2x2x2 Cube Synthesizer

Preliminary Document

Introduction

Pocket Cubes are **2x2x2** cubes. They may be solved for a *single* face out of six to display pictures or patterns on a selected front face.

By twisting and rotating some parts of the cube, it is possible to move selected cubelets from any face to the front face. Note that each letter, number or symbol on a solved face should have the right orientation, i.e. should generally be oriented North (0°).

Maneuvers used for twisting and rotating parts of a cube are coded as a series of letters called an *algorithm*. An algorithm is then a code for a sequence of moves used to change the state of a cube from an *initial* (unsolved) state to a *final* (solved) state.

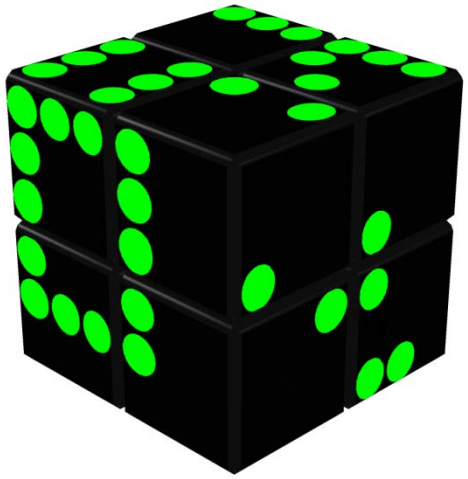
The *initial* state of a cube is given by a particular layout of letters, numbers and symbols shown on the cube *texture* whereas the *final* state is given by what we would like to see displayed on a selected front face. This is where we would need a software tool for *automatically* generating an algorithm to set the cube to a *user-selected* final state. This is what is called *synthesis*, which is just the reverse of *analysis*. and the software tool to do this is called a *Synthesizer*. The Synthesizer input data is the *final* state data.

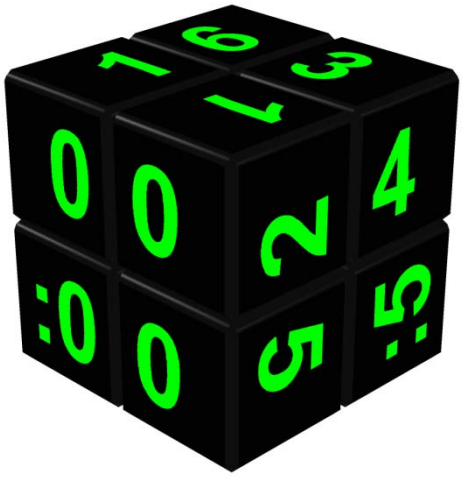
Basic algorithms are used to change the state of each front face cubie from an initial to a final state. Synthesized algorithms are then basic algorithms that have been concatenated.

Download CubeSynthesizer2 Version 1.0
Microsoft Excel 2007
http://www.mementoslangues.fr/CubeDesign/CubeSynthesizer2.xlsm
Microsoft Excel 97-2003
http://www.mementoslangues.fr/CubeDesign/CubeSynthesizer2.xls

2x2x2 Demo Cubes

Reference Cube	**Demo Dot Matrix Cube**	**Demo Clock & Timer Cube**





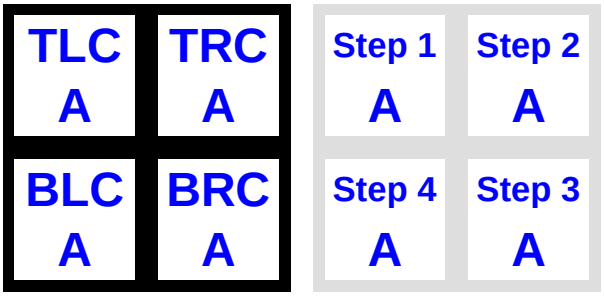
2x2x2 Cube Corners: Notations

Isolated (or strings of) letters, numbers, characters, symbols or pictures are placed on corner cubes. These may be oriented **N**orth (0°), **E**ast (90°), **S**outh (180°) or **W**est (270°). Corner cube notations are abbreviated as follows:

- **T**op **L**eft **C**orner (**TLC**)
- **T**op **R**ight **C**orner (**TRC**)
- **B**ottom **L**eft **C**orner (**BLC**)
- **B**ottom **R**ight **C**orner (**BRC**)

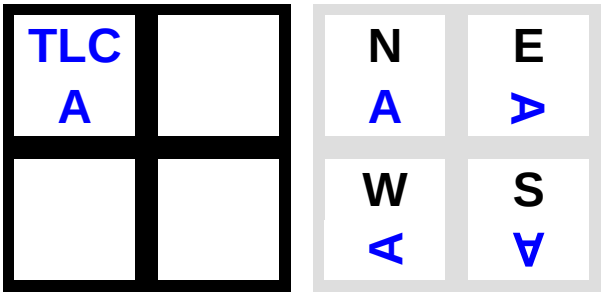
Notations & Solving Sequence

Center Cube Notations | **Solving Centers in 4 Steps CW**



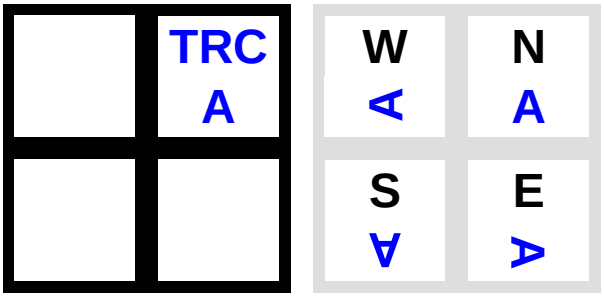
Center Cube Moves – Step 1

To Front Face – TLC North | **From Any Face – N E S W**



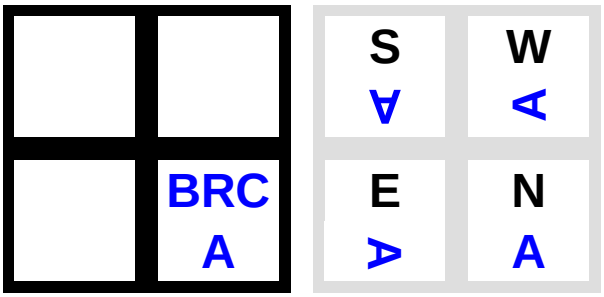
Center Cube Moves – Step 2

To Front Face – TRC North | **From Any Face – W N E S**



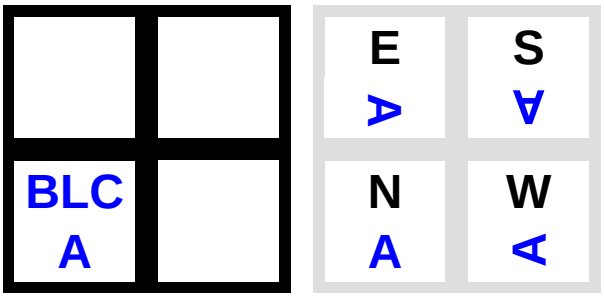
Center Cube Moves – Step 3

To Front Face – BRC North **From Any Face – S W N E**



Center Cube Moves – Step 4

To Front Face – BLC North **From Any Face – E S W N**



Corner Cubes Location

		Up	Up					TLC	TRC		
		Up	Up					BLC	BRC		
Left	Left	Front	Front	Right	Right	TLC	TRC	TLC	TRC	TLC	TRC
Left	Left	Front	Front	Right	Right	BLC	BRC	BLC	BRC	BLC	BRC
		Down	Down	Back	Back			TLC	TRC	TLC	TRC
		Down	Down	Back	Back			BLC	BRC	BLC	BRC

Corner Cubes States Numbering and Orientation – Initial State (Texture State)

Intial State Numbering

Initial State Orientation (degrees)

		9	10					0	0		
		11	22					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	22			0	0	0	0
		19	20	23	24			0	0	0	0

Example: Corner Cubes States – Step 1: From U [TLC, N] To F [TLC, N]

Numbering

Orientation (degrees)

		11	10					90	0		
		22	12					180	0		
1	13	9	2	5	6	0	90	0	0	0	0
20	16	3	4	7	24	90	0	0	0	0	0
		17	18	21	14			0	0	0	0
		8	19	15	23			90	270	0	270

Algorithm Synthesizer

Introduction

A computer program named *CubeSynthesizer2* has been designed for synthesizing algorithms for moving corners on 2x2x2 cubes that need to be solved for a *single* face. The program has been developed using Microsoft Office Excel and Visual Basic Editor. There is only a Developer's version of this program available at present.

The program can be used as follows:

1- Open *CubeSynthesizer2* in Excel
2- Press TRCl+Shift+S to display the Synthesizer Input Form
3- Select a cube from the Form
4- Click the OK Button and wait until algorithm synthesis is completed
5- Browse through the list of synthesized algorithms in Worksheet 'Main'
6- Copy a selected algorithm into CubeTwister or into an applet

Algorithms

A 2x2x2 Reference Cube has been used to check basic algorithms and fill in lookup tables with numbers indicating the cube state. All basic algorithms do not modify any facelet on the *Front* face other than the origin or destination facelets. A *complete* algorithm for a whole front face is then obtained by *concatenating* up to 4 basic algorithms.

Synthesized algorithms are basic algorithms that have been concatenated. Finding basic algorithms can de done *manually* by searching the path of letter 'A' on a cube wire grid model from an initial to a final location. The tip of Letter 'A' is used to show the orientation of a facelet.

Short Program description

There are 4 steps for solving the 4 corners on a front face. Steps 1 to 4 are applied CW (ClockWise), 1 step per corner facelet. There is an option for optimizing the order of steps 1 to 4 to find the shortest length algorithm. In this case, algorithms are computed for 4! = 24 sequences and the shortest length algorithm is selected at the end of the optimization process. These sequences are shown in the Table below.

Algorithm Length Optimization – The 24 Sequences of Steps											
1	2	3	4	5	6	7	8	9	10	11	12
Step 1	Step 1	Step 1	Step 1	Step 1	Step 1	Step 2	Step 2	Step 3	Step 3	Step 4	Step 4
Step 2	Step 2	Step 3	Step 3	Step 4	Step 4	Step 1	Step 1	Step 1	Step 1	Step 1	Step 1
Step 3	Step 4	Step 2	Step 4	Step 2	Step 3	Step 3	Step 4	Step 2	Step 4	Step 2	Step 3
Step 4	Step 3	Step 4	Step 2	Step 3	Step 2	Step 4	Step 3	Step 4	Step 2	Step 3	Step 2
13	14	15	16	17	18	19	20	21	22	23	24
Step 2	Step 2	Step 2	Step 2	Step 3	Step 3	Step 3	Step 3	Step 4	Step 4	Step 4	Step 4
Step 3	Step 3	Step 4	Step 4	Step 4	Step 4	Step 2	Step 2	Step 2	Step 2	Step 3	Step 3
Step 4	Step 1	Step 1	Step 3	Step 1	Step 2	Step 4	Step 1	Step 1	Step 3	Step 1	Step 2
Step 1	Step 4	Step 3	Step 1	Step 2	Step 1	Step 1	Step 4	Step 3	Step 1	Step 2	Step 1

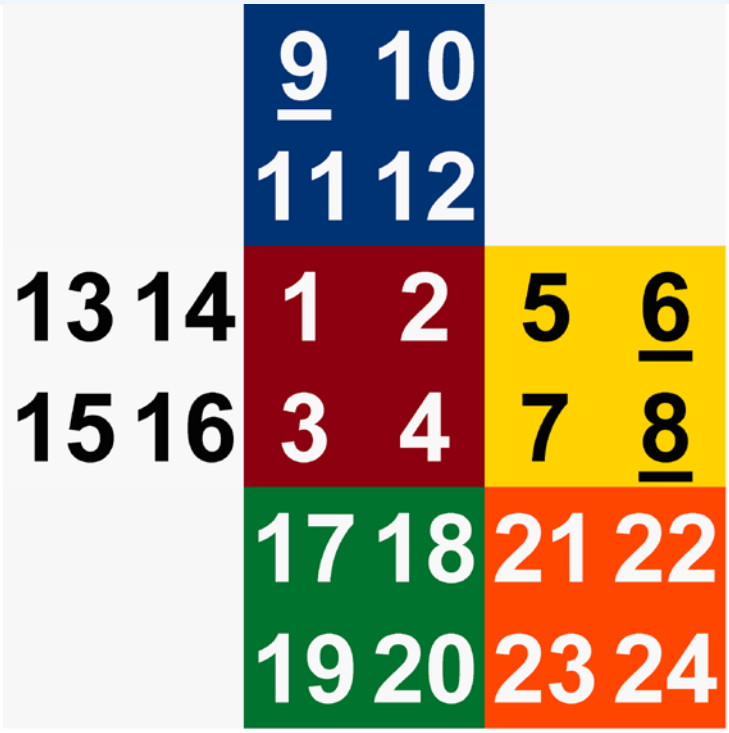
For each step, basic algorithms are automatically selected in look-up tables. A synthesized algorithm is then obtained by concatenating 4 basic algorithms. In order to shorten the synthesized algorithm length, *trivial* combinations between successive basic algorithms such as **F F'** are suppressed or simplified when concatenating basic algorithms.

