

# A Rubik's cube solution that is easy to memorize

[Cedric Beust](#), January 2003

## Foreword

A couple of weeks ago at a party, I came in contact with a Rubik's cube. It's not that I hadn't seen one in a long time (my very own faithful cube has been in my possession for over twenty years now), but for some reason, playing with that one revived in me the will to solve it again.

I used to be crazy about the Rubik's cube, back in high school something like twenty years ago. We were running contests and I was able to solve it in a minute overall. Not stellar, but decent. There was one major difference, though: back then, we didn't have the Internet. I had gotten my solution in various magazines and I had added my own maneuvers in an attempt to speed up the process and beat my classmates.

When I looked it up on the Internet, I wasn't really surprised to find a wealth of information. Much more than anything I had ever read on the topic. There are all kinds of methodologies out there and a lot of people who took the time to put up Web pages have used various ways to reach their own solution, often assisted by a computer (see the links section below for details).

But at this point, I'm not really interested in speed cubing. I just want a solution that's easy to memorize so I can revive the old feeling of beating the cube without reading a paper. None of the solutions I read were really aimed at easy memorization, so I created this page.

You will find out that the first half of this solution is simple common sense and even though I took the trouble of enumerating each maneuver for the sake of completeness, you only need to memorize the maneuvers explained in the second part of this solution. I am confident that the first part will stick with you since I remembered how to get that part myself even after twenty years of inactivity.

Therefore, I split this solution in two parts: the easy one (in which you build the first two layers except for one edge) and the harder one, where you complete the cube using more complex maneuvers that you need to learn by heart.

As a side note, I focused on providing the maneuvers that you absolutely need to know in order to finish the cube (a total of eight maneuvers). For every step of the second part, you can find on the Web similar maneuvers that will solve this stage when the cubies are in different locations. I didn't include them in this solution so you are not overwhelmed or discouraged by the amount of what you need to learn, but once you are familiar with the maneuvers below to the point where you no longer need to think, I strongly recommend you follow the links I provide at the end of this page: they will teach you more specialized maneuvers that will greatly speed up your cube solving.

As a final thought, it is just amazing how finger memory works. It took me a couple of hours of practice to have this solution totally memorized in my fingers. No more thinking in terms of "U" and "R prime", it just comes automatically. Give it a try, practice these maneuvers over and over (even on an unmade cube), and you will learn it in no time.

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## Notation

I am using the popular notation that I found pretty much everywhere. Each side is represented by its initial: Front, Back, Left, Right, Up, Down. A letter by itself (e.g. "R") means "turn this side clockwise". A letter followed by a prime (e.g. "F'") means "turn this side counter-clockwise. Finally, a letter followed by 2 (e.g. "L2", it should really be a square, not a 2) means "turn this side 180 degrees". If you have any doubts, the applets will clear up any confusion you might feel.

[Rubik's Revolution](#)

Everything you wanted to know about the all new electronic Rubik's cube [www.rubiksrevolution.com](http://www.rubiksrevolution.com)

One last note before we begin: I shamelessly stole the slick cube applet from Lars, whose Web site you can find in the links section. Be sure to check out his Rubik's page, there is a lot of information contained there.

And now, let's start.

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## Phase one

This is the easy part where you could pretty much guess all these moves by yourself. Before you can start, you need to pick a side and place the edges correctly so that the cube shows a cross. I will skip this part because it's trivial, but if you disagree, please let me know and I will add a step-by-step description of how to get there.

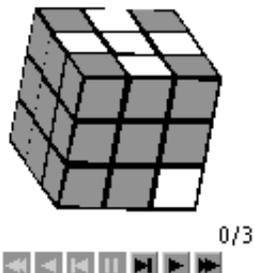
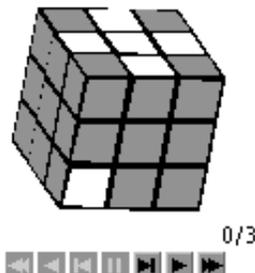
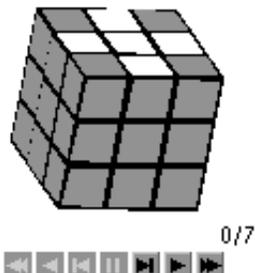
[How To Solve Every Sudoku](#)

