

1ST ORAL

From

Team



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Chapter 1

Introduction

It has been two month since the last presentation. Two month is a short time and we had a lot to do the task was almost daunting. Indeed, when we learned that we did not have all points on the progress, not only did we want to realize all the task written in the book of specifications but we had to do more.

And more, meant to us, impressing terrain generation, amazing FPS through a complete rewriting of the displaying system an even better GUI than planned, a console and awesome physics such as Jumping all around the place.

However, creating those features were really time consuming, we literally spent days coding them and, throughout this report we will show you the best of our game.

Chapter 2

Communications

2.1 Twitter, Facebook and YouTube

Since our game is starting to be playable, we wanted to show the world what it looked like. To do so, we created accounts on the two main social networking web sites: Facebook and Twitter. Also to give people the possibility to really have an idea of what our game look like, we have made a small footage showing the main goal of our game and its advancement and posted it on Youtube.



2.2 Web site

You might have seen it at the first oral presentation, our website was a little bit empty. Knowing that we made some efforts, and added some pages to the website. The first we added was the download page, the second we added was the page World. Finally, we created an admin area where we could edit the news on the front page.

This is done using an SQL database, this means as we are using Symfony, we use Doctrine. An example of Doctrine is the following class (this is not all the class) :

```
<?php
/* @ORM\Table()
 * @ORM\Entity(repositoryClass="SkyLands\KernelBundle\Entity\NewsRepository") ←
 */
class News {
    /**
     * @var integer
     * @ORM\Column(name="id", type="integer")
     * @ORM\Id
     * @ORM\GeneratedValue(strategy="AUTO")
     */
    private $id;

    /**
     * @var string
     * @ORM\Column(name="author", type="string", length=255)
     */
    private $author;
    /**
     * @var string
     * @ORM\Column(name="message", type="text")
     */
    private $message;

    /*Get id
     * @return integer
     */
    public function getId() { return $this->id; }
?>
```

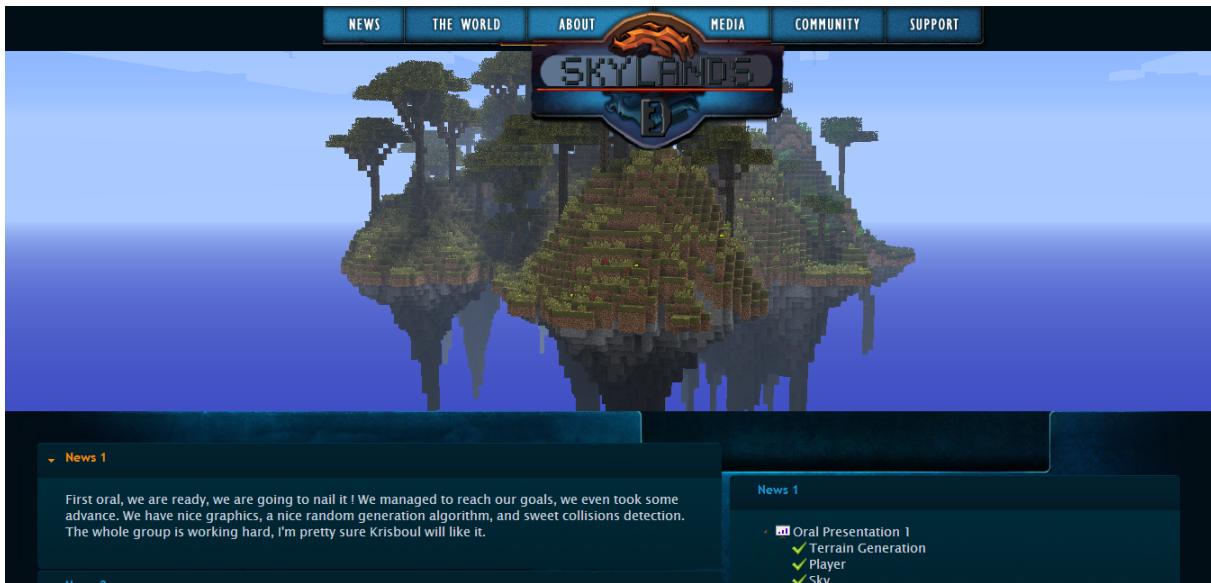
Thanks to symfony, creating the file and launching a php command line Symfony will detect all new doctrine class (marked with a @ORM comment) and update the database for us (creating a table). Also creating a new row in a table and reading from a table is made easier with doctrine :

```
<?php
// writing
$article = new News();
$article->setTitle('2nd Oral presentation');
$article->setAuteur('Dedalus');

$em = $this->getDoctrine()->getManager();
$em->persist($article);
$em->flush();

// reading
getRepository = $this->getDoctrine()->getManager()->
getRepository('SkyLandsKernelBundle:News');

$newsList = $repository->findBy(array(), array('date' => 'desc'), 4, 0);
// newsList is an array of array access it with newsList[i][fieldName]
?>
```



