



# MACHINE INTELLIGENCE

## Machine Learning Models

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# MACHINE INTELLIGENCE

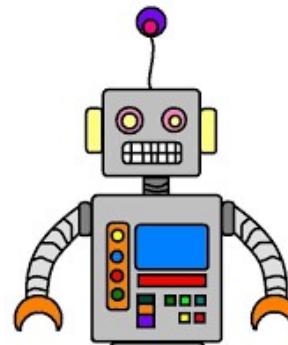
## Machine Learning – an intuitive definition

- Consider the world ,we have humans and we have computers
- Can we get computers to learn from experience too???
- YES -and that is precisely what machine learning means
- but for computers we have a different term for experience that is data



Learn from experience

Learn from ~~experience~~  
data



Follow instructions

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Machine Learning – Answers questions

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Machine Learning is  
using **data** to  
**answer questions**

## MACHINE INTELLIGENCE

### Two broad Phases of Machine Learning

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Training

using  
***data***

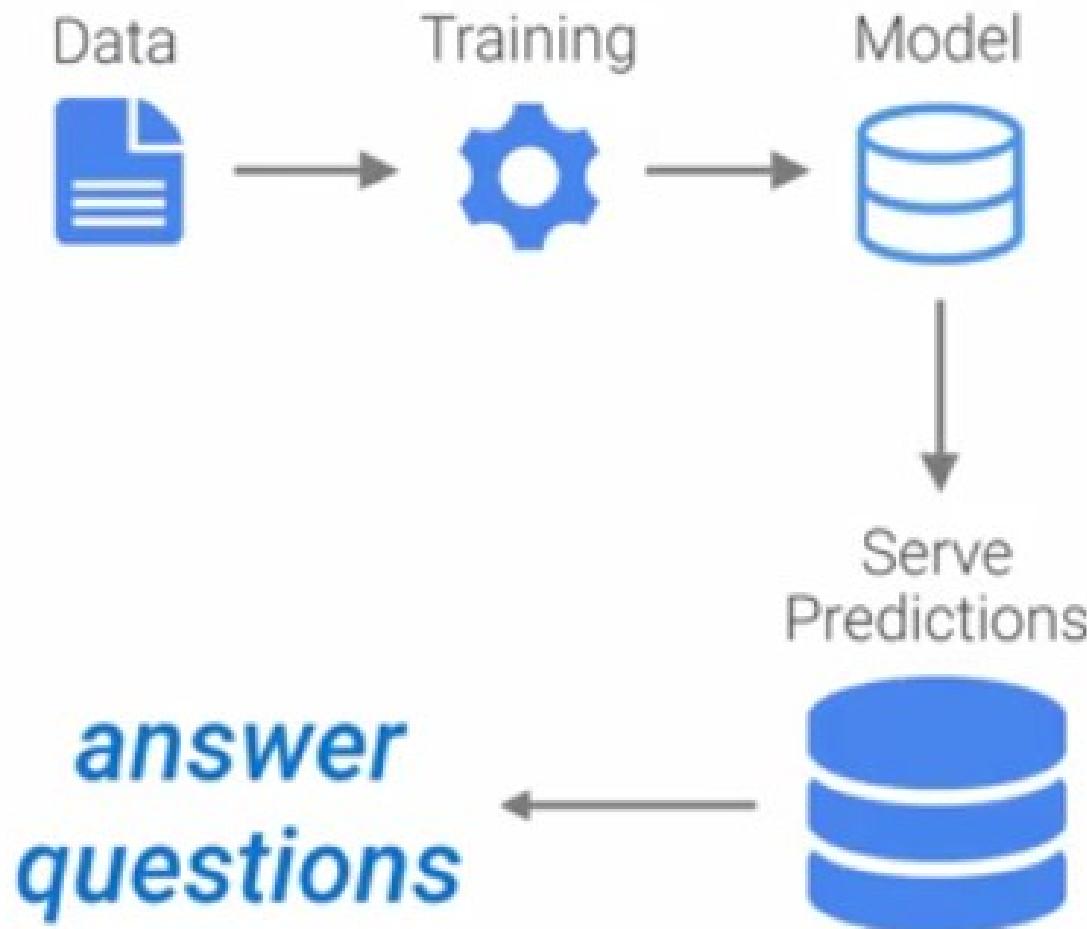
Prediction

***answer  
questions***

- Training refers to using our data to inform the creation and fine tuning of a predictive model.
- The predictive model is used to serve up predictions on previously unseen data and answer those queries.

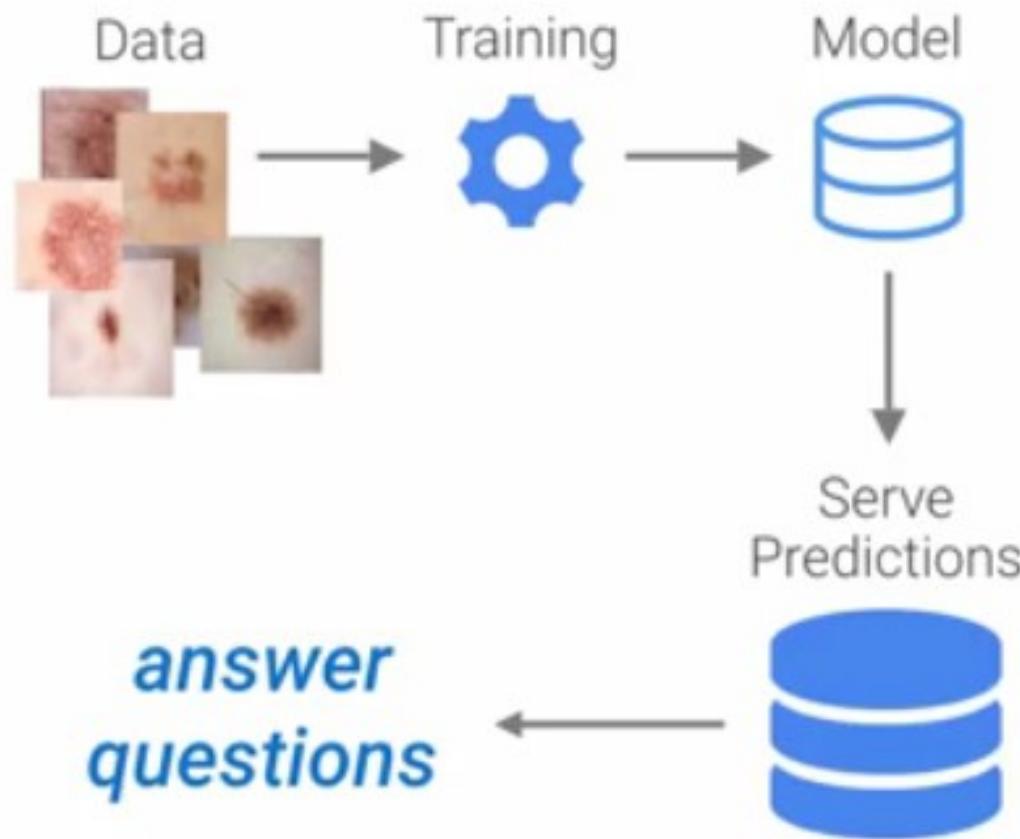
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## Machine Learning – As a flow



