MACHINE INTELLIGENCE

Machine Learning Models

K.S.Srinivas
Department of Computer Science and Engineering

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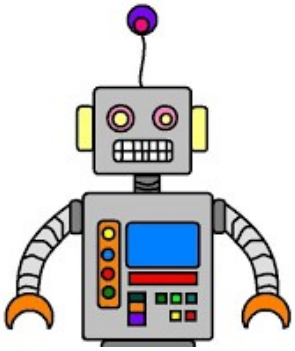
Machine Learning – an intuitive definition

- 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 is

using ***data*** *to*

answer questions

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Two broad Phases of Machine Learning

- 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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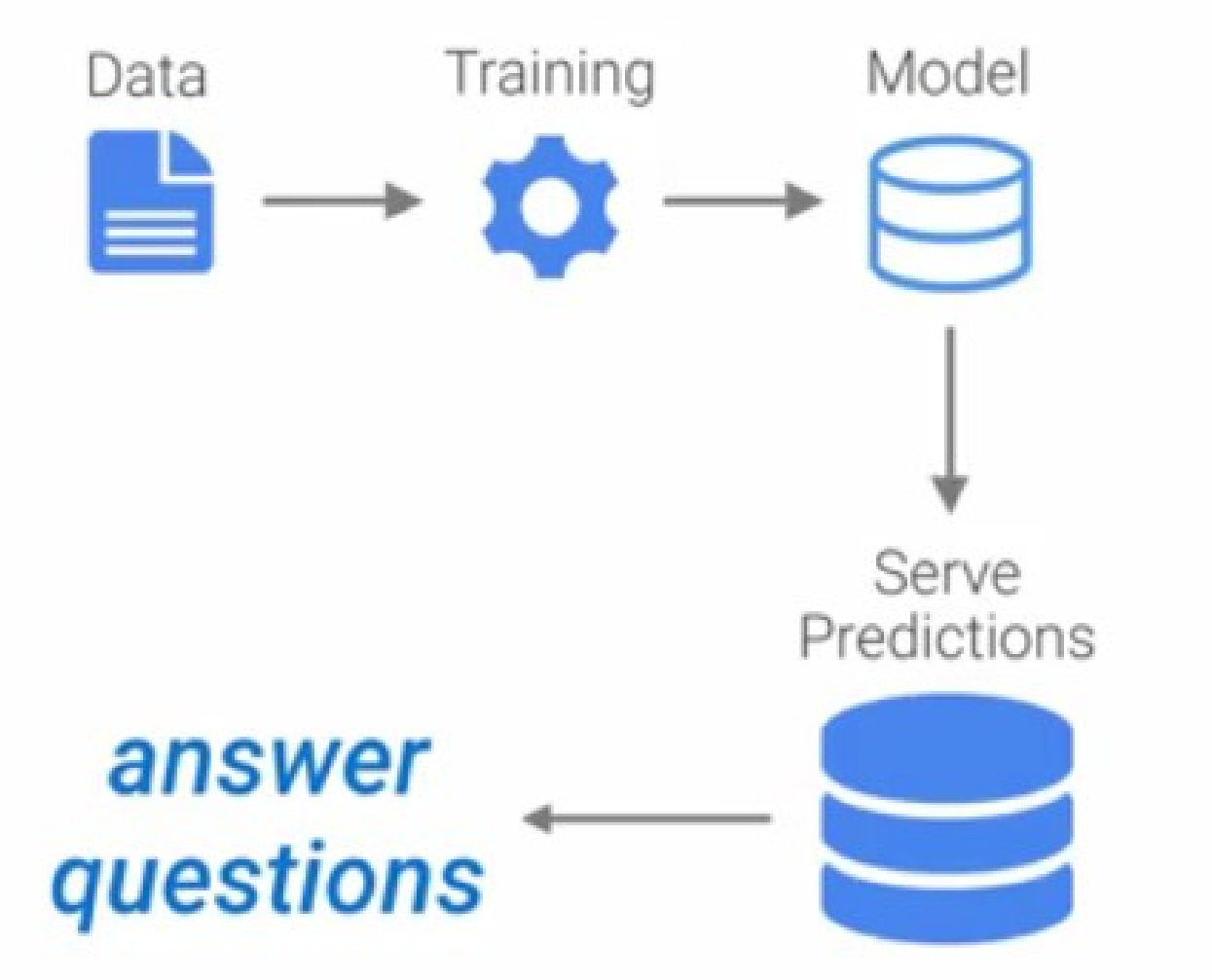
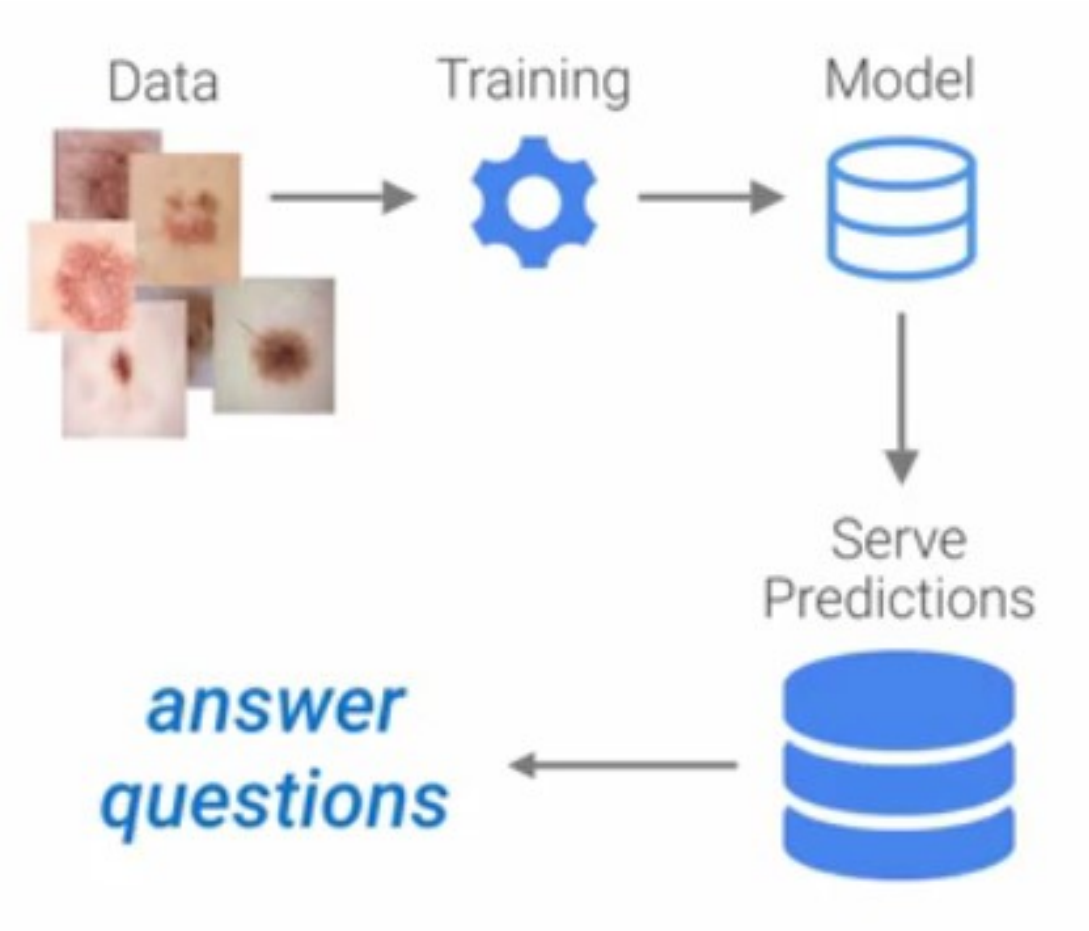
Machine Learning – As a flow



Machine Learning



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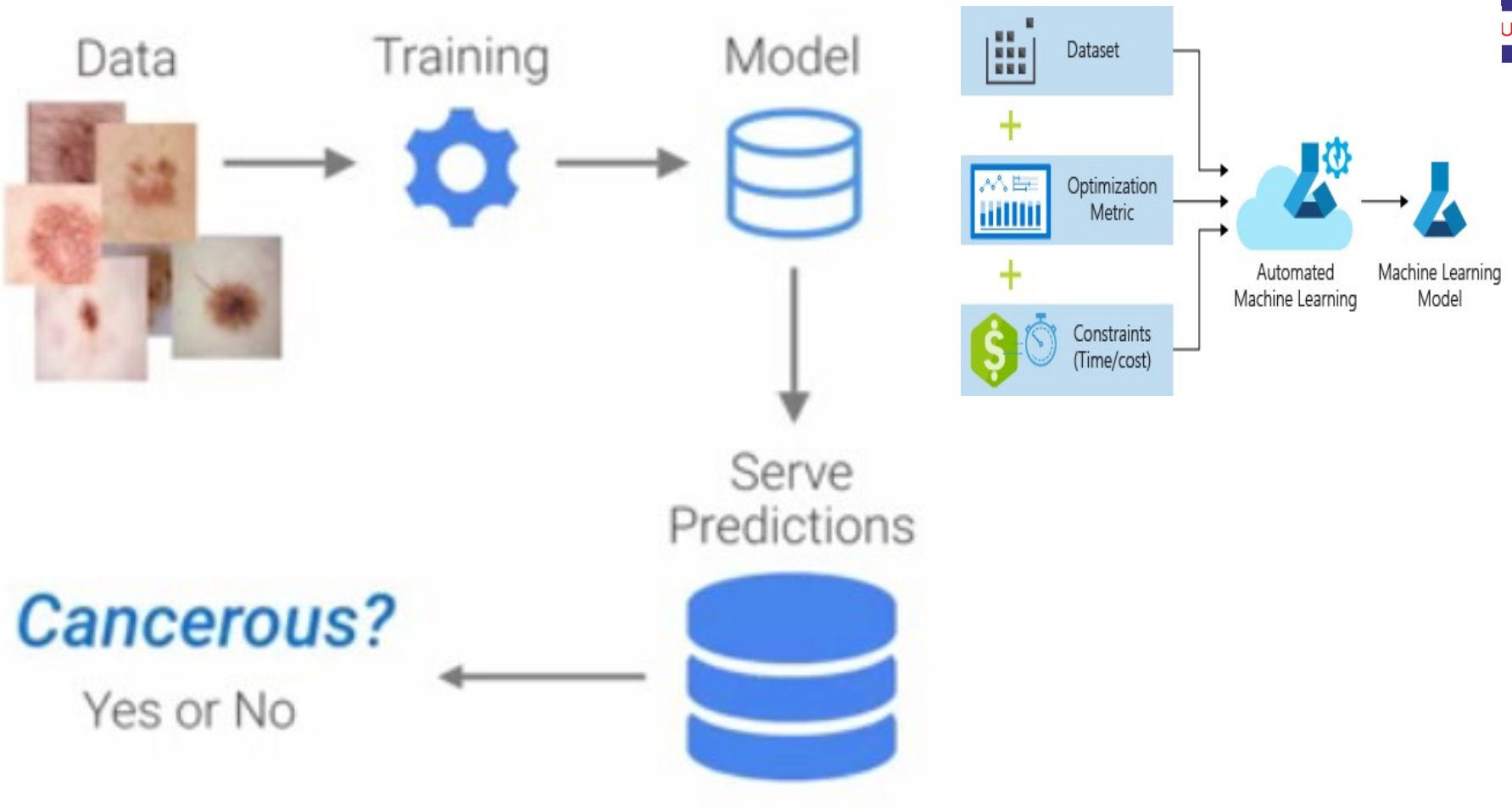
Inputs to a machine learning model



