4th Oral Presentation

From

Team

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Chapter 1

Introduction

Markus “Notch” Persson spent two years on Minecraft full time, helped with five to ten people who were all experienced game developers.
As for us, students of Epita, we spent a mere nine month develeloping and, the result is an awesome game!

SkyLands is a Minecraft-like game in which we added some strategy. Thus you are able to create units and buildings in order to defeat your foes just like a strategy game, except that it’s in a Minecraft world!

At Dedalus corporation we like the variety of languages as well as new technologies! Thus our project has been coded using five differente languages and uses about four frameworks.
At first there is our 3d engine Ogre written in C++ then our Game which uses Ogre is mostly written in C#. But then what’s interesting is that we don’t have a GUI but a web UI thus we are using not only HTML and CSS in our menus but JavaScript as well!

Chapter 2

Licensing

At Dedalus, we consider that Licensing our code is an important task. According to the French legal code, a license is an authorization.
First, we explored the available licenses and, one of the first license we were directed to was the GNU GPL.

2.1 GNU LGPL

The GNU Lesser General Public License or LGPL (formerly the GNU Library General Public License) is a free software license published by the Free Software Foundation (FSF).
The LGPL allows developers and companies to use and integrate LGPL software into their own (even proprietary) software without being required (by the terms of a strong copyleft) to release the source code of their own software-parts. Merely the LGPL software-parts need to be modifiable by end-users (via source code availability): therefore, in the case of proprietary software, the LGPL-parts are usually used in the form of a shared library (e.g. DLL), so that there is a clear separation between the proprietary parts and open source LGPL parts.

However one of the downside of the LGPL is that if you do not use the code in a DLL, so you put it in your code, your project automatically gets under the LGPL. It is usually said that the licence is viral. That is one the only thing we do not agree with.

2.2 BSD license

BSD licenses are a family of permissive free software licenses, imposing minimal restrictions on the redistribution of covered software. This is in contrast to copyleft licenses, which have reciprocity share-alike requirements. The original BSD license was used for its namesake, the Berkeley Software Distribution (BSD), a Unix-like operating system. The original version has since been revised and its descendants are more properly termed modified BSD licenses. This is the license we choose. Basically, anyone can copy our source code choose the license he wants or even choose to make his code proprietary. But he must say that he used our code. This was the only condition we wanted on our source code.

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Chapter 3

GUI and Web UI

3.1 A windowed Game

Following the example given by Minecraft, we decided to give up on a full screen game and go for a windowed game.
This means that users can resize the window in which the game is to any size they want.

3.2 A GUI flawed

We recently discovered that Mogre, the 3d engine we were using was no longer maintained (and hasen't been for two years) and that it had tremendous flaws!
You already know that Mogre is a .NET wrapper for Ogre (a C++ 3d engine), which means that Mogre is just a "translator" however translating from C# to C++ isn't that easy.
Thus many functions which are in Ogre are not translated in Mogre and therefore, for some special cases, we need to access directly to the C++ functions or use pointers.

For the GUI it was worse, we could get Mogre to display images but never text, and we couldn't do anything about it because of a C# to C++ error...
We tried tinkering in the source of Mogre but we never could make our way out (they were using a weird procedure, wrapping from C++ to JAVA and the translating the wrapper in C#).
We tried using some of the new Ogre features which were added in the 1.8 version of Ogre (they are now writting the 2.0 version) however after to translating a few thousands lines of C++ to C#, without surprise we dsicovered that the latest version of Mogre (1.7.4) could not work with the new GUI features.

At that moment our spirit was really low, we didn't know what to do and couldn't really continue our Menus without doing horrible things.
However by sheer luck we discovered an awesome library, which allowed us to create Web UI which is just a fancy term for any interface built with HTML, JS, and CSS. Awesomium is a library which provides the special sauce that allowed us to integrate Web UI content in any .NET application!
And guess what! The C# version of Awesomium is just a wrapper of the C++ version!

