Matlab Workshop I

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What is Matlab?

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- Matlab is an interactive program for numerical computation and data visualization.
Most Important Matlab Command: `help`

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  a long list of help \texttt{topics} for which on-line help is available

- \texttt{help topic}

  a list of those \texttt{functions} under the topic for which help is available. For example, \texttt{help elmat} gives a list of elementary matrices and matrix manipulation
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a list of those **functions** under the topic for which help is available. For example, **help elmat** gives a list of elementary matrices and matrix manipulation

- **help function-name**
  
information about a specific function. For example, **help eye** gives information about generating an identity matrix.
Scalar, Vector, and Matrices

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Matrices

- Entered by an explicit list of elements. For example,
  \[
  A = \begin{bmatrix}
  1 & 2 & 3 \\
  4 & 5 & 6 \\
  7 & 8 & 9
  \end{bmatrix}
  \]

- Generated by built-in functions. For example,
  \[\text{eye}(m,n), \text{zeros}(m,n), \text{ones}(m,n), \text{linspace}(a,b,n), 1:n, \text{randn}(m,n), \text{rand}(m,n), \text{diag}(v,k), \text{diag}(A), \text{blkdiag}\]
Scalar, Vector, and Matrices

*Matlab works with a rectangular numerical matrix*
*All variables represent matrices!!!*

 Scalars: 1-by-1 matrices

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 Matrices

 - Entered by an explicit list of elements. For example,
   \[ A = \begin{bmatrix} 1 & 2 & 3; 4 & 5 & 6; 7 & 8 & 9 \end{bmatrix} \]

 - Generated by built-in functions. For example,
   \[ \text{eye}(m,n), \text{zeros}(m,n), \text{ones}(m,n), \]
   \[ \text{linspace}(a, b, n), 1:n, \text{randn}(m,n), \]
   \[ \text{rand}(m,n), \text{diag}(v,k), \text{diag}(A), \text{blkdiag} \]

 Empty Matrix: [ ]
Values of Useful Constants

pi \quad 3.14159265\ldots

i \quad \text{Imaginary unit, } \sqrt{-1}

j \quad \text{Same as } i

eps \quad \text{Floating-point relative precision, } \epsilon = 2^{-52}

realmin \quad \text{Smallest floating-point number, } 2^{-1022}

realmax \quad \text{Largest floating-point number, } (2 - \epsilon)^{1023}

Inf \quad \text{Infinity}

NaN \quad \text{Not-a-number}
who(s), clear, save

who

This shows all active variables. Try the command whos
who (s), clear, save

- **who**
  
  This shows all active variables. Try the command **whos**

- **clear a b**
  
  This removes the variables **a** and **b**
who(s), clear, save

- **who**
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- **clear a b**
  This removes the variables \( a \) and \( b \)

- **clear all**
  This remove all variables
**who (s), clear, save**

- **who**
  This shows all active variables. Try the command `whos`

- **clear a b**
  This removes the variables `a` and `b`

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- **save filename**
  This creates a file `filename.mat` which contains all variables
who(s), clear, save

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- **clear a b**
  This removes the variables **a** and **b**

- **clear all**
  This remove all variables

- **save filename**
  This creates a file **filename.mat** which contains all variables

- **save filename x y z**
  This creates a file **filename.mat** which contains variables **x y z**
Format Functions

format  Default. Same as short
format short  Fixed point with 5 decimal places
format long  Fixed point with 15 decimal places
format short e  Floating point with 5 decimal places
format long e  Floating point with 15 decimal places
format short g  Best of fixed or floating point with 5 DPs
format long g  Best of fixed or floating point with 15 DPs
format hex  Hexadecimal format
format compact  Suppress extra line-feeds
format loose  Put the extra line-feeds back in

Try the example $t = [4/3 \ 1.2345e-6]$
Sub-matrices and Colon Notation

1:5
0.4:0.2:1.2
A(1:4,3)
A(:,3)
A(1:4,:)
A(:, [2 4]) = [ ]
A(:, [2 4]) = B(:,1:2)
the column vector with the first four entries of the third column
the third column of A
the first four rows of A
delete columns 2 and 4 of A
replacing columns 2,4 with the first two columns of B

Effort should be made to become familiar with them!!!
Standard Operators

+ addition
− subtraction
∗ multiplication
ˆ power
′ conjugate transpose
\ left division
/ right division

\[ x = A\backslash b \quad \text{the solution of } A \ast x = b \]
\[ x = b \div A \quad \text{the solution of } x \ast A = b \]
Pointwise Operation

+    addition
−    subtraction
.*  Element-by-element multiplication
.^  Element-by-element power
./  Element-by-element left division
./  Element-by-element right division
.
    Unconjugate array transpose (same as transpose(A))
## Pointwise Operation: Some Examples

<table>
<thead>
<tr>
<th>Matlab Command</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>[1,2,3] .* [5,6,7]</code></td>
<td><code>[5,12,21]</code></td>
</tr>
<tr>
<td><code>[10:-2:0] .^ 2</code></td>
<td><code>[100, 64, 36, 16, 4, 0]</code></td>
</tr>
<tr>
<td><code>2 .^ [1:6]</code></td>
<td><code>[2, 4, 8, 16, 32, 64]</code></td>
</tr>
<tr>
<td><code>[2,4,6] ./ 2</code></td>
<td><code>[1,2,3]</code></td>
</tr>
<tr>
<td><code>2./ [2,4,6]</code></td>
<td><code>[1.000 0.5000 0.3333]</code></td>
</tr>
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<td><code>[2,2,2] ./ [2,4,6]</code></td>
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</tr>
<tr>
<td><code>[1 1+2*i; i 3].'</code></td>
<td><code>1.0000 0+1.0000i 3.0000</code></td>
</tr>
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</table>
Math Functions

The Matlab command `help elfun` gives a list of elementary math functions

- **Trigonometric**: `sin`, `sinh`, `asin`, `asinh`, `cos`, `cosh`, `acos`, `acosh`, `tan`, `tanh`, `atan`, `atan2`, `atanh`, `sec`, `sech`, `asech`, `csc`, `csch`, `acsc`, `acsch`, `cot`, `coth`, `acot`, `acoth`

The variables of these functions could be matrices!!!
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- **Exponential**: `exp`, `log`, `log10`, `log2`, `pow2`, `sqrt`, `nextpow2`

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- **Exponential:** `exp`, `log`, `log10`, `log2`, `pow2`, `sqrt`, `nextpow2`

- **Complex:** `abs`, `angle`, `complex`, `conj`, `imag`, `real`, `unwrap`, `isreal`, `cplxpair`

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- **Trigonometric:** `sin, sinh, asin, asinh, cos, cosh, acos, acosh, tan, tanh, atan, atan2, atanh, sec, sech, asec, acsch, csc, csch, acsc, acsch, cot, coth, acot, acoth`

- **Exponential:** `exp, log, log10, log2, pow2, sqrt, nextpow2`

- **Complex:** `abs, angle, complex, conj, imag, real, unwrap, isreal, cplxpair`

- **Rounding and remainder:** `fix, floor, ceil, round, rem, sign`

*The variables of these functions could be matrices!!!*
The Matlab command

`diary filename`

causes what appears subsequently on the screen (except graphics) to be written to the named diskfile (if no file is specified, the file ‘diary’ is used). To save space, don’t forget the command `format compact`
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The Matlab command

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suspends \texttt{diary}
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The Matlab command

\texttt{diary \texttt{on}}

turns \texttt{diary} back on