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Introduction to Machine Learning

Definition of ML, Types of ML, Why ML?

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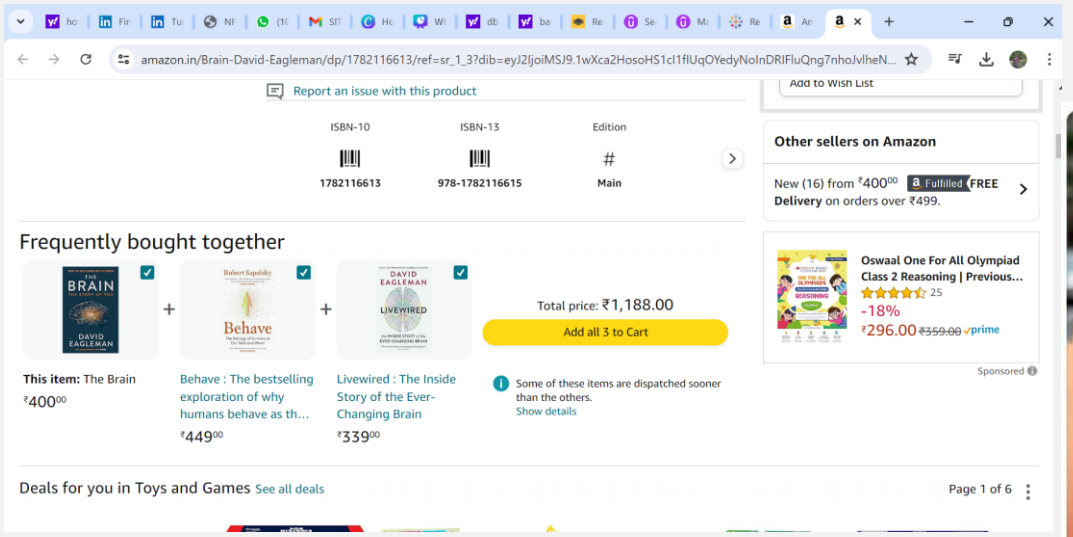
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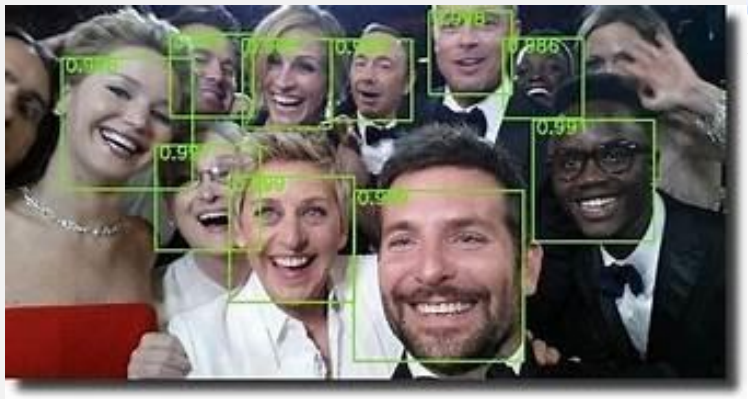

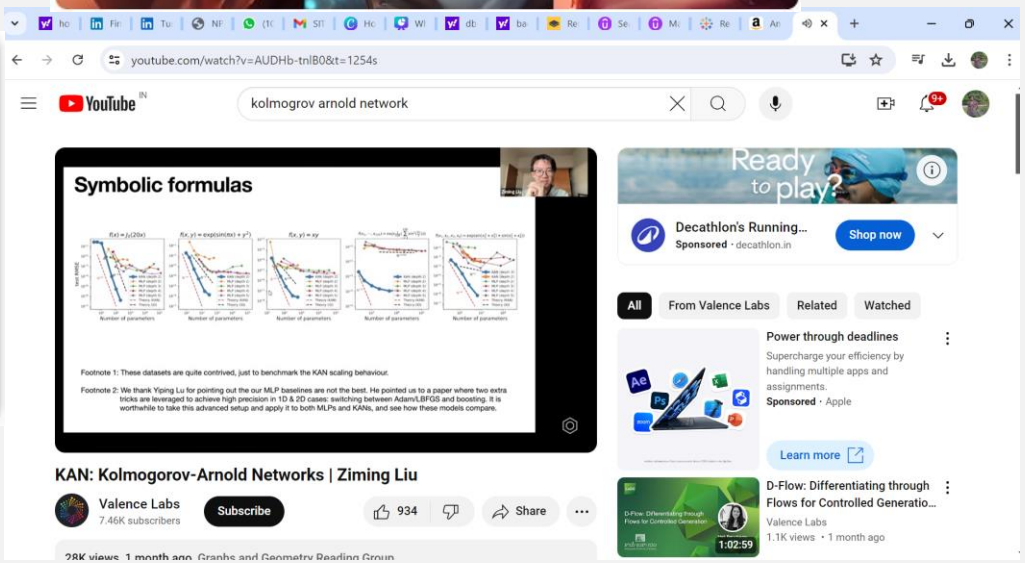
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Definition of ML

