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GOD'S NUMBER IN THE SIMULTANEOUSLY-POSSIBLE TURN METRIC

by

Andrew James Gould

A Dissertation Submitted in

Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy in Mathematics

at

The University of Wisconsin-Milwaukee December 2017

ABSTRACT

GOD'S NUMBER IN THE SIMULTANEOUSLY-POSSIBLE TURN METRIC

by

Andrew James Gould

The University of Wisconsin-Milwaukee, 2017 Under the Supervision of Professor Hans Volkmer, PhD

In 2010 it was found that God's number is 20 in the face turn metric. That is, if the Rubik's cube hasn't been disassembled, it can always be solved in 20 twists or fewer, but sometimes requires 20 twists. However, the face turn metric only allows one face to be turned at a time for a total of 18 generators, or 18 possible twists at any time. This dissertation allows opposing, parallel faces to be twisted independent amounts at the same time and still get counted as 1 twist for a total of 45 generators. A new optimal-solving program was constructed, and the results so far show that God's number is at least 16 for the simultaneously-possible turn metric.

I note that in 3 dimensions the simultaneously-possible turn metric is the same as the axial turn metric (or robot turn metric), but not in 4 dimensions nor higher (e.g. 2×2×2×2, 3×3×3, 4×4×4×4, etc.--not to be confused with the 3-dimensional 4×4×4 cube). This difference is also described.

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TABLE OF CONTENTS

Abstract	ii
List of Figures	V
List of Tables	vi
List of Nomenclature	viii
Acknowledgements	іх
1 Introduction	1
1.1 Proofs of What is not Possible	3
2 What is Possible	7
2.1 Some Turn Metrics on the 2×2×2×2	8
3 The Optimal Solver	12
3.1 The Parts Common to Other Solvers	12
3.2 Testing and Verifying	14
4 Results	17
4.1 Random State Results	23
4.2 Symmetric State Results	23
Works Cited	39
Appendix	40
Curriculum Vitae	54

LIST OF FIGURES

0.1	Priority Tile Locations	viii
1.1	Impossible States	6
2.0	Two Compatible Subsets	7
2.1	4D Hinge	11

LIST OF TABLES

1.1.01	Change in Corner Cubie Orientation	4
2.1.01	Possible Twists in some Different Turn Metrics on the 2×2×2×2	8
2.1.02	Counts of possible twists for the 0-intersection turn metric on the $2 \times 2 \times 2 \times 2$	9
2.1.03	Counts of possible twists for the SPTM on the 2×2×2×2	10
3.2.01	FTM Simple Counting Method	15
3.2.02	SPTM Simple Counting Method	15
3.2.03	FTM States	15
3.2.04	SPTM States	15
4.0.01	Distance 16 (SPTM) states so far	17
4.0.02	Distance 16 (SPTM) neighbors	17
4.1.01	Distances of 2000 Random States	23
4.2.00	SPTM Distance of 20moves.txt	24
4.2.01	Symmetry Type O _h	24
4.2.02	Symmetry Type T _h	24
4.2.03	Symmetry Type T	25
4.2.04	Symmetry Type D _{3d}	25
4.2.05	Symmetry Type C _{3v}	25
4.2.06	Symmetry Type D ₃	26
4.2.07	Symmetry Type S ₆	26
4.2.08	Symmetry Type C ₃ [SPTM results not computed]	27
4.2.09	Symmetry Type D _{4h}	27
4.2.10	Symmetry Type D ₄	28
4.2.11	Symmetry Type C _{4v}	29

4.2.12	Symmetry Type C _{4h}	30
4.2.13	Symmetry Type C ₄	31
4.2.14	Symmetry Type S ₄	32
4.2.15	Symmetry Type D _{2d} (edge)	32
4.2.16	Symmetry Type D _{2d} (face)	33
4.2.17	Symmetry Type D _{2h} (edge)	33
4.2.18	Symmetry Type D _{2h} (face)	34
4.2.19	Symmetry Type D ₂ (edge)	34
4.2.20	Symmetry Type D ₂ (face)	35
4.2.21	Symmetry Type C _{2v} (a1)	35
4.2.22	Symmetry Type C _{2v} (a2)	36
4.2.23	Symmetry Type C _{2v} (b)	36
4.2.24	Symmetry Type C _{2h} (a)	37
4.2.25	Symmetry Type C _{2h} (b)	38

LIST OF NOMENCLATURE

- 0 orientation: a cubie has 0 orientation if its Priority: The priority order of faces is as highest priority tile is located on the highest priority face available for that location. (If needed, i.e. 4D and higher, additionally its secondary tile is on the secondary face, etc.) In 3D, a corner cubie has orientation 1 if its priority tile is one tile clockwise from a priority tile location (see Priority at right and Figures 0.1 and 1.1)
- 2D twist: a 2D twist on an M^N Rubik's cube is a twist of a subset with size such that two of • Symmetry: A rotation and/or a reflection of the dimensions are M and the rest are 1.
- 3D face: see Cube.
- Compatible subsets: two twistable subsets, A and B are compatible for a simultaneous twist if $A \cap B = \emptyset$, $A \subseteq B$, or $B \subseteq A$.
- Cube: Considering the M^N Rubik's cube, It has 2^N total vertices.
 - It has N*2^{N-1} total edges.
 - It has $\binom{N}{k}$ * 2^{N-k} total kD faces for any integer k with $2 \le k \le N-1$. When k=N-1, these are faces.

The ND volume is the whole puzzle.

- Cubie: Each mini-cube of the Rubik's cube is called a cubie. There are M^N cubies for an M^N Rubik's cube (including the central cubie(s) where applicable).
- Distance: |g| = the minimum twists necessary to obtain state g from the solved state.
- Face: see Cube.
- God's number = max({|g|:all states, g possible via twists alone}). (see Distance)
- Inversion symmetry class: Two sequences of twists, A and B are in the same inversion symmetry class if there exists a symmetry, s such that sAs⁻¹ has the same effect as B or B⁻¹. Alternatively, {symmetry class} U {symmetry class of inverse}. (compare: Symmetry class)
- Optimal solution: A solution is optimal if it cannot be solved in fewer twists.

- follows: Up Down Face Back Right Left. (see Figure 0.1)
- Slice: A twistable subset of an M^N Rubik's cube of size 1×...×1×M×...×M (at least one 1 and at least 2 M's).
- Support: The support of a series of twists is the set of cubies that don't return to the locations and orientations they were in at the start of the sequence of twists.
- the whole puzzle that maps all vertices to vertices, edges to edges, etc. Unless a stated otherwise, a symmetry is not a twist and counts as 0 in the turn metric. Ex. $|F_{all}(g)| =$ |g|. There are 24 rotations of a cube—48 symmetries.
- Symmetry class: Two sequences of twists, A and B are in the same symmetry class if there exists a symmetry, s such that sAs⁻¹ has the same effect as B.
- Tiles: the new version of stickers.
- Turn Metrics: ATM: A twist is of twistable subset(s) of the puzzle about a common axis.
- FTM: Face Turn Metric. A twist is of a face. 90-, 180-, and 270-degree twists count as 1.
- SPTM: A twist is actually a set of twists applied to proper subsets of the puzzle simultaneously.
- U D ... or U1 D1 ... 90-degree clockwise twist
- U2 D2 F2 B2 R2 L2 180-degree twist
- U3 or U' 90-degree counterclockwise twist

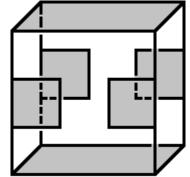


Figure 0.1 – Priority Tile Locations

ACKNOWLEDGEMENTS

I want to thank everybody: Mom, Dad, and the rest of my family including my mom's parents in whose house around 1993 I memorized my first solution method, layer-by-layer; my friends; my teachers in both school and extracurricular activities; Tomas Rokicki, whose general advice on using lookup tables was very helpful to me who, before this, had only written a few small programs outside of two and one third programming courses; Bruce Wade who suggested I move over to C++ from MATLAB (it's much faster now); and last, but not least, my advisor whose hands-off approach was good for my exact situation.

Chapter 1 Introduction

Each face of the Rubik's cube has 9 tiles, but many solvers focus on the cubic pieces. The 1-tile pieces, one in the center of each of the 6 faces, only spin--they never move. Additionally, there are 20 pieces that move: 12 edge pieces or 2-tile pieces which move from edge to edge, as well as 8 corner pieces or 3-tile pieces which move from corner to corner. Knowing this alone does not help novice solvers much. The main difficulty in solving is moving only a few pieces without messing up others. This is done with memorized twist sequences which move the pieces you want while only temporarily messing up other pieces before moving them back to exactly how they were. Many professional human solvers have a whole collection of memorized solving sequences as well as twist sequences that can create pretty patterns, but many solvers from beginner to professional are stunned when they find out that the Rubik's cube can always be solved in 20 face turns (FTM) or less.

One famous pretty pattern is the superflip, a state of the Rubik's cube for which all cubic pieces are in their solved locations, but where the corner pieces are completely solved, all edge pieces are flipped. For example, the orange and yellow edge cubie is correctly between the orange and yellow faces, but its yellow tile is on the orange face and its orange tile is on the yellow face. In 1995, Michael Reid used about 210 cpu hours [1] to prove that the superflip requires 20 face turns to be solved. It was the first state of the cube for which this property was found. It meant that God's number is at least 20 (FTM).

1

The main result of Cube20 [2] is that in 2010 Tomas Rokicki, Herbert Kociemba, Morley Davidson, and John Dethridge used 35 years of CPU time donated by Google to determine that 20 face turns suffice to solve any position [3]. That is, God's number is no more than 20. Along with the lower bound found by Michael Reid, this means that God's number is 20 (FTM). This also gives an upper bound of 20 for God's number in SPTM and the slice turn metric (because face turns are allowed in STM and SPTM and count as 1 twist) where a lower bound of 18 is known. (STM allows a single slice at a time to get twisted any amount and count as 1 twist.)

