NSU NOVA SOUTHEASTERN UNIVERSITY

Nova Southeastern University

College of Engineering and Computing

Summer I 2021 (202150) Course Schedule

Master Level Course CISC 680

Software Engineering

CRN: 50514 Sec: L01 Cr: 3.0 - On Line

Dates: 05/10/2021 - 08/01/2021– (12 weeks)

Please review Chapter 3 carefully, including the further readings and information sources.

Assignment Due date: Check class calendar

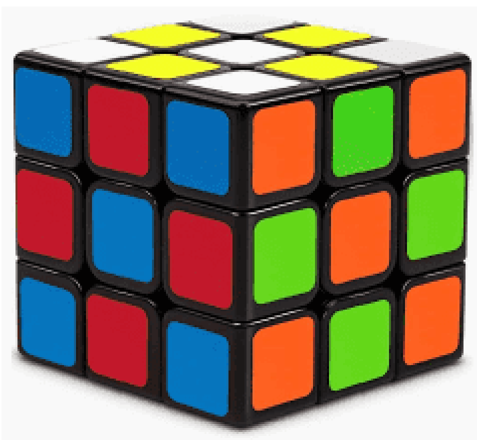
Project:

Using Agile Techniques, the students will design a Rubik’s cube GUI simulation application. This will involve each student identifying and classifying which components need addressing and how, using Agile development, this will be

achieved. The final outcome of this will a document or documents addressing these components, (Communication, planning, modeling, construction and deployment).
Organization and Flow:

- Project planning
- Use case development
- Requirement gathering
- Rapid design
- Code generation (not necessary)
- Testing

Device:



Area of work:

Using Agile Techniques, the students will design a Rubik's cube GUI simulation application, This may involve discussion collaboration among the class students as they identify and classify which components need addressing and how, using Agile development, this will be achieved.

The final outcome of this will a document or documents addressing these components, (Communication, planning, modeling, construction and deployment).

The assignment will be further discussed during the lectures

Customer Requirements will be discussed in class

Overview:

Reference: https://en.wikipedia.org/wiki/Rubik%27s_Cube

In the mid-1970s, Ernő Rubik worked at the Department of Interior Design at the Academy of Applied Arts and Crafts in Budapest.[16] Although it is widely reported that the Cube was built as a teaching tool to help his students understand 3D objects, his actual purpose was solving the structural problem of moving the parts independently without the entire mechanism falling apart. He did not realise that he had created a puzzle until the first time he scrambled his new Cube and then tried to restore it.[17] Rubik applied for a patent in Hungary for his "Magic Cube" (Bűvös kocka in Hungarian) on 30 January 1975,[4] and HU170062 was granted later that year.

The Rubik's Cube is a 3-D combination puzzle invented in 1974[2][3] by Hungarian sculptor and professor of architecture Ernő Rubik. Originally called the Magic Cube,[4] the puzzle was licensed by Rubik to be sold by Ideal Toy Corp. in 1980[5] via businessman Tibor Laczi and Seven Towns founder Tom Kremer.[6] Rubik's Cube won the 1980 German Game of the Year special award for Best Puzzle. As of January 2009, 350 million cubes had been sold worldwide,[7][8] making it the world's top-selling puzzle game.[9][10] It is widely considered to be the world's best-selling toy.[11]

On the original classic Rubik's Cube, each of the six faces was covered by nine stickers, each of one of six solid colours: white, red, blue, orange, green, and yellow. Some later versions of the cube have been updated to use coloured plastic panels instead, which prevents peeling and fading.[12] In models as of 1988, white is opposite yellow, blue is opposite green, and orange is opposite red, and the red, white, and blue are arranged in that order in a clockwise arrangement.[13] On early cubes, the position of the colours varied from cube to cube.[14] An internal pivot mechanism enables each face to turn independently, thus mixing up the colours. For the puzzle to be solved, each face must be returned to have only one colour. Similar puzzles have now been produced with various numbers of sides, dimensions, and stickers, not all of them by Rubik.

