Solving Rubik's Cube for speed.

By Lars Petrus

Introduction

This is a tutorial for my method of solving Rubik's Cube. It is intended both for beginners and experienced cubers. There is no group theory or strange notation involved, I just show you how to move. You very much need a Java-enabled browser.

Using this method, I won the 1981 Swedish championships, and finished 4th in the [1982 world championships in Budapest](#). I also won the 2005 world championships in Orlando for solving in fewest moves. My average of 10 best is 21.88 seconds from 2002, and for a single solution 13.60 in 2006.

Please take a look at my [terminology](#), so you know the difference between a turn and a twist, for example.

If you are a total beginner, look at this description of [the basic concepts](#) of Rubiks Cube.

The [animated Java cubes](#) that are used for illustrations and examples are explained [here](#).

The Basic Idea

Most people solve the cube layer by layer. This is a simple way for the human mind to approach the problem, but it is useless for speed cubing. No matter how good you are, you will use more than 100 moves. Going for speed, I use 60 moves on average. Going for few moves, I average 45.

In the final of the Swedish championship, 8 of 11 competitors used a vanilla layer-by-layer method. The other 3 of us finished 1, 2 and 3!

The basic problem with the layer method is a big one, and it's obvious once you realize it. When you have completed the first layer, you can do **nothing** without breaking it up. So you break it, do something useful, then restore it. Break it, do something, restore it. Again and again. In a good solution you do something useful all the time. The first layer is in the way of the solution, not a part of it!

The Method

The Petrus method has 7 steps:

- Step 1 - [Build a 2x2x2 corner](#)
- Step 2 - [Expand to 2x2x3](#)
- Step 3 - [Twist the edges](#) --- *[2](#), [4](#) or [6](#) bad edges*
- Step 4 - [Finish 2 layers](#) --- *[Step 4b tricks](#)*
- Step 5 - [Position the corners](#) --- *[Complete Step 5+6 index](#)*
- Step 6 - [Twist the corners](#) --- *[Complete Step 6+7 index](#)*
- Step 7 - [Position the edges](#)
- Step 1, 2 & 4 - [Block building tricks](#)
- Practice - [13 example solutions](#)

I also have some tips on the [physical](#) as well as the [mental](#) aspects

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of speed cubing.

You can [download](#) the java code for the cubes.

Fun and Games

I made a [cube backtracking game](#).

And a java cube you can [solve on time](#).

[Thanks and Credits](#).

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This page created March 9 1997.

Click play for a sample solution in 41 turns.

- Turn 1-5 is step 1
- Turn 6-12 is step 2
- Turn 12-16 is step 3
- Turn 17-29 is step 4
- Step 5 was not needed
- Turn 30-41 is step 6-7, using [F4](#)

Step 1

The goal in this step is to build a 2x2x2 block. Or more precisely, to place one corner and its three adjoining edges in their correct positions, as is done in the cube to the right..

Beginner

For the beginner it is often easiest to pick a corner that you will always start with. This makes it easy to find the pieces you need. We will use the blue-yellow-orange corner. This means that the three edges are the blue-orange, the orange-yellow, and the blue-yellow.

What if you don't HAVE a blue-yellow-orange corner??
That's normal. There are many different color schemes on cubes in the world, so unfortunately, whatever colors I pick for my site, it will not match most cubes. The method works for any set of colors, obviously, so try to focus on the method, not the particular colors used as examples.

First find the 4 pieces you need, and then try to build the 2x2x2. It's not really hard, but it can take a while if you're a rookie. It's best to try youself for a while, to get a feel for it, but if it still doesn't work out, try following the description below.

There are many special cases, but this is the basic way I solve it. Remember, we're trying to join up 1 corner, 3 edges and 3 centers.

1. Pair up the corner with an edge.
2. Pair up another edge with a center.
3. Join the pairs from 1 & 2 to make a 2x2x1 block.
4. Join the remaining edge with the 2 other centers.
5. Put it all together in one final move.

The animation shows a concrete example

1. Pair corner with blue-orange edge. *[Turn 1]*
2. Pair up blue-yellow edge with orange center. *[Turn 2]*
3. Join. [Turn 3-4]
4. Blue-yellow edge fitted between blue and yellow center.*[Turn 5-7]*
5. All done! *[Turn 8]*

Intermediate

After you can easily do one corner, you should start looking at all 8 corners and choosing to start with the one that is fastest to solve. Normally, one or two are real easy (and some are hard). Picking the easy one makes quite a difference. It can be a difficult transition to use different colors all the time, but it is worth it. After a while you'll be completely used to it.

At competitions, there is normally a 15 second period where you get to look at the cube before timing starts. This is what you do during that time (though 2-5 seconds are usually enough).
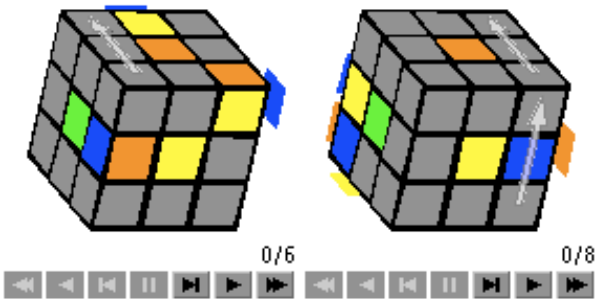
Advanced:

Try to be aware of where the four pieces are at all times. You should be able to visualise the full step

solution in your mind before starting.

Spend a lot of time looking at this step, and you will start seeing 5 moves ahead or more surprisingly often.

Here are my solutions for 4 random cube positions. When you can choose between 8 corners you should get 1-2 less moves on average.

You can rotate a cube
yourself by
grabbing it
with the mouse.

And you can turn sides
by shift- and/or control-
clicking them.

Try it! Now!

0/6   0/8   0/7   0/6
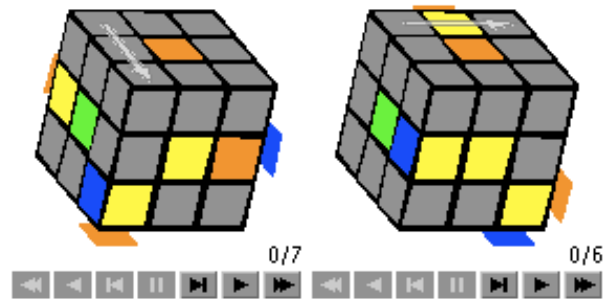
For more advanced techniques, check out the block building page.

