Outline

plot

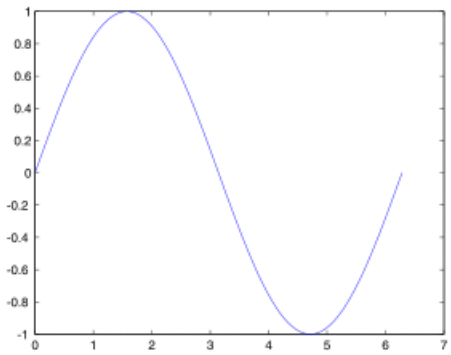
Graphics

[edit]

Function *plot* can be used to produce a graph from two vectors *x* and *y*. The code:

```
x = 0:pi/100:2*pi;
y = sin(x);
plot(x,y)
```

produces the following figure of the sine function:

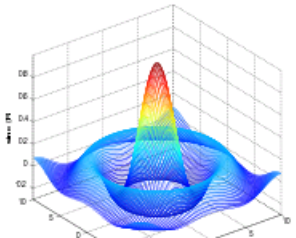


TEXT IS TOO SMALL, SO READ THIS ON YOUR SCREEN!

Three-dimensional graphics can be produced using the functions *surf*, *plot3* or *mesh*.

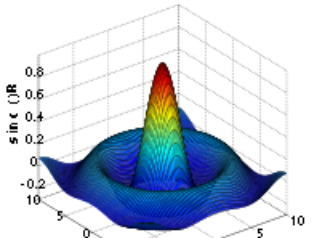
```
[X,Y] = meshgrid(-10:0.25:10,-10:0.25:10);
f = sinc(sqrt((X/pi).^2+(Y/pi).^2));
mesh(X,Y,f);
axis([-10 10 -10 10 -0.3 1])
xlabel('{\bfx}')
ylabel('{\bfy}')
zlabel('{\bfsinc} ({\bfR})')
hidden off
```

This code produces a **wireframe** 3D plot of the two-dimensional unnormalized sinc function:



```
[X,Y] = meshgrid(-10:0.25:10,-10:0.25:10);
f = sinc(sqrt((X/pi).^2+(Y/pi).^2));
surf(X,Y,f);
axis([-10 10 -10 10 -0.3 1])
xlabel('{\bfx}')
ylabel('{\bfy}')
zlabel('{\bfsinc} ({\bfR})')
```

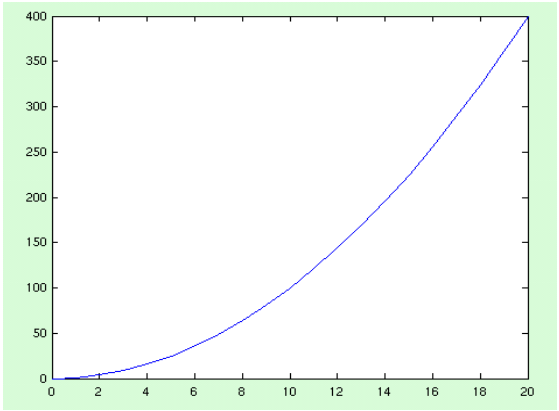
This code produces a **surface** 3D plot of the two-dimensional unnormalized sinc function:



2D plotting

1. Define x-vector
2. Define y-vector
3. plot(x,y)

```
>> x = 1:20;
>> y = x^2;
>> plot(x, y)
```



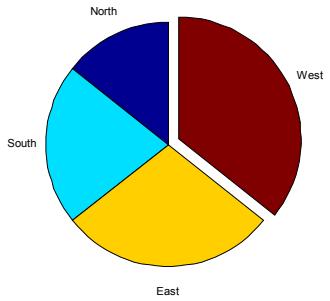
plot just gives a normal x-y graph with linear axes.

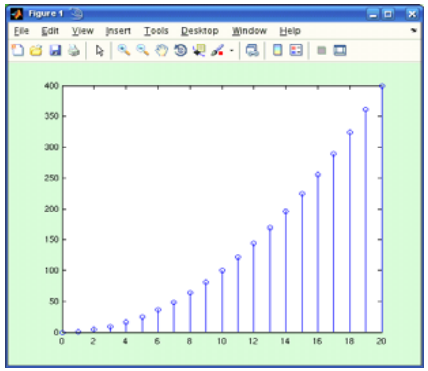
There are other 2D plotting commands, e.g:

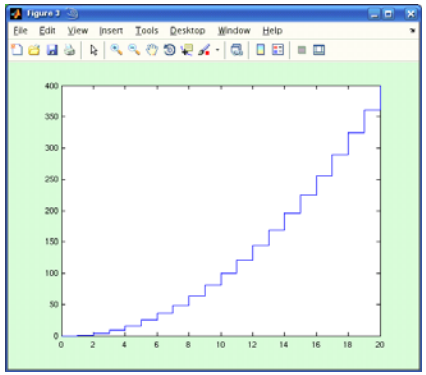
semilogy, semilogx, loglog

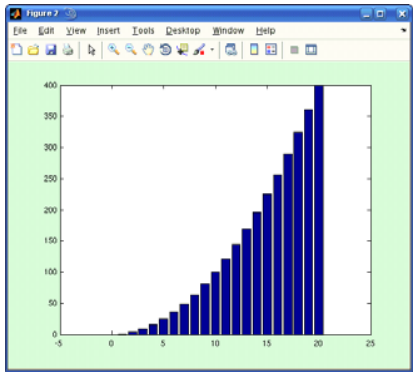
stem, stairs, bar

pie, hist









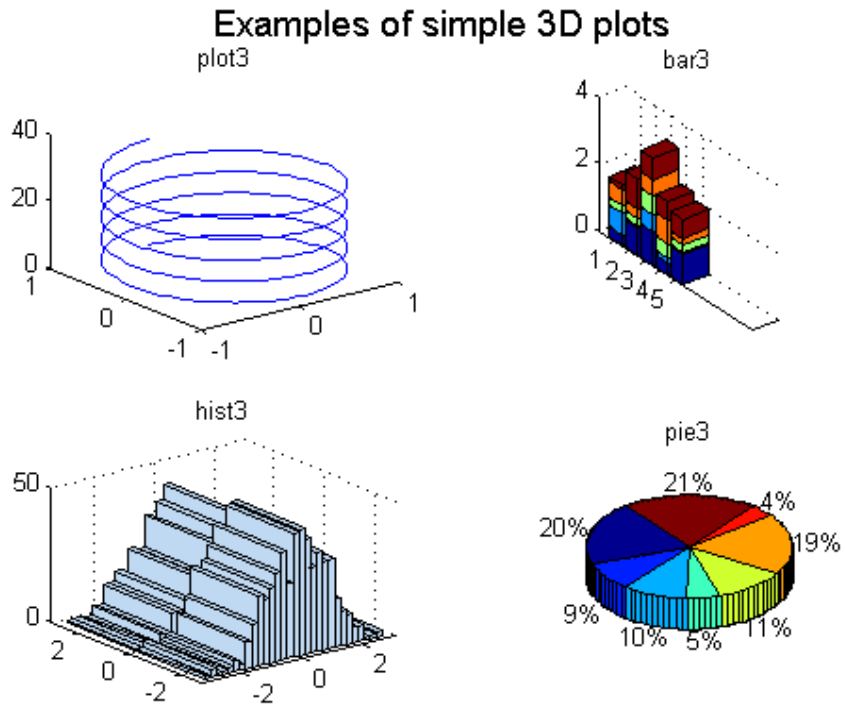
3D plotting

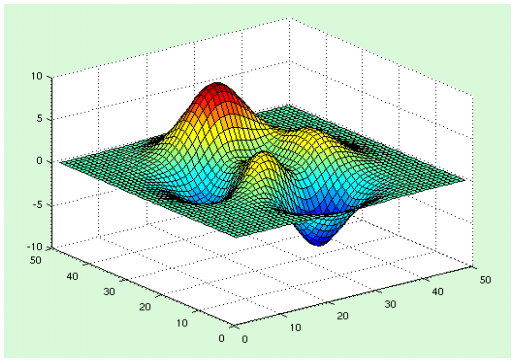
1. Define x-vector
2. Define y-vector
3. Define z-vector
4. plot3(x,y,z)

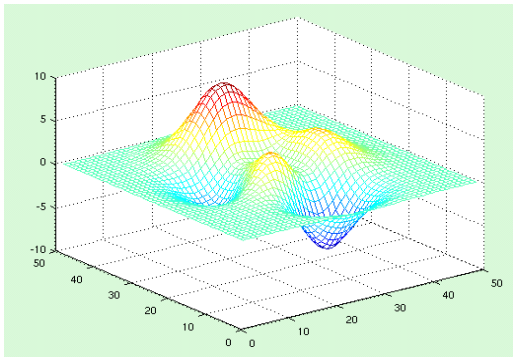
There are other 3D plotting commands, e.g:

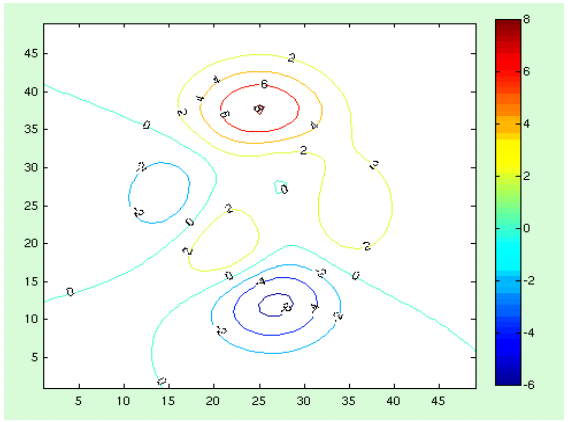
surf, mesh, contour

pie3, bar3, hist3







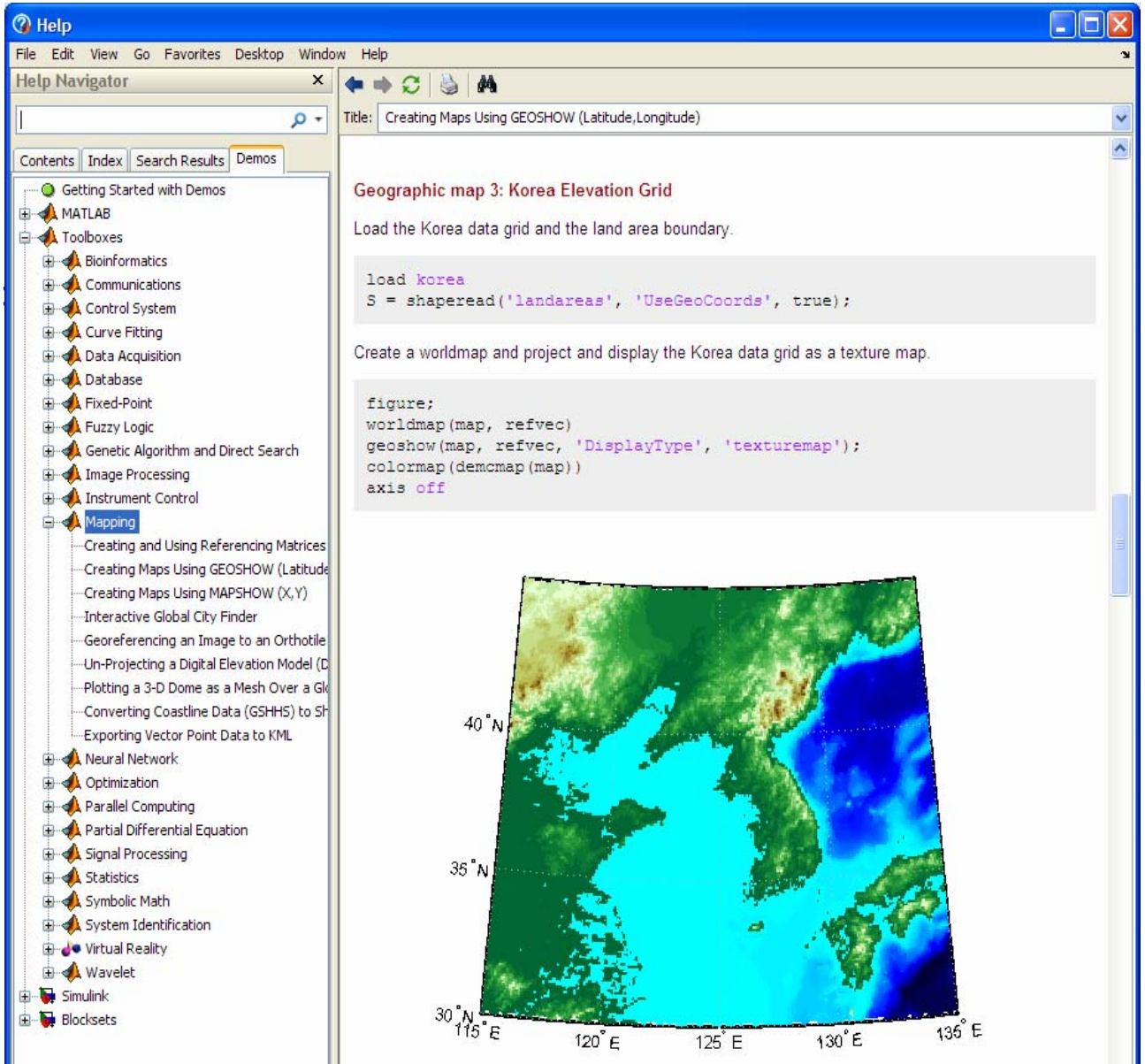


Plotting maps: the Mapping Toolbox

>> help map
>> mapdemos

Can write KML (GoogleEarth):
>> help kmlwrite

Alternative to GMT



Outline

Changing the line style: plot(x,y,s)

By default, plot(x,y) uses a blue line to connect data points

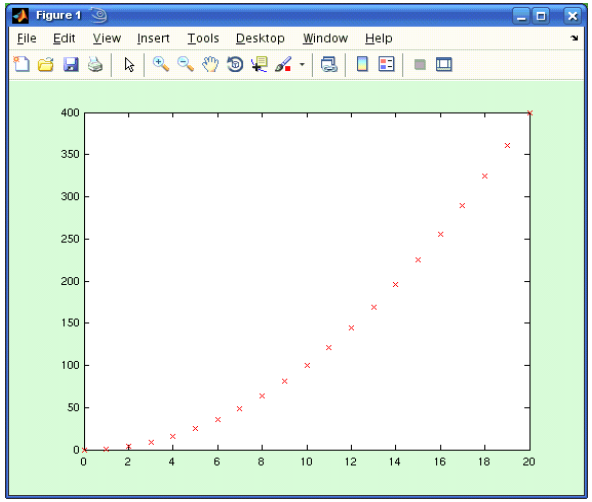
>> help plot

```
Various line types, plot symbols and colors may be obtained with
    PLOT(X,Y,S) where S is a character string made from one element
    from any or all the following 3 columns:

        b     blue          .     point              -     solid
        g     green         o     circle             :     dotted
        r     red           x     x-mark             -.    dashdot
        c     cyan          +     plus               --    dashed
        m     magenta       *     star             (none)  no line
        y     yellow        s     square
        k     black         d     diamond
        w     white         v     triangle (down)
                            ^     triangle (up)
                            <     triangle (left)
                            >     triangle (right)
                            p     pentagram
                            h     hexagram
```

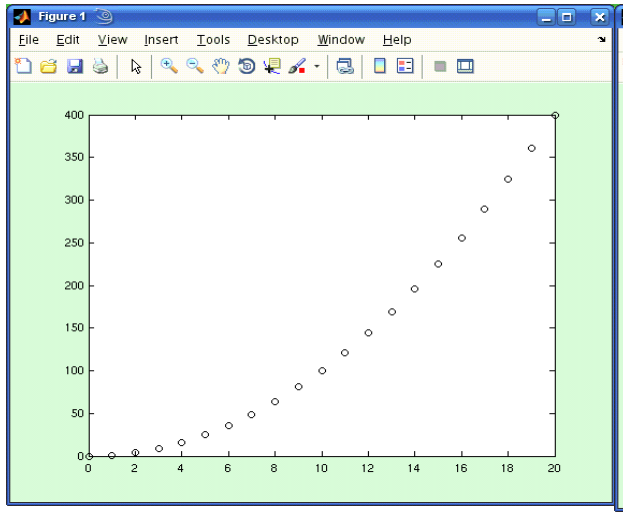
plot(x,y,s)

plot(x,y,'rx')



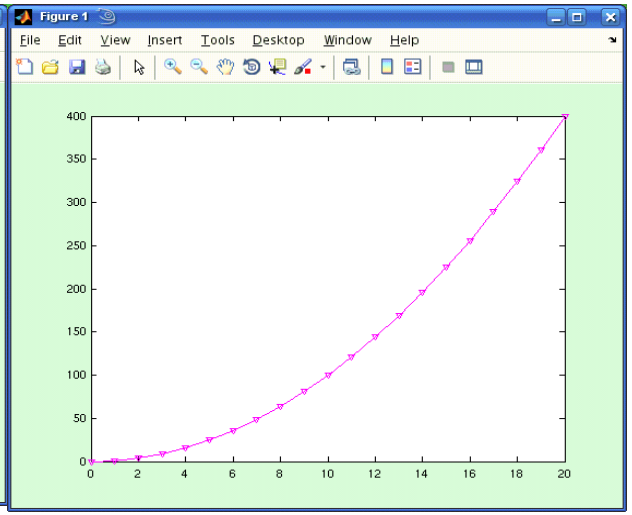
red crosses

plot(x,y,'bo')



black circles

plot(x, y, 'mv-')



