



MML

Machine Learning: An Introduction

Foundations of Modern Machine Learning
IHUB-Data, IIIT Hyderabad





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What is Learning?



Human vs. Machine

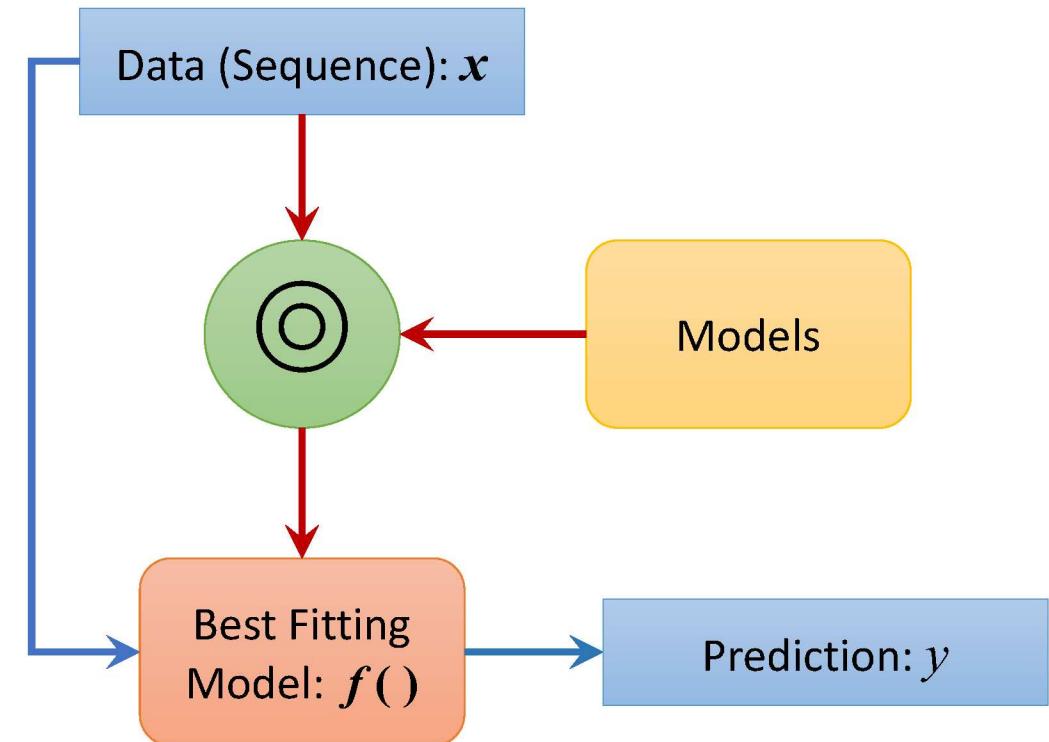




What is next?

- 2, 4, 6,
 - 3, 5, 7, 11
 - 2, 3, 5, 8,
 - 2, 7, 56,
-
- How do we get the machine to do this?

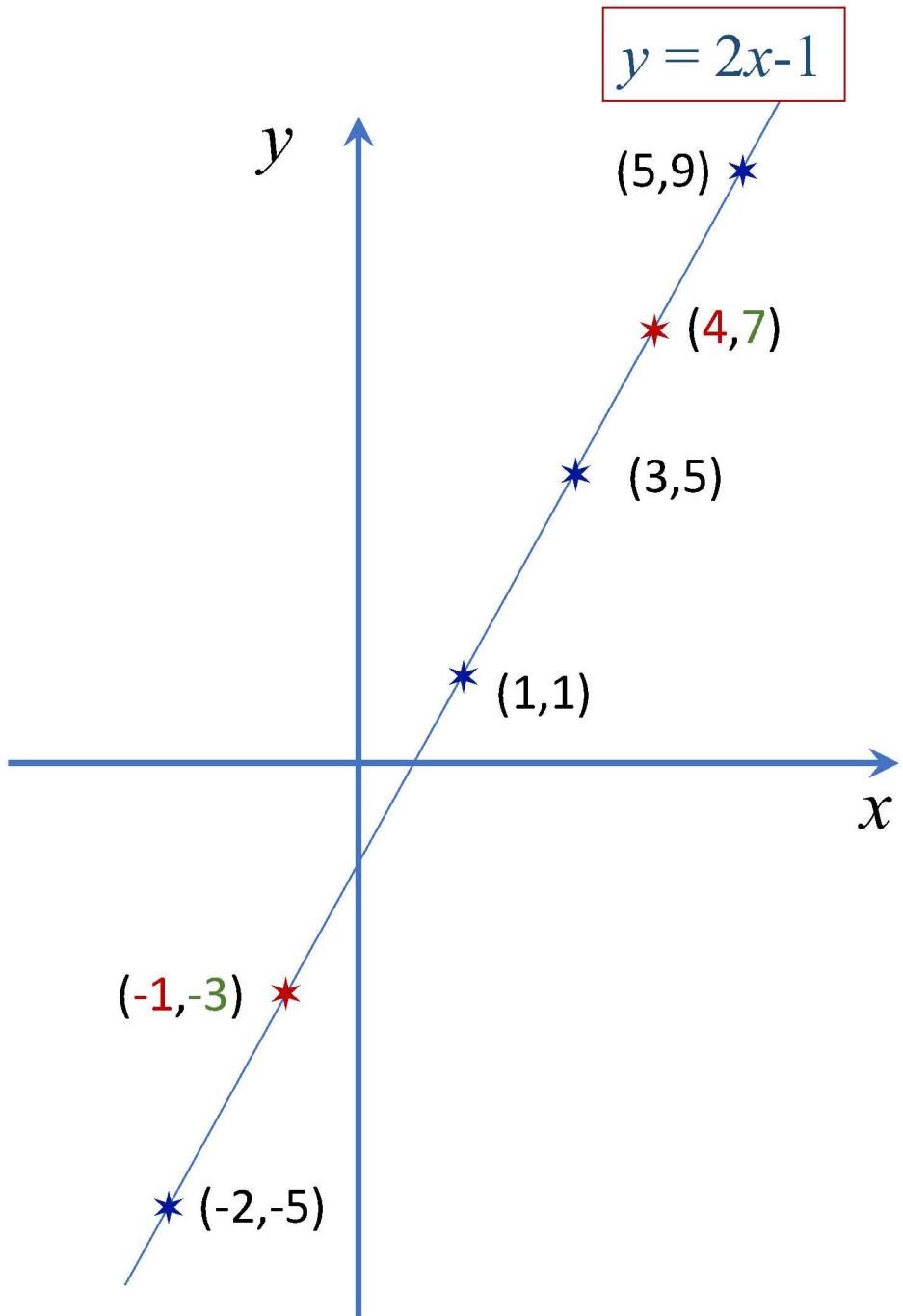
- How do we solve it?





