12.010 Computational Methods of Scientific Programming

Lecturers
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Overview Today

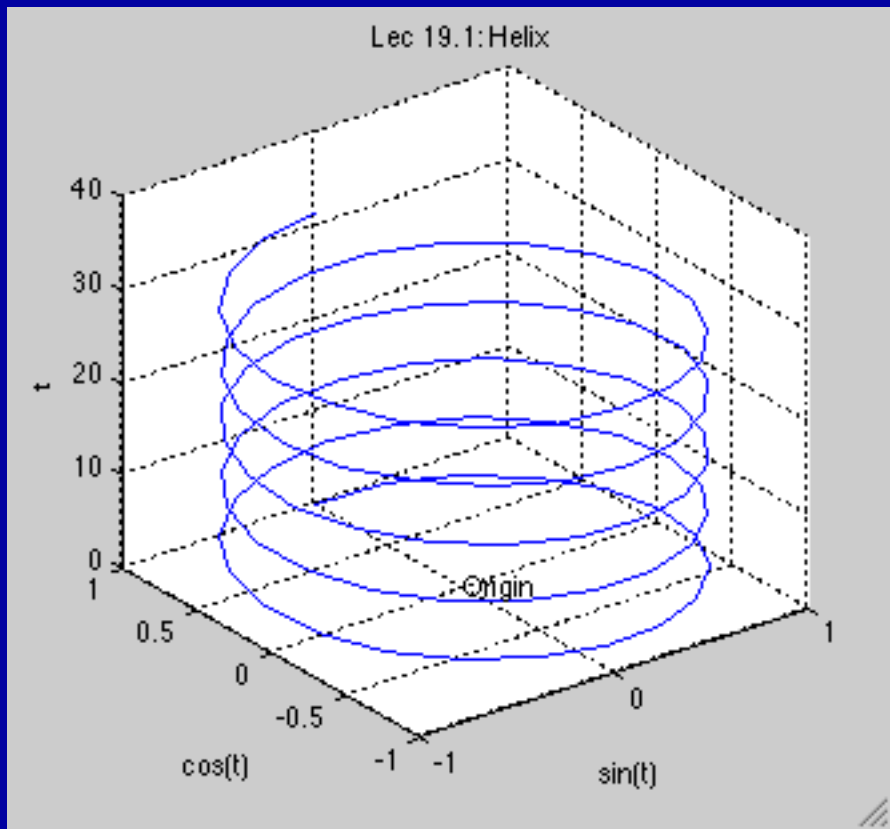
- Examine image and 3-D graphics in Matlab
- Examples used in this lecture are:
  http://geoweb.mit.edu/~tah/12.010/Lec18_3D.m

- 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

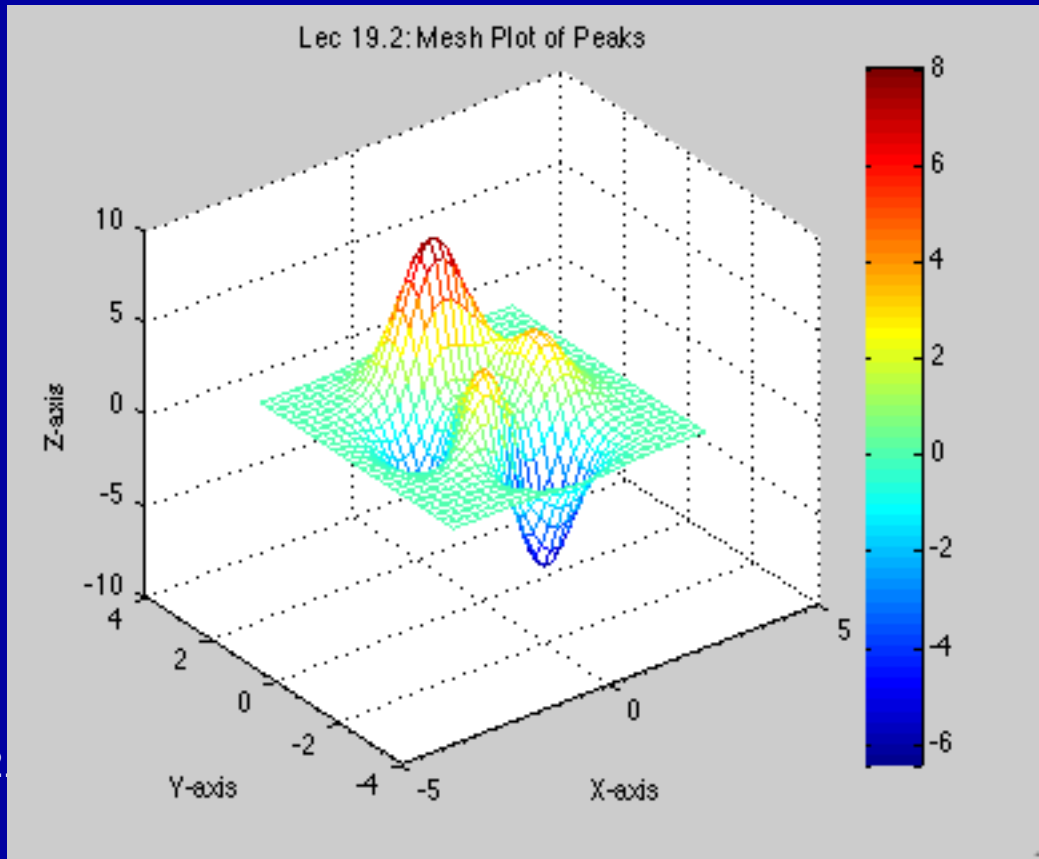
