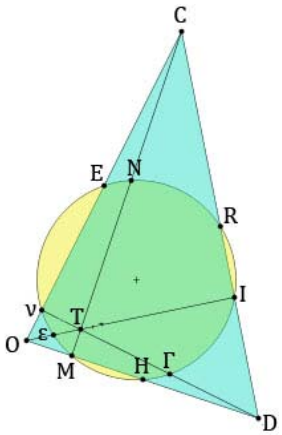
COD Summer Bridge Enrichment - 2011

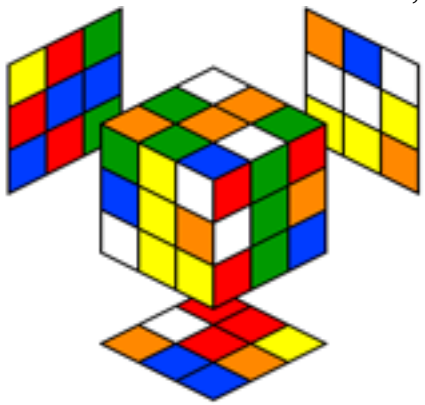
Rubik's Cube, the Basic Solve Algorithm.



If you want a good java applet for Rubik's Cube, try this: http://www.schubart.net/rc/

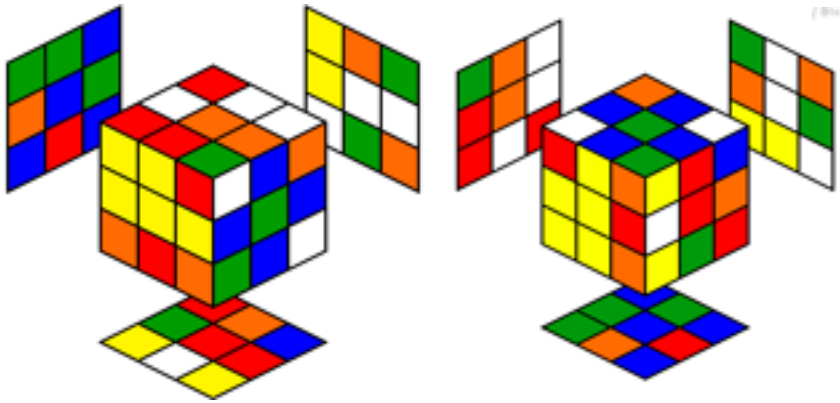
Here is a common basic method of solution, as provided with some versions of Rubik's Cube.

Rubik's cube is characterized by three pairs of opposite colors. The usual cube has white opposite yellow, blue opposite green and red opposite orange. So note that the center cubelet that's green (front face) below is opposite the center cubelet that's blue. Also center white is opposite center yellow and center red is opposite center orange. This will always be the case with a standard cube. The schubart.net cube, however, does not fit that standard.

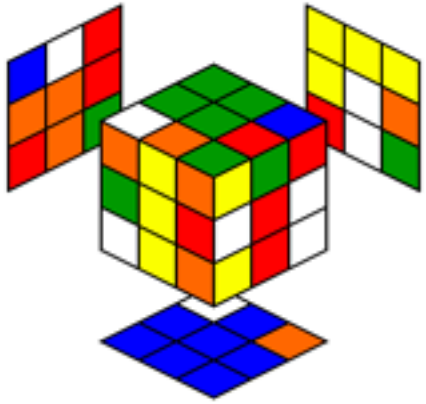


The "Basic Solve" Algorithm:

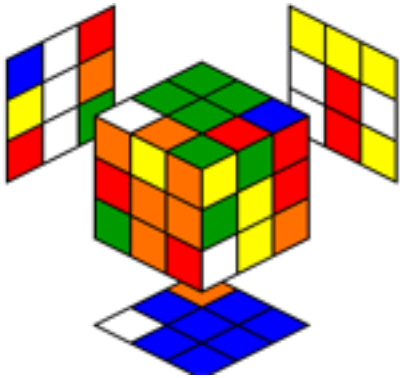
1. Pick a pair of opposite colors, say blue and green and rotate the edges so that four green edges surround a blue center. This is called "the daisy." For the cube above we can do this by $\mathbf{R^2L'DB^2U^2}$., but in general it's easiest just to wing this by observation. The result is show below. Now turn this so that the daisy is facing up:



2. Now we want to align the edge colors of the daisy with the corresponding colors on the respective faces. Luckily, this is already true all the edges here: red, white, orange and yellow, so we can do $\mathbf{F^2R^2B^2L^2}$ to get the blue cross on the bottom (with a couple of corners, too), as shown below:

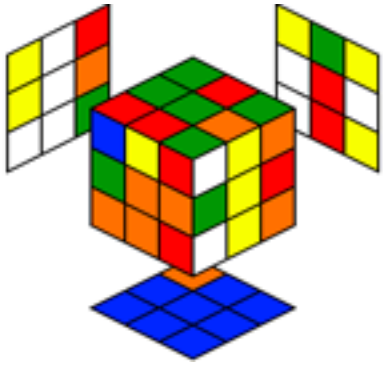


3. Now we want to work on the corners of the blue face. So look for a blue corner in the top layer with the blue not facing up. The BLU (heh) corner above, for instance. The other outward facing color on that corner is orange, so rotate the cube to make the orange face match an orange center, as shown below, for instance:

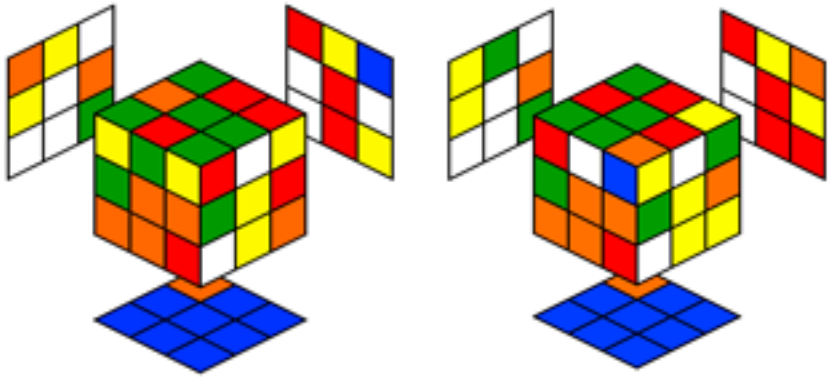


The rotate the layer with that other color (orange, here) upwards, rotate the top layer to match the blue corner with the blue edge and then rotate these together to the bottom. In the above figure, this would be a

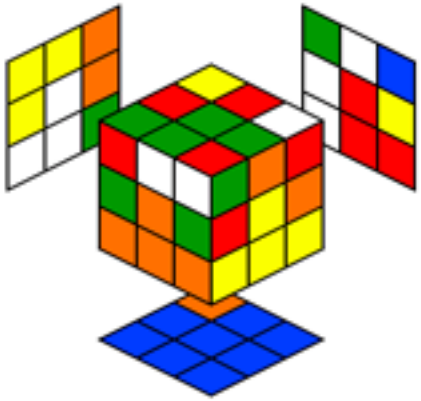
B′U′B. The result of that is shown below. Notice that the BLU corner has been moved to the BLD corner and is now in the correct position.



Repeat this step for the blue corner facing left at BLU. First rotate the top so that the yellow face of that corner is aligned with the yellow center cubelet (first image below) then rotate the yellow back with a **R**, then swing the blue into position with a **U** and rotate the corner into place with a **R′**, the result is in the second image below:

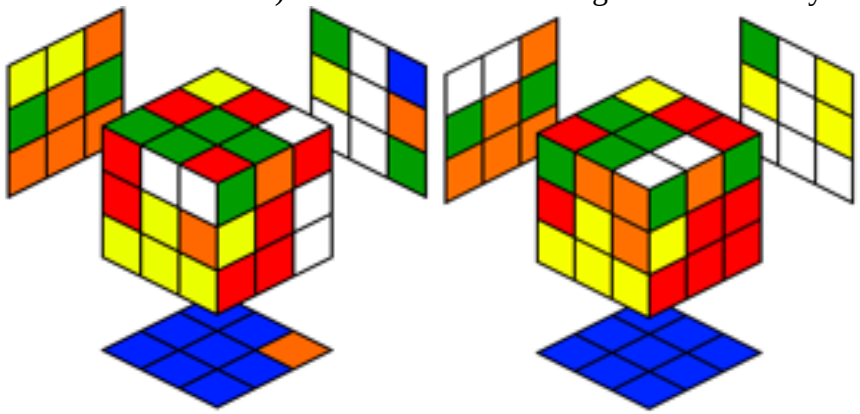


So two blue corners are good and two left to go. The FLU corner is already in place for a **L′U′L**, the result of which is shown below:

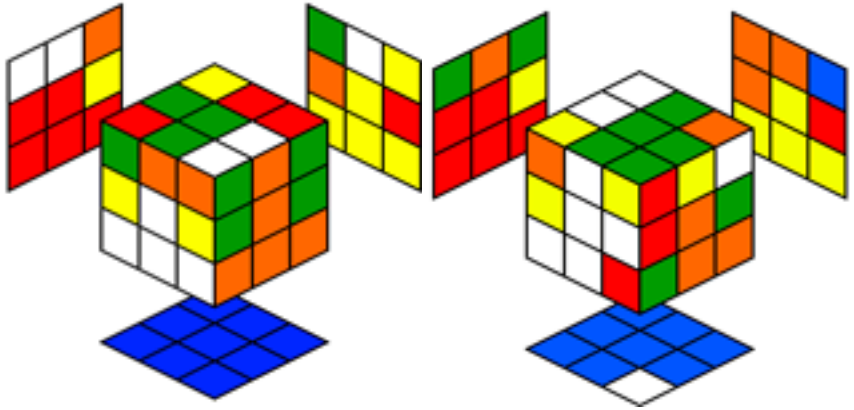


The last blue corner is done the same way. Rotate its other color, red, to match the red center (shown

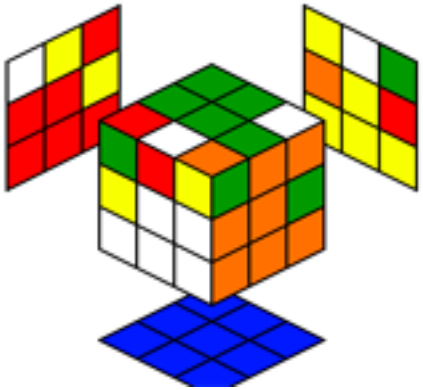
below left, after the whole cube is rotated) and then do a **RUR′** to get the bottom layer completely correct:



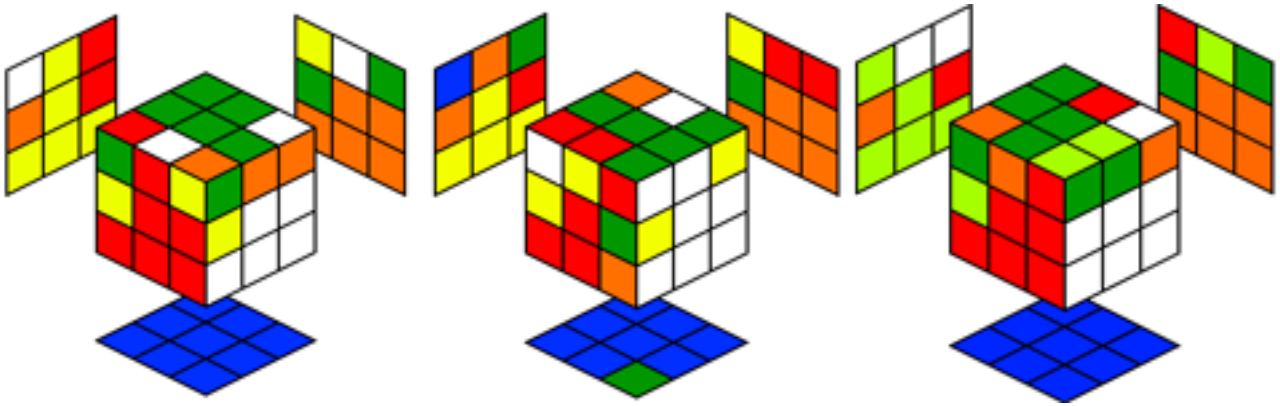
4. The next step in this algorithm is to get the edges in the middle layer correct. First you want to examine the top layer to find these edge pieces. For, instance. The cube as depicted on the right above has the orange/white edge piece in the upper front position. Rotate the top so the orange face matches the orange center, as shown below left. Now we'd like to rotate that orange/white edge 90 degrees to the left, so we do a **U′L′U′L**. The result is shown to the right below:



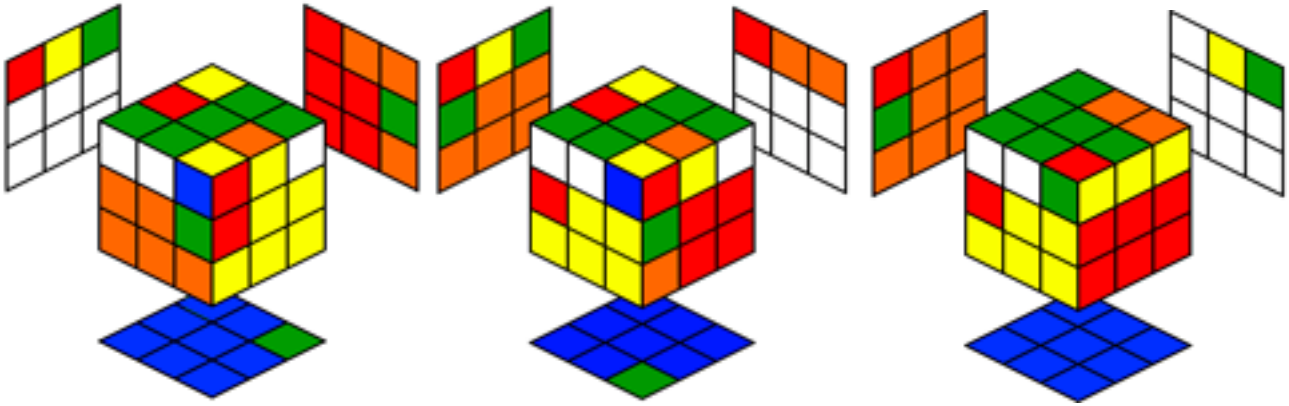
But…whoops! We've lost the blue corner on the bottom. The trick at this point is to go back to step 3 to fix this. So you want to rotate **U** to bring the white side of the misplace corner in line and then do a **FU′F′** to get the bottom blue back in tune:



Now repeat this, more or less, for the other three middle edge pieces. Next you might do the red/white edge. Positioning this edge piece to match the center red (first illustration below), we see this time we want to rotate it 90 degrees to the right, instead of to the left. So instead of **U′L′U′L**, do **URUR′**. Then fix the blue bottom with **U′L′U′L**:



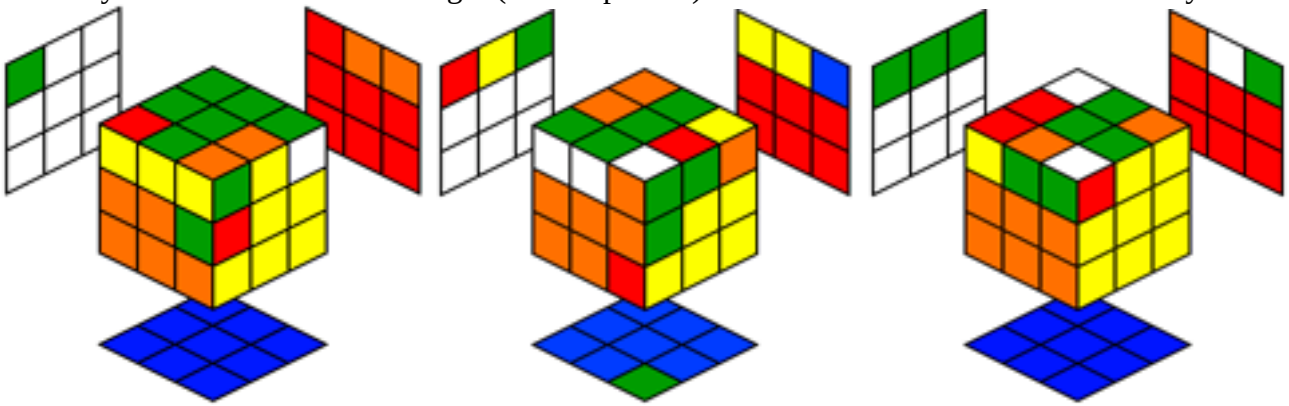
Now move the red/yellow edge on top into place. First match the yellow center, then **URUR′** to rotate it 90 degrees to the right, followed by **U′F′U′F?…ruh roh. Got lost!**



