MATLAB Tutorials

Department of Nuclear Science and Engineering - Spring 2008

web.mit.edu/acmath/matlab/nuclear

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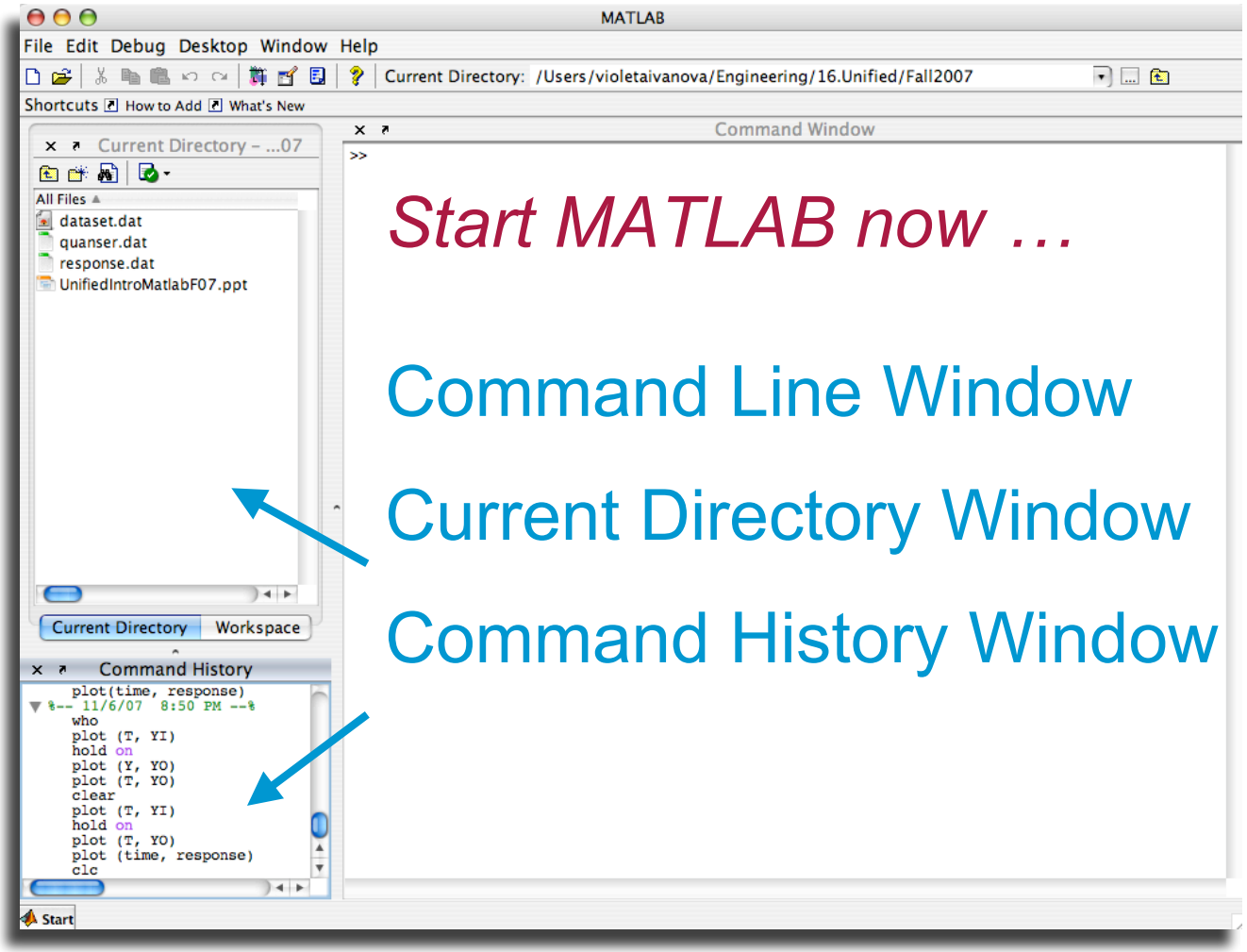
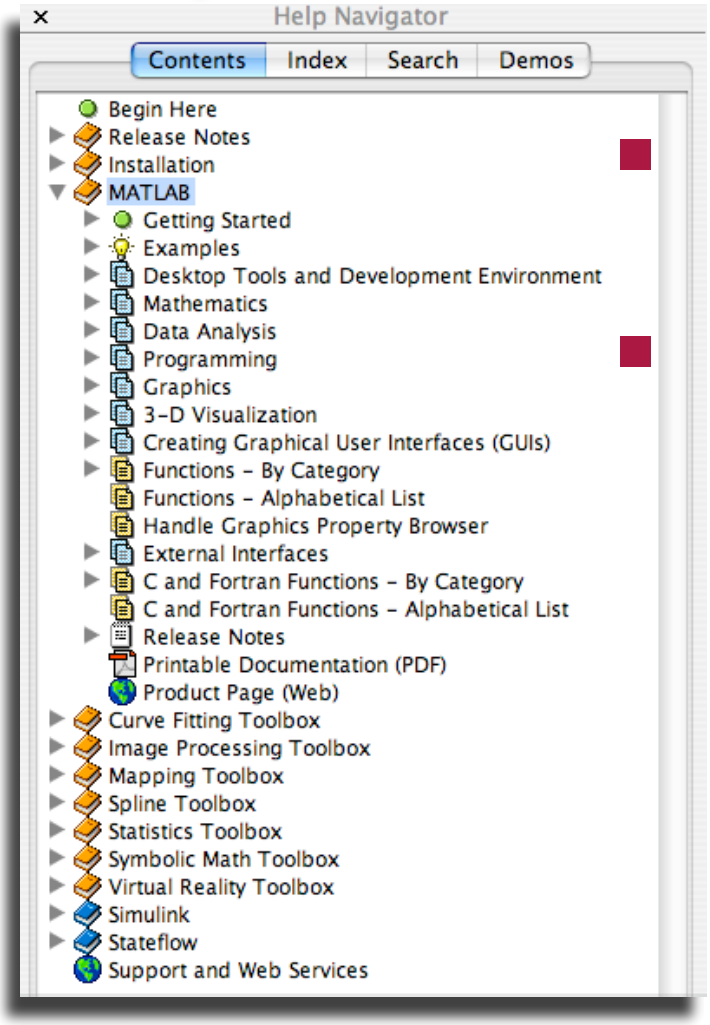
MATLAB Desktop Interface



