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Deep Learning
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Advantages & Disadvantages of Deep Learning

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Advantages of Deep Learning

- Features are automatically deduced and optimally tuned for the desired outcome. Features are not required to be extracted ahead of time. This avoids time-consuming machine learning techniques.
- Robustness to natural variations in the data is automatically learned.
- The same neural network-based approach can be applied to many different applications and data types.
- Massive parallel computations can be performed using GPUs and are scalable for large volumes of data. Moreover, it delivers better performance results when the amount of data are huge.
- The deep learning architecture is flexible to be adapted to new problems in the future.

Disadvantages of Deep Learning

- It requires a very large amount of data in order to perform better than other techniques.
- It is extremely expensive to train due to complex data models. Moreover, deep learning requires expensive GPUs and hundreds of machines. These increases cost to the users.
- There is no standard theory to guide you in selecting the right deep learning tools as it requires knowledge of topology, training method, and other parameters. As a result, it is difficult to be adopted by less skilled people.
- It is not easy to comprehend output based on mere learning and requires classifiers to do so. Convolutional neural network-based algorithms perform such tasks

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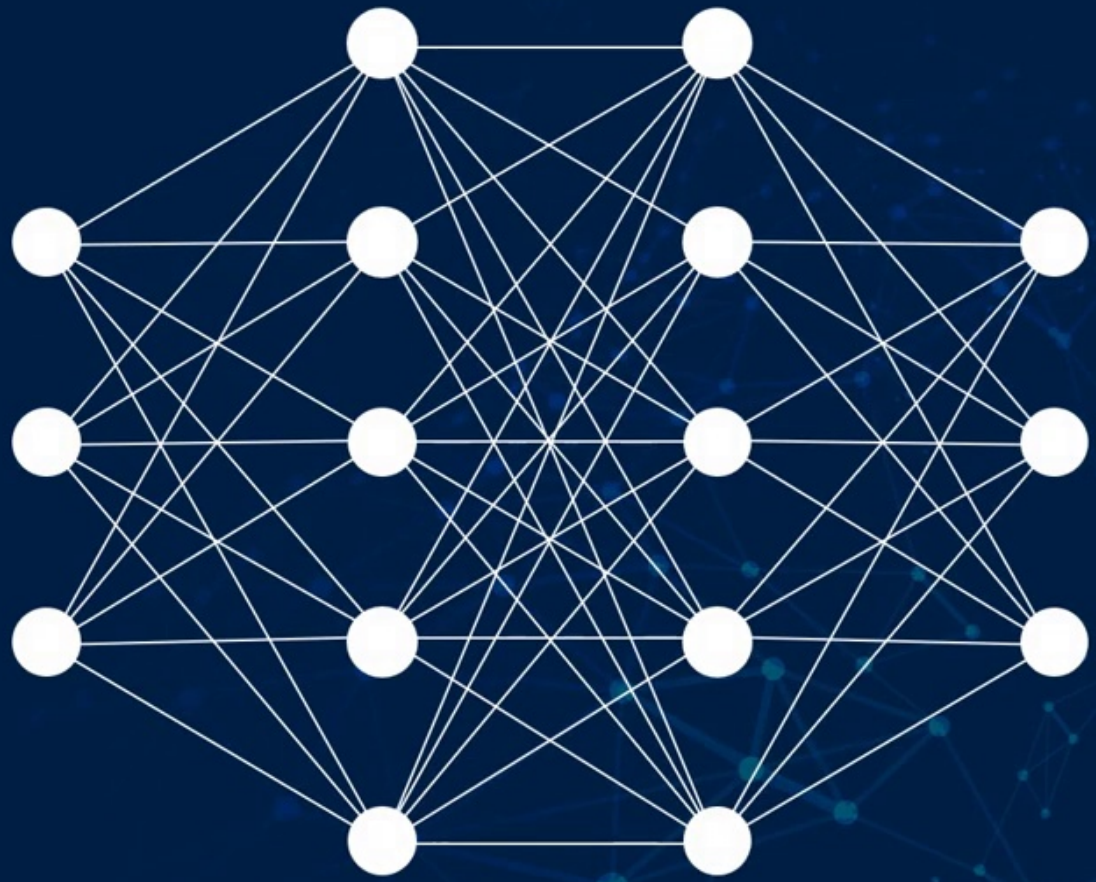
Neural Networks

A neural network is a series of algorithms that endeavors to recognize underlying relationships in a set of data through a process that mimics the way the human brain operates. In this sense, neural networks refer to systems of neurons, either organic or artificial in nature. Neural networks can adapt to changing input; so the network generates the best possible result without needing to redesign the output criteria. The concept of neural networks, which has its roots in artificial intelligence, is swiftly gaining popularity in the development of trading systems.



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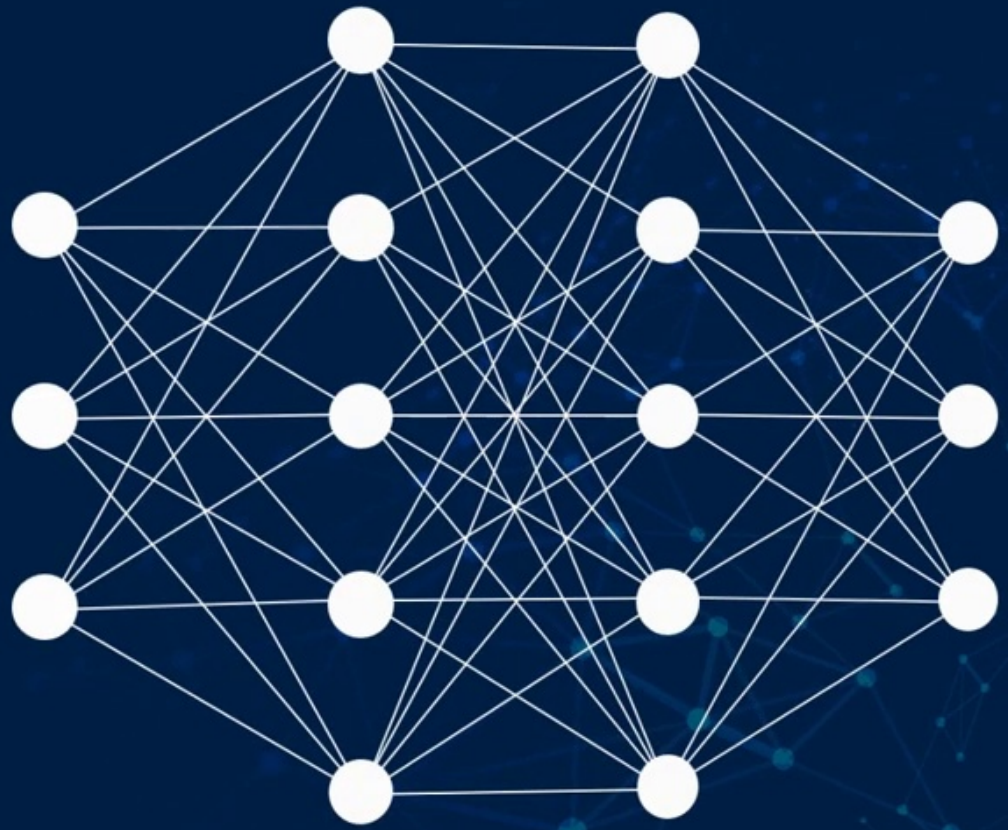
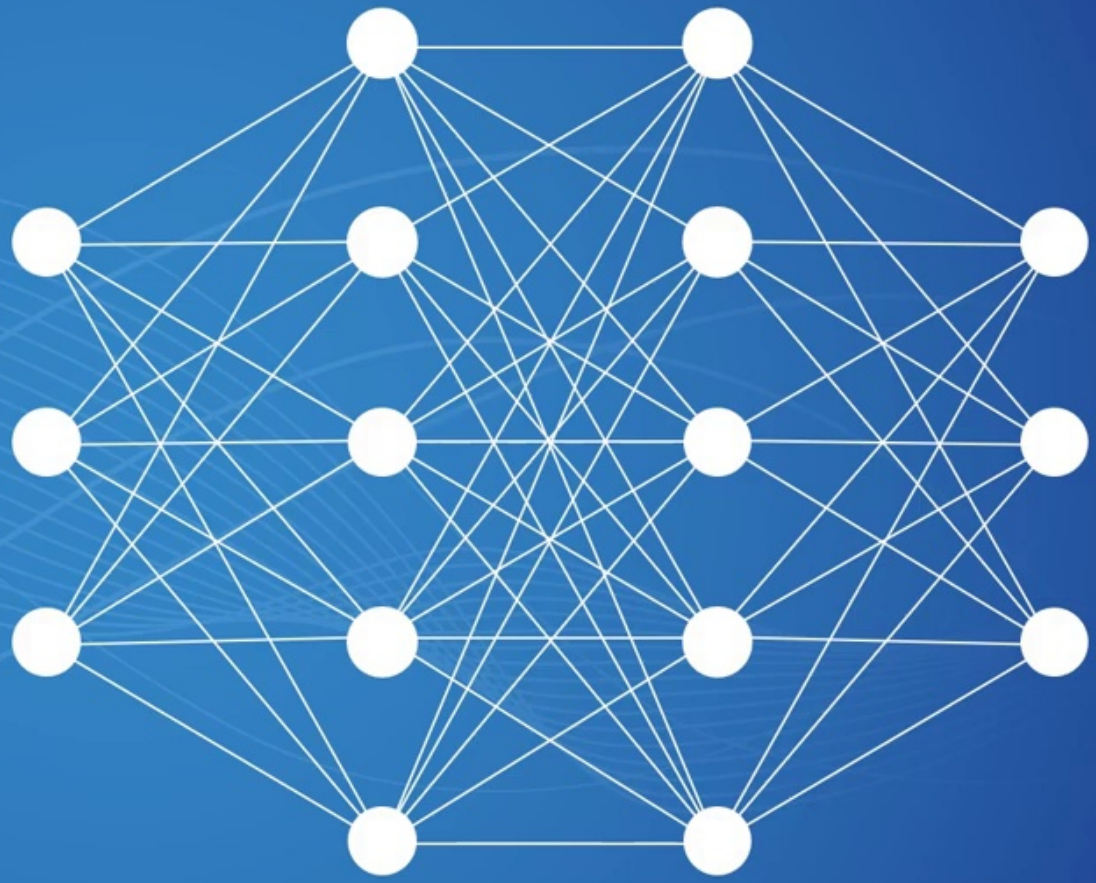


