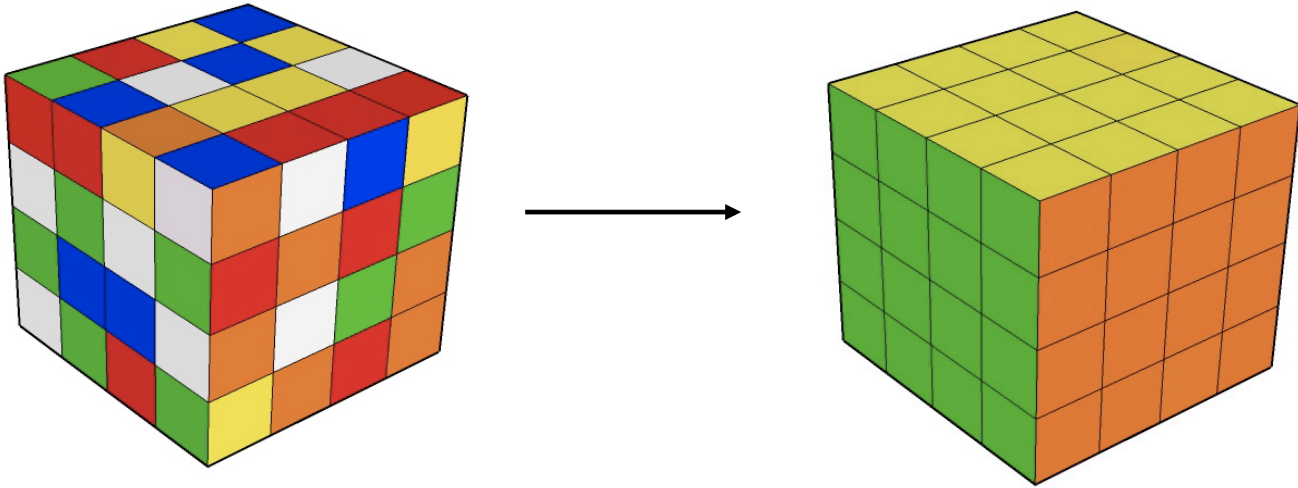# How to solve a 4x4 Rubik's Cube

By: Brian Egenriether

Notation conventions:

U = upper layer;   u = layer just below upper layer

R = rightmost side;   r = layer just left of rightmost side

L = leftmost side;   l = layer just right of leftmost side

B = Back layer

F = Front layer

D = Down (Bottom) layer

Any gray sticker is one that we don't care about at the moment. I've made them gray so as not to confuse the point.   When I refer to the Front layer in a diagram, it will be the layer that is shown in the first picture below:
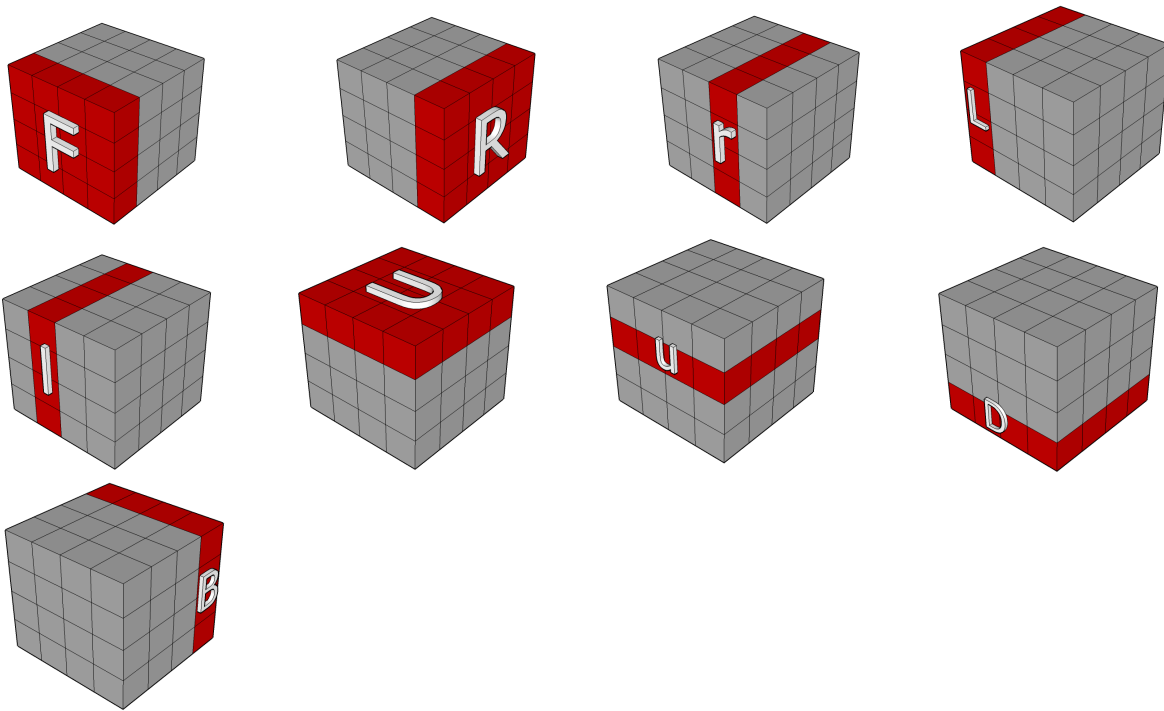
Clockwise 90˚ rotations are given by the layer name that you will rotate. Ex. " **U, F** " means rotate the Upper layer 90˚ followed by the Front layer 90˚.

A 180˚ rotation is denoted by a "2". Ex. " **u2** " means rotate the u layer 180˚

A counterclockwise rotation is denoted with a prime notation. Ex. " **B'** " means rotate the Back layer counterclockwise 90˚.

Note: This means clockwise or counterclockwise when you are looking **at that face**. So a counterclockwise rotation of the Back layer looks clockwise from the front! Also left and right look different too when viewed from the front.

Also "**(Uu)**" means rotate both of the upper layers together, and **(Rr)'** means move both right layers ccw.
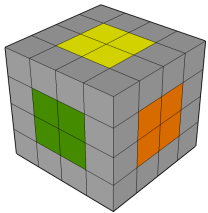
The first goal is to get all of the centers looking like this. On a conventional Rubik's Cube the color scheme is: yellow opposite white, green opposite blue, and orange opposite red. **When looking at the green face, with the yellow on top, the orange should be on the right, as shown here**. If the faces aren't solved this way in the beginning, there will be no way to finish it. (For example if yellow and white are put on adjacent faces, there are no yellow/white edges to go between them.)
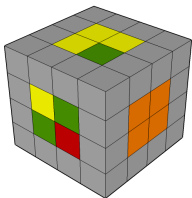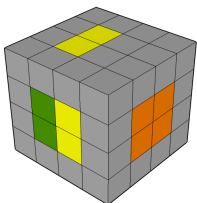
To solve these centers you pair up groups of two like colors and put them into position. In this picture we want the yellow sticker on the "F" layer to be in the "U" layer where the green one is. Do the following move to get you to the next figure:
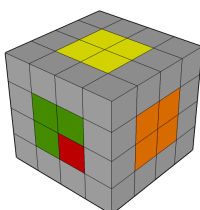
R'r'
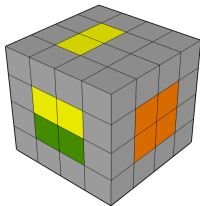
Now the yellows are "paired up" on the "F" layer. Now we want to put them in the "U" layer without messing up any other side. To do this, do:
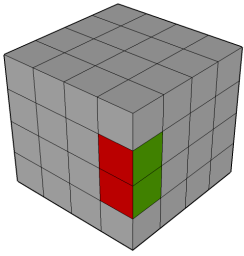
F

Rotating the Front layer will get it to look like the next figure. Next, perform the following:

Rr

Do all of the others like this and remember to keep the color scheme correct!

