

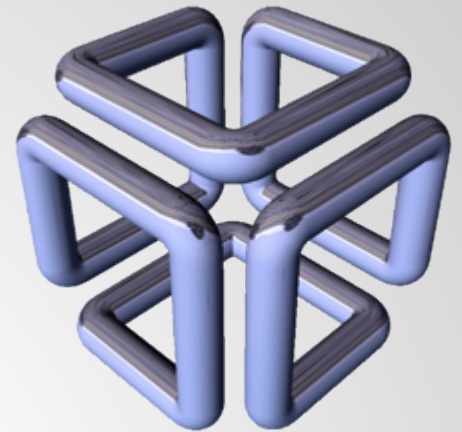
# Introduction to OpenGL

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[kite.freeshell.org](http://kite.freeshell.org)

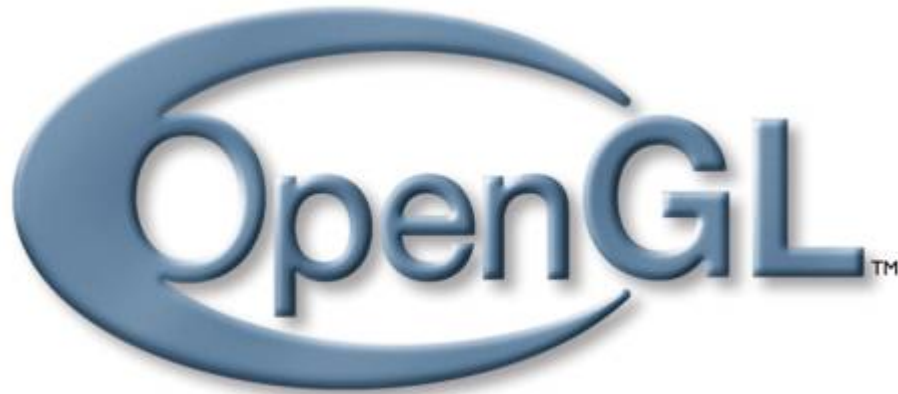
# History

- 1990s Silicon Graphics - IRIS GL
- Sun Microsystems, Hewlett-Packard and IBM
- Building a Standard
- January 1992 OpenGL 1.0
- Microsoft's Direct X
- Unifying OpenGL + Direct X
- Failure...



# What OpenGL is not...

- A Model loader
- A set input selector (keyboard/mouse)
- A Window Manager



# What is OpenGL

- API for developing graphical interfaces
  - hardware independent
  - cross-platform
  - cross-language
- Importing OpenGL
  - Linux: `#include <GL/glu.h>`
  - Mac: `#include <OpenGL/glu.h>`

# What Is OpenGL

- Primitive Geometric sets
- Building Models
  - Points
  - Lines
  - Polygons
- Specified to Vertices
- texture Mapping

# What is OpenGL

- State Machine
  - Constant states until changed.
- Examples:
  - Rotation - glRotate
  - Translation - glTranslate
  - scaling - glScale
  - Color - glColor

# Introducing GLUT

- Window independent toolkit
- Importing GLUT
  - OS X: `#include <GLUT/glut.h>`
  - Linux: `#include <GL/glut.h>`

# Why use GLUT?

- Simplest way of handling window display, and for Mouse and Keyboard callbacks
- Great for starting off with OpenGL
- small to medium sized applications



# Alternatives to GLUT

- cross-platform GUI toolkit like
  - Qt
  - wxWidgets.
  - GLUI

# Glut: displaying a window

- Window Management.
  - `glutInit(&argc, argv)`
  - `glutInitDisplayMode`
  - `glutInitWindowSize (int x, int y)`
  - `glutInitWindowPosition (int x, int y)`
  - `glutMainLoop()`

# Glut: displaying a window (cont.)

- `glutInit(&argc, argv)`
  - Is Called before any other GLUT function. This initializes the GLUT library.
- `glutInitDisplayMode(mode)`
  - Used to determine color display and buffer mode to be used
- `glutInitWindowSize (int x, int y)`
  - specifies the window size of the application