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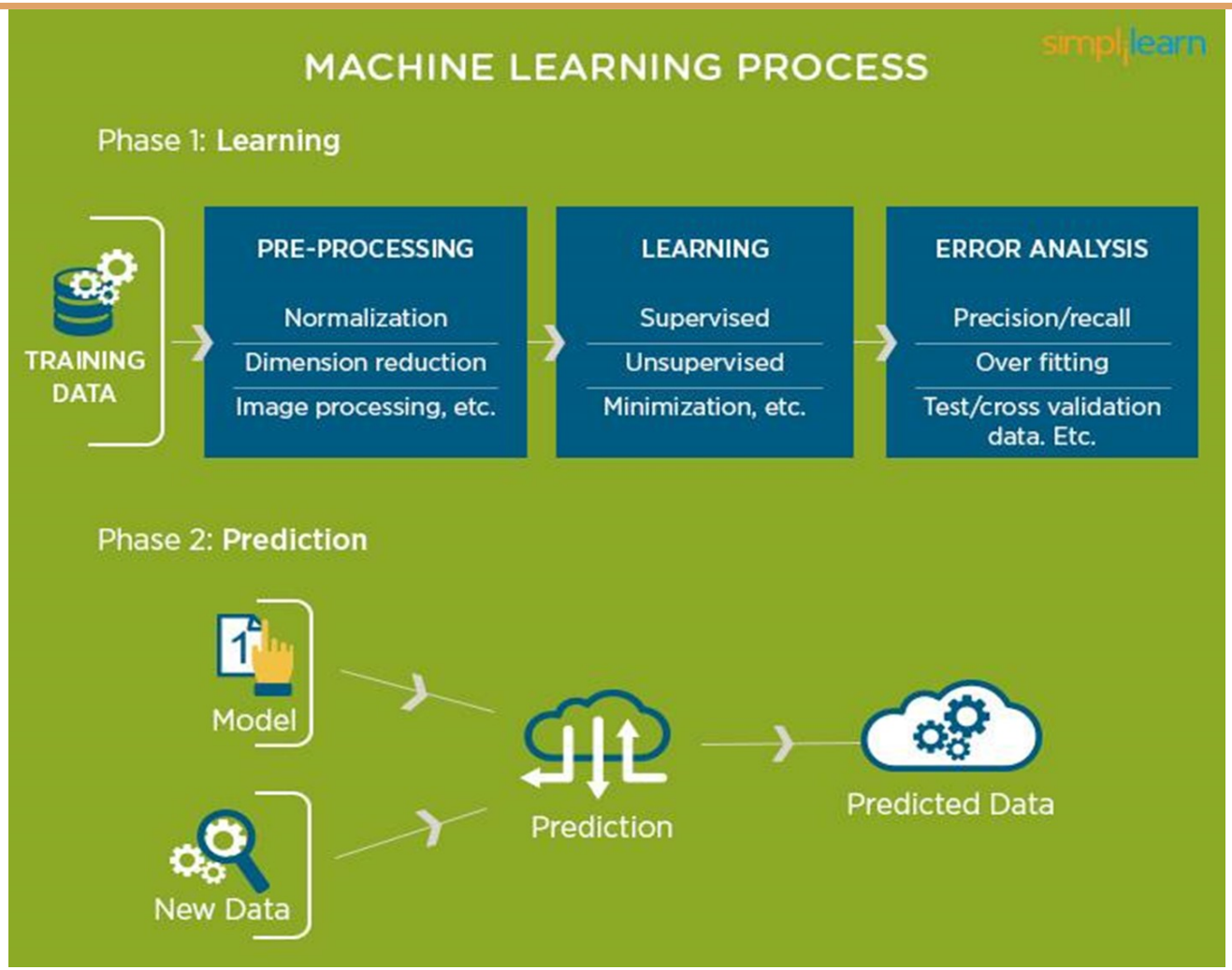
Metrics to Machine Learning Algorithm Evaluation



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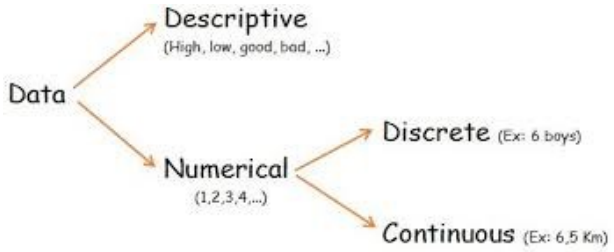
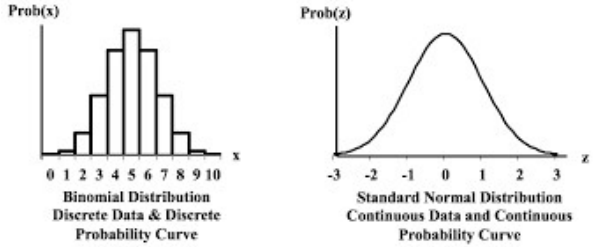
Data Types





7 Steps to Machine Learning

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

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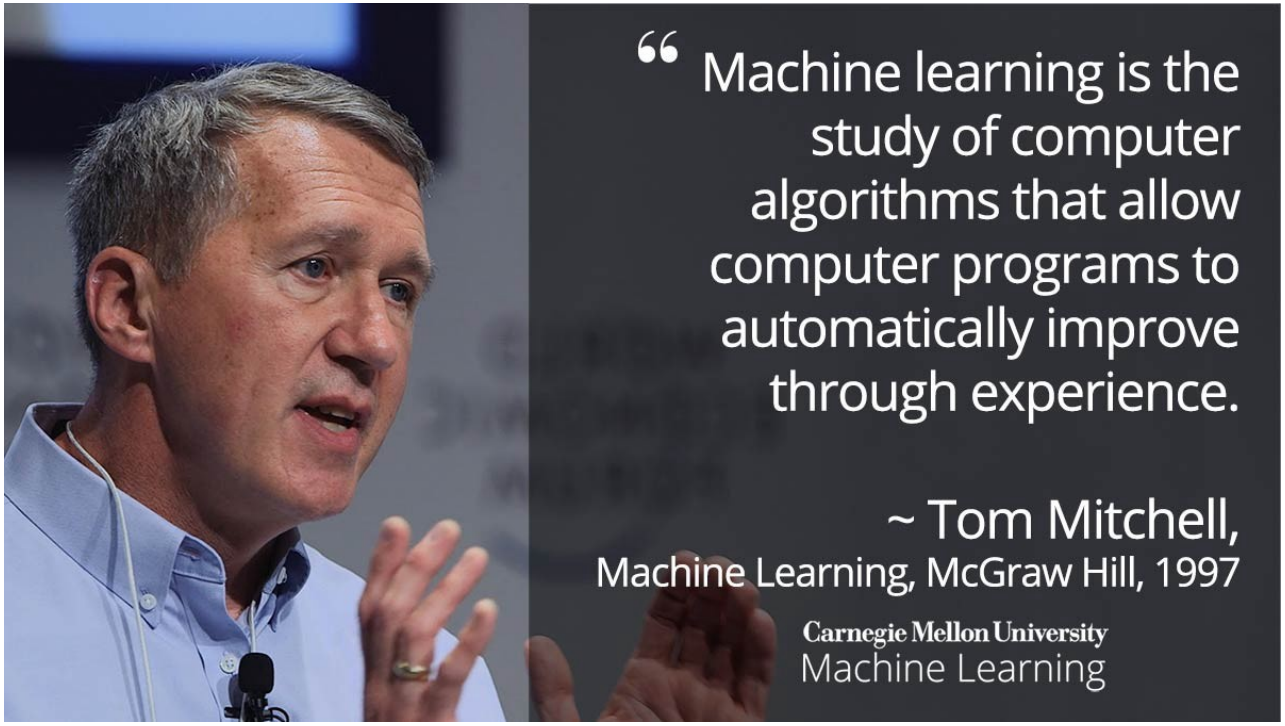
Formal Definition of Machine Learning



PTE Machine Learning Model Definition

"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 <P,T,E>.

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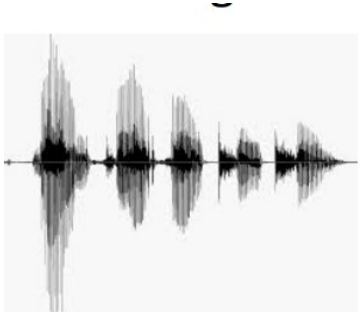
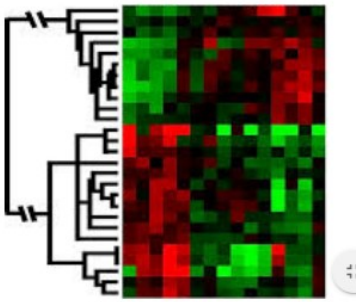
Machine Learning usage

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)

