



BITS Pilani

K K Birla Goa Campus

Dept. of Computer Science and Information Systems

Machine Learning

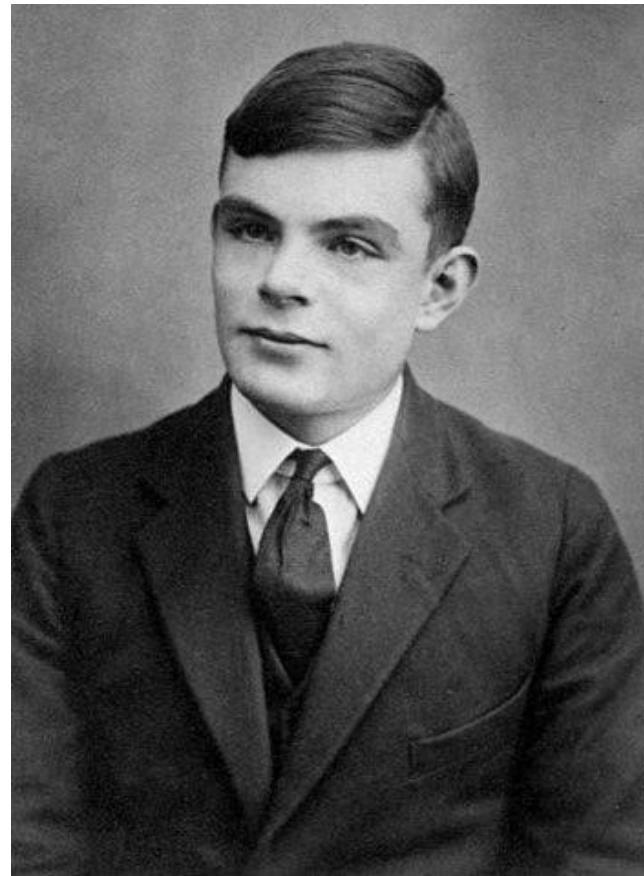
BITS F464

Lecture 1: The Roots of Artificial Intelligence

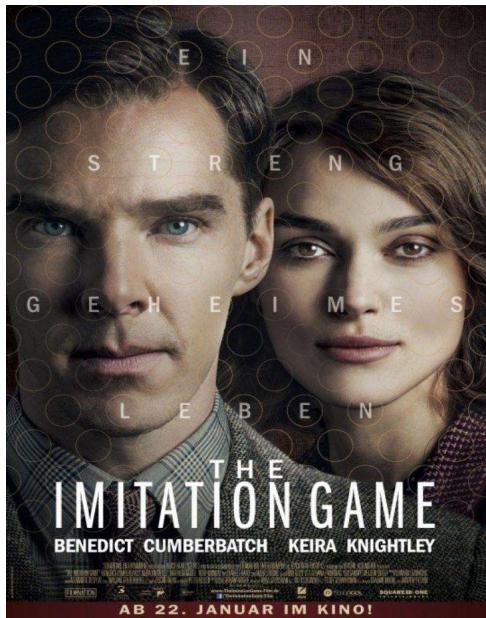
Harikrishnan N B
Visiting Faculty
D 262

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Identify the Personality



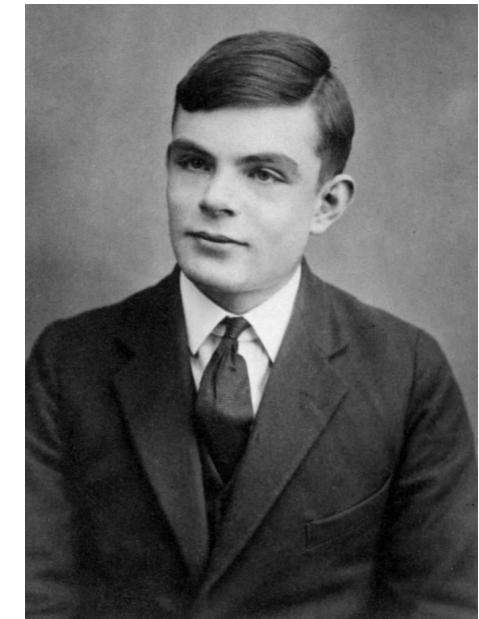
Who is Alan Mathison Turing?



- Mathematician
- Computer Theorist
- **World War II Code Breaker**



- Father of Modern Computer Science
- Founding Fathers of AI (along with John McCarthy, Marvin Minsky, Allen Newell and Herbert A Simon)



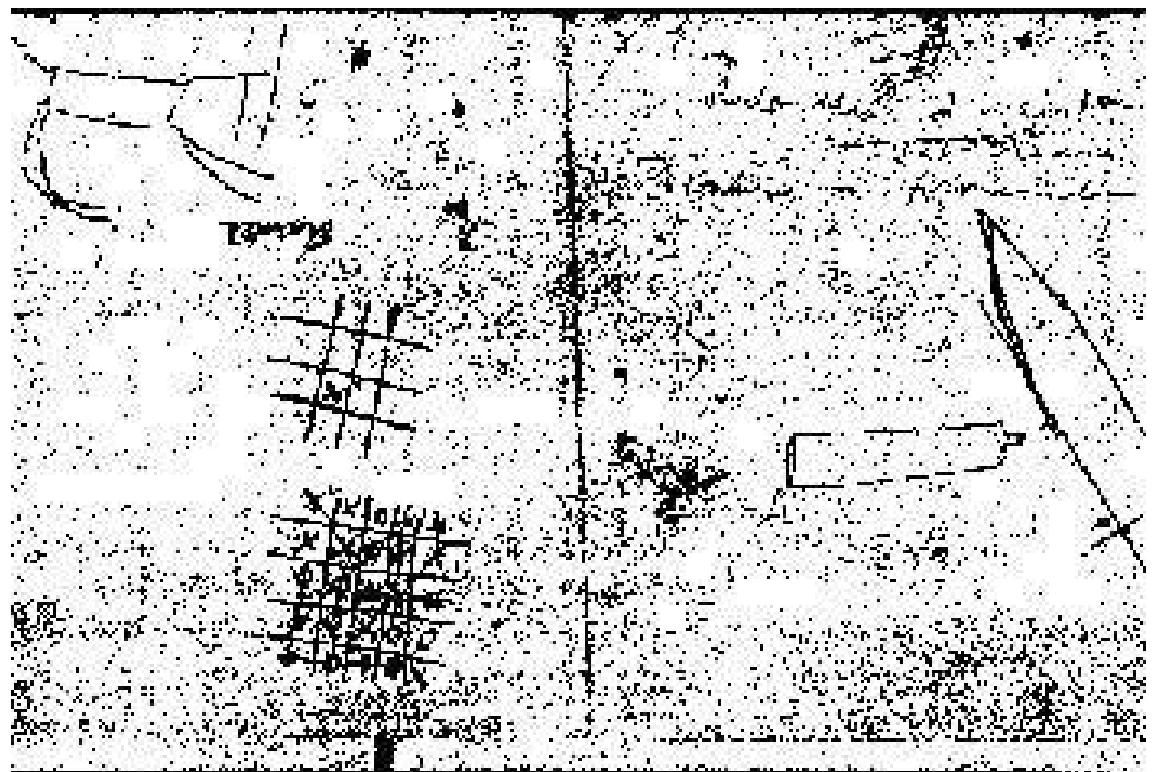
Alan, Christopher and Mathematical World



Alan Turing



Christopher Morcom



Reference : <https://www.turing.org.uk/scrapbook/spirit.html>

Christopher Morcom died on 13 February 1930

- Deeply affected by the loss, Alan became obsessed with unravelling the nature of consciousness, its structures and its origin.
- Thus he immersed himself in related works of **biology, philosophy, metaphysics, and even mathematical logic and quantum mechanics.**
- Turing Machine, **Turing test** and Church - Turing Thesis - pioneering works in Computer Science
- Sadly his accomplishments were cut short by his death by cyanide poisoning in 1954, allegedly from eating a poisoned apple.