Examples

Example #1: 2x2x2 Reference Cube

2x2x2 Reference Cube

Texture



Virtual Cube

2x2x2 Reference Cube – Basic Algorithms Examples

Step 1: From U [TLC, N] To F [TLC, N]

Number '**9**' is brought from face **U** to face **F** (+0°)

Step 2: From R [BRC, E] To F [TRC, N]

Number '**8**' is brought from face **R** to face **F** (+270°)

Basic Algorithms

B' L' B L

B' R B2 R'

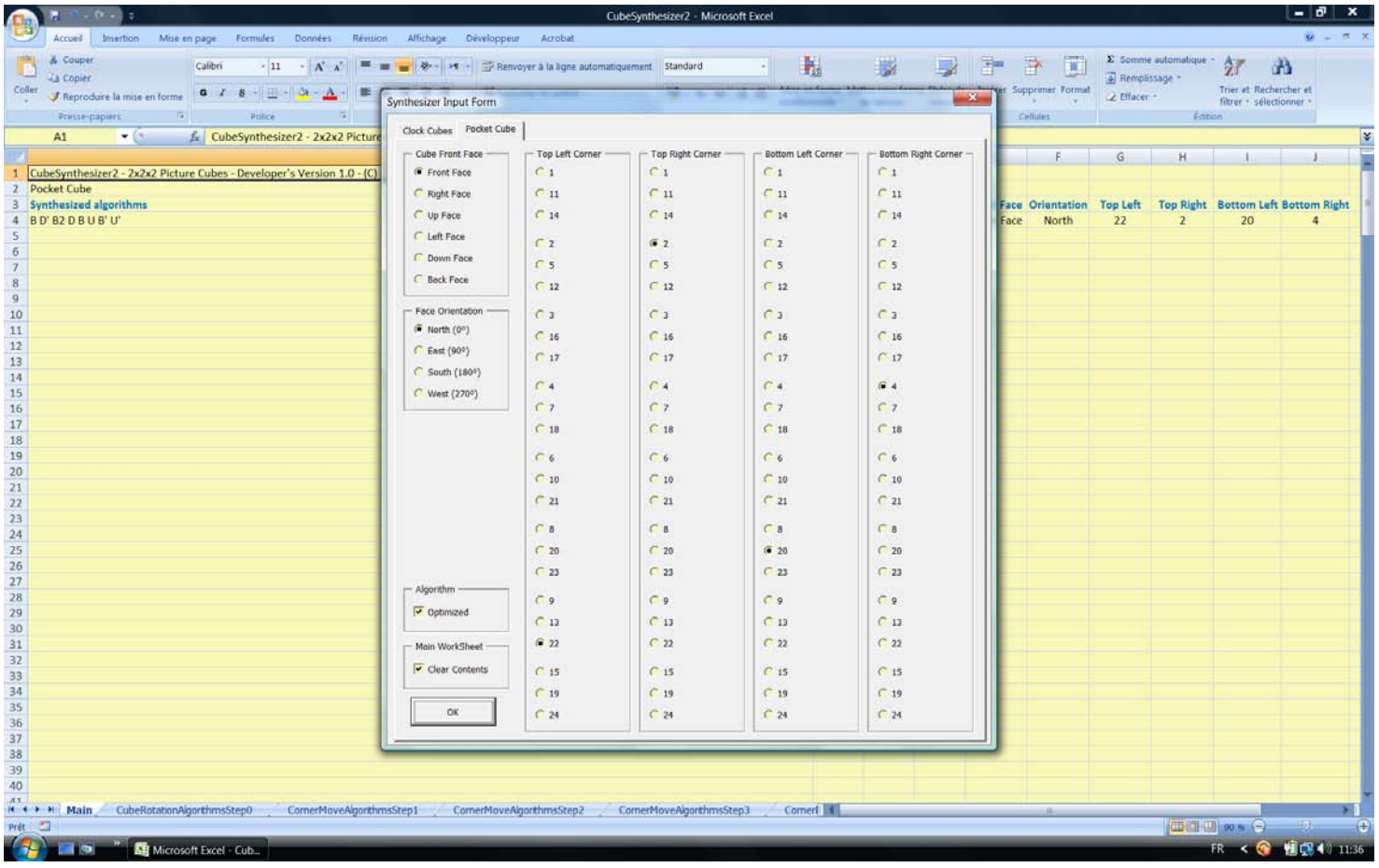
A 2x2x2 Reference Cube is used to check basic algorithms and fill in lookup tables with numbers indicating the cube state. All basic algorithms do not modify any facelet on the *Front* face other than the origin or destination facelets.

Example #2: Dot Matrix Cube (Demo)

Example of a Dot Matrix Screen

Dot Matrix Screen

Synthesizer Input Form Example



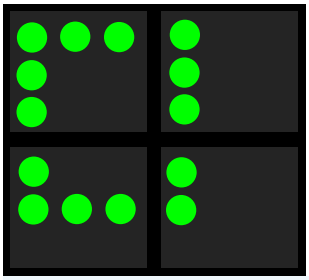
This example shows how to use an Input Form for synthesizing algorithms for the Pocket Cube. We can see that corners 22, 2, 20 and 4 have been selected for displaying letter '**A**'. Note that by unchecking the 'Clear Contents' CheckBox, algorithms are displayed one after another and stay on screen. Optimized algorithms can also be computed by checking the 'Optimized' CheckBox.

Possible Dot Matrix Cube Patterns on a Pocket Cube

Dot Matrix Cube Patterns

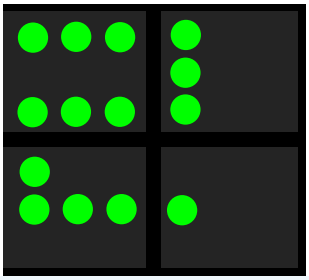
Numerals

'0'

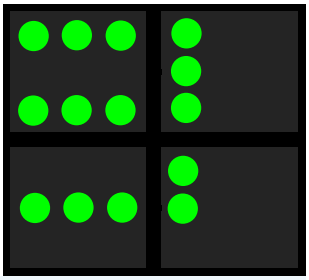


'1'

'2'

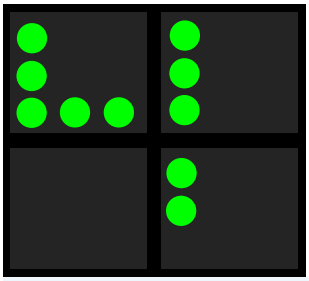


'3'

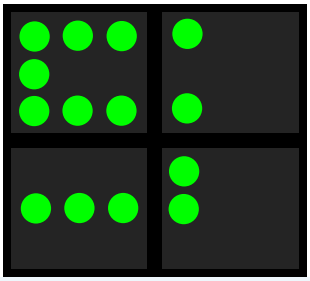


Numerals

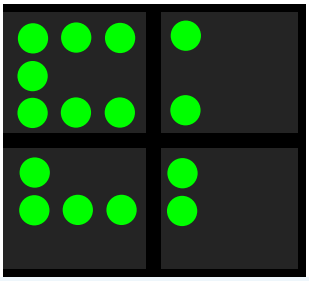
'4'



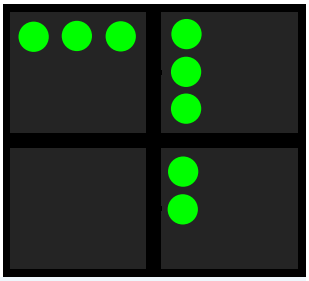
'5'



'6'

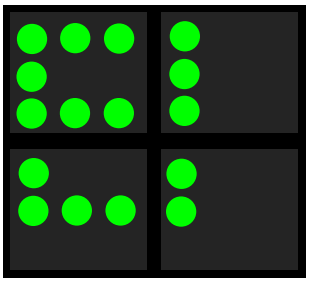


'7'

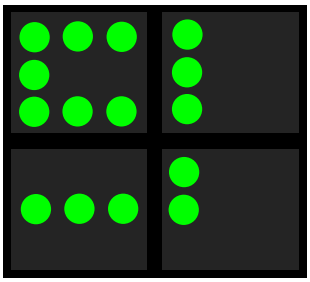


Numerals

'8'



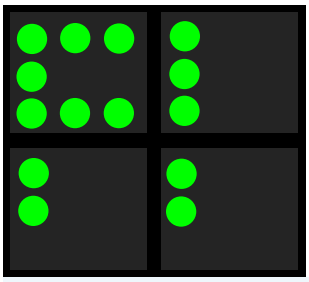
'9'



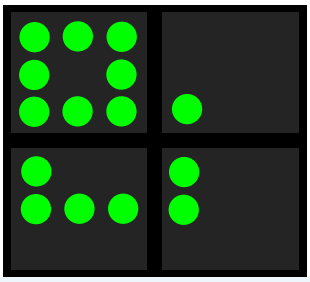
Dot Matrix Cube Patterns

Capital Letters

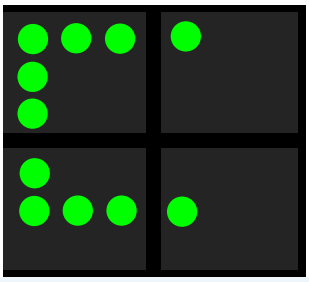
'A'



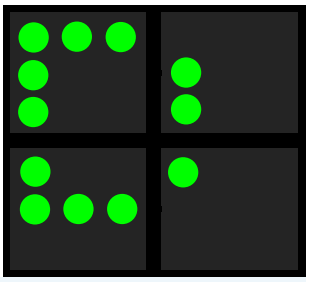
'B'



'C'

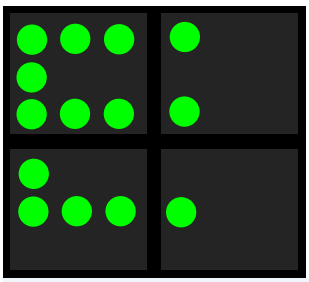


'D'

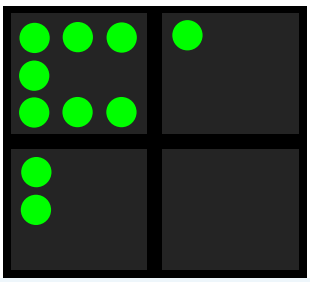


Capital Letters

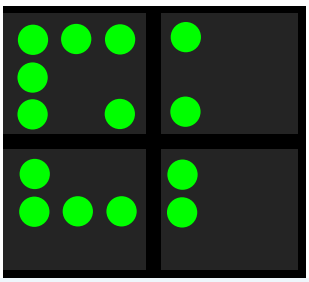
'E'



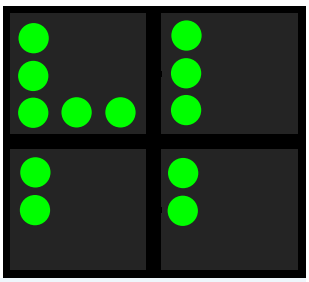
'F'



'G'

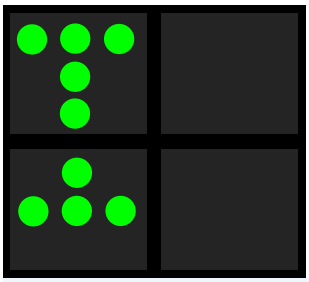


'H'

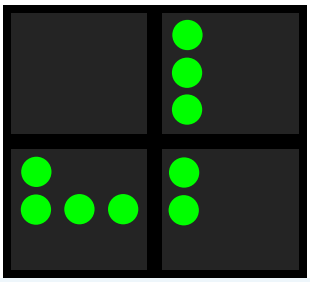


Capital Letters

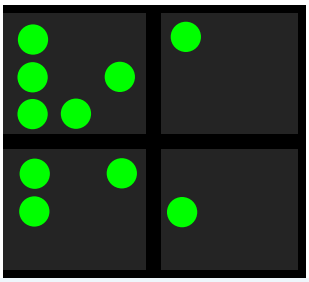
'I'



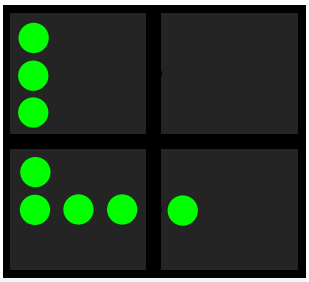
'J'



'K'

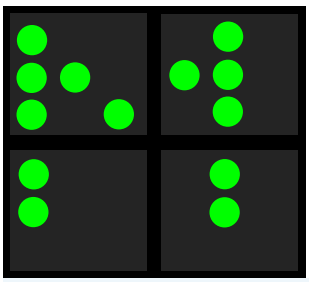


'L'

