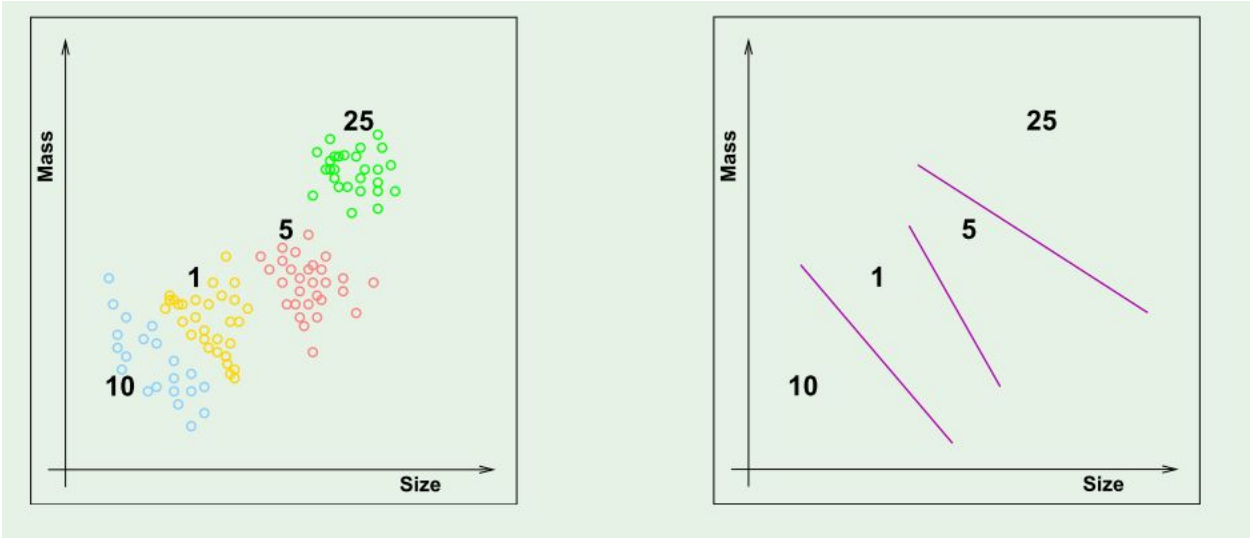
- Given a training set consisting of **inputs** and **outputs**, learn to map novel, unseen inputs to outputs

