FINAL
TAKE-HOME EXAM
Fall 2017

Artificial Intelligence

CMSC 409

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Name & ID

Due Monday, Dec. 11 at 5pm.

Student certification:
Please read and sign the following statement before you begin: I fully understand that I am on my honor to do my own work on this examination. If I violate this confidence, I may receive a letter grade of "F" for this exam or for the course, or be expelled from the program.
Further, I certify that I have neither given nor received any aid on this test.

Print Name: Kyle Hammerschmidt *Date:* 12/10/17
Signed : Kyle Hammerschmidt *(you can sign/scan or use e-signature)*

Note: Select one problem between Ex.2.1 and Ex.2.2 to solve for "regular" and the other as extra credit. Problems 2.3 and 2.4 are regular credit problems.

Ex.2.1. Competitive learning *(25p)*
Examine the data set "Ex1_data.txt". This data set comes from IRIS data set https://archive.ics.uci.edu/ml/datasets/Iris, with labels and two out of four features removed. Code and execute Kohonen's Winner Take All clustering algorithm. Test the following assumptions:

1. Use the two-neuron, single layer network and assign weights randomly. First run the algorithm once to explore the data. Use the outcome to understand the arrangement of data points (you can also plot the data and weights). Based on what you understood, choose more suitable initial weights and run the algorithm on the same network again. Observe the changes in weights (plot) after each pattern applied. Report on the process of choosing weights, number of iterations, speed of convergence, and other "lessons learned". Attach the code and plots created during process. Provide intermediate and final plot describing clusters found.
2. Repeat 1. with 3 and 7 neurons. Discuss.

Ex.2.2. Bayes classifier *(25p)*
Examine the training and testing data sets: "Ex2_train.txt" and "Ex2_test.txt". This is also IRIS data set https://archive.ics.uci.edu/ml/datasets/Iris, but with labels this time (and three out of four features removed). Code the Bayes classifier.

1. Use training data set to estimate $P(x|C_i)$ and $P(C_i)$. Plot density probability distributions.
   a. Execute trained Bayes classifier on test data set. How accurate the algorithm is?

Attach the code and other plots you may have created. Discuss the solution.

Note: Bayes classifier is a representative of supervised clustering techniques. Provided data set contain three classes.

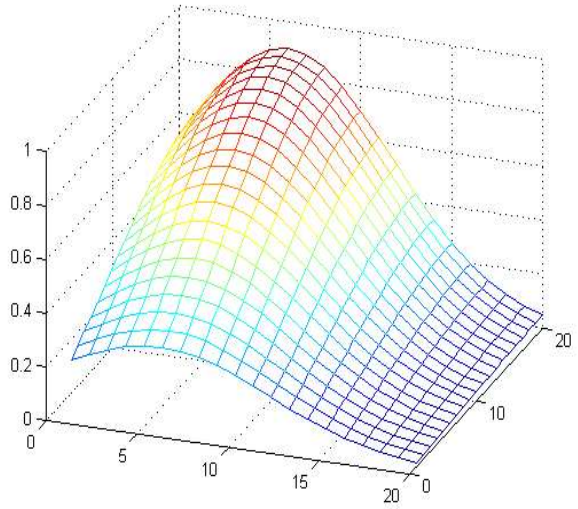
Ex.2.3. Designing controller *(35p)*
The required control surface is given by the following formula:

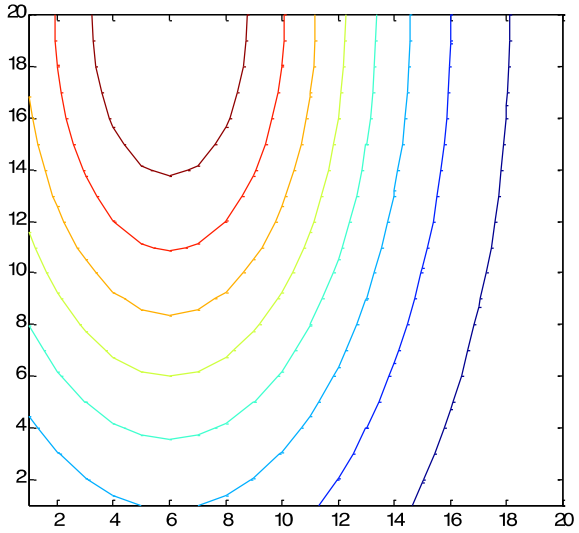
$$z = 0.9 \exp\left[-0.003 \left(x - 20 \right)^2 - 0.015 \left(y - 6 \right)^2 \right]$$

and the following MATLAB code:

```
clear all; x=[1:20]; y=[1:20];
for i=1:20;   for j=1:20;
    z(i,j)=0.9*exp(-0.003*(x(i)-20).^2-0.015*(y(j)-6).^2);
end; end;
figure(1); clf; contour(z);
```

```
figure(2); clf; mesh(z); view(20,30);
```





Manually design a fuzzy controller for the given control surface. Select adequate number membership functions for both input variables (you may select equal or not equal spacing). Use triangular membership functions. Identify adequate number of output singletons with values of your choice. Fully document the design process of your controller.

a) Test your controller on two points:
   Point 1: values (X,Y)=(6, 6).
   Point 2: values (X,Y)=(18, 18).
b) Plot required control surface and control surface from your controller. Compare and comment.
c) What is the error of your controller? Can you plot this error (the difference between the two)? Discuss and comment.

Ex.2.4 Creating neural network via design (selecting 2D area) *(15p)*

A character presented via square patterns is shown in the figure below.

a) Design a network that extracts a character formed by rectangular patterns.
b) Clearly indicate your choice of transfer function and neuron definition. Draw the network architecture and clearly indicate weights. Present desired outputs.
c) Comment.