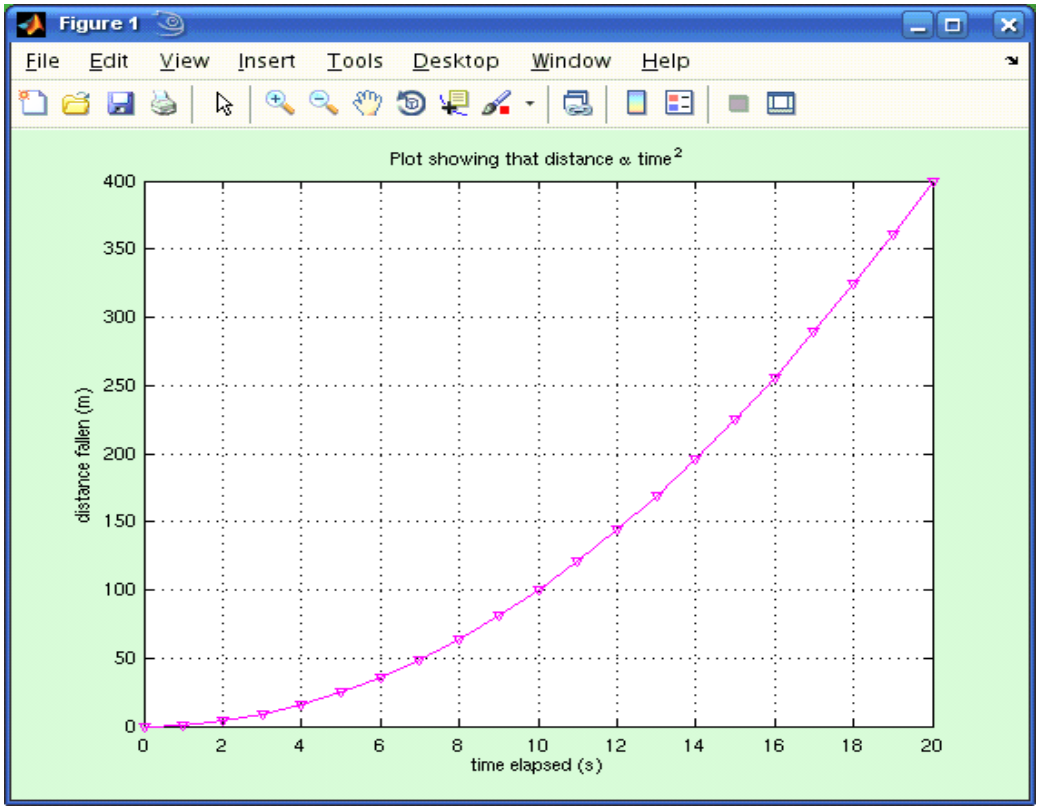
magenta triangles + line

Labelling axes

```
>> xlabel('time elapsed (s)');
>> ylabel('distance fallen (m)')
>> title('Plot showing that distance \alpha time^2')
>> grid on
>>
```

xlabel
ylabel
title
grid on

Superscripts: ‘time^2’ => time^2
Subscripts: ‘SO_2’ => SO_2
Greek characters: \alpha => α



Adding text

To add text at the position xpos, ypos to the current axes use:
>> **text(xpos, ypos, ‘some_string’)**;

Remember you can use sprintf.
>> **text(2.3, 5.1, sprintf(‘station %s’,station{stationNum}));**

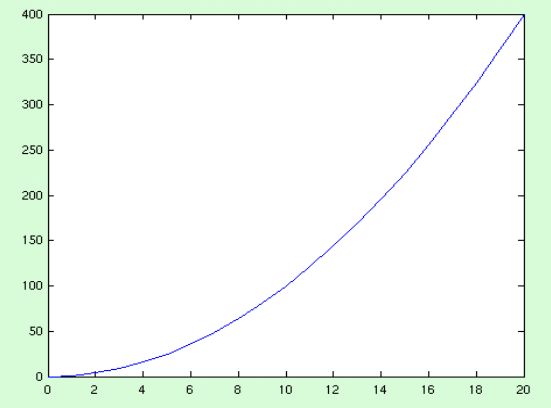
Changing the data range shown

Default: show all the data.

To override use:

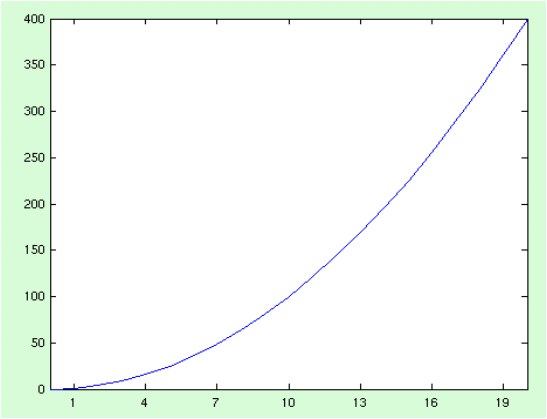
>> **set(gca, 'XLim', [xmin xmax]);** % x-axis only
>> **set(gca, 'YLim', [ymin ymax]);** % y-axis only
>> **set(gca, 'XLim', [xmin xmax], 'YLim', [ymin ymax]);** % both axes

Changing the tick positions/labels

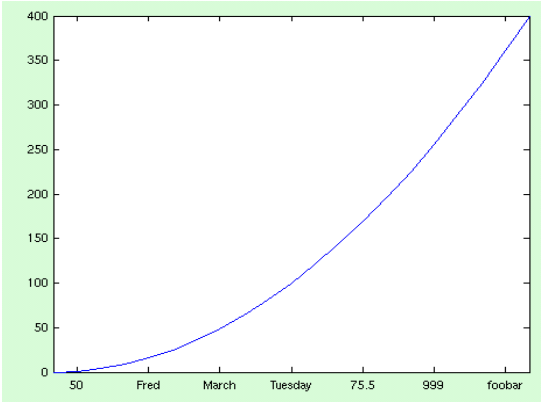



```
>> get(gca, 'XTick')
ans =
     0     2     4     6     8    10    12    14    16    18    20
```

set(gca, 'XTick', 1:3:22)



set(gca, 'XTickLabel', {50, 'Fred', 'March', 'Tuesday', 75.5, 999, 'foobar'})



Plotting against date/time: datenum & datetick

datenum() returns the day number (and fractional day number) in the calendar starting 1st January in the year 0 AD.