- [Machine Learning is the] field of study that gives computers the ability to learn without being explicitly programmed.—Arthur Samuel, 1959
- A computer program is said to learn from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E.—Tom Mitchell, 1997

Why to use ML?

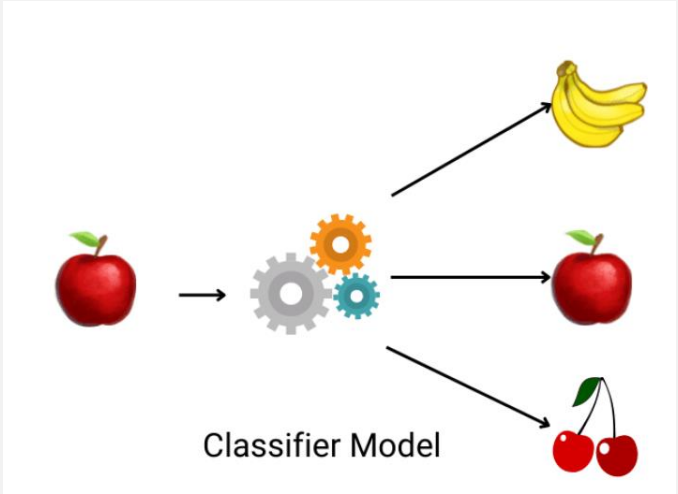
- Machine Learning algorithm can often simplify code and perform better.
- Complex problems for which there is no good solution at all using a traditional approach: the best Machine Learning techniques can find a solution.
- Fluctuating environments: a Machine Learning system can adapt to new data.
- Getting insights about complex problems and large amounts of data.

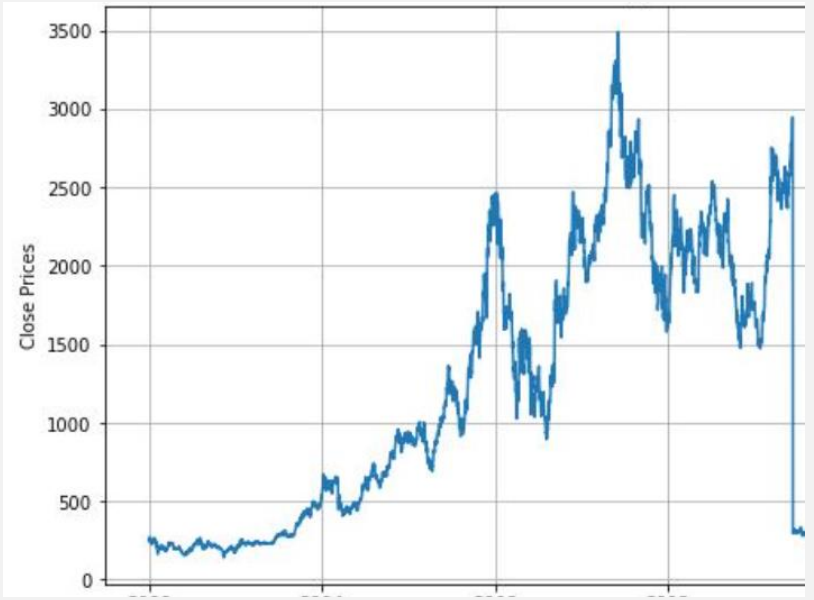
Types of Machine Learning:

- Supervised learning
- Unsupervised learning
- Semisupervised learning
- Reinforcement Learning.

