An Introduction to Matlab

For CSE 802: Pattern Recognition

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Start Matlab

- You can access it from CSE lab but it's more easy to go to engineering lab and use Matlab there.
- Machines in engineering building's labs.
  - Start->All Programs->Matlab 7.0.
- License issues, especially for some toolbox.
  - Exit Matlab if you do not use it.

Topics

- Data structure of Matlab.
- Some useful Matlab functions for this course.
- Plotting of data.
- Two examples:
  - Plotting of multivariate Gaussian data.
  - PCA: compute PCA and plot the data of reduced dimensionality.

Scalars, Vectors and Matrices

- Scalar:
  - Just a number: a = 1; b = 3;
- Vector:
  - Column vector: a = [1; 2; 3; 4].
  - Row vector: b = [1 2 3 4].
  - Transpose: a = b';
- Matrix:
  - A = [1 2 3; 4 5 6; 7 8 9];

Access Elements in Matrices

- Access a single element.
  - A[row index, colum index]
  - A[1,3] = 3;
- Access a sub-matrix.
  - Extract out part of rows: B = A[1:2, :];
  - Extract out part of columns: C=A[:,1:2];

Operations on Matrix

- Cell by cell operation.
  - ‘.’
  - E.g. B = A.^2;
  - B= [1 4 9; 16 25 36; 49; 64; 81];
- Matrix operation.
  - ‘+’, ‘-’, ‘*’.

Control Structures for Matlab(1)

- Conditional statements.

```
if expression1
    statements1
elseif expression2
    statements2
else
    statements3
end
```

- Example

```
if (a>3)
  b=4;
end;
```

Control Structure for Matlab(2)

- Loop structure: for loop

```
for variable = expression
    statements
end
```

```
j=0;
for i=1:10
        j = j+i;
end
```

- Loop structure: while loop.

```
while expression
    statements
end
```

Symbolic Toolbox(1)

- Declare a symbol object.
  - Not a number but a symbol.
  - Syntax: syms arg1 arg2 ... real.
  - Use symbols to represent a function.

```
syms x u real
syms s positive
f = exp(-(x-u)^2/s^2);
```

Symbolic Toolbox(2)

- Manipulate the function.
  - Compute integration.
  - g = int(f,x, -inf, inf); result: g =s*pi^(1/2)
  - Gaussian distribution: f/g
- There are many other ways to manipulate the functions: e.g. differentiation.

Load and save data

- Load data:
  - Matrix format: load(‘file path’);
- Save data:
  - Matrix format: save(‘file path’, ‘matrix name’, ‘-ascii’);

Common Functions in CSE 802

- Functions related to Multivariate Gaussian distribution.
  - mean(A)
  - cov(x), cov(x,y); x, y are vectors.
  - inv(A): inverse of the matrix.
  - det(A): determinant of the matrix.
  - mvnrnd(mu, sigma, num of data.)
- Functions related to dimensionality reduction.
  - eigs(A): compute eigenvector of A.