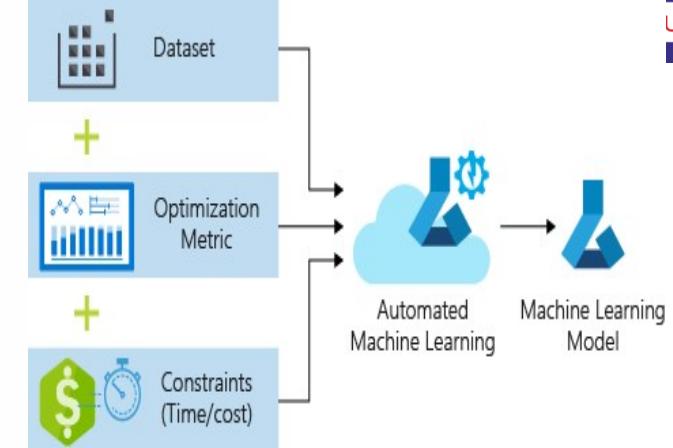
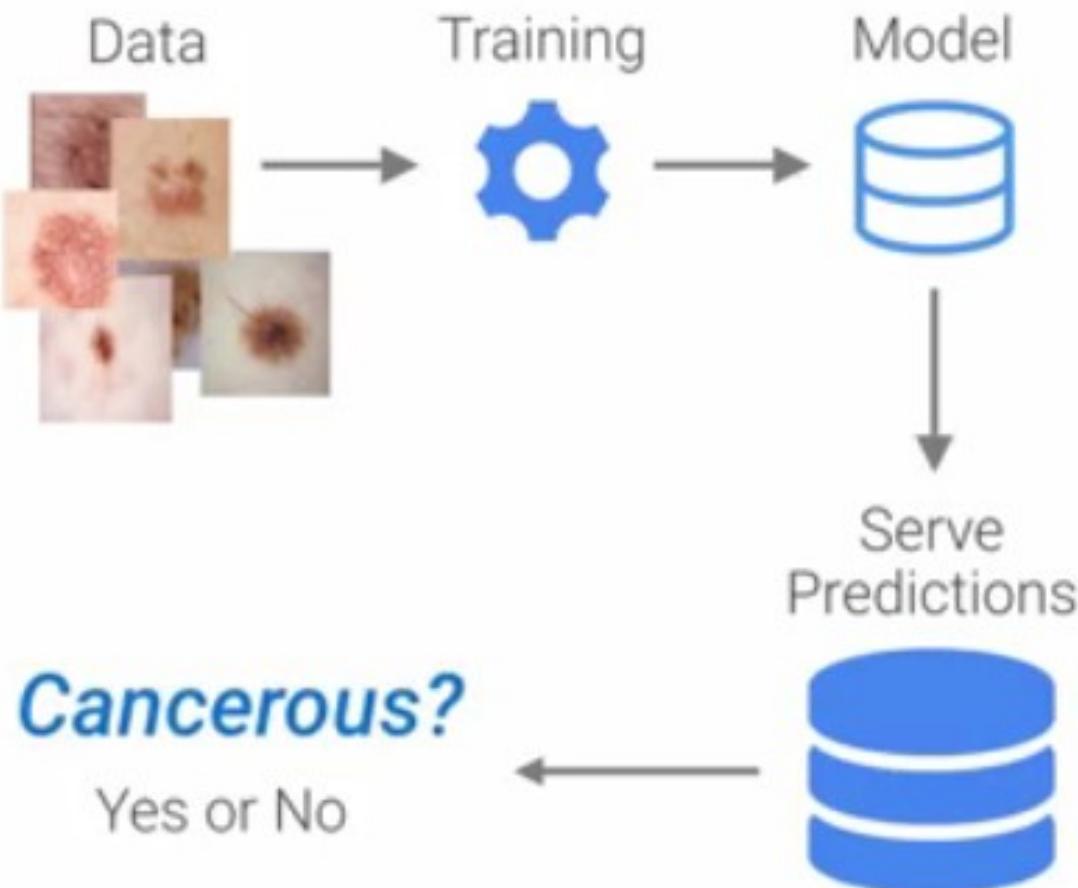
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## Machine Learning



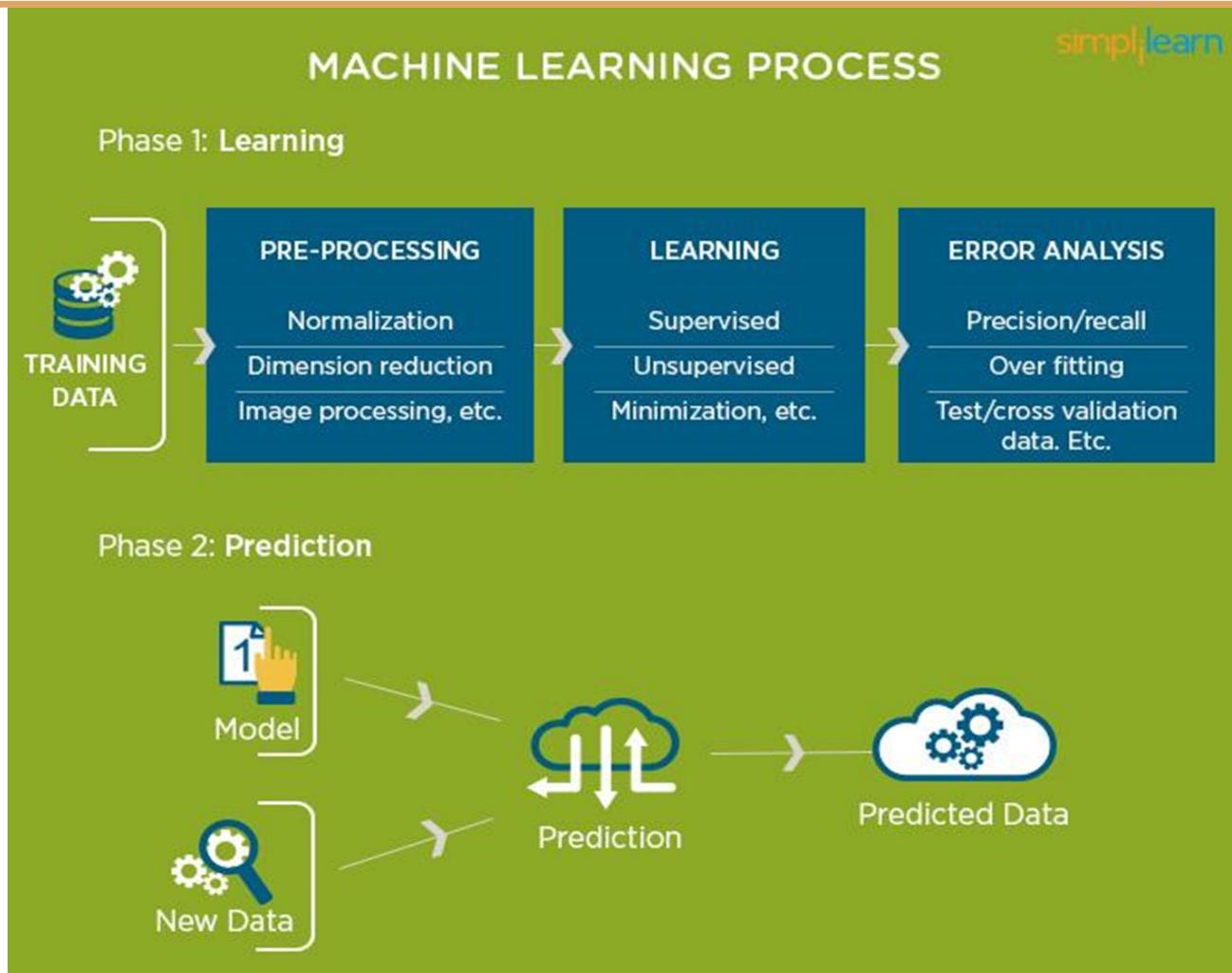
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## Inputs to a machine learning model



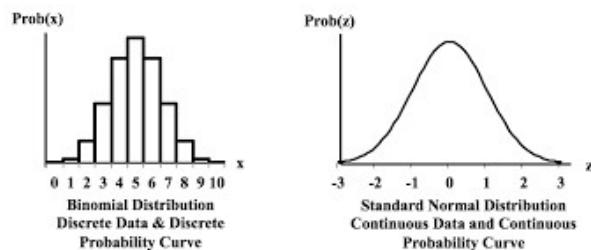
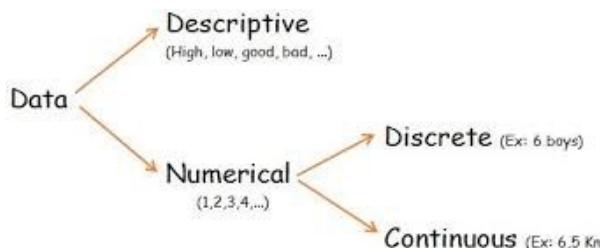
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## Metrics to Machine Learning Algorithm Evaluation



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## Data Types



- Gathering data
- Data preparation
- Choosing a model
- Training
- Evaluation
- Parameter tuning
- Prediction

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## Formal Definition of Machine Learning

A portrait photograph of Tom Mitchell, a man with grey hair, wearing a light blue shirt, gesturing with his hands while speaking.

“ Machine learning is the study of computer algorithms that allow computer programs to automatically improve through experience.

