

# Simple Way of Solving the Rubik's Cube



By Alan Chang

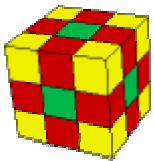


## Introduction

There are different approaches for solving the Rubik's Cube (layer by layer, solving the corners first, start with 2x2x2 block and expand). Each of these methods can be broken down into different levels of difficulty. For example, this solution uses a very easy way of solving it layer by layer that only requires a few algorithms. There exists a layer by layer method that requires over 50 algorithms that lets you solve the cube less than 20 seconds.

## Structure of the cube

Using math, (volume of a cube= $s^3$ ) you might think the Rubik's Cube is made up of 27 little cubes. Instead of thinking it that way, think of it as 8 corners, 12 edges, and 6 fixed centers. The centers can't rotate. Instead, the corners and edges rotate around the centers. This makes it so that the colors of the centers determine the color of that face when the cube is solved.



The cubes in red are edge pieces. They have 2 stickers.

The cubes in yellow are corners pieces. They have 3 stickers.

The cubes in green are the centers. They have 1 sticker.

## Solving the Cube

You will need 7 steps to solve the cube.

1. Form Cross (0 algorithms needed)
2. Insert First Layer Corners (0 algorithms needed)
3. Insert Second Layer Edges (2 algorithms needed)
4. Orient Last Layer Edges (2 algorithms needed)
5. Orient Last Layer Corners (2 algorithms needed)
6. Permute Last Layer Corners (1 algorithm needed)
7. Permute Last Layer Edges (2 algorithms needed)

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# Notation

These terms will be used in algorithms:










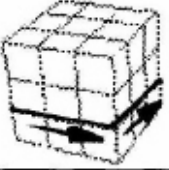
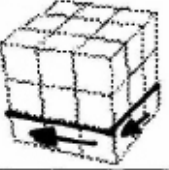
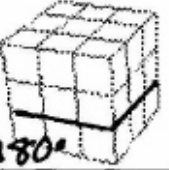
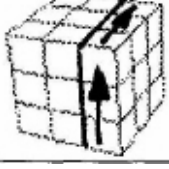
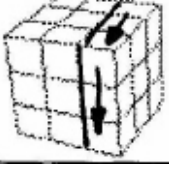

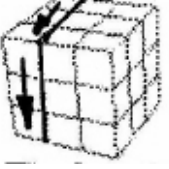


- **U** = Upper face
- **D** = Down (bottom) face
- **L** = Left face
- **R** = Right face
- **F** = Front face
- **B** = Back face

A letter by itself means to turn that face clockwise 90 degrees (e.g. F)

A letter with an apostrophe after it means to turn that face counterclockwise 90 degrees (e.g. F')

A letter with a 2 after it means to turn that face 180 degrees (e.g. F2)

To decide whether to turn clockwise or counterclockwise, pretend that you are looking at the face you are turning. In the algorithms, the core of the cube should not be turned.

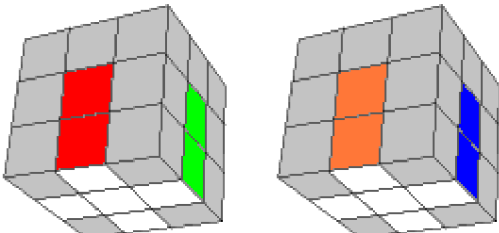
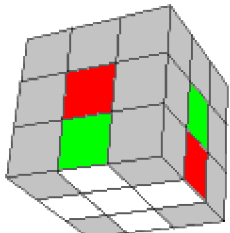
<b>F</b> 	<b>F'</b> 	<b>F2</b> 	<b>B</b> 	<b>B'</b> 	<b>B2</b> 
<b>U</b> 	<b>U'</b> 	<b>U2</b> 	<b>D</b> 	<b>D'</b> 	<b>D2</b> 
<b>R</b> 	<b>R'</b> 	<b>R2</b> 	<b>L</b> 	<b>L'</b> 	<b>L2</b> 

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# Step 1: Form Cross

In this step, you have to form a cross on the D-face. I prefer to make a white cross because it stands out more from the other colors so it is easier to find. From now on, the rest of the guide will refer to white as the color of the cross. If you do a cross with a different color, just change "white" to your color.

