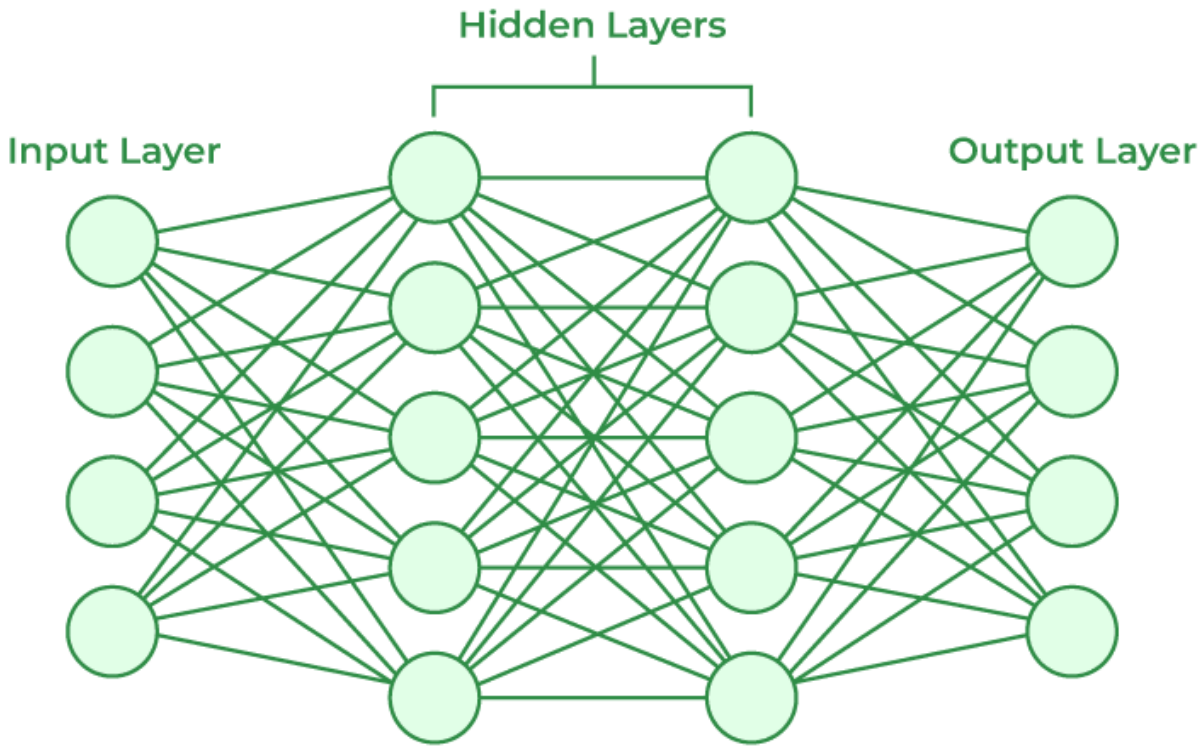
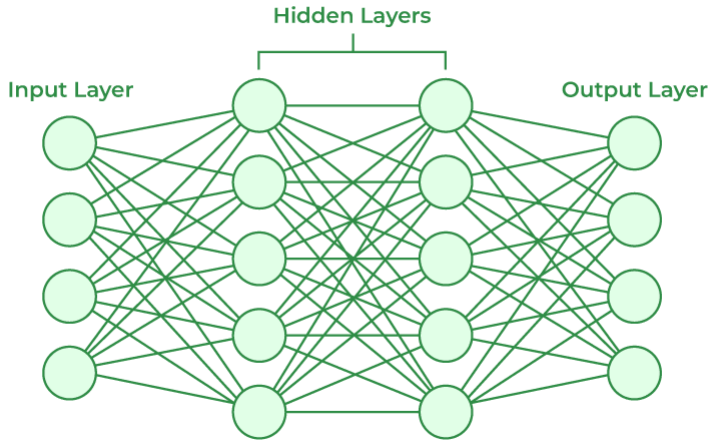
Neural Networks

- Neural Networks are based on how the brain works. They contain artificial neurons called nodes which are arranged in a series of layers.
- They have an input and output layer with hidden layers in between.



