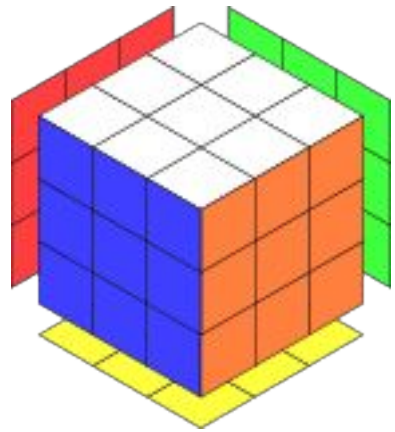
Solving Rubik's Cubes



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This presentation can be found at reaperworld.com/rubiks.pdf

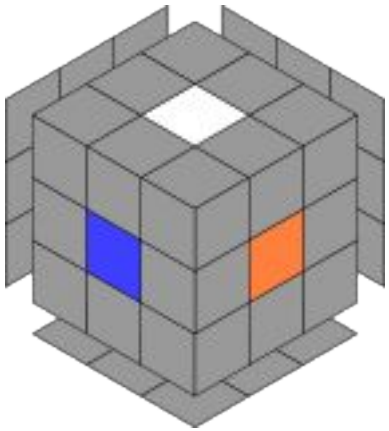
Introduction

Many people believe that only "smart people" can solve Rubik's Cubes. I disagree and say anyone can solve a Rubik's Cube. I see solving a Rubik's Cube as nothing more than pattern-matching and memorization.

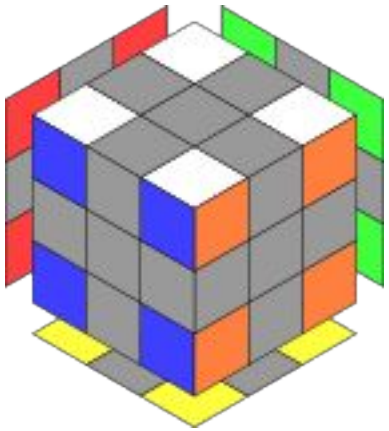
This guide will show you how to solve a Rubik's Cube using the layer-by-layer approach. It is based heavily on the beginner solution written by Leyan Lo since his tutorial is how I learned to solve the Rubik's Cube.

There are 8 algorithms you'll need to learn to solve a Rubik's Cube. You will find all of the algorithms, as well as when to use them, in this presentation.

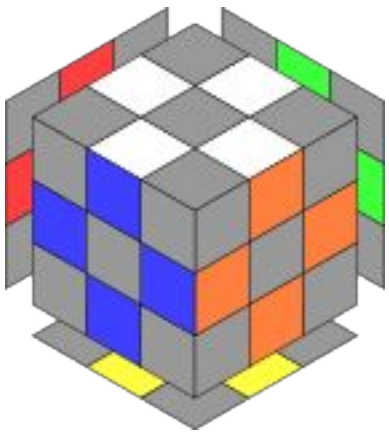
Identification: Pieces



These are the centers. Every cube has 6.



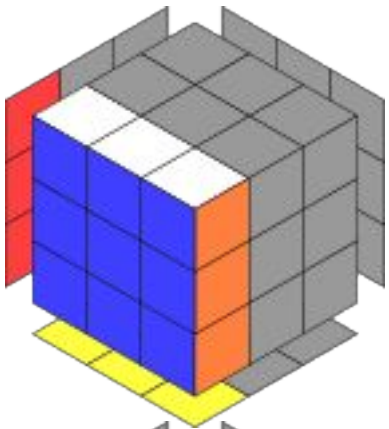
These are the corners. Every cube has 8.



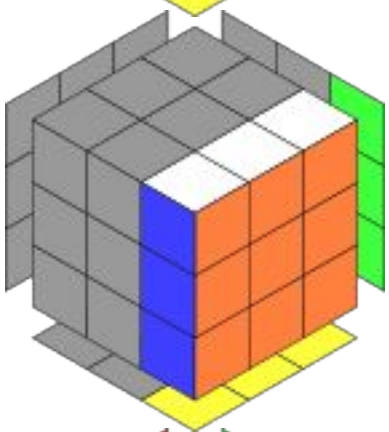
These are the edges. Every cube has 12.

