University of London International Programmes

Computing Coursework assignments 2016–2017

CO3311 Neural networks

Coursework assignment 1

Important

Your coursework assignment should be submitted using the following file-naming conventions:

FamilyName_SRN_COxxxxcw#.pdf (e.g. Zuckerberg_920000000_CO3311cw1.pdf)

- **FamilyName** is your family name (also known as last name or surname) as it appears in your student record (check your student portal)
- **SRN** is your Student Reference Number, for example 920000000
- **COXXXX** is the course number, for example CO3311, and
- **cw#** is either cw1 (coursework 1) or cw2 (coursework 2).

Question 1

Use the library's databases**,** *scholar.google.co.uk* and *google.books,* to find articles on 'Spiking neural networks'. Use the results, and any other useful sources you can find, to write a 1,000 word summary about these neural networks. Your answer should use the following headings:

a) Introduction: what is a spiking neural network?
b) How spiking neural networks differ from the models covered in CO3311.
c) Applications of spiking neural networks.
d) Conclusions.
e) References.

Your answer can gain up to 5 per cent for each of the headings a)-d); penalties will be given if the answer is not supported by references, as required in e).

Remember the rules on plagiarism and the requirement to use the Harvard system for references and citations.

Here are a few sources to get you started:

https://pdfs.semanticscholar.org/1474/853a6ba097f5880501bbdd94fb782ef3e4d3.pdf

http://eda.mmci.uni-saarland.de/pubs/2002/spiking_neural_networks_an_introduction-vreeken.pdf

https://en.wikipedia.org/wiki/Spiking_neural_network [but do not rely on this source]

Rojas, R. *Neural networks: a systematic introduction*. (Springer, 1996) [ISBN 9783540605058 (pbk)]. Reprinted 2012. This book is also available for free download from the author's website: https://page.mi.fu-berlin.de/rojas/ neural/neuron.pdf

[20%]

Question 2

For this question, we are going to see, using the 2-sigmoid spreadsheet available on the course website, what a 2-input unit with sigmoidal activation is able to model. We will run a number of experiments using:

a) Different targets: Five sets of four targets in the range (.1 to .9) chosen randomly.
b) Different initial conditions (weights). Five sets with each of ***bias,*** w_a and w_b chosen randomly in the range (-1 to 1).
c) Different learning rates (.01, .1, .25, .50, 1 and 2).

Random number choices:

i. Use Excel to find the 20 random numbers needed for a) above.
ii. Use Excel to find the 15 random numbers needed for b) above. These 35 numbers are the only random numbers needed for the question.
iii. Extend the formulae of the spreadsheet to do 2,000 iterations (you may need to unprotect the sheet in order to do this, but remember to protect it again after checking that you have extended it correctly). Alternatively, you may use software of your choice.
iv. Produce a spreadsheet of results with the following columns:
    - Column 1: Experiment number: (this is unique for each row: 1 to 150 = 5 × 5 × 6)
    - Column 2: Target set (1, 2, 3, 4 or 5)
    - Columns 3–6: Targets: the four randomly chosen target values. (Each set appears once, for each combination of learning rate and initial condition. That is 6 × 5 = 30 times.)
    - Columns 7–9: Initial weights (one of the sets for b) above)
    - Column 10: Result from column M of '2-sigmoid' after 1,000 iterations
    - Column 11: Result from column M of '2-sigmoid' after 2,000 iterations
    - Columns 12+: Other columns as needed to analyse the results.

Write up your experiments carefully so that they could be reproduced by your readers. Look for advice on this in the module materials. Remember the rules on plagiarism and the need to use the Harvard system for references and citations.

Your answer should include:

a) An introduction
b) A note explaining how you extended the '2-sigmoid' spreadsheet. Include the modified file in your submission
c) An analysis of the results obtained in terms of how effective different learning rates were, how the results depend on initial conditions and target set
d) The 12+ column spreadsheet described above containing the raw results and results of any analysis.

[80%]

[END OF COURSEWORK ASSIGNMENT 1]

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Coursework assignment 2

Important

Your coursework assignment should be submitted using the following file-naming conventions:

FamilyName_SRN_COxxxxcw#.pdf (e.g. Zuckerberg_920000000_CO3311cw2.pdf)

- **FamilyName** is your family name (also known as last name or surname) as it appears in your student record (check your student portal)
- **SRN** is your Student Reference Number, for example 920000000
- **COXXXX** is the course number, for example CO3311, and
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Question 1

A course such as this can only cover a few of the many models of neural networks that have been attempted. In this question, your task is to review the 'Caffe' system developed at UC Berkeley in no more than 1,500 words.

You are not expected to build your own models but to explore the resources at the links below and any others that you find of interest.

Initial links are:

http://caffe.berkeleyvision.org/

https://arxiv.org/pdf/1408.5093.pdf

[CAV note: again, should these be Harvard format?]

Write up your findings, including an explanation of how you found the sources you used. Remember the rules on plagiarism and the requirement to use the Harvard system for references and citations.

Use the following headings:

- Introduction
- Applications published (not just on the main website - use Google Scholar as well to find others)
- Strengths: List and explain the things that writers say they like about the system
- Weaknesses: List and explain what writers say should be improved
- Conclusions: How does this compare with other means of modelling neural networks?

[25%]

Question 2

i. Using Excel, or a tool of your choice, implement a 4-unit Hopfield network. [You may wish to modify the 3-Hopfield network available from the course website.] Note that there are ten as yet unknown weights corresponding to the 6 green cells in 3-Hopfield.
ii. Test your implementation until you are convinced that it is correct.
iii. Test your program further using the following weight matrices:
    a) All zeros
    b) All -1
    c) A pseudo random sequence generated as follows: Suppose that your SRN is 123456789.

    Put 123456789 in cell A1 of a spreadsheet and the following formula in cell A2:

    =IF(MOD(INT(10^9*A1),2)=0,A1/2,1+3*A1-INT(3*A1)).

    Copy this formula down until cell A10 giving you 10 'pseudorandom' numbers starting with your SRN. Use these weights in your network.

iv. Choose more sets of random weights to find sets that give 1 or 2 stable states.
v. See if you can find other numbers of stable states.

Write up your experiments carefully so that they could be reproduced by your readers. Look for advice on this in the module materials. Remember the rules on plagiarism and the requirement to use the Harvard system for references and citations.

See if you can deduce why the 'stable states' are stable, and explain this in your write up.

Your submission should be zipped into a single file and contain:

a) The write up
b) The programs/spreadsheets needed to duplicate your results
c) The results obtained
d) Your analysis of the results
e) Any conclusions that you can make.

[75%]

[END OF COURSEWORK ASSIGNMENT 2]