FTM requires only one face can be twisted at a time, but I've enjoyed simultaneous twists since my early cube solving days in the 1990's. If you're good at them (finger placement changes back and forth from 'on the cracks' to 'next to the cracks'), they help mix up the cube faster and solve the cube faster. Thus, the question arose, is it possible to solve every state in fewer than 20 twists if simultaneous turns were allowed?

I used the simple counting method around 2011 to find that God's number for the simultaneously-possible turn metric was at least 14 (the fewest number of twists before a cumulative total of upper bounds of states is greater than the total number of states of the Rubik's Cube, 4.3252*10¹⁹—see Tables 3.2.01 and 3.2.02), and I embarked on programming a new optimal solver.

In the meantime, Tomas Rokicki and Morley Davidson used about 29 years of CPU time at the Ohio Supercomputing Center (ending Aug. 2014) to essentially solve every state of the Rubik's cube in 26 moves or less in the quarter turn metric [4]. (Here twisting faces counts as 1 twist unless you are twisting by 180 degrees in which case it counts as 2 twists.) The lower

2

bound of the superflip + 4-spot requiring 26 twists (QTM) to be solved implies that God's number in the quarter turn metric is 26.

Originally my program was in MATLAB and compatible with both FTM and SPTM. This helped with bug checking and verification. After my proposal hearing followed by my first correspondence with Tomas Rokicki in 2015 I switched to C++. I actually rewrote the program from scratch and used more lookup tables per Tomas Rokicki's advice. The changes made it faster. It was then only compatible with SPTM, but I verified with my MATLAB numbers.

About the start of June 2017, I found states that were at least distance 15 (SPTM) on my computer. By the start of July, I had tacked on a solver and had found a 14-twist solution (SPTM) for the superflip. It solves the superflip in a little over 7 seconds—7.009 seconds which I couldn't believe at first, but my program takes advantage of symmetry, and I verified the twists by hand. In the first 10 days of August, 2017 I had the program running on UWM's Peregrine system and discovered the first 4 states that were precisely distance 16 (SPTM). This was while solving states in 20moves.txt from the symmetric2 page of the Kociemba website [5] (a representative from each inversion symmetry class that exhibits symmetry at distance 20 FTM). I found 5th and 6th states that were distance 16 (SPTM) (distance 18 and 20 FTM) in late September while solving C2va1.txt. Thus, my results have set a lower bound of 16 for God's number in the simultaneously-possible turn metric which is what I set out to do.

1.1 Proofs of What is not Possible

According to [6] the three things that are not possible are well-known [7, 8], but I insert my proofs of here of Theorems 4, 5, and 6 for convenience.

Lemma 1. Any possible twist of an M^N Rubik's cube can be composed with 90-degree twists of 2D twistable subsets of the Rubik's cube.

Note. If M is an odd integer greater than 2, every 90-degree 2D face twist of the M³ cube performs an odd permutation (4-cycle) of middle-edge cubies and an odd permutation (4-cycle) of corner cubies.

Definition. If N = 3 and a corner cubie's priority tile is one location clockwise from a priority tile location, the cubie is said to have orientation 1. If its priority tile is one location counterclockwise from a priority tile location, the cubie is said to have orientation 2. (Recall if the priority tile is located on a priority face it has orientation 0, or solved orientation.)

Lemma 2. Let N=3. Every 90-degree face twist preserves the summation of orientation of all the corner cubies (mod 3).

Proof. Note that U, U', D, D', and a 180-degree twist of any face preserve the orientation of each cubie. The remaining possibilities are in Table 1.1.01. Note that each of these possibilities has 2 cubies in each, the middle and right columns.

	Cubies that stay on the U (or	Cubies that go from the U to
	D) face	the D face (or vice versa)
F, B, R, L	+1 (mod 3)	-1 (mod 3)
F3, B3, R3, L3	-1 (mod 3)	+1 (mod 3)

Table 1.1.01 – Change in Corner Cubie Orientation

Lemma 3. For N=3 and an odd integer, M greater than 2, every twist performs an even permutation of middle-edge tiles.

Proof. An arbitrary 90-degree twist performs two four-cycles of middle-edge tiles. Lemma 1 implies an arbitrary twist will perform an even permutation.

Theorem 4. Let M be an odd integer greater than 2. For the M³ Rubik's cube, any sequence of twists performs an odd permutation of middle-edge cubies if and only if it performs an odd permutation of corner cubies.

Proof. Let A1 be a sequence of twists on a M^3 Rubik's cube. By Lemma 1, there exists a sequence of twists, A2 of 90-degree twists that has the same effect as A1.

The Note implies that each of the 90-degree twists of A2 performs an odd permutation of middle-edge cubies and an odd permutation of corner cubies. Suppose A2 performs n many 90-degree twists. Then A2 performs an odd permutation of middle-edge cubies if and only if n is odd, which happens if and only if A2 performs an odd permutation of corner cubies.

Theorem 5. For the 3³ Rubik's cube, every sequence of twists preserves the summation of orientation of corner cubies.

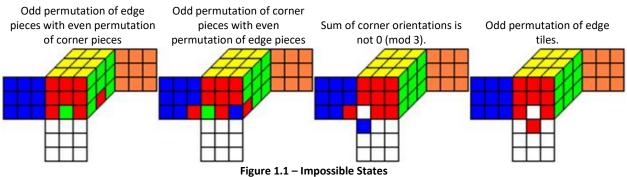
Proof. Let A1 be a sequence of twists on a 3³ Rubik's cube. Each of these twists is either a 90-degree twist or preserves the orientation of each corner cubie, thus preserving the summation. Lemma 2 implies that each of the 90-degree twists of A1 also preserves the summation of orientation of corner cubies.

Theorem 6. For N=3 and an odd integer M greater than 2, every sequence of twists of an M^N Rubik's cube performs an even permutation of middle-edge tiles.

Proof. Let A1 be a sequence of twists of such a M^N Rubik's cube. By Lemma 1, there exists a

5

sequence of twists, A2 of 90-degree twists that has the same effect as A1. Lemma 3 implies that each of the twists of A2 performs an even permutation of middle-edge tiles. Therefore, A2 performs an even permutation of middle-edge tiles.



Although one can get from the left-most picture to the left-of-center picture and back, it is not possible to go between any of the other possible pairings of these pictures even if the solved state were included.

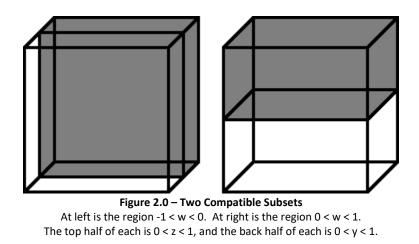
The left 2 pictures feature states with all cubies having 0 orientation, but one pair of cubies has been swapped. The right 2 pictures feature states with all cubies having solved location, but the right-most picture has one edge piece with orientation 1 while the right-of-center picture has one corner piece with orientation 2.

Pictures created using [9].

Chapter 2 What is Possible

In 3 dimensions, the axial turn metric (or robot turn metric) is the same as the simultaneously-possible turn metric. However, the term "simultaneously-possible" doesn't require all movement to be parallel to one plane of rotation.

In 4 dimensions there is room for two proper, twistable subsets to have distinct planes of rotation if the subsets are compatible (either non-intersecting or nested, i.e. one is contained in the other). For example, two non-intersecting 2D faces could be { (w,x,y,z) | -1 < w < 0 and 0 < y < 1 } and { (x,y,z,w) | 0 < w < 1 and 0 < z < 1 } as in Figure 2.0. The first set has an x-z plane of rotation and the second has an x-y plane of rotation. These subsets don't intersect because they're on opposing 3D W faces.



An example of two nested subsets in the $2 \times 2 \times 2 \times 2$ puzzle would be a 2D face inside a 3D face: { (w,x,y,z) | 0 < w < 1 and 0 < z < 1 } \subset { (w,x,y,z) | 0 < w < 1 }. Here the x-y plane of rotation for the 2D subset may not necessarily stay so as it moves while the 3D subset turns.

2.1 Some Turn Metrics on the 2×2×2×2

The 4-dimensional 2×2×2×2 Rubik's cube has twenty-four 2-dimensional faces and eight 3-dimensional faces. I made a spreadsheet to tally the number of states just 1 twist from solved. As you will see, the tallies grow very large quickly for a few metrics. To verify the spreadsheet, I made a MATLAB program that first makes a table to keep track of which pairs of twistable, proper subsets are compatible. It then constructs all possible unions of subsets that are pairwise compatible and performs all possible combinations of twists on them. Finally, it removes duplicates, and the results are shown in Table 2.1.01.

I will lead you in with, in the 2D quarter turn metric, each of the twenty-four 2D faces can move 90-degrees in either direction. Also, all motion is relative to one corner.

.

•

of states that are 1 twist from solved.				
Twist Metric	Possible Twists			
2D QTM	48			
2D FTM	72			
2D Axial	378			
3D QTM	24			
3D Atomic	80			
3D FTM	92			
QTM	72			
Atomic	128			
FTM	164			
Atomic, Same Angle	140			
Same Angle	182			
Axial	434			
0-intersection	6,194			
SPTM	10,082			

 Table 2.1.01 – Possible Twists in Some

 Different Turn Metrics on the 2x2x2x2

 These numbers can also represent the number

• FTM stands for face turn metric.

QTM stands for quarter turn metric (only 90-degree twists). Axial turn metric means any motion is about a common axis (The

planes of rotation are parallel, but the twist angles can differ for different subsets). The 3D Axial turn metric is not listed because it's the same as the 3D FTM.

Atomic means only the smallest angle is allowed in each direction (this allows 270-degree twists but restricts the 180-degree twists which are twice a 90-degree twist).

Same Angle means all subsets being twisted at that time will be twisted by the same angle.

Partial breakdowns of twist counts for the simultaneously-possible turn metric and the

0-intersection turn metric are in the following two tables:

Table 2.1.02 – Counts of possible twists for the 0-intersection turn metric on the 2×2×2×2

First note, the union of two opposing 3D faces is the whole puzzle (also the union of four distinct, parallel 2D faces). Often a category won't appear because it's counted in another category (for example, 'Two 3D faces' is counted in 'One 3D face' because motion is relative to one corner cubie).