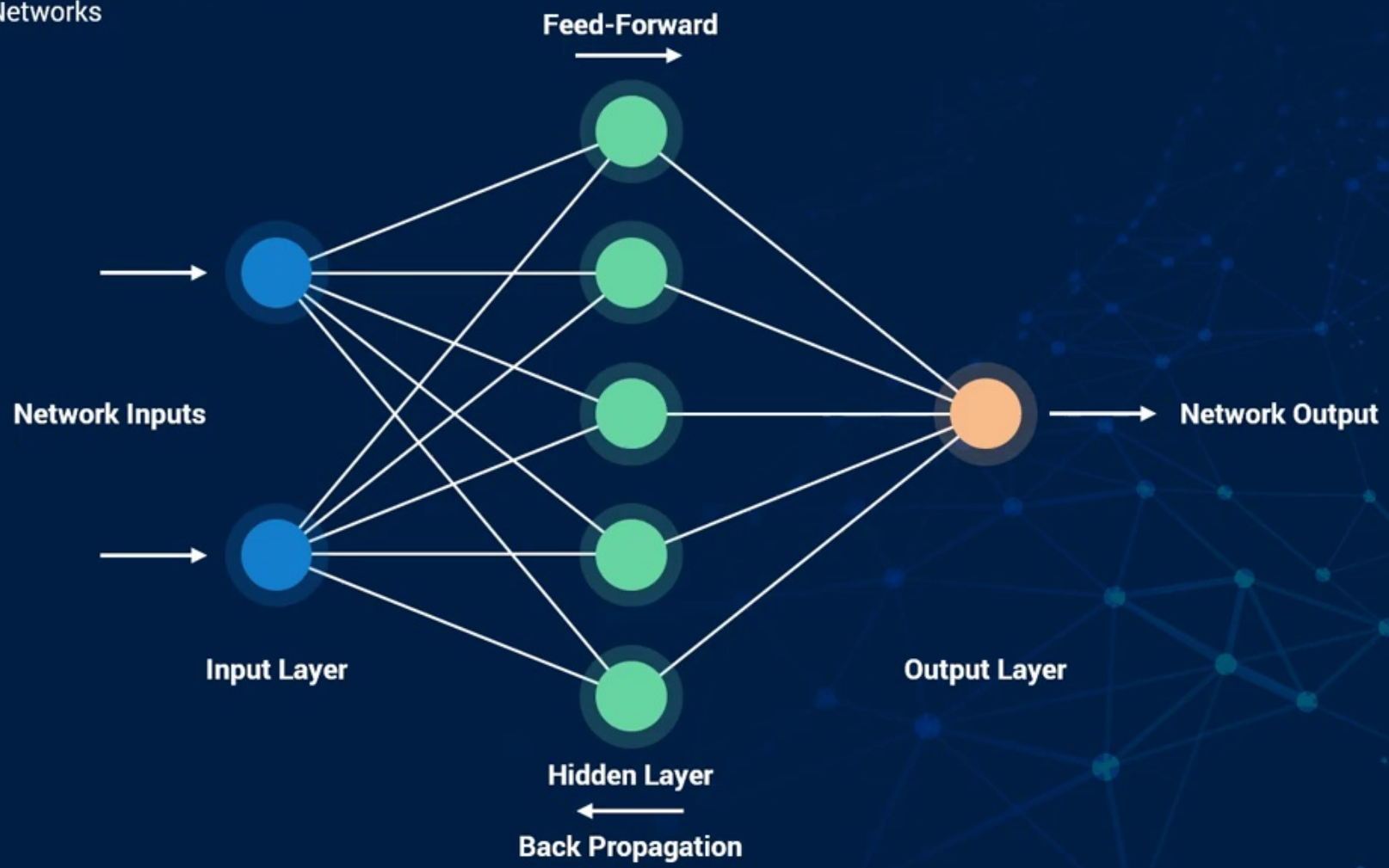
What is Artificial Neural Networks?

A neural network is a group of connected I/O units where each connection has a weight associated with its computer programs. It helps you to build predictive models from large databases. This model builds upon the human nervous system. It helps you to conduct image understanding, human learning, computer speech, etc.



Artificial Neural Networks

Artificial Neural Networks



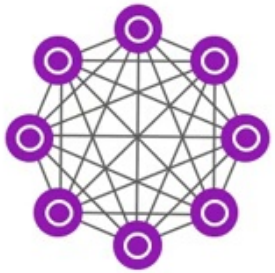
Types of Neural Networks in Artificial Intelligence

Types of Neural Networks in Artificial Intelligence

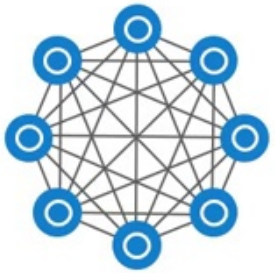
Parameter	Types	Description
Based on the connection pattern	**Feed-Forward, Recurrent**	**Feed-forward** – In which graphs have no loops. **Recurrent** – Loops occur because of feedback.
Based on the number of hidden layers	**Single-layer, Multi-Layer**	**Single Layer** – Having one secret layer. E.g., Single Perceptron **Multilayer** – Having multiple secret layers. Multilayer Perceptron
Based on the nature of weights	**Fixed, Adaptive**	**Fixed** – Weights are a fixed priority and not changed at all. **Adaptive** – Updates the weights and changes during training.
Based on the Memory unit	**Static, Dynamic**	**Static** – Memoryless unit. The current output depends on the current input. E.g., Feedforward network. **Dynamic** – Memory unit – The output depends upon the current input as well as the current output. E.g., Recurrent Neural Network

Neural Network Architecture Types - 2/3

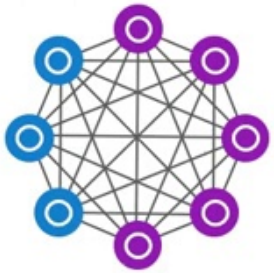
Markov Chain (MC)



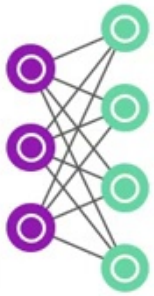
Hopfield Network (HN)