Supervised Learning

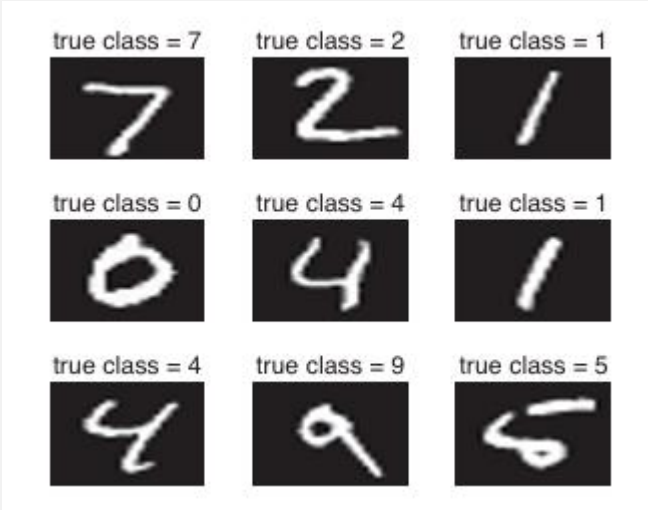
- The training data you feed to the algorithm includes the desired solutions, called labels.
- A typical supervised learning task is classification.
- Another typical task is to predict a target numeric value, such as the price of a car, given a set of features (mileage, age, brand, etc.) called predictors.





Classification Problem

- For the supervised problem the training data $\mathrm{D} = \{(\mathrm{x}_1, \mathrm{y}_1), (\mathrm{x}_2, \mathrm{y}_2), \ldots, (\mathrm{x}_\mathrm{N}, \mathrm{y}_\mathrm{N})\}$ consists of inputs $x_i \in \backslash\mathbb{R}^d$ and output y_i pair.
- In the case of classification, the output set is categorical i.e. $y_i \in \{1,2, \ldots, K\}$
- If $y_i \in \{1,0\}$, then the classification problem is called binary classification problem.
- If output set contains more than two class then it is called multi-class classification.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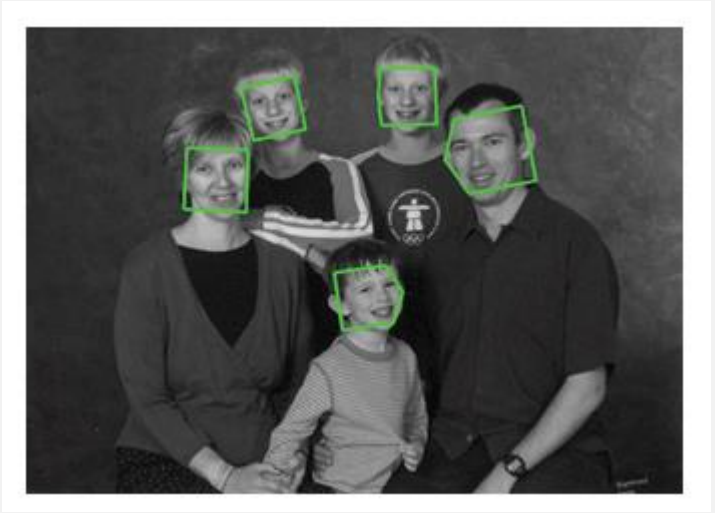
true class = 2
true class = 1
true class = 0
true class = 4
true class = 1
true class = 4
true class = 9
true class = 5