~ Tom Mitchell,  
Machine Learning, McGraw Hill, 1997

Carnegie Mellon University  
Machine Learning

## MACHINE INTELLIGENCE

### PTE Machine Learning Model Definition

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“Learning is any process by which a system improves performance from experience.”

- Herbert Simon

Definition by Tom Mitchell (1998):

Machine Learning is the study of algorithms that

- improve their performance P
- at some task T
- with experience E.

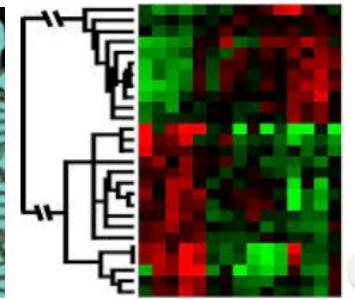
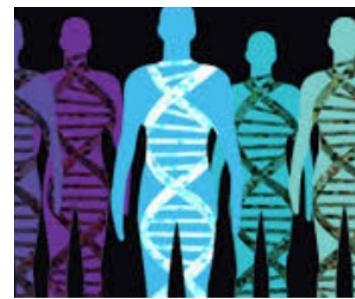
A well-defined learning task is given by  $\langle P, T, E \rangle$ .

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### Machine Learning usage

ML is used when:

- Human expertise does not exist (navigating on Mars)
- Humans can't explain their expertise (speech recognition)
- Models must be customized (personalized medicine)
- Models are based on huge amounts of data (genomics)



## MACHINE INTELLIGENCE

### Example of a Machine Learning Task

A classic example of a task that requires machine learning:

It is very hard to say what makes a 2:



0 0 0 1 1 ( 1 1 1 1 2

2 2 2 2 2 2 2 3 3 3

3 4 4 4 4 4 5 5 5 5

6 6 2 2 7 7 7 7 8 8 8

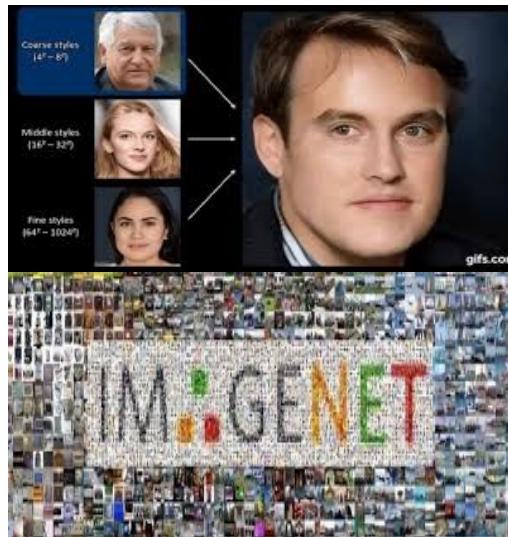
8 8 8 7 9 4 9 9 9

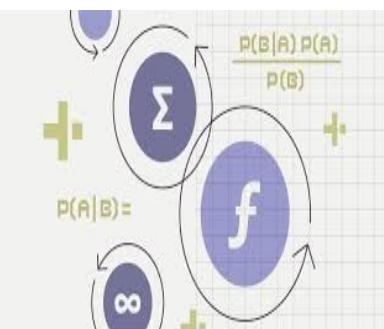
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## Machine Learning Classes

Some more examples of tasks that are best solved by using a learning algorithm:

- Recognizing patterns:
  - Facial identities or facial expressions
  - Handwritten or spoken words
  - Medical images
- Generating patterns:
  - Generating images or motion sequences
- Prediction:
  - Future stock prices or currency exchange rates





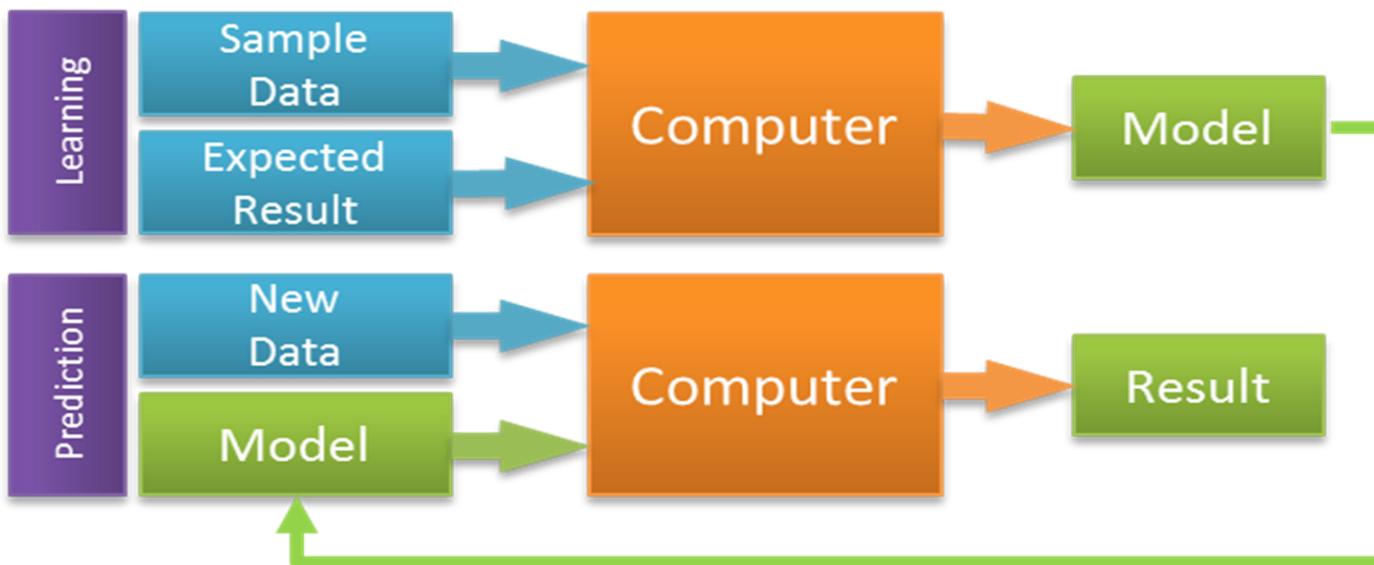
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Traditional Models are Different