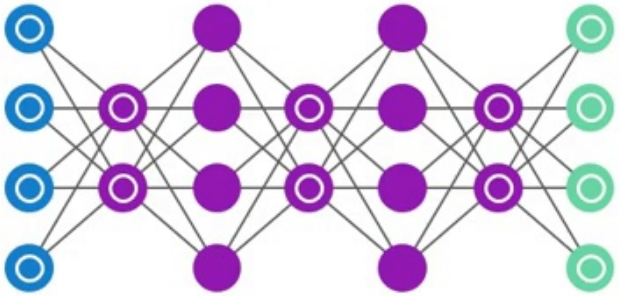
Boltzmann Machine (BM)



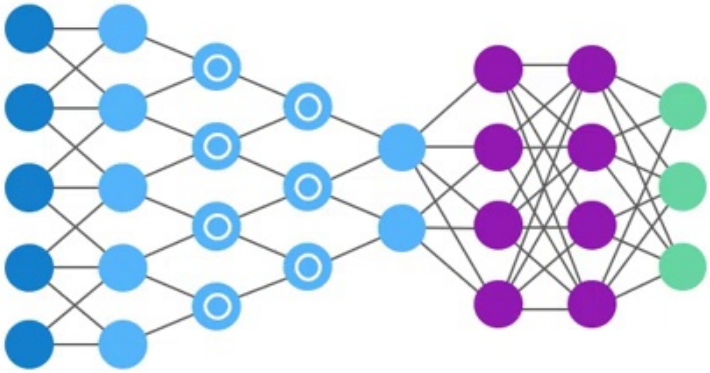
Restricted BM (RBM)



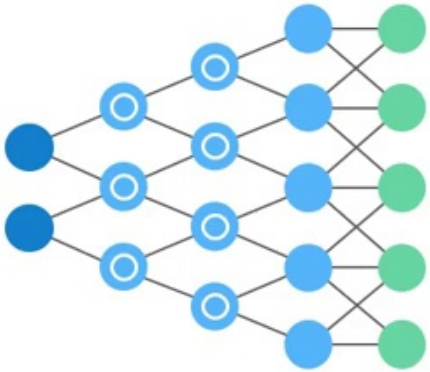
Deep Belief Network (DBN)



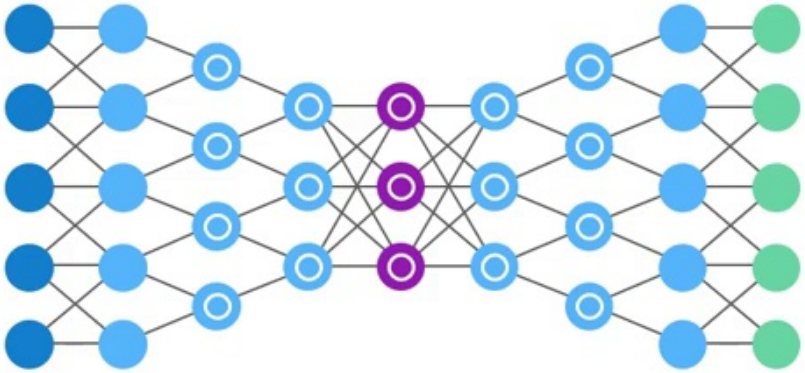
Deep Convolutional Network (DCN)

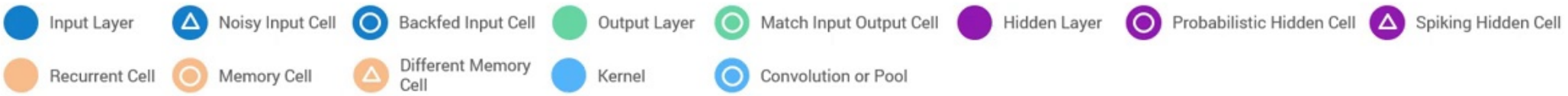


Deconvolutional Network (DN)



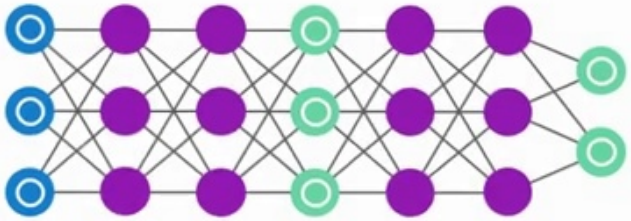
Deep Convolutional Inverse Graphics Network (DCIGN)



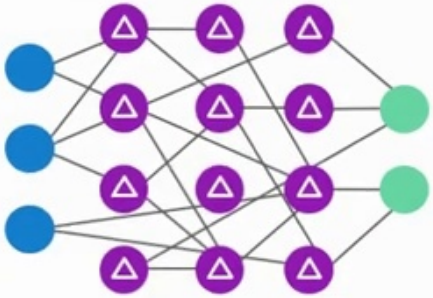


Neural Network Architecture Types - 3/3

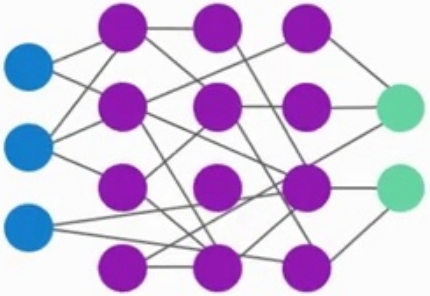
Generative Adversarial Network (GAN)



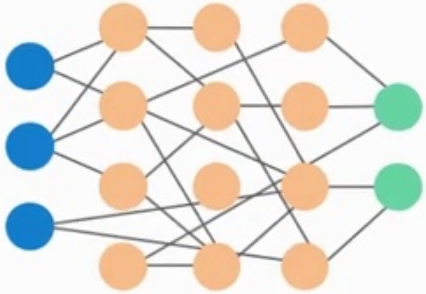
Liquid State Machine (LSM)



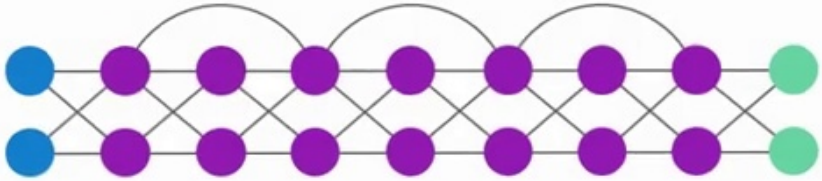
Extreme Learning Machine (ELM)



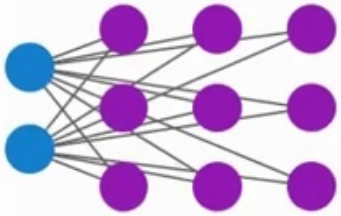
Echo State Network (ESN)



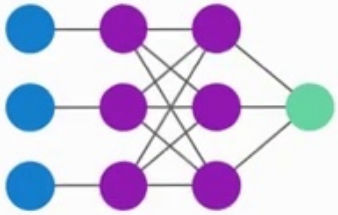
Deep Residual Network (DRN)



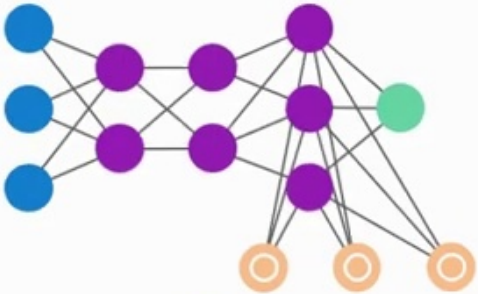
Kohonen Network (KN)



Support Vector Machine (SVM)

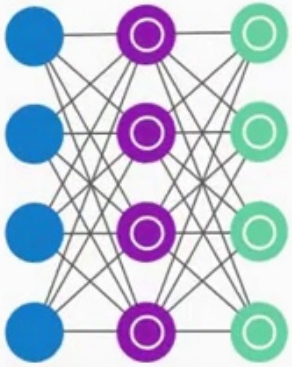


Neural Turing Machine (NTM)



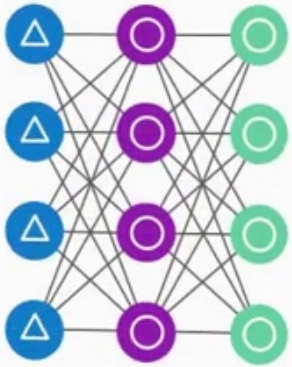
Input Layer
Noisy Input Cell
Backfed Input Cell
Output Layer
Match Input Output Cell
Hidden Layer
Probabilistic Hidden Cell
Spiking Hidden Cell
Recurrent Cell
Memory Cell
Different Memory Cell
Kernel
Convolution or Pool