Identification: Faces

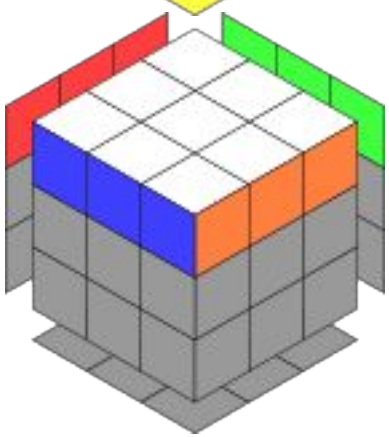
The cube's 6 faces are relative to the way you're holding it.



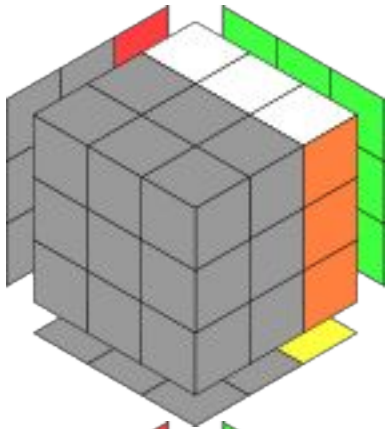
Front: The face that's facing you



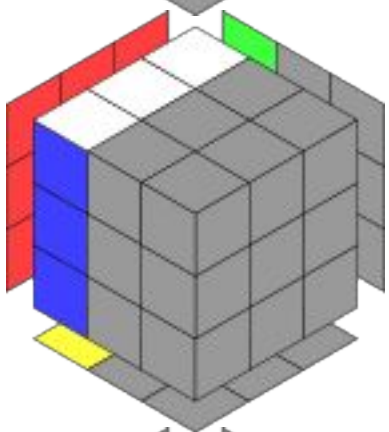
Right: The face that's to your right



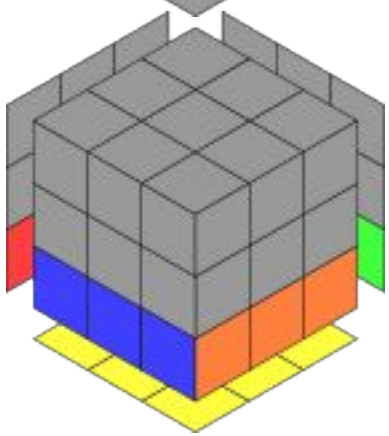
Up: The face that's facing up



Back: Faces away from you



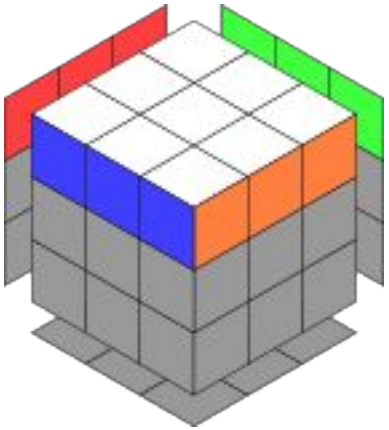
Left: The face that's to your left.



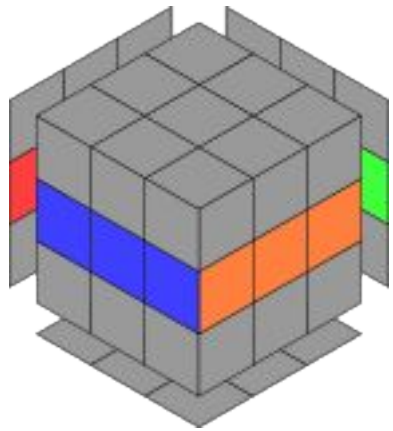
Down: The face that's facing down

Identification: Layers

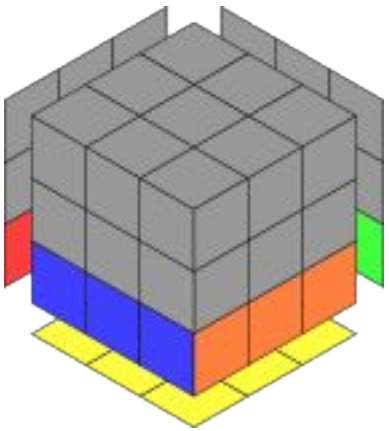
Since we're solving using the layer-by-layer approach, it's important to understand how the layers are defined.



This is the top, or first layer of the cube. For the beginning of this tutorial it will be the **U** face. Once it's solved it becomes the **D** face.



This is the middle, or second layer of the cube.



This is the third or final layer of the cube.

