Dot Matrix Cube Design

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WebSites	http://www.mementoslangues.fr/	http://www.randelshofer.ch/

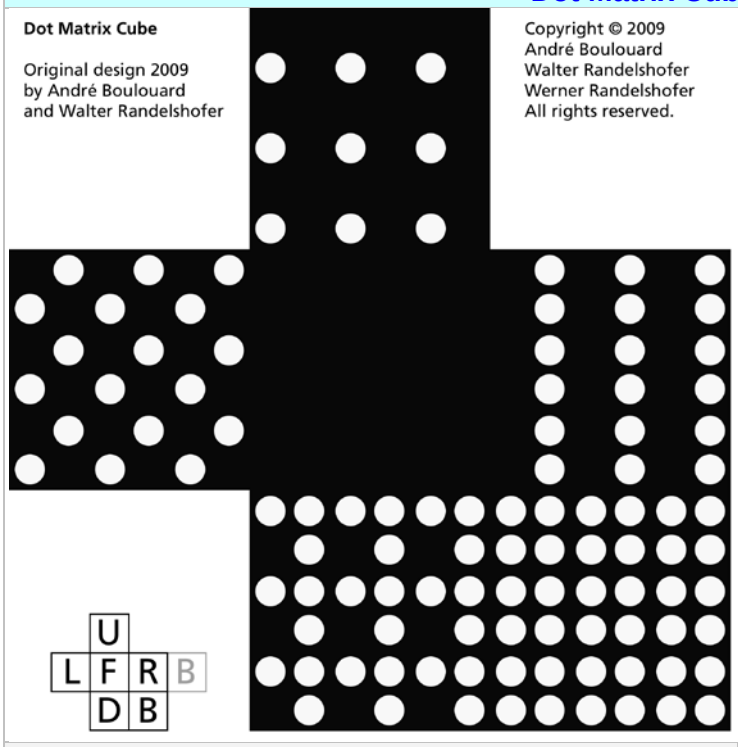
Introduction

A **Dot Matrix Cube** is a 3x3x3 **Rubik's Cube** used to generate dotted characters, symbols, images, smileys and graphs on a 2-dimensional array of dots.

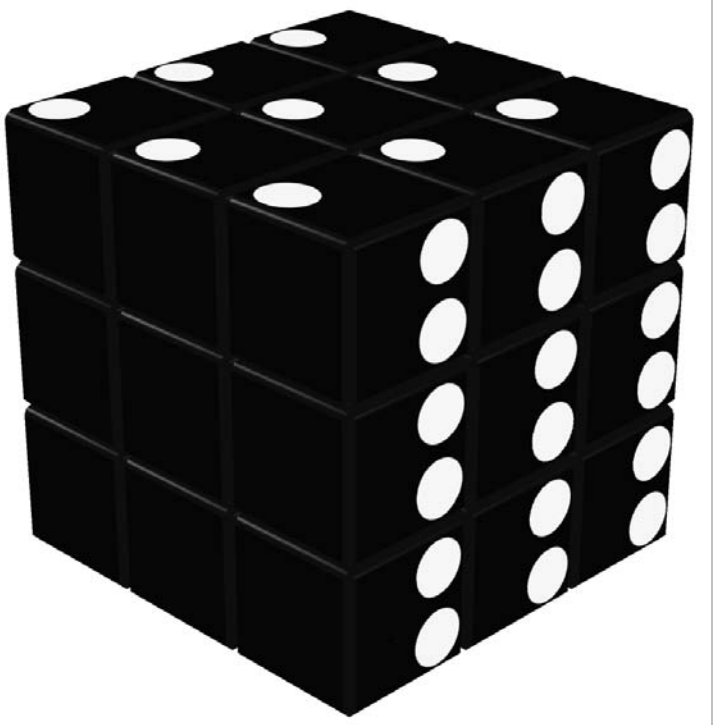
Dot Matrix – Useful Links	
http://en.wikipedia.org/wiki/Dot-matrix	http://en.wikipedia.org/wiki/Dot_matrix_display

There are **virtual cubes** that can be *virtually* rotated and twisted on a computer screen and **real cubes** that can only be *physically* rotated and twisted by hand. A **texture** is laid down on a virtual cube whereas real **stickers** are stuck down on a real cube. A Dot Matrix Cube is designed by placing dots on a texture which is then laid down on a virtual cube (see http://www.randelshofer.ch/ for more details). Characters, symbols and images can be displayed on a *selected* cube face by rotating and twisting some parts of the cube. When this has been achieved, we say that the cube has been *solved*. The following example shows the *initial* state of the cube where there are no dots displayed on the front face.

Dot Matrix Cube – Initial State



Cube Texture



Virtual Cube

Dot Matrix Cube Features

The cube can be used in 3 modes:

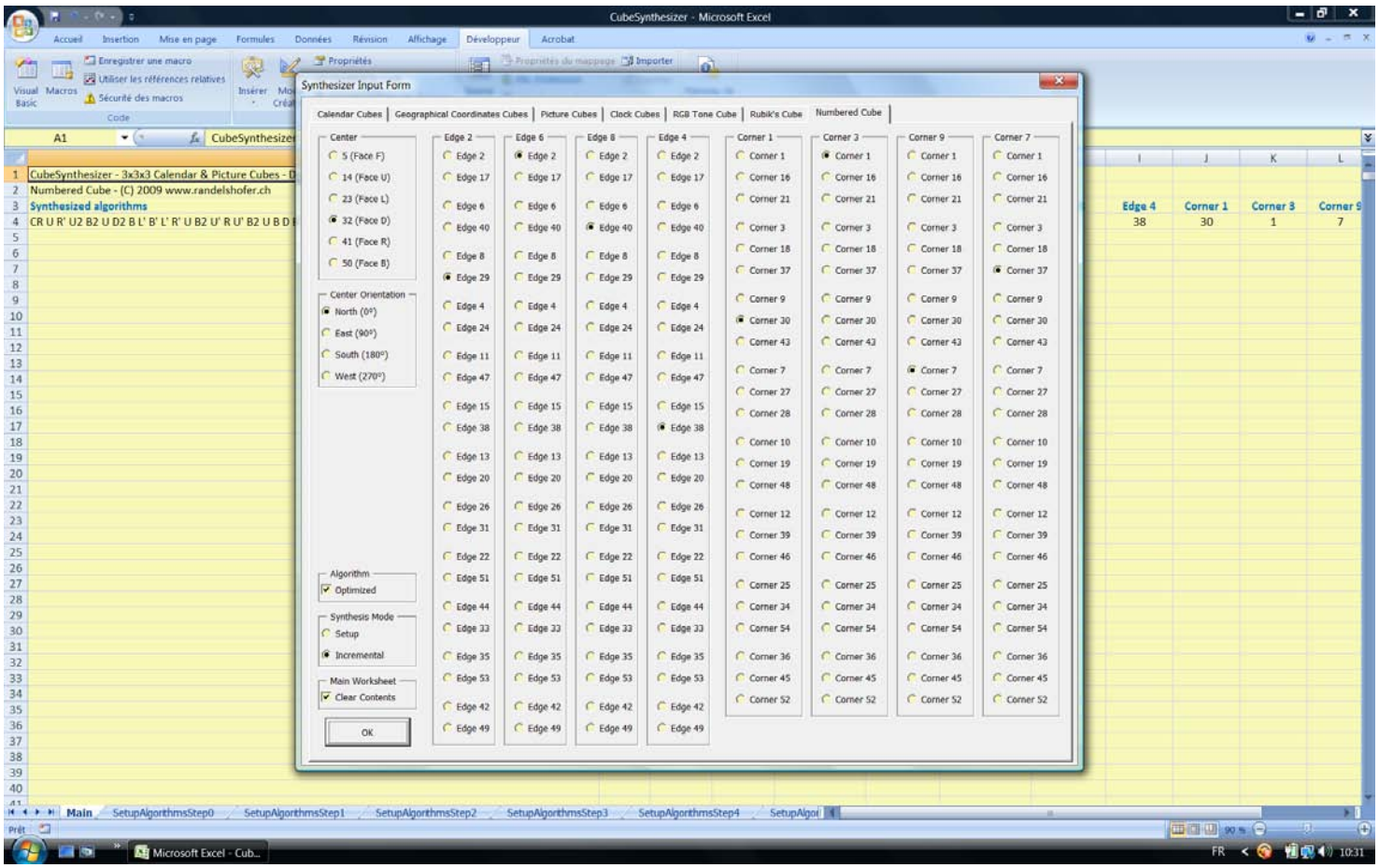
1- Mode A (Alpha-numerical dot matrix display)
2- Mode B (Graph dot matrix display)
3- Mode C (Picture dot matrix display)

There are 6 basic 2x2 dot patterns that can be displayed on a cubie, from which all other patterns can be obtained by a 90°, 180° or 270° rotation.

Example of a Dot Matrix Screen

Dot Matrix Screen

Synthesizer Input Form Example

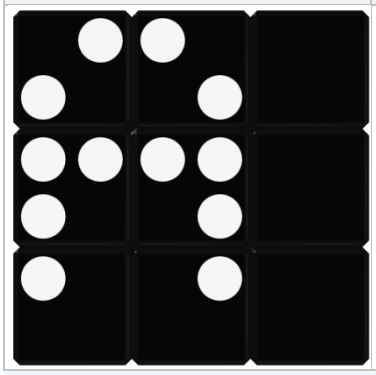
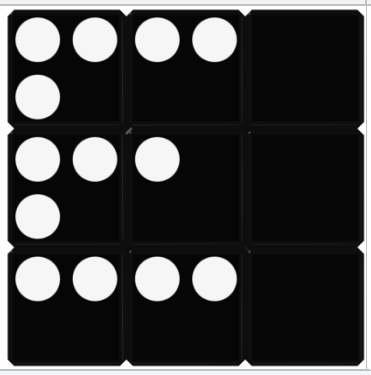
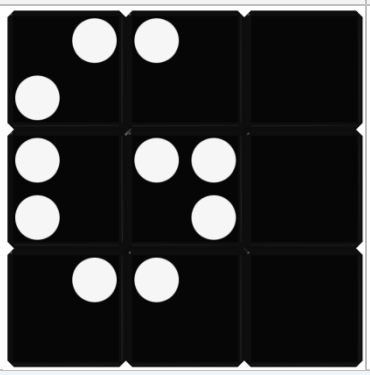
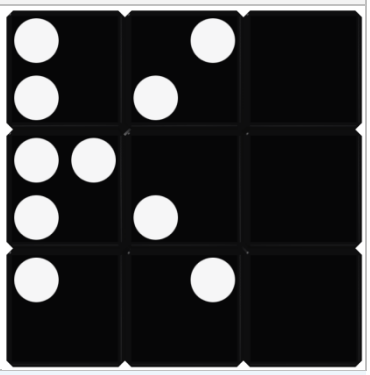


This example shows how to use an Input Form for synthesizing algorithms. Numbered center, edges and corners cubies have been selected for displaying numeral '**9**' on the (North oriented) Down face. Note that by checking both the 'Optimized' and 'Incremental' CheckBoxes, shortest length algorithms are synthesized. See CubeSynthesizer for more details.