Chapter 3

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.

3.1 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.



3.2 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.

Here are the terms of our license :

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Chapter 4

Terrain display

4.1 What was done

For the 1st oral presentation, the display system was the biggest problem we had, FPS were very low, around 30, even though we only displayed little Islands (5*5*5 chunks, which are 16*16*16 blocks tall).

This system consisted in displaying visible faces of each blocks a unique entity. MOGRE had troubles supporting thousands of faces at a time thus limiting the maximum size of an Island.

4.2 Optimizations

So we came up with another idea, which was a bit risky. Basically creating an entity in mogre is very simple :

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

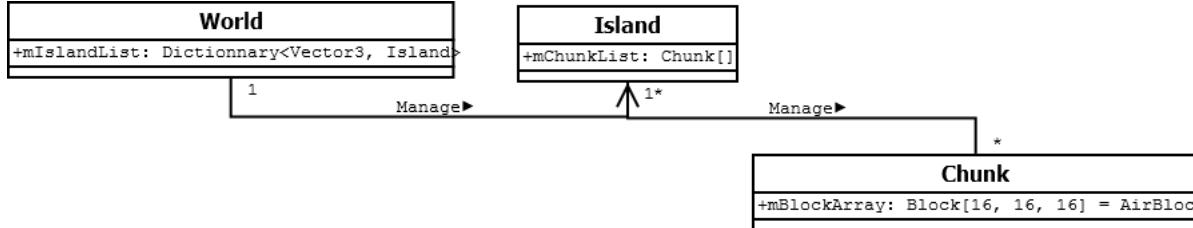
block.Position(new Vector3(0, 0, 0));
block.Position(new Vector3(0, 100, 0));
block.Position(new Vector3(100, 0, 0));
block.Position(new Vector3(100, 100, 0));

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

As you can see, we only have to give the object position and to tell to draw a quad (which is actually a shortcut to creating 2 triangles). Basically, the idea we had was to gather all visible blocks of the same material in an instance of an object (which was called multiblock). However this was not simple for 2 reasons :

