

Intermediate Solution to the Rubik's Cube

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Images by Jasmine Lee, Lance Taylor, and Speedsolving.com

Introduction

There are many different methods for speedsolving the Rubik's cube. The one you will be learning here is the Jessica Fridrich Method, also known as CFOP (Cross, F2L, OLL, PLL). It is just a step up from the beginner's method, using intuitive pairing and more algorithms.

Extended Notation

In addition to L, R, F, B, U, and D, there will be more notation.

- x , y , and z denote rotations of the entire cube. x goes with R. x' goes with R'. Imagine doing an R turn, but rotating the whole cube instead of the layer. (cont.) y goes with U. y' goes with U'. z goes with F. z' goes with F'.
- A lowercase letter (l , r , f , b , u , d) denotes a turn of that kind including the middle layer (double layer turn). r would be the equivalent of L x . d' would be the equivalent of U' y .
- M is the middle layer/slice between the L and R layers. If you turn the M slice, the only sides not disturbed are L and R. M goes like an L. M' goes like an L'. M2 is just a double turn.

Learn about more notation here: <http://www.worldcubeassociation.org/regulations/#notation>

The Solution

The Cross

The Cross in the Intermediate method is the same as in the Beginner's method. But what you want to start working on is lowering your move-count for the cross. In WCA competitions each competitor is given 15 seconds of inspection time before he/she starts the solve. When you're practicing to get faster at home, you should use that 15 seconds to plan out your cross. You should find what cross you want to start on by looking for edges that are already matched up (e.g. if you see that one edge is already solved on the yellow face, you should consider starting with yellow cross).

After you have found the cross you want to start with, you should plan out the exact moves you would perform to solve that cross. Now there are two ways you should plan out your cross. Your solution to the cross should be either move-optimal or speed-optimal. A move-optimal cross solution is the one with the fewest moves needed to solve that cross. A speed-optimal cross solution would be one that can be performed the fastest, being finger trick friendly. Often the best cross solution would be a mix of move-optimal and speed-optimal. What I do is find a move-optimal solution, then tweak/ make small changes to it so that the solution can be done quickly (sometimes the move-optimal solution is also speed-optimal, and vice versa).

Also, another thing you want to start doing is solving the cross on the bottom, the D face. When you're solving with cross on bottom you can see the U layer and look ahead into F2L. With this view your brain can plan out your next step while your fingers solve the cross. This will come with practice. If you're having trouble solving the cross on bottom, one thing you can do is rotate the cube while performing your cross solution so that when you're done, the cross ends up on the bottom anyway, and you don't have to do a cube rotation in-between Cross and F2L.

F2L (First 2 Layers)

F2L is a concept of solving the first layer corners and the second layer edges at the same time. There are four first layer corners and four second layer edges, making four F2L slots being solved in this step. What you'll be doing is, while holding your solved cross on bottom, pairing up matching first layer corners (the ones with the cross color on them) with the second layer edges (the ones without the last layer color on them). After pairing them up, the pair will be inserted into the correct F2L slot. This process will be repeated three more times for the three remaining pairs.

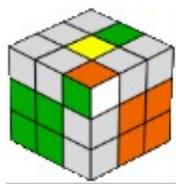
There are two ways to solve the F2L in the Jessica Fridrich method: First we have what's called an intuitive F2L, in which the solver identifies all situations as one of three elementary cases. Since this is done by intuition, any variations or mirrors of those elementary cases can be easily taken be accounted for with this method, so there are very few 'difficult' situations. Secondly, we have algorithmic F2L (or Full F2L) in which the solver identifies each situation as one of forty-one possible cases. Most intuitive solvers, given enough time, will eventually find the 'ideal' set of moves for most cases, but there are some algorithms that are non-intuitive that are also very fast. For this reason, advanced solvers tend to trade in their intuitive F2L for a more algorithmic F2L. In this Intermediate method you will using Intuitive F2L.

"Intuitive F2L is easy to learn, and much faster compared to the beginner's method. This is the biggest step you will ever take in getting faster at the Rubik's cube. The basic idea is that all cases can be boiled down to just 3 cases and their mirrors."



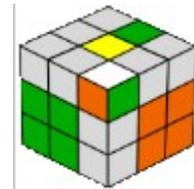
Same on Top

$U' R U^2 R' U^2 (R U' R')$



Opposite on Top

$R U R'$



Bottom Color Up

$U R U^2 R' U R U' R'$

"Please note that this is not an algorithmic method. I provide the algorithms above so that you can do it a few times, and *watch* why it works. Once you understand how the algorithms above work, you will be able to use similar moves to solve the "3 main cases" (For each of the 3 main cases, there are 4 different possible arrangements, so just knowing the the algorithms above will NOT work. You must do a slightly different moves for each case.)

The rule is that you have to have both the corner and it's corresponding edge together in the top layer, but not touching each other. If these conditions are met, the algorithm that you need to place the pair will be one of the following three cases (or something very similar)."

- Lance Taylor, blueknightcubing.com

Here is a very good F2L video tutorial by badmephisto:

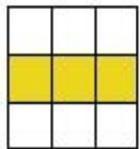
<http://www.youtube.com/watch?v=k-xbcAMfWwM>

I highly recommend watching this if you are having trouble with Intuitive F2L.

