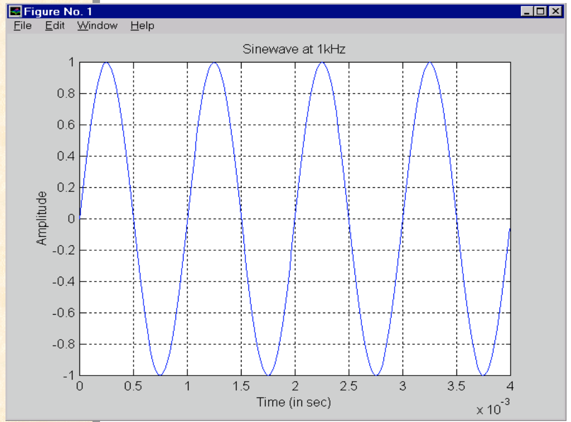
Matlab Lecture 3: Finishing with MATLAB

- Part solution to Lab 1:-

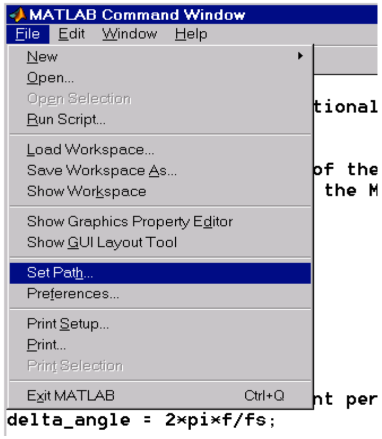
```
function [t, sinewave] = sinegen(fsig, fsamp, ncycle)
% Sinewave Generation
%   fsig = signal frequency
%   fsamp = sampling frequency
%   ncycle = number of cycles to generate
%
%   Peter Cheung
%   15th October 1998.

% calculate angular increment per sample
delta_angle = 2*pi*fsig/fsamp;

% create angle vector for ncycle cycles
t = 0:delta_angle:ncycle*(2*pi);

% create sine wave
sinewave = sin(t);
% convert angle to time: time = angle/(2*pi*f)
t = t/(2*pi*fsig);
```

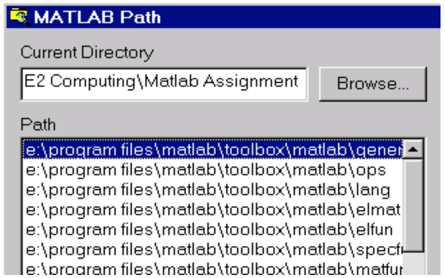

Solution to Lab 1 (con't)

```
% Model answer to Lab Session 1
% Exercise 2 - file: lab1_2.m

% define sampling frequency
fs = 44100;

% define signal frequency
f = 1000;

% create sine wave
[t,sinewave]=sinegen(f,fs,4);

% plot it
plot(t,sinewave);
grid

% label axes
xlabel('Time (in sec)');
ylabel('Amplitude');
title('Sinewave at 1kHz');
```



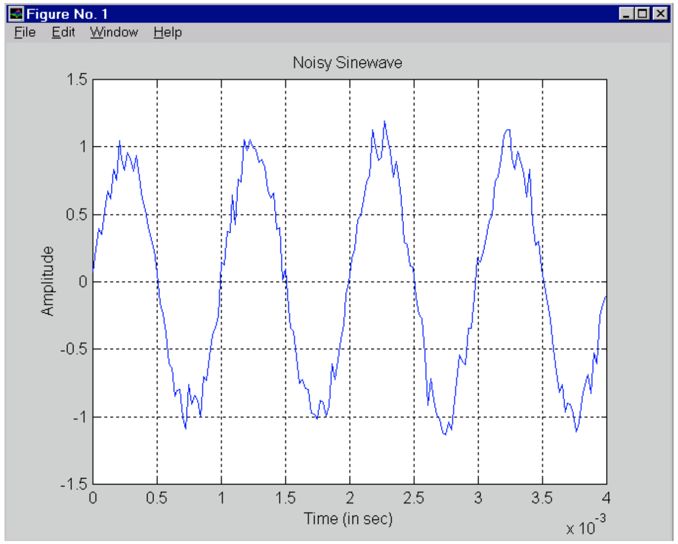
Must use Add Path (or Set Path)





- Must use Set Path manual or addpath command to make new .m files visible!