- Simple line and scatter plots use plot3 which takes 3 vectors as arguments and plots them much like 2-D plot.

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



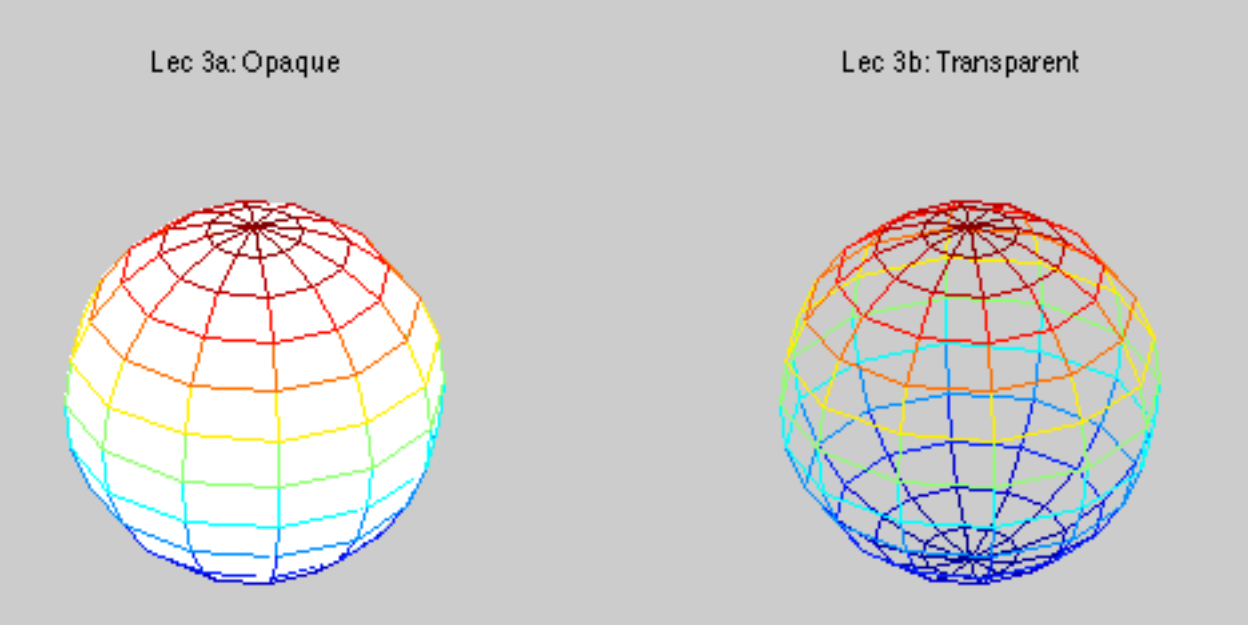
Mesh plots

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



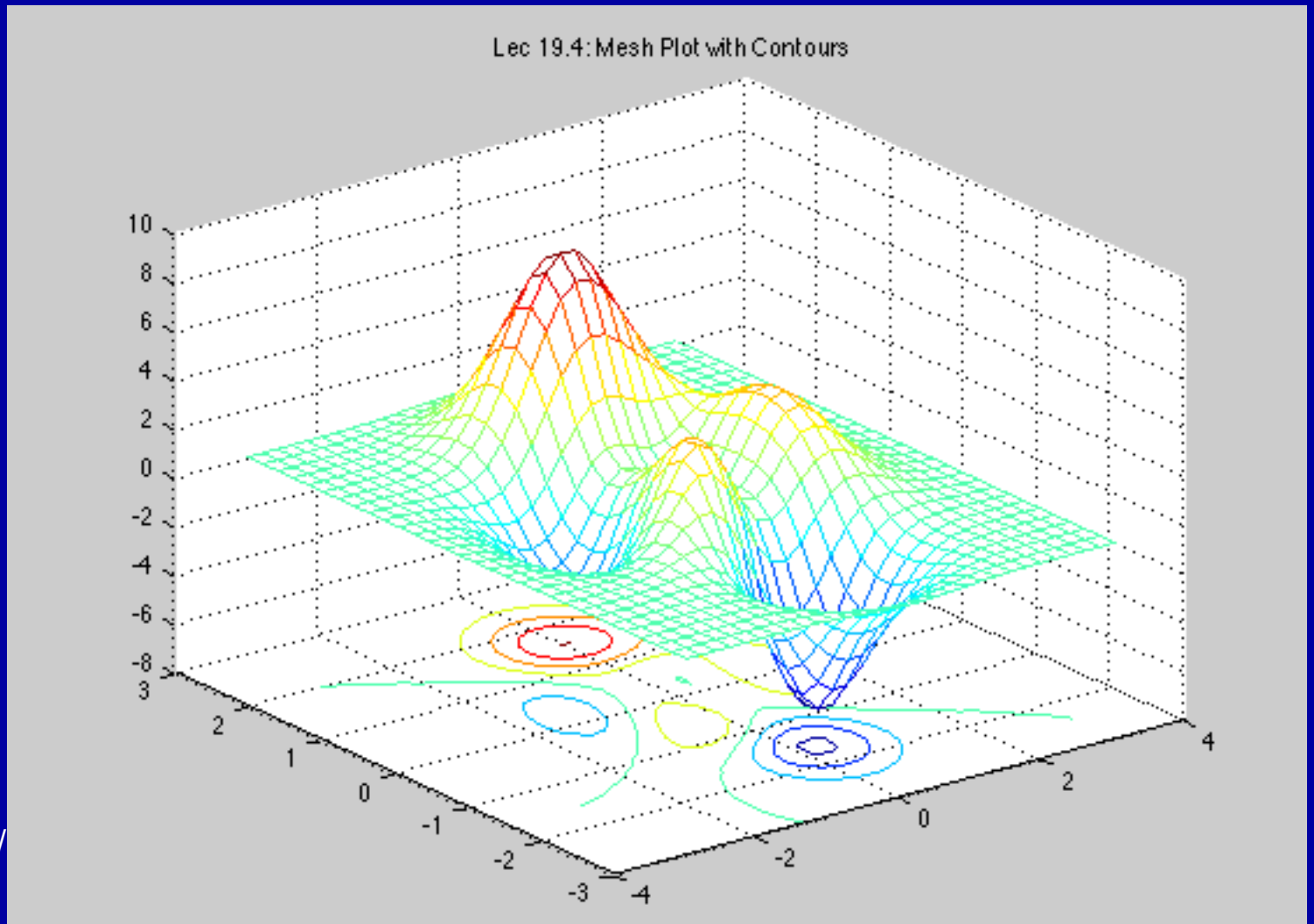
Transparency control

```
[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`

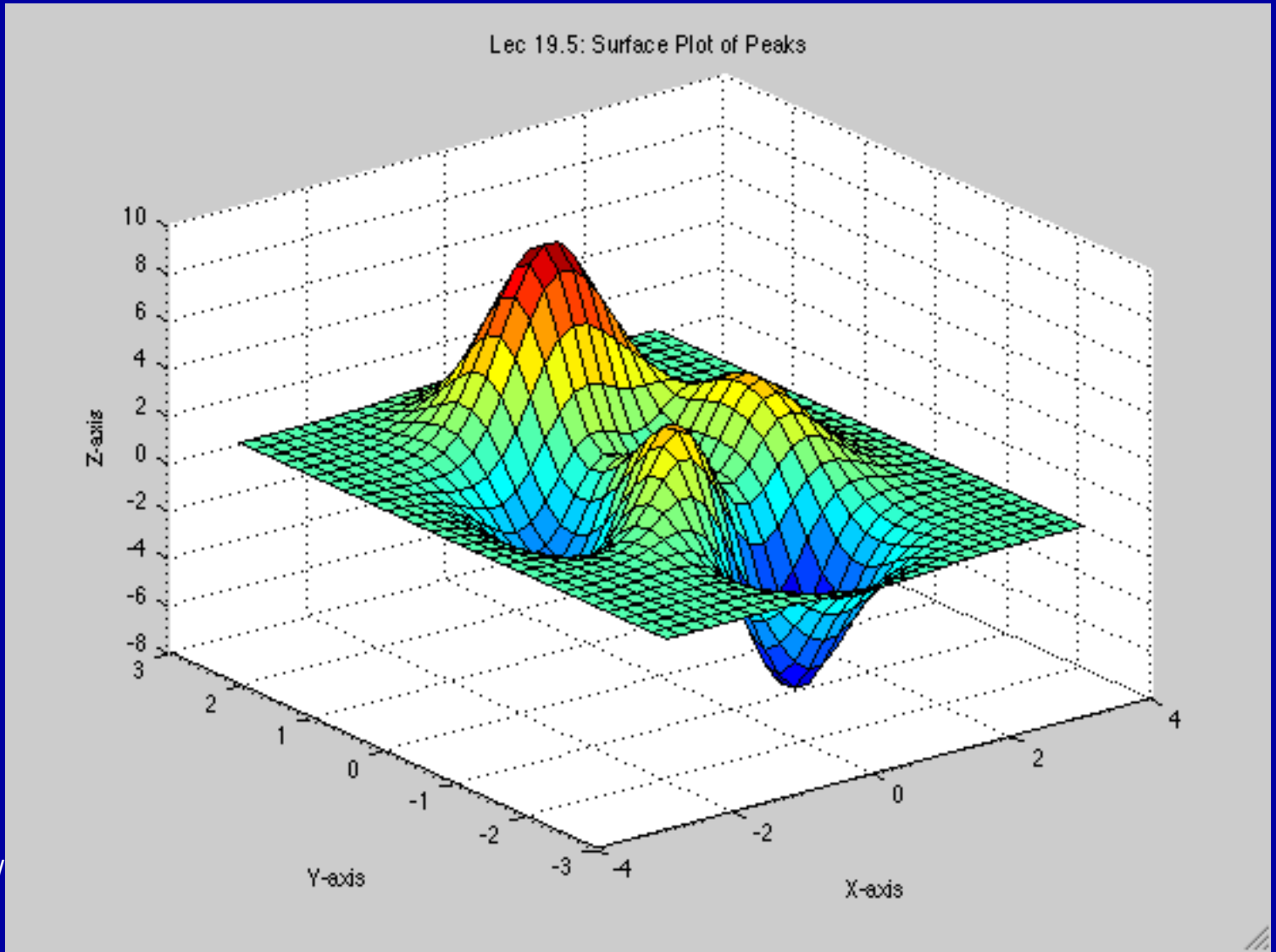