Next Step - Go for 2x2x3

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Step 2

After step 1, we have a solved part of the cube, and we have three sides that we can move freely, without breaking up what we have accomplished. Not bad!

In step 2 we expand what we have to a 2x2x3 block. That is, we add one corner and two edges in to the solved block.

Beginner

Choose one of the three possible corners to expand to. We will use the green-yellow-orange corner, and of course the yellow-green and green-orange edges.

This is quite similar to how you work in step 1, join the corner with one of the edges and work from there. When you're familiar with step 1 you should have no problem.

But be sure not to break up the 2x2x2 block! You need to be aware where it is at all times. Otherwise it's back to step 1...

Intermediate

You have three corners to choose from. It's important to pick the easiest, just like in step 1.

The hardest positions are when a piece is in it's right position, but twisted the wrong way. The easiest way to deal with that is to just pick another corner to solve!

Advanced

These simple and very useful moves (to the right) took me months to figure out (actually I didn't, someone I taught showed me...), since it involves breaking the holy 2x2x2 block. As an exercise, try to find how to do the the third example cube above in 7 moves instead of 9 by breaking the 2x2x2. It's not easy, so here is a hint: **First move:** turn green layer 1/4 clock wise. **Second move** breaks the 2x2x2 (highlight to show text)

Sometimes, the first move of step 3 will be the opposite of the last move in this phase. So with some foresight you can skip both. Also, while doing the last turn of step 2, you can often stop half way, and fix a pair of bad edges midway. See the examples page for several examples of this.

For more advanced techniques, check out the block building page.

Next Step - Twist the edges

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Step 3

The basic idea of the method is to solve the entire cube from here by just turning the 2 free sides. But if you try to do that, you soon discover that some edges are always twisted the wrong way. We call those the "bad" edges. We need to fix that before we move on. Step 3 is this fix.

Step 3 can seem incomprehensible before you "get" it, but it is really the simplest step in the method.

Beginner

If you don't like the beginner instructions, take a look at the intermediate ones. You may like that approach more.

Basically, we need to do 2 things in step 3.

1. Identify the bad edges.
There are 7 edges not part of the 2x2x3. Pick any one of them, say the red/blue one. Using only the 2 free layers (that is, not breaking up the 2x2x3), place it between the red and blue center pieces. If it's twisted right, it's good. Otherwise it's bad. That's all. Make a (mental or on paper) note of it, and check the next edge. When checking the second and later edges, **do not** try to keep the previous edges in place. It is not only extremely difficult, but also completely unnecessary. Once you know if an edge is good or bad, you know.

2. Turn bad edges into good edges.
There are always an even number of bad edges. You can make them good in pairs. The simplest way is the 3 move sequence shown to the right. Just place two bad edges in the positions of the colored edges, and do it. Check that your edges actually became good the first times, to be sure you're doing it right.

Continue until you're sure all edges are good.

Intermediate

Since we only want to know if an edge **would** be correctly twisted if it was placed in its correct location, we don't have to waste moves actually moving it there.

It is easy to see immediately which edges are mistwisted without moving them. Let's call the colors of the two remaining centre pieces A and B (red and white in the illustrations on this page). Ignore everything except the stickers on the (unsolved) edges that are either color A or B.

Here are the four rules to remember:

1. An edge in the A layer that has an A color sticker next to the center is **good**.
2. An edge in the A layer that has an A color sticker away from the center is **bad**.
3. An edge in the B layer that has an A color sticker next to the center is **bad**.
4. An edge in the B layer that has an A color sticker away from the center is **good**.
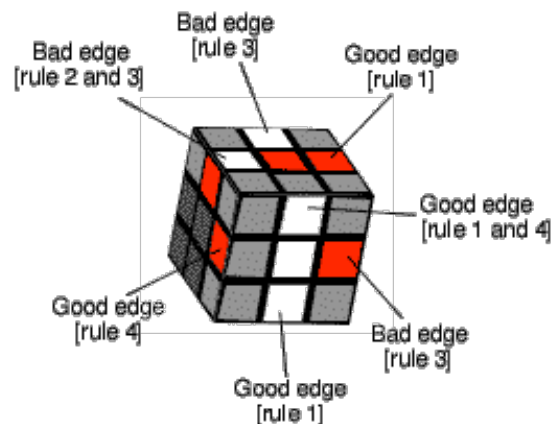
The usual advice applies in step 3 as well: Look ahead, and try to make a good beginning for the next step.

Advanced

Why does the move sequence in the animation above work? It's not just a "magic move". You can understand it. What happens is [1] one bad edge is flipped when moved to the other layer, [2] another bad edge replaces it, and is [3] (un)flipped when the first turn is reversed. Both edges get flipped in the process and so become good. Once you understand that, you can figure out several other moves that do the same thing.

I find that way of thinking much easier than just learning all cases by heart. However you want to learn them, **every** possible case is given the fastest solution in the links below.

2 bad edges | 4 bad edges | 6 bad edges

Next Step - Finish 2 layers

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Step 4

This is the hardest step, by far.

Or put in a more optimistic way, the other steps are pretty damn easy!

Beginner

What you do in this step is pretty much the same thing that you do in step 1 and 2. But here you have one hand tied behind your back. You have only two sides you can turn, and halfway through the step you can't even do many of those moves, since they would destroy what you already built in the step.

From the piece perspective, the goal of step 4 is to add 2 corners and 3 edges to the 2x2x3 block, to make it into a 2x3x3 block (or 2 full layers in other words).

You have a choice of two ways to expand, either leaving the red or the white layer for last. In the examples we will leave red, expanding with the white-green-orange and white-blue-orange corners and the white-blue, white-green and white-orange edges. We will have 12 of the 20 pieces solved after this.

It's best for the beginner to think of this step as two separate steps, **4a** and **4b**.

Step 4a

First focus on getting one corner and it's two adjacent edges in position. The same techniques you use in step 1 and 2 can be used, but since you can only turn two sides, more manouvering is needed. To do what you want, you first have to move the pieces in a position where the desired turns can be made on the two free sides.

Make sure to **only** turn the two unsolved sides! It can be easy to get lost and start turning other sides. Keep a firm grip around the 2x2x3 with one hand.