Find the Matching Pair

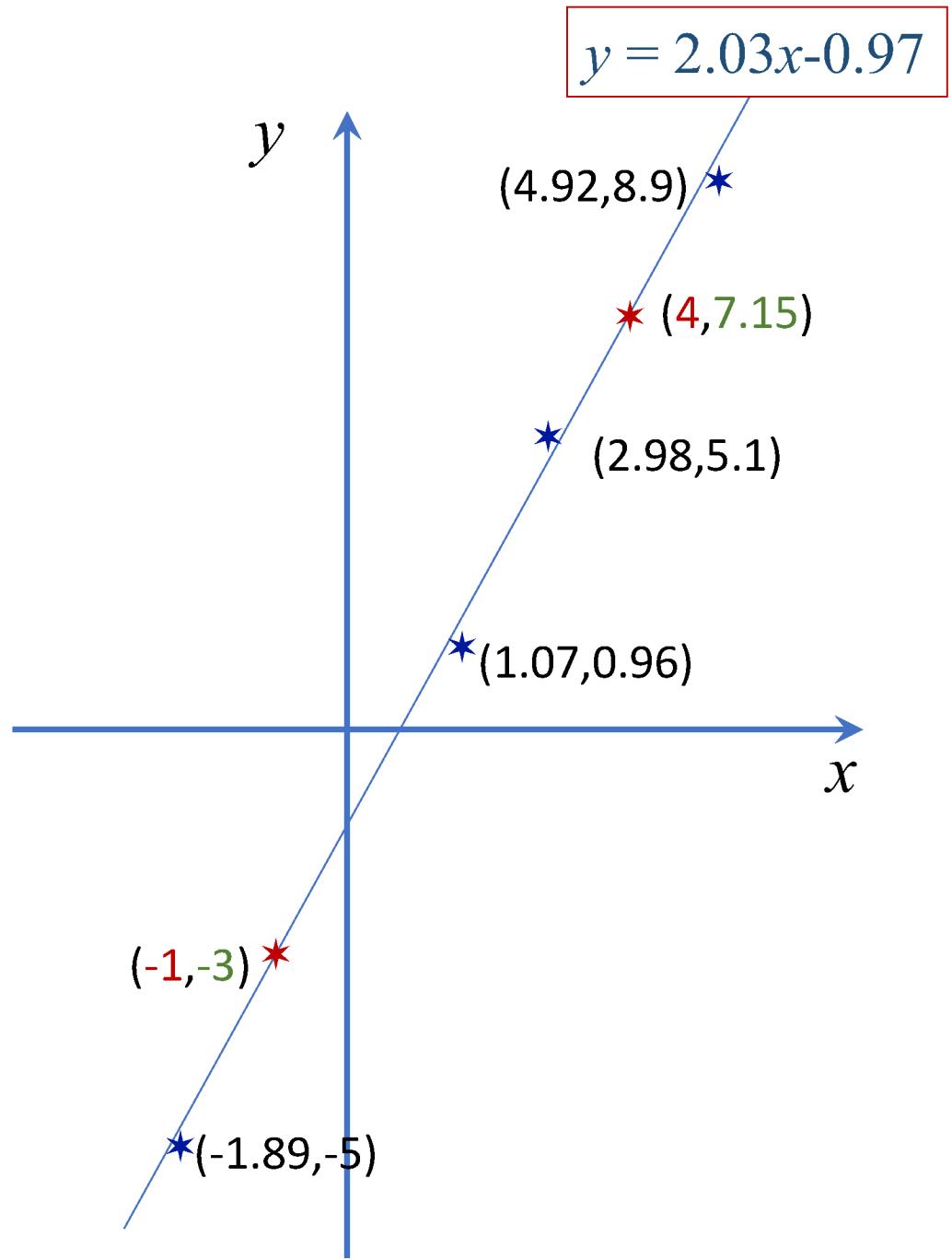
- Given:
 $(3 : 5)$, $(1 : 1)$, $(5 : 9)$, $(-2 : -5)$
- Find:
 - $(4 : ?)$
 - $(-1 : ?)$
- Model: $y = 2x-1$
- How do we solve it?
- How do we get the machine to do this?





Challenges: Noisy Data

- Values may be noisy
 - (2.98 : 5.1)
 - (1.07 : 0.96)
 - (4.92 : 8.9)
 - (-1.89 : -5)
 - (4 : ?)
 - (-1 : ?)
- Difficult for humans
- How about machines?





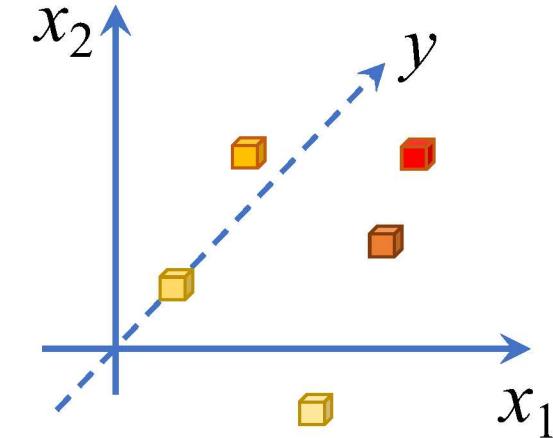
Challenges: Complex Data

- What is x if not a simple number?
 - A 2D point?
 - A 100-dim vector?
 - Entities other than numbers?
 - A picture?
 - A sound bite?



