MATLAB for The Human Sciences

Reaction Time Demonstration

Neil Carter

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Outline

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Definition of a Matrix

- A matrix is a uniform rectangular (two dimensional) grid of values; basically a table with rows, each with the same number of columns.
- We refer to its elements in "*row*, *column*" order, and "*rows* $\times$ *columns*" size.

$$\begin{bmatrix} 1,1 & 1,2 & 1,3 & \dots & 1,c \\ 2,1 & 2,2 & 2,3 & \dots & 2,c \\ 3,1 & 3,2 & 3,3 & \dots & 3,c \\ \vdots & & & \ddots & \\ r,1 & r,2 & r,3 & \dots & r,c \end{bmatrix}$$

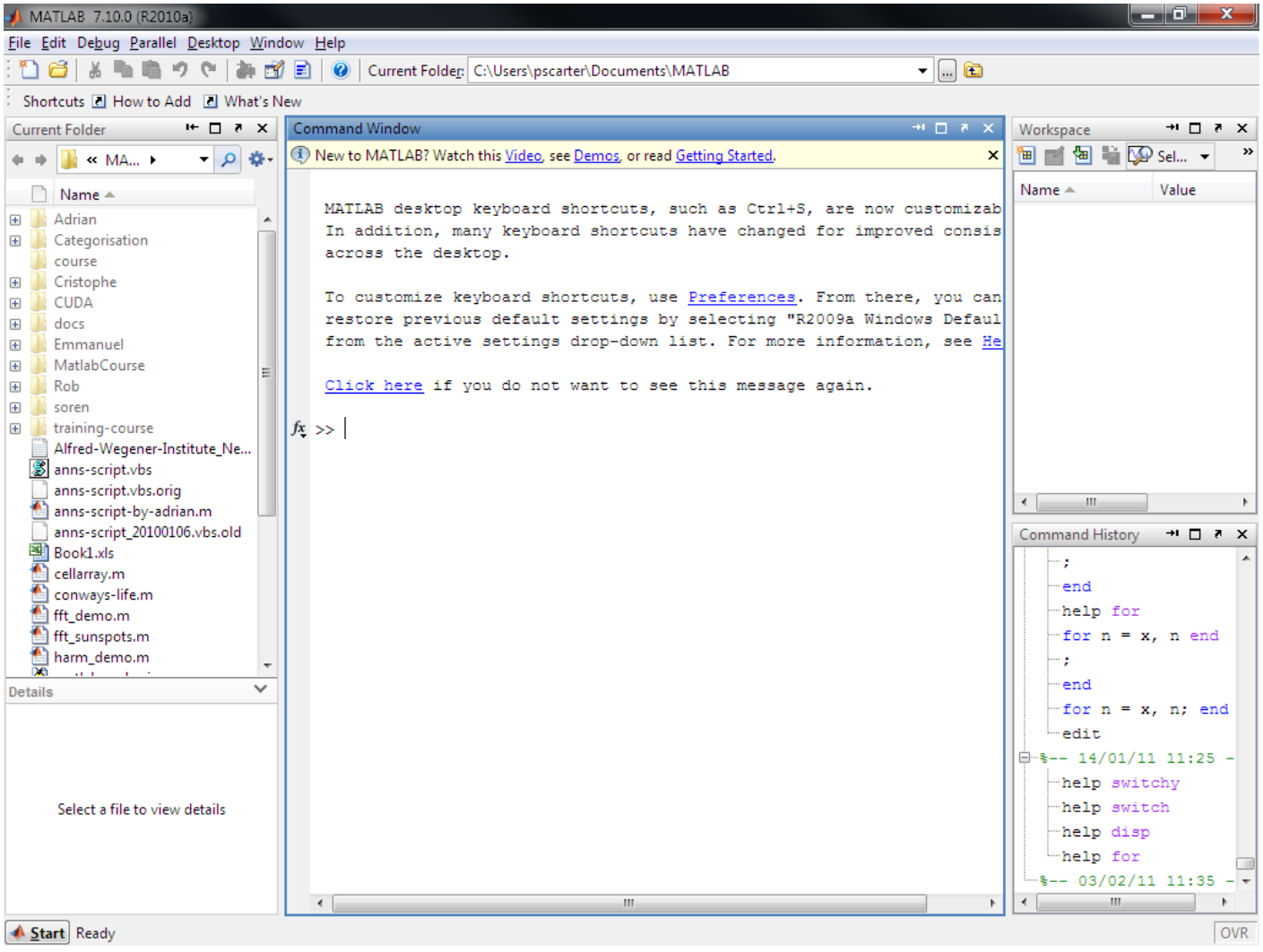
Experimental Data Arranged as a Matrix

- The results from psychological experiments typically feature a small number of variables, and a large number of observations arranged as a table. For example:

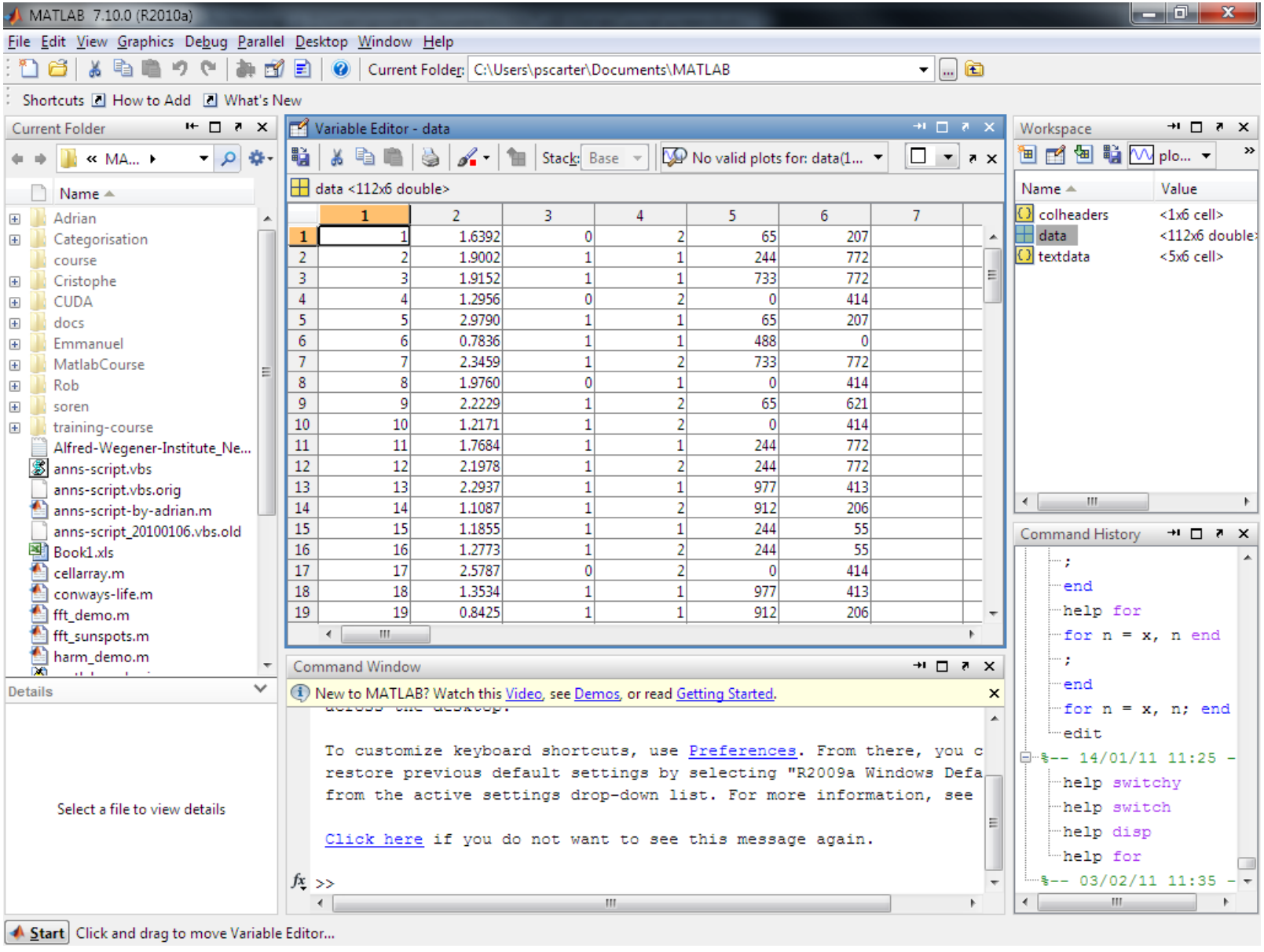
RT	Accuracy	SearchType	TargetX	TargetY
1.639241	0	2	65	207
1.900153	1	1	244	772
1.915216	1	1	733	772
1.295573	0	2	0	414
2.979001	1	1	65	207
0.783612	1	1	488	0
2.345930	1	2	733	772
...				

- Columns = Variables, Rows = Observations (Trials or Cases)
- Such a table of data can be considered as a matrix.

