DataLab Preparation (Week 2, DataLab I, Monday)

**3. Introduction to Deep Learning**

**3a What is the difference between machine learning and deep learning?**

The main difference between machine learning and deep learning is better performance for many problems. Machine learning involves transforming the input data into one or two consecutive representation spaces, whereas deep learning automatically learns all features in one pass, allowing a model to learn all layers of representation jointly.

**3b Explain 5 recent deep learning breakthroughs.**

- Near-human-level image classification

- Near-human-level speech transcription

- Near-human-level handwriting transcription

- Improved machine translation

- Improved text-to-speech conversation

**3c Describe how the recent advancements in hardware, data availability, algorithms, and democratization of tools favored the recent developments and popularity of deep learning.**

Advances in hardware such as faster GPUs and better storage, in data availability such as the internet making it easier to collect and distribute very large datasets, in algorithms such as better activation functions, and in democratization of tools such as the simplification o machine learning libraries, and therefore, improved accesibility, have all contributed to the popularity of deep learning. Additionally, improved funding resulting from high hopes for the industry and the general use of the internet have facilitated an environment where anyone can learn how to train a simple machine learning model right on their laptops. Such a thing was deemed impossible 25 years ago.

**3d What is a Sequential model?**

A sequential API is a deep learning model comprised of a stack of layers (input layer, multiple hidden layers, and an output layer).

**3e What is a Dense layer?**

A dense layer is a layer of neurons in which each neuron receives input from all the neurons of the previous layer.

**3f What is defined by the parameter input\_shape in a Dense layer?**

The parameter input\_shape defines how many neurons are in the input Dense layer.

**3g What function is used to compile a model in Keras?**

model.compile(optimizer = '', loss = '')

**3h What function is used to train a model in Keras?**

model.fit(X\_train, y\_train, epochs =)

**4. The Mathematical Building Blocks of Neural Networks**

**4a What defines the number of neurons in the input layer of a neural network?**

The number of neurons in the input layer of a neural network is defined by the number of features in the input data. As an example, in the second chapter of the DataCamp course, there are 2 neurons in the input layer, one for the x coordinate and one for the y coordinate of each of the red and blue circles in the graph.

**4b What defines the number of neurons in the output layer of a neural network?**

The number of neurons in the output layer of a neural network is determined by the number of values that are being predicted. As an example, in the second chapter of the DataCamp course, there is one are 2 neurons in the output layer because the model is predicting whether a dot is either blue or red.

**4c What is the output of a sigmoid activation function?**

A number between 0 and 1.

**4d Describe and provide examples of machine learning problems for binary classification, multi-class classification, and multi-label classification.**

Binary classification:

An example of a machine learning problem for binary classification could be a model that differentiates between fake and real dollar bills. It uses features like texture, color, and size, trained on labelled data to predict whether a given bill is authentic or counterfeit with high accuracy.

Multi-class classification:

A multi-class classification model example is a model which predicts which out of four players has thrown a dart on the board in a game of darts. This model uses a probability between 0 and 1 per output neuron.

Multi-label classification:

For example, we can use multi-label classification models to tag a series' genres by its plot summary. This involves training models using labelled data and evaluating their performance.

**4e What is the purpose of early stopping when training a model?**

Early stopping a model can help solve the overfitting problem since it stops training when the model no longer improves.

**4f Follow the steps described in section 2.1 to train and evaluate a neural network using the MNIST dataset. Then, write the accuracy obtained for a test set. You must also provide a screenshot of the output as evidence that you executed all the steps to train and evaluate the model.**

test\_acc: 0.9781000018119812

97.8% accuracy

**4g What is a loss function?**

A loss function is a measure of how well a machine learning model's predictions match the true values or labels of the training data.

**4h What is a tensor?**

Tensors are multidimensional NumPy arrays. It is a container for data.

They are generalisations of matrices.

**4i Describe the key attributes of a tensor.**

A tensor is defined by 3 key attributes:

- Rank (nr of axes) - in NumPy it is called the tensor's ndim

- Shape - a tuple of integers that describes how many dimensions the tensor has along each axis

- Data type - the type of the data contained in the tensor