Find information about Neural Networks

AI and neuroscience are two fields that are becoming more and more intertwined. A neural network is a mathematical representation on how the brain functions based on modern theories about how the brain works according to neuroscience. The most effective forms of artificial neural networks are indeed modeled after the biological neural networks of the brain.
There are many different types of neural networks that all try to model different parts of functioning in the human brain.

In terms of learning, the network's learning methods reflect the theory about how the brain learns. Neural network first learns to find an explanation of something unfamiliar and once an abstract explanation is found it removes the irrelevant information about it. This is similar to how people and their brains learn. When you see a new concept you first understand nothing, but after a while you understand an abstract version of the concept well enough to save the concept into your memory which changes the way you experience the world. By doing so, you have trained your own cognitive model of a certain aspect. Later on you find out what is mostly important about the idea so you can explain it with your own words so you can discard the lesser important facts about it. An example about this case is learning what a duck is and a rubber duck. At first you would definitely figure out all features of both of them but in the end, the important difference that you know about it is that one of them is alive and the other one isn't.

The brain is based on neurons that are connected with synapses. Hebbian learning is an explanation on how neurons learns the biological way. The idea is that once neurons fire they will have a lower threshold for firing again. Thus when a neuron fires a signal to other neurons, it is said that it strengthens it connections to it. This partly explains the first part of learning. We are more likely to notice a new concept because the action potential needed for neuronal activity is decreased.

The network is based on input, hidden and output layer which can be translated into sensors (eyes), computational power of the brain and memory itself.

Input gets traversed from the input layer and through the network of the nodes, transforming at every step. A node is a function that takes an input and returns a value between 0 and 1 based on its activation function in the code. Once data reaches a node at its input, the activation function is applied to see if the node should be activated or not.

The hidden layers are then a representation of combinations of the first layer. Then the next hidden layers that come after is then a representation of the layers before it.

Thus the layers that are close to the output try to decode the data towards the output while the layers close to input try to encode input data given. Neural network first find a connection and then remove the unnecessary connections, just like the brain does.

Neural networks have shown promising performance in computer vision and pattern detection. They can often find and classify shapes and colors faster than human eye and brain can currently. The most interesting network which I am most fond of are the Generative adversarial networks. Unbelievable images and videos have been generated by them such as continuous video loops or style transfer techniques.

Question 1

Networks are often combinations of three types of layers namely input, hidden and output layer. What is the difference between them? What does it mean to add an extra layer to a neural network?

Input layer are a set of inputs that the network will receive and analyze. The output layer are the neurons at the end of the network that the network determines what it has learned and what values it derives from the data originally learned from. The hidden layer are the neurons in-between the input and output that send signals to the neurons they are connected to by using an activation function. We know what goes in the input layer and what comes out of the output layer but we will not know what values the hidden layer is computing. By adding an extra layer means that more complex calculations and patterns can be found at the price of more computation.

Question 2

Name three different types of neural networks and describe them briefly.

- Recurrent Neural Network – connections between neurons in input and output layer can be connected to form a directed cycle. By doing so, it allows the networks to use its output as a small internal memory to process sequences of older inputs.
- Convolutional Neural Network – a collection of feed forward neural networks that are often used to analyze images. It searches for certain patterns in a part of an image and tries to look for similarity in other parts.
- Generative Adversarial Network – a combination of two networks that are competing. One of the network tries to mimic a real data that the other one holds. The former network replicates a similar data until the other can cannot tell the difference between the real and the fake one.

Question 3

What does back propagation mean in terms of neural networks and how does it benefit the network?

Back propagation is a recursive calculation on the neural networks. It means that you get an output a little bit different than the expected output. It runs the correct value back through the network by applying the chain rule to every node and step taken in the network to reduce the error at every step. By doing so, it adjusts the weights of the networks so next time the network will see a similar data it will give a more correct answer.

Question 4

Neural networks architecture and design is based on how the human brain works. Discuss how the brain and a neural network is related.

The architecture of a neural networks is based on the known biology knowledge of how the brain works. The brain, according to research, is a combination of cells that are all connected to one or more neurons and send signals between each other by firing that signal based on values it receives. The biological neuroscience are thus the mathematical and biological neurons that form neural networks.

(read more precise answer at top)

Question 5

Explain what an activation function means in terms of a neural network and name two different types.

An activation function is a value function at each neuron in a layer. It takes all neurons connected to it and combines their totals value as an input. If that input passes a certain threshold, the neuron will "fire", sending a value based on its activation function to the neurons it is connected in the next layer. Two different types of an activation functions are Sigmoid and Relu. The former one was more popular in the early days of neural network development but in the past years Relu has gained more popularity due it a better performance and outcomes. Softmax also exists but is not used as much as the others.