Sometimes only some of the twists will appear in a category because the rest were counted in another category. For example, in 'Three 2D faces,' (all) three adjacent: if two of these faces have the same twist, apply the inverse of that twist to the whole puzzle to arrive at a 0-intersection twist performed on two 2D faces.

Such redundancies can also occur when a twist of a 3D face is the same as a twist of an external 2D face (or the inverse of a twist of a nested 2D face).

Also note, any twists involving a 2D face nested inside (outside of) a 3D face can be generated by the internal (external) complement of said 2D face relative to the 3D face.

0-intersection	Union	s Twists		
	/sets	per	Twists	
One 2D face:	24	3	72	
One 3D face:	4	23	92	- 4 not 8 because all motion is relative to one corner cubie.
One 3D face and				- For the 2D faces, no need to count their still-external
one 2D face:				complement, so 8 3D faces * 3 2D faces = 24 ways.
	24	66	1584	- 66 and not 69: when the 3D subset's twist = twist of 2D face the
	24	00	1584	result can also be generated by a single 2D face twist.
Two 2D faces:				- Two adjacent 2D faces were counted in 'One 3D face and one 2D
				face.'
				- "1/2" is in the formula because: same twist applied to opposing
opposing	12	7.5	90	2D faces = inverse twist applied to their complement, another pair
				of opposing 2D faces.
	0.0	0	064	- Each 2D face has 8 non-parallel 2D faces to union with, but then
else	96	9	864	each face gets counted twice, so 24*8/2 = 96.
Three 2D faces:				
2	C	C	26	- Due to complements, there is only one unique union for the four
3 adjacent	6	6	36	ways to union the xy slices. Six unique twists for this union.
2 adjacent	96	18	1728	 Twenty-four possible adjacent pairs * 4 non-adjacent = 96.
0 adia aont	22	27	864	- The complement of any union is 2 opposing edges, and each pair
0 adjacent	32	27	864	of opposing edges (16 pairs) has 2 unique unions.
Four 2D faces:				
4			~	
4 adjacent			0	- Already counted in 'Union of three 2D faces3 adjacent'
1 1/4 36 864		- 4 ways to choose two 3D bricks, the first of which has 3 possible		
adjacent				2D faces, the second has 2 remaining choices.
Total			6194	

SPTM	Unions	Twists		sible twists for the SPT witturn metric on the 2×2×2×2
	/sets	per	Twists	
2D faces:	24	3	72	
3D faces:	4	23	92	
One 3D face and	•	25	-	Here, you can either count 8 3D faces * 3 2D faces = 24 or
one 2D face:				4 3D faces $*$ 6 2D faces = 24 ways.
one 2D lace.				- 66 and not 69: when the 3D subset's twist = twist of
	24	66	1584	external 2D subset (or inverse of nested) the result can also
	24	00		be generated by a single 2D face twist.
Two 2D faces:				- Two adjacent 2D faces were counted in 'One 3D face and
Two 2D faces.				one 2D face.'
				- "1/2" is in the formula because: same twist applied to
opposing	12	7.5	90	opposing 2D faces = inverse twist applied to their
opposing	12	7.5		complement, another pair of opposing 2D faces.
				- Each 2D face has 8 non-parallel 2D faces to union with, but
not parallel	96	9	864	then each face gets counted twice, so $24*8/2 = 96$.
One 3D face and				
two 2D faces,				
one nested, one				
not but they				- No need for subsection, '2D faces are opposing.' All of those
are:				are counted here in 'adjacent.'
				- 180 not 207: 3D twists parallel to the nested subset's twist
adjacent	12	180	2160	are counted in 'Three 2D faces.'
				- 162 not 180 because of two situations: 3D twist = twist of
not parallel	24	162	3888	external 2D face, and 3D twist = twist of external 2D face
not paranet		101		applied to inverse twist of nested 2D face.
Three 2D faces:				
3 adjacent	6	6	36	- If 2 of 3 were the same twist, you could apply the inverse of
				that twist to the whole puzzle to get two 2D faces
2 adjacent	24	18	432	- Alternate count for 0 adjacent: complement of any union
				here is 2 opposing edges, and each pair of opposing edges has
0 adjacent	32	27	864	2 unique unions in its complement (there are 32 edges).
Total			10082	

Table 2.1.03 – Counts of possible twists for the SPTM turn metric on the 2×2×2×2

If you're skeptical of what twists are possible in 4 dimensions and higher, I also include one possible design for a 4D hinge in Figure 2.1. As a visual aid, it also contains 2D slices of what a 3D version of this hinge would look like. The classic design of corner cubies of the Rubik's Cube also extends to 4D and higher.

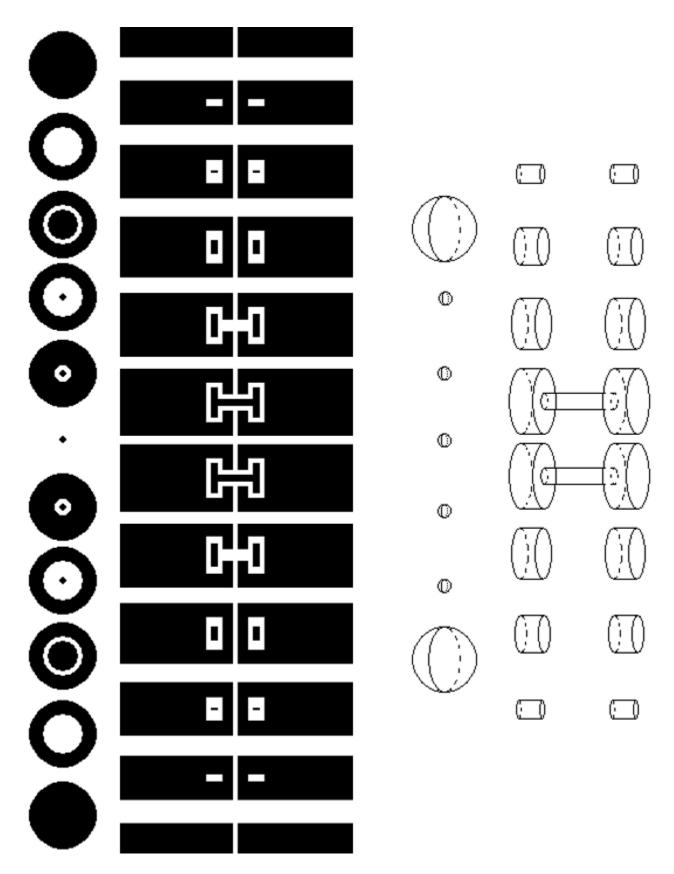


Figure 2.1 – 4D Hinge. yz and xz 2D slices of a 3D hinge (left). wyz and xyz 3D slices of a 4D hinge without enclosure (right).

Chapter 3 The Optimal Solver

3.1 The Parts Common to Other Solvers

I focus on two properties of the 20 moving pieces: location and orientation. The corner locations and corner pieces are numbered 0 through 7 while the edge locations and edge pieces are numbered 0 through 11. Corner piece 0's location is solved when it's in location 0, corner piece 1's location is solved when it's in location 1, etc. This is the same for the edges.

I can now describe applying one set of cubie locations to another. If the solved state is eight corner pieces ordered via 0 1 2 3 4 5 6 7, consider the two states: a = 7 2 3 5 0 6 4 1 and b = 2 0 1 3 7 4 5 6. Backwards notation is used. This comes from my MATLAB version of the program where backwards notation was more convenient for batch application. Thus 7 2 3 5 0 6 4 1 means that piece 7 is in location 0, piece 2 is in location 1, ..., and piece 1 is in location 7. Furthermore, b[0] accesses address 0 of b, which is 2. Therefore, b applied to a is

a[b[0]] a[b[1]] a[b[2]] a[b[3]] a[b[4]] a[b[5]] a[b[6]] a[b[7]] =

a[2] a[0] a[1] a[3] a[7] a[4] a[5] a[6] =

37251064

In C++, each is computed separately via

*c=a[*b], c[1]=a[b[1]], c[2]=a[b[2]], c[3]=a[b[3]], c[4]=a[b[4]], c[5]=a[b[5]], c[6]=a[b[6]], c[7]=a[b[7]];

If this happens millions of times, consider using constant pointers to b and c via

Yet another alternate method that seemed to be fastest for me is defining a uint64_t

pointer to the 8 bytes of the uint8_t c.

```
uint64_t *const c_8B = (uint64_t*) c;
//used via
*c_8B = ((uint64_t)((a[*b7]<<24)|(a[*b6]<<16)|(a[*b5]<<8)|a[*b4])<<32)|
((a[*b3]<<24)|(a[*b2]<<16)|(a[*b1]<<8)|a[*b]);
```

Now suppose the state corresponding to a has orientations $d1 = 0 \ 1 \ 0 \ 2 \ 0 \ 1 \ 0 \ 2$ and the state corresponding to b has orientations $d2 = 1 \ 2 \ 1 \ 2 \ 2 \ 1 \ 2$. Reading left to right, d1 means that the piece in location 0 has orientation 0, the piece in location 1 has orientation 1, the piece in location 2 has orientation 0, etc. Still applying b to a, b will move each piece from a and add the orientations together (mod 3). Hence, the resulting orientation is

d1[b[0]]+d2[0] (mod3) d1[b[1]]+d2[1] (mod3) d1[b[2]]+d2[2] (mod3) ... d1[b[7]]+d2[7] (mod3)

Two similar stages exist for the edges, although edges only have 2 possible orientations, 0 and 1 so addition mod 2 can be performed with the xor function. Cube20 combines location and orientation into one set of numbers, but in different ways. For each corner, they use the first 3 bits for the corner location and the next 2 bits for orientation. For the edges, they use the first bit for orientation and the next 4 bits for location. The difference between my method and theirs is minimal, at least for corners as this is only used to make lookup tables which are much faster than computing 8 permutations and worth it when the computation is to be performed millions of times. If you have single numbers, A and B representing a and b, usage of lookup tables may look like C = Lookup Table[A*40320+B] where 8! = 40320.