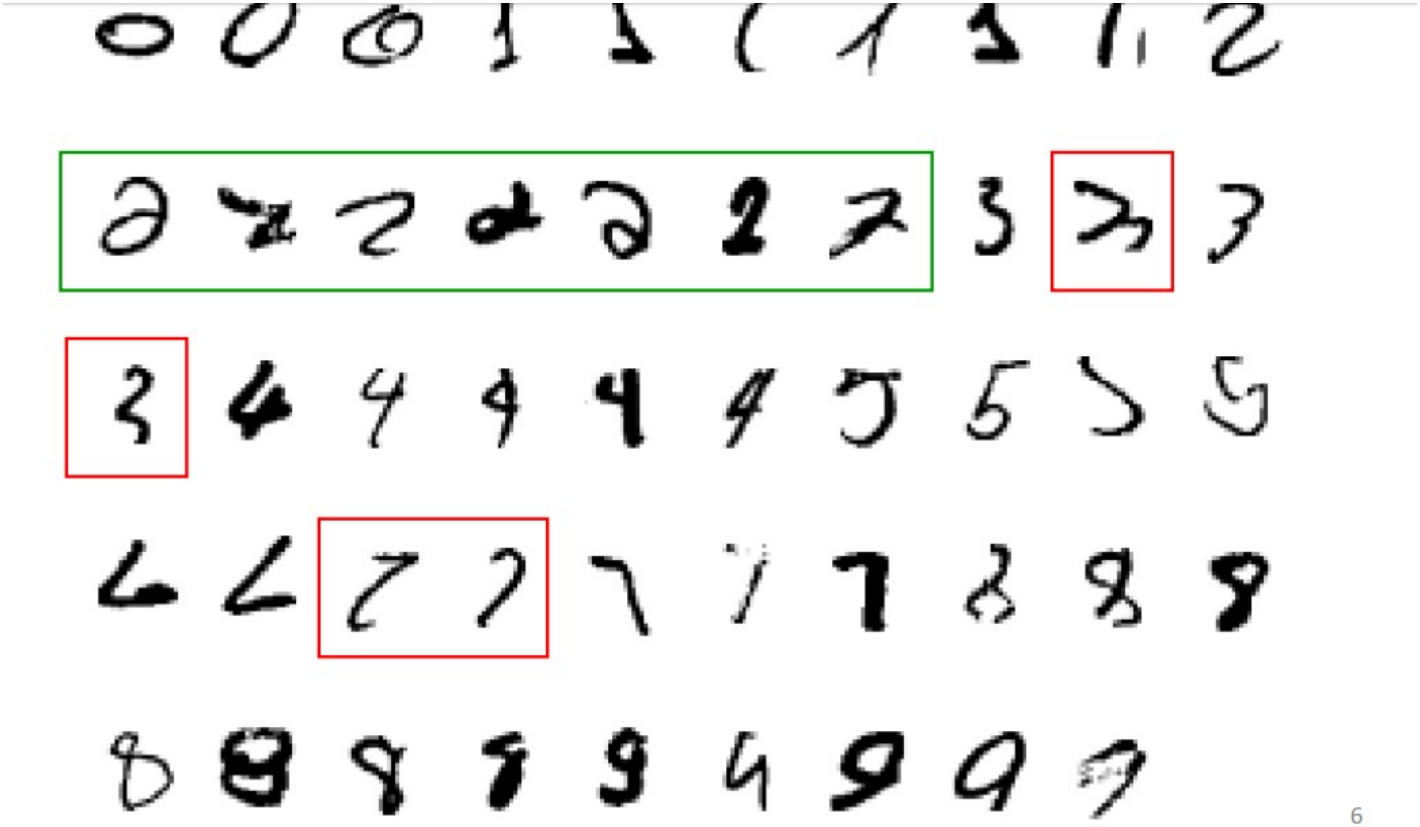





Example of a Machine Learning Task

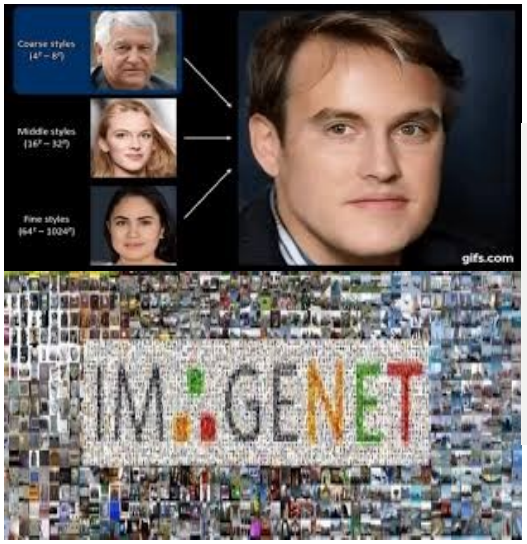
A classic example of a task that requires machine learning:

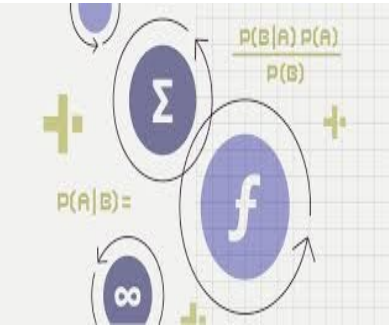
It is very hard to say what makes a 2:



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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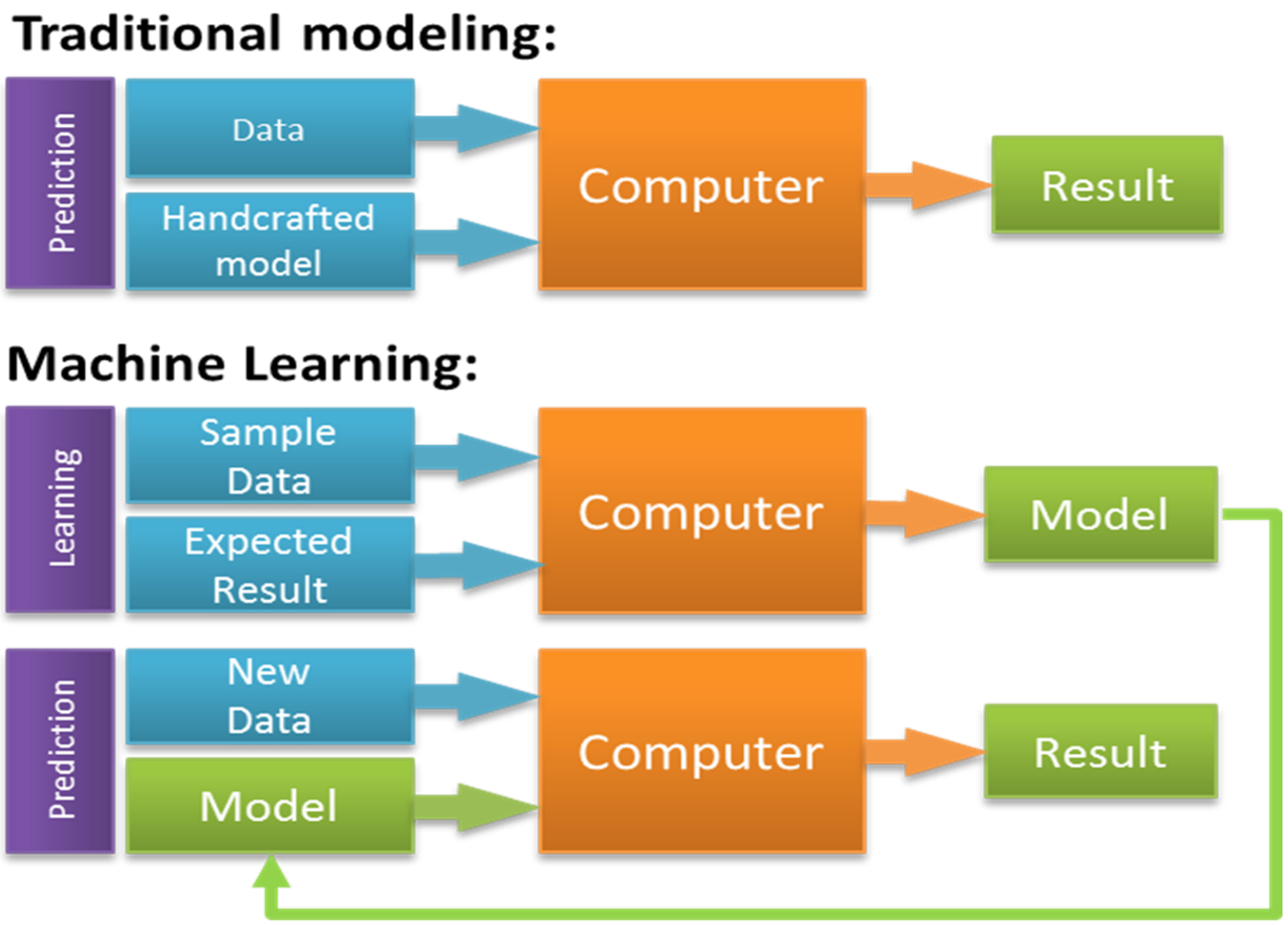
Traditional Models are Different



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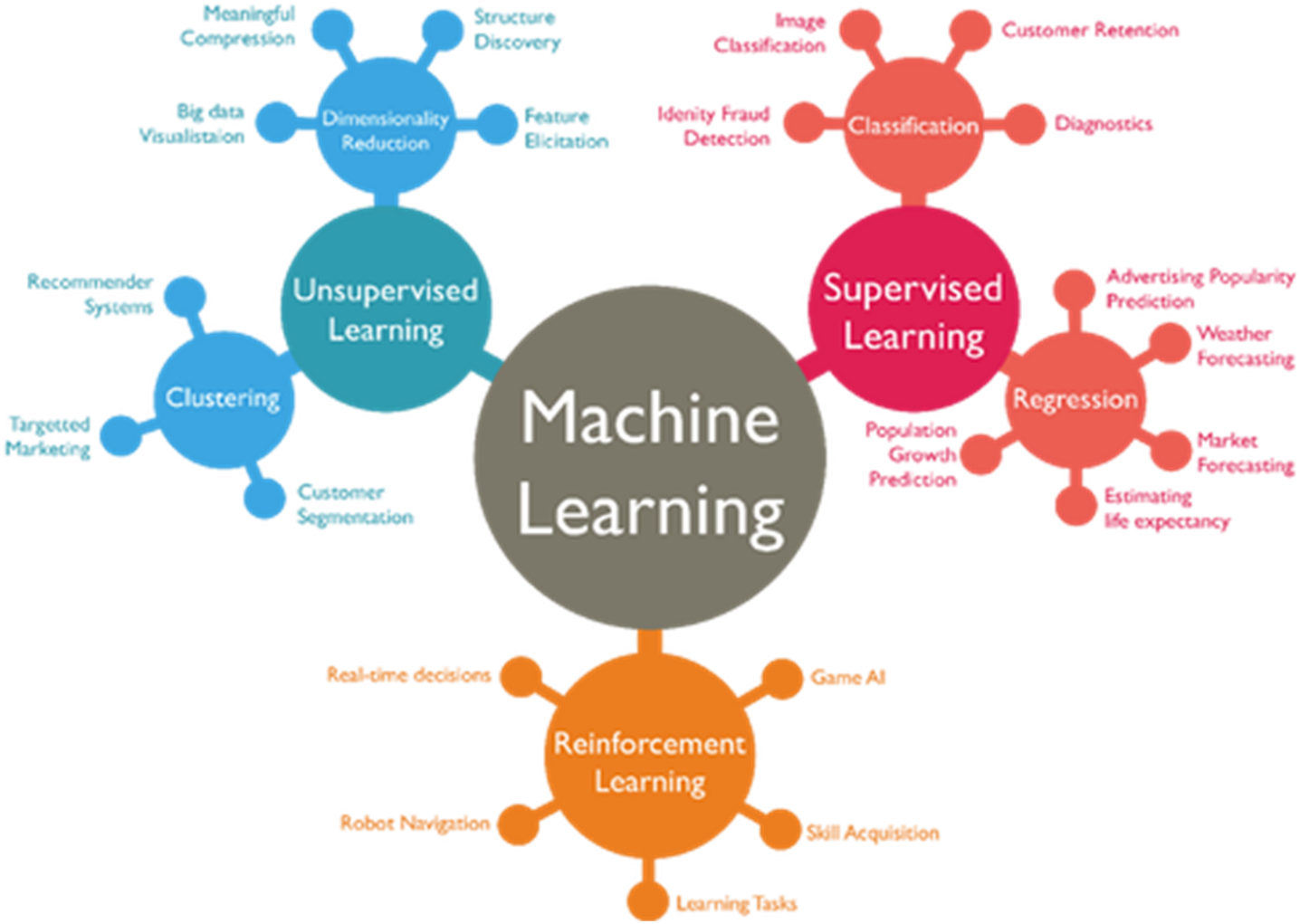
Three Broad Categories of Machine Learning



