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# Types of Learning

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# Introduction

- Learning is the ability to improve behavior based on experience.

# Introduction…

- ML is about building computer systems that automatically improve with experience.
- ML explores the algorithms that learn from data and builds model, and this model can be used for different tasks like prediction, decision making or solving tasks.

# Definition by Arthur Samual(1959):

- ML: Field of study that gives computers the ability to learn without being explicitly programmed
- **The major aim of ML is to allow the systems to learn by themselves through the experience without any kind of human intervention or assistance.**

# Definition by Tom Mitchell (1998):

Definition: A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E.

- To have a well-defined learning problem, we must identify the three terms:
  1. The class of tasks (T)
  2. Performance measure (P)
  3. The source of Experience (E)

# A well-defined learning task

Ex. Suppose we want to classify emails as spam or not spam

T: classifying emails as spam or not spam

E: emails we have collected

P: The number of emails correctly classified as spam or not spam

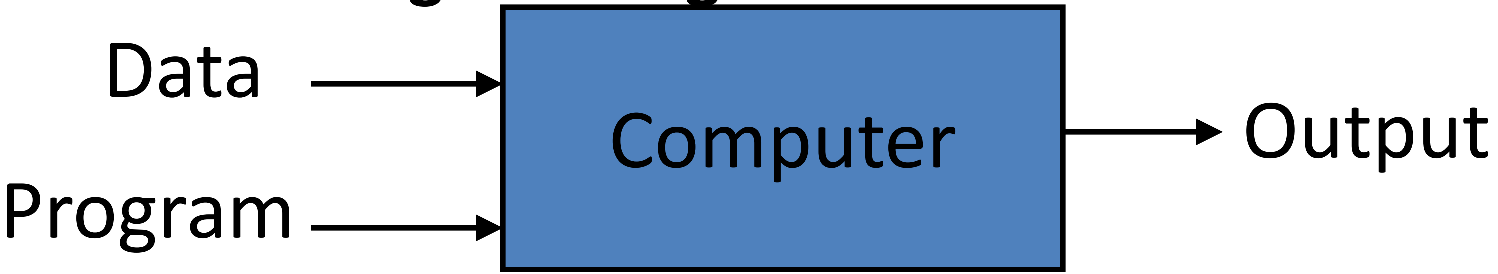
# A well-defined learning task

Ex. **A checkers learning problem:**

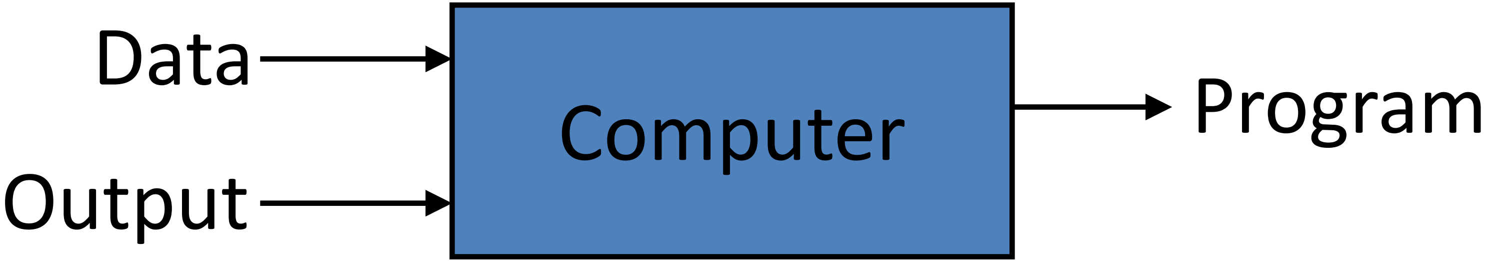
**Task T:** playing checkers
**Performance measure P:** percent of games won against opponents
**Training experience E:** playing practice games against itself