# Glut: displaying a window (cont.)

- `glutInitWindowPosition (int x, int y)`
  - specifies the location on screen for the upper-left corner of the window
- `glutMainLoop()`
  - event processing
  - display callback is called
  - registered callbacks are stored

# OpenGL: Registering Callbacks

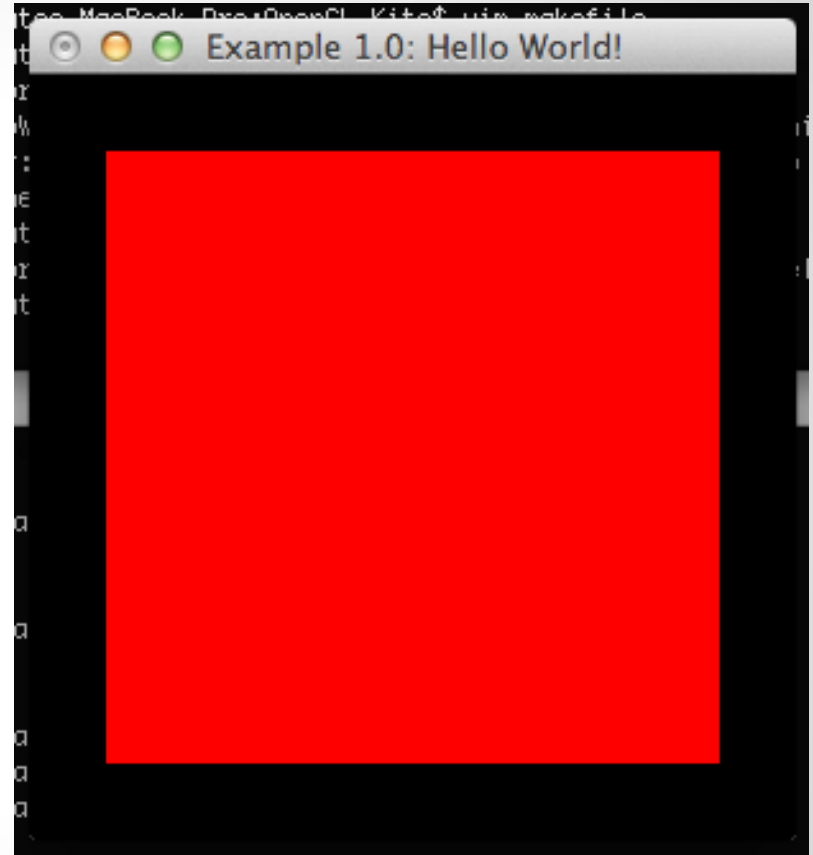
- What is a callback?
  - Commands that are registered to a GLUT function
  - Callbacks are triggered when the user interacts with the keyboard, mouse or display
- `glutKeyboardFunc(void (*func))`
  - `(*func) = myKBFunc()`

# Types of Callbacks

- Display Callback
  - `glutDisplayFunc(func);`
- Input Callbacks
  - Keyboard
  - Mouse
  - Mouse motion
- Example:
  - `glutDisplayFunc(displayForGLUT);`

# Simple Hello World

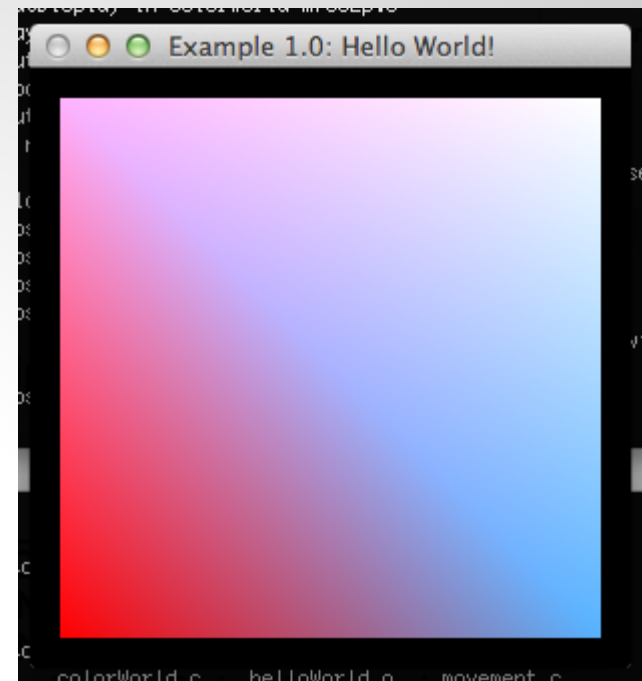
- OpenGL's Hello World
  - GLUT
- OpenGL Points
  - `glVertex3f(x, y, z);`
  - `glVertex2f(x, y);`