Help in MATLAB



Help Browser

`Help->MATLAB Help`

Command line help

`>> help <command>`

e.g. `help cos`

`>> lookfor <keyword>`

e.g. `lookfor cosine`

Variables

- Begin with an alphabetic character: `a`
- Case sensitive: `a, A`
- No data typing: `a=5; a='ok'; a=1.3`
- Default output variable: `ans`
- Built-in constants: **`pi i j Inf`**
- **`clear`** removes variables
- **`who`** lists variables
- Special characters

  `[] () {} ; % : = . ... @`

Vectors

- Row vector

```
>> R1 = [1 6 3 8 5]
>> R2 = [1 : 5]
>> R3 = [-pi : pi/3 : pi]
```

- Column vector

```
>> C1 = [1; 2; 3; 4; 5]
>> C2 = R2'
```

Matrices

- Creating a matrix

```
>> A = [1 2.5 5 0; 1 1.3 pi 4]
>> A = [R1; R2]
```

- Accessing elements

```
>> A(1,1)
>> A(1:2, 2:4)
>> A(:,2)
```

Matrix Operations

- Operators + and –

```
>> X = [1 2 3]
>> Y = [4 5 6]
>> A = X + Y
   A =
        5 7 9
```

- Operators *, /, and ^

```
>> Ainv = A^-1
```

Matrix math is default!

Element-Wise Operations

- Operators **.*** , **./** , and **.^**

```
>> z = [2 3 4]'
>> B = [z.^2   z   z.^0]
B =
    4    2    1
    9    3    1
   16    4    1
```

File Input / Output

- Import Wizard for data import

  `File->Import Data …`

- File input with `load`

```
B = load('datain.txt')
```

- File output with `save`

```
save('dataout', 'A', '-ascii')
```

2D Graphics

- Linear plots

```
>> plot (X, Y)
```

  Plotting commands open the Figure editor.

- Graphics customization
  - Plot Edit mode: 
  - Annotation: `View->Property Editor`
  - Publication: `File->Save as`

Multiple Plots

- Multiple datasets on a plot

```
>> plot(xcurve, ycurve)
>> hold on
>> plot(Xpoints, Ypoints)
>> hold off
```

- Subplots on a figure

```
>> subplot(1, 2, 1)
>> plot(time, velocity)
>> subplot(1, 2, 2)
>> plot(time, acceleration)
```