13

My optimal solver program uses tables to check if the state in question is the solved state, if it's distance 1 from solved, if it's distance 2 from solved, ..., if it's distance 8 from solved, then it checks if it's distance 1 from distance 8, distance 2 from distance 8, etc.

3.2 Testing and Verifying

Along the way to constructing an optimal solver, anything that could be verified needed to be verified. This is because there are a limited number of ways to double-check that a result is optimal. When I originally made my MATLAB program it was compatible with FTM in part so that the number of states at each distance could be verified with known FTM numbers. My program can create a list of all inversion symmetry class representatives at small to medium distances. This was performed, and via computing the total number of states in each representative's inversion symmetry class, the total number of states at each distance was calculated and verified with Cube20's numbers (see Table 3.2.03).

When I switched to C++ the analogous SPTM numbers were verified with my MATLAB SPTM numbers (Table 3.2.04).

When construction of the optimal solver was completed, every state of a list of all 348,938 distance-5 inversion symmetry class representatives was put into the solver. The program solved them in a way that was similar to how it solves high-distance states. Each one was correctly found to be distance 5.

Similarly, every state of a list of all 9,602,778 distance-6, and every 40th state of a list of all 266,133,337 distance-7 inversion symmetry class representatives were put into the solver. Each one was correctly found to be their respective distance.

14

Table 3.2.01 – FTM Simple Counting Method 18 generators, and then each bound below that is 13.5 times the one above it: 12 twists on perpendicular faces + 3 on the opposing, parallel face get counted twice. From this table we can conclude that God's number for the FTM is at least 18.

	Upper bound		
FTM	For States	Cumulative	
-			
0	1	1	
1	18	19	
2	243	262	
3	3280.5	3542.5	
4	44286.75	47829.25	
5	597871.125	645700.375	
6	8071260.188	8716960.56	
7	108962012.5	117678973	
8	1470987169	1588666142	
9	19858326784	2.1447E+10	
10	2.6809E+11	2.8953E+11	
11	3.6192E+12	3.9087E+12	
12	4.8859E+13	5.2768E+13	
13	6.5960E+14	7.1236E+14	
14	8.9045E+15	9.6169E+15	
15	1.2021E+17	1.2983E+17	
16	1.6229E+18	18 1.7527E+18	
17	2.1909E+19	2.3661E+19	
18	2.9577E+20	3.1943E+20	
19	3.9928E+21	4.3123E+21	

Table 3.2.03 - FTM States

The 'States' column is from Cube20's website [2]. My MATLAB program agreed as far as it reached (4 FTM and 7 FTM with Inversion Symmetry).

		, ,,
FTM	States	Symmetry Classes
0	1	1
1	18	2
2	243	9
3	3240	75
4	43239	934
5	574908	12077
6	7618438	159131
7	100803036	2101575
8	1332343288	

Table 3.2.02 – SPTM Simple Counting Method

45 generators, and then each bound below that is 30 times the one above it since twisting the same pair of faces twice in a row has already been counted.

It stops when **4.32E+19** is passed. From this table we can conclude that God's number for the SPTM is at least 14.

	Upper bound		
SPTM	For States	Cumulative	
0	1	1	
1	45	46	
2	1350	1396	
3	40500	41896	
4	1215000	1256896	
5	36450000	37706896	
6	1093500000	1131206896	
7	32805000000	33936206896	
8	9.8400E+11	1.0200E+12	
9	2.9500E+13	3.0500E+13	
10	8.8600E+14	9.1600E+14	
11	2.6600E+16	2.7500E+16	
12	7.9700E+17	8.2500E+17	
13	2.3900E+19	2.4700E+19	
14	7.1700E+20	7.4200E+20	
15	2.1500E+22	2.2300E+22	

Table 3.2.04 - SPTM States

This is the number of states that can be solved in this many twists (and cannot be solved in fewer). My C++ program has gathered a representative from each inversion symmetry class at SPTM 8.

			Inversion
		Symmetry	Symmetry
SPTM	States	Classes	Classes
0	1	1	1
1	45	6	6
2	1347	45	27
3	39631	994	578
4	1152290	25382	12912
5	32717804	692436	348938
6	917301226	19189952	9602778
7	25514695958		266133337
8	7.05325E+11		7348986607

Additionally, a verifier program in C++ was created to make sure input states and resultant optimal generators have the same effect on the puzzle. It was used on all resultant states in Section 4.2 and the Appendix, where the input was most of the lists of the symmetric2 page of the Kociemba website [5]. It was also used to verify that the original sequences of twists to get to the 'neighbors' early in Chapter 4 have the same effect on the cube as the resultant optimal generators for the neighbors.

The verifier program itself was tested via changing one small twist (e.g. a U to an F). It correctly reported 1 row failed each time.

Chapter 4 Results

Optimal solutions for two types of states were found: random states, and symmetric

states. Of all the states tested, 6 were found to be distance 16 (SPTM), all the rest were

distance 15 or less.

Table 4.0.01 – Distance 16 (SPTM) states so far

All six are distance 20 (FTM) except for the fifth which is distance 18 (FTM). They are all symmetric states. Note, Theorem 5 (Section 1.1) implies: only 3 disoriented corners means they must have the same orientation, and only 2 disoriented corners means they must have differing orientation.

 only 2 disonenced corners means they must have differing orientation.									
• U1F1U2F2L2U2R3B2U3L3F3R2F2U1R1D3F2B1U1R1	(Superflip + 2 opposing corners disoriented)								
• U1F1U1F2D2F2R3D1L3F2D2F2B3L2U2F3D1R3U1B3	(Superflip + 2 adjacent corners disoriented)								
 U1F1U1R2U1D1R3F1U3R1L1U3B1R3U1D1R2U1B1D3 	(Superflip + 2 same-face [but not adjacent] corners disoriented)								
• U1B1U1B2U1L3U2B3F1L3R1B3D3L2D2L1F2L2B1D3	(Superflip + 3 non-adjacent corners disoriented—all 3 adjacent to								
	a common, oriented corner)								
 R2U3F2B3U1D3F3R3D1B1D3R3B1U2R3U2F3R2 									
• B2R1B1L3F3U1B1R3U1L2D1L3D3F2L1F3R3F1R3U3									

All neighbors of these 6 states (that is, all states that are one twist from these states)

were also tested and all were found to be distance 15 (see Table 4.0.02).

Table 4.0.02 - Distance 16 (SPTM) neighbors The odd lines with a common neighbor start the same except the last face twist or two. The even, indented lines are optimal generators (all distance 15 SPTM) for the preceding line. The six chunks here, surrounded by mid-page horizontal lines, correspond with the six states of Table 4.0.01. F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3R1 D1U2F1R3D3U1L1R2F1B1R3F3D2U3R3F3R1F3B3D2F2B3 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3R2 D3U2B3U1L2F2B3D1U3L3R2D3U1L3R2U2F2B1L3R2F1B3L2R1F3B2 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3R3 B1D3U3L2F1B3L2D2U1R3F1L1R2F1D1U1R3D3U1R1D3 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L1 F3D1U1R2F1B3R2D3U2L1B3L2R3B3D3U3L1D3U1L3U1 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L1R1 F2B1L3R2D3U3B1D2U1F3B1D2F3B2U3L2R3F1B2L1R3F1R2D1 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L1R2 D1F2D3L1R2D1F2B1L3F2B2D3U3F1B1D3U3F2B2R3F2B3D3 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L1R3 F2B1D2U1R2F3L2R1D2U2F1D3L2D1U3F1B2L3R1F3B2D3F2B3 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L2 D2U1F1D3R2F1B2D1U3L2R1D3U1L2R1D2F3B2L2R1F1B3L3R2F2B1 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L2R1 F2D2U1L2R2B3L1R2F1B2R3F3B3D2U1F2B3L2R3D3L3R3U1F3B2

F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L2R2 B1D3U3L2R2F3L1R3U1B3D1U1F1B3U1L2R1F1B1D2U3B2D3 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L2R3 U3B2U1L2R3U3F3B2R1F2B2D1U1F3B3D1U1F2B2L1F1B2U1 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L3 D2U3B3L1D3U1L2R3F3B3L1B1D1U2L1B1L3F1B1U2F1B2 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L3R1 F3L2R1F1B1L1R3F3B2D3F1B1L2R3F2R3F2B2D3U2L3R3F2B2D1 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L3R2 B2D3U2L2R2F1L2R3F2B3L1F1B1D3U2F1B2L1R2U1L1R1D3F2B1 F1B3L2R1U1L1R2F1B3L3R2D1U3F2U1L3D2U2F2B3L1B2D3U2L2R3L3R3 F3B2L2R1D1U1F3D3U2F3B1U2F2B1D1L1R2F2B3L1R3B3L2U3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3R1 U1F2B1U3L2U1F2B3U3R1F1D1U1F2B2L3R3D3U3L2R2B1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3R2 D3F2B3L3R2D2L3R3F3B2R2D1U2F3D1U3L2R1D3U3L1F3U3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3R3 D3F2B3D1L2D3F2B1D1R3F3D3U3F2B2L1R1D1U1L2R2B3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L1 U1F2B1U3L2U1F2B3U3L1D1F1B1D2U2L3R3F3B3L2R2U1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L1R1 D2U3R1F2B1L1R1D2L3R2D1U3L1R1F1B1D3U2R1F1B1L1F1B3D2U3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L1R2 D3F2B3D1L2D3F2B1D1L1R2D3F3B3D2U2L1R1F1B1L2R2U3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L1R3 F3B2L1R3D3U2F2R1D3L3R2B2D2U3F2B1D3U1F3B2D1U2R2F3B2 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L2 F3B3L1D3F1L3R3F1U3L1F3B3L2F3U3F3B1D3F3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L2R1 D3F2B3D1L2D3F2B1D1L2R1B3D3U3F2B2L1R1D1U1L2R2F3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L2R2 F3R3F2B3R2F1U1F1B3D1U1L2F3B2L1R1D1U2R2F1B2D2 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L2R3 U1F2B1U3L2U1F2B3U3L2R3B1D1U1F2B2L3R3D3U3L2R2F1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L3 D3F2B3D1L2D3F2B1D1L3U3F3B3D2U2L1R1F1B1L2R2D3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L3R1 F1B2L3R1D2U1F2R3U1L1R2B2D1U2F2B3D3U1F1B2D2U3R2F1B2 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L3R2 U1F2B1U3L2U1F2B3U3L3R2U1F1B1D2U2L3R3F3B3L2R2D1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3L3R3 D1U2R3F2B3L3R3U2L1R2D1U3L3R3F3B3D2U1R3F3B3L3F3B1D1U2 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3B1 D3L3R3D2U2F1B1L1R1F2B2U3B1L3D2U3L1F2L3D2U1L1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3B2 U1R1F3D1U1F2B3D3U1R1D3U2B2L2R1F1B1D2F1B2L1R2D1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3B3 U1L1R1D2U2F3B3L3R3F2B2D1B3L1D1U2L3F2L1D3U2L3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F1 D3L3R3D2U2F1B1L1R1F2B2U3F1U3L2R3U1F2U3L2R1U1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F1B1 L3R2D1U3F1D1U1B1L2R3D1U1F1B1L3R1F3B2R2F1B1D2U1B1L3R2 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F1B2 D3L3R3D2U2F1B1L1R1F2B2U3F1B2U1L1R2U3F2U1L3R2U3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F1B3 D2U3B2L1R2D2U3L3R1D1U2L2R3D2F3B2L3B1U2L3R2F1B3D2U3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F2 L1U1L1R3D1L1F2L1R1F3D1L3F1B1L3U1F3L1R1

