MICHIGAN ENGINEERING
UNIVERSITY OF MICHIGAN

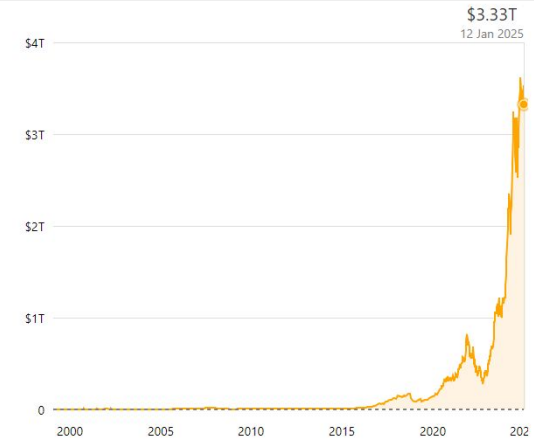
# DeepRob Discussion 0

1/14/2025

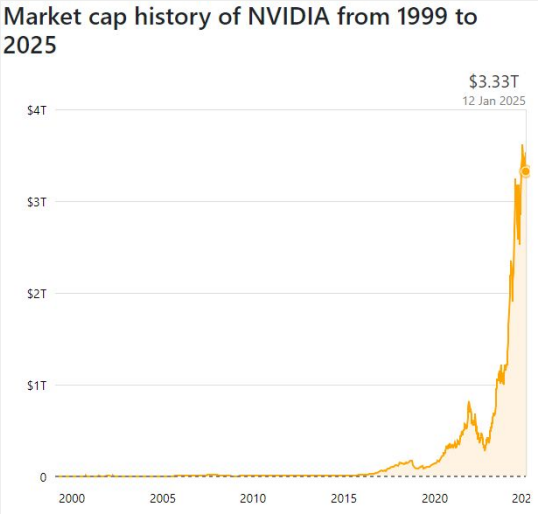
# Session Objective

- Overview of ML and the path forward
- Overview of the tools and how they relate
- Overview of the autograder and mechanics
- Solve a couple cases of P0 together
- Everyone leaves with at least 10 points of P0

# A Riddle…



# A Riddle…


Market cap history of NVIDIA from 1999 to 2025
$3.33T
12 Jan 2025
$4T
$3T
$2T
$1T
0
2000
2005
2010
2015
2020
202

# Learning Objective

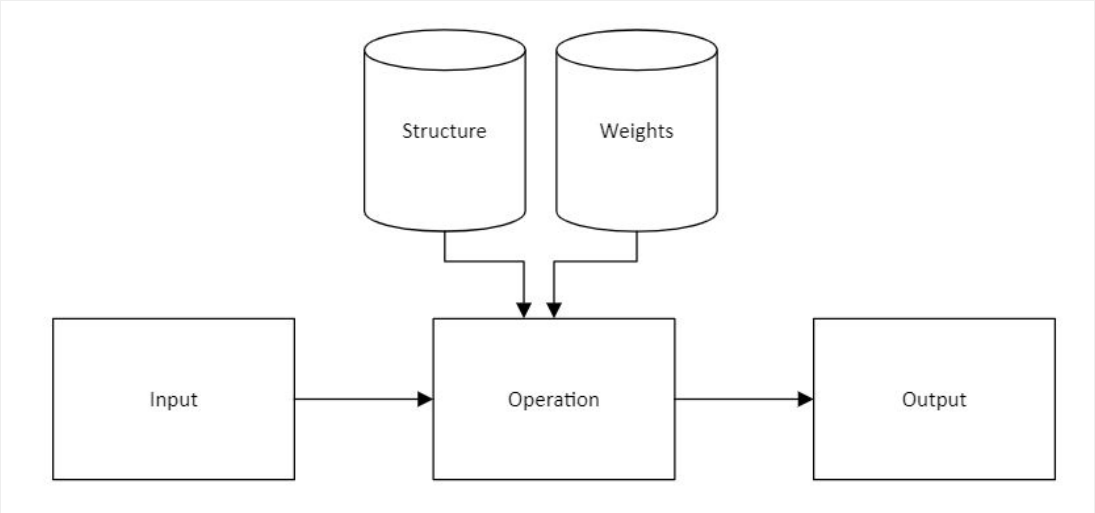
- Describe general structure of a machine learning models and how it relates to robot vision tasks.