Mechanics

A standard Rubik's Cube measures 5.6 centimetres (2 1⁄4 in) on each side. The puzzle consists of 26 unique miniature cubes, also known "cubies" or "cubelets". Each of these includes a concealed inward extension that interlocks with the other cubes while permitting them to move to different locations. However, the centre cube of each of the six faces is merely a single square façade; all six are affixed to the core mechanism. These provide structure for the other pieces to fit into and rotate around. Hence, there are 21 pieces: a single core piece consisting of three intersecting axes holding the six centre squares in place but letting them rotate, and 20 smaller plastic pieces which fit into it to form the assembled puzzle.

Each of the six centre pieces pivots on a screw (fastener) held by the centre piece, a "3D cross". A spring between each screw head and its corresponding piece tensions the piece inward, so that collectively, the whole assembly remains compact but can still be easily manipulated. The screw can be tightened or loosened to change the "feel" of the Cube. Newer official Rubik's brand cubes have rivets instead of screws and cannot be adjusted. However, Old Cubes made by the Rubik's Brand Ltd. and from dollar stores do not have screws or springs, all they have is a Plastic clip to keep the centre piece in place and freely rotate.

The Cube can be taken apart without much difficulty, typically by rotating the top layer by 45° and then prying one of its edge cubes away from the other two layers. Consequently, it is a simple process to "solve" a Cube by taking it apart and reassembling it in a solved state.

There are six central pieces that show one coloured face, twelve edge pieces which show two coloured faces, and eight corner pieces which show three coloured faces. Each piece shows a unique colour combination, but not all combinations are present (for example, if red and orange are on opposite sides of the solved Cube, there is no edge piece with both red and orange sides). The location of these cubes relative to one another can be altered by twisting an outer third of the Cube by increments of 90 degrees, but the location of the coloured sides relative to one another in the completed state of the puzzle cannot be altered; it is fixed by the relative positions of the centre squares. However, Cubes with alternative colour arrangements also exist; for example, with the yellow face opposite the green, the blue face opposite the white, and red and orange remaining opposite each other.

Douglas Hofstadter, in the July 1982 issue of Scientific American, pointed out that Cubes could be coloured in such a way as to emphasise the corners or edges, rather than the faces as the standard colouring does; but neither of these alternative colourings has ever become popular.[43]

Algorithms

In Rubik's cubers' parlance, a memorised sequence of moves that has a desired effect on the cube is called an algorithm. This terminology is derived from the mathematical use of algorithm, meaning a list of well-defined instructions for performing a task from a given initial state, through well-defined successive states, to a desired end-state.

Each method of solving the Cube employs its own set of algorithms, together with descriptions of what effect the algorithm has, and when it can be used to bring the cube closer to being solved.

Many algorithms are designed to transform only a small part of the cube without interfering with other parts that have already been solved so that they can be applied repeatedly to different parts of the cube until the whole is solved. For example, there are well-known algorithms for cycling three corners without changing the rest of the puzzle or flipping the orientation of a pair of edges while leaving the others intact.

Some algorithms do have a certain desired effect on the cube (for example, swapping two corners) but may also have the side-effect of changing other parts of the cube (such as permuting some edges). Such algorithms are often simpler than the ones without side-effects and are employed early on in the solution when most of the puzzle has not yet been solved and the side-effects are not important. Most are long and difficult to memorise. Towards the end of the solution, the more specific (and usually more complicated) algorithms are used instead

Move notation

Many 3×3×3 Rubik's Cube enthusiasts use a notation developed by David Singmaster to denote a sequence of moves, referred to as "Singmaster notation".[53] Its relative nature allows algorithms to be written in such a way that they can be applied regardless of which side is designated the top or how the colours are organised on a particular cube.