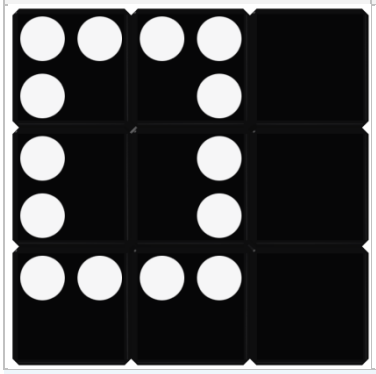
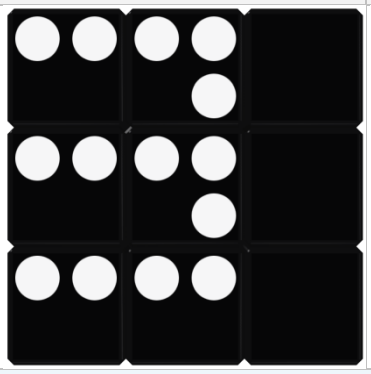
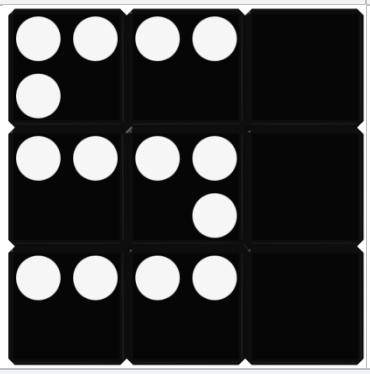
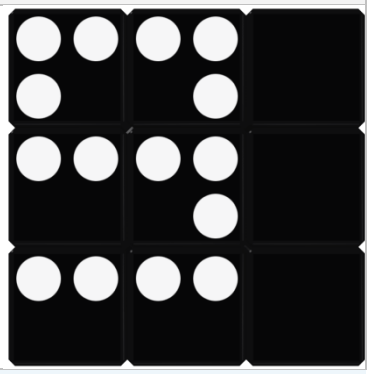
Dot Matrix Cube Synthesized Algorithms

Dot Matrix Cube – 5x5 dot Character Set Algorithms	
Letters	**Optimized Synthesized Algorithms**
A	CR R' U' D2 U' B U L B' L2 B2 L' R' B2 R2 B2 R' U B2 U'
B	CR R U R' U' B2 U D2 U B U' L2 R' B2 R2 B' R' D B D2 B2 D B L' B L
C	CF' CU' MF2 R' MF' R L' MF2 L U D MF2 D' U2 MF2 U R B2 R' U' B2 U D B2 D2 U B' U' B D
D	CU B' U2 L2 B D' R L' D U2 L U B U R B2 R' D' B' D2 B2 D2 B2 D L' B L
E	CF CU D B R' U L2 B D' R L B D2 L' D' B2 D B2 U B' U' D U' B U D'
F	CF CU D B R' U D2 B R2 L D2 B' D' L' B2 L2 B L2 B' L' B2 U' B U R B2 R'
C	CR B' U2 L' B2 R2 B2 D2 U' B U L2 R' B R D B2 D2 U B' U2 B2 D U
G	CR R' U D2 U B U' L B' L2 B2 L' U' B2 U R' B2 R
H	D MF D' MF U' MF' U MU' B' MU B' MU B2 MU' L' B2 L U' B U D' U B' U' B2 D
I	CU MU ML B ML' B MU' R MF L' B' R' L2 B2 L' B2 R' B R L' B L
J	CR' L' U' R2 D' R' B U' L U B2 U B' U2 B2 U B L B' L'
K	D2 B R' D' R' U' L U B2 U B' U' L B2 L' B2 U' B U D B' D'
L	CF CU D2 B2 U2 R L' D' L B2 L' R' B2 R U B2 U' L' B2 L
M	CR R' U D2 B U' L U2 D' B D U' B' L' B L B2 R B' R2 B R
N	CU B' U2 L2 B D' R L' D U2 L U2 B D B' D' R B' R' L' B L2 B2 L'
O	CF CU U2 R B U2 L B D' R D2 L' R' B2 R2 B' R2 B R L B2 L'
P	CF CU' R B U2 D B R2 B' D' L' D' L' R B' R' L2 B2 L' B2 D B' D' L' B L
Q	CU' CR2 B U2 R' D B R2 D' L B D B' D R' B2 R2 B2 R' U B2 U' B2 L B' L'
R	CF' CR B2 U2 R' D2 U' B U L B' L2 B2 L' U' B2 U B D B' D' U B2 U'
S	CU' CR2 U' R B U2 L' B D' R L B D2 B' L2 R' B2 R D' B D B2 D B' D' U' B2 U
T	CU L' B D' R L' B D2 U2 L U2 L' B2 L U B2 U2 B2 U B' D' B D2 B2 D' R' B2 R
U	CF' CU' R U L2 B2 R2 D' L' D2 R' B R D' U B' U' B2 D U' B U
V	CF CR' B' MU B MU2 B' MU U' MF' U MF' D MF D' B L B' L' B' U' B U2 B' U' R' B R
W	CF CR' R' U D' R D L B D2 U' B U L' B2 L' D' B2 D L' B L U' B U D B' D'
X	CU' CR2 R2 B U2 L' B D' R L B D2 U' B U L2 B2 L B' L' R' B2 R L' B L B2 U' B U
Y	CF CU B' U2 L2 B D' R L' B D2 U2 L U2 R B2 R' B L B' L' D B2 D'
Z	CR R' U' D2 U' B U L B' L2 B2 L' R' B2 R2 B2 R' U B2 U'
Numerals	**Optimized Synthesized Algorithms**
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
A	
B	
C	
D	
E	
F	

Examples of Dot Matrix Cube Synthesized Algorithms

Dot Matrix Cube Synthesized Algorithms			
Letter '**A**'		Letter '**G**'	
			

Optimized Synthesized Algorithms
Letter '**A**'
CR R' U' D2 U' B U L2 R' U B2 U' B R D B2 D' L B2 L' U' B2 U
Letter '**E**'
CF CU D B R' U L2 B D' R L B D2 L' D' B2 D B2 U B' U2 B U D B2 D' R' B2 R
Letter '**G**'
CR B' U2 L' B2 R2 B2 D2 U' B U L2 R' B R D B2 D2 U B' U2 B2 D U
Letter '**K**'
CR' L' U' R2 D' R' B U' L U B2 U B' U2 B2 U B L B' L'

Numeral '**0**'	Numeral '**3**'	Numeral '**5**'	Numeral '**9**'
			

Optimized Synthesized Algorithms
Numeral '**0**'
CU D' B R' U B' R2 L2 B D2 U2 L U D' B2 D U B2 R B' R2 B2 R B2 U B' U'
Numeral '**3**'
CR U R' U2 B2 U D2 B L' B' L' D B2 D' R' B2 R2 B' R'
Numeral '**5**'
CR R2 U D' R' D B' D' L2 B2 R' B R B2 L B' L' B2 L' B L
Numeral '**9**'
CR U R' U2 B2 U D2 B L' B' L' R' U B2 U' R U' B2 U B D B' D'

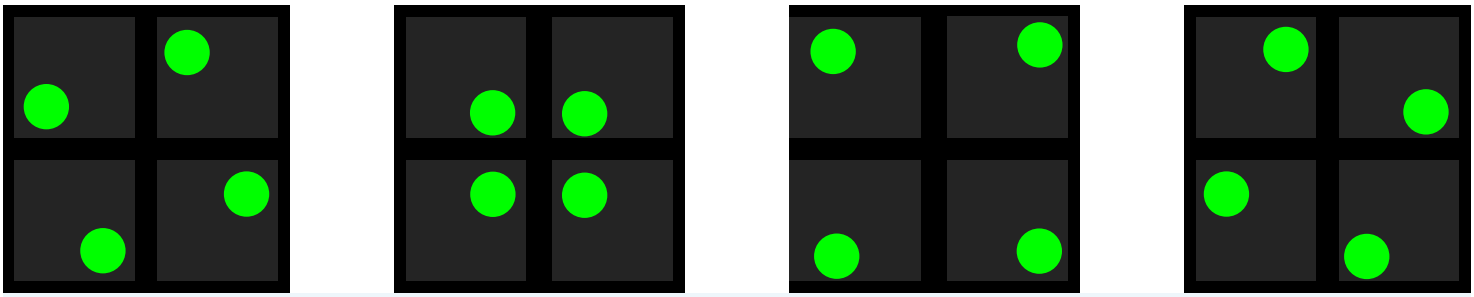
Dot Matrix Cube Patterns

Dot Matrix Cube Patterns

Basic patterns are located Top Left – The 3 other patterns are obtained by a 90°, 180° or 270° rotation

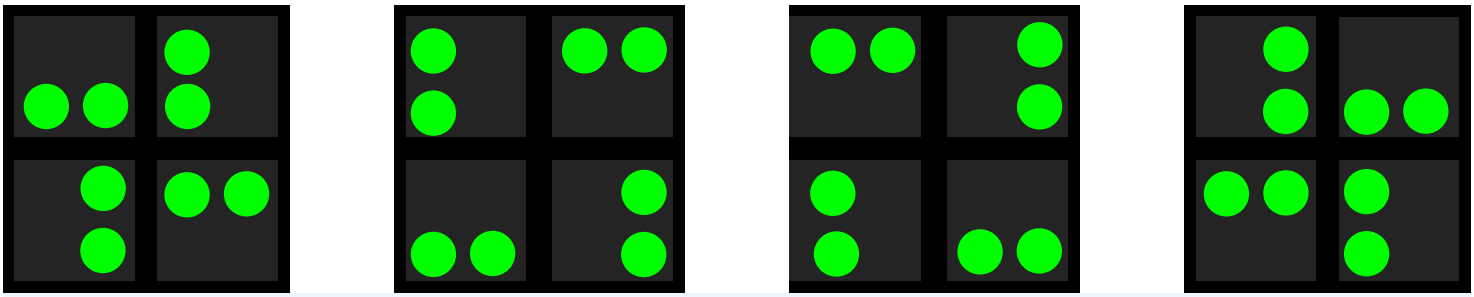
1-dot Patterns: 4 Patterns

P3



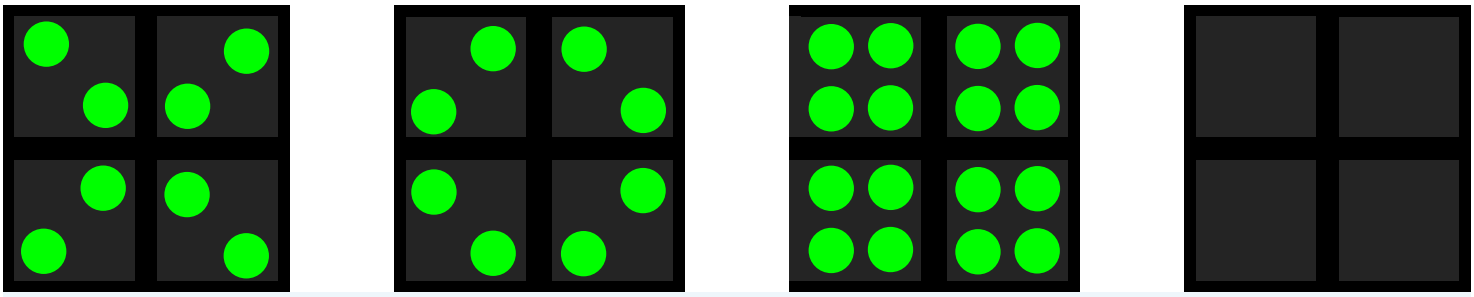
2-dot Patterns: 6 Patterns

P2



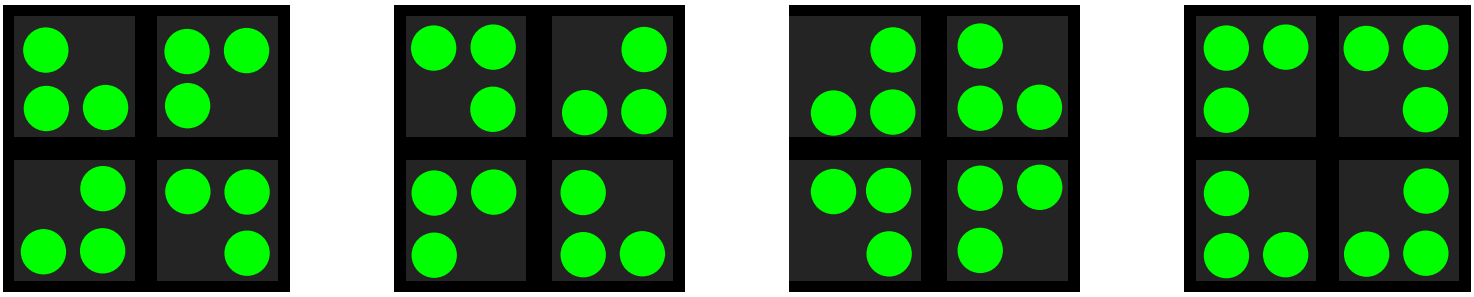
2-dot Patterns (cont'd) | **4-dot Pattern** | **0-dot Pattern**