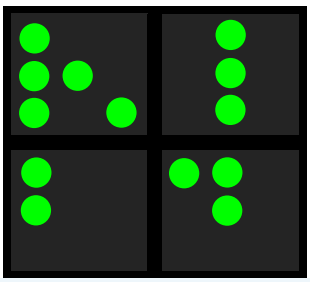


Capital Letters

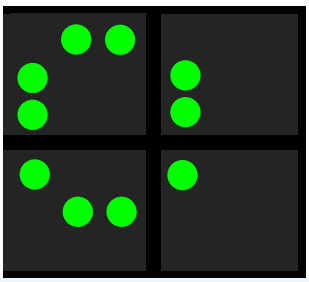
'M'



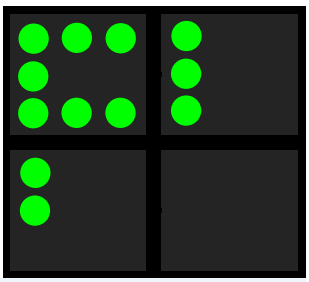
'N'



'O'

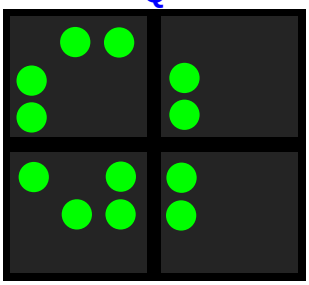


'P'

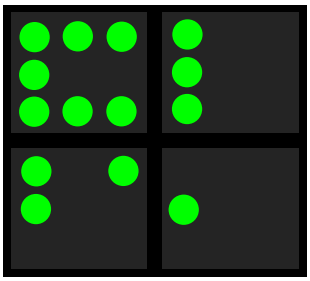


Capital Letters

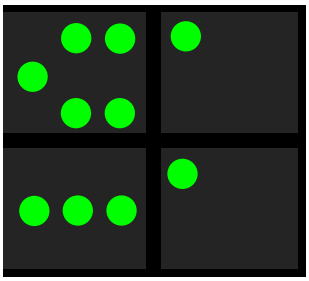
'Q'



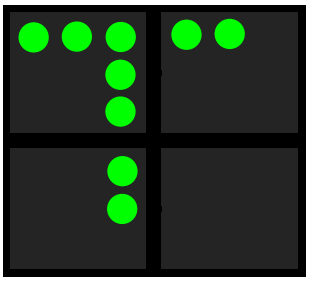
'R'



'S'



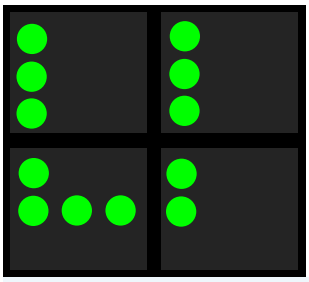
'T'



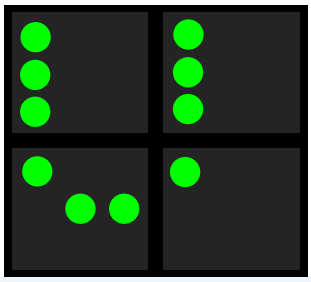
Dot Matrix Cube Patterns

Capital Letters

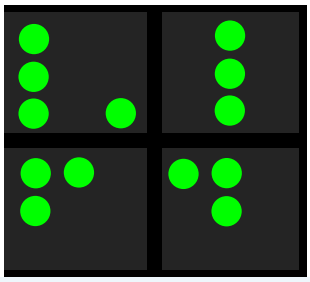
'U'



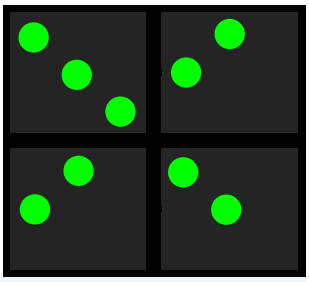
'V'



'W'

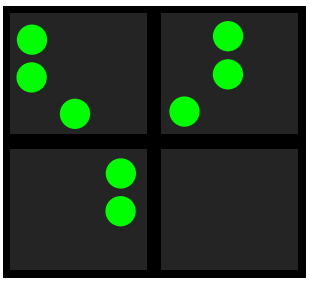


'X'

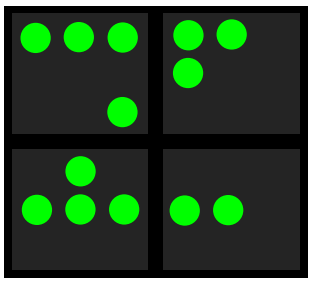


Capital Letters

'Y'



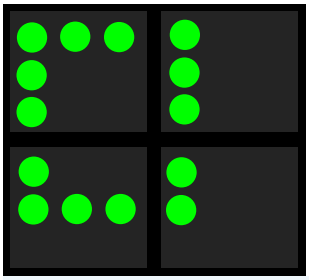
'Z'



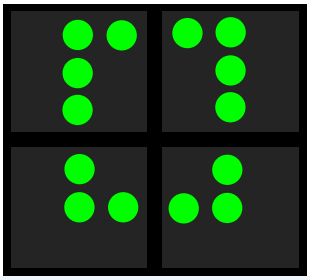
Moving Numerals on a Dot Matrix Cube

Numeral '0' – Moving from Left to Right

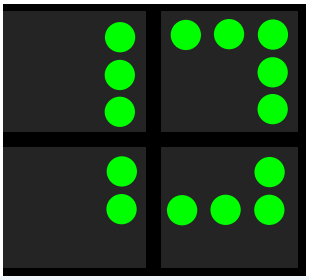
+0



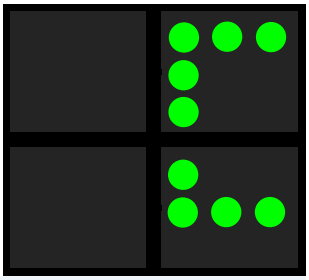
+1



+2



+3



Numeral '0' – Moving from Left to Right

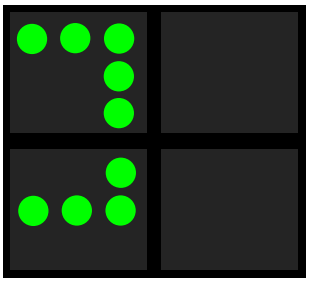
+4

+5

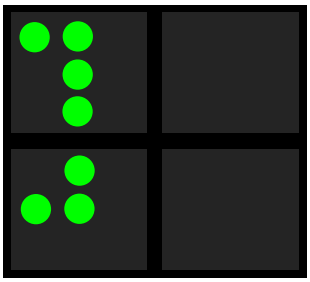
+6

Numeral '0' – Moving from Right to Left

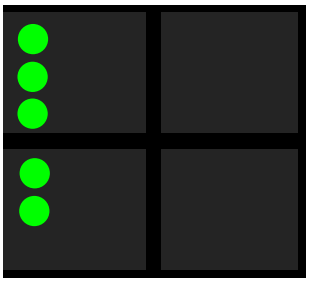
-1



-2



-3



-4

Choosing an Optimum Dot Size

An optimum dot size can be found if the distance between 2 dots is equal to the gap between 2 stickers. As the Sticker Width to Gap ratio is approximately 9:1 for a Pocket Cube, the optimum dot Diameter is then equal to:

$$\text{Dot Diameter} = (7.\text{Sticker Width}/17)$$

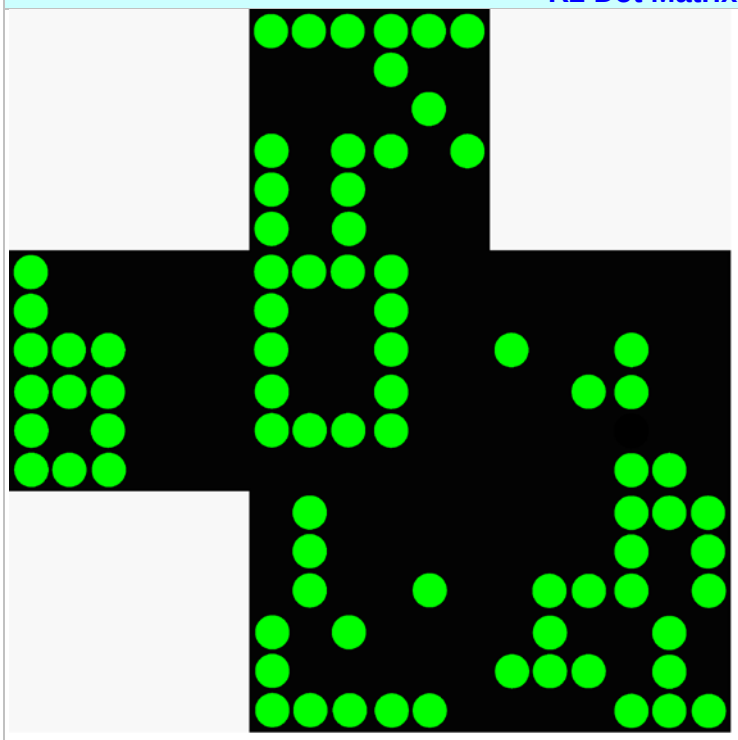
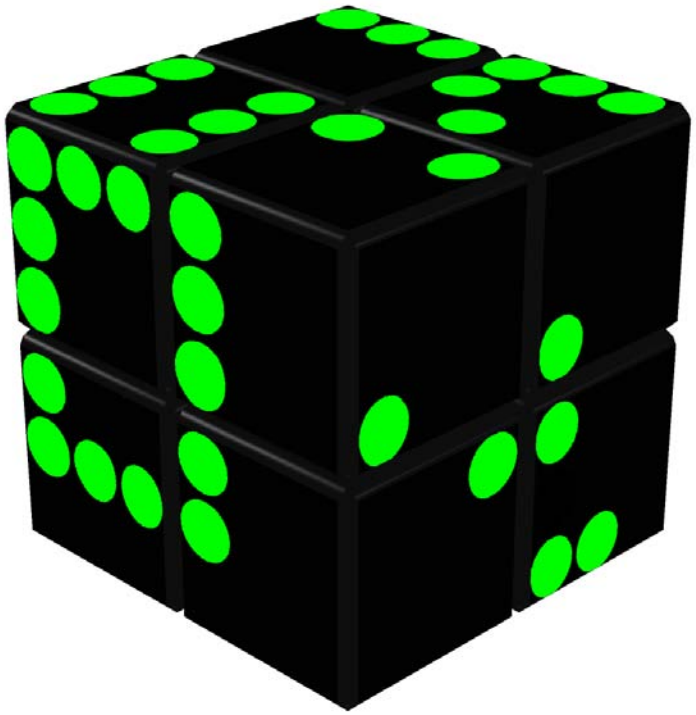
Note that this holds only for 3x3x3 dot patterns.

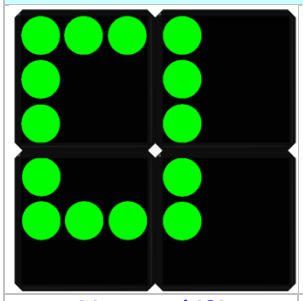
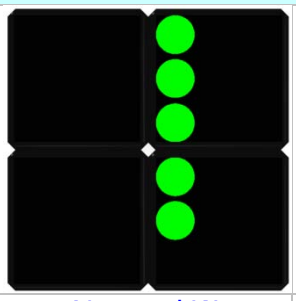
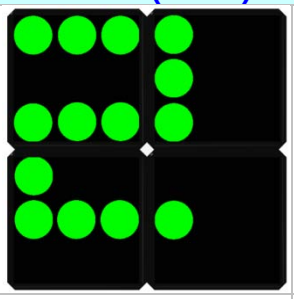
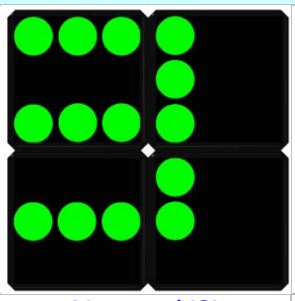
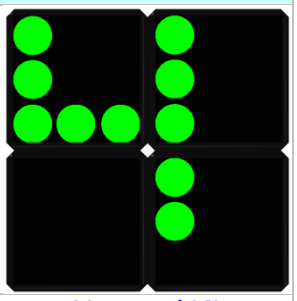
Selecting Dot Matrix Cube Patterns

There are many patterns that can be designed using 3x3x3 basic patterns on each of the 4 front face cubies. So, we have to make a choice on the most suitable basic patterns. These have been selected as explained below:

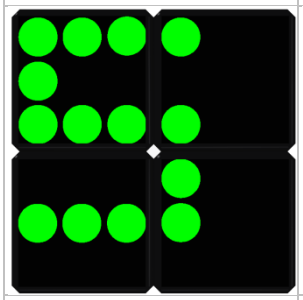
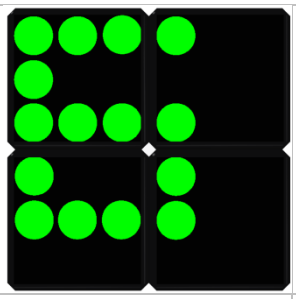
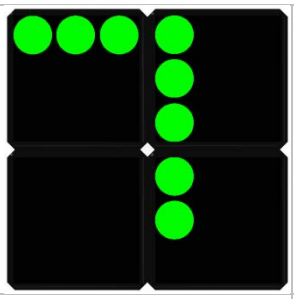
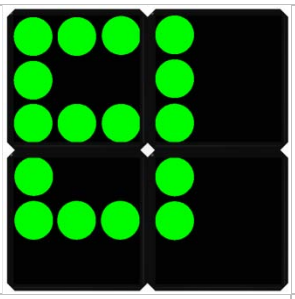
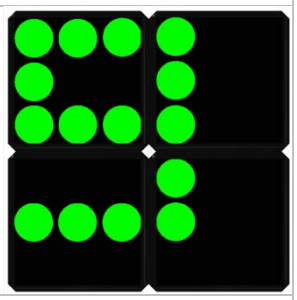
1- There is no unique choice: other patterns could also have been selected as well.
2- Basic patterns for numerals '**0**' to '**9**' have been selected.
3- Basic patterns for letters '**A**' to '**K**' have been selected.