D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F2B1 D3L3R3D2U2F1B1L1R1F2B2U3F2B1R1D2U1R3F2R1D2U3R3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F2B2 D2L2R3B2D3U2F3B3L2R1F2D3U3L1R3U3R3B2L1R2B1R1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F2B3 U1L1R1D2U2F3B3L3R3F2B2D1F2B3R3D3U2R1F2R3D1U2R1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F3 U1L1R1D2U2F3B3L3R3F2B2D1F3D1L2R1D3F2D1L2R3D3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F3B1 D1U2B2L3R2D1U2L1R3D2U3L2R1U2F1B2L1B3D2L1R2F3B1D1U2 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F3B2 U1L1R1D2U2F3B3L3R3F2B2D1F3B2D3L3R2D1F2D3L1R2D1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3F3B3 L1R2D1U3F3D3U3B3L2R1D3U3F3B3L1R3F1B2R2F3B3D3U2B3L1R2 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3D1 B1L1D1U1L2R2F3B3D3U3F2B2R1B3D1L2R1D3F2D1L2R3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3D2 F3B2D1U2F1B3D2U3F2B1L2D2U3L1R3D2U3L3R1F2B3U2L1B3L2R3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3D3 L1R1U2F3B2R2B2L3R3F2B1D3U1F1D2U1L3R2D1U1R3F2B2L3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U1 L3R3D2F1B2R2B2L1R1F2B3D3U1F3D3U2L1R2D3U3R1F2B2L1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U1D1 F1D2L1D3U1L1R2D3U2B3L3R2F2L3R1F2B1R1F3B3D2U3L2R1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U1D2 F3B3D2U3L1R3F1L1R1B1D3U2L1R1F1B1D1U3F3B2D2F1B1L2R1B1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U1D3 L2R3F1B3D2B1R3F2B2D2U3R1U2F3B2L3R2D1U3L1R2B1L2R1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U2 F1B2D2U3F3B1D1U2F2B3L2D1U2L3R1D1U2L1R3F2B1D2L3B1L2R1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U2D1 F1B1R1U3F2L2B1D2U1F2B1D1U1B2L3R2D3U1L3R3D3U1L1R2 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U2D2 F1B1D2U1L3F3B3U1L1R2D1L2R2F3B3L3R2U1F1B1L3D2U3R3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U2D3 F1B1D1U2L3R1F3L3R3B3D2U1L3R3F3B3D1U3F1B2U2F3B3L2R3B3 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U3 B3L3D3U3L2R2F1B1D1U1F2B2R3B1U3L2R3U1F2U3L2R1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U3D1 F3B2L3R3F3B2L1D1U2L1R1B2L2R3F3B1L1R1D1U1F2B3L1D1U1R1 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U3D2 F3B3R3D1F2L2B3D3U2F2B3D3U3B2L1R2D3U1L1R1D3U1L3R2 D2U3F3B3D2U1F2B3D1U2F1B1L2R3F1B3U1R3D1U3R3F2B1D1U1F2B3L3R3U3D3 F3U2L3D3U1L3R2D2U1B1L1R2F2L1R3F2B3R3F1B1D1U2L2R3 U3F1B2D1F2B1L2R3F2B1R2F1B3D2U1L2R3D3R1D2L1R3F2B3L2R3R1 D1R3D1U3R1D3U3F3L3R2F3R1D2U3L2F3B1L2D1U1B3 U3F1B2D1F2B1L2R3F2B1R2F1B3D2U1L2R3D3R1D2L1R3F2B3L2R3R2 F3B2D1B1R3D1U2L1R2D2L1R2F3R3D1F2B3L1R3D1U3F2B3 U3F1B2D1F2B1L2R3F2B1R2F1B3D2U1L2R3D3R1D2L1R3F2B3L2R3R3 F2B1R3U2R1F2B3R3D1F1L1R1F2B2D3U3L3R3D2U2B1D3 U3F1B2D1F2B1L2R3F2B1R2F1B3D2U1L2R3D3R1D2L1R3F2B3L2R3L1 D3U2F2D3U3L1U3L3F2B3U3L3D1U1L2R1F3B1L3U1F1B2 U3F1B2D1F2B1L2R3F2B1R2F1B3D2U1L2R3D3R1D2L1R3F2B3L2R3L1R1 B2L2R2F3L1R3B1D2U3L2R1F3B2D1U1B3R3D3B1L1R3F1B2 U3F1B2D1F2B1L2R3F2B1R2F1B3D2U1L2R3D3R1D2L1R3F2B3L2R3L1R2 D1U2L3R1D3U3L3R1D3U2B2L1R1F2B1L2R1B1D2F2R3U1F1B1 U3F1B2D1F2B1L2R3F2B1R2F1B3D2U1L2R3D3R1D2L1R3F2B3L2R3L1R3 F1B1L1R3B2R3F3B2L3R3D1U2F2D3U2B3D1U1F2B3L3R1D2U3F2B1

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F2B3L2R3D1B3U1F3U3F2B2D1U3L2F2B1R3B3U3F3B2L2R1R2
R1F1L3R1F2D2U1F3L1R1D2U1L3R2D2U3L3R3D1B3L3R1D1U1
F2B3L2R3D1B3U1F3U3F2B2D1U3L2F2B1R3B3U3F3B2L2R1R3
F2B2D2U3F2B2L1F1D2L2R1F3B2U3L2D1U2F2B3L1R2U2B1
F2B3L2R3D1B3U1F3U3F2B2D1U3L2F2B1R3B3U3F3B2L2R1L1R1
D3U3B1L3U3L3R2F2B3D2F2L1R1F1B1D3L3R1D1L1D1U2
F2B3L2R3D1B3U1F3U3F2B2D1U3L2F2B1R3B3U3F3B2L2R1L1R2
L1R1F1B1L3R1U3F1L3R3F2B3L3R2F2B1L1R1D3F2B1D2L3R1D1
F2B3L2R3D1B3U1F3U3F2B2D1U3L2F2B1R3B3U3F3B2L2R1L1R3
D1U3F1L1B1L1U2F2B1D3U2L3D3F2B1L1R1F3B2D2F2B1
F2B3L2R3D1B3U1F3U3F2B2D1U3L2F2B1R3B3U3F3B2L2R1L2R2
F3L2R3D3U2B2L1R2U3B1D2U1F2B1L1U2F3B1U3R3D3U1

F2B3L2R3D1B3U1F3U3F2B2D1U3L2F2B1R3B3U3F3B2L2R1L2R3 D3U1L3D2U3L1R1F1B2U3L3D1L1R2D2U1R3F3B3L1R1F3B2D2 F2B3L2R3D1B3U1F3U3F2B2D1U3L2F2B1R3B3U3F3B2L2R1L3R3 B1U2L3R2F3D3U2B1R2B2D2U1F1B2L1R1F2R2F2B3U3

4.1 Random State Results

2000 random states were gathered in C++ using a time seed in srand() and then rand().

They were solved on 2 computers using message passing with an average time of 83 seconds

per solve (or an estimated 166 seconds/solve had only one computer been solving it). The

resulting distances are in Table 4.1.01.

SPTM	Number	
distance	of States	
11	1	
12	15	
13	414	
14	1546	
15	24	

Table 4.1.01 – Distances of 2000 Random States

4.2 Symmetric State Results

The main type of state solved was symmetric states. This was because Tomas Rokicki pointed out, my solver seemed to solve symmetric states faster. Also, he knows they are at larger distances than random states [10]. All available lists of symmetry class representatives from the symmetric2 page of the Kociemba website [5] were solved except the largest, C₃ (note that the 5 lists of symmetric states larger than C₃ were not available for download and were not tested). I use light parentheses for only Table 4.2.01. For the 9 shortest lists, see Appendix for optimal generators to these class representatives in each, FTM [5] and SPTM side by side.