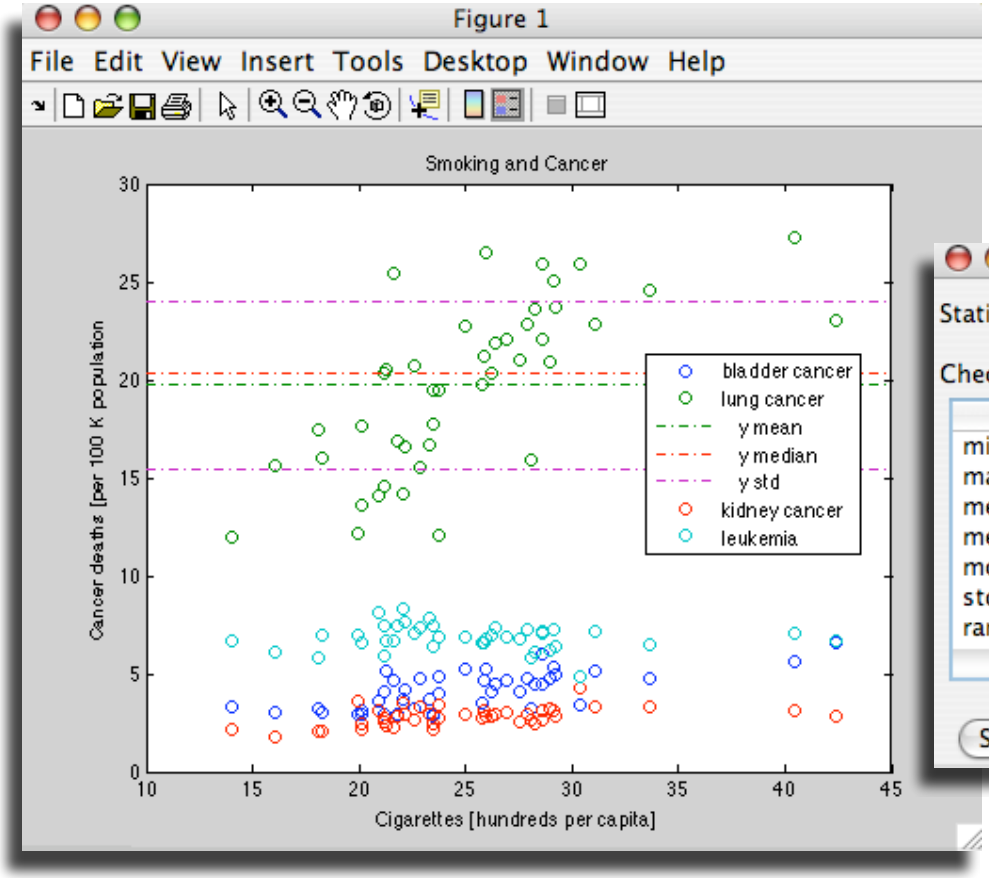
Exercise One

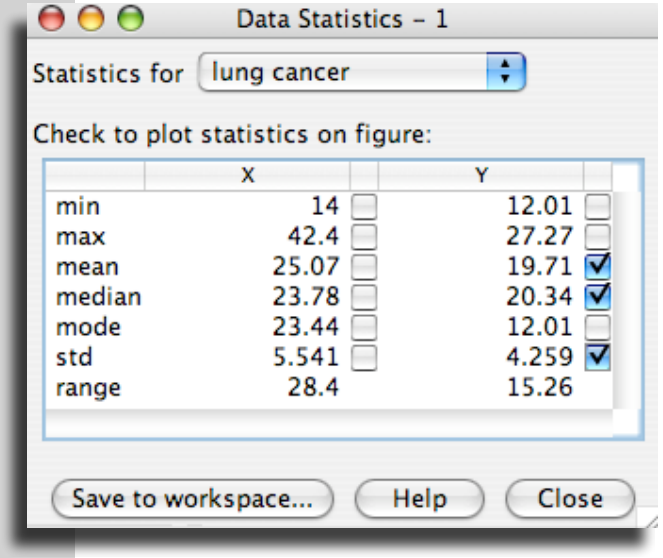
- Frequency response: `subplots.m`
  - Import data from `response.dat`
  - Create graph with two subplots
  - Plot $y_{in}(t)$ and $y_{out}(t)$ in entire interval
  - Define amplitude and phase change

