FINAL
TAKE-HOME EXAM
Fall 2015

Artificial Intelligence

CMSC 409

Name & ID

Starting on Friday, Dec. 4 at 6pm,
due Sunday, Dec. 6 at 6pm.

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: _____ *Date:*_____
Signed : _____

Ex.2.1. *(40p)*
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 network and randomly assign weights. Run the algorithm to explore the data first. Try to understand (you can also plot the data and weights) the arrangement of data points. 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. *(40p)*
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 sets contain three classes.

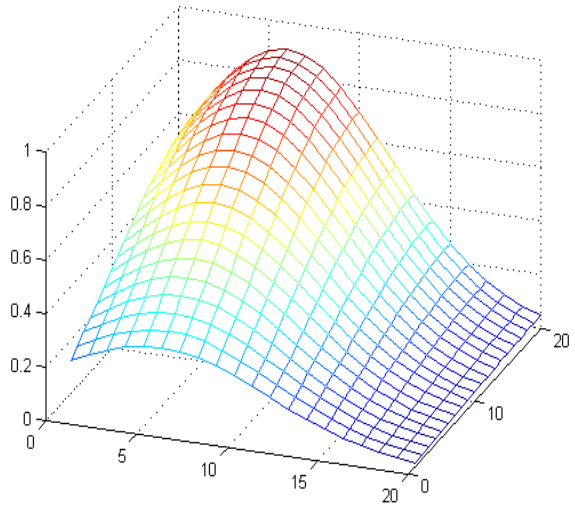
Ex.3. Extra Credit *(40p)*

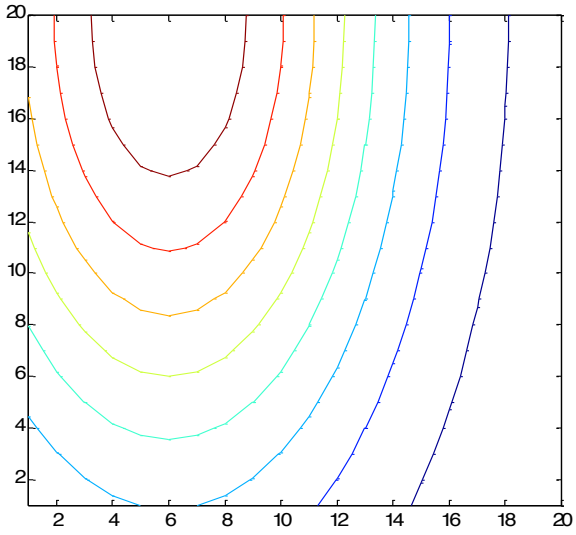
The required control surface is given by the following formula:

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

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)=(5, 10).
   Point 2: values (X,Y)=(18, 18).
b) Compare the results obtained from your controller and results obtained from analytical form. What is the error of your controller? Discuss and comment.