3.1
-2.6
0.41
1.89
15.2
:
9.23

3.9 m
₹ 8.2 L
Blue
Sedan



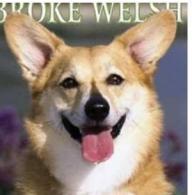


Challenges: Complex Data





Challenges: Complex Data

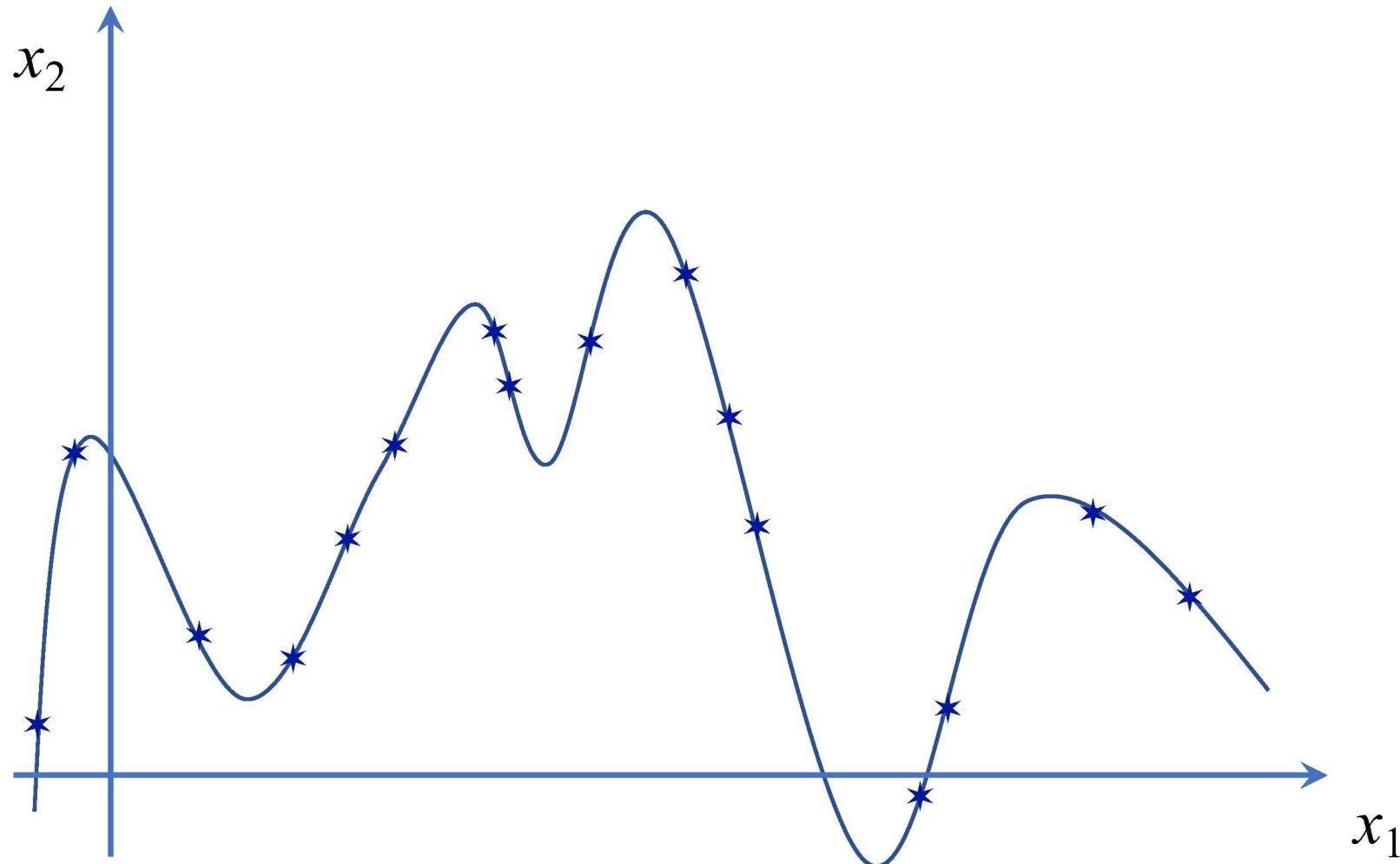


- There is too much information in raw data
- Relevant information is hidden
- Feature Extraction: Extract useful information (x) from raw data



Challenges: Complex Models

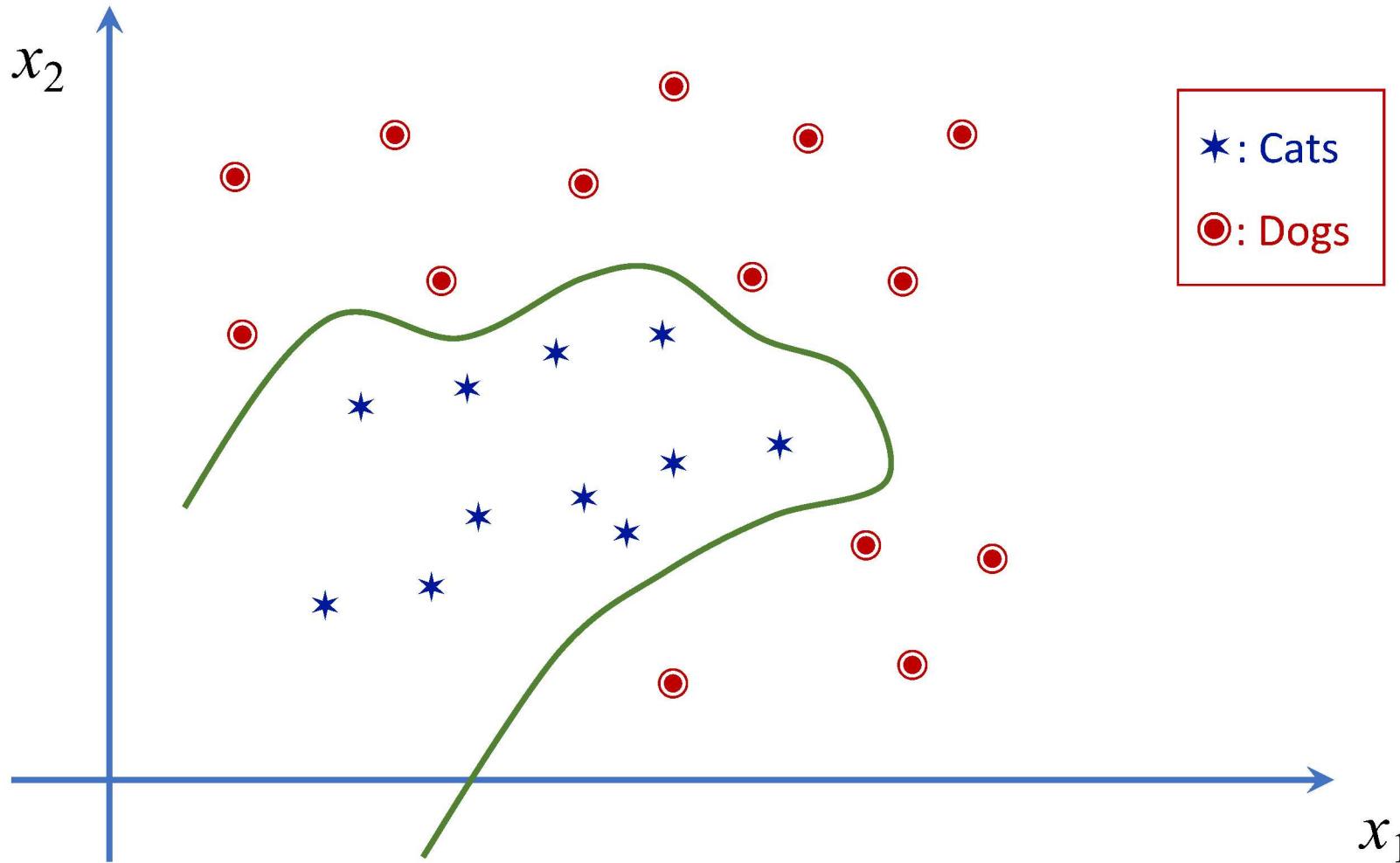
- What if relationship between numbers are not linear?





Challenges: Complex Models

- What if your prediction is not a number?