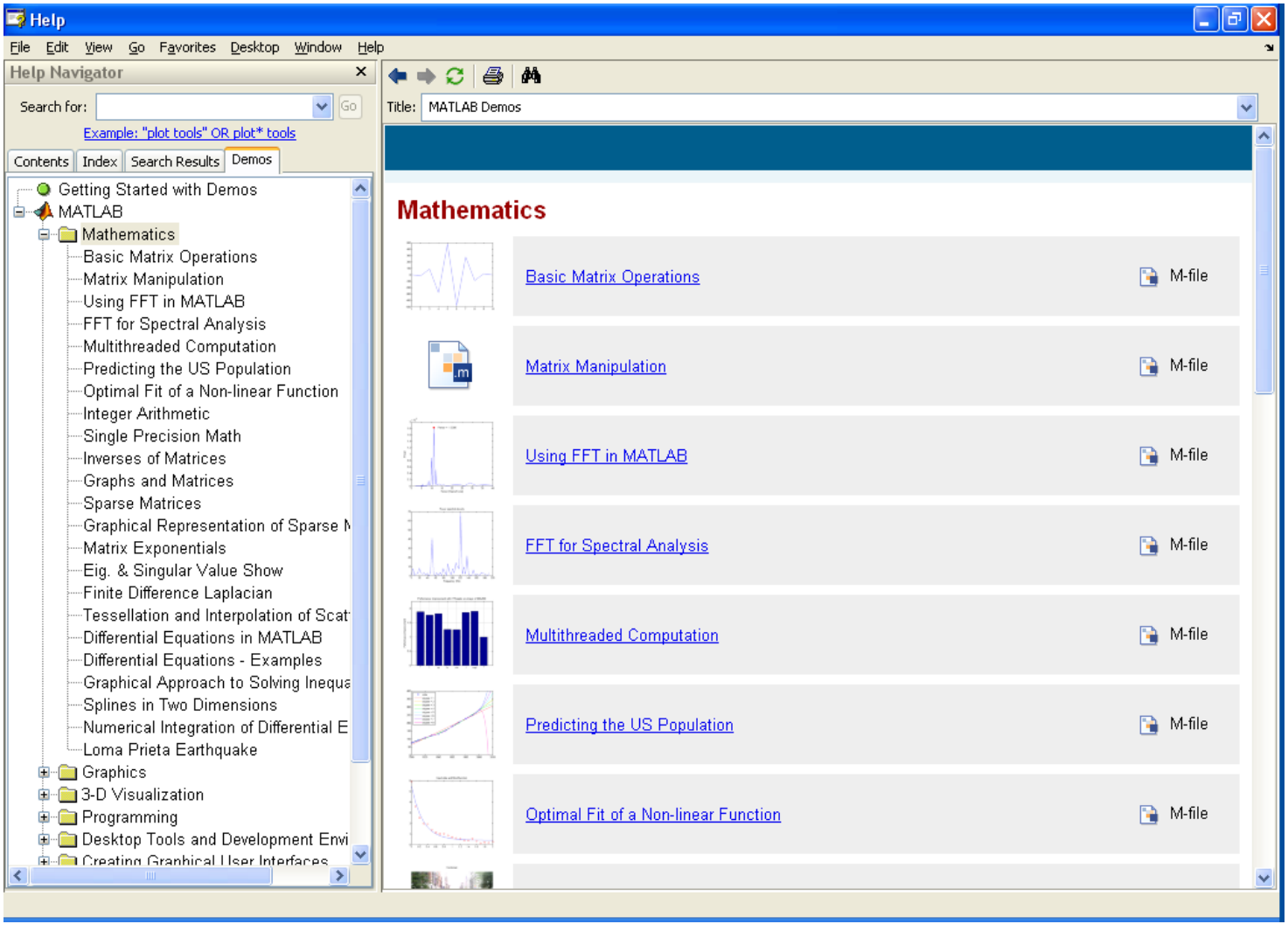
The MATLAB 2010 Desktop



The MATLAB Variable Editor



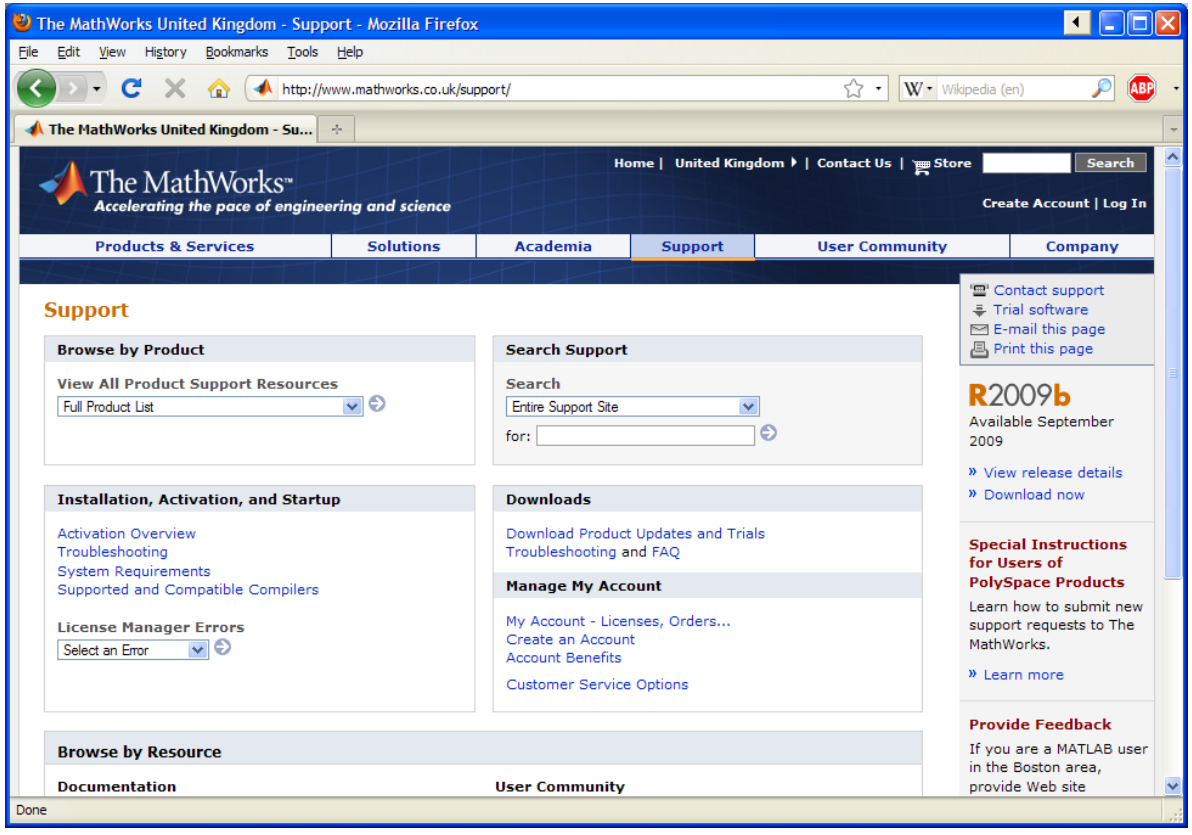
The MatLab Demonstrations



MathWorks

MatLab is produced by a company called MathWorks. They have a very comprehensive support web site:

http://www.mathworks.co.uk/support/

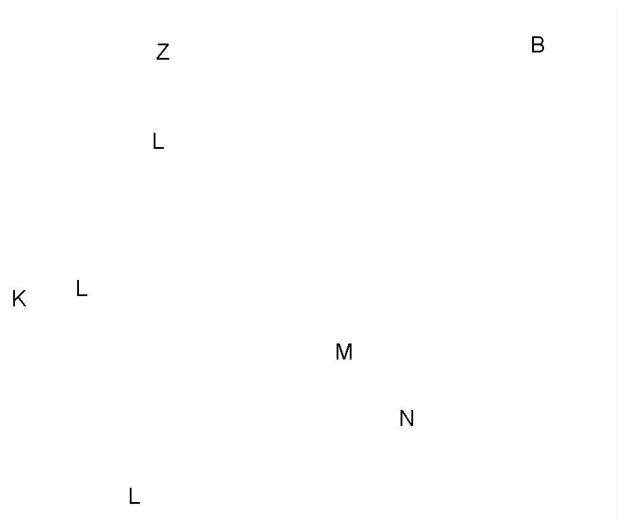


Outline

A Visual Search Experiment

- Subject had unilateral neglect; they miss objects on the left hand side.