Follow instructions in the m-file …

Data Statistics

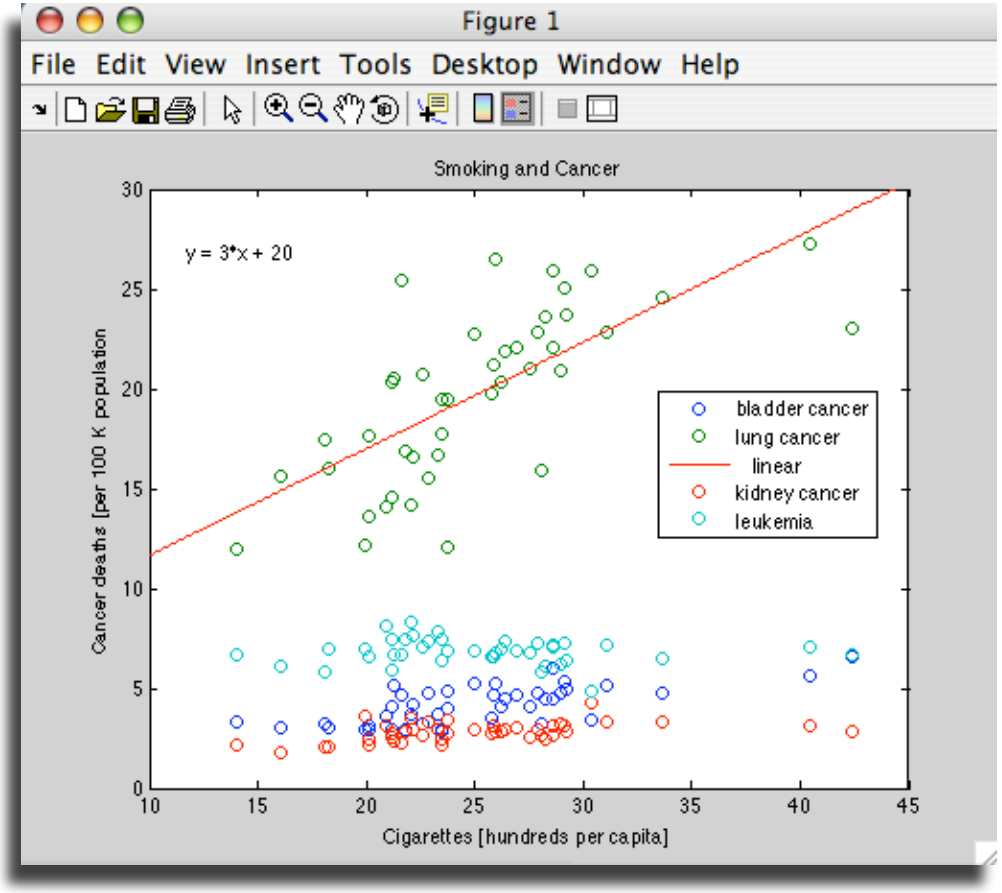
Figure editor: `Tools->Data Statistics`





Basic Fitting

Figure editor: `Tools->Basic Fitting …`



M-File Programming

- Script M-Files
  - Automate a series of steps.
  - Share workspace with other scripts and the command line interface.
- Function M-Files
  - Extend the MATLAB language.
  - Can accept input arguments and return output arguments.
  - Store variables in internal workspace.

Function M-Files

Example: amodel.m

```
function Y = amodel(t, A, B, a, w, p)
% H1 line: AMODEL computes step response.
% Help text: appears when you type
% "help amodel" in command line window.

% Comment: function body is below.
Y = A * exp(-b.*t).*cos(w.*t + p) + B;
```

Script M-Files

Example: model.m

```
% Define input
T = [0 : 0.01 : 30];

% Compute model
Y = exp(-T);

% Plot model
plot (T, Y);
```

MATLAB Program

- Always has one script M-File
- Uses built-in and user-defined functions
- Created in MATLAB Editor

```
>> edit model.m
```

- Run from Command Line Window

```
>> model
```

Built-in Functions

- MATLAB "main"

```
>> m = mean(X)
>> s = std(X)
```

- Toolboxes, e.g., Statistics

```
>> Y = exppdf(X, mu)
>> m = expfit(data)
```

Statistics Toolbox

- Hypothesis Testing
  - Null and alternative hypotheses
  - Test statistic and P-value
- Correlation coefficient

$$\rho_{X,Y} = \frac{\operatorname{cov}(X,Y)}{\sigma_X \sigma_Y}$$

Data Analysis Example

- Correlation and confidence interval

```
>> [R, P] = corrcoef(X);
>> [i, j] = find(P < 0.05);
```

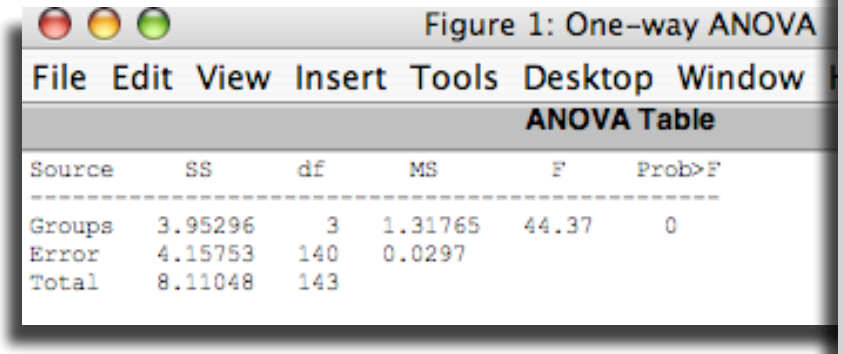
```
X =

   18.2000   17.0500    6.1500
   25.8200   19.8000    6.6100
   18.2400   15.9800    6.9400
   28.6000   22.0700    7.0600
   31.1000   22.8300    7.2000
   33.6000   24.5500    6.4500
   40.4600   27.2700    7.0800
   28.2700   23.5700    6.0700
   20.1000   13.5800    6.6200
   27.9100   22.8000    7.2700
   26.1800   20.3000    7.0000
   22.1200   16.5900    7.6900
   21.8400   16.8400    7.4200
             17.7100    6.4100
             4500       6.7100
                        6.2400
```