Notation

To help explain how to solve the cube, we will be using a simple notation that tells us which faces to turn.

The faces are named so that we can use the first letter of their name to uniquely identify them. So Front is **F**, Right is **R**, Left is **L**, Up is **U**, Back is **B**, and Down is **D**.

However, every face can turn both clockwise and counter-clockwise. To distinguish between this, we use an **'**. So a **U'** means to turn the Up face counter-clockwise 90 degrees.

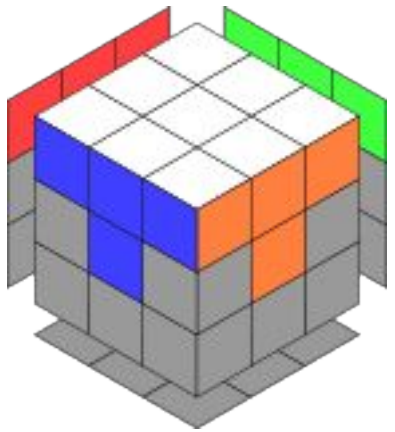
Sometimes we'll need to turn a face 180 degrees. So instead of representing this with a **U U** or **U' U'**, we represent it with a **U2**. This makes it easier to read especially since direction doesn't matter for a 180 degree turn.

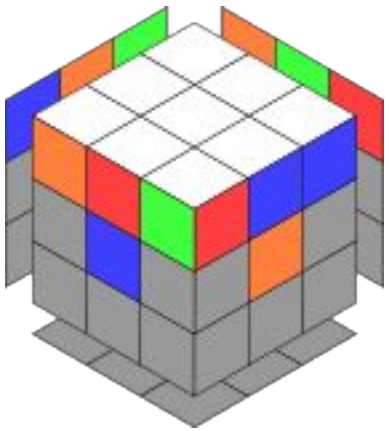
The First Layer

For the first layer, you can pick any color you want, but for this tutorial we're going to solve the white face first. There are 2 phases to solving the first layer: the edges and the corners.

The first layer is the easiest to solve, but the hardest to explain. Likewise, I will be giving you the methods to fix the most common moves, but you'll have to figure some of it out yourself.

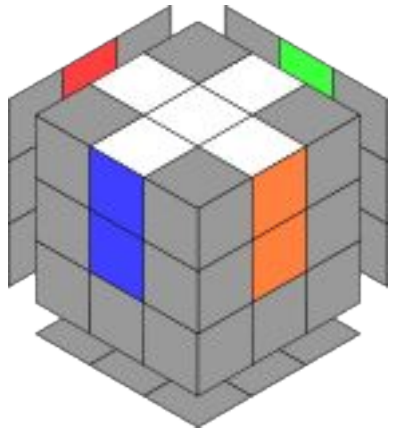
When done correctly, your cube should look like this.





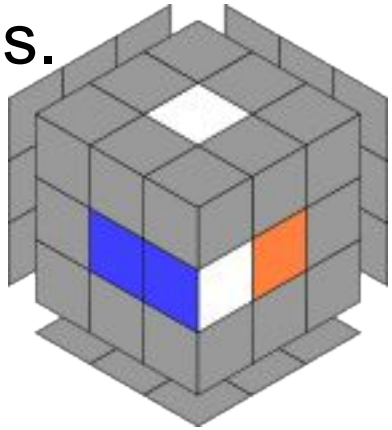
If you've only been paying attention to the white face, your cube will end up looking like this.

The First Layer: Edges

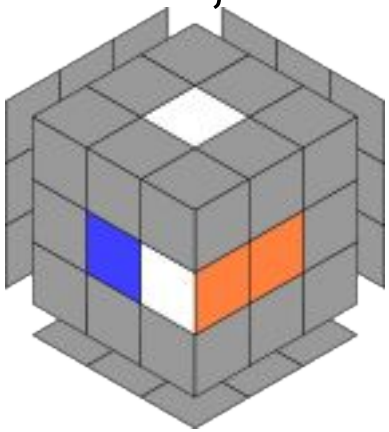


The first thing we're going to do to solve the first layer is to correctly position the edges. When we're done, your cube should look something like this.

Before we start moving the edges in place, we need to remember that all of them go into a specific place, so we might have to move the first layer by performing **U** to position them correctly without messing up the already solved edges.