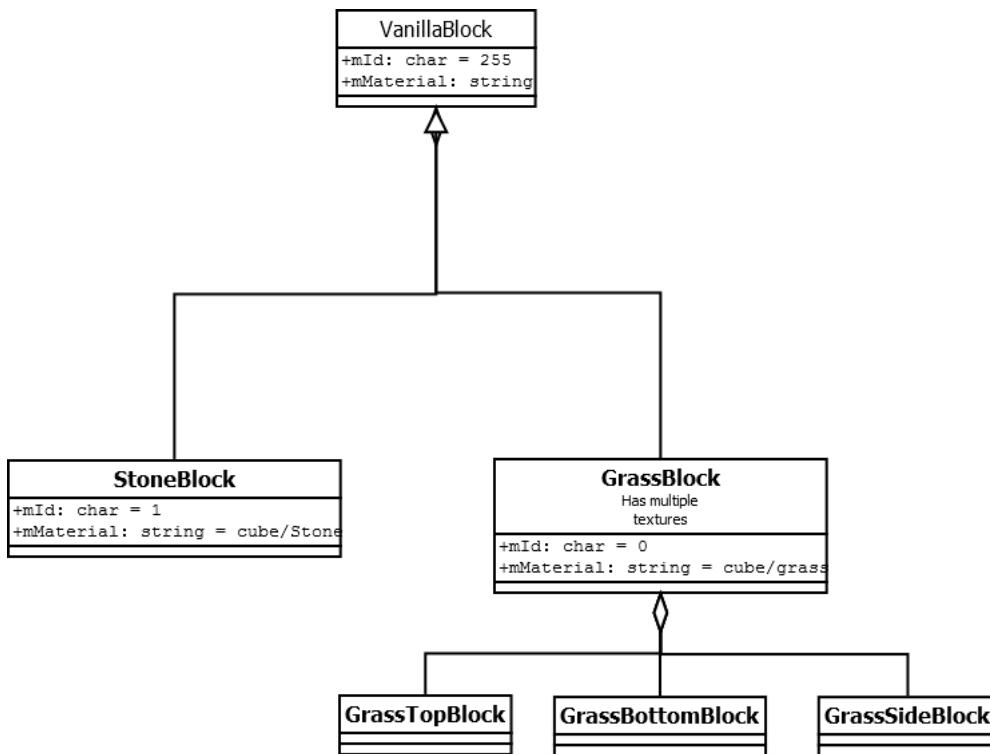
- We cannot tell the material to delete a face at a certain position neither can we add new faces to it
- We wanted blocks which had more than one texture on it (for example the grass cube doesn't have the same texture on the top face than on the bottom face)

First of all you need to understand our architecture :



As you can see here each chunk contains an array of block. At first, in this array, we stored in each cell a new instance of an object (The cube object) which had an attribute defining it's material.

However this way was memory consuming and unadapted for the future uses of the blocks (e.g. GUI). Thus, to save memory we rewrote the this part of the code and now it is more Object oriented and developer friendly :



Basically, using reflexion, in a static constructor of Chunk, we instantiate an object in charge of displaying each blocks in the namespace containing the blocks except, abstract class, the airBlock and class which has class inheriting from.

Thus, in this example, the following blocks would be instantiated : stoneBlock, GrassTopBlock, GrassBottomBlock, GrassSideBlock. Obviously in our code there are way more blocks than in this example.

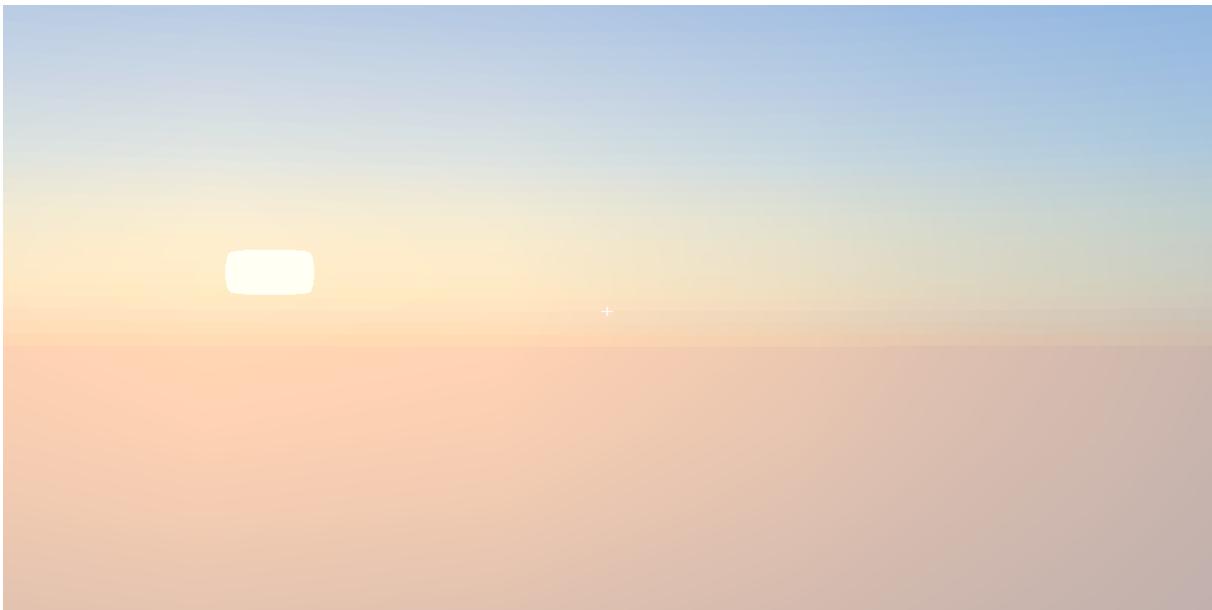
This system may seem a bit complicated, and it was, but it was totally worth the cost, we increased the frame rate by 20, and it now turns around 400FPS. Also, the Islands size were tripled, getting from 4×4 to 12×12 (on the x, z coordinates with y the height) and can even be increased to 30×30 . This means that if we assimilated the terrain as one continuous layer of block we would have : $30 \times 30 \times 16 \times 16 = 230400$ cubes, counting only top faces and bottom faces : 460800 faces and 921600 triangles, around 1 000 000 triangles (with about 100 FPS).

