只有你能決定如何使用上帝給你的時間

- 節錄自《魔戒》，托爾金
I. Install
II. Demonstration
III. Introduction
IV. Simple Project
   a. Regression curve
   b. Simple Lossy Data compression by SVD
請參閱計中的步驟說明下載並安裝matlab

http://ca.nctu.edu.tw/html/4_Install/05_MatLab.php
II. Demonstration

![Power Spectrum with a MUSIC spectrum for 1 beamwidth separation, Noise = 10dB]
II. Demonstration
II. Demonstration

Typical Urban in 900kHz Bandwidth

- Simple $\chi^2$
- ~a priori known
  Similar to $\chi^2$
- NOT a priori known!!
  Far away from $\chi^2$
  Depends on strategy and QoS
II. Demonstration

24 chunks a 375kHz, 100358 samples a 0.5ms = 50.179sec, v=3kmh, case3
II. Demonstration

pathloss exp: 3.76; Reuse: 1; 2 Rings (57 BSs)
II. Demonstration
II. Demonstration
II. Demonstration
II. Demonstration
II. Demonstration
III. Introduction

- Workspace: can be switched to a view of all currently known variables.
- History window
- Command window: where you type matlab commands
- Current Directory
- Editor
III. Introduction
III. Introduction

- Getting Help: You can open Matlab help window by pressing F1.
III. Introduction

Matrix Creation

Matrices can be created by listing their elements in square brackets. The rows are divided using semicolons ";". The entries for the single columns within a row are divided by white spaces " ".

For example, the matrix
\[
\begin{bmatrix}
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9 \\
\end{bmatrix}
\]
can be created by writing \([1 \ 2 \ 3; \ 4 \ 5 \ 6; \ 7 \ 8 \ 9]\).

Row and column vectors can be declared using the same syntax:

\[
\begin{bmatrix}
1 \\
2 \\
3 \\
\end{bmatrix} \quad \Rightarrow \quad [1; \ 2; \ 3]
\]

\[
\begin{bmatrix}
1 \\ 2 \\ 3
\end{bmatrix} \quad \Rightarrow \quad [1 \ 2 \ 3]
\]
III. Introduction

**Matrix transposition:** Matrices can be transposed using the ' operator:

\[
x = \begin{bmatrix} 1 & 2; 3 & 4; 5 & 6 \end{bmatrix}
\]
\[
y = x'
\]

result: \[y = \begin{bmatrix} 1 & 3 & 5 \\ 2 & 4 & 6 \end{bmatrix}.
\]

**Matrix addition:** Matrices can be added using the + operator:

\[
C = A + B
\]

**Scalar multiplication:** Matrices can be multiplied with a scalar using the * operator:

\[
C = 2*A
\]

**Matrix multiplication:** The * operator can also be used to multiply matrices:

\[
C = A*B
\]

Of course the inner dimensions of the matrices must match. The * operator can also be used to apply the dot product:

\[
x = a' * b
\]

**Matrix power:** There is also a power operator for matrices: ^

\[
C = A^2
\]
III. Introduction

**Element by element matrix multiplication:** Matlab can multiply two matrices, having the same dimensions, element by element. This is done using the .\* operator.

\[
A = \begin{bmatrix}
1 & 2 & 3 \\
4 & 5 & 6
\end{bmatrix}
\]

\[
B = \begin{bmatrix}
7 & 8 & 9 \\
1 & 2 & 3
\end{bmatrix}
\]

\[
C = A \times B
\]

result: \[
C = \begin{bmatrix}
7 & 16 & 27 \\
4 & 10 & 18
\end{bmatrix}
\]

**Element by Element Matrix Division:** Matrices can divided element by element using the ./ operator:

\[
A = \begin{bmatrix}
27 & 16 & 15 \\
8 & 4 & 2
\end{bmatrix}
\]

\[
B = \begin{bmatrix}
9 & 4 & 5 \\
2 & 2 & 2
\end{bmatrix}
\]

\[
C = A ./ B
\]

result: \[
C = \begin{bmatrix}
3 & 4 & 3 \\
4 & 2 & 1
\end{bmatrix}
\]
III. Introduction

Assume that $A$ is a matrix build of elements $a_{i,j}$ and $\mathbf{x}$ is a vector out of $x_i$.