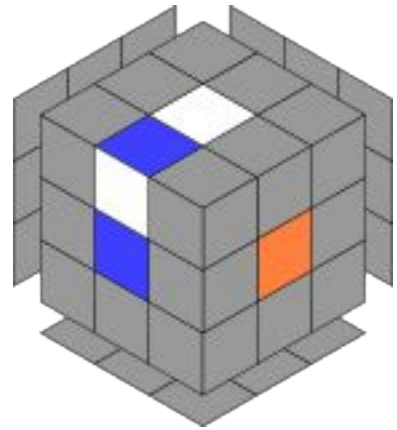
If your edge is in the middle layer, to the right of its center, we can easily move it into place by a **F'**.

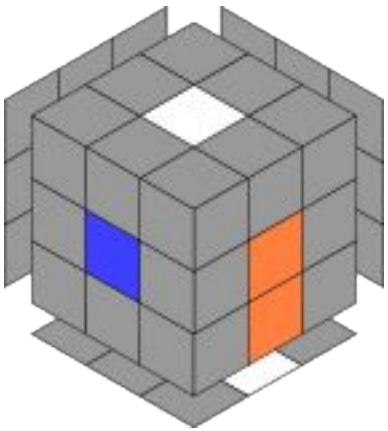


If your edge is in the middle layer, to the left of its center, we can easily move it into place by a **R**.

The First Layer: Edges

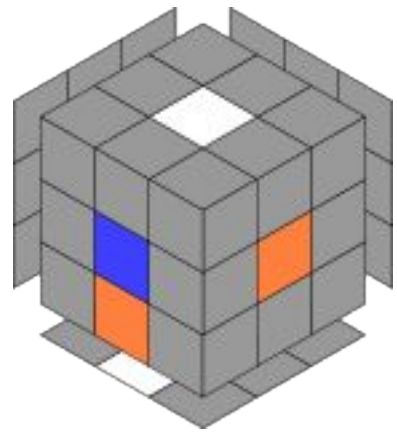
If your edge is in the correct location but flipped, we can correct it by doing **U' R' U F'**.



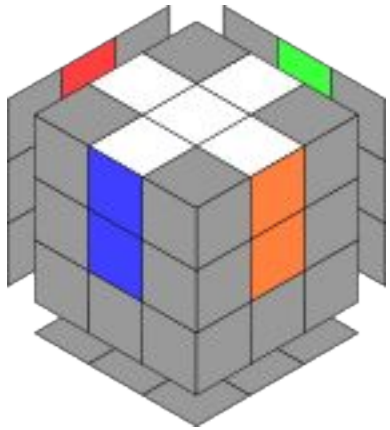


If your edge is in the third layer, under it's center, you can fix it by doing **R2**.

If your edge is in the third layer, under an adjacent center, you can fix it by doing **F' R F**.



The First Layer: Edges

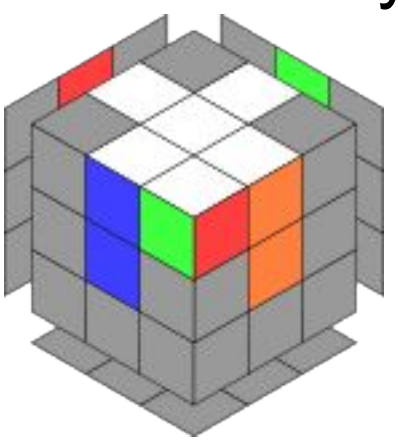


After solving the four edges, your cube will hopefully looks something like this.

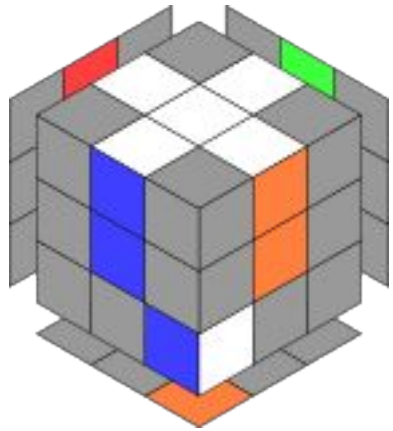
If your cube does not look like this, please review the last couple of slides to get them into their correct places.

The First Layer: Corners

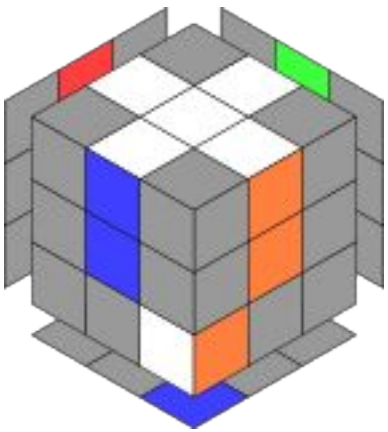
Solving the corners of the first layer is pretty straightforward but can be tricky since we have to preserve the edges.