Note that you now have two completed 2x2x3 blocks! Remember which of them you started with. If you accidentally start using the other, bad edges **will** reappear, and you have to go back to Step 3. A firm grip of the 2x2x3 is at its most important now!

Step 4b

Putting the final 2 pieces in place without breaking anything is almost claustrophobic (there are a few other options (explained below)). Since you can't break up the "2x2x1" block you created in this 4a, you have no choices in how to the white side. You're forced to wiggle it back and forth, 1/4 turn all the time. So your only degree of freedom is to choose one of three possible turns with the red layer every other turn!

The normal way of doing this is to join the two pieces in the upper layer, and then put the pair in place, as in these examples (which are the continuations of the examples above).

0/4   0/12   0/8

A good thing about this step is that its many turns can be done [blindingly fast](), since we only turn the same 2 sides all the time, and never need to change grip.

Intermediate

If you can place the final corner by itself, it's often good to do so.

There are easy ways to put the final edge in position, by very briefly breaking up our previous achievements. For the mirrored positions, almost identical sequences apply. Note that the second one is a variation of Allan™ from step 7!

0/9   0/9
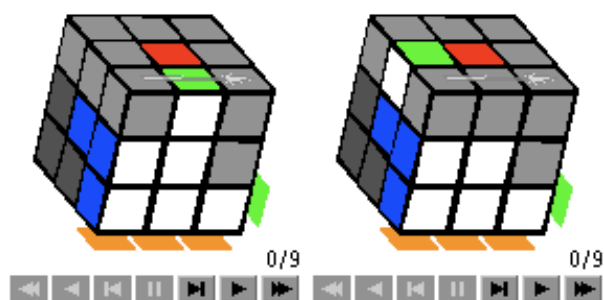
Advanced

The worst positions you can get is when the last corner and edge are next to each other, but misaligned (cube to the left). You **can** untangle the pieces and put them back together using only the "beginner" moves. But it is often faster to use a Sune™. A reverse Sune™ fixes the case when the corner is twisted the other way.

Check out the [examples page]() for a description of the ["broken corner"]() position, which is pretty common and good to know.

0/7 As an exercise, try to find how to do the the middle of the three example cube above in 6 + 4 moves instead of 10 + 12. 0/10
The solution is here to the right, but it's more fun to try to figure it out yourself.

Here are a few less than obvious 4b tricks. There are many more on the [Step 4b tricks page]()!

For more advanced techniques, check out the [block building page](#).

Next Step - [Position the corners](#)

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Step 5

Now we're at the final layer. Here we do not think as much. We recognise patterns and apply rules.

Common mistake: If the edges are not twisted right here, you have either not done [step 3](#) correctly, or screwed up the edges by breaking the 2x2x3 in [step 4](#).

When entering this step, you should have only one layer remain unsolved, and the edges in it already correctly twisted ("forming a cross"). In this step we will **place** the top corners correctly, nothing else. To do this we need a tool that moves the top corners without twisting the top edges. This tool is Niklas™, and you can see it to the right.

In the example, don't worry about how the corners get twisted, just note that the two white cornes swap position. (Turn 8 is just to align the corners to the centers to show clearly how the corners move. Niklas is a 7 turn sequence.)

Beginner

These are the odds:
1/6 of the time, the corners will already be correct. You can go to [step 6](#).
1/6 of the time, two corners diagonally opposed will have switched positions.
4/6 of the time, two adjacent corners will have switched positions.

First we need to find which two corners (if any) that have switched positions. That's easy. Just turn the top layer until two corners are in correct positions. The two others are either correct or need swapping. There are only four positions to check.

Niklas™ will swap the two corners opposite the layer where you make its first move. Two Niklas™es will solve the diagonal case. You can start with any Niklas™.

You **can** do this by just looking at the top layer corners, but I find it much easier to turn it so the colors match up with the rest of the cube. You waste a move but gain time.

Intermediate

The fast way to check corners that I use is to find two adjacent corners with the same (non top) color, and move them to the side of that color. If the corners are correct, all 4 will be in place. If adjacent corners are switched, two will be correct, and you can see which ones. If diagonal corners are switched, all four corners will be placed wrong.

Example: Start with the red/blue/white one. Red is the top color, so only blue and white are interesting. Start with blue. Check if any of the adjacent corners have a blue sticker. If so move those corners to the blue side. If not, do the same for white.
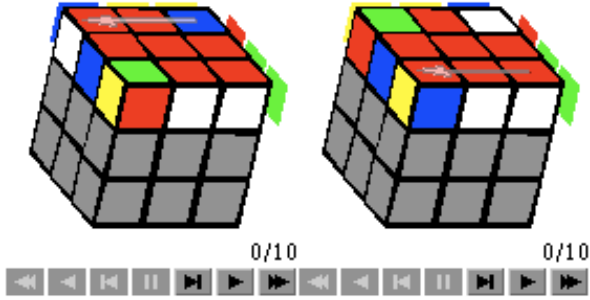
Here is a useful move sequence that directly switches two corners diagonally. It is a different (and as good) way of doing [Eve](#).

Note that Niklas™ twists the corners in the same way as Sune™ does, so the same "target" rules apply. A Niklas™ that hits a target starts with the same turn as a Sune™ that hits the same target. About half the time you can avoid one Sune™ this way.

Advanced

For the advanced cuber, the steps 5-7 meld together to one single step of dozens or even hundreds of special cases. To achieve real speed, you need to be able to remember them in a fraction of a second. Below are a few examples. For what to do for each of the 25 different corner cases, check out the [complete Step 5+6 index](#)

0/10   0/10

Next Step - [Twist the corners](#)

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[Step 1](#) | [Step 2](#) | [Step 3](#) | [Step 4](#) | [Step 5](#) | Step 6 | [Step 7](#) | [Examples](#) | [Block building](#)

Step 6

Beginner

So far we have the edges twisted right, and the corners placed right. The next step is twisting the corners right. This can all be done by one simple move sequence seen to the right. I call it Sune™. It twists three corners, leaving one untwisted. It also moves edges, but we don't care about that yet.

Step 6 can always be done with 2 Sunes or less. You do **need** to learn it to use this method.

