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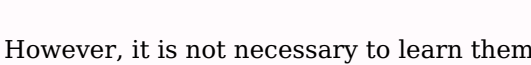**I'm not robot!**

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Orientation of Last Layer (RU'U')(R'2FRF')U2(R'FRF') F(RUR'U')F'f(RUR'U')f' f(RUR'U')f'U'F(RUR'U')F' f(RUR'U')f'UF(RUR'U')F' (r'U2)(RUR'U)r (rU'U')(R'U'RU'r') (rUR'U)(RU'U'r') (r'U'RU')(RU'r2) (RUR'U')(R'F)(R2UR'U')F' (RUR'U)(R'FRF')(RU'U'R') (r'R2UR'U)(RU'R'U)M' M'(R'U'RU')(R'U2RU')M f(RU)(R2U')(R'URU')f' (R'F)(RUR'F'R)(FU'F') (r'U'r)(R'U'RU)(r'Ur) (rU2r')(RUR'U)(rU'r') (iU'f)(R2BR'UR'U'f') (rUR'U)(RU'U'r)(r'U'RU')(R'U2r) (r'RU)(RUR'U'r)(R'2FRF') (rUR'U')M'2U(RU'R'U)M' (RU'U')(R'U'RUR'U)(RU'R') (RU'U')(R'U2')(R2U')(R'2U')(U'R) (R2D')(RU'U'R'D)(RU'R) (rUR'U')(r'FRF') F'(rUR'U')(r'FR) (RU'U')(R'U'RU'R') (RUR'U)(RU'U'R') (rUR'U')(r'FRF') F'(rUR'U')(r'FR) (RU'U')(R'U'RU'R') (RUR'U)(RU'U'R')(r'FRF') (RUR'F'U')(R)(U2R') (R'F)(RUR'U')F'(UR) (RUR'U')R')F(RUR'U')F' (R'U'RU')(R'U2R)F(RUR'U')F' (B'U')(R'URB) f(RUR'U')f' F(RUR'U')F' (R'U')(R'FRF')U R) b'(U'R'URU2b F(RUR'U')2F' (RB')(R'2FR2B)(R'2F'R) (r'U)(r2U'r'2U')(r2Ur') f(RUR'U')2f' (R'F'U'FU')(RUR'UR) (r'U2)(RUR'U')(RUR'Ur) (rU'U')(R'U'RU)(R'U'RU'r') (rU'U'R'U')(r'R2UR'U')(rU'r') (rUr')(URU'R')2(rU'r') (RUR'U')M'(URU'r') Scan this QR code to download the app now Or check it out in the app stores Method in speedcubing The CFOP method (Cross – F2L – OLL – PLL), also known as the Fridrich method, is one of the most commonly used methods in speedsolving a 3x3×3 Rubik's Cube.

