COMP2261 ARTIFICIAL INTELLIGENCE / MACHINE LEARNING

Supervised Learning

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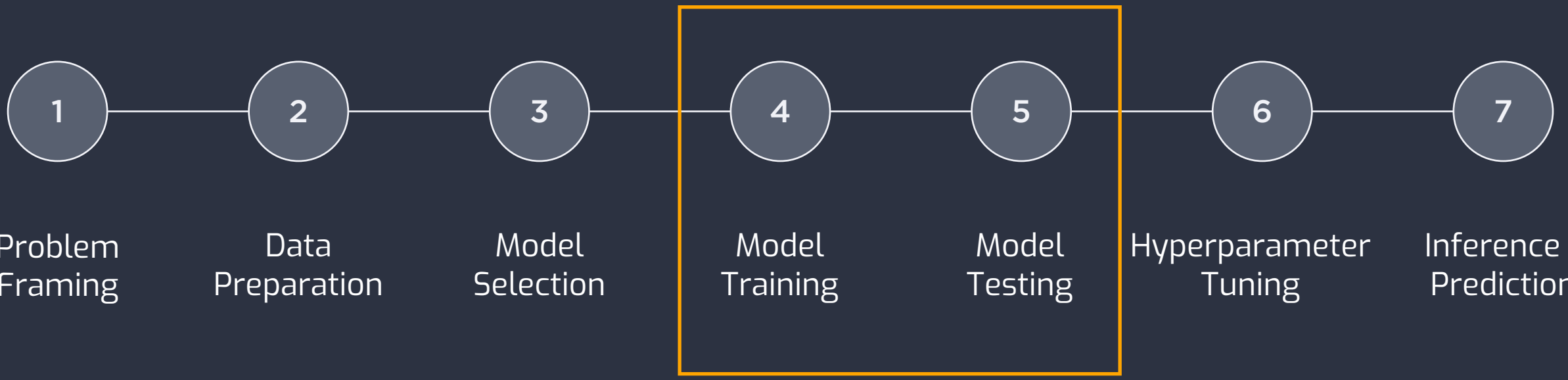
learning lab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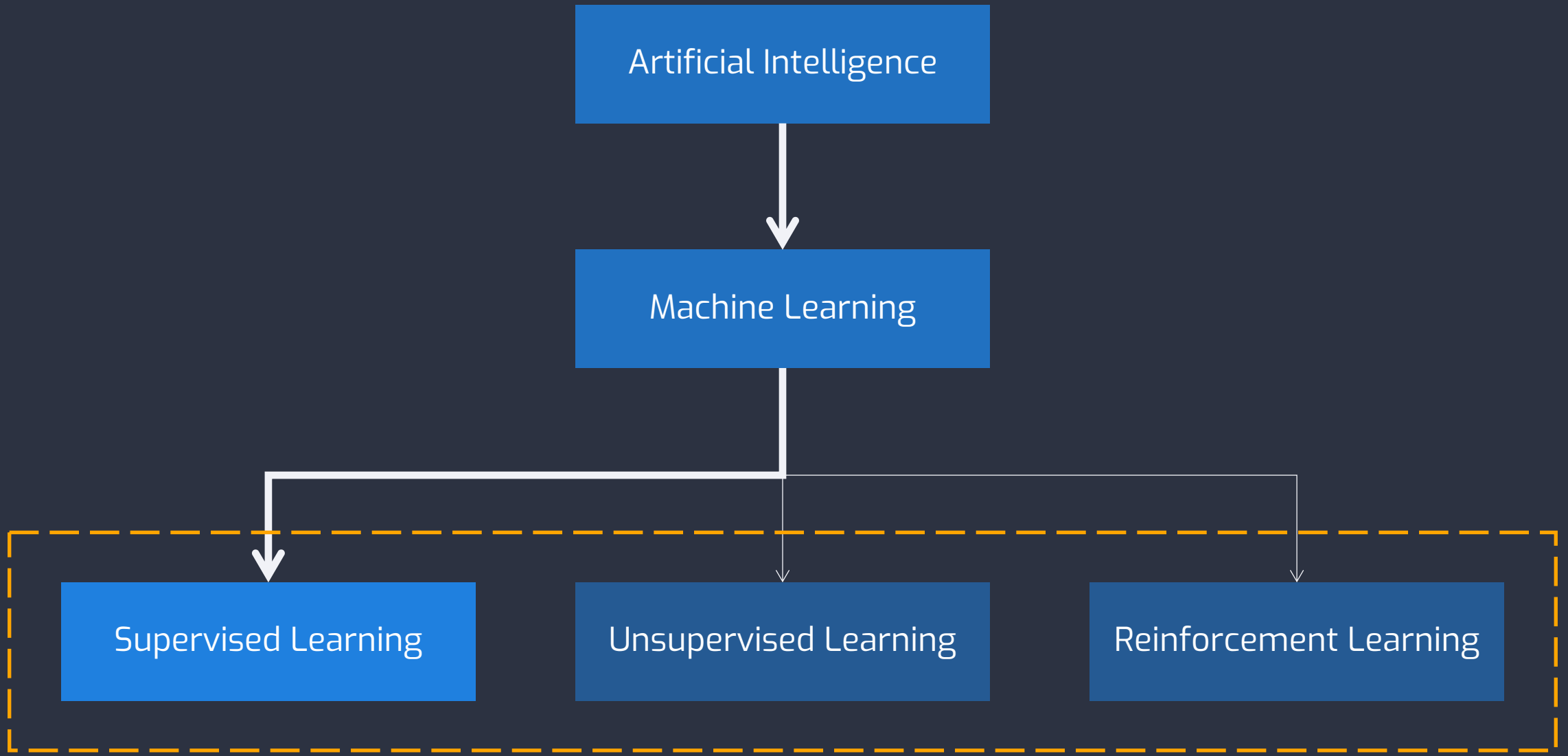
Problem Framing
Data Preparation
Model Selection
Model Training
Model Testing
Hyperparameter Tuning
Inference / Prediction

