University of London International Programmes

Computing and Information Systems/Creative Computing

CO3311 Neural networks

Coursework assignments 1 & 2 2017–2018

Important

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

YourName_SRN_COxxxxcw#.pdf (*e.g.* MarkZuckerberg_920000000_CO3311cw1.pdf)

- **YourName** is your full name as it appears on 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).

REMINDER: It is important that your submitted assignment is your own individual work and, for the most part, written in your own words. You must provide appropriate in-text citation for both paraphrase and quotation, with a detailed reference section at the end of your assignment (this should not be included in any word count). Copying, plagiarism and unaccredited and wholesale reproduction of material from books or from any online source is unacceptable, and will be penalised (see our guide on how to avoid plagiarism on the VLE).

Coursework assignment 1

Question 1

The Asimov institute's website has an interesting poster entitled 'The Neural Network Zoo' available at http://www.asimovinstitute.org/neural-network-zoo/.

Read the poster and summarise its contents in about 1000 words. Your answer should include the following headings:

a) Introduction
b) The graphical notations used in the poster
c) The main features distinguishing networks
d) What have the unit types in common?
e) The main differences between units
f) The major types of network
g) Conclusions
h) References

Remember to include in-text citations and provide a reference section for all the sources used, in correct Harvard format.

[20%]

Question 2

This question requires you to design three input threshold units and see how a change in the required outputs is accommodated by the Perceptron learning algorithm.

Suppose that we start with a threshold unit which implements a particular binary function, let's call this function *S*. If *S* is linearly separable then you might be able to choose suitable weights fairly easily by inspection – you might be asked to do this in an examination. Whenever possible choose weights that are small integers. If you have difficulty finding weights, then use the training algorithm to find a set of weights and then change them to integers.

Once you have a set of weights, check that the resulting unit has the required behaviour by testing it on all eight possible inputs.

Next, choose a different target binary function, let's call this *T*, and train the unit, keeping a record of the weight changes at each step. If *T* is linearly separable then we should eventually end up with a set of weights that implement *T*, though these are unlikely to be integer!

For each experiment you conduct, produce a plot of the four weights as a function of training iterations (not epochs). Use Excel for this and use different colours for each weight.

Use the following table for functions *S* and *T* to carry out **as a minimum** these four experiments.

Experiment	***S***	***T***
1	AND	OR
2	OR	AND
3	NOR	NAND
4	NAND	NOR

To develop your work, try exploring what is happening by making some other systematic possible choices for *S* and *T* (there are of course too many possible pairs of *S* and *T* for you to investigate them all).

Write up your experiments carefully so that they could be reproduced by your readers. You will find advice on this in the course materials. Your answer should include:

a) An introduction
b) A description of your program or spreadsheet and how you developed and tested it
c) Sets of results with the given set of *S* and *T* showing how the weights morph from one set of values to another during training
d) An analysis of the results obtained including any surprising or interesting observations that you made
e) A conclusion

Remember to include in-text citations and provide a reference section for all the sources used, in correct Harvard format.

[80%]

[Total 100%]

[END OF COURSEWORK ASSIGNMENT 1]

Coursework assignment 2

Question 1

In order to train an artificial neural network, we need to have a way of evaluating how well it has trained and how well it does at its task. Some key information on this is provided in the subject guide but there is much more to it than we had space and time to summarise.

In about 1000 words, summarise the measures that are used to evaluate the training of an artificial neural network.

To answer this question you will need to undertake further research. You will find it helpful to use the databases of academic papers made available to you through the University's Online Library, Google Books, Google Scholar, *etc.*

Your report must include the following:

a) Introduction
b) The need for evaluation techniques
c) The main requirements for convergence criteria
d) The pros and cons of major evaluation measures
e) Conclusions
f) References.

Remember to include in-text citations and provide a reference section for all the sources used, in correct Harvard format.

[25%]

Question 2

For this question you need to implement a Kohonen-Grossberg network, though we will ignore the Grossberg layer. A set of data is provided in Appendix A, and you are to train a number of networks with it.

Using Excel, or another tool of your choice, implement a Kohonen network which can have up to five units. Make it flexible so that units can be added and subtracted easily.

Perform three sets of experiments:

Set 1: Train 4 networks with 2, 3, 4 and 5 units respectively against the data. Use 400 epochs for each network.

Set 2: Train a new network with 2 units for 100 epochs and then, keeping the current units as they are, add another unit and repeat the training for another 100 epochs. Continue adding and training until you have 5 units and have trained for 400 epochs in total.

Set 3: Train a new network with 5 units for 100 epochs. Remove one unit and train for another 100 epochs. Repeat this removal and training until you have results for 2 units and 400 epochs in total.