P4 **P6** **P1**



3-dot Patterns: 4 Patterns

P5

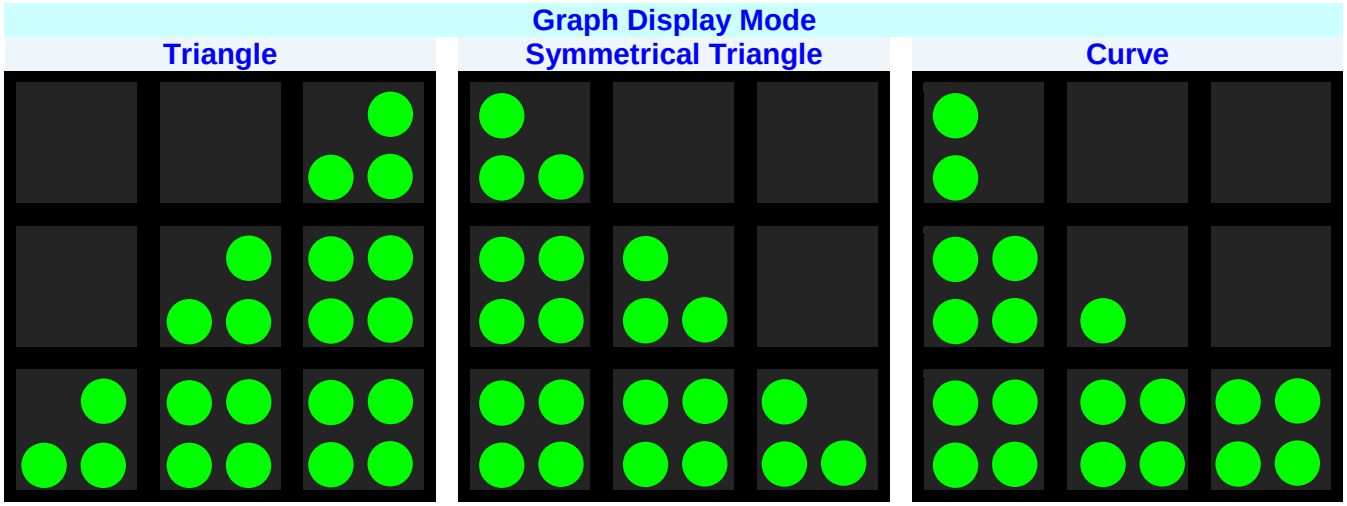


Selecting Dot Matrix Cube Patterns

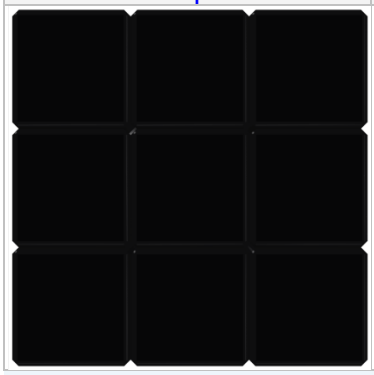
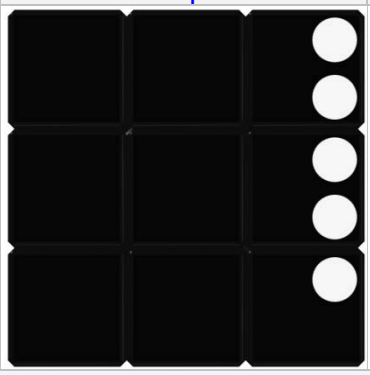
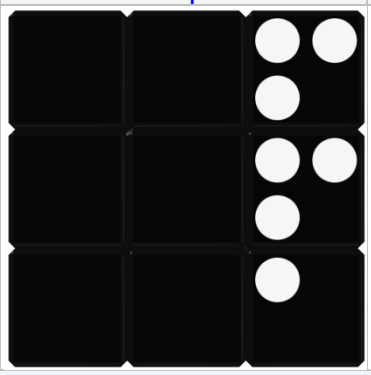
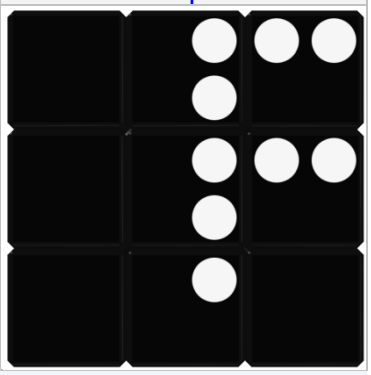
There is a total of 16 different patterns for 54 cubies. So, we have to make a choice on the most suitable patterns. Patterns P1 – P6 have been selected as explained below:

1- There is no unique choice: other patterns could have been selected as well.
2- As there are 6 center cubies, only 6 patterns have to be considered.
3- One 1-dot, two 2-dot, one 3-dot, one 4-dot and one 0-dot patterns have been selected.
4- The same 6 patterns are repeated on all 6 cubies of each face.

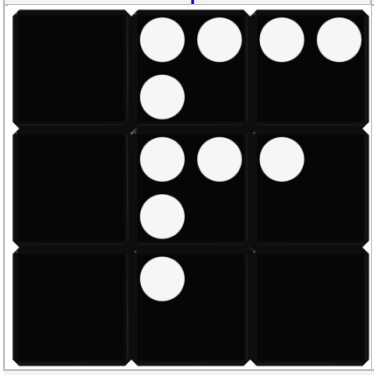
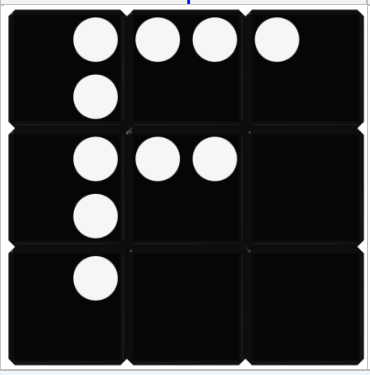
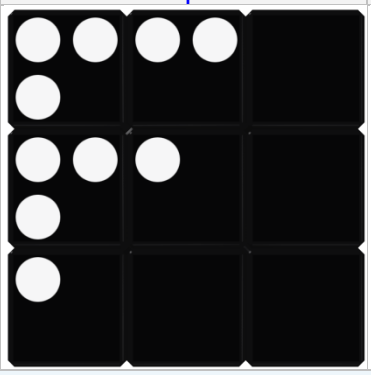
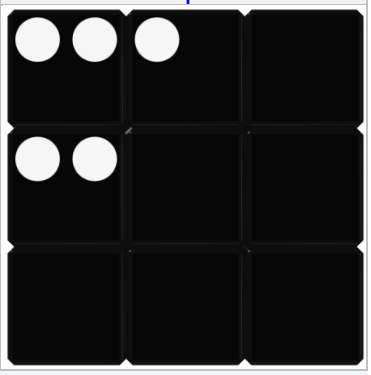
Graph Display Mode



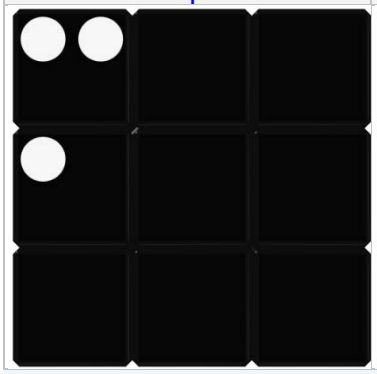
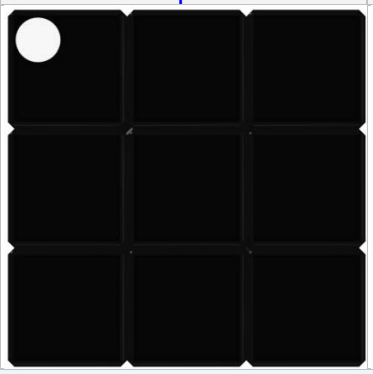
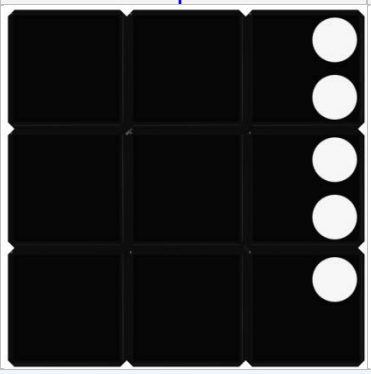
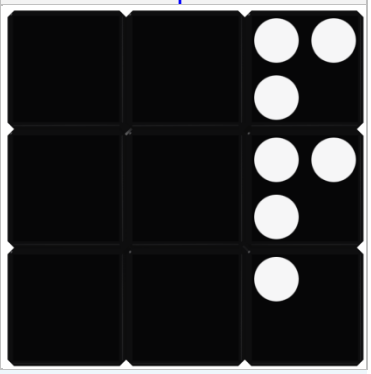
Moving Letters on the Cube

Moving Letter 'F' from Right to Left			
Step1	Step2	Step3	Step4
			

Optimized Synthesized Algorithms	
Step 1	Initial State
Step 2	B MU' B' MU R' B2 R B' U' B U
Step 3	D' R D R' B R
Step 4	CU D2 B R2 D2 L B D' L' D' L B' L'