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Types of Machine Learning

- 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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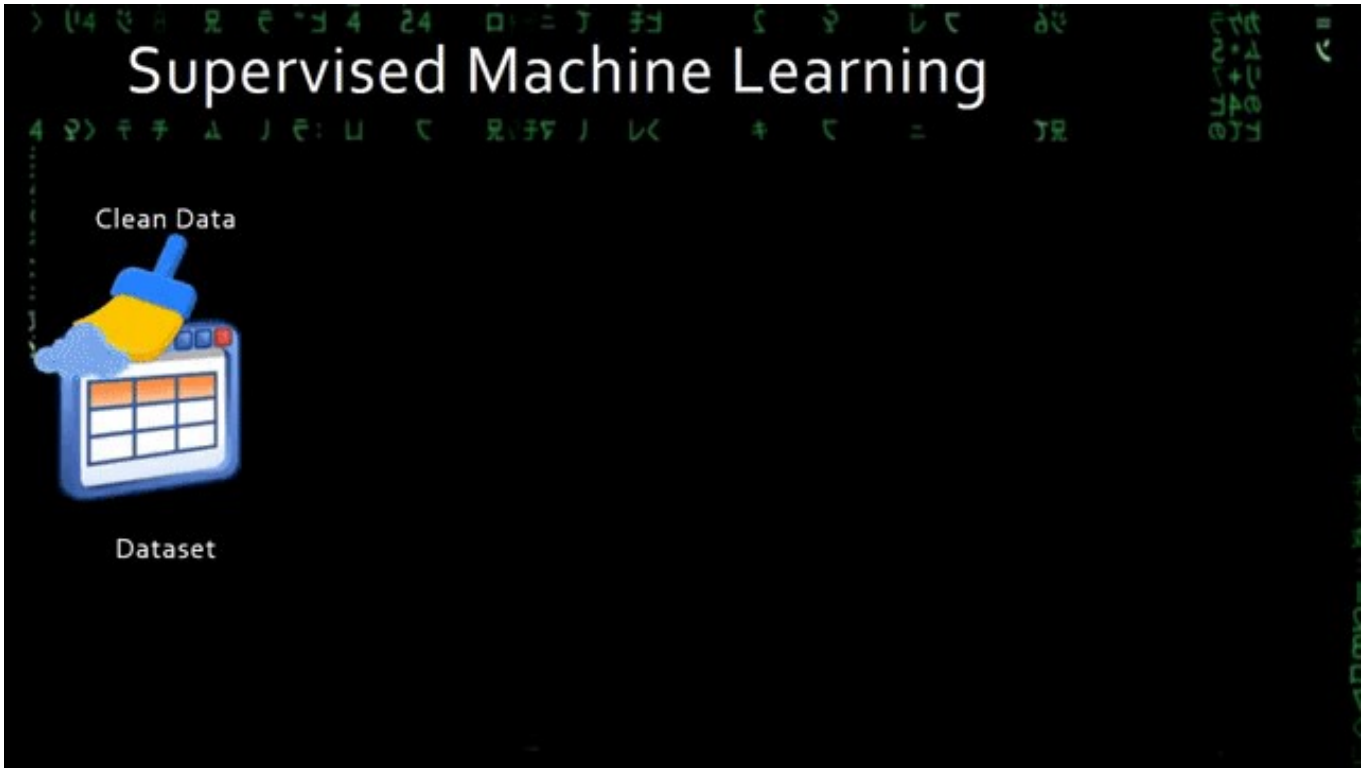
Supervised Learning



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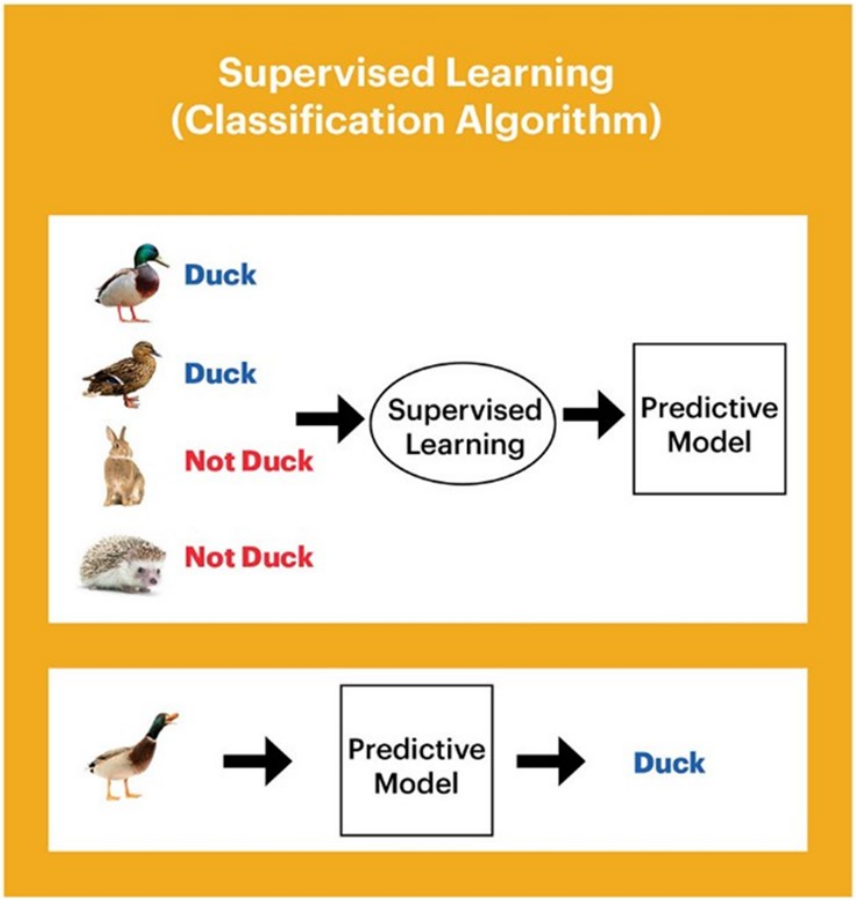
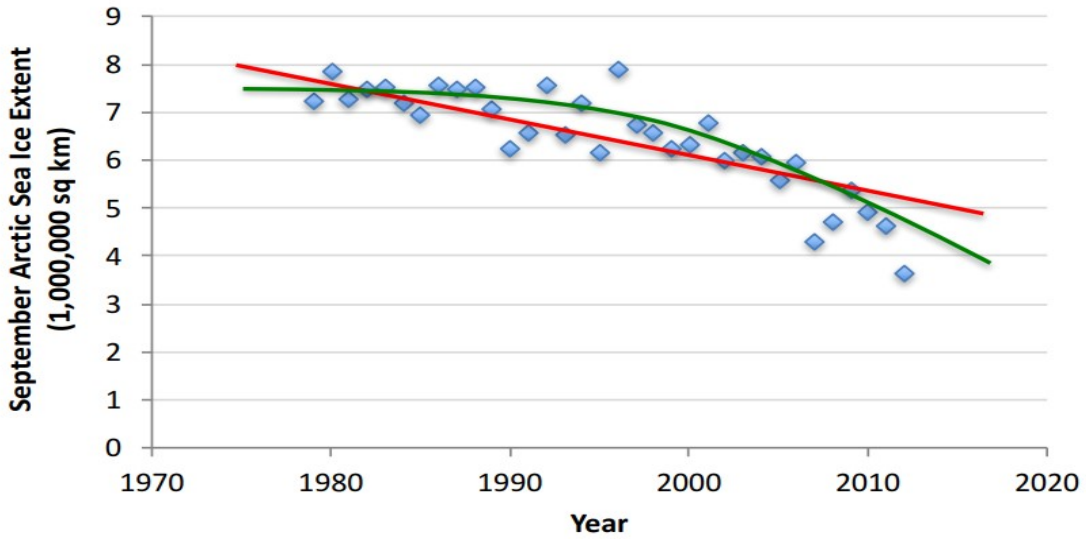
Supervised Learning



Formal Definition of Supervised Learning

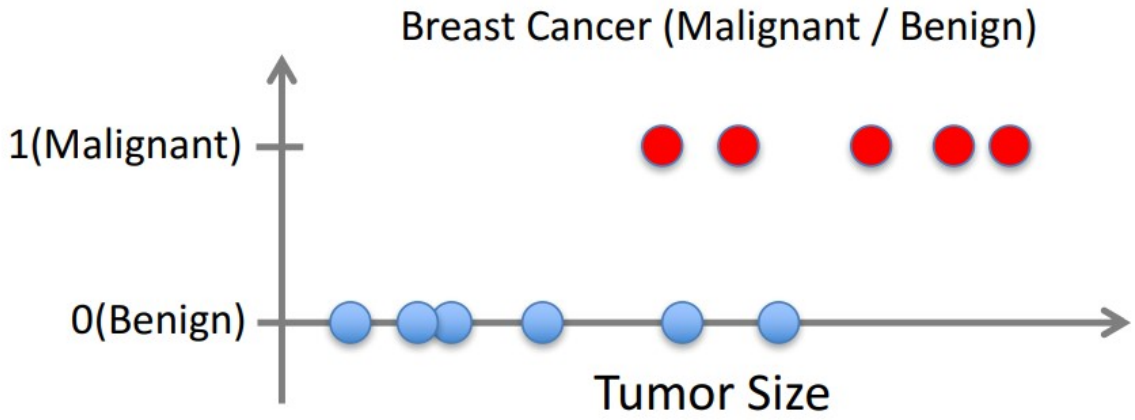
REGRESSION:

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



CLASSIFICATION:

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



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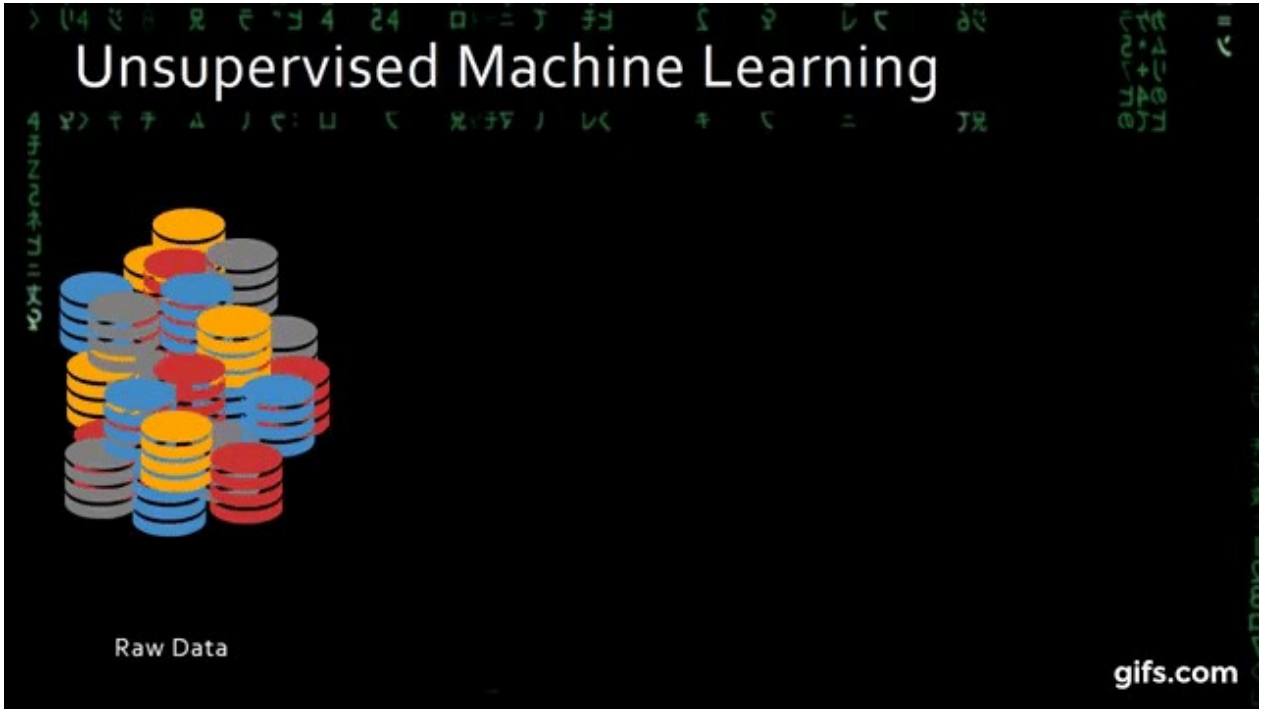
Machine Intelligence is Omni Present



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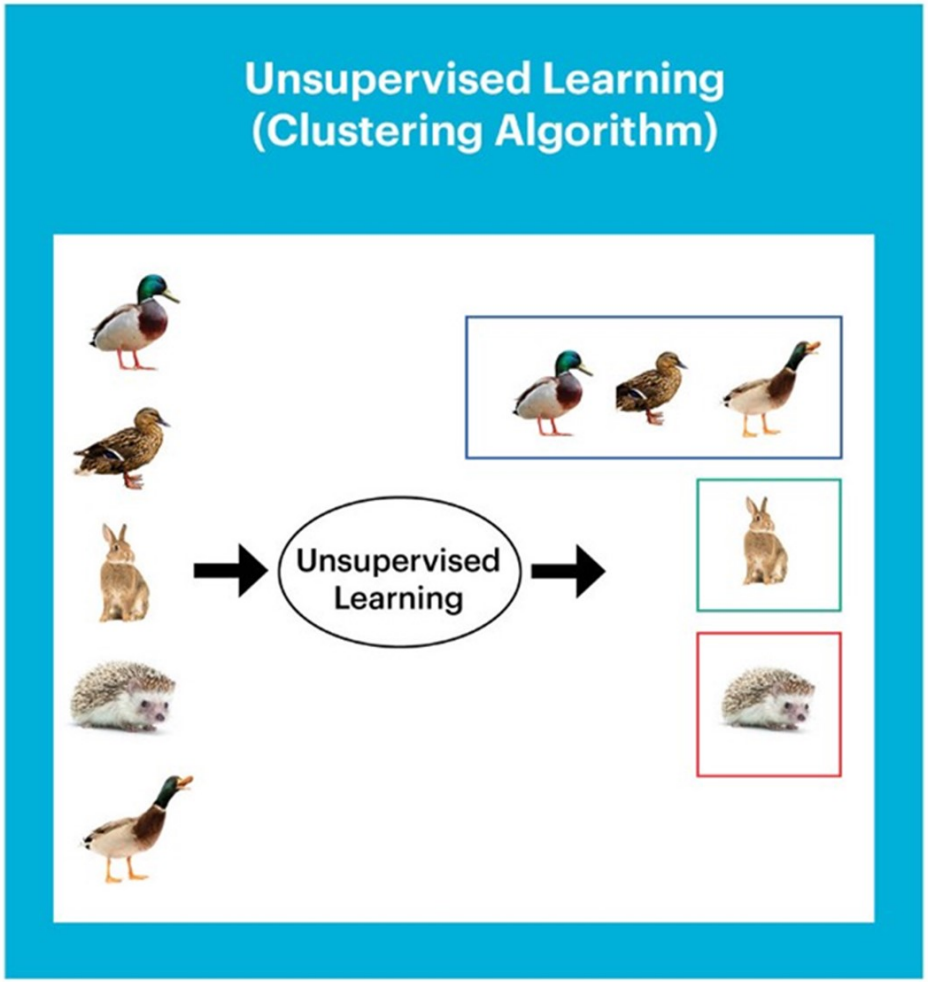
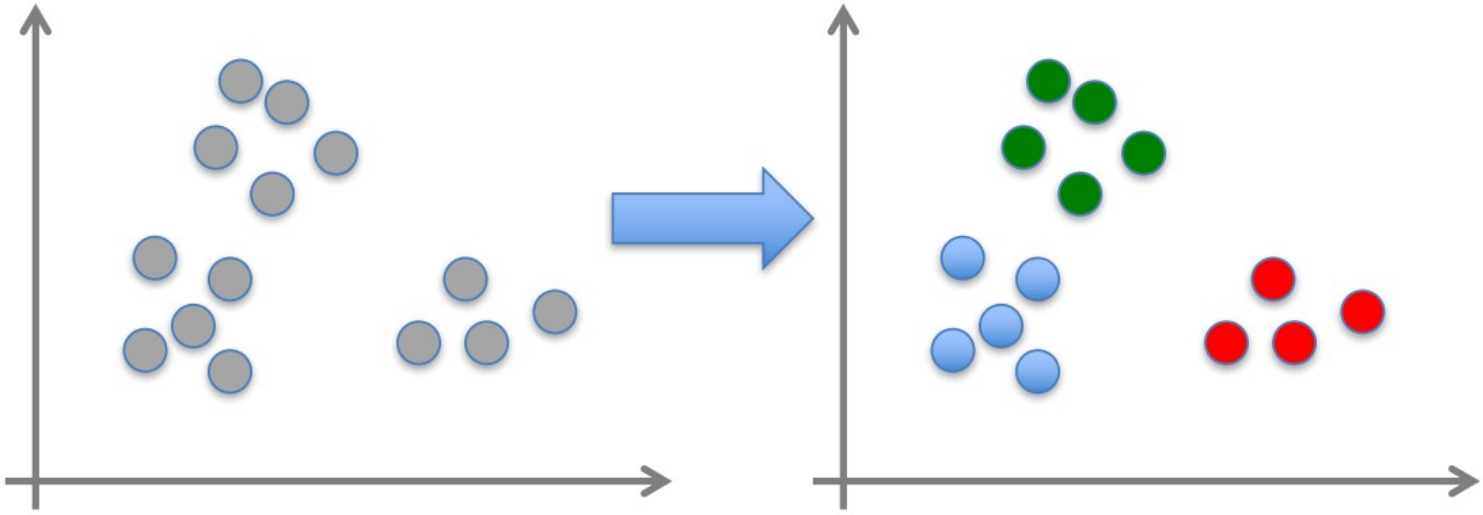
Unsupervised Learning



Unsupervised Learning

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



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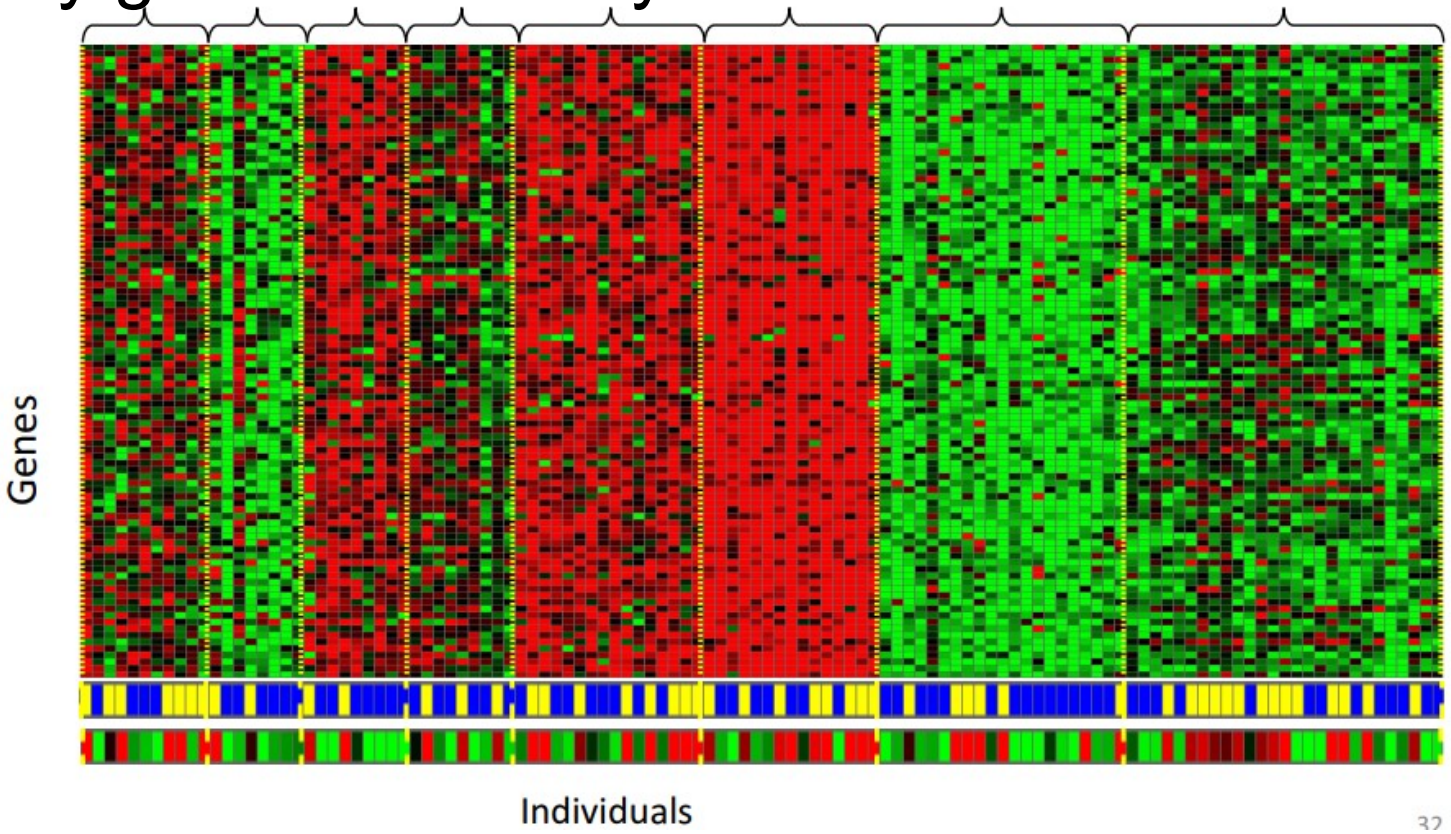
Genomics application: group individuals by genetic similarity