Excel dates and times are similar except Excel uses the origin 1st January 1900. But you normally ask Excel to format those cells with a particular date/time format, so you don't see the raw numbers. In MATLAB, datenum gives those raw numbers.

To convert from Excel day-numbers to MATLAB datenum format:

```
mtime = etime + datenum(1900, 1, 1);
```

Call it like:

```
datenum(YYYY, MM, DD)
datenum(YYYY, MM, DD, hh, mi, ss)
datenum('2009/04/29 18:27:00')
```

Remember to use vectorisation:

```
redoubtEventTimes = {'2009/03/22 22:38'; '2009/03/23 04:11'; '2009/03/23 06:23'}
dnum = datenum(redoubtEventTimes); % result is a 3 x 1 vector of datenums.
```

datetick('x'); % can give unexpected results, ask for help.

datestr

I often use dates in plot labels, or in file paths/names.

datestr(array, dateform) is used to generate a human-readable string from an array of dates/times in datenum format.

```
>> lectureTime = datenum(2009, 4, 29, 12, 30, 0)
733890.5208
>> datestr(lectureTime, 30)
20090427T123000
>> datestr(lectureTime, 31)
2009-04-29 12:30:00
>> datestr(lectureTime, 'mm/dd/yyyy')
04/29/2009
>> xlabel( sprintf('This plot was generated at %s', datestr(now, 31) ) );
```

An aside – making dates work for you:

YYYYMMDD, not MMYYDD (U.S.) or DDMMYY (Europe).

Outline

MATLAB Graphics Object Hierarchy

Screen

- Figure1
  - Axes1 (xlabel, ylabel, title, tick marks, tick labels)
    - Graph1 (linestyle, legendlabel)
    - Graph2
    - …
  - Axes2
    - Graph1
    - …
- Figure2
  - Axes1
    - Graph1
    - Graph2
  - Axes2
    - Graph1
- …

figure axes plot

figure

To create a new figure with no axes:
>> figure;

To highlight a figure that is already displayed (if it doesn't already exist, it will be created):
>> figure(2)

To get all the properties associated with a figure:
>> get(figure(2))

To get a particular property associated with a figure:
>> get(figure(1), 'Position')
[420 528 560 420]

To modify a particular property associated with a figure:
>> set(figure(1), 'Position', [100 100 560 420])

This particular example will just move where figure(1) is plotted on the screen.

To get a 'handle' for the current active figure window use **gcf**.
>> get(gcf, 'Position')
Will return the screen position of the current active figure window.

axes

New figures are created without a set of axes.

To get a 'handle' for the current active set of axes use **gca** (get current axes).
Example: get a list of all properties associated with current axes
>> get(gca)

>> get(gca, 'position')
This will return the screen position of the current active figure window, which by default is:
[0.13 0.11 0.775 0.815]
Format here is [xorigin yorigin xwidth yheight] in fractions of the figure window width.

To modify the position of the current axes within a figure:
>> set(gca, 'position', [0.2 0.3 0.6 0.4])
The axes would start 20% of the way across the screen, 30% of the way up,
and be 60% the screen width, and 40% the screen height.

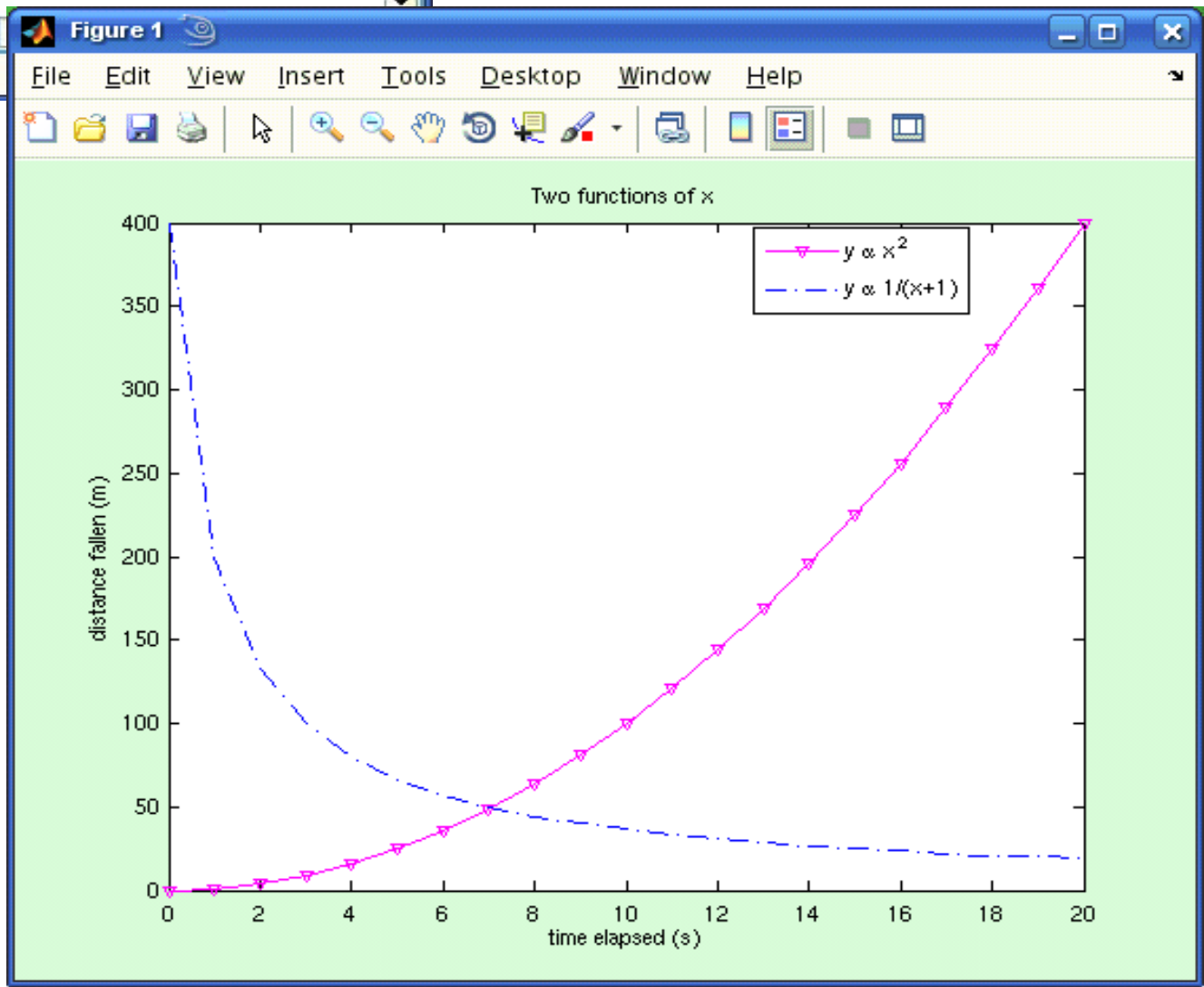
An alternative syntax is just to call the axes command:

>> axes('position', [0.2 0.3 0.6 0.4]);
Either will create a figure if none already exists. Or modify the current set of axes on the current figure.

Multiple plots on a figure 1: hold on

```
>> grid off
>> y2 = 400./(x+1);
>> hold on
>> plot(x,y2,'b-.')
>> title('Two functions of x')
>> legend('y \alpha x^2', 'y \alpha 1/(x+1)')
>>
```

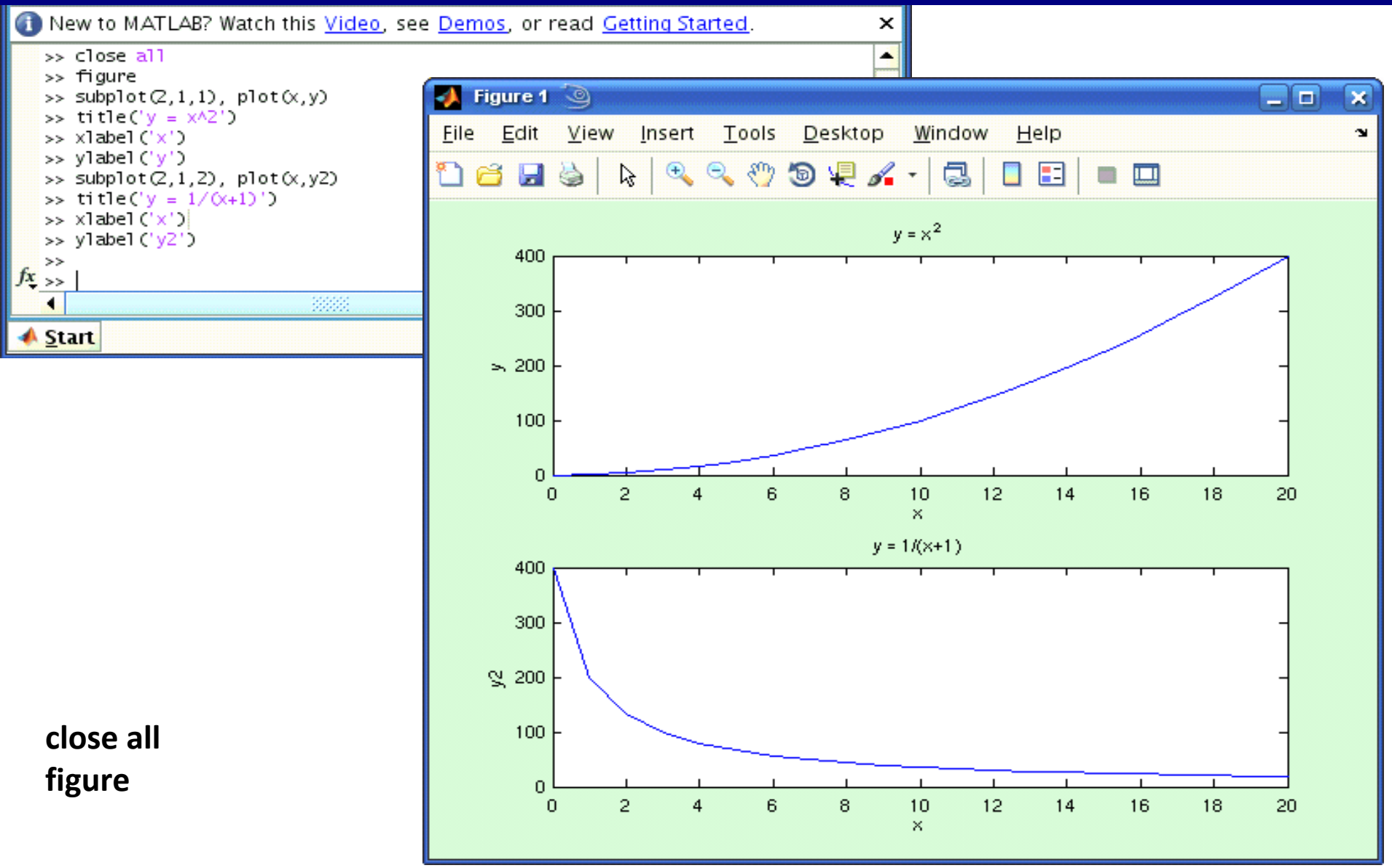
hold on "holds on" to graphs already in the current axes.
Normally they would be erased