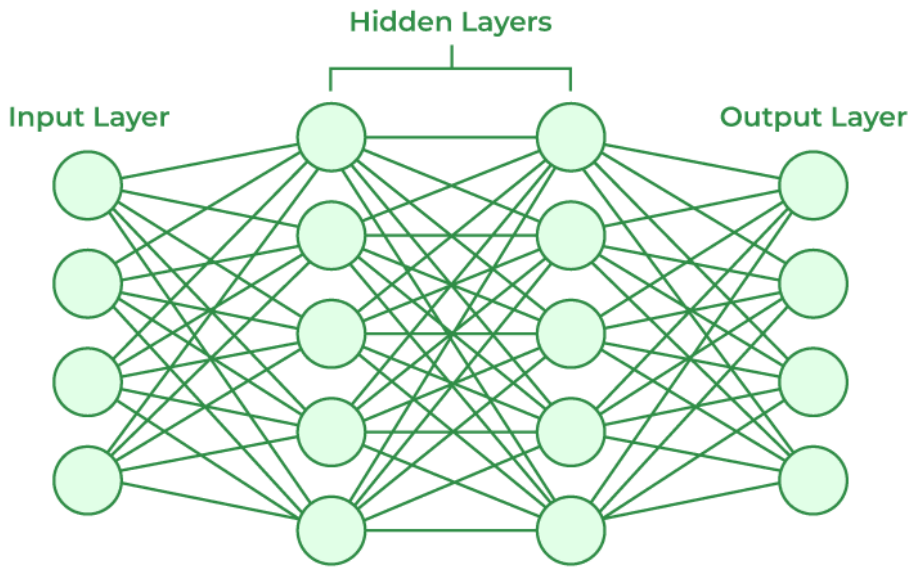
Neural Networks

- The input layer receives data which the neural network needs to analyze.
- Nodes are interconnected from one layer to another.
- Each connection between nodes has a weight that signifies its relative importance.
- If a node receives a high enough total value of weights from all its inputs then it fires and passes data on to the next layer.
- The data transfers through the layers until producing an output.



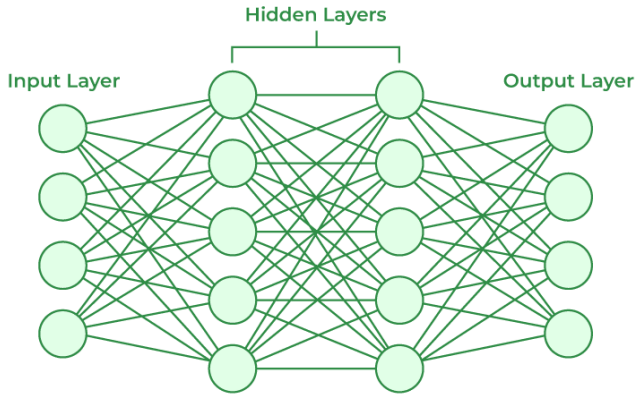
Deep Learning

- Deep Learning is a type of Machine Learning based on a Neural Network with at least 2 hidden layers (at least 4 layers in total)
- The multiple layers can progressively analyze the input more deeply.
- For example in image classification, lower layers may identify edges in an image, while higher layers classify it as an animal or vehicle.



Neural Network Training

- The path data takes across the Neural Network and the final output is influenced by the weight of connections.
- If the wrong output is produced, for example an image of a cat is classified as a dog, it must be corrected.
- Backpropagation is used to signal back through the network that the weights have to be changed.
- Backpropagation uses a mathematical function to iteratively fine tune the weights of connections until accurate output is consistently produced.