- Subject asked to search amongst a set of letters displayed on-screen, and to decide if a target (the letter ‘Z’ in this case) was present or not.
- In half of the searches (trials), the target was not present.

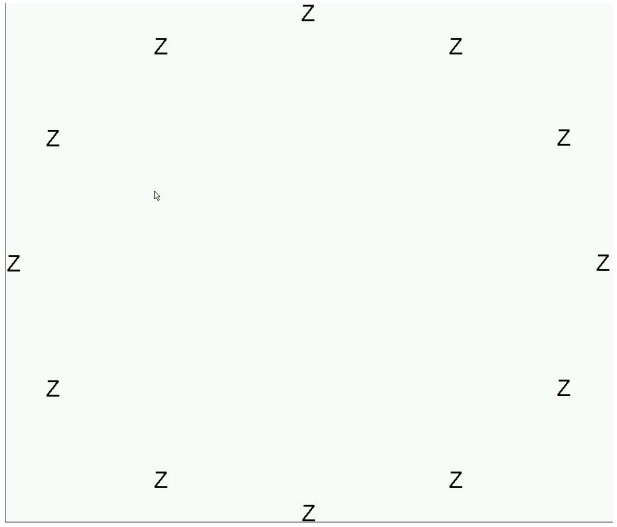
Complex Search



The Visual Search Task

Targets shown at locations spread evenly (vertically as well as horizontally) across the screen, and muddled-up with other letters (distractors).

