

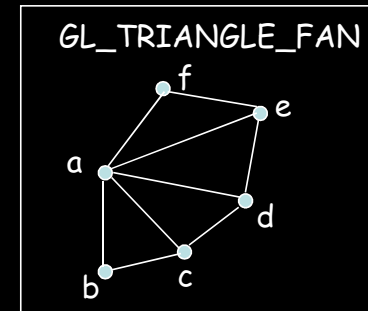
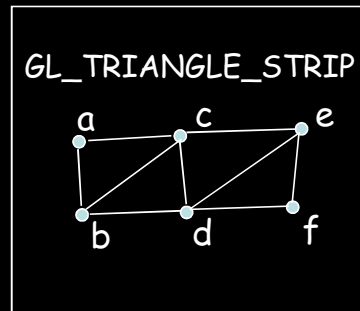
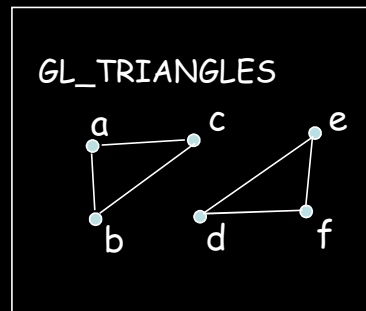
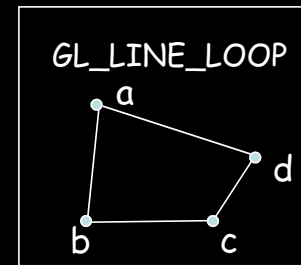
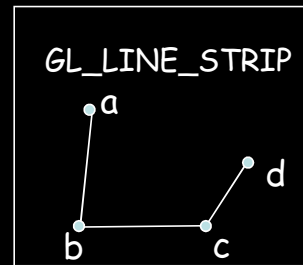
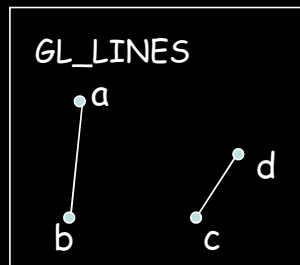


Generating Geometry

Terrains



OpenGL Primitives

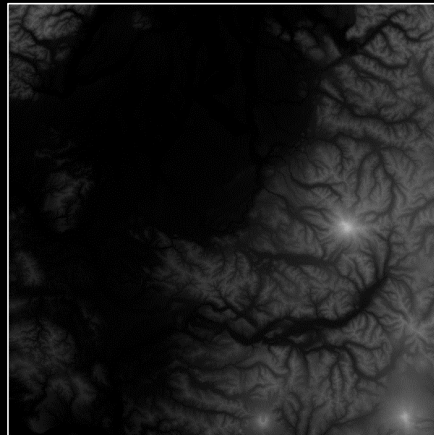




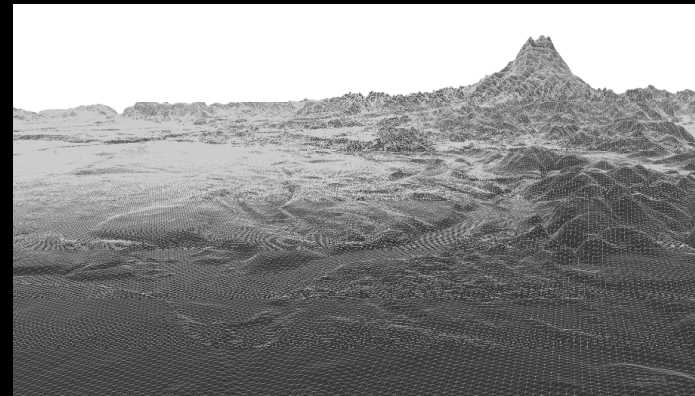
Height Maps

Pixel intensity represents height in a grid

Height map



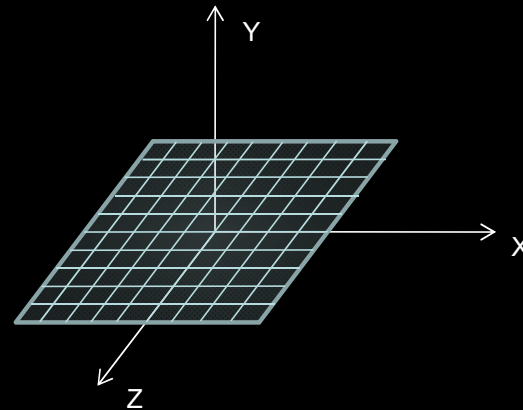
Rendering





Terrains from Images

- Goal:
 - Given an image, create a regular grid such that the height of each grid point matches the corresponding pixel's intensity.
- Tasks:
 - Load the image
 - Create the grid based on the matrix of pixels read from the image.