Learning Objectives

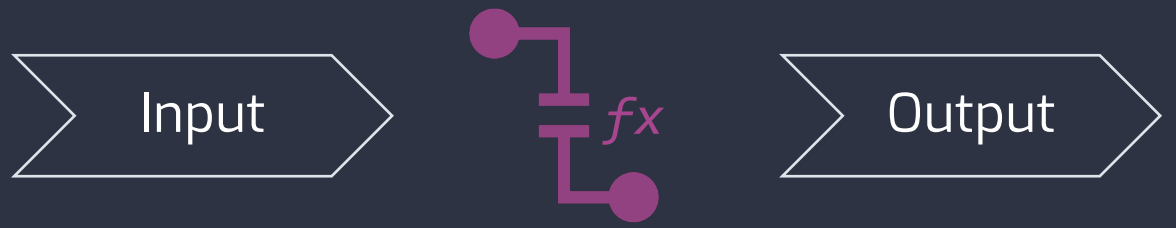
- Understand how to formally define supervised learning tasks
- Understand what is feature vector
- Understand hypothesis function $\mathbf{h(x)}$


Artificial Intelligence
Machine Learning
Supervised Learning
Unsupervised Learning
Reinforcement Learning

What is Supervised Learning?

Supervised Learning

- Learning a function, which is inferred from labelled training data containing a set of training instances, to map an input to an output.



- Called "supervised" learning, not because there must be someone standing beside the machine to supervise how the machine should work, but because there are labelled instances for learning algorithm to learn from or train on.

Supervised Learning Task

m n-dimensional feature vectors (each vector has n elements)

$$\boldsymbol{x}^{(i)} = \begin{bmatrix} x_1^{(i)} \\ x_2^{(i)} \\ x_3^{(i)} \\ \dots \\ x_n^{(i)} \end{bmatrix} \in \mathbb{R}^n \qquad i \in (1,2,\dots,m)$$

A collection of corresponding labels $\mathbf{y}$. (m is the number of instances)

$$\boldsymbol{y} = \begin{bmatrix} y^{(1)} \\ y^{(2)} \\ y^{(3)} \\ \dots \\ y^{(m)} \end{bmatrix}$$