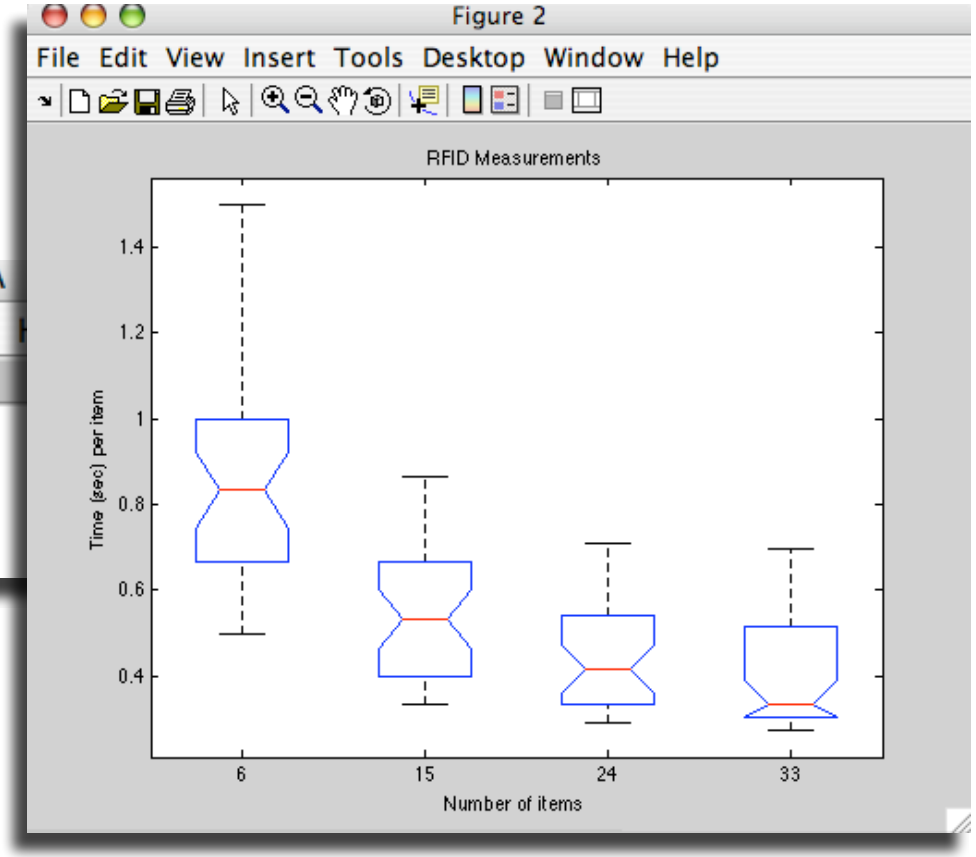
```
>> [r,p]=corrcoef(X)

r =

    1.0000    0.6974   -0.0685
    0.6974    1.0000   -0.1516
   -0.0685   -0.1516    1.0000


p =

    1.0000    0.0000    0.6587
    0.0000    1.0000    0.3260
    0.6587    0.3260    1.0000
```

Analysis of Variance (ANOVA)

- One-way ANOVA

```
>> anova1(X,group)
```





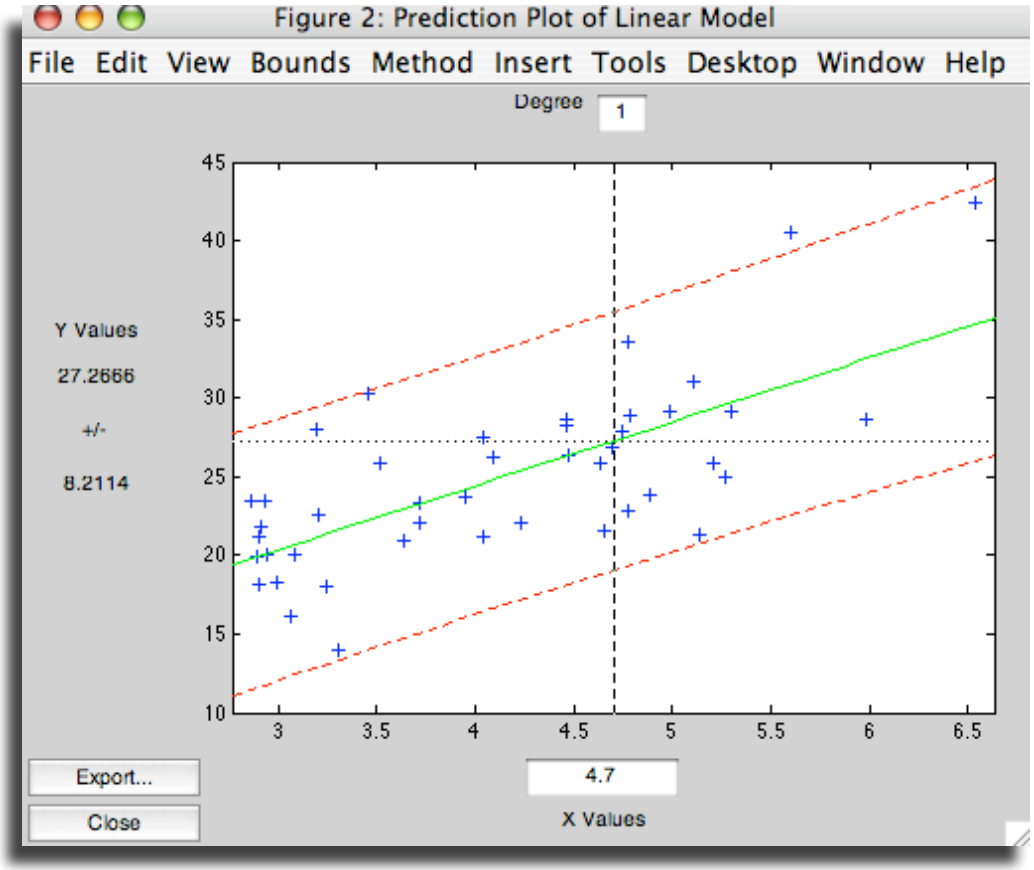
Exercise Two

- Carcinogens: `correlation.m`
  - Import data from `smokingcancer.dat`
  - Plot and graphically analyze data
  - Compute correlation coefficients and P's
  - *Quantitatively* test hypotheses …

