Xi'an Jiaotong-Liverpool University

西交利物浦大学

PAPER CODE	EXAMINER	DEPARTMENT	TEL
INT301		INTELLIGENT SCIENCE	

1st SEMESTER 2022/23 FINAL EXAMINATION

UNDERGRADUATE – YEAR 4

BIO-COMPUTATION

TIME ALLOWED: 2 HOURS

INSTRUCTIONS TO CANDIDATES

1. **This is a closed-book examination.**
2. **Total marks available are 100. This exam will count for 80% in the final assessment.**
3. **Answer all questions. There is NO penalty for providing a wrong answer.**
4. **Answer should be written in the answer booklet(s) provided.**
5. **Only English solutions are accepted.**
6. **All materials must be returned to the exam supervisor upon completion of the exam. Failure to do so will be deemed academic misconduct and will be dealt with accordingly**.

Question 1. [10 MARKS]

You want to design a neural network with sigmoid units to predict a person's academic role from his webpage. Possible roles are "professor", "student", and "staff". However, each person can take any number (from 0 to all 3) of these roles at the same time. Briefly describe:
(1) How you would represent the role label of a person in your training data. **[5 MARKS]**
(2) Suggest a possible threshold value for the outputs. **[5 MARKS]**

Question 2. [20 MARKS]

Apply the backpropagation algorithm to find the new weights of a feedforward neural network after applying the input-output pattern ({1, 0}, 0), where {1, 0} are two inputs, and 0 is the output. Assume the network has a single hidden layer with 2 neurons and all weights (including bias in hidden and output layers) are initially zero. The learning rate is 0.1 and all neurons use the sigmoid activation function. **[20 MARKS]**

Question 3. [12+6=18 MARKS]

(a) Compute the weight matrix for a Hopfield network with the two memory vectors [1; -1; 1; -1; 1; 1] and [1; 1; 1; -1; -1; -1] stored in it. **[12 MARKS]**

(b) Confirm that both these vectors are stable states of the network. **[6 MARKS]**

Question 4. [10 MARKS]
Consider the following Boolean function:

A	B	$\neg A \vee B$
1	1	1
1	0	0
0	1	1
0	0	1

Construct a perceptron network that represents the function. **[10 MARKS]**

Question 5. [5+5+5=15 MARKS]

(1) Please explain the Matlab codes related to neural networks below by providing the comments at the corresponding locations. **[5 MARKS]**

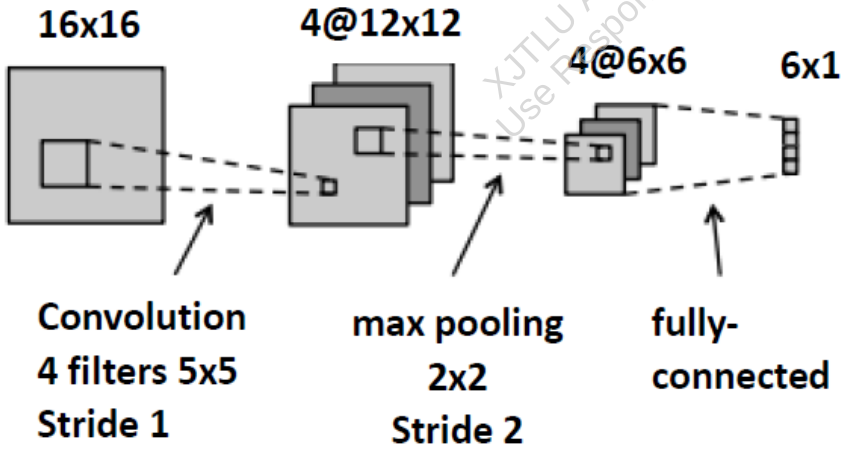
```
%
P = [A B C D];

%
T=[repmat(a,1,length(A)) repmat(b,1,length(B)) repmat(c,1,length(C)) repmat(d,1,length(D))];

%
net = feedforwardnet([5,3]);

%
[net,tr,Y] = train(net,P,T);

%
view(net)
```

(2) What would happen if the transfer functions (at the hidden and output layer) in a multi-layer perceptron would be omitted; i.e. if the activation would simply be the weighted sum of all input signals? Explain why this (simpler) activation scheme is not normally used in MLPs although it would simplify and accelerate the calculations for the backpropogation algorithm? **[5 MARKS]**

(3) Give an example of a task for which a Self-Organizing Map network would be more appropriate than a feed-forward network or a traditional competitive learning network. **[5 MARKS]**

Question 6. [5+5+5=15 MARKS]

The following figure is a diagram of a small convolutional neural network that converts a 16x16 image into 4 output values (16x16 → 4x12x12 → 4x6x6 → 6x1). The network has the following layers/operations from input to output: convolution with 4 filters, max pooling, ReLu (after pooling), and finally a fully-connected layer (with no hidden layer). For this network we will not be using any bias/offset parameters. Please answer the following questions about this network.



(1) How many weights in the convolutional layer do we need to learn? Please explain.
[5 MARKS]

(2) How many ReLu operations (after pooling, before fully-connected layer) are performed on the forward pass? Please explain.
[5 MARKS]

(3) How many weights do we need to learn for the entire network? Please explain.
[5 MARKS]

Question 7. [6+6=12 MARKS]

For a medical diagnosis problem of a certain disease, there are measurements of different medical parameters (blood pressure, blood values, etc.) that are thought to be relevant for the disease. Measurements from both patients with the disease and from healthy persons are available. The medical doctors have asked you to help them analyse and use this data to improve and simplify the diagnosis of new patients.

(1) Explain briefly what you could do with supervised learning techniques (indicate clearly the algorithm name, model/network topology, training/learning algorithm and input/output). **[6 MARKS]**

(2) Explain briefly what you could do with unsupervised learning techniques (indicate clearly the algorithm name, model/network topology, training/learning algorithm and input/output). **[6 MARKS]**

END OF EXAM PAPER