12.010 Computational Methods of Scientific Programming

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Web page http://www-gpsg.mit.edu/~tah/12.010
Overview Today

- Examine image and 3-D graphics in Matlab
Simple 3-D graphics

- Simple line and scatter plots use plot3 which takes 3 vectors as arguments and plots them much like 2-D plot.

```matlab
    t = linspace(0,10*pi);
    figure(1); clf;
    plot3(sin(t),cos(t),t)
```

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Mesh plots

\[ X, Y, Z = \text{peaks}(30); \] % 30x30 version of Gaussians
\[ \text{mesh}(X,Y,Z) \]
\[ \text{xlabel('X-axis'), ylabel('Y-axis'), zlabel('Z-axis')} \]
\[ \text{colorbar; daspect([1 1 2.5])}; \]
\[ \text{title('Lec 19.2: Mesh Plot of Peaks')} \]
Transparency control

[X,Y,Z]=sphere(12);
subplot(1,2,1)
mesh(X,Y,Z), title('Lec 3a: Opaque')
hidden on
axis square off
subplot(1,2,2)
mesh(X,Y,Z), title('Lec 3b: Transparent')
hidden off
axis square off
Mesh with contour

- `meshc(X,Y,Z)` % mesh plot with underlying contour plot
Surface plots

- Surface plots are like mesh except that the surface is filled
- The appearance of these plots depends on the method of shading and how they are light.
- The commands here are:
  - `surf` -- surface plot
    * shading flat has flat faceted look
    * shading interp interpolates the surface and looks smoother
  - `surfc` -- surface plot with contours (like `meshc`)
  - `surfl` -- surface with lighting
  - `surf norm` -- surface with normal plotted
- Following figures give example of these commands using the peaks(30) data set.
- We can look at these plots in Matlab and change colormap and view angles
**Standard surf**

- Generated using `surf(X,Y,Z)`
Surf with shading flat

- The command shading flat added
Surf with shading interp

- Command shading interp used
Surfl used

• Command surfl is surface with lighting; here the colormap is changed to pink to enhance effect
Surfnorm to add normals

- Generated on a 15 grid to keep down clutter.
Working with irregular data

- Previous figures were generated using a regular grid of X and Y values from which Z values can be computed.
- Routine griddata takes irregularly spaced x y data with associated z values and fits a surface to a regularly specified grid of values. Mesh surf etc can be used to plot results
- Routines trimesh and trisurf form Delanunay triangles to irregular data and plot based on these facetted surfaces.
Griddata example
Trisurf example
Vertical view of each figure
Inside 3-D objects

• Matlab has methods for visualization of 3-D volumes
• These are figure generated to display some quantity which is a function of X Y and Z coordinates. Examples would be temperature is a 3-D body
• Functions slice and contourslice are used to see inside the body. Slice can be along coordinate planes or a surface shape can be specified.
• Isosurface renders the shape of the volume at a particular value. (Equivalent to a 3-D contour map with just one contour shown).
Slice along coordinate axes

\[ \text{slice}(X,Y,Z,V,[0 \ 3],[5 \ 15],[-3 \ 5]) \]
\[ x \text{ cut } 0 \ & \ 3; \ y \text{ cut } 5 \ & \ 15, \ z \text{ cut } -3 \ & \ 5 \]
Slice with contours added

contourslice(X, Y, Z, V, 3, [5 15], [])
Oscillating sinusoidal surface
Isosurface viewing

- Previous cut at level 2 using isosurface
Example with outer volume filled

- Added called to isocaps
Examples using Matlab flow function
Matlab flow example

• This example needs to be viewed in 3-D in Matlab.
• Here color map shows fine structure.
This loads a series of jpg images and concatenates them together to make movie. Saved in AVI format. Example is Lec19_TotalANC.avi and Lec19_RateANC.avi
Viewing real data

- Example of reading a geo-tiff file and displaying it on a Northing/Easting grid
- Main feature here is using imfinfo to retrieve information about the contents of an image file and then imread to read the image data
- Imagesc used to display image with coordinates:
  \[ \text{imagesc([UTMR(1:2)], [UTMR(3:4)], Def)} \]
Dif_1006_0407.fig contains this figure;
Summary

- Matlab has many 3-D view methods and functions available
- There are many options to many of these and sometime experimentation is needed to find out what works best.
- Demo example in Matlab can yield good ideas on how to solve specific problems.