1,091,994 states that are distance 20 (FTM) and exhibit symmetry.											
FTM	l. s.	Symmetry	States	SPTM	l. s.	Symmetry					
distance	classes	classes		distance	classes	classes	States				
				<11	0	0	0				
				11	7	8	192				
				12	176	197	4510				
				13	1592	2078	46408				
				14	17656	26117	615820				
<20	0	0	0	15	13189	18109	424980				
20	32625	46514	1091994	16	5	5	84				
-	•	•	•	13 14 15	1592 17656	2078 26117 18109	46408 615820 424980				

Table 4.2.00 – SPTM Distances of 20moves.txt All 32,625 inversion symmetry classes, 46,514 symmetry classes, and

Table 4.2.01 – Symmetry Type O_h

All 4 inversion symmetry classes, 4 symmetry classes, and 4 states.

In FTM the solved state is 0 twists from solved.
Pons Asinorum is 6 twists: B2 F2 L2 R2 D2 U2
Pons Asinorum + superflip is 19 twists: R B L F D L R' B2 F D' U L D' U R' D' F' R' U'
The superflip is 20 twists: D' R2 F' D2 F2 U2 L' R D' R2 B F R' U2 L' F2 R' U2 R' U'
In SPTM the solved state is still 0 twists from solved.
Pons Asinorum is 3 twists: (D2U2)(F2B2)(L2R2)
Pons Asinorum + superflip is 13: B2(L3R2)(F1B3)(L1R3)B1(L1R1)U3B2(L1R3)U2B3(D1U1)(L1R1)
The superflip is 14 twists: D2(F2B1)(L3R3)(D1U1)F2D1(L3R1)(D3U1)R1(F3B3)(L2R2)D3B2(L3R1)

All 8 inversion symmetry classes, 10 symmetry classes, and 20 states.									
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry			
distance	classes	classes	States	distance	classes	classes	States		
<8	0	0	0	<6	0	0	0		
8	1	1	2	6	1	1	2		
9	0	0	0	7	0	0	0		
10	0	0	0	8	0	0	0		
11	0	0	0	9	0	0	0		
12	0	0	0	10	1	1	2		
13	0	0	0	11	2	3	6		
14	0	0	0	12	0	0	0		
15	0	0	0	13	3	4	8		
16	3	4	8	14	1	1	2		
17	1	1	2						
18	0	0	0						
19	0	0	0						
20	3	4	8						

Table 4.2.02 – Symmetry Type T_h

All 12 inversion symmetry classes, 12 symmetry classes, and 48 states.								
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry		
distance	classes	classes	States	distance	classes	classes	States	
<12	0	0	0	<6	0	0	0	
12	2	2	8	6	2	2	8	
13	0	0	0	7	0	0	0	
14	0	0	0	8	0	0	0	
15	0	0	0	9	0	0	0	
16	0	0	0	10	0	0	0	
17	2	2	8	11	2	2	8	
18	5	5	20	12	3	3	12	
19	3	3	12	13	5	5	20	

 Table 4.2.03 – Symmetry Type T

 All 12 inversion symmetry classes, 12 symmetry classes, and 48 states.

 Table 4.2.04 – Symmetry Type D_{3d}

 All 12 inversion symmetry classes, 12 symmetry classes, and 48 state

All 12 inversion symmetry classes, 12 symmetry classes, and 48 states.								
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry		
distance	classes	classes	States	distance	classes	classes	States	
<14	0	0	0	<11	0	0	0	
14	1	1	4	11	1	1	4	
15	0	0	0	12	1	1	4	
16	0	0	0	13	3	3	12	
17	3	3	12	14	7	7	28	
18	4	4	16					
19	4	4	16					

Table 4.2.05 – Symmetry Type C_{3v}

All 16 inversion symmetry classes, 16 symmetry classes, and 128 states.									
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry			
distance	classes	classes	States	distance	classes	classes	States		
<13	0	0	0	<10	0	0	0		
13	2	2	16	10	1	1	8		
14	1	1	8	11	2	2	16		
15	3	3	24	12	3	3	24		
16	2	2	16	13	7	7	56		
17	2	2	16	14	3	3	24		
18	4	4	32						
19	2	2	16						

All 160 inversion symmetry classes, 208 symmetry classes, and 1,664 states.									
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry			
distance	classes	classes	States	distance	classes	classes	States		
<11	0	0	0	<8	0	0	0		
11	1	1	8	8	1	1	8		
12	2	2	16	9	1	1	8		
13	0	0	0	10	2	2	16		
14	5	6	48	11	5	8	64		
15	5	5	40	12	10	11	88		
16	11	14	112	13	34	43	344		
17	18	26	208	14	78	108	864		
18	62	85	680	15	29	34	272		
19	52	65	520						
20	4	4	32						

Table 4.2.06 – Symmetry Type D₃ All 160 inversion symmetry classes, 208 symmetry classes, and 1,664 states.

Table 4.2.07 – Symmetry Type S₆ All 2,610 inversion symmetry classes, 3,870 symmetry classes, and 30,960 states.

FTM I. s. Symmetry SprtM I. s.							•
distance	classes	classes	States	distance	classes	Symmetry classes	States
<8	0	0	0	<4	0	0	0
8	1	1	8	4	1	1	8
9	2	3	24	5	1	1	8
10	2	2	16	6	0	0	0
11	1	2	16	7	2	3	24
12	8	11	88	8	8	11	88
13	0	0	0	9	0	0	0
14	10	12	96	10	7	7	56
15	16	22	176	11	15	22	176
16	106	158	1264	12	114	152	1216
17	261	397	3176	13	379	557	4456
18	979	1476	11808	14	1198	1830	14640
19	1143	1698	13584	15	884	1285	10280
20	81	88	704	16	1	1	8

Table 4.2.08 – Symmetry Type C₃

	All 497	,882 in	versio	n syn	nmet	try cl	asses	5,
-	-						-	

942,716	symmetry c	lasses, and 15,0	83,456 states.
	•		

FTM	l. s.	Symmetry	
distance	classes	classes	States
<9	0	0	0
9	3	3	48
10	5	6	96
11	3	5	80
12	28	32	512
13	46	71	1136
14	260	418	6688
15	1238	2216	35456
16	9105	16705	267280
17	62806	120050	1920800
18	271003	520076	8321216
19	152809	282475	4519600
20	576	659	10544

A vast majority of the SPTM results for

the 942,716 symmetry classes of C₃ remain

unchecked so only FTM results appear here.

	All 124 inve	ersion symmetry		24 symmetry		d 372 states.	
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<2	0	0	0	0	0	0	0
2	1	1	3	1	1	1	3
3	0	0	0	2	1	1	3
4	1	1	3	3	0	0	0
5	0	0	0	4	6	6	18
6	3	3	9	5	4	4	12
7	0	0	0	6	6	6	18
8	6	6	18	7	4	4	12
9	1	1	3	8	14	14	42
10	2	2	6	9	10	10	30
11	0	0	0	10	8	8	24
12	6	6	18	11	16	16	48
13	14	14	42	12	28	28	84
14	18	18	54	13	25	25	75
15	3	3	9	14	1	1	3
16	19	19	57				
17	20	20	60				
18	19	19	57				
19	10	10	30				
20	1	1	3				

		rsion symmetry	Classes, 15				
FTM	l. s.	Symmetry	c	SPTM	l. s.	Symmetry	<u>.</u>
distance	classes	classes	States	distance	classes	classes	States
<2	0	0	0	0	0	0	0
2	1	1	6	1	1	1	6
3	0	0	0	2	0	0	0
4	0	0	0	3	1	2	12
5	0	0	0	4	6	7	42
6	3	4	24	5	5	5	30
7	4	5	30	6	11	11	66
8	5	5	30	7	18	19	114
9	1	1	6	8	24	27	162
10	3	3	18	9	15	17	102
11	5	5	30	10	6	6	36
12	27	30	180	11	1	1	6
13	21	24	144	12	56	64	384
14	8	8	48	13	32	32	192
15	12	12	72				
16	16	20	120				
17	34	38	228				
18	22	22	132				
19	14	14	84				

Table 4.2.10 – Symmetry Type D₄ All 176 inversion symmetry classes, 192 symmetry classes, and 1,152 states.

FTM	I. s.	symmetry Symmetry	Classes, 44	SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
0	0	0	0	0	0	0	0
1	1	1	6	1	1	1	6
2	0	0	0	2	0	0	0
3	0	0	0	3	1	2	12
4	0	0	0	4	2	3	18
5	1	2	12	5	2	2	12
6	0	0	0	6	8	8	48
7	1	1	6	7	44	46	276
8	2	3	18	8	44	54	324
9	1	1	6	9	38	48	288
10	6	6	36	10	91	103	618
11	10	10	60	11	81	85	510
12	32	37	222	12	42	50	300
13	57	70	420	13	46	46	276
14	63	67	402				
15	39	49	294				
16	57	61	366				
17	75	83	498				
18	51	53	318				
19	4	4	24				

 Table 4.2.11 – Symmetry Type C_{4v}

 All 400 inversion symmetry classes, 448 symmetry classes, and 2,688 states.

FTM	I. s.	symmetry Symmetry	Classes, 70	SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<2	0	0	0	0	0	0	0
2	1	1	6	1	1	1	6
3	0	0	0	2	0	0	0
4	0	0	0	3	3	3	18
5	0	0	0	4	1	1	6
6	3	3	18	5	1	1	6
7	1	1	6	6	2	2	12
8	3	3	18	7	14	14	84
9	0	0	0	8	38	38	228
10	0	0	0	9	22	22	132
11	10	10	60	10	15	16	96
12	27	28	168	11	14	22	132
13	35	35	210	12	148	159	954
14	15	20	120	13	247	283	1698
15	29	34	204	14	94	126	756
16	76	87	522	15	8	16	96
17	86	95	570				
18	162	184	1104				
19	132	171	1026				
20	28	32	192				

 Table 4.2.12 – Symmetry Type C4h

 All 608 inversion symmetry classes, 704 symmetry classes, and 4,224 states.

