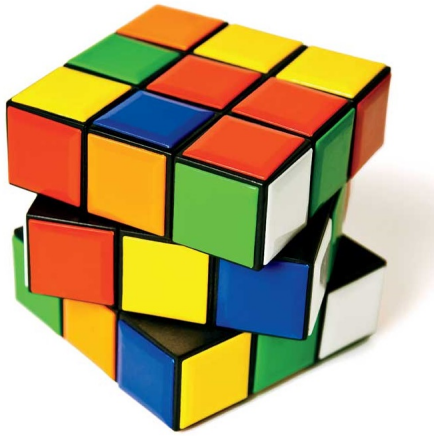
The Rubik's Cube Manual

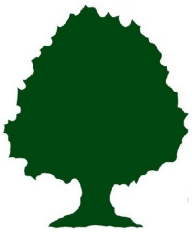
A Guide to the Beginners Method

An in depth step by step guide to solving the world's most famous puzzle



Author

Simon Guichandut,
Puzzle Master



June 15th 2015
In Honor of the 2014 Cedar Ridge Camp Raffle

Contents

Introduction

Hello and welcome to this Rubik's Cube manual. This guide will teach you how to solve the famous puzzle using a basic method designed for beginners. Hopefully, by the end of this read, you will have a good understanding of how the cube works and how to solve it. Keep in mind that before being able to amaze your friends, you will need to practice a lot as a big part of the solving is pure memory. Eventually however, you won't need to mentally memorize anything, as it will become muscle memory, just like riding a bike or paddling! Your fingers will solve the cube and you'll barely have to think about it! Here are a few things you will need :

- A standard 3x3x3 Rubik's Cube
- Patience
- Determination
- Decent memory

This guide will teach you how to intuietively solve some parts of the Rubik's Cube, but mostly, it will teach you algorithms. When it comes to puzzles like this one, an algorithm is a sequence of move that get you from one configuration of the cube to another. They are vital to solving the Rubik's Cube. If anyone tells you that they can solve the cube just by figuring it out, do not believe them, they are lying. They would have to be unbelievably intelligent or extraodinarily lucky to do this. Algorithms are most often computer generated, but are not necessarily super complicated – you'll get the hang of them. Most *cubers* use the same notation system for algorithms.

R is for right side ; **L** is for left side

U is for up side ; **D** is for down side

F is for front side ; **B** is for back side

ALL ACCORDING TO WHERE YOU EYES ARE! Therefore, **F** is the side that you are looking at when holding the cube and **B** is never visible. Also, during a given solve, sides will change letters, as you will not be doing the algorithms from always the same position. For example, **F** might be for the side with de red center at first, and white center last.

A letter by itself (ex : **R**) means turn this specific side clockwise

A letter with a prime (ex : **R'**) means turn this specific side counter-clockwise

Clockwise/counter-clockwise is determined by the way you look at it. If you want to do an R, you must turn your hands so that you are looking at the right side, and then turn it clockwise (in practice, you won't be doing this everytime). Pick up the cube and try all the combinations : **R, R' , L, L', U, U', D, D', F, F'**. Notice how **R** turns the opposite way as **L** and same way as **L'**. Same for **U** and **D**. Make sure you understand that well, because that is often a source of mistakes for beginners.

The algorithm will be written from left to right and that is how you must perform it. It's like following a choreography, only in this case you are reading it.

Here is an example of an algorithm that we will use later on :

U R U' L' U R' U' L

Go ahead, try it out. It won't do anything though, because we are not at that step yet!

*IMPORTANT : When doing an algorithm, the placement of the sides should NEVER change. In other words, **F** should always correspond to the same side. Same for **U**, **R**, etc. Only once you are done with an algorithm can you turn the cube and make a new side correspond to **F**.

Before we get started, here are a couple things you need to know and understand about the geometry of the cube.

- Corners are literally the corners of the cube. They have three sides and there are 8 of them. They must be placed and oriented properly
- Edges are between two corners. They have two sides and there are 12 of them. They must be placed and oriented properly.
- Centerpieces are in the center of every side. They only have one side and can not be moved, because they are attached to the core of the cube. This means the color of a side is defined by the color of its centerpiece.

Your goal is therefore to arrange all corners and edges around the appropriate centerpiece (this is called *Permuting*) and turning them into their right orientation (*Orienting*).