# AI/ML Background

Input/Output Formats

- Text
- Numbers
- Images
- Video
- Multi-Modal

All are converted to numbers to feed into model



# Operation Simple Case

(Input * 5.3 + 3.6) = Output

Structure:
(Input * p1 + p2) = Output

Weights/Parameters:
P1 = 5.3, P2 = 3.6

# (Slightly less) Simple Case

(Input * 5.3 + 3.6) * 6.4 + 3.9 = Output

Structure:
(Input * P1 + P2) * P3 + P4 = Output

If f: Input * x + y = Output
f(f(Input)) = Output

However X's and Y's are different for each layer!

Weights/Parameters:
P1 = 5.3, P2 = 3.6, P3 = 6.4, P4 = 3.9

# (Slightly, slightly less) Simple Case

(Input * 5.3 + 3.6) * 6.4 + 3.9 = Output

Structure:
(Input * P1 + P2) * P3 + P4 = Output

Input = 2.4

↓

Input = [2.4, 4.5]

Weights:
P1 = 5.3, P2 = 3.6, P3 = 6.4, P4 = 3.9

↓

Weights (Matrix):
P1 = [5.6, 5.3], P2 = [p21, p22], …

# (Slightly, slightly less) Simple Case

(Input * 5.3 + 3.6) * 6.4 + 3.9 = Output

Structure:
(Input * P1 + P2) * P3 + P4 = Output

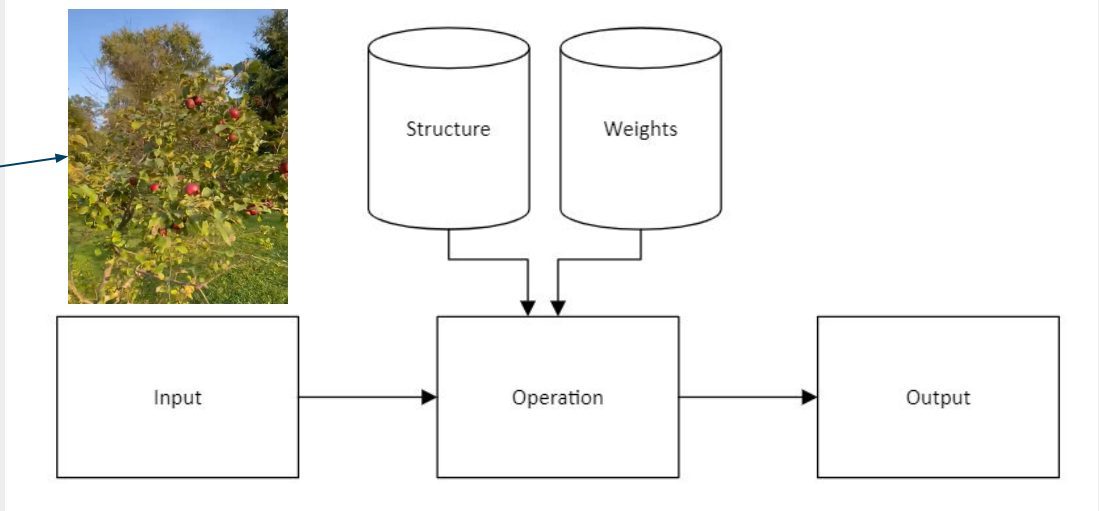


This operation is orders of magnitude more efficient on GPUs