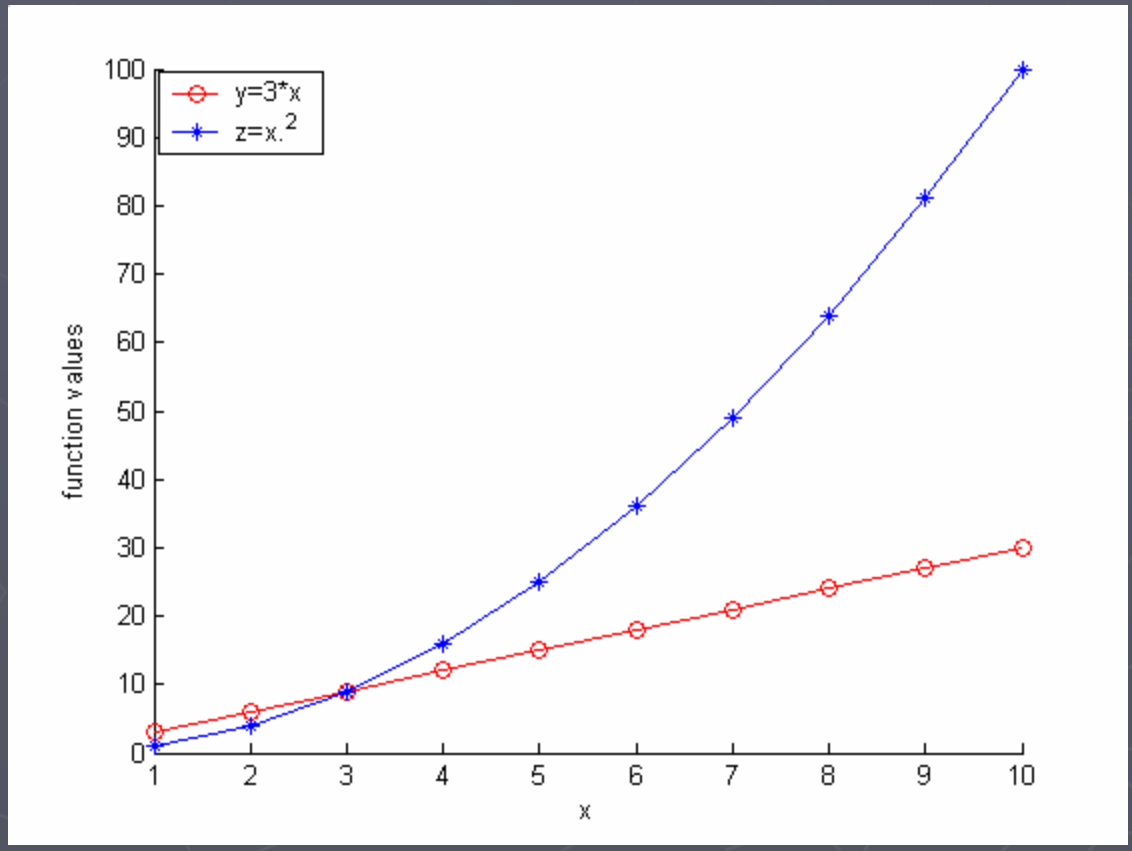
Plotting

- Plot function:
  - Plot one line: plot(X1,Y1,LineSpec).
  - Plot several lines on the same figure:
    - figure(1);
    - hold on;
    - plot(x1, y1, LineSpec1);
    - plot(x2, y2, LineSpec2);
    - ...
    - hold off;
    - legend(‘line 1’, ‘line 2’, ...);
    - xlabel(‘description of x axis’); ylabel(‘description of y axis’);

Plotting Example

```
x = 1:10 ;
y = 3*x;
z = x.^2;

figure(1)
hold on;
plot(x, y, '-ro');
plot(x, z, '-b*');
hold off;
legend('y=3*x', 'z=x.^2');
xlabel('x');
ylabel('function values');
```