If your corner is in the first layer but in the wrong position we need to move it to the third layer using **R' D R**.



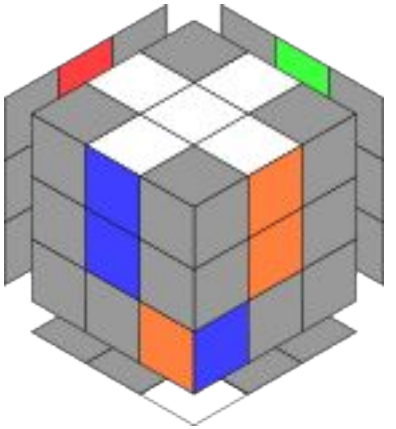
If your corner is in the third layer on the correct face with the adjacent color on the down face we can position it using **D F D' F'**.

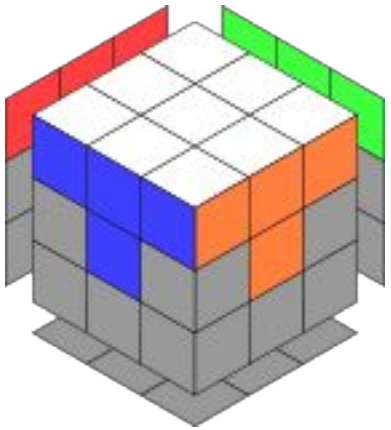


Likewise, if your corner meets the above criteria but is on the other side of the cube, we can position it using **D' R' D R**.

The First Layer: Corners

If you have a corner where the colors are swapped between adjacent faces and the top color is on the bottom. We can reorient it to use one of the previous algorithms by doing **R' D R**.



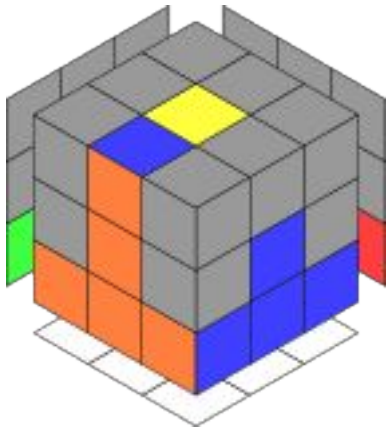


After solving all 4 corners, your cube should now look like this. If not, please review this and the previous slide to correct it before moving on.

Now that the first layer is complete, we will now flip the cube over turning the **U** face into the **D** face.

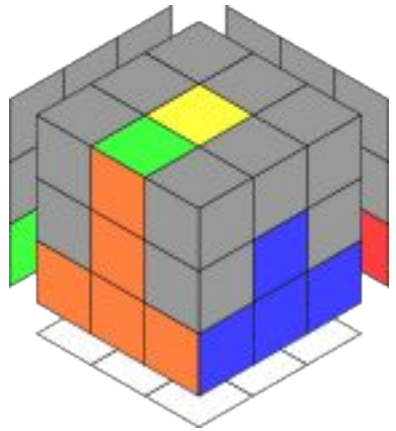
The Middle Layer

The middle layer is pretty simple. We need to solve 4 edges which can be in 3 different positions. You may need to perform a few **U** moves to move the edges into the correct place to use these algorithms.

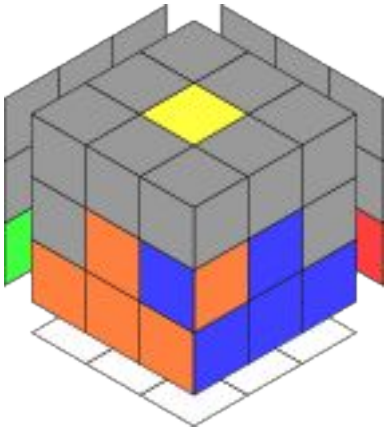


If your edge needs to move down and to the right, we can do that by performing **U R U' R' F R' F' R**.

If your edge needs to move down and to the left, we can do that by performing **U' L' U L F' L F L'**.