Surface plots

- 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 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

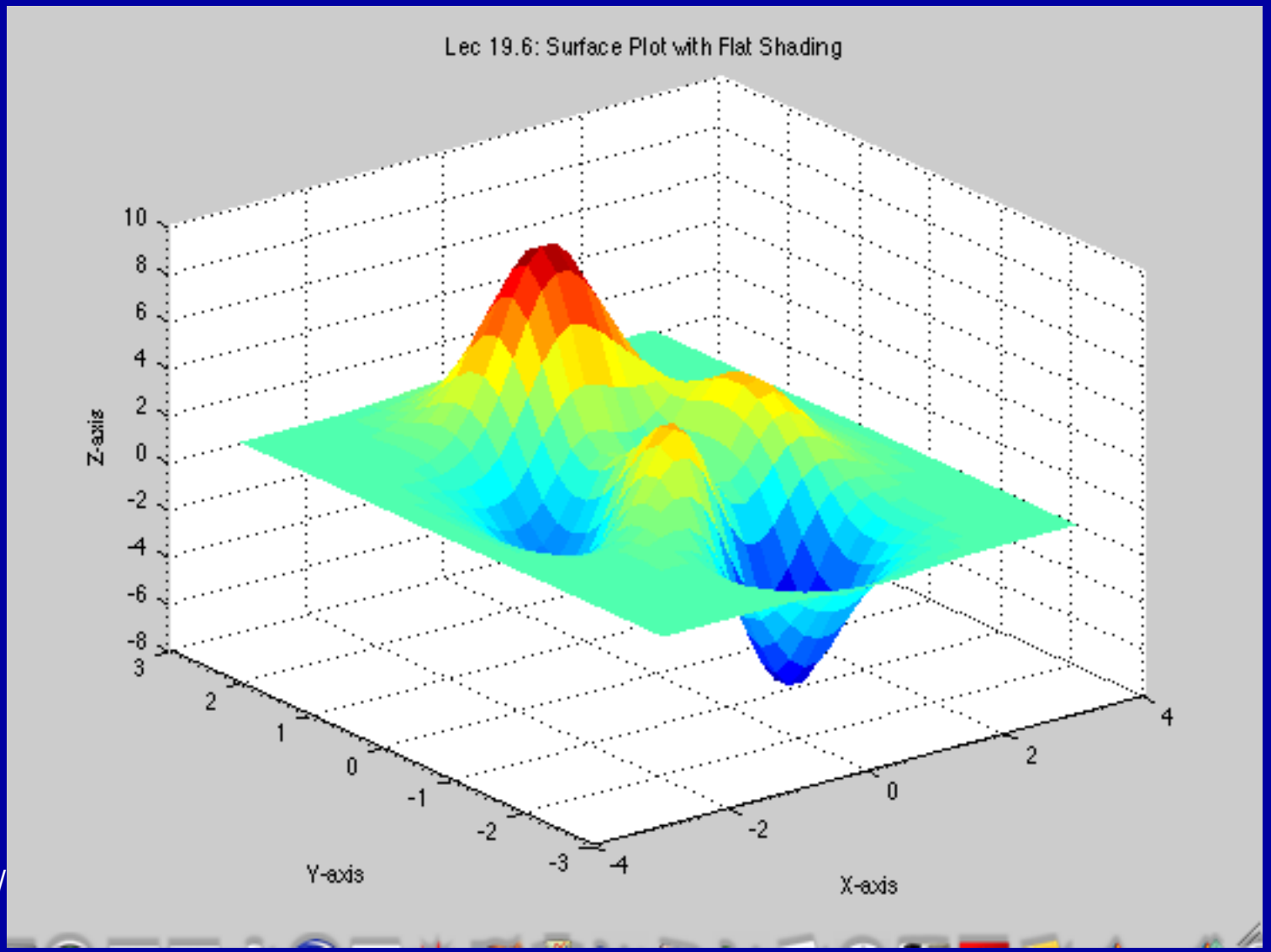
Standard surf

- Generated using surf[X,Y,Z]



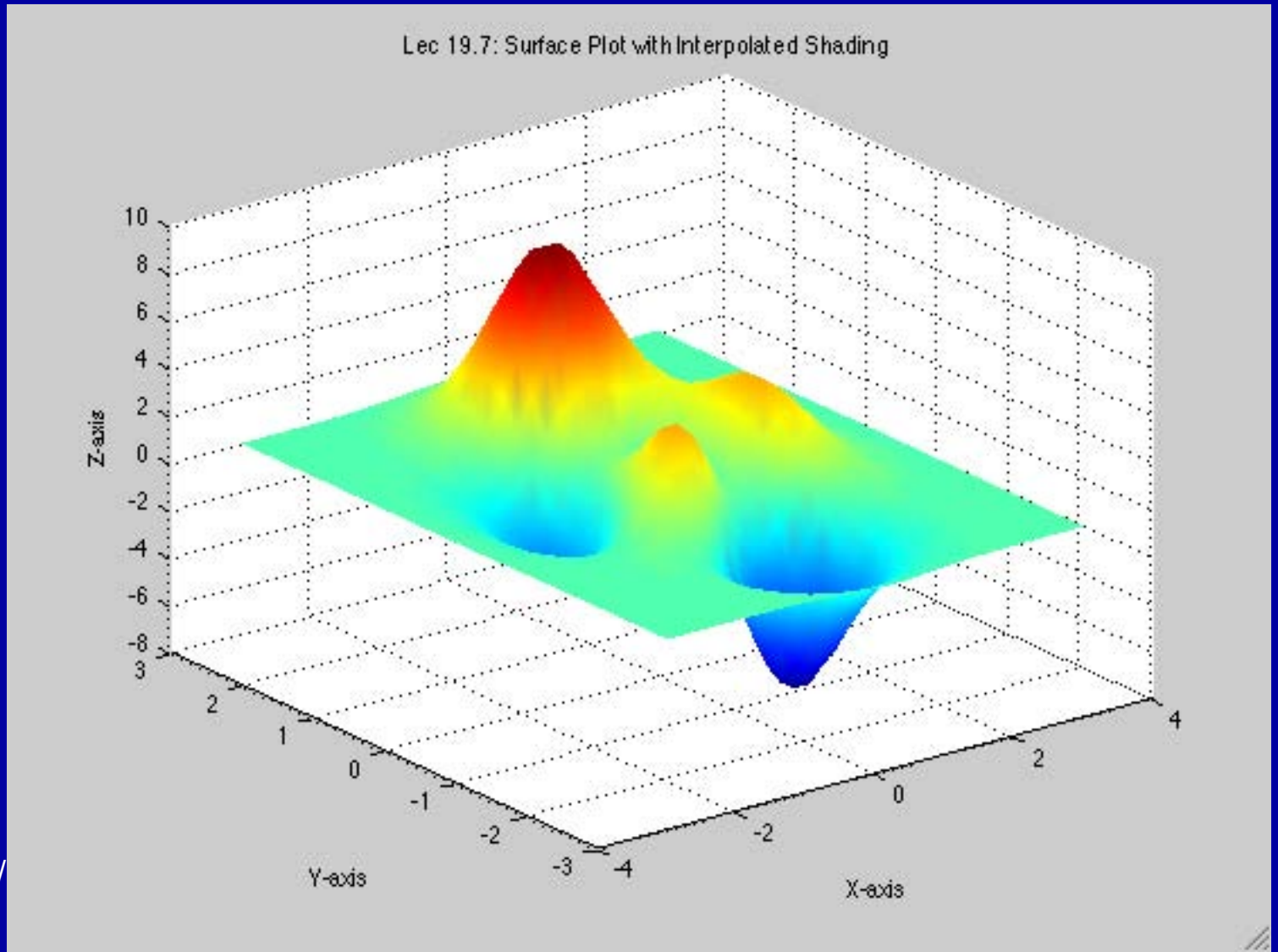
Surf with shading flat

- The command shading flat added



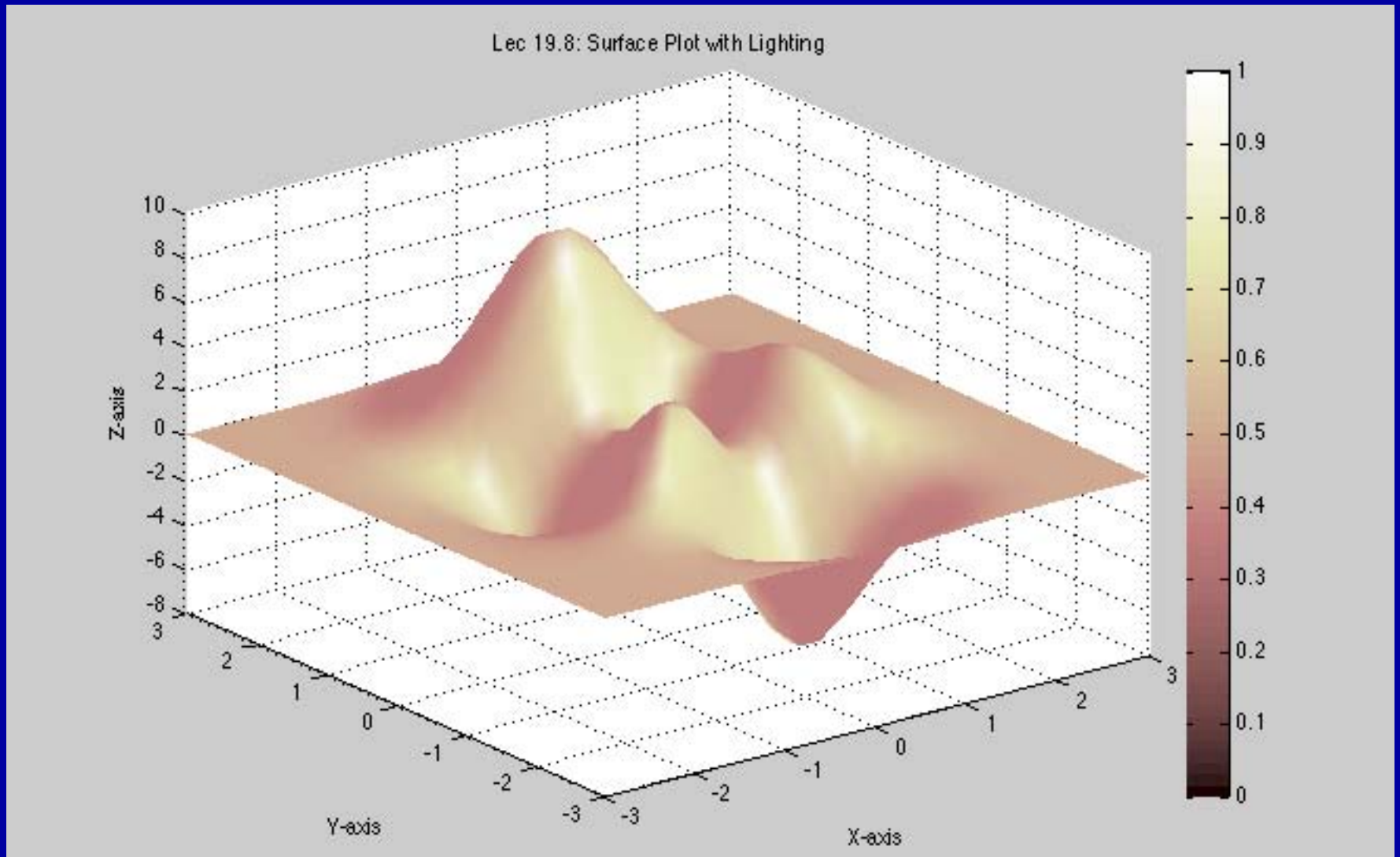
Surf with shading interp