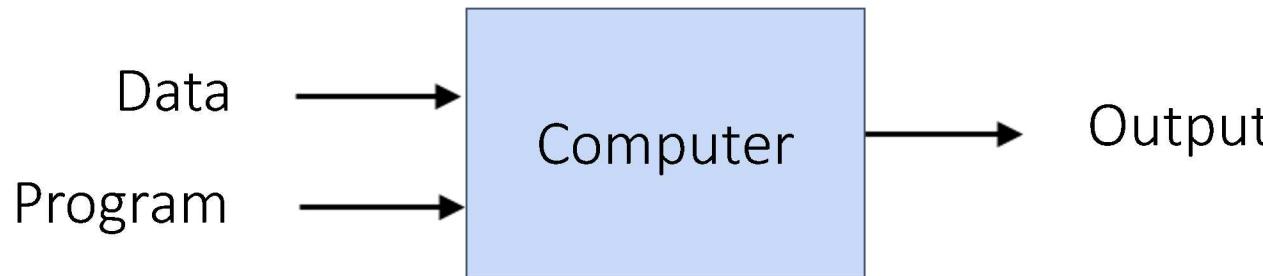
Solution:

- Convert all data into a vector of real numbers: \mathbf{x}
 - Points in a feature space
- Convert all predictions into an integer/real number: y
- We are given a set of n examples: (\mathbf{x}_i, y_i)
- Our goal is to learn a model: $y = f(\mathbf{x})$, that captures the pattern of the training samples
 - e.g., A line that passes through the points; More complex curves
 - Assume a model and learn its parameters
- Once we learn the model, we can predict the output, y' corresponding to any new input, \mathbf{x}' : $y' = f(\mathbf{x}')$



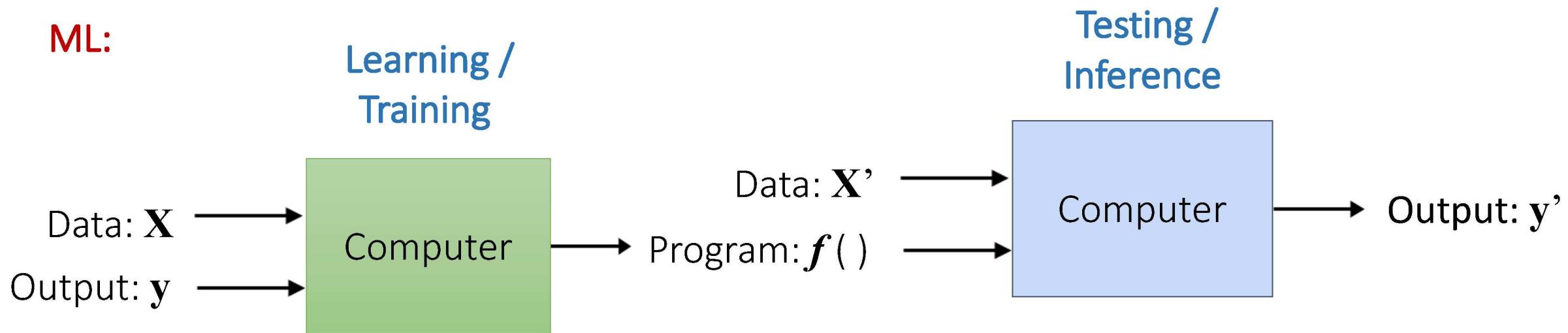
Programming vs. Machine Learning

Programming:



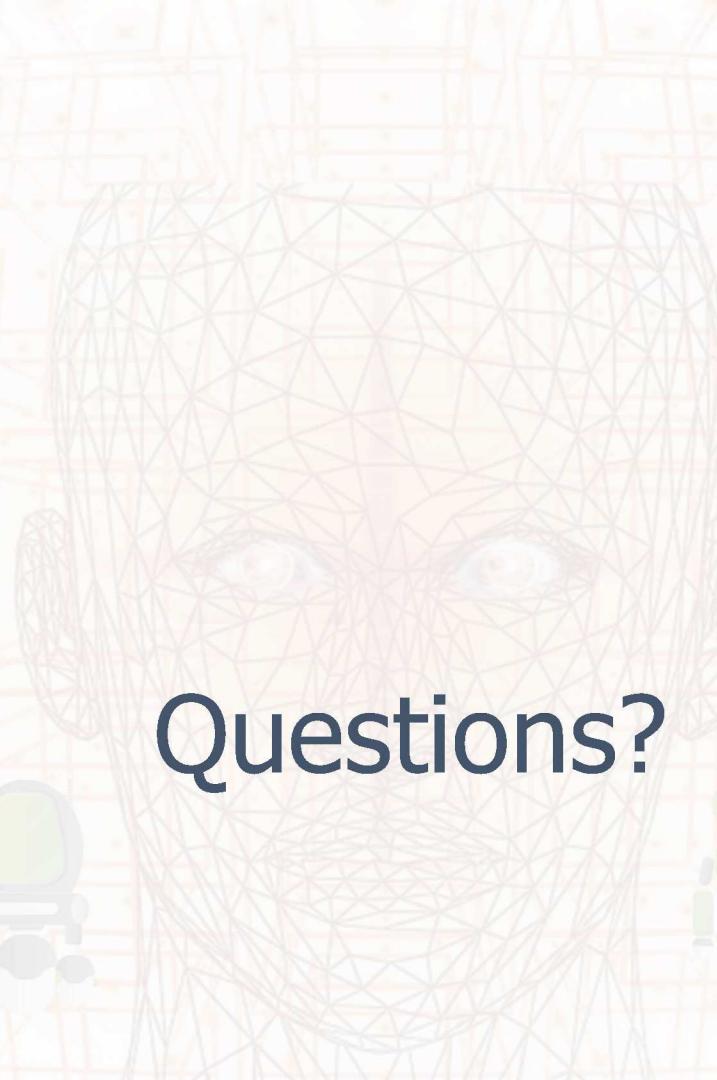
How does this
relate to
Human Learning?

ML:





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Questions?