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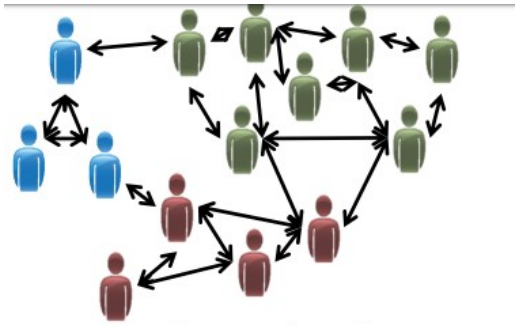
Example of Unsupervised Learning Applications

Organize computing clusters



Social network analysis

Market segmentation

Astronomical data analysis

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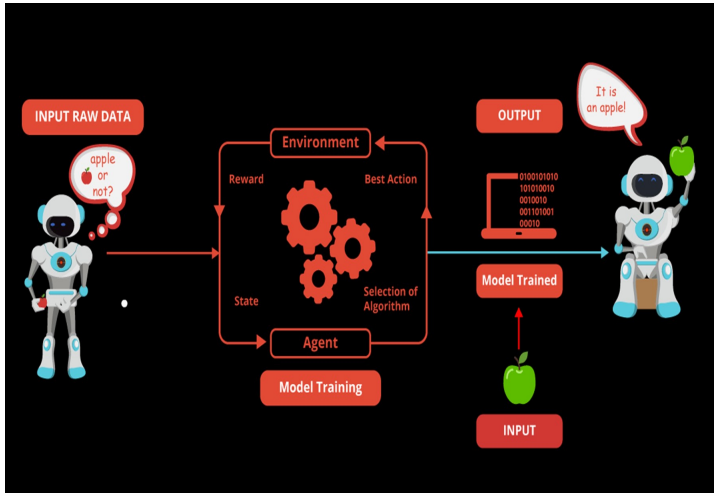
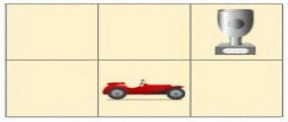
Reinforcement learning



Game Board:



Current state (s): 0 0 0 / 0 1 0

Q Table: $\gamma = 0.95$

	0 0 0 1 0 0	0 0 0 0 1 0	0 0 0 0 0 1	1 0 0 0 0 0	0 1 0 0 0 0	0 0 1 0 0 0
⇧	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

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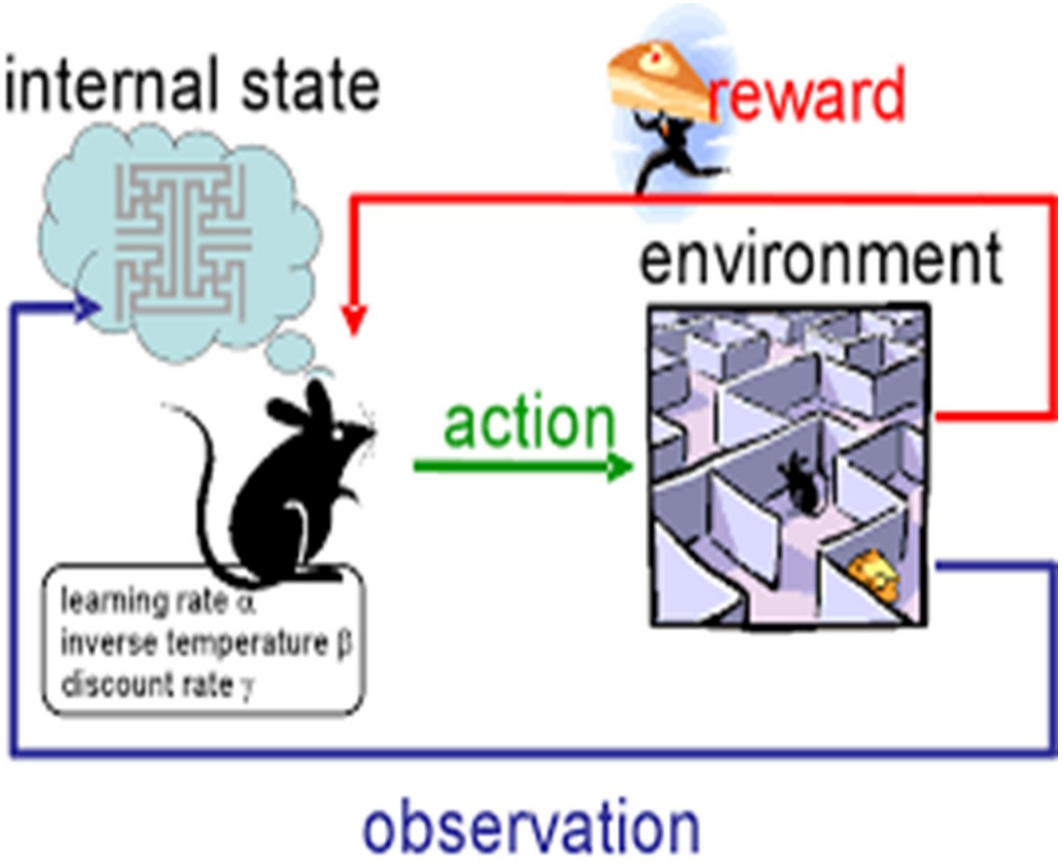
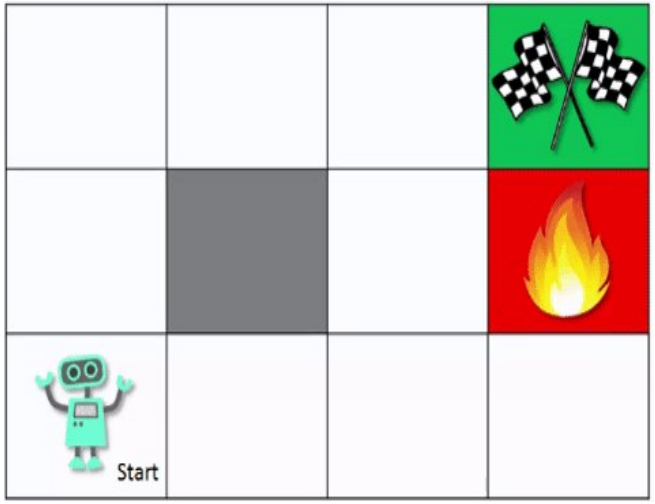
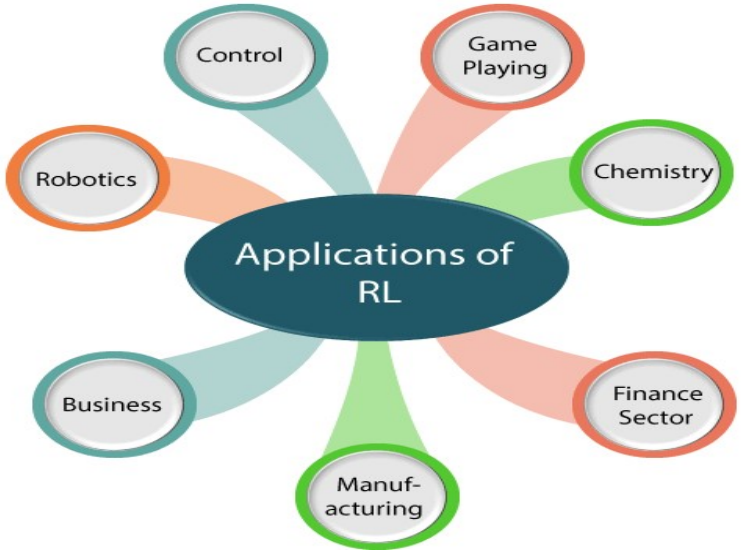
Reinforcement Learning





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



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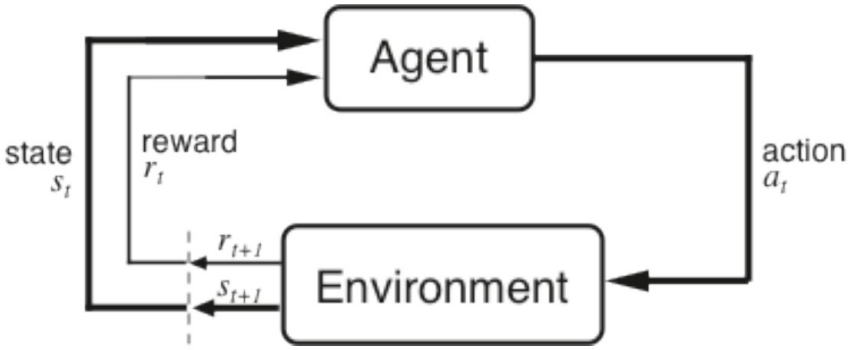
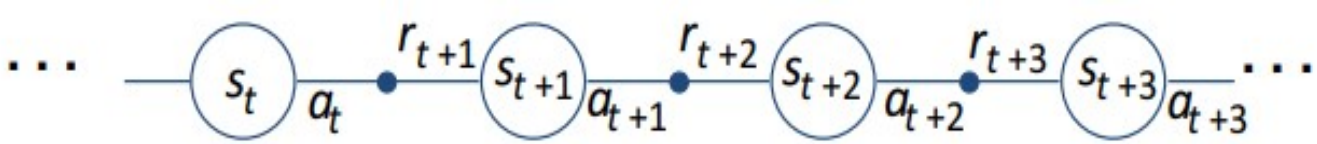
Reinforcement learning - learning process

- 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 □ S
- produces action at step t : a_t □ $A(s_t)$
- gets resulting reward : r_t +1 □ □
- and resulting next state : s_t +1