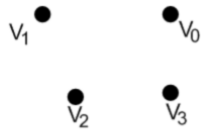
- `glOrtho(left, right, bottom, top, near, far)`

# Manipulating the Square

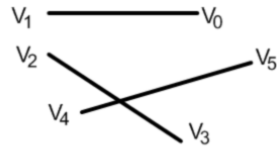
- `glBegin();`
  - `GL_LINE_LOOP`
  - `GL_QUADS`
  - `GL_TRIANGLES`
  - `GL_TRIANGLE_STRIP`
- Effects of adding Color for each Vertex
  - `glColor3f(r, g, b)`



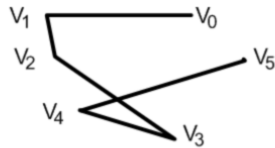




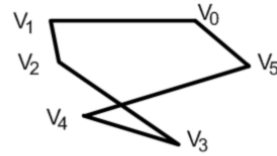
GL\_POINTS



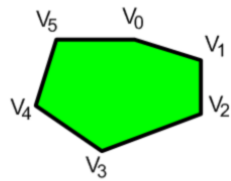
GL\_LINES



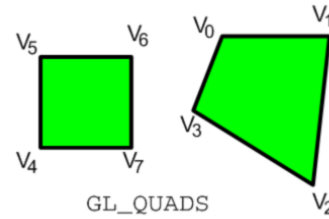
GL\_LINE\_STRIP



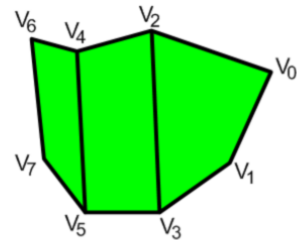
GL\_LINE\_LOOP



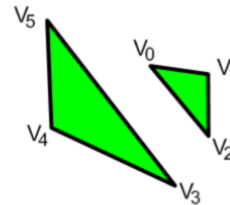
GL\_POLYGON



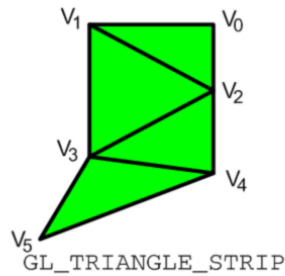
GL\_QUADS



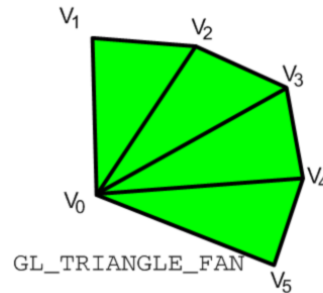
GL\_QUAD\_STRIP



GL\_TRIANGLES



GL\_TRIANGLE\_STRIP



GL\_TRIANGLE\_FAN

# Using the keyboard

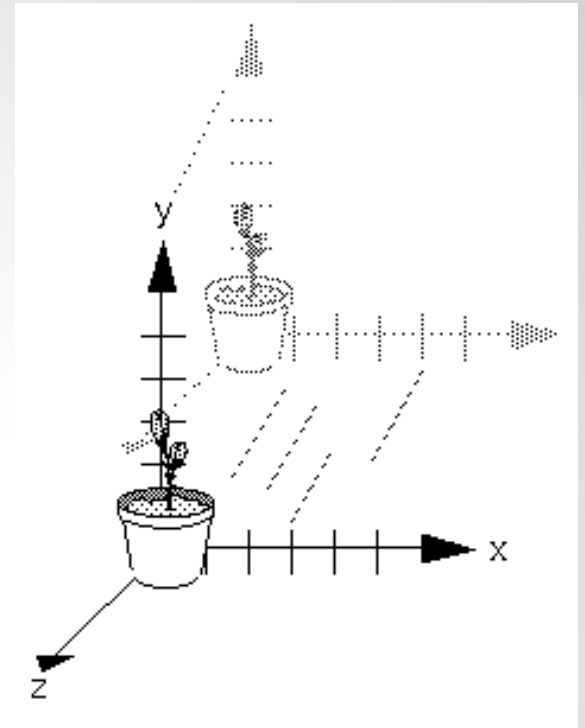
- Assigning the Callback functions
- `glutKeyboardFunc` vs `glutSpecialFunc`