Neural Network Architecture Types



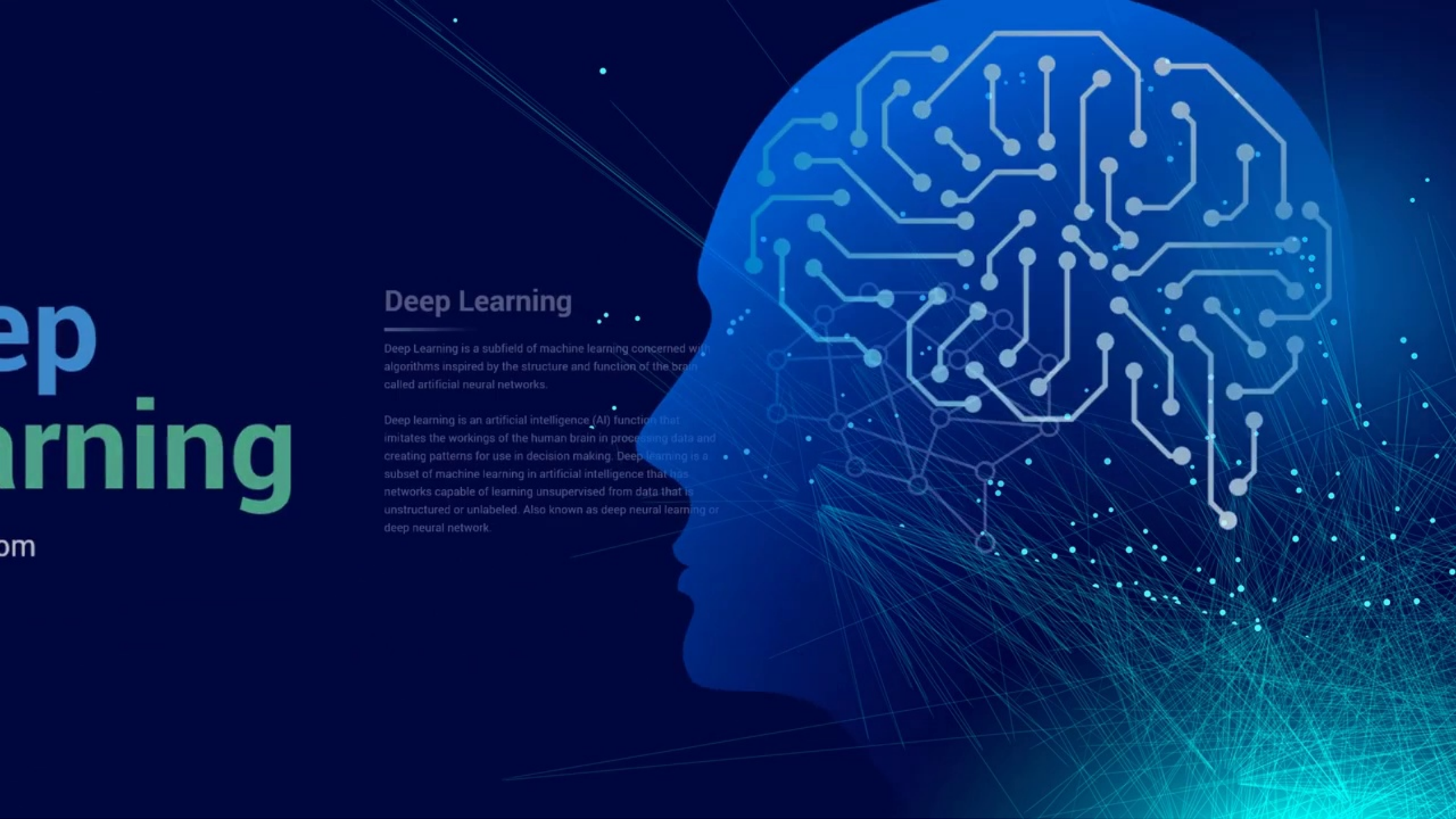
Variational AE (VAE) Neural Network

VAEs, comparing to AE, compress probabilities instead of features.
Despite that simple change, when AEs answer the question “how can we generalize data?”, VAEs answer the question “how strong is a connection between two events? should we distribute error between the two events or they are completely independent?”.



Denoising AE (DAE) Neural Network

While AEs are cool, they sometimes, instead of finding the most robust features, just adapt to input data (it is actually an example of overfitting).
DAEs add a bit of noise on the input cells — vary the data by random bit, randomly switch bits in input, etc. By doing that, one forces DAE to reconstruct output from a bit noisy input, making it more general and forcing it to pick more common features.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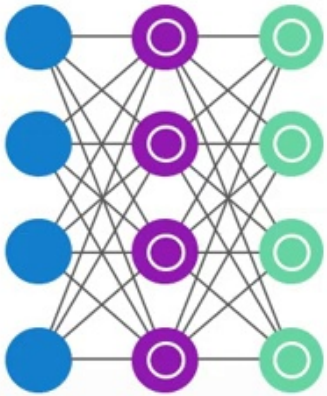
Deep Learning
Deep Learning is a subfield of machine learning concerned with algorithms inspired by the structure and function of the brain called artificial neural networks.
Deep learning is an artificial intelligence (AI) function that imitates the workings of the human brain in processing data and creating patterns for use in decision making. Deep learning is a subset of machine learning in artificial intelligence that has networks capable of learning unsupervised from data that is unstructured or unlabeled. Also known as deep neural learning or deep neural network.

Neural Network Architecture Types



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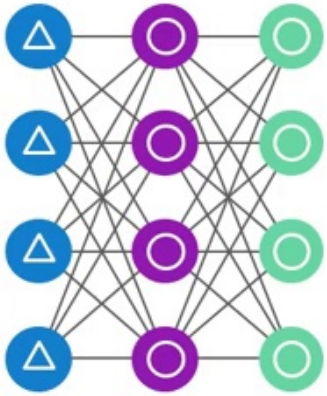

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[illegible] Neural Network Architecture Types

[illegible] Neural Network

[illegible] some hidden grouping [illegible] the hidden cell count is bigger than the [illegible]

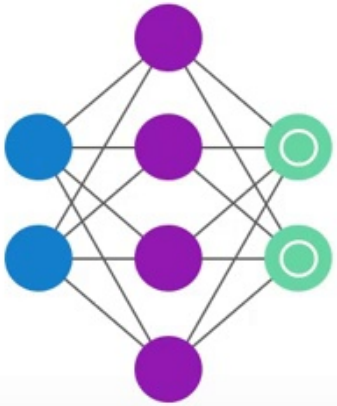
[illegible] (MC) Neural Network

[illegible] each edge has a probability. In old [illegible] we might have word clear with [illegible] by the way, uses MCs [illegible]

[illegible] can be used for classification based [illegible] and as a finite

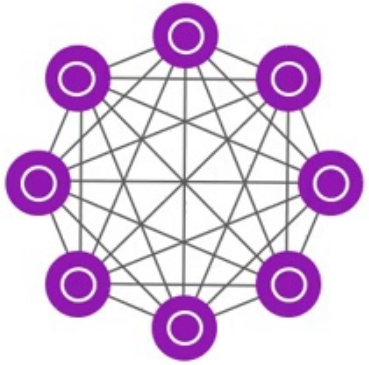
Neural Network Architecture Types

Neural Network Architecture Types



Sparse AE (SAE) Neural Network

SAE is yet another autoencoder type that in some cases can reveal some hidden grouping patterns in data. The structure is the same as in AE but the hidden cell count is bigger than the input/output layer cell count.