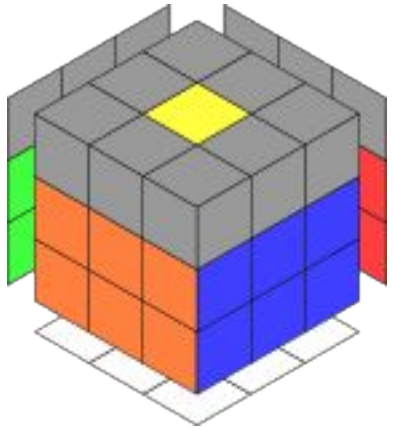


The Middle Layer



If your edge is in the correct position but flipped, we can pop it out of its position using **R U' R' F R' F' R**. This will move it to the final layer where we can use one of the two previous algorithms to position it correctly.

Once all 4 edges have been positioned correctly, your cube should look something like this.



If not, please review this and the previous slides to correct it before moving on.

The Final Layer

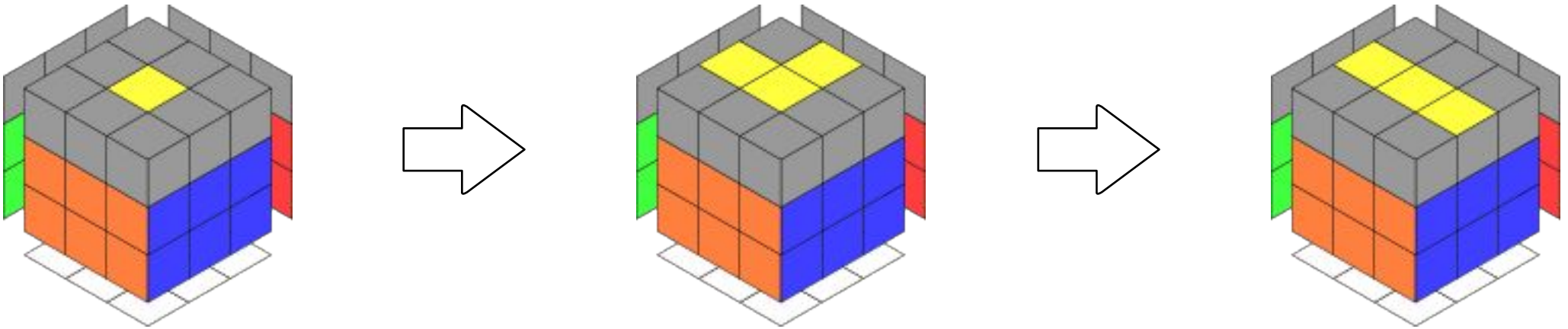
The final layer has 4 different phases and requires up to 5 algorithms to solve.

The 4 phases are edges, corners, corner positions, and edge positions, and we will be completing them in that order.

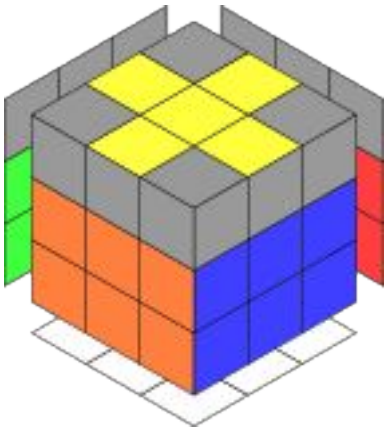
However, unlike the first layer, we will be solving the **U** face first and disregarding that the pieces are in the wrong position.

The Final Layer: Edges

The edges of the final layer are pretty simple to solve. We will start in one of the three following positions.

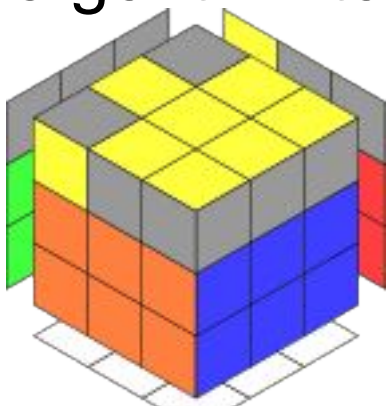


Orient your cube according to the pictures and perform **F R U R' U' F'**. Continue this until your cube looks something like this.