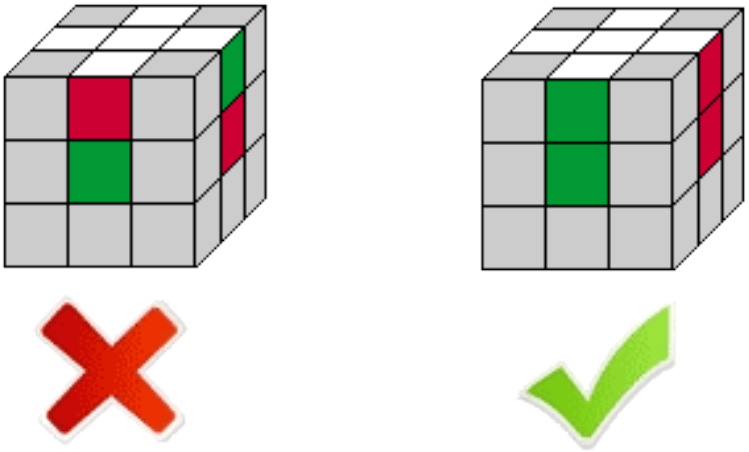
Step 1 : First Cross

This is the first step but it is one of the hardest. The reason for that is that there is no definite set of algorithm to do it. You will have to figure out how to do it. With practice, you'll eventually find ways to do it more efficiently.

Basically, you are picking a color (color 1) to start with (picking a centerpiece) and arranging all 4 edges that have color 1 on one of their two sides so that :

- Color 1 side of the edge is matching with color 1 centerpiece
- Other color (color 2) of the edge is matching with color 2 centerpiece

And this is for all 4 of the edges that have color 1.



It is clear that the shape you're going for is a cross, but take note of the fact that if the edges aren't matching with the other centerpieces as well (the four others), your cross will be useless.

So how do you do that cross? Start by placing the white side on the top or **U** side. From now on, when I say place, I mean just move the cube, don't actually turn any sides. Now, find an edge that has white on it and put it on the bottom or **D** side. Then, by turning the bottom side, align the edge with the side of the its other color and turn that side two times. This will put your edge on top, besides the white center. You will proceed to do the same thing with all three other edges. Find the edge, move it to the bottom, align it and flip it up. However, you have to be careful when moving your edge to the bottom so as to not mess up what you've already done. For example, you have an edge # 1 that is in a side where there is also another edge # 2 that you have previously properly placed and you want to move # 1 to the bottom so that you can place it. However, if you

turn the side to move # 1 to the bottom, # 2 will rotate away from where you want it. The easy fix is turn the bottom side once # 1 is there so as to move # 1 out of the side that also has # 2. Then, you can put # 2 back.

When you flip your edge up from the bottom layer to the top, it can be in one of those two configurations.

1 - This is the right orientation for the edge. Awesome!

2 - This is the wrong orientation for the edge.. No big deal! Hold the cube so that white side is **U** and edge in question is **F** and do this algorithm : **F U' R U**

This will put your edge in the correct orientation without messing up any other edge.

This is it for the cross. That was a long explanation, but really you could do all this just by logic, and with practice, it'll become very easy and natural.

Step 2 : First Corners

You are now going to place all 4 white corners, thus completing the first layer. This step is simple and requires only one algorithm : the corner algorithm (also called RD algorithm and/or beginner algorithm).

R' D' R D

This is a very important algorithm in this method, as we will also use it in the most crucial and dangerous part of the solve. So, go ahead, practice it and make sure you get it down. If you happen to have a solved Rubik's cube around, try doing the corner algorithm six times in a row and you will see that the cube will go back to the solved state. This is because every algorithm is in fact part of a cycle, which makes it so that if you repeat it enough times, the cube will return to its original position. The corner algorithm is a good way to demonstrate that.

To solve a corner, you want to have it on the bottom layer, straight underneath where it needs to go – your corner and the spot where you want it to go should be seperated by a single edgepiece. Then, hold it so that the corner is on the bottom right of the front face and perform the corner algorithm. Do it as many times as it takes for the corner to go up AND be properly oriented. Depending on the original orientation of the corner, that will be 1, 3 or 5 times the algorithm. Pay

attention so that you don't miss it! Something that could happen is that you have a corner already in the right spot, but not oriented properly, or you have a corner that is in the wrong spot. For both of those cases, take any corner that has no white on it and perform the corner algorithm once underneath the corner that you want to fix. This will simply pop the corner out of its spot and into the bottom layer, after which you can put it up properly.