Target Positions

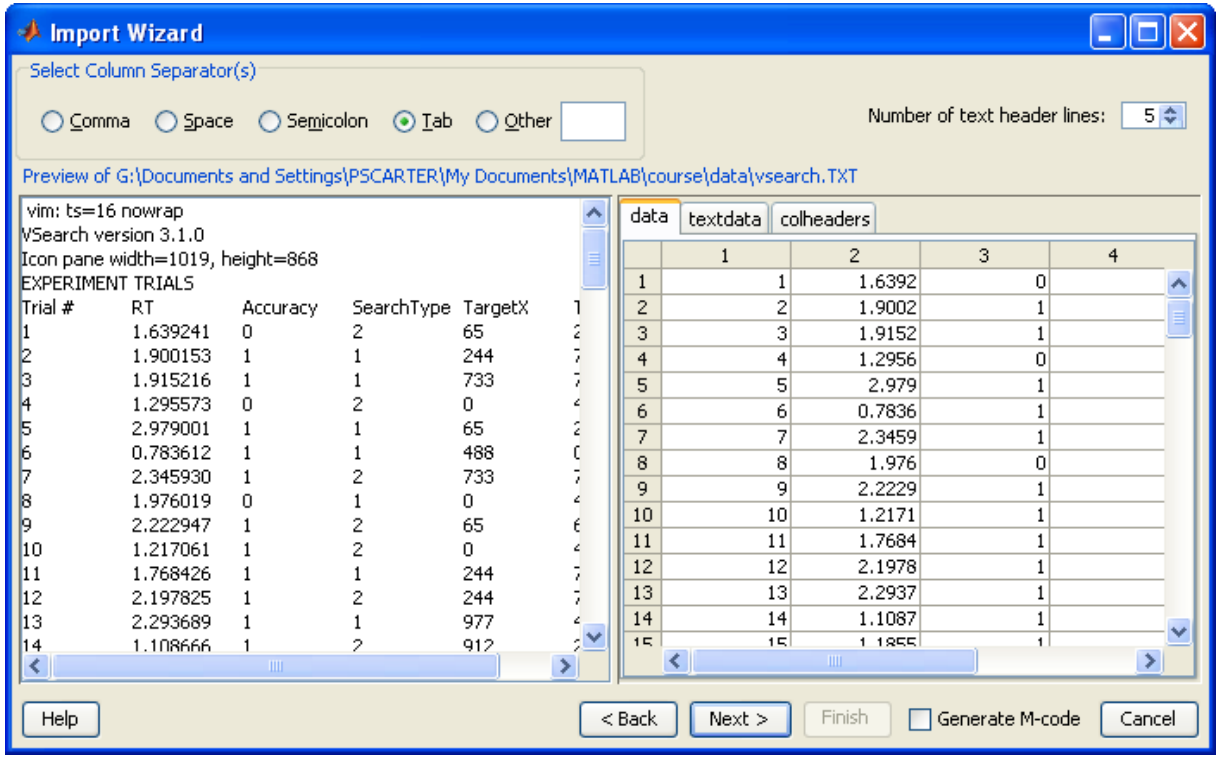


Analysing The Visual Search Results

- Program recorded how long the subject took to decide if the target was present or not.
- When the targets were on the left, we expected the subject to be wrong more often, and to take longer to respond. MATLAB made it easy to check this hypothesis, as we shall see...

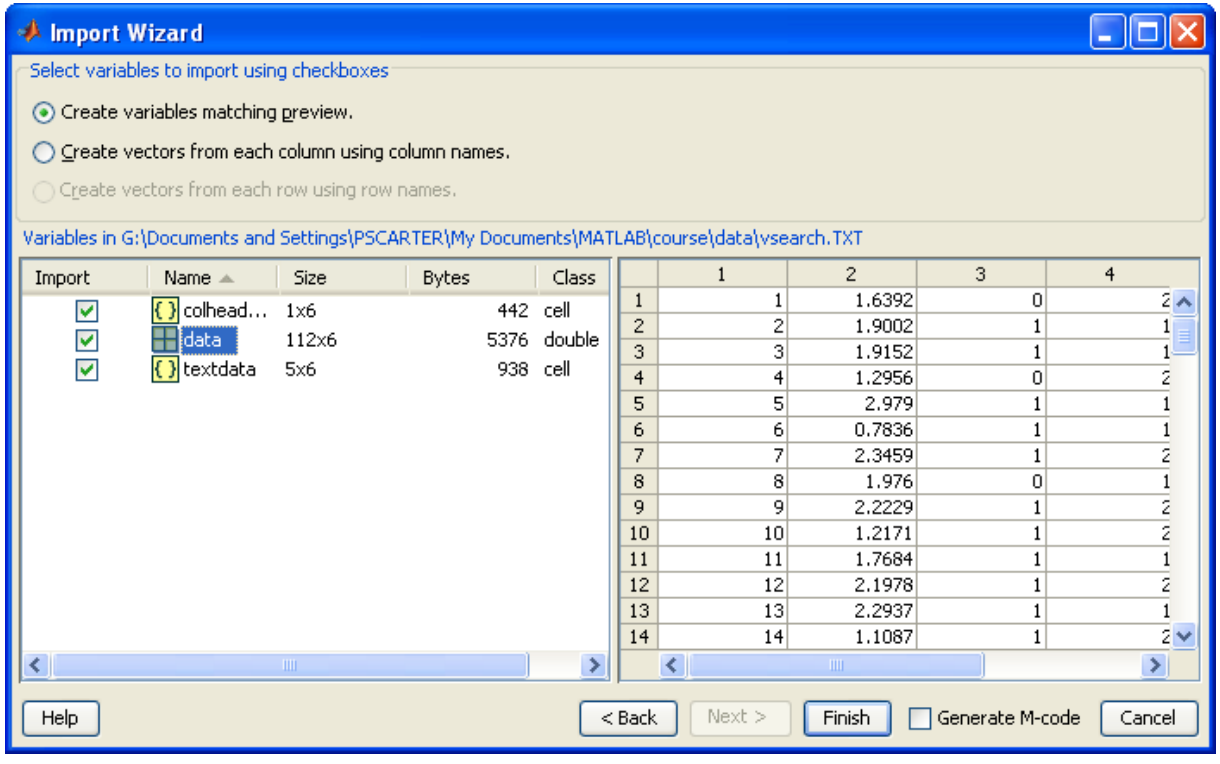
Importing Data

We have to tell MATLAB how to read our data file. As long as the columns in the data table are separated with, e.g., tabs, all we have to do is to skip the file-header lines:



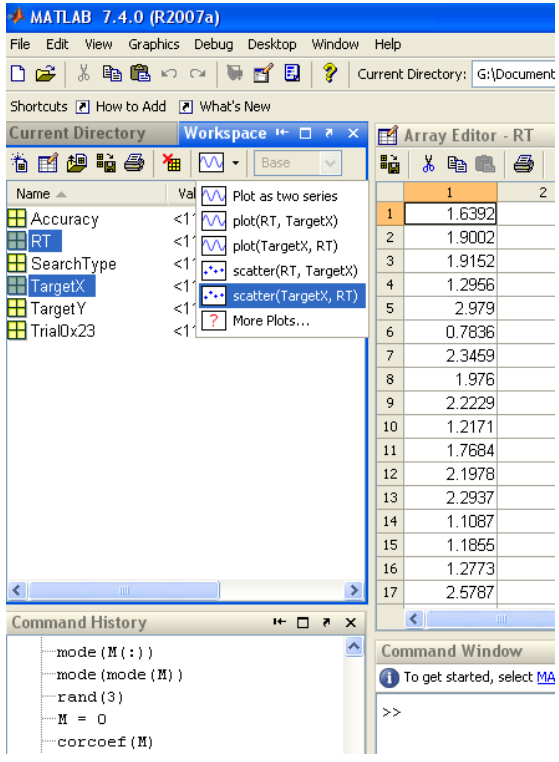
Import Data into Variables

We can tell MATLAB to use the column headings to name the variables.



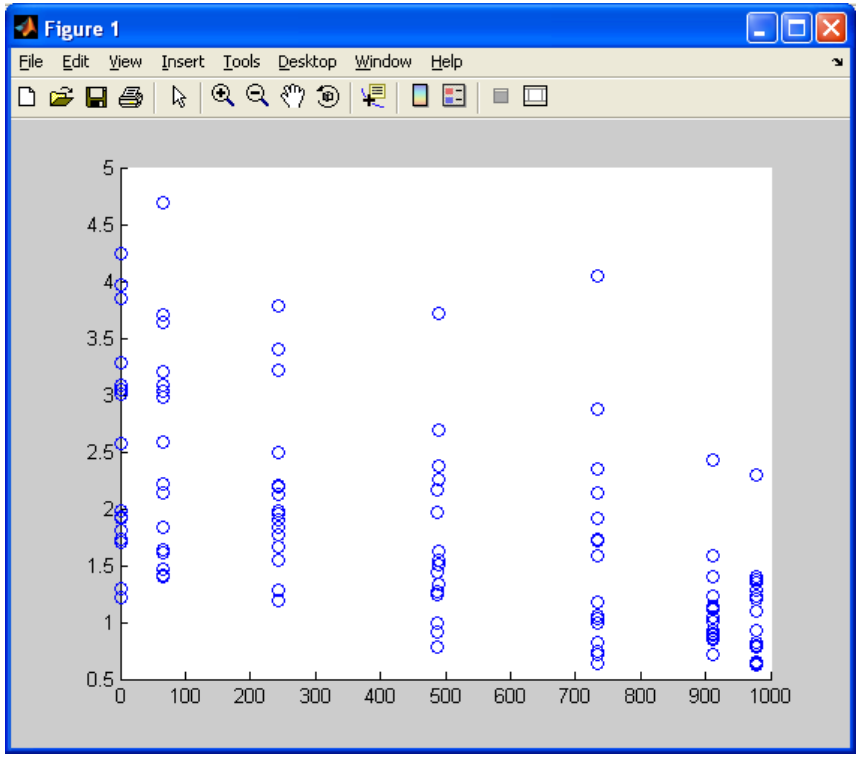
Plotting Data as a Scatter

There are a variety of graph styles to choose from in the Plot Tool.



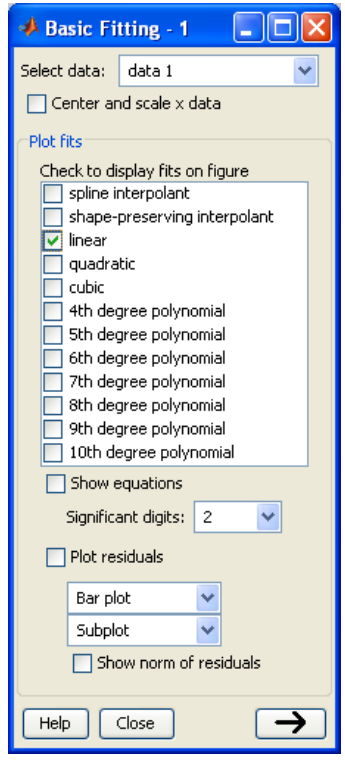
Scatter Plot

A scatter plot of reaction time against the target's horizontal position.