4.3 Sky

At the first oral, the sky we presented you was created using the library Caelum. However we wanted to try another well-known library : SkyX. Once again we used a wrapper of the original library coded in C++. It took us a very long time and much efforts.

Unfortunately it appeared that even if SkyX is a great library in C++ its wrapper is much less interesting. Indeed many functions weren't implemented in the wrapper. This lack leads to a far less awesome render than in the C++ version. Besides we had lots of troubles integrating this library to our project because of the different existing versions of Mogre.

That's why we ended up choosing Caelum. But we didn't make this choice because it was the first we saw but because this is the best one we can have.



Chapter 5

Player actions

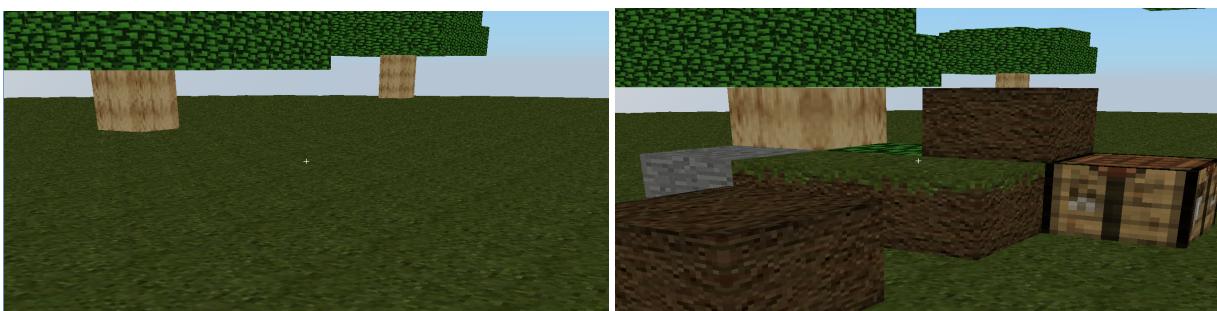
5.1 Adding blocks

Our player can now add blocks on the terrain using the mouse. We added a cursor at the center of the screen to help the player seeing the targeted block.

The first difficulty was to compute the actual position of this cursor in the 3 dimensional world. Then we had to cast a ray in the camera's direction so that we could store the blocks hit by this ray. But this isn't it; we then had to find out which face was actually clicked so that we could place the new block next to this face. Computing the position of the new block is only half of the work, we then had to add the faces at the right position.

One of the downside of gathering all faces in one object is that you can't add faces to the object. Therefore we had to think a bit outside the object. What we did was the following : When the player adds cube to the terrain, we display the face as an independent object. And we remember the position where he added a block. When he has added 30 blocks, we launch a new thread whose role is to recreate each multiblocks that were modified.

First this thread must change the list of Vector3 of the instance of each multiblock which were modified and add the blocks the player added to its list. Then he must recreate the object and when it's done remove the old one and replace it with a new one. C# having a thread system which is easy to handle, this part was pretty easy.