Step 3 : Second Layer

You've succesfully solved the first layer, now onto the second one! Since the centers don't need to be solved, all that needs to be done here is to solve 4 edges. This step is nothing but algorithms, so if you didn't like the logical thinking that was required in the first step, you'll like this one!

Start by flipping your cube so that the white layer you have just solved is now on the bottom. Then, find an edge piece on the top layer that has NO yellow on it. If it has yellow on it, it belongs on the third layer, not the second one, as yellow is the opposite of white on a standard color scheme Rubik's cube.

When you find it, turn the top layer as to align the edge with one of the four side centerpieces, so that the two are matching in colors. If you're following this example which has started with white, you're aligning your edge with either red, blue, green or orange. Now, you want to get that edgepiece down to the second layer, either diagonally to the right or diagonally to the left. The way you figure this out is by looking at the other color on the edgepiece : the edge wants to go in between the two centerpieces with which it has matching colors (complicated sentence for a very simple principle).

If your edge needs to go left, do this algorithm:

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

If your edge needs to go right, do this algorithm:

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

You'll notice that these two algorithms are the same, but mirrored – it makes sense, right?

If every edge on the top layer has yellow on it, but the second layer still does not look finished, this means an edgepiece is either in the wrong spot or isn't properly oriented. Much like what we did for the corners in the previous step, all you need to do is take a random edgepiece (that has yellow on it) and swap it with the edge that is wrong by performing the algorithm. The edge will return to the top layer and you can then place it properly.

And that is it for this step. Congrats! Now you're thinking : Yeah, 2/3 of the way done. I'm sorry to disappoint, but no. Last layer is the hardest , but you've made it this far, so you can do it!

Step 4 : Third Layer Cross

The first part of completing the third and last layer is building a cross just like in the first step. However, this time, we're going to need algorithms. Well, actually, only one, but you will most likely need to repeat it multiple times. Here it is :

F R U R' U' F'

It's an easy algorithm, but it only works if the cube is set up properly. When first getting to the third layer, there are 4 edge patterns you will encounter (the corners do not matter here):

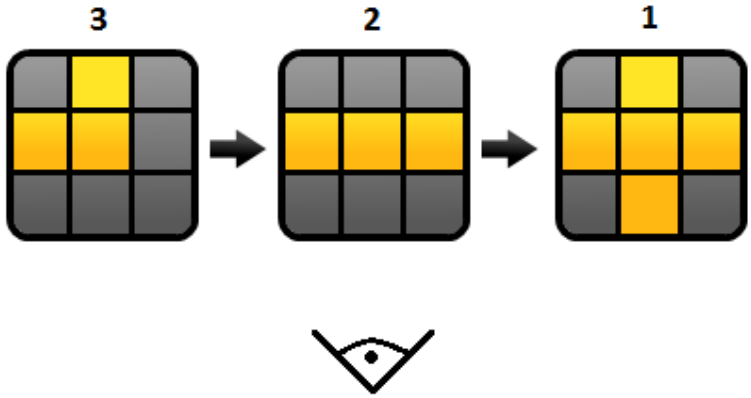
1 - Cross already done

2 - Line (1 centerpiece and 2 edges in a line)

3 - L-shape (1 centerpiece and 2 edges not aligned)

4 - Dot (Only the centerpiece)

1 is least likely while 2 and 3 happen most of the time. The idea here is that the applying this algorithm will get you to the higher number edge pattern. Use it to get from 4 to 3, 3 to 2 and 2 to 1. Indicated on the drawings is how you should hold the cube while doing the algorithm. Hold the third layer upwards and place the cube as shown.



There is no drawing for pattern #4, since a centerdot stays the same no matter the way the cube is held.

Step 5 : Third Layer Edges

In this part you will learn one of the most famous algorithms in the Rubik's cube world, the *Sune* algorithm. This is an algorithm that is used in almost all widely known methods of solving because of its quickness and power. We're only going to use it for edge permutation, but know that it can do much more!