3.3 A Web UI

Finding a way to display our menus and what's more in HTML, CSS and JavaScript was a releif. However we had to completly destroy the old interface and thus rebuild our GIU from scratch. We first had to rebuild the previous GUI (we chose a different theme that time) and then the ingame HUD.

3.3.1 Main Menu

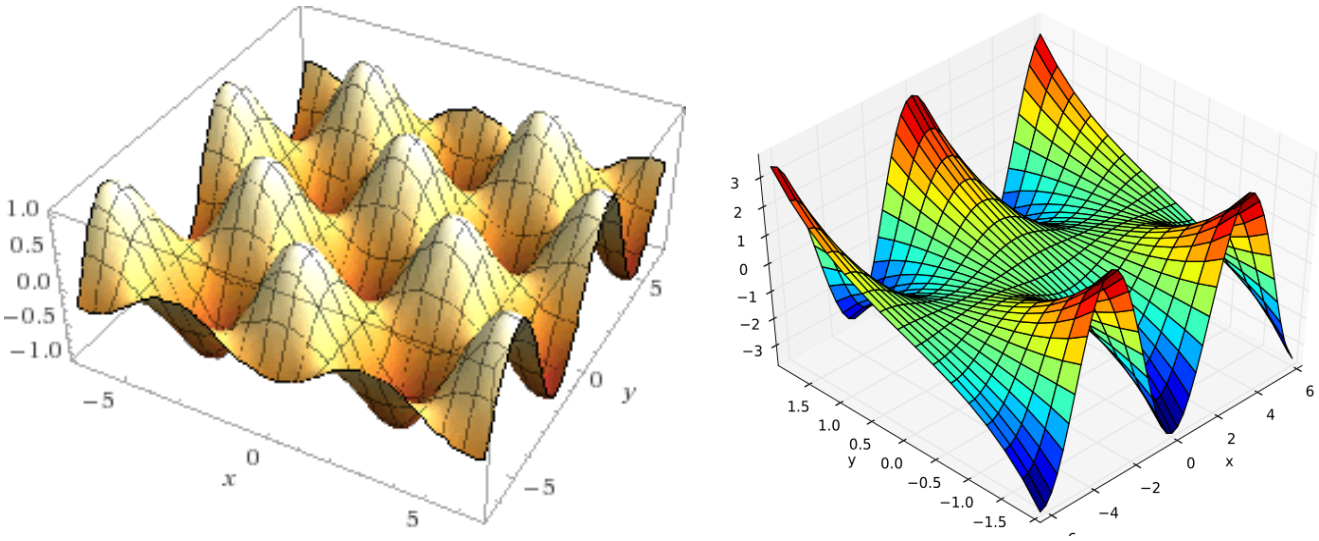
Chapter 4

Random Terrain Generation

4.1 At First Static Terrain

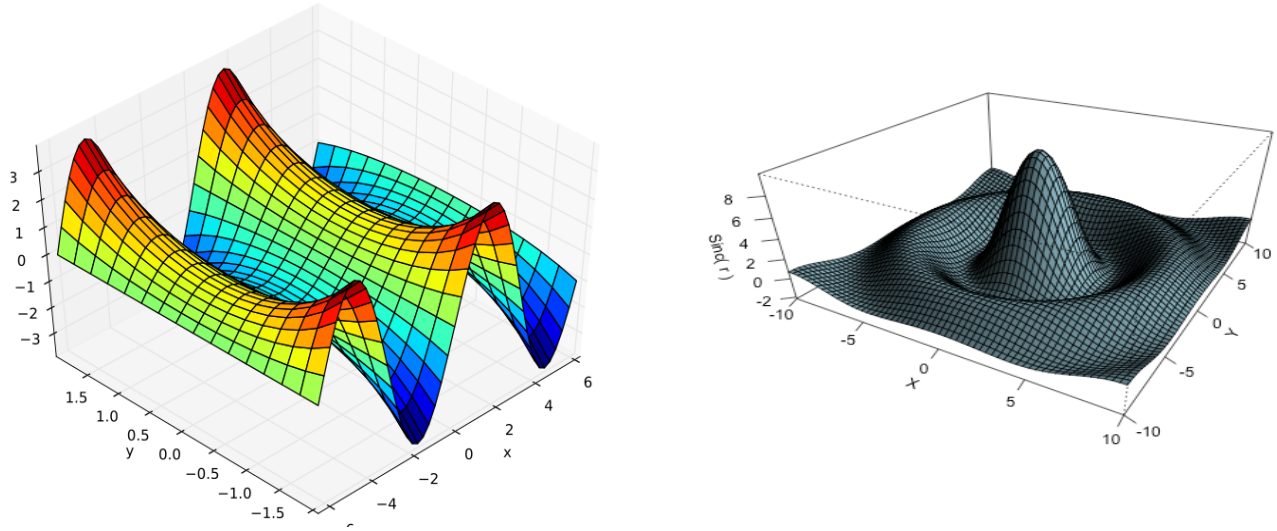
At the begining of the year, the pattern we used for creating islands was very simple and extremely fast. We applied basic functions as well as more advanced functions such as :

