

Fred's Guide to the Rubik's Cube



Contents

1	Introduction	2
1.1	What to expect from this guide	2
1.2	Facts about the Rubik's Cube	2
1.3	About the Author	3
1.4	About the Guide	3
2	Notation and Terminology	5
2.1	Edge, Corner, Piece, Facelet	5
2.2	Face	5
2.3	Turn	6
2.4	Layer	7
3	Beginner's Guide	8
3.1	What is the Strategy?	8
3.2	Notation	10
3.3	Step 1: The Top Cross	10
3.4	Step 2: Complete the Top Layer	11
3.5	Step 3: Complete the Middle Layer	11
3.6	Step 4: Position the Corners of the Bottom Layer	12
3.7	Step 5: Twist the Corners of the Bottom Layer	13
3.8	Step 6: Position the Edges of the Bottom Layer	14
3.9	Step 7: Twist the Edges of the Bottom Layer	15

Chapter 1

Introduction

For 30 years now, the Rubik's cube has mesmerized millions of people from all over the world. It captivated the hearts and minds of many alike, maybe because it combines simplicity and complexity in one innovation. This guide is dedicated to this wonderful invention.

1.1 What to expect from this guide

This guide is intended for beginners. It lists some facts about the Rubik's cube and provides a guide to solve it step by step. At a later stage, I plan to include speedcubing techniques (which let you solve the cube in 20 seconds or less!) as well.

1.2 Facts about the Rubik's Cube

Did you know?

- The Rubik's Cube was invented in 1974 by Erno Rubik.

- Erno Rubik holds Hungarian patent no. 170062 for the mechanism by which the Rubik's Cube operates.
- "Rubik's Cube" is a trademark of Seven Towns Limited.
- There are 43,252,003,274,489,856,000 different possible positions.
- All cubes can be solved in 29 moves or fewer from any random starting position.
- It is estimated that more than 100,000,000 Rubik's Cubes were sold worldwide.
- Apart from the well known 3x3x3 cube, there also exists other cubes: the 2x2x2 (Pocket Cube), 4x4x4 (Rubik's Revenge) and 5x5x5 (Professor's Cube).

1.3 About the Author

Hi! My name is Fred Senekal. Nothing special about me - I am just a great fan of the Rubik's Cube.

Before you get bored reading about me, let me rather share with you something I read recently: "The difference between what we are doing and what we are capable of doing would solve most of the worlds problems". I would like to believe that if each of us just did a little bit more to care for ourselves and others, we would make the world a better place. Sometimes you need to roll up your sleeves, be a worker ant and consider what is best for the colony.

1.4 About the Guide

You are welcome to distribute this guide to anyone provided that:

- No alterations are made to the document.
- You do not ask money for doing so.

There are rules in ant colonies too! I retain all rights to this document.

If you have any ideas for something to be added, removed or altered, please let me know. You are most welcome to contact me at fsenekal@gmail.com.

Chapter 2

Notation and Terminology

In order to explain the moves that are required to solve the Rubik's Cube or to execute some of the algorithms described in this guide, it is necessary that we share a common understanding of what is meant by certain terms. This section will explain the different terms and the notation that are used to describe the algorithms.

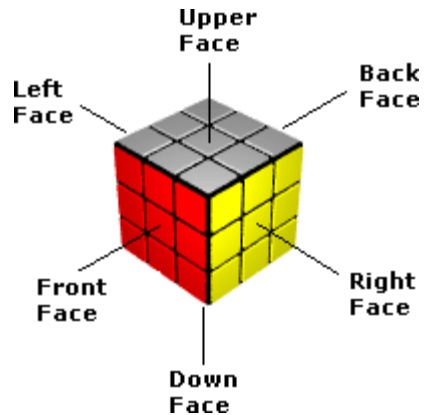
2.1 Edge, Corner, Piece, Facelet

Here is a couple of things you need to identify:

- Facelet** A coloured sticker. There are 9 facelets on each face of the cube, 54 in total.
- Corner** A plastic piece with 3 facelets. There are 8 corners on a Rubik's Cube.
- Edge** A plastic piece with 2 facelets. There are 12 edges on a Rubik's Cube.
- Piece** A corner or edge. There are 20 pieces on a Rubik's Cube.

2.2 Face

A face is one of the six sides of the Rubik's Cube. In its solved state, each face will have a different colour.



We will assign a letter to each of the different faces, as follows:

- U** Upper (or top) face
- D** Down (or bottom) face
- F** Front face
- B** Back face
- R** Right face
- L** Left face

In the drawings that follow, the cube will be displayed in three dimensions, as shown in the picture. The front and right faces will always be visible and either the upper or down face depending on which step we are at.

2.3 Turn

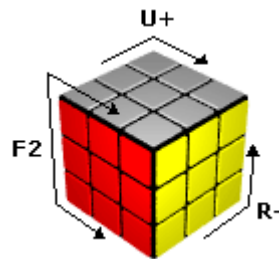
A turn is the rotation of one of the faces of the cube. If you think about it a bit, you will realize that each of the faces can be turned in one of three significant ways: clockwise, anti-clockwise or through 180 degrees.