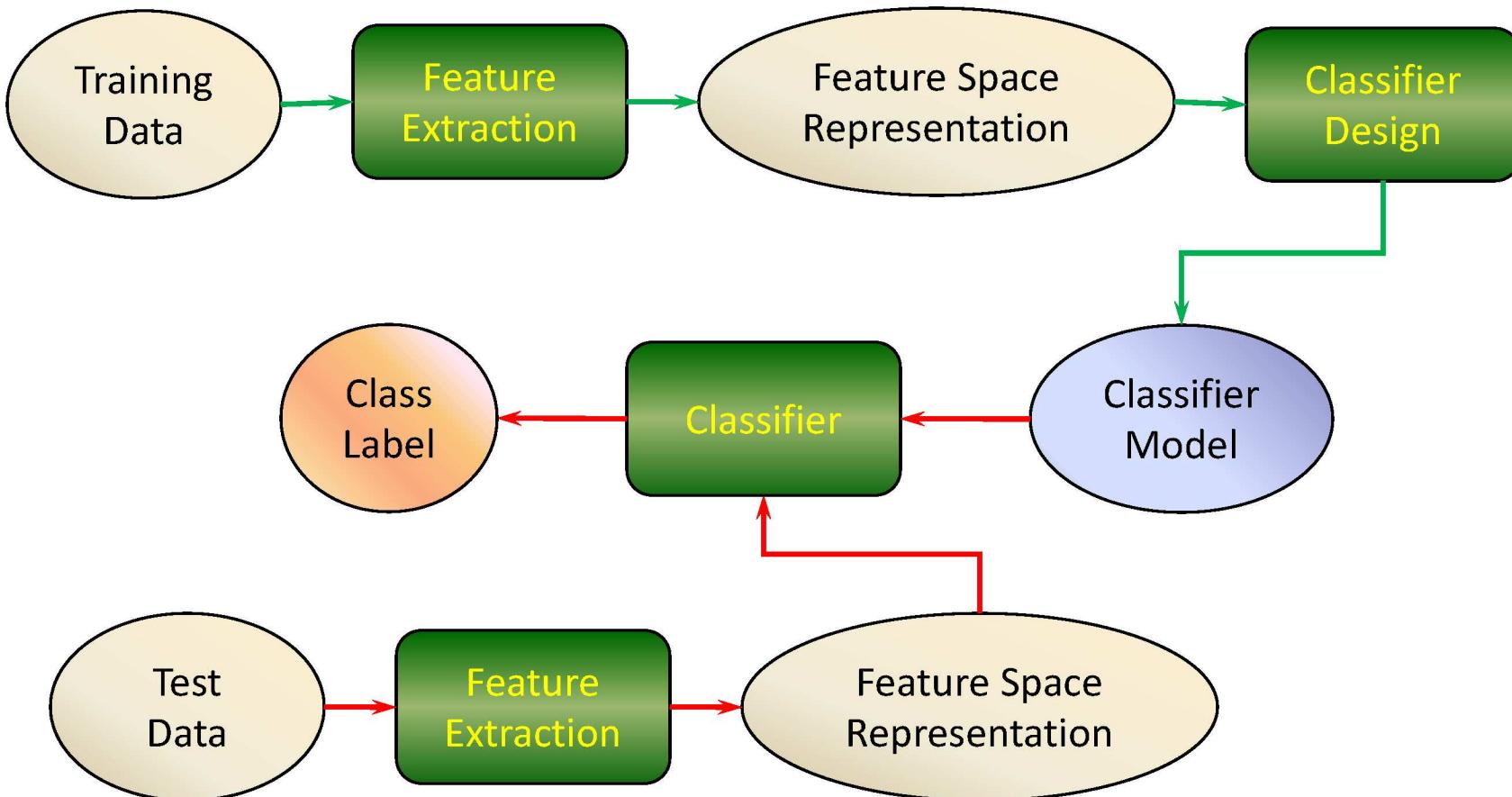
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Representation