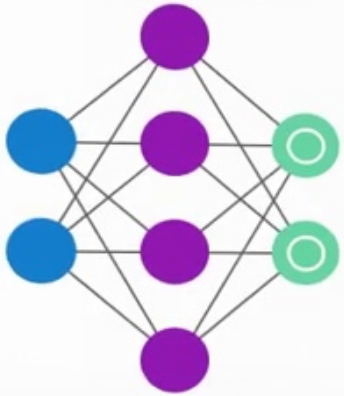


Markov Chain (MC) Neural Network

Markov Chains are a pretty old concept of graphs where each edge has a probability. In old times they were used to construct texts like “afterword hello we might have word dear with 0.0053% probability and word you with 0.03551% probability” (your T9, by the way, uses MCs to predict your input).
These MCs are not neural networks in a classic way, MCs can be used for classification based on probabilities (like Bayesian filters), for clustering (of some sort), and as a finite

Neural Network Architecture Types

Neural Network Architecture Types



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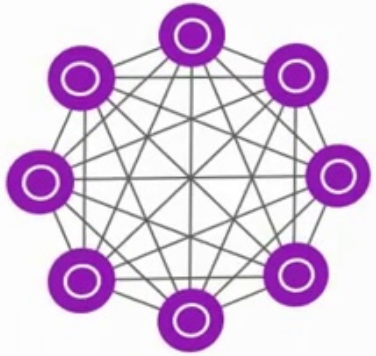

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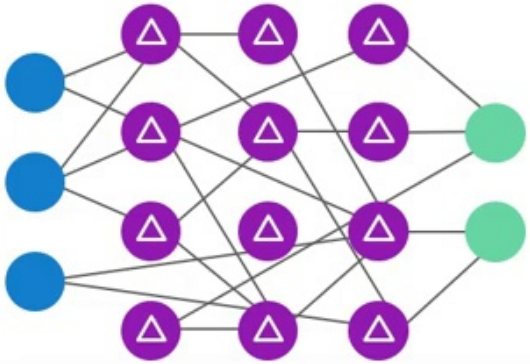
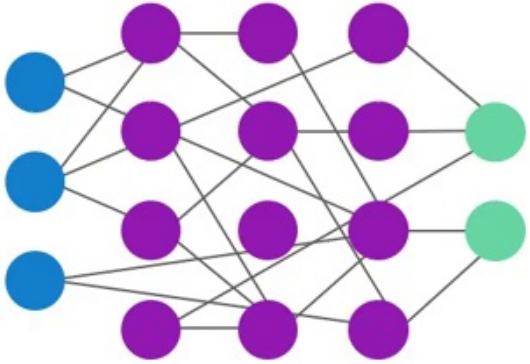


Liquid State Machine (LSM)

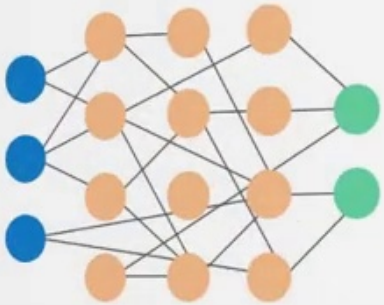
LSM is a sparse (not fully connected) neural network where activation functions are replaced by threshold levels. Cell accumulates values from sequential samples and emits output only when the threshold is reached, setting the internal counter again to zero. Such an idea is taken from the human brain, and these networks are widely used in computer vision and speech recognition systems, but without major breakthroughs



Extreme Learning Machine (ELM)

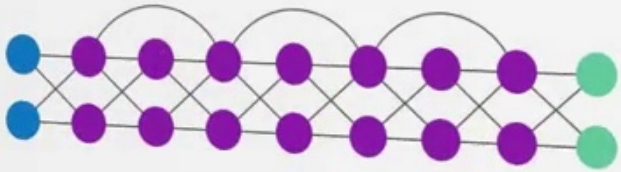
ELM is an attempt to reduce the complexity behind FF networks by creating sparse hidden layers with random connections. They require less computational power, but the actual efficiency heavily depends on the task and data.

Neural Network Architecture Types



Echo State Network (ESN)

ESN is a subtype of recurrent networks with a special training approach. The data is passed to input, then the output if being monitored for multiple iterations (allowing the recurrent features to kick in). Only weights between hidden cells are updated after that.

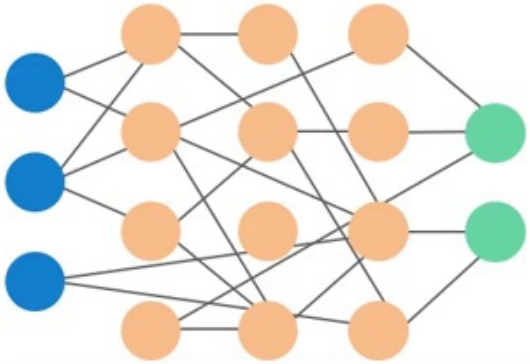


Deep Residual Network (DRN)

DRN is a deep network where some part of input data is passed to the next layers. This feature allows them to be really deep (up to 300 layers), but actually, they are kind of RNN without explicit delay.

Neural Network Architecture Types

Neural Network Architecture Types



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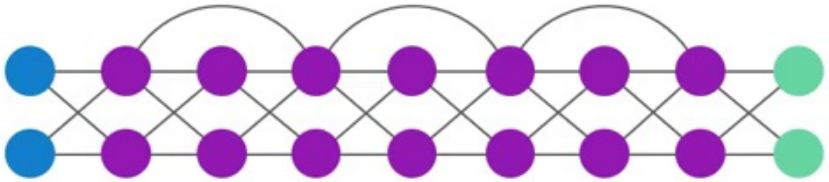

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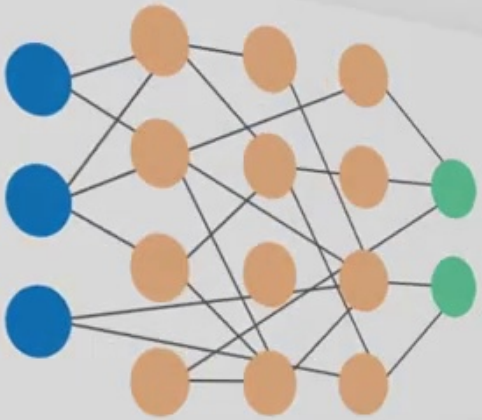

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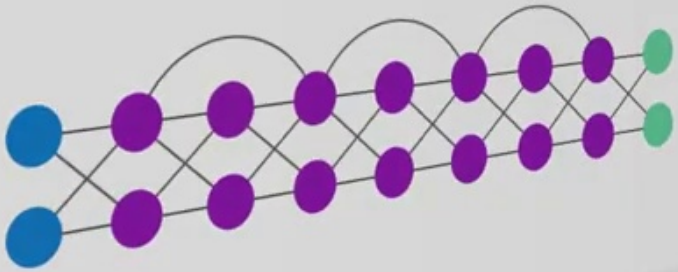

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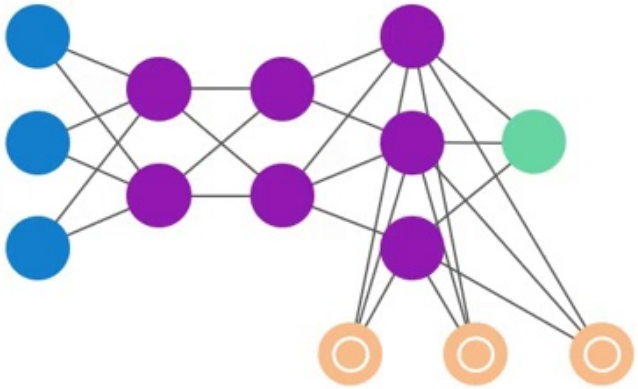


Neural Turing Machine (NTM)

Neural networks are kinda black-boxes — we can train them, get results, enhance them but the actual decision path is mostly hidden from us.
The NTM is an attempt to fix it — is it a FF with memory cells extracted. Some authors also say that it is an abstraction over LSTM.
The memory is addressed by its contents, and the network can read from and write to the memory depending on the current state, representing a Turing-complete neural network.