Reference: <https://www.nndb.com/people/952/000023883/>



ICONS:
THE GREATEST PERSON OF THE 20TH CENTURY

WINNER!
ALAN TURING

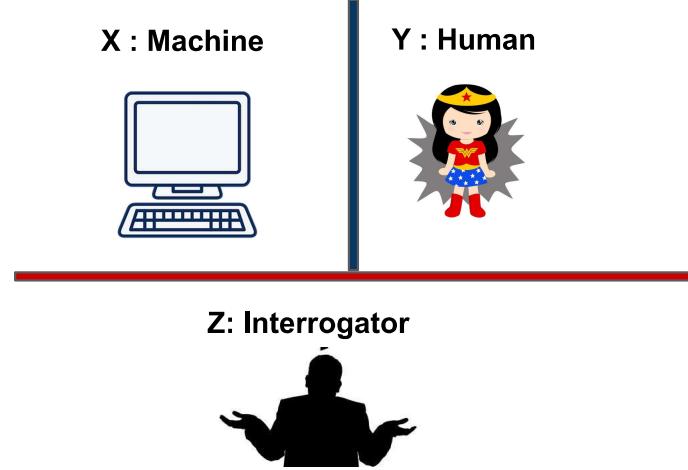
Reference : <https://www.bbc.co.uk/programmes/articles/3Tk2LpLg755Js0LQF7t3TQ2/the-finalists>

Roots of Artificial Intelligence

1950: Can Machines Think?*



Alan M. Turing



Samuel's 1952 checkers player**



*Ref: Turing, Alan Mathison. "Computing Machinery and Intelligence." *Mind* 59.236 (1950): 433-460.

**Ref: Samuel's 1952 Checker Player: <http://www.incompleteideas.net/book/ebook/node/109.html>

Image Source:

<https://engineering.stanford.edu/news/stanfords-john-mccarthy-seminal-figure-artificial-intelligence-dead-84>

<https://www.semanticscholar.org/paper/Marvin-Minsky-the-father-of-AI-Verwijnen/ef31300364bb686178d7013f8d53ae91da26bac9>

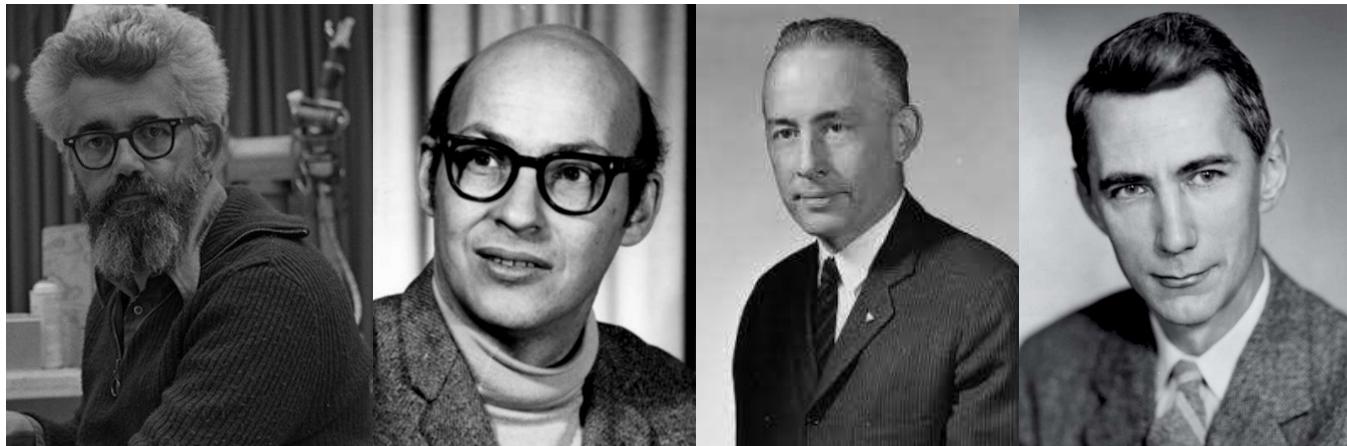
<https://modha.org/2006/09/nathaniel-rochester-iii-1919-2001/>

<https://aeon.co/essays/how-a-polymath-transformed-our-understanding-of-information>

When was the term Artificial Intelligence Coined?
Who coined the term Artificial Intelligence?

Birth Of Artificial Intelligence

1956: Dartmouth Summer Research Project on Artificial Intelligence**



John McCarthy

Marvin Minsky

Nathaniel Rochester

Claude E. Shannon

The proposal for this project was initiated by **August 31, 1955** authored by John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon. The Dartmouth Summer Research Project happened in 1956.

**Ref: McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (2006). [A proposal for the dartmouth summer research project on artificial intelligence](#), august 31, 1955. *AI magazine*, 27(4), 12-12.

What was the goal of the Dartmouth Summer Research Project on AI?

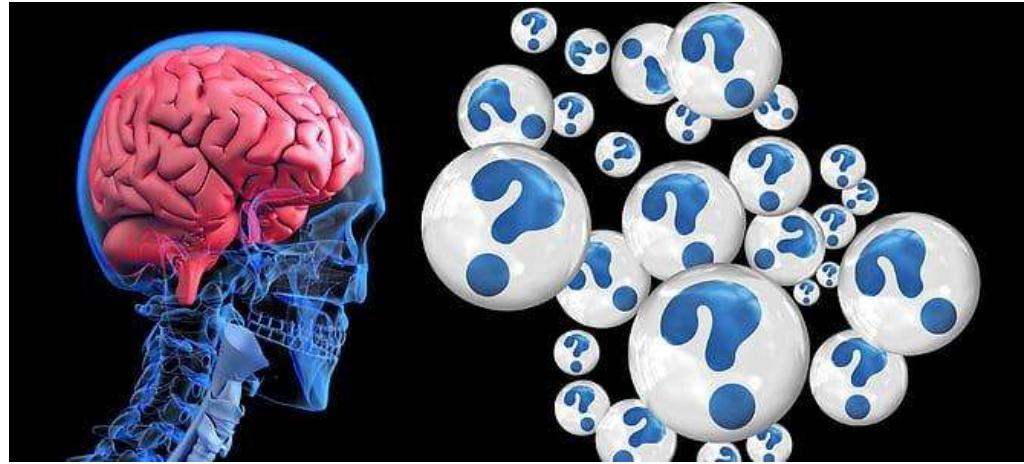
The study is to proceed on the basis of the **conjecture** that **every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it**. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves.

**Ref: McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (2006). [A proposal for the dartmouth summer research project on artificial intelligence](#), august 31, 1955. *AI magazine*, 27(4), 12-12.

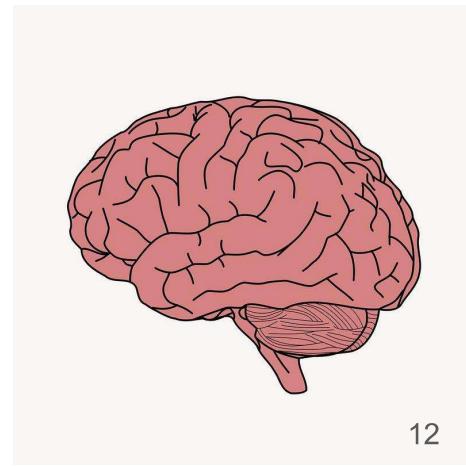
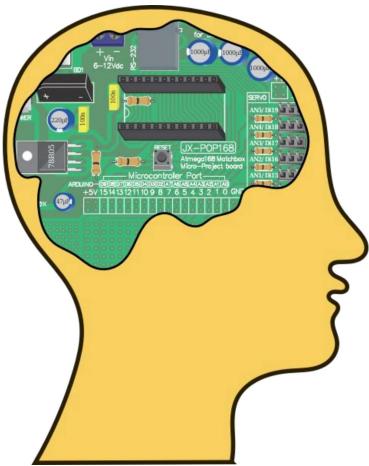
Ideas Proposed in the Conference

1. Natural Language Processing
2. Neural Networks
3. **Machine Learning**
4. Abstract concepts and Reasoning
5. Creativity and Randomness