- The novel inputs are called a test set



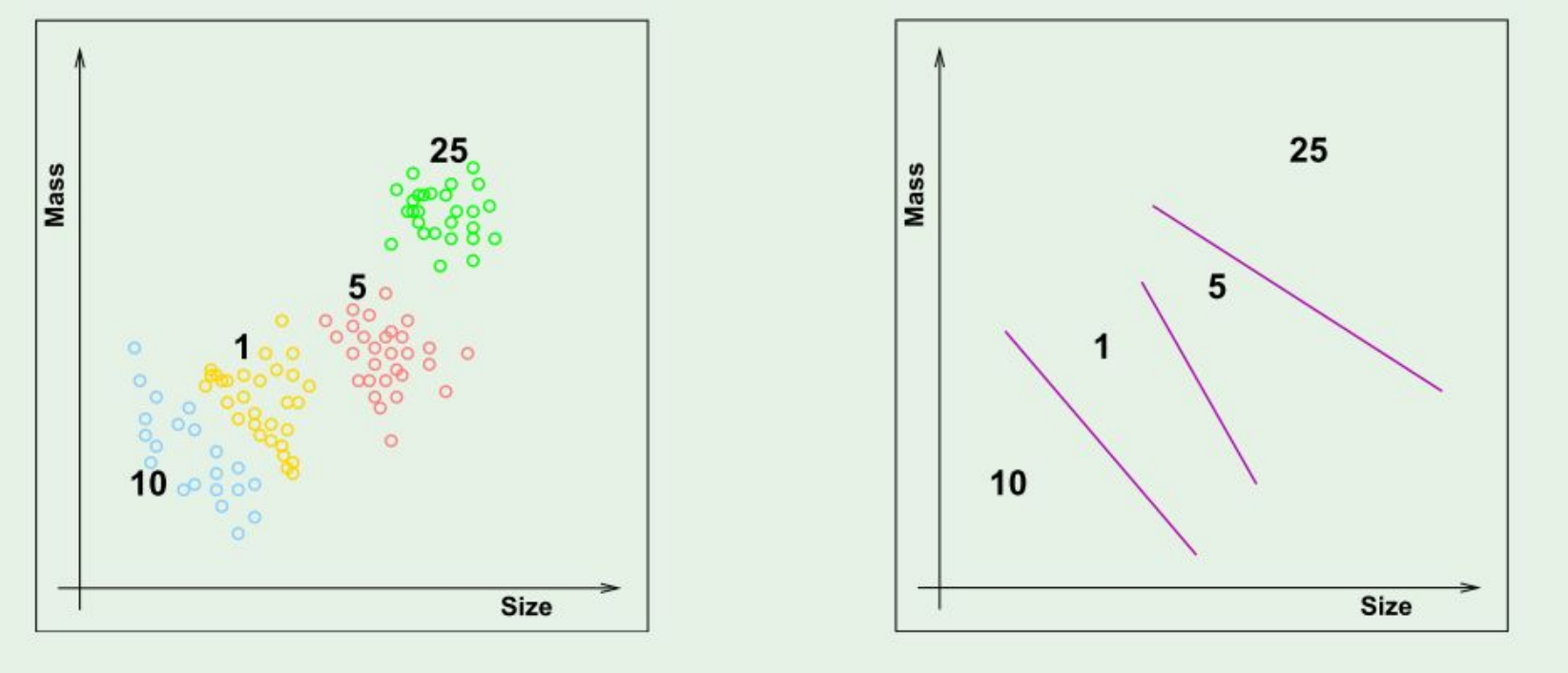
Example of Supervised Learning

recognize coins



- Given training set consisting of coin denomination (penny, nickel, dime, quarter), mass and size
- Learn to predict denomination

Input	Mass, size
Output	Denomination

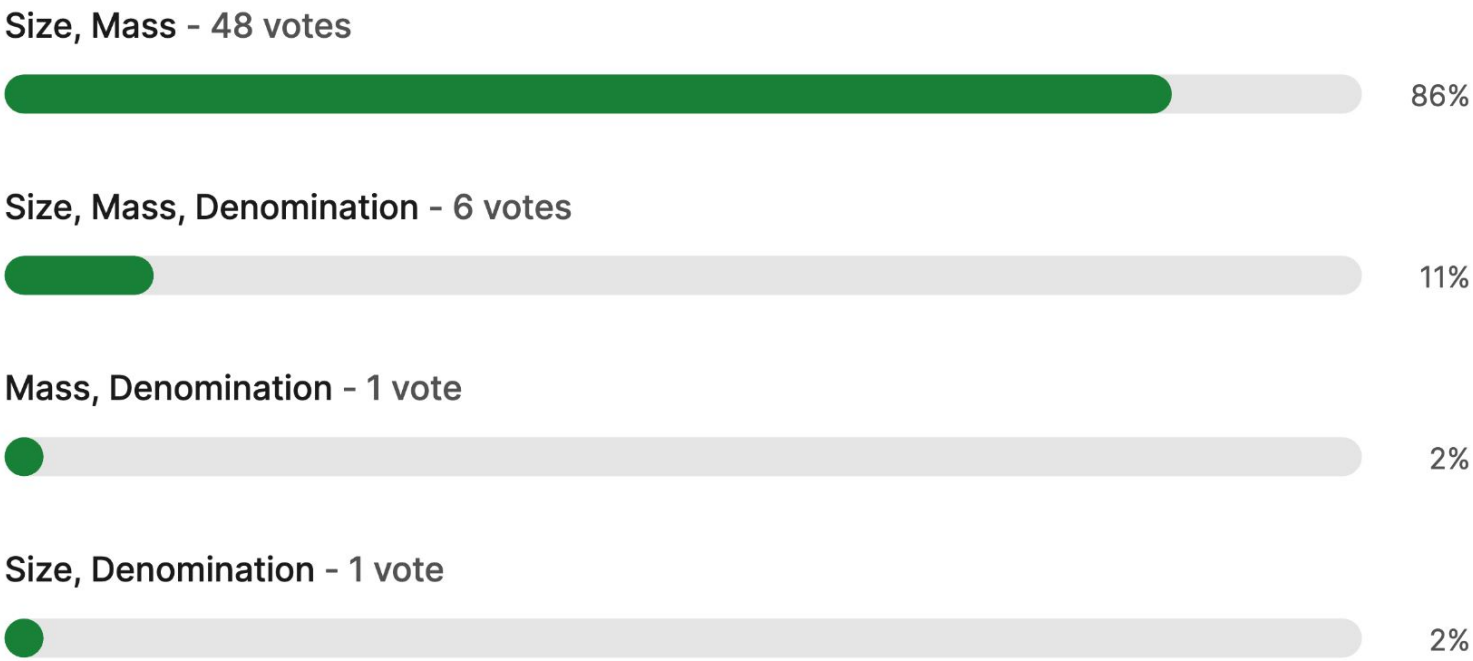


From the plots, what are the inputs to the model?