Step 5	Step 6	Step 7	Step 8
			

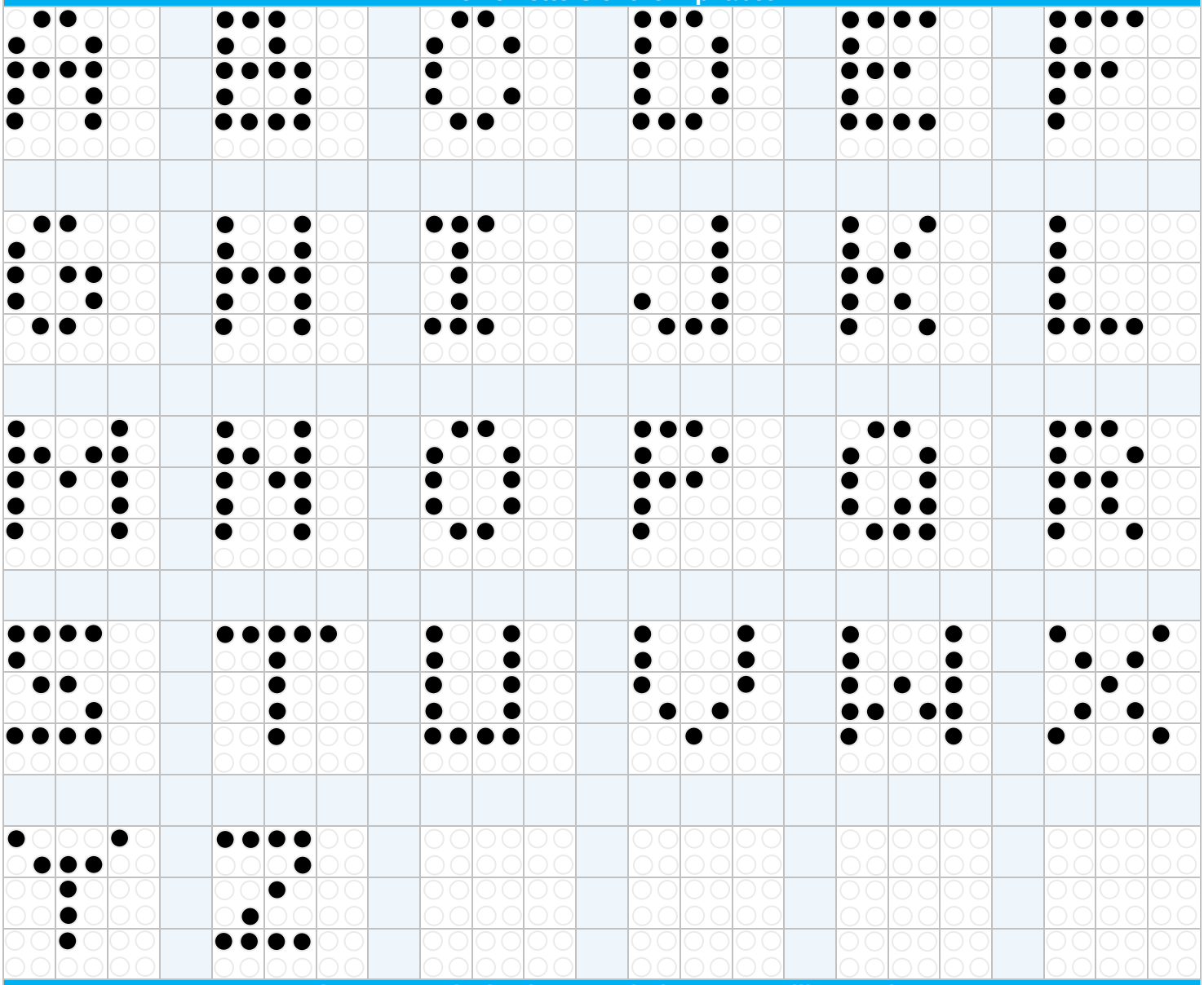
Optimized Synthesized Algorithms	
Step 5	CF' CU R2 B2 D' B' D' L2 R' B R B' U' B U B L' B L
Step 6	CF' CR' D2 R L B D2 B2 L' B2 L' D' B2 D L' B L B R B' R'
Step 7	CF CU D B R' U D2 B R2 L D2 B' D' L' B2 L2 B L2 B' L' B2 U' B U R B2 R'
Step 8	L' MF' L MF2 U' MF' U L' B L

Step 9	Step 10	Step 11	Step 12
			

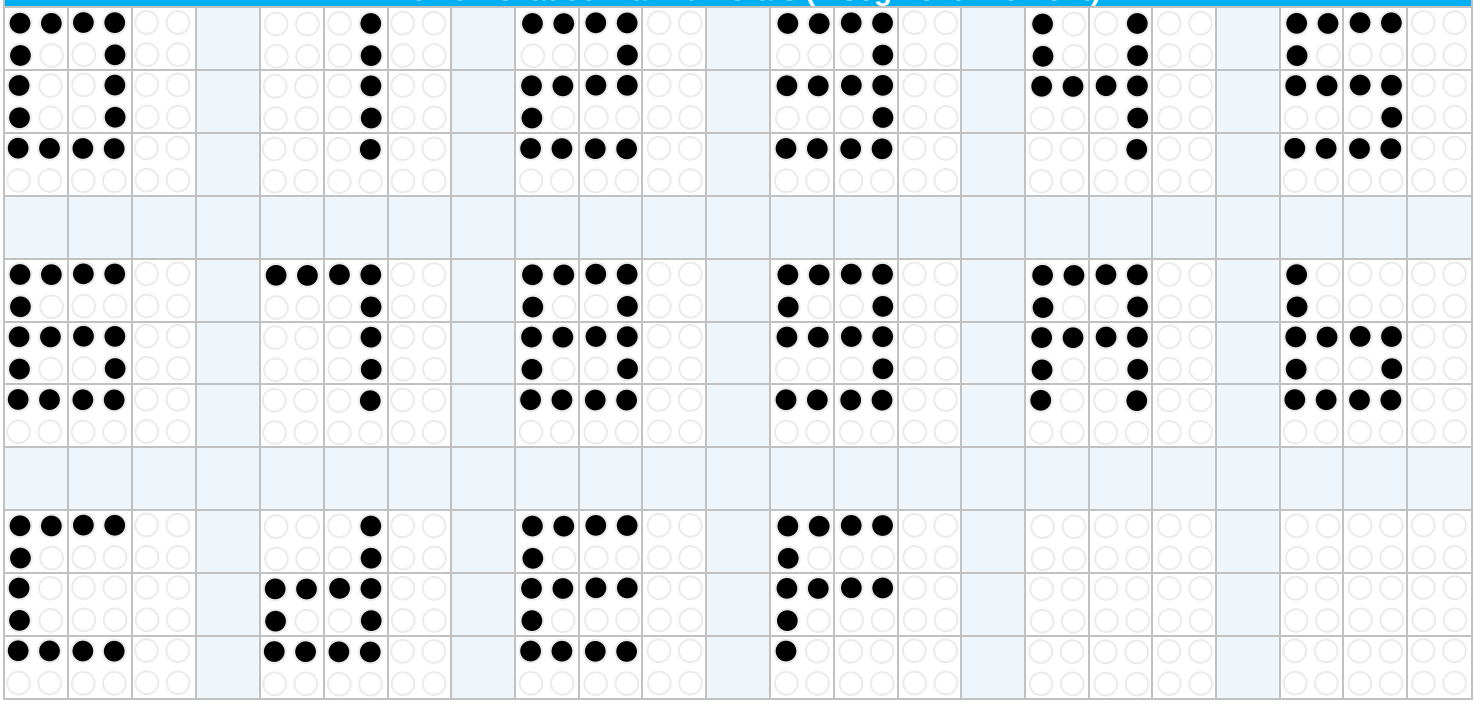
Optimized Synthesized Algorithms	
Step 9	L2 B' U L U B L' B L2 B L' U' B U B2 L B' L'
Step 10	U B2 U' L' B2 L
Step 11	B MU' B' MU R' B2 R B' U' B U
Step 12	CU D2 B R2 D2 L B D' L' D' L B' L'

Dot Matrix Cube – 5x5 dot Character Set

The 26 Letters of the Alphabet

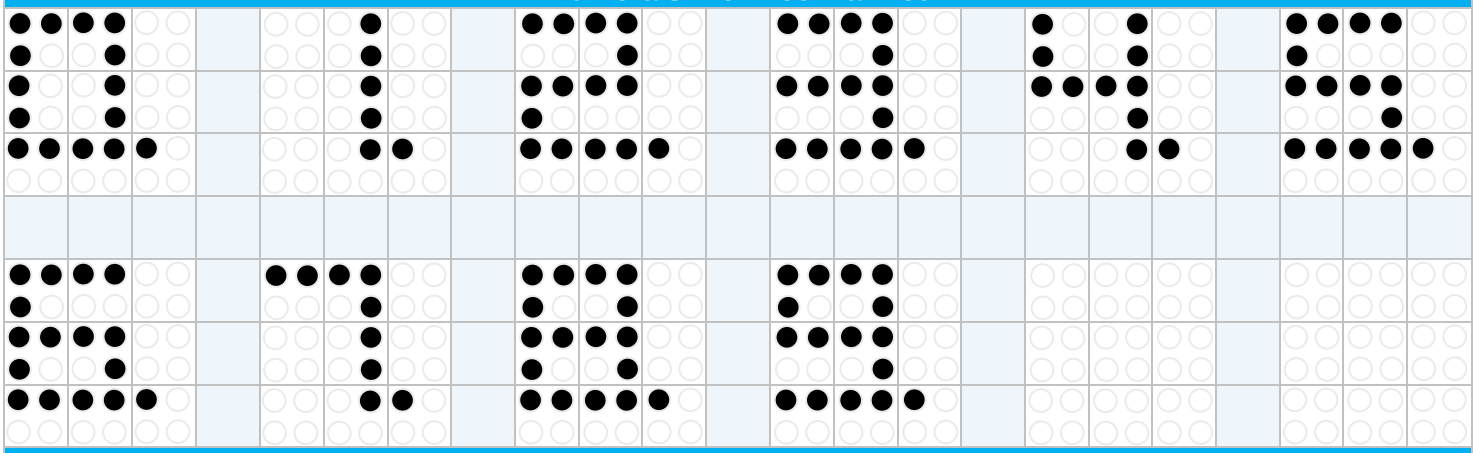


The 16 Hexadecimal Numerals (7-segment like Font)