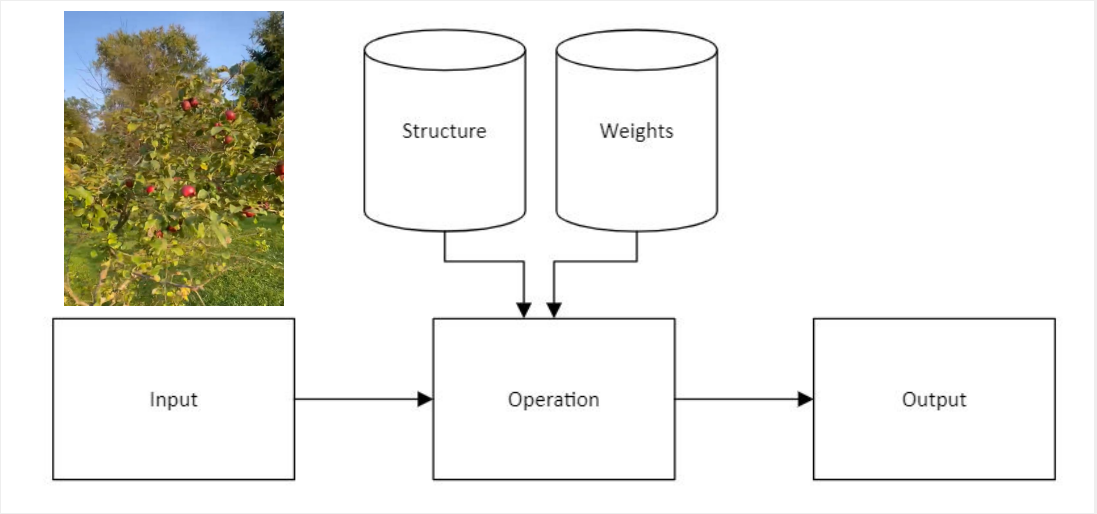
This is the reason NVidia is worth $3.3***T***

# Bringing It Back, Input and Output

- Input for vision models are images and video
- An images is represented by a matrix of pixels
- A video is a dimensional extension of images



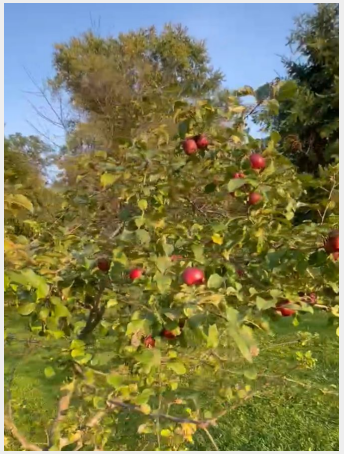
# Bringing It Back, Input and Output




- Output is determined by the structure of the function
- Structure of the function is chosen to facilitate a task

# What vision tasks can we design for? How does it relate to output?

Input



Output Formats

| Text | Numbers | Images | Video* |
|---|---|---|---|
| “apple, tree, leaf, outdoors”<br><br>Example: CLiP | apple is located at [x,y] and is [w,z] in size<br><br>Examples: YOLO, PoseCNN | Pixel segmentation, color correction<br><br>Example: YOLO-Seg, Affinity-LCFCN | Video segmentation<br><br>Example: SAM2 |

# Potential Vision Outputs: Text

Youtube-BB

**airplane, person** (89.0%) Ranked 1 out of 23 labels

✓ a photo of a **airplane**.

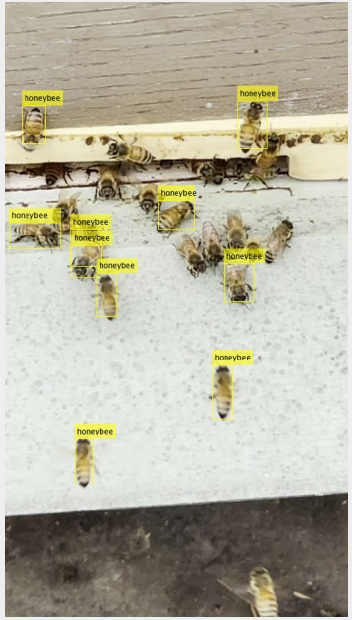
× a photo of a **bird**.

