Introduction to MATLAB

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IST Information Services and Technology

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Topics

✓ MATLAB Interface and Basics

✓ Linear Algebra and Calculus

➢ Graphics

■ Programming

■ Graphical User Interface

■ Math On the Web (optional)

Class Materials

- On laptops download from:
  http://web.mit.edu/acmath/matlab/IntroMATLAB
- On Athena copy from locker acmath

```
athena% add acmath
athena% cp
    /mit/acmath/matlab/IntroMATLAB/Graphics.tar .
```

Help in MATLAB

- ## Command line help

  ```
  >> help command
          e.g. help surf
  >> lookfor keyword
          e.g. lookfor surfaces
  ```

- ## Desktop menu

  - Help->Help MATLAB

MATLAB Help Browser

- **MATLAB**
    - **+ Graphics**
        - **+ MATLAB Plotting Tools**
        - **+ Annotating Graphs**
        - **+ Basic Plotting Commands**
        - **+ Figure Properties**
        - **+ Axes Properties**
    - **+ 3D Visualization**
        - **+ Creating 3D Graphs**
- **Other Toolboxes**

MATLAB Graphics

2D and 3D Plotting

Figure Property Editing

Animation

Built-In Functions

- ■ Basic plots and graphs
    - `>> plot`
    - `>> plot3`
    - `>> semilogy, semilogx`
    - `>> polar`

- ■ Surface and mesh graphs
    - `>> surf`
    - `>> mesh`

- ■ Specialized plots
    - `>> contour`
    - `>> scatter`

Built-In Functions (continued)

- Annotating figures

  ```
  >> xlabel, ylabel, zlabel
  >> title
  >> legend
  >> colorbar
  ```

- Multiple plots

  ```
  >> hold on, hold off
  >> subplot
  ```

- Saving figures

  ```
  >> saveas
  ```

Built-In Functions (continued)

- ## Animation
  - `>> drawnow`
  - `>> getframe`
  - `>> movie2avi`

- ## Domain generation
  - `>> meshgrid`
  - `>> griddata`

- ## Object properties
  - `>> get`
  - `>> set`

Built-In Functions (continued)

- ## Axes' properties
  - `>> axes`
  - `>> axis`

- ## Graphics handles
  - `>> gcf`
  - `>> gca`

- ## And many others
  - `>> view`
  - `>> length`
  - etc.

Figure Editor

- To open a new figure window:
  ```
  >> figure
  ```
- To plot in the current figure window:
  ```
  >> plot (X, Y, 'ro')
  >> surf (x, y, z)
  >> contour (x, y, z, N)
  ```
- Plotting commands create a figure window if none is open.

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Creating 2D Graphs

- Linear plots

```
>> plot (X, Y, 'ro')
>> plot (X, Y, 'Color', [0.5 0 0], …
            'Marker', 'o', …
            'LineStyle', 'none')
```

- Colors: b, r, g, y, m, c, k, w
- Markers: o, *, ., +, x, d
- Line styles: -, --, -., :

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Other 2D Graphs

- ## Contour plots

  `>> contour (x, y, z, N)`

  Note: `x, y,` and `z` are matrices, not vectors.

- ## Polar coordinates

  `>> polar(theta, rho)`

  e.g. `>> t = [0 : 0.01 : 2*pi]`

  `>> polar (sin(t), cos(t))`

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Creating 3D Graphs

- **Linear plots**

  ```
  >> plot3 (X, Y, Z, 'ro')
  ```

  Note: `X`, `Y`, and `Z` are vectors.

- **Surface and mesh plots**

  ```
  >> surf(x, y, z)
  >> mesh (x, y, z)
  ```

  Note: `x`, `y`, and `z` are matrices, not vectors.

- **3D contour plots**

  ```
  >> contour3(x, y, z, N)
  ```

3D Graph Example

- ## Domain Generation
  ```
  >> [x, y] = meshgrid([-3 : 0.25 : 3], …
                   -3 : 0.25 :3]);

  >> z = x .* exp(-(x.^2 + y.^2));
  ```

- ## Plot generation
  ```
  >> s1 = surf(x, y, z)
  ```

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Annotating Graphs

- ## Create and plot a graph

  e.g. `>> plot (t, z, 'r-')`

- ## Annotate the gragh

  `>> legend ('z=f(t)')`

  `>> title ('Position vs. Time')`

  `>> xlabel ('Time')`

  `>> ylabel ('Position')`

Multiple Graphs on One Plot

- **Built-in function** `hold`

```
>> p1 = plot(t, z, 'r-')
>> hold on
>> p2 = plot(t, -z, 'b--')
>> hold on
>> p3 = plot(T, Z, 'go')
>> hold off
```

Subplots on One Figure

- **Built-in function** `subplot`

  ```
  >> s1 = subplot(1, 3, 1)
  >> p1 = plot(t, z, 'r-')
  >> s2 = subplot(1, 3, 2)
  >> p2 = plot(t, -z, 'b--')
  >> s3 = subplot(1, 3, 3)
  >> p3 = plot(T, Z, 'go')
  ```

Multiple Figures

- Create figure windows:
  ```
  >> figure
  >> fig1 = gcf
  >> figure
  >> fig2 = gcf
  ```
- Navigate between figures:
  ```
  >> figure(fig1)
  ```
  … or click on a figure window to make it active.

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Figure and Axes Handles

- Get current figure and axes:

```
>> p1 = plot3(X, Y, 'ro')
>> fig1 = gcf
>> ax1 = gca
% Alternatively:
>> ax1 = get(fig1, 'CurrentAxes')
```

- Set figure and axes' properties:

```
>> set(fig1, 'Color', [0.9 0.8 0.7])
>> axes(ax1)
>> axis([Xmin Xmax Ymin Ymax])
```

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Property Editor

- Start Plot Edit mode

  `>> plotedit on`

  ... or click on [▶] in the Figure window.

- Open Property Editor

  `View->Property Editor`

- Select element - the Property Editor changes

  e.g. `Property Editor - Axes`

- Edit figure elements

Saving Figures

- From the Figure window
  `File->Save As`
  - MATLAB format: *`figurename.fig`*
  - Other formats: TIFF, JPEG, etc.
- From the command line
  `>> saveas(fig1, 'figurename.tif')`

Animation

- Create animated plot of y(x)

```
for i = 1 : length(x)
    p1 = plot(x(i), y(i), 'bo')
    hold on
    % Enforce the same axes
    set(gca, 'XLim', [xmin xmax], …
              'YLim', [ymin ymax])
    drawnow
end
```

- Export animation: `getframe, movie2avi`

Graphics Exercises

- **Exercise One:** `example1.m`
  - ○ 3D plotting, multiple graphs, multiple figures
  - ○ Figure editor, annotation, Plot Edit mode
  - ○ Figure and graphics handles
  - ○ Graphics export

- **Exercise Two:** `example2.m`
  - ○ 2D plotting, subplots on figure
  - ○ Property Editor, graphics customization

- **Exercise Three:** `example3.m`
  - ○ Animation

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