

$$\bar{x}_1 = \frac{1+3+3+6+8+9}{6} = 5$$

$$\bar{x}_2 = 2+4+4+8+12 = 30$$

$$\bar{x}_3 = 4+7+1+6 = 18$$

$$\log_b b^x = x$$

$$\log_a x = \frac{\log_b x}{\log_b a}$$



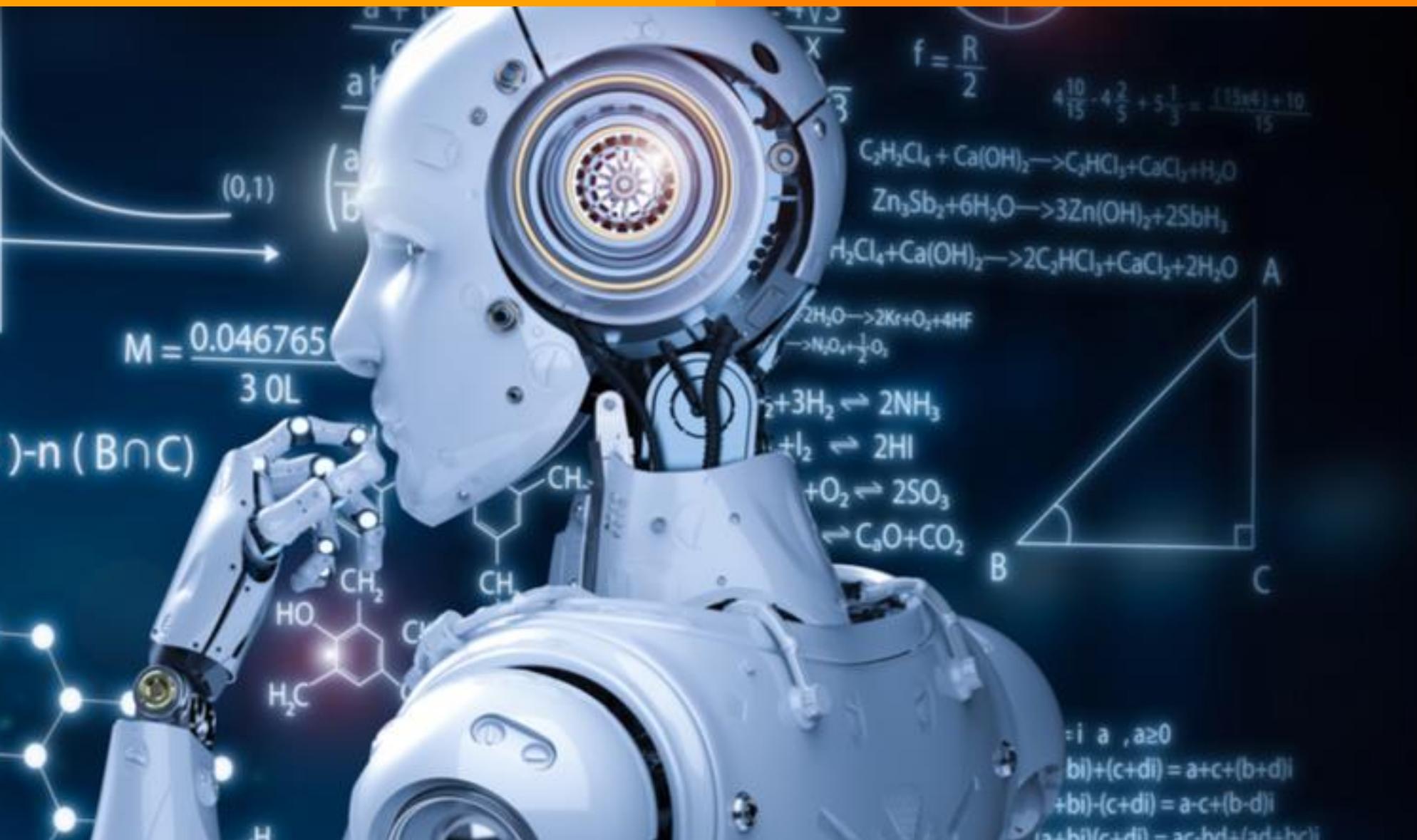
$$\begin{aligned} \frac{(a)}{(b)} &= \frac{a}{bc} & X^2 - 4X + 5 \leq 5 \\ \frac{a}{(b)} &= \frac{ac}{b} & X^2 - 4X \leq 0 \\ \frac{a}{b} + \frac{c}{d} &= \frac{ad+bc}{bd} & n(B \cap C) = 22 \\ && n(B) = 68 \\ && n(C) = 84 \end{aligned}$$

$$n(B \cup C) = n(B) + n(C) - n(B \cap C)$$

$$He = 4.002602$$

$$Na = 22.989769$$

$$Ar = 39.948$$



# Lecture 01 - Introduction to Machine Learning



# 1. Course plan & logistics

# Logistics

- Course Name
  - Applied Machine Learning – AML 5102
- Hours per week: 3 lectures + 3 hours lab
- Total 36 hours theory + 36 hours lab

# Course Objectives

- Understand/compare/choose between ML paradigm
- Supervised & Unsupervised ML, Feature Engg.
- My unofficial objectives -
  - Make you develop a passion for all things ML
  - Help you excel in theoretical & practical aspects of ML
  - Aid you in gaining employable skills
- Not comprehensive intro to popular software frameworks like numpy, pandas, sklearn, tensorflow, pytorch
  - Numerous videos available on youtube

# Your objectives



# Evaluation

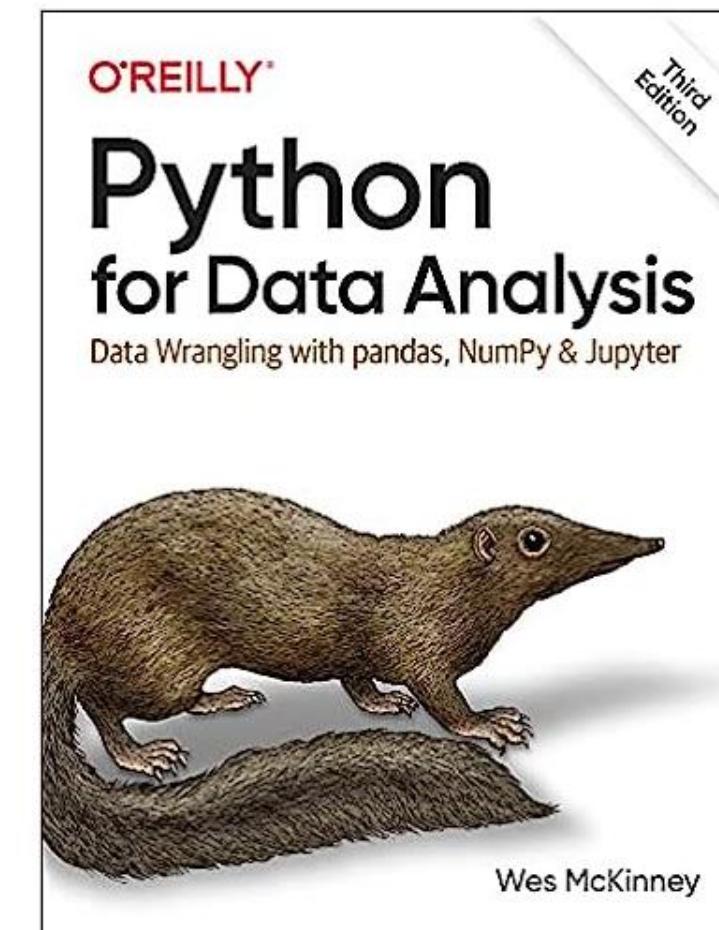
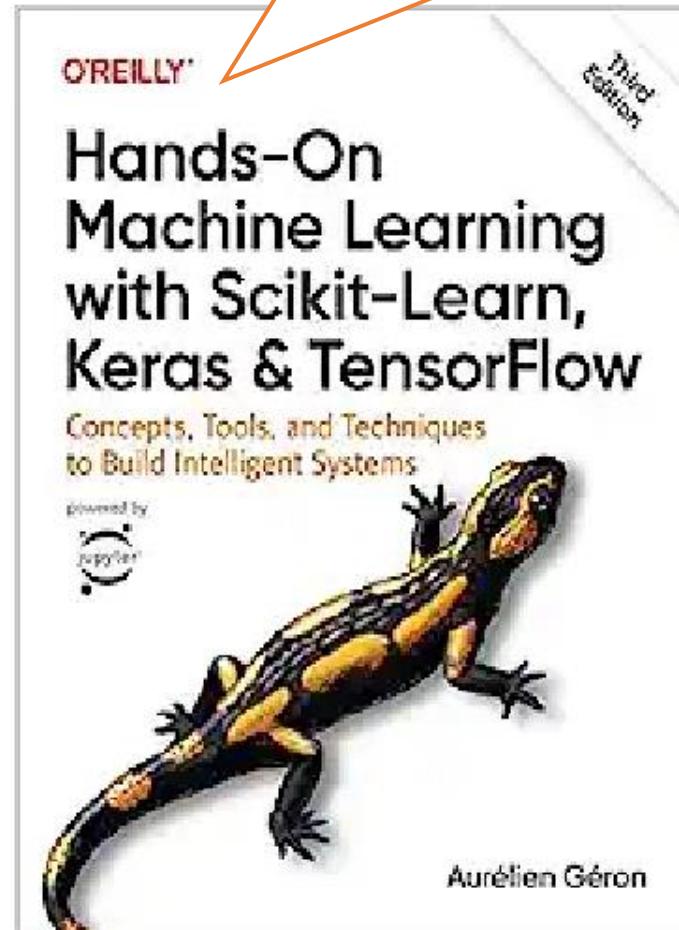
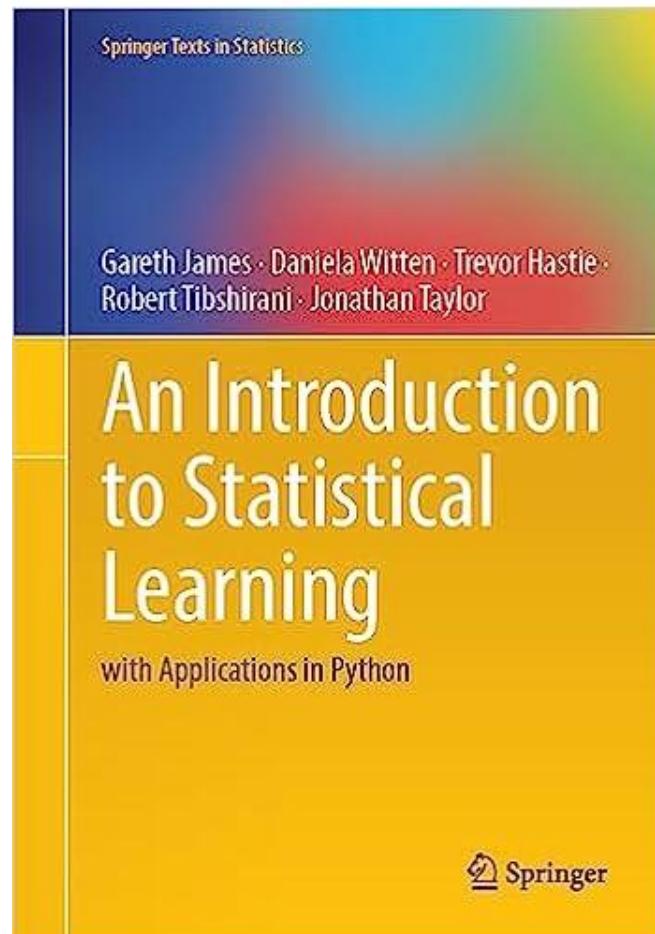
- Memorization not important for exams
- Exam will test your
  - Core understanding & interdisciplinary thinking
  - Capability to apply Linear algebra to
    - Various scenarios & Machine Learning problems
  - Objective type, True/False, Problems, 2-3 sentence
    - Negative marking for objective type, True/False
    - True/False will also need a 1-2 sentence reasoning.
    - Both have to be correct.

# Grading policy

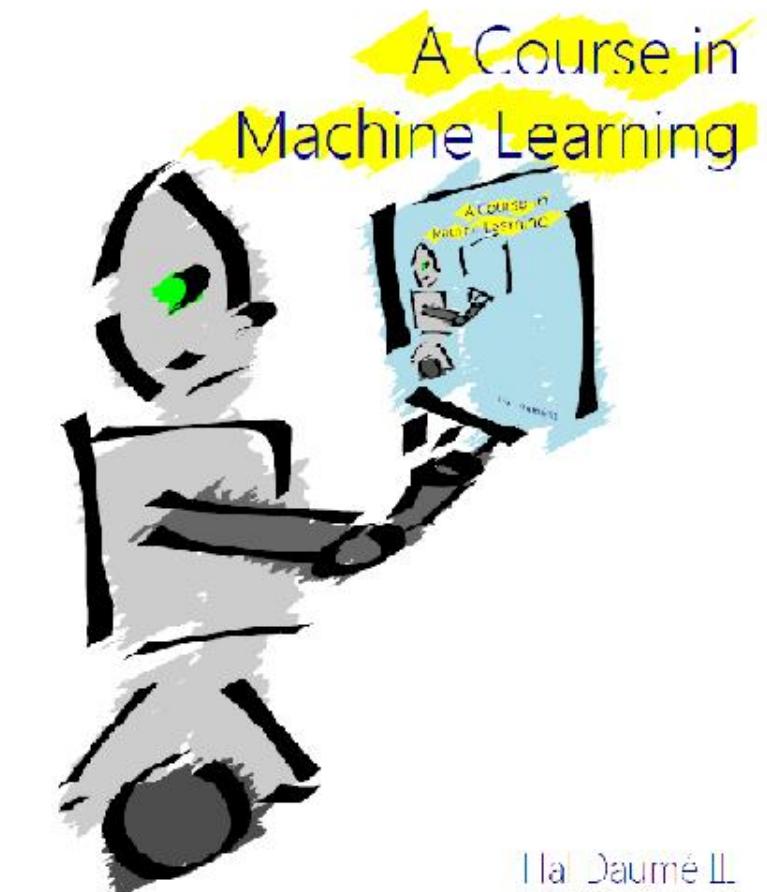
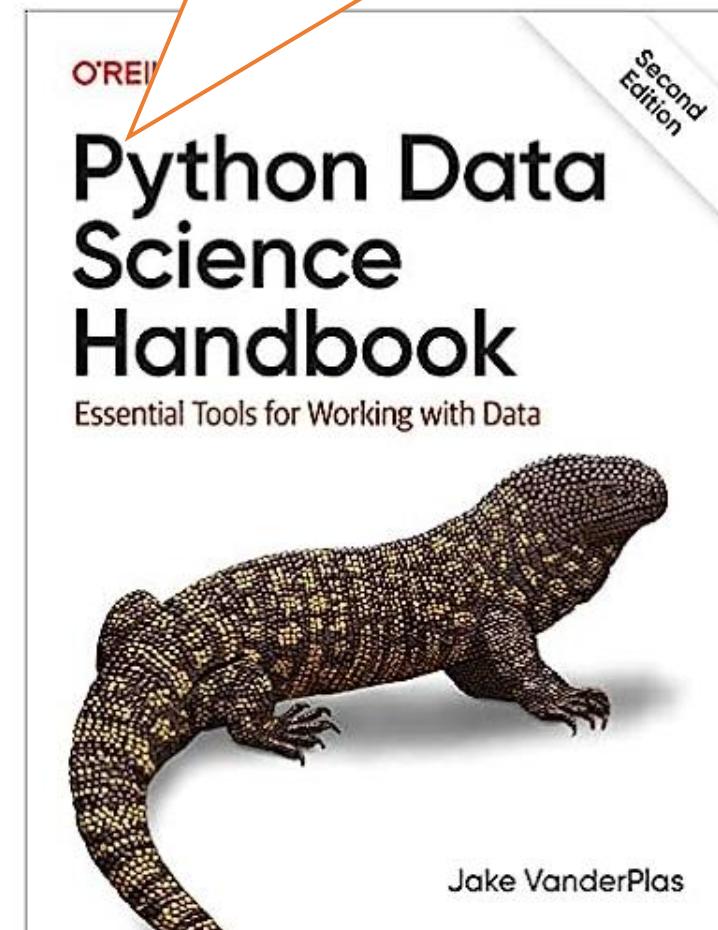
- 2 sessional + 1 end semester exam
- One big implication of chosen approach 😞
- Continuous assessment
  - 2-3 problem sets per semester
  - Many surprise quizzes
  - Daily summarization by randomly chosen student