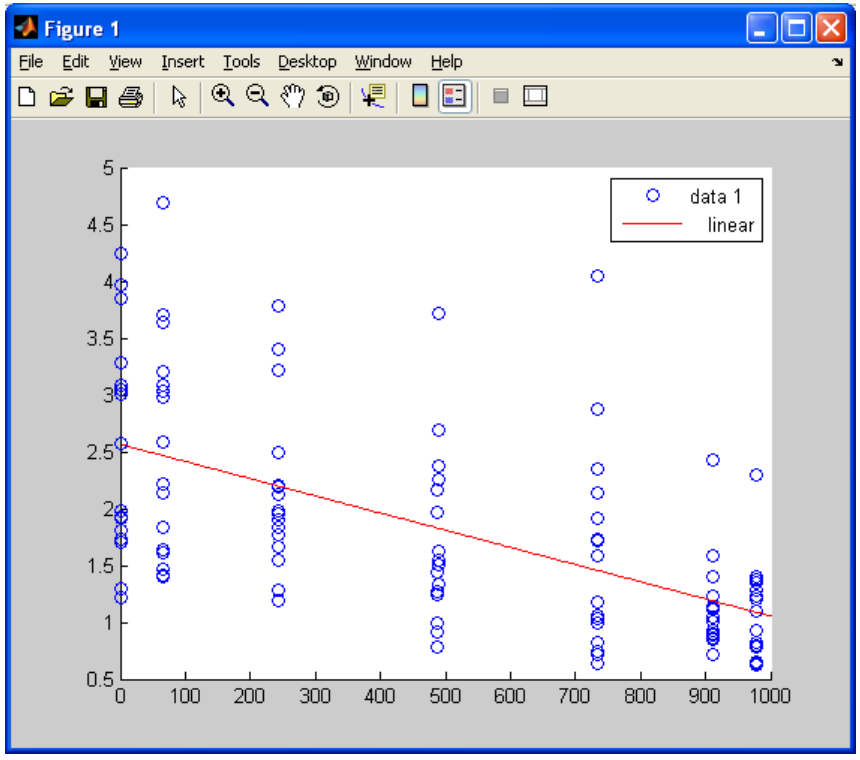
Curve Fitting Dialog

There is a curve fitting tool, with a wide range of polynomial orders.



Curve Fitted

There is a strong linear trend in this data. A cubic trend is also present.



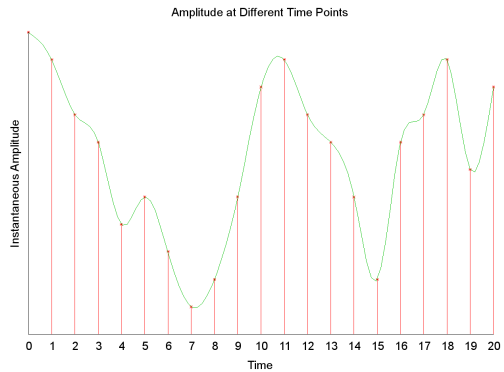
Outline

Why MATLAB?

- MATLAB, Excel and SPSS are all capable of many mathematical operations, and share a lot of functionality. However...
- SPSS and Excel seem almost to hide their programming interface behind the GUI, whilst MATLAB gives them equal status.
- Operations are easier to examine, modify, and repeat (or perform in bulk) when run from a program.
- There is an enormous number of commercial and public-domain toolboxes and programs available via the Internet.

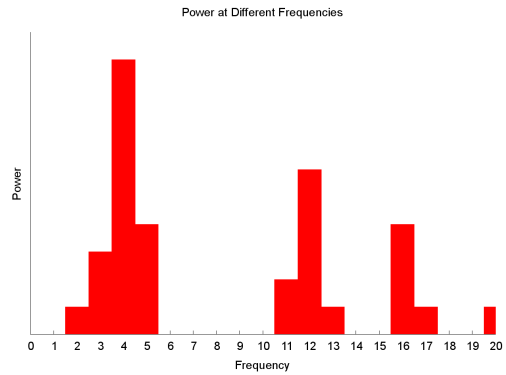
Manipulating Sounds

- A digital sound recording is just a series of amplitude values and a sampling rate.
- MATLAB treats the recording as just another matrix, allowing any and all mathematical operations upon it, including noise removal, filtering, amplification, distortion, frequency analysis, and so on.



Amplitude over time

FFT



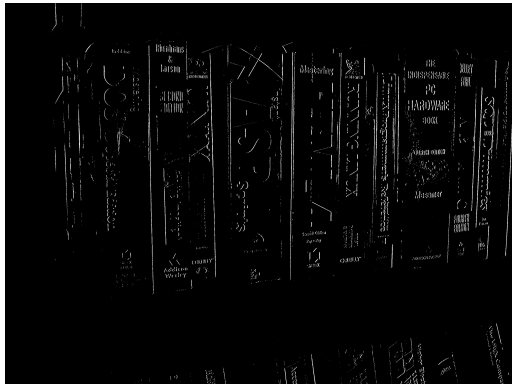
Power against Frequency

Manipulating Images

- Digital images are one (for greyscale) or three (for RGB colour) matrices of pixel values.
- MATLAB can do any mathematical operation on them, including feature emphasis, noise removal, colour filtering, and so on.