- Command shading interp used



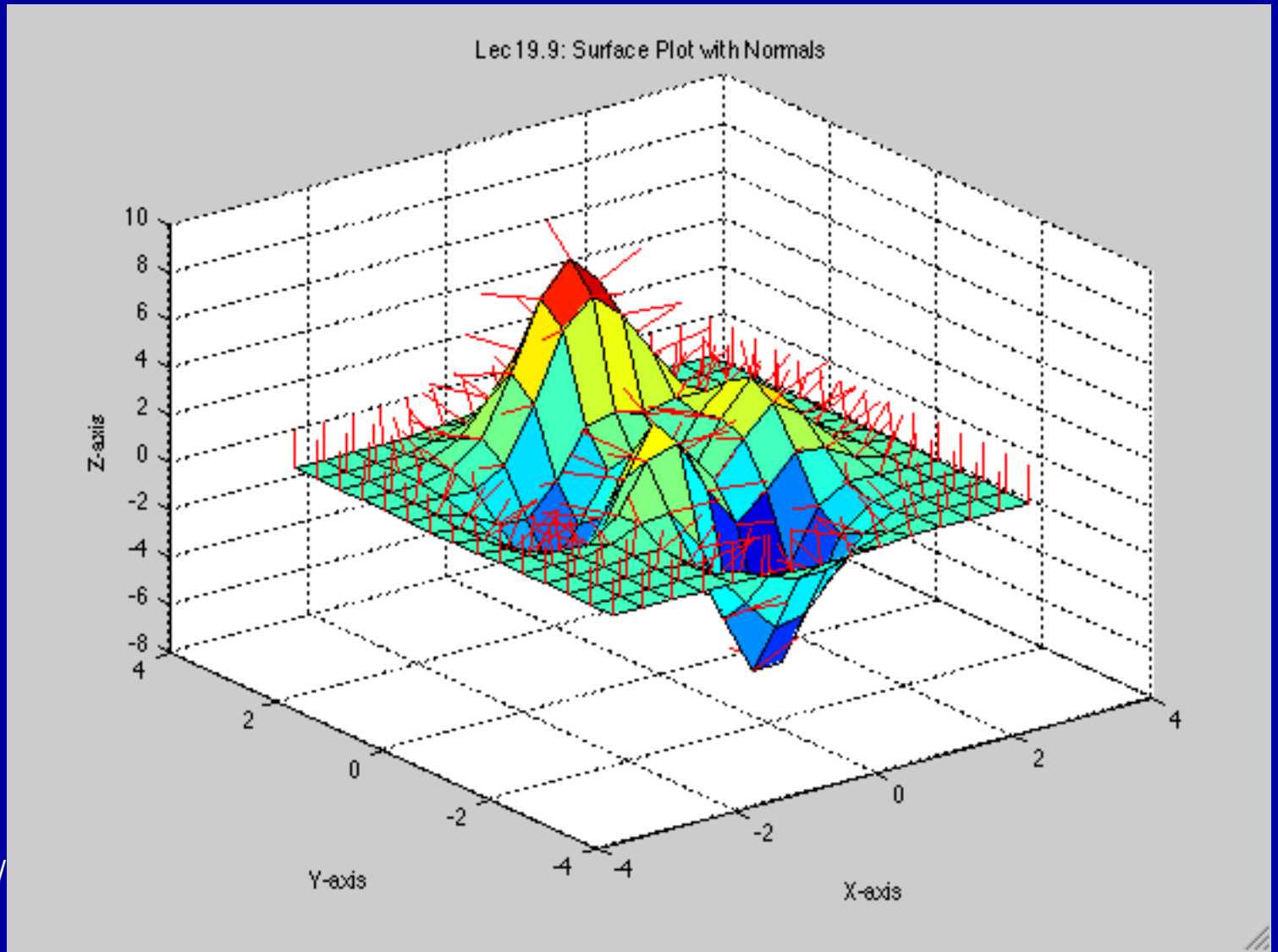
Surfl used

- Command surfl is surface with lighting; here the colormap is changed to pink to enhance effect



Surfnorm to add normals

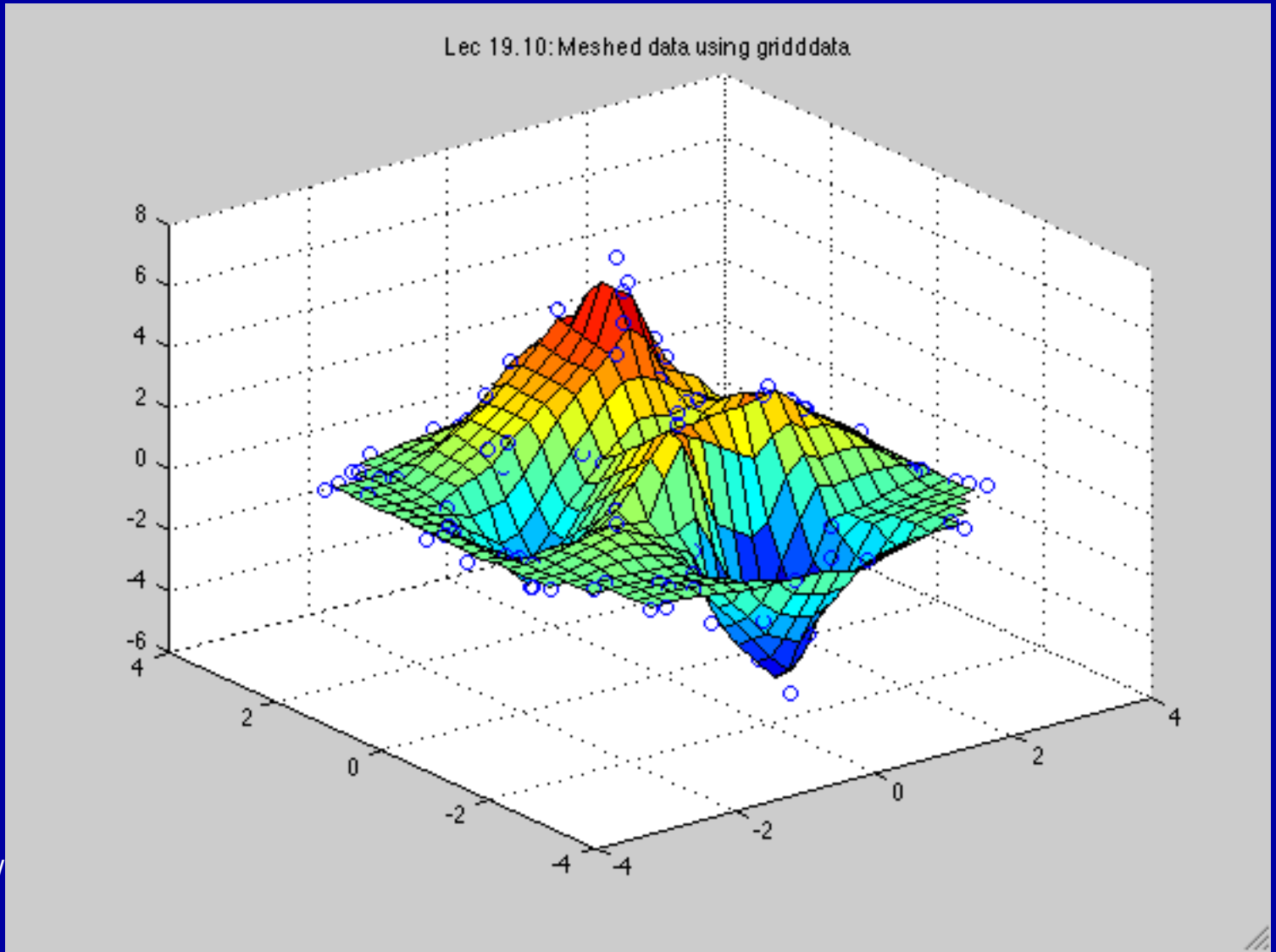
- Generated on a 15 grid to keep down clutter.



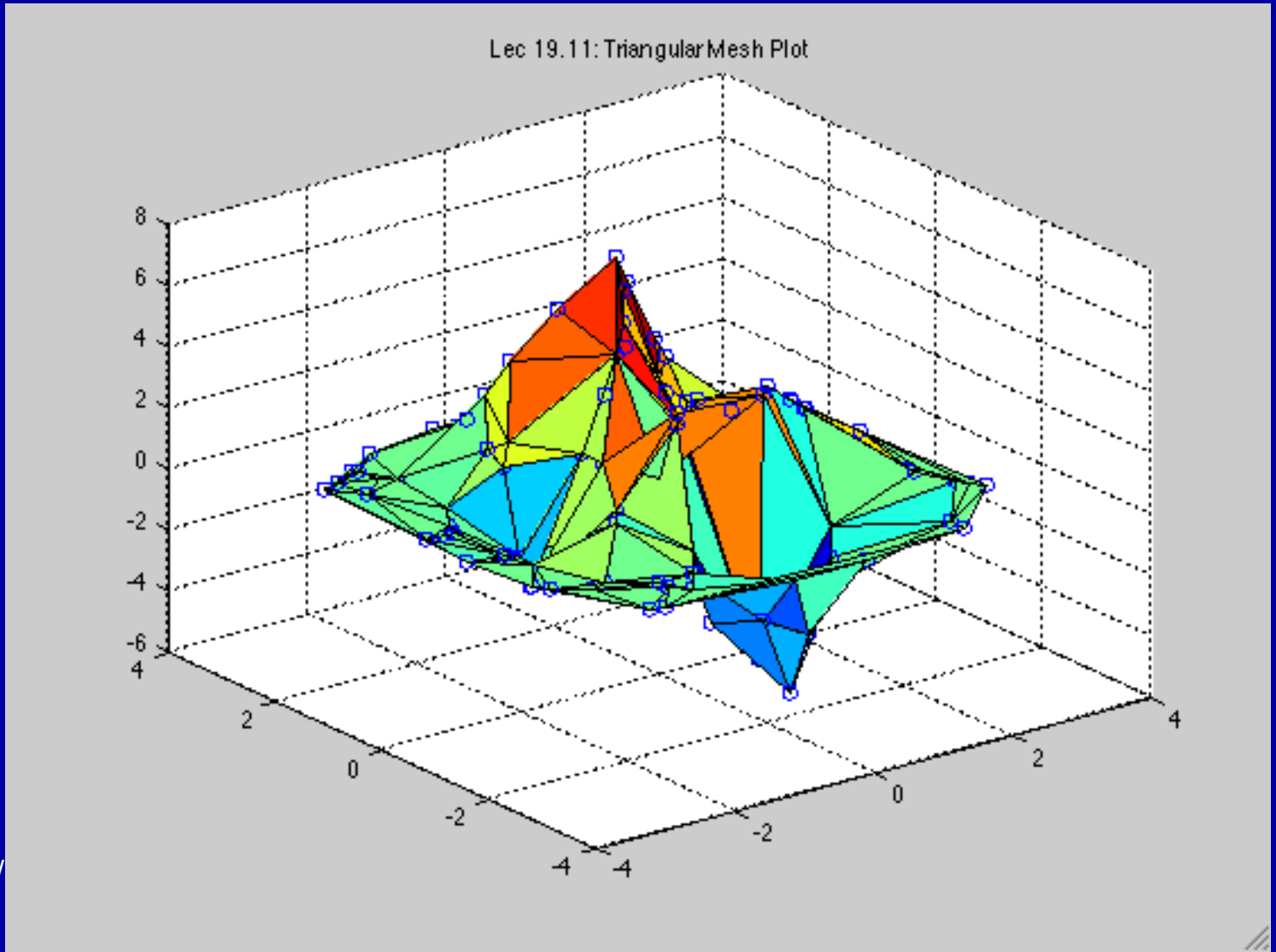
Working with irregular data

- 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.