5.2 Removing Blocks

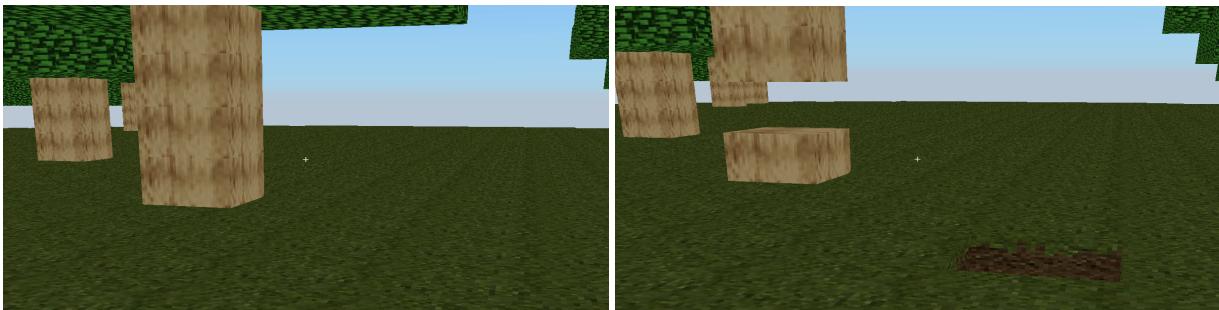
If we can add block, then it would be great if we could also remove blocks. So that's what we did. Computing the position of the targeted block the same work as for adding blocks.

However, removing blocks from the scene was a tricky part. Because the function we needed was not implemented in C# (traveling through the Manual object and modifying the faces, which are vector3) we had to get it from the C++ libraries. And, what's more, when we found the function we needed, we discovered the function needed pointers, thus so we had to use the unsafe option.

The basic idea is that a Manual Object is just a buffer of pointers to a Vector3 (actually it's a pointer to an array of size 3 which represent the coordinates of the vector3). Thus we had to get the vertex buffer, Lock it, get the position of the first element and from there on tell what was the face number we wanted to access, and multiply this number by the "size" of a Vector3 this would set the pointer to the right position. From there on we only had to set for a face, it's 4 coords to 0 and check how many faces were visible.

However 2 problems arose : the first block with multiple textures, had to be dealt with in a separate way.

The second was that when removing a block, we had to refresh the surrounding blocks, thus most of the time creating faces which were not in the manual object, that was the cause of a bug where we tried to suppress faces which were not in the manual object. You can imagine that it was deleting other faces than the one we wanted deleted.



Chapter 6

Terrain generation

6.1 A new structure

After the first oral, we wished for a more modable, and more object oriented structure. Thus most of the code was rewritten, allowing us to first create island which were not using Perlin 3D and secondly, when generating the terrain have what we called “populators” which were called after the terrain was generated.

Thus, in game you will now see trees and cactus as well. We can also set what we call the “ground cover” which define which blocks you’ll find on the first second and third layer of the ground.

6.2 Perlin 3D algorithm

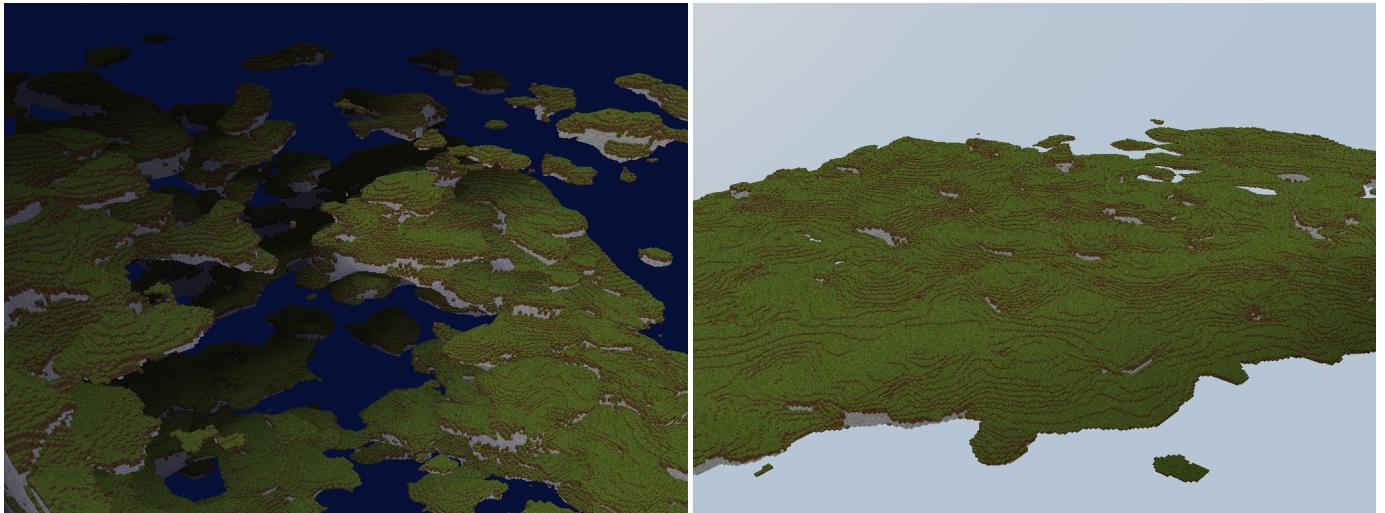
Thanks to our display optimization, we can now generate bigger islands. On the other hand the terrain’s generation algorithm is still an algorithm of complexity $O(n)$ (we have to travel through the terrain in the 3 dimensions). And can not be as optimized as the display.

