MATLAB: Introduction

Part 2

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Outline

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1 MATLAB Classes

ND Arrays

- MATLAB allows *multidimensional* arrays (*n* dimensions)
  - `>> nd1 = zeros(2,3,4)` % `2-by-3-by-4` full of 0s
  - `>> nd2 = ones(10,5,8,7)` % `10-by-5-by-8-by-7` full of 1s
  - `>> nd1(:,1,2) = 1:2` % Replaces column 1 of *page* 2 by `[1,2]`
  - `>> nd2(:,:,5,7) = rand(10,5)` % Replaces rows and columns of *page* 5 and *chapter* 7 by random `10-by-5` matrix

Cell and Structure Arrays

- Cell Arrays (`cell`): generic *containers* (store any type of data)
  - `>> cell1 = {'aaa', 1, rand(2,3)}` % Use curly braces to retrieve/assign values
  - `>> a = cell1(1)` % 'a' is the first ***container*** (also a `cell`)
  - `>> b = cell1{1}` % 'b' is the first ***content*** (a `char` array)
  - `>> cell1{:}` % *{:}* generates a *comma-separated list*
  - `>> [a,b,c] = cell1{:}` % Assigns each *content* to a variable
- Structure Arrays (`struct`): data types with *fields* and *values*
  - `>> methane.omega = .012;` % Methane's acentric factor
  - `>> methane.Tc = 190.6;` % Its critical temperature, K
  - `>> methane.Pc = 45.99;` % Its critical pressure, bar
  - `>> methane` % Display `methane` fields and values

2 Elements of Programming

Relational and Logical Operators

- Relational Operators:

`>, <`	greater than, smaller than
`>=, <=`	greater or equal than, smaller or equal than
`==, ~=`	equal to, not equal to

- Logical Operators:

`&&, &`	short-circuiting AND, element-wise AND
`||, |`	short-circuiting OR, element-wise OR
`~`	element-wise NOT

`if-elseif-else` Statements: Flow Control

- General form:

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

- Example:

```
r = rand;
if (r < .3)
      r = r*2;
elseif (r >= .3 && ...
         r < .6)
      r = r*3;
else
      r = r*4;
end
```

`switch-case` Statements: Flow Control

- General form:

```
switch switch_expr
       case case_expr
              statement, ..., statement
       case {case_expr1, case_expr2, case_expr3, ...}
              statement, ..., statement
       otherwise
              statement, ..., statement
end
```

- Example:

```
method = 'Bilinear';
switch lower(method)
     case {'linear', 'bilinear'}
          disp('Method is linear')
     otherwise
          disp('Unknown method')
end
```

`for` Loop Statements

- General form:

```
for var = init:step:end
      statement
      statement
      ...
end
```

- Example:

```
a = zeros(10);
for i = 1:10
   for j = 1:10
      a(i,j) = 1/(i+j-1);
   end
end
```

`while` Loop Statements

- General form:

```
while expression
      statement
      statement
      ...
end
```

- Example:

```
x0 = .5;
x = x0 - tan(x0);
while (sqrt(x^2 - x0^2) > 1E-3)
      x0 = x;
      x = x0 - tan(x0);
end
sprintf('x_end = %g', x)
```

`try-catch` Statements: Error Handling

- General form:

```
try
      statement
      ...
catch [ME] % Optional
      statement
      ...
end
```

- Example:

```
try
      fid = fopen('a.txt', 'r');
      d_in = fread(fid);
catch EX
      disp('Exception caught!')
      EX
end
```

3 Plotting

3.1 2-D Plotting

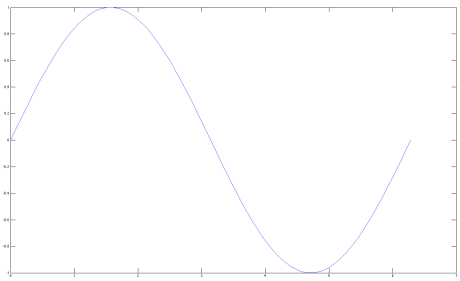
2-D Plotting

- The plotting commands in MATLAB work in a similar way: `command(data1,data2,...,['Prop1Name',Prop1Value,...])`

  where `data1`, `data2`, ... are arrays of data to be graphed and `'Prop1Name'`, `Prop1Value`, ... are the plotting properties' names and respective values (optional)