Generative AI Models

- Three common generative models built on neural networks are:
  - Transformer Models
  - Generative Adversarial Networks (GANs)
  - Variational Auto Encoders (VAEs)

Unimodal and Multimodal Models

- Transformer Models typically work with text
- GANs and VAEs typically work with visual data
- The models are not mutually exclusive, an AI system can use multiple models
- Unimodal models take instructions from the same input type as their output. For example creating text from a text prompt.
- Multimodal models can take input from different sources and generate output in various forms. For example from a text input creating an image and a text caption.

Transformer Models

- A Transformer model tracks relationships in sequential data. They learn what is appropriate to come next in sequences
- They use a mathematical ‘self-attention’ technique to understand the importance of different parts of the sequence and determine context
- They are often used with text but can work with any type of sequential data eg DNA, video
- They typically use massive datasets
- They can analyse data unsupervised and with parallel processing so they are acceptably fast to implement

Transformer Models (Cont.)

- The Transformer architecture is composed of encoder and decoder neural networks.
- The encoder is only concerned with the input and is typically used for classification.
- The decoder is used for output and is used to generate data, such as a text article or programming code.
- The encoder and decoder can be used together for tasks such as text translation.
- LLM Large Language Models are built on Transformers

NLP Natural Language Processing and LLM

- NLP Natural Language Processing uses a broad range of rule-based methods and machine learning to enable computers to understand and generate language as it is spoken and written.
- It focuses on recognizing patterns in language to understand its structure.
- Its tasks include understanding, generating and classifying language, translation, text-to-speech and speech-to-text.
- NLP applications use a comparatively small dataset and a method which is relevant to their specific goal.

LLM Large Language Model

- Like NLP, LLMs also perform complex language processing tasks.
- While NLP models choose a method relevant to their specific goal, an LLM uses a Transformer based neural network built with a huge dataset.
- They can handle almost any NLP task and are very good at generating humanlike text in response to instructions.
- Their tasks include chatbots, text summarization, translation, and writing original content such as essays or code.

GPT Generative Pre-Trained Transformers

- Generative Pre-Trained Transformers (GPTs) are a Transformer based LLM
- GPT-1, GPT-2 etc were developed by OpenAI but all LLMs with the same characteristics can be broadly known as GPTs
- ChatGPT from OpenAI is built on its GPT models
- GPT uses a decoder to generate text from a prompt

Transformers in Network Operations

- The following are examples of how you can use a Transformer in network operations:
- Provide a prompt to generate device configurations
- Provide network data and device configurations to generate network diagrams.
- Ask it questions such as to check an error message.

- Beware of hallucinations when using general GPTs.

GAN Generative Adversarial Networks

- With GANs two deep learning models compete against each other, the generator and the discriminator.
- The generator learns to create new data such as text, images, audio or video that resembles the training dataset.
- The discriminator learns to distinguish between the generated data and the real data.

GAN Generative Adversarial Networks (Cont.)

- The discriminator will typically easily identify early efforts as fake and tell the generator to retry.
- As training progresses the generator will produce data that can fool the discriminator and humans.
- The discriminator also improves with training.
- GANs are often used to create visual data.

GAN in Network Operations

- GAN models can generate network traffic simulations and train AI applications to detect network anomalies and security threats.
- The generator creates network traffic simulations.
- With training the generator learns to create more realistic simulations (normal traffic patterns), and the discriminator learns to detect if the traffic patterns are fake (have anomalies).
- GANs are good at creating network diagrams. They can do this in conjunction with Transformer models.

VAE Variational Auto Encoders

- VAEs also use two neural networks to generate data
- An encoder and decoder work in tandem to generate output that is similar to the input
- The encoder compresses the input data, optimizing to retain only the most important information.
- The decoder then reconstructs the input from the compressed representation.

VAE Variational Auto Encoders (Cont.)

- The decoder generates content which is optimized for the important information, reducing less desired characteristics.
- VAEs are good at cleaning noise from images, and finding anomalies (it differentiates between ‘good’ and ‘bad’ characteristics).
- Like GAN, VAE can also be used to detect network anomalies and security threats.
- It can also be used to generate network traffic simulations.
- GANs are better for network diagrams because they produce more detailed output.