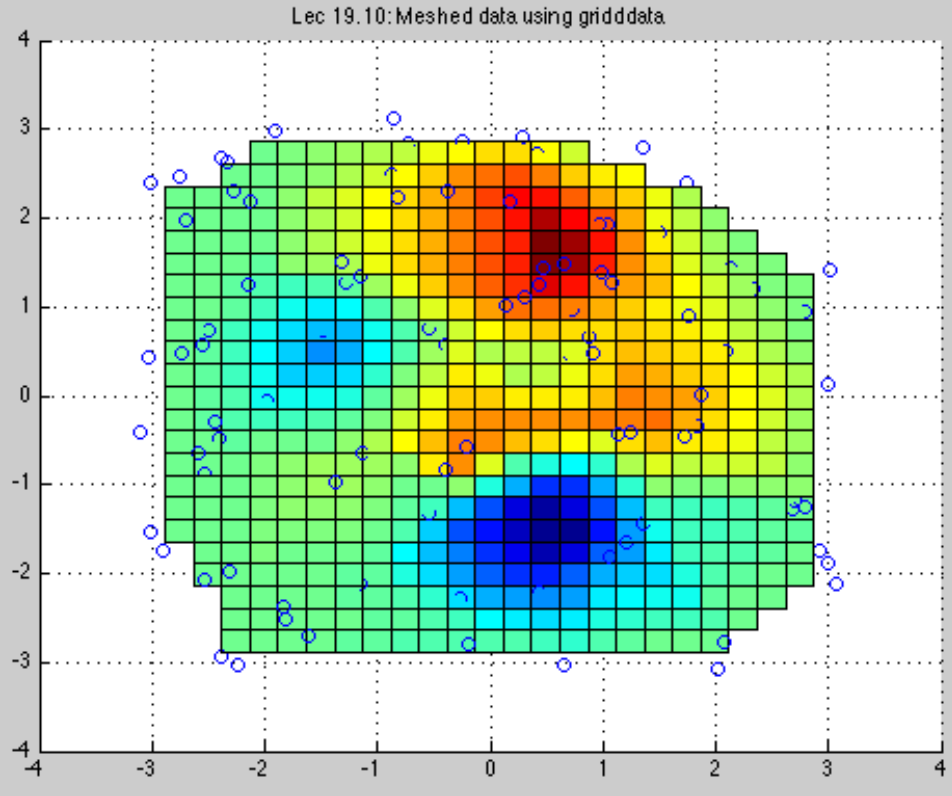
Griddata example

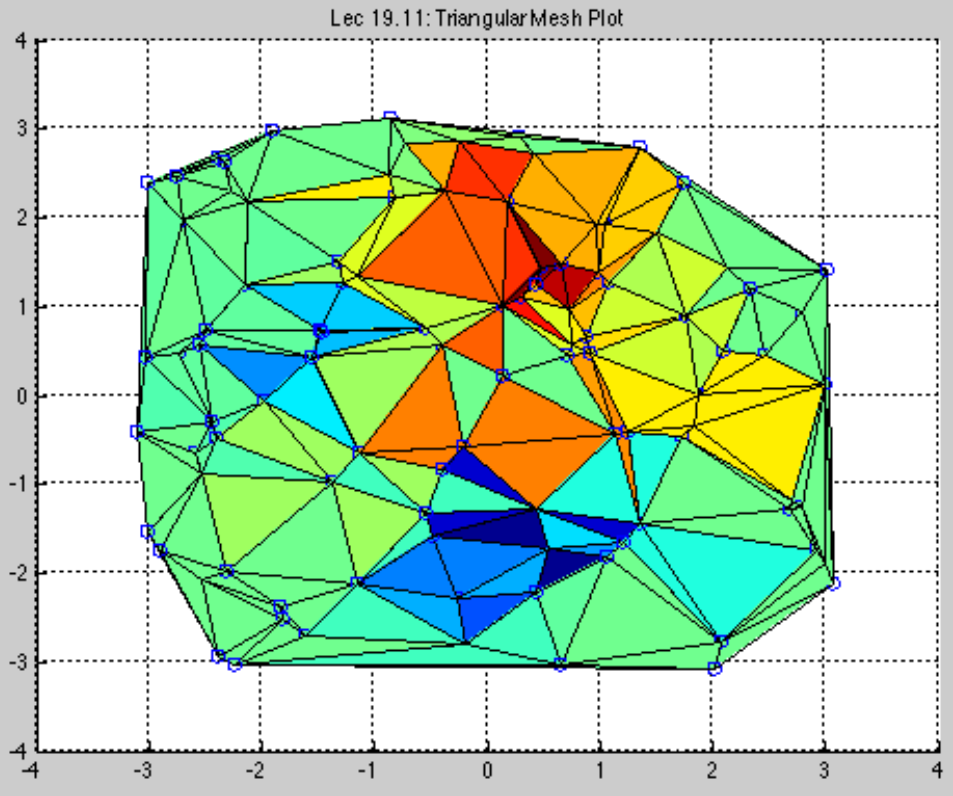


Trisurf example



Vertical view of each figure





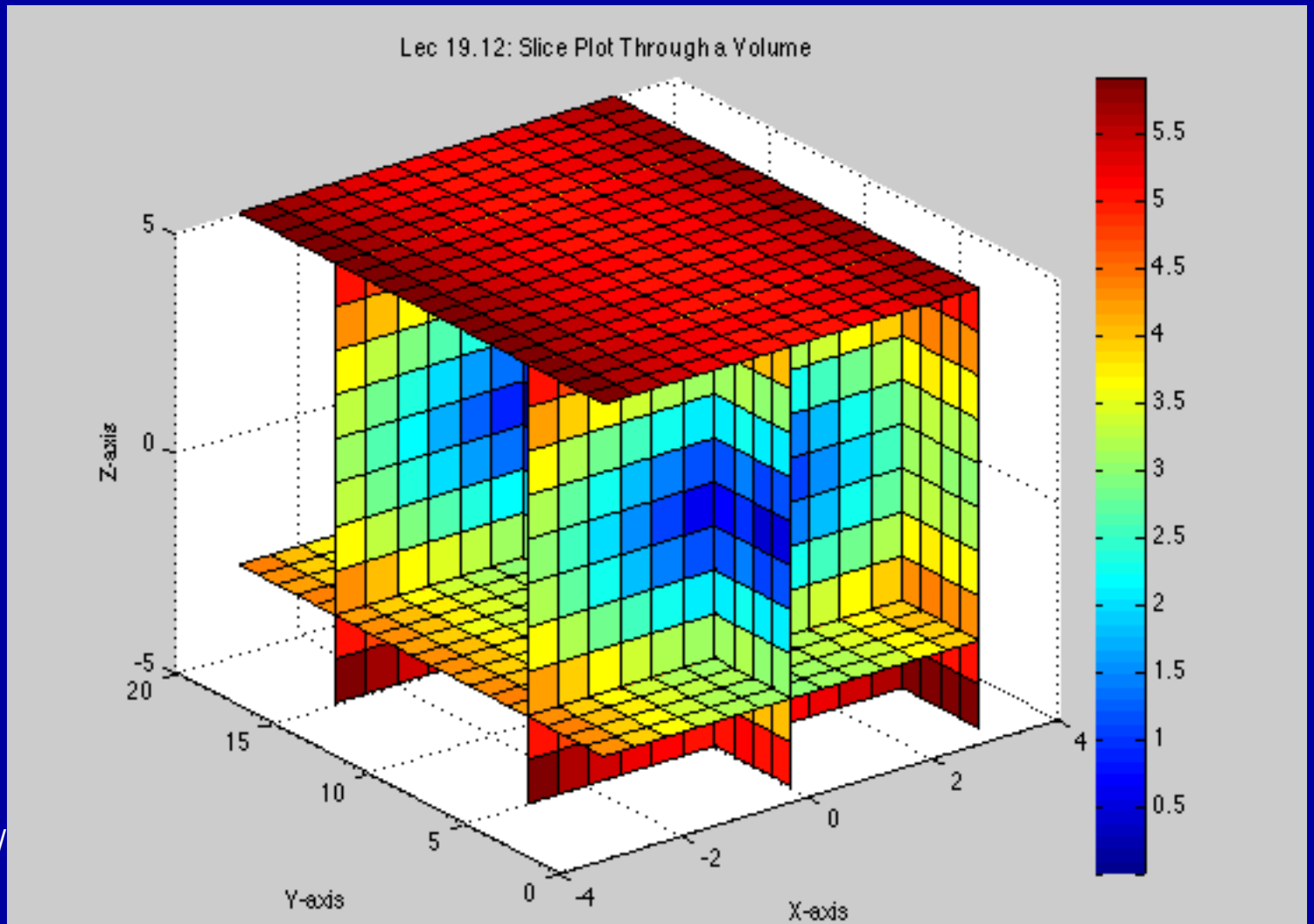
Inside 3-D objects

- 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