Our Perlin 3D algorithm still works combining 3d noise in a polynomial expression :

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

Basically, perlin noise generate solid terrain and not islands. Removing the absolute value of $1/elevation$ to the noise value ensure that we get a more Island shaped terrain.
The 2nd degree polynomial and the $smoothHeight + 20$ is a form we came after hours of testing.

Combining a bigger terrain and and an upgraded perlin algorithm gave us nice results :



6.3 Biomes

You must have noticed in the previous formula the minElevation variable. This is an essential part of the terrain generation. When it's low value, the terrain is flatter. Whereas a higher value will generate multiple levels and "mountains".

Therefore we took advantage of this and created what we called the class Biome which not only had a value determining the minElevation variable but also had the ability to change the blocks on the ground (ground cover) and had populators.

Chapter 7

Buildings

7.1 Constructions blocks

Unlike in Minecraft, our player can build some presaved buildings. This is the basic of a Starcraft-like game. These buildings will allow the players to spawn some units for his army and also to gather few basic resources.

We didn't want the player to build the buildings block per block, all he will have to do is to place a "construction block". Then when he clicks this block, a menu opens and the player will have to give the required resources to start the construction. The inventory system isn't implemented yet; however clicking on the construction block will build a simple structure.

For this oral presentation, our buildings are simple. The player will actually be able to save his own buildings for the fourth presentation, this is part of the "map editor".

7.2 Saving and loading the structure and terrain

This wasn't very complicated, basically as we already explained you a block has an id which is a char. We only had to save each char in a file using a `StreamWriter` so as a byte.

This is how it works : foreach Islands, call the function `save`. This function will create a new file in the users' AppData/Roaming/SkyLands called Islands-Position.