# Machine learning solution vs programmatic solution

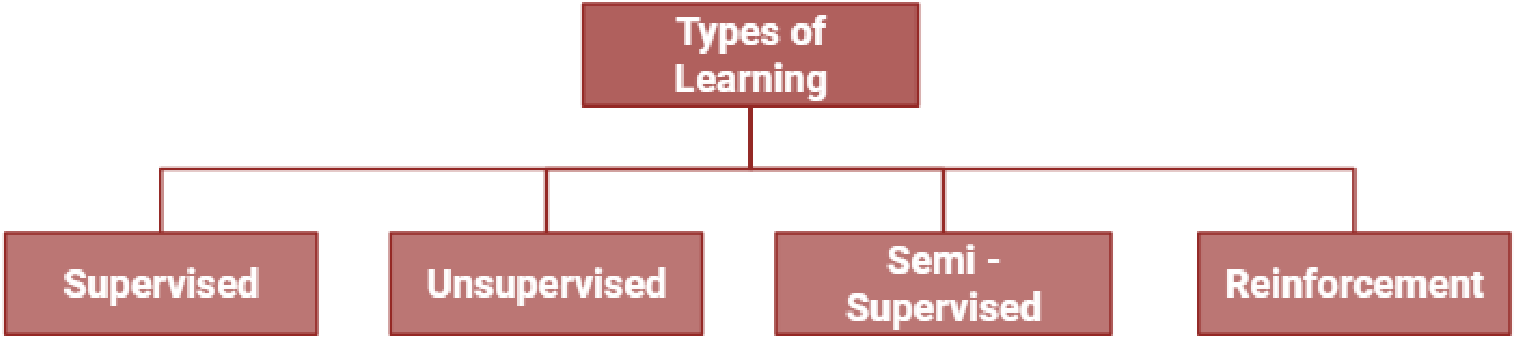
## Traditional Programming




## Machine Learning



# The Types of Machine Learning Algorithms



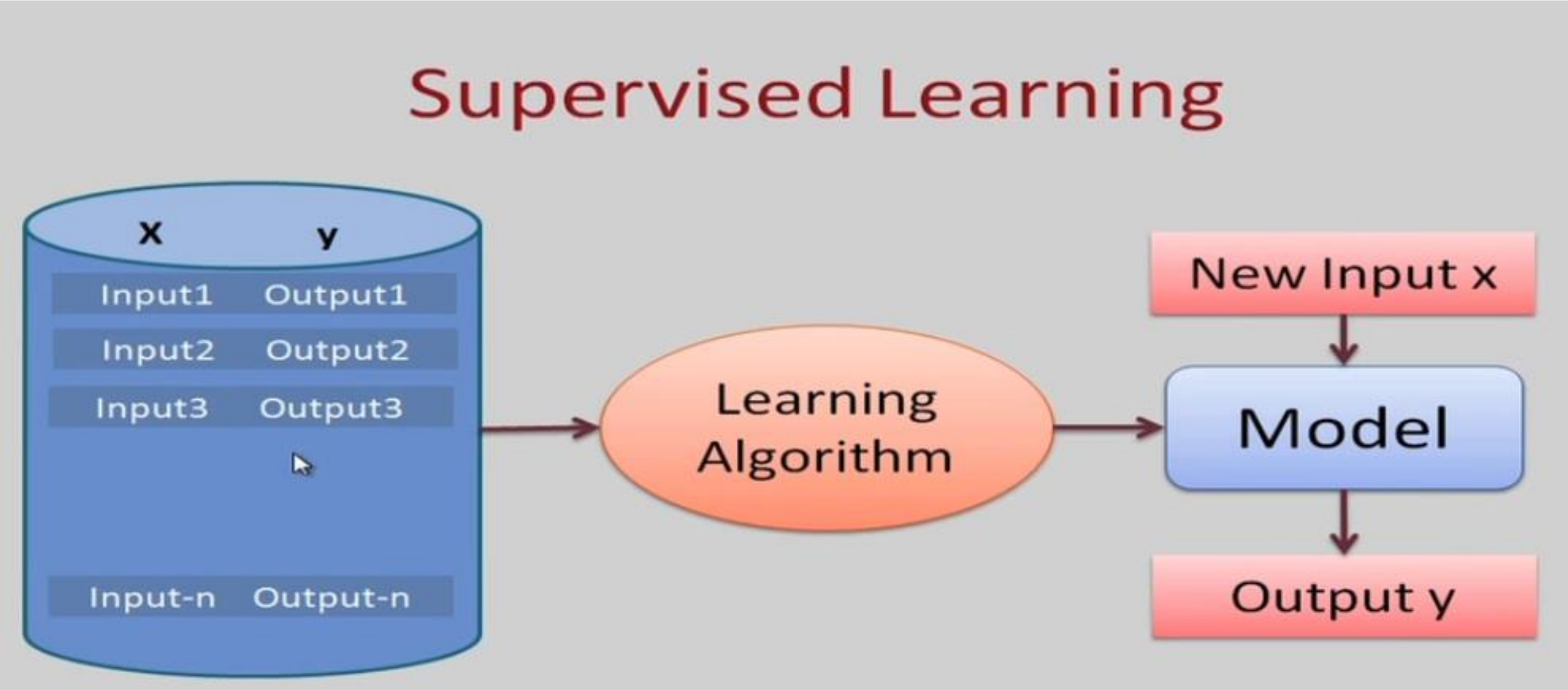
# Supervised Learning

- Works on labeled data
- In supervised learning approach, the goal is to learn a mapping from input  to output y, given a set of input – output pairs.

