Statistics 120
Examining Three-Dimensional Data

Geometry

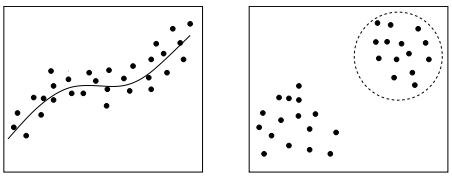
- Each case (x_i, y_i, z_i) can be regarded as a point in three dimensional space.
- The entire set of points (x_i, y_i, z_i) $(i = 1, \ldots, n)$ can be viewed as a "point cloud" in three dimensions.
- How can such a point-cloud be represented?

Examining Two Variables

- The most important tool is the scatter plot.
- Scatter plots do two things well
  - They display relationships between variables. (Smoothing can help with this).
  - They make it easy to detect similar observations and to see clusters of observations.

1. Physical Models

- Construct a three dimensional model (using straws and clay balls).
- It is time consuming to produce this kind of plot, especially if there are several thousand points to be plotted.
- Experimental use of this kind of graph is nearly impossible.



1. Relationship 2. Clustering

2. Two Dimensional Pictures

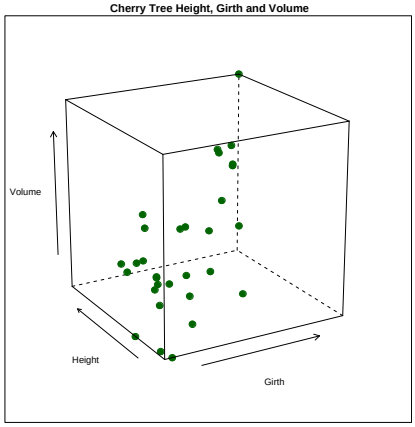
- Draw a two dimensional picture of a three dimensional graph.
- Such graphs invariably have a "flat" appearance, but can have their 3-d character enhanced.
- The Trellis function `cloud` can be used to draw point-clouds.
- There is also and R library called `scatterplot3d` which has some 3d capabilities.

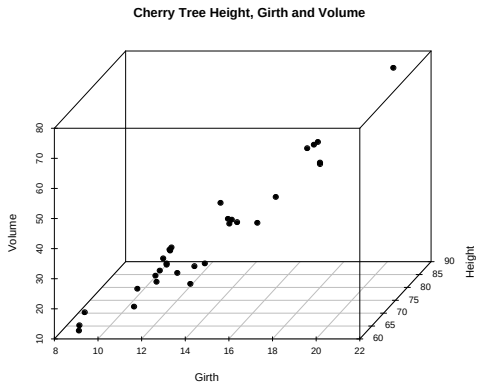
Three Variables

- Three dimensional data sets:

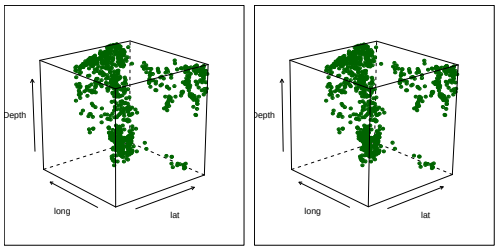
	Var 1	Var 2	Var 3
Case 1	x_1	y_1	z_1
Case 2	x_2	y_2	z_2
Case 3	x_3	y_3	z_3
	$\vdots$	$\vdots$	$\vdots$
Case n	x_n	y_n	z_n

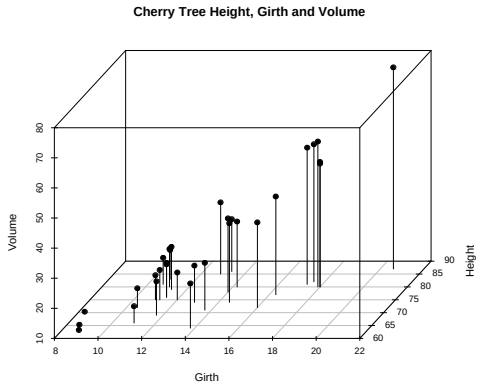
- Here there are 3 variables and n cases.





An Eyes-Crossed Stereogram of
The Tonga Trench Earthquake Locations





Specialist Stereographic Tools

- There are a number of specialist tools which help the stereoscopic experience.
- These range from inexpensive and low-tech to very expensive and high tech.
  - A stereopticon
  - Red/blue, left/right glasses.
  - Polarising glasses
  - A virtual reality helmet.

3. Stereoscopic Viewing

- By presenting a suitable image to each eye separately it is possible to have the brain synthesise a fully 3d image.
- There are two “hardware-less” techniques for “fusing” separate images.
  - Defocussing the eyes and looking through the two images (the technique used for the “Magic Eye” books.
  - Crossing the eyes and looking at the left image with the right eye and the right image with the left eye.
- A switch between the two techniques requires a left-right switch of the two images being examined.

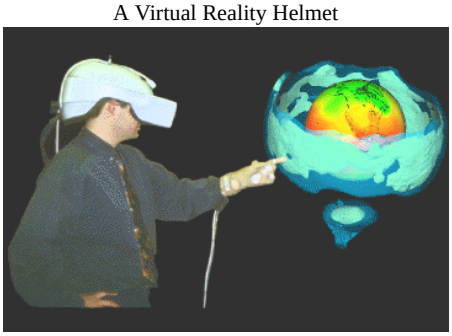
A Stereopticon

An Example: Earthquake Locations

- The next figure shows an eyes-crossed stereogram of the Tonga Trench earthquake locations.
- You will find a large version of this attached to the back of the lecture handouts.
- Hold the image at a comfortable reading distance and cross your eyes slightly.
- When your eyes are correctly positioned you should be aware of three copies of the image in front of you – the middle image should appear three dimensional.

Polarising Glasses

A Virtual Reality Helmet



4. Motion Graphics

- Making a point-cloud rotate on screen produces a convincing illusion of depth.
- This is happens because of the way we process motion parallax (things seem to move more slowly when they are further away).
- This is related to perspective.

Motion Graphics Systems

- Most statistical software systems offer some sort of motion graphics system.
- A good system will offer more than just the ability to rotate a point cloud.
- One of the best motion graphics facilities is provided by the XGobi system.
- This system is a research prototype which was developed under the Unix operating system,
- A Windows version of this system is under development is under development, but is not fully mature yet.

XGobi Demonstration

- The data for the demonstration consists of the surface location and relative time position of the volcanoes in the Auckland Volcanic field.
- A map showing the location of the Auckland volcanoes is shown at the back of the lecture notes.
- Conventional seismological wisdom says that there is no structure to the space-time pattern of the volcanoes.