- sin 2d
- sin 3d
- cos 3d
- sin(x) cos(y)
- sinc 3d (sin(x) / x)



*The sin(x) * cos(y) and the sinus 3d function*

However we quickly understood that using basic functions was not enough. We also wanted random terrain generation however, those functions didn't provide any random factor.
Therefore after some research we ended up using a Perlinh Noise algorithm.



The sin(x) function represented in 2d and the sinc 3d function

4.2 Then Perlin Noise

If you look at many things in nature, you will notice that they are fractal. They have various levels of detail. A common example is the outline of a mountain range. It contains large variations in height (the mountains), medium variations (hills), small variations (boulders), tiny variations (stones) . . . you could go on.
Look at almost anything: the distribution of patchy grass on a field, waves in the sea, the movements of an ant, the movement of branches of a tree, patterns in marble, winds. All these phenomena exhibit the same pattern of large and small variations. The Perlin Noise function recreates this by simply adding up noisy functions at a range of different scales.

4.2.1 Noise

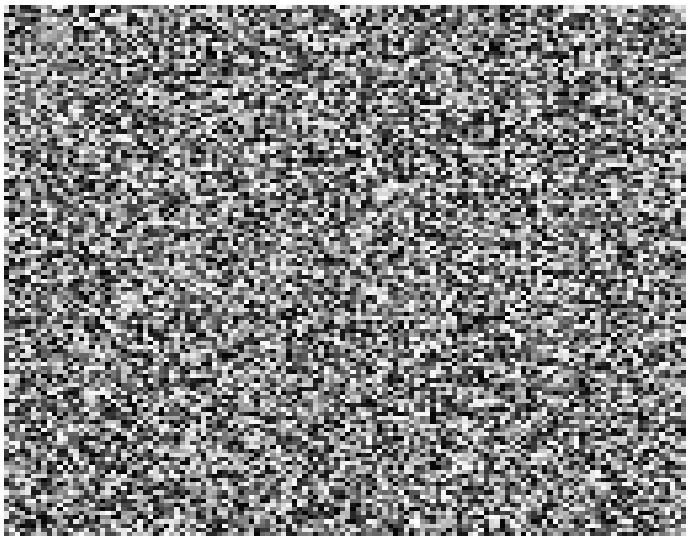
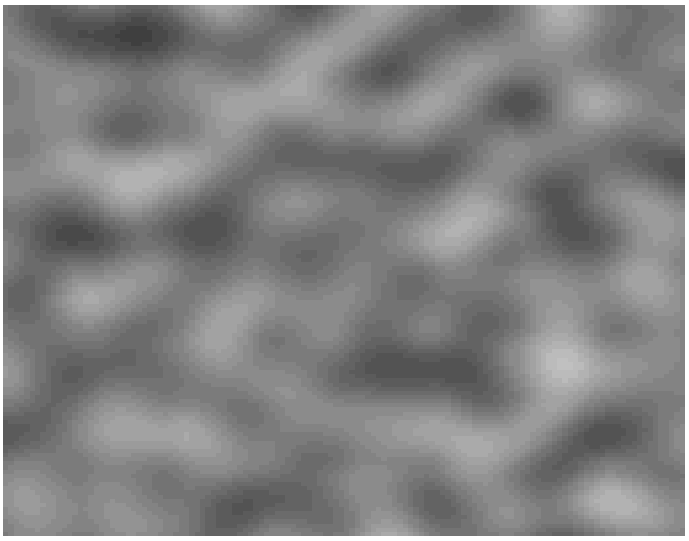
Perlin noise generates coherent noise over a space. Coherent noise means that for any two points in the space, the value of the noise function changes smoothly as you move from one point to the other – that is, there are no discontinuities.