FTM	l. s.	symmetry Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
0	0	0	0	0	0	0	0
1	1	1	12	1	2	2	24
2	1	1	12	2	0	0	0
3	0	0	0	3	2	4	48
4	0	0	0	4	8	12	144
5	1	2	24	5	6	8	96
6	5	8	96	6	16	17	204
7	5	7	84	7	280	377	4524
8	5	7	84	8	685	1115	13380
9	7	7	84	9	1407	2300	27600
10	41	42	504	10	3173	5325	63900
11	131	177	2124	11	6413	11303	135636
12	267	381	4572	12	6750	11564	138768
13	389	583	6996	13	2569	3684	44208
14	674	958	11496	14	341	431	5172
15	1507	2302	27624	15	12	18	216
16	3148	5362	64344				
17	6475	11461	137532				
18	7118	12066	144792				
19	1852	2756	33072				
20	37	39	468				

 Table 4.2.13 – Symmetry Type C₄

 All 21,664 inversion symmetry classes, 36,160 symmetry classes, and 433,920 states.

		sion symmetry c	185565, 109,5				ites.
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<7	0	0	0	<5	0	0	0
7	7	7	84	5	22	22	264
8	16	16	192	6	34	45	540
9	19	25	300	7	141	180	2160
10	40	48	576	8	580	838	10056
11	90	110	1320	9	2016	3231	38772
12	210	256	3072	10	6214	10879	130548
13	697	937	11244	11	18509	33296	399552
14	1283	1944	23328	12	23682	43595	523140
15	3011	4965	59580	13	9441	15803	189636
16	7588	12900	154800	14	1189	1474	17688
17	17201	31218	374616	15	12	13	156
18	24049	43854	526248				
19	7554	13014	156168				
20	75	82	984				

Table 4.2.14 – Symmetry Type S₄ All 61,840 inversion symmetry classes, 109,376 symmetry classes, and 1,312,512 states.

Table 4.2.15 – Symmetry Type D_{2d}(edge)

All	1,152 inve	rsion symmetry	classes, 1,	472 symmetr	y classes, ar	nd 8,832 states.	
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<7	0	0	0	<4	0	0	0
7	3	3	18	4	1	1	6
8	8	8	48	5	13	14	84
9	11	13	78	6	15	20	120
10	6	10	60	7	41	45	270
11	18	22	132	8	62	66	396
12	39	41	246	9	72	82	492
13	52	57	342	10	195	237	1422
14	98	103	618	11	190	239	1434
15	93	103	618	12	219	310	1860
16	161	208	1248	13	280	367	2202
17	192	242	1452	14	64	91	546
18	288	389	2334				
19	172	256	1536				
20	11	17	102				

		rsion symmetry	Classes, 15				
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<8	0	0	0	<4	0	0	0
8	1	1	6	4	1	1	6
9	0	0	0	5	1	2	12
10	9	11	66	6	13	14	84
11	9	9	54	7	17	17	102
12	27	28	168	8	32	35	210
13	19	22	132	9	17	20	120
14	16	18	108	10	6	6	36
15	5	5	30	11	5	7	42
16	12	14	84	12	39	45	270
17	24	28	168	13	39	39	234
18	42	44	264	14	6	6	36
19	12	12	72				

Table 4.2.16 – Symmetry Type D_{2d}(face) All 176 inversion symmetry classes, 192 symmetry classes, and 1,152 states.

Table 4.2.17 – Symmetry Type D_{2h}(edge) on symmetry classes, 960 symmetry classes, a

		Table 4.2	.17 – Symm	etry Type D ₂	h(edge)		
	All 960 inve	ersion symmetry	v classes, 96	0 symmetry o	classes, and	5,760 states.	
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<7	0	0	0	<4	0	0	0
7	2	2	12	4	1	1	6
8	4	4	24	5	7	7	42
9	1	1	6	6	1	1	6
10	11	11	66	7	35	35	210
11	28	28	168	8	60	60	360
12	42	42	252	9	94	94	564
13	57	57	342	10	30	30	180
14	54	54	324	11	52	52	312
15	71	71	426	12	201	201	1206
16	106	106	636	13	305	305	1830
17	254	254	1524	14	169	169	1014
18	218	218	1308	15	5	5	30
19	107	107	642				
20	5	5	30				

		sion symmetry o	classes, 1,5				•
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<4	0	0	0	<3	0	0	0
4	2	2	12	3	6	6	36
5	0	0	0	4	6	6	36
6	11	11	66	5	15	15	90
7	0	0	0	6	13	13	78
8	20	20	120	7	63	63	378
9	0	0	0	8	220	220	1320
10	2	2	12	9	148	148	888
11	0	0	0	10	187	200	1200
12	45	45	270	11	196	279	1674
13	106	106	636	12	400	459	2754
14	375	378	2268	13	341	435	2610
15	164	172	1032	14	77	138	828
16	137	161	966				
17	244	252	1512				
18	406	568	3408				
19	143	240	1440				
20	17	25	150				

Table 4.2.18 – Symmetry Type D_{2h}(face) All 1,672 inversion symmetry classes, 1,982 symmetry classes, and 11,892 states.

Table 4.2.19 – Symmetry Type D₂(edge)

Al	l 16,720 inv	ersion symmetr	y classes, 23,	232 symmetry	y classes, and	d 278,784 states.	
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<6	0	0	0	<5	0	0	0
6	4	4	48	5	28	32	384
7	6	6	72	6	71	89	1068
8	18	22	264	7	271	347	4164
9	9	10	120	8	470	608	7296
10	91	111	1332	9	1156	1439	17268
11	172	230	2760	10	1310	1727	20724
12	304	403	4836	11	1610	2394	28728
13	373	461	5532	12	2812	3864	46368
14	861	1064	12768	13	5662	7717	92604
15	1111	1396	16752	14	3231	4854	58248
16	2051	2667	32004	15	99	161	1932
17	3980	5397	64764				
18	5922	8736	104832				
19	1807	2713	32556				
20	11	12	144				

All 1	All 13,752 inversion symmetry classes, 23,356 symmetry classes, and 280,272 states.						
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<4	0	0	0	<2	0	0	0
4	3	4	48	2	3	4	48
5	1	2	24	3	15	22	264
6	18	27	324	4	65	102	1224
7	10	18	216	5	204	336	4032
8	98	152	1824	6	477	773	9276
9	79	132	1584	7	980	1683	20196
10	321	515	6180	8	1598	2686	32232
11	387	641	7692	9	1385	2236	26832
12	881	1428	17136	10	1040	1798	21576
13	897	1608	19296	11	2262	4056	48672
14	1257	2185	26220	12	3657	6263	75156
15	1135	1850	22200	13	1994	3276	39312
16	2207	3708	44496	14	72	121	1452
17	3104	5370	64440				
18	2601	4456	53472				
19	749	1256	15072				
20	4	4	48				

Table 4.2.20 – Symmetry Type D₂(face)

 Table 4.2.21 – Symmetry Type C_{2v}(a1)

 ymmetry classes, 15,552 symmetry classe
 All 12 352 inversio

All 12	All 12,352 inversion symmetry classes, 15,552 symmetry classes, and 186,624 states.						es.
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<7	0	0	0	<5	0	0	0
7	1	1	12	5	2	2	24
8	1	1	12	6	2	2	24
9	1	1	12	7	65	73	876
10	20	22	264	8	205	255	3060
11	73	92	1104	9	826	1092	13104
12	107	134	1608	10	890	1086	13032
13	102	130	1560	11	998	1258	15096
14	554	704	8448	12	1272	1593	19116
15	993	1249	14988	13	1913	2390	28680
16	1824	2347	28164	14	4372	5595	67140
17	2933	3735	44820	15	1805	2204	26448
18	4174	5340	64080	16	2	2	24
19	1530	1757	21084				
20	39	39	468				

FTM	l. s.	Symmetry	y classes, 290,	SPTM	l. s.	Symmetry	ates.
distance	classes	classes	States	distance	classes	classes	States
<3	0	0	0	<2	0	0	0
3	1	2	24	2	1	2	24
4	0	0	0	3	3	4	48
5	6	8	96	4	13	21	252
6	3	4	48	5	21	30	360
7	21	33	396	6	58	93	1116
8	13	17	204	7	365	503	6036
9	26	34	408	8	980	1362	16344
10	86	111	1332	9	2261	2957	35484
11	203	280	3360	10	4694	6551	78612
12	715	960	11520	11	9946	15378	184536
13	1551	2080	24960	12	29270	48006	576072
14	3313	4549	54588	13	45967	74514	894168
15	5542	7712	92544	14	57690	100192	1202304
16	14838	22012	264144	15	24107	41267	495204
17	34551	55305	663660				
18	72962	125363	1504356				
19	41100	71764	861168				
20	445	646	7752				

Table 4.2.22 – Symmetry Type C2v(a2)All 175,376 inversion symmetry classes, 290,880 symmetry classes, and 3,490,560 states.

Table 4.2.23 – Symmetry Type C_{2v}(b)

	Table 4.2.23 – Symmetry Type C _{2v} (b)						
All	36,864 inve	rsion symmetry	classes, 48,	128 symmetr	y classes, ar	nd 577,536 state	es.
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<6	0	0	0	<5	0	0	0
6	3	3	36	5	6	6	72
7	1	1	12	6	4	4	48
8	3	3	36	7	66	66	792
9	18	18	216	8	131	131	1572
10	34	34	408	9	468	468	5616
11	58	58	696	10	881	916	10992
12	180	183	2196	11	2104	2427	29124
13	289	293	3516	12	3646	4824	57888
14	622	671	8052	13	8723	11964	143568
15	1292	1491	17892	14	16171	21668	260016
16	3625	4381	52572	15	4664	5654	67848
17	7840	10329	123948				
18	15168	20873	250476				
19	7638	9696	116352				
20	93	94	1128				

The symmetry classes in the $C_{2v}(b)$ list took 19 days, 11 hours, 10 minutes to solve.

Subtracting the 10-minute startup time, this averages to 34.9 seconds/solve. Had it had no symmetry instead of a symmetry factor of 4 and only had one computer working on it instead of 2, it would have been an estimated 280 seconds/solve. Their average distance was 17.59 (FTM), 13.36 (SPTM), or the breakdown at the end of the previous page.