After all the centers are correct you have to get each edge piece paired up with its "twin" like the figure to the left. My method of solving the larger Rubik's Cubes is to make it look like a 3x3 Cube first, and then solve it like I would a "normal" (3x3) Rubik's Cube. There are 12 "double edges". The first 8 are relatively easy. The last 4 require a little more work.
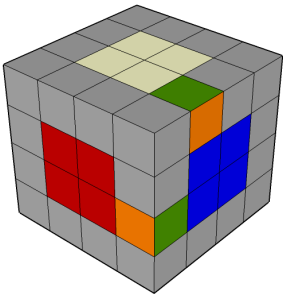
Here is how to get the green/orange edges together from here:

U, R', U', R, u

There are only two cases: the one here and another where one of the edges is flipped the other way (For example the one in the "U" layer would have its orange sticker on top and the green on the right side) To do **that** case:

B, U', B', u

I've also drawn in the center colors here to show you that while you're doing the first 8 double edges the centers will get a little mixed up. It's ok; leave them that way until you're done with the first 8 edge pairs.
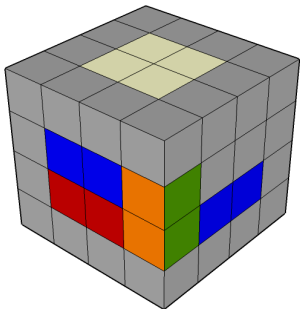
Note that the blue is now where the red was. Next you have to put this new double edge in the top layer with the following move:

R, U, R'

This will get it out of the way so you can make another edge pair. You will put the first 4 in the top layer, then turn the whole cube over (which effectively makes the bottom the new top) and put the next 4 into the new top until all of the top and bottom are filled. Note that if done correctly at the end of the 8 pairs you'll only have to rotate the "u" layer to realign the centers. If you can't get your centers back with a simple "u" layer rotation, you've messed something up. What's most important is to pick a top color (here it's white) and stick with it while you make the four pairs. The pairs up here will be safe while you rotate the middle layers to make other pairs.
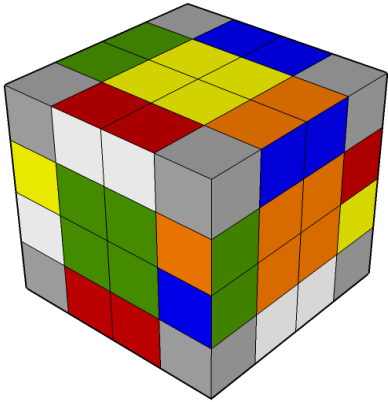
When you're done, it should look something like this, but with whatever edge colors you decided to solve (that's up to you). The remaining 4 must be solved in a way that does not mess up the centers. We were able to mess the centers up before because we'd put the edges in the Up and Down layers afterwards and then we were free to rotate the centers back again. If we try that now, every pair we create would get separated when we tried to do the next one. Also, when we were finished with them, the centers would need fixing and this would destroy those edges too.

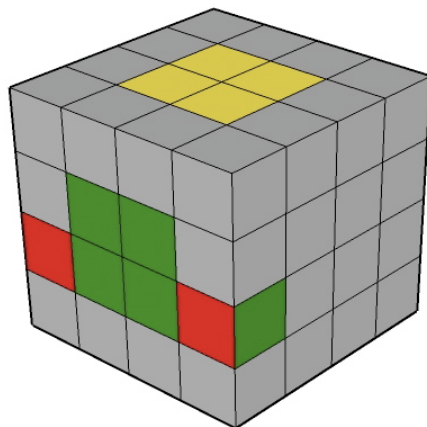To do this right we need a new move. Here it is:

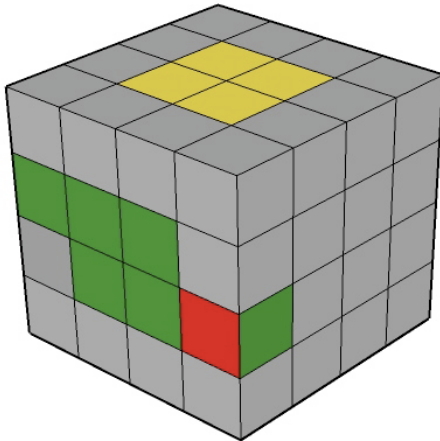**R, U, R' F, R', F', R**

This **flips** an edge like this:
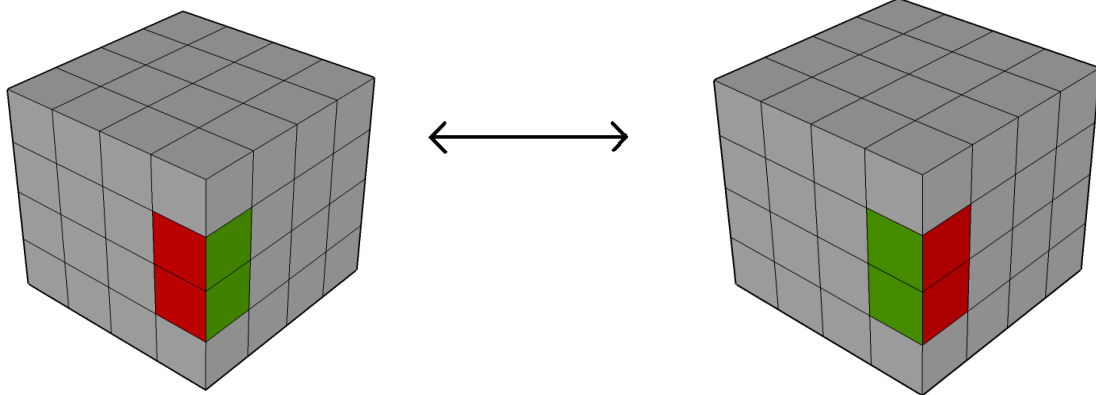
It also moves other edge pairs and corners around but the order of the other parts is not yet important. Here is how we'll use this: Imagine that in the figure below the red/green edges weren't paired up yet like they are in the picture above (left) but were on opposite edges like this:

First you would rotate the "u" layer ccw, perform the flip move, and then put the "u" layer back, i.e.

u', R, U, R' F, R', F', R, u

Notice that the center is only messed up during the flip and then it is restored. Watch how the technique works, it's quite neat (I did not come up with this one so I can say that!). Also note that if the cube had looked like the one below, you would have had to perform the flip on the right side first, to get the red/green edge in the "u" layer, rotate the "d" layer clockwise, then perform the flip again, then rotate the "d" layer ccw to put it back in place. So here is a rule of thumb: When the two edges to be paired have the same color on the same face you can do the flip once. If the colors are opposite (pictured left) two flips are needed, one for the "setup" then one that puts it in place.

Note also that the flip works on the right side only so you'll always want to bring a "junk" edge over to the right side in the opposite layer as the one that has the piece you want to flip. Then once you flip the right side you'll put that layer back. For example in the picture on the left you'd perform the following:
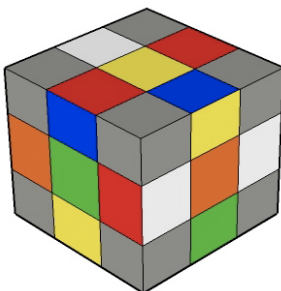
R, U, R' F, R', F', R, d, R, U, R' F, R', F', R, d'

While this does look long, the flip will become second nature and then moves like this are easier.

