Representation Guide

March 25, 2015

1 Introduction

We will need to have some way of representing the state of the puzzle at any given point. We have chosen a very specific representation which is quite nuanced, so we have included a guide here detailing how it works.

2 Positioning

The state of the Rubik's World is represented as a list of size 8. Figure 1 shows the list indices and the corresponding positions in Rubik's World. When you run the simulator, you will see the view given in Figure 1. To understand this representation, do not play with the orientation of the camera on the simulator, we assume it is fixed in space. When you rotate the southern hemisphere to your left for example (by pressing y), the contents of index 4 in the list (bottom left in the simulator) will now be whatever was previously at index 5 (bottom right). So the view in the figure is fixed, index 0 in our list always explains what is in the top left portion of the sphere. Note also how the indices were numbered, they do not traverse each hemisphere circularly.

This explains the list we use, but what about the contents of the list? We need to say what is at index 0 in the list; we have to describe what piece of the earth goes there and whether its the right way up or perhaps been rotated. This brings us to octant IDs and orientation.

3 Octant IDs

For our purposes, octants are the physical slices of the sphere as it has been cut in Figure 1. We can also think of them as the actual subcubes of a Rubiks cube, or textured rectangles (world sections) which the simulator maps onto the sphere in Figure 1. In our representation, octants are given IDs between 1 and 8. Figure 2 shows the IDs of the various world sections. Notice here that they are numbered curiously too. In the default position (when you fire up the simulator), octant ID 1 (containing the top left of Africa) will be in position 0 in the list (see Figure 1), and octant ID 7 (boring) at position 6 (out of view) for instance. They are labelled this way so that octant ID i is at index $i - 1$ when the simulator starts. To be clear, the representation in Figure 1 does not change when we rotate our cubes, rather the octant ID for each relevant sphere position will change (so position 0 will show a different octant ID). But it is not enough to keep track of which piece of the earth goes where, we must also describe the orientation of the texture at its given position.

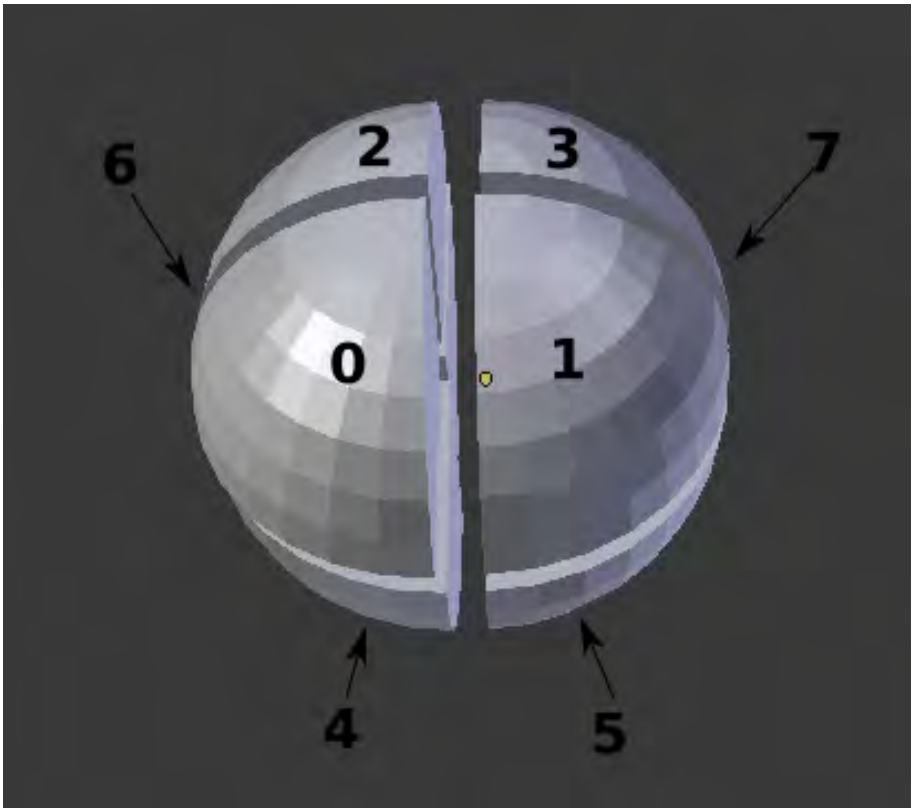

Figure 1: *Sphere positions as they correspond to list positions.*

Figure 2: *IDs of the respective segments of the earth. The red lines are used as reference points for figuring out a specific octant's orientation.*