F (Front): the side currently facing the solver
B (Back): the side opposite the front
U (Up): the side above or on top of the front side
D (Down): the side opposite the top, underneath the Cube
L (Left): the side directly to the left of the front
R (Right): the side directly to the right of the front
f (Front two layers): the side facing the solver and the corresponding middle layer
b (Back two layers): the side opposite the front and the corresponding middle layer
u (Up two layers): the top side and the corresponding middle layer
d (Down two layers): the bottom layer and the corresponding middle layer

l (Left two layers): the side to the left of the front and the corresponding middle layer
r (Right two layers): the side to the right of the front and the corresponding middle layer
x (rotate): rotate the entire Cube on R
y (rotate): rotate the entire Cube on U
z (rotate): rotate the entire Cube on F
When a prime symbol (′) follows a letter, it denotes an anticlockwise face turn; while a letter without a prime symbol denotes a clockwise turn. These directions are as one is looking at the specified face. A letter followed by a 2 (occasionally a superscript 2) denotes two turns, or a 180-degree turn. R is right side clockwise, but R′ is right side anticlockwise. The letters x, y, and z are used to indicate that the entire Cube should be turned about one of its axes, corresponding to R, U, and F turns respectively. When x, y, or z are primed, it is an indication that the cube must be rotated in the opposite direction. When they are squared, the cube must be rotated 180 degrees.