Examples of Dot Matrix Patterns

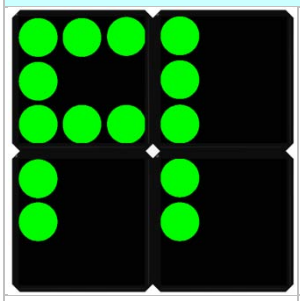
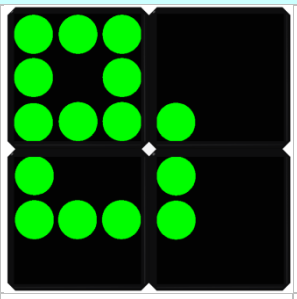
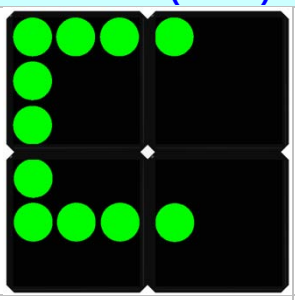
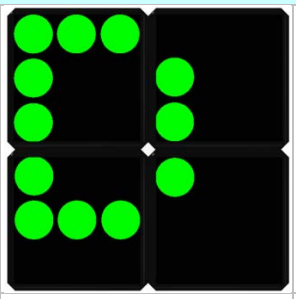
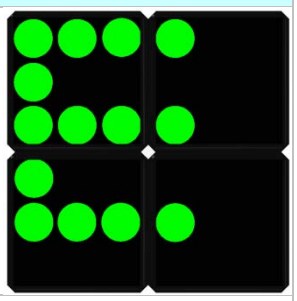
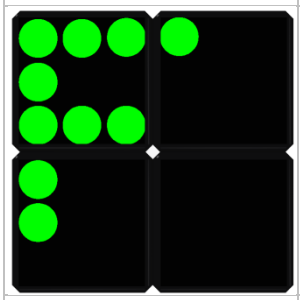
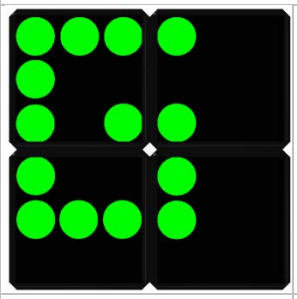
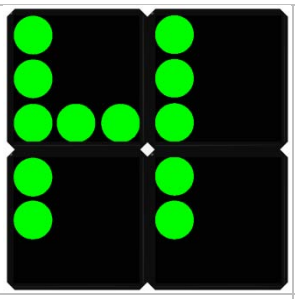
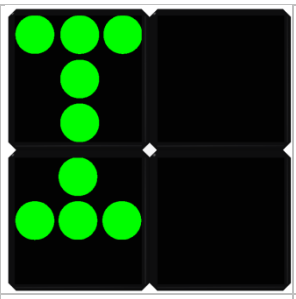
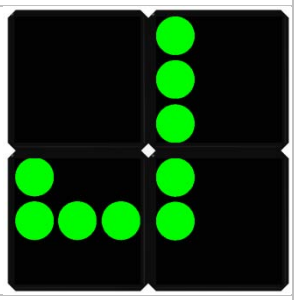
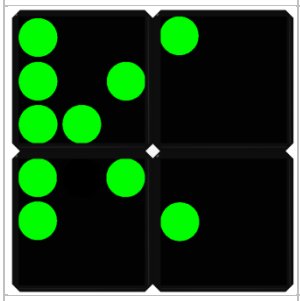
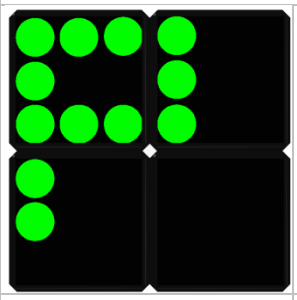
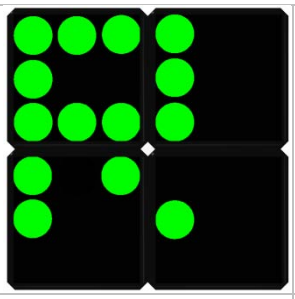
R2 Dot Matrix Cube (Demo)	
	
Texture	Virtual Cube

R2 Dot Matrix Cube (Demo) – Numerals				
				
Numeral '**0**'	Numeral '**1**'	Numeral '**2**'	Numeral '**3**'	Numeral '**4**'

Numerals	Optimized Synthesized Algorithms
'**0**'	No Move
'**1**'	L B2 L' D' B2 D L' B2 L U B2 U'
'**2**'	D B2 D' R' B2 R U B2 U' L' B2 L
'**3**'	D' B2 D L B2 L' U B2 U' L' B2 L
'**4**'	B U B' U' B' L B2 L'

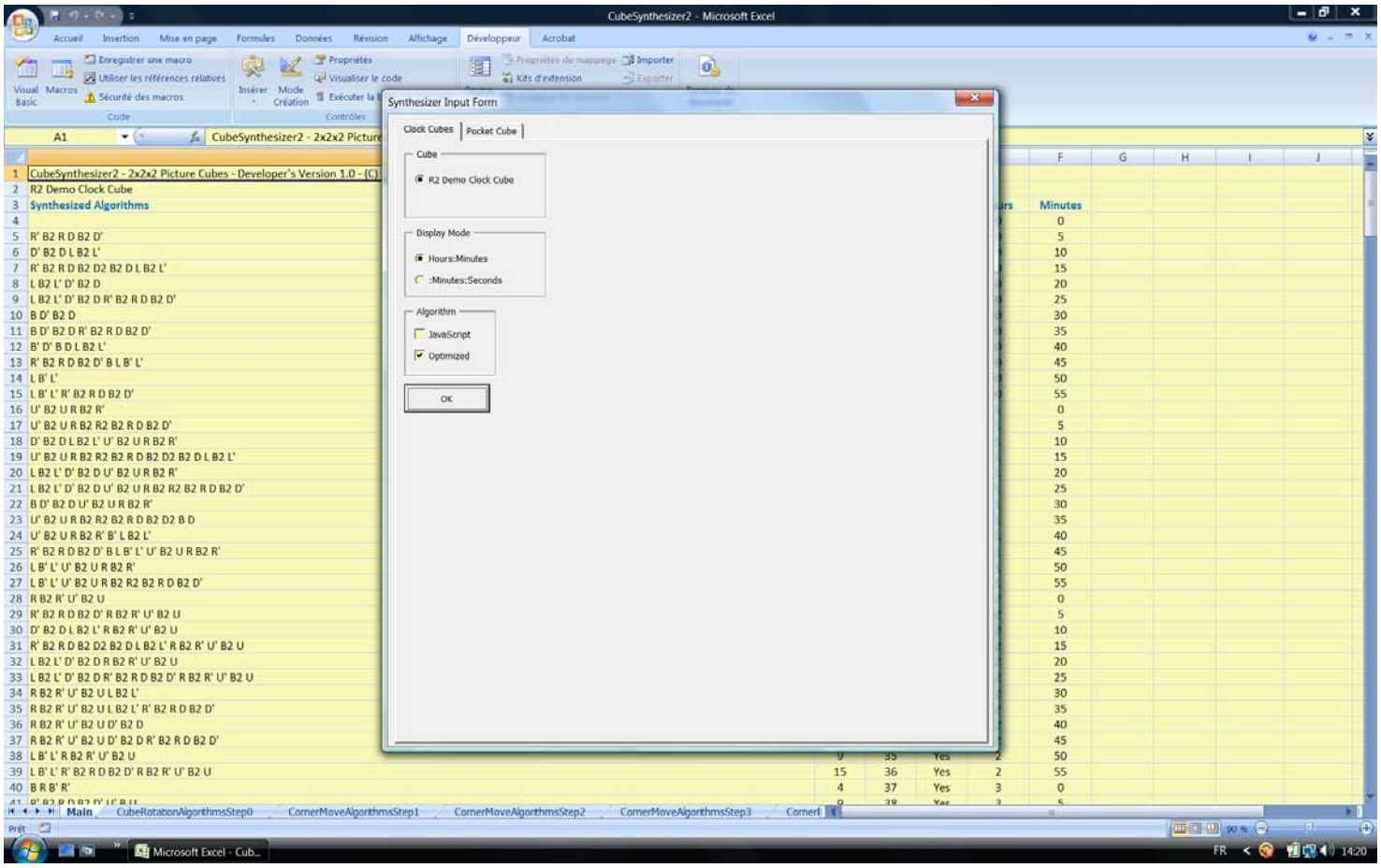
				
Numeral '**5**'	Numeral '**6**'	Numeral '**7**'	Numeral '**8**'	Numeral '**9**'

Numerals	Optimized Synthesized Algorithms
'**5**'	D' B2 D L B2 L' U B2 U2 B2 U R B2 R'
'**6**'	U' B2 U R B2 R' B' U B2 U'
'**7**'	B' L' B L B D' B D L B2 L'
'**8**'	U B' U' L' B2 L
'**9**'	D' B2 D L B2 L' U B2 U'

R2 Dot Matrix Cube (Demo) – Letters				
				
Letter '**A**'	Letter '**B**'	Letter '**C**'	Letter '**D**'	Letter '**E**'
Letters	**Optimized Synthesized Algorithms**			
'**A**'	B D' B2 D B U B' U'			
'**B**'	B2 L' B L U' B2 U			
'**C**'	D B2 D' R' B2 R2 B2 R' U' B2 U			
'**D**'	R' B2 R D B2 D' B' R B2 R'			
'**E**'	D B2 D' R' B2 R U' B2 U R B2 R' L' B L			
				
Letter '**F**'	Letter '**G**'	Letter '**H**'	Letter '**I**'	Letter '**J**'
Letters	**Optimized Synthesized Algorithms**			
'**F**'	R B2 R' U' B2 U L' B2 L B2 D B2 D2 B2 D			
'**G**'	U B' U2 B2 U R B2 R'			
'**H**'	B U B' U' D' B2 D			
'**I**'	D U' L B' L2 B2 L'			
'**J**'	L' B2 L U B2 U'			
				
Letter '**K**'	Letter '**P**'	Letter '**R**'		
Letters	**Optimized Synthesized Algorithms**			
'**K**'	D B2 D' R' B2 R2 B2 R' U' B2 U2 B' U' L B' L'			
'**P**'	B D' B2 D B U B' U' D B2 D'			
'**R**'	L B' L' D B2 D' R' B2 R B U B' U'			