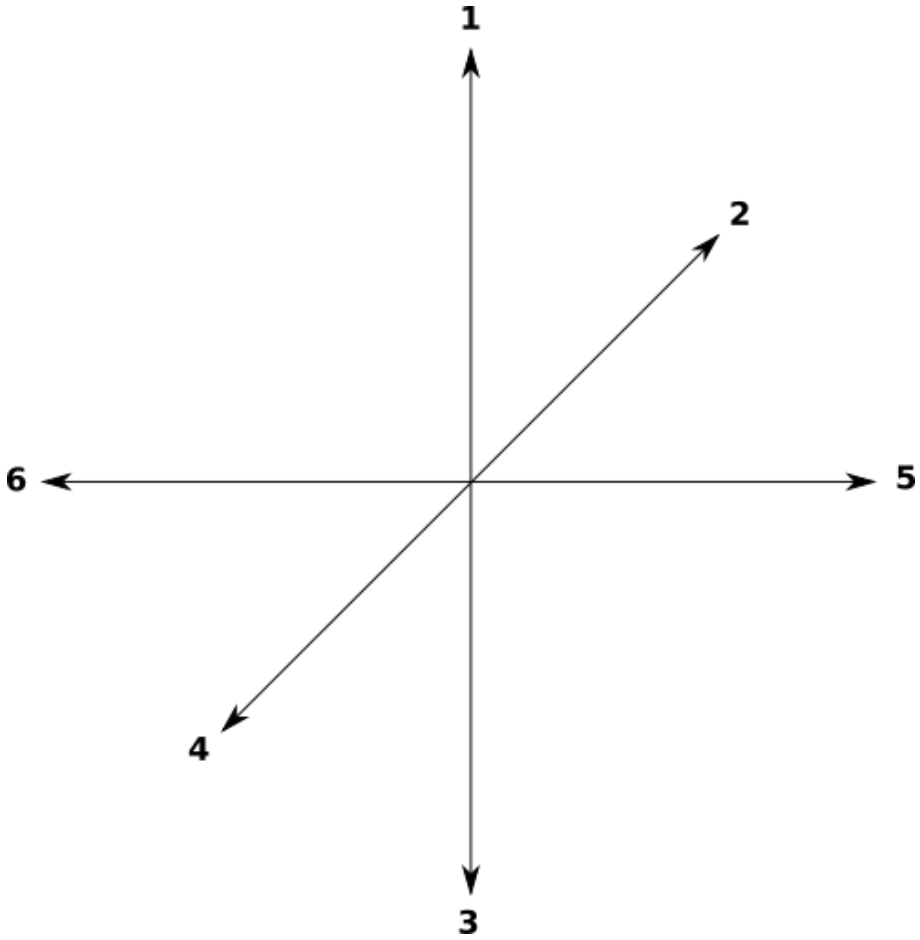

Figure 3: *Orientation IDs of the various directions.*

4 Orientations

The 6 axis aligned labels are assigned integers between 1 and 6 (Figure 3). An octant's orientation is determined by the direction that the red line in Figure 2 is facing towards on the sphere. If you think about it, the tiles in Figure 2 will pinch along the red lines when they are mapped to the sphere. For each octant, you can form the line starting at the center of the earth and ending at this red point, which will be in one of the 6 directions in Figure 3.

Think of the rectangle with ID 1 for example (Figure 3). At the top if the rectangle lies the North pole, which is just a point. So when we map this rectangle to the sphere, the red line pinches to a single point. When we start the simulator this point is upward in Figure 1, so it gets an orientation of 1 (which get from Figure 3). If we rotated the face of the sphere clockwise (shift+Z on the simulator) then octant ID 1 (initially at index 0) would now be second in the list (index 1) and the orientation would now be to the right (ie, the orientation would be 5).

5 Putting it all together

For any given state, we need to know which octant ID from Figure 2 is at each of the indices in Figure 1, as well as its orientation (Figure 3). The state of the Rubik's World at any given point is thus represented by a list of 8 sub-lists. Each of these sub-lists contain 2 numbers, the first representing the octant ID, and the second representing the orientation. An example of this is the starting state, which is represented as ((1 1) (2 1) (3 1) (4 1) (5 3) (6 3) (7 3) (8 3)). You can see this information on the simulator by hitting Toggle Sphere Info.