ⓘ Click **Present with Slido** or install our Chrome extension to activate this poll while presenting.

From the plots, what are the inputs to the model?

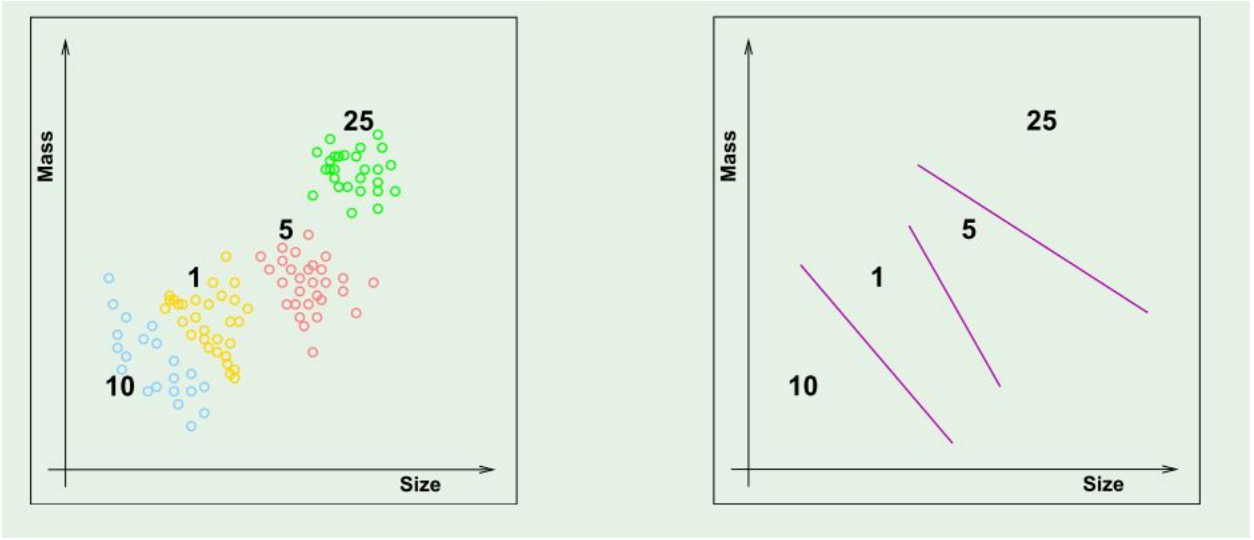
Multiple Choice Poll | 56 votes | 56 participants



slido

Example of Supervised Learning

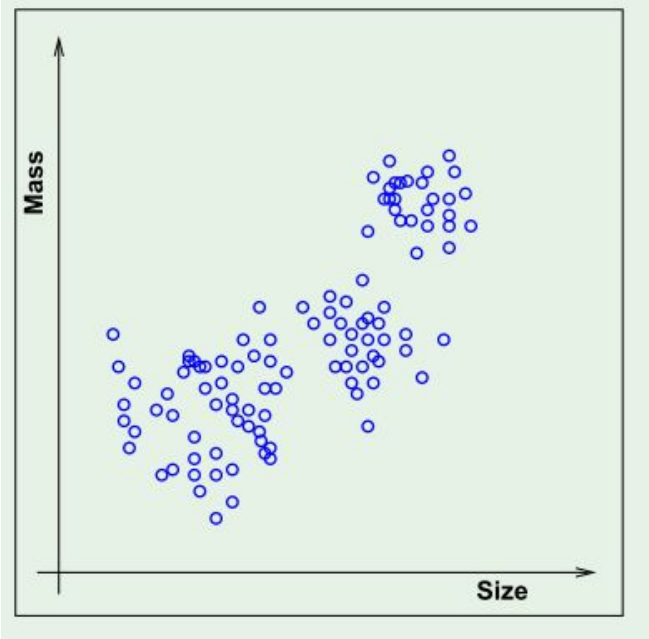
recognize coins



- Given training set consisting of coin denomination (penny, nickel, dime, quarter), mass and size
- Learn to predict denomination

Input	Mass, size
Output	Denomination

Unsupervised Learning



- Given training set consisting of ~~coin denomination (penny, nickel, dime, quarter)~~ mass and size
- Learn… something?