Once all 4 double edges are done your cube will look something like this:
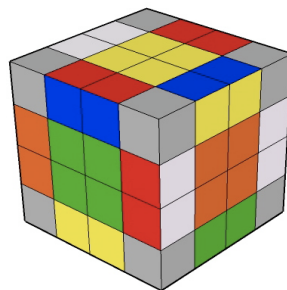
Notice how the 3x3 cube below resembles the 4x4 above. From here on, the solution is one that can be used to solve a "standard" Rubik's Cube.

When solving this stage you again must pick a color for the top and always hold the cube so that this color is the center square of the "U" layer. I use yellow for the top and I will draw the diagrams as such. The first step is to make a "cross" on the bottom (D) layer (white in this case). This aligns the center pieces of the sides. Doing this is pretty easy so I'll leave that part to you, but this is what it will look like:
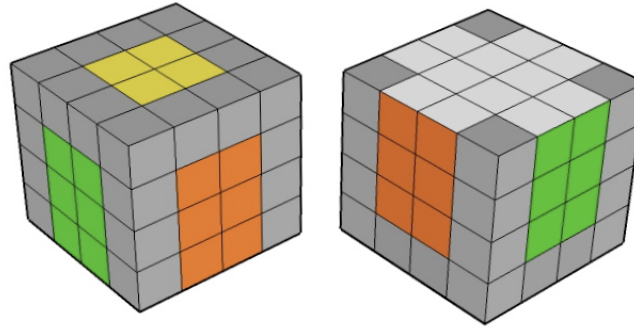

Top view   Bottom view

The next step is to get the corners and the edges, leaving only the "U" layer unsolved. I do the corners and edges together; it's easier and more intuitive than doing the corners and then doing the edges afterwards. The first step is to get the edge and corner both in the top layer, then pair them up, and then place them where they go. This part requires more intuition than "algorithms" but the essentials can be described and you can see which case you have. There are only three cases based on the orientation of the corner you're placing. Getting your corners and edges in these orientations may take a little work. The first thing is to get the edge piece and corner piece separated. In these examples they already are, but the edge pair could be in one of the two edge positions adjacent to the corner, or in one of the remaining edge positions on the side of the cube. Any of these are unacceptable and the edge piece must be moved to one of the two edge positions in the "U" layer that are not adjacent to the corner of interest. If they are in adjacent positions in the "U" layer, to move them "break" the pair by rotating the layer that has the corner in it so that the corner is out of the U layer but the edge piece is left there, rotate the U layer, then rotate the corner back into the U layer and proceed. Be sure not to rotate a finished edge/corner pair into the "U" layer when doing this, or you'll displace it.

CASE 1: Notice that the orange sticker on the R face matches the sticker on the U L layer. Here the orange/white/green corner is to be paired up with the orange/green edge (which is on the L face and the U layer). The following move will put it in place:
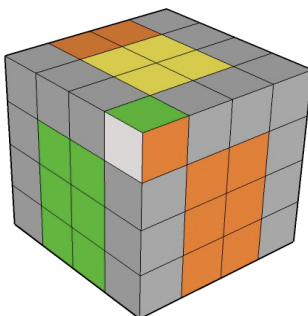
$$F',\ U',\ F$$

It's important to see that the orange sticker on the corner piece matches the orange center piece when doing this move. If yours doesn't look like this, first rotate the top until it does. Also if the edge piece you want to pair up with is not in the U layer but instead on one of

the sides, put it in the U layer first. For example if it is in the F R position the move **R, U, R'** will put it in the U layer and not disturb other pieces.
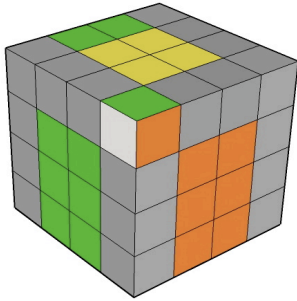
CASE 2: Here the orange sticker on the R face does not match the green/orange edge piece in the U L, so the move in case 1 will not pair them up. Here we have to do:
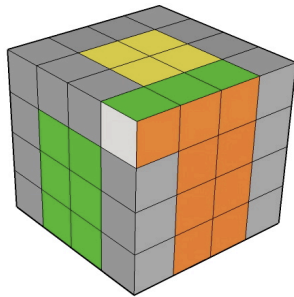
$$F,\ U2,\ F'$$

This only pairs them up. Now we must place them. But first notice that during this move, the F L edge was temporarily brought into the "U" layer. It was then rotated out before the front layer was put back. So you must be sure that whatever is in F L position is NOT a finished edge/corner pair, or else they will be   displaced.