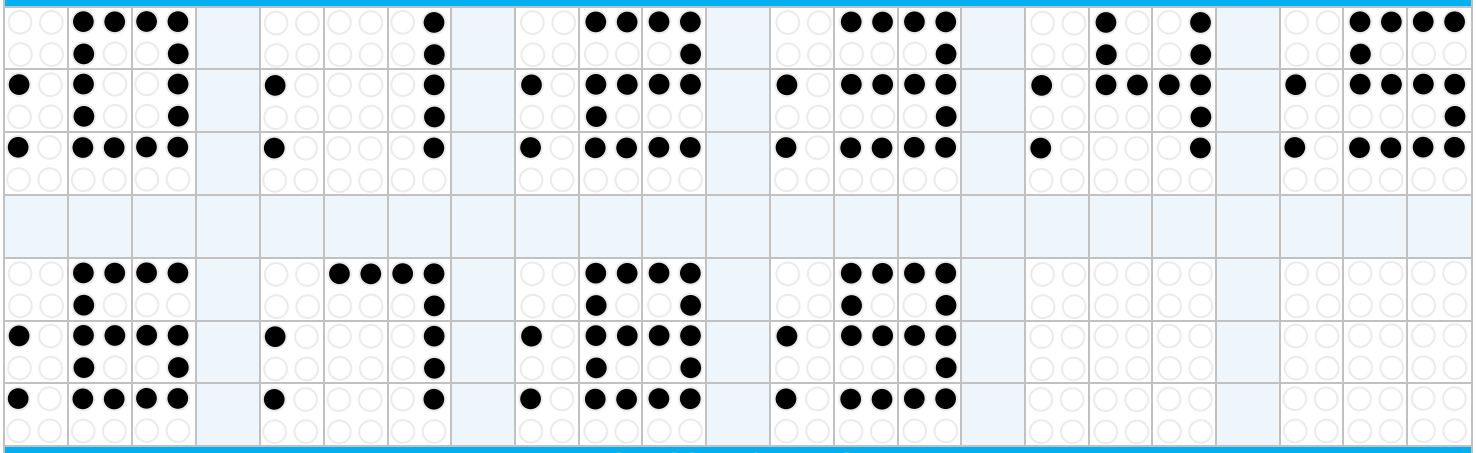


Dot Matrix Cube – 5x5 dot Character Set

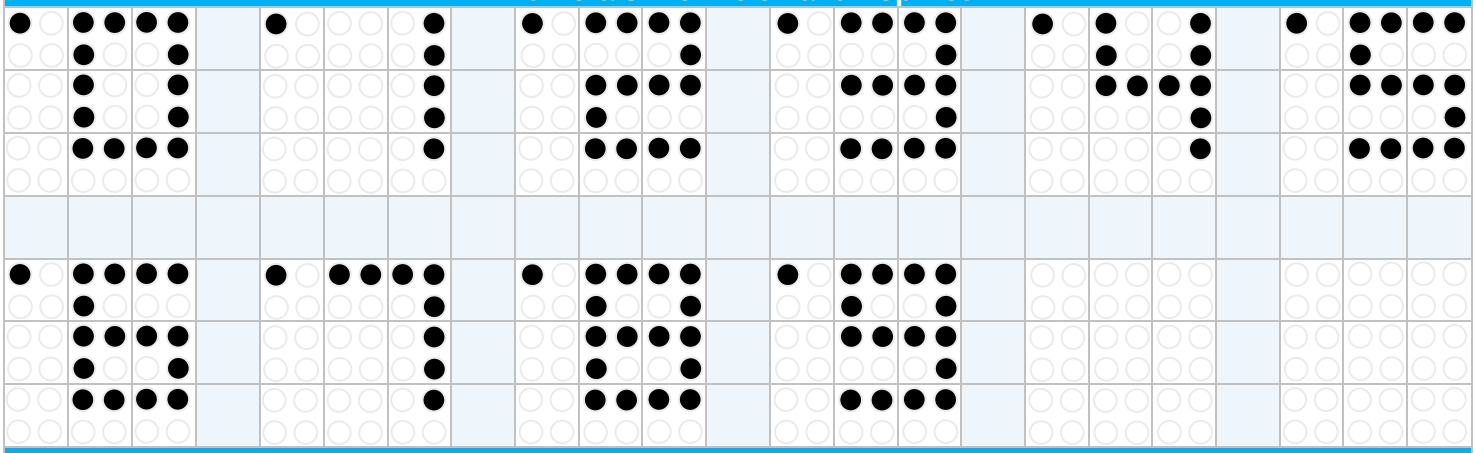
Numerals with Decimal Dot



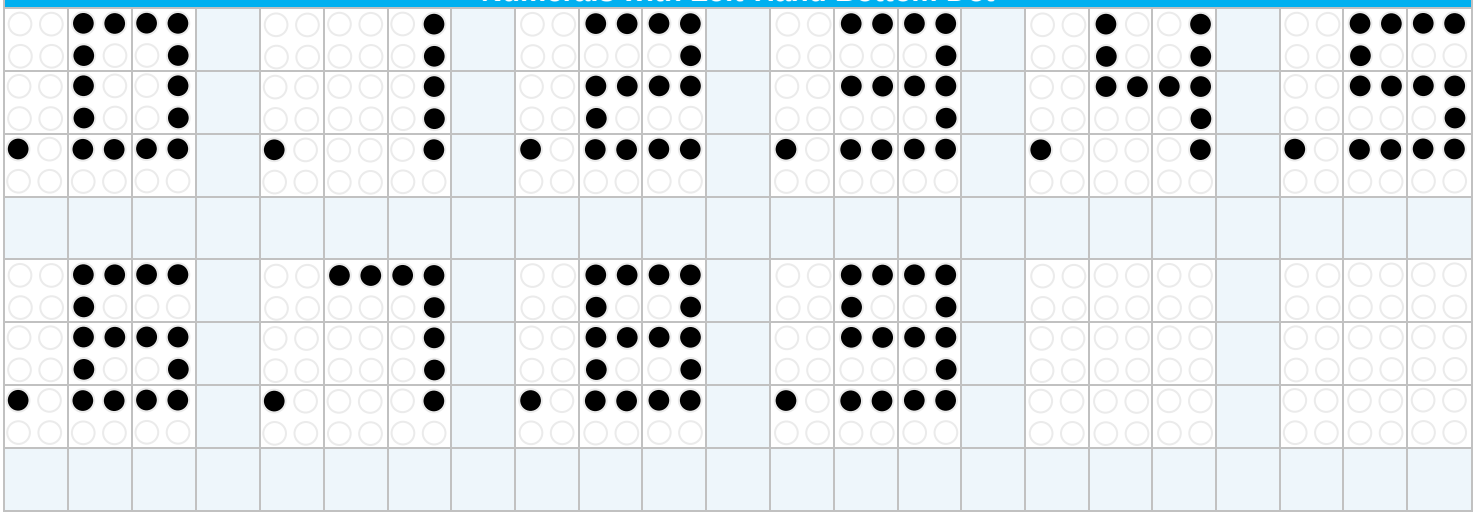
Numerals with Left-Hand Colon



Numerals with Left-Hand Top Dot

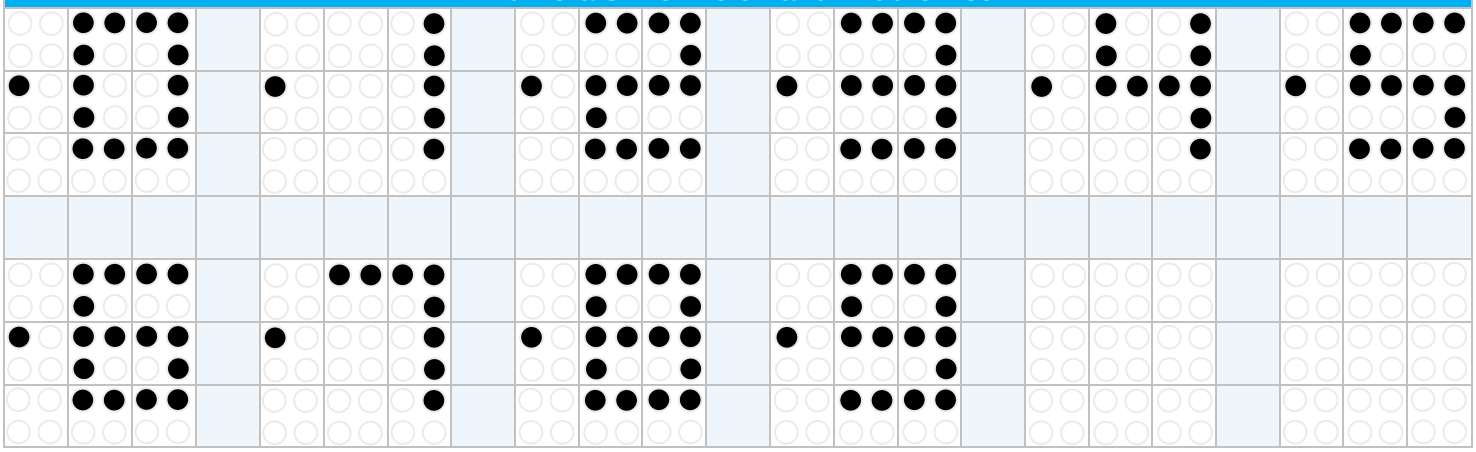


Numerals with Left-Hand Bottom Dot



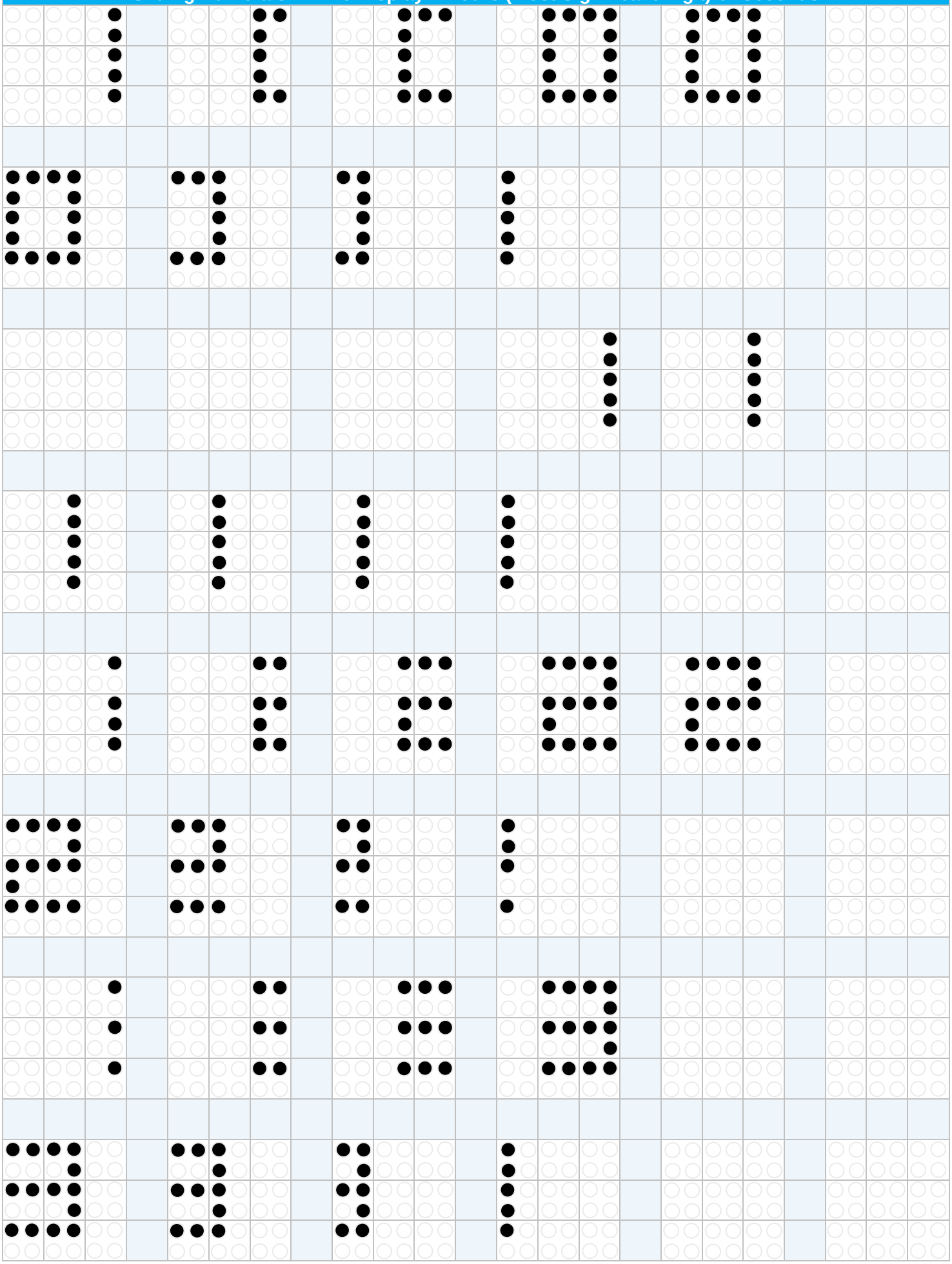
Dot Matrix Cube – 5x5 dot Character Set