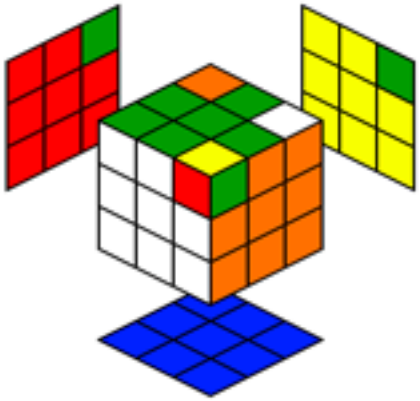
Getting lost is a common occurrence, so let's just roll with it. After some flailing about I arrive at the above left configuration of the cube. To bring the blue corner back into place, rotate its red face to match

the red center (middle configuration above) and then do a **L′U′L** to get the edge in place.

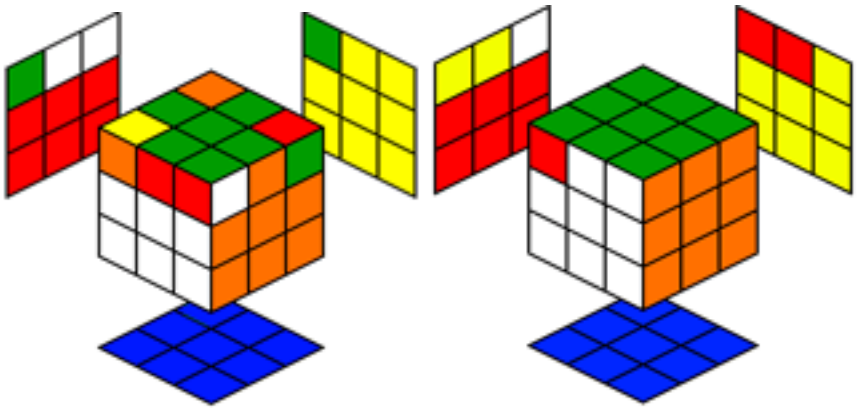
One more edge: the orange/yellow. Do $\mathbf{U^2}$, to match the yellow center (image on left below) and then observe you want to **U′L′U′L** to begin (middle picture) and then **UFUF′** solves the middle layer:



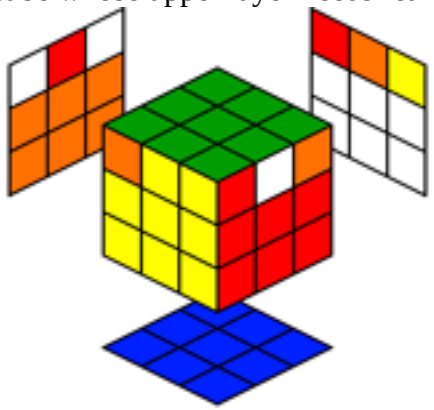
5. Now use **FURU′R′F′** to get (1) the bar, (2) the backwards L and finally (3) the cross on the up layer. In the figure on the right above, the three green faces on the top just need to be rotated to get the backwards L and then a **FURU′R′F′** will produce the cross below:



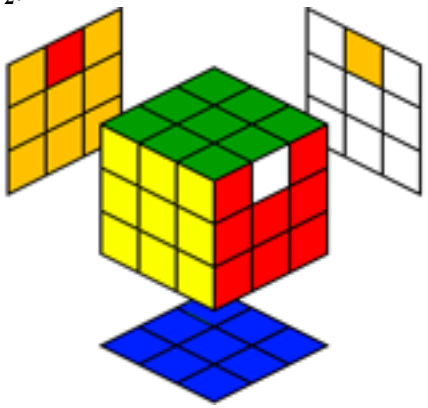
6. The goal of this step is to make the top face a solid color.
   Count the number of corners with green faces on the top. In this case, there is one. There could also be none or two or four – it is not possible for a correctly constructed cube to have three.
   Let the move $\mathbf{M_1 = RUR'URU^2R'}$**.** (Menomic: **“**Are you our prime? You are! You too are prime.”)
   CASE 1: If there are no target (green, in this case) colors facing up on the top corners, turn the cube so that the left face of the FLU corner is the target (green, here) and do $\mathbf{M_1}$. You may need to do $\mathbf{M_1}$ twice.
   CASE 2: If there is one target color facing up on the top (that’s the case above) then put that corner in the FLU position and do $\mathbf{M_1}$. You may end up with one target color facing up, as is the case here (see figure on the left below) , in which case you just repeat the prescription (the result is shown on right below):
   CASE 3: If there are two target colors facing up on the top, turn the cube so the target color is on the front face of FLU and do $\mathbf{M_1}$.



