

# Adam's Rubiks Cube Solution

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Yet another description of how to solve the cube. My solution was strongly influenced by conversations with Jeff Varasano, back in the early 80's when the cube was still popular...

This solution is optimized for **visual speed**, because the slowest part of solving the cube is not making the moves, but locating the pieces to place. Hence it is very color oriented, using easy-to-spot patterns instead of more difficult questions most solutions normally require, such as "where is the correct position for this corner relative to its center pieces?"

With a good cube, I was averaging (in 1981) 26 seconds over 100 attempts. Today, with a bad cube and out of practice, I would probably average around 45 or 50 seconds.

The strategy is as follows:

1. Get the top X (all corners) in any position
2. Solve the bottom X (all corners)
3. Move all corners (top & bottom) into the correct position simultaneously
4. Fill in the edges on one side, except for a keyhole (one missing piece)
5. Fill in the edges on the opposite side
6. Replace the keyhole. The top and bottom are now completely solved.
7. Position the remaining edges (middle slice)
8. Orient the remaining edges

In the illustrations accompanying this page, I've selected the color **BLUE** as the target color when possible, so that is the color you should pay attention to unless otherwise indicated.

During this solution, I've included instructions for both the expert cubist (fastest possible solution, but requires lots of memorizing), or for the beginner (memorize only four easy patterns to solve the whole cube, but takes much longer).

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## Notational Help

These are the symbols used in the moves described below. Should be pretty obvious. The pictures represent the cube as if you were looking at it straight on, at eye level. In all cases, the pictures below represent turning just one slice of the cube.



The front face clockwise, counterclockwise, and twice.



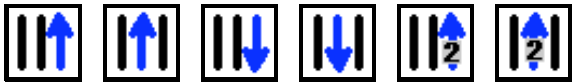
The back face twice.



Horizontal slices to the left



Horizontal slices to the right



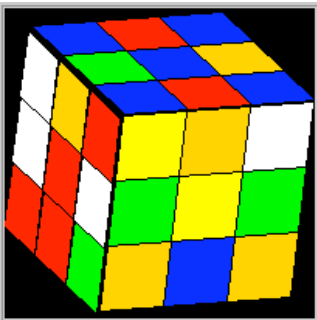
Vertical slice moves

(can you tell I'm righty? Feel free to transpose the listed moves to have a more left-handed emphasis).

Also note: any double moves (with a 2 on them) can be turned double in either direction. Sometimes it's more natural to turn double in another direction than pictured; I just didn't want to draw pictures for every possibility -- lazy me.

## Top X

You're on your own here. Get a single X on one side of the cube, by positioning the corners and the center piece on the same side. Note: all that matters is to get an X of a single color, the position of the corners relative to each other **does not matter!!**

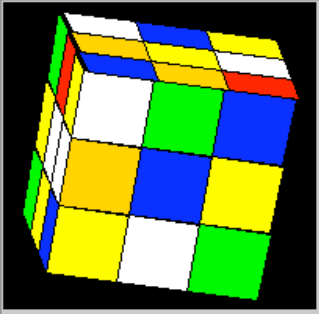


A blue 'X' formed by 4 corners and a center. Choose any color you like.

## Bottom X

Turn the cube over, so that the side with the completed X (from step 1) is facing away from your, and count the number of corners that are correctly twisted (i.e. touching the blue center piece). If the bottom X is not already solved, you will see one six possibilities (note, we are again using **BLUE** to illustrate the new target corners and center). When comparing your configuration with the pictures below, take into account **all** visible blue corners shown, even those not on the bottom side.

For each possibility, we have listed a direct solution, and, for those who don't want to memorize many complex moves, we have also listed how the configuration can be solved by multiple combinations (at most 3) of an easy to remember move, labeled BX-1. If you remember the inverse of BX-1, you can solve each position in at most two executions of BX-1 and BX-1 Inverse.

1.  One corner correct: Hold as shown and apply BX-1.

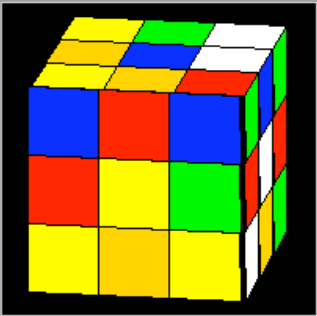
BX-1: 



If your position better matches this picture (check remaining corners), read below

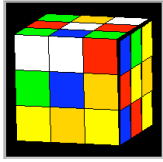
This position can either be solved by holding the cube as in the larger picture above, and executing BX-1 **twice**, or else holding it as displayed in this picture and executing BX-1 Inverse:

BX-1 Inverse: 

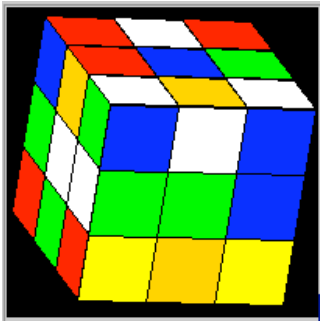
2.  Zero corners correct, remaining corners paired.  
Hold as shown (target side on top):