Numerals with Left-Hand Middle Dot



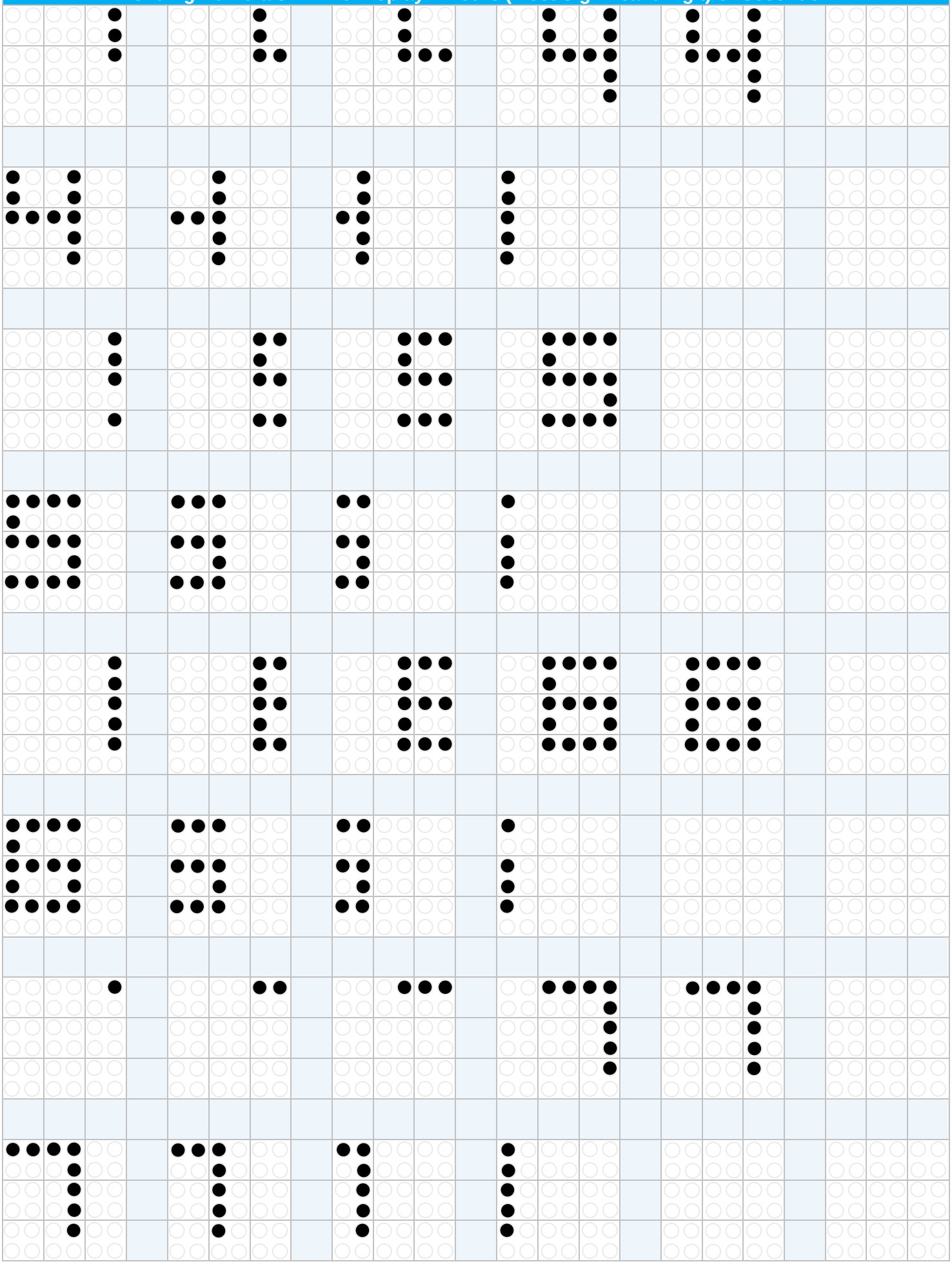
Dot Matrix Cube – 5x5 dot Character Set

Sliding Numerals – Time Display – Hours (Most Significant Digit) or Seconds



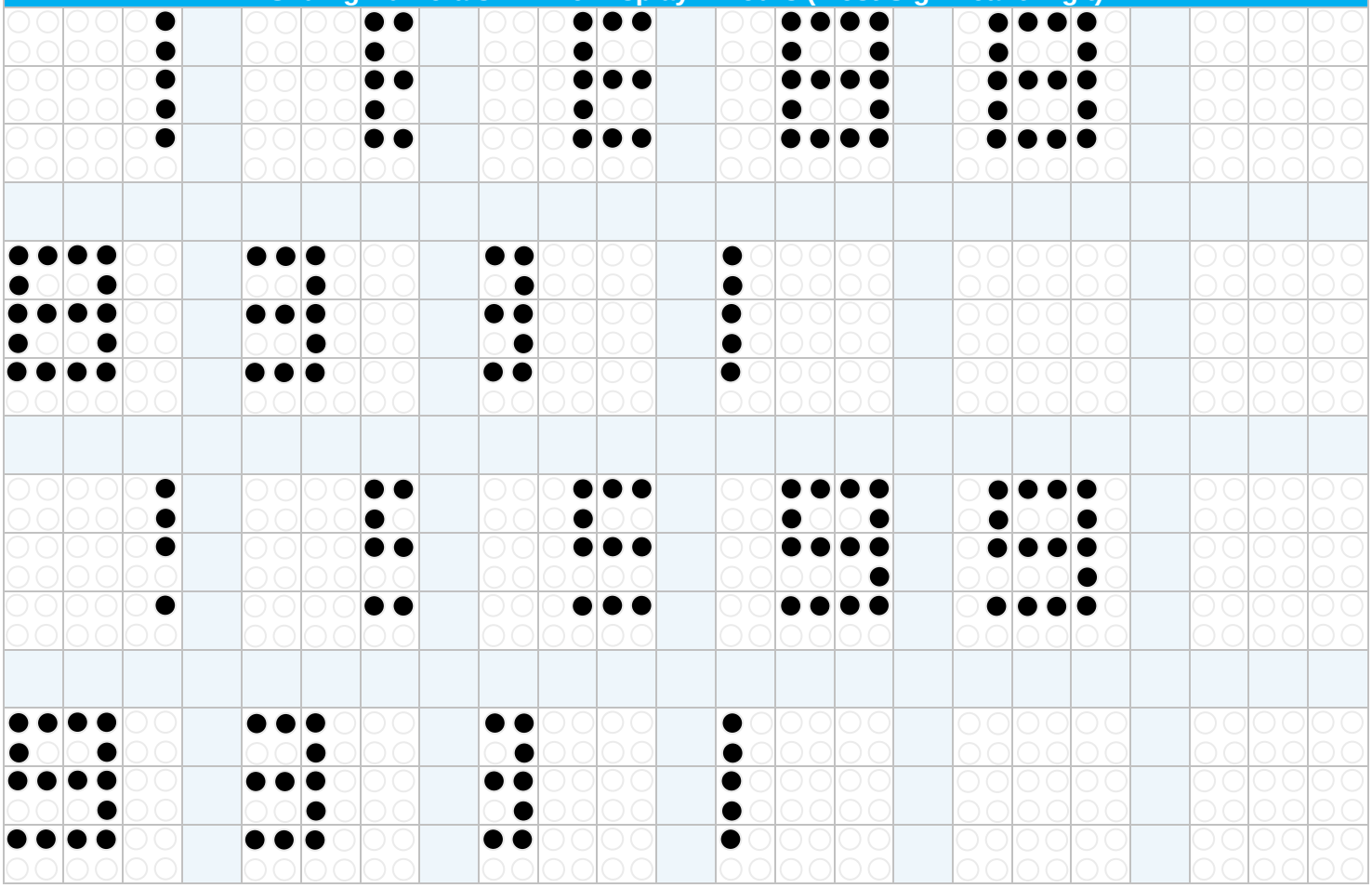
Dot Matrix Cube – 5x5 dot Character Set

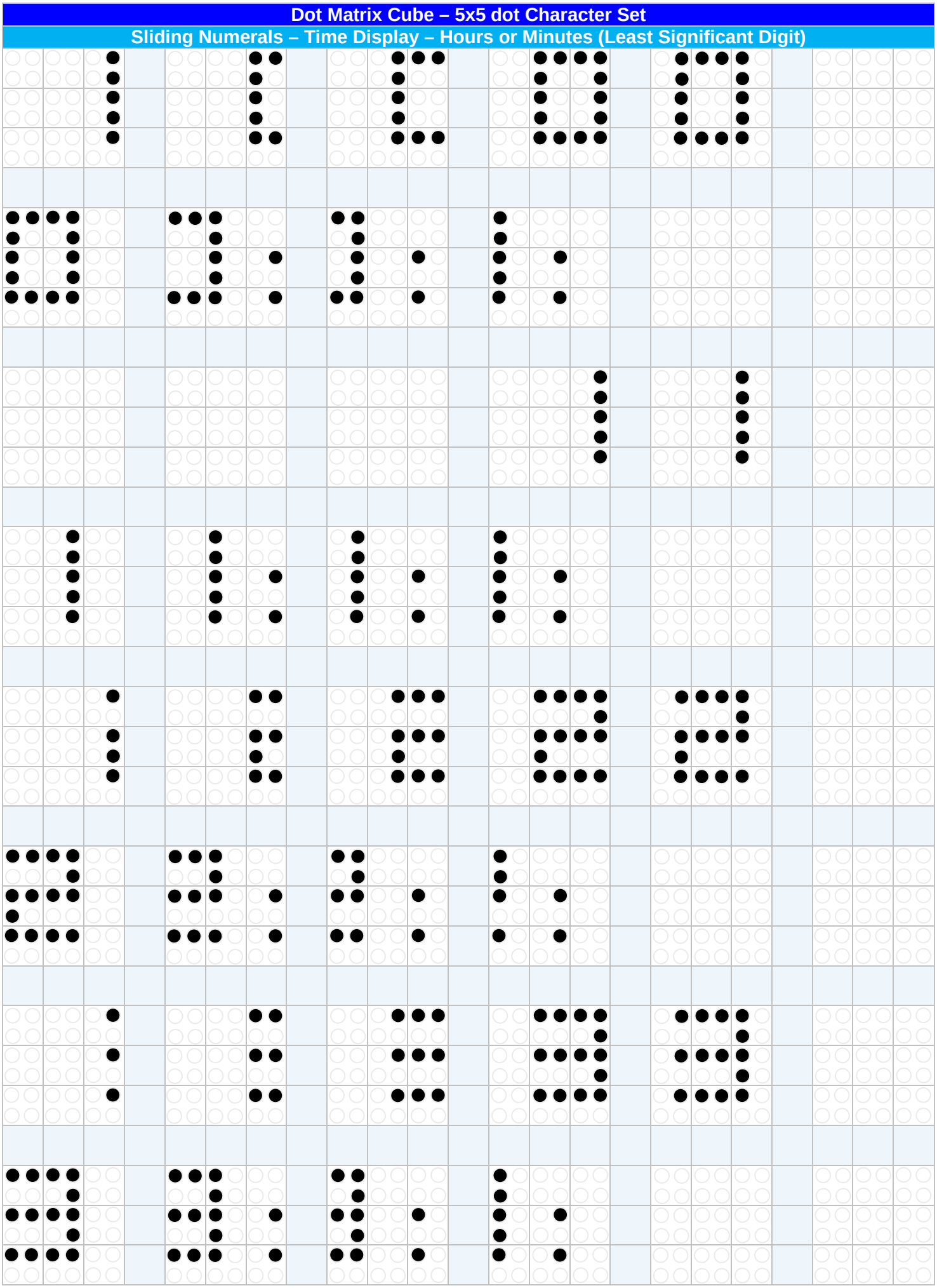
Sliding Numerals – Time Display – Hours (Most Significant Digit) or Seconds