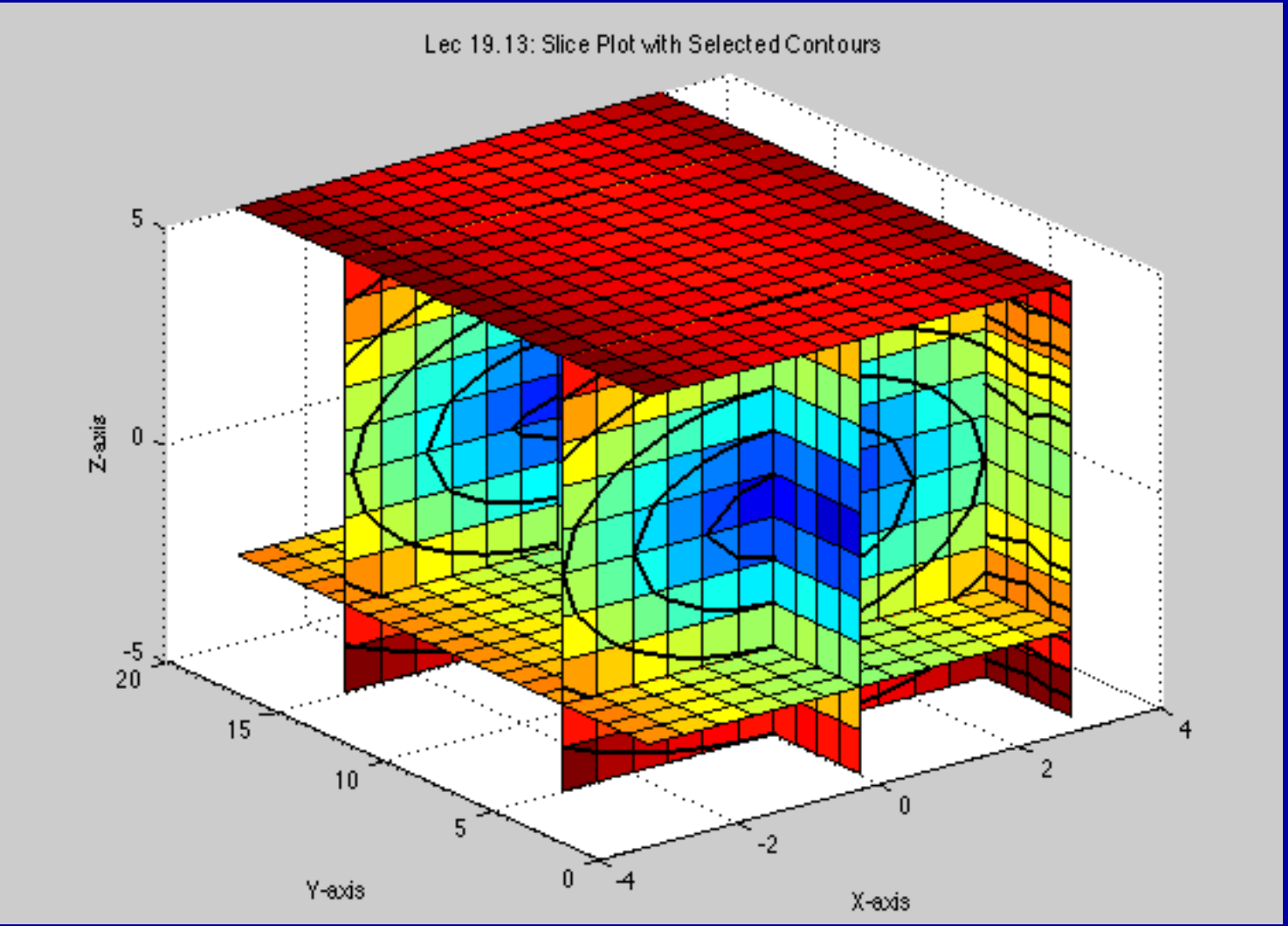
```
slice(X,Y,Z,V,[0 3],[5 15],[-3 5])
```

x cut 0 & 3; y cut 5 & 15, z cut -3 & 5

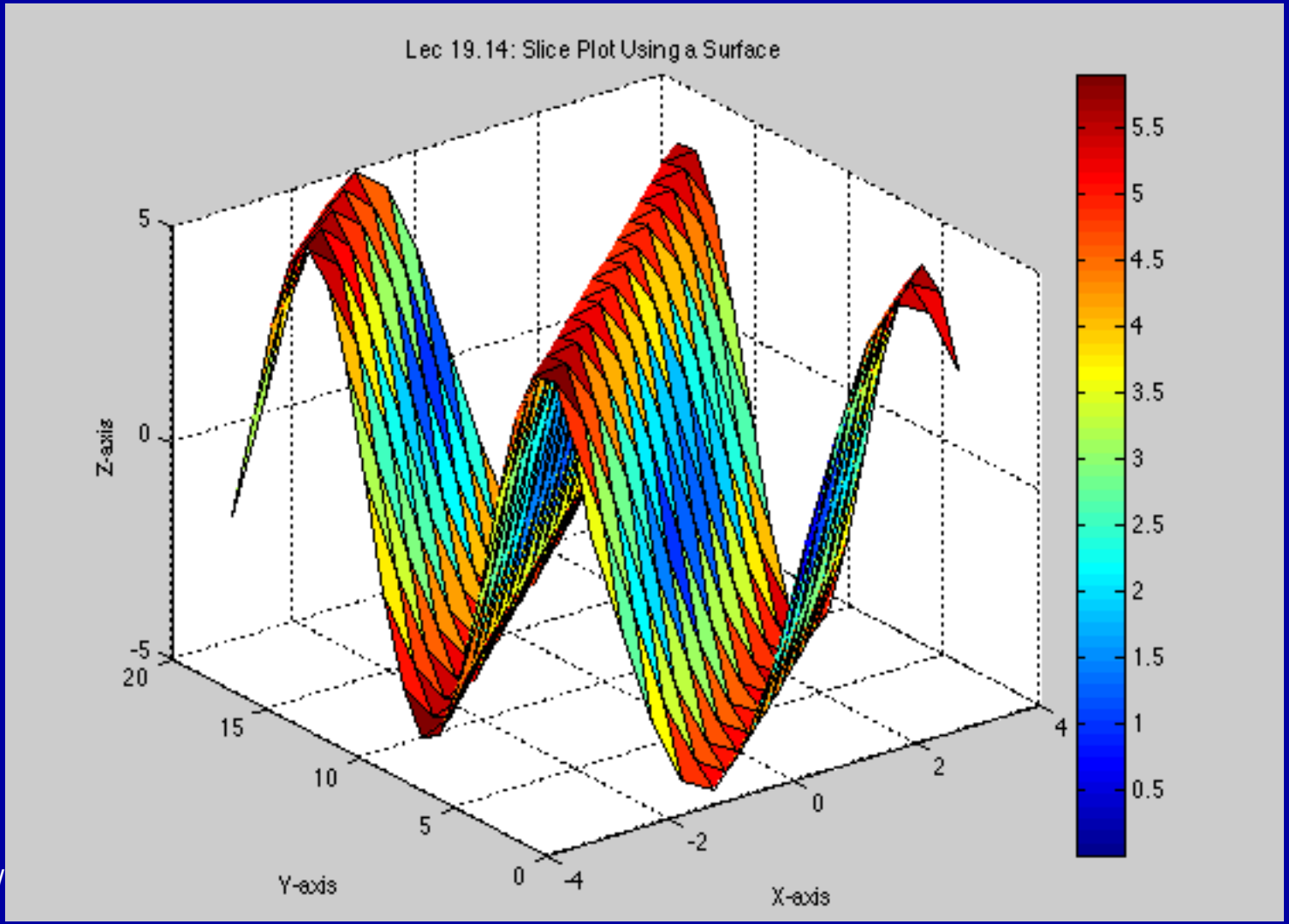


Slice with contours added

```
contourslice(X,Y,Z,V,3,[5 15],[])
```

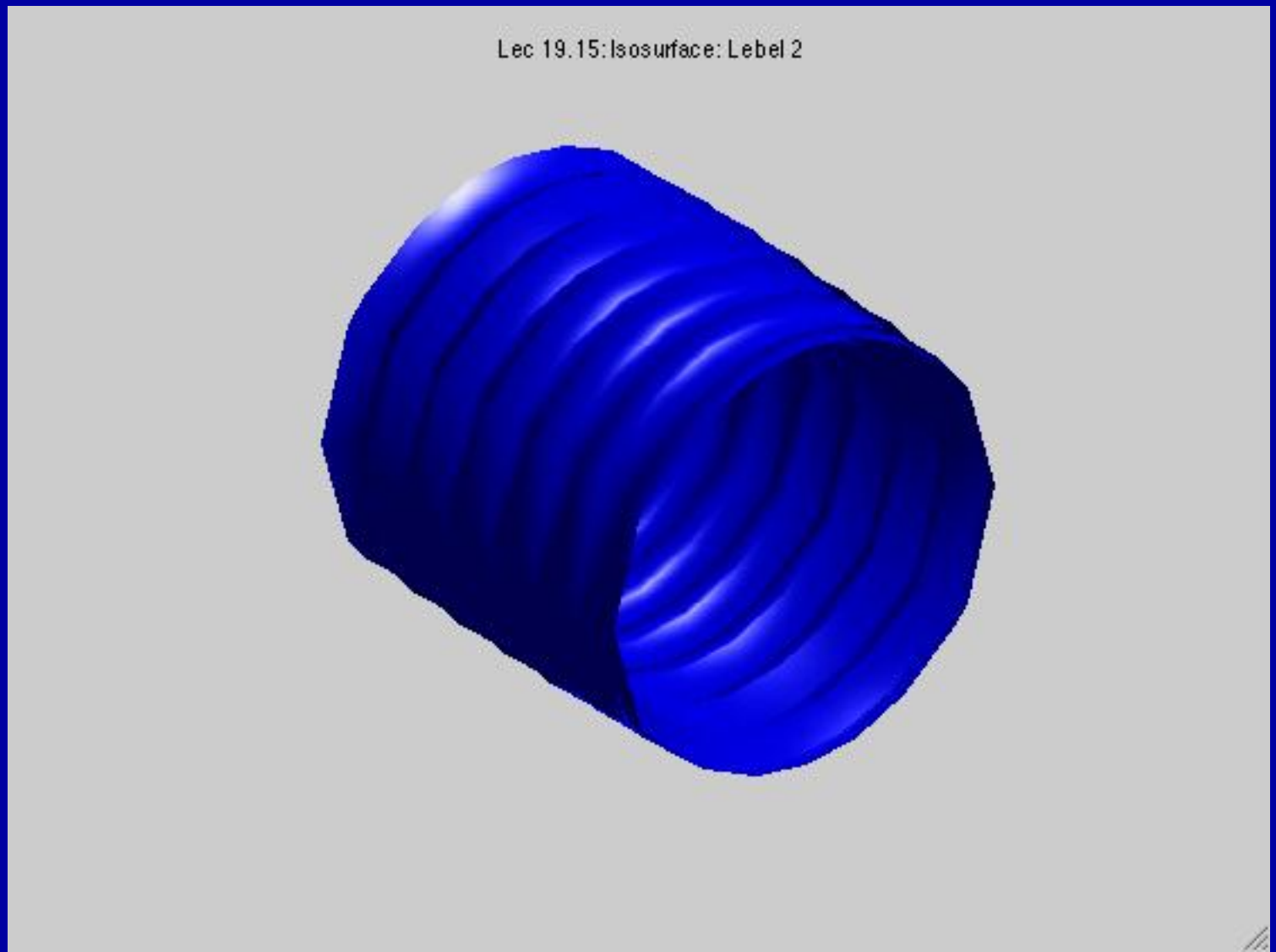


Oscillating sinusoidal surface