# Rotation

- `glRotate*(angle, x, y, z);`
- example:
  - `glRotatef(45.0, 1.0, 0.0, 0.0);`
  - 45 degrees in the x axis

# glTranslate

- `glTranslate*(x, y, z);`
- example:
  - `glTranslatef(0.0, 0.0, 1.0);`



# glScale

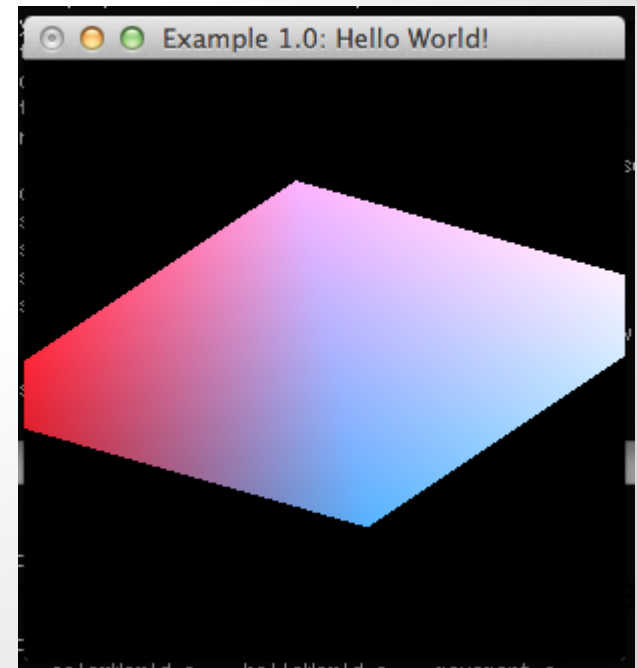
- `glScale*(x, y, z);`
- **example:**
  - `glScale*(0.0, 0.5, 0.0);`

# Resetting the Matrix

- `glLoadIdentity();`
  - replaces the current matrix with the identity matrix
- `glFrustum();`
  - multiply the current matrix by a perspective matrix

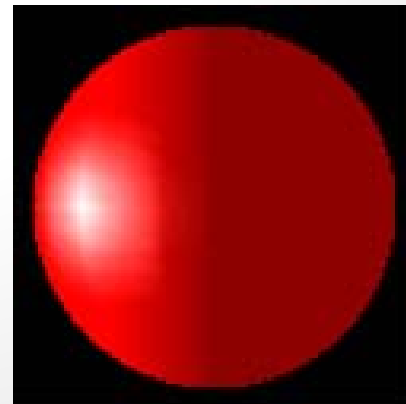
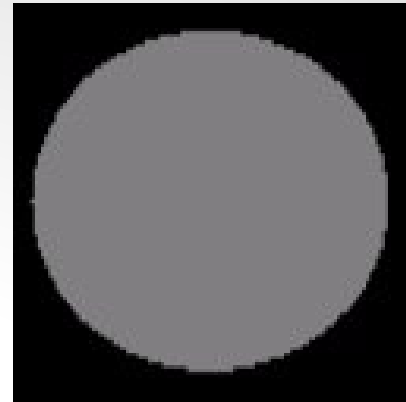
# Putting it all together

- `glPostRedisplay();`
- Example with Rotation, Translate, scale and resetting the Matrix