# Textbook & References

Helps in placements



Good book for hands-on numpy, pandas & more

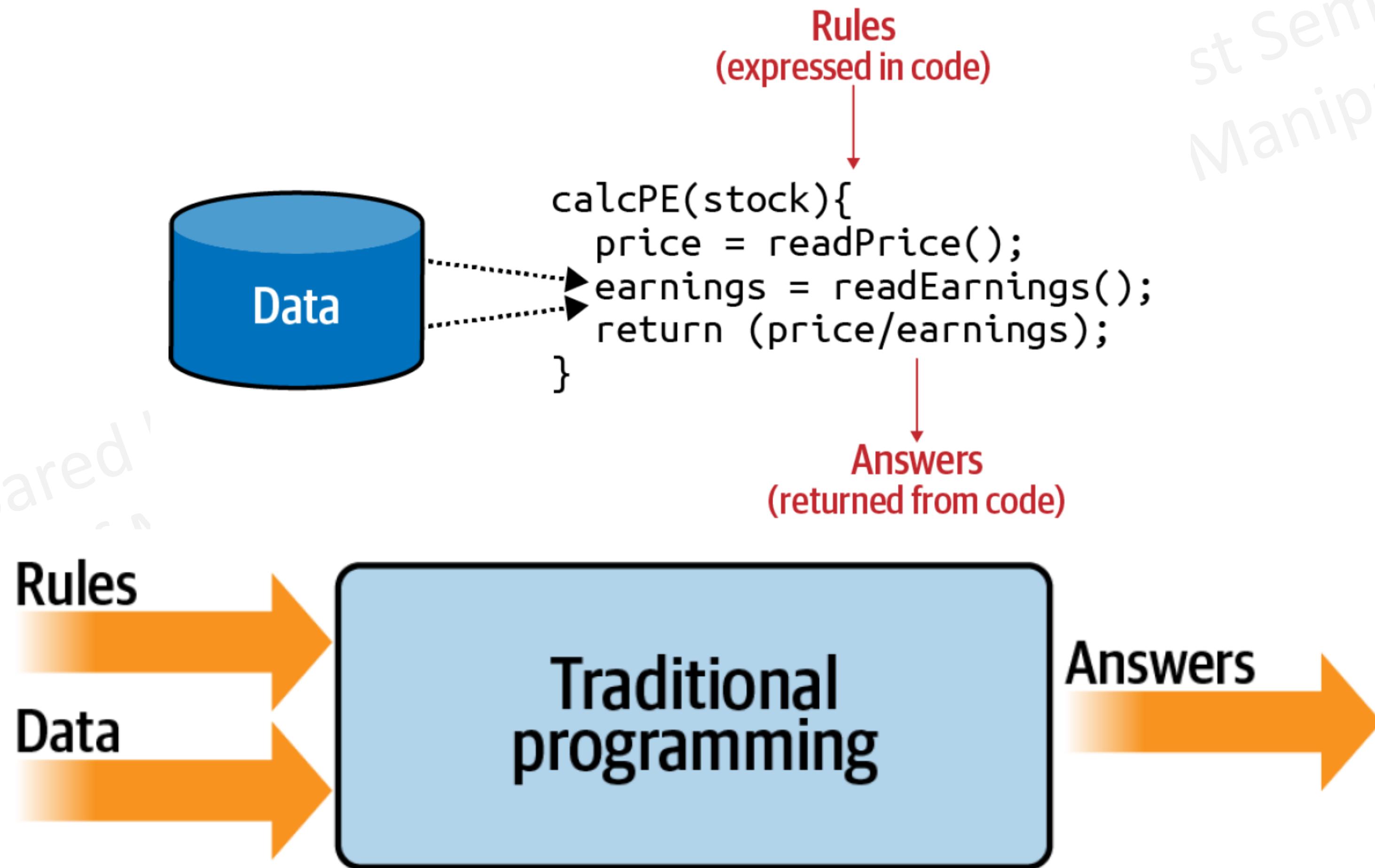


- Recommended, but none required
- Reading materials from various sources
- Mandatory and recommended videos
- For every lecture – Slides, Lecture Notes (for select topics)



## 2. What is Machine Learning

# Traditional Programming



# Solving it traditional way

Rules

Data

Traditional  
programming

Answers

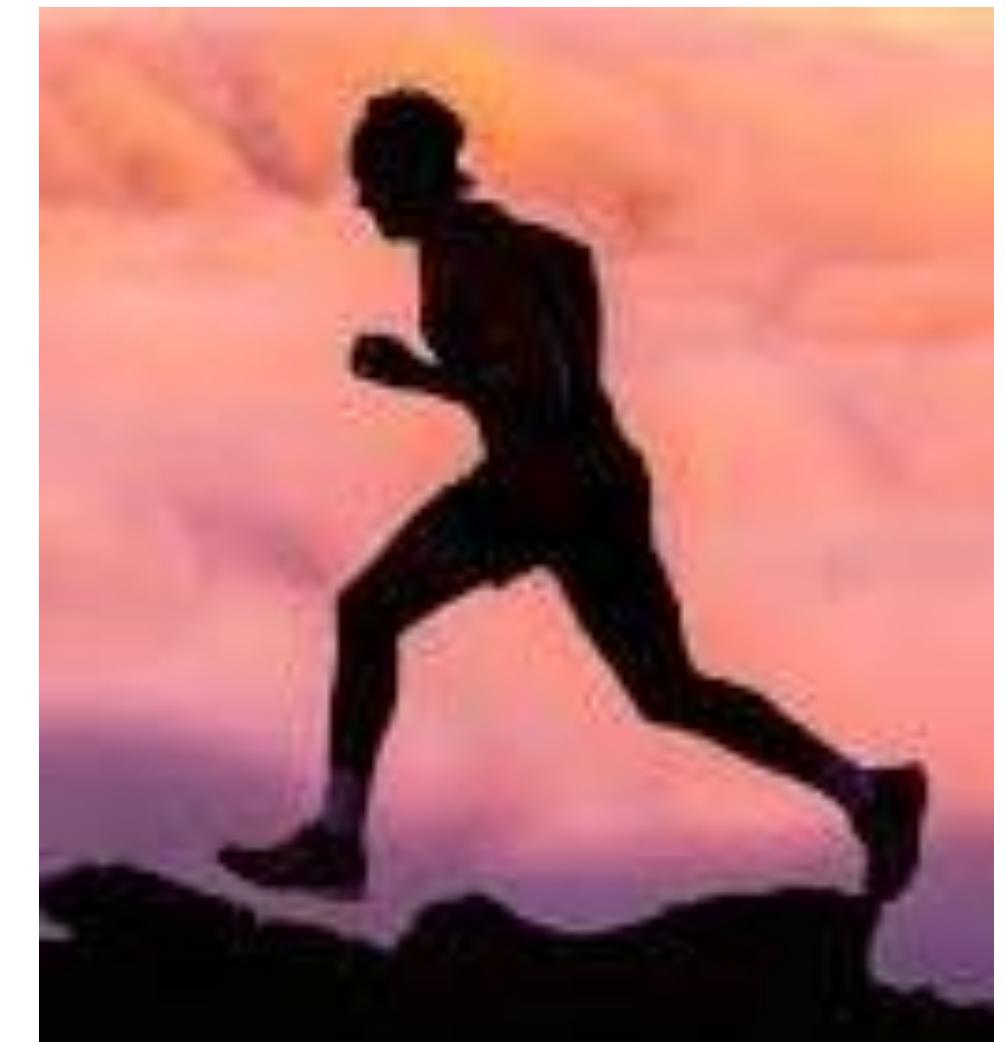
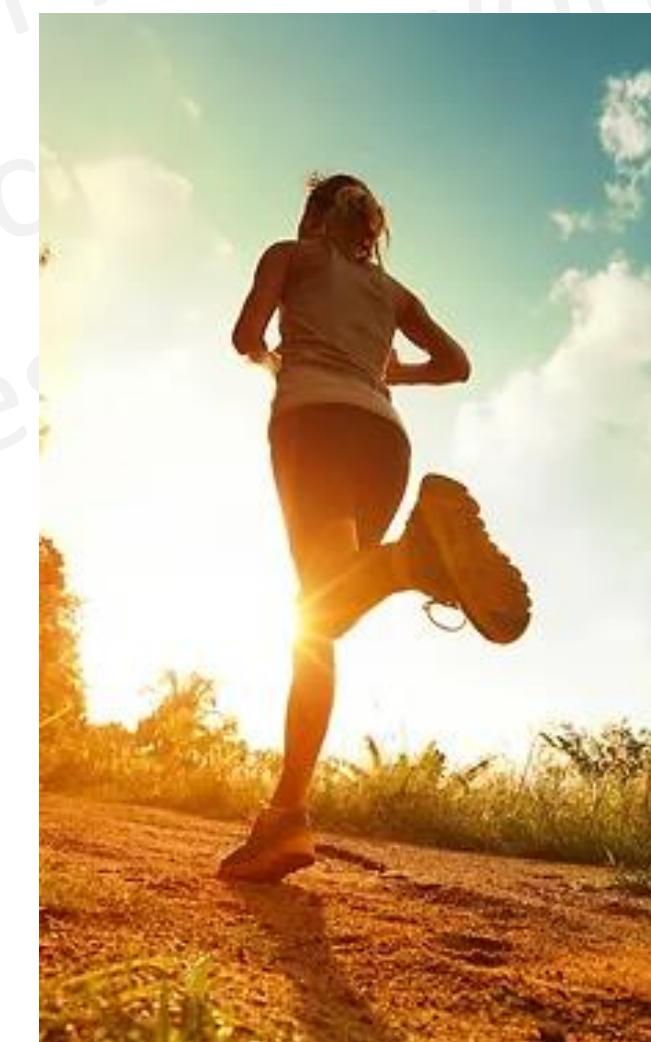
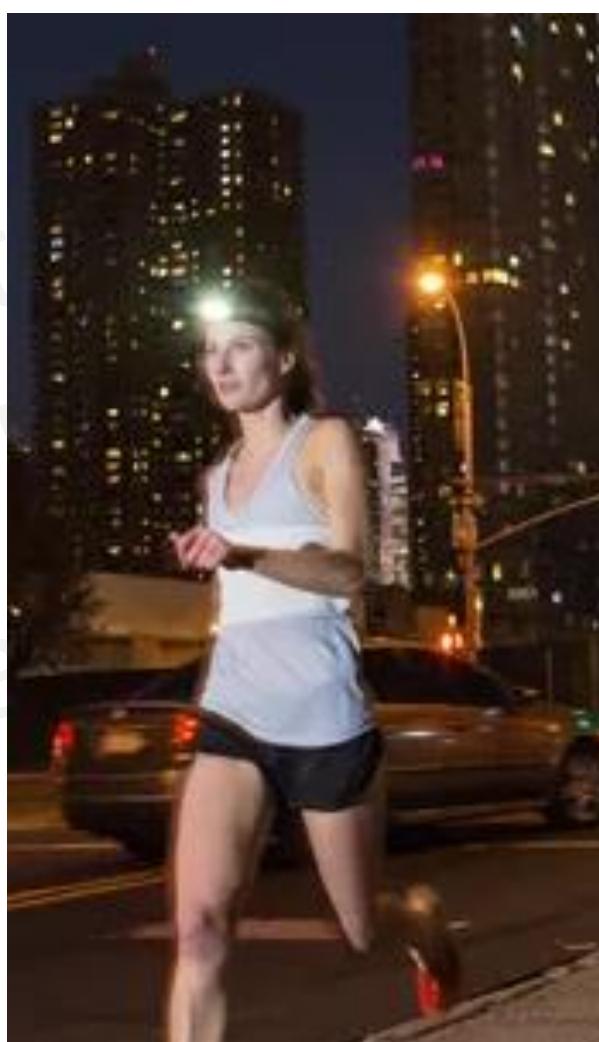
Explicit coding  
will not work



```
1 public class Model {  
2     public static double score(double[] input) {  
3         double var0;  
4         if (input[4] <= 0.728433221578598) {  
5             if (input[0] <= 0.3851476162672043) {  
6                 if (input[0] <= -0.8715016543865204) {  
7                     if (input[3] <= 0.629336342215538) {  
8                         if (input[0] <= -1.2120069861412048) {  
9                             if (input[2] <= -0.34459860622882843) {  
10                                if (input[1] <= -0.01869487762451172) {  
11                                    if (input[0] <= -1.438126027584076) {  
12                                        if (input[2] <= -1.5603920221328735) {  
13                                            if (input[0] <= -1.5781668424606323) {  
14                                                var0 = 1607.5101318359375;  
15                                            } else {  
16                                                if (input[2] <= -2.2775022983551025) {  
17                                                    var0 = 1727.7850341796875;  
18                                                } else {  
19                                                    var0 = 1728.89697265625;  
20                                                }  
21                                            }  
22                                        }  
23                                    }  
24                                }  
25                            }  
26                        }  
27                    }  
28                }  
29            }  
30        }  
31    }  
32}
```

# Traditional approach can't scale

- Consider running activity. What variations exist?
  - Front pose, perspective, low lighting



# Machine Learning approach



0101001010100101010  
1001010101001011101  
0100101010010101001  
0101001010100101010

Label = WALKING



1010100101001010101  
0101010010010010001  
0010011111010101111  
1010100100111101011

Label = RUNNING



1001010011110101011  
1101010111010101110  
1010101111010101011  
1111110001111010101

Label = BIKING



111111111010011101  
0011111010111110101  
0101110101010101110  
1010101010100111110