Dot Matrix Cube – 5x5 dot Character Set

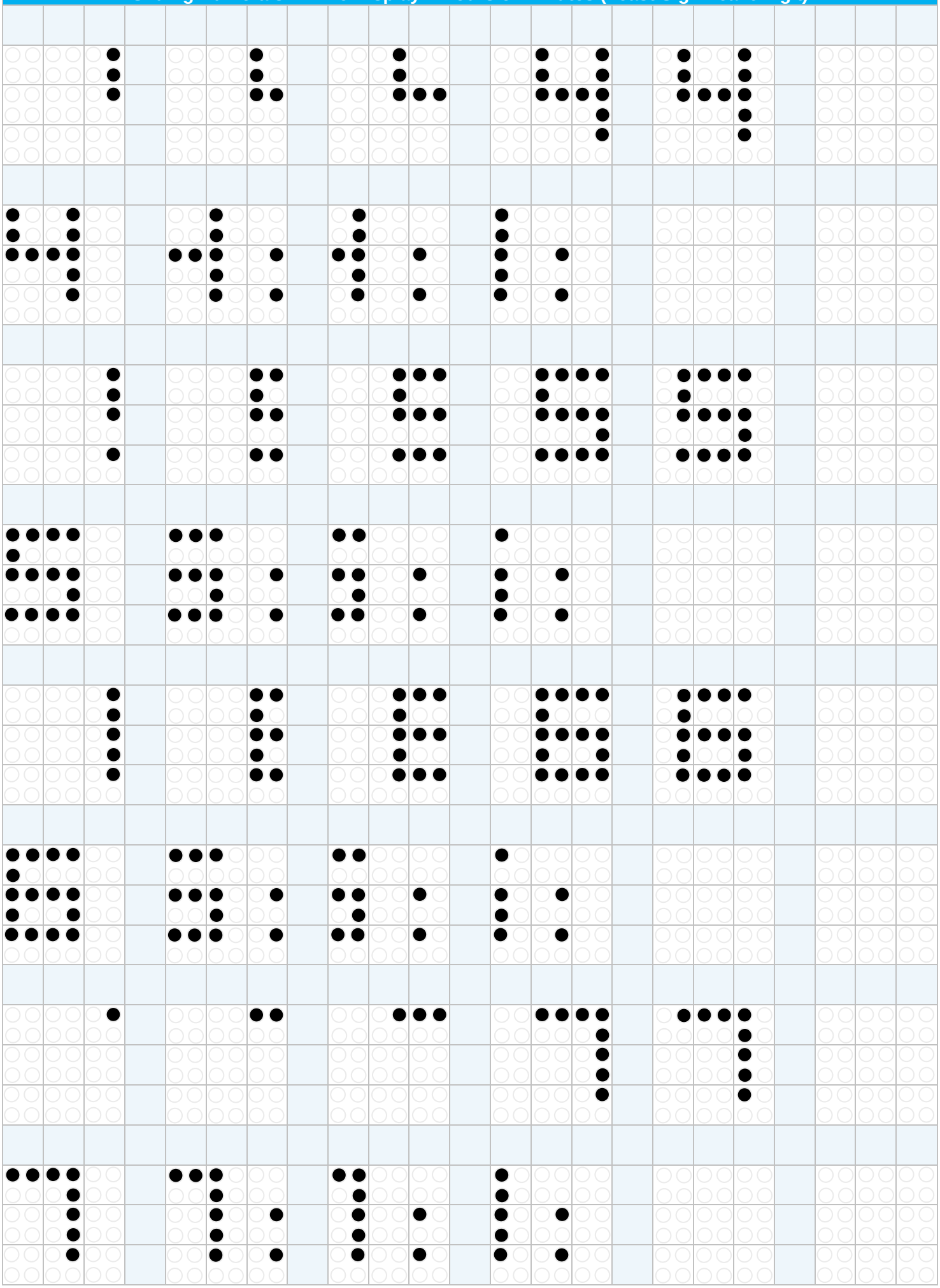
Sliding Numerals – Time Display – Hours (Most Significant Digit)




Dot Matrix Cube – 5x5 dot Character Set
Sliding Numerals – Time Display – Hours or Minutes (Least Significant Digit)

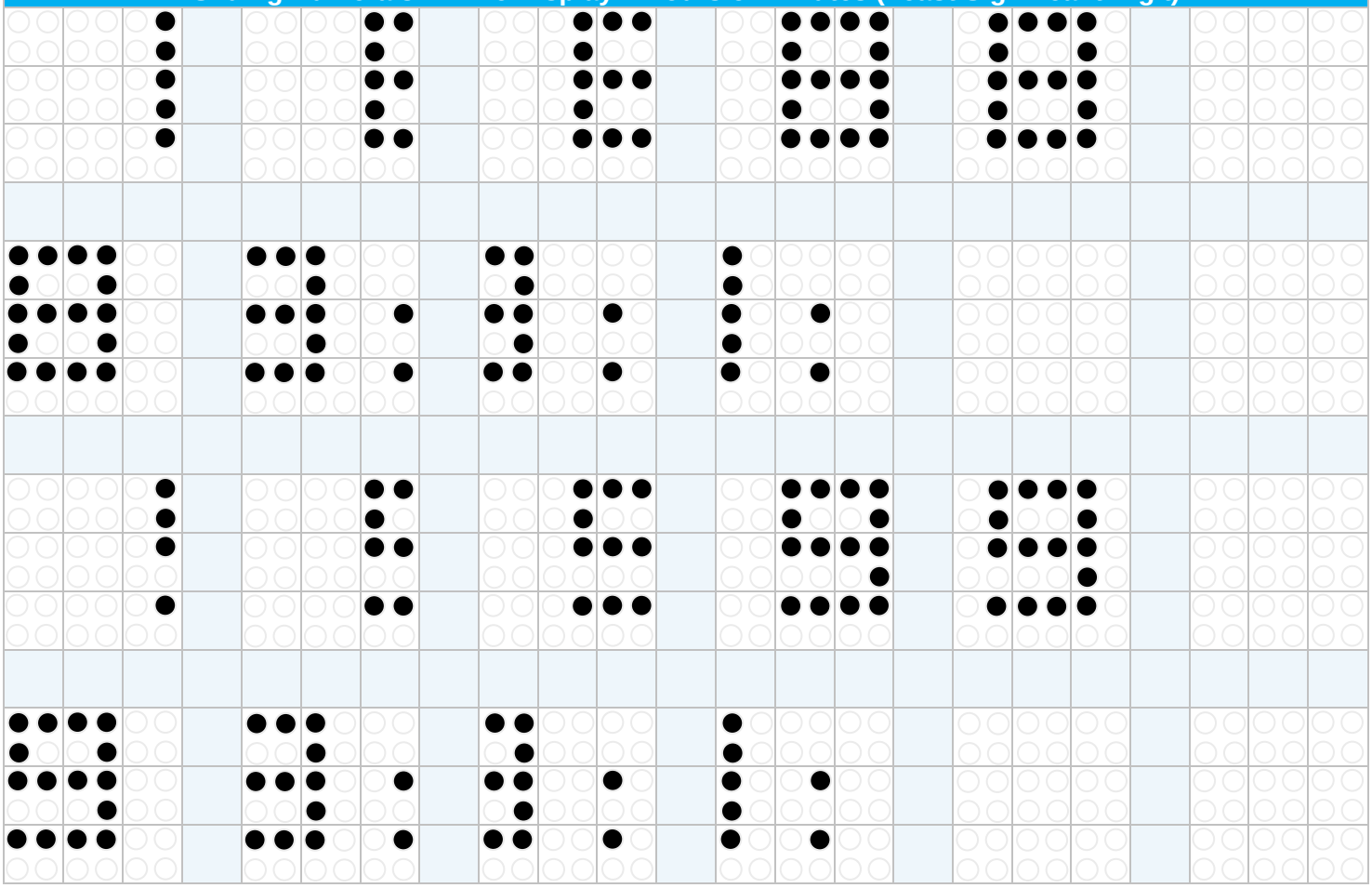
Dot Matrix Cube – 5x5 dot Character Set

Sliding Numerals – Time Display – Hours or Minutes (Least Significant Digit)



Dot Matrix Cube – 5x5 dot Character Set

Sliding Numerals – Time Display – Hours or Minutes (Least Significant Digit)

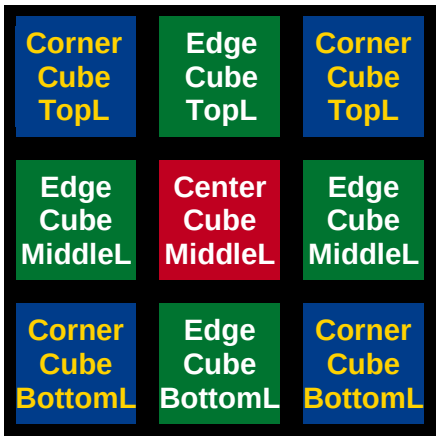


Dot Matrix Cube – 5x5 dot Customized Character Set

Build Your Own Character Set

Terminology

In a 3x3x3 **Rubik's Cube**, there are 8 *Corner Cubes*, 12 *Edge Cubes*, 6 *Center Cubes* and 6 *Cube Faces*. There are also 4 Corner Cube faces, 4 Edge Cube faces and 1 Center Cube face *per Cube Face*, as shown below.



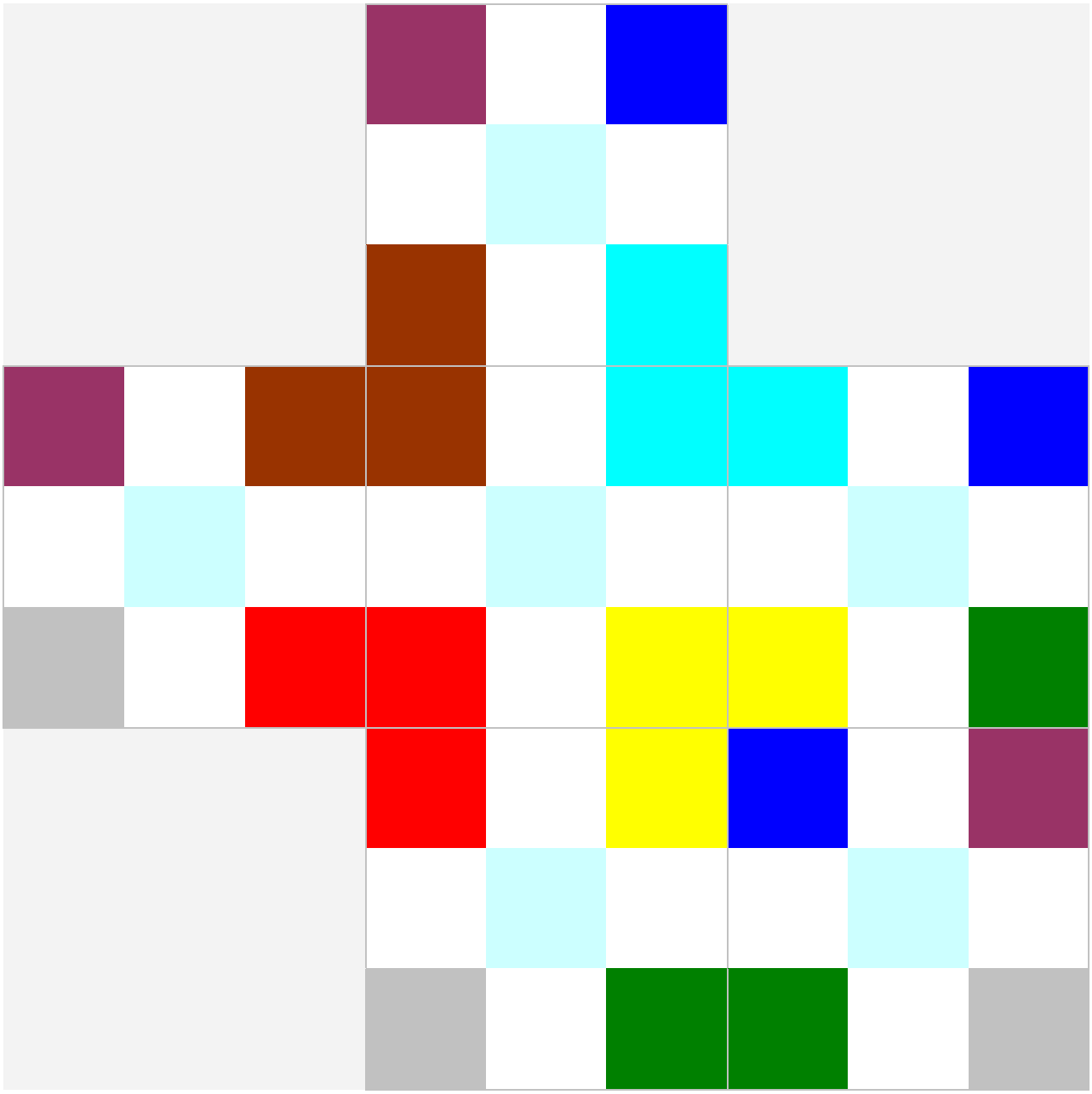
There are 1 face per Center Cube, 2 faces per Edge Cube and 3 faces per Corner Cube.