From Raw Data to Useful Numbers

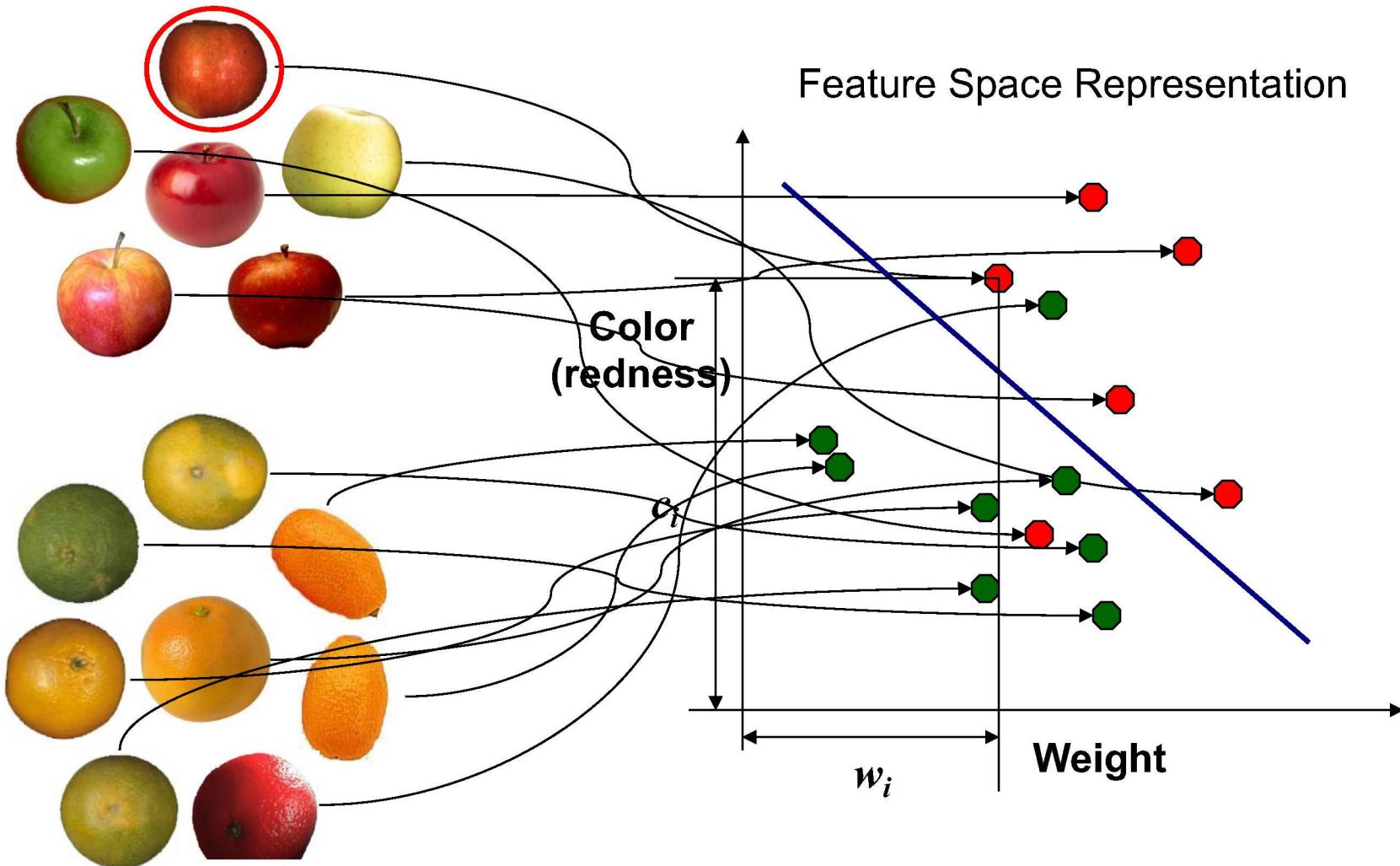


The Machine Learning Process



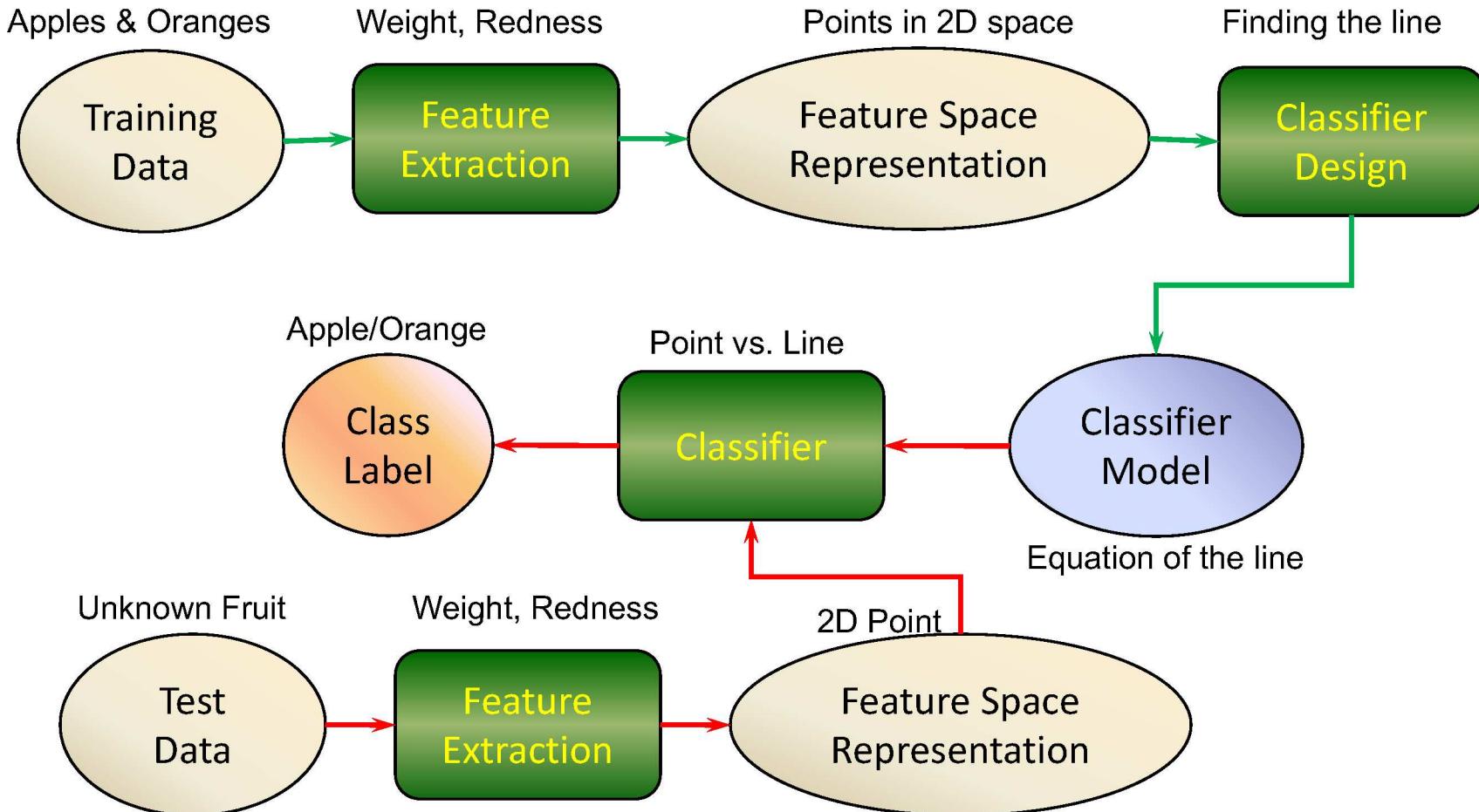


Data Representation





The Machine Learning Process



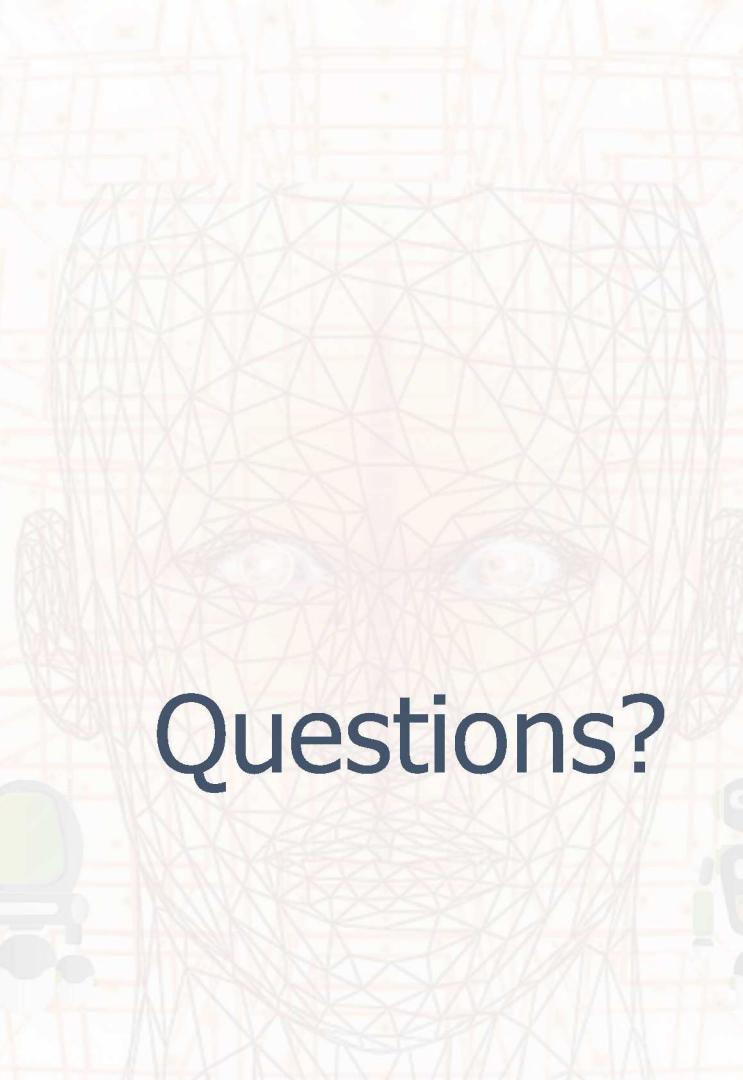


Representation: Simple Examples

- Sound
 - Amplitude and frequencies
 - Wavelet coefficients?
- Images
 - Numbers that capture the shape, size, color, texture of objects
 - Statistics of gradients of images?
- Text
 - Statistics of characters, words, etc.
 - Numbers that capture the meanings of words?
- Videos
 - Tracks of objects: sequence of 2D locations



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Questions?