Label = GOLFING

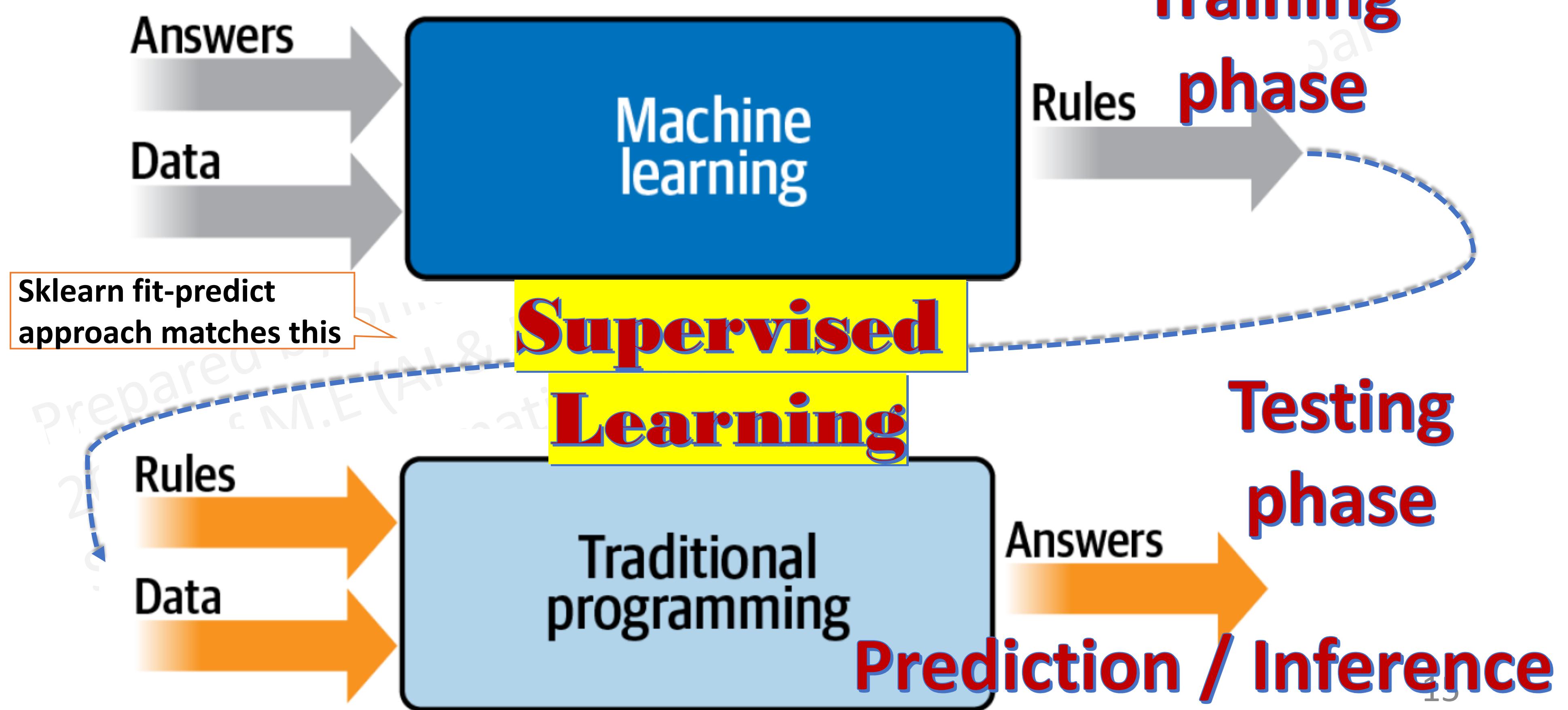
**Answers**

**Data**

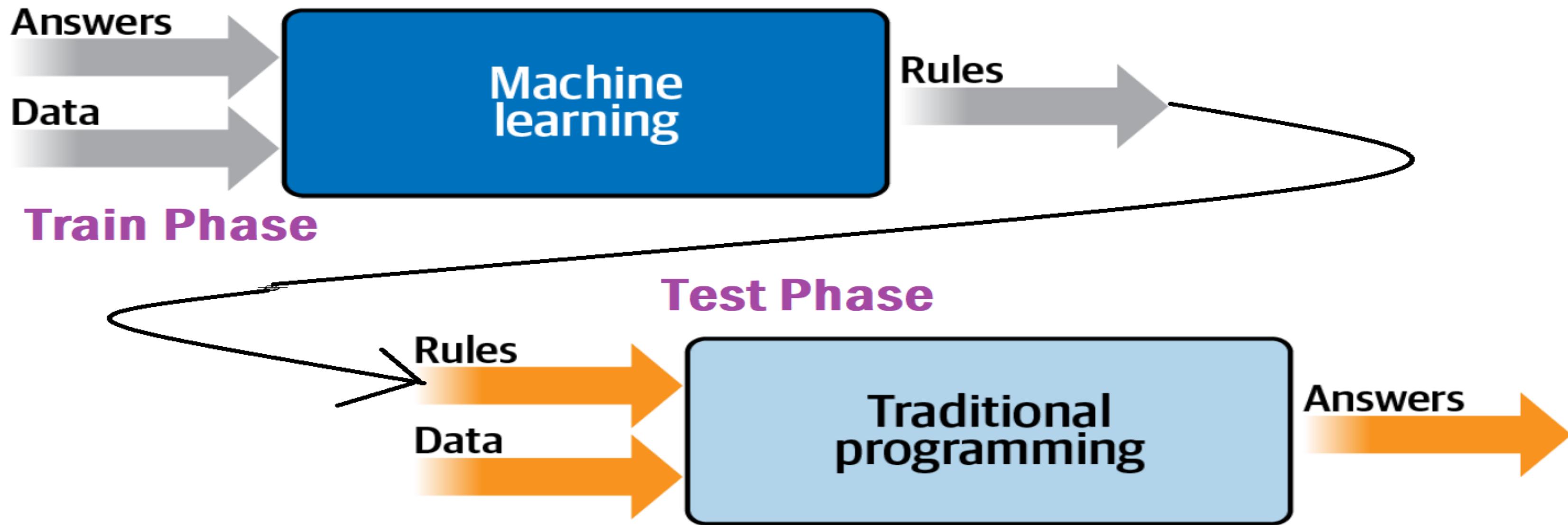
**Machine learning**

**Rules**

And then...

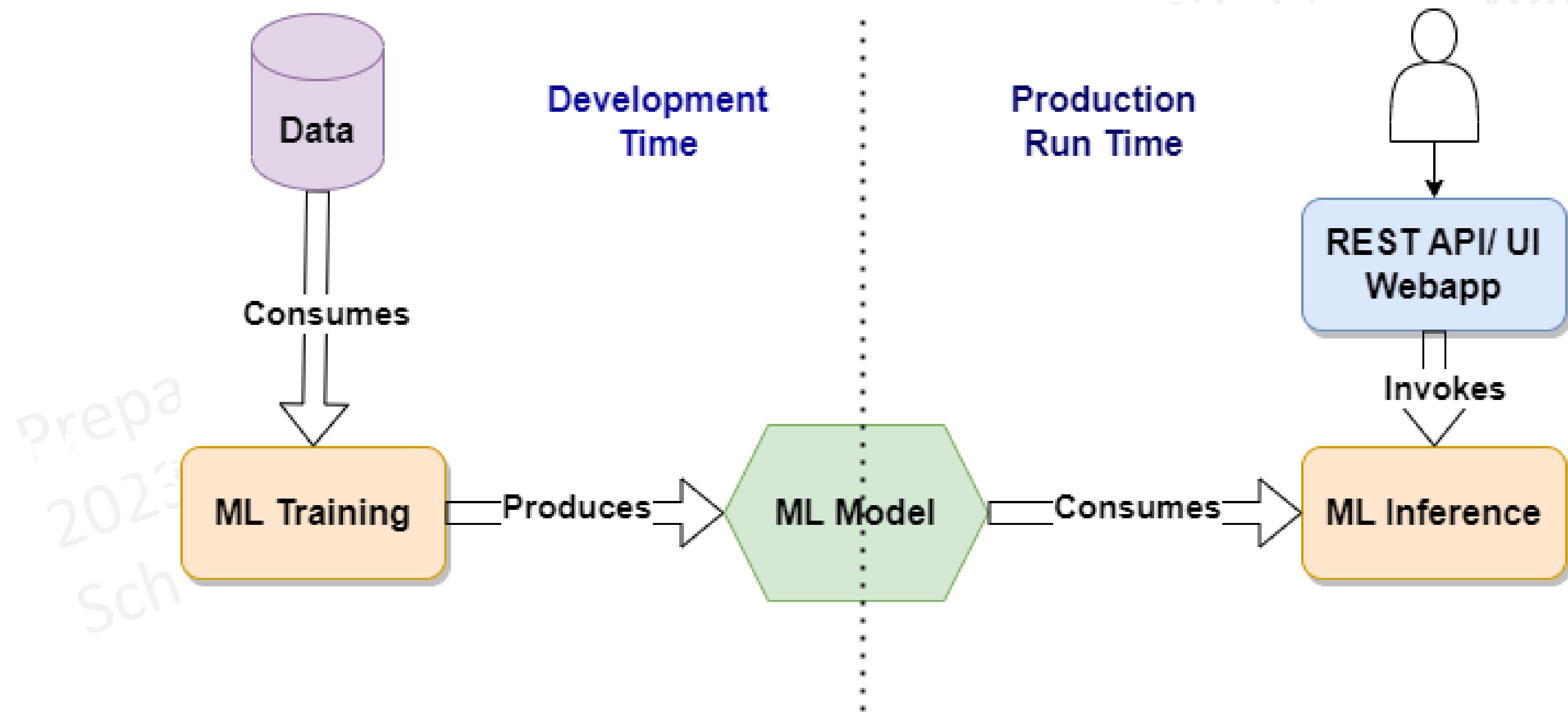


# Machine Learning is like exam



- Success is measured on
  - How one performs in test
  - Not how one practices

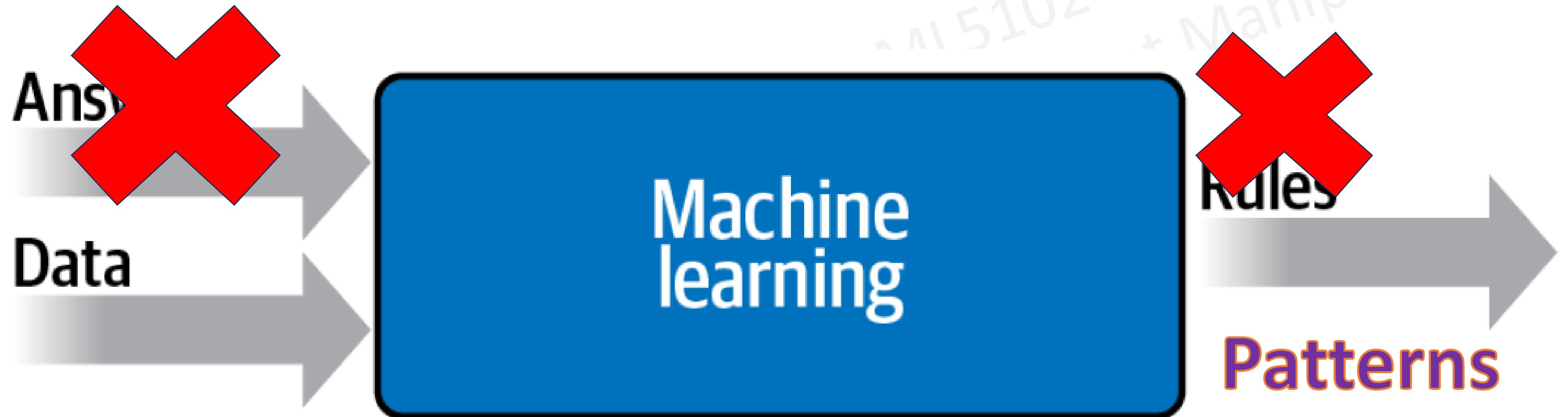
# From development to production



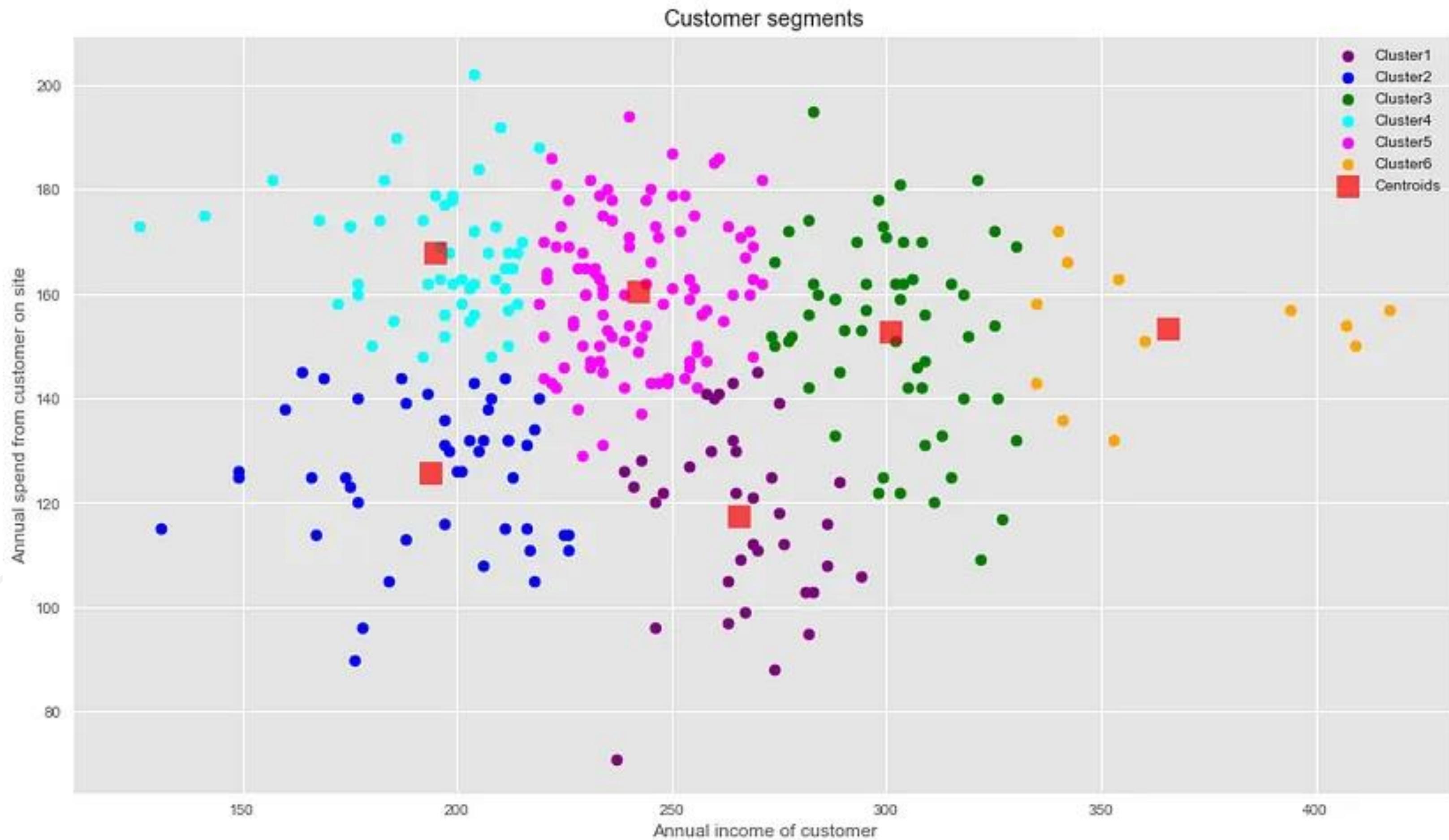
# What format are the rules

- In memory python object (tuned model)
- Pickle file
- Weights matrix stored as numpy, tf, pytorch
- NNEF
- ONNX – de-facto standard for exchanging deep learning models
- sklearn-onnx
- Mlflow
- Plain Ugly Code