To talk about how to use Sune™ we need to define the concept the Sune™'s **target**. The target of a Sune™ in the example is the yellow sticker. In words, the target is the sticker on the corner opposite the side of the first Sune™ turn that is left untwisted. Or in *other* words, the first turn of a Sune™ targets the sticker that (a) is on the opposite side from the side of the first turn, and (b) of the two corner stickers there, it targets the one on the side that is turned *up*.
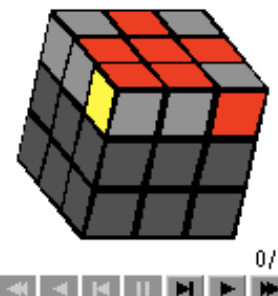
Once you've understood the target concept, you only have these three rules to keep in mind. If the final layer is red...

- ...with **no** correct corners, target a red sticker. This leaves one correct corner.
- ...with **one** correct corner, target like the animation on the top of page.
- ...with **two** correct corners, target a non red sticker of an incorrectly twisted corner. This leaves one correct corner.

Three corners is an impossible position, and four correct corners is of course the solved position.

Here are examples of zero, one and two correct corners. The target is yellow, or orange when it's both red and a target.
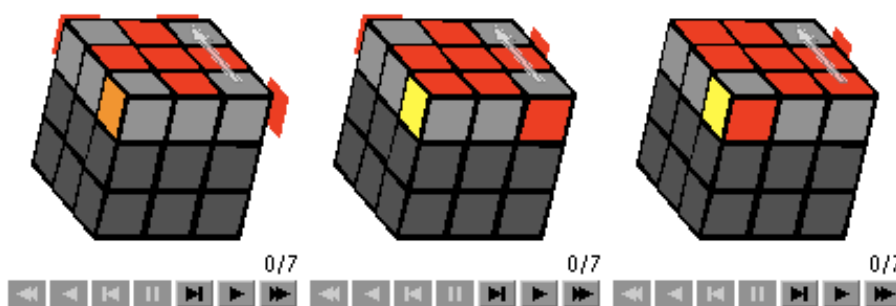
Intermediate

Doing Sune™ backwards and mirror imaged should also be on your repertoire. Which sticker is the target of a backwards Sune™ is left as an excercise for the reader.

Here are the two most useful other move sequences. The first is a double Sune, and the second is a Bruno.

0/11   0/9
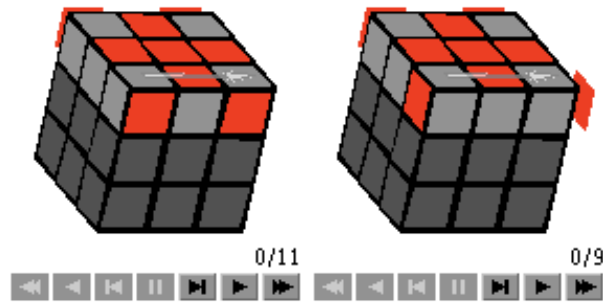
Advanced

You need to learn a lot of move sequences, and you need to learn to recignize them quickly. Most of the time there is a move sequence that solves this step directly, without going to step 7.

There are only 49 possible position here. Here are solutions to every single one.

Next Step - Position the edges

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Solution examples

13 annotated solutions

I hope this will provide the kind of understanding that disjointed theory steps can not. Like how I actually think when solving, what the considerations are, how much I can and can't see ahead, etc. The positions are random ones taken from the Sunday competition for the [Yahoo Speed Cubing club](#) on Nov 25 2001. This is of course not speed solutions. Each took me several minutes, and I think hard and study the cube very carefully for each turn. What I did not do was to try out several different options to see which one would lead to the best solution in the end. It's all based on what I can see and think ahead about when looking at a position. Sometimes I did check what alternatives would have resulted in afterwards, as you can see.

You can follow this fairly well by looking at the java cubes. I recommend stepping one turn at the time, and turning the cube around a lot (click and drag on the cube) to see where the pieces are. But the best way is to get the same position on your own cube, and go through the solutions there. You can do that by stepping backwards from the solved position, but I prefer taking the cube apart and putting it back together in the right state.

A few observations from doing this page:

- In the final turn of S2, I always check if I can flip a bad edge before or during it. About half the time I do. This is something I learned while going for few moves, but it's even more useful for speed cubing, since you can see and act on it immediately. You can see this in examples 4, 5, 6, 7, 8, 10 and 12
- One position that comes up a few times is the one to the right. Let's call it "Broken corner". It's very useful in S4, but also in S1 and S2. It's well worth memorizing. It's in examples 2 and 4
- Surprisingly, for 7 of the 13, I solve S1+S2 in one go, instead of doing S1 and S2 separately. For most of them I didn't do that because it looked so good, but because the S1 situation looked so bad. Still the S1+2 solutions averaged 9.2 moves vs 11.5 for the normal cases, even though they started out from a worse position. Maybe that's coincidence. But I doubt it. When speeding I don't do nearly as much S1+2 starts. They're often far too complicated to plan out in 15 seconds.

Acronyms etc:

S1, S2... = Step 1, Step 2
T1-7 = Turn 1-7
YB edge = Yellow-Blue edge
BWO corner = Blue-White-Orange corner
RY/B pair = Red-Yellow edge and Red-Yellow-Blue corner
[P13/3] = The perfect solution is 13 turns, and would save 3 turns. I don't use it since I don't know it.
T16 = When I merge the final turn(s) of one step with the first in the next, I indicate that with blue turn counters. I hope it's not too confusing that some steps never seem to get completed. They are complete in my head!

Example 1

- **T1-7. S1.** Several 7 turn corners available. I could easily start with another.
- **T8-10. S2.** The BWO corner is the obvious choice, but BYR is also excellent.
- **T11-15. S3.** 4 bad edges. It's tempting to try

Example 2

- **T1-4. S1.** The existing BW/O pair makes this the obvious start.

to preserve the RY/B and/or OG/Y pairs, but it's rarely worth it. I just go straight for the bad edges.