7. The goal of step 7 is to get the top corners correctly oriented. Since I screwed up the last one (that happens, ☹) let's start with another cube whose upper layer needs rearranging.



The key move here is $\mathbf{M_2 = R'FR'B^2RF'R'B^2R^2}$.
First look for two two cubes of the same color facing out on the top layer. In this case the back layer has two whites facing out. If you don't have two together like that, do the move and then you will. If these are not in the back side then rotate the cube so they are and do the move. Here we get lucky and the corners are correct after one application of $\mathbf{M_2}$:



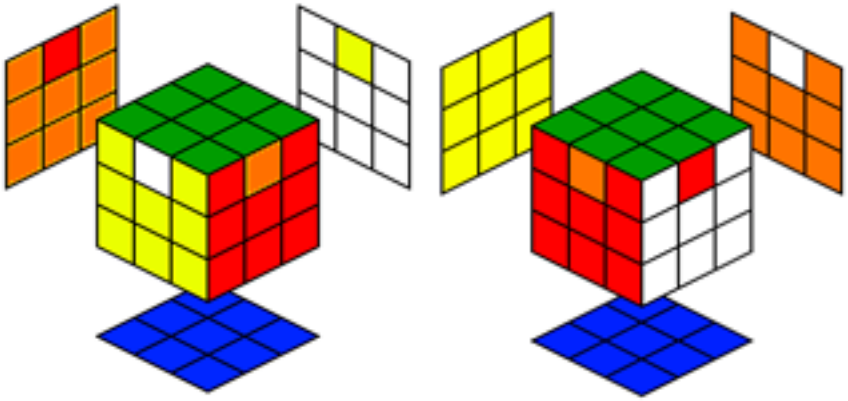
8. Now for the top edges we use

$$\mathbf{M_3 = F^2UR'LF^2L'RUF^2}$$

or

$$\mathbf{M_4 = F^2U'R'LF^2L'RU'F^2}$$

In this case, $\mathbf{M_3}$ produces the figure on the left below. So the edge cube on the back is unmoved while the other three are rotated clockwise. This suggest instead first rotating the cube so the yellow is on the back and then doing the same move from that position. The result is the solved cube. Oops, no! It's the cube shown in the middle. But yet another application of will do it. Hooray!



Summing up:

1. Get the daisy by direct observation. Be sure to involve a pair of opposite colors like yellow/white, red/orange or green/blue.
2. Get the cross. Do this by lining up edge pieces on the front with the center pieces and doing a F2. You'll need to do this maybe 4 times to get the cross.
3. Get the corner pieces on the bottom by lining up other color of misplace corner pieces on top with center front and then doing **RUR′** or **L′U′L**.
4. Find misplaced middle layer edge pieces on the lop layer and line them up with front center color to do either **U′L′U′L** or **URUR′**, depending on on whether you want to do a left or right rotation of the edge piece and then repeat step 3 to finish. You may need to do this as many as four times to complete the middle layer.
5. Use **FURU′R′F′** to get (1) the bar, (2) the backwards L and finally (3) the cross on the up layer.
6. Use $\mathbf{M_1 = RUR'URU^2R'}$ first orienting the cube depending on
   CASE 1: If no target colors facing up on the top corners, turn the cube so that the left face of the FLU corner is the target. You may need to do $\mathbf{M_1}$ twice.
   CASE 2: If one target color facing up on the top corners, put that corner in the FLU position and do $\mathbf{M_1}$, maybe twice.
   CASE 3: If there are two target colors facing up on the top, turn the cube so the target color is on the front face of FLU and do $\mathbf{M_1}$.
7. The top face is now a solid color. Use $\mathbf{M_2 = R'FR'B^2RF'R'B^2R^2}$ to orient the corners correctly, first put a

pair of correct corners in the back if you can. Repeat.

8. Now for the top edges we use $\mathbf{M_3 = F^2UR'LF^2L'RUF^2}$ or $\mathbf{M_4 = F^2U'R'LF^2L'RU'F^2}$. Put a correct edge in the back, if there is one.

http://www.alchemistmatt.com/cube/rubiksteps2and3.html#step2