This method was first developed in the early 1980s combining innovations by a number of speed cubers. Czech speedcuber and the namesake of the method Jessica Fridrich is generally credited for popularizing it by publishing it online in 1997.[1] The method works on a layer-by-layer system, first solving a cross typically on the bottom, continuing to solve the first two layers (F2L), orienting the last layer (OLL), and finally permuting the last layer (PLL). There are 78 algorithms in total to learn for OLL and PLL but there are other algorithm sets like ZBLL and COLL that can be learned as an extension to CFOP to improve solving efficiency. History Basic layer-by-layer methods were among the first to arise during the early 1980s craze, such as James Nourse's The Simple Solution to Rubik's Cube which proposed the use of a cross, and worked its way down. David Singmaster published a faster layer-based solution in 1980.[2] The major innovation of CFOP over the simpler LBL methods is its use of F2L, which solves the first two layers simultaneously by solving top-corners and vertical edges together after the Cross is established. According to Singmaster's report on the 1982 World Rubik's Cube Championship, this step was not invented by Jessica Fridrich, who was then using a basic layer method. Another difference between the CFOP method over Nourse's simple solution is that it orients the Last Layer first, and then positions the pieces. In the simple solution, the pieces are positioned first, and then oriented. The last layer steps OLL (orient last layer) and PLL (position last layer) involve first orienting the last layer pieces, then permuting them into their correct positions. This innovation was proposed by Hans Dockhorn and Anneke Treep. Fridrich switched to F2L later in 1982. Her main contribution to the method was developing the OLL and PLL algorithms, which together allowed any last layer position to be solved with two algorithms and was significantly faster than the previous last layer systems.[3] CFOP, with small tweaks, is by far the most popular method that top cubers use. Users include Mats Valk, Feliks Zemdegs, Tymon Kolasiński and Max Park. Method Cross solved (White on bottom) Cross This first stage involves solving the four edge pieces around one center, matching the colors of that center and each of the adjacent centers, forming the eponymous cross shape on the first layer. Most beginner methods start in identical fashion, so this step will be familiar, however while the beginner method typically recommends looking at the cross while solving it, most CFOP tutorials recommend solving the cross on the bottom side to avoid cube rotations and to get an overall better view of the important pieces needed for the next step (known as "lookahead"). This step is usually performed intuitively, with competition speedsolvers given up to 15 seconds to inspect the puzzle, most of which is spent planning the most efficient moves to create the cross. The white cross is most commonly used for demonstration and by beginner and intermediate speedsolvers, though more advanced speedcubers can use any of the six colors to form the cross (choosing the one that requires the fewest/easiest moves), a practice known as "color neutrality".[4] First Two Layers (F2L) solved First Two Layers (F2L) While the Nourse method focuses on solving the four white corners and then matching the vertical edges to the corners, the CFOP method solves each corner along with its vertical edge at the same time. There are 41 unique cases for the permutations of a corner and its matching edge on the cube, and the most efficient algorithm to solve each case without "breaking" any already-solved pair is known and can be memorized. All these algorithms are based on a simple sequence which brings the pieces to the top layer, aligns them with the color faces showing, and then inserting them into the pair's "slot" between the matching centers. This sequence can be intuitively followed, and there are special cases that can improve on the general-case solution for a pair if other conditions are met (such as another slot being unsolved or "open"). Orientation of the Last Layer (OLL) complete Orient Last Layer (OLL) This stage involves manipulating the top layer (yellow, if the cross is solved on white) so that all the pieces have the correct color on top, while largely ignoring the sides of these pieces. This stage involves a total of 57 algorithms, each solving a unique permutation of the top layer in a single sequence. A simpler version, called "two-look OLL", orients the edges first to produce a cross, then uses a second algorithm to orient the corners. Many beginner methods use OLL algorithms from CFOP, so this stage is often familiar to beginner solvers. True two-look requires only ten algorithms, typically named for the shape or "case" shown by the top-color facelets that is solved by the algorithm. Three algorithms - Dot, L and Line - are used for edge orientation, and seven - Sune, Antisune, Pi, H, Bowtie, Headlights and T - for corner orientation. Edge orientation in two-look is commonly taught as two algorithms, one of which is a simple variation of the other; the Dot case is solved by performing both algorithms consecutively.

Additionally, the required algorithms for corner orientation can be reduced to just two, the Sune and Antisune, as all other permutations can be solved either by performing two Sunes or a Sune followed by an Antisune. Additional algorithms, more efficient than the Sune-Antisune sequences, can be learned at the solver's own pace. Permute Last Layer (PLL) The final stage involves moving the pieces of the top layer while preserving their orientation. There are a total of 21 algorithms for this stage. They are distinguished by letter names, often based on what they look like with arrows representing what pieces are swapped around (e.g., A-perm, F-perm, T-perm, etc.). "Two-look" PLL solves the corners first, followed by the edges, and requires learning just six algorithms of the full PLL set. The most common subset uses the A-perm and E-perm to solve corners (as these algorithms only permute the corners), then the U-perm (in clockwise and counter-clockwise variants), H-perm and Z-perm for edges. However, as corners are solved first in two-look, the relative position of edges is unimportant, and so algorithms that permute both corners and edges can be used to solve corners. The J, T, F, and R-perms are all valid substitutes for the A-perm, while the N, V and Y-perm can do the same job as the E-perm. Even fewer algorithms can be used to solve PLL - as few as two, such as the A-perm and U-perm - at the expense of having to repeat these algorithms to solve other cases, with additional "looks" to identify the next step.[5] Skipped stages Depending on the initial state of the cube and the exact moves made in previous stages, it is possible to complete one stage in such a way that the next stage is also already complete. This is known as a "skip", commonly referred to specifically by the stage that isn't required in the solve. A "PLL skip" is the most common, occurring (when "unforced") approximately once in 72 solves, followed by an OLL skip with a 1 in 216 chance to occur.

A combination of the two, a full "Last Layer Skip", occurs approximately once in 15,552 solves. The Cross and F2L stages of a competition-legal scramble are almost certainly not skippable, though a scramble may present the solver with "free" cross pieces or F2L pairs that are already solved or matched. As speedsolving time is closely related to the number of moves required, any opportunity to make fewer moves presents a significant advantage to the solver. Many speedsolvers have the ability, falling under the general skillset of "lookahead", to identify the likely permutation they will see for the next stage based on the progress of the current stage, and they can vary their solution to avoid permutations that require more moves or an algorithm they are slower to perform. This same ability can allow the solver, in specific known scenarios, to "force" a stage skip with a particular sequence of moves to solve the remainder of the current stage; for instance, by recognizing a particular OLL permutation and performing a specific OLL algorithm, the solver can simultaneously solve PLL, effectively obtaining a PLL skip.[6] There also exist many advanced extension algorithm sets to be used alongside CFOP, such as COLL,[7] Winter Variation,[8] VLS, ZBLL, and more.

