Introduction to MATLAB

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Introduction to MATLAB: Graphics and Visualization

Topics

- MATLAB Interface and Basics
- Calculus, Linear Algebra, ODEs
  - Graphics and Visualization
- Basic Programming
- Programming Practice
- Statistics and Data Analysis
Resources

- Class materials
  - Previous session: InterfaceBasics <.zip, .tar>
  - This session: Graphics <.zip, .tar>

- Mathematical Tools at MIT web site
  http://web.mit.edu/ist/topics/math
MATLAB Help Browser

MATLAB

+ Graphics
  + MATLAB Plotting Tools
  + Annotating Graphs
  + Basic Plotting Commands
  + Figure Properties
  + Axes Properties

+ 3D Visualization
  + Creating 3D Graphs
MATLAB Graphics

2D and 3D Plotting
Figure Property Editing
Animation
Figure Editor

- To open a new figure window:
  \[ \text{figure} \]

- To plot in the current figure window:
  \[ \text{plot} \ (X, \ Y, \ 'ro') \]
  \[ \text{surf} \ (x, \ y, \ z) \]
  \[ \text{contour} \ (x, \ y, \ z, \ N) \]

- Plotting commands create a figure window if none is open.
Creating 2D Graphs

- **2D linear plots:** `plot`
  ```
  >> plot (t, z, 'r-')
  >> plot (X, Y, 'Color', [1 0 1], ...
        'Marker', 'o', ...
        'LineStyle', 'none')
  ```

- **Graph annotation**
  ```
  >> legend ('z = f(t)')
  >> title ('Position vs. Time')
  >> xlabel ('Time')
  >> ylabel ('Position')
  ```
**Multiple Plots**

- **Multiple datasets on a plot**
  
  ```
  >> p1 = plot(xcurve, ycurve)
  >> hold on
  >> p2 = plot(Xpoints, Ypoints, 'ro')
  >> hold off
  ```

- **Subplots on a figure**
  
  ```
  >> s1 = subplot(1, 2, 1)
  >> p1 = plot(time, velocity)
  >> s2 = subplot(1, 2, 2)
  >> p2 = plot(time, acceleration)
  ```
Exercise One: `subplots.m`

- 2D plotting
- Subplots
- Property Editor

*Follow instructions in m-file ...*
Other 2D Graphs

- Contour plots

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

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

- Polar coordinates

  ```matlab
  >> polar(theta, rho)
  ```

  e.g.
  ```matlab
  >> t = [0 : 0.01 : 2*pi]
  >> polar (sin(t), cos(t))
  ```
Creating 3D Graphs

- Linear plots
  \[ \text{>> plot3}(X, Y, Z, 'ro') \]
  Note: \( X, Y, \) and \( Z \) are **vectors**.

- Surface and mesh plots
  \[ \text{>> surf}(x, y, z) \]
  \[ \text{>> mesh}(x, y, z) \]
  Note: \( x, y, \) and \( z \) are **matrices**, not vectors.

- 3D contour plots
  \[ \text{>> contour3}(x, y, z, N) \]
3D Graph Example

- Domain Generation

\[
\begin{align*}
& \gg [x, y] = \text{meshgrid}([-3 : 0.25 : 3], \ldots \nonumber \\
& \quad \quad \quad \quad \quad \quad -3 : 0.25 : 3]); \\
& \gg z = x \times \exp(-(x.^2 + y.^2));
\end{align*}
\]

- Plot generation

\[
\begin{align*}
& \gg s1 = \text{surf}(x, y, z)
\end{align*}
\]
Figure and Axes Handles

- Get current figure and axes:
  
  ```matlab
  >> p1 = plot3(X, Y, 'ro')
  >> fig1 = gcf
  >> ax1 = gca
  % Alternatively:
  >> ax1 = get(fig1, 'CurrentAxes')
  ```

- Set figure and axes’ properties:
  
  ```matlab
  >> set(fig1, 'Color', [0.9 0.8 0.7])
  >> axes(ax1)
  >> axis([Xmin Xmax Ymin Ymax])
  ```
Property Editor

- Start Plot Edit mode
  >> `plotedit on`
  ... or click on in the Figure window.

- Open Property Editor
  View->Property Editor

- Select element to edit
  e.g. Property Editor - Axes

- Edit element-specific properties
Saving Figures

- From the Figure window
  File->Save As
  - **MATLAB format**: `figurename.fig`
  - Other formats: TIFF, JPEG, etc.

- From the command line
  ```matlab
  >> saveas(fig1, 'figurename.tif')
  ```
Graphics Exercises

- **Exercise Two:** `surfacepoints.m`
  - 3D plotting
  - Multiple datasets
  - Figure and graphics handles
  - Graphics customizations
  - Graphics export

*Follow instructions in m-file ...*
Animation

- Create animated plot of $y(x)$

```matlab
set(gcf, 'DoubleBuffer', 'on')
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])
end
```

- Export animation: `getframe`, `movie2avi`
Graphics Exercises

- Animation Example: helix.m
- Exercise Three: cubic.m
  - Animations

Follow instructions in m-file …