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Machine Learning Solutions

Examples in real world



Modern ML Solutions



Autonomous Cars and Navigation



Create Photographs, Paintings



Personal Assistants



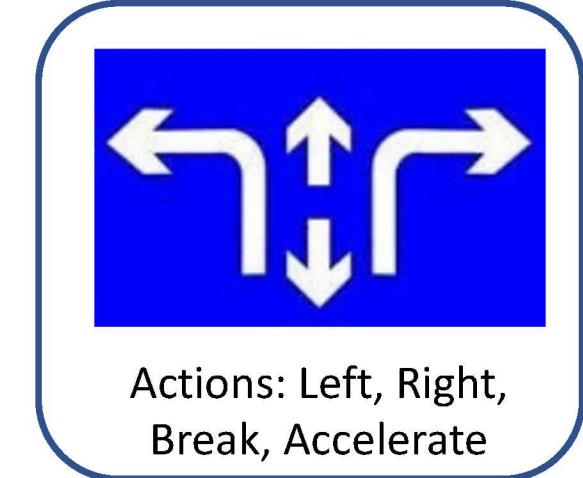
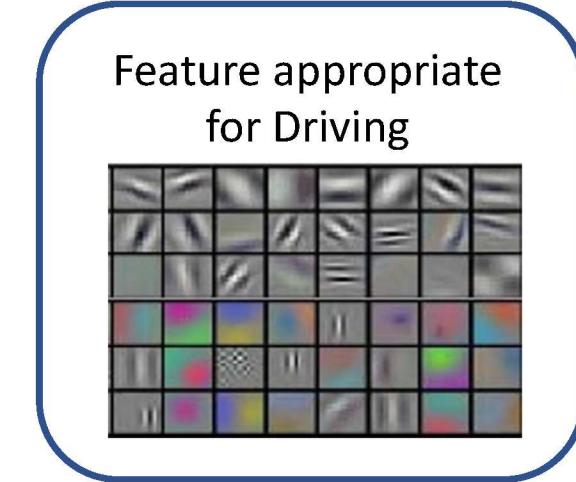
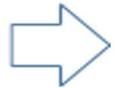
Chess / Go Champions



How do we solve a Problem?



Image from the car



- What features should we use here?
- What are the actions?
- What is the nature of the function: $y = f(x)$?
- What are the challenges?



Fields impacted by Modern ML



Computer Vision



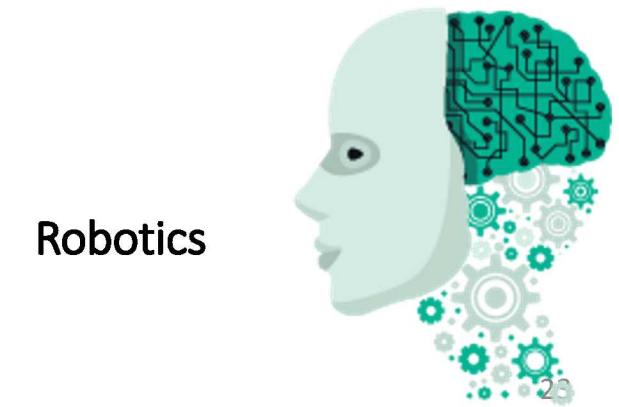
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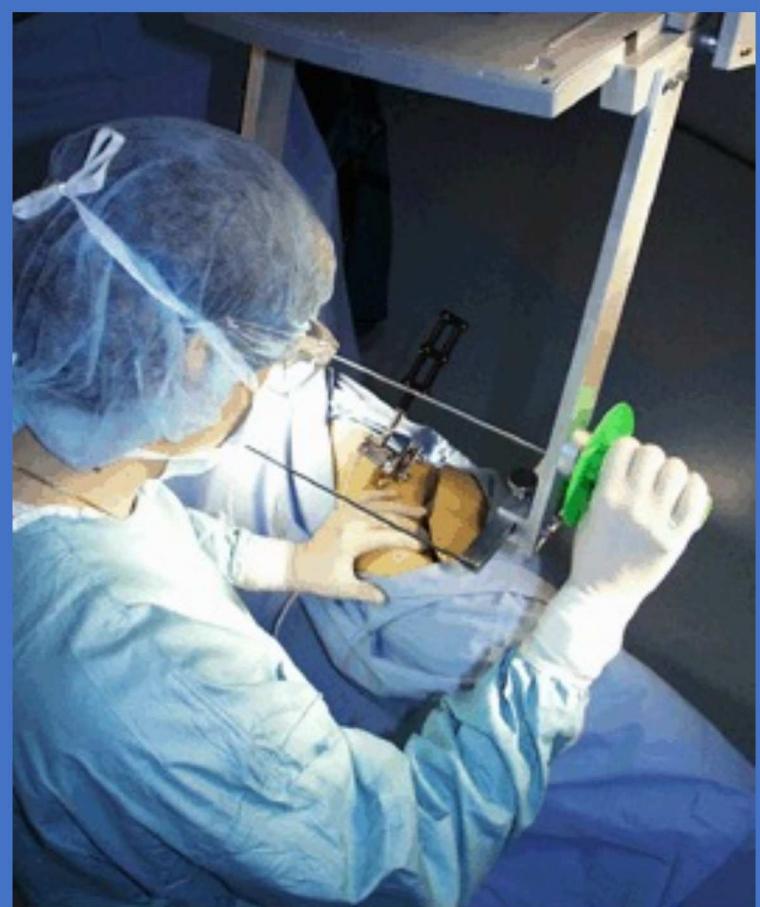
Speech Processing



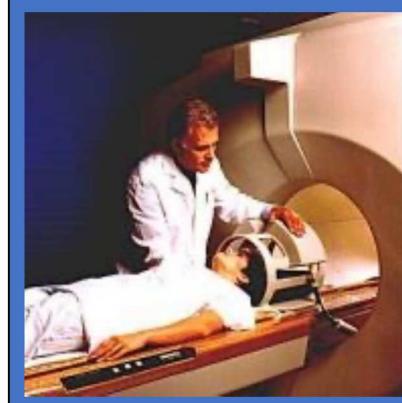
Robotics



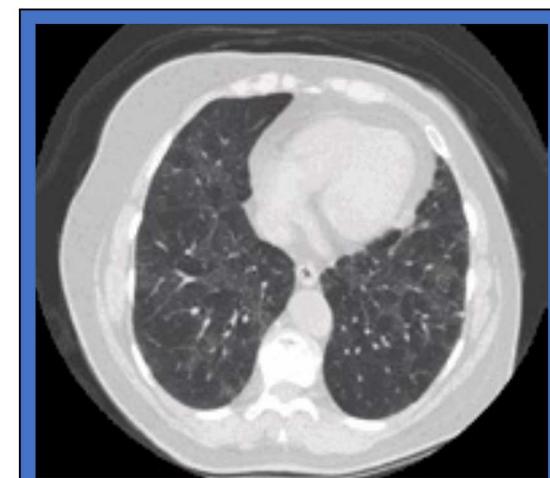
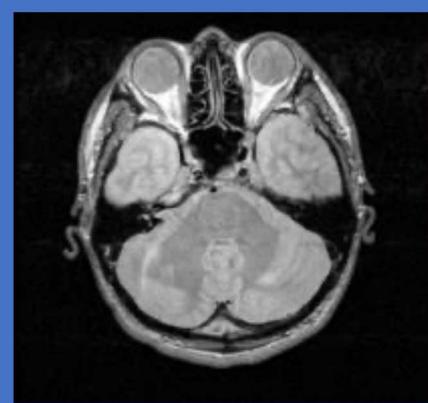
Applications: Medical