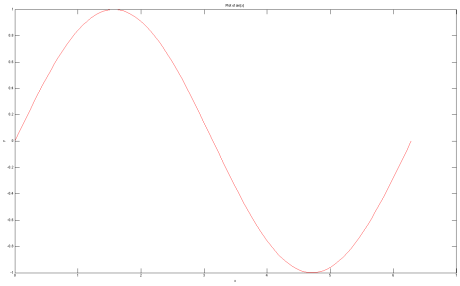
- See MATLAB's Help for a description of all `lineseries properties`
- Some plotting commands: `plot`, `loglog`, `semilogx`, `semilogy`
- Basic example: plot `sin(x)` between `[0, 2π]`

```
x = linspace(0,2*pi);
y = sin(x);
figure
plot(x,y);
```



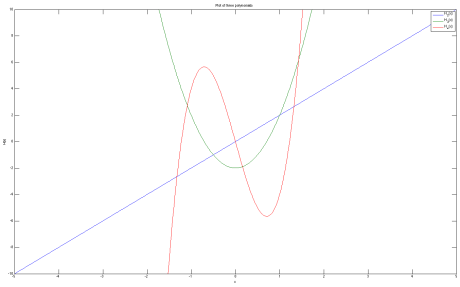
- Adding more information to the plot of `sin(x)` between `[0, 2π]`

```
x = linspace(0,2*pi);
y = sin(x);
figure
plot(x,y,'Color','red');
title('Plot of sin(x)');
xlabel('x');
ylabel('y');
```



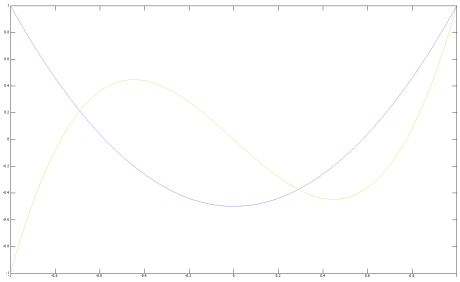
- Plotting multiple data on the same figure

```
x = linspace(-10,10,1000);
y = 2*x;
z = 4*x.^2 - 2;
w = 8*x.^3 - 12*x;
figure
plot(x,y,x,z,x,w);
title('Plot of three polynomials');
xlabel('x');
ylabel('H(x)');
ylim([-10 10]);
legend('H_2(x)','H_3(x)','H_4(x)');
```



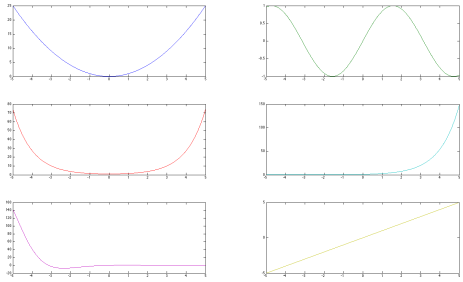
- Plotting multiple data on the same figure with `hold on` and `hold off`

```
x = linspace(-1,1,1000);
y = (3*x.^2 - 1)/2;
z = (5*x.^3 - 3*x)/2;
figure
plot(x,y,'Color',rand(1,3));
hold on;
plot(x,z,'Color',rand(1,3));
hold off;
```



- Adding multiple plots on the same figure: `subplot`

```
x = linspace(-5,5,1000).';
y = [x.^2, sin(x), cosh(x), exp(x), exp(-x).*sin(x), x];
colors = lines(6);
figure('Name','3-by-2 Plots','Color','white');
for i = 1:6
    subplot(3,2,i);
    plot(x,y(:,i),'Color',colors(i,:));
end
```

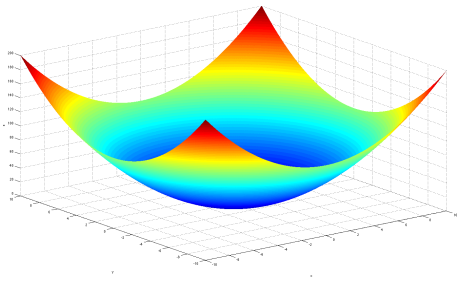


3.2 3-D Plotting

3-D Plotting

- In three dimensions, you can plot lines (`plot3`) and surfaces (`surf`, `surfc`, `mesh`, `meshc`)
- See MATLAB's Help for a description of all `surface properties`
- Set the current color map with the command `colormap`
- Basic example: plot `z = x^2 + y^2`

```
x = linspace(-10,10,1000);
y = x;
[X,Y] = meshgrid(x,y);
Z = X.^2 + Y.^2;
figure
surf(X,Y,Z,'EdgeColor','none');
xlabel('x');
ylabel('y');
zlabel('z');
```



- Adding contours to `z = x^2 - y^2`

```
x = linspace(-5,5,50);
y = x;
[X,Y] = meshgrid(x,y);
Z = X.^2 - Y.^2;
figure
colormap('cool');
meshc(X,Y,Z);
xlabel('x');
ylabel('y');
zlabel('z');
```