4 Dimensional Space

Hypercube Display using Java 2D
What is a Hypercube?

- A hypercube is a cube with more than three dimensions. That is, more than length, width, and height.
- A tesseract is a hypercube having four dimensions. That is, the cube has length, width, and height plus a fourth dimension the we will call hyperspace.
Creating a Four Dimensional Object

- Take a point, a position in space with no dimensional attributes.
- Translate that point and connect the old point and the new point with a line.
Creating a Four Dimensional Object

- The resulting line is a one dimensional object: an object with a length attribute.
- Translate the line and connect the endpoints of the two lines with two new lines.
Creating a Four Dimensional Object

- The resulting plane is a two dimensional object: having both length and width.
- Translate the plane and connect the vertices with lines.
Creating a Four Dimensional Object

- The resulting cube is a three dimensional object: having length, width, and height.
- Translate the cube and connect the vertices with lines.
Creating a Four Dimensional Object

- Translating the cube becomes a problem. What direction is a right angle to the cube?
- How can you connect the cubes in this phantom direction?
Viewing Four Dimensional Space

- Being three dimensional beings, we must view four dimensions as an abstract.
Choosing Java

- Dr. Riggs wanted a program to display a hypercube and to allow people to manipulate the hypercube on a website.
- OpenGL and C seem natural to draw and manipulate an object of any sort but are difficult to integrate into a webpage.
Choosing Java

- Java easily integrates into a webpage but is not well known for its graphical capabilities.
- In order to create a Java program I would have to write my own routines to manipulate the tesseract.
Rotation of a tesseract

- In order to rotate a three dimensional cube, we must rotate around a line in any of three different directions. In terms of Cartesian coordinates, we rotate along the x, y, or z-axis.
- In four dimensions, the rotation travels around a plane. There are six different planes of rotation. The xy, yz, zx, xh, yh, and zh planes are all used for rotation in three dimensions.