hold on
plot(x,y,'-.')
title
legend
hold off

If your graphs have very different scales, and you have just two, try **plotyy**

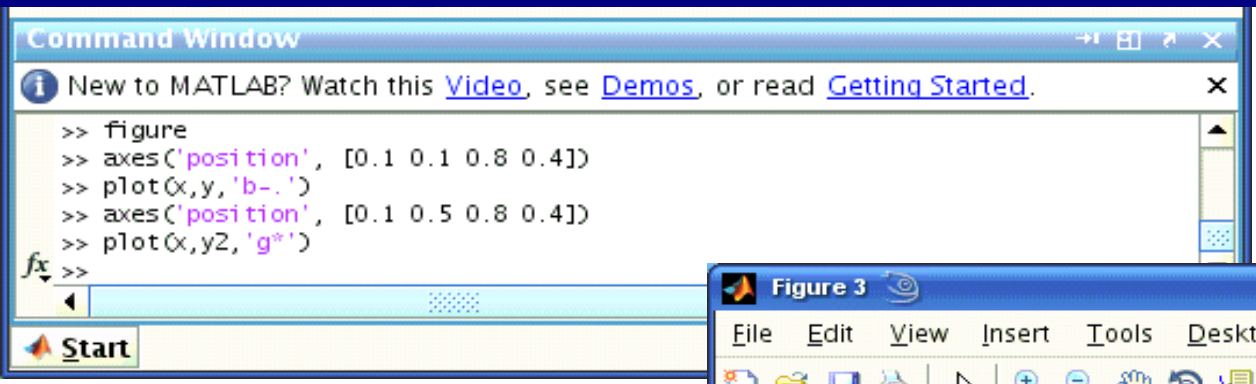
Multiple plots on a figure 2: subplot

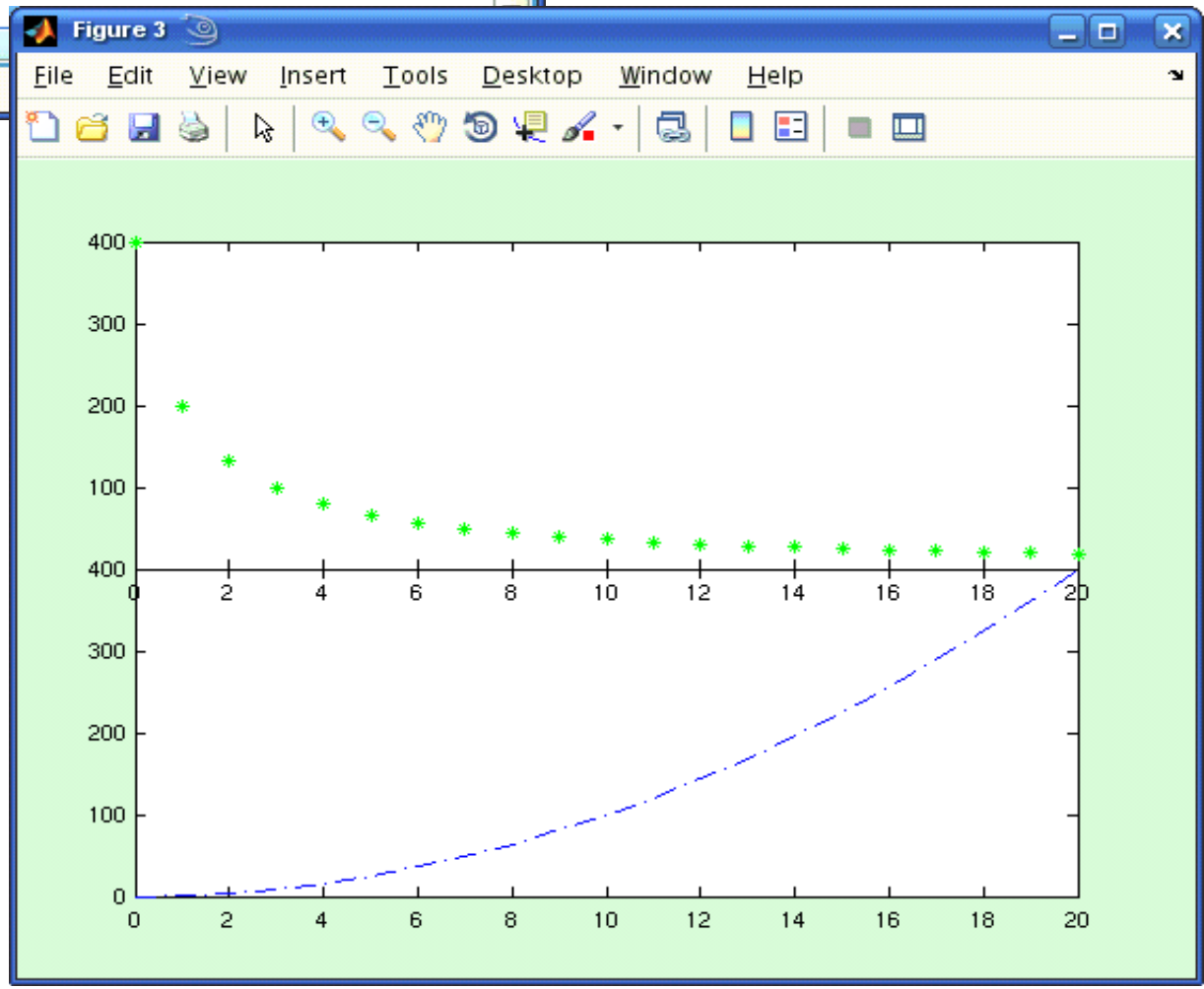


close all
figure

subplot(M, N, plotnum) - an M x N array of plot axes

Multiple plots on a figure 3: axes('position', [ ])