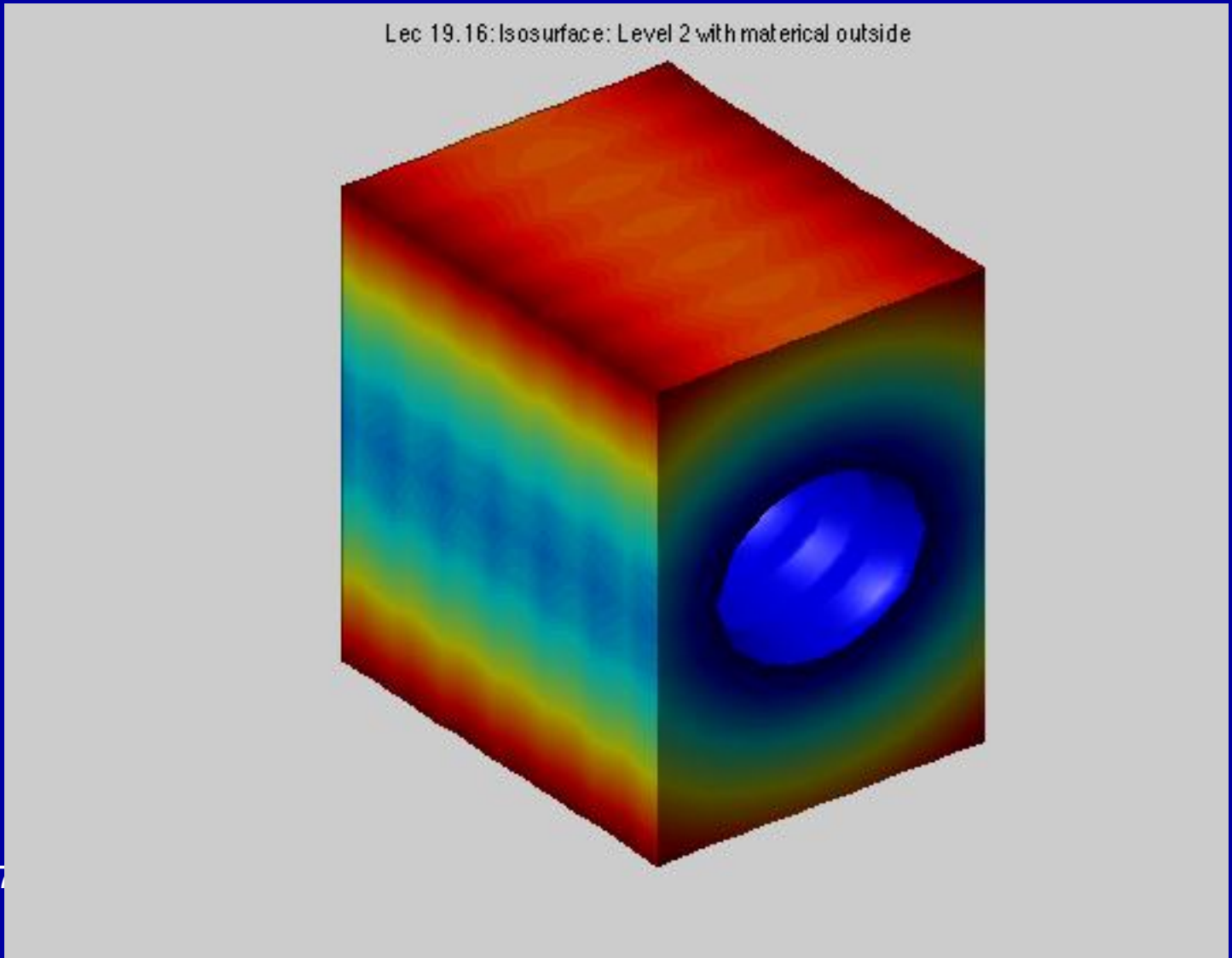
Isosurface viewing

- Previous cut at level 2 using isosurface

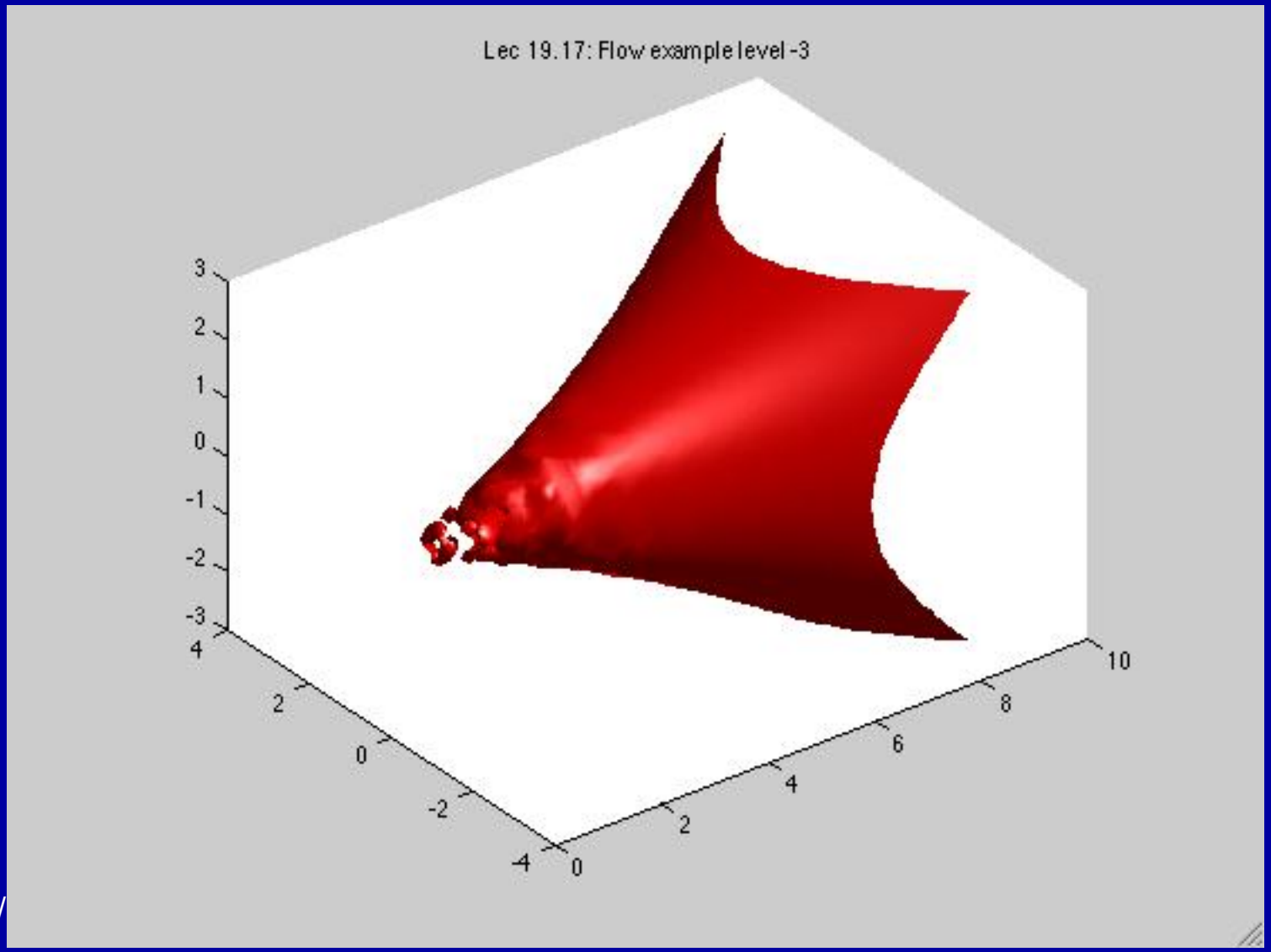


Example with outer volume filled

- Added called to isocaps

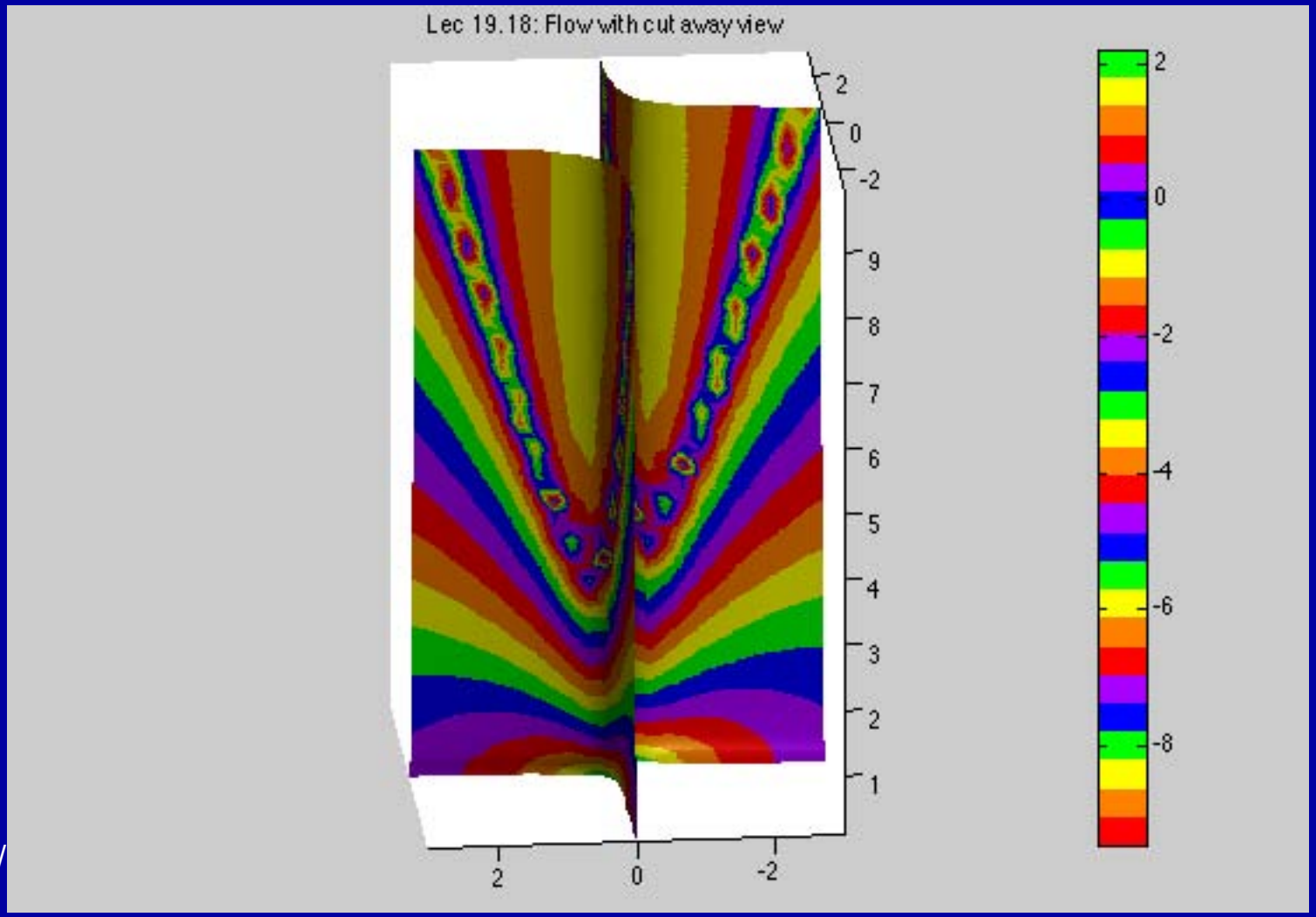


Examples using Matlab flow function