# Unsupervised Learning



# Clustering



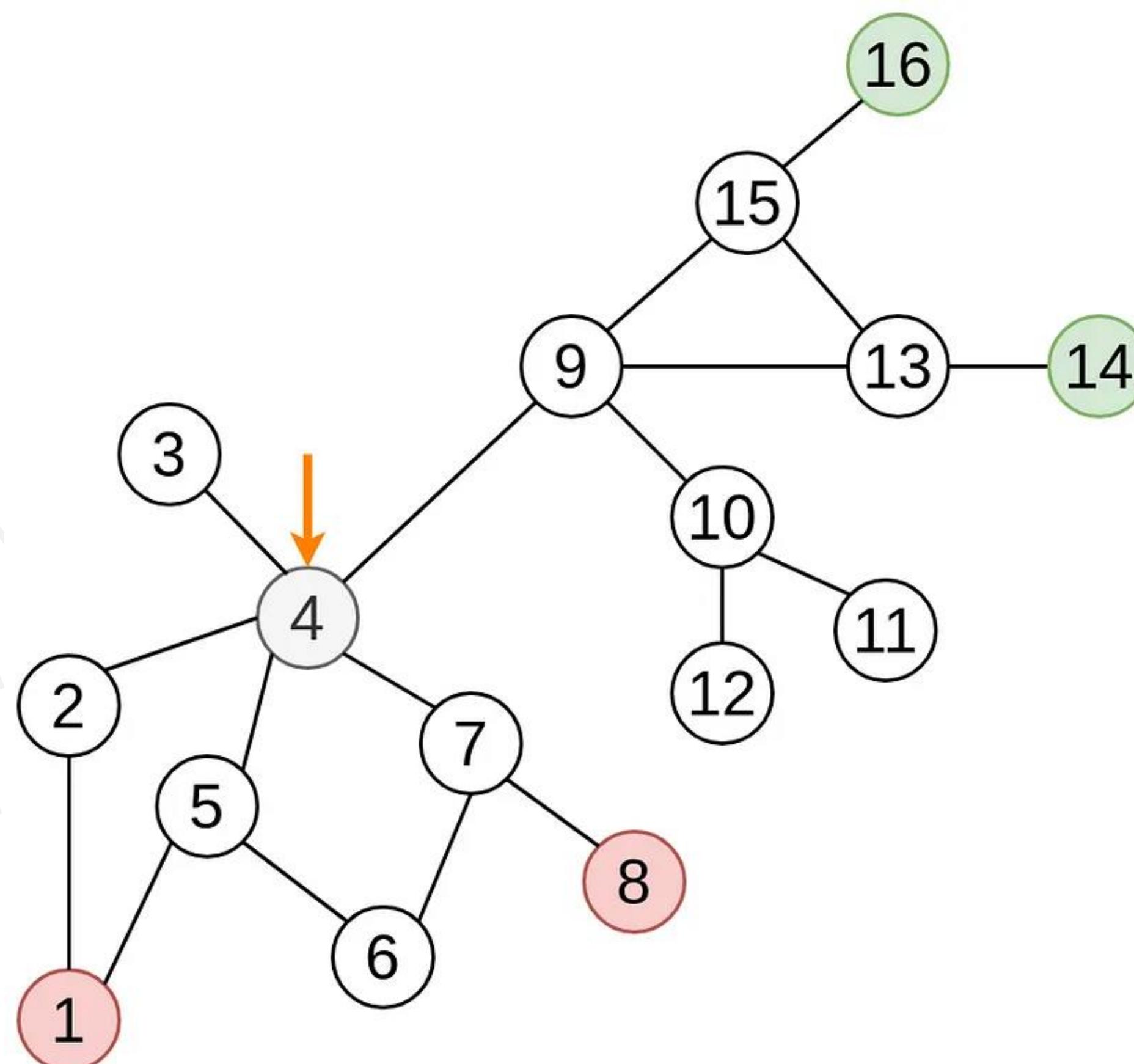
# Unsupervised learning examples

- Anomaly Detection
- Principal Component Analysis
- Independent Component Analysis
- Auto encoders (Neural Networks)