× a photo of a **bear**.

× a photo of a **giraffe**.

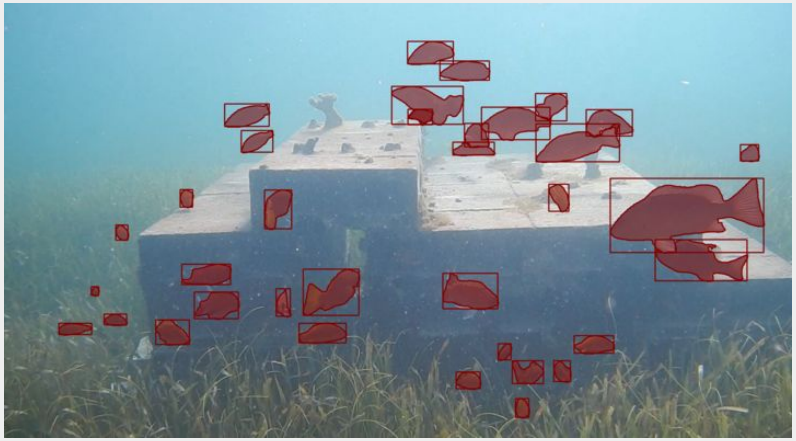
× a photo of a **car**.

# Potential Vision Outputs: Numbers





# Potential Vision Outputs: Images (Masks)



# Potential Vision Outputs: Video

# Potential Vision Outputs: Video

# Back to Our Learning Objective

- Describe general structure of a machine learning models and how it relates to robot vision tasks.
  - Machine learning paradigms are composed of inputs, outputs, structures and weights
  - Inputs for machine vision are primarily images and video
  - Structure is determined by task to be accomplished
  - Weights are tuned via training
  - Outputs are determined by structure: example outputs shown included recognition, detection, classification, and segmentation

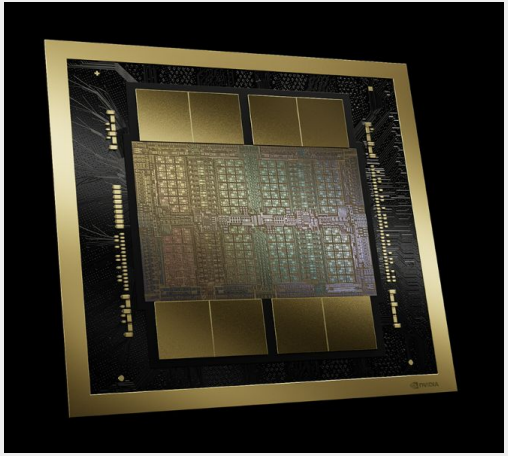
# Demo - Inspect SAM2 Codebase

# Learning Objective

- Identify core tools used in this class
  - Hardware
  - Programming Languages
  - Libraries
  - Environments
  - Course Tools

# Hardware

- GPUs
  - Specifically CUDA-enabled
- What are some of the advantages?
- What are some of the disadvantages?
- Specific to class?



# Programing Languages

- Python!
- What are some of the advantages?
- What are some of the disadvantages?
- Specific to class?

# Libraries

- PyTorch ecosystem
- What are some of the advantages?
- What are some of the disadvantages?
- Specific to class?

# Environments

- Colab vs. Local
- What are some of the advantages?
- What are some of the disadvantages?
- Specific to class?

Visual Studio Code

# Learning Objective

- Identify core tools used in this class
  - Hardware - CUDA hardware
  - Programming Languages - Python
  - Libraries - PyTorch
  - Environments - Colab/VS Code

Quick break!

# Learning Objective - Class Tools

- Class Specific Tools
  - Autograder
    - Demo Later
    - Nuances of submission
  - Piazza