**Given:**  (x1, y1), (x2, y2), ..., (xn, yn)

- Classification: When $y_i$ is discrete value
- Regression: When $y_i$ is continuous value i.e., real number

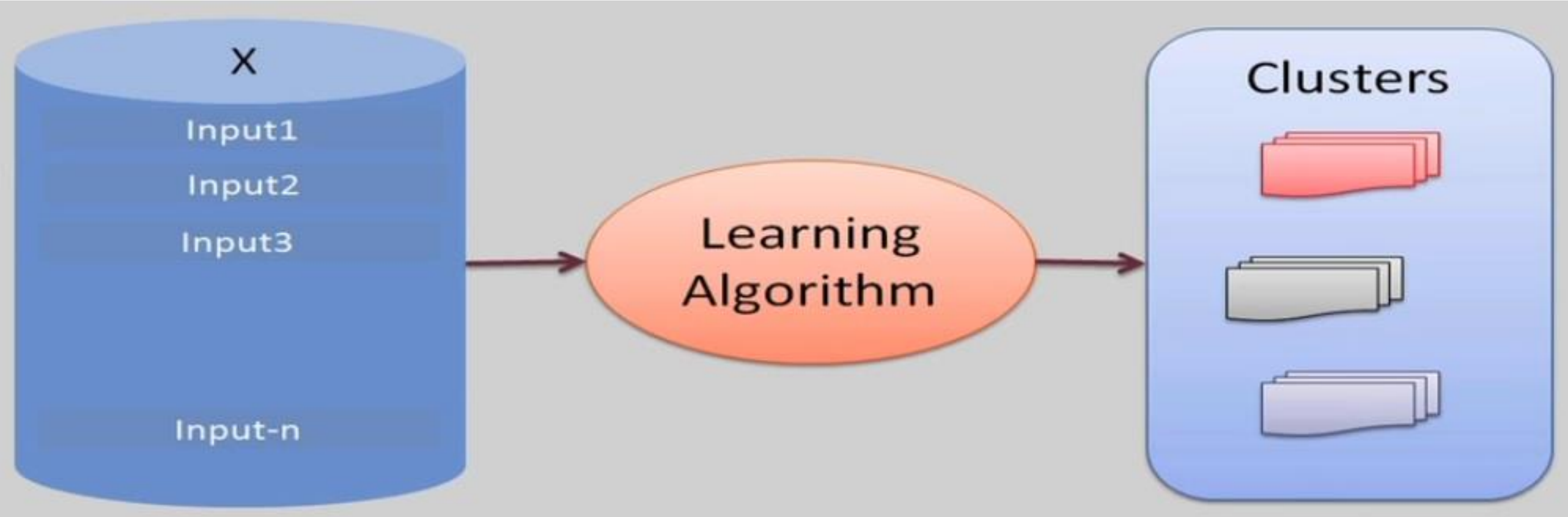
# Supervised Learning



# Unsupervised Learning

- Works on unlabeled data
- In unsupervised learning you have only inputs and no corresponding output variable
- The goal for unsupervised learning is to find interesting patterns in the data
- The most important unsupervised learning is clustering

