

## Chapter 3

### Layer By Layer Method

**History:** In 1980, David Singmaster developed the layer-by-layer method for solving the Rubik's Cube. He was a research professor and was later promoted to Reader and Research Professor at South Bank Polytechnic in September 1992. That same year, the Polytechnic was granted university status and became London South Bank University, where Singmaster was appointed Professor of Mathematics in the School of Computing, Information Systems, and Mathematics.

**Layer-By-Layer Method:** The Layer-by-Layer method is a beginner-friendly approach that uses simple algorithms to solve the Rubik's Cube. This method divides the cube into layers, allowing you to solve each one sequentially without disturbing the pieces already in place. Each step involves applying a specific algorithm to progress toward a fully solved cube.

For a deeper understanding, each of the seven stages in this method is explained on a dedicated page, complete with detailed descriptions and examples. While following the instructions is helpful, you are also encouraged to experiment and try solving the cube on your own to become more familiar with its structure and logic.

Now, let us examine the seven key figures that illustrate the steps of the Layer-by-Layer method.

In Figure 3.01, Figures 1 to 7 show.....

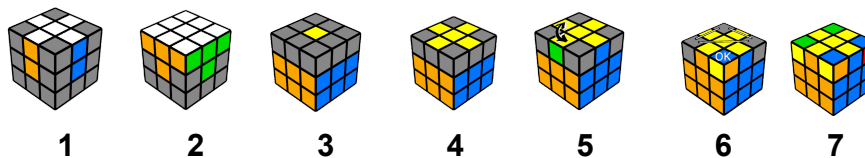


Figure 3.01

The following section demonstrates how to solve each of the seven figures step by step.....

**Figure 1-** As illustrated in the first figure, the initial step is to form a white cross on the scrambled Rubik's Cube. It is important to ensure that, once the white cross is completed, each white edge piece also aligns with the center color of the adjacent face.

**A little mind towards making a cross in white:**

There are two methods of making crosses: with **Pre-cross** and **Non- Pre-Cross**.

**Pre-Cross Step (Figure 3.02):** Begin by positioning the yellow center on the top face of the cube. The goal at this stage is to place white edge pieces around the yellow center, forming a preliminary border. This creates the appearance of white edges surrounding a yellow center — a helpful setup before forming the final white cross.

Next, choose any one face of the cube to be the front layer (F). For example, let's assume the green center is in the front. Now examine the top edge of the front face.

- If the edge piece displays green, apply the F2 move to place it correctly.
- If the edge shows a different color, use U or U' to rotate the top layer until the edge color matches the center color. Once aligned, apply F2 to insert the white edge correctly.



Fig: 3.02

Repeat this process for the remaining three edges. Once complete, the top layer will have a correctly aligned white cross with matching center colors on all adjacent sides.

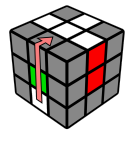


Fig: 3.03

The bottom face should now be white, with a color-aligned cross formed by the edge pieces.

**Non Pre-Cross Step:** Non Pre-Cross build a cross on the Rubik's Cube without the help of the yellow center. However, there are four key areas that must be carefully addressed during this step.

The number of cases is -

|                                                                                   |                                                                                   |                                                                                    |                                                                                     |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |  |  |
| <b>F U' R U</b>                                                                   | <b>F' U' R U</b>                                                                  | <b>U' R U</b>                                                                      | <b>R U' R' U R</b>                                                                  |

**Figure 2-** As shown in the second figure, we now need to match the white corners. White corners are the easiest to match. Hold your cube so that the white center is on top ie in the U layer. And now suppose you have a green centerpiece in the F layer and a red centerpiece in the R layer. F has a green center and R has a red centerpiece. Now take the center piece of the U,F,R layer and notice, it will need the white, green and red corners. Seen Figure 3.04. All you have to do is memorize a short algorithm and iterate until the piece is solved  $R' D R D'$



Fig: 3.04

Similarly, we can look at the three center colors and tell which colors can be matched to the corner. Now let us learn some shortcuts for matching angles as shown in Figure 3.06 below.

Notice the white on the cable corner and complete the first step by applying the algorithm:



$R' D' R$



Fig: 3.06

$F D F'$



$R' D^2 R D R' D' R$

In addition, sometimes the corners fit into place. seen Figure 3.07. Sometimes corners of other colours, areas of other colors are seen, as shown in Figure 3.08, Then simply apply  $R' D' R$  and bring the corner-piece to the D layer. and match it as shown in Figure 3.06.



$R' D' R D R' D' R$



$F D F' D F' D F'$

Fig: 3.07



Fig: 3.08

**Figure 3-** As shown in Figure 3, we will now place the white color of the Rubik's cube on the bottom. And now let's try to solve the second layer. Find an edge that is not yellow. Identify the color of your front edge piece and rotate the top layer to match the center of the same color. It's one to watch shape an inverted T. as shown in Figure 3.09. Of edge matching the yellow center above Identify the section and locate the uniformly colored center. If the center belongs to the current of the cube is to the right of the position, use the right-hand algorithm. and if the center belongs to the cube is to the left of the current position, use the left algorithm.