DevIL

- Cross-platform image loading library

(<http://openil.sourceforge.net/>)

In the cpp file:

```
#include <IL/il.h>
```

// Note: in Linux and Macs it may be required to specify the full path to `il.h`

After GLUT callback registration do:

```
ilInit();
```

- Other Image Libraries can be found here: https://www.opengl.org/wiki/Image_Libraries



DevIL – Loading an Image

```
unsigned int t, tw, th;
unsigned char *imageData;

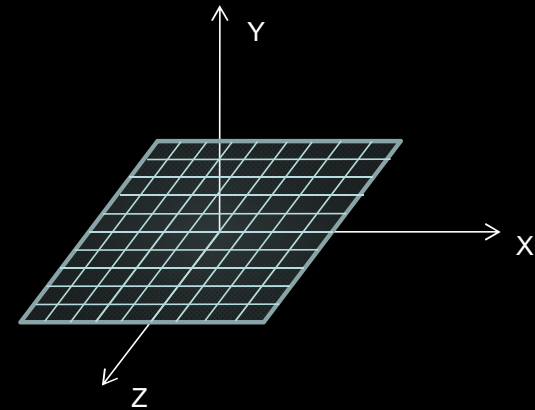
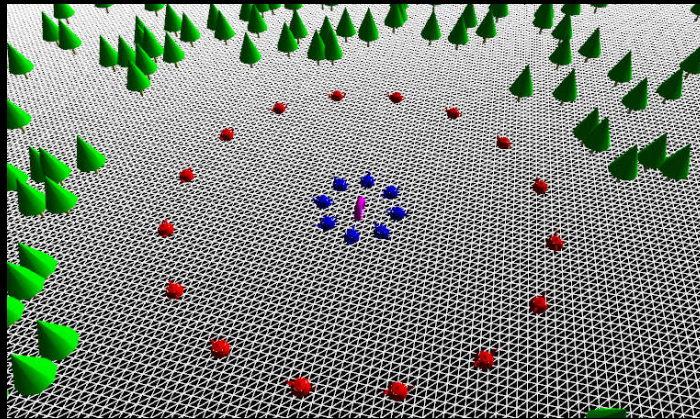
ilGenImages(1,&t);
ilBindImage(t);
// terreno.jpg is the image containing our height map
ilLoadImage((ILstring)"terreno.jpg");
// convert the image to single channel per pixel
// with values ranging between 0 and 255
ilConvertImage(IL_LUMINANCE, IL_UNSIGNED_BYTE);

// important: check tw and th values
// both should be equal to 256
// if not there was an error loading the image
// most likely the image could not be found
tw = ilGetInteger(IL_IMAGE_WIDTH);
th = ilGetInteger(IL_IMAGE_HEIGHT);
// imageData is a LINEAR array with the pixel values
imageData = ilGetData();
```



Terrains from Images

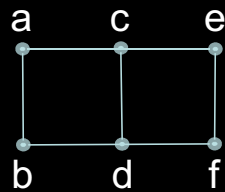
- Step 1:
 - Build a regular grid with height 0.0 for every point. Use the width and height of the image as the input dimensions for the grid:
 - there are as many vertices in the grid as pixels in the image





Triangle Strips

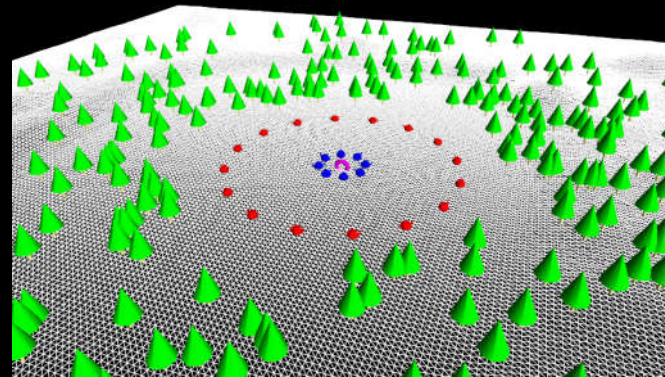
- Array with triangle vertices: {a,b,c,d,e,f}
- `glDrawArrays(GL_TRIANGLE_STRIP, first, count)`
- Number of strips = image height - 1





Terrains from Images

- Step 2:
 - Set the height for the grid's vertices according to the pixels intensity
 - `float h(int i, int j)` function to return the value of pixel in column `i`, row `j` (required to build the terrain geometry).
 - Note: scale the heights from 0-255 (pixel intensity) to 0 - 30 meters for a more appropriate rendering
 - Note: this lesson is only focused on the terrain, not on the trees and teapots.





VBO - Init

- **Step 1 – Allocate and fill arrays with vertices**

```
// array for vertices  
float *vertexB;  
// fill arrays with vertex values
```

- **Step 2 - Enable Buffers**

```
glEnableClientState(GL_VERTEX_ARRAY);
```

- **Step 3: Generate Vertex Buffer Objects**

```
GLuint buffers[1];  
...  
glGenBuffers(1, buffers);  
glBindBuffer(GL_ARRAY_BUFFER, buffers[0]);  
glBufferData(GL_ARRAY_BUFFER, arraySize, vertexB, GL_STATIC_DRAW);
```



VBO - Render

- Step 1: Define the semantic for each buffer

```
glBindBuffer(GL_ARRAY_BUFFER, buffers[0]);  
glVertexPointer(3, GL_FLOAT, 0, 0);
```

- Step 2 : Draw VBOs

```
glDrawArrays(GL_TRIANGLE_STRIP, first, count);
```

- first – the starting index
- count – the number of vertices (not triangles) to draw



Assignment

- Given an image, interpret it as a height map, and generate the corresponding terrain.
 - Add the initialization part to the `init()` function
 - Add the terrain rendering part to `drawTerrain()` function



DevIL (Linux & Mac)

- ```
sudo apt-get install libdevil-dev
```

```
sudo apt-get install libdevil-dev
```

- ```
brew install devil
```

```
brew install devil
```