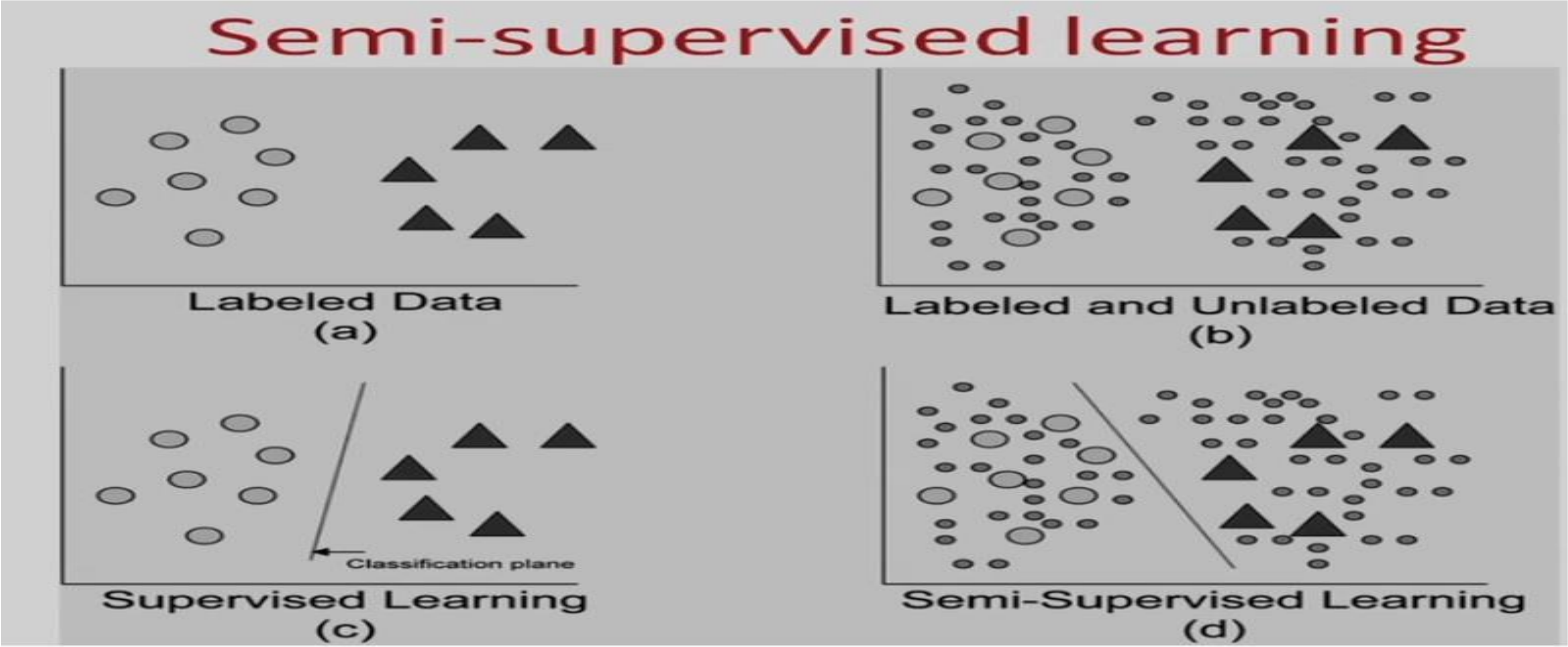
# Unsupervised Learning



# Semi-supervised Learning

- As the name suggests, its working lies between Supervised and Unsupervised techniques.
- We use these techniques when we are dealing with a data which is a little bit labelled and rest large portion of it is unlabeled.
- We can use unsupervised technique to predict labels and then feed these labels to supervised techniques.
- This technique is mostly applicable in case of image data-sets where usually all images are not labelled.

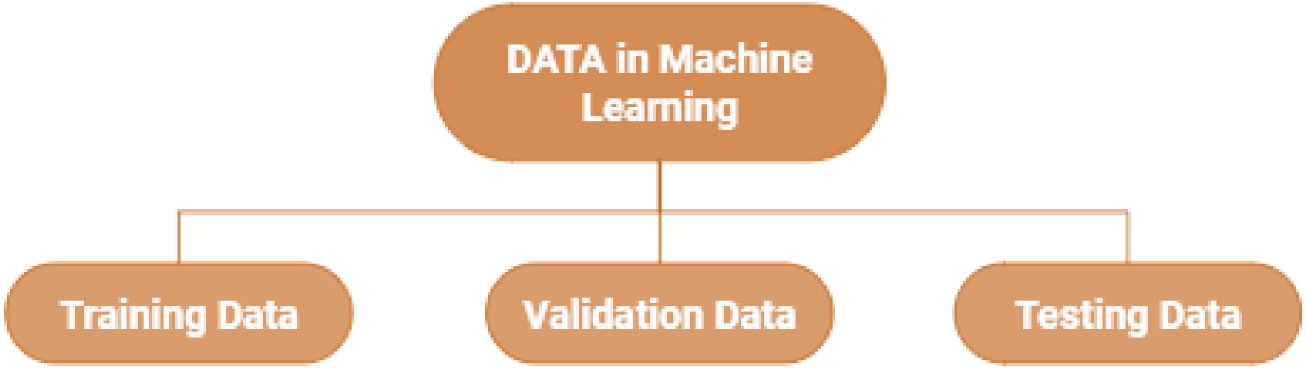
# Semi-supervised Learning



# Reinforcement Learning

- The binary feedback of right/ wrong is sent back to the input.
- The role of reinforcement learning is that a critic who is authorized to say right or wrong. Thus, the learning continues till the critic agree with the learning system.
- In this technique, model keeps on increasing its performance using a Reward Feedback to learn the behavior or pattern.
- Ex. Google Self-driving cars