4.2.2 Generating Perlin Noise

The outline of our algorithm to create noise is very simple. Given an input point P, look at each of the surrounding grid points. In three dimensions there will be eight.
For each surrounding grid point Q, we choose a pseudo-random gradient vector G. It is very important that for any particular grid point you always choose the same gradient vector.

Compute the inner product G . (P-Q). This will give the value at P of the linear function with gradient G which is zero at the grid point Q.

When we have 8 of these values. We interpolate between them down to the point, using an S-shaped cross-fade curve (eg: 3t2-2t3) to weight the interpolant in each dimension (we could use a sin function but it would be too slow). This step requires computing 8 S curves, followed by 8-1 linear interpolations (the

value has a dimension of degree 1).

We then create an array of the width, height and length of the terrain and fill it with the perlin noise value. We then iterate through the array's 3 dimensions and calculate a noise value for each cells of the array.
The noise value is based on experimentations and advice given by experienced people. At the begining, the value was computed using a simple linear function, however it is now computed using a polynomal function ad two noise arrays :

```
double noiseValue = (noise[xx, yy, zz]) * noise2[xx, 255 - yy, zz] + noise[xx
    , yy, zz] - System.Math.Abs(1 / smoothHeight * (yy - smoothHeight -
    minElevation + 20))
```

Where smoothHeight correspond to (maxElevation - minElevation) / 2. The noise value computed is a value between -1 and 1 and if it is lower than 0 we consider that it is air.

4.3 Different Islands

The smoothHeight value allows us to make different type of Islands, such as plains or even mountains. Because when smoothHeight's value is High, the values computed by noiseValue are higher and tend to be more scattered whereas low values tend to be more concentrated on one level.

4.4 Decorating the Islands

By default, the terrain is just a big cube of stone. However, when generating it, we add air blocks and, solid blocks under air blocks are usually grass (it can be set to another block).
Since we do not want to iterate through the terrain multiple times, this is done when generating the terrain thanks to little algorithm trick :

```
for (int xx = 0; xx < this.mIslandSize.x; xx++) {
    for (int zz = 0; zz < this.mIslandSize.z; zz++) {
      for (int yy = Cst.MAXHEIGHT; yy > 0; yy--) {
```

We create the terrain from the top, which allow us to check for each block if it's under an air block and if that's true, place a block of grass.
In case the block we just created is solid, we calculate it's distance from the surface and if we told the program beforeHand that there was a special block at the block's particular depth then the type of block will be the one we set, else it's stone.
Thus in most of the Islands, the first layer is grass and the next two are dirt. The height and the layers are set in a class called Biome.

Once we finished generating the terrain, the next step is to populate it. Which means to add trees or cactus in the different biomes.
Basically we choose a random x and a random z and look for the highest solid block. We then add the cactus and trees.