The most common deviation from Singmaster notation, and in fact the current official standard, is to use "w", for "wide", instead of lowercase letters to represent moves of two layers; thus, a move of Rw is equivalent to one of r.[54]

For methods using middle-layer turns (particularly corners-first methods), there is a generally accepted "MES" extension to the notation where letters M, E, and S denote middle layer turns. It was used e.g. in Marc Waterman's Algorithm.[55]

M (Middle): the layer between L and R, turn direction as L (top-down)
E (Equator): the layer between U and D, turn direction as D (left-right)
S (Standing): the layer between F and B, turn direction as F
The 4×4×4 and larger cubes use an extended notation to refer to the additional middle layers.

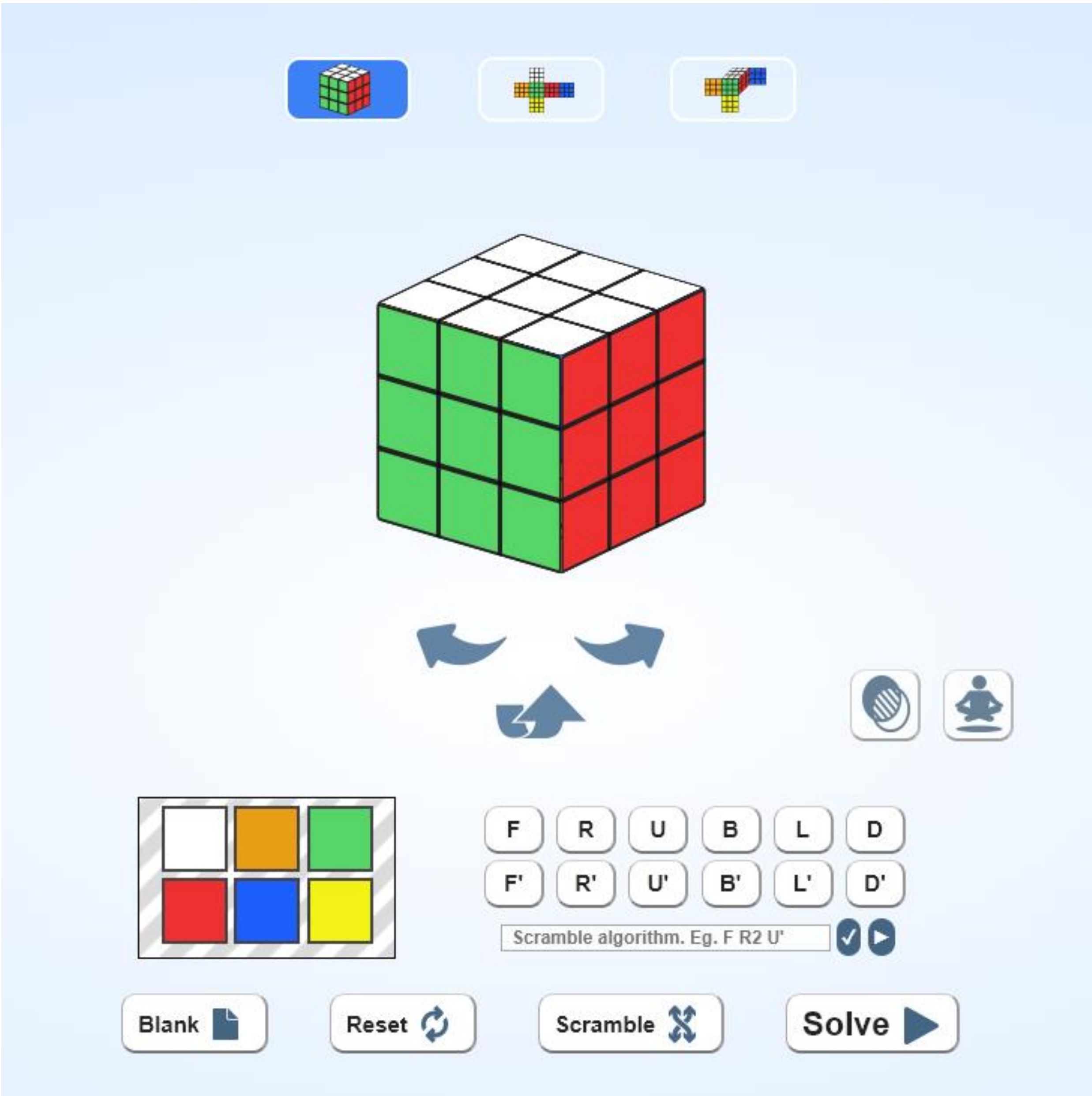
Generally speaking, uppercase letters (F B U D L R) refer to the outermost portions of the cube (called faces). Lowercase letters (f b u d l r) refer to the inner portions of the cube (called slices). An asterisk (L*), a number in front of it (2L), or two layers in parentheses (Ll), means to turn the two layers at the same time (both the inner and the outer left faces) For example: (Rr)' l2 f' means to turn the two rightmost layers anticlockwise, then the left inner layer twice, and then the inner front layer anticlockwise. By extension, for cubes of 6×6×6 and larger, moves of three layers are notated by the number 3, for example, 3L.

