IE4497 RA4 SUBMISSION

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1. What does a neuron do as an input-output device?

Neuron as an Input-Output Device: A neuron in a neural network functions as a basic input-output device. It receives one or more inputs (which can be data points or the outputs from other neurons), processes them through a mathematical function (which includes weighted summing of the inputs and then applying an activation function), and produces an output. The activation function determines whether and to what extent the signal processed by the neuron is forwarded through the network. This mechanism lets the neuron capture and transmit linear and non-linear relationships between its inputs and output.

2. How do you (in principle) compose a neuron network to do anything you want?

To compose a neural network capable of performing a desired task, neurons are organized in layers: input, hidden, and output layers. The input layer receives the raw data, hidden layers perform computations through interconnected neurons, and the output layer produces the final result or prediction. By adjusting the connections (weights) between neurons through a process known as training (typically using backpropagation and gradient descent), the network learns to map inputs to the correct outputs. The architecture of the network (such as the number of layers and neurons in each layer) and the weights are tuned so that the network can perform specific tasks, ranging from classification to regression, depending on the training data.

3. Why does a neural network need many neurons to be accurate?

A neural network requires many neurons to be accurate because complex problems involve capturing and representing intricate patterns, relationships, and dependencies within the data. More neurons (and layers) provide the network with a higher capacity to learn these complexities by enabling the representation of a larger variety of features and the modelling of more complex functions. Increasing the number of neurons enhances the network's ability to approximate non-linear functions and make more accurate predictions or classifications on diverse datasets.

4. What are the main reasons for the success of deep learning in recent years (as opposed to the previous century)?

Reason for the success of Deep Learning in Recent Years:

- Increased Computational Power: The advent of powerful GPUs and TPUs has dramatically accelerated the training of deep neural networks, making it feasible to process large volumes of data and train more complex models.
- Availability of Big Data: The explosion of data from the web, sensors, smartphones, and many other sources has provided the large datasets necessary for training deep neural networks effectively.
- Advances in Neural Network Architecture: Innovations in neural network design, such as convolutional neural networks (CNNs) for image tasks and recurrent neural networks (RNNs) for sequential data, have significantly improved performance in tasks like image recognition, natural language processing, and many others.
- Improvements in Training Techniques: Enhancements in training methodologies, including new activation functions, optimization algorithms, and regularization methods, have made neural networks more stable, faster to train, and more capable of generalizing from training data to unseen data.