Fastest: 

or



Easy: BX-1 + turn cube as specified above for 1 corner + BX-1

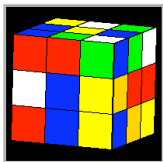


3. Zero corners correct, separated.  
Hold as shown (target side on top):

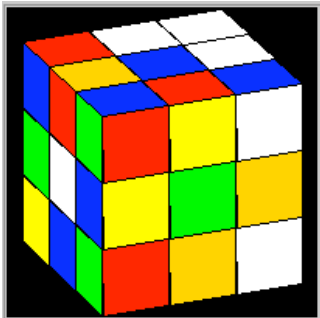
Fastest:



or



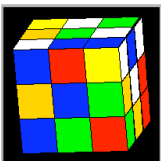
Easy: BX-1 + turn cube + BX-1



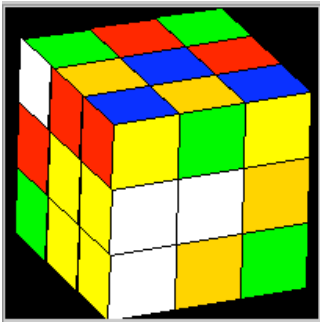
4. Two corners correct, remaining corners separated.  
Hold as shown (target side on top):



or



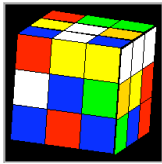
Easy: BX-1 + turn cube + BX-1 Inverse



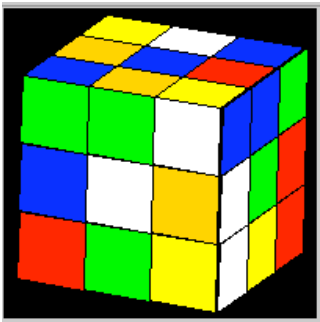
5. Two corners correct, remaining corners together. Hold as shown (target side on top):

Fastest: 

or



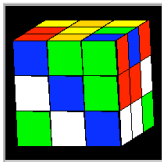
Easy: then BX-1 + turn cube + BX-1 Inverse



6. Two corners correct, diagonal. Hold as shown (target side on top):

Fastest: 

or



Easy: then BX-1 + turn cube + BX-1 Inverse

**For the curious:**

Note: you might wonder "where do these (fastest) patterns come from? Did they just miraculously appear in someone's head? If I don't like the patterns you gave, how can I make up my own?"

The strategy for making up new patterns is very simple:

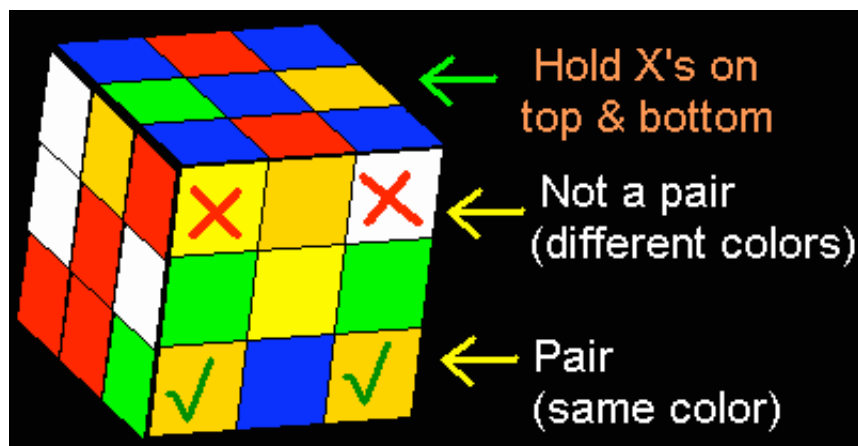
- Use the above patterns to start with the top and bottom X completed.
- Now make some arbitrary moves that remove one or more corners from the top X, and then puts them back differently so that the top X is restored. Write the moves down on paper as you go so you don't forget them.
- In all probability, doing this has now "messed up" the bottom X. Well, if you look at the resulting "mess", you now have a new move for solving that particular bottom X configuration: just reverse the moves you did to get it like that. Write it down and move continue until you have patterns for all bottom flip combinations!

You might ask: how do I know that the list of possibilities for bottom X configurations listed above is complete? Well, on the cube (according to group theory), it is not possible to flip only a single corner -- other corners are implicated. The two minimal flip possibilities are: three corners flip in the same direction (e.g. clockwise or counterclockwise), or two corners flip in opposition directions (one clockwise, one counter). So, given that four of the corners are guaranteed to be correctly flipped (you already have one X), the resulting positions are everything you can do using these two minimal flip primitives.

Similar logic and rules apply to moving corners, as well as positioning and flipping edges, all of which we will see very soon...