Soon... Clashes of Ideas.. Struggle in Defining Intelligence



Today we realize the enormous complexity involved in understanding intelligence

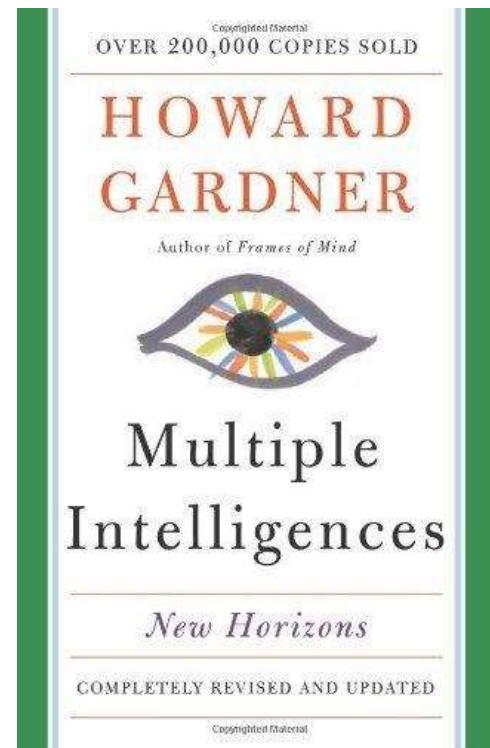
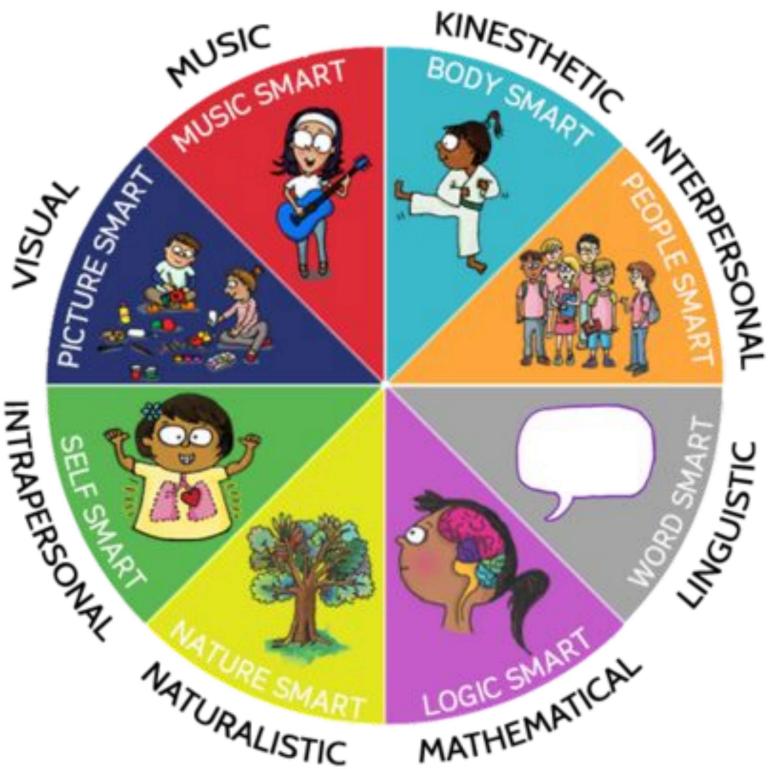


Image Source:

[https://projectrangeet.com/howard-gardners-theory-of-multiple-intelligences-and-why-educators-should-be-u
sing-the-lockdown-to-childrens-advantage/](https://projectrangeet.com/howard-gardners-theory-of-multiple-intelligences-and-why-educators-should-be-using-the-lockdown-to-childrens-advantage/)

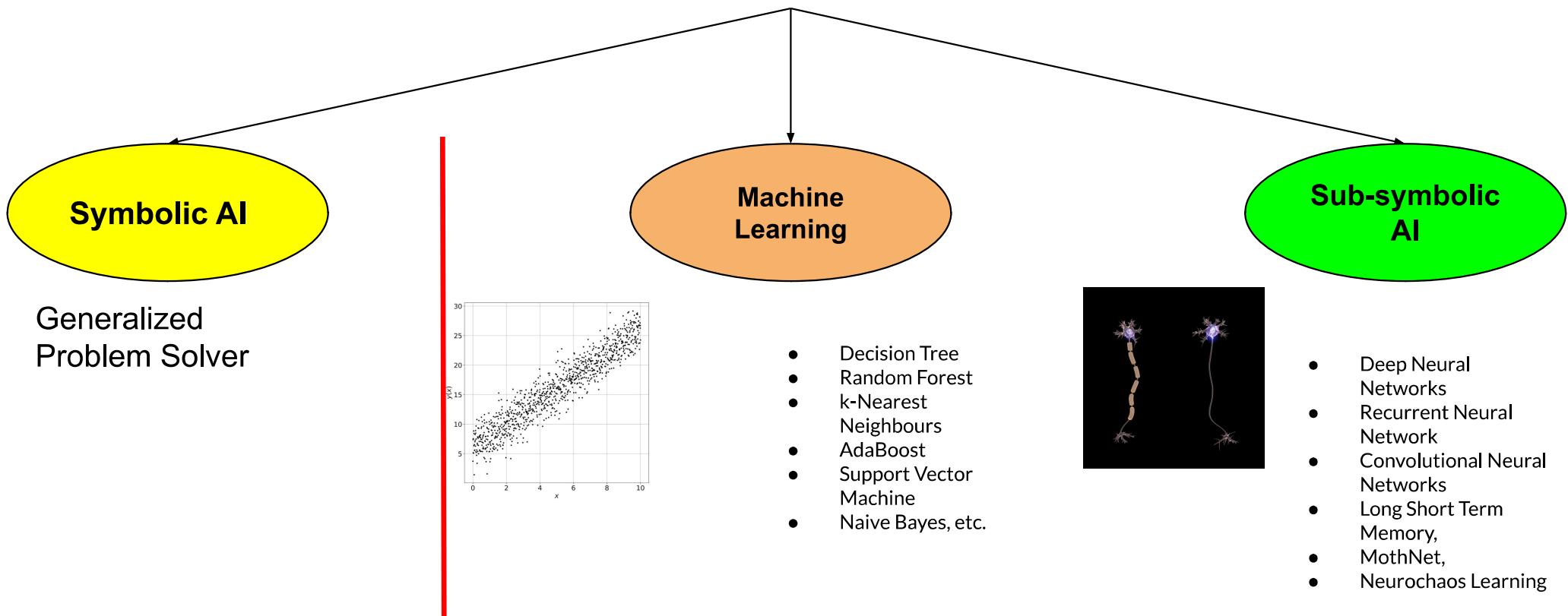
AI is a field that includes a broad set of approaches, with the goal of creating machines with intelligence.