- **T16-24. S4.** A simple S4 with no real choices except in T21, where you can pick either of 2 options. The other leads to a 44 move solution the way I usually do it.
- **T25** makes it easier to see the corners. **[P13/3]**
- **T26-33 S5+6** is a fundamental move to solve S5-6 for this corner config
- **T33-41 S7** Arne (A2)
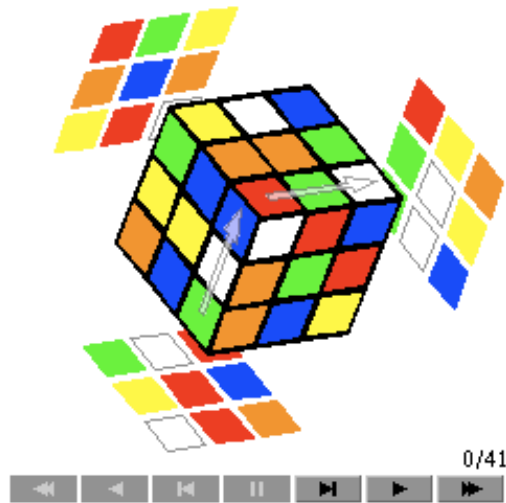
Example 3

- **T1-8. S1+2** The RY/B pair gives an obvious starting point. Luckily, that also forms the OY/B pair, and with some unusual moves I can fix both S1 and S2 simultaneously. If you pick a half turn instead of the quarter turn in T6, you get the beautiful solution to the right (uses perfect B4), but that's hardly possible to see then.
- **T9-13. S3.** With both the BW/R and OW/R pairs already formed, you'd think there was some clever way to do S3 and S4 in one sweep, but I can't figure one out. So I just fix the edges without breaking the pairs.
- **T14-20. S4.** It's too hard to preserve both blue pairs. I just do the simple one, luckily, the other falls right into place.
- **T21-27 S5-6.** is solved with a Niklas. The perfect FL solution is 12 moves, 4-5 moves faster.
- **T28** color adjustment.
- **T29-37 S7.** Allan (A4)

- **T5-10. S2.** The BYO corner is a little easier than the other two
- **T11-15. S3.** There are 2 ways to fix these bad edges in 5 moves. They look equally good to me. I pick one on random.
- **T16-29. S4.** Nothing too obvious here, so I go for the GOW "broken corner".
- **T30** makes it easier to see the corners.
- **T31-40 S6+7.** (no S5) Bruno (G4)
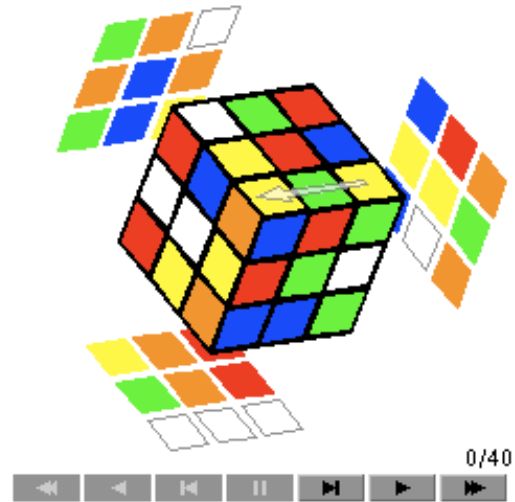
Example 4

- **T1-9. S1+2** There are two good pairs to start from. I pick the GO/W, since the first turn also forms the GR/W pair. Some original thinking lets us do both S1 & S2 at once.
- **T9-15 S3.** 2 bad edges left after.
- **T16-26. S4** GRY is a "broken corner".
- **T27** color adjustment.
- **T28-34 S5.** A Niklas does S5 and sets up the corners in Sune position. Niklas twists corners like Sune, so the "target" rules from S6 apply.
- **T35-41 S7.** I end with a Sune (B5) **[P11/3]**
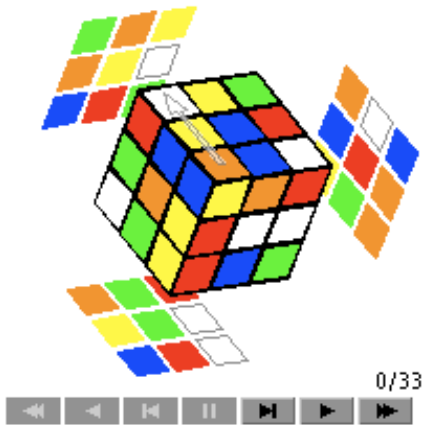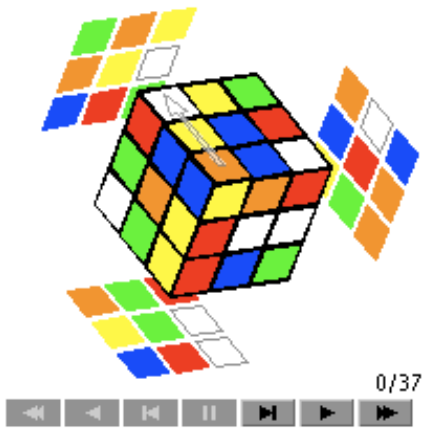
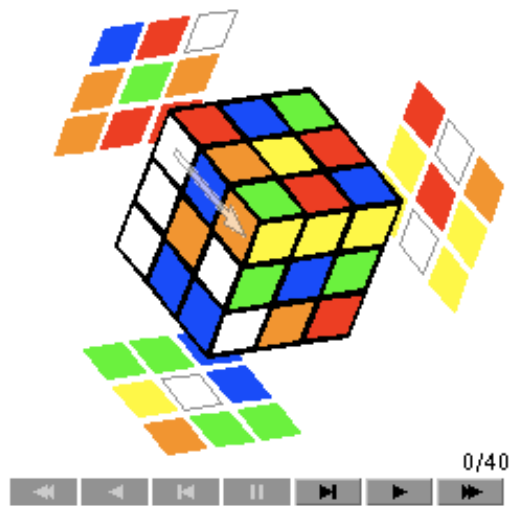## Example 5