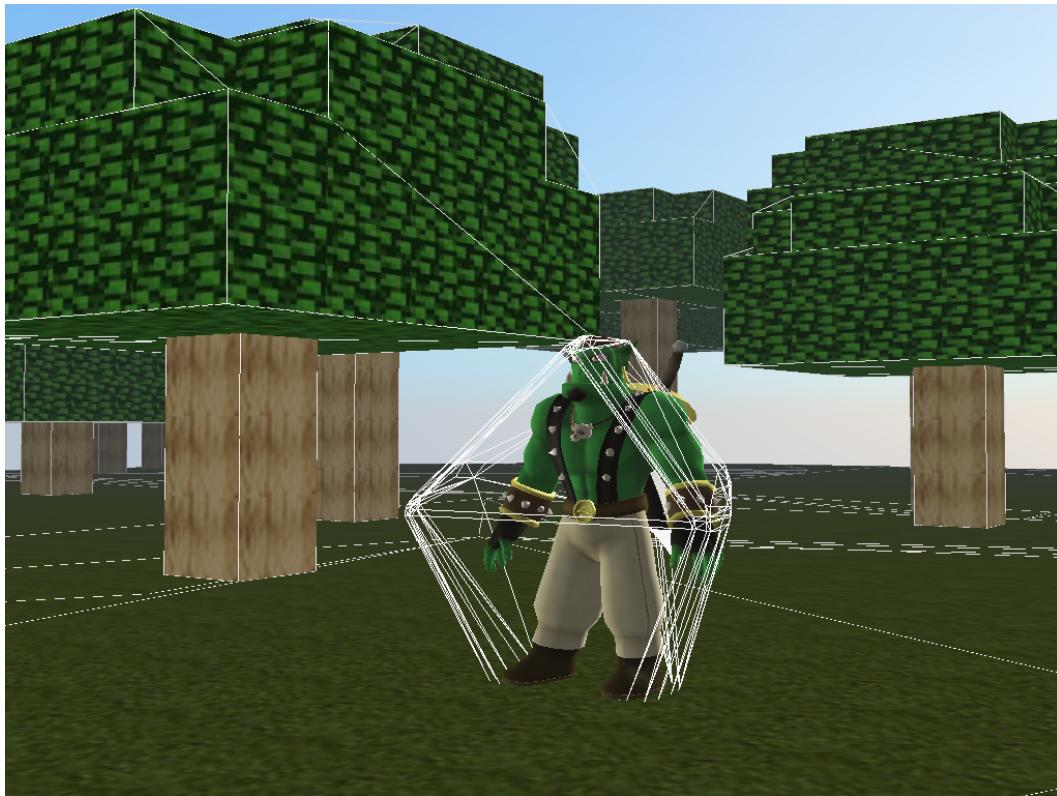
It will write in the file it's X, Y, Z size (in chunks and not in blocks) and then begin to write the information using 3 simple for loops. The results talk for themselves, for 100 000 blocks = 100 000 bytes = 100 ko. which would be around the number of blocks contained in a 15 * 15 island.

Chapter 8

Physics

8.1 Collisions

Because we want the best of our game, we tried implementing the library MogreNewt. This library provides a physic engine and handle collisions detection. It is a powerful tool but it implies to add each cube one by one as a “Body” that is to say about 80 000 blocks. This leads to an important loss of FPS which is definitely what we don’t want. You can see below all the wires of the bodies. Note that the character body was automatically created using its mesh file.



Eventually, we kept our system using the height points of each corner since we consider our character as a parallelepiped rectangle. This isn't an AABB collision algorithm because we look at the type of block there are next to the points. It may sounds easy but it is definitely not. Those height points have to move and rotate just as the character does.

Moreover when there is a collision, we have to replace the character at the exact position so that we avoid the collisions and also so that we avoid the same test of collisions at the next frame. For instance, when the character hit the floor, if he is replaced just one pixel to height, he will fall again on the next frame. As a result, we would see the player being like at 2 different places.

8.2 Jump

As promised our characters can now jump. Once the collisions with the floor worked this wasn't a hard task. We use a second order polynomial to determine the actual speed of the jump depending on the time since the character has jumped. Then our gravity system takes care to make him fall.



Chapter 9

AI

9.1 Pathfinding

Pathfinding refers to the plotting, by a computer application, of the shortest route between two points. At its core, a pathfinding algorithm searches a graph by starting at one vertex and exploring adjacent nodes until the destination node is reached. Although graph searching methods such as a breadth-first search would find a route if given enough time, other methods, which explore the graph, would tend to reach the destination sooner.

It is useful when integrating an IA. With it, a character will dodge holes and dead ends. An example use of the pathfinding : if an enemy sees the player, the algorithm will find the shortest path the enemy can take to come and attack the player.

9.2 A star (A*)

The A* (A star) is an algorithm widely used in pathfinding and graph traversal, the process of plotting an efficiently traversable path between points, called nodes. Noted for its performance and accuracy, it enjoys widespread use.

The A* uses a best-first search and finds a least-cost path from a given initial node to one goal node. As A* traverses the graph, it follows a path of the lowest expected total cost or distance, keeping a sorted priority queue of alternate path segments along the way.