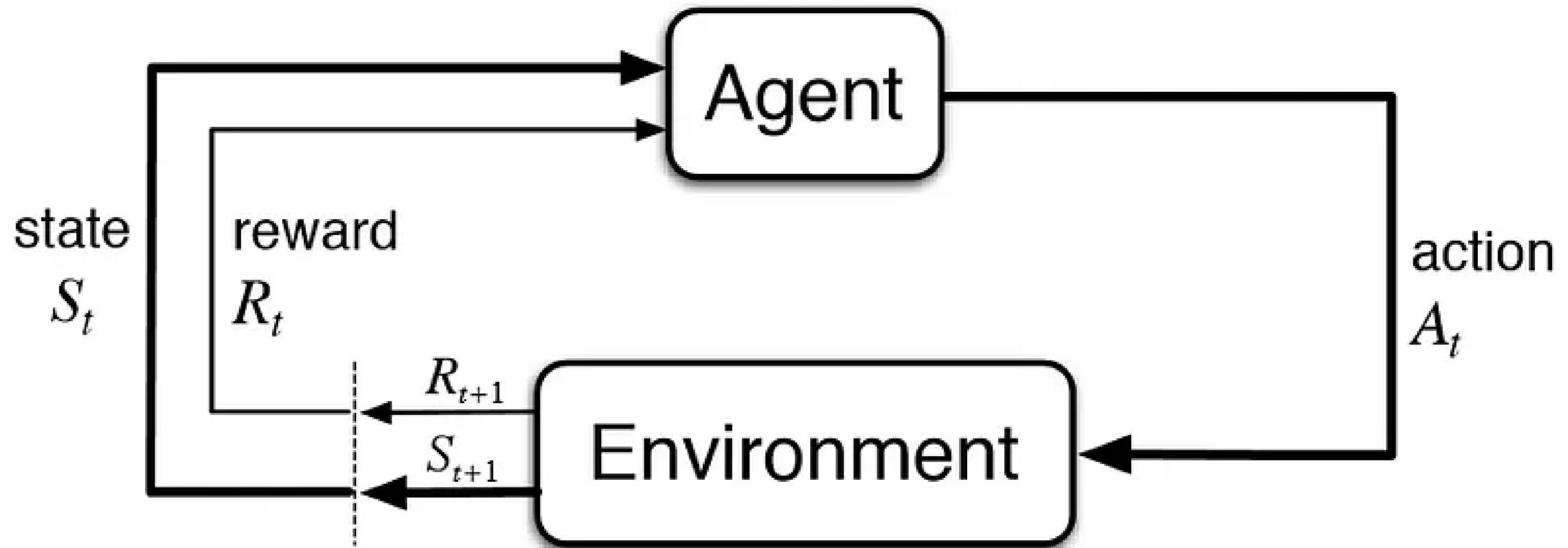
# Semi Supervised Learning

Prepared by  
2023 of M  
School of

First Semester  
< at Manipal

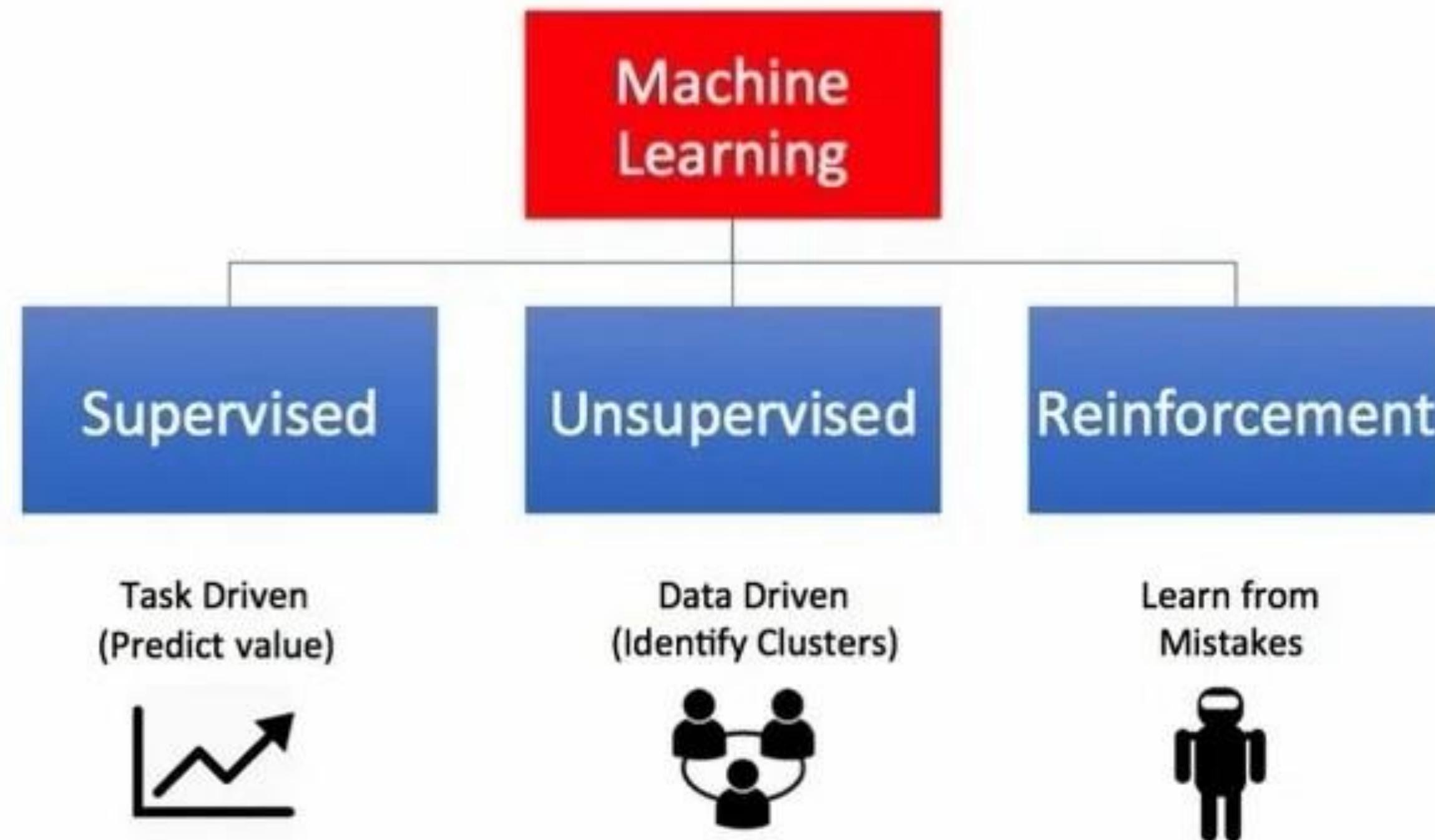


# Reinforcement Learning

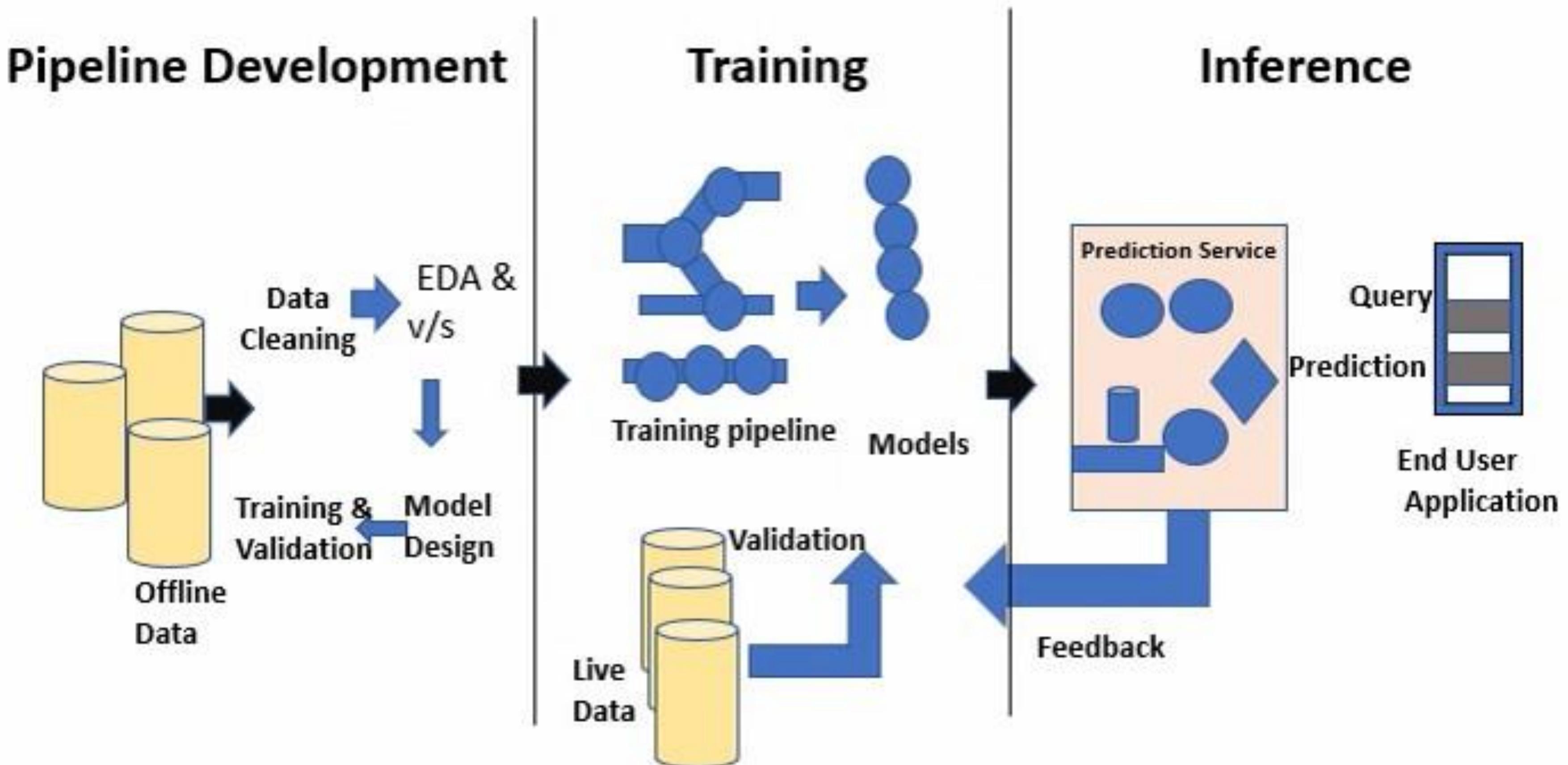


# Comparison

## Types of Machine Learning



# Machine Learning lifecycle

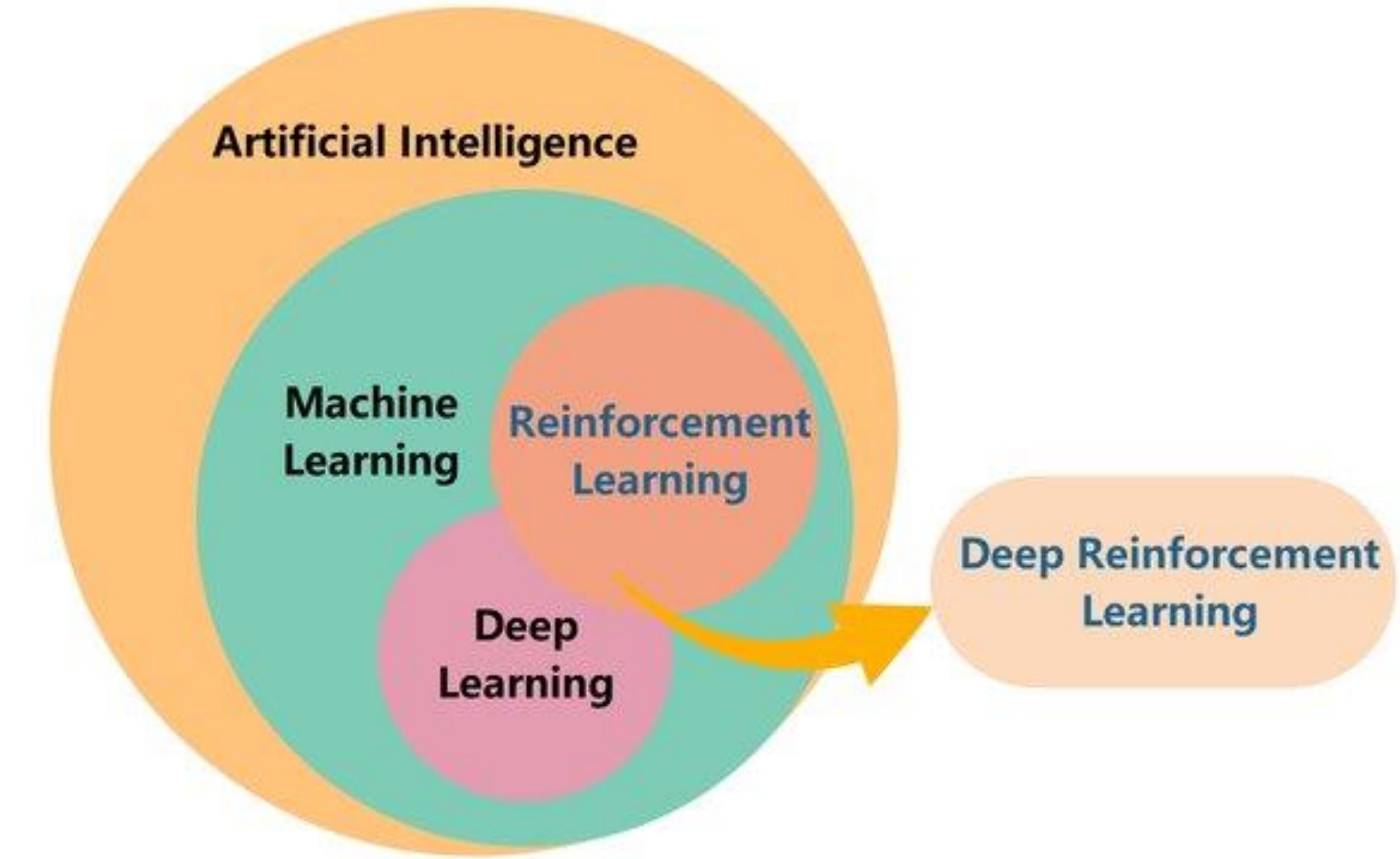




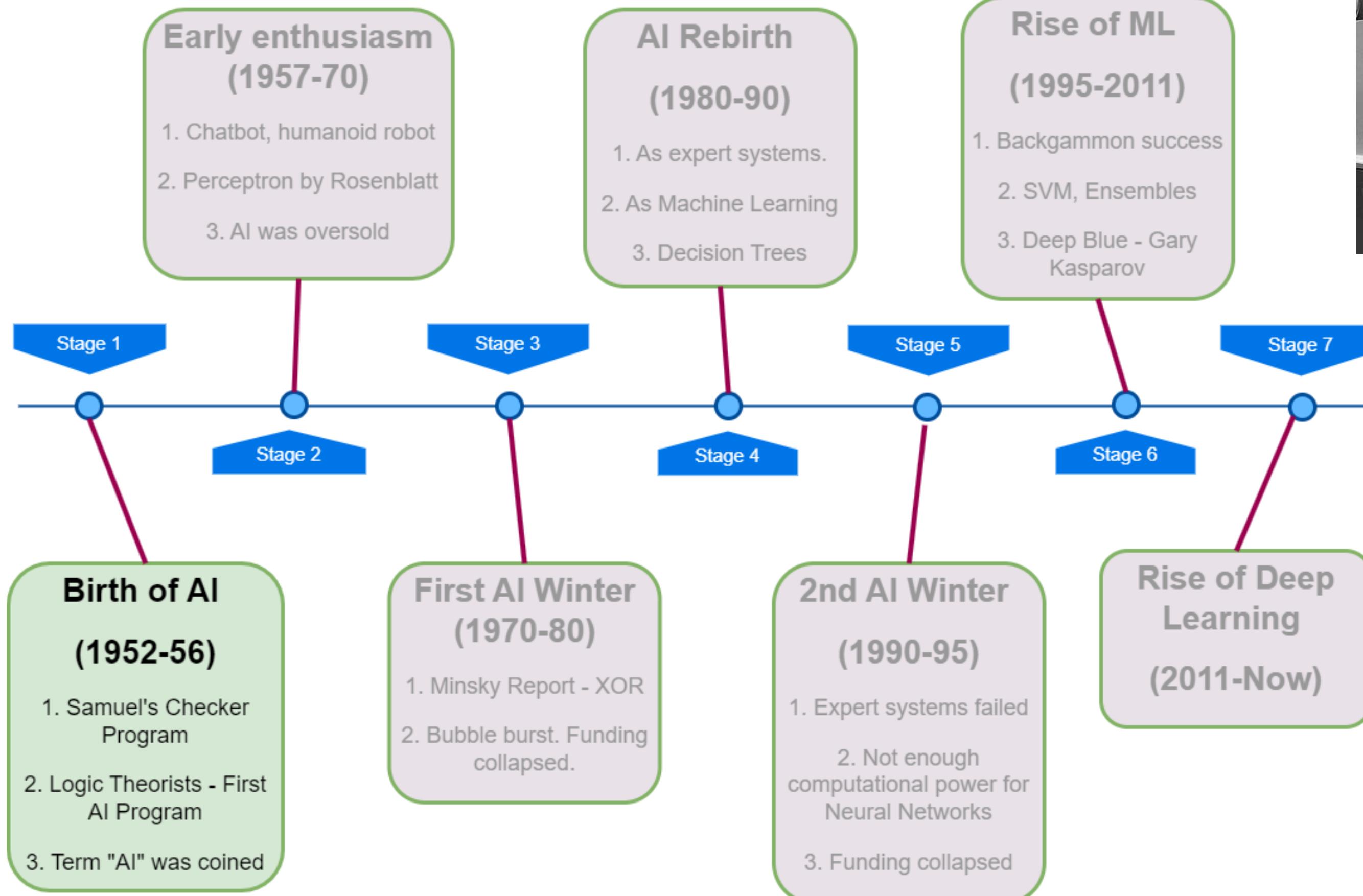
### 3. AI history from ML perspective

# Goal of classic AI

- To make computers
  - Think and act like humans
  - Make correct inferences
  - Be human like in decision making

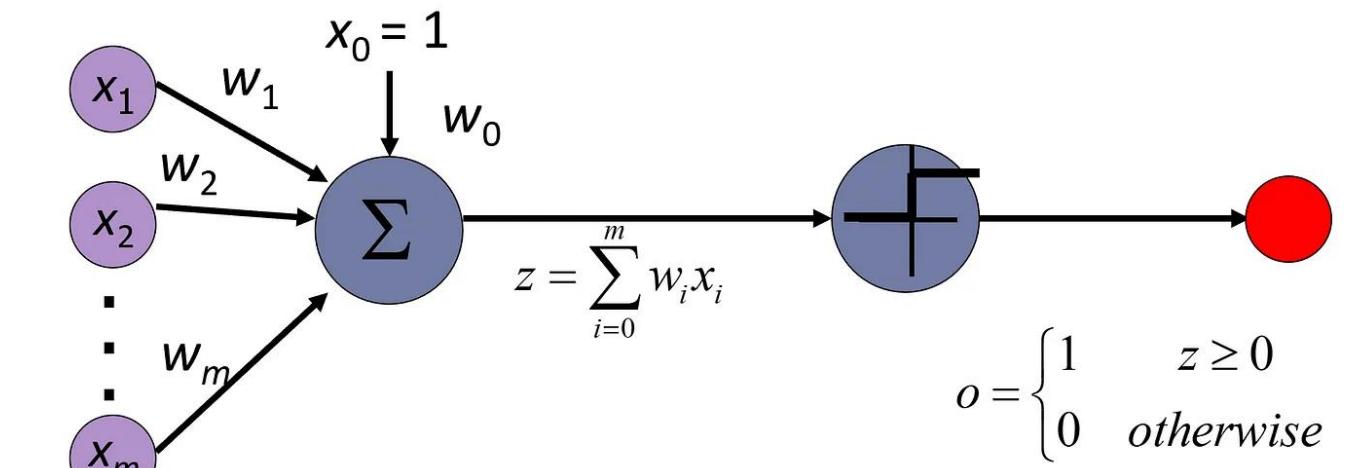
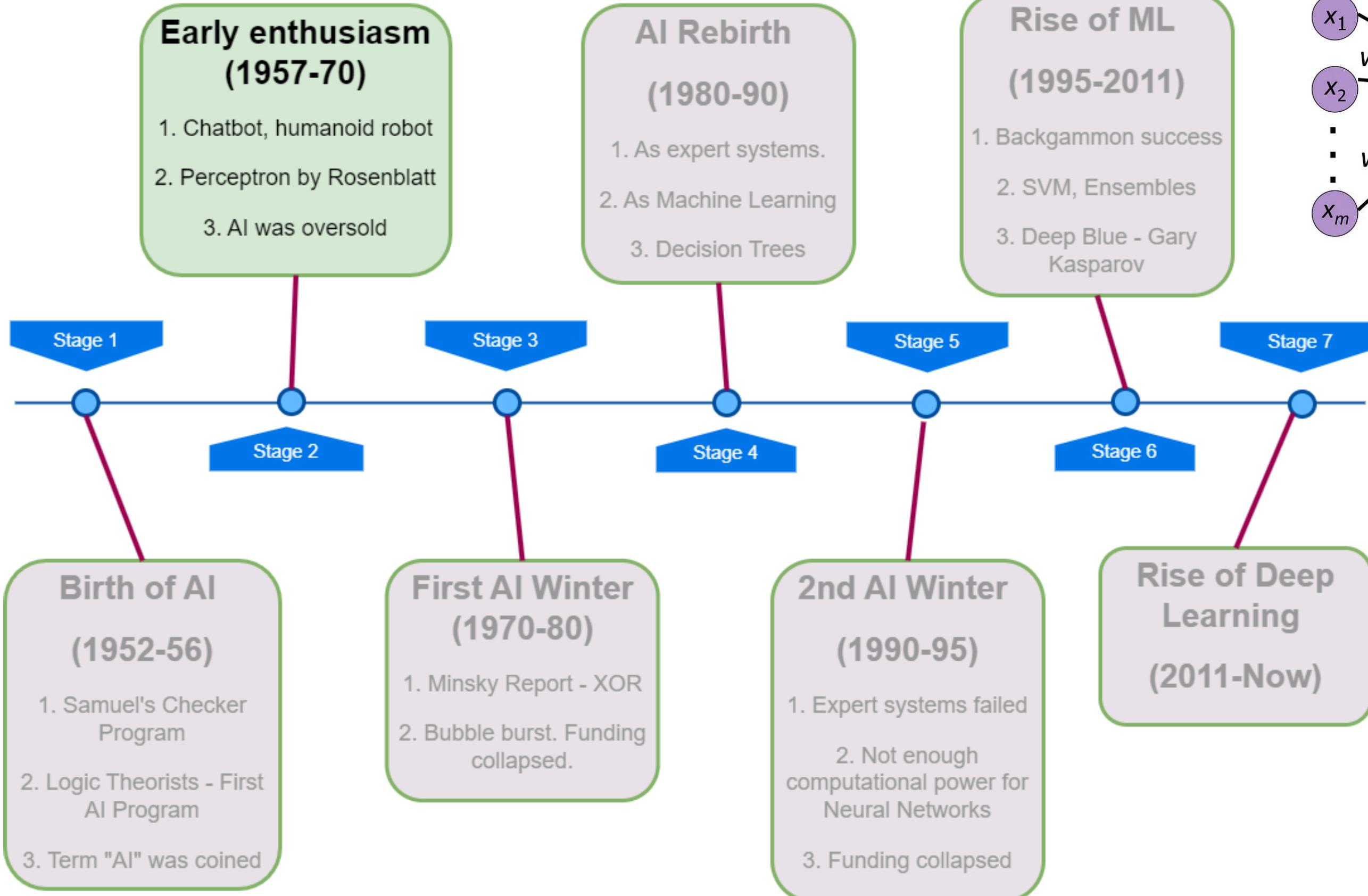


# Stage 1 – Birth of AI



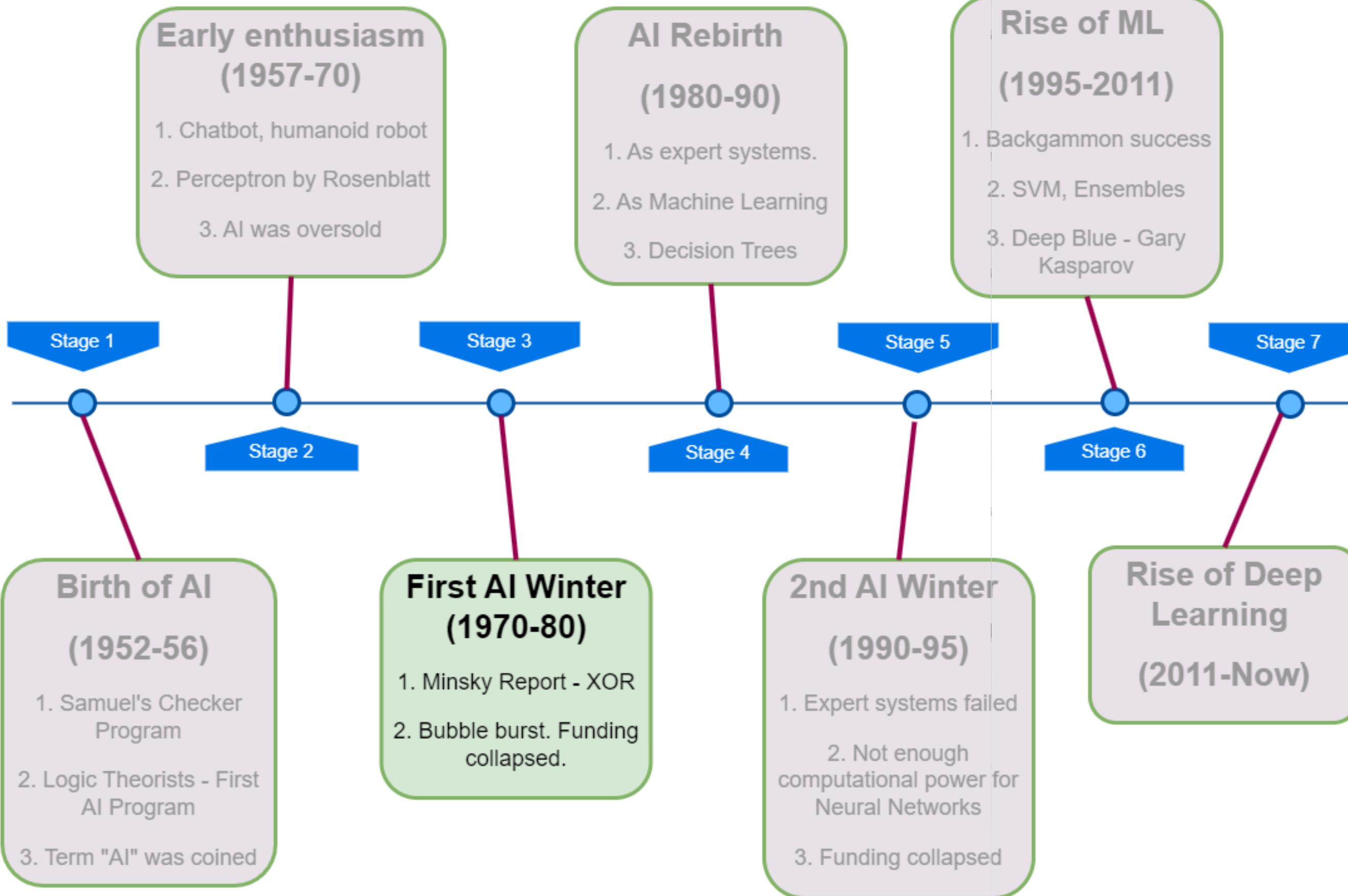
Minimax  
algorithm  
with brute  
force search  
in entire  
“move space”  
28