- **T1-5. S1.** Despite WO/G being done, it needs 7 moves. YOB is the only decent corner to start with.
- **T6-12. S2.** All 3 corners suck. BWO looks a little more fun.
- **T12-20 S3.** There are 4 equally good ways to do T17. One day I might show all four here.
- **T21-31 S4.** All the other corners look downright hostile, so I start with the RYB one (OK, OYG has some promise too). T25 is key! Forming RW/B midway is unusual, but works great here.
- **T31-40 S7.** (No S5 or S6) Allan (A4). A great ending of a problematic solve. Bypassing S5 & S6 is just luck. I'm not **that** good!
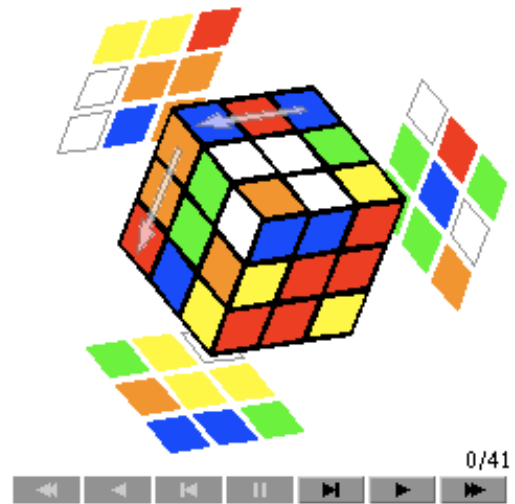
Example 6

- **T1-9. S1+2.** The GO/Y pair is "stuck", so I start for the GOW corner instead, while preserving the pair. With some very careful maneuvering in T4&T5 it all falls in place very nicely.
- **T9-14. S3.** I pick a half turn in T10 to preserve the RW/G pair
- **T15-27 S4.** GRW is the obvious corner for S4a. I make sure to split up the malformed GR/Y pair while building GRW. For T24 I can pick one of two turns, and do the one that gives a better corner configuration.
- **T28-34 S5+6.** Niklas
- **T35-43 S7.** Allan (A4)

0/40

Example 7

- **T1-12. S1+2.** Only bad corners here. The WO/B pair is awkardly placed. The best I can come up with is to do the YOB corner, while preserving the WO/B pair, and try to keep things together. 12 moves is good for such a bad start.
- **T12-19. S3.** 6 bad edges needs 7 moves. The third move you can go two ways, but I can't say which one is better.
- **T20-33 S4.** One of the 4 corners is slightly less bad than the other 3. In T20 I choose the move that separates the misformed BR/Y pair. In T30 I can go two ways. They look equally good (the other also ends in 52, but I didn't know that)
- **T34-41 S5+6.** This handy move solves this corner configuration for S5+6.
- **T41-52 S7.** Bert (A3).

0/43

Example 8

- **T1-7. S1.** This one was painful! The GW/R pair looks great, but can't be completed in under 8 moves. The others don't look any better. The best I can find is this 7 mover for OYG
- **T8-10. S2.** I kept an eye at WOG during S1, and made sure it was in good position. T5 was key. .
- **T10-12 S3.** Only 2 bad edges.
- **T13-24 S4.** YBO is the obvious choice for S4a. Very standard S4b move.
- **T25-31 S5.** Maybe my least favorite corner config. There's a 13 turn S5+6 sequence that I don't know... So I do a Niklas.
- **T32-41 S6+7.** A lucky Bruno (G4). These can go much worse.

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Example 9

- **T1-6. S1+2.** GO/Y *looks* like the perfect start,

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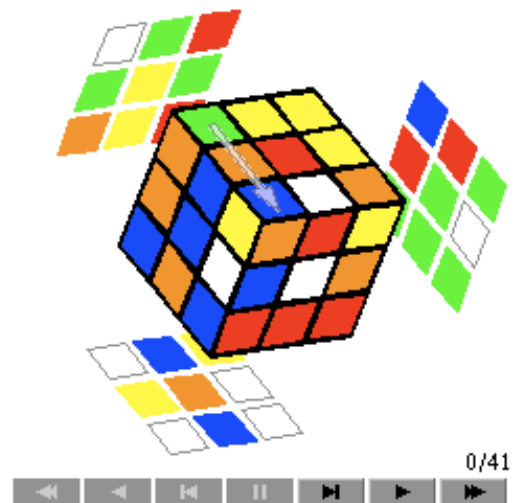
Example 10

- **T1-7. S1.** One of several 7 move options.
- **T8-14 S2.** One of several mediocre options.

but if you look more you see that you can build GR/Y first, while keeping the GO/Y pair intact, and do S1+2 as fast as you could do just S1 with GO/Y.

- **T7-12. S3.** In T10 I can go two ways, this one is best for the RGW corner
- **T13-23 S4.** Both RGW and BOY look good. RGW is 2 moves shorter.
- **T23-32 S5+6.** One of the 2 diagonal corner swaps I know.
- **T32-40 S7.** Arne (A2)

0/40
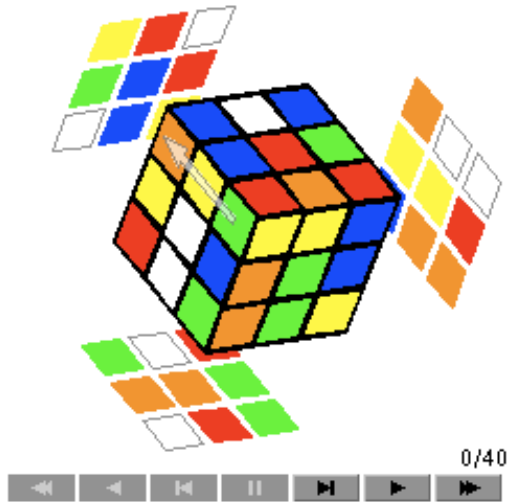
Example 11

- **T1-10. S1+2.** It's clear that RWG and OWG are the corners to go for. How to get there quickest is trickier. There may be a shorter solution.
- **T11-18 S3.** 3 moves longer than needed to preserve the 2 pairs. It seems worth it.
- **T19-25 S4.** The pairs work. I primarily build on the RWB trio, but the RY/G pair gets nicely built up using the same moves.
- **T26-36 S5+6+7.** Well known Niklas plus Sune (B5) case. 7 + 7 = 11 when the sequences melt together. **[P10/1]**.