Supervised Learning Task

feature vectors X

label vector y

	1 total credit	2 short term loan	3 credit utilisation	...	n missing payments	n+1 credit score
1	$x_1^{(1)}$	$x_2^{(1)}$	$x_3^{(1)}$	...	$x_n^{(1)}$	$y^{(1)}$
2	$x_1^{(2)}$	$x_2^{(2)}$	$x_3^{(2)}$	...	$x_n^{(2)}$	$y^{(2)}$
3	$x_1^{(3)}$	$x_2^{(3)}$	$x_3^{(3)}$	...	$x_n^{(3)}$	$y^{(3)}$
...	...	...	...	...	...	...
m	$x_1^{(m)}$	$x_2^{(m)}$	$x_3^{(m)}$	...	$x_n^{(m)}$	$y^{(m)}$

features

labels

Supervised Learning Task

- The goal is to build a model, which is just a real-valued function.

$$\text{credit score} = f(\text{total credit}, \text{short term loan}, \text{credit utilisation}, \text{missing payments})$$

$$y' = h(X)$$

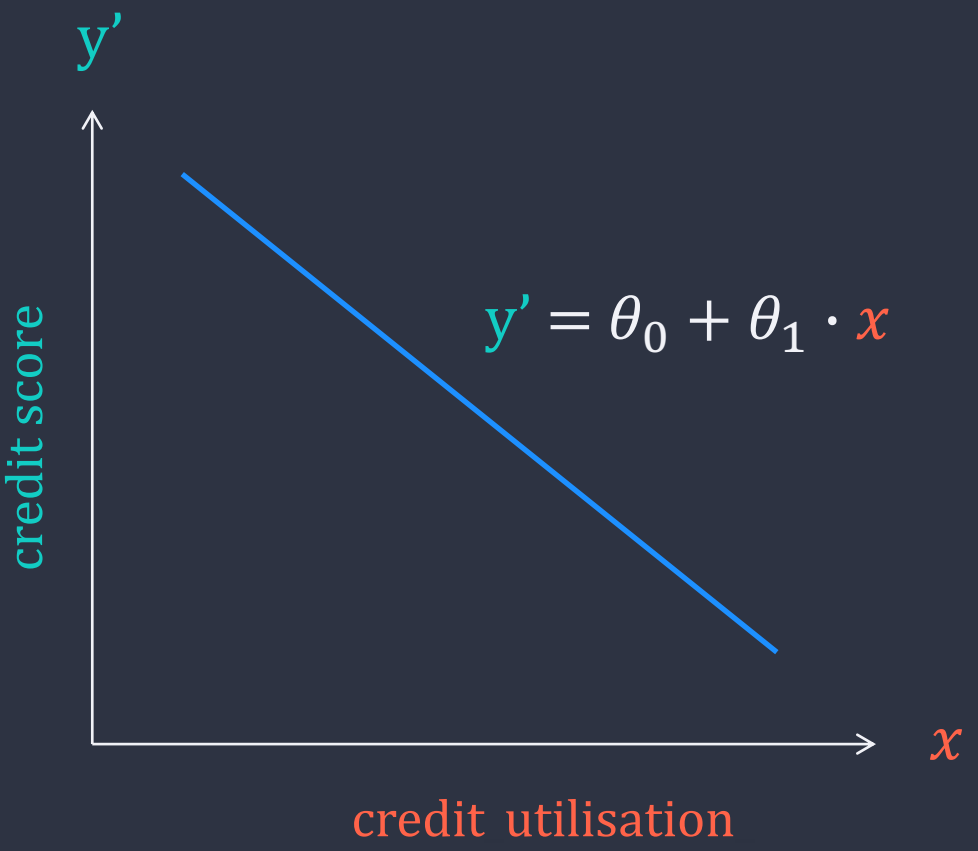
- Hypothesis function
  - defined on a set of feature vectors X, to make certain conclusions about y
  - to make certain conclusions about y, e.g. to make a prediction of y, i.e. y'
- In any supervised learning tasks, there will be a hypothesis h(x) created by the machine learning algorithm, and it can be represented as a function h of X.

