12.010 Computational Methods of Scientific Programming

Lecturers
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Overview Today

• Examine image and 3-D graphics in Matlab
• Examples used in this lecture are:
  http://geoweb.mit.edu/~tah/12.010/Lec18_3D.m

• Results from animations
  http://geoweb.mit.edu/~tah/12.010/Lec18_TotalANC.avi
  http://geoweb.mit.edu/~tah/12.010/Lec18_RateANC.avi
  http://geoweb.mit.edu/~tah/12.010/Dif_1006_0407.fig
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)
```
Mesh plots

\[
[X, Y, Z] = \text{peaks}(30); \quad \% \text{30x30 version of Gaussians}
\]
\[
\text{mesh}(X, Y, Z)
\]
\[
\text{xlabel(}'X\text{-axis}'\text{)}, \quad \text{ylabel(}'Y\text{-axis}'\text{)}, \quad \text{zlabel(}'Z\text{-axis}'\text{)}
\]
\[
\text{colorbar;} \quad \text{daspect}([1 \ 1 \ 2.5]);
\]
\[
\text{title(}'\text{Lec 19.2: Mesh Plot of Peaks}'\text{)}
\]
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 facetted look
    - shading interp interpolates the surface and looks smoother
  - `surfc` -- surface plot with contours (like `meshc`)
  - `surfl` -- surface with lighting
  - `surfnorm` -- 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 `surf` 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

Lec 19.10: Meshed data using griddata

Lec 19.11: Triangular Mesh Plot
Inside 3-D objects

- Matlab has methods for visualization of 3-D volumes
- These are figures 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

\texttt{slice(X,Y,Z,V,[0 3],[5 15],[-3 5])}

x cut 0 & 3; y cut 5 & 15, z cut -3 & 5
`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.
Making AVI Movies

```
hf = figure('Position',[50 50 797 634]);
set(fig,'DoubleBuffer','on');
set(gca,'Visible','off','Position',[0 0 1 1],'NextPlot','replace');
mov = avifile('YibalTotalANC.avi','FPS',1);
for n = 2:35
    f = sprintf('TotalANC%3.3d.jpg',n);
    Im = imread(f,'JPG');
    hi = image(Im);
    Fr = getframe;
    mov = addframe(mov,Fr);
end
```
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:
  imagesc([UTMR(1:2)], [UTMR(3:4)], Def)
Figure generated imagesc
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.