The four edge pieces that are used to form the cross have a specific place. The color other than the color of the cross has to match with the color of the center of the face it is in. The grey stickers mean no specific color is needed.

<b>Good Cross</b>	<b>Bad Cross</b>
	
<p>The red-white edge piece lines up with the red center. The green-white edge piece lines up with the green center. The orange-white edge piece lines up with the orange center. The blue-white edge piece lines up with the blue center.</p>	<p>The red-white edge piece does not line up with the red center. The green-white edge piece does not line up with the green center.</p>

Making the cross is probably the hardest step in the solution. There is no specific way to make the cross. You just have to know how to do it. The first few tries might be hard, but eventually, it will get easier and easier.



## Step 2: Insert First Layer Corners



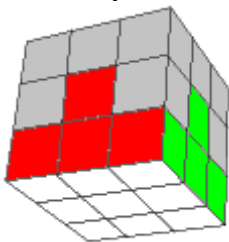
Now that you have formed the cross, you have to put in the corners. Just like the four edge pieces used to form the cross, the four corners have specific positions. Holding the cube so the cross is on the bottom, find a corner in the top layer that has white on one side and find where in the bottom layer it has to go. Turn the top layer so that that corner is directly above its designated location. This is that start position.

You have to do this to all four corners. In all these five states, there is a solved cross in the D-face. These should not be considered algorithms. Do the "algorithms" slowly and watch carefully to see why the corner gets place in.

State 1	State 2	State 3	State 4	State 5
Do <b>F' U' F</b> to get the corner piece in.	Do <b>R U R'</b> to get the corner piece in.	Do <b>R U<sup>2</sup> R' U'</b> to get it to look like state 2.	Do <b>R U R' U'</b> to get it to look like state 2.	Do <b>F' U' F U</b> to get it to look like state 1.

If a corner is in the wrong place in the D layer insert the correct one to get it out. If they are all in the wrong place, insert any corner in to get one out.

When you are done, your cube should look like this:

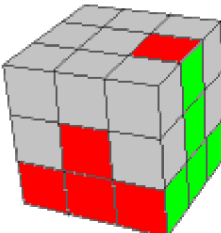
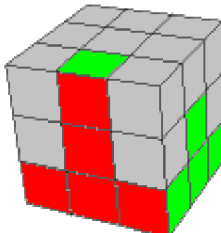
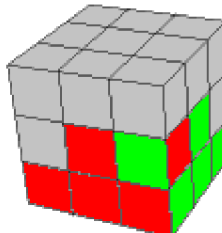




# Step 3: Insert Second Layer Edges

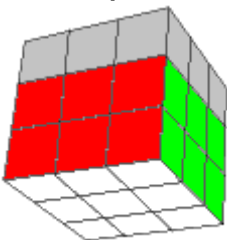


To put the second layer edges in, find a edge in the U-layer that does not have the color of the center of the U-layer (usually yellow if you are using the white cross) on either sticker. Look at the sticker in the U-layer but NOT on the U face and turn the U-face until that sticker matches the color of the center directly under it. This is the start position.

State 1	State 2	State 3
		
<p><b>U' F' U F U R U' R'</b></p>	<p><b>U R U' R' U' F' U F</b></p>	<p>Do either the algorithm for state 1 or 2 to get the piece out, and then do the correct algorithm to put the piece back in correctly.</p>

If a second layer edge is in the wrong place in the second layer, insert the correct piece to get it out. If all the second layer edges are in the wrong place in the second layer, insert any edge from the top layer to get one of the edges out.

When you are done, your cube should look like this:





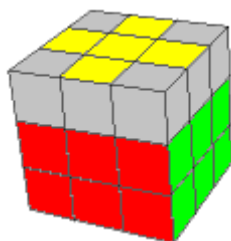
# Step 4: Orient Last Layer Edges



In this step, you have to form a cross on the U-face. If you already have a cross, skip to the next step. Unlike the cross you made for the first layer, it doesn't matter where the edges are in this one, just that there is a cross.

State 1	State 2	State 3	State 4
You're done! Go to the next step.	<b>F U R U' R' F'</b>	<b>F R U R' U' F'</b>	Do either the algorithm for state 1 or 2. When you are done your U-face should now look like state 1 or 2.