Original Image

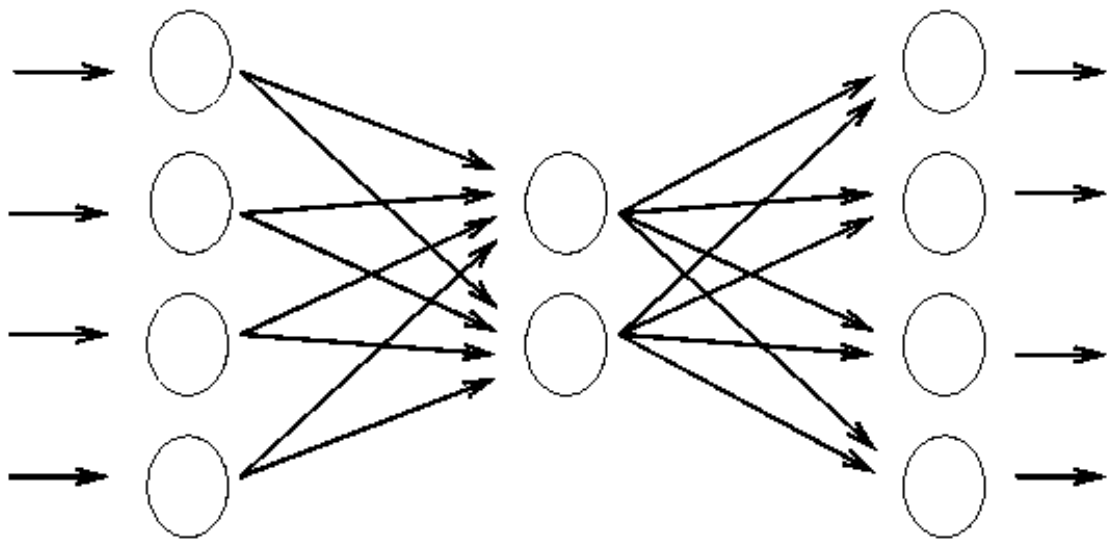
Convolution $\Longrightarrow$



Vertical Edges

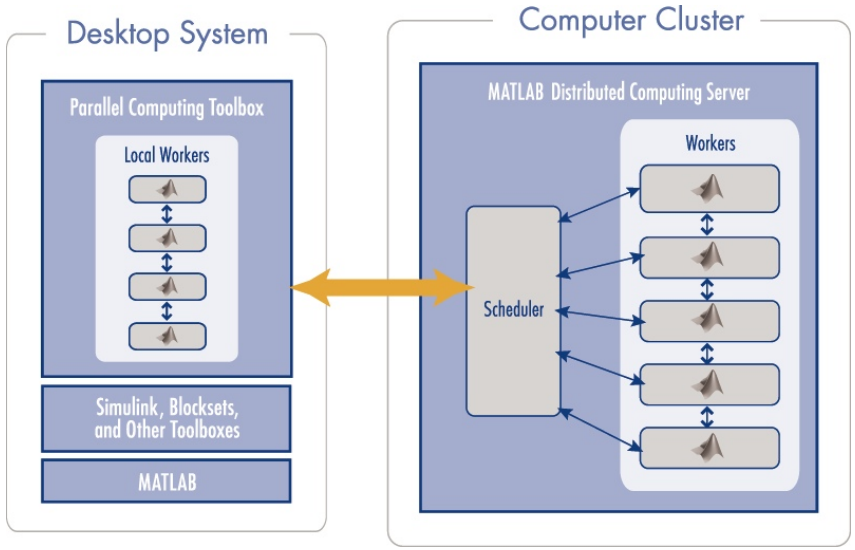
Neural Networks

- Matrices lend themselves to the storage of neural networks.
- Mathworks offer a toolbox for neural networks.



Performance

- MATLAB has been fine-tuned over the years to be as fast as possible, and to handle massive data sets.
- Apart from this optimised speed, MATLAB's Parallel Toolbox allows it to distribute the workload using multiple cores and clusters.
- Parallel computing allows faster performance by dividing the work and/or the data.



MATLAB Toolboxes

- **Cogent** a graphics toolbox for MATLAB on the PC. It can be used to generate realtime graphical animations for use as stimuli in vision research and to monitor subject input via keyboard and mouse:

  http://www.vislab.ucl.ac.uk/cogent.php
- **Psychtoolbox** MATLAB functions for vision research. It makes it easy to synthesize and show accurately controlled visual stimuli and interact with the observer:

  http://psychtoolbox.org/

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Useful MATLAB Resources

- **Antonia Hamilton's lab for Social Cognition** a basic guide to tell you only the bits of MATLAB which you need to know for running and analysing psychology experiments:

  http://www.antoniahamilton.com/matlab.html

Octave

There is a freely available alternative for MatLab, called Octave and produced by the GNU Free Software Foundation. It is highly compatible with MatLab (the commands are the same). Its website is as follows:

http://www.gnu.org/software/octave/

and it can be downloaded from here (click the **Windows Installer** link):

http://octave.sourceforge.net/