Reinforcement Learning

learn to pick up coins

- Given only input, but can take action
- Predict output (action), get a reward for it

Lab sessions tomorrow

- Introduction to numpy
- Hands-on exercises graded based on participation
  - **Bring your laptop** so you can participate
  - Lab materials will be posted to piazza
  - Upload your lab solutions on gradescope
  - Graded based on participation

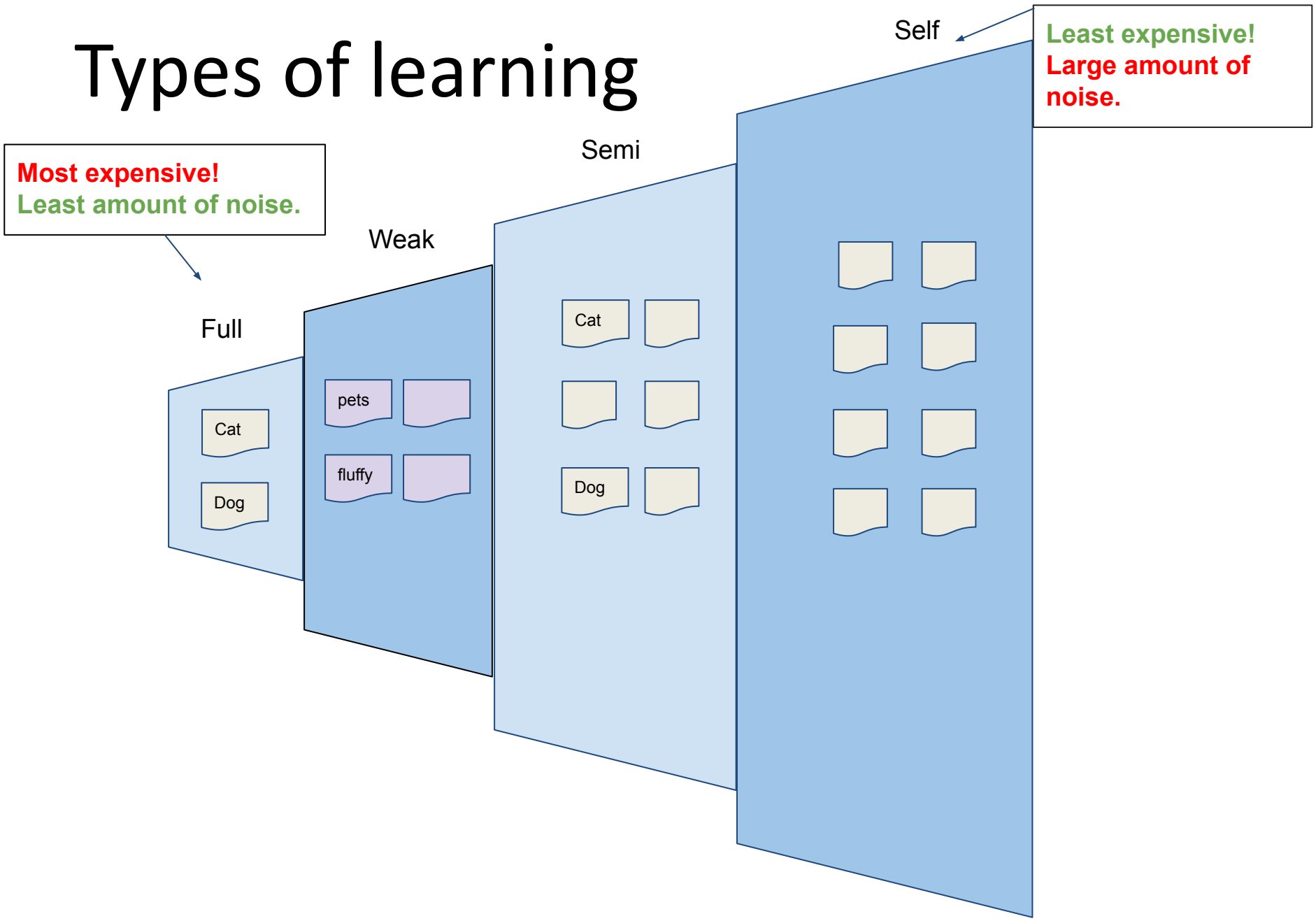
Next Class

Classification I:

Classification intro, error rates, nearest neighbors;

Reading: Forsyth Ch 1.1-1.3

Types of learning



Levels of supervision