# How have we split data in Machine Learning?



# How split data in Machine Learning?

- **Training Data:** The part of data we use to train our model. This is the data which your model actually sees(both input and output) and learn from.
- **Validation Data:** The part of data which is used to do a frequent evaluation of model, fit on training dataset along with improving involved hyper parameters (initially set parameters before the model begins learning). This data plays it's part when the model is actually training.
- **Testing Data:** Once our model is completely trained, testing data provides the unbiased evaluation. When we feed in the inputs of Testing data, our model will predict some values(without seeing actual output). After prediction, we evaluate our model by comparing it with actual output present in the testing data.

# Evaluation of Learning Algorithm

- Suppose you have hypothesis h, and you get an example x and you want to make a prediction on x.
  - Given: y is the actual value for input x.
  - $\hat{y}$ is the predicted value of input i.e., h(x) = $\hat{y}$
- if $\hat{y}$ and y are same then there is no error and
- if they are different there is an error.
- we have to discuss how this error is measured.

# Error measured method

- **Mean Absolute Error:**

$$\text{Mean Absolute error} = \frac{1}{m}\sum_{i=1}^{m} |h(x^{(i)) -} y^{(i)}|$$

- **Sum of Square Error:**

$$\text{sum of square error} = \frac{1}{m}\sum_{i=1}^{m} (h(x^{(i)) -} y^{(i))2}$$

- These are useful for  regression problem.

# Confusion Matrix in Machine Learning

- A confusion matrix is a table that is often used to describe the performance of a classification model (or “classifier”) on a set of test data for which the true values are known.
- Suppose you have a two class classification problem.

- Class 1 : Positive
- Class 2 : Negative

| **Actual** / **Pred.** | Positive | Negative |
|---|---|---|
| Positive | TP | FP |
| Negative | FN | TN |

# Confusion Matrix in Machine Learning

- **Positive (P) :** Actual is positive
- **Negative (N) :** Actual is not positive
- **True Positive (TP) :** Actual is positive and is predicted to be positive.
- **False Negative (FN) :** Actual is positive but is predicted negative.
- **True Negative (TN) :** Actual is negative and is predicted to be negative.
- **False Positive (FP) :** Actual is negative, but is predicted positive

# Confusion Matrix in Machine Learning

$$\textbf{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$\textbf{\textit{Recall}} = \frac{TP}{TP + FN}$$

$$\textbf{\textit{Precision}} = \frac{TP}{TP + FP}$$

$$\textbf{\textit{F - measure}} = \frac{2*Recall*Precision}{Recall + Precision}$$

# Exemple to interprete confusion matrix

| Actual / Pred. | Positive | Negative |
|---|---|---|
| Positive | TP =100 | FP = 10 |
| Negative | FN = 5 | TN = 50 |

- m=165
- Accuracy = (TP + TN) / (TP + TN + FP + FN)

  = (100 + 50) /(100 + 5 + 10 + 50) = 150/165

  = 0.90

# Exemple to interprète confusion matrix

- m=165

| Actual / Pred. | Positive | Negative |
|---|---|---|
| Positive | TP =100 | FP = 10 |
| Negative | FN = 5 | TN = 50 |

- Recall = TP / (TP + FN) = 100 / (100 + 5) = 0.95
- Precision = TP / (TP + FP)=100/ (100+10) = 0.91
- F-measure = (2 * Recall * Precision) / (Recall + Precision)

  = (2 * 0.95 * 0.91) / (0.91 + 0.95) = 0.92

# Linear Regression

- Linear Regression is a supervised machine learning algorithm.
- It tries to find out the best linear relationship that describes the data you have i.e. .

  **Given:** (X, Y) training examples

  **Goal:** find a (hypothesis) function (h) which predicts y for given x
- In regression y is continuous value i.e., real numbers.
- Input feature X can be comprise of a single feature or multiple feature

# Linear Regression

- It works in a such that it finds the best fit line from the given data.
  - So, the goal of linear regression is to fit a line through a set of points.
  - Linear regression looks at entire data points and plots a best-fit line.