Now the edge/corner pair will look like this. Notice that they don't have to be in the same place in the U layer as here. In fact to get this one (pictured left) in place will require us to rotate the top layer 90˚ first. Here is the move:

$$U,\ R,\ U',\ R'$$

So the **U** step at the beginning of that move was only necessary to get the pair where they needed to be to put them in place.
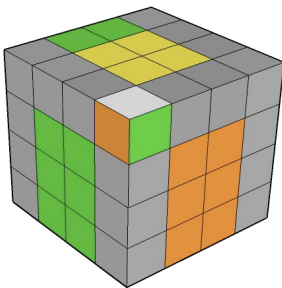
CASE 3: Here the white sticker is on top. In this case, rotate the top until the side edge sticker pairs up with its correct center. In the picture on the left that would mean rotating the top 180˚ to make the orange center match the orange stickers of the edge piece.

$$U2$$
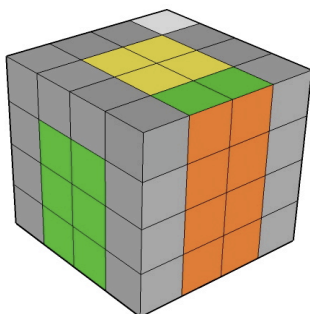
Now it will look like this. Notice how the orange edge sticker matches up with the orange center. The next step is to turn the face that has the color you just aligned (orange here) away from the side with the other color (green here). So in this picture that means rotate the R layer clockwise. This moves the green stickers on the top toward the blue

center (which is the opposite side as green). Then you rotate the top until the corner piece is aligned with this center. Then rotate the R layer counterclockwise back where it was. This will result in the same situation we saw in Case 2:
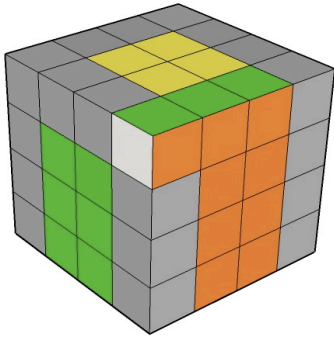
(Which we already saw how to solve)

Case 3 (Recap) This was the starting point (which is one of many). The first thing is to get the edge piece and corner piece separated. Here they already are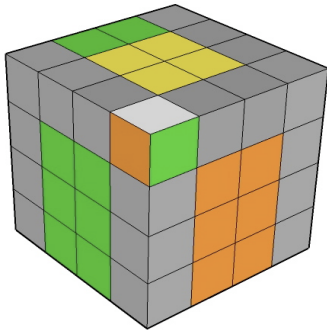, but the edge pair could be in one of the two edge positions adjacent to the corner, or in one of the remaining edge positions on the side of the cube. Any of these are unacceptable and the edge piece must be moved to one of the two edge positions in the "U" layer that are not adjacent to the corner of interest. To solve this completely from this picture you'd do the following:

U2, R, U, R', U, R, U', R'

Do all 4 edges and corners with one of these 3 cases, remembering that you will have to be careful when doing them that the edge you bring into the upper layer must NOT be one that is already finished. This will become apparent when you are doing the edges. When finished your cube will look something like this:
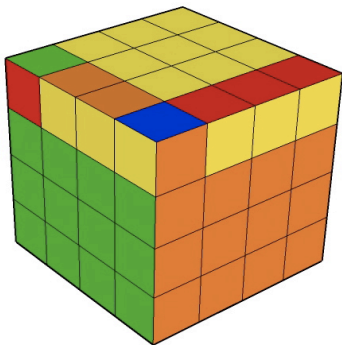
I have put in the remaining colored pieces on top instead of grayed out ones to show that all remaining parts must have a yellow side. The final steps require getting a yellow cross on top (like we did for the white bottom in the beginning), aligning the edges of the cross with their respective edge pieces, flipping the corner pieces so that their yellow side is facing up, then permuting the corners to align them with their correct placement.