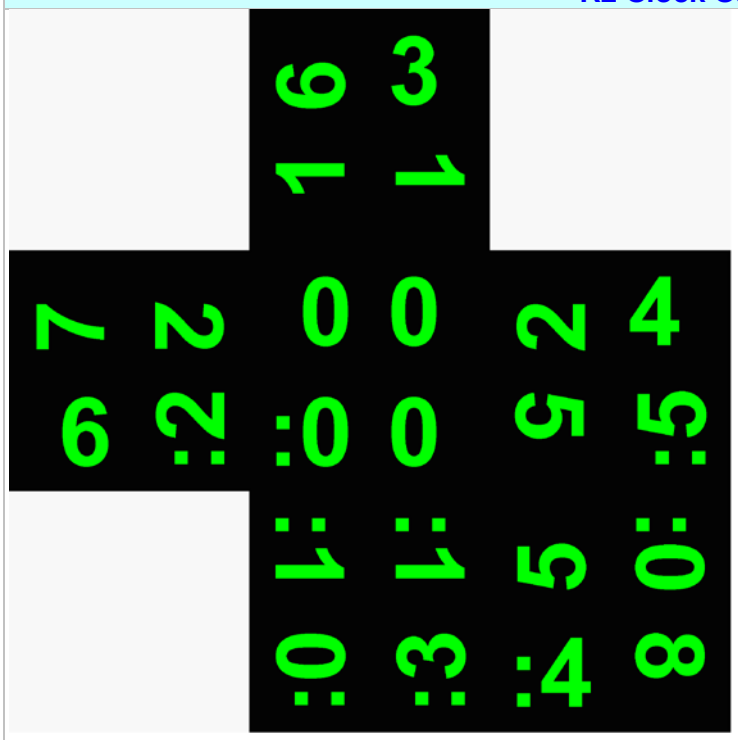
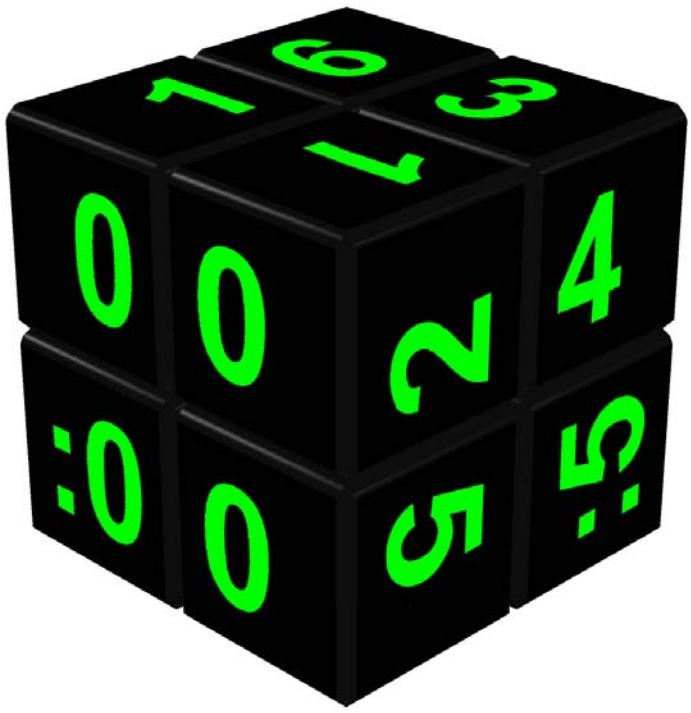
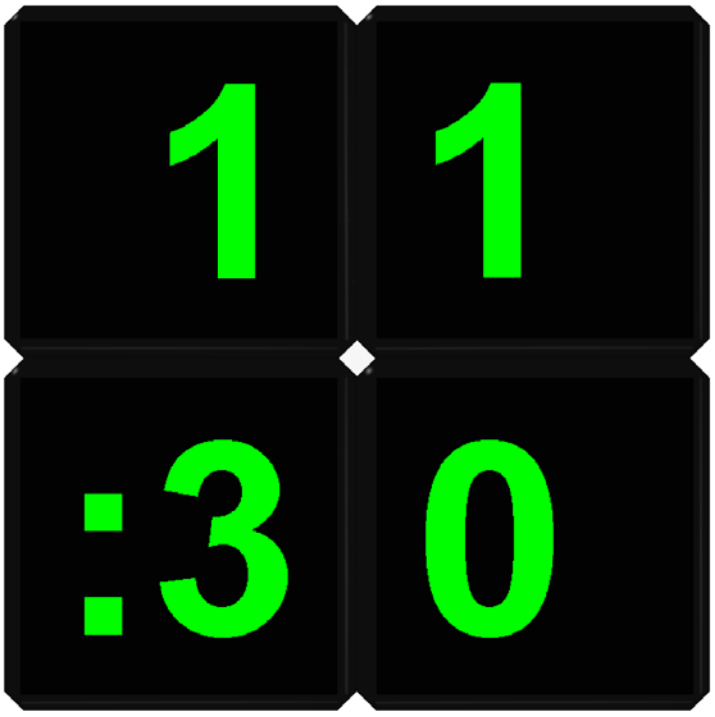
Example #3: Clock Cube (Demo)

Synthesizer Input Form Example



This example shows how to use an Input Form for synthesizing algorithms. We can see that the R2 Demo Clock Cube has been been selected. Note that by unchecking the 'Optimized' CheckBox, *un-optimized* algorithms are displayed. This can be used for speeding the algorithm synthesis because in this case, Synthesizer routines are executed only once per algorithm. Otherwise, execution time would be 24 times longer…but at least 10% of synthesized algorithms would be shorter.

Examples of [Hours:Minutes] or [:Minutes:Seconds] on Corner Cubes

R2 Clock Cube (Demo)	
	
Texture	Virtual Cube (Initial State)
R2 Clock Cube (Demo) – Clock Examples	
	
Virtual Clock Cube (11:30)	Virtual Clock Cube (23:55)
Optimized Synthesized Algorithms	
B D' B2 D U' B2 U R B2 R' U B2 U' L' B2 L	B R B' R2 B2 R D B2 D' L B2 L2 B2 L U B2 U'

The cube can display the time in 3 modes:

1. Clock Mode: Time of the day from 00:00 up to 23:55 in 5-minute steps (24-hour period)
2. Timer 1 Mode : Elapsed time from :00:00 up to :09:55 in 5-second steps (first 10-minute period)
3. Timer 2 Mode : Elapsed time from :10:00 up to :19:50 in 10-second steps (second 10-minute period)

R2 Clock Cube (Demo) – Timer Examples	
	
Virtual Timer 1 Cube (:09:55)	Virtual Timer 2 Cube (:19:50)
Optimized Synthesized Algorithms	
L B' L' R' B2 R D B2 D' U' B U B' L' B L	L B' L' B R B' R2 B U2 R B' R' B R

Clock Cube Design

Top **L**eft **C**orner: [0,1,2]
Top **R**ight **C**orners: [0,1,2], [3,4,5], [6,7,:0_**TLC**], [8,9,:0_**TLC**]
Bottom **L**eft **C**orners: [:0,:1,:2], [:3,;4,:5]
Bottom **R**ight **C**orner: [0,5,:1_**TLC**]

Note 1: Numeral :0_**TLC** is used on 2 corners to insure that it will be available at any time.
Note 2: Numerals :0_**TLC** and 1_**TLC** are used in Timer Modes 1 & 2 respectively.
Note 3: **T**op **L**eft **C**orner '0' is used **B**ottom **R**ight in Timer Mode 2.

R2 Cube Rotation Algorithms (Check: done)

Step 0 – R2 Cube Rotation Algorithms: From F/R/U/L/D/B to F [N]					
To F [N]		From F			
	Orientation		Orientation	Algorithm	Moves
	N		N	No move	0
	N		E	CF'	0
	N		S	CF2	0
	N		W	CF	0
To F [N]		From R			
	Orientation		Orientation	Algorithm	Moves
	N		N	CU	0
	N		E	CF' CR'	0
	N		S	CU' CR2	0
	N		W	CF CR	0
To F [N]		From U			
	Orientation		Orientation	Algorithm	Moves
	N		N	CR'	0
	N		E	CF' CU'	0
	N		S	CR CU2	0
	N		W	CF CU	0
To F [N]		From L			
	Orientation		Orientation	Algorithm	Moves
	N		N	CU'	0
	N		E	CF' CR	0
	N		S	CF2 CU	0
	N		W	CF CR'	0
To F [N]		From D			
	Orientation		Orientation	Algorithm	Moves
	N		N	CR	0
	N		E	CF' CU	0
	N		S	CF2 CR'	0
	N		W	CF CU'	0
To F [N]		From B			
	Orientation		Orientation	Algorithm	Moves
	N		N	CU2	0
	N		E	CF CU2	0
	N		S	CR2	0
	N		W	CF' CU2	0

R2 Corner Move Algorithms (Check: done)

Front face center cubies other than the origin and destination center cubies are left unchanged.

Step 1 – R2 Corner Move Algorithms: From F/R/U/L/D/B to F [TLC, N]					
To F [TLC, N]		**From F**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TLC	N	TLC	N	No move	0
TLC	N	TRC	E	U' L' B L	4
TLC	N	BRC	S	R' L' B2 L R	5
TLC	N	BLC	W	L U B' U'	4
To F [TLC, N]		**From R**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TLC	N	TLC	N	U	1
TLC	N	TRC	E	L' B L	3
TLC	N	BRC	S	U B2 U'	3
TLC	N	BLC	W	R' B2 U' R	4
To F [TLC, N]		**From U**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TLC	N	TLC	N	B' L' B L	4
TLC	N	TRC	E	B' U B2 U'	4
TLC	N	BRC	S	U' B U'	3
TLC	N	BLC	W	U B2 U' L' B2 L	6
To F [TLC, N]		**From L**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TLC	N	TLC	N	B U B' U'	4
TLC	N	TRC	E	L' B2 L U B2 U'	6
TLC	N	BRC	S	L B' L	3
TLC	N	BLC	W	B2 L' B L	4
To F [TLC, N]		**From D**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TLC	N	TLC	N	L'	1
TLC	N	TRC	E	R' B U2 R	4
TLC	N	BRC	S	L' B2 L	3
TLC	N	BLC	W	U B' U'	3
To F [TLC, N]		**From B**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TLC	N	TLC	N	B U B' U' L' B2 L	7
TLC	N	TRC	E	U B' U' L' B2 L	6
TLC	N	BRC	S	B' U B' U' L' B2 L	7
TLC	N	BLC	W	B2 U B' U' L' B2 L	7

Step 2 – R2 Corner Move Algorithms: From F/R/U/L/D/B to F [TRC, N]					
To F [TRC, N]		**From F**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TRC	N	TLC	W	U R B' R'	4
TRC	N	TRC	N	No Move	0
TRC	N	BRC	E	D B2 D' R B' R'	6
TRC	N	BLC	S	D' U' B2 U D	5
To F [TRC, N]		**From R**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TRC	N	TLC	W	R B2 R' U' B2 U	6
TRC	N	TRC	N	L U L'	3
TRC	N	BRC	E	B' R B2 R'	4
TRC	N	BLC	S	R2 L U L'	4
To F [TRC, N]		**From U**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TRC	N	TLC	W	B2 U' B U	4
TRC	N	TRC	N	B R B' R'	4
TRC	N	BRC	E	U' B2 U R B2 R'	6
TRC	N	BLC	S	U B' U	3
To F [TRC, N]		**From L**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TRC	N	TLC	W	R B' R'	3
TRC	N	TRC	N	U'	1
TRC	N	BRC	E	L B2 U L'	4
TRC	N	BLC	S	U' B2 U	3
To F [TRC, N]		**From D**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TRC	N	TLC	W	D' R B2 R' D	5
TRC	N	TRC	N	R	1
TRC	N	BRC	E	U' B U	3
TRC	N	BLC	S	R B2 R'	3
To F [TRC, N]		**From B**			
Location	Orientation	Location	Orientation	Algorithms	Moves
TRC	N	TLC	W	U' B U R B2 R'	6
TRC	N	TRC	N	B' U' B U R B2 R'	7
TRC	N	BRC	E	B2 U' B U R B2 R'	7
TRC	N	BLC	S	B U' B U R B2 R'	7

Step 3 – R2 Corner Move Algorithms: From F/R/U/L/D/B to F [BRC, N]					
To F [BRC, N]		**From F**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BRC	N	TLC	S	U D B2 D' U'	5
BRC	N	TRC	W	R D B' D'	4
BRC	N	BRC	N	No Move	0
BRC	N	BLC	E	D' R' B R	4
To F [BRC, N]		**From R**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BRC	N	TLC	S	R B' R	3
BRC	N	TRC	W	B2 R' B R	4
BRC	N	BRC	N	B2 D B2 D'	4
BRC	N	BLC	E	R' B2 R D B2 D'	6
To F [BRC, N]		**From U**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BRC	N	TLC	S	R' B2 R	3
BRC	N	TRC	W	D B' D'	3
BRC	N	BRC	N	R'	1
BRC	N	BLC	E	U R' B2 R U'	5
To F [BRC, N]		**From L**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BRC	N	TLC	S	D B2 D'	3
BRC	N	TRC	W	L' D B2 D' L	5
BRC	N	BRC	N	D	1
BRC	N	BLC	E	R' B R	3
To F [BRC, N]		**From D**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BRC	N	TLC	S	D2 B' R' B R	5
BRC	N	TRC	W	D B2 D' R' B2 R	6
BRC	N	BRC	N	B' R' B R	4
BRC	N	BLC	E	B' D B2 D'	4
To F [BRC, N]		**From B**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BRC	N	TLC	S	B' D B' D' R' B2 R	7
BRC	N	TRC	W	B2 D B' D' R' B2 R	7
BRC	N	BRC	N	B D B' D' R' B2 R	7
BRC	N	BLC	E	D B' D' R' B2 R	6