We will use the following notation to indicate a turn:

- +** Clockwise turn through 90 degrees
- Anti-clockwise turn through 90 degrees
- 2** 180 degree turn (2 turns either way)

By combining the face and turn indicators, we can thus uniquely specify that a certain movement be executed. A total of 18 different types of turns are thus possible: **U+**, **U-**, **U2**, **D+**, **D-**, **D2**, **F+**, **F-**, **F2**, **B+**, **B-**, **B2**, **R+**, **R-**, **R2**, **L+**, **L-** and **L2**.

A big note! Clockwise and anti-clockwise depend on where you are looking from. To make things consistent, clockwise and anti-clockwise will be defined as usual as if you were looking straight at the face with the face visible. Thus, the turns **R+** and **L-** will both result in pieces that were originally in the front face to end up in the upper face.



2.4 Layer

We will sometimes refer to a layer. We will talk about three layers: the Top, Middle and Bottom layers, as indicated in the picture.



Chapter 3

Beginner's Guide

This chapter describes an easy method to solve the Rubik's Cube.

3.1 What is the Strategy?

When tackling a difficult problem, it is always good to have some plan or strategy to follow. The Rubik's Cube is no exception. By following the easy strategy explained in this section, you will be well on your way to mastering the Rubik's Cube.

The strategy can be broken down into 7 steps (which, if you think about the steps, would seem quite natural):

Step 1
The Top Cross

(after which the edges of the top layer are correct)



Step 2
Complete the Top Layer

(after which the whole top layer is correct)



Step 3
Complete the Middle Layer

(after which the top and middle layers are correct)



Step 4
Position the Corners of the Bottom Layer

(after which the corners of the bottom layer are in position, but not necessarily correctly orientated)



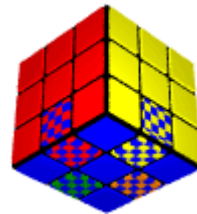
Step 5
Twist the Corners of the Bottom Layer

(after which the corners of the bottom layer are in position and correctly orientated)



Step 6
Position the Edges of the Bottom Layer

(after which the edges of the bottom layer are in position, but not necessarily correctly orientated)



Step 7
Twist the Edges of the Bottom Layer

(after which the Rubik's cube is solved!)



3.2 Notation

Throughout this tutorial, the colours of the center block will indicate a certain face:

White	Upper Face
Red	Front Face
Yellow	Right Face
Blue	Down Face
Orange	Back Face
Green	Left Face

Take note of two things:

1. Your block may have a different colour coding, i.e. it may be that the colours you see in the diagrams are different from those on your block.
2. You may be required from the very first step to rotate your whole block around the Up/Down axis, i.e. the Front, Left, Right and Back faces will change. What use to be the Front face in one step or part of a step, may become the Left, Right or Back face in a subsequent step.

Thus, do not take the colours in the diagrams literally, they are only coloured that way to aid the explanation. Rather study the move sequences (which are independent of colour).

3.3 Step 1: The Top Cross

In this step you need to place all the edges of the top layer correctly. This means that there should form a “cross” on the top layer and that the facelets above the center pieces of the front, right, left and back faces should be the same colour as the center pieces.

This step should be relatively easy, so try to complete this step on your own.



3.4 Step 2: Complete the Top Layer

In this step you need to insert the corners of the top layer into their correct positions. When this step is completed, all the edges and corners of the top layer should be correct.

This step is a little trickier than the previous step, but you should still be able to complete it on your own. Here is a tip: you will have to temporarily break the cross at the top, position the corner that you are trying to solve next to its associated edge, and turn both the edge and corner into position.



3.5 Step 3: Complete the Middle Layer

At this point, the edges of the middle layer need to be solved. Turn the down layer until the edge that need to be solved forms the letter 'T' as shown in option 3A or 3B and execute sequence 3.1 or 3.2.

If the edge that need to be solved is not in the down layer, it will be in the middle layer (it cannot be in the top layer since the top layer is solved!). In this case, you will need to execute a Turnaround or Swap movement as in sequences 3.3 or 3.4.

Simply repeat this process for all four edges in the middle layer.

Option 3A: The Front Swing Option 3B: The Right Swing



Sequence 3.1

$D^- R^- D^+ R^+ D^+ F^+ D^- F^-$
(8 turns)



Sequence 3.2

$D^+ F^+ D^- F^- D^- R^- D^+ R^+$
(8 turns)

Option 3C: Turnaround



Sequence 3.3

$R^2 D^2 F^- R^2 F^+ D^2 R^+ D^- R^+$
(9 turns)

Option 3D: Swap



Sequence 3.4

$F^2 D^2 F^2 D^2 F^2$
(5 turns)

3.6 Step 4: Position the Corners of the Bottom Layer

Turn the bottom layer until either the DLB and DRB corners (Option 4A) or the DLB and DRF corners (Option 4B) are correctly positioned. Then execute sequence 4.1 (Option 4A) or 4.2 (Option 4B). Magic! All four corners are in position.