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Element-wise Functions</strong></td>
<td></td>
</tr>
<tr>
<td>$\text{sqrt}(A)$</td>
<td>square root (element-wise)</td>
<td>$\sqrt{a_{i,j}}$</td>
</tr>
<tr>
<td>$\text{exp}(A)$</td>
<td>exponential function (element-wise)</td>
<td>$e^{a_{i,j}}$</td>
</tr>
<tr>
<td>$\text{log}(A)$</td>
<td>natural logarithm (element-wise)</td>
<td>$\ln a_{i,j}$</td>
</tr>
<tr>
<td>$\text{log10}(A)$</td>
<td>logarithm to the basis 10 (element-wise)</td>
<td>$\log_{10} a_{i,j}$</td>
</tr>
<tr>
<td>$\text{abs}(A)$</td>
<td>absolute value (element-wise)</td>
<td>$</td>
</tr>
<tr>
<td>$\text{sign}(A)$</td>
<td>signum function (element-wise)</td>
<td>$\text{sgn}(a_{i,j})$</td>
</tr>
<tr>
<td></td>
<td><strong>Matrix functions</strong></td>
<td></td>
</tr>
<tr>
<td>$\text{norm}(\mathbf{x})$</td>
<td>second norm of vector $\mathbf{x}$</td>
<td>$</td>
</tr>
<tr>
<td>$\text{inv}(A)$</td>
<td>inverse of matrix $A$</td>
<td>$A^{-1}$</td>
</tr>
<tr>
<td>$\text{diag}(A)$</td>
<td>column vector of diagonal elements of matrix $A$</td>
<td>$[a_{i,i}]$</td>
</tr>
<tr>
<td>$\text{size}(A)$</td>
<td>row vector of two components holding number of rows and number of columns.</td>
<td>$\begin{bmatrix} \tau &amp; c \end{bmatrix}$</td>
</tr>
<tr>
<td>$\text{length}(\mathbf{x})$</td>
<td>dimension of a vector $\mathbf{x}$</td>
<td>$n$</td>
</tr>
<tr>
<td>$\text{det}(A)$</td>
<td>determinant of matrix $A$</td>
<td>$\det(A)$</td>
</tr>
<tr>
<td>$\text{trace}(A)$</td>
<td>trace (sum of diagonal elements) of matrix $A$</td>
<td>$\sum a_{i,i}$</td>
</tr>
</tbody>
</table>
### III. Introduction

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<th>Function</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>eye(r)</strong></td>
<td>identity matrix with ( r ) rows and columns.</td>
<td>( I_r )</td>
</tr>
<tr>
<td><strong>ones(r,c)</strong></td>
<td>( r \times c ) matrix of ones</td>
<td>( \begin{bmatrix} 1 \ \vdots \ 1 \end{bmatrix} \in \mathbb{R}^{r\times c} )</td>
</tr>
<tr>
<td><strong>zeros(r,c)</strong></td>
<td>( r \times c ) matrix of zeros</td>
<td>( \begin{bmatrix} 0 \ \vdots \ 0 \end{bmatrix} \in \mathbb{R}^{r\times c} )</td>
</tr>
<tr>
<td><strong>diag(x)</strong></td>
<td>matrix having ( x ) as diagonal</td>
<td>( \begin{bmatrix} x_1 &amp; 0 \ \vdots &amp; \vdots \ 0 &amp; x_n \end{bmatrix} )</td>
</tr>
<tr>
<td><strong>linspace(a,b,n)</strong></td>
<td>row vector of ( n ) linearly distributed values between ( a ) and ( b )</td>
<td>( \begin{bmatrix} \cdots &amp; a + \frac{b-a}{n-1} i &amp; \cdots \ i = 0 \ldots n-1 \end{bmatrix} )</td>
</tr>
<tr>
<td><strong>logspace(a,b,n)</strong></td>
<td>row vector of ( n ) logarithmically distributed values between ( 10^{a} ) and ( 10^{b} )</td>
<td>( \begin{bmatrix} \cdots &amp; 10^{\frac{b-a}{n-1} i} &amp; \cdots \ i = 0 \ldots n-1 \end{bmatrix} )</td>
</tr>
<tr>
<td><strong>a:b</strong></td>
<td>(Colon operator) Row vector of values between ( a ) and ( b ) with a step of ( s ) (defaults to 1)</td>
<td>( \begin{bmatrix} a, &amp; a+1, &amp; \cdots b \ a, &amp; a+1s, &amp; \cdots b \end{bmatrix} )</td>
</tr>
</tbody>
</table>
Matrices can be compared element by element using the following operators:

- `==` equal
- `~=` not equal
- `<` less than
- `<=` less than or equal
- `>` greater
- `>=` greater than or equal

Comparisons can be grouped by parentheses and combined using the following logical operators:

- `~` not
- `&` and
- `&&` Shortcut-and (stops evaluation after first false condition)
- `|` or
- `||` Shortcut-or (stops evaluation after first true condition)
Matrices can be easily concatenated using the same syntax used for matrix creation:

\[ a = \begin{bmatrix} 1 & 2 & 3 \end{bmatrix}, \quad b = \begin{bmatrix} 4 & 5 & 6 \end{bmatrix} \]

\[
\begin{bmatrix} a & b \end{bmatrix} \leftrightarrow \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 \end{bmatrix}
\]

\[
\begin{bmatrix} a' & b' \end{bmatrix} \leftrightarrow \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{bmatrix}
\]

\[
\begin{bmatrix} a; b \end{bmatrix} \leftrightarrow \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}
\]

\[
\begin{bmatrix} a' & b' \end{bmatrix} \leftrightarrow \begin{bmatrix} 1 & 4 \\ 2 & 5 \\ 3 & 6 \end{bmatrix}
\]
A single element of a matrix can be extracted using the index operator:

\[ a = \begin{bmatrix} 1 & 2 & 3 \end{bmatrix} \quad a(2) \rightarrow 2 \]

The vector \( a \) is a one dimensional vector. It is indexed by a single index, which is the number of the element.

\[ B = \begin{bmatrix} 1 & 2 & 3 ; & 4 & 5 & 6 \end{bmatrix} \quad B(2,2) \rightarrow 5 \]

The vector \( B \) is a two dimensional vector. It is indexed by a row index and a column index.

Submatrices can be extracted by using a matrix of indices:

\[ v = \begin{bmatrix} 101 & 102 & 103 & 104 & 105 & 106 & 107 \end{bmatrix} \]

\[ r = v([3 \ 5 \ 1 \ 7]) \]

Result \( r \): [103 105 101 107]

The resulting vector is of the same size as the index vector and contains the data referenced by the index vector.

The index vector can also be created using the colon operator:

\[ a(2:3) \rightarrow \begin{bmatrix} 2 & 3 \end{bmatrix} \]
\[ B(1:2,2:3) \rightarrow \begin{bmatrix} 2 & 3 \\ 5 & 6 \end{bmatrix} \]
III. Introduction

Exercise:

Calculate \( \log(25^3) \) and assign the result to a variable \( a \).

Calculate \( \log(25) \) and assign the result to a variable \( b \).

Calculate \( \frac{a}{b} \).

Define \( \mathbf{x} = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \).

Define \( \mathbf{A} = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \).

Calculate \( \mathbf{A} \mathbf{x} \).

Calculate \( \mathbf{x}^T \mathbf{x} \).
III. Introduction

M-File

Let’s Learn M-File and plot directly by a practical exercise.

Create a new M-File.

Create a vector $x$ containing values from $-5$ to $5$ in steps of $0.1$.

Calculate $f(x) = x^3 - 5x$ and store the results in the vector $y$.

Plot $y$ vs. $x$

Switch the plot style to a red, dashed line.
III. Introduction

Function:
Let’s Learn function and plot directly by a practical exercise.

Create a function \( f(x) = x^2 + 2x + 1 \).

Plot this function using ezplot.

```matlab
ezplot(@(x)ex1(x),[-2,2])
```
IV. Simple Project

- a. Regression curve
IV. Simple Project

- Simple Lossy Data compression by SVD