# Adding Light

- Extremely simple
- (pseudo) shading
  
- Types of Light
  - Ambient
  - Diffused
  - Specular





# Adding Light

```
void lightDisplay(void){
    GLfloat mat_spec[] = {0.0, 0.0, 0.1, 1.0};
    GLfloat mat_shininess[] = {100.0};
    GLfloat light_position[] = {0.5, 0.5, 0.3, 4.0};
    GLfloat light_specular[] = {1.0, 1.0, 1.0, 1.0};
    glClearColor(0.0, 0.0, 0.0, 0.0);
    glShadeModel(GL_SMOOTH);
    glEnable(GL_LIGHT0);
    glLightfv(GL_LIGHT0, GL_POSITION, light_position);
    glLightfv(GL_LIGHT0, GL_SPECULAR, light_specular);
    glMaterialfv(GL_FRONT, GL_SPECULAR, mat_spec);
    glMaterialfv(GL_FRONT, GL_SHININESS, mat_shininess);
}
```

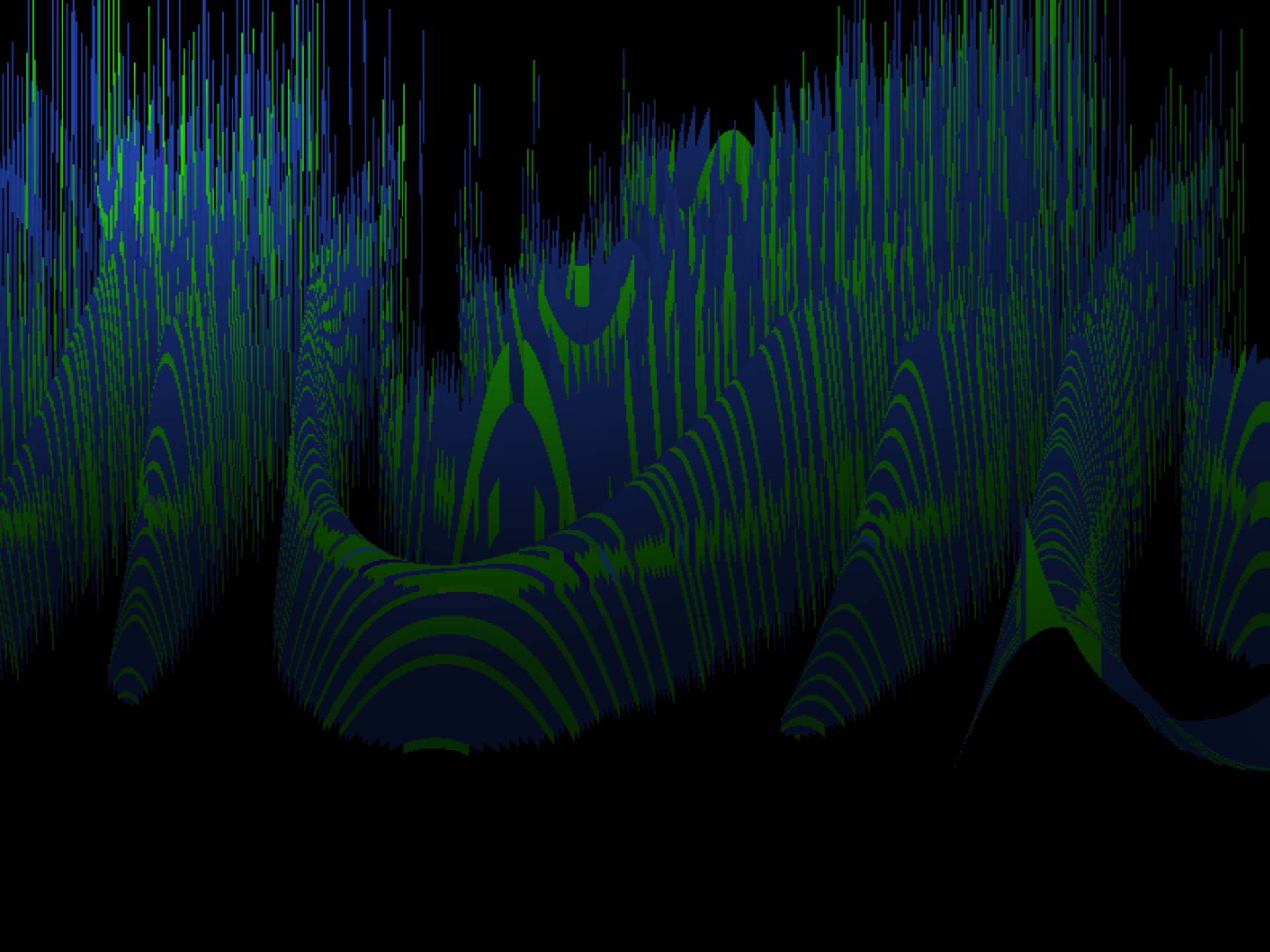
# Adding Light

- Turning Light on!

```
void displayForGlut(void){  
    glClear(GL_COLOR_BUFFER_BIT);  
    lightDisplay();  
    ....
```

- Initializing the Light

```
glEnable(GL_LIGHTING);  
glEnable(GL_LIGHT0);  
glEnable(GL_COLOR_MATERIAL);  
glHint(GL_PERSPECTIVE_CORRECTION_HINT,  
GL_NICEST);
```



# Complex Objects With OpenGL

- Easy as a For Loop

```
for(int i = 0; i < 500; i++){  
    glBegin(GL_POINTS);  
        glVertex3f(i%5, i%3, i%2);  
    glEnd();  
}
```

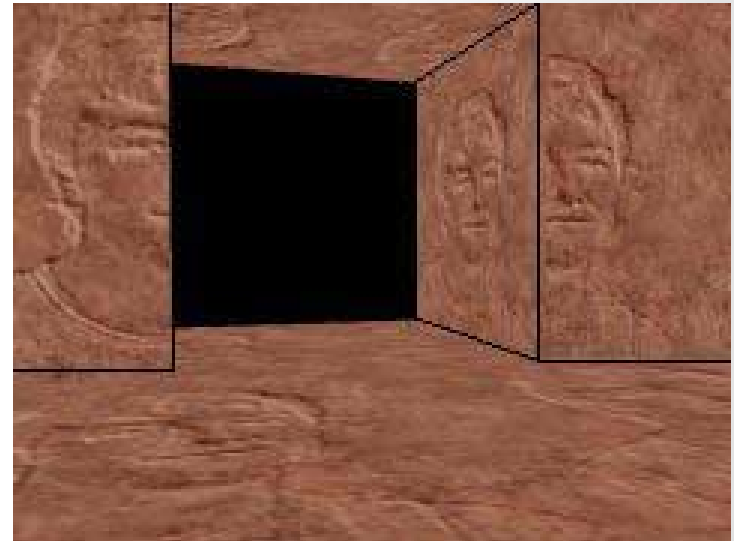
- Generating x, y, z
- Graphing