When you are done, your cube should look like this:





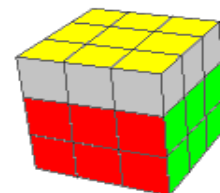
# Step 5: Orient Last Layer Corners



You have seven possible orienting last layer corners states. Your goal is to completely solve the U-face, so that it is all yellow (or the color of the top layer) on the top layer.

State		
1		<b>R U R' U R U2 R'</b>
2		<b>R U2 R' U' R U' R'</b>
3, 4		For these cases, two corners need to be rotated clockwise, while the other two need to be rotated counterclockwise. Hold the cube as shown in the diagrams for states 3 and 4. Notice the two yellow stickers on the top layer of the left face. Make sure they are, then do the algorithm for state 1. You should now have state 1.
5, 6, 7		For these cases, one corner needs to be rotated clockwise and the other needs to be rotated counterclockwise. Find the one that needs to be twisted counterclockwise. Hold the cube so that that corner is located at the bottom left corner of the top layer. There should be a yellow sticker on the front-face side of the front-up-left corner. If you have done the set-up correctly, your cube will match one of the three states below. Do the algorithm for state 1. Now it should have state 2.

When you are done, your cube should look like this:



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# Step 6: Permute Last Layer Corners

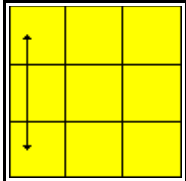
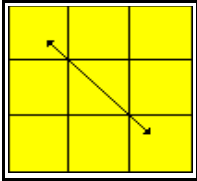


Turn the top layer until exactly two of the corners are in their correct place. To the right is an example of a corner in the correct place. See how the color of each sticker of the corner matches the color of the center that sticker is on?

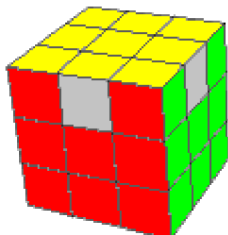
Now you will have one of the two states below. Either the two correct corners are adjacent to each other (and therefore the two that need to be swapped would be adjacent too), or the two correct corners are diagonal from each other (and the two that need to be swapped would be diagonal too).

The corners that need to be swapped have arrows pointing to them. Therefore, the two correct corners in State 1 are the two on the right side, and the two correct corners in State 2 are the bottom-left and top-right ones. (Actually for state 2, the algorithm would still work if the two correct corners were at the top-left and bottom-right instead.)

*Note:* Remember that 'B2' is to turn the **BACK** side twice, not the bottom. D, for "down," is for bottom.

State 1	State 2
	
<p><b>R2 B2 R F R' B2 R F' R</b> Then do <b>U</b> to correctly align the four corners.</p>	<p>Do the algorithm for state 1 and it should look like state 1.</p>

When you are done, your cube should look like this:



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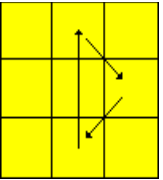
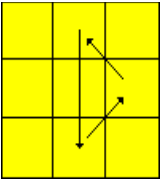
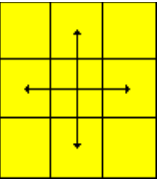
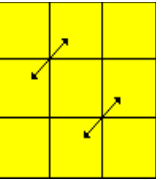


# Step 7: Permute Last Layer Edges



Yay! Last step! There are 4 possible states for permuting the edges. Two algorithms are needed.

Be careful on the B and B' turns. Don't mix those two up. Remember that in the notation used, you pretend you are looking at the face you are turning to determine which way is clockwise and which is counterclockwise. Therefore, a B will look counterclockwise from the front, but if you were to turn the cube around and look at it from the back, the move would be clockwise. The same thing with B'.

State 1	State 2	State 3	State 4
			
<b>R2 U F B' R2 F' B U R2</b>	<b>R2 U' F B' R2 F' B U' R2</b>  (This is almost the same as state 1, except for the second turn and second-to-last turn.)	Do an algorithm for state 1 or 2 and it should look like state 1 or 2.	Do an algorithm for state 1 or 2 and it should look like state 1 or 2.

When you are done, your cube should look... solved!

**You are done with the cube! Congratulations!!!  
Now you can go impress your friends and family and teachers!!!**

(Just don't play with it in class unless you have one of those very nice teachers. You might get it confiscated.)

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