- **T14-18 S3.** The only way.
- **T19-23 S4a.** RGW looks slightly better than the others
- **T20** Quarter turn instead of half turn to break up the problematic RB/W pair.
- **T28** Half turn instead of quarter turn gives better final layer position
- **T24-31 S4b.** Simple standard move that uses many turns.
- **T32-39 S5+6.** My standard move for this corner position.
- **T39-51 S7.** Bert (A3)

0/51
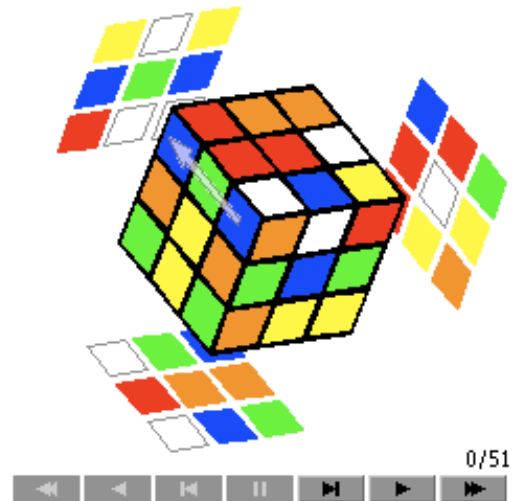
Example 12

- **T1-7. S1.** BRY is one of several 7 move solutions.
- **T8-13 S2.** BRW is the least bad alternative.
- **T13-20 S3.** I have to work for it here too.
- **T21-31 S4.** GRY looks best.
- **T32-45 S6+7.** No S5. G3. **[P12/2]**

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0/45
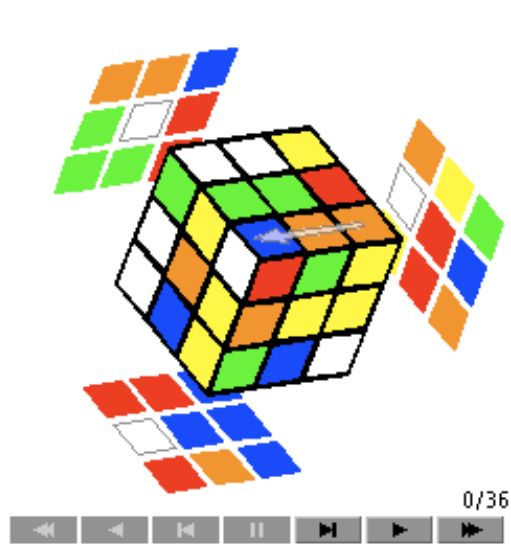
Example 13

- **T1-10. S1+2.** A few 6 turn corners. I picked one at random. Midway I decided to do S1+S2. T5-6 sets up S2 in mid S1.
- **T11-15 S3.** Textbook S3.
- **T16-28 S4.** No easy pickings. I do the easiest corner the hard way.
- **T29** Color adjustment
- **T30-40 S5+6.** My standard move for this corner position. **[P13/6]** (131).
- **T40-48 S7.** Allan (A4)
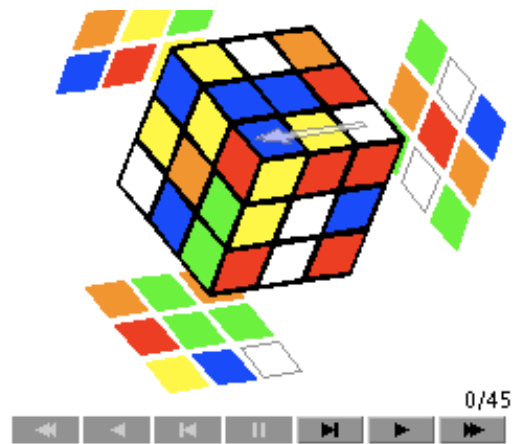
- **Statistics**
- S1+S2: 10.2 turns
- S3: 5.6 turns
- S4: 11.3 turns
- S5-7: 15.4 turns
- Total: 42.5 turns
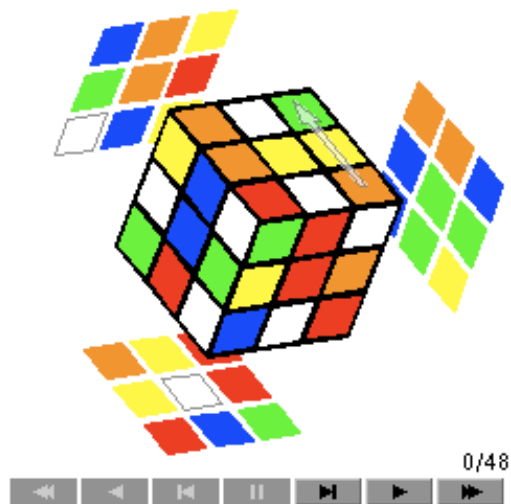
0/48

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Block building patterns

The core of this method is to build blocks. It is what steps 1, 2 and 4 are all about. This can be done intuitively, but with experience you will pick up some patterns you can immediately recognize, which is one of **the** keys to doing this fast.

Here are some of my favorite patterns. I hope they can be of help. I'll add some more when I think of good ones.

"simple join"

This is trivial in a way, but I don't want to overlook it since it is really the one I use the most. It's the second thing I start looking for on a mixed cube, if there are no already formed pairs. And it is the basis for a lot of my block building - if I have nothing better to do, I start doing or preparing **simple join**s, and that makes things happen. It simply consists of finding a corner and edge that are one move away from forming a pair.
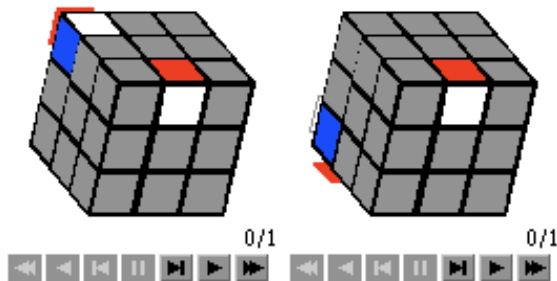
"double join"

Also very basic and very useful. It doesn't "just happen" as much as a **simple join**, but it's the most common second goal once you've formed a pair. Since we're building a 2x2x1 block a center needs to be part of it, as well as the corner and 2 edges.
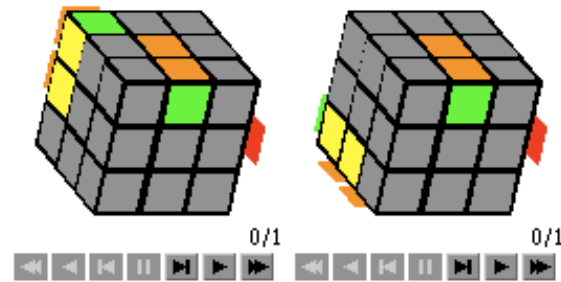

"double swing"

This is a very good Step 1 start, and it sometimes happens in Step 2 as well. Again, this is a two move setup for a **double join**, but while it's good to be aware of that, I think you have to recognize it on its own. While it is fairly rare in this pure form, you can quite often get there with one or two setup moves (see below).
Since it's symmetric, you can do it in two ways, as shown. But if the edges are switched, things look very similar, but you have a fairly awkward 6 move solution instead.