# Butterfly Curve

- Has Rotation, Translation
- Rotation = animation
- Lighting & shading
- Complex figure from a for loop
- keyboard callback
- 3D

# Game Development - NEHE

- 48 Lessons



# Game Development - OpenGL ES

- iPhone/iPad
- Android
- Cell Phones



# WebGL



DEMOS:

<http://www.chromeexperiments.com/webgl>

Quick Demo:

<http://www.sketchpatch.net/livecodelab/index.html>



# Example of OpenGL in the real world

- Google Maps - MapGL
- Dwarf Fortress
- Angry Birds - PC and Android Versions
- Half Life series
- Runescape - HD mode
- Unreal Tournament



# Resources

[OpenGL Red Book](#) - free online

<http://nehe.gamedev.net/> - game  
development tutorials

# references

- <http://fly.cc.fer.hr/~unreal/theredbook/figures/fig3-5.gif>
- <http://www.sgi.faktor0.de/sgi-logo-256x256x32bit.png>
- [http://pages.mscsoftware.com/rs/mscsoftware/images/sgi\\_logo.jpg](http://pages.mscsoftware.com/rs/mscsoftware/images/sgi_logo.jpg)
- [http://db-in.com/blog/wp-content/uploads/2011/05/opengl\\_part3.png](http://db-in.com/blog/wp-content/uploads/2011/05/opengl_part3.png)
- <http://nehe.gamedev.net/tutorial/>
- <http://www.falloutsoftware.com/tutorials/gl/gl8.htm>
- <http://www.3dfxzone.it/koolsmoky/images/ut.jpg>

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