Follow instructions in the m-file …

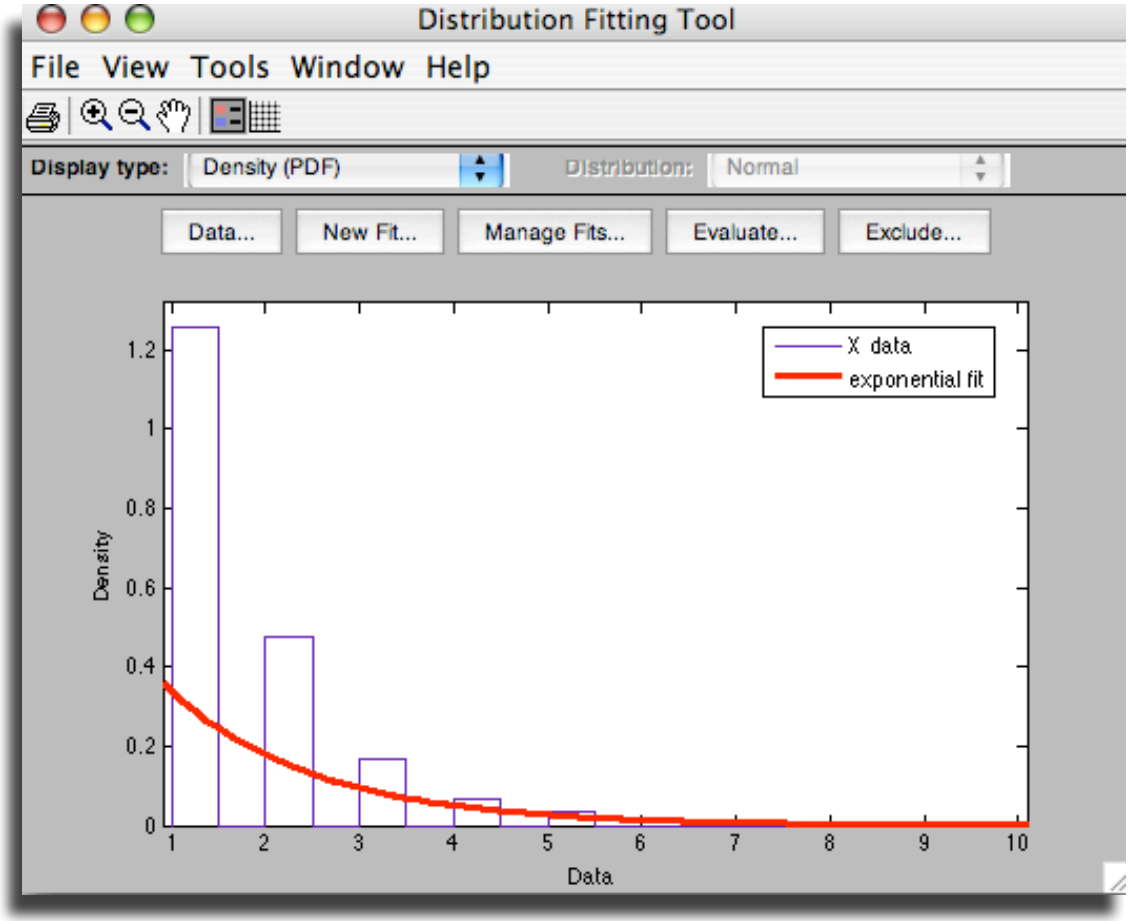
Polynomial Fitting Tool

```
>> polytool(X, Y)
```