Step 4 – R2 Corner Move Algorithms: From F/R/U/L/D/B to F [BLC, N]					
To F [BLC, N]		**From F**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BLC	N	TLC	E	L' D' B D	4
BLC	N	TRC	S	U' D' B2 D U	5
BLC	N	BRC	W	D L B' L'	4
BLC	N	BLC	N	No Move	0
To F [BLC, N]		**From R**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BLC	N	TLC	E	R B2 D R'	4
BLC	N	TRC	S	D' B2 D	3
BLC	N	BRC	W	L B' L'	3
BLC	N	BLC	N	D'	1
To F [BLC, N]		**From U**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BLC	N	TLC	E	D' B D	3
BLC	N	TRC	S	L B2 L'	3
BLC	N	BRC	W	L U' B2 L'	4
BLC	N	BLC	N	L	1
To F [BLC, N]		**From L**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BLC	N	TLC	E	B' L B2 L'	4
BLC	N	TRC	S	L2 B' D' B D	5
BLC	N	BRC	W	L B2 L' D' B2 D	6
BLC	N	BLC	N	B' D' B D	4
To F [BLC, N]		**From D**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BLC	N	TLC	E	D' B2 D L B2 L'	6
BLC	N	TRC	S	D2 B2 L B2 L'	5
BLC	N	BRC	W	B D' B2 D	4
BLC	N	BLC	N	B L B' L'	4
To F [BLC, N]		**From B**			
Location	Orientation	Location	Orientation	Algorithms	Moves
BLC	N	TLC	E	B2 D' B D L B2 L'	7
BLC	N	TRC	S	B D' B D L B2 L'	7
BLC	N	BRC	W	D' B D L B2 L'	6
BLC	N	BLC	N	B' D' B D L B2 L'	7

R2 Cube Rotation – Corner Cubes States

Step 0 (Check: done)

Corner Cubes States – Step 0: From F [E] To F [N]											
		6	8					0	0		
		5	7					0	0		
10	12	2	4	18	20	0	0	0	0	0	0
9	11	1	3	17	19	0	0	0	0	0	0
		14	16	23	21			0	0	0	0
		13	15	24	22			0	0	0	0

Corner Cubes States – Step 0: From F [S] To F [N]											
		20	19					0	0		
		18	17					0	0		
8	7	4	3	16	15	0	0	0	0	0	0
6	5	2	1	14	13	0	0	0	0	0	0
		12	11	24	23			0	0	0	0
		10	9	22	21			0	0	0	0

Corner Cubes States – Step 0: From F [W] To F [N]											
		15	13					0	0		
		16	14					0	0		
19	17	3	1	11	9	0	0	0	0	0	0
20	18	4	2	12	10	0	0	0	0	0	0
		7	5	22	24			0	0	0	0
		8	6	21	23			0	0	0	0

Corner Cubes States – Step 0: From R [N] To F [N]

		11	9					0	0		
		12	10					0	0		
1	2	5	6	21	22	0	0	0	0	0	0
3	4	7	8	23	24	0	0	0	0	0	0
		18	20	13	14			0	0	0	0
		17	19	15	16			0	0	0	0

Corner Cubes States – Step 0: From R [E] To F [N]

		22	24					0	0		
		21	23					0	0		
9	10	6	8	20	19	0	0	0	0	0	0
11	12	5	7	18	17	0	0	0	0	0	0
		2	4	15	13			0	0	0	0
		1	3	16	14			0	0	0	0

Corner Cubes States – Step 0: From R [S] To F [N]

		19	17					0	0		
		20	18					0	0		
24	23	8	7	4	3	0	0	0	0	0	0
22	21	6	5	2	1	0	0	0	0	0	0
		10	12	16	15			0	0	0	0
		9	11	14	13			0	0	0	0

Corner Cubes States – Step 0: From R [W] To F [N]

		3	1					0	0		
		4	2					0	0		
17	18	7	5	12	11	0	0	0	0	0	0
19	20	8	6	10	9	0	0	0	0	0	0
		23	21	14	16			0	0	0	0
		24	22	13	15			0	0	0	0

Corner Cubes States – Step 0: From U [N] To F [N]

		24	23					0	0		
		22	21					0	0		
15	13	9	10	6	8	0	0	0	0	0	0
16	14	11	12	5	7	0	0	0	0	0	0
		1	2	20	19			0	0	0	0
		3	4	18	17			0	0	0	0

Corner Cubes States – Step 0: From U [E] To F [N]

		8	7					0	0		
		6	5					0	0		
23	21	10	12	2	4	0	0	0	0	0	0
24	22	9	11	1	3	0	0	0	0	0	0
		13	14	18	20			0	0	0	0
		15	16	17	19			0	0	0	0

Corner Cubes States – Step 0: From U [S] To F [N]

		4	3					0	0		
		2	1					0	0		
7	5	12	11	14	16	0	0	0	0	0	0
8	6	10	9	13	15	0	0	0	0	0	0
		21	22	17	18			0	0	0	0
		23	24	19	20			0	0	0	0

Corner Cubes States – Step 0: From U [W] To F [N]

		16	15					0	0		
		14	13					0	0		
3	1	11	9	22	24	0	0	0	0	0	0
4	2	12	10	21	23	0	0	0	0	0	0
		5	6	19	17			0	0	0	0
		7	8	20	18			0	0	0	0

Corner Cubes States – Step 0: From L [N] To F [N]

		10	12					0	0		
		9	11					0	0		
21	22	13	14	1	2	0	0	0	0	0	0
23	24	15	16	3	4	0	0	0	0	0	0
		19	17	5	6			0	0	0	0
		20	18	7	8			0	0	0	0

Corner Cubes States – Step 0: From L [E] To F [N]

		2	4					0	0		
		1	3					0	0		
12	11	14	16	17	18	0	0	0	0	0	0
10	9	13	15	19	20	0	0	0	0	0	0
		22	24	7	5			0	0	0	0
		21	23	8	6			0	0	0	0

Corner Cubes States – Step 0: From L [S] To F [N]

		18	20					0	0		
		17	19					0	0		
4	3	16	15	24	23	0	0	0	0	0	0
2	1	14	13	22	21	0	0	0	0	0	0
		11	9	8	7			0	0	0	0
		12	10	6	5			0	0	0	0

Corner Cubes States – Step 0: From L [W] To F [N]

		23	21					0	0		
		24	22					0	0		
20	19	15	13	9	10	0	0	0	0	0	0
18	17	16	14	11	12	0	0	0	0	0	0
		3	1	6	8			0	0	0	0
		4	2	5	7			0	0	0	0

Corner Cubes States – Step 0: From D [N] To F [N]

		1	2					0	0		
		3	4					0	0		
14	16	17	18	7	5	0	0	0	0	0	0
13	15	19	20	8	6	0	0	0	0	0	0
		24	23	12	11			0	0	0	0
		22	21	10	9			0	0	0	0

Corner Cubes States – Step 0: From D [E] To F [N]

		5	6					0	0		
		7	8					0	0		
2	4	18	20	23	21	0	0	0	0	0	0
1	3	17	19	24	22	0	0	0	0	0	0
		16	15	10	12			0	0	0	0
		14	13	9	11			0	0	0	0

Corner Cubes States – Step 0: From D [S] To F [N]

		21	22					0	0		
		23	24					0	0		
6	8	20	19	15	13	0	0	0	0	0	0
5	7	18	17	16	14	0	0	0	0	0	0
		4	3	9	10			0	0	0	0
		2	1	11	12			0	0	0	0

Corner Cubes States – Step 0: From D [W] To F [N]

		13	14					0	0		
		15	16					0	0		
22	24	19	17	3	1	0	0	0	0	0	0
21	23	20	18	4	2	0	0	0	0	0	0
		8	7	11	9			0	0	0	0
		6	5	12	10			0	0	0	0

Corner Cubes States – Step 0: From B [N] To F [N]

		12	11					0	0		
		10	9					0	0		
5	6	21	22	13	14	0	0	0	0	0	0
7	8	23	24	15	16	0	0	0	0	0	0
		20	19	1	2			0	0	0	0
		18	17	3	4			0	0	0	0

Corner Cubes States – Step 0: From B [E] To F [N]

		14	16					0	0		
		13	15					0	0		
11	9	22	24	19	17	0	0	0	0	0	0
12	10	21	23	20	18	0	0	0	0	0	0
		6	8	3	1			0	0	0	0
		5	7	4	2			0	0	0	0

Corner Cubes States – Step 0: From B [S] To F [N]

		17	18					0	0		
		19	20					0	0		
16	15	24	23	8	7	0	0	0	0	0	0
14	13	22	21	6	5	0	0	0	0	0	0
		9	10	4	3			0	0	0	0
		11	12	2	1			0	0	0	0

Corner Cubes States – Step 0: From B [W] To F [N]

		7	5					0	0		
		8	6					0	0		
18	20	23	21	10	12	0	0	0	0	0	0
17	19	24	22	9	11	0	0	0	0	0	0
		15	13	2	4			0	0	0	0
		16	14	1	3			0	0	0	0

Corner Cubes States

Step 1 (Check: done)

Corner Cubes States – Step 1: From F [TRC, E] To F [TLC, N]											
		9	8					0	0		
		5	11					0	0		
13	12	2	14	1	20	0	0	0	0	0	0
15	16	3	4	7	6	0	0	0	0	0	0
		17	18	23	22			0	0	0	0
		19	21	10	24			0	0	0	0

Corner Cubes States – Step 1: From F [BRC, S] To F [TLC, N]											
		20	10					0	0		
		18	12					0	0		
8	7	4	2	5	6	0	0	0	0	0	0
15	16	3	1	14	13	0	0	0	0	0	0
		17	11	21	23			0	0	0	0
		19	9	22	24			0	0	0	0

Corner Cubes States – Step 1: From F [BLC, W] To F [TLC, N]											
		9	10					0	0		
		16	12					0	0		
13	17	3	2	5	6	0	0	0	0	0	0
20	14	11	4	7	24	0	0	0	0	0	0
		1	18	21	22			0	0	0	0
		8	19	15	23			0	0	0	0

Corner Cubes States – Step 1: From R [TLC, N] To F [TLC, N]

		11	9					0	0		
		12	10					0	0		
1	2	5	6	21	22	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	13	14			0	0	0	0
		19	20	23	24			0	0	0	0

Corner Cubes States – Step 1: From R [TRC, E] To F [TLC, N]

		11	8					0	0		
		21	12					0	0		
1	10	6	2	5	20	0	0	0	0	0	0
15	16	3	4	7	22	0	0	0	0	0	0
		17	18	23	14			0	0	0	0
		19	13	9	24			0	0	0	0

Corner Cubes States – Step 1: From R [BRC, S] To F [TLC, N]

		19	10					0	0		
		20	12					0	0		
24	23	8	2	5	6	0	0	0	0	0	0
22	16	3	4	7	1	0	0	0	0	0	0
		17	18	21	15			0	0	0	0
		9	11	14	13			0	0	0	0

Corner Cubes States – Step 1: From R [BLC, W] To F [TLC, N]

		19	14					0	0		
		4	12					0	0		
24	18	7	2	5	1	0	0	0	0	0	0
8	16	3	9	13	10	0	0	0	0	0	0
		17	22	11	15			0	0	0	0
		23	6	21	20			0	0	0	0

Corner Cubes States – Step 1: From U [TLC, N] To F [TLC, N]

		11	10					0	0		
		22	12					0	0		
1	13	9	2	5	6	0	0	0	0	0	0
20	16	3	4	7	24	0	0	0	0	0	0
		17	18	21	14			0	0	0	0
		8	19	15	23			0	0	0	0

Corner Cubes States – Step 1: From U [TRC, E] To F [TLC, N]

		8	13					0	0		
		6	12					0	0		
23	21	10	2	5	9	0	0	0	0	0	0
24	16	3	4	7	1	0	0	0	0	0	0
		17	18	22	20			0	0	0	0
		15	11	14	19			0	0	0	0

Corner Cubes States – Step 1: From U [BRC, S] To F [TLC, N]

		8	11					0	0		
		2	9					0	0		
23	5	12	22	13	14	0	0	0	0	0	0
10	16	3	4	7	19	0	0	0	0	0	0
		17	18	1	20			0	0	0	0
		21	15	24	6			0	0	0	0

Corner Cubes States – Step 1: From U [BLC, W] To F [TLC, N]

		21	15					0	0		
		14	12					0	0		
6	1	11	2	5	24	0	0	0	0	0	0
22	16	3	4	7	23	0	0	0	0	0	0
		17	18	19	10			0	0	0	0
		9	8	20	13			0	0	0	0

Corner Cubes States – Step 1: From L [TLC, N] To F [TLC, N]

		1	8					0	0		
		9	12					0	0		
14	22	13	2	5	20	0	0	0	0	0	0
15	16	3	4	7	6	0	0	0	0	0	0
		17	18	23	11			0	0	0	0
		19	21	10	24			0	0	0	0

Corner Cubes States – Step 1: From L [TRC, E] To F [TLC, N]

		19	22					0	0		
		1	12					0	0		
24	11	14	2	5	13	0	0	0	0	0	0
10	16	3	4	7	20	0	0	0	0	0	0
		17	18	9	15			0	0	0	0
		21	23	8	6			0	0	0	0

Corner Cubes States – Step 1: From L [BRC, S] To F [TLC, N]

		23	15					0	0		
		17	12					0	0		
20	3	16	2	5	24	0	0	0	0	0	0
14	13	22	4	7	10	0	0	0	0	0	0
		9	18	19	8			0	0	0	0
		11	6	21	1			0	0	0	0

Corner Cubes States – Step 1: From L [BLC, W] To F [TLC, N]