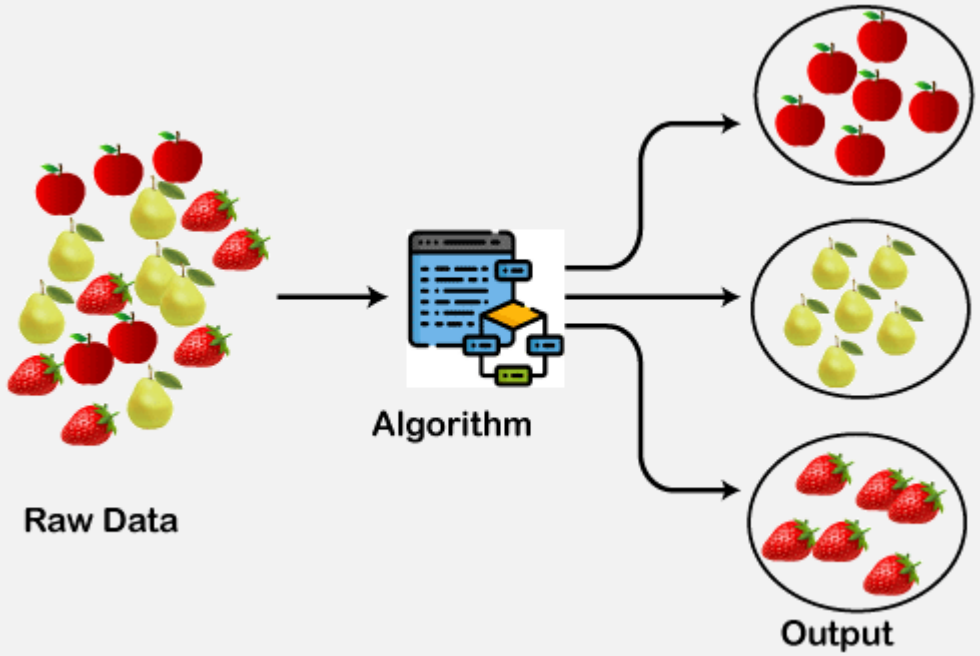

(a)
(b)
(c)

Regression Problem

- For regression problem the output or target variable is continuous.
- Input $x_i \in \mathbb{R}^d$ and the output $y_i \in \mathbb{R}$.
- Stock price prediction
- Temperature prediction

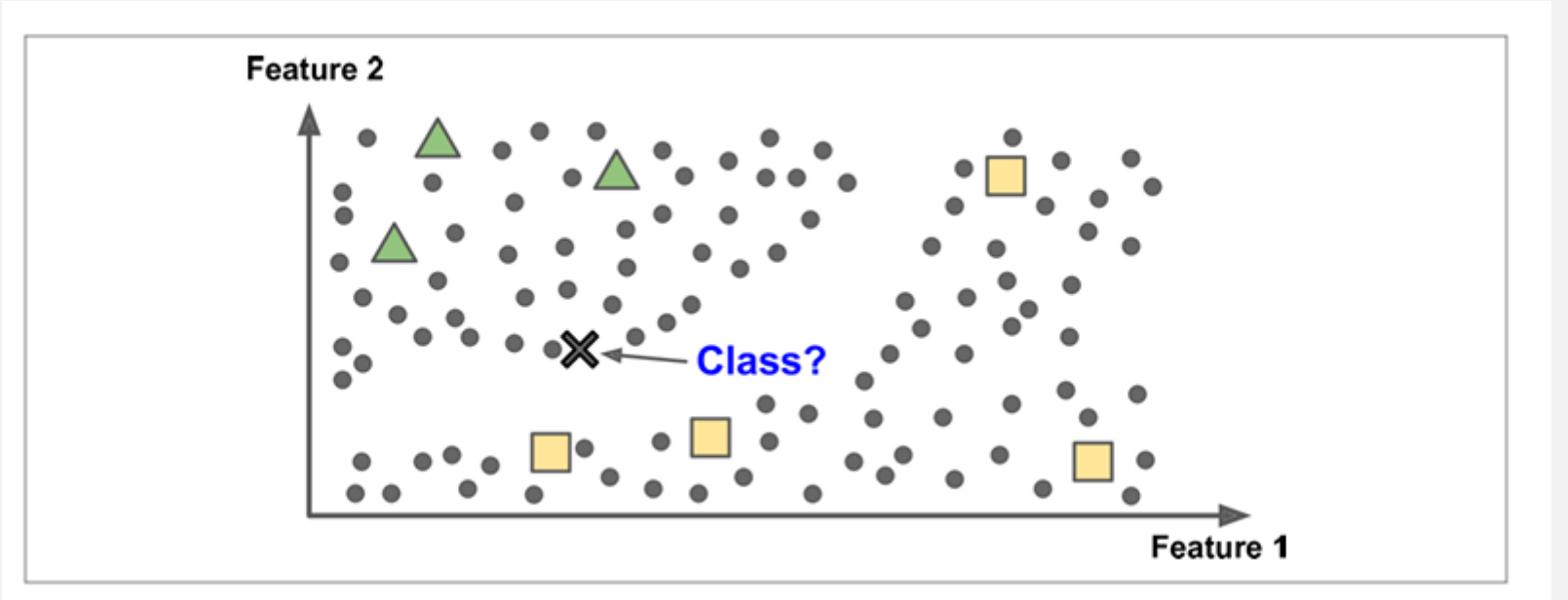
Unsupervised Learning

- The training data is unlabeled. The system tries to learn without a teacher.