Researchers Approach to AI

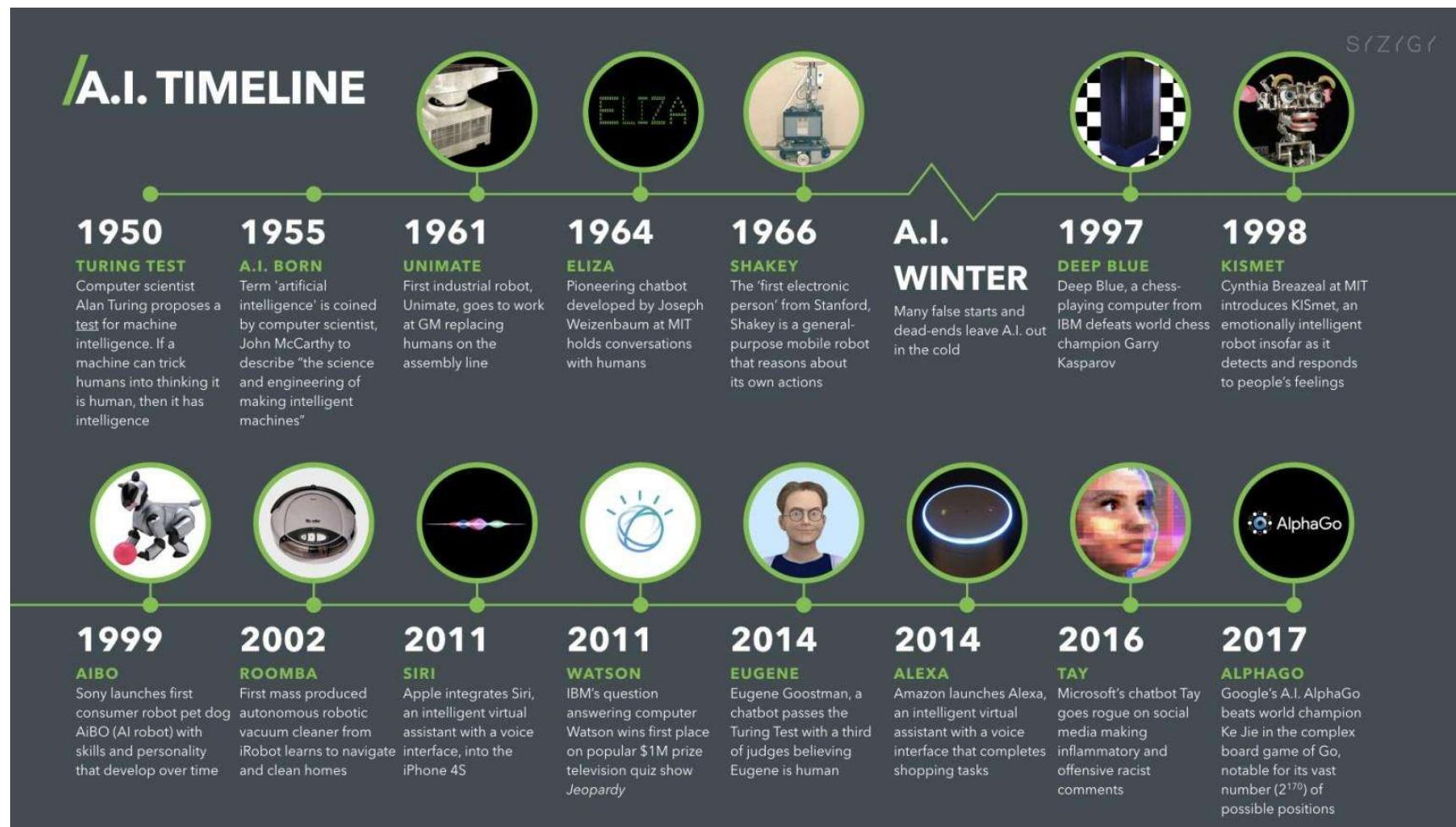
- **On the scientific side:** AI researchers are investigating the mechanism of ‘natural’ (biological) intelligence by trying to embed it in computers.
- **On the practical side:** **AI proponents simply want to create computer programs that performs tasks as well as or better than humans, without worrying about whether these programs are actually thinking in the way humans think.**

ALL THIS IS BASED ON WHERE THEIR FUNDING CURRENTLY COMES FROM!!!

Artificial Intelligence: An Anarchy of Methods



- Ref: Lehman, Joel, Jeff Clune, and Sebastian Risi. "An anarchy of methods: Current trends in how intelligence is abstracted in ai." *IEEE Intelligent Systems* 29.6 (2014): 56-62.
- Ref: James, Gareth, et al. "An introduction to statistical learning." Vol. 112. New York: springer, 2013.



Perceptron: 1957 Frank Rosenblatt, Cornell University

Minsky & Papert "killed AI": 1969 - Perceptron cannot solve XOR

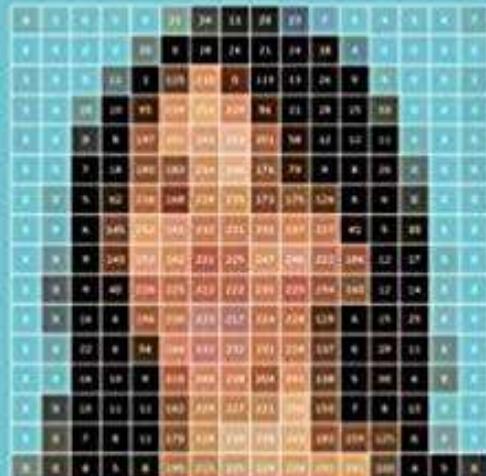
Image Source: <https://sohailzahid.com/2019/02/02/a-brief-history-of-ai/>

A PELICAN BOOK

Artificial Intelligence

A Guide for Thinking Humans

Melanie Mitchell



Topic of Interest

Machine Learning
BITS F464
Course Logistics

Course Objective

This course covers the foundations of Machine Learning. This includes the theoretical and applications of various algorithms. The following topics shall be covered: Decision Tree, Naive Bayes, Logistic Regression, Linear Regression (both matrix and matrix free methods), Bias -Variance Trade off, k-Nearest Neighbours, Principal Component Analysis, Singular Value Decomposition, Dynamic Mode Decomposition for time series forecasting, Learning Theory, Boosting, Kernels, Support Vector Machine. After the successful completion of the course, the student will learn (a) the principled way to do machine learning, (b) read, understand and implement Machine Learning research papers.

Course Plan

Check Handout

Course Resources

1. **Textbook (T1):** Tom M. Mitchell. *Machine learning*. Vol. 1, no. 9. New York: McGraw-hill, 1997.
2. **Textbook (T2):** Bishop, Christopher M., and Nasser M. Nasrabadi. *Pattern recognition and machine learning*. Vol. 4, no. 4. New York: springer, 2006.
3. **Textbook (T3):** James, Gareth, Daniela Witten, Trevor Hastie, and Robert Tibshirani. An introduction to statistical learning. Vol. 112. New York: springer, 2013.
4. **Reference (R1):** Hastie, Trevor, Robert Tibshirani, Jerome H. Friedman, and Jerome H. Friedman. *The elements of statistical learning: data mining, inference, and prediction*. Vol. 2. New York: springer, 2009.
5. **Reference (R2):** Brunton, Steven L., and J. Nathan Kutz. *Data-driven science and engineering: Machine learning, dynamical systems, and control*. Cambridge University Press, 2022.
6. **Reference (R3):** Strang, Gilbert. "Introduction to linear algebra." (2020).
[**More on Handout**](#)

Course Timings

Course Timing:

DAY	TIME	VENUE
Tuesday	09:00 AM - 09:50 AM	DLT8
Thursday	09:00 AM - 09:50 AM	DLT8
Friday	02:00 PM - 02:50 PM	DLT8

Evaluation

Components	Duration	Weightage	Date & Time	Remarks
Mid Semester Exam	90 mts	30%		Closed Book
Assignment(s)/ Quizz(es)	-----	20%		Open Book/ Closed Book
Term Project		10%		Presentation
Comprehensive Examination	180 mts	40%		Closed Book

Honour Code

"I affirm that I have not given or received any unauthorised help on this assignment, and that this work is my own. Any part of the text or material of the assignment submission, if copied from internet sources, need to be cited and quoted, without which I will be held liable to have committed **plagiarism**. For group projects, I accept responsibility for my role in ensuring the integrity of the work submitted by the group in which I participated. I understand that any violation of the stated policies, as determined by the FIC, shall be subject to scrutiny by the FIC and is liable for punishment."