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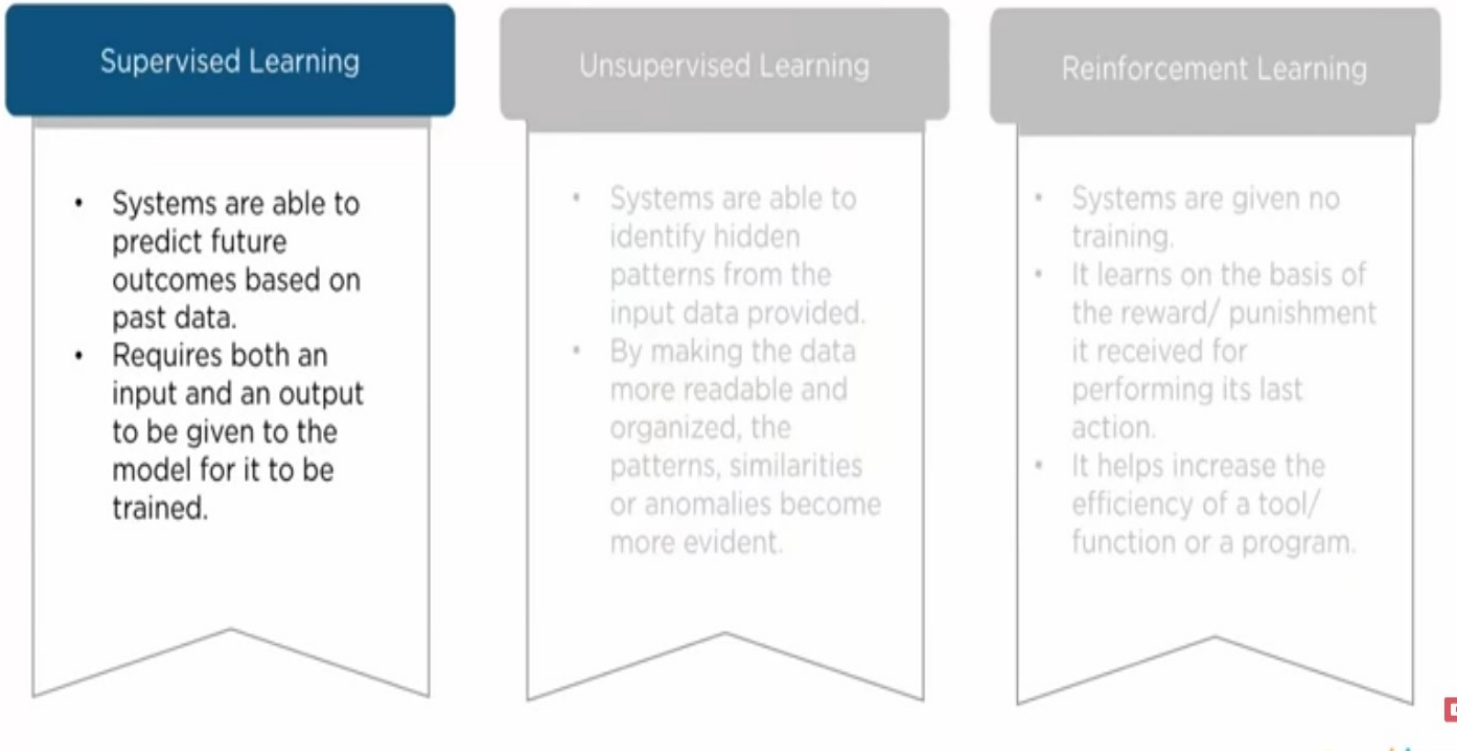
ML Model Summary



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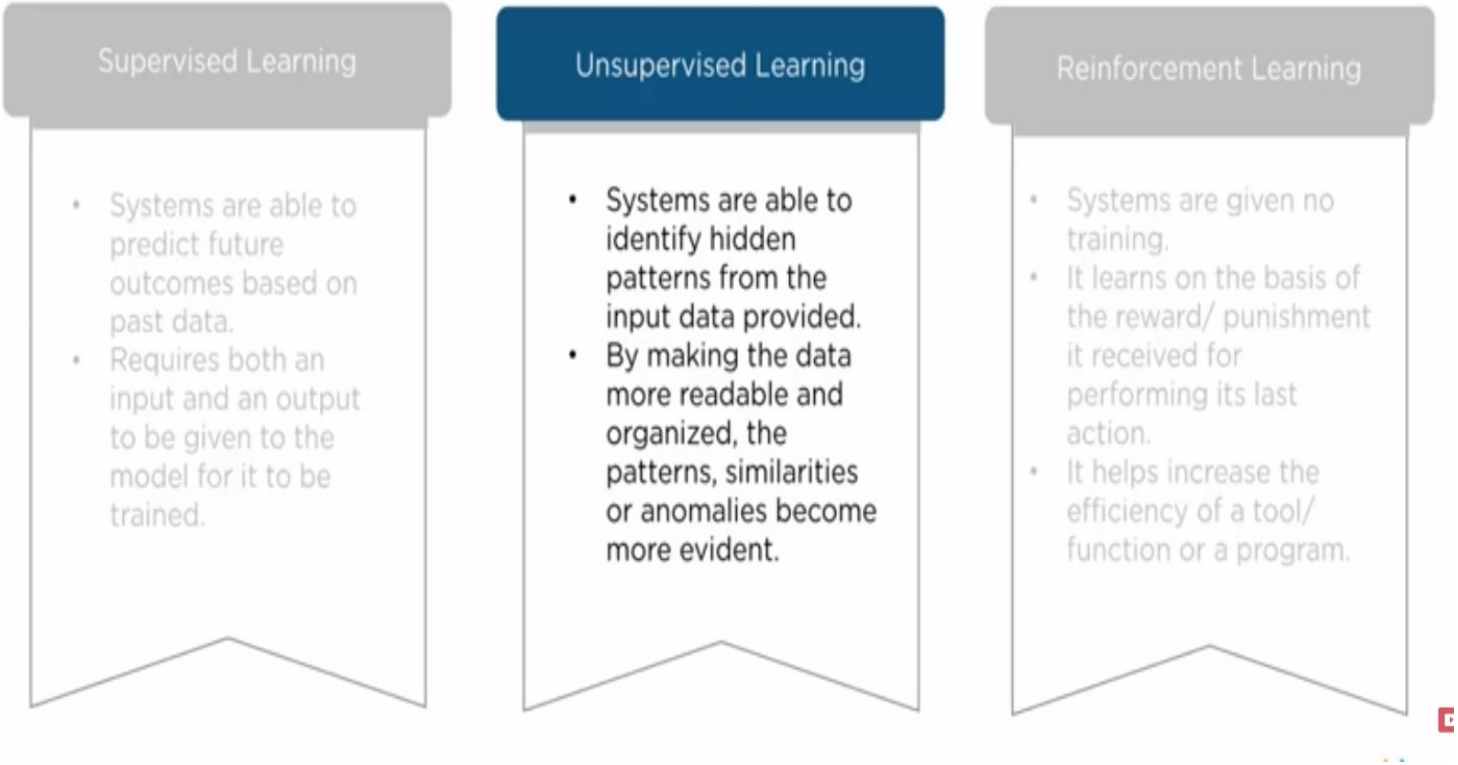

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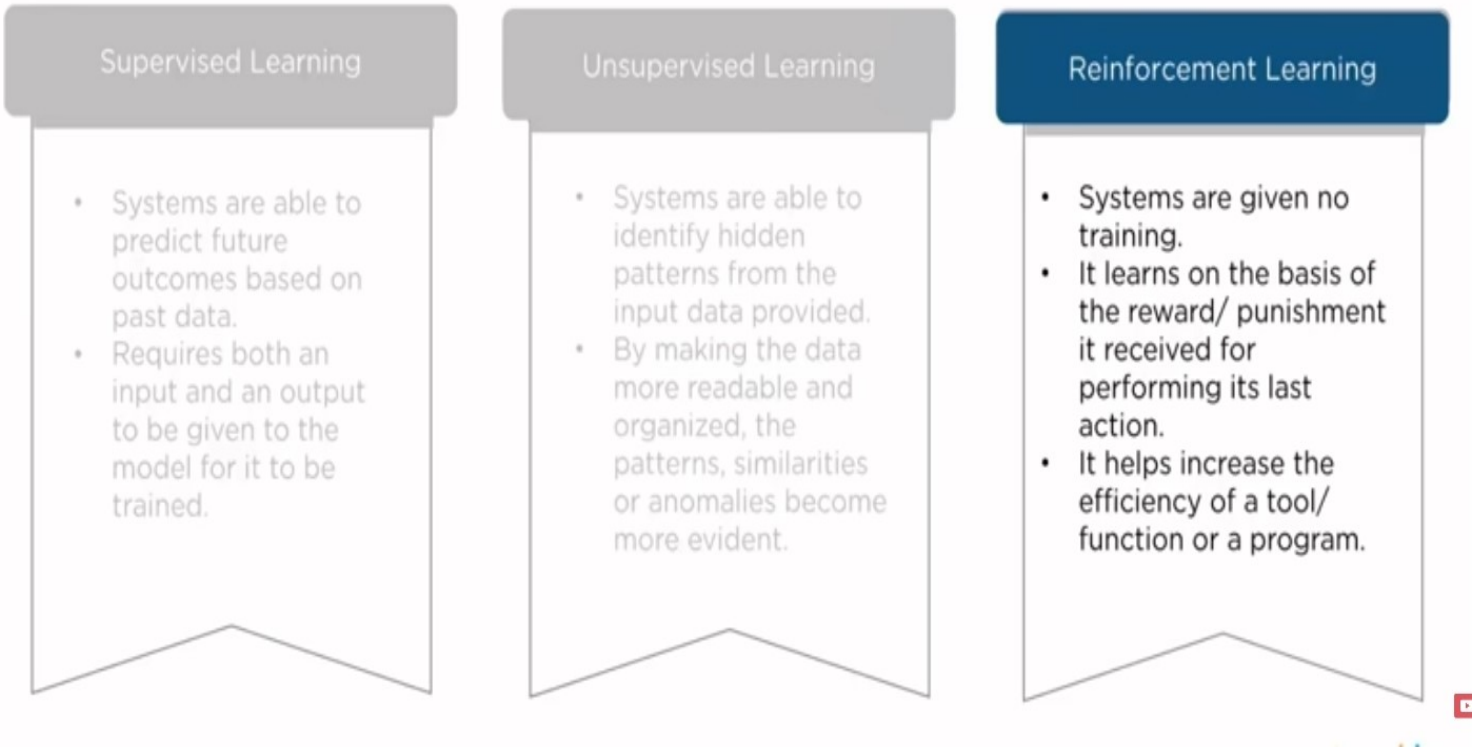