R U R' U R 2U R'

(2U means two U turns, either clockwise or anti-clockwise)

We're going to use the *Sune* algorithm to turn two solved edges into 4. You will always be able to find on the third layer two edges that are solved and next to each other, simply by turning that layer and checking if the edges match the side centerpieces. When you find them, place the cube so that one solved edge is on the right side and the other on the back side (third layer is still the up side). Perform the algorithm, turn the top side on last time (U) and you're done.

Hey look at that, your puzzle is almost completed! Only a couple corners remain, let's find out how to solve them.

Step 6 : Third Layer Corners Permutation

If you got to this part it means you did not get incredible luck by having the corners already done after the cross and last edges (and thus the whole cube). Don't worry, it almost never happens.

What we're going to do here is simply place the corners in their right place, not necessarily orient them properly. It's important that from now on you don't turn the third layer, since you've just solved the edges. The algorithm for this part is long but really it's super easy - eventually, you'll see how the corners are moved around and it'll make a lot of sense.

U R U' L' U R' U' L

(Try saying that out loud five times in a row!)

There will be either none, one or all four corner(s) that is/are in the right spot (not necessarily oriented properly, just where it should be in the end according to the centerpieces). In the first case, pick one position and keep performing the algorithm until you have at least one corner (if you do this more than three times, you probably misunderstood the *right spot* part). When you have the one corner, hold the cube so that this piece is facing you and to the right (bottom right of top side). Perform the algorithm until all the corners are in their right position (maximum two times). The end is near!

Step 7 : Third Layer Corners Orientation

This is it, the final step to solving the Rubik's Cube. Your parents, your friends, your teachers, have never made it this far. Completing your first cube is pretty much the Nirvana of the puzzle world.

But BE CAREFUL! If you're going to mess up your whole solve at any point, it is now. This last step is very easy to understand, but one wrong move and it's over. I'm serious!! So read carefully. All your corners are in their right spot. How many are oriented properly? Either 0, 1, 2 or 4. If it's 4, you're not reading this, you're celebrating your luck. If it's anything else, here we go:

We're actually using the easiest algorithm ever. It's the first one we used too :

R' D' R D

The problem is, a lot of beginners forget the last D move. Sounds stupid, but the thing is this step makes it look like you just ruined your solve by messing everything up, and it's hard to see what's going on and miss a move. All I'm saying is, never forget the last move!!!

Basically what that algorithm does is take one corner and move it from the top to the bottom over and over again, changing its orientation every time. When performed six times, your cube comes back to its original position, which is why this step doesn't mess up the whole cube.

On every unsolved corner, you need to perform this algorithm until it is solved. You need to ignore everything that looks messed up on the cube and only focus on that corner and the centerpieces surrounding it. Remember to always finish your algorithm! You will have to do it once is the most favourable orientation, and four times in the worst.

Having the third layer up, pick one corner to start with (bottom right of top side) and solve it. After, turn the top side to bring into the working spot (the spot where corners are being flipped) another unsolved corner, and solve it. And one more time if you had three unsolved corners. Notice how it's turn the top side and not move the cube; that is crucial.

Well, that's it! If you've followed all the steps without forgetting any move, you are done. Congratulations! If everything looks wrong, then I'm sorry but you messed up. That's ok though, it won't take too long to come back to this part.

Conclusion

Well there you go, you made it, you have solved the Rubik's Cube! Whoever you are and how you got your hands on this guide, I'm glad it helped you reach your goal in what I hope was a structured and logical way. My main goal with this guide was to explain a method in a clear step-by-step fashion while underlining the similarities between different steps, as to give you a fairly deep understanding of how a Rubik's Cube and algorithms work. If you know me personally, I welcome any feedback on this guide so I can perhaps make improvements on it in the future.

Learning algorithms, their purpose, their effect and how to perform them, is unlike anything else people learn in their regular life, which is why it can take a while to understand how to solve the cube. Some will pick it up in a heartbeat, some will take longer, and that's completely fine. If you're reading this even though you haven't been able to solve the cube with this guide, do not despair! Sometimes it helps to have more visuals to learn, which is why a lot of people like to look on the internet for tutorial videos, which show you how to perform the algorithms move by move. So you might want to turn your eyes to the web for an easier learning experience. Honestly though, learning with this guide is just cooler.

