6. Artificial Intelligence (AI)

18.1 Artificial Intelligence

How graphs aid AI

- Artificial Neural Networks can be represented using graphs
- Graphs provide structures for relationships
- AI problems can be defined as finding a path in a graph
- Graphs may be analysed by a range of algorithms e.g. Dijksta's algorithm

Purpose of A* and Dijkstra's Algorithms

- To find the optimal shortest and most cost-effective route between two nodes based on distance/cost/time

Artificial Neural Network

- Part of AI that is meant to simulate the function of a human brain
- Key component of machine learning
- Have self-learning capabilities – enables production of better results as more data becomes available
- Can solve complex problems humans cannot/find it difficult to

Artificial Neural Networks

Multiple Hidden Layers in an Artificial Neural Network

- Enables deep learning to take place
- Needed when the problem you are trying to solve has a higher level of complexity (requires more layers to solve)
- Enables the neural network to learn and make decisions on its own
- Improve accuracy of results – more hidden layers means more complex learning capabilities

How Artificial Neural Networks Enable Machine Learning

- They are intended to replicate the way human brains work
- Weights/values are assigned between nodes – adjusted through training to give more accurate results
- The output layer provides the results
- Data is input at the input layer and is passed into the system

➜ it is then analysed at each subsequent (hidden) layer where characteristics are extracted/outputs are calculated

➜ reinforcement learning takes place through repeating the training/learning process

- Decisions can be made without being specifically programmed
- The deep learning net will have created complex feature detectors
- Back propagation (of errors) will be used to correct any errors that have been made.

Deep Learning

- simulates data processing abilities of the human brain to make decisions
- uses artificial neural networks which are modelled after the human brain – structures algorithms in layers – an input layer, output layer and many hidden layers
- uses large number of hidden layers to progressively extract higher level features from the raw input (has more success)
- is a specialised form of machine learning
- trained using large amounts of unlabeled data

Reasons For Use

- makes good use of unstructured data
- outperforms other methods of machine learning if the data size is large
- enables machines to process data with a nonlinear approach
- is effective at identifying hidden patterns (ones that are too complex for humans to spot/are undetectable)
- can provide more accurate outcome with higher numbers of hidden layers

Reinforcement Learning

- based on feedback – AI learns in an interactive environment through actions and seeing the results of each action (works through trial and error, learns through its own experiences)
- for each good action, the AI gets positive feedback, for each bad one it receives negative feedback
- Node weightings are adjusted to achieve correct outcome – the AI uses feedback to improve its performance in similar tasks

Reasons for Use

- **enables autonomous learning using feedback without any labelled data**

Machine Learning

Supervised Learning

- **allows data to be collected/a data output to be produced from a previous experience**
- **a known input and associated outputs are given – uses sample data with known outputs (labelled input data)**
- **able to predict future outcomes based on past data**

Unsupervised Learning

- **helps all kinds of unknown patterns in data to be found – enables learning by allowing the process to discover previously undetected patterns on its**
- **only requires input data to be given**
- **uses any data – not trained using a right output (uses unlabeled input data)**