Propagation in Neural Network

Back Propagation in Neural Network

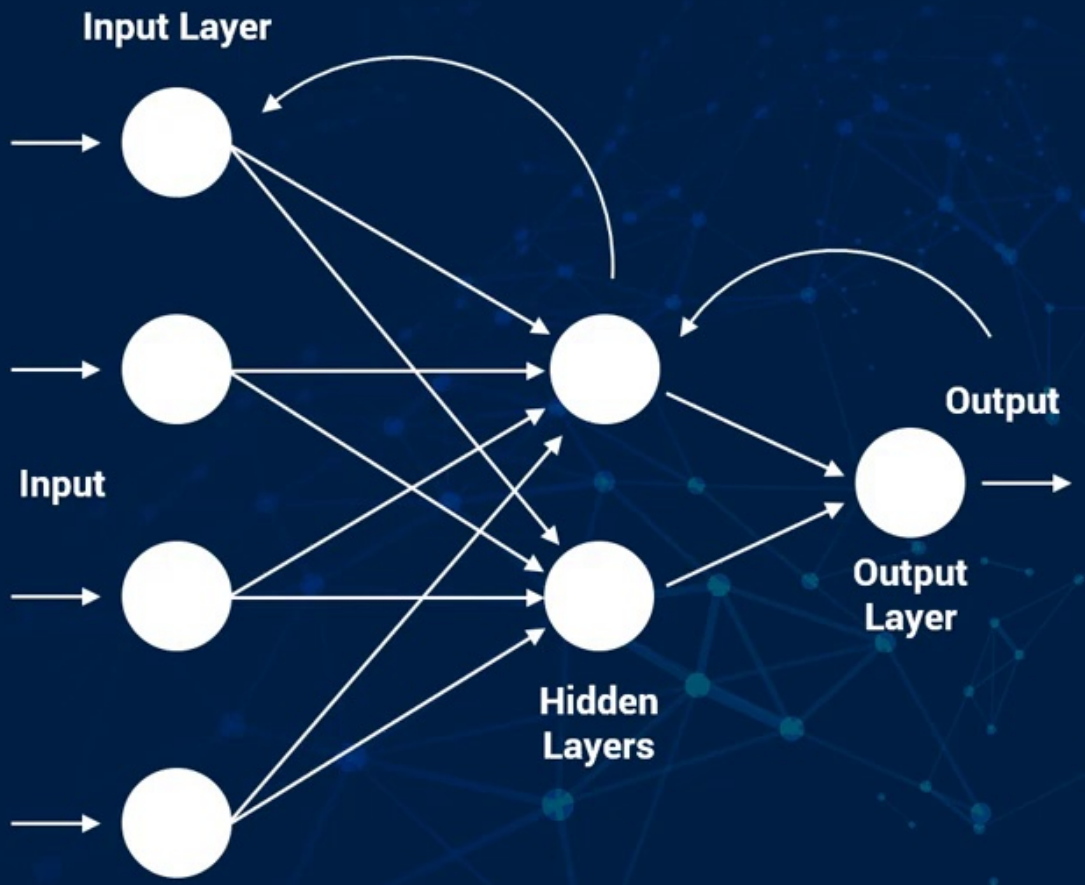
Backpropagation is the essence of neural network training. It is the method of fine-tuning the weights of a neural network based on the error rate obtained in the previous epoch (i.e., iteration). Proper tuning of the weights allows you to reduce error rates and make the model reliable by increasing its generalization.

Backpropagation in the neural networks is a short form for "backward propagation of errors." It is a standard method of training artificial neural networks. This method helps calculate the gradient of a loss function with respect to all the weights in the network.

Steps involved in Back Propagation are:

- Forward Propagation
- Back Propagation
- Calculating the updated weight value.

This Process keeps on repeating until the error is minimized.



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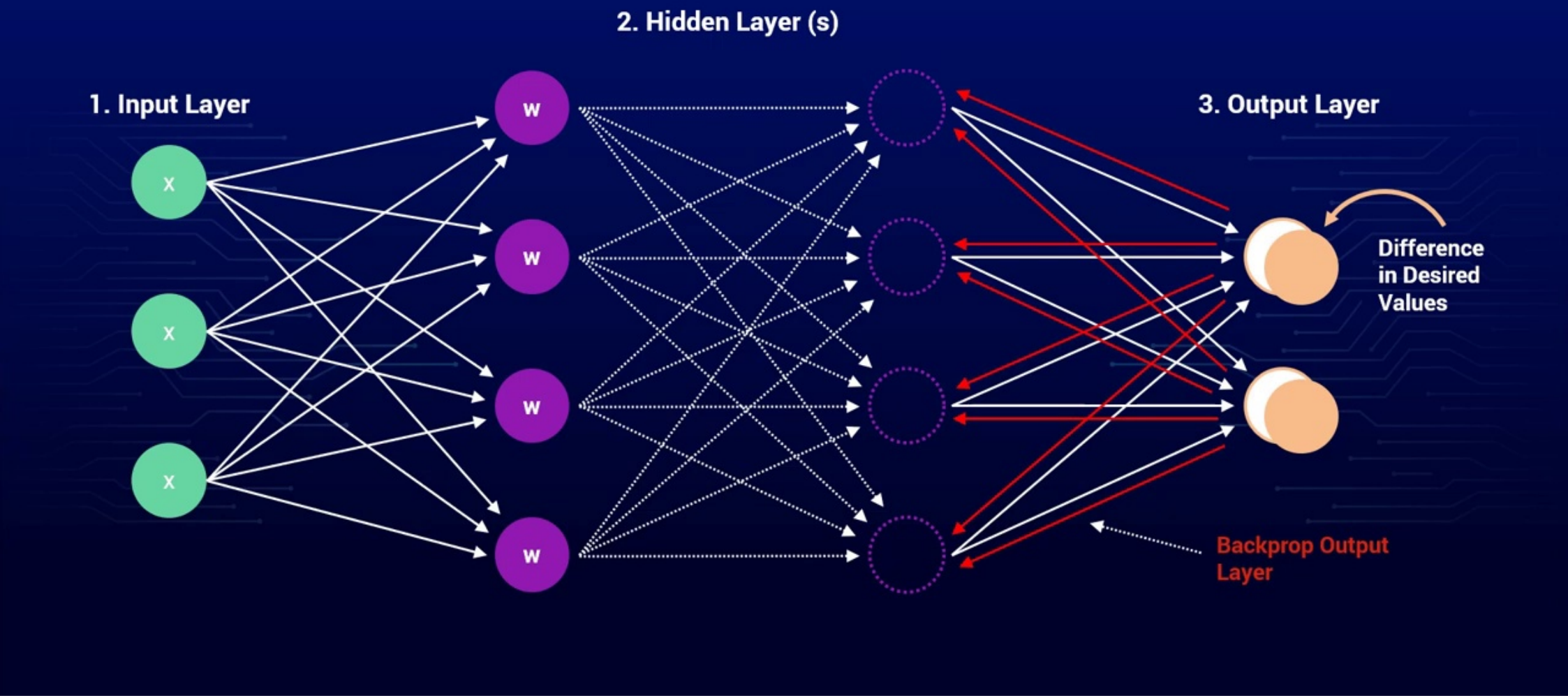
Deep Learning

Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability—allowing it to "learn" from large amounts of data. While a neural network with a single layer can still make approximate predictions, additional hidden layers can help to optimize and refine for accuracy.

Deep learning drives much artificial intelligence (AI) applications and services that improve automation, performing analytical and physical tasks without human intervention. Deep learning technology lies behind everyday products and services (such as digital assistants, voice-enabled TV remotes, and credit card fraud detection) as well as emerging technologies (such as self-driving cars).