4.5 Structures

The different structures are usually specific to the biomes and are generated procedurally. As for the cactus and the trees, we get a random point and add the structure. We have multiple structures :

4.5.1 Pyramid

4.5.2 Caverns

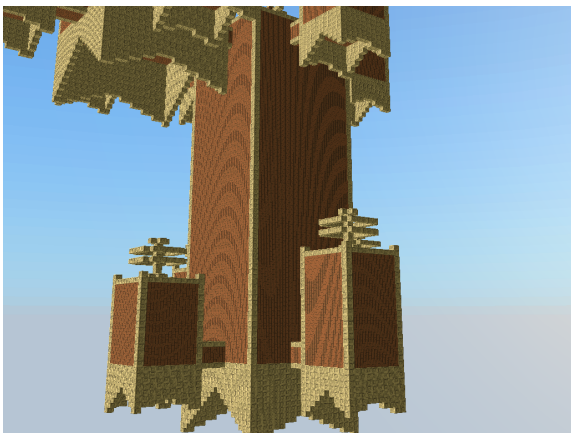
4.5.3 DarkTower

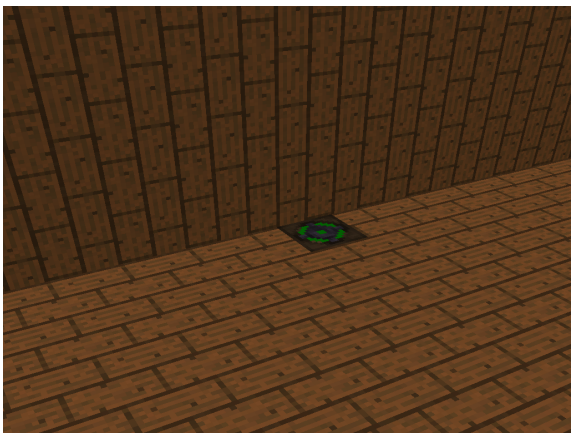
Introduction to the dark tower

The dark tower is the biggest structure we made, it is composed of four main towers floating in the sky and is part of the plain biome. This structure is huge because it size can reach 362 blocks on the y axis and has almost 41 floors

The main buildings

The tower consists in four main buildings whose height vary between 60 and 88 blocks it has about seven floors which can be climbed using the arcane levitator which as it names implies allows you to levitate. Basically if you are on the levitator, it will lift you up to the next floor.

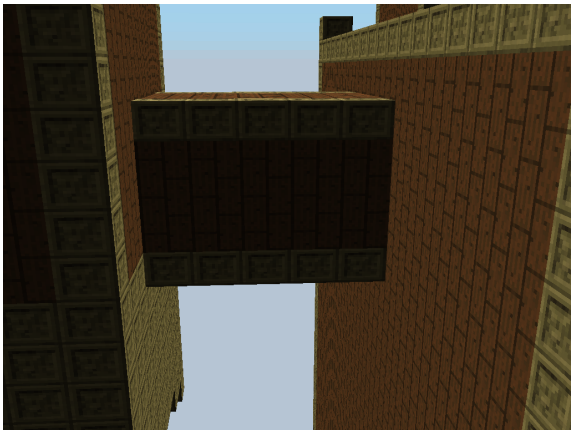
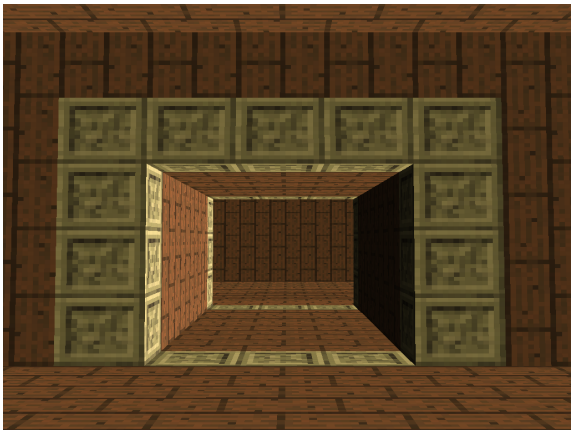




finally on the first and last floor of the main tower, bridges connect the main towers to medium towers or another main tower.