For each experiment record the 'final error' which is the sum of the distances between training examples and their class in the trained network. Use random weights for new units but retain those of remaining units.

You may include more columns for measures of error if you wish, but make sure that you give an explanation of all of the measures you use.

The following table shows the experiments that you need to perform:

	Experiment	Number of units	Cumulative epochs	Error Unit 1	Error Unit 2	Error Unit 3	Error Unit 4	Error Unit 5
	Set 1							
1	1-100	5	100					
2	1-200	5	200					
3	1-300	5	300					
4	1-400	5	400					
	Set 2							
5	2-2	2	100			N/A	N/A	N/A
6	2-3	3	200				N/A	N/A
7	2-4	4	300					N/A
8	2-5	5	400					
	Set 3							
9	3-5	5	100					
10	3-4	4	200					N/A
11	3-3	3	300				N/A	N/A
12	3-2	2	400			N/A	N/A	N/A

Summary of experiments

A useful source of ideas for this question might be http://www.mit.edu/~9.54/fall14/slides/Class13.pdf

What to submit:

- A description of the measure of errors that you used to monitor progress in your experiments.
- A description of the way that you implemented the networks, including sufficient detail to enable others to duplicate your work.
- Program code or an Excel spreadsheet for each of the experiments.
- Table(s) of results.
- A commentary on the results that you have obtained, describing any features that you feel are notable.

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 draw.

[75%]

[Total 100%]

[END OF COURSEWORK ASSIGNMENT 2]

Appendix A

Data for Question 2

X	Y	X	Y	X	Y
-13.47342924	1.485324891	-0.799879301	2.360629866	0.96256999	0.526801876
-13.46626583	0.824306212	-0.797554339	1.026800784	0.970869444	1.049744022
-12.94539339	6.655183246	-0.797372251	1.652456256	0.980398857	0.207185729
-8.433378045	1.850829613	-0.756945877	1.960644303	1.027646134	0.130564599
-6.293635146	1.558518619	-0.709138935	14.53863116	1.051427088	0.783929699
-5.020696292	5.507720407	-0.669627533	0.745457451	1.145638215	0.915628384
-4.429530254	2.183167276	-0.626895327	0.824685359	1.175422785	2.047343344
-3.120048053	0.94556359	-0.473416516	1.426578622	1.288012733	0.177301926
-2.697803867	4.413787379	-0.423670268	1.365669613	1.315262088	0.247387425
-2.444305084	0.689918097	-0.334526192	6.229707229	1.319494836	1.63585651
-2.174816566	0.337058807	-0.324086806	4.927669365	1.329089055	0.551107472
-2.076440712	0.324787793	-0.244067534	13.53468923	1.512802335	3.034299423
-2.009103906	0.60144051	-0.220138333	1.449965989	1.570275567	0.33981722
-1.871379215	2.827274965	-0.218787649	2.658771771	1.572520236	1.41201838
-1.685405898	1.505738827	-0.15318949	1.302527418	1.572985945	0.012562309
-1.542505556	3.252216893	-0.019852526	2.067851662	1.644425782	1.873030728
-1.488923409	2.691846523	0.025061188	1.097011002	1.681173982	0.425352918
-1.394539712	1.247909467	0.234668708	13.13761833	1.716807516	0.72806138
-1.365776548	0.534337606	0.287342112	1.166057869	1.763722592	0.397582668
-1.341614196	1.91579323	0.30292095	1.19493219	2.146711025	0.70673491
-1.287477328	0.782831028	0.310771323	0.95264318	2.153434041	0.10172929
-1.226177986	2.002386866	0.400750807	0.955249958	2.259477644	7.101910737
-1.208953424	1.243262917	0.44338725	1.262744093	2.360762739	0.00572568
-1.204616578	0.518597719	0.461305127	2.212473737	2.386021064	1.03475933
-1.185339954	2.041617664	0.472220558	1.668615836	2.430311227	1.108121018
-1.16481717	1.207511091	0.490458394	1.20410271	2.935201029	1.420516473
-1.141817599	0.235861981	0.490847439	1.529807142	3.384181551	0.207024458
-1.124328698	1.690788572	0.617846026	0.820986472	4.105443449	2.744502089
-1.079428129	1.189989923	0.741370227	1.368526943	4.49653429	4.671188609
-1.019918154	20.36521089	0.782205938	1.035043954	7.280173936	1.59419033
-0.954869018	5.266195439	0.837386716	0.619122323	9.288756612	10.18663827
-0.937508802	0.570209126	0.874710974	1.726219904	9.969340172	9.80197476
-0.871874838	1.015356669	0.895342776	0.78133656	12.23625445	7.883447912