## Traditional modeling:

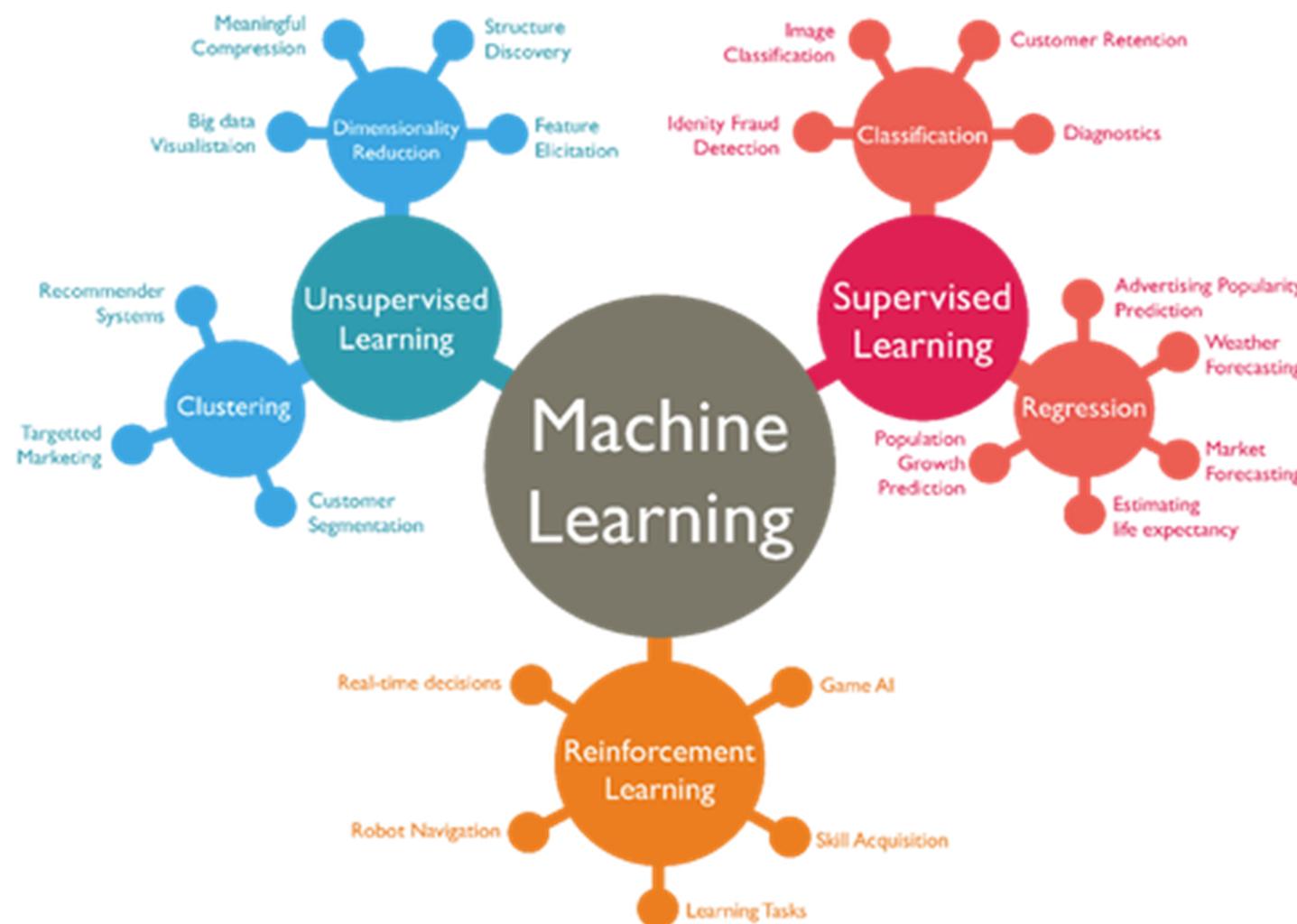


## Machine Learning:



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## Three Broad Categories of Machine Learning



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### Types of Machine Learning

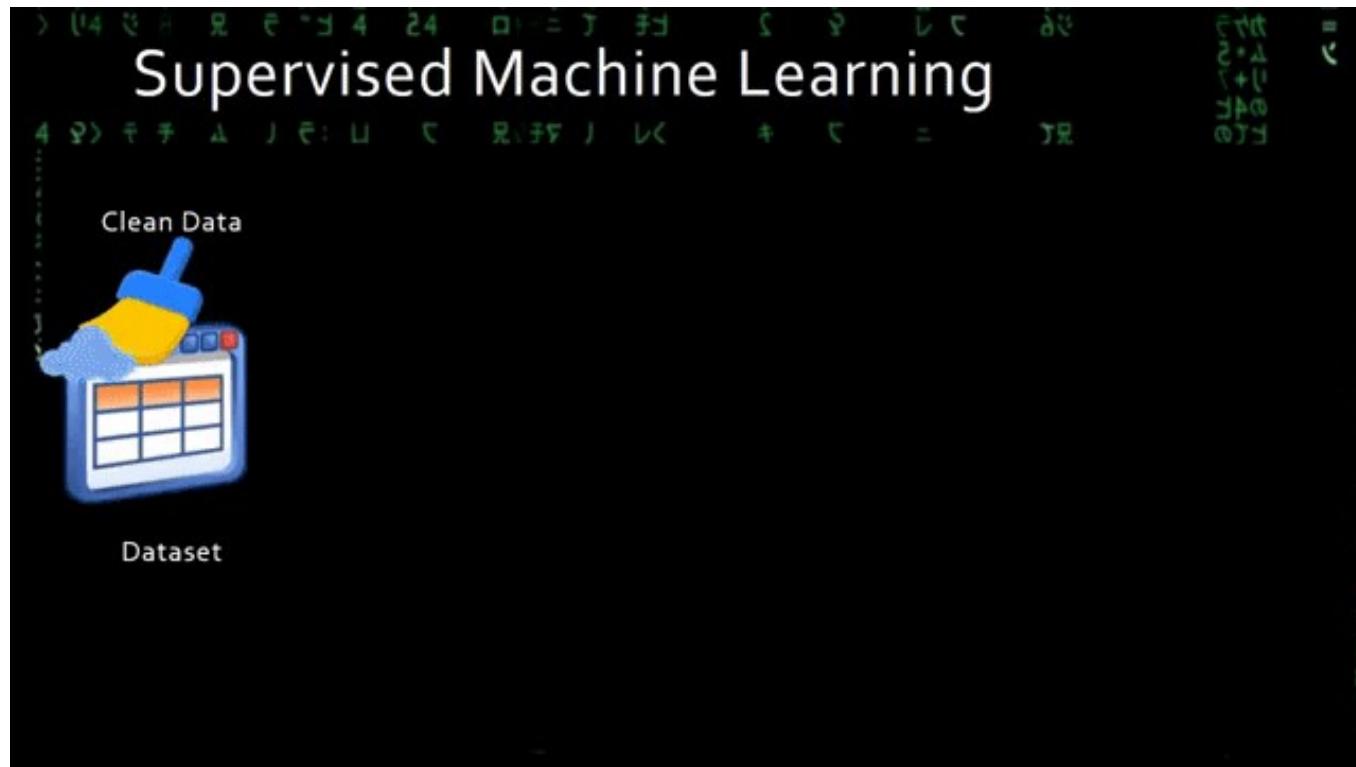
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- Supervised (inductive) learning-
  - Given: training data +desired outputs (labels)
- Unsupervised learning-
  - Given:training data (without desired outputs)
- Reinforcement learning
  - Rewards from sequence of actions

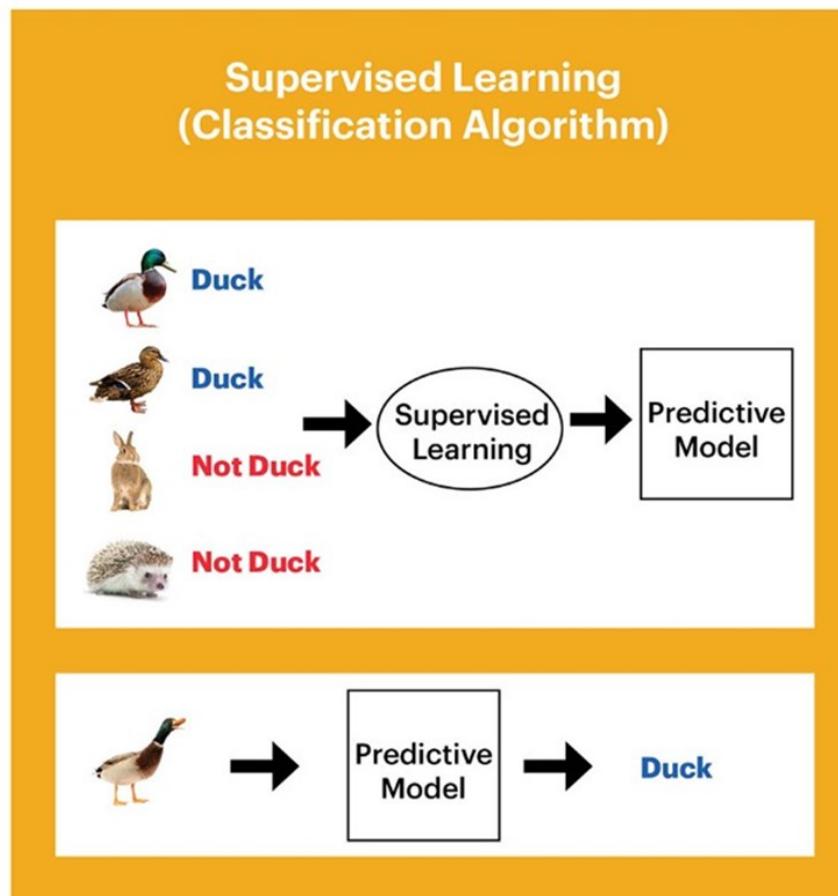
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## Supervised Learning