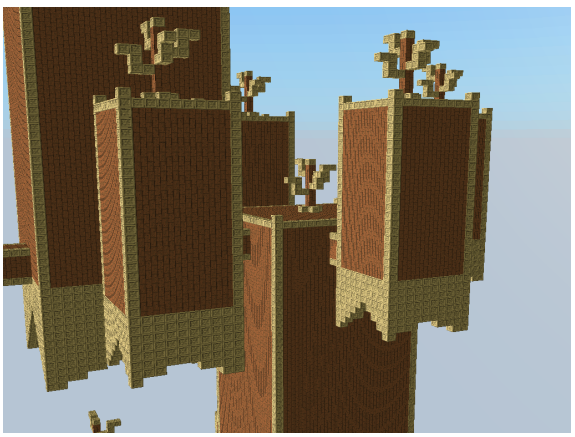
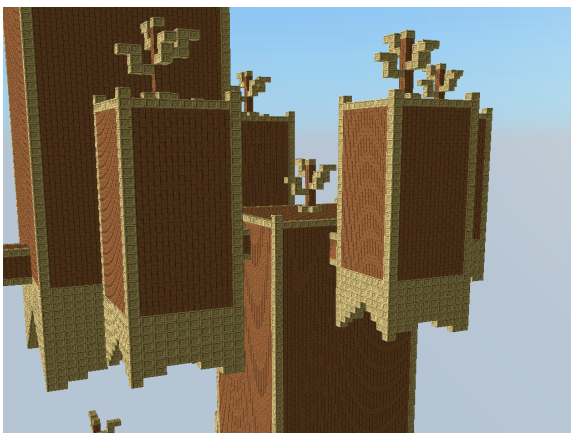
Bridges

Bridges are generated only by the main towers and allows the player to continue climbing the dark tower. One difficulty we encountered while "building" the tower was the orientation. Indeed, the algorith to build a bridge facing north is not the same as the algorithm to build a bridge facing west. We struggled to find a way to "unify" those algorithm but we finally choose the simplest solution using a switch. Here is the result :

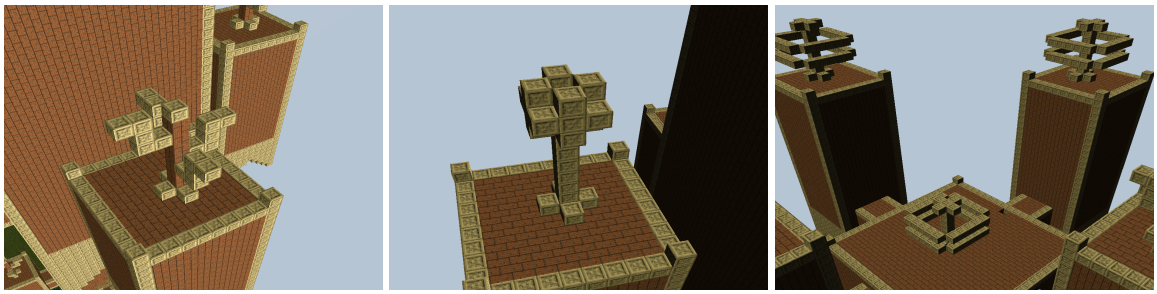
Lower towers

As I've already said before the main tower are linked by bridges to lower towers their height vary between 15 and 30 blocks and in most of them, the player will find prisonners unit guarded by ennemies and when they are defeated (the ennemies), the prisonners joins the player which can then command them.