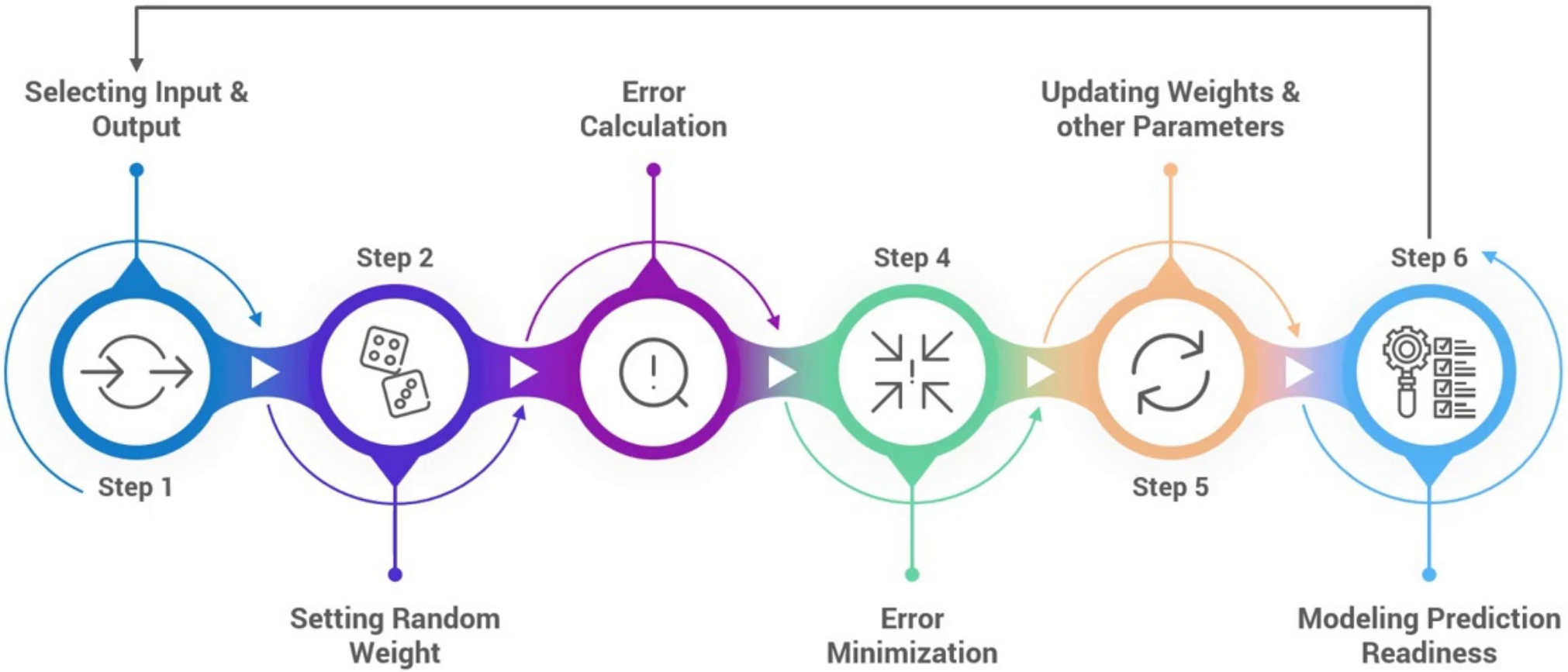
How Backpropagation Algorithm Works

Backpropagation Neural Networking



Back Propagation Algorithm Steps

Back Propagation Algorithm Steps



How Backpropagation Algorithm Works

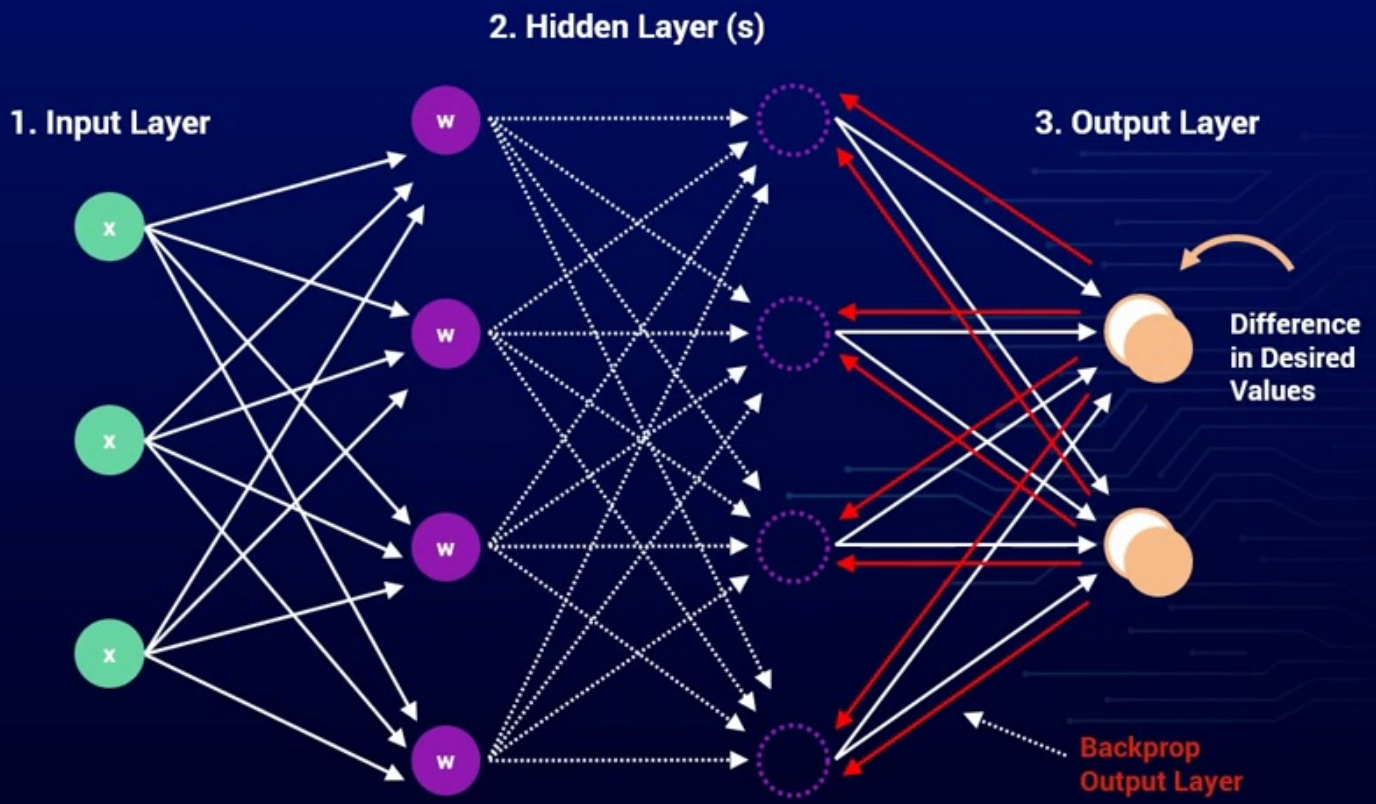
Backpropagation Neural Networking

1. Inputs X, arrive through the preconnected path
2. Input is modeled using real weights W. The weights are usually randomly selected.
3. Calculate the output for every neuron from the input layer, to the hidden layers, to the output layer.
4. Calculate the error in the outputs

ErrorB= Actual Output – Desired Output

5. Travel back from the output layer to the hidden layer to adjust the weights such that the error is decreased.

Keep repeating the process until the desired output is achieved



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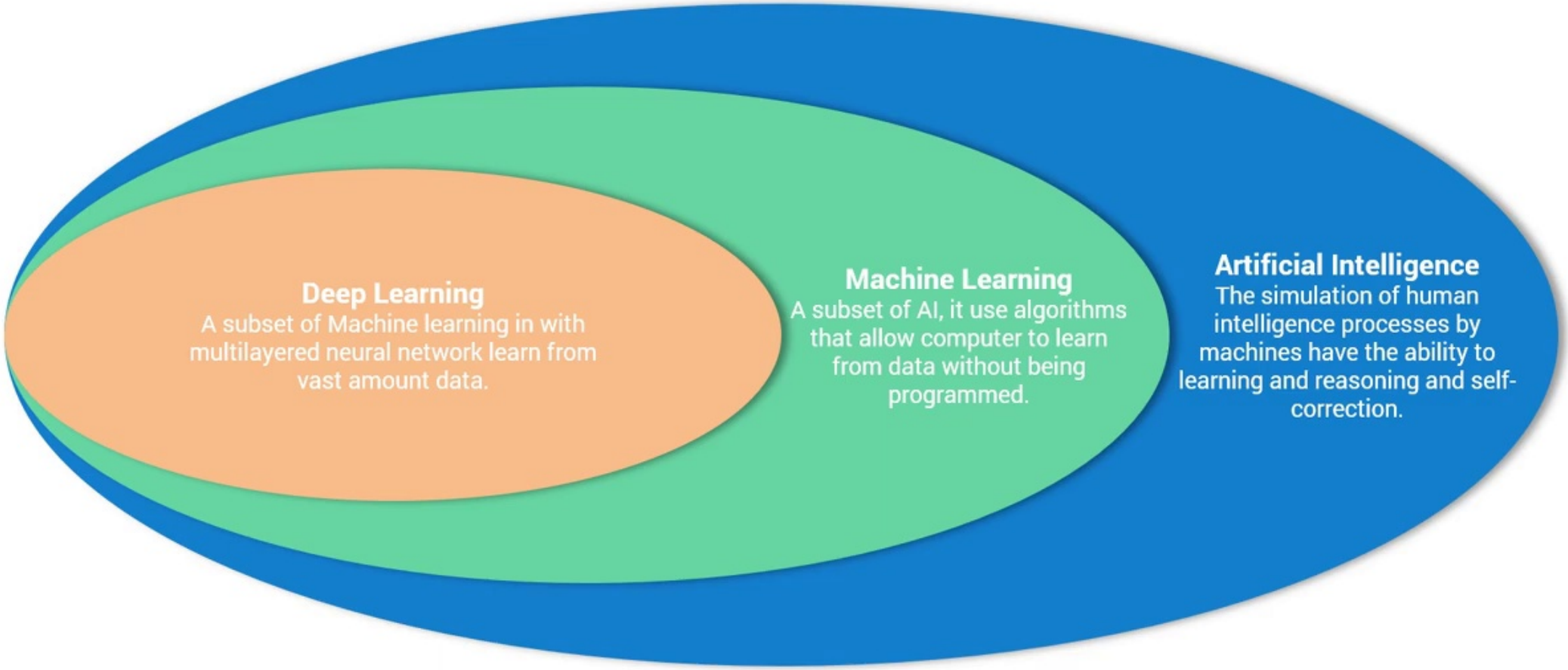
AI vs Machine Learning vs Deep Learning

Deep learning and machine learning are subfields of artificial intelligence



AI vs Machine Learning vs Deep Learning

AI vs Machine Learning vs Deep Learning

Artificial Intelligence
"Engineering of making intelligent machines and programs."