# Stage 2 – Early enthusiasm

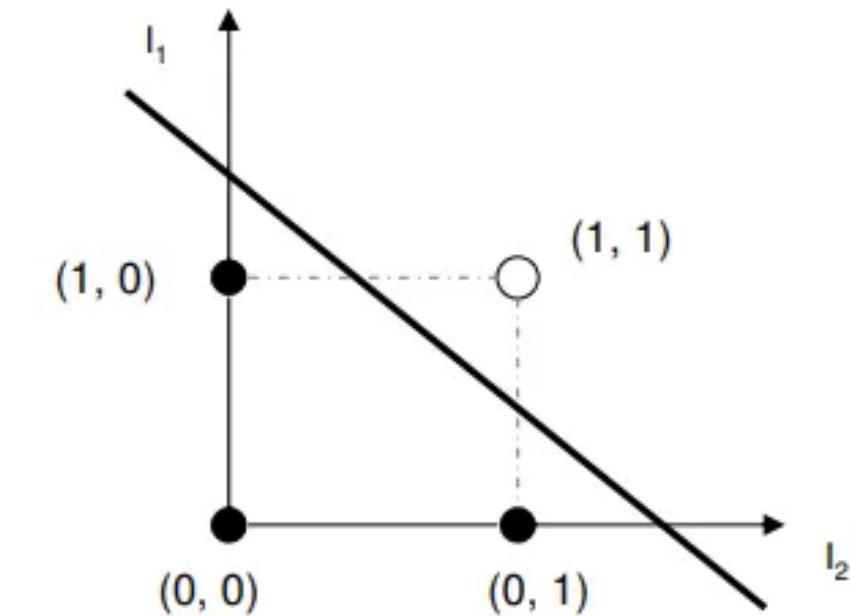


Perceptron is  
the  
cornerstone  
of neural  
networks

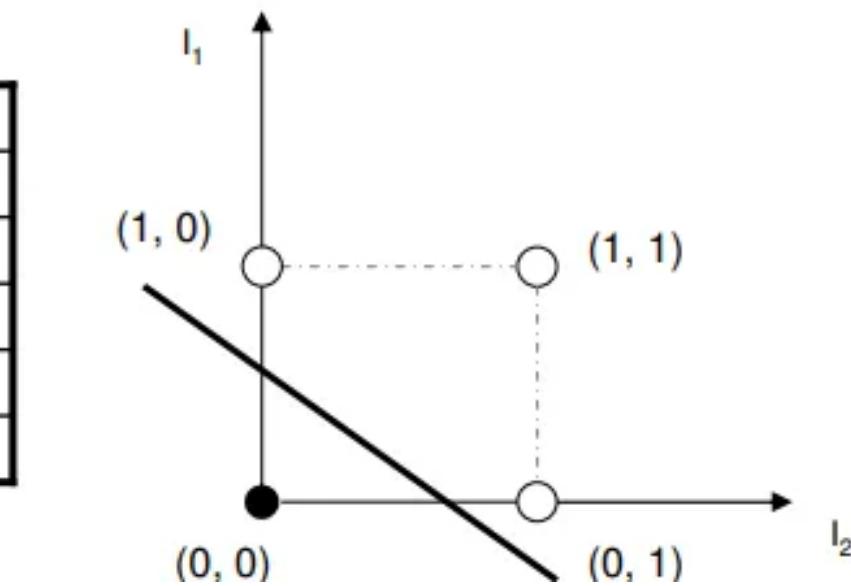
# Stage 3 – First AI winter



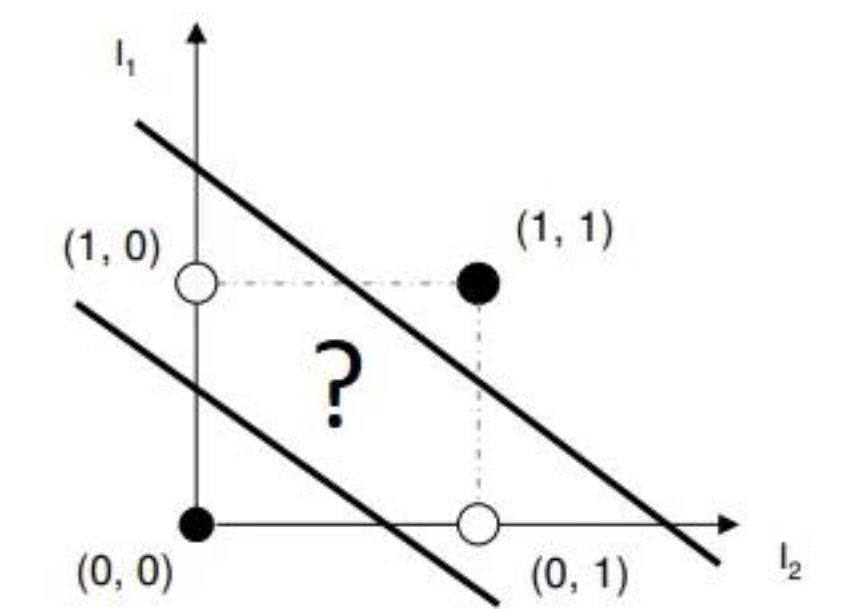
AND		
$I_1$	$I_2$	out
0	0	0
0	1	0
1	0	0
1	1	1



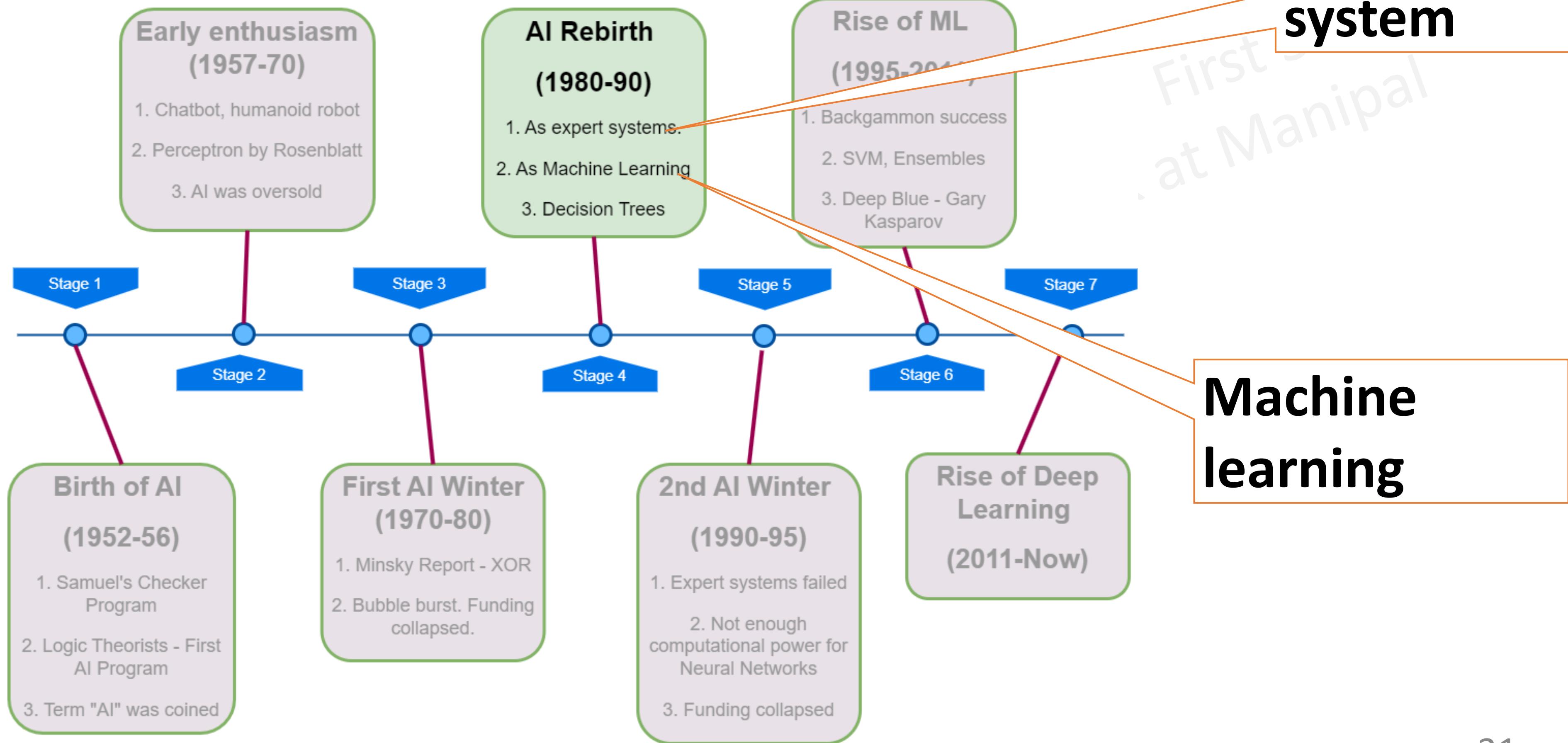
OR		
$I_1$	$I_2$	out
0	0	0
0	1	1
1	0	1
1	1	1



XOR		
$I_1$	$I_2$	out
0	0	0
0	1	1
1	0	1
1	1	0

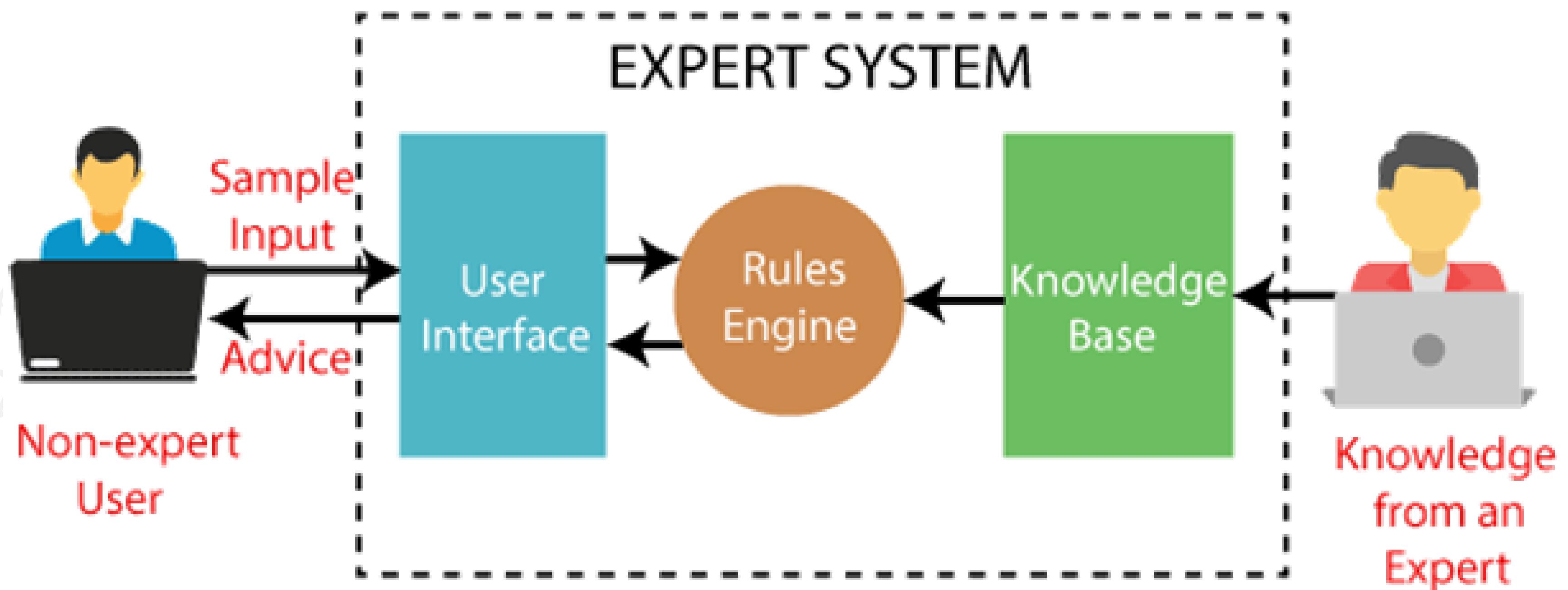


# Stage 4 –AI rebirth



## 4. AI rebirth (contd.)

- Expert Systems
  - Emulate human decision making



## 4. AI rebirth – Expert Systems

- Used in healthcare. E.g. MYCIN
- Limitations
  - Needed experts to capture the domain knowledge
  - Cannot scale with knowledge explosion
  - Cannot apply for unknown areas

IF

1. the infection is primary bacteria, and
2. The site of the culture is one of the sterile sites and
3. The suspected portal of entry is gastro intestinal

THEN

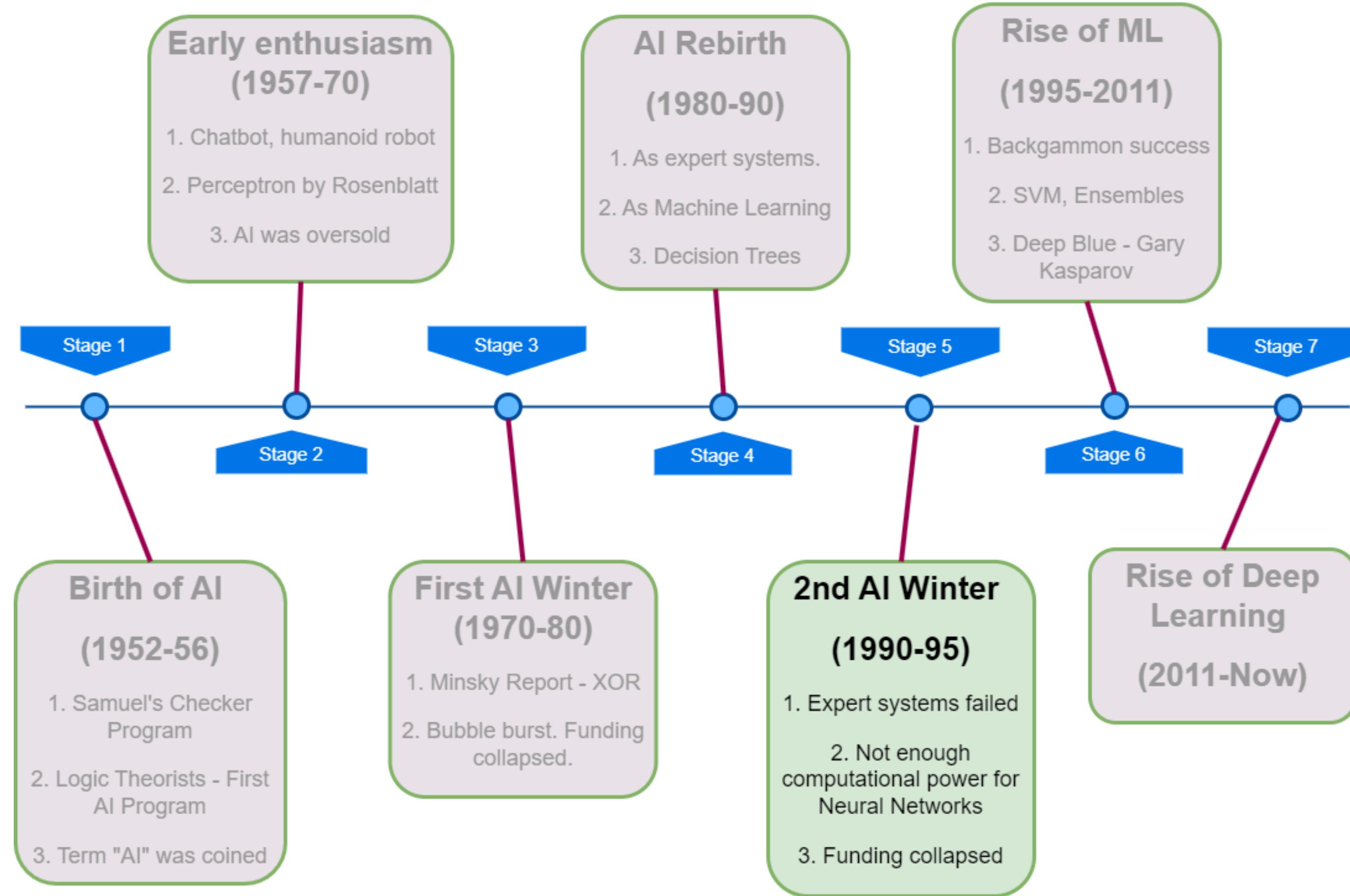
Suggested evidence of 0.7 that the organism is a bactericide