The 7 Secret Tips That Help You Solve Sudoku, Even Challenging Ones [www.HowToSolveAllSudc](http://www.HowToSolveAllSudc)

### 1a) Position three corners

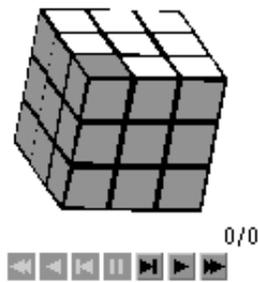
All four edges are in place, now we want to position three corners so that we end up with the first layer finished except for one corner. Move a corner under its final position and apply one of the three following maneuvers:

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<p>F D F'</p>	<p>F' D' F</p>	<p>F' D2 F D F' D' F</p>

Note that even though the third maneuver looks intimidating, it's actually quite simple: we can't place the corner directly in its final location if it's facing downwards, so we move the cube in order to reach one of the first two scenarios, which we can then solve.

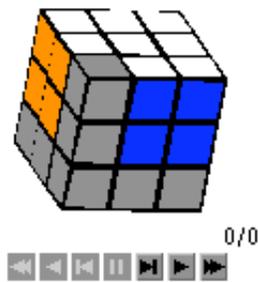
At the end of this step, your cube will look like this:



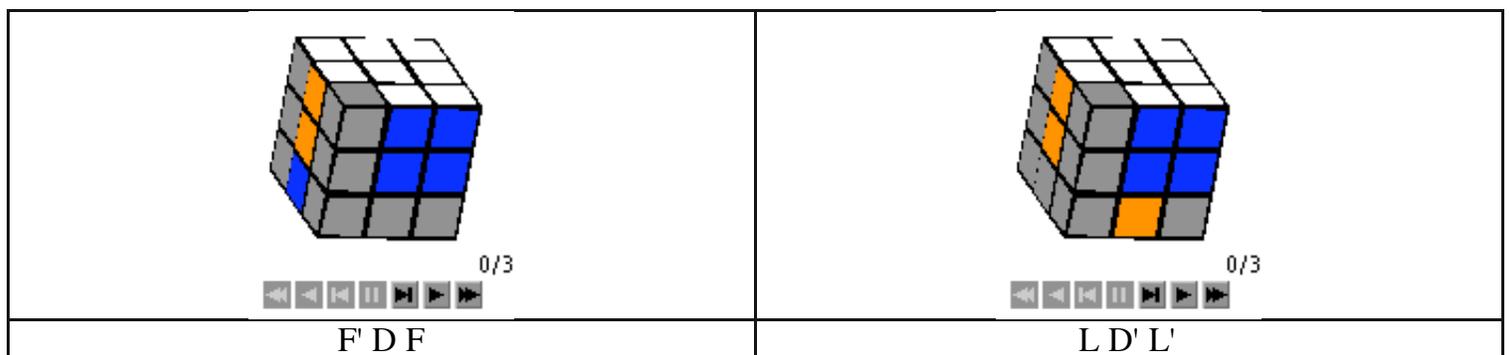
We will use this missing corner (also called "working corner") to install the second layer.

### 1b) Position three edges in the middle layer

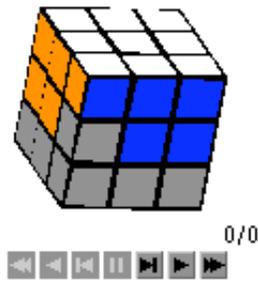
Our goal in this phase is to bring the cube with the first two layers complete except for one corner and one edge:



To achieve this, we are going to position three middle edge cubies using the working corner. For each edge, you have two possible configurations. Bring the working corner on top of the edge you want to install, and use one of the two following maneuvers:



Repeat these maneuvers for the three cubies until you reach the point where the two layers are finished except for one corner and the edge below it. Then use the maneuvers shown in 1a) to position the final corner of the first layer. Your cube should now look like this:



From this point on, we're going to need formulas to finish the cube. Until then, all the maneuvers were pretty straightforward and you can even reconstitute them yourself, but you are going to have to memorize what follows from this point on.

