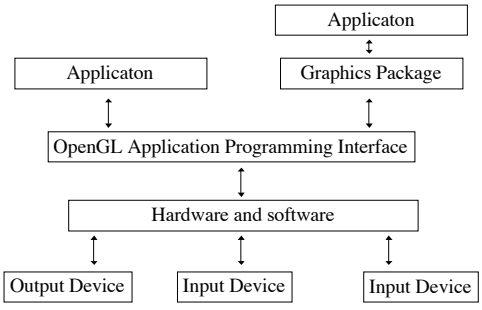
# Introduction to OpenGL

CS 351-50

## OpenGL: Open Graphics Library

- Graphics API
  ( Application Programming Interface)
  - Software library
  - Layer between programmer and graphics hardware (and other software
- Several hundred procedures and functions

## Programmer's View




## What is OpenGL

- Configurable state machine
  - Input is 2D or 3D data
  - Output is framebuffer
  - Modify state to modify functionality

## What is OpenGL

- Widely used and supported
- “the” choice for Linux developers
- Very well documented
- Easy to use
- Supports high-end graphics features
- Geometric and pixel processing

## OpenGL History

- Originally developed by SGI in early 90’s
- No longer SGI propritary
- License free

## OpenGL History

- Evolution controlled by OpenGL ARB
  (architecture review board)
  – One vote per company
    - Includes Microsoft, SUN, SGI, nVidia, ATI

## What is OpenGL used for

- Real-time applications
- Fast preview for visualizations
- Interactive virtual environments
- Video games (Quake, by id Software)

## What OpenGL is not used for

- Quality rendering
  - OpenGL uses scan-line rasterization
  - Use ray-tracing or radiosity for quality

## How does OpenGL do it?

- Client-server interpretation
  - Program (client) issues commands
    - Eg. Enable lighting, render triangle, etc.
  - Commands interpreted and processed by server
    - the “GL”

## OpenGL

- Does not provides a means of modeling complex objects
  - Requires a higher level API
- Does not provide support for peripherals
  - Ie mouse, sound, etc
  - Requires other libraries
- Does not provide windowing or a GUI
  - For this we use GLUT
    - (Graphics Library Utility Toolkit)

## OpenGL: In a nut shell

- 2D, 3D data goes in
- Framebuffer comes out

MAGIC!

## What does this mean to you? (Why lean thru OpenGL)

- High quality rendering
- Easy to program
- Portable code (hopefully)

## What you need to know

- How GL works
- How to interface with it
  - How to configure it
  - How to pass data to it
- How to know what went wrong

## Libraries

- #include <GL/gl.h>
- #include <GL/glu.h>
- #include <GL/glut.h>

## Window System Interaction

- OpenGL is completely platform dependent
- Need a windowing system for things like
  - Interaction
  - Opening/Closing Windows
  - Handling events
- Options:
  - GLX (*nix)
  - WGL (windows)
  - GLUT (window-system independent)

## Event Driven Interaction

- OpenGL does not dictate any particular model of interaction
- Applications respond to events generated by devices (ie mice) and window system events (ie window resized)
- Events usually placed in a queue awaiting action
- *Callbacks* let you associate a function with a particular type of event
  - Mouse callback

## Create a window with GLUT

- glutInitWindowSize
- glutInitDisplayMode
- glutCreateWindow

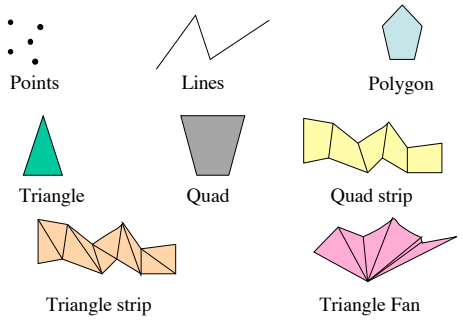
## How do I render a geometric primitive?

- To Framebuffer
- OpenGL primitives
  - A group of one or more vertices
  - Vertex defines:
    - A point
    - An endpoint of an edge
    - A corner of a polygon where two edges meet

## OpenGL Rendering

- Data consists of
  - Positional coordinates
  - Colors
  - Normals
  - Texture Coordinates
- Each vertex is processed
  - independely
  - In order
  - In the same way

## OpenGL Primitives




## OpenGL drawing

- To draw a primitive, call glBegin()
- glEnd() encloses a list of vertices and their attributes
- Coordinates of a primitive are given counter-clockwise order

## Function calls to draw a primitive

```
glBegin(GL_POINTS);
    glVertex3f(0.0f, 0.0f, 0.0f);
glEnd();
```

## Draw a triangle:

```
glBegin(GL_TRIANGLES);
      glVertex3f(0.0f, 1.0f, 0.0f);
      glVertex3f(-1.0f, -1.0f, 0.0f);
      glVertex3f(1.0f, -1.0f, 0.0f);
glEnd();
```

## Draws a triangle with different colors at each vertex

```
glBegin(GL_TRIANGLES);
        glColor3f(1.0f, 0.0f, 0.0f); //pure red
        glVertex3f(0.0f, 1.0f, 0.0f);

        glColor3f(0.0f, 1.0f, 0.0f); //pure green
        glVertex3f(-1.0f, -1.0f, 0.0f);

        glColor3f(0.0f, 0.0f, 1.0f); //pure blue
        glVertex3f(1.0f, -1.0f, 0.0f);
glEnd();
```