An alternative notation, Wolstenholme notation,[56] is designed to make memorizing sequences of moves easier for novices. This notation uses the same letters for faces except it replaces U with T (top), so that all are consonants. The key difference is the use of the vowels O, A, and I for clockwise, anticlockwise, and twice (180-degree) turns, which results in word-like sequences such as LOTA RATO LATA ROTI (equivalent to LU′ R′ U L′ U′ R U2 in Singmaster notation). Addition of a C implies rotation of the entire cube, so ROC is the clockwise rotation of the cube around its right face. Middle layer moves are denoted by adding an M to corresponding face move, so RIM means a 180-degree turn of the middle layer adjacent to the R face.

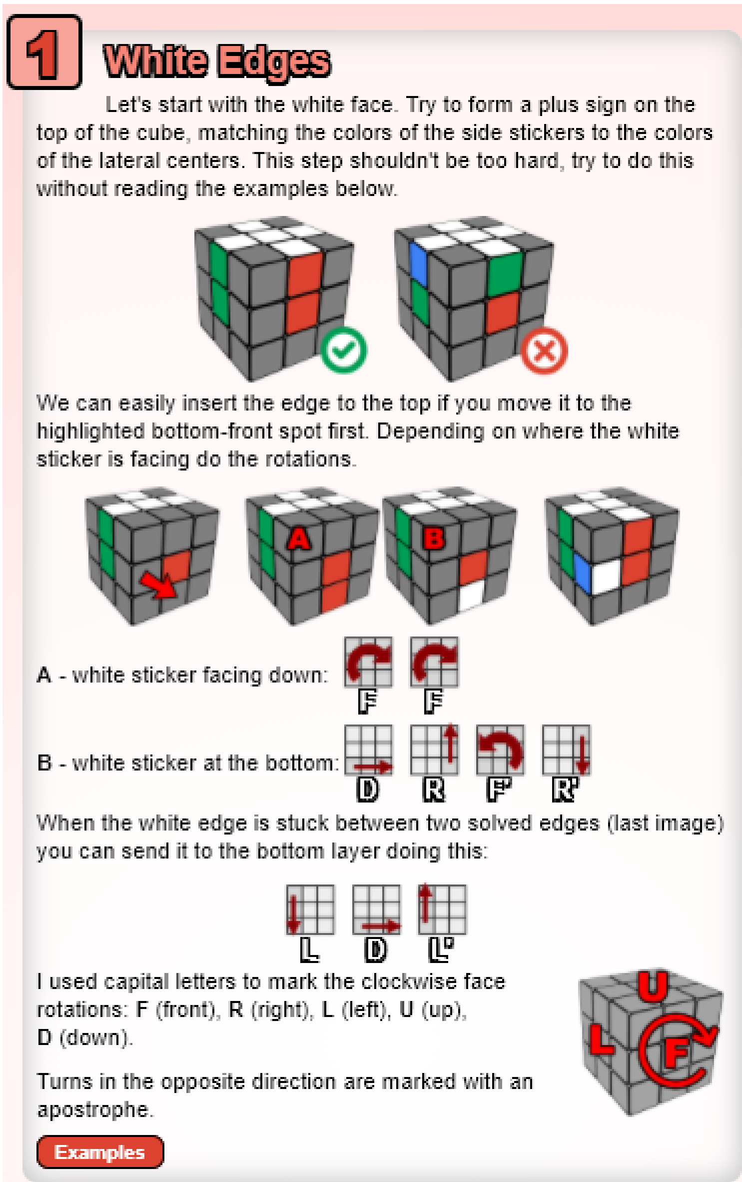
Another notation appeared in the 1981 book The Simple Solution to Rubik's Cube. Singmaster notation was not widely known at the time of publication. The faces were named Top (T), Bottom (B), Left (L), Right (R), Front (F), and Posterior (P), with + for clockwise, – for anticlockwise, and 2 for 180-degree turns.

Another notation appeared in the 1982 "The Ideal Solution" book for Rubik's Revenge. Horizontal planes were noted as tables, with table 1 or T1 starting at the top. Vertical front to back planes were noted as books, with book 1 or B1 starting from the left. Vertical left to right planes were noted as windows, with window 1 or W1 starting at the front. Using the front face as a reference view, table moves were left or right, book moves were up or down, and window moves were clockwise or anticlockwise.

Example GUI Screen:
Reference: https://rubikscu.be/



Example of GUI movement: How to solve rubik’s cube
Reference: https://rubikscu.be/



1 White Edges

Let's start with the white face. Try to form a plus sign on the top of the cube, matching the colors of the side stickers to the colors of the lateral centers. This step shouldn't be too hard, try to do this without reading the examples below.

We can easily insert the edge to the top if you move it to the highlighted bottom-front spot first. Depending on where the white sticker is facing do the rotations.

A B

A - white sticker facing down: F F

B - white sticker at the bottom: D R F' R'

When the white edge is stuck between two solved edges (last image) you can send it to the bottom layer doing this:

L D L'

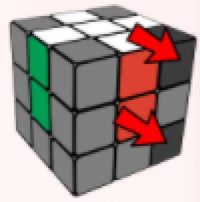
I used capital letters to mark the clockwise face rotations: **F** (front), **R** (right), **L** (left), **U** (up), **D** (down).

U L F

Turns in the opposite direction are marked with an apostrophe.

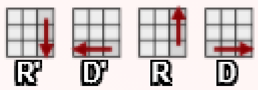
Examples

2 Finish The White Face



When the white edges are matching we can move on to solve the white coners.

First put the white corner that belongs to the spot marked with the upper arrow in either of the highlighted positions. Next repeat the algorithm below until the white piece comes to its desired destination.



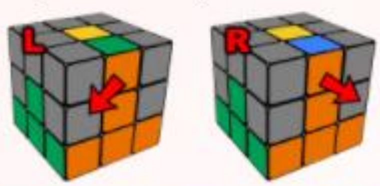
This trick sends the piece back and forth between the top and bottom locations, twisting the corner in each step. Using this you can solve each white corner in less than 6 iterations.