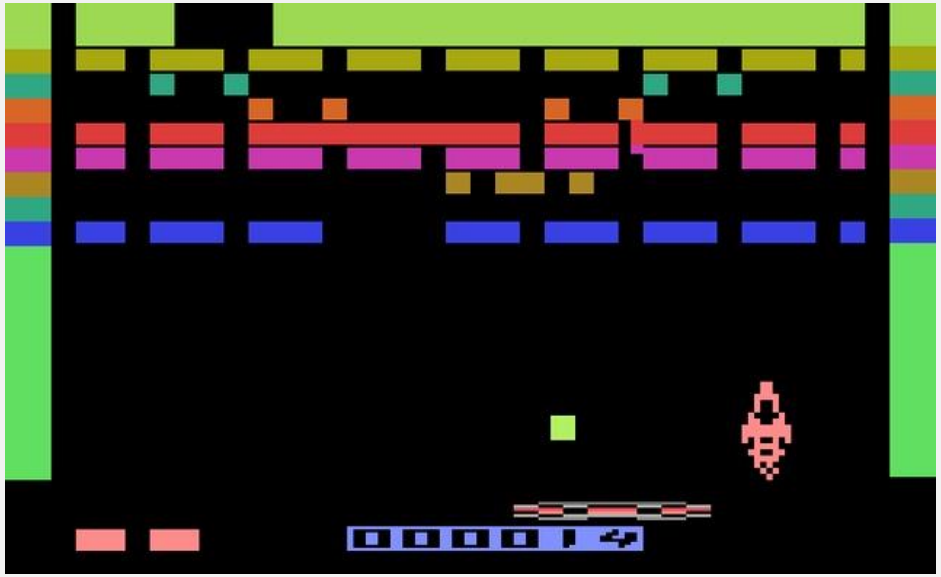
Semi-supervised Learning

- Some algorithms can deal with partially labeled training data, usually a lot of unlabeled data and a little bit of labeled data. This is called semisupervised learning.



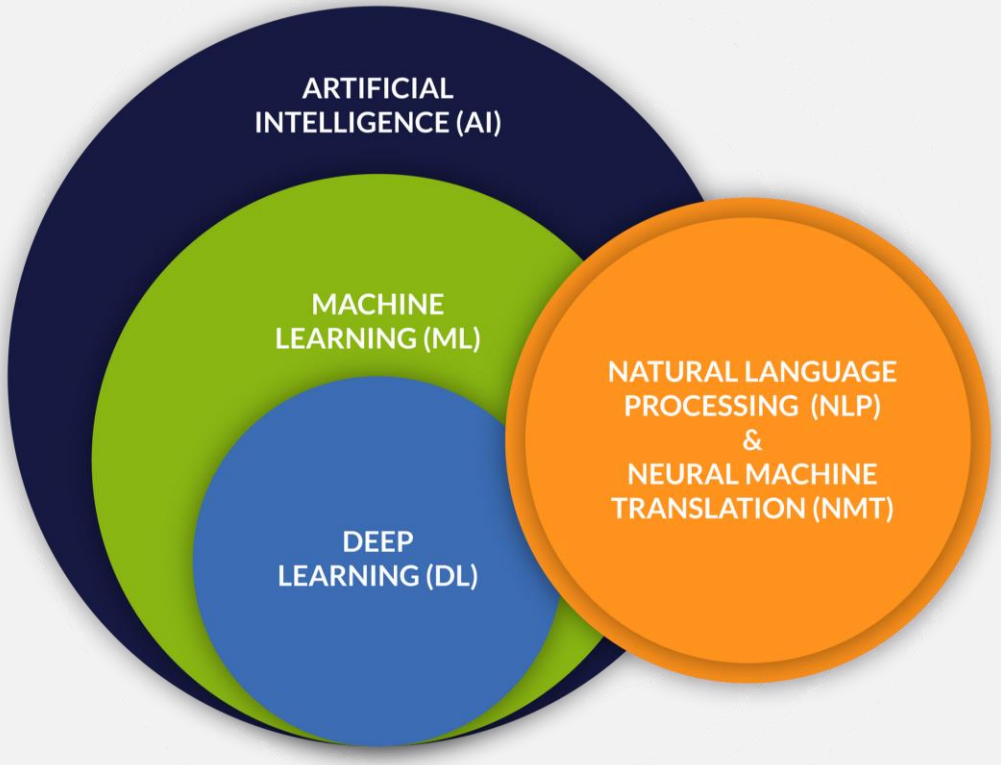
Reinforcement Learning

- The learning system, called an agent in this context, can observe the environment, select and perform actions, and get rewards in return.
- It must then learn by itself what is the best strategy, called a policy, to get the most reward over time.
- A policy defines what action the agent should choose when it is in a given situation.



