

Biologically Inspired Computing: Neural Computation

Tutorial

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Tutorial

- ✓ This is not a coursework. This is just to guide you during your preparation to the final exam
- ✓ There is no need to deliver the answers partially or in total (although there will be no harm if you do so!)
- ✓ Some exam questions might be “inspired” by this tutorial
- ✓ Any doubts please contact Patricia @ p.a.vargas@hw.ac.uk

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- 1) Define “Neural Computation” and “Artificial Neural Networks”?
- 2) Define “synaptic plasticity”.
- 3) Explain the main reasons why the study of the brain *cortex*, also know as the *grey matter*, gave rise to some successful artificial neural network models?
- 4) Define “synaptic modulation”.
- 5) What are the most important mechanisms in both biological and artificial neural networks? And how they are related to synaptic plasticity and synaptic modulation?

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- 6) Draw a schematic of the first neuron model proposed by McCulloch and Pitts (1943) and represent the activation function graphically.
- 7) Draw a schematic of the Perceptron proposed by Frank Rosenblatt (1957) with five inputs and 1 output in the range $[0,1]$, including the weights and bias. Represent the chosen activation function graphically.
- 8) Write a pseudocode for a Perceptron algorithm to learn the logical function OR, with brief explanation of any terms and parameters used in your pseudocode.
- 9) Give an example of a learning task which a Perceptron cannot perform. Demonstrate that this task is unlearnable graphically.

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- 10) What is the main difference between the “Sigmoid” activation function and the “Hyperbolic Tangent” activation function? Represent both activation functions graphically.
- 11) What is the main difference between a “Feed Forward” ANN and a “Recurrent” ANN? Give a schematic example.
- 12) What is “Supervised Learning”?
- 13) What is “Unsupervised Learning”?
- 14) What is “Reinforcement Learning”?
- 15) Why the unsupervised and reinforcement learning are categorised as “learning without a teacher”?

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- 16) What are the main types of unsupervised/self-organised learning? Explain each of them.
- 17) Draw a schematic of a Multi-Layer Perceptron (MLP) with 2 inputs, 2 hidden layers, 3 neurons on the first layer and second layer and 1 output, including the weights and bias. The output should range in the interval $[-1,1]$. Represent the chosen activation function graphically.
- 18) What is the “Back-Propagation” algorithm, also known as the “Gradient Descent” algorithm? What is it applied to? Write a pseudocode for it.
- 19) Explain why the advent of the MLP and its famous “back propagation” training algorithm might be linked to the “renaissance” in the field of ANN research? How this is related to Minsky and Papert’s book “Perceptrons” published in 1969?

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- 20) Explain the differences between the “batch” and “on-line” learning while using the back-propagation algorithm. What are the advantages and disadvantages of each one.
- 21) What is “associative memory” and how it is related to feedback mechanisms?
- 22) Define the “Hopfield Neural Network”. Show a graphical example.
- 23) Write the pseudocode and execution step by step of a hopfield neural network designed to learn and retrieve the pattern “1010”. Draw all the matrices involved during the execution of the pseudocode both during training and and execution. Try to execute the same trained network to recall the pattern given in Lecture 4. Could the network recall it correctly? Why?

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- 24) Explain the main differences between the original GasNet model and the standard artificial neural networks.
- 25) What are the main differences between GasNet models?
- 26) Would you use evolutionary computation techniques to evolve ANNs? Why?
- 27) What is “evolvability”?
- 28) Represent graphically a one round execution of the distributed GA over a population of 25 individuals to be evolved to perform a chosen task. Explain each step.

Learning Material:
@ David Corne's webpage