However, it is not necessary to learn them in order to solve the cube or to use the CFOP method. Competition use CFOP is heavily used and relied upon by many speedcubers, including Max Park, Feliks Zemdegs, and Tymon Kolasiński, for its heavy reliance on algorithms, pattern recognition, and muscle memory, as opposed to more intuitive methods such as the Roux, Petrus, and ZZ methods. The vast majority of top speedcubers on the WCA ranking list are CFOP solvers, including the current 3x3x3 single world record holder Max Park with the time of 3.13 seconds.[9] References ^ Shotaro "Macky" Makisumi. "Speedcubing". cubefreak.net. Archived from the original on 2007-07-03. Retrieved 2007-08-31. ^ "Beginner's Rubik's Cube Solution". Archived from the original on 26 September 2015. Retrieved 15 June 2012.

^ Fridrich, Jessica. "20 years of speedcubing". Retrieved 15 June 2012. ^ "Colour Neutrality". ^ Zemdegs, Feliks. "2-look last layer". Cubeskills. ^ "PLL Skip Cases - Sarah's Cubing Site". Retrieved 2022-12-16. ^ "COLL". jperm.net. Retrieved 2022-09-18. ^ "Winter Variation". jperm.net. Retrieved 2022-09-18. ^ "WCA Live". live.worldcubeassociation.org. Retrieved 2023-06-12. External links Jessica Fridrich's official site CubeRoot has latest CFOP algorithms CFOP method on Speedsolving.com Wiki All OLL and PLL algorithms can be found on How to solve Rubik's Cube Retrieved from '' F2L is the most important part of the solve. From beginner level to pro level, F2L is usually the step with the most room for improvement because it requires recognizing and tracking multiple pieces at once, while having quite a lot of freedom. Intuitive F2L Recommended: Any level Make sure you're learning intuitive F2L.

In other words, you know how F2L works logically. In theory, there are so many unique F2L cases that memorizing them all would be a very slow way to learn it. Once you understand the intuitive concepts from this tutorial, you should practice it until it feels somewhat natural, before moving on. Advanced F2L Recommended for: Sub-30 Basic intuitive F2L has a lot of steps, and some of those steps can be combined. For example, you can move pieces to the top and pair them at the same time! Traditionally, watching walkthrough solves was the best way to learn advanced F2L. But in this video, the advanced concepts are structured to be easy to learn. Walkthrough solves are still useful though, as you can learn good habits and situational tricks. Look Ahead Recommended for: Sub-20 As you improve, look ahead will rapidly become the most important concept in all of speedsolving. Look ahead means tracking pieces as they move in order to quickly predict what to do next. Using human reaction time to recognize each separate case is rather slow, yet pros never seem to pause and look. This is all because of good look ahead, which the biggest difference between slower and faster cubers. The reason we don't work on look ahead at an earlier stage is because the brain can't focus on multiple things very well when going fast.

Once F2L cases become like muscle memory, then you can put your focus into what to solve next.

The Advanced F2L Playlist has multiple videos on look ahead techniques.

F2L Optimization Recommended for: Sub-15 You don't have to learn 77 algorithms. As much as possible, cube rotations and extra moves should be avoided. While intuitive F2L takes you most of the way there, it's not always enough. With this video and the F2L algorithm document, you can check all of your solutions against the best ones. I don't recommend learning straight from this document without having a solid grasp of your own F2L solutions, which is why I recommend being at least sub-15 before trying to optimize your F2L. Predicting First Pair Recommended for: Sub-15 This is one of the most overlooked fundamentals of advanced CFOP. By predicting the first F2L pair in inspection, you reduce a pause after finishing the cross. Additionally, the harder part of the solve begins with fewer unsolved pieces and with more time to track your next F2L pair.

This is one of the most difficult skills to master (competition inspection time is 15 seconds), but is also the most rewarding skill for reducing times at a high level. Next Steps Recommended for: Sub-12 I strongly recommend watching at least a good portion of the Advanced F2L Playlist to pick up a lot of tricks and ideas to apply. This includes: Where to look during bad cases Multiple options per case depending on the situation Practice techniques How to predict/recognize cases faster No matter what level you are at, improving F2L should be near the top of your priority list!