Matlab flow example

- This example needs to be viewed in 3-D in Matlab.
- Here color map shows fine structure.



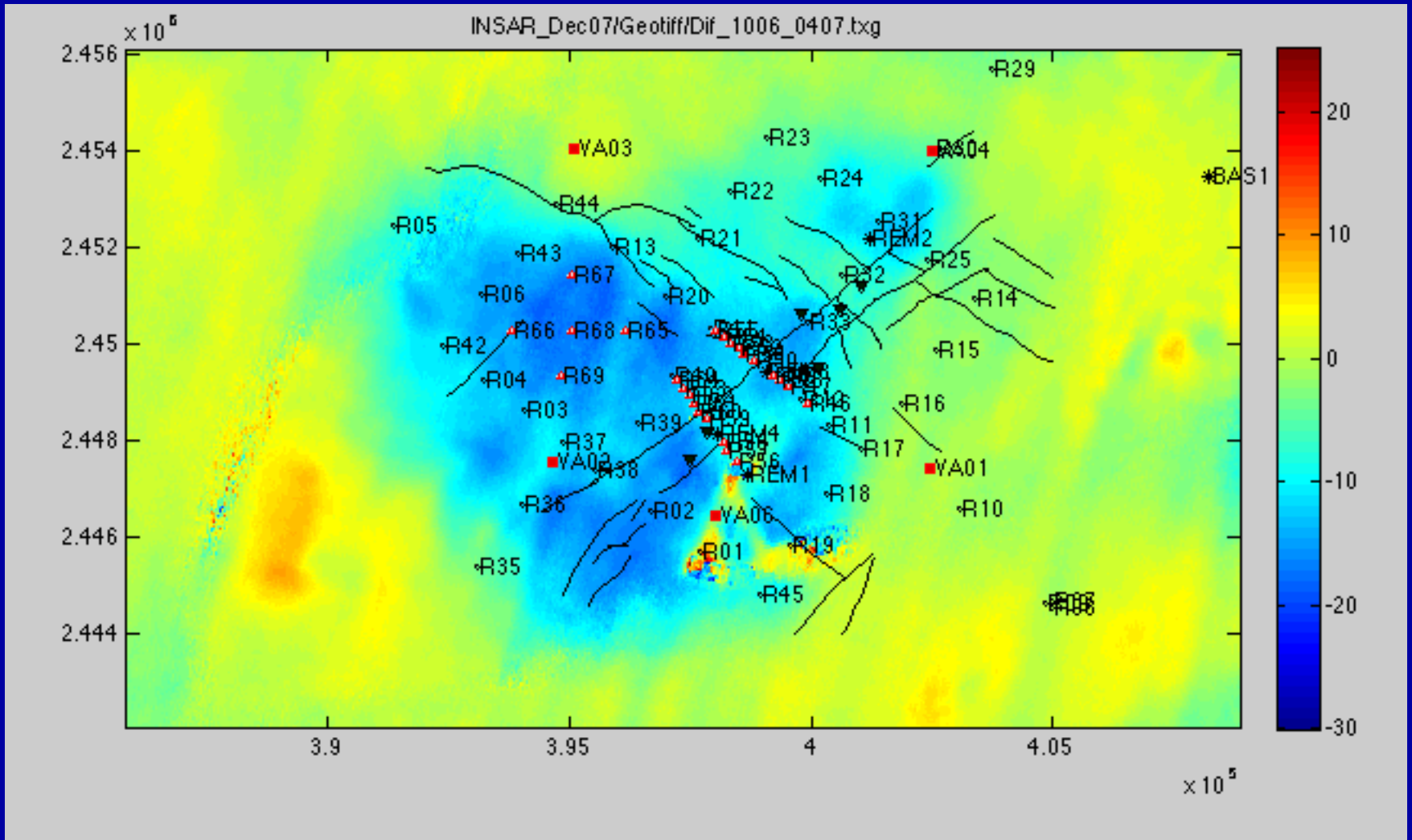
Making AVI Movies

```
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.

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