# Stage 4. AI rebirth

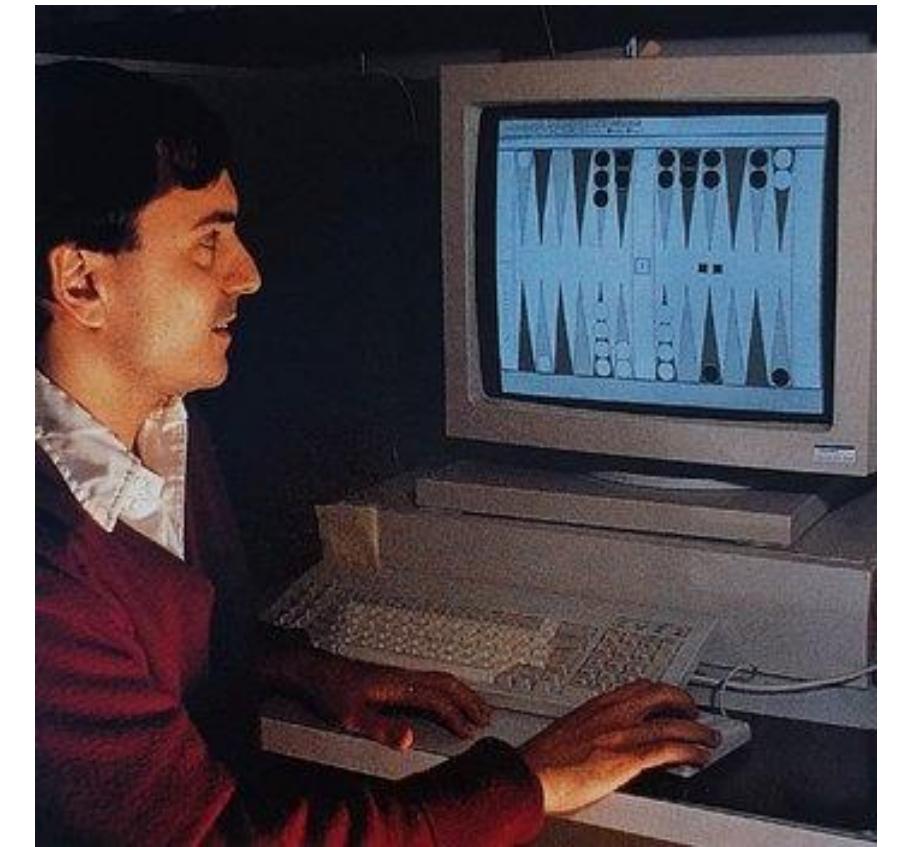
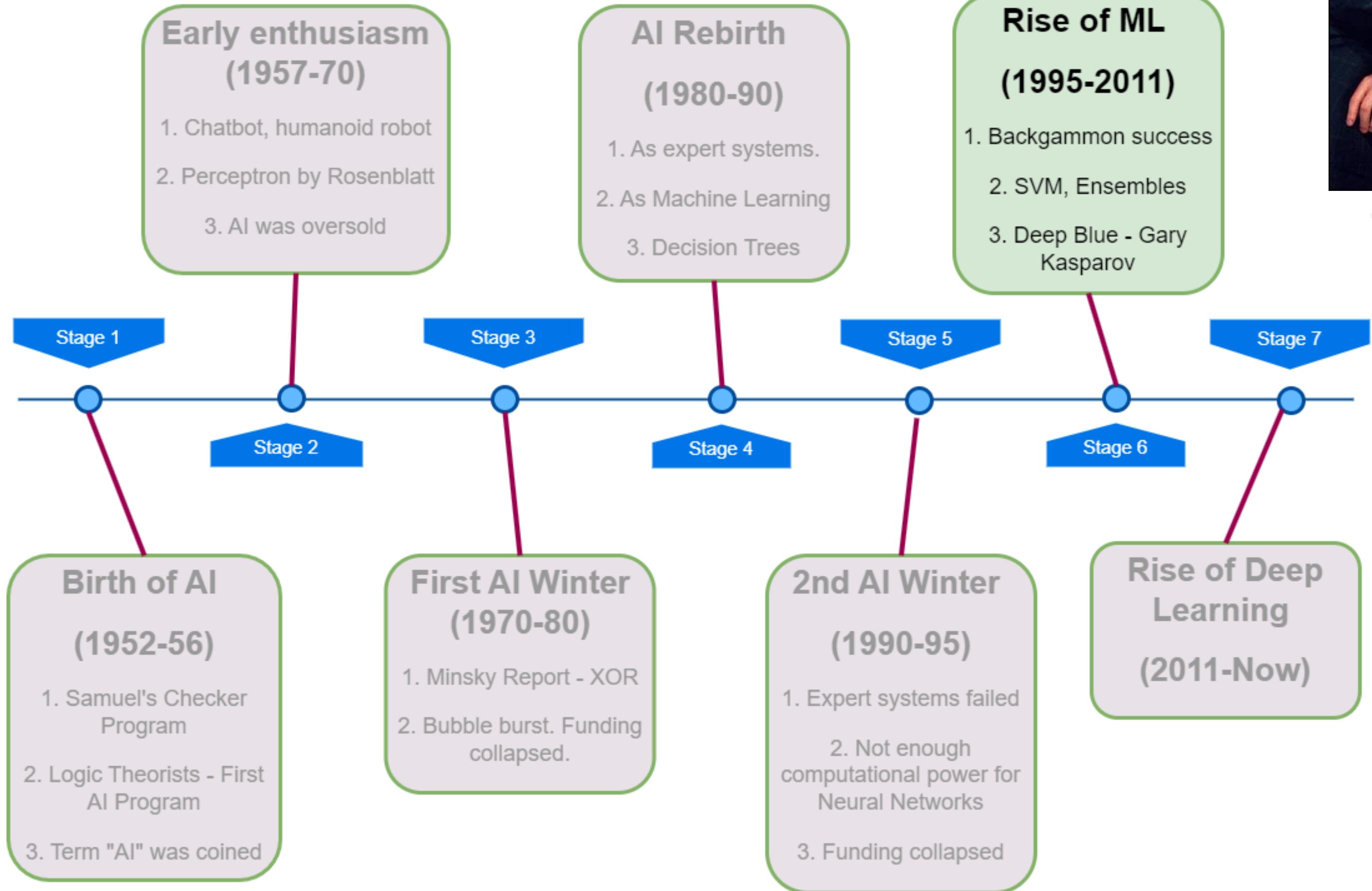
- Machine Learning: new term coined for funding

Key Differences		
	Artificial Intelligence	Machine Learning
APPROACH	Top down	Bottom up
GOAL	Grand goal	Practical smaller goals
BASED ON	Logic	Statistics & Optimization

# Stage 5 – 2<sup>nd</sup> AI winter

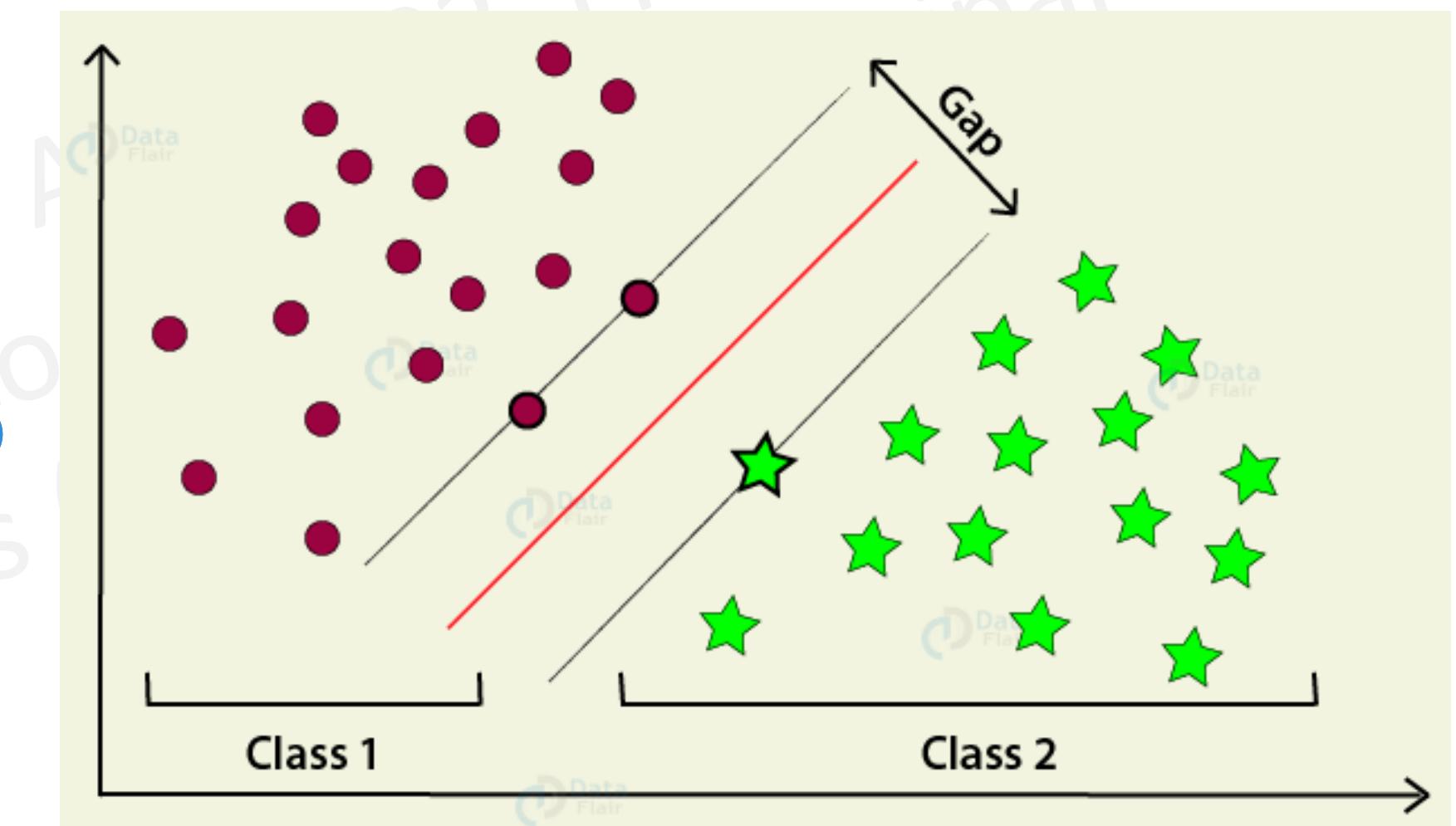
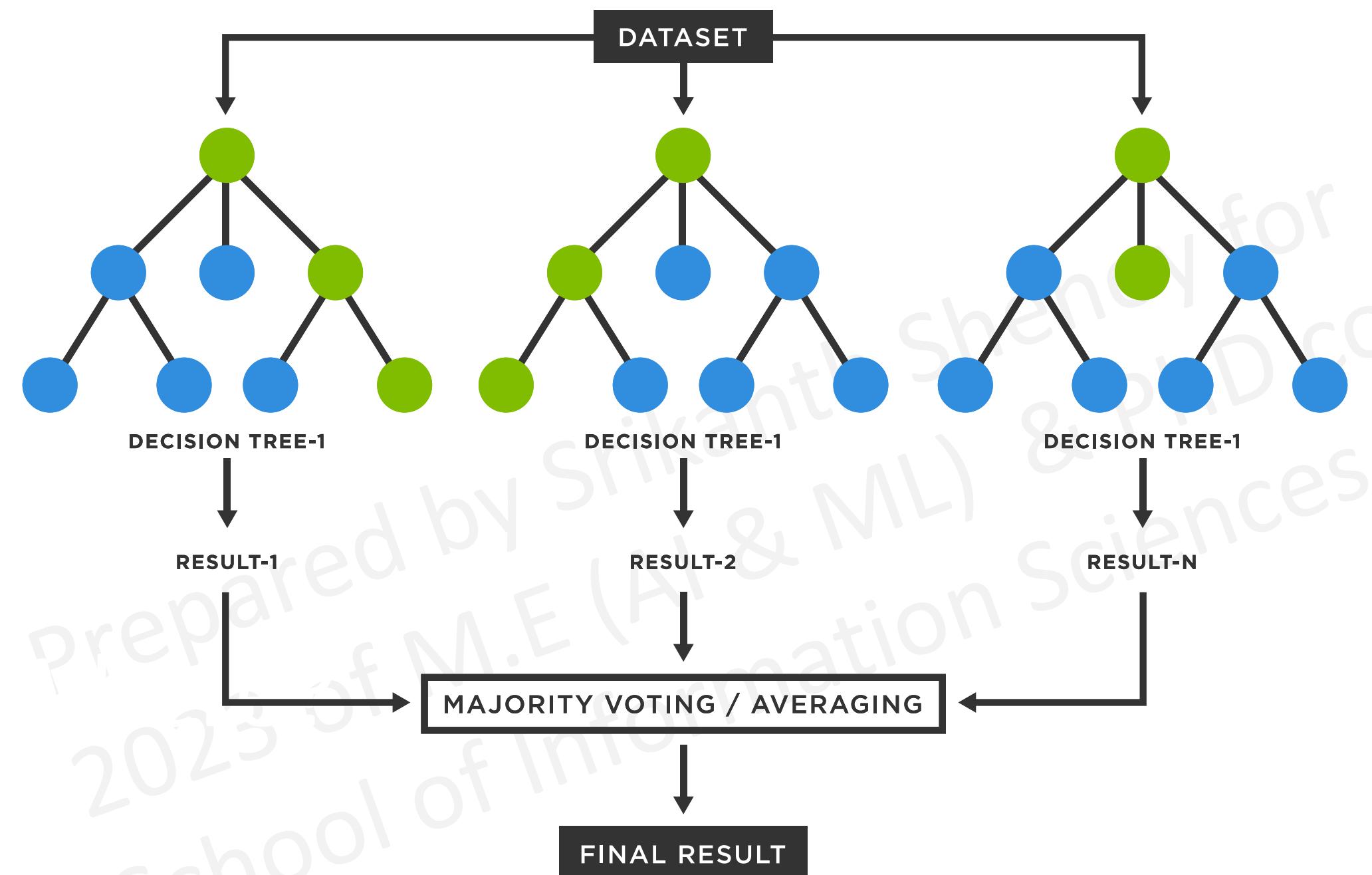