Computer Assisted Surgery



CT Scan



Segmentation



Applications: Space Imaging



Ikonos



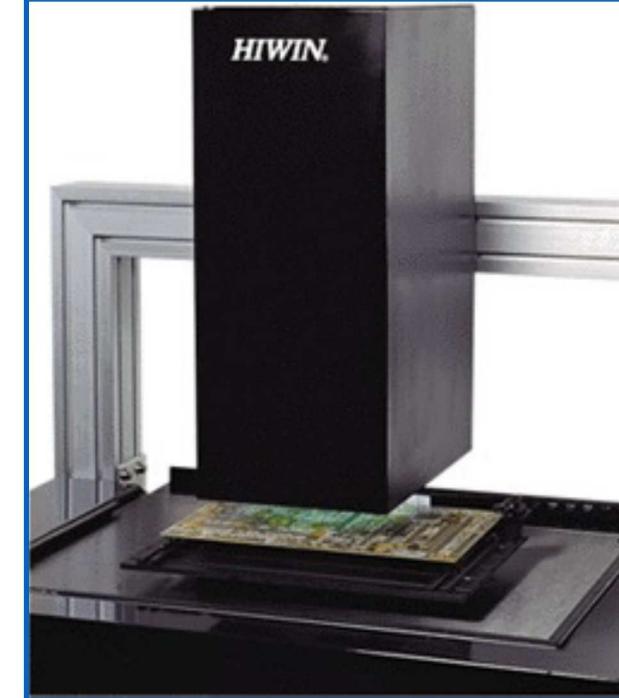
Rio Negro (black) meets Amazon (blue)



Applications: Automated Inspection



Manual PCB Inspection



Automated PCB Inspection



Applications: Biometrics



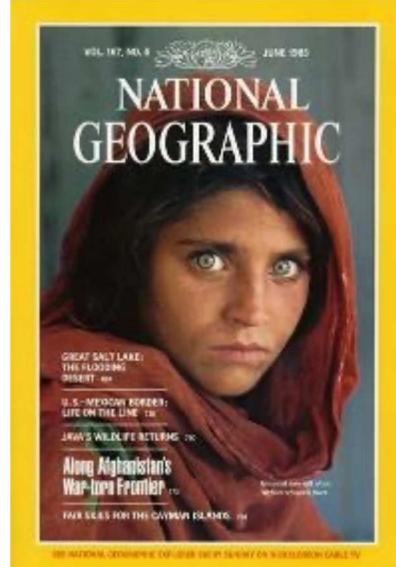
Travel



Disney Land

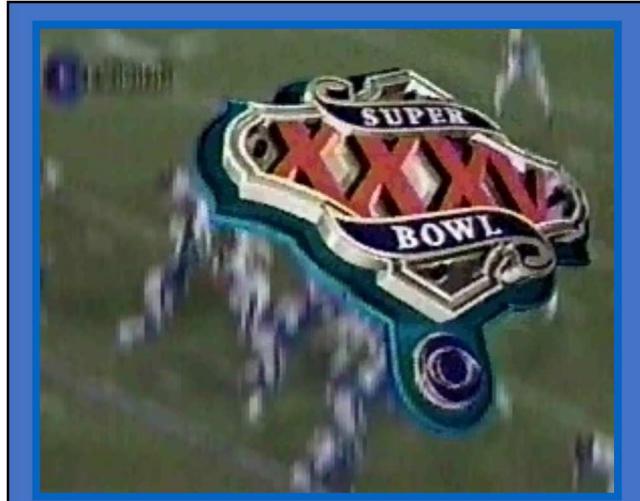


Computer Access





Applications: Broadcasting



Virtual Replay



Chroma Keying: Replacing Backgrounds



Image Overlay



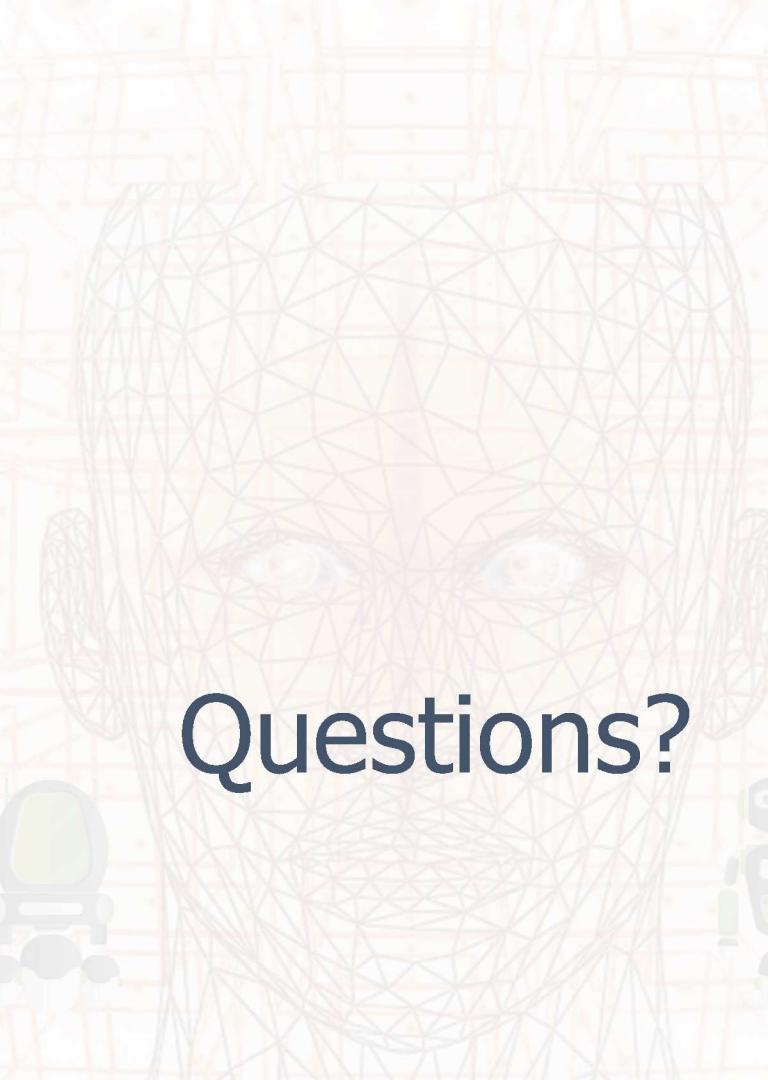
Applications: Others

- Surveillance
- Automated Assembly
- Mail Sorting
- Face detection (photography)
- Robot Navigation
- Content-Based Image Retrieval
- Entertainment
- And many more...





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Questions?