Solving the last layer
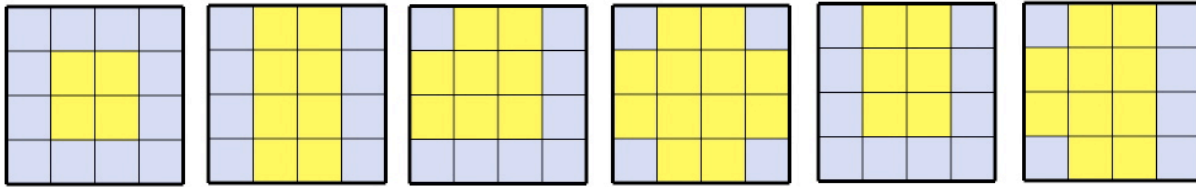
A	B	C	D	E	F

At this stage, the top of your cube should resemble one of the six patterns above. With a 3x3 Rubik's Cube only A-D are possible. With the 4x4 puzzle, E and F are also possible. **The goal of this step is to get the top in the form seen in D**, which is another cross.

> If your cube looks like figure **D** skip the following steps.

> If your cube looks like figure **A**:

Choosing any side as your front (keeping yellow on top) perform the following: **F, R, U, R', U', F'**

This will put your cube in the state in figure C. From here refer to the instructions for solving C.

> If your cube looks like figure **B**:

Orient the cube so that one of the non-yellow edges are in the front, and the two yellow edges are on the left and right. Perform the following: **F, R, U, R', U', F'**

> If your cube looks like figure **C**:

Orient the cube as it appears in the figure, with the non-yellow edges in the front and right and perform the following: **F, U, R, U', R', F'**

> If your cube resembles **E** or **F** you must perform the following (dreadful) algorithm. It takes a while to memorize it (I did not invent this one, so don't go blaming me for it!). The move flips a double edge without rearranging anything else. Typically, the less a move disrupts other parts of the cube, the longer the move must be in order to accomplish this. This is why it is longer that the other flip we used earlier, although you could use this one for that purpose also.

Making any side the front (the front top edge is what gets flipped) perform the following

**r2, B2, U2, l, U2, r,' U2, r, U2, F2, r, F2, l,' B2, r2**

Ok, that was bad, but notice what the move does. By flipping only the front edge you can decide where your cube ends up. For example, if your cube looks like **F**, you could flip the non-yellow edge, by holding your cube so that it is in the F layer, and get right to the cross (figure D).

At this stage, you have to orient the top edge pieces so that they match up with their respective centers. You will find that one, two, or four will match. If four of them are matched, you are done with this part and can move on the next step.

If only **one** of them matches, as is pictured left, you will be able to choose which one that is. For example, in this picture we could choose to make the blue edge match up with its center but then the green would not. Putting the edge that is matched up in the front layer, perform the following. Note, you may have to perform this twice

<div align="center">

R, U2, R', U', R, U', R'

</div>

If you have two that match, rotate the top so that **none** of them are aligned and perform the above steps. This will make **one** of the edges align. Then the above procedure must be performed with the one correct edge in the front.
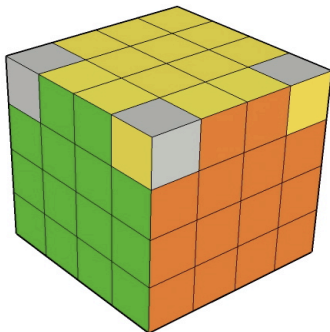

At this point you only have two steps left. First, you have to flip any corners whose yellow stickers are not on the top of the cube so that they are facing up. Then we have to put each corner in its place. That's it!