## Phase 2

### 2a) Finish the middle layer

Turn the cube around and bring the missing edge near its final position. Depending on where the missing edge is, use one of the two following maneuvers:

$U F U' F' U' L' U L$	$U' L' U L U F U' F'$

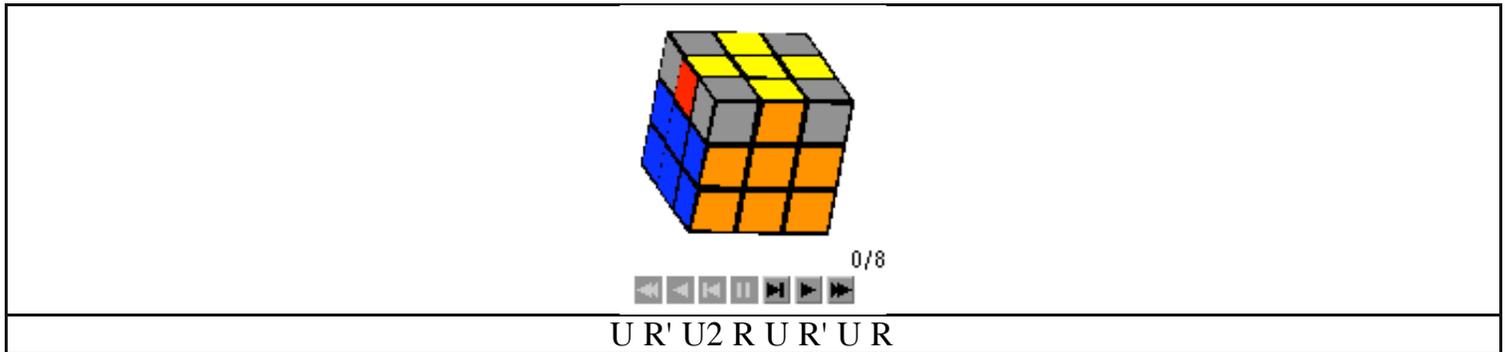
### 2b) Orient the edges on the last layer

Now we only have one layer left. The first step is to orient all four edges correctly. The following maneuvers take care of orienting pairs of edges, either adjacent, or opposed:

$F U R U' R' F'$	$F R U R' U' F'$

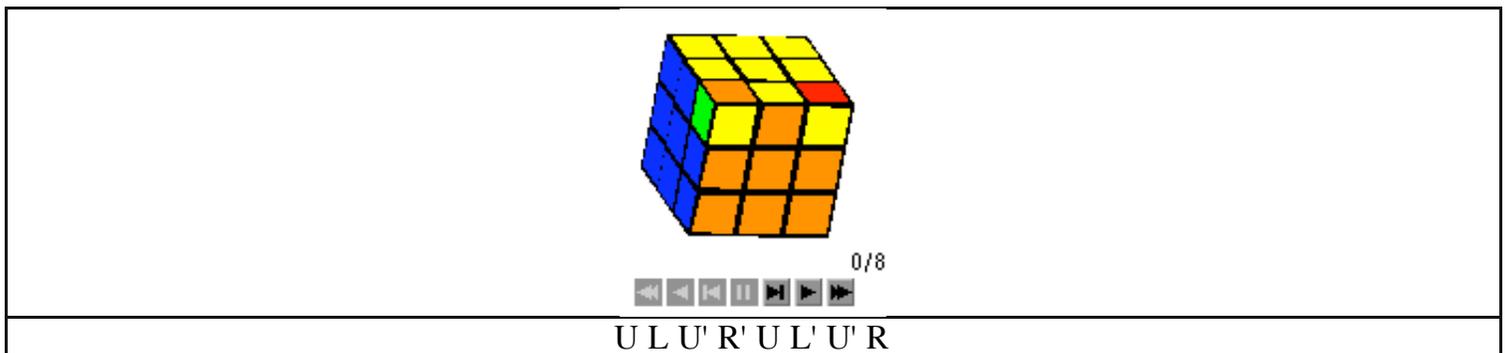
### 2c) Position the edges

Now that the edges are oriented correctly, we need to put them in their final location. The following maneuver switches the two edges opposed to you:



## 2d) Position the corners

We are done with the edges. Next, we need to position the corners to their final position (not necessarily well oriented). The following maneuver leaves the corner at the northwest corner untouched but rotates the other three counter-clockwise. You might have to make this maneuver several times until you have placed all four corners.