"swing"

Brilliant when you can get it. That's pretty often for S1, and occasionally in S2. If you want to think of it that way, the first move is just a setup move for a **double join** in the second move. Both the lone edge and the pair can be in other positions, as in example 2.

0/2   0/2

0/3   0/3
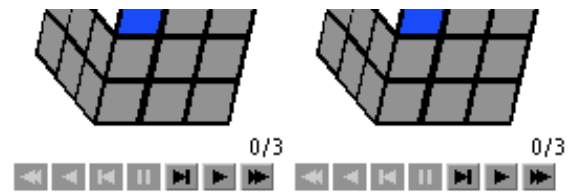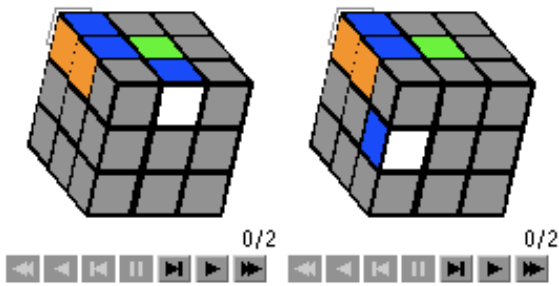
Two of **many** examples of similar positions or setups. There's a lot of positions that are very close, and it's hard to recognize them all.


0/3   0/4
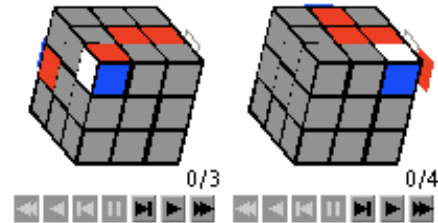
"roundabout"

This is almost only useful as a start of Step 1. If there is no corner/edge pair already formed, there is usually one of these available to form one in 3 moves. There are always ways with fewer moves as well, but these are very easy to spot.

While useful in themselves, they get really interesting if you can "pick up" one of the other edges on the way (example 2 & 3). In those cases, since you're building a 2x2x1 block, the center needs to be in the right place as well. If you allow one setup move (Examples 4 & 5), it's a fairly common start.

"parallell roundabout"

This one is not very common, but it *is* very cool, so it gets it's own entry.

In Step 4, the **roundabout** becomes the fairly tortured sequence to the left. Sometimes I have no better ideas, and do it just make something happen. But occasionally you'll get the situation on the right, which is in fact two roundabout situations at the same time, and the same sequence solves both. Hehe!!

0/3   0/3   0/3

0/3   0/4

0/5   0/6
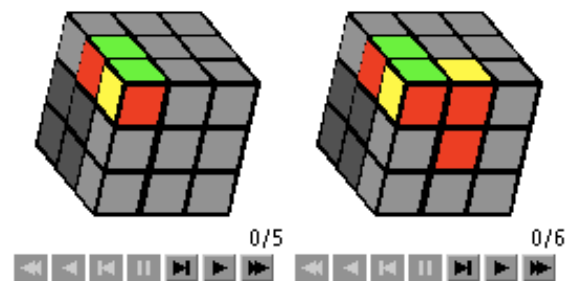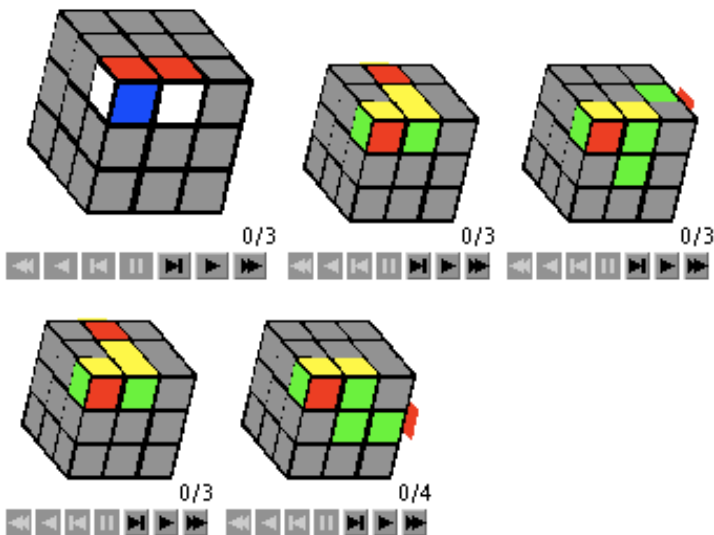
"broken corner"

One of my favorites in Step 4, but it can of course occur earlier also.

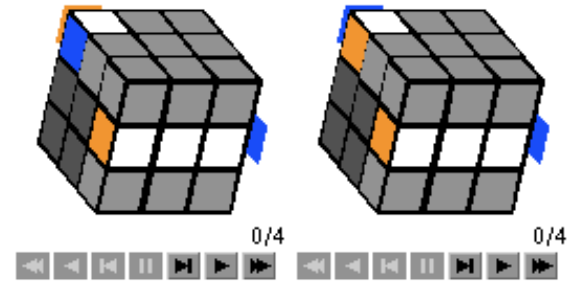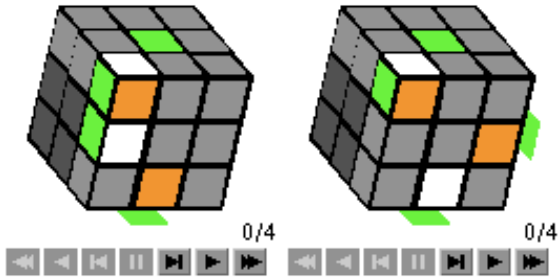This is just something you learn to recognize. But in the position *after* the first move, you should be able

"pillar"

to "smell" that the next move sets up the corner for two **simple join**s that adds up to a **double join**. Once you're good at block building, that is - no hurry!

To the right is the same idea with a half move as second move.

0/4

0/4

This Step 4 trick is fairly common, and very easy to spot. This is again a setup for a **double join**.

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0/4

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