Make-Up Policy

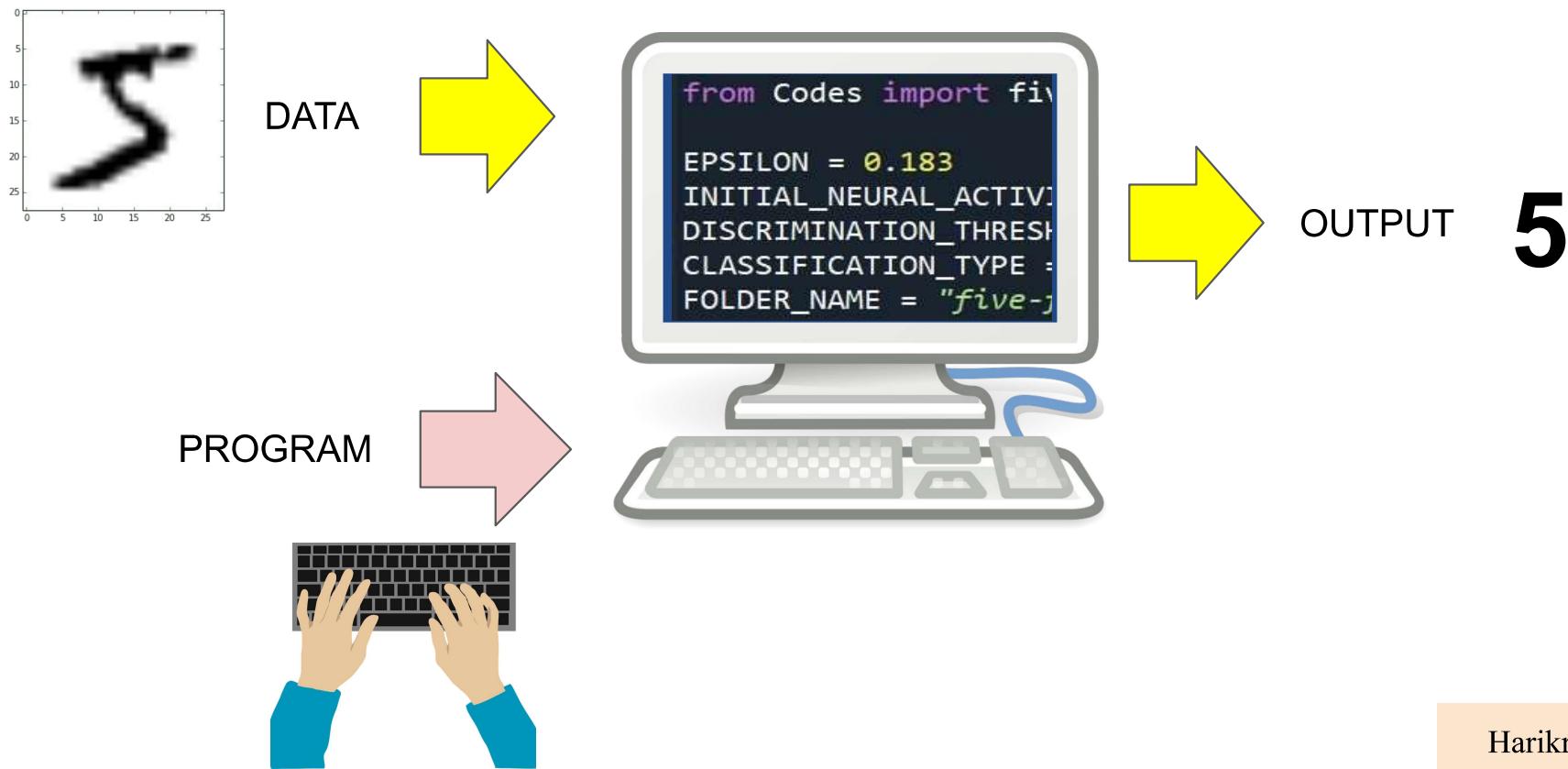
Make-up for any component of evaluation will be given only in genuine cases of absence. If the absence is anticipated prior permission of the instructor-in-charge before the examination is necessary. **There is no make-up policy for quiz and assignments. The best N-1 out of N quiz and assignments will be considered for grading.** Make-up policy is granted only in case of serious illness or emergency on a case by case basis for Mid-sem Test and Comprehensive Exam only.

First Degree Teaching Assistants

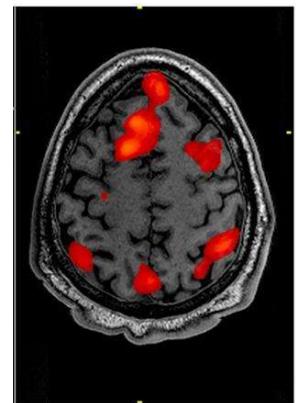
- Biyani Param Hemant Kumar
- Devale Tanmay Abhijit

What is Machine Learning?

Traditional Computer Science



Real World Problem



DATA A yellow arrow pointing from the brain scan towards the computer monitor.

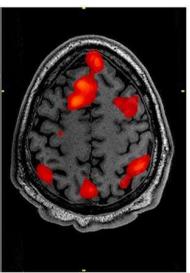


OUTPUT A yellow arrow pointing from the computer monitor towards the text "OUTPUT".

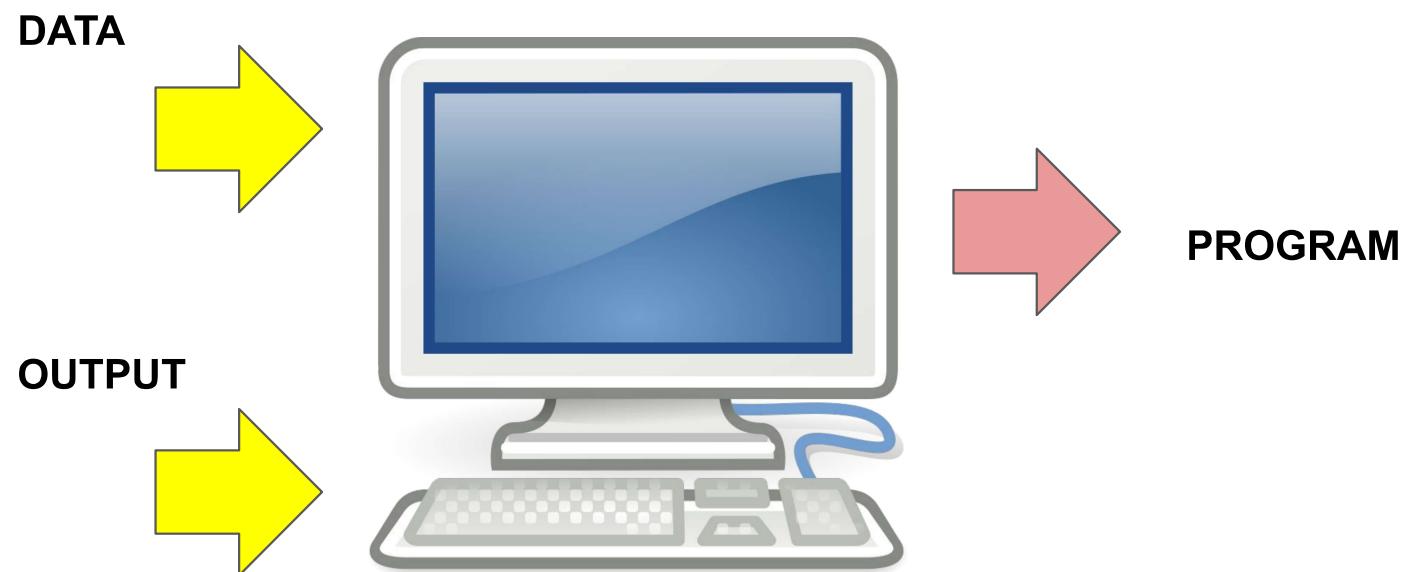
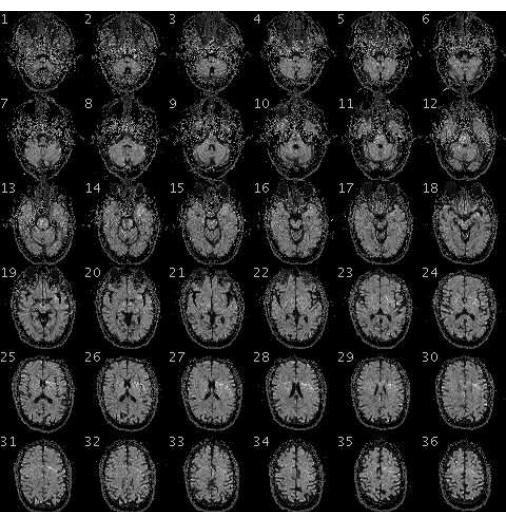


PROGRAM A red arrow pointing from the cartoon character towards the computer monitor.