Lab 1 (con't) - Noisy Sinewave



Logical Subscripting

- The logical vectors created from logical and relational operations can be used to reference subarrays.
- Suppose `X` is an ordinary matrix and `L` is a matrix of the same size that is the result of some logical operation. Then `X(L)` specifies the elements of `X` where the elements of `L` are nonzero.
- Suppose:

```
x = 2.1 1.7 1.6 1.5 NaN 1.9 1.8 1.5 5.1 1.8 1.4 2.2 1.6 1.8

» x = x(finite(x))
x = 2.1 1.7 1.6 1.5 1.9 1.8 1.5 5.1 1.8 1.4 2.2 1.6 1.8
```


Logical Subscripting in action

- Now there is one observation, `5.1`, which seems to be very different from the others. It is an ***outlier***. The following statement removes ***outlier***s, in this case those elements **more than three standard deviations** from the mean.

```
x = x(abs(x-mean(x)) <= 3*std(x))
x = 2.1 1.7 1.6 1.5 1.9 1.8 1.5 1.8 1.4 2.2 1.6 1.8
```


Structures in MATLAB

- Structures are multidimensional MATLAB arrays with elements accessed by textual *field designators*. For example,

```
S.name = 'Ed Plum';
S.score = 83;
S.grade = 'B+'
```

- creates a scalar structure with three fields.

```
S =
     name: 'Ed Plum'
    score: 83
    grade: 'B+'
```

- an entire element can be added with a single statement.

```
S(3) = struct('name','Jerry Garcia',...
              'score',70,'grade','C')
```

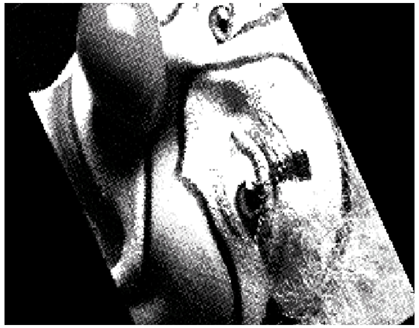

Assignment: Image Warping

- Four Tasks:
  - Image rotation
  - Image shearing
  - Edge detection
  - Image blurring
- Deadline
  - See Assignment sheet - submit to Level 6 Teaching Office
- Deliverables:-
  - Well commented listing of your MATLAB files
  - Evidence that it works (i.e. hardcopy for each of the special effects)
  - Floppy disk containing a ready-to-try copy of your programmes

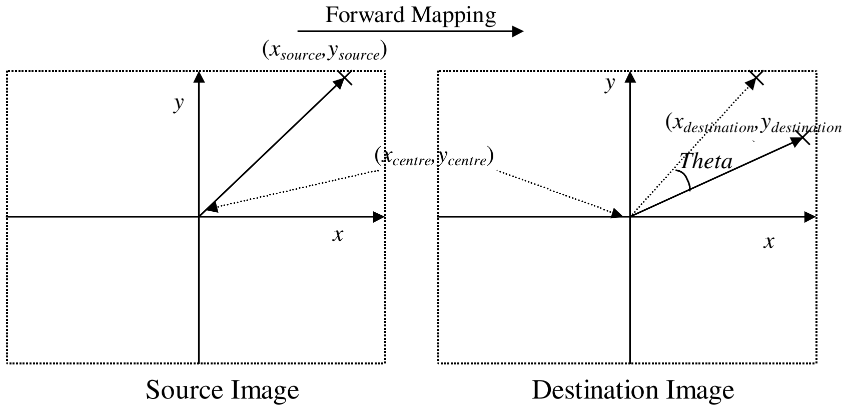
Problem 1: Rotation (1)

`Show(clown)`

`Show(rotate(clown,pi/3))`



Problem 1: Rotation (2)



$$\begin{pmatrix} x_{destination} \\ y_{destination} \end{pmatrix} = \begin{pmatrix} \cos(theta) & \sin(theta) \\ -\sin(theta) & \cos(theta) \end{pmatrix} \left(\begin{pmatrix} x_{source} \\ y_{source} \end{pmatrix} - \begin{pmatrix} x_{centre} \\ y_{centre} \end{pmatrix} \right) + \begin{pmatrix} x_{centre} \\ y_{centre} \end{pmatrix}$$

Problem 1: Rotation (2)

For each pixel in the source image {
Work out the destination pixel location using the forward mapping equation.
Paint that destination pixel with the source image value.
}

Pixel Number

Source Image

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Forward Mapping ⇒

Destination Image

	1,2		3,4
5,9	6	7	
	10	11	8,12
	14,15	16	

Problem 1: Rotation (3)

Pixel Number

Source Image

	3	4	
1,2	6,7	8	
	9,10	11	12
	13	14	15

⇐ Reverse Mapping

Destination Image

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

$$\begin{pmatrix} x_{source} \\ y_{source} \end{pmatrix} = \begin{pmatrix} \cos(theta) & \sin(theta) \\ -\sin(theta) & \cos(theta) \end{pmatrix}^{-1} \left(\begin{pmatrix} x_{destination} \\ y_{destination} \end{pmatrix} - \begin{pmatrix} x_{centre} \\ y_{centre} \end{pmatrix} \right) + \begin{pmatrix} x_{centre} \\ y_{centre} \end{pmatrix}$$

For each pixel in the destination image {
Work out where the pixel maps to in the source image, using the reverse mapping equation
Paint the destination pixel with that source pixel value.
}

Problem 2 & 3: Shearing & Edge Detection