## 2e) Orient the corners

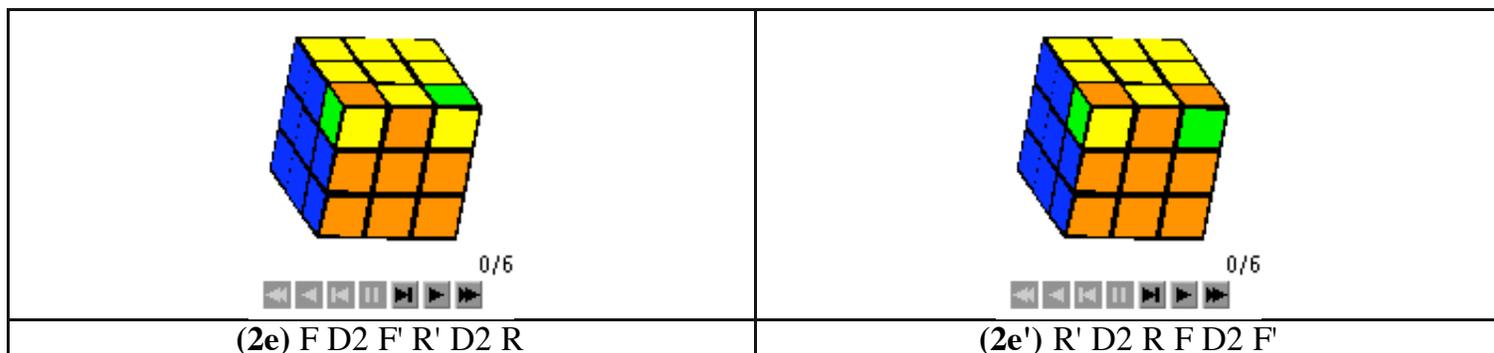
And finally, we orient the last corners. This maneuver is a bit particular since it's going to mess up the cube as long as we are not done with all the corners. The idea is to bring the corner you want to orient in front of you, as shown below. Depending on what side you need to adjust, use one of the two following maneuvers (named respectively  $2e$  and  $2e'$ ). Once you are done, you will notice that the corner is now in its final location, but the rest of the cube seems messed up. It's not. Rotate the up layer to bring the next corner you want to work on, and repeat the maneuver. When you are done with the last corner, the cube will magically be solved.

There is an additional gotcha with this final maneuver, which was pointed out by Jonathan Felder (thanks a lot, Jonathan!): you need to make sure that you execute as many  $2e$  as  $2e'$ . Failing to do that will result in the final side solved but the rest of the cube messed up.

For example, one possible scenario is that you have three corners left that need to be oriented. If your cube

is in a solvable state, it can apparently be solved with either  $(2e U 2e U 2e)$  or  $(2e' U 2e' U 2e')$ . This won't work, so instead, you will need to use something like  $(2e'2e' U 2e U 2e)$  or  $(2e2e U 2e' U 2e')$  in order to even out the number of  $2e$  and  $2e'$ .

Here are  $2e$  and  $2e'$  (notice that  $2e2e = 2e'$  and  $2e'2e' = 2e$ ).



Since this is a bit tricky, let's look at an example. The cube below has two corners that need to be oriented. The first six moves correspond to the second maneuver above, and they fix the corner facing us. Then I rotate the up layer twice in order to bring the second mis-oriented corner facing me, and I apply the first maneuver (since this time, the yellow part is facing me).



$(R' D2 R F D2 F') U2 (F D2 F' R' D2 R) U2$

## Other Rubik's cube links

- The [Puzzle Solver Web site](#) is where I took most of the phase two maneuvers. Their first phase differs slightly from mine, but you should check it out if you want to speed up your cube resolution as it supplies additional maneuvers to solve some of the stages.
- [Lars](#) is the author of the cube applet that I used in these pages and his solution is geared toward speed cubing. It is a layered solution but he uses different means and maneuvers to solve the two layers. I found his solution a little harder to follow because there are a lot of assumptions in-between the stages, but once you understand it, you will no doubt cut down your cube solving time dramatically.
- The [Cube Explorer](#) is an amazing program that will solve any given Rubik's cube in an average of twenty moves (most of the time, less than that). It is in average just three moves above the theoretical

optimal solution and it uses brute forces to reach that result. Amazing.

- [Jessica Fridrich's page](#) is the ultimate resource for speed cubing. A lot of formulas to remember, but if you can pull it off, your times will probably drop below the thirty second barrier.

There are many other pages available and I won't enumerate them all here since Google does a much better job at it.

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Back to my [home page](#).