The Machine Learning Way



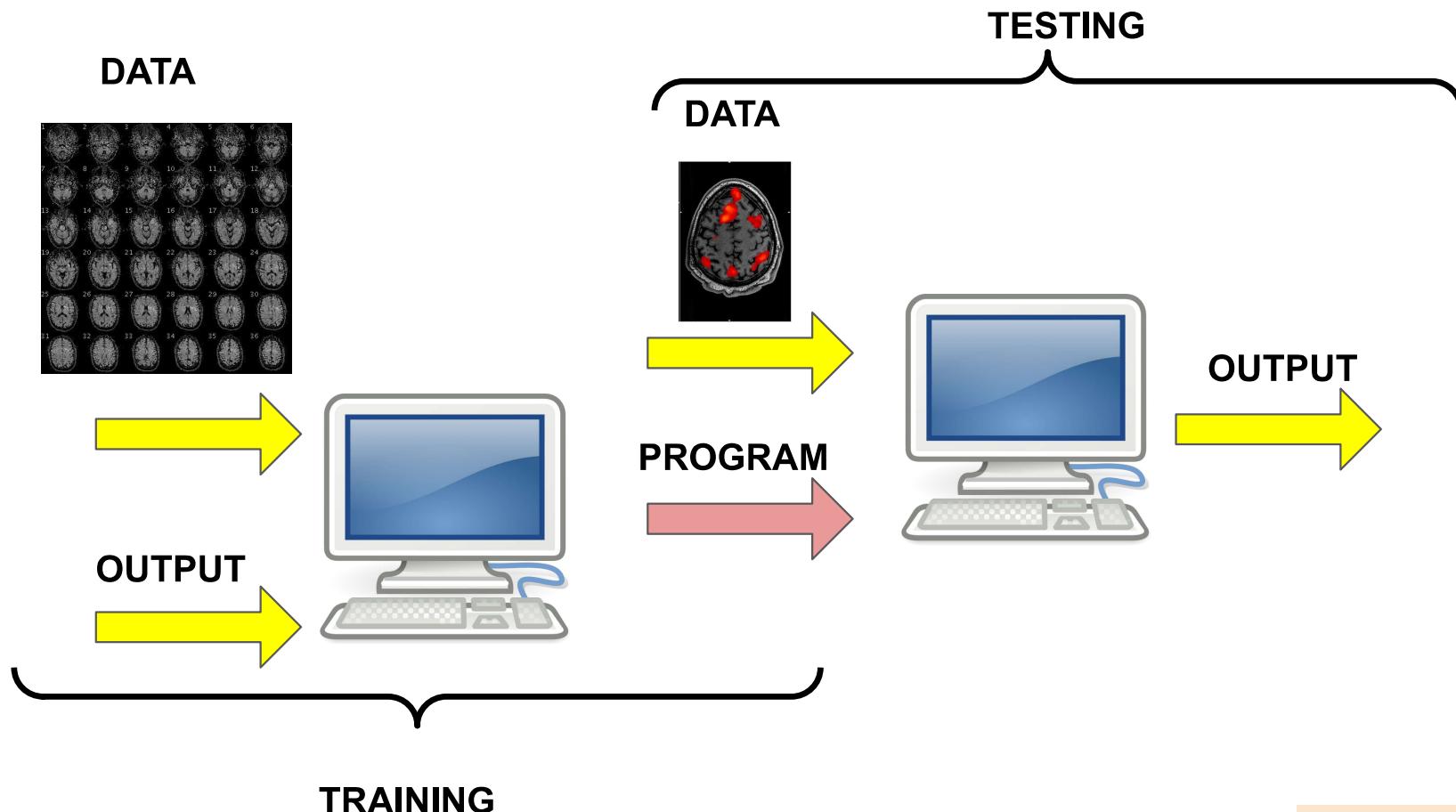
?



Traditional Computer Science vs. Machine Learning



Supervised Learning



Machine Learning

Study of algorithms that

- Improve their **performance P**
- At some **task T**
- With **experience E**

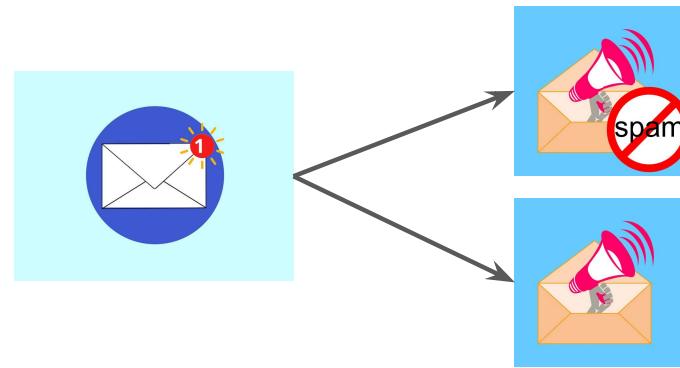
Well-defined learning task $\langle P, T, E \rangle$

Spam Filter

Study of algorithms that

- Improve their **performance P**
- At some **task T**
- With **experience E**

Well-defined learning task $\langle P, T, E \rangle$



Types of Learning

- 1. Supervised Learning**
- 2. Unsupervised Learning**
- 3. Semi-Supervised Learning**
- 4. Reinforcement Learning**