		11	13					0	0		
		24	12					0	0		
1	19	15	2	5	9	0	0	0	0	0	0
6	16	3	4	7	23	0	0	0	0	0	0
		17	18	22	14			0	0	0	0
		10	8	20	21			0	0	0	0

Corner Cubes States – Step 1: From D [TLC, N] To F [TLC, N]

		1	10					0	0		
		3	12					0	0		
14	16	17	2	5	6	0	0	0	0	0	0
13	15	19	4	7	8	0	0	0	0	0	0
		24	18	21	11			0	0	0	0
		22	20	23	9			0	0	0	0

Corner Cubes States – Step 1: From D [TRC, E] To F [TLC, N]

		21	20					0	0		
		7	12					0	0		
6	4	18	2	5	23	0	0	0	0	0	0
9	16	3	15	19	14	0	0	0	0	0	0
		17	24	8	10			0	0	0	0
		13	1	11	22			0	0	0	0

Corner Cubes States – Step 1: From D [BRC, S] To F [TLC, N]

		21	22					0	0		
		23	12					0	0		
6	8	20	2	5	13	0	0	0	0	0	0
15	16	3	4	7	14	0	0	0	0	0	0
		17	18	9	10			0	0	0	0
		19	1	11	24			0	0	0	0

Corner Cubes States – Step 1: From D [BLC, W] To F [TLC, N]

		1	10					0	0		
		15	12					0	0		
14	24	19	2	5	6	0	0	0	0	0	0
20	16	3	4	7	9	0	0	0	0	0	0
		17	18	21	11			0	0	0	0
		8	22	13	23			0	0	0	0

Corner Cubes States – Step 1: From B [TLC, N] To F [TLC, N]

		23	11					0	0		
		10	12					0	0		
20	6	21	2	5	14	0	0	0	0	0	0
15	16	3	4	7	22	0	0	0	0	0	0
		17	18	1	8			0	0	0	0
		19	13	9	24			0	0	0	0

Corner Cubes States – Step 1: From B [TRC, E] To F [TLC, N]

		21	11					0	0		
		13	12					0	0		
6	9	22	2	5	14	0	0	0	0	0	0
20	16	3	4	7	24	0	0	0	0	0	0
		17	18	1	10			0	0	0	0
		8	19	15	23			0	0	0	0

Corner Cubes States – Step 1: From B [BRC, S] To F [TLC, N]

		22	11					0	0		
		19	12					0	0		
9	15	24	2	5	14	0	0	0	0	0	0
6	16	3	4	7	23	0	0	0	0	0	0
		17	18	1	13			0	0	0	0
		10	8	20	21			0	0	0	0

Corner Cubes States – Step 1: From B [BLC, W] To F [TLC, N]

		24	11					0	0		
		8	12					0	0		
15	20	23	2	5	14	0	0	0	0	0	0
9	16	3	4	7	21	0	0	0	0	0	0
		17	18	1	19			0	0	0	0
		13	10	6	22			0	0	0	0

Step 2 (Check: done)

Corner Cubes States – Step 2: From F [TLC, W] To F [TRC, N]											
		15	10					0	0		
		12	14					0	0		
19	2	5	1	11	6	0	0	0	0	0	0
13	16	3	4	7	8	0	0	0	0	0	0
		17	18	21	24			0	0	0	0
		22	20	23	9			0	0	0	0

Corner Cubes States – Step 2: From F [BRC, E] To F [TRC, N]											
		15	12					0	0		
		11	7					0	0		
19	14	1	4	18	2	0	0	0	0	0	0
8	16	3	13	22	21	0	0	0	0	0	0
		17	9	5	24			0	0	0	0
		23	10	6	20			0	0	0	0

Corner Cubes States – Step 2: From F [BLC, S] To F [TRC, N]											
		9	19					0	0		
		11	17					0	0		
13	14	1	3	16	15	0	0	0	0	0	0
6	5	2	4	7	8	0	0	0	0	0	0
		12	18	24	22			0	0	0	0
		10	20	23	21			0	0	0	0

Corner Cubes States – Step 2: From R [TLC, W] To F [TRC, N]

		21	20					0	0		
		11	2					0	0		
6	14	1	5	12	23	0	0	0	0	0	0
19	16	3	4	7	9	0	0	0	0	0	0
		17	18	8	10			0	0	0	0
		24	22	13	15			0	0	0	0

Corner Cubes States – Step 2: From R [TRC, N] To F [TRC, N]

		5	24					0	0		
		11	10					0	0		
2	14	1	6	21	19	0	0	0	0	0	0
9	16	3	4	7	8	0	0	0	0	0	0
		17	18	15	12			0	0	0	0
		13	20	23	22			0	0	0	0

Corner Cubes States – Step 2: From R [BRC, E] To F [TRC, N]

		22	24					0	0		
		11	23					0	0		
9	14	1	8	20	19	0	0	0	0	0	0
5	16	3	4	7	10	0	0	0	0	0	0
		17	18	15	13			0	0	0	0
		2	6	21	12			0	0	0	0

Corner Cubes States – Step 2: From R [BLC, S] To F [TRC, N]

		8	24					0	0		
		11	18					0	0		
23	14	1	7	4	19	0	0	0	0	0	0
9	16	3	21	6	5	0	0	0	0	0	0
		17	10	15	20			0	0	0	0
		13	12	2	22			0	0	0	0

Corner Cubes States – Step 2: From U [TLC, W] To F [TRC, N]

		20	2					0	0		
		11	13					0	0		
8	14	1	9	22	5	0	0	0	0	0	0
19	16	3	4	7	10	0	0	0	0	0	0
		17	18	12	23			0	0	0	0
		24	6	21	15			0	0	0	0

Corner Cubes States – Step 2: From U [TRC, N] To F [TRC, N]

		9	12					0	0		
		11	21					0	0		
13	14	1	10	6	2	0	0	0	0	0	0
23	16	3	4	7	19	0	0	0	0	0	0
		17	18	5	22			0	0	0	0
		20	15	24	8			0	0	0	0

Corner Cubes States – Step 2: From U [BRC, E] To F [TRC, N]

		8	22					0	0		
		11	5					0	0		
23	14	1	12	2	13	0	0	0	0	0	0
24	16	3	4	7	21	0	0	0	0	0	0
		17	18	9	20			0	0	0	0
		15	10	6	19			0	0	0	0

Corner Cubes States – Step 2: From U [BLC, S] To F [TRC, N]

		12	15					0	0		
		10	1					0	0		
5	6	21	11	14	24	0	0	0	0	0	0
20	16	3	4	7	9	0	0	0	0	0	0
		17	18	19	2			0	0	0	0
		8	22	13	23			0	0	0	0

Corner Cubes States – Step 2: From L [TLC, W] To F [TRC, N]

		15	12					0	0		
		11	22					0	0		
19	14	1	13	9	2	0	0	0	0	0	0
21	16	3	4	7	8	0	0	0	0	0	0
		17	18	5	24			0	0	0	0
		6	20	23	10			0	0	0	0

Corner Cubes States – Step 2: From L [TRC, N] To F [TRC, N]

		10	12					0	0		
		9	11					0	0		
21	22	13	14	1	2	0	0	0	0	0	0
15	16	3	4	7	8	0	0	0	0	0	0
		17	18	5	6			0	0	0	0
		19	20	23	24			0	0	0	0

Corner Cubes States – Step 2: From L [BRC, E] To F [TRC, N]

		5	20					0	0		
		11	3					0	0		
2	14	1	16	17	23	0	0	0	0	0	0
9	6	10	4	7	15	0	0	0	0	0	0
		21	18	8	12			0	0	0	0
		13	24	19	22			0	0	0	0

Corner Cubes States – Step 2: From L [BLC, S] To F [TRC, N]

		9	20					0	0		
		11	19					0	0		
13	14	1	15	24	23	0	0	0	0	0	0
2	16	3	4	7	21	0	0	0	0	0	0
		17	18	8	22			0	0	0	0
		12	10	6	5			0	0	0	0

Corner Cubes States – Step 2: From D [TLC, W] To F [TRC, N]

		21	22					0	0		
		11	16					0	0		
6	14	1	17	3	13	0	0	0	0	0	0
15	12	5	4	7	8	0	0	0	0	0	0
		2	18	9	10			0	0	0	0
		19	20	23	24			0	0	0	0

Corner Cubes States – Step 2: From D [TRC, N] To F [TRC, N]

		9	2					0	0		
		11	4					0	0		
13	14	1	18	7	5	0	0	0	0	0	0
15	16	3	20	8	6	0	0	0	0	0	0
		17	23	12	22			0	0	0	0
		19	21	10	24			0	0	0	0

Corner Cubes States – Step 2: From D [BRC, E] To F [TRC, N]

		9	2					0	0		
		11	8					0	0		
13	14	1	20	23	5	0	0	0	0	0	0
10	16	3	4	7	19	0	0	0	0	0	0
		17	18	12	22			0	0	0	0
		21	15	24	6			0	0	0	0

Corner Cubes States – Step 2: From D [BLC, S] To F [TRC, N]

		21	22					0	0		
		11	24					0	0		
6	14	1	19	15	13	0	0	0	0	0	0
5	16	3	4	7	8	0	0	0	0	0	0
		17	18	9	10			0	0	0	0
		2	20	23	12			0	0	0	0

Corner Cubes States – Step 2: From B [TLC, W] To F [TRC, N]

		12	22					0	0		
		11	6					0	0		
5	14	1	21	10	13	0	0	0	0	0	0
23	16	3	4	7	19	0	0	0	0	0	0
		17	18	9	2			0	0	0	0
		20	15	24	8			0	0	0	0

Corner Cubes States – Step 2: From B [TRC, N] To F [TRC, N]

		12	24					0	0		
		11	9					0	0		
5	14	1	22	13	19	0	0	0	0	0	0
21	16	3	4	7	8	0	0	0	0	0	0
		17	18	15	2			0	0	0	0
		6	20	23	10			0	0	0	0

Corner Cubes States – Step 2: From B [BRC, E] To F [TRC, N]

		12	23					0	0		
		11	15					0	0		
5	14	1	24	19	8	0	0	0	0	0	0
22	16	3	4	7	10	0	0	0	0	0	0
		17	18	20	2			0	0	0	0
		9	6	21	13			0	0	0	0

Corner Cubes States – Step 2: From B [BLC, S] To F [TRC, N]

		12	21					0	0		
		11	20					0	0		
5	14	1	23	8	10	0	0	0	0	0	0
24	16	3	4	7	13	0	0	0	0	0	0
		17	18	6	2			0	0	0	0
		15	9	22	19			0	0	0	0

Step 3 (Check: done)

Corner Cubes States – Step 3: From F [TLC, S] To F [BRC, N]

		20	10					0	0		
		18	12					0	0		
8	7	4	2	5	6	0	0	0	0	0	0
15	16	3	1	14	13	0	0	0	0	0	0
		17	11	21	23			0	0	0	0
		19	9	22	24			0	0	0	0

Corner Cubes States – Step 3: From F [TRC, W] To F [BRC, N]

		10	13					0	0		
		11	4					0	0		
21	14	1	18	7	9	0	0	0	0	0	0
15	16	3	2	12	8	0	0	0	0	0	0
		17	5	22	6			0	0	0	0
		19	20	23	24			0	0	0	0

Corner Cubes States – Step 3: From F [BLC, E] To F [BRC, N]

		24	10					0	0		
		11	12					0	0		
15	14	1	2	5	6	0	0	0	0	0	0
9	4	7	3	17	8	0	0	0	0	0	0
		18	16	21	19			0	0	0	0
		13	20	23	22			0	0	0	0

Corner Cubes States – Step 3: From R [TLC, S] To F [BRC, N]

		15	18					0	0		
		11	20					0	0		
19	14	1	23	8	7	0	0	0	0	0	0
21	16	3	5	2	9	0	0	0	0	0	0
		17	12	4	24			0	0	0	0
		6	22	13	10			0	0	0	0

Corner Cubes States – Step 3: From R [TRC, W] To F [BRC, N]

		13	19					0	0		
		11	12					0	0		
22	14	1	2	5	15	0	0	0	0	0	0
20	16	3	6	10	4	0	0	0	0	0	0
		17	21	24	9			0	0	0	0
		8	18	7	23			0	0	0	0

Corner Cubes States – Step 3: From R [BRC, N] To F [BRC, N]

		18	9					0	0		
		11	12					0	0		
4	14	1	2	5	22	0	0	0	0	0	0
6	16	3	8	23	24	0	0	0	0	0	0
		17	20	13	7			0	0	0	0
		10	19	15	21			0	0	0	0

Corner Cubes States – Step 3: From R [BLC, E] To F [BRC, N]

		22	24					0	0		
		11	12					0	0		
9	14	1	2	5	19	0	0	0	0	0	0
8	16	3	7	18	21	0	0	0	0	0	0
		17	4	15	13			0	0	0	0
		23	10	6	20			0	0	0	0

Corner Cubes States – Step 3: From U [TLC, S] To F [BRC, N]