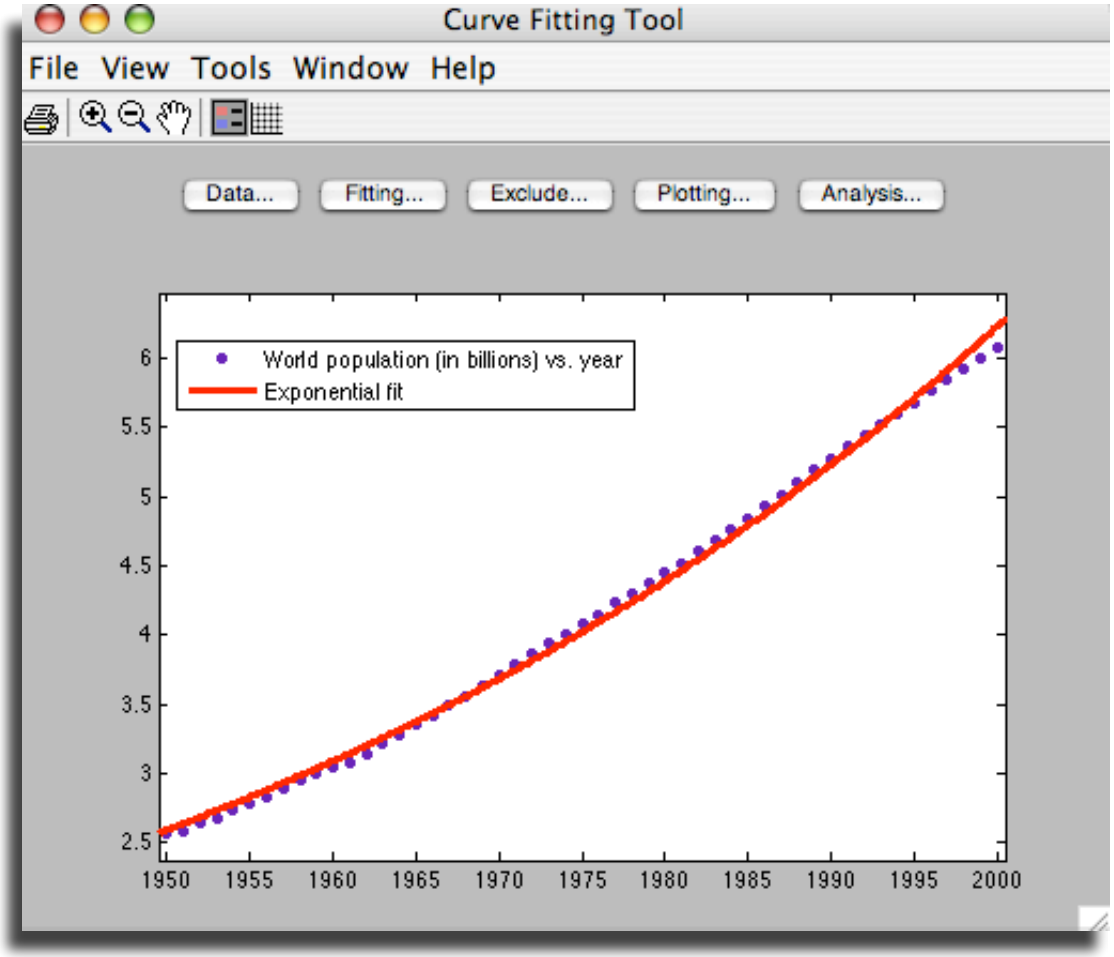
Distribution Fitting Tool

```
>> dfittool
```