Supervised Learning

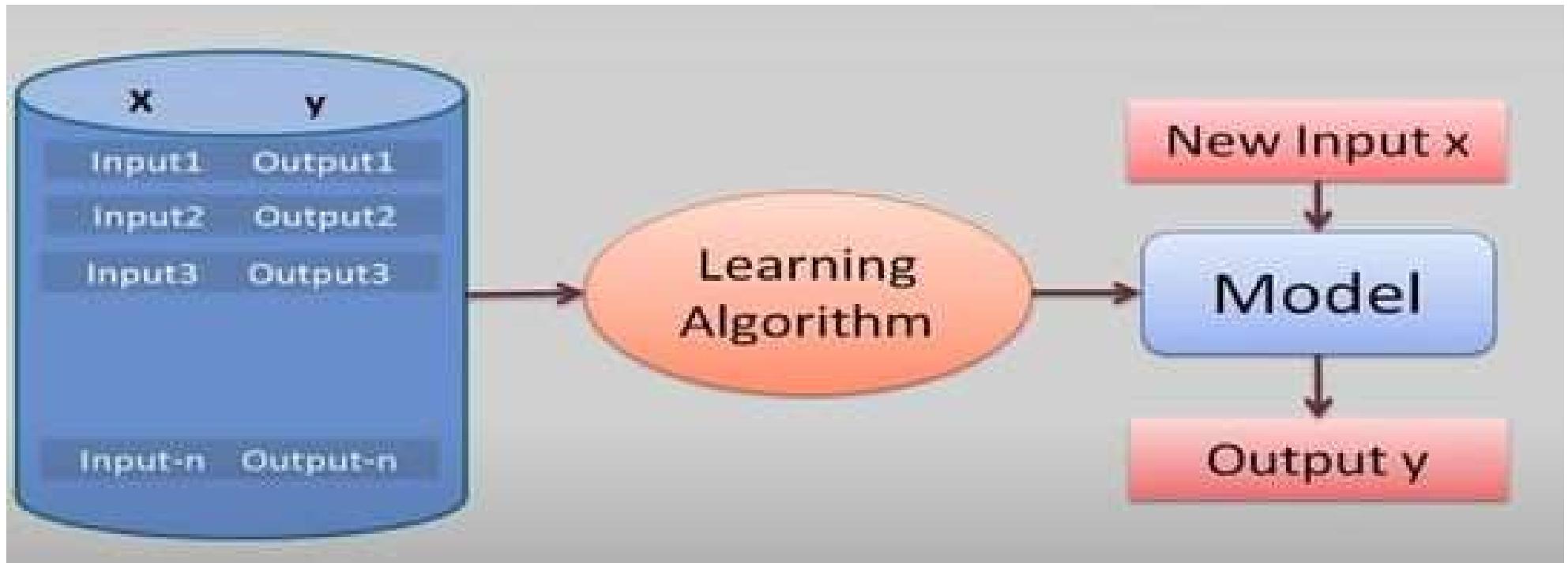
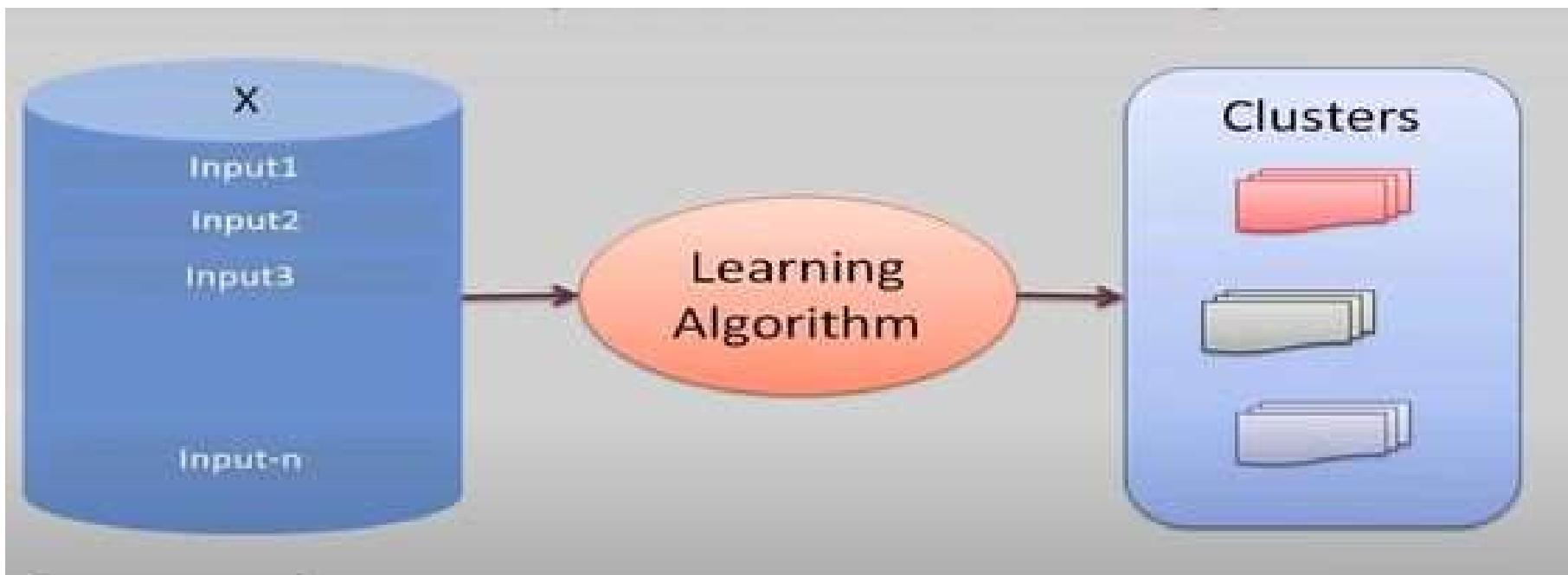
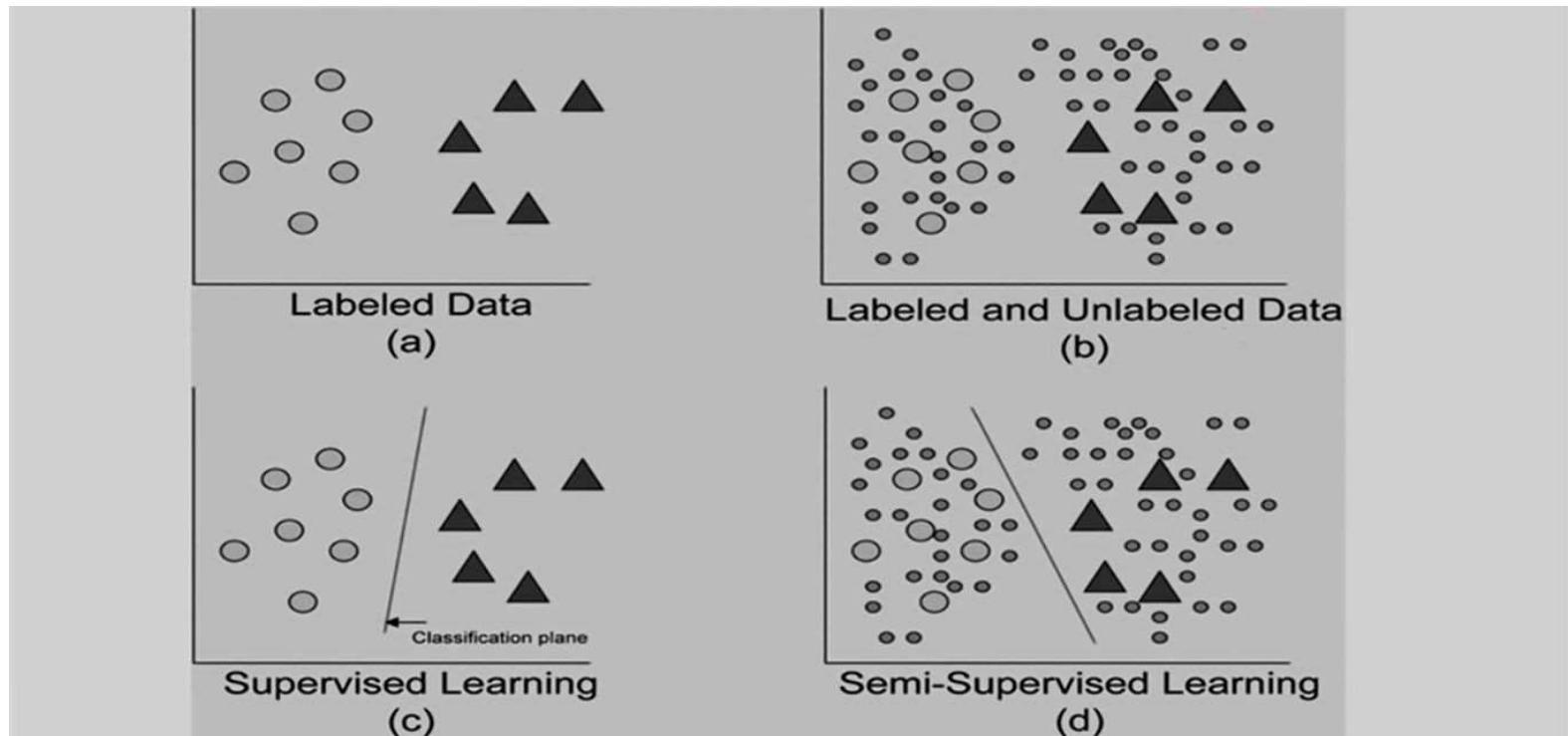


Image Source: Prof. Sudeshna Sarkar's lecture

Unsupervised Learning

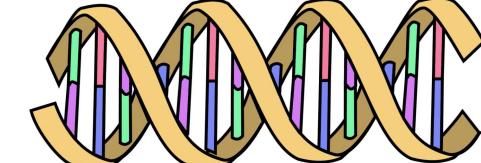
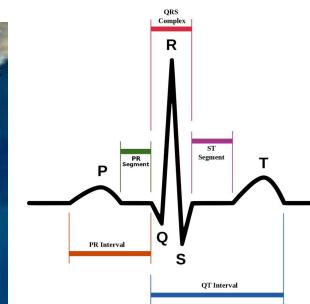
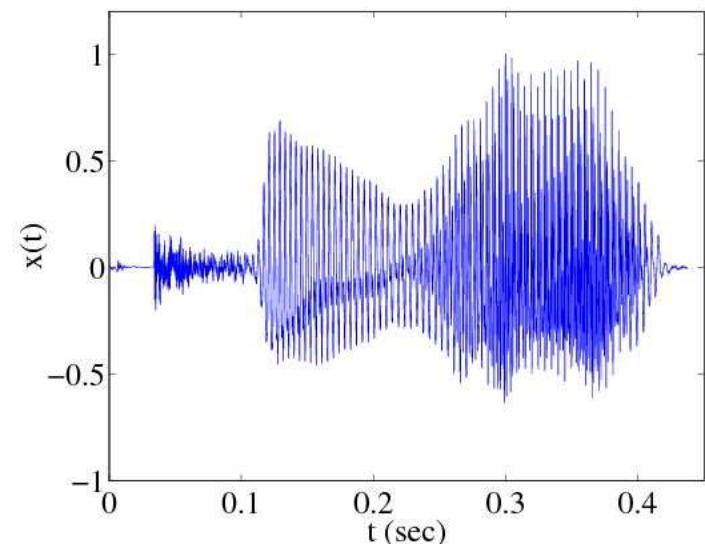


Semi-Supervised Learning



Data is the king - AI Community

What is **Data**?