There are also 3 horizontal *Layers* called *Top*, *Middle* and *Bottom Layers*.

Cube Lexicon		
English	**Français**	**Deutsch**
Cube	Cube	Würfel
cubie, cube	cube, petit cube	Würfelteil, Teil des Würfels
face	face	Seite, Seitenfläche
front face	face avant	vordere Seite, vorne
back face	face arrière	hintere Seite, hinten
left face	face gauche	linke Seite, links
right face	face droite	rechte Seite, rechts
top face	face supérieure	obere Seite, oben
bottom face	face inférieure	untere Seite, unten
sticker	étiquette (autocollante), plaquette	Kleber, Farbkleber
tile	tuile, plaquette	Plättchen, Farbplättchen
center cube, center	cube central, centre	Mittelwürfel, Mittelstein, Mitte
edge cube, edge	cube-arête, arête	Kantenwürfel, Kantenstein, Kante
corner cube, corner	cube de coin, coin	Eckwürfel, Eckstein, Ecke
layer	couronne	Schicht, Scheibe
top layer	couronne supérieure	obere Schicht, obere Scheibe
middle layer	couronne intermédiaire	mittlere Schicht, mittlere Scheibe, Mittelschicht, Mittelscheibe
bottom layer	couronne inférieure	untere Schicht, untere Scheibe
orientation, direction	orientation	Orientierung
to solve	résoudre	lösen, zusammen drehen
to twist	pivoter	drehen
to rotate	tourner, effectuer une rotation	drehen
clockwise	dans le sens horaire	im Uhrzeigersinn
anticlockwise, counter-clockwise	dans le sens anti-horaire	im Gegenuhrzeigersinn

Corner Cubes Final Check

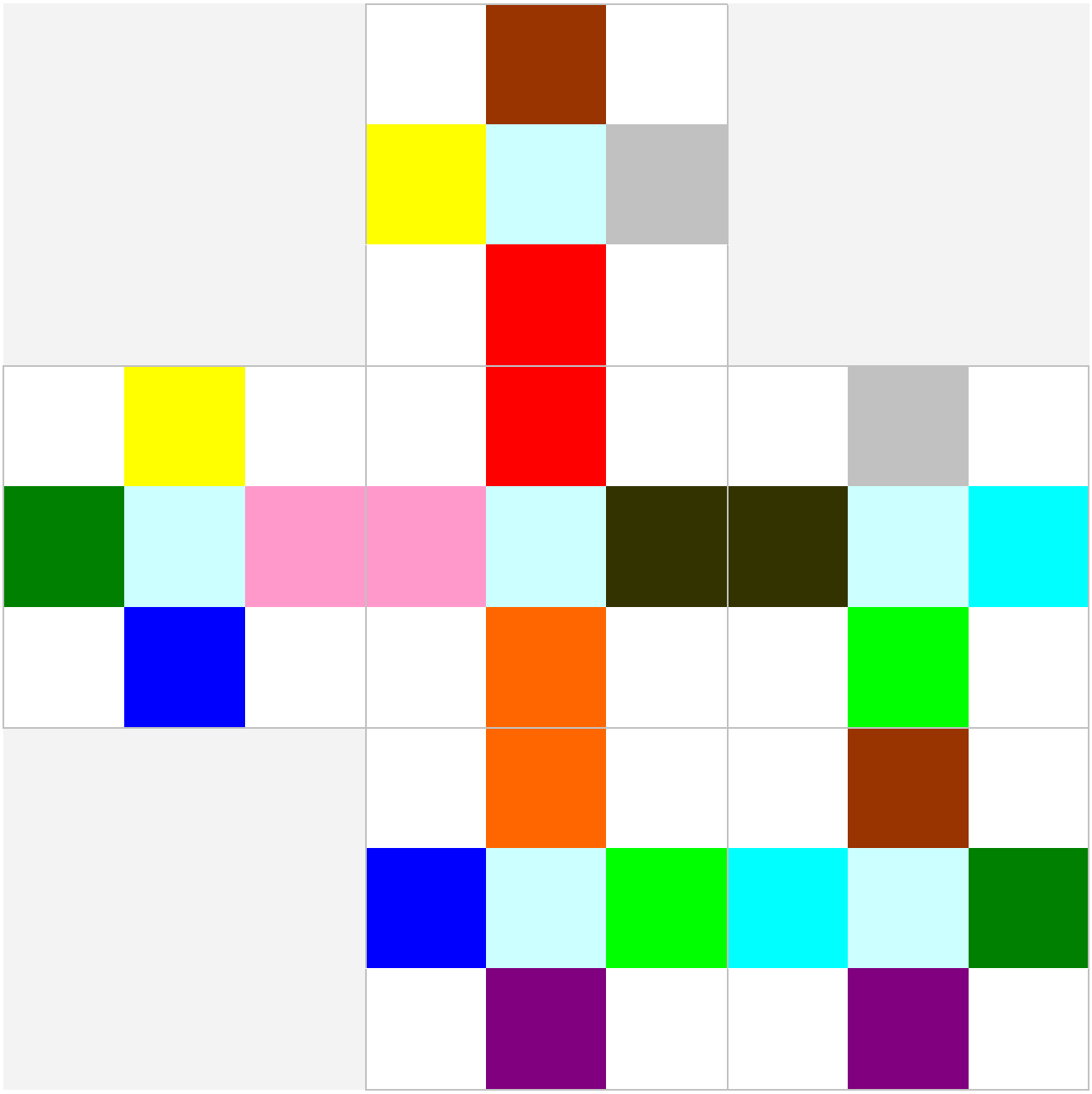
There are 8 Corner Cubes and 3 faces per Corner Cube. In the diagram below, each Corner Cube is displayed in 8 different colors and with the same color applied to each of its 3 faces. This diagram can be used as a convenient *visual aid* to check Design Rules (DRC).



	Up		
Left	**F**ront	**R**ight	**B**ack
	Down	**B**ack	

Edge Cubes Final Check

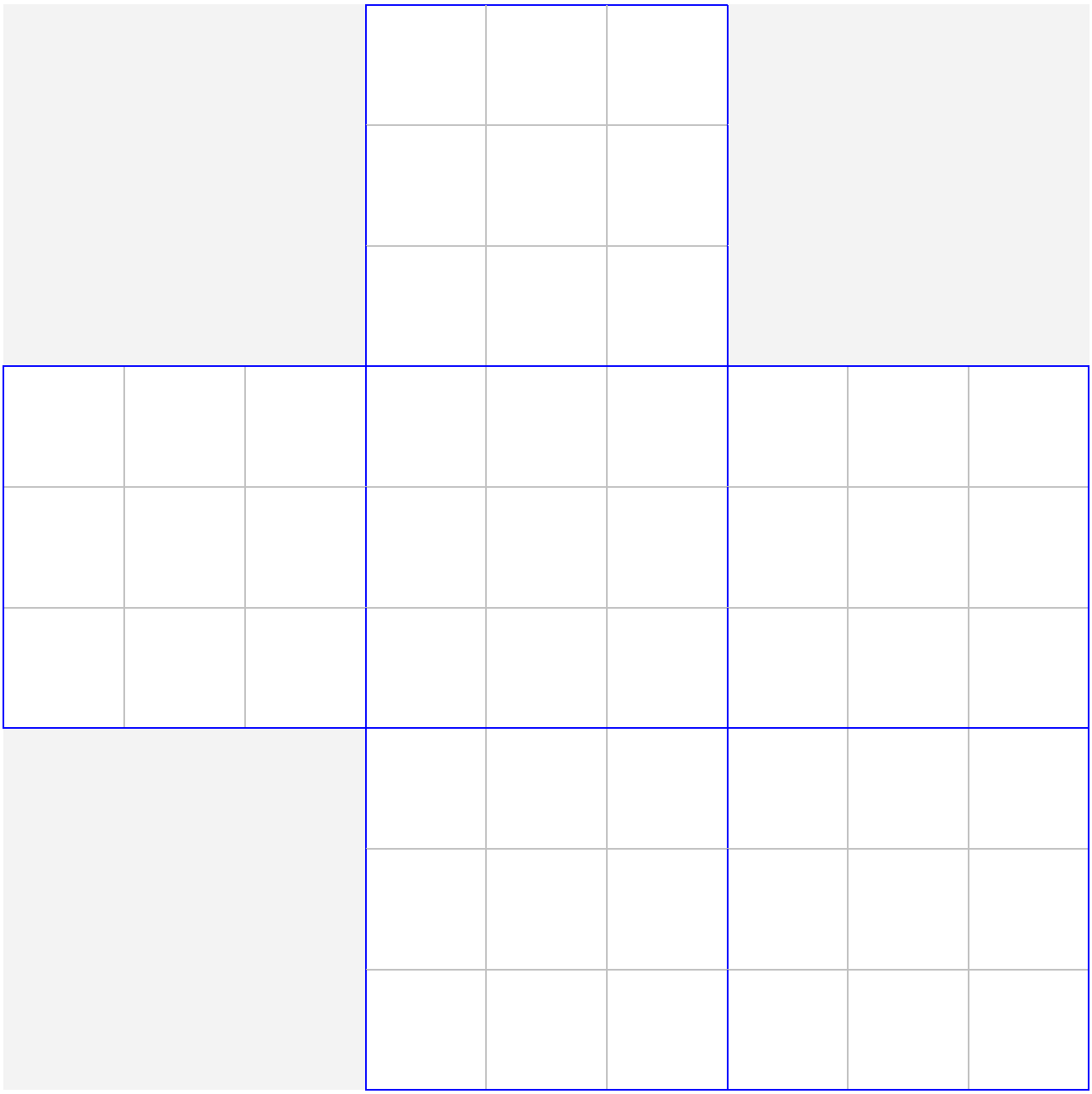
There are 12 Edge Cubes and 2 faces per Edge Cube. In the diagram below, each Edge Cube is displayed in 12 different colors and with the same color applied to each of its 2 faces. This diagram can be used as a convenient *visual aid* to check Design Rules (DRC).



	Up		
Left	**F**ront	**R**ight	**B**ack
	Down	**B**ack	

Texture Template

This is a texture template that can be printed out and used for writing down numbers and letters by hand *prior to* texture design. All is needed are pencil, rubber…and time.



	Up		
Left	**F**ront	**R**ight	**B**ack
	Down	**B**ack	