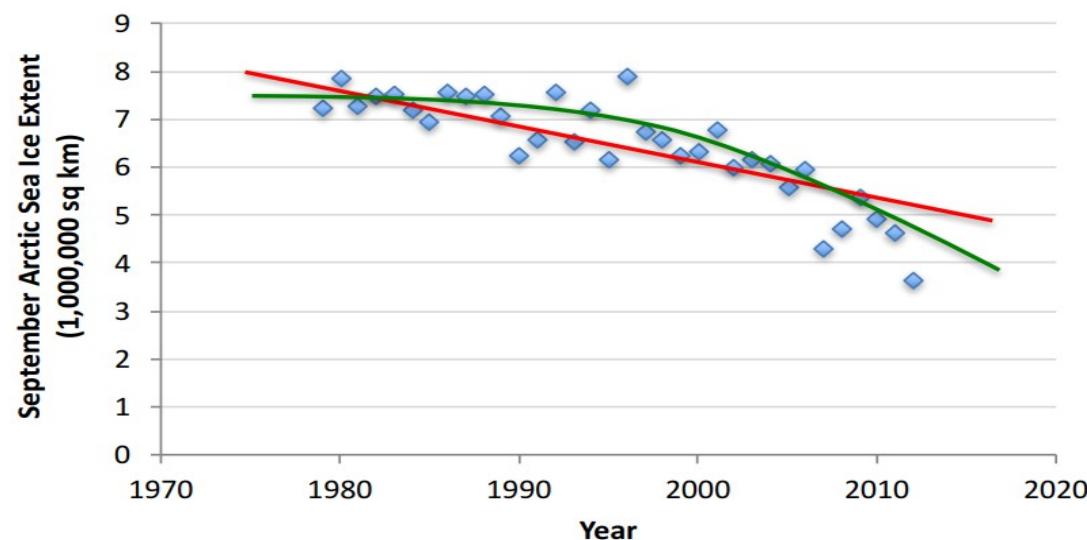
# MACHINE INTELLIGENCE

## Supervised Learning



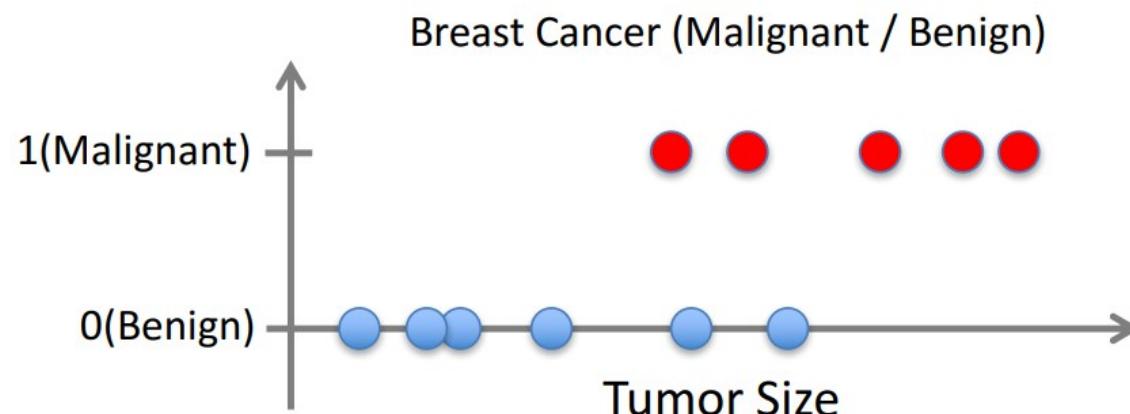
## REGRESSION:

- Given  $(x_1, y_1), (x_2, y_2), \dots, (x_n, y_n)$
- Learn a function  $f(x)$  to predict  $y$  given  $x$ 
  - $y$  is real-valued == regression



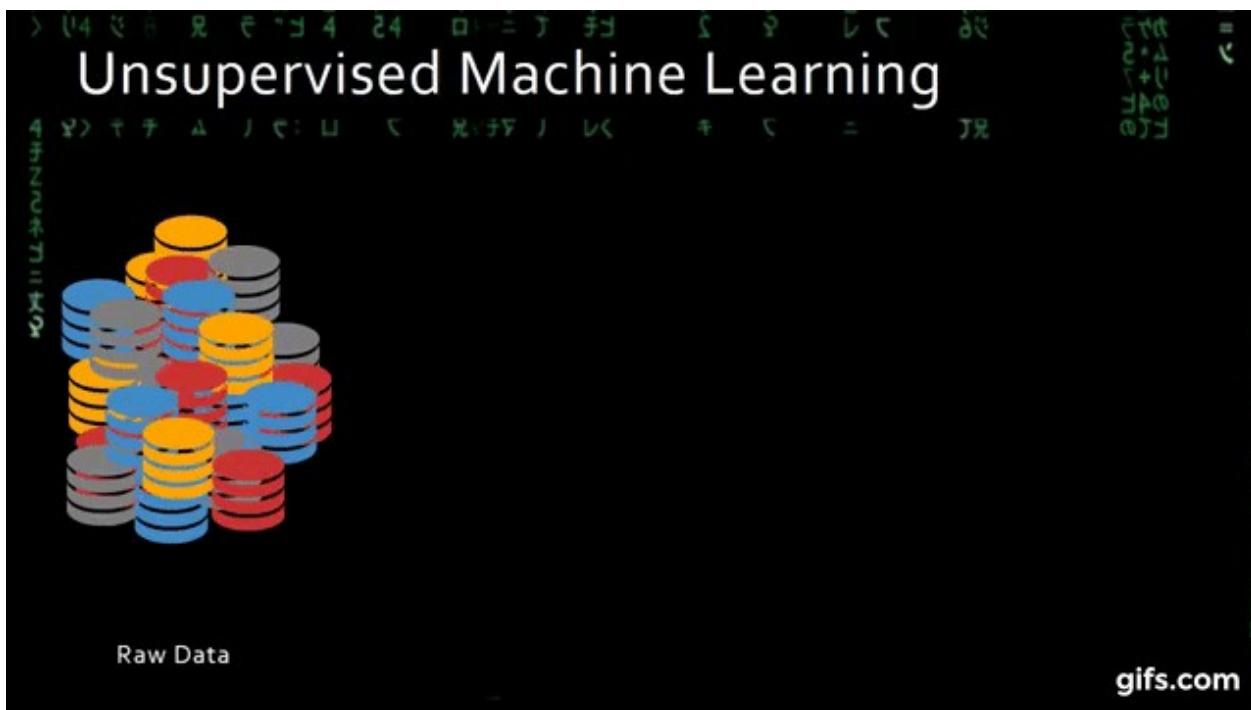
#### CLASSIFICATION:

- Given  $(x_1, y_1), (x_2, y_2), \dots, (x_n, y_n)$
- Learn a function  $f(x)$  to predict  $y$  given  $x$ 
  - $y$  is categorical == classification



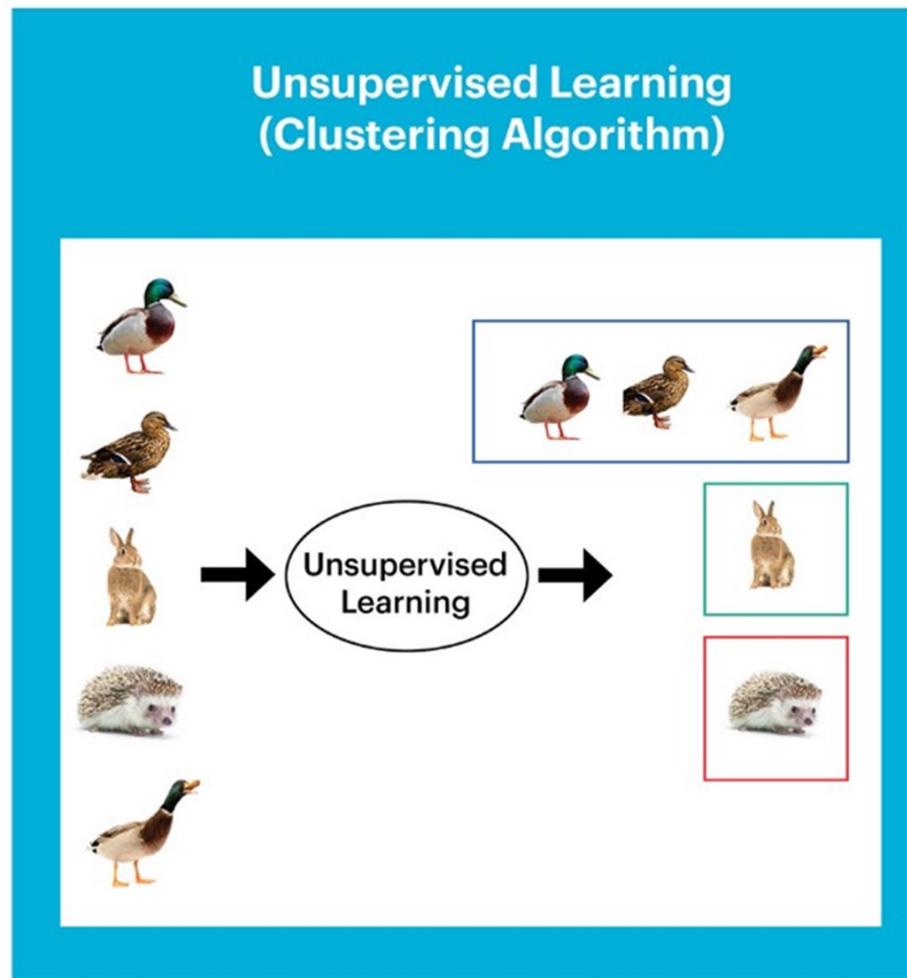
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Machine Intelligence is Omni Present