axes('position', [xorigin yorigin xwidth yheight]);
– for finer control than subplot

set(gca, 'XTickLabel', {})
- remove x tick labels

Multiple plots on a figure 4: long form of plot command

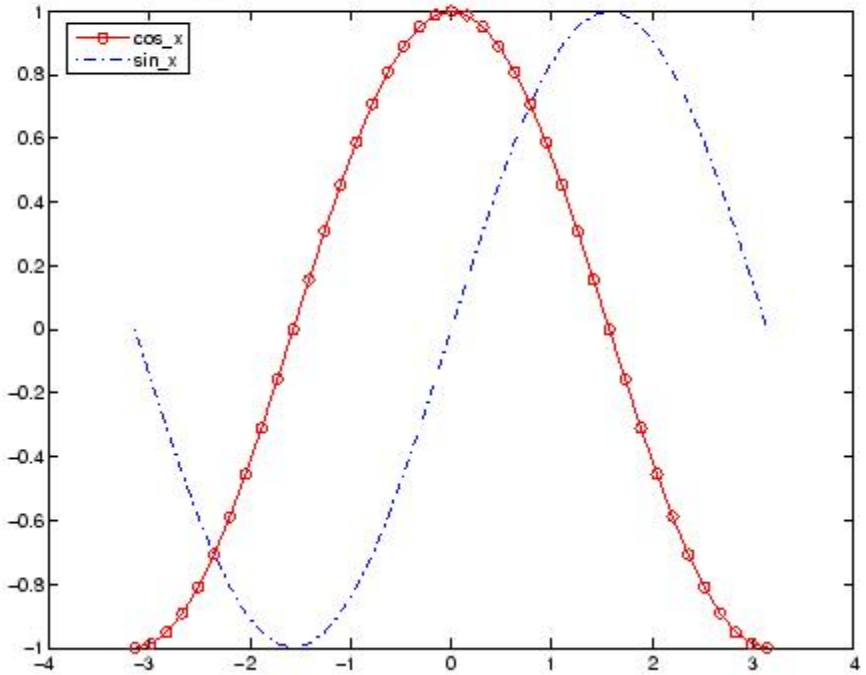
plot(x1, y1, x2, y2, …, xn, yn)
% a way of plotting multiple graphs without using **hold on**

plot(x1, y1, s1, x2, y2, s2, …, xn, yn, sn)
% as above, but override the default lin styles.

You can then use **legend** to create a ke for the different graphs in your figure.

Add a legend to a graph showing a sine and cosine function:

```
x = -pi:pi/20:pi;
plot(x,cos(x),'-ro',x,sin(x),'-.b')
h = legend('cos_x','sin_x',2);
set(h,'Interpreter','none')
```



Outline

Writing an image file - print

print -f1 -dpng myplotfilename.png - script form

print('-f1', '-dpng', '-r200', 'myplotfilename.png') - functional form

-r200 means print with resolution 200 dots per inch (use lower number for small plot)

-f2 means print figure 2

Devices include:

ps, psc, ps2, psc2 - Postscript (c = colour, 2 = level 2)

eps, epsc, eps2, eps2 - Encapsulated Postscript (c = colour, 2 = level 2)

ill - Adobe Illustrator format

jpeg90 - JPEG with quality 90 (can be 01 to 99)

tiff - TIFF

png - PNG

Can also capture a figure window with:
>> print –dmeta
on a Windows system, and paste it into your document. It does the same thing as ALT-PRT SC.

Writing an image file - print

Example:

You have (numberOfPlots) figures and you want to save all of them as level-2 color encapsulated postscript files with names like myplot1.eps, myplot2.eps:

for plotNum = 1 : numberOfPlots

print('-depsc2', sprintf('-f%d',plotNum), '-r70', sprintf('myplot%d.eps',plotNum));

end

For plotNum = 2, the print line would evaluate to:

print('-depsc2', '-f2', '-r70', 'myplot2.eps')

Saving your Figure (2): `saveas`

`saveas`

- **saveas**`(h, 'filename.ext');`
  saveas`(h, 'filename', 'format');`
- saves figure with the handle `h` to file `filename`.
- file format is either handled by the extention `ext` or the specified `format`:

`ai`	Adobe Illustrator	`bmp`	Windows bitmap
`emf`	Enhanced metafile	`eps`	EPS Level 1
`fig`	Matlab figure	`jpg`	JPEG
`m`	Matlab M-file	`pbm`	Portable bitmap
`pcx`	Paintbrush 24-bit	`pdf`	Portable Document Format
`pgm`	Portable Graymap	`png`	Portable Network Graphics
`ppm`	Portable Pixmap	`tif`	TIFF image, compressed

Saving your Figure: Font Sizes and Line Weigths

There is a difference between screen mode and presentation mode:

screen mode vs. presentation mode:

- Matlab defaults work great on a screen, too small for presentations!
- don't be the guy that says "Well sorry, you can't read this . . . " there is a cure!
- two functions help: `get, set`
- `'property', 'value'` pairs help in respective functions (`title, (x,y,z)label,...`)

List of Figure/Axis Properties:

try: `plot(0:10,0:10), get(gcf), get(gca)`
check:
`http://www.mathworks.com/help/techdoc/ref/axes_props.h`

Saving your Figure: Font Sizes and Line Weigths

Change Figure/Axis Properties:

```
clear all, clc, close all;

%plot some data
plot(0:10:100, 0:10, 'rx-');

%change axis defaults
set(gca, 'FontSize', 12, 'FontWeight', 'bold', 'FontAngle', 'oblique', ...
    'XAxisLocation', 'top')

%now for the labeling
title('Depth plot', 'FontSize', 20, 'FontAngle', 'normal');
xlabel('Distance (km)');
ylabel('Depth (km)');

%now for non-default ticks
set(gca, 'XTick', 0:10:100, ...
    'YMinorTick', 'on', ...
    'YDir', 'reverse')              %reverse y-direction to allow for
                                    %positive depth values
```

e