Fig: 3.09

**For example, Figure 3.10 shows:**

**R.H.S Algorithm**



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

Fig: 3.10

**L.H.S Algorithm**



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



Fig: 3.11

Sometimes the edge may coincide as shown in Figure 3.11, but its color will be reversed. Then use either the right or left algorithm to bring the piece to the top layer.

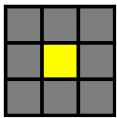
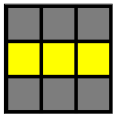
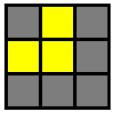
**Figure 4-** Once the first and second layers are complete, the next step is to form a yellow cross on the top layer. On the yellow face, you will encounter one of three possible cases. While the algorithm used remains the same for all, the starting position varies slightly depending on the pattern. At this stage, we are only concerned with forming a yellow cross on the top face — it is not necessary for the edge pieces to match the center colors of the side faces yet.

The three common cases are:

- Dot: No yellow edges are oriented correctly — only a single yellow center is visible.
- Line: Two opposite yellow edges are oriented correctly, forming a straight line.
- Inverted L: Two adjacent yellow edges are correct, forming an L-shape in a corner.

Refer to the case list to determine the correct orientation and apply the appropriate algorithm from the correct starting position to solve the yellow cross.:

**Note that applying the point size algorithm does not yield a cross the first time.**

| Dot/point                                                                         | Line                                                                              | Inverted L                                                                          |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |  |
| <b>F R U R' U' F'</b>                                                             | <b>F R U R' U' F'</b>                                                             | <b>F U R U' R' F'</b>                                                               |

**Figure 5-** We now need to match the edges on the last layer to their centers. Any two edges of the top layer will coincide with its center at the middle layer. If none matches, then try U or U', after the edge matches its center, place one matching edge in layer B and the other in layer R. And now **R U R' U R U2 R' U2 M2 U M2 U M2 U M'** algorithm. Sometimes again, when the two edges are facing each other, apply the **M' U M2 U M2 U M' U2 M2 U2** algorithm.

|                                                                                     |                                                                                       |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|  |  |
| <b>R U R' U R U2 R' U</b>                                                           | <b>M' U M2 U M2 U M' U2 M2 U2</b>                                                     |

**Figure 6-** Now you need to match the four corner pieces of the top layer. First find a matching corner and place it on the FRU cone of the cube. Then apply the **U R U' L' U R' U' L** algorithm. Consider Figure 3.13. Apply the same algorithm until the other three corners coincide with their centers. Sometimes a corner piece is not in the right place, Apply the algorithm from one direction. And now a corner meets, now this Repeat the same algorithm.



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

Fig: 3.12

**Figure7-** We are very close to finishing our Rubik's Cube solution. At this point, only the yellow squares remained unresolved. which we are going to solve with the last algorithm. This algorithm is known as Sexy Move. Apply this algorithm very carefully, as this is when errors are very likely to occur. Place a matching corner in the **FRU** corner as shown in Figure 3.13 and apply the algorithm until the corner matches. After a corner matches, place the mismatched corner in an **FRU** corner with a U and repeat the same algorithm.

Congratulations on completing the cube! While solving the first time is confusing, it usually takes at least 10-20 solutions to get comfortable with the new method. So keep practicing.



R' D' R D  
Fig: 3.13

**Example Solve-** Scramble the cube so that green is at the front, red on the right, and white on top-

**Scramble:** B2 L2 D2 L B2 D2 L B2 D2 L2 R' B D' L2 F D' U2 B' D2 F'

**Solve:** The front of the cube is green, the right side is orange and the top is yellow

Solve by keeping-

Figure 1 : U B L'

2 : R U R'

U F U' F'

R' U' R

L U L'

3 : (y') R U' R' U' F' U F

L2 U2 L2 U2 L2

L' U L U F U' F'

(y2 U') L' U L U F U' F'

(y U2) R U' R' U' F' U F

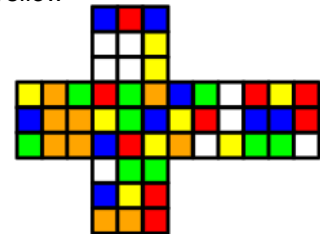
4 : (U') F R U R' U' F'

5 : (U') R U R' U R U2 R'

6 : U2 R U' L' U R' U' L

7 : (R' D' R D) (R' D' R D)

U' (R' D' R D R' D' R D) (R' D' R D R' D' R D)



Scramble the cube so that green is at the front, red on the right, and white on top-

**Scramble:** B2 L2 D2 L B2 D2 L B2 D2 L2 R' B D' L2 F D' U2 B' D2 F'

**Solve:** The front of the cube is green, the right side is orange and the top is yellow

Solve by keeping-

Figure 1 : U B L'

2 : R U R'

U F U' F'

R' U' R

L U L'

3 : (y') R U' R' U' F' U F

L2 U2 L2 U2 L2

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

(y2 U) R U' R' U' F' U F

(y' U2) L' U L U F U' F'

4 : (U') F R U R' U' F'

5 : M' U M2 U M2 U M' U2 M2 U2

6 : U2 (R U' L' U R' U' L) U (R U' L' U R' U' L)

7 : U (R' D' R D) (R' D' R D)

U' (R' D' R D) (R' D' R D)

U' (R' D' R D) (R' D' R D)

-----xxxxx-----