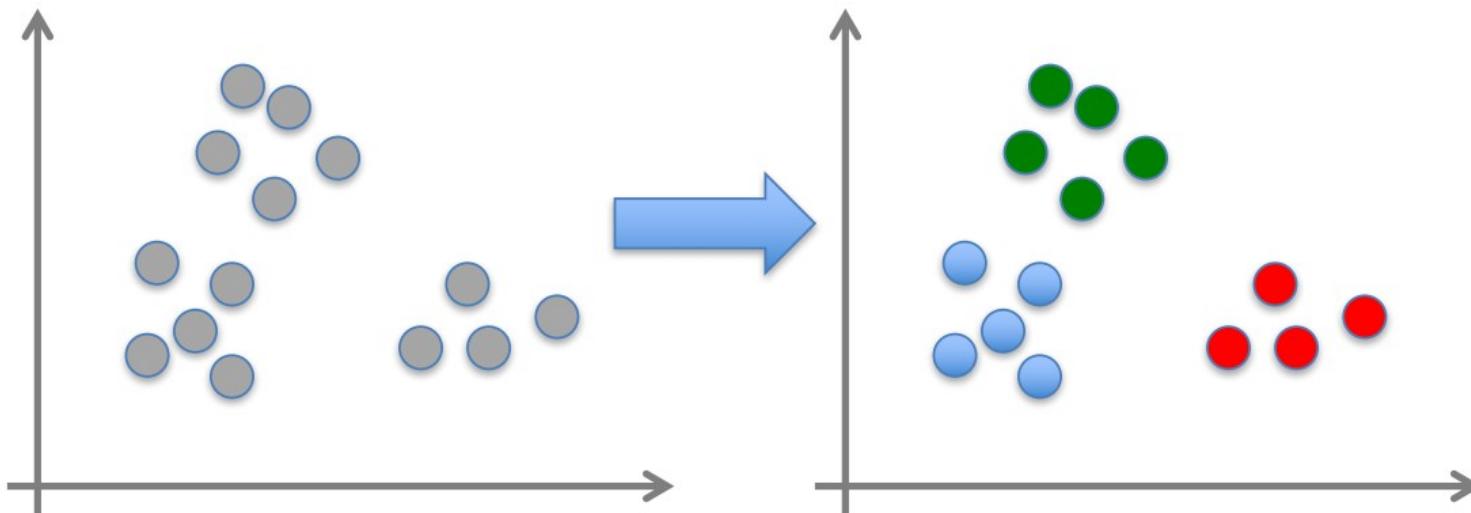


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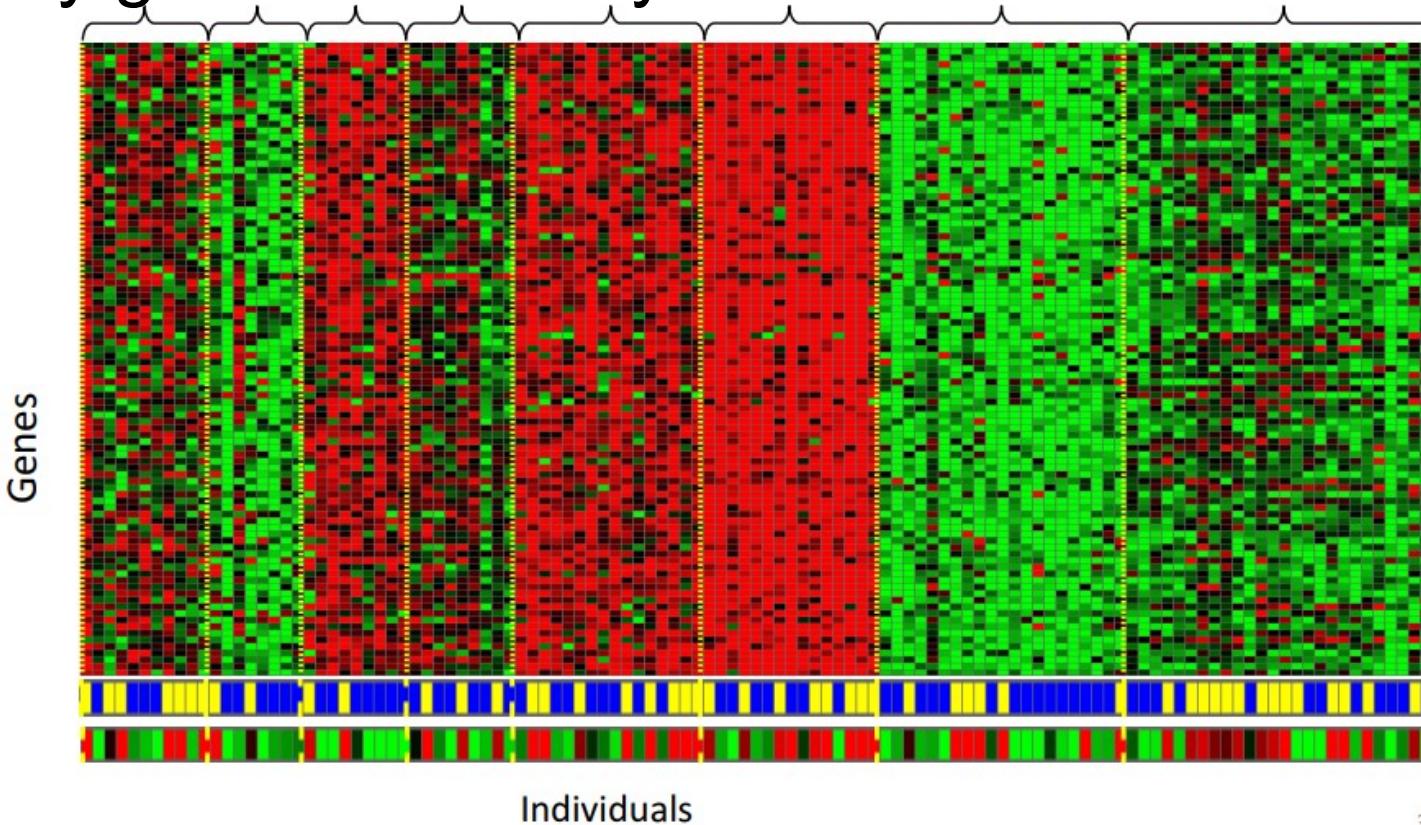
## Unsupervised Learning



- Given  $x_1, x_2, \dots, x_n$  (without labels)
- Output hidden structure behind the x's
  - E.g., clustering



## Genomics application: group individuals by genetic similarity

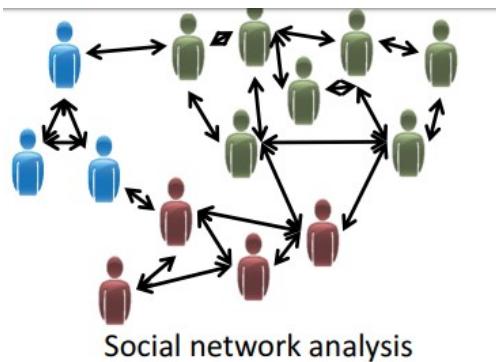


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## Example of Unsupervised Learning Applications



Organize computing clusters



Market segmentation



Astronomical data analysis

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## Reinforcement learning



## **Game Board:**



Current state ( $s$ ):      **0 0 0**  
                                **0 1 0**