Plotting function on graph

- E.g. use credit utilisation to predict credit score

	credit utilisation	credit score
1	$x_1^{(1)}$	$y^{(1)}$
2	$x_1^{(2)}$	$y^{(2)}$
3	$x_1^{(3)}$	$y^{(3)}$
…	…	…
m	$x_1^{(m)}$	$y^{(m)}$

feature label

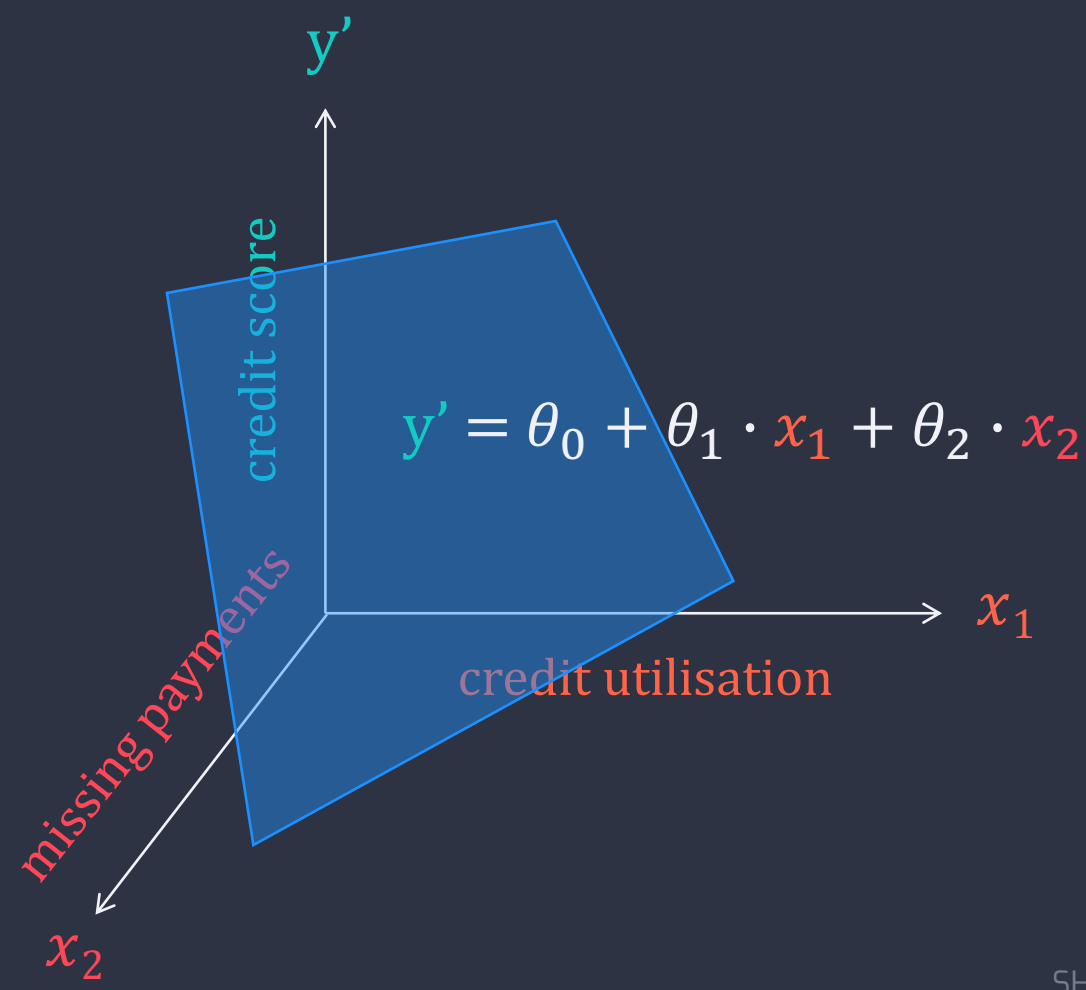


Plotting function on graph

- E.g. use credit utilisation and missing payments to predict credit score

	credit utilisation	missing payments	credit score
1	$x_1^{(1)}$	$x_2^{(1)}$	$y^{(1)}$
2	$x_1^{(2)}$	$x_2^{(2)}$	$y^{(2)}$
3	$x_1^{(3)}$	$x_2^{(3)}$	$y^{(3)}$
…	…	…	…
m	$x_1^{(m)}$	$x_2^{(m)}$	$y^{(m)}$

feature label



Takeaway Points

- Supervised learning is a type of machine learning task that learns a function, which is inferred from labelled training data containing a set of training instances, to map an input to an output.
- Supervised learning is called "supervised" learning, as there are labelled instances for algorithm to learn from or train on.
- Supervised learning tasks can be formalised using vectors and hypothesis functions $\mathbf{h(x)}$.