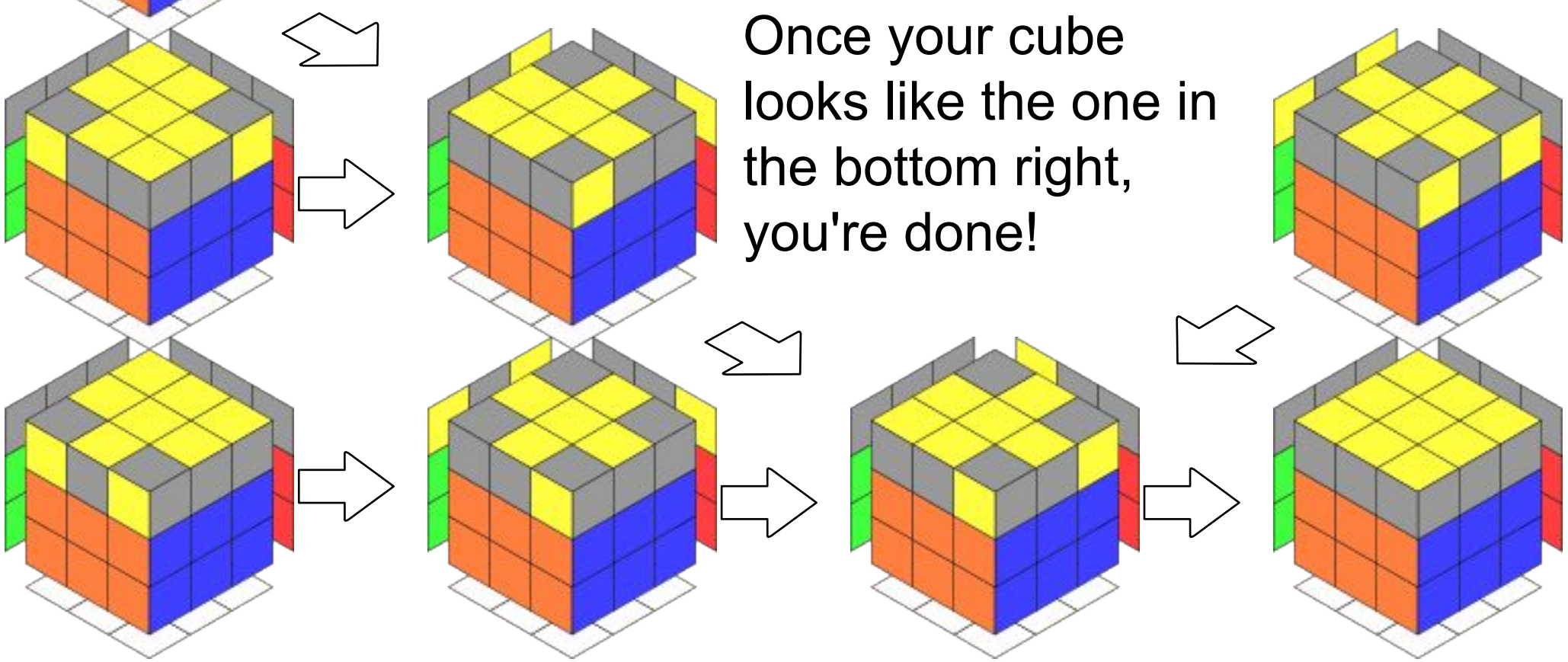


The Final Layer: Corners

Similar to the final layer edges, the corners use a single algorithm to iterate through the different possible positions.



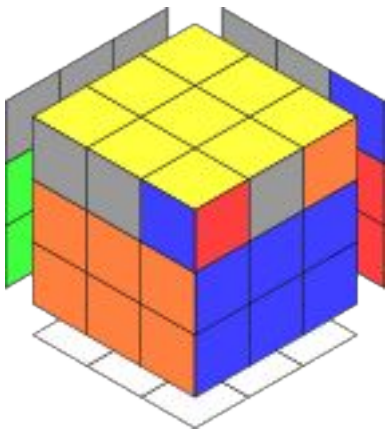
Find the image that represents your cube and perform **R U R' U R U2 R'** to move to the next picture.



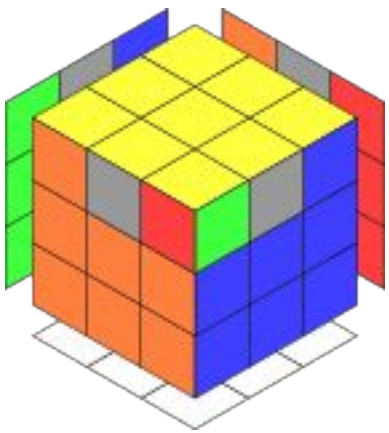
Once your cube looks like the one in the bottom right, you're done!