		4	10					0	0		
		11	12					0	0		
7	14	1	2	5	6	0	0	0	0	0	0
8	16	3	9	13	15	0	0	0	0	0	0
		17	22	21	18			0	0	0	0
		23	24	19	20			0	0	0	0

Corner Cubes States – Step 3: From U [TRC, W] To F [BRC, N]

		23	13					0	0		
		11	12					0	0		
20	14	1	2	5	9	0	0	0	0	0	0
15	16	3	10	21	7	0	0	0	0	0	0
		17	6	22	8			0	0	0	0
		19	4	18	24			0	0	0	0

Corner Cubes States – Step 3: From U [BRC, N] To F [BRC, N]

		9	23					0	0		
		11	21					0	0		
13	14	1	10	6	8	0	0	0	0	0	0
15	16	3	12	5	7	0	0	0	0	0	0
		17	2	20	22			0	0	0	0
		19	4	18	24			0	0	0	0

Corner Cubes States – Step 3: From U [BLC, E] To F [BRC, N]

		9	10					0	0		
		4	12					0	0		
13	18	7	2	5	6	0	0	0	0	0	0
8	16	3	11	1	15	0	0	0	0	0	0
		17	14	21	22			0	0	0	0
		23	24	19	20			0	0	0	0

Corner Cubes States – Step 3: From L [TLC, S] To F [BRC, N]

		18	20					0	0		
		11	12					0	0		
4	14	1	2	5	23	0	0	0	0	0	0
15	16	3	13	22	21	0	0	0	0	0	0
		17	9	8	7			0	0	0	0
		19	10	6	24			0	0	0	0

Corner Cubes States – Step 3: From L [TRC, W] To F [BRC, N]

		9	20					0	0		
		7	12					0	0		
13	4	18	2	5	23	0	0	0	0	0	0
15	16	3	14	11	21	0	0	0	0	0	0
		17	1	8	22			0	0	0	0
		19	10	6	24			0	0	0	0

Corner Cubes States – Step 3: From L [BRC, N] To F [BRC, N]

		9	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
23	24	15	16	3	4	0	0	0	0	0	0
		19	17	21	22			0	0	0	0
		20	18	7	8			0	0	0	0

Corner Cubes States – Step 3: From L [BLC, E] To F [BRC, N]

		8	10					0	0		
		11	12					0	0		
23	14	1	2	5	6	0	0	0	0	0	0
9	16	3	15	19	4	0	0	0	0	0	0
		17	24	21	20			0	0	0	0
		13	18	7	22			0	0	0	0

Corner Cubes States – Step 3: From D [TLC, S] To F [BRC, N]

		10	13					0	0		
		11	12					0	0		
21	14	1	2	5	9	0	0	0	0	0	0
7	8	23	17	16	24	0	0	0	0	0	0
		20	3	22	6			0	0	0	0
		18	19	15	4			0	0	0	0

Corner Cubes States – Step 3: From D [TRC, W] To F [BRC, N]

		13	20					0	0		
		11	12					0	0		
22	14	1	2	5	23	0	0	0	0	0	0
21	16	3	18	4	15	0	0	0	0	0	0
		17	7	8	9			0	0	0	0
		6	24	19	10			0	0	0	0

Corner Cubes States – Step 3: From D [BRC, N] To F [BRC, N]

		10	13					0	0		
		11	12					0	0		
21	14	1	2	5	9	0	0	0	0	0	0
15	16	3	20	8	4	0	0	0	0	0	0
		17	23	22	6			0	0	0	0
		19	18	7	24			0	0	0	0

Corner Cubes States – Step 3: From D [BLC, E] To F [BRC, N]

		18	6					0	0		
		11	12					0	0		
4	14	1	2	5	21	0	0	0	0	0	0
20	16	3	19	24	22	0	0	0	0	0	0
		17	15	10	7			0	0	0	0
		8	13	9	23			0	0	0	0

Corner Cubes States – Step 3: From B [TLC, S] To F [BRC, N]

		13	19					0	0		
		11	12					0	0		
22	14	1	2	5	15	0	0	0	0	0	0
7	16	3	21	6	20	0	0	0	0	0	0
		17	10	24	9			0	0	0	0
		18	23	8	4			0	0	0	0

Corner Cubes States – Step 3: From B [TRC, W] To F [BRC, N]

		19	8					0	0		
		11	12					0	0		
24	14	1	2	5	20	0	0	0	0	0	0
7	16	3	22	9	6	0	0	0	0	0	0
		17	13	23	15			0	0	0	0
		18	21	10	4			0	0	0	0

Corner Cubes States – Step 3: From B [BRC, N] To F [BRC, N]

		8	10					0	0		
		11	12					0	0		
23	14	1	2	5	6	0	0	0	0	0	0
7	16	3	24	15	9	0	0	0	0	0	0
		17	19	21	20			0	0	0	0
		18	22	13	4			0	0	0	0

Corner Cubes States – Step 3: From B [BLC, E] To F [BRC, N]

		10	13					0	0		
		11	12					0	0		
21	14	1	2	5	9	0	0	0	0	0	0
7	16	3	23	20	15	0	0	0	0	0	0
		17	8	22	6			0	0	0	0
		18	24	19	4			0	0	0	0

Step 4 (Check: done)

Corner Cubes States – Step 4: From F [TLC, E] To F [BLC, N]											
		6	9					0	0		
		3	12					0	0		
10	16	17	2	5	22	0	0	0	0	0	0
15	11	1	4	7	8	0	0	0	0	0	0
		14	18	13	21			0	0	0	0
		19	20	23	24			0	0	0	0

Corner Cubes States – Step 4: From F [TRC, S] To F [BLC, N]											
		9	19					0	0		
		11	17					0	0		
13	14	1	3	16	15	0	0	0	0	0	0
6	5	2	4	7	8	0	0	0	0	0	0
		12	18	24	22			0	0	0	0
		10	20	23	21			0	0	0	0

Corner Cubes States – Step 4: From F [BRC, W] To F [BLC, N]											
		9	23					0	0		
		11	12					0	0		
13	14	1	2	5	8	0	0	0	0	0	0
15	18	4	16	3	10	0	0	0	0	0	0
		7	17	20	22			0	0	0	0
		19	6	21	24			0	0	0	0

Corner Cubes States – Step 4: From R [TLC, E] To F [BLC, N]

		21	8					0	0		
		11	24					0	0		
6	14	1	19	15	20	0	0	0	0	0	0
22	12	5	4	7	3	0	0	0	0	0	0
		2	18	23	10			0	0	0	0
		9	16	17	13			0	0	0	0

Corner Cubes States – Step 4: From R [TRC, S] To F [BLC, N]

		19	17					0	0		
		11	12					0	0		
24	14	1	2	5	3	0	0	0	0	0	0
22	21	6	4	7	8	0	0	0	0	0	0
		10	18	16	15			0	0	0	0
		9	20	23	13			0	0	0	0

Corner Cubes States – Step 4: From R [BRC, W] To F [BLC, N]

		9	15					0	0		
		11	12					0	0		
13	14	1	2	5	24	0	0	0	0	0	0
3	20	8	4	7	10	0	0	0	0	0	0
		23	18	19	22			0	0	0	0
		17	6	21	16			0	0	0	0

Corner Cubes States – Step 4: From R [BLC, N] To F [BLC, N]

		9	10					0	0		
		11	12					0	0		
13	14	1	2	5	6	0	0	0	0	0	0
3	4	7	8	23	24	0	0	0	0	0	0
		18	20	21	22			0	0	0	0
		17	19	15	16			0	0	0	0

Corner Cubes States – Step 4: From U [TLC, E] To F [BLC, N]

		6	24					0	0		
		11	12					0	0		
10	14	1	2	5	19	0	0	0	0	0	0
16	22	9	4	7	8	0	0	0	0	0	0
		13	18	15	21			0	0	0	0
		3	20	23	17			0	0	0	0

Corner Cubes States – Step 4: From U [TRC, S] To F [BLC, N]

		9	3					0	0		
		11	12					0	0		
13	14	1	2	5	16	0	0	0	0	0	0
8	6	10	4	7	15	0	0	0	0	0	0
		21	18	17	22			0	0	0	0
		23	24	19	20			0	0	0	0

Corner Cubes States – Step 4: From U [BRC, W] To F [BLC, N]

		15	3					0	0		
		11	22					0	0		
19	14	1	13	9	16	0	0	0	0	0	0
8	2	12	4	7	21	0	0	0	0	0	0
		5	18	17	24			0	0	0	0
		23	10	6	20			0	0	0	0

Corner Cubes States – Step 4: From U [BLC, N] To F [BLC, N]

		24	10					0	0		
		22	12					0	0		
15	13	9	2	5	6	0	0	0	0	0	0
16	14	11	4	7	8	0	0	0	0	0	0
		1	18	21	19			0	0	0	0
		3	20	23	17			0	0	0	0

Corner Cubes States – Step 4: From L [TLC, E] To F [BLC, N]

		15	3					0	0		
		11	12					0	0		
19	14	1	2	5	16	0	0	0	0	0	0
10	9	13	4	7	20	0	0	0	0	0	0
		22	18	17	24			0	0	0	0
		21	23	8	6			0	0	0	0

Corner Cubes States – Step 4: From L [TRC, S] To F [BLC, N]

		17	23					0	0		
		19	12					0	0		
16	15	24	2	5	8	0	0	0	0	0	0
13	1	14	4	7	10	0	0	0	0	0	0
		11	18	20	3			0	0	0	0
		22	6	21	9			0	0	0	0

Corner Cubes States – Step 4: From L [BRC, W] To F [BLC, N]

		23	21					0	0		
		11	12					0	0		
20	14	1	2	5	10	0	0	0	0	0	0
22	17	16	4	7	15	0	0	0	0	0	0
		3	18	6	8			0	0	0	0
		9	24	19	13			0	0	0	0

Corner Cubes States – Step 4: From L [BLC, N] To F [BLC, N]

		9	23					0	0		
		11	12					0	0		
13	14	1	2	5	8	0	0	0	0	0	0
16	24	15	4	7	10	0	0	0	0	0	0
		19	18	20	22			0	0	0	0
		3	6	21	17			0	0	0	0

Corner Cubes States – Step 4: From D [TLC, E] To F [BLC, N]

		19	6					0	0		
		11	12					0	0		
24	14	1	2	5	21	0	0	0	0	0	0
8	3	17	4	7	22	0	0	0	0	0	0
		16	18	10	15			0	0	0	0
		23	13	9	20			0	0	0	0

Corner Cubes States – Step 4: From D [TRC, S] To F [BLC, N]

		17	23					0	0		
		11	12					0	0		
16	14	1	2	5	8	0	0	0	0	0	0
13	7	18	24	15	6	0	0	0	0	0	0
		4	19	20	3			0	0	0	0
		22	21	10	9			0	0	0	0

Corner Cubes States – Step 4: From D [BRC, W] To F [BLC, N]

		13	17					0	0		
		11	12					0	0		
22	14	1	2	5	3	0	0	0	0	0	0
21	23	20	4	7	19	0	0	0	0	0	0
		8	18	16	9			0	0	0	0
		6	15	24	10			0	0	0	0

Corner Cubes States – Step 4: From D [BLC, N] To F [BLC, N]

		6	9					0	0		
		11	12					0	0		
10	14	1	2	5	22	0	0	0	0	0	0
3	15	19	4	7	8	0	0	0	0	0	0
		24	18	13	21			0	0	0	0
		17	20	23	16			0	0	0	0

Corner Cubes States – Step 4: From B [TLC, E] To F [BLC, N]

		15	20					0	0		
		11	12					0	0		
19	14	1	2	5	23	0	0	0	0	0	0
13	10	21	4	7	16	0	0	0	0	0	0
		6	18	8	24			0	0	0	0
		22	17	3	9			0	0	0	0

Corner Cubes States – Step 4: From B [TRC, S] To F [BLC, N]

		20	6					0	0		
		11	12					0	0		
8	14	1	2	5	21	0	0	0	0	0	0
19	13	22	4	7	16	0	0	0	0	0	0
		9	18	10	23			0	0	0	0
		24	17	3	15			0	0	0	0

Corner Cubes States – Step 4: From B [BRC, W] To F [BLC, N]

		6	9					0	0		
		11	12					0	0		
10	14	1	2	5	22	0	0	0	0	0	0
8	19	24	4	7	16	0	0	0	0	0	0
		15	18	13	21			0	0	0	0
		23	17	3	20			0	0	0	0

Corner Cubes States – Step 4: From B [BLC, N] To F [BLC, N]

		9	15					0	0		
		11	12					0	0		
13	14	1	2	5	24	0	0	0	0	0	0
10	8	23	4	7	16	0	0	0	0	0	0
		20	18	19	22			0	0	0	0
		21	17	3	6			0	0	0	0

2x2x2 Cube Wire Grid Model

Using a wire grid model, it is easy to see through the cube where letters are. This model can be used with pencil and rubber to find a path on the cube.

This model may be used to find algorithms for moving a single character from a location to another.