7	6	5	6	7	8	9	10	11		19	20	21	22
6	5	4	5	6	7	8	9	10		18	19	20	21
5	4	3	4	5	6	7	8	9		17	18	19	20
4	3	2	3	4	5	6	7	8		16	17	18	19
3	2	1	2	3	4	5	6	7		15	16	17	18
2	1	0	1	2	3	4	5	6		14	15	16	17
3	2	1	2	3	4	5	6	7		13	14	15	16
4	3	2	3	4	5	6	7	8		12	13	14	15
5	4	3	4	5	6	7	8	9	10	11	12	13	14
6	5	4	5	6	7	8	9	10	11	12	13	14	15

Chapter 10

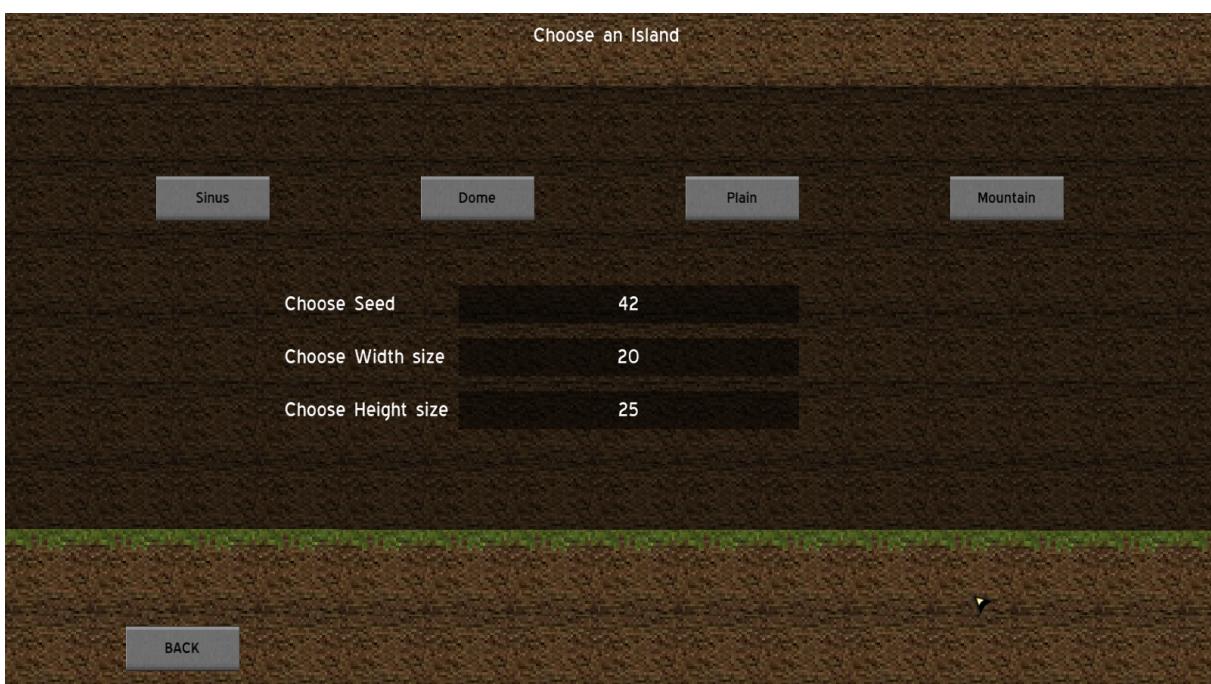
Menu

10.1 Console

Something we understood is that we need a console in game to gather some informations directly. Most of the time this is temporary informations but this is still useful. We used a system of listener so that we could be notified anywhere in the code that the player entered a command. That's why we can easily for instance get the character position.

10.2 New menu

Since the last oral presentation, we added many menus. First, we have some options in the main menu. We also added an intermediate menu in game for the escape key and menu when we click on a construction block.



Chapter 11

Conclusion

This is the end of our fabulous report ! We hope you enjoyed it, and that it interested you. We are convinced that the goals of this oral presentation were reached, and that we did more than what was written in our book of specification (Jump, display optimization, saving and loading the world). Most of our work was directed towards the optimization part because of the fact that 25 fps is clearly not enough for what was going to be added (AI and shadows). It would have caused huge lags.

Finally, we already have an impressive game and we don't intend to stop now. We intend to finish this game, make it more playable and even more awesome