EXAM 1

Started: Mar 1 at 12pm

Quiz Instructions

Instructions:

The exam can be done online, but you should have zoom running with a camera on until you submit the exam.

You will have 3 hours to complete the exam from **Noon - 3PM on Wednesday, March 1**.

Submit the answer to each question by uploading a file (either .doc, .docx, or pdf). It is to your advantage to show your work since you may get partial credit if your answer is incorrect. So, you are encouraged to show all the steps of your thought process (uploading scratch paper is fine!). Email me if you have any questions, with the subject line **INFSCI 2410 EXAM 1 QUESTION**. Good luck!

Of course, you may **not** collaborate or receive help from any person.

You may use any printed or online reference source, but using a chatbot is not allowed.

Question 1 — 15 pts

Consider a 6-unit Hopfield Network that has stored the three patterns below.

```
P1  =   + + - - + +
P2  =   - + + + + -
P3  =   - - - - - +
```

a. Find the 15 weights in the network.

b. Using the weight matrix from part (a), find the Goodness value for the pattern **- - - - - -**

c. Find a pattern with a Goodness value greater than the pattern in part (b)

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Question 2

25 pts

a. Find an associative matrix that will store the stimulus-response pair

s1=[0 .6 0.0 -0.8 0.0] T1=[-2 3 3]

b. Find an associative matrix that will store the stimulus-response pair

s2=[0.8 0.0 0.6 0.0] T2=[2 -1 1]

c. Determine whether **s1** and **s2** are orthonormal.

d. Sum the two matrices from parts (a) and (b) and response to the stimulus vector **s3**:

s3=[1.4 1 -0.2 1]

e. Using the weight matrix from part (d), find an input vector that will generate a response of **[0 1 2]**

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Question 3

12 pts

In Matlab, type the command **rng(222)** to set the random number seed. The reason for this is so that everyone will generate the same values using the following commands:

xdata=1:6 ;

ydata = xdata + 0.5*randn(1,6) ;

a. Find a linear fit to the data. Using the linear parameters, plot the linear fit together with a scatterplot of the data.

b. Generate a polynomial fit that fits the data points **exactly**. Plot a smooth curve using the parameters, and show the fit together with a scatterplot.

c. Reset the random number seed using **rng(12345)**. Generate test data using the commands below:

xtest = 1.5:5.5 ;

ytest = xtest + 0.5*randn(1,5) ;

d. Using **polyval.m**, generate y-value estimates (predictions) from **xtest** using the linear predictor

e. Using **polyval.m**, generate y-value estimates (predictions) from **xtest** using the higher order predictor from part (b) .

f. Find summed squared error values by comparing the predicted values in parts (d) and (e) with **ytest** from part (c). Compare to determine which fit is preferred.

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Question 4

28 pts

A network with two input units with the following input patterns and targets

	Input		Target	h_1	h_2
A	0	1	0	0	0
B	1	2	1	1	1
C	2	1	1	1	1
D	1	0	0	1	0

a. Sketch the points **A,B,C,D** in stimulus space, with the points that have **Target = 1** as filled circles and points with **Target = 0** as open circles.

b. Find weights and bias values for two linear threshold units that give the responses in columns $\mathbf{h_1}$ and $\mathbf{h_2}$ in the table.

c. Assume that the hidden units $\mathbf{h_1}$ and $\mathbf{h_2}$ are inputs to an output unit **r**. Find weights and bias values for **r** that will compute the **Target** function on the inputs.

d. Use **bp3.m** to train a 2-2-1 network on this task. Plot the hidden unit representations.

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Question 5

20 pts

5. Set the random number seed using the command **rng(2023).** Create two sets of data as follows:

d1=5+randn(50,1)

d2=6+.5*randn(50,1)

a. Create a boxplot that compares the two datasets.

b. Assuming **d1** is a "negative" group and **d2** is a "positive" group (for some disease), plot the ROC curve, and find the area under the curve (AUC).

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