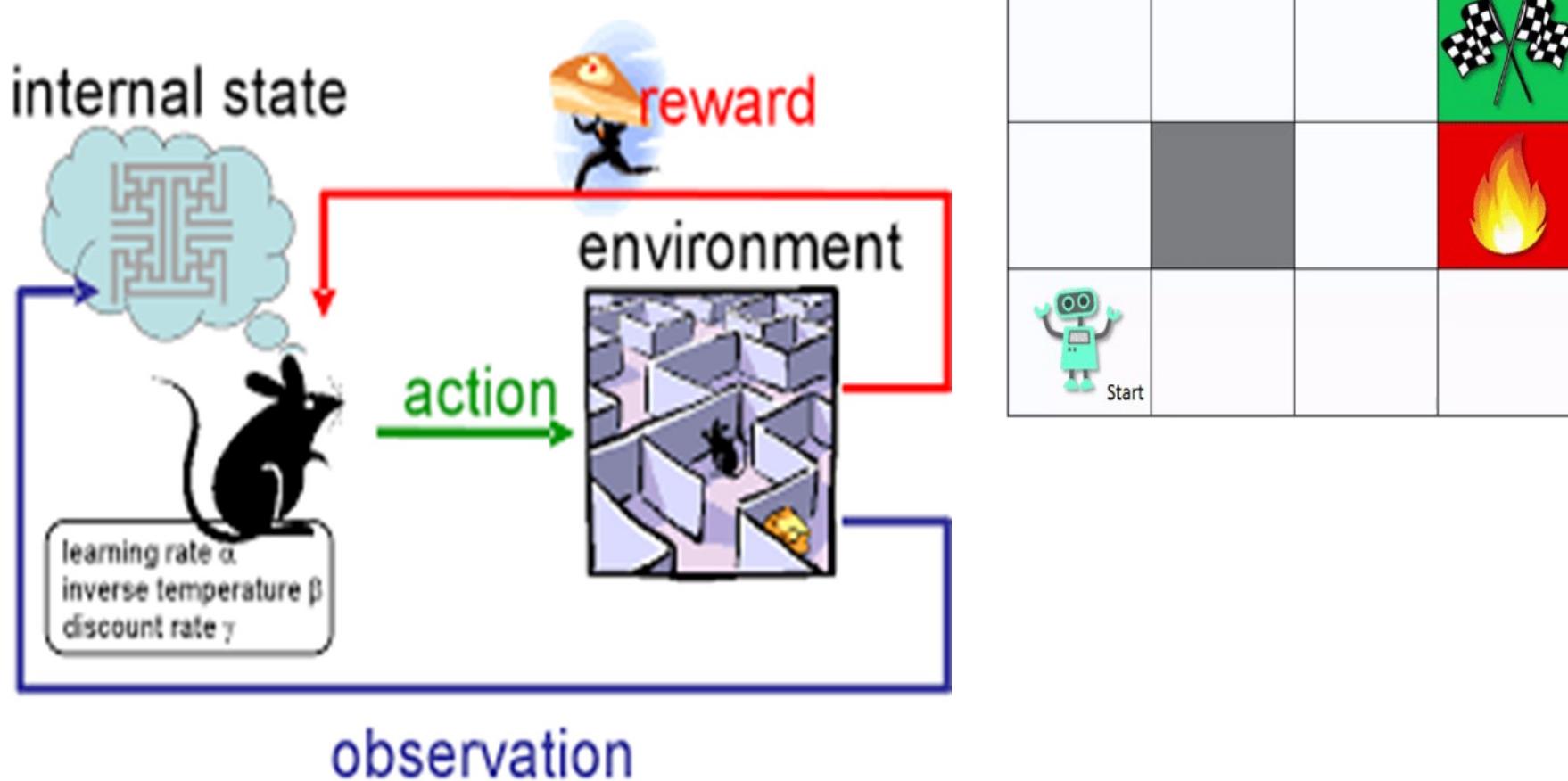
### **Q Table:**

	<b>0 0 0</b> <b>1 0 0</b>	<b>0 0 0</b> <b>0 1 0</b>	<b>0 0 0</b> <b>0 0 1</b>	<b>1 0 0</b> <b>0 0 0</b>	<b>0 1 0</b> <b>0 0 0</b>	<b>0 0 1</b> <b>0 0 0</b>
	0.2	0.3	1.0	-0.22	-0.3	0.0
	-0.5	-0.4	-0.2	-0.04	-0.02	0.0
	0.21	0.4	-0.3	0.5	1.0	0.0
	-0.6	-0.1	-0.1	-0.31	-0.01	0.0

Y = 0.95

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## Reinforcement Learning



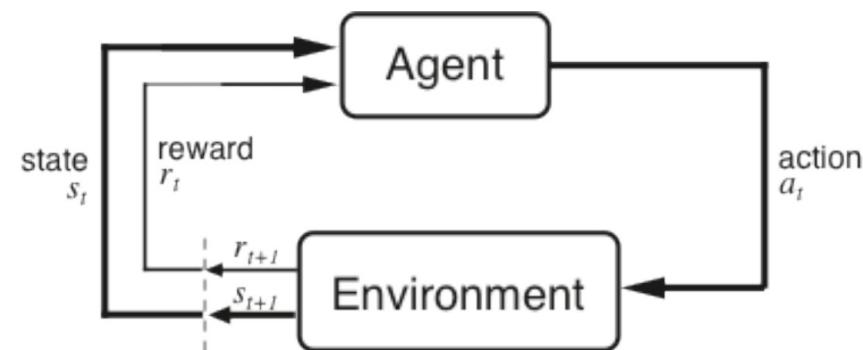
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## Reinforcement Learning

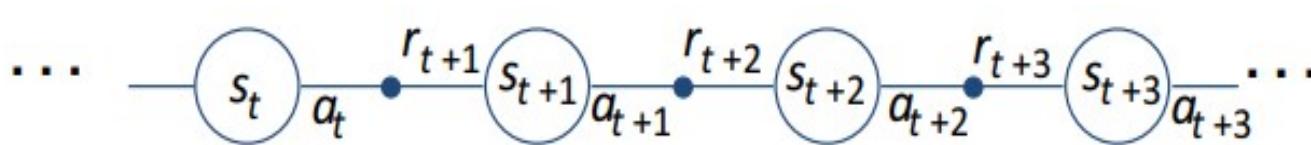
- Given a sequence of states and actions with (delayed) rewards, output a policy.
  - Policy is a mapping from states  $\rightarrow$  actions ,that tells you what to do in a given state



- The Agent-Environment Interface



- Agent and environment interact at discrete time steps :  $t = 0, 1, 2, K$
- Agent observes state at step  $t$ :  $s_t \in S$
- produces action at step  $t$  :  $a_t \in A(s_t)$
- gets resulting reward :  $r_t + 1 \in \mathbb{R}$
- and resulting next state :  $s_{t+1}$



# MACHINE INTELLIGENCE

## ML Model Summary

### Supervised Learning

- Systems are able to predict future outcomes based on past data.
- Requires both an input and an output to be given to the model for it to be trained.

### Unsupervised Learning

- Systems are able to identify hidden patterns from the input data provided.
- By making the data more readable and organized, the patterns, similarities or anomalies become more evident.

### Reinforcement Learning

- Systems are given no training.
- It learns on the basis of the reward/ punishment it received for performing its last action.
- It helps increase the efficiency of a tool/ function or a program.

