**Layers in Artificial Neural Networks (ANN)**

Definition :

* In an [ANN](https://www.geeksforgeeks.org/artificial-neural-networks-and-its-applications/), data flows from the input layer, through one or more hidden layers, to the output layer. Each layer consists of neurons that receive input, process it, and pass the output to the next layer. The layers work together to extract features, transform data, and make predictions.
* An ANN typically consists of three primary types of layers :
  + **INPUT LAYER**
  + **HIDDEN LAYER**
  + **OUTPUT LAYER**
* Each layer is composed of nodes (neurons) that are interconnected. The layers work together to process data through a series of transformations.

## Types of Hidden Layers in Artificial Neural Networks :

### Dense (Fully Connected) Layer :

* A dense layer is the most common type of hidden layer in an ANN. Every neuron in a dense layer is connected to every neuron in the previous and subsequent layers. This layer performs a weighted sum of inputs and applies an activation function to introduce non-linearity. The [activation function](https://www.geeksforgeeks.org/activation-functions-neural-networks/) (like [ReLU](https://www.geeksforgeeks.org/why-is-relu-used-as-an-activation-function/" \t "_blank), [Sigmoid](https://www.geeksforgeeks.org/derivative-of-the-sigmoid-function/), or Tanh) helps the network learn complex patterns.
* **ROLE :** Learns representations from input data
* **FUNCTION :** Performs weighted sum and activation.

### Convolutional Layer :

* Convolutional layers are primarily used in [Convolutional Neural Networks (CNNs)](https://www.geeksforgeeks.org/convolutional-neural-network-cnn-in-machine-learning/) for image processing tasks. They apply convolution operations to the input, capturing spatial hierarchies in the data. Convolutional layers use filters to scan across the input and generate feature maps. This helps in detecting edges, textures, and other visual features.
* **ROLE :** Extracts spatial features from images.
* **FUNCTION :** Applies convolution using filters.

### Recurrent Layer :

* Recurrent layers, such as [Long Short-Term Memory (LSTM)](https://www.geeksforgeeks.org/deep-learning-introduction-to-long-short-term-memory/) and [Gated Recurrent Unit (GRU),](https://www.geeksforgeeks.org/gated-recurrent-unit-networks/) are used in [Recurrent Neural Networks](https://www.geeksforgeeks.org/introduction-to-recurrent-neural-network/) (RNNs) for sequence data like time series or natural language. They have connections that loop back, allowing information to persist across time steps. This makes them suitable for tasks where context and temporal dependencies are important.
* **ROLE :** Processes sequential data with temporal dependencies.
* **FUNCTION :** Maintains state across time steps.

### Dropout Layer :

* [Dropout layers](https://www.geeksforgeeks.org/dropout-in-neural-networks/) are a [regularization](https://www.geeksforgeeks.org/regularization-in-machine-learning/) technique used to prevent overfitting. They randomly drop a fraction of the neurons during training, which forces the network to learn more robust features and reduces dependency on specific neurons. During training, each neuron is retained with a probability ppp.
* **ROLE :** Prevents overfitting.
* **FUNCTION :** Randomly drops neurons during training.

### Pooling Layer :

* A [**Pooling Layer**](https://www.geeksforgeeks.org/cnn-introduction-to-pooling-layer/) is used to reduce the spatial dimensions of the data, thereby decreasing the computational load and controlling overfitting. Common types of pooling include Max Pooling and Average Pooling.
* **USE CASES :** Dimensionality reduction in CNNs

### Batch Normalization Layer :

* A [**Batch Normalization Layer**](https://www.geeksforgeeks.org/what-is-batch-normalization-in-cnn/) normalizes the output of a previous activation layer by subtracting the batch mean and dividing by the batch standard deviation. This helps in accelerating the training process and improving the performance of the network.
* **USE CASES :** Stabilizing and speeding up training