At the end your cube should have a solid white face with the lateral stickers matching the lateral centers.

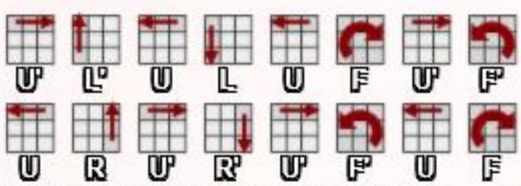
Examples

3 Center Layer

Turn your cube upside down because we don't need to work with the white face anymore. We can insert an edge piece from the top-front position to the middle layer using a trick. Do the left or right algorithm depending on which side you have to insert the piece:



Left:
Right:



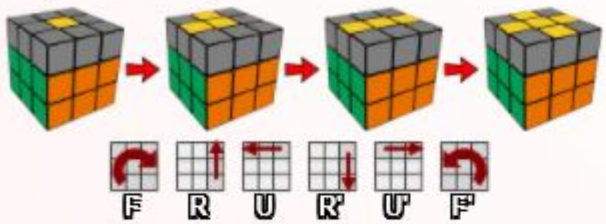
When a center layer piece is in a wrong position you can use the same trick to take it out.

You'll have two solved layers when you finish this stage. We're almost there.

More...

4 Yellow Cross

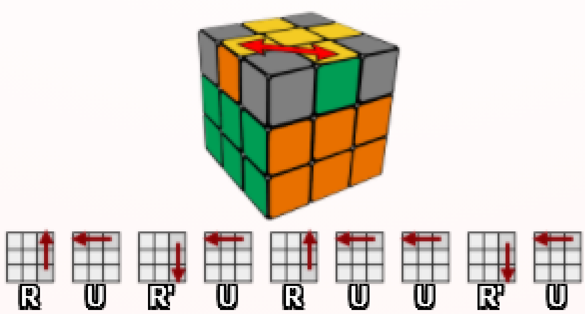
Inspect the top of your cube. You see a yellow cross, a line, an L-shape or a dot. Our goal is to form a yellow cross.



Use this algorithm to shift from one state to the other.

5 Swap Edges

We have a yellow cross on the top but the edges are not in their final position. They need to match the side colors.

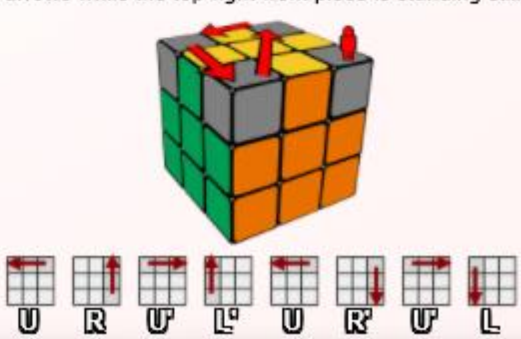


Use this to swap the front and left yellow edges in the top layer.

6 Cycle Corners

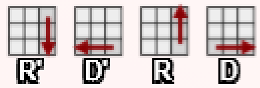
Only the yellow corners are left unsolved at this point. Now we are going to put them in their final position and we'll rotate them in the last step.

Use the algorithm below to cycle the pieces in the direction marked with the arrows while the top-right-front piece is standing still.

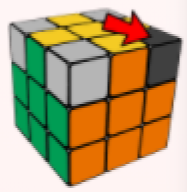


7 Orient Corners

Everything is positioned, we just have to orient the yellow corners. We use the same algorithm that we used for solving the white corners in the second step:



This step can be confusing for most people so read the explanation very carefully and do exactly what it says!



1. Hold the cube in your hand having an unsolved yellow corner in the highlighted top-right-front position.
2. Repeat the algorithm until this piece is solved.
3. Turn the top layer to bring another unsolved piece in the highlighted position.
4. Repeat **R' D' R D** until that one is also solved.
5. Do 3 and 4 for any other unsolved yellow corner.

Important! During the process it might seem that you have messed up the whole cube but don't worry because it will come together if you do it correctly, following the instructions.

Examples

Deliverables: will be discussed in the Lecture