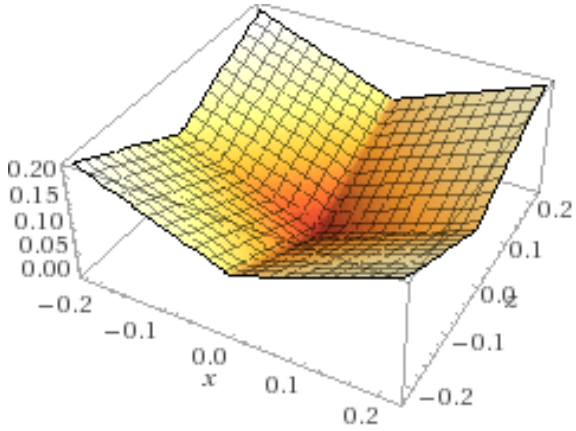
Roofs

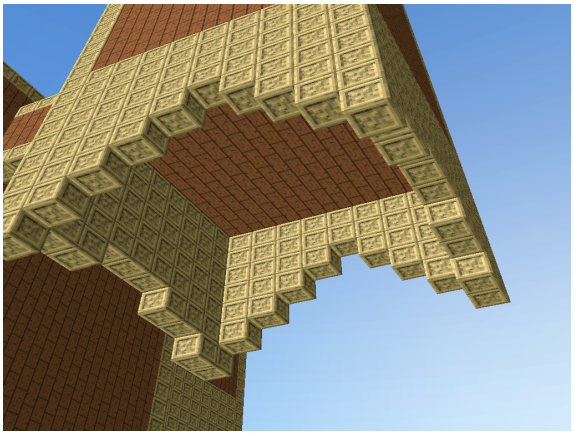
Among the multiple things which make the tower, one of the most beautiful thing are the structures on the roof, we made 3 of them :



DarkBeard

Finally, we had to deal with the bottom of the towers. At the beginning we thought that it would stay flat but, we managed to find a function that made the bottom look amazing. We called it the dark beard.





4.6 Displaying

4.6.1 Displaying Cubes

At first, we thought of dissplaying cubes which where imported entities from blender.
Of course we only displayed visible cubes (cubes which had other cubes adjacent to all his sides were not visibles). However the result was a mere 1 to 10 Frames Per Seconds with a 40 by 40 blocks terrain. In other words a ridiculous amount of FPS.

This lag was mostly caused by the fact that when displaying an entity on the terrain, all it's faces are visible even the ones which you can not see.

4.6.2 Displaying Only Faces

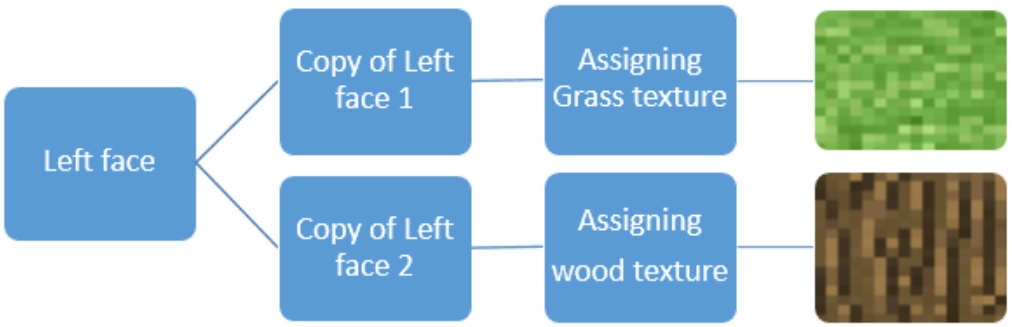
Because of the lag caused by this method, we had no other choice but to find another way of displaying the terrain.
Thus we came up with the following idea :
We created in the code the six different faces which are composing a block.
Thanks to Ogre, this was a fairly easy process, creating an object whith little triangle composing it in the code is no more than seven line!

```
ManualObject block = new ManualObject("name");
block.Begin("texture here", RenderOperation.OperationTypes.OT_TRIANGLE_LIST);
    block.Position(new Vector3(0,   0,     0));
    block.Position(new Vector3(0,   100,   0));
    block.Position(new Vector3(100, 0,     0));
    block.Position(new Vector3(100, 100,   0));

    block.Triangle(0, 1, 2);
    block.Triangle(1, 2, 3);
block.End();
```

Of course there are other things we have to do such as specifying the coordinates of the textures or the normals (normals are used in order to cast shadow on the surface).

Once the six different faces were created, we would iterate through the terrain and each time we would find a visible face (face that is not hidden by another block), we would make a copy of the created face, assign it a texture and then, place it at the correct position.



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