Option 4A



Sequence 4.1

$R^- D^- R^+ F^+ D^+ F^- R^- D^+ R^+ D^2$ (10 turns)

Option 4B



Sequence 4.2

$R^- D^- R^+ F^+ D^2 F^- R^- D^+ R^+ D^-$ (10 turns)

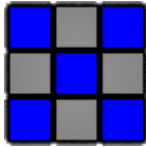
3.7 Step 5: Twist the Corners of the Bottom Layer

After completing the previous step, all the bottom corners will be in the correct position. It may happen by chance that they are correctly oriented as well as shown in option 5A (the figures show the cube as if looking directly onto the down face). There are seven other possibilities of how the corners may be oriented at the start of this step (B to G). You may need to rotate the cube until you observe one of these patterns.

To complete this step, you will need to apply sequence 5.1, up to a maximum of 3 times. If you feel like it, you can learn sequence 5.2. This will enable you to complete step 5 by applying sequences 5.1 and 5.2 a maximum of 2 times.

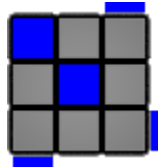
Sequence 5.1: $R^- D^- R^+ D^- R^- D^2 R^+ D^2$ (8 turns) Sequence 5.2: $D^2 R^- D^2 R^+ D^- R^- D^- R^+$ (8 turns - the inverse of 5.1)

Option 5A

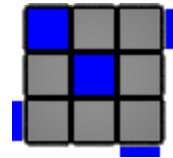


Everything OK, go to step 6! Sequence 5.1: goto 5A.

Option 5B

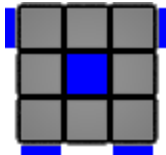


Option 5C



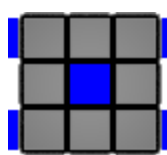
Sequence 5.2: goto 5A
(Or sequence 5.1: goto 5B)

Option 5D



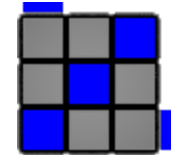
Sequence 5.1: goto 5B

Option 5E



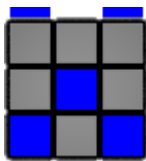
Sequence 5.1: goto 5B

Option 5F



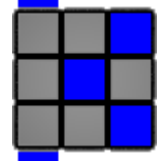
Sequence 5.1: goto 5C

Option 5G



Sequence 5.1: goto 5C

Option 5H

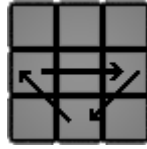


Sequence 5.1: goto 5C

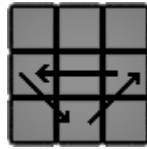
3.8 Step 6: Position the Edges of the Bottom Layer

When reaching this step, either all, one or none of the bottom edges will be correctly positioned. If no edge is correctly positioned, execute sequence 6.1. This will ensure that exactly one edge is correctly positioned. When this is the case, hold the Rubik's Cube such that the correct edge is in the DF position. Executing sequence 6.1 or 6.2 will complete the step.

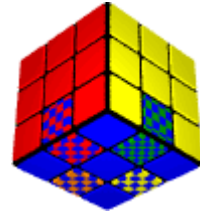
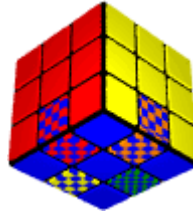
Sequence 6.1: $R^+ L^- F^+ R^- L^+ D^2 R^+ L^- F^+ R^- L^+$ (11 turns). This repositions the DR, DB and DL edges clockwise.



Sequence 6.2: $R+ L- F- R- L+ D2 R+ L- F- R- L+$ (11 turns). This repositions the DR, DB and DL edges anti-clockwise



Option 6A: No edge correct **Option 6B: Clockwise** **Option 6C: Anti-clockwise**



Sequence 6.1: goto 6B or 6C

Sequence 6.1

Sequence 6.2 (or 6.1 twice)

3.9 Step 7: Twist the Edges of the Bottom Layer

Almost there (or if you are lucky it may already be right)! When you reach this step, the Rubik's Cube may have either one of the following three patterns on the bottom face:

Option 7A: Checkerboard Option 7B: H-Pattern Option 7C: Arrow



Sequence 7.1

R+ L- F2 R- L+ D2
 R+ L- F+ R- L+ D2
 R+ L- F2 R- L+ D-
 (18 turns)



Sequence 7.2

R+ L- F+ R- L+ D+
 R+ L- F+ R- L+ D+
 R+ L- F2 R- L+ D+
 R+ L- F+ R- L+ D+
 R+ L- F+ R- L+ D2
 (30 turns)



Sequence 7.3

R+ L- F+ R- L+ D+
 R+ L- F+ R- L+ D+
 R+ L- F2 R- L+ D2
 R+ L- F+ R- L+ D-
 R+ L- F+ R- L+ D2
 R+ L- F+ R- L+
 (35 turns)

Eureka! You have mastered the Rubik's Cube!!