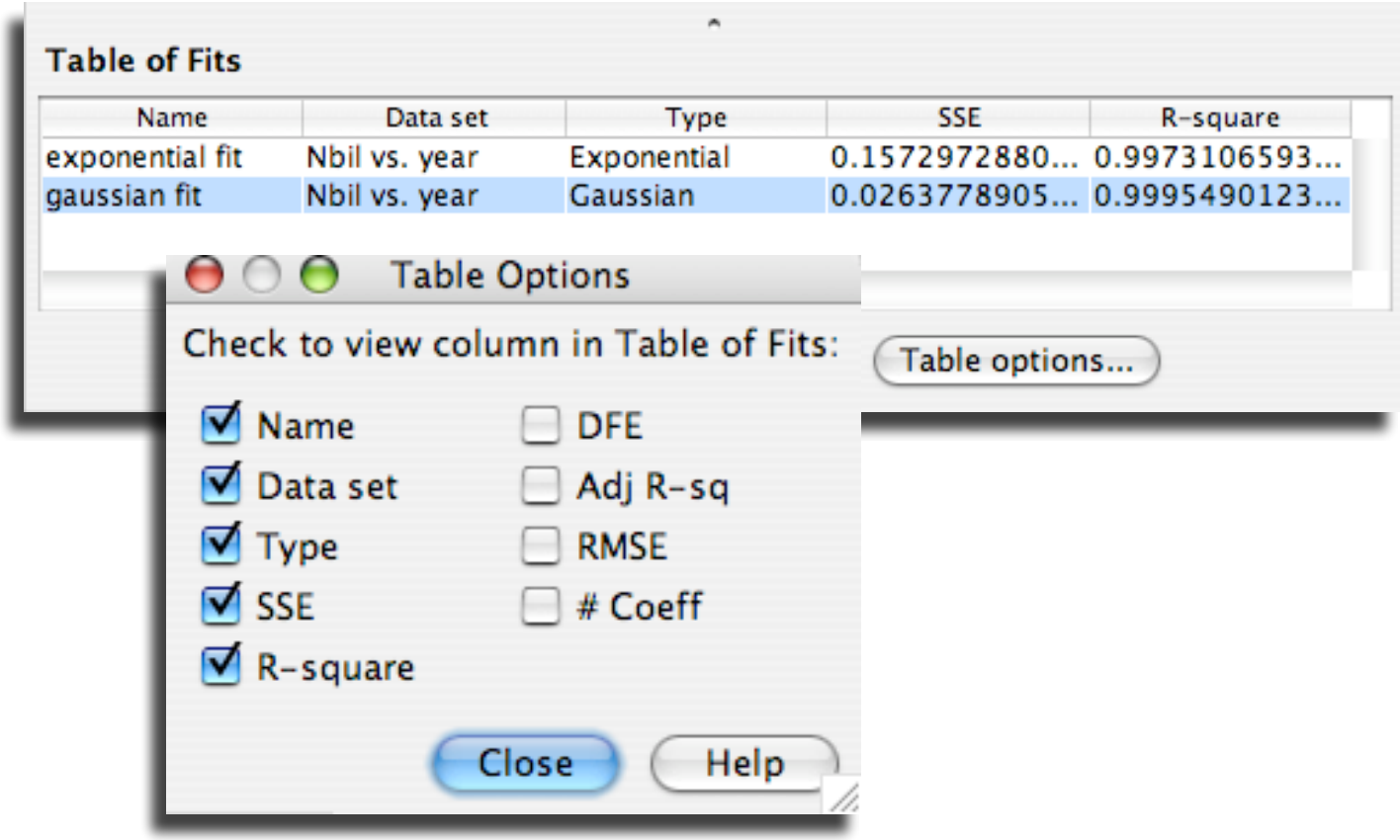


Curve Fitting Tool

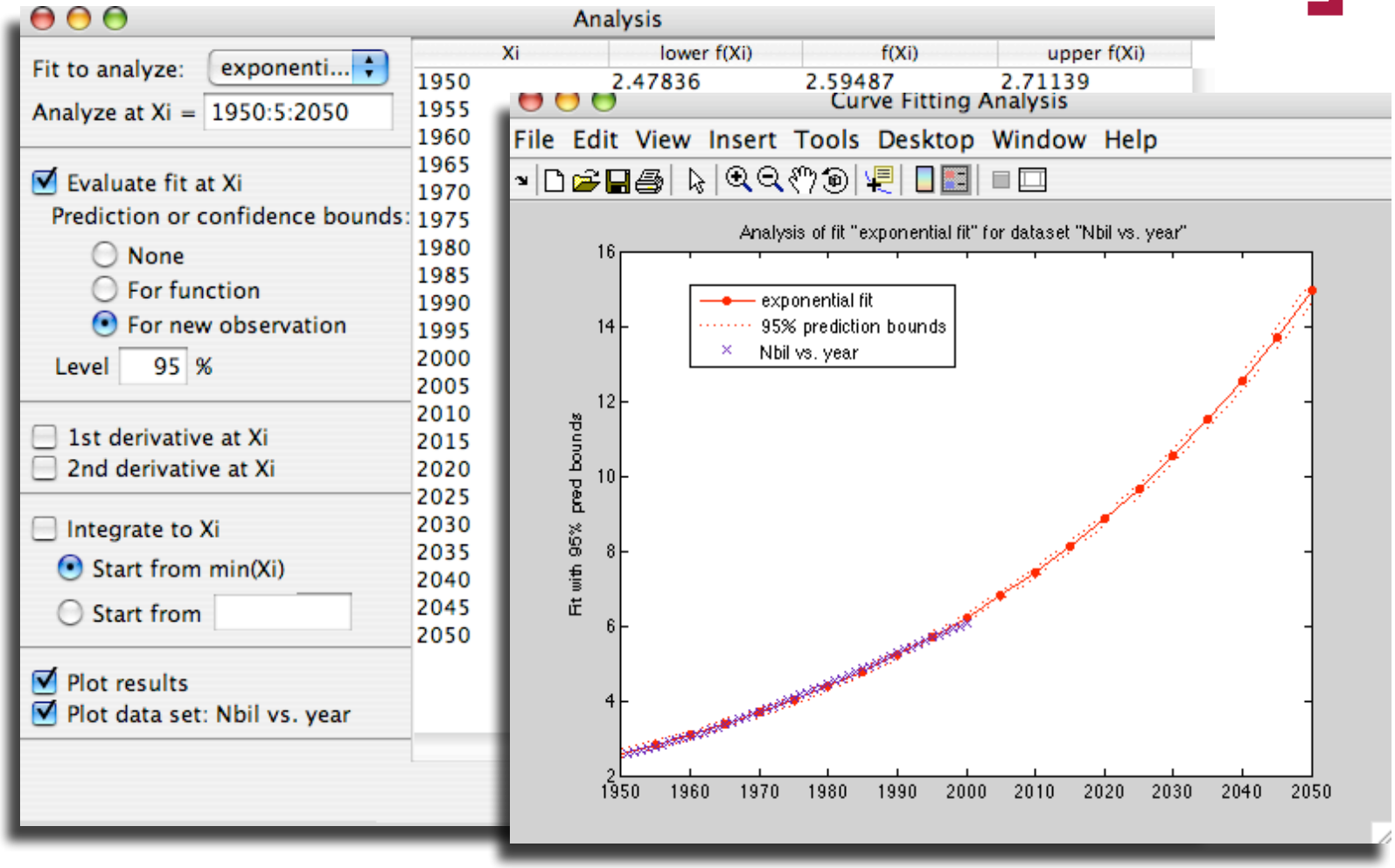
```
>> cftool
```



Goodness of Fit Statistics



Analyzing a Fit



Exercise Three

- World population: `regression.m`
  - Import data from `worlddata.dat`
  - Fit quadratic with polytool
  - Fit exponential with cftool
  - Forecast population in 2050

Follow instructions in the m-file …

References

- Mathematical Tools at MIT

  web.mit.edu/ist/topics/math

QUESTIONS?