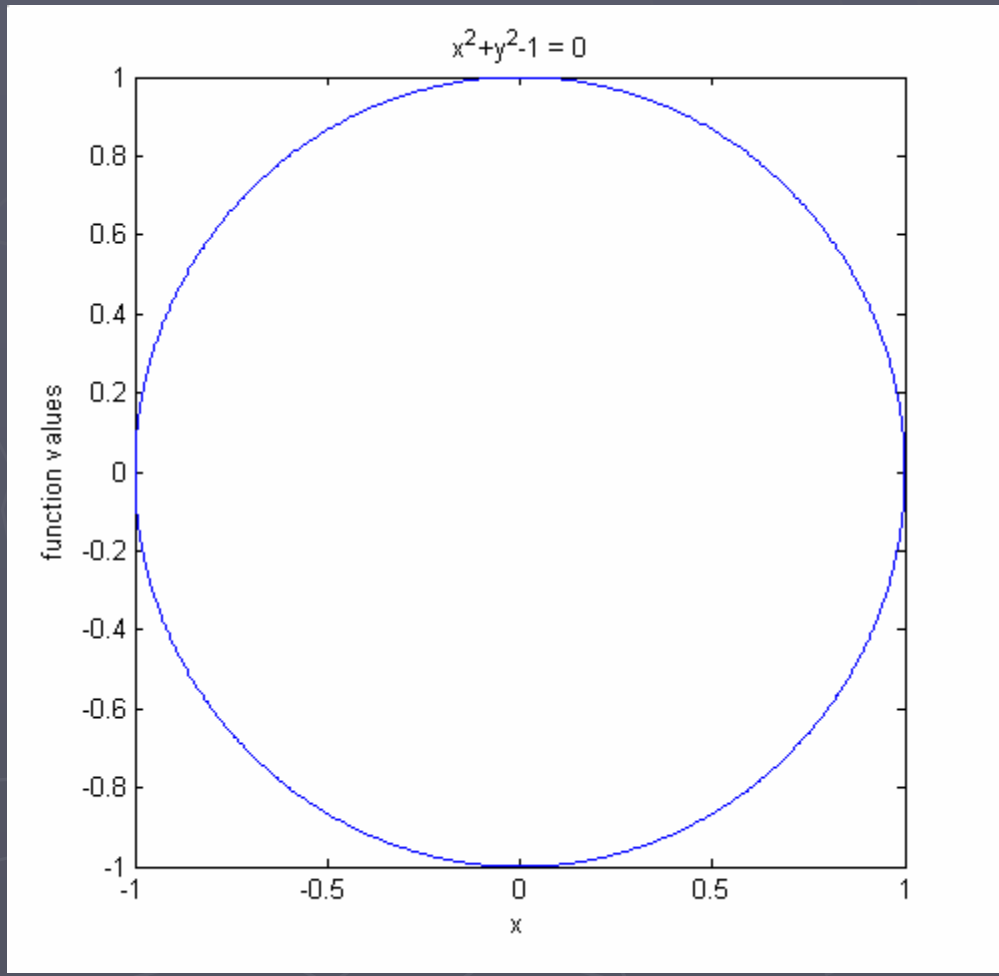


Ezplot

- Mainly used for implicitly defined functions.
  - Sometimes, it's more convenient to plot the implicit form of the functions.
    - E.g. $x^2 + y^2 = 1$
  - Function format: ezplot(f,[xmin,xmax,ymin,ymax]) plots f(x,y) = 0 over xmin < x < xmax and ymin < y < ymax.
    - The first parameter f is passed as a string.

Ezplot Example

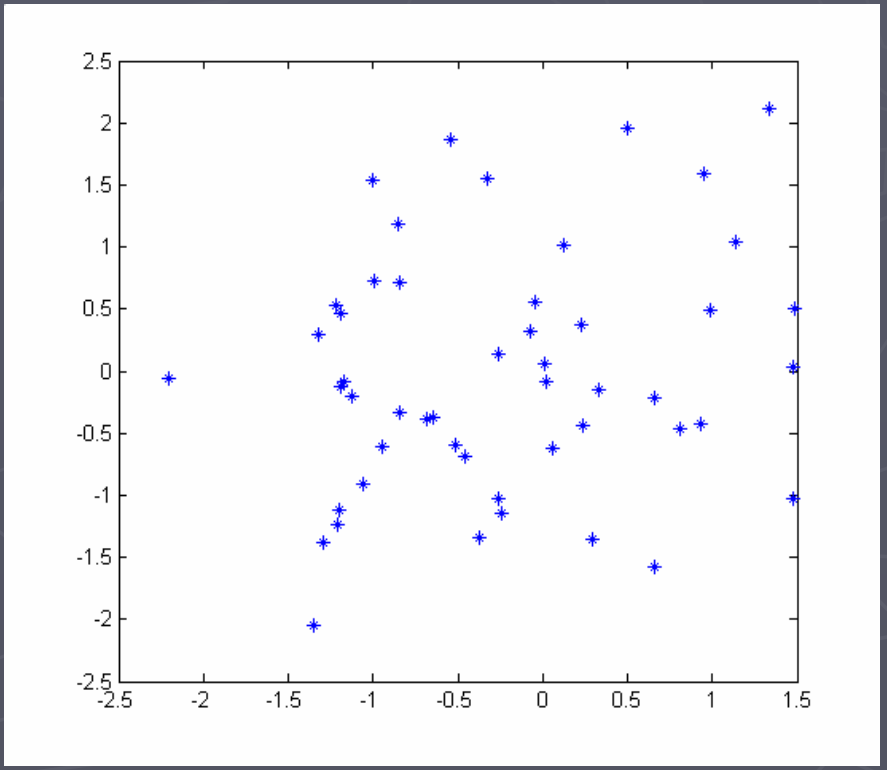
```
figure(1)
ezplot('x^2+y^2-1',[-1,1,-1,1]);
xlabel('x');
ylabel('function values');
```



Generate Multivariate Gaussian Data

- Generate multivariate Gaussian data.
  - rand_data = mvnrnd(mu, sigma, num of data.)
  - E.g.

```
mu1 = [0 0];
sigma1 = [1 0; 0 1];
r1 = mvnrnd(mu1, sigma1, 50);
plot(r1(:,1), r1(:,2), '*');
```



PCA to Extract the Major Information in Data and Plot it.

- PCA to reduce dimensionality of data and plot them in 2-D space.

- Example: IRIS data:
  - four dimensional data. Hard to visualize.
  - Apply PCA to reduce to two dimensional data and plot them.

Example codes of PCA

- Codes:

```
X = load('iris_data');
c = mean(X);
X = X - repmat(c, size(X,1), 1);
covar = cov(X);
opt.disp = 0;
[p, D] = eigs(covar, 2, 'LA', opt);
reduced = X*p;
figure(1)
hold on;
plot(reduced(1:50, 1), reduced(1:50, 2), 'o');
plot(reduced(51:100, 1), reduced(51:100, 2), '*');
plot(reduced(101:150, 1), reduced(101:150, 2), '+');
hold off;
legend('Setosa', 'Versicolour','Virginica');
```

Plot of PCA