You will have 2, 3, or 4 corners that need flipping. Here I have shown 3. To flip a corner, put it in the **back, right** position and perform the following move. **Note:** you may have to perform this move twice, depending on the orientation of the corner. Do it once, look to see if the top of the corner is yellow, if it's not, repeat it.

<div align="center">

R, D, R', D', R, D, R', D'

</div>

Once the top of the corner is yellow, rotate **only** the top layer to put the next un-flipped piece in the back right, and repeat. **Note: During this move you must NEVER rotate the cube in your hands, only the top layer.** This is because this step involves messing up the bottom, but it will be returned to its original state automatically once all of the corners are flipped. Do all corners this way, skipping any that are already yellow on top by simply rotating past them. It does not matter what order you do the corners in.
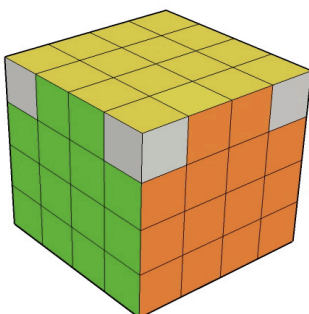
After the last move, will probably have to rotate the top layer to properly realign the edges with their centers. Once you do so, your

cube should look like this. It is possible that all of your corners are in the right place and you have finished solving the cube (Congratulations!).

It is here again that the 4x4 cube can differ from the 3x3. If you have no corners in the right place, or if you have one corner in the right place, you are probably in good shape. This is what a 3x3 cube would have. If you have two corners in the wrong place (and thus 2 in the right place), you have more work to do.

In the case of **two** correctly placed corners perform the following move:

<div align="center">

r2, U2, r2, (Uu)2, r2, U2

</div>

(Recalling that (Uu)2 means rotate the top two layers together.) This will set you back a few steps. Start over with matching the edges to the centers (top of page 10) When you get to this step again, the corners will be right, you will not have to perform this step again.

If you have **one** corner in the right place, hold the cube so that the correctly aligned corner is in the front left corner and perform the following steps. I have grouped the move (R', D2, R) in parenthesis because it is repeated several times. Seeing it grouped like this might help you to see the pattern. Note: you may have to do this twice to completely solve the cube.

<div align="center">

(R', D2, R), U, (R', D2, R), U, (R', D2, R), U2, (R', D2, R)

</div>

If you have **no** corners in the right place do the above algorithm and this will put one corner in the right place. As above, hold the cube so the correctly aligned corner is in the front left position and perform the above steps again. **Note: you may have had 4 corners not in the right place, performed the above steps, and then realized you have two corners in the wrong place. You will have to go back to the move at the top of this page and continue from there.** You can see the pattern when this is going to happen before doing the last move, and thereby save time. If none of the corners are in the right place but **one** (and only one) side has both corner stickers the same color, this will happen.

When you are done your cube will look like this:
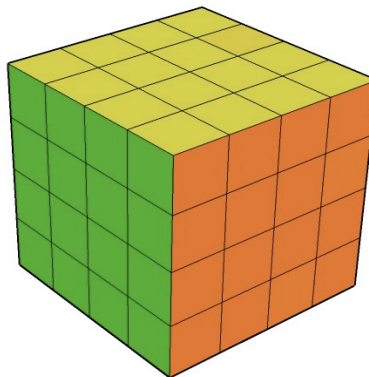
You may have to redo some of these steps because you can get close to the end and mess something up. I do it all the time, but you will get better with practice. It is worth the work! You may also find shorter ways of doing things. Many of these steps are not the way I solve the cube but they require less memorization, as such they are not the fastest way.

Happy cubing!

--Brian Egenriether