Documentation:

The Program has the main Class: Cube. It simulates 2x2 Rubik's Cube Problem.
It contains an implementation of the main functions: Graphsearch using Algorithm A* and Iterative Backtrack function.
The program runs 2 functions solving the Rubik's Cube problem one after another.
Main points in the Code:

Main function: creates a Cube according to a given input –
or a default Cube State, and calls both graphsearch function and backtrack function.

backtrack: This function consistently checks if the goal is achieved, or any possible fail that prevents us continue keep searching for a solution in a specific branch. Otherwise, continues do deeper at the search tree and update 3 global variables each iteration.
If backtrack is failed the MaxDepth Value is increased by 1 each iteration

graphsearch: This function creates a search tree by initialize a root and expand it by all the applicable rules. Of course, all of the rules are applicable in each state. There are 2 lists that help to track each node: Open – nodes that were generated, Close – nodes that were expanded.

A new node is inserted to the list according **Heuristic:** f(n) = d(n) + h(n), such that:

d(n) = depth of node n
h(n) = average number of unique colors on each face +
number of each full-colored face

Outputs:

Random Cube Value:

```
GraphSearch Function:
SOLVED!
States:
YGRW GORO WOWG OYWB RBGB YBYR
YGGR YOOO OGWW BBWB RWGR YBYR
YGYO BOBO GWOW WRWB RRGG YBYR
YYYY OOBB GGOO WWWW RRGG BBRR
YYYY BBBB OOOO WWWW GGGG RRRR
Rules:
B
F'
F'
R'
U
number of nodes that were generated:
246
number of nodes that were expanded:
26
Time of GraphSearch Function:
0.203125
```

```
Backtrack Function:
Depth 1 Failed
Depth 2 Failed
Depth 3 Failed
Goal achieved
---------Rules-----------------
F
F
R'
U
---------States----------------
YGRW GORO WOWG OYWB RBGB YBYR
YGBB ROWO WWGO RGWB ROGY YBYR
YGYO BOBO GWOW WRWB RRGG YBYR
YYYY OOBB GGOO WWWW RRGG BBRR
YYYY BBBB OOOO WWWW GGGG RRRR
Number of Failures:
8918
Number of backtrack calls:
8923
Time of Backtrack Function:
Depth 4 is OK!
0.046875
```

2nd Random Cube Value:

```
GraphSearch Function:
SOLVED!
States:
WGYW ROWR BGRO WGYY OORB YBBG
WGYO WRRO BGRY WBYY OORB WBGG
WGWR BRWO GYBR OBYY OORY WBGG
WWRG WBWO BRBR OBYY GYRY OOGG
WWWW BBOO RRBB YYYY GGRR OOGG
WWWW OOOO BBBB YYYY RRRR GGGG
Rules:
L'
R
F'
U
F'
U
number of nodes that were generated:
1375
number of nodes that were expanded:
167
Time of GraphSearch Function:
6.0
```

```
Backtrack Function:
Depth 1 Failed
Depth 2 Failed
Depth 3 Failed
Depth 4 Failed
Goal achieved
---------Rules----------------
R
F'
U
F'
U
---------States----------------
WGYW ROWR BGRO WGYY OORB YBBG
WGYO WRRO BGRY WBYY OORB WBGG
WGWR BRWO GYBR OBYY OORY WBGG
WWRG WBWO BRBR OBYY GYRY OOGG
WWWW BBOO RRBB YYYY GGRR OOGG
WWWW OOOO BBBB YYYY RRRR GGGG
Number of Failures:
62572
Number of backtrack calls:
62578
Time of Backtrack Function:
Depth 5 is OK!
0.359375
```

3rd Random Cube Value:

```
GraphSearch Function:
SOLVED!
States:
BBGO GRGB WYWY BROO ORGR YYWW
RBGO GOGO WYWY BROG BRBR WYWY
RYGY GGOO WRWG BWOW BRBR OYBY
RRGG OGOG WWWW BBOO BRBR YYYY
RRRR GGGG WWWW OOOO BBBB YYYY
Rules:
D
B
R
R
F
number of nodes that were generated:
260
number of nodes that were expanded:
29
Time of GraphSearch Function:
0.21875
```

```
Backtrack Function:
Depth 1 Failed
Depth 2 Failed
Depth 3 Failed
Goal achieved
Goal achieved
---------Rules-----------------
F
U
D
R
---------States-----------------
BBGO GRGB WYWY BROO ORGR YYWW
BBRR GROB WWYY GGOO OBGR YYWW
RBRB YYOB GRYY GGOO WWGR OBWW
RBRB YYYY GRGR OGOG WWWW OBOB
RRRR YYYY GGGG OOOO WWWW BBBB
Number of Failures:
8358
Number of backtrack calls:
8365
Time of Backtrack Function:
Depth 4 is OK!
0.03125
```