**LECTURE 2: Lab**

Q: what are dendrites? (2.18)

Q: What is a neuron? {2.45}

Q: list and explain some properties of the human brain [additional reading to identify properties not mentioned in the video] {5.50}

Q: what is neuroplasticity? How does neuroplasticity assist in the recovery of lost functions after stroke?

Q: Are large language models like ChatGPT intelligent? {9.40}

Q: There is an ongoing debate about AGI alignment. What is alignment, and how dangerous is misalignment?

Q: Brains operate at much lower clock speeds than modern microprocessors. How can they possibly perform as fast as computers? Is this true for all tasks (i.e. are brains always as fast as computers?). If not, what are the characteristics of tasks on which the brain can achieve comparable performance? {10.00}

Q: explain how convolution network architectures were motivated by the human brain, with reference to the visual cortex {14.00}

Q: List and explain 6 properties of ANNs (you may read from additional sources) {17.00}

Q: Does the time taken by a biological neuron to compute its output depend on the number of inputs? (Research needed to answer this). What about for an artificial neuron? {18.25}

**Intro to the Lecture 2 Notebook: Where do system identification problems come from?**

Most real-life systems have at least two variables of interest. In some cases, there is reason to believe that some relationship exists between one or more “dependent” variables and another one or group of “independent”[[1]](#footnote-1) variables. For numerous reasons, it may prove valuable to understand this relationship well enough to be able to predict future values of the dependent variables. Take for example, the stock market in which there may be strong interest in predicting future movements of particular stocks, given time and other “independent” variables. Another example might be the relationship between the velocity of a car and one of a number of variables related to the car’s performance. Or, consider a standard weather forecasting problem in which there is a requirement to predict future values of particular atmospheric variables, given a model based on previous data.

There is another situation that necessitates the determination of this relationship. For a proper control scheme to be developed for most systems, their behaviours usually need to be understood. Hence, SI can also be a prelude to the development of appropriate regulation of aspects of interest in the system of under consideration.

In most of the examples above, as with most real-life problems, it is impossible to get a nice analytical equation relating the different variables merely from first principles. That equation, if at all it will be found, will be found experimentally. This is system identification. In this lab, we will explore scenarios in which attempts are made to represent the unknown system with some general equation which we then attempt to fit more accurately to the system’s observed behaviour. Once we get to a point where we feel we have an accurate equation, we can us it to predict future values of the output, or properly control the system.

It should be noted that in other situations, a system’s behaviour can be accurately modelled without explicit equations. Consider image classification task carried out by a neural network. In training the neural network to discriminate between two different categories, some sort of “understanding” is arrived at, without necessarily needing to explicitly fit an equation.

Now, run the accompanying Jupyter notebook

After running the notebook, student should be able to answer these and other questions:

Q: write out, in pseudocode, the batch gradient descent algorithm.

Q: implement the algorithm in Python

Q: write, in pseudocode, the stochastic gradient descent algorithm

Q: What informs the name “**stochastic**” gradient descent?

1. The terms dependent and independent are here used for convenience only. In many cases, all variables in a system affect each other in highly complicated manner that makes it impossible for any to be said to be truly independent. [↑](#footnote-ref-1)