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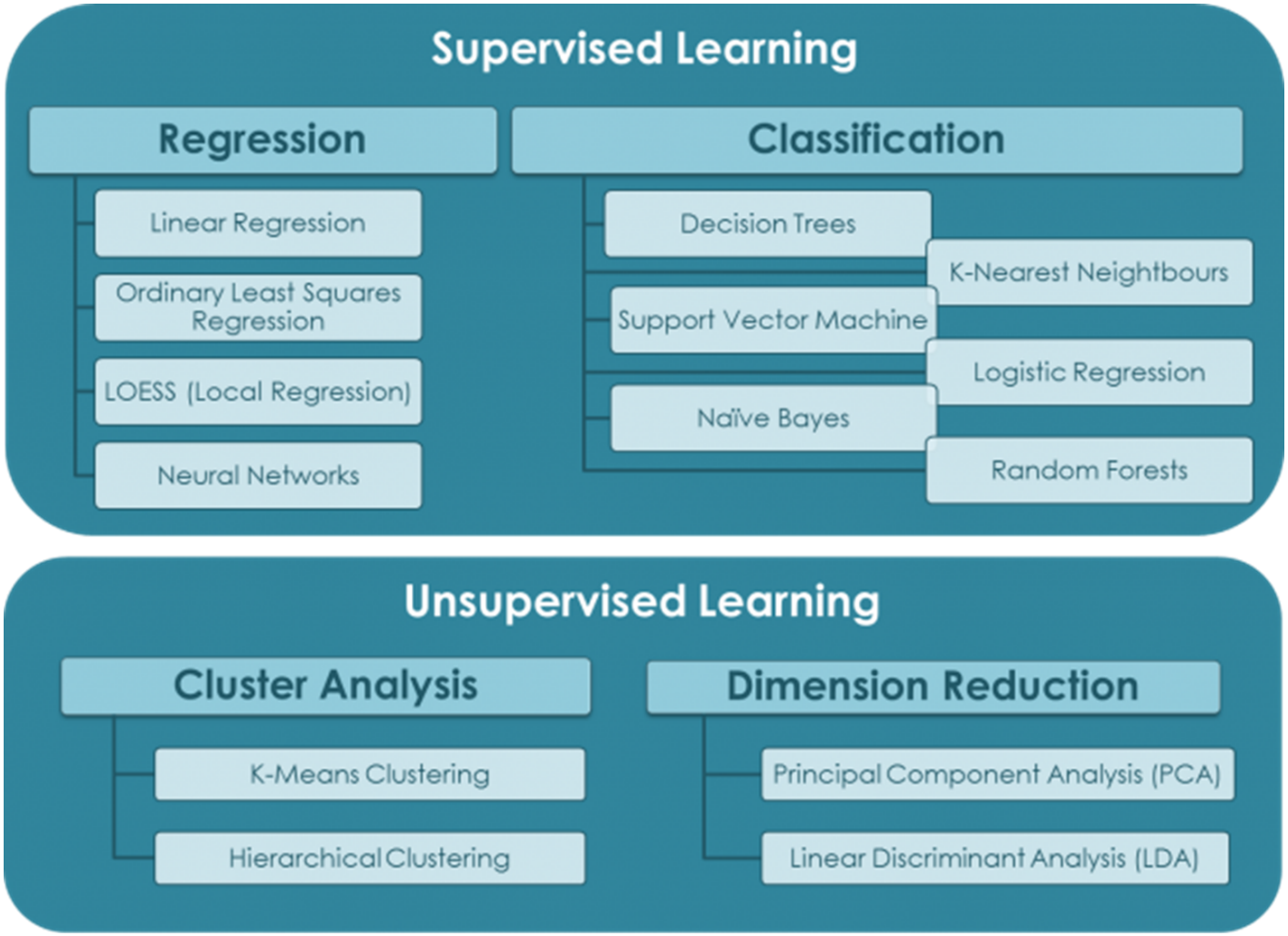
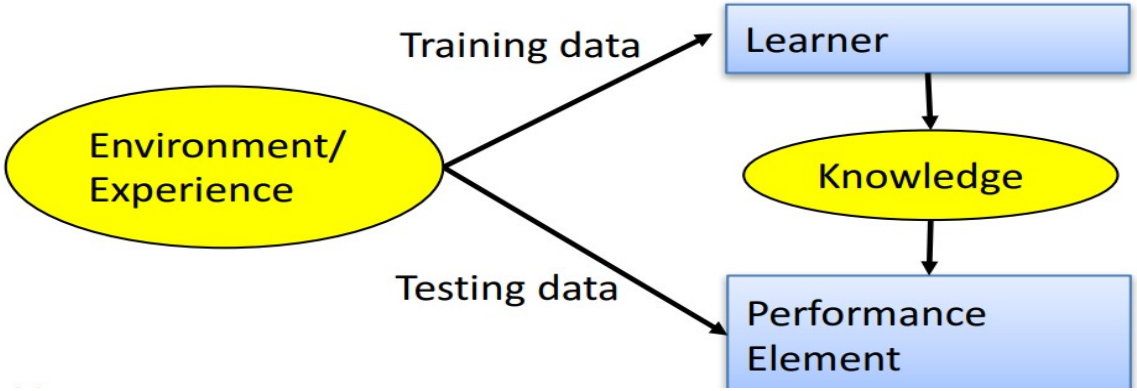
Subtypes within Models



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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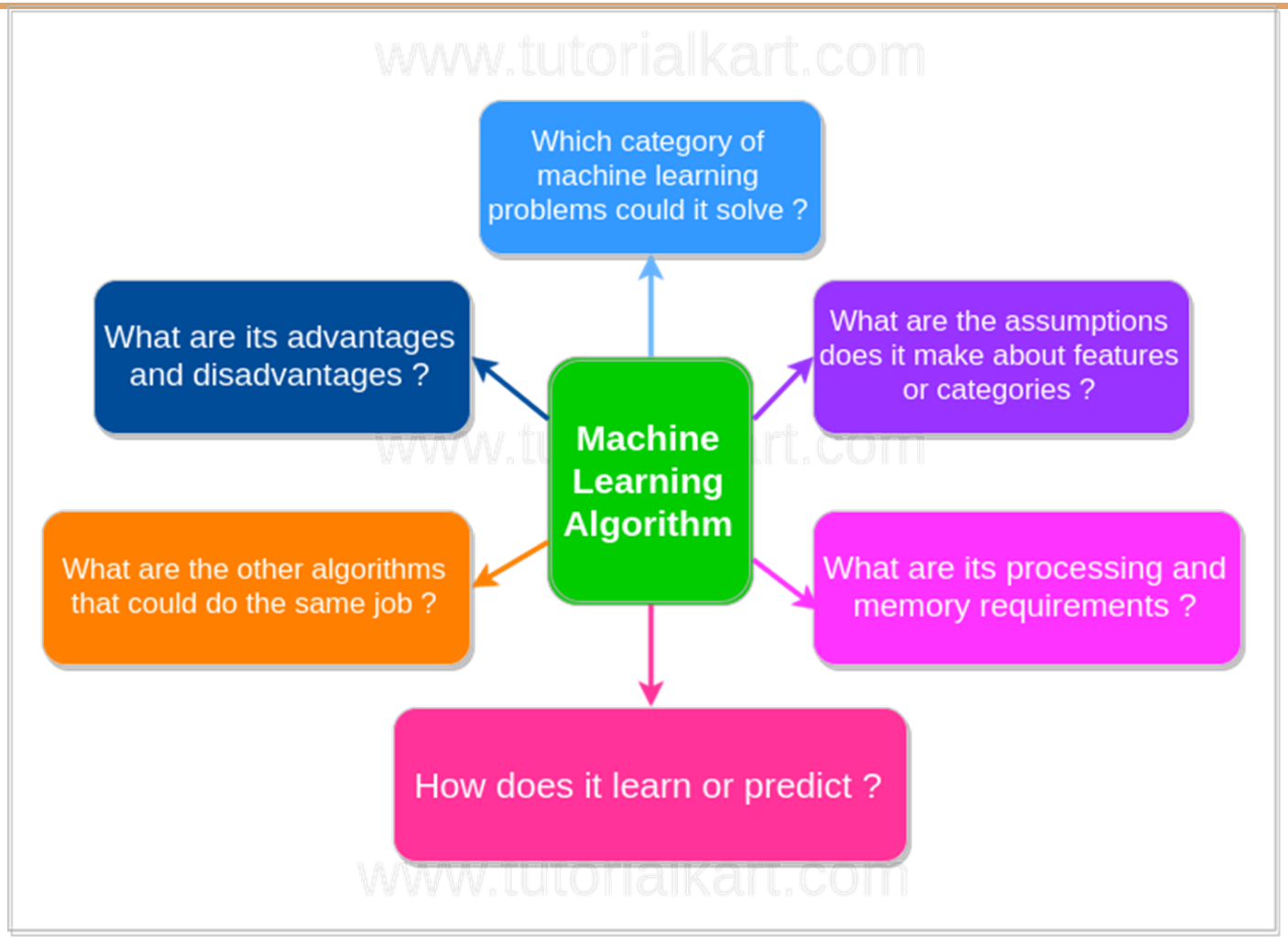
Machine Learning – Choosing the right algorithm



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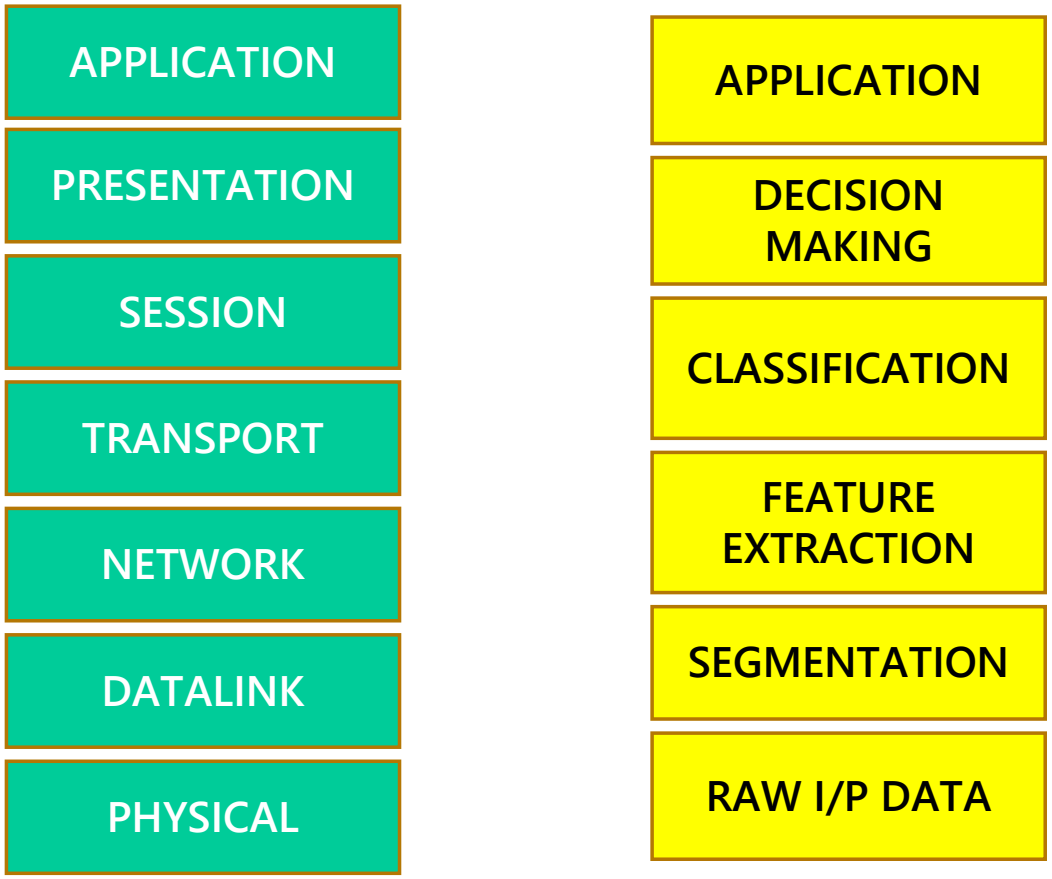
OSI Analogy



THANK YOU

K.S.Srinivas

srinivasks@pes.edu

+91 80 2672 1983 Extn 701