Now if all you wanted was to learn how to solve the cube, you can go practice before showing off your skills to your friends. If you want to learn more however, keep reading!

. . . . . .

As I mentioned in the introduction, this was a guide on the beginner's method. This method is great for learning, but it is very slow and ineffective. Think of all the time it takes to orient the last corners using the RD algorithm. Also, when your friends see your do that algorithm, it makes them think solving the cube is just repeating two moves, which you now know is very false! There are many other more advanced methods that allow you to solve the cube faster. And by faster, I mean extremely fast. There is a whole community out there of *Speedcubers*, people who solve cubes ridiculously fast as a hobby, but also in competitive environments. The official world record for standard single Rubik's Cube solve has been held since 2013 by Dutch teen Mats Valk (17 at the time) : 5.55 seconds. And yes, it does come down to milliseconds. There are also most notably world records for one-handed (8.75 sec.), feet(25.14 sec,), and even blindfolded solves (21.75 sec., including memorizing time).

The most common method for speedsolving is called the Fridrich Method, named after its brilliant inventor, Jessica Fridrich. And you know what, you should be able to understand how it works! The only thing is, there are more than 70 algorithms to this method, so learning it takes a lot of dedication. Here are the steps to the Friedrich Method :

1 - F2L (First Two Layers)

This step combines the first three steps of the beginners method. As you are building your first cross, you are also building edge-corner couples, which you then insert into the appropriate place. Then, you already have your first two layers built. No more of that single corner insertion and annoying edge insertion step. Actually, if you look closely at the cube when you are doing that edge insertion part (Step 3 in this guide), you'll see that you're actually popping a corner out to pair it with an edge, and then putting the two back in together. That's basically what F2L does, except better!

2 - OLL (Orient Last Layer)

This is where things start to get different. Instead of building a cross, permutting edges, and so on, the whole face of the top layer is solved, without the pieces being in the right spot. Say you had started your first cross on the white layer, this step would aim to make the opposite side all yellow using a single algorithm. This means that for every single configuration of edges and corners, there is an algorithm that will orient that layer the way you want it. And there are 57 of those configurations, so that is 57 OLL algorithms you would need to learn. Yes, that is a lot! There is also a slower but simpler way of doing the OLL skip and it is called the 2-look OLL. It consists of building the third layer cross like you know how to first, and then orient the remaining corners, which reduces the number of algorithms to only 7.

3 - PLL (Permute Last Layer)

This last step simply consists of permuting all the edges and corners from the last layer into their finished position, again using a single algorithm. For this part, there are 21 algorithms to know.

So you pretty much went to a cube with two layers solved to a fully solved one using 2 or 3 algorithms and in a matter of seconds. Compare that to the beginner method! Yes, it's a hassle to learn all these algorithms, but if it's something that interests you, you should definitely give it a try.

. . . . . .

So that is it for the Fridrich method as well as me rambling in this extended conclusion. You will find in the next page a table of algorithms that includes every one mentioned in this guide as well as some extra ones that you can try to see what cool patterns they make.

So keep practising,

Understand your puzzle,

Enjoy yourself,

Show off, but not too much,

Happy Cubing!

Table of Algorithms

Cross edge flip	:	**F U' R U**
Corner algorithm	:	**R' D' R D**
Left edge insertion	:	**U' L' U' L U F U F'**
Right edge insertion	:	**U R U R' U' F' U' F**
Third layer cross	:	**F R U R' U' F'**
Sune	:	**R U R' U R 2U R'**
Corner permutation	:	**U R U' L' U R' U' L**
Corner orientation	:	**R' D' R D**

. . . . . .

.

Checkerboard	:	**2U 2D 2R 2L 2F 2B**
Dots	:	**U D' R L' F B' U D'**
Cross	:	**U F B' 2L 2U 2L F' B 2U 2L U**
Cube in a Cube	:	**F L F U' R U 2F 2L U' L' B D' B' 2L U**
Cube in a Cube in a Cube	:	**U' L' U' F' 2R B' R F U 2B U B' L U' F U R F'**
Snake	:	**L U B' U' R L' B R' F B' D R D' F'**
Superflip	:	**U 2R F B R 2B R 2U L 2B R U' D' 2R F R' L 2B 2U 2F**