## All X's

Now that we have a top and bottom X, count the number of **pairs** along the top and bottom edges of the cube. A pair is when both corners along either the top or bottom edge of the cube are the same color.



After counting all the pairs along the top and bottom edges of the cube, you will have one of the five following possibilities:

## 0 Pairs

Hold cube with the X's on the top and bottom:



## 1 Pair

Hold pair on upper left side of cube



## 2 Pair

Fastest: Hold both pairs in front of cube



Easiest: Hold both pairs on the left side of the cube and do 1 Pair + 0 Pairs + 1 Pair.

## 4 Pair

Fastest: long and complicated, don't bother. 4 Pairs is pretty rare.

Easiest: 2 Pairs twice, starting from anywhere or 1 Pair twice, starting from anywhere.

## 5 Pair

Fastest: Hold four pairs on the bottom and one pair on the upper left side of cube

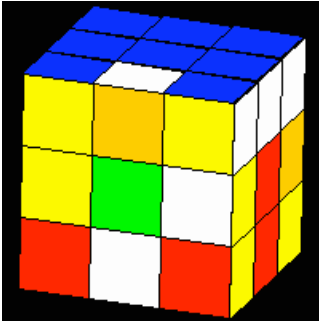


Easiest: 0 Pair + 1 Pair

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## Top side minus keyhole

Choosing one side as the top, fill in three of the edges so that they are correctly positioned. The last edge position will serve as a keyhole, which we will use to fill in the bottom side. Make sure that you do not lose the corner alignments when filling in edges (you should always have 8 pairs).



Three edges on top side completed, one remaining "keyhole"

## Bottom side using keyhole

Fill in the bottom edges using this basic strategy:

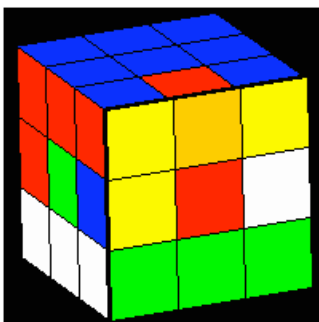
1. Find a target piece on the middle horizontal slice to be moved to the bottom side.
2. Position its destination under the keyhole.
3. Turn the middle slice so that the bottom color is on the back side of the cube.
4. Turn the front face of the cube so that the destination moves towards the target piece.
5. Move the middle slice to insert the target piece into its destination.
6. Return the front face to upright position.

Note: If there are no available target pieces on the middle horizontal slice, move one there by moving some badly positioned piece under the keyhole, turning the front face once, moving the piece out onto the middle slice, and repositioning the front face.

## Fill in Keyhole

To fill in the last keyhole, use the following basic strategy:

1. With the keyhole in the top front, turn the middle horizontal slice until the target piece is at the front of the cube, but NOT on the front face..



Step 1. Position target piece (blue) under keyhole.

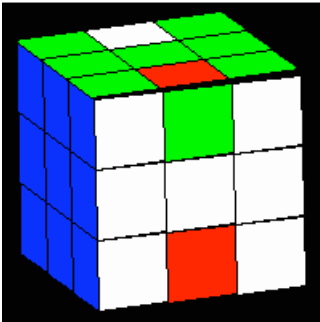
2. Position one of the bottom pieces into the keyhole by turning the front face, sliding the middle slice



to position the piece, and replacing the front face. Now, fill in the initial target piece using the strategy defined in the previous section.

## Position Remaining Edges

Hold the cube with the two finished sides on the left and right, and consider the remaining edges of the vertical middle slice.



Only the center slice edges are left!

To cycle three edges, hold the edge that shouldn't move in the lower back area of the cube.

EC-1: Edge-cycle: 

EC-1 cycles the edges in a triangle *downwards*. Either position the cube so that EC-1 will solve this in a single execution, or else just execute EC-1 twice.

To swap four edges with each other (top two switch and bottom two switch):

Fastest: Edge-swap: 

or

Easy: EC-1 plus EC-1.

## Flip Remaining Edges

To flip two edges, hold the edges to be flipped on the top side:

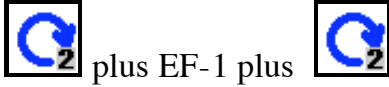
EF-1:





Note: you may need to flip four edges; in this case, just flip them two at a time using EF-1 twice.

If the two corners which need to be flipped are diagonally opposite each other, hold the cube so that one of the corners to be flipped is in the lower front part of the cube and then do:



There are also "fastest" moves for performing the two last steps (positioning and flipping edges) in a single step. I think I'll leave this as an exercise for the readers to derive...

Hint: position an edge where you'd like it, move another bad edge into its place, now reverse the original move to restore the cube.

For other web resources on Rubik's cube, see [here](#)

If you have comments or suggestions, email me at [cheyer@ai.sri.com](mailto:cheyer@ai.sri.com)