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## Subtypes within Models

### Supervised Learning

#### Regression

- Linear Regression
- Ordinary Least Squares Regression
- LOESS (Local Regression)
- Neural Networks

#### Classification

- Decision Trees
- Support Vector Machine
- Naïve Bayes
- K-Nearest Neighbours
- Logistic Regression
- Random Forests

### Unsupervised Learning

#### Cluster Analysis

- K-Means Clustering
- Hierarchical Clustering

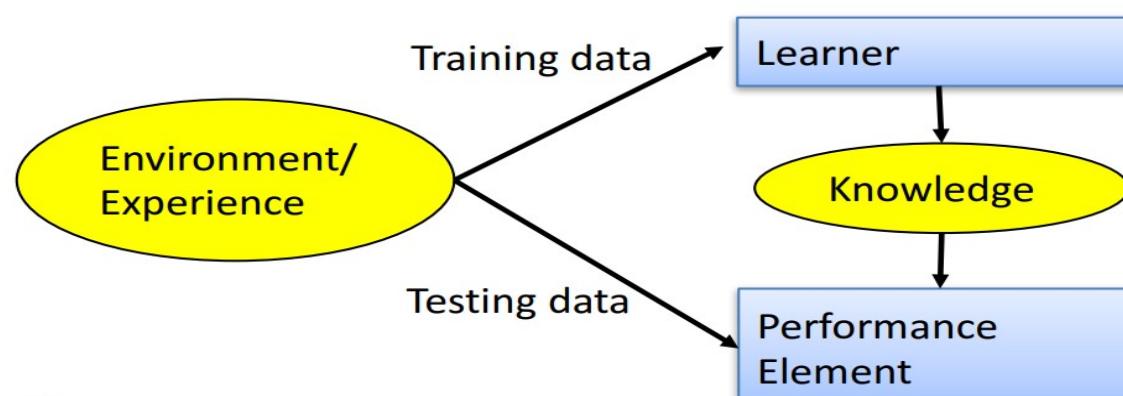
#### Dimension Reduction

- Principal Component Analysis (PCA)
- Linear Discriminant Analysis (LDA)

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## Designing a learning system

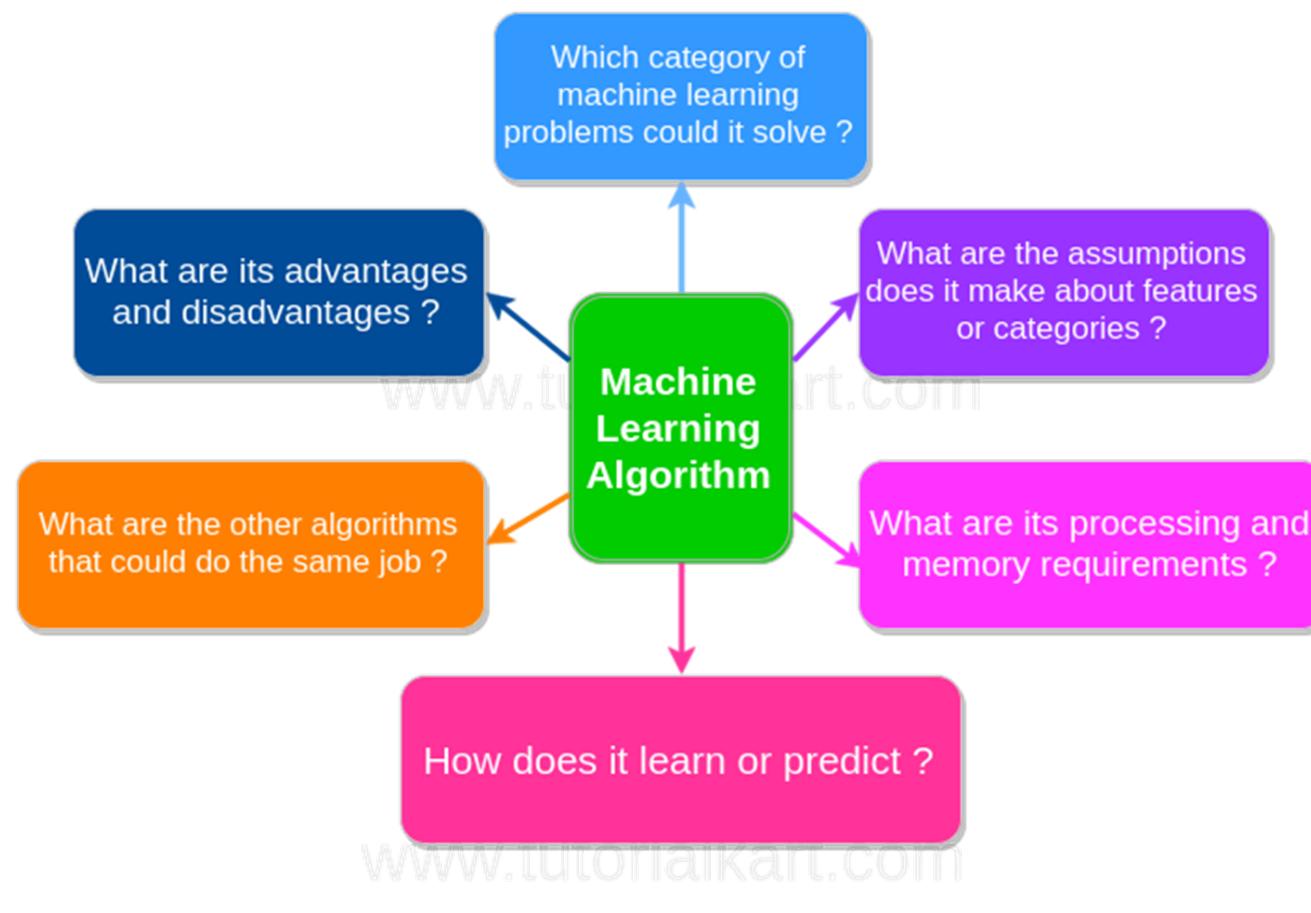
- Choose the training experience
- Choose exactly what is to be learned
  - i.e. the target function
- Choose how to represent the target function
- Choose a learning algorithm to infer the target function from the experience



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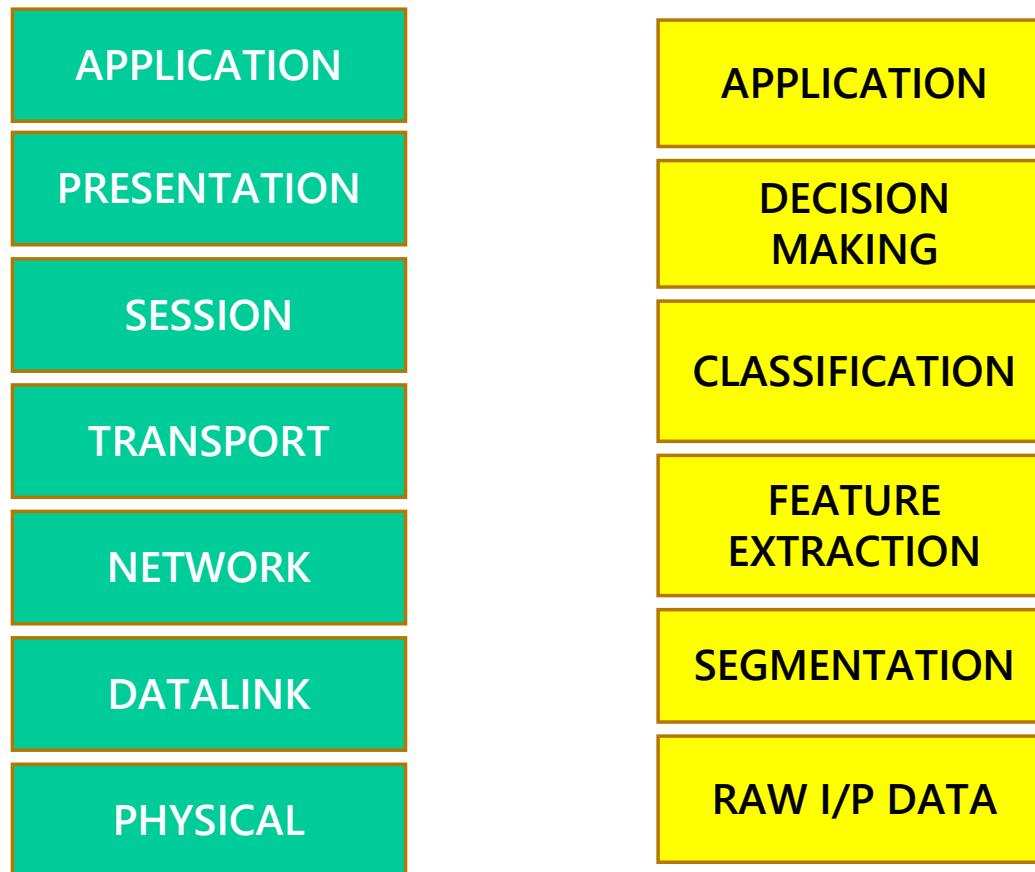
## Machine Learning – Choosing the right algorithm

www.tutorialkart.com



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## OSI Analogy





THANK YOU

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