OLL (Orientation of the Last Layer)

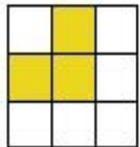
For the Intermediate method, you are going to be doing 2-Look OLL. The "2 looks" are the two algorithms you are going to use each time you do OLL. One alg for the edges, one for the corners. That means you will need to know all 3 edge cases and all 7 corner cases. You should already know the edge cases and two of the corner cases, but if you don't, here are all of the algorithms you will need to know to do 2-Look OLL.

When you get to OLL, you will first orient the edges, using one of these three algorithms. If all four edges are already orientated, move on to orienting the corners.



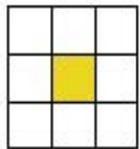
State 1

F R U R' U' F'



State 2

F U R U' R' F'

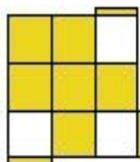


State 3

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

(State 2) alignment (State 1)

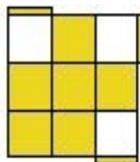
After all the edges are oriented, then you will orient the corners using one of these seven algorithms. If all four corners are already oriented, move onto PLL.



State 1.

R' U' R U' R' U2 R

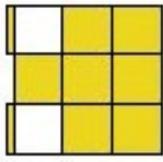
This algorithm is known as the Anti-Sune.



State 2.

R U R' U R U2 R'

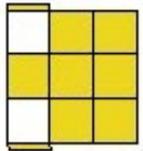
This algorithm is known as the Sune.



State 3.

$(R U R' U') (R U' R' U^2) (R U' R' U^2) R U R'$

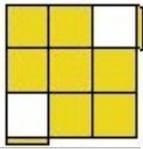
This algorithm is sometimes called the Superman.



State 4.

$r U R' U' L' U R U' x'$

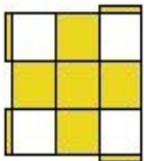
This algorithm is sometimes called the Chameleon.



State 5.

$x U R' U' L U R U' r'$ (*this is just the Chameleon backwards*)

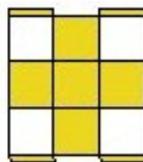
This algorithm is sometimes called the Triple Sune.



State 6.

$R U^2 R^2 U' R^2 U' R^2 U^2 R$

This algorithm is sometimes called the Bruno.



State 7.

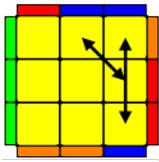
$R U^2 R' U' R U R' U' R U' R'$

This algorithm is sometimes called the Double Sune.

PLL (Permutation of the Last Layer)

Just like OLL, you are going to be learning 2-Look PLL. That means you will be doing a 4-Look Last Layer (2-Look OLL, 2-Look PLL). For 2-Look PLL, you are going to need to know the 2 corner cases (you should already know 1 of them), and 4 edge cases (you should already know 2 of them). There are other PLLs you could learn now, but all you *need* to know are these 6.

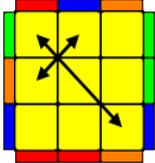
When you get to PLL, you will first permute the corners, using one of these two algorithms. You'll notice that both of these algs not only swap two corners, but also two edges. When you're setting up to do one of these algs, don't worry about where the edges are because you will solve them in the next step.



State 1. Adjacent Corners Swapped

L U' R' U L' U2 R U' R' U2 R

This algorithm is known as the L Perm (Sometimes Ja Perm).

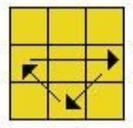


State 2. Opposite Corners Swapped

F R U' R' U' R U R' F' (R U R' U') (R' F R F')

This algorithm is known as the Y Perm.

After all the corners are solved, then you will permute the edges using one of these four algorithms. If all four edges are already permuted, then you are done!

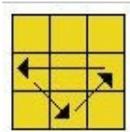


State 1

**R2 U R U R' U' R' U'
R' U R'**

This is the Ua Perm. It cycles 3 edges clockwise:

UR>UF>UL

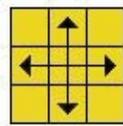


State 2

**R U' R U R U R U' R'
U' R2**

This is the Ub Perm. It's just the Ua Perm backwards. It cycles 3 edges anti-clockwise:

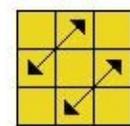
UL>UF>UR



State 3

M2 U M2 U2 M2 U M2

This is the H Perm.



State 4

**M2 U M2 U M' U2 M2
U2 M' U2**

This is the Z Perm.

That is the Intermediate Fridrich Method. With practice you should be able to get times under 30 seconds, or even faster. Improving at F2L will drop the most time off your solves, so make sure to practice F2L a lot. At first your times will be slower than what you got with the Beginner's method, but once you have gotten used to this method, your times will drop rapidly.

Next Steps

If this intermediate method is too easy and boring for you then check out the following. Find the Advanced solution here: cubeflip.webs.com/solutionsdownloads

http://www.speedsolving.com/wiki/index.php/Main_Page Wikipedia for cubing? Very helpful.

http://www.speedsolving.com/wiki/index.php/Competitions_General Information about Official WCA (World Cube Association) Rubik's Cube Competitions!