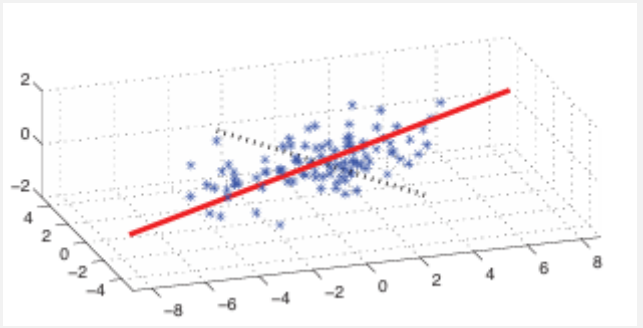
AI, ML, and DL

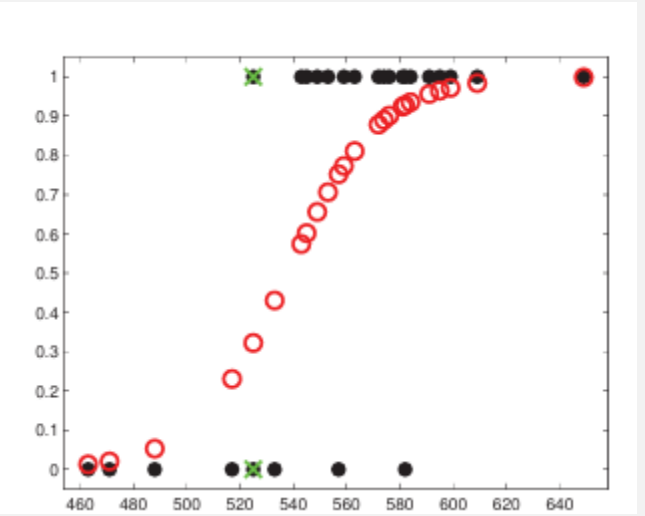
- Artificial intelligence, or AI, is technology that enables computers and machines to simulate human intelligence and problem-solving capabilities.
- Machine Learning is a subset of artificial intelligence that helps you build AI-driven applications.
- Deep Learning is a subset of machine learning that uses vast volumes of data and complex algorithms to train a model.



Model as a function

- A predictor is a function that, when given a particular input example, produces an output. For simplicity we are considering here that the output is a single number i.e. a real number or scalar value.
- $f(x)$: $\mathbb{R}^{N\times d} \rightarrow \mathbb{R}$
- $f(x) = \beta_0 + \beta x$





Model as Probability Distribution

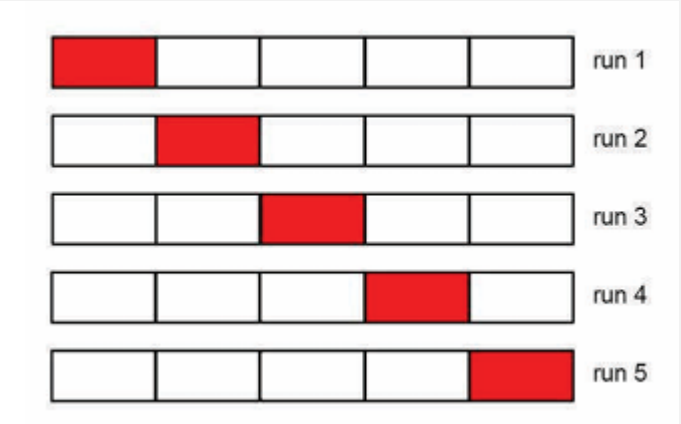
- Machine learning techniques adopt a probabilistic approach, treating the target variable as a distribution of possible functions rather than a single function.
- $P(y|x) = P(y|f(x)) = P(y|x, \beta)$

Learning in Machine Learning

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

Model Selection

- When we have a variety of models of different complexity, how should we pick the right one?
- The most conventional method is to select the model with minimum error.
- Train-Test-Validation Split
- Cross Validation



Reference

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- Hands-on Machine Learning with Scikit-Learn, Keras and Tensorflow-Aurelien Geron