# Stage 6 –Rise of ML

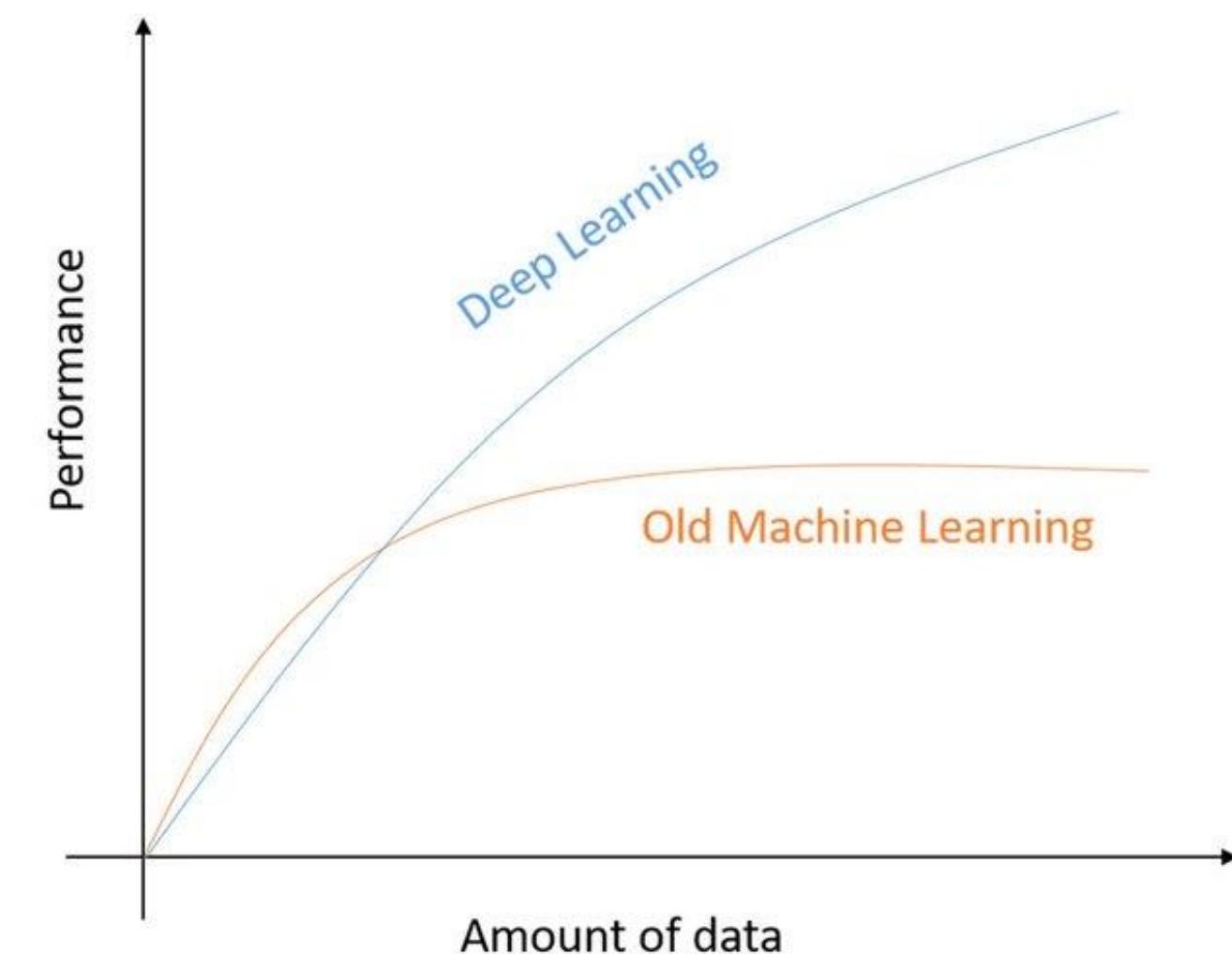
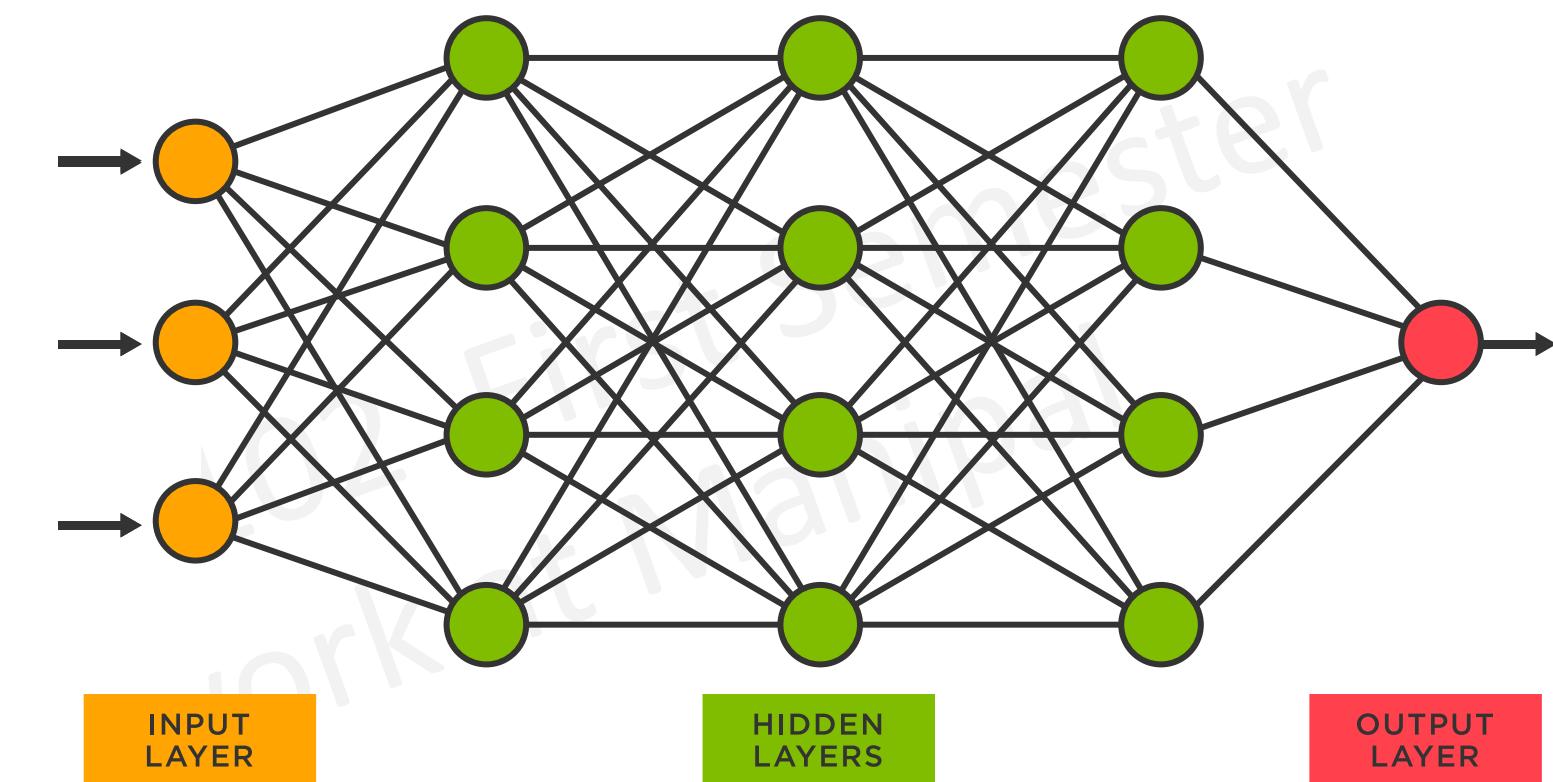
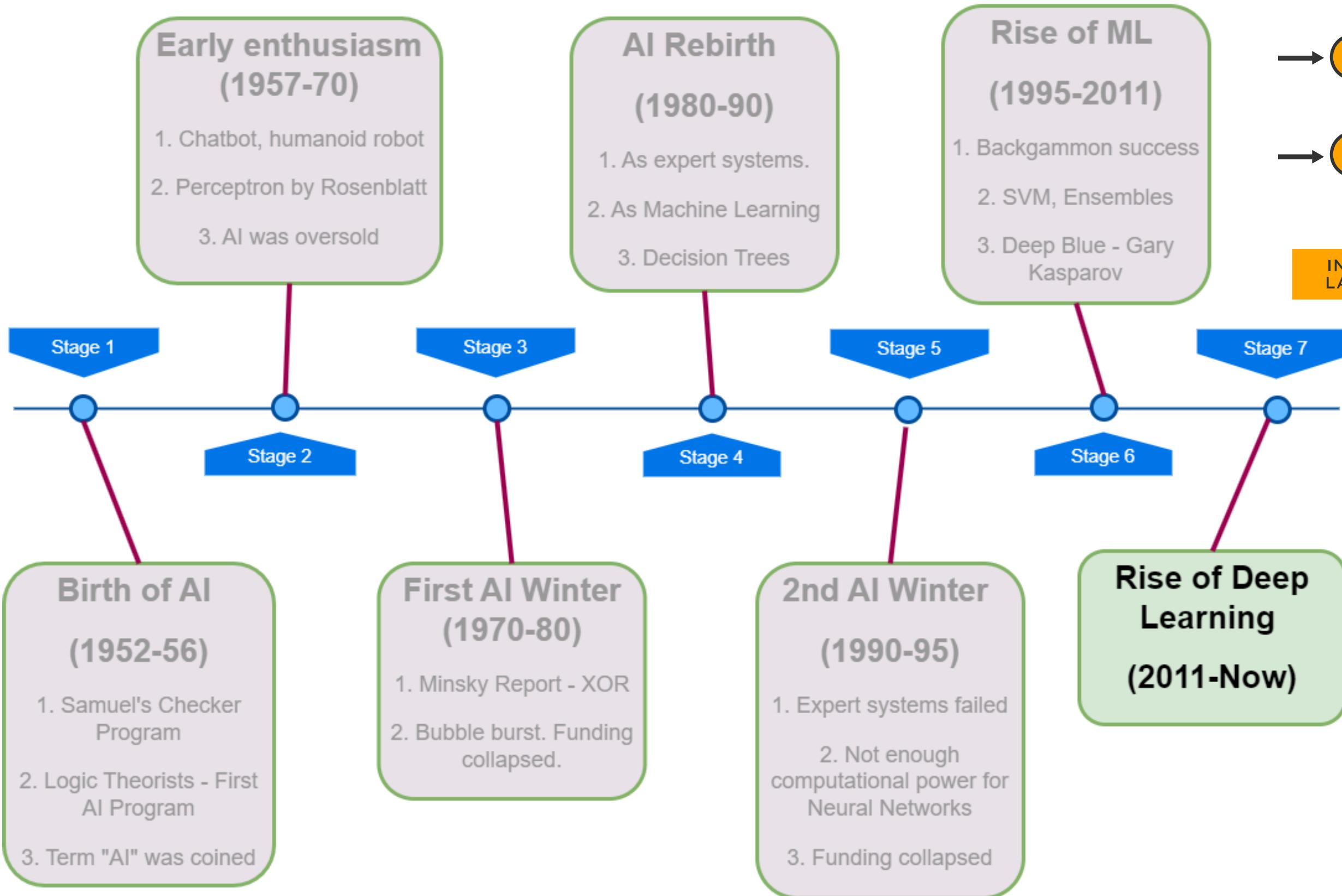


Compare with  
Alpha Zero -  
2017

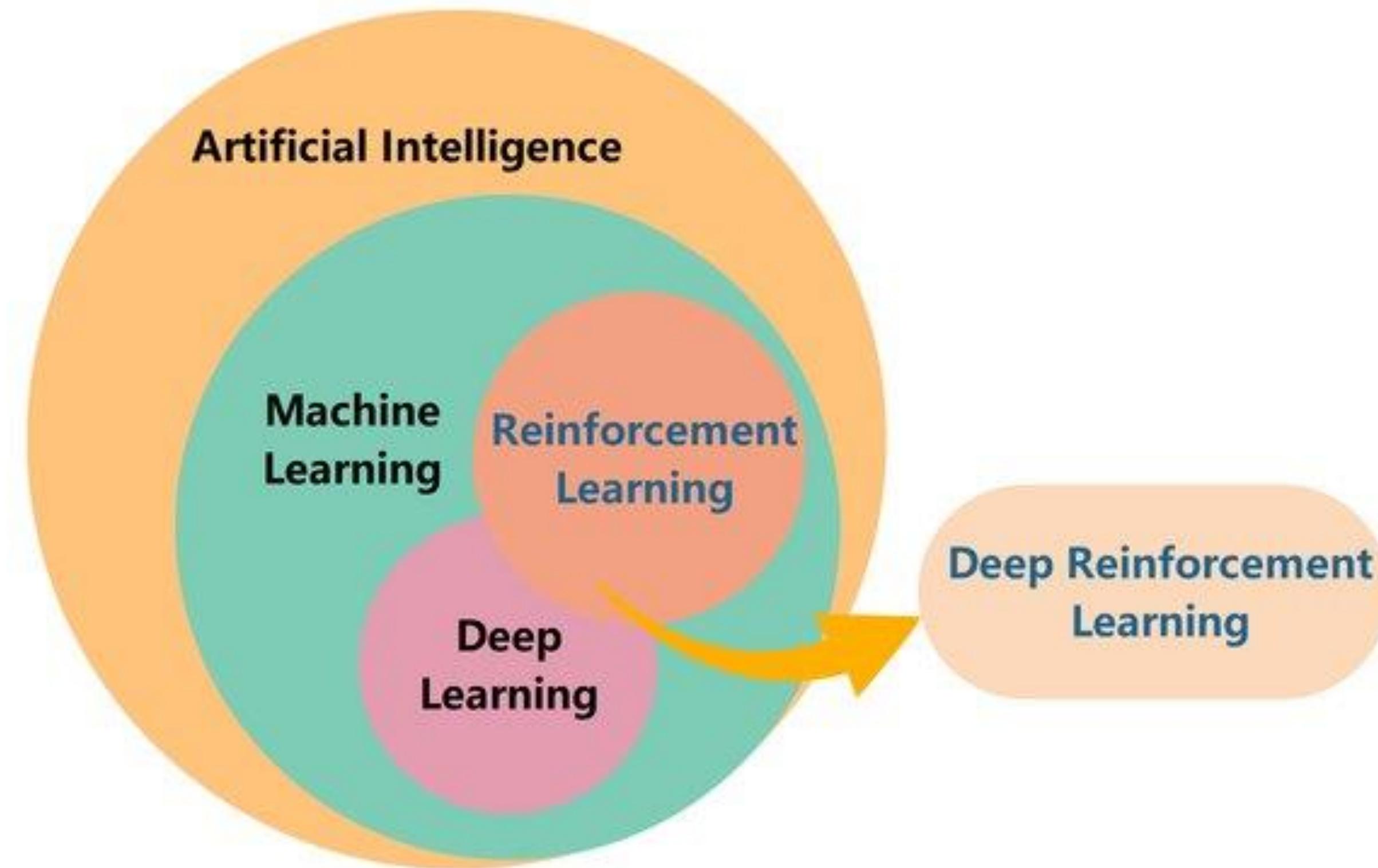
# Stage 6 – Rise of ML



# Stage 7 –Rise of Deep Learning



# ML, DL v/s AI



# Takeaways

- Compare & Contrast
  - Traditional programming with machine learning
  - How ML scales by learning the pattern
- Brief history of AI from ML perspective
- Compare & Contrast AI and ML
- Where DL wins against ML

# Approach to Machine Learning

- Four pillars
  - Linear Algebra
  - Calculus & Optimization
  - Probability & Statistics
  - Programming



# QUESTIONS