ELE 888 Intelligent Systems

Lab 0: Introduction to Matlab

Objective

- To get familiarized with the Matlab programming environment

Background

Introduction to Matlab Software

Matlab, developed by Mathworks Inc., is a powerful software environment that integrates numerical computation, visualization, and a high-level language with an extensive range of application-specific toolboxes[1] . It is designed to handle large datasets and matrix operations easily and efficiently. It is well suited for solving problems in various engineering disciplines and especially an attractive software tool for pattern classification applications.

In the lab machines to run Matlab, type matlab at the xterm prompt. Type intro at the Matlab prompt to get an introduction to the package. Matlab has extensive online documentation on its commands and toolboxes. If you feel you need more assistance, type help at the Matlab prompt (help topic, will give you help on the topic requested). Matlab commands can be executed at the prompt individually or can be grouped to run specific tasks as programs. To quit Matlab at any time, type quit at the Matlab prompt.

Practice Programming Exercises

Part I

Type help topic to learn about the following functions relevant to ELE 888/ EE 8209 :
zeros, ones, min, max, std, abs, median, sum, sort, hist, norm, corrcoef, cov, size, length, det, inv, eye, diag, rand, save, clc, clear, load, whos, imread, imshow, imhist, pi, plot, plot3d, mesh, subplot, semilogy, axis, xlabel, ylabel, title, grid, print, pause, text

Part II

Type the following expressions step by step at the Matlab prompt and observe the output

Vectors and Matrices

```
V=[3, 6, 9, 1.25, -2]

V(3)

find(V<4)
```

[1] A Matlab toolbox is a collection of programs specific to a particular application area

```
M=[3 4 6; 2 5 7; 1 2 4]
M'      % Transpose
M(1:3, 2)
B = M(1:2, :)
K=[1 2 3; 4 5 6]
L=[2 3; 1 2; 6 5]
P=K*L  % Matrix multiplication
P^2
N=M(:,1:2)'
K+N    % Matrix Addition
K-N    % Matrix Subtraction
Z = zeros(2, 4)
F = 4*ones(1, 3)
diag(M)
eye(3,3)
```

Data Analysis

```
D1=[2 -1 6 21 1 0 -11 3 2 8]
min(D1)
max(D1)
std(D1)
D2=[2 -1; 6 21; 1 0]
corrcoef(D2)
cov(D2)
```

Save, Load, and Clear

```
whos
clear all
whos
D1=[2 -1 6 21 1 0 -11 3 2 8]
D2=[2 -1; 6 21; 1 0]
whos
clear D2
whos
save Data D1
save Data_asc D1 -ascii
clear all
load Data
whos
clear all
load Data_asc
whos
```

Relational and Logical Operators

```
% A value of  ‘ ‘1’ ’  is returned when a statement is TRUE and a value of
 ‘ ‘0’ ’  is
% returned when a statement is FALSE
6<4
6>4
7~=3+4
7<=5
9==3+3+3
(2==1+1) & (7==9-2)
(11>=12) | (15==7+8)
```

```
~(7==3+4)
```

Flow Control Statements

```
%if . . .   else . . .  end

%for . . . end

clear all

A = [3 0 7]
for i=1:3
if( A(i)==0 )
%do nothing
else
A(i)=A(i)+100
end
end

%switch . . . case . . . end

%while . . . end
```

Plots

```
% A sine wave plot

step=1/1000;

t=0:step:1;

s=sin(2*pi*10*t);

plot(s)

xlabel(' time in seconds' )

ylabel(' amplitude in volts' )

title(' sine wave' )
```

```
% A sample feature space

A=[0.1 0.3 0.25 0.4 0.15 0.51 0.62 0.8 0.58 0.9];
B=[0.11 0.23 0.5 0.36 0.27 0.75 0.68 0.59 0.65 0.8];
plot(A(1:5),B(1:5),' b+' );
hold on
plot(A(6:10),B(6:10),' ro' );
axis([0 1 0 1])
xlabel(' Sample Feature 1' )
ylabel(' Sample Feature 2' )
title(' Feature Space' )

% An example 3D plot

[X,Y]=meshgrid(-3:.125:3);
z=peaks(X,Y); %Matlab built-in-function, use help to learn more about this
function.
meshc(X,Y,Z);
axis([-3 3 -3 3 -10 5]);
```

Part III

M-File (functions)

```
%*********************************************************************
%* Author: Xiofeng Wang
%* ID # : 112903
%* Lab Sec: 0
%* Lab #: 0
%* File: statex.m
%* Date: Jan 16, 2007
%*********************************************************************
function [me, stdev] = statex(x)
% Mean and standard deviation
[m n] = size(x);
if m == 1
    m = n;
end
me = sum(x)/m;
temp=x-me;
stdev = sqrt((1/(m-1))*sum(temp.^2));

%*********************************************************************


% save the above program as statex.m
% call the program from the Matlab command prompt

clear all
A=[7 4 2 5];
[Amean,Astdev]=statex(A)
```

Note: The above handout covers only few basic Matlab operations. Extensive Matlab learning resources are available in the public domain and students who need to improve their Matlab skills are encouraged to utilize those resources.

Part IV

Familiarization with the UC Irvine Machine Learning Repository
- (Real-World Datasets for Machine Learning/ Pattern Classification)

The UCI machine learning repository is a valuable source of real-world data sets relating to specific machine learning problems that have been, or continue to be the subject of ongoing research. These datasets are made available to the general machine learning community, and are often useful when attempting to benchmark various classification techniques.

Website: *archive.ics.uci.edu/ml/*

In this final exercise, please become familiar with the site, and some of the datasets on offer.
In particular, please consider the following 2 datasets:
a) IRIS
b) WINE

With reference to the Matlab help system (F1) for reading external files (text, etc), download both sets of data and write a function to read each data set into an array form.
(The datasets along with their descriptions can be downloaded from the link at the top of each associated page).

Experiment with some of the functionality explored in earlier parts of this lab and investigate the commands "*figure()*" and "*subplot()*".

Use them to create a figure that contains 2x2 subplots, where each subplot shows a scatter plot of data samples in terms of two different features (attributes). I.e., for IRIS, one of the subplots would show the distribution of samples in the IRIS dataset by plotting attribute 1. (sepal length in cm) vs. Attribute 2. (sepal width in cm).

Use the class labels to plot points in the above graphs according to different colours/markers. Finally, consider which features/attributes appear to achieve good vs. weak separation of the existing classes.