Data is everywhere!

Supervised Learning Data Format

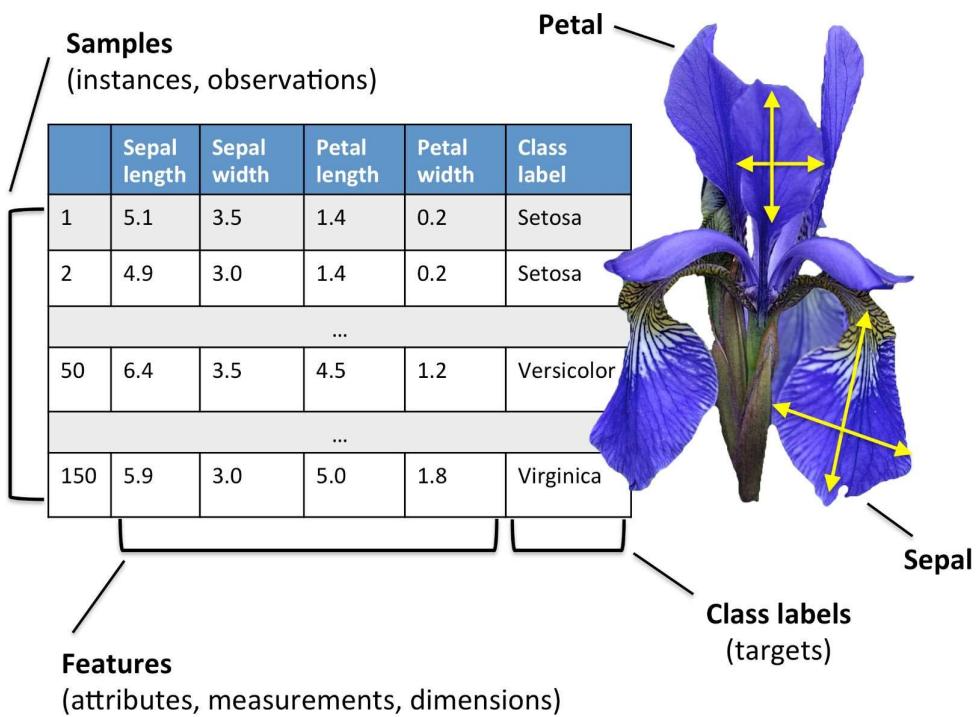
X1	X2	Xn	Output (Y)
a1	a2	an	y1
b1	b2	bn	y2

X_1, X_2, \dots, X_n are called features

Each row is a data instance or a feature vector

Y is the output

Example Dataset:



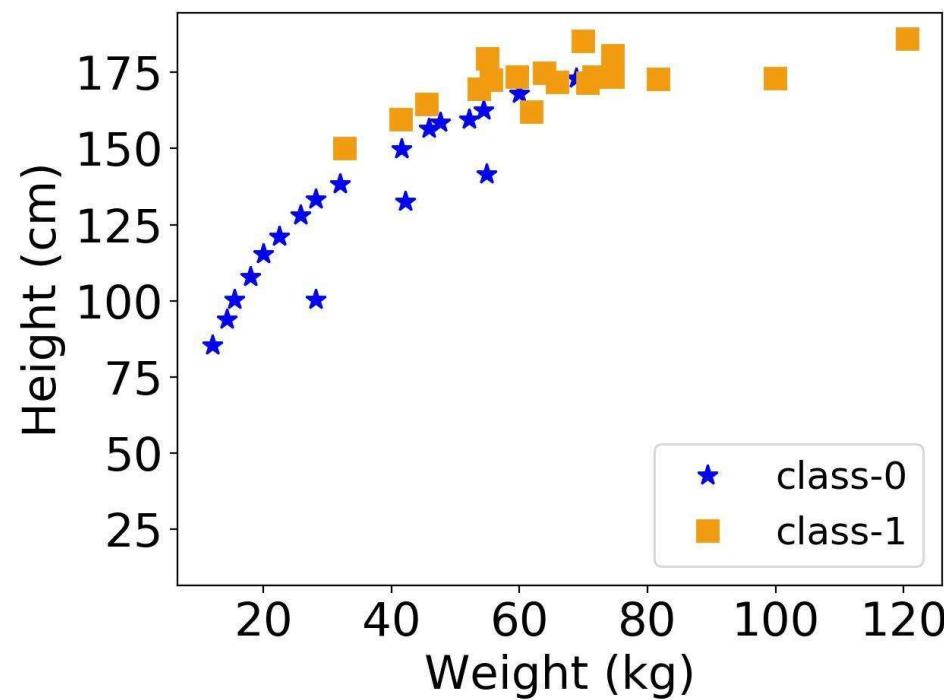
A	B	C	D	E
R&D Spend	Administration	Marketing Spend	State	Profit
165349.2	136897.8	471784.1	New York	192261.83
162597.7	151377.59	443898.53	California	191792.06
153441.51	101145.55	407934.54	Florida	191050.39
144372.41	118671.85	383199.62	New York	182901.99
142107.34	91391.77	366168.42	Florida	166187.94
131876.9	99814.71	362861.36	New York	156991.12
134615.46	147198.87	127716.82	California	156122.51
130298.13	145530.06	323876.68	Florida	155752.6
120542.52	148718.95	311613.29	New York	152211.77
123334.88	108679.17	304981.62	California	149759.96
101913.08	110594.11	229160.95	Florida	146121.95
100671.96	91790.61	249744.55	California	144259.4

Image Source: <https://setscholars.net/applied-machine-learning-coding-turicreate-in-python-iris-dataset/>

Understanding Classification Via Example

A	B	C
Weight (kg)	Height (cm)	Class
12	85.5	0
14.2	94	0
15.4	100.3	0
17.9	107.9	0
199	115.5	0
22.4	121.1	0
25.8	128.2	0
28.1	133.3	0
28.1	100.4	0
31.9	138.4	0
74.6	173.6	1
71.6	173.6	1
59.6	173.6	1
55.6	172.6	1
74.6	180.5	1
70.6	171.6	1
53.6	169.6	1
45.5	164.6	1
41.44	159.65	1
32.68	149.99	1
54.93	179.62	1

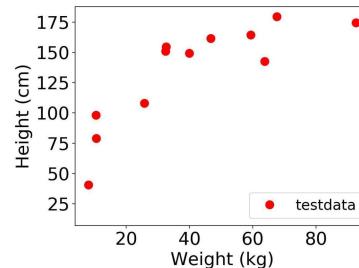
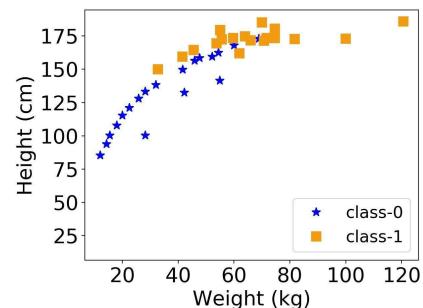
Class-0 below 15 years
Class-1 above 15 years



Supervised Learning

TESTING

TESTDATA



TRAINDATA



PROGRAM



OUTPUT

OUTPUT

Class-0 below 15 years
Class-1 above 15 years



TRAINING