CM3015: Machine Learning Neural Networks Summary

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1 Introduction to Machine Learning and Neural Networks

Learning Outcomes

   ✓ Explain fundamental machine learning concepts

   ✓ Describe various types of machine learning problem

   ✓ Describe various applications of machine learning

1.1 Types of Machine Learning

In most cases where machine learning is used, we don't know what the actual problem is. There are two types of ML problems.

Supervised learning   The agent observes input-output pairs and learns a *function* that maps from input to output. The outputs ("answers") provided are called **labels**.

Given a training set of N example input-output pairs

$$(x_1, y_1), (x_2, y_2), ... (x_n, y_n)$$

where each pair was generated by an unknown function $y = f(x)$, discover a function h that approximates the true function f, stated as

$$h(x) \to y$$

Essentially, we provide the "answers" to the problem as inputs, and the AI system comes up with the "rules".

The outputs can be **discrete**, for example a classification into a specific group, or **continuous**, for example predicting a specific price.

Unsupervised learning   The agent only receives data but no labels, and is tasked with finding meaningful representations of the data with a variety of techniques.

textbf   Reinforcement learning The agent gets a reward for completing a desired outcome, making the agent better over time.

1.1.1 Types of algorithms

Depending on the problem, different algorithms are suitable to be used by an agent.

Regression   When predicting a continuous variable.

Classification   When predicting a discrete output, such as assigning data to groups.

Clustering When identifying new groupings of data in an unsupervised scenario.

1.2 Machine Learning Black Box

A typical machine learning pipeline involves taking a set of **labels** Y and a set of **data** X, which the agent processes into a **mapping** of X to Y. This mapping can then be used to map new data to a prediction.

Within the agent, data is often taken through **feature pre-processing** before reaching the ML algorithm, which is fed with the labels.

1.3 Deep Learning

A subset of ML, **deep learning** is an approach to learning representations from data that puts an emphasis on learning *successive layers* of increasingly meaningful representations.

In deep learning, these layered representations are (almost always) learned via models called *neural networks*.
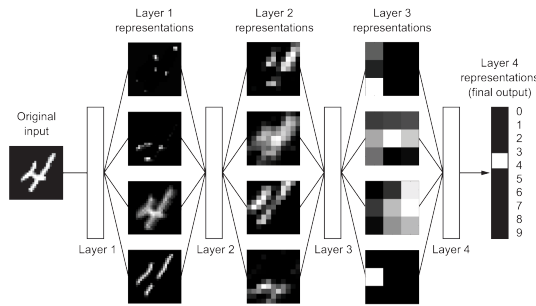

Figure 1. *Deep learning representation*