Machine Learning
"Ability to learn without being explicitly programmed."

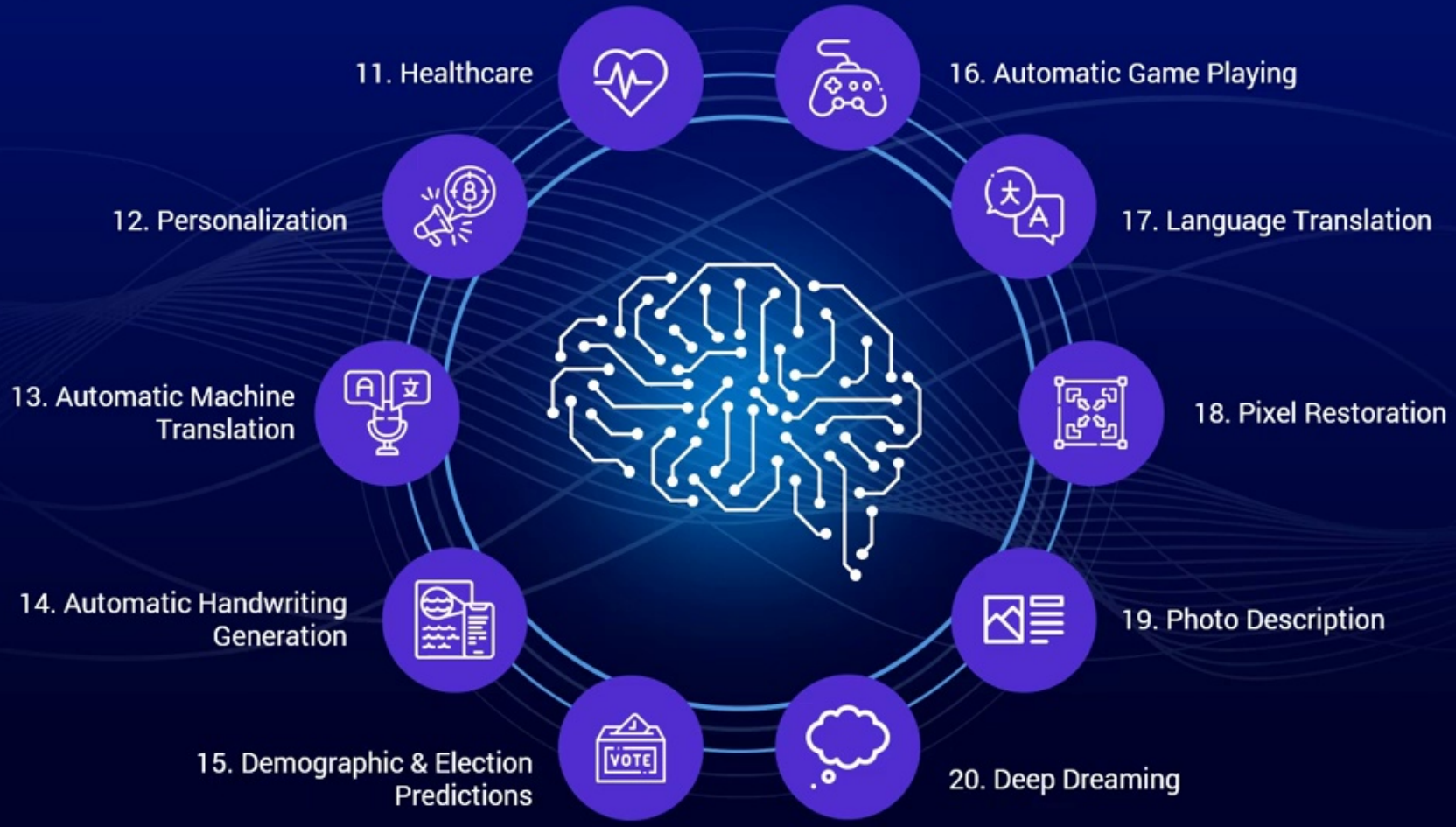
Deep Learning
"Learning based on network."

Why is Deep Learning Important?

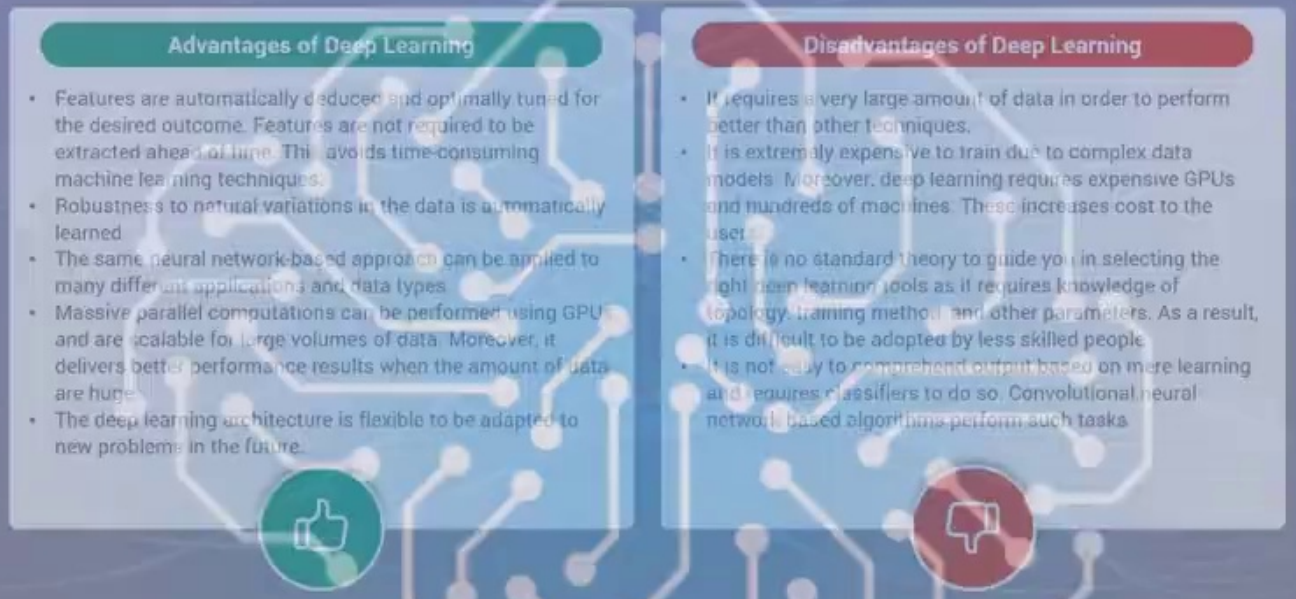
Why is Deep Learning Important?

Deep Learning Applications 2/2

Deep Learning Applications



Advantages & Disadvantages of Deep Learning



Advantages of Deep Learning

- Features are automatically deduced and optimally tuned for the desired outcome. Features are not required to be extracted ahead of time. This avoids time-consuming machine learning techniques.
- Robustness to natural variations in the data is automatically learned
- The same neural network-based approach can be applied to many different applications and data types
- Massive parallel computations can be performed using GPU and are scalable for large volumes of data. Moreover, it delivers better performance results when the amount of data are huge.
- The deep learning architecture is flexible to be adapted to new problems in the future.

Disadvantages of Deep Learning

- It requires a very large amount of data in order to perform better than other techniques.
- It is extremely expensive to train due to complex data models. Moreover, deep learning requires expensive GPUs and hundreds of machines. These increases cost to the user.
- There is no standard theory to guide you in selecting the right deep learning tools as it requires knowledge of topology, training method and other parameters. As a result, it is difficult to be adopted by less skilled people.
- It is not easy to comprehend output based on mere learning and requires classifiers to do so. Convolutional neural network based algorithms perform such tasks.