The Final Layer: Positioning Corners

At this point, the corners of the last layer can be in one of 2 positions. To determine which state we're in, we need to perform **U** to see if any 2 corners are adjacent.



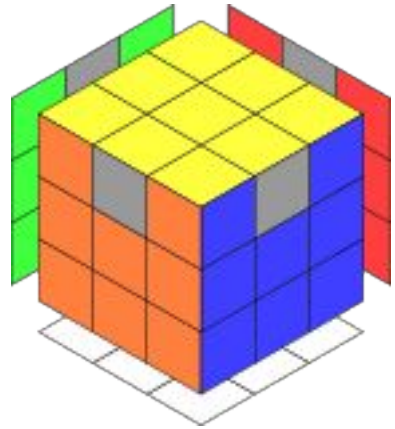
If you have 2 adjacent corners, orient the cube so that the two incorrect edges are both on the right face. Then perform **R U2 R' U' R U2 L' U R' U' L**. Now perform **U** until all of the corners are in their correct positions.



If you do not have 2 adjacent corners, you need to run the above algorithm twice. Again you need to position the two edges to swap on right face. After you have swapped the first 2 corners, you need to perform **U2** and then perform the algorithm to swap the next two.

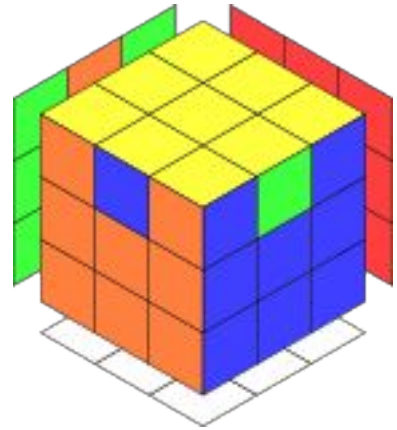
The Final Layer: Positioning Corners

Your cube should now look like this. If it doesn't please review the previous slide before continuing.

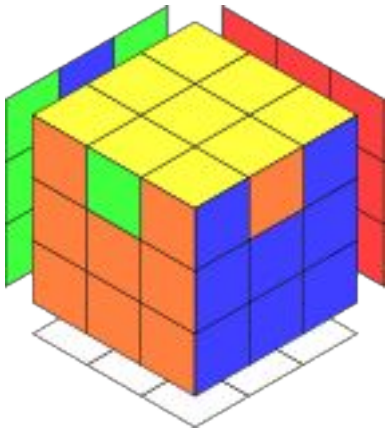


The Final Layer: Positioning Edges

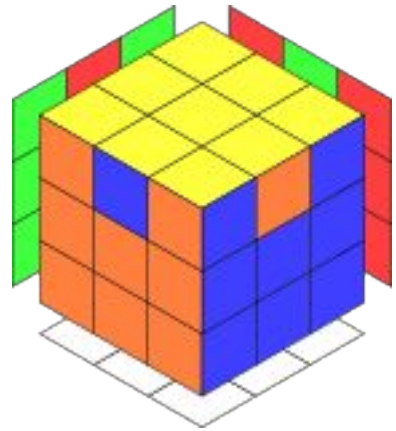
The edges of the final layer can be in one of three situations. We will be using up to 2 algorithms to correct position them.



In this situation, we want to move the blue edge to the blue face, the green to green and the orange to orange. We do this by performing **F2 U' L R' F2 L' R U' F2**.

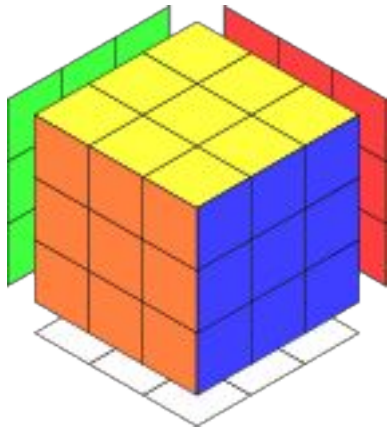


In the second situation, we want to move the green edge to the green face, the orange to orange and the blue to blue. We do this by performing **F2 U L R' F2 L' R U F2**.



The final situation requires us to perform a combination of the 2 above algorithms. We want to solve one of the edges first. So here we'd perform the first algorithm twice.

CONGRATULATIONS!



Your Rubik's Cube should now be solved!

If it isn't please review the slides and try again.