	J,864 Invers	sion symmetry c	lasses, 143,		/ classes, ar	10 1,722,624 Sta	ites.
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<4	0	0	0	<2	0	0	0
4	1	2	24	2	1	2	24
5	1	2	24	3	1	2	24
6	4	5	60	4	14	17	204
7	7	7	84	5	31	35	420
8	35	42	504	6	78	103	1236
9	29	33	396	7	377	457	5484
10	89	115	1380	8	749	922	11064
11	327	423	5076	9	1325	1614	19368
12	521	622	7464	10	2855	3691	44292
13	1043	1285	15420	11	7118	10357	124284
14	1997	2489	29868	12	14940	22618	271416
15	3566	4636	55632	13	16812	25741	308892
16	8057	11153	133836	14	33660	55953	671436
17	17388	26636	319632	15	12903	22040	264480
18	35586	58874	706488				
19	21920	36878	442536				
20	293	350	4200				

Table 4.2.24 – Symmetry Type C_{2h}(a)

		rsion symmetry	Classes, 40,				
FTM	l. s.	Symmetry		SPTM	l. s.	Symmetry	
distance	classes	classes	States	distance	classes	classes	States
<6	0	0	0	<4	0	0	0
6	1	1	12	4	2	2	24
7	1	1	12	5	8	8	96
8	7	7	84	6	2	2	24
9	10	10	120	7	92	92	1104
10	33	33	396	8	212	212	2544
11	72	72	864	9	473	473	5676
12	191	192	2304	10	902	918	11016
13	323	329	3948	11	1844	2215	26580
14	634	671	8052	12	4069	5422	65064
15	1471	1720	20640	13	9982	13643	163716
16	3496	4360	52320	14	15563	20708	248496
17	7953	10513	126156	15	3703	4421	53052
18	15207	20776	249312				
19	7384	9360	112320				
20	69	71	852				

 Table 4.2.25 – Symmetry Type C2h(b)

 All 36.852 inversion symmetry classes, 48.116 symmetry classes, and 577.392 states

The symmetry classes in the $C_{2h}(b)$ list took 15 days, 16 hours 58 minutes. Subtracting the 10-minute startup time, this averages to 28.2 seconds/solve. Had it had no symmetry instead of a symmetry factor of 4 and only had one computer working on it instead of 2, this would have been an estimated 226 seconds/solve. Their average distance was 17.56 (FTM), 13.28 (SPTM), or the breakdown above.

God's number in the simultaneously-possible turn metric is at least 16.

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L 'J		

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APPENDIX The 9 Shortest Lists of Symmetric Types

(Optimal FTM solutions on left [5])

(An optimal SPTM solution to the same state on right)

Symmetry Type O _h				
(0f*)	(0sp*)			
B2F2L2R2D2U2 (6f*)	B2F2L2R2D2U2 (3sp*)			
RBLFDLR'B2FD'ULD'UR'D'F'R'U' (19f*)	B2L3R2F1B3L1R3B1L1R1U3B2L1R3U2B3D1U1L1R1 (13sp*)			
D'R2F'D2F2U2L'RD'R2BFR'U2L'F2R'U2R'U' (20f*)	D2F2B1L3R3D1U1F2D1L3R1D3U1R1F3B3L2R2D3B2L3R1 (14sp*)			

Symmetry Type T _h					
U2L2F2D2U2F2R2U2	D1U1B2D2U2L2R2F2D3U3				
UL'B'L'RUFL'RU'R'D'UB'F2RU'	D3U1L1R2U2L3R3F1B1D3U2B2L3R1D2F2B3L3R3D2U1L3R1				
B2LR2B2F2D2U2R'F2DU2B2F2L2R2U'	F1B2L2R2D2U2B3U2L2R1F2B2D2U2L3D2				
B2U'R2BFR2DF2D2BR2DUR2F'U2	F2L2R1D2U2F2B2L3F2D3F2B2L2R2U3L2R2				
BU'RD2B'D2B'RB'D2FURFLB2D'U'R'U'	L3R3F1B1L1R1F1D1L2R3D1U3B3D3U1F1B2D1U3R1D2U1F3B2				
B'FULU2BL2B2R2D'L'RDL2F2R2F'U2R'U'	L1R2F1B1R1D1U1L3R2D1U1L3R2F1B1D2U2R1D1U1R3F3B3				
R2D2RB2DUF2RU2R2D'F2L'R'F2U'	D1U2L2R2F2B2U3L3R3F2B2D2U3F2B2L2R2D1L1R1				
LF2DUF2RU2L2U'F2L'R'B2U'R2U2	F3B3D2U1L2R2F2B2D3L2R2F1B1U1F2B2L2R2D3U2				
B2R'B2FUL2F2LF'DBF2L2F2RUL2B'R'U'	R3D3U3R3D2U2F3B3L3R2D3U3L3D3U3L2R3F3B3L3R2F1B1				
UF2R2F2DU2BU'L'RF'U'F2L'D2B'R2DF2R'	L3R3F2B1L1R1F3D1U1F2B1D1U1B1L1R1D2U2F3D1U1F3B2				

Symmetry Type T

Symmetry type t	
BFL'R'BFD'U'LRD'U'	D1U1F3B3L1R1F3B3L1R1D3U3
R2FLR'BFD'L'R'D'F2LD'U'L'F2U'	F1L3R2D3U1L3R1D3F2B1D1U3F3B1D3U2L2R2F1B2
DULB'FL'RB2F'R2DULU2B'FR2U'	D1B2L3R1D2F3D3U3B2L1R2F1B3L3R1F3D3U3
B2L'R2D2B'L'R'BD2L'B'F'L'DUBF'U'	L3D2U2F2B2L1F1B1D1U1F3B3D3U3L2R3F2B2D2U2R3
R'ULR'B2D2U2R'BLFRUFRU'F'R'U'	L2R1F3B3L3D3U3L3R2D2U2L1F1B1L2R1F2B2D3U3F2B2L1R2
F'D'F2L2B2R2UL'D'U'L'D'U2B2R2U'F'D'U'	L3D3U3R3F3B3R3F1B1D3U3L3F3B3L2R3D3U3L2R1F2B2
BFLRB'F'D'U'LRDU	D1U1F1B1L3R3F3B3L1R1D1U1
DBLDLURFLUF2RF'DU'RU	D2U3F2B2L3R3U3L1R1D1F1B1D2U3L1R1D2U1F3B3D1F1B1
UB2F2L2R2UBFU2LRU'B2F2U2L2R2U'	D3U3L3R3D3U3F2B1D2U2L2R2B1L3R3F2B1L2R2D2U2B1
D'B'F'D'LRD'B2F2L2R2U'BFU'L'R'U'	D3U3L3R2F2B2D2U2L3F1B2D1U3F2B2D3U1B1D3U3
D'U'L'D'UR2FU2BD2FU2L'RUR2F2U'	B2R2U2F1B1D2U3F2B2L1R1F3D3U1F3B1D2U3L1R1F3
BDRFRD2URB2U'F'LUB'R2B'U'R'U	D1L3R3D1F1B1D1L1R1U1L2R2F1B1U3F3B3D2U3L3R3

Symmetry Type D _{3d}	
ULDUL'D'U'RB2U2B2L'R'U'	L1R2F1B1U2R2U2F3L3R3B1L1R1B3L3R2
U2L2R2F'R'UBR'DB2F2L'B'DRB'U'	B1L3R2F2L2R1B3U3L3D2L1R3D1U1F1B2D2R2D2U1
L2B'UB'D'BFD2F'U'BL2U'F2U2R2U'	L1R2F1B1U2R2U2F3L3R3B1L1R1B3L1F2B2D2U2
D2B'U2LB2D2UF2DB2R'B2UBD'F2U'	L1R2U1L1R3B3D3U2L2R3D2U3L3R1U2R1F3B3L2R3U3
DFR'U2B2U2R'U'LR'BU'R2F2R2U'R'U'	F1B3D1U1R3D2U1F2B1D2U1F1B2D3U2F2B3D2U3F2B3L1F3B3D3U1
ULUB'U'LR2U2BU'L'U'BF2R2B'F2U'	L2R1D3U2F3B3L2R2D1U2R1D2U2F1B1L3R3U2F3B2L1R1D1L2R3
F'D'RU2BFL2B2R2D2LD'UR2U2RB'U'	F1B2D2U2R1D3U3F2B2L1F2B1L3R1F1B3R3D2U3F2B3
DBD'LUBF'R'F'LBLR'D'F'UR'U'	F2B3D2U3F2B1L3R1F2B1D3U2B1U3F1B2D2U3L3R1D2U3F2B1D2U1
R'B'U'B2R'B'D'ULUB2FD2U'LUFR'U'	L1R3F3D1U2F1L1R3D2U1F2B1L3R2F3B1D3F3B2D2U3F1B3D3U2
LR2D'BF2L2R'B'D2R2D'U'R'D2BDU'F'U'	D3U2L1F2B3D2U1B1L3R1U1L3R1B2L3R3B1L3R1F1R1
D'U2B2L2R2B'RDU'LR'DB2F2RB'F'RU'	F3B2D1U2L1R1D2U3F2B2D1U1B3D1U3F1B3D3L2R1D2U2B3
FL'B2F2UB2F'DRD2B2UF2LBFD'R'U'	D2U2L3R2F1B2D1U1F3L2F3B1L1R2F1B2L2R1U1F1B3L3B1

	DELEDELEO I EODEOEI ENEO NEO	
	U'L2D'L2DB2F2L2R2DF2U'F2U'	L2R1B2L1B2L3D2U2F2B2L3D2R1D2R3
	RD'LDU2B2R'U2L'D'U2L'DU2	D1R3U1L2R1F2D3L2U3L2R3U3L2R1
	UR2DF'LD2U2R'D2U2FD'R2U'	D3U3F2R1D2U2F3D2U2B1R3F2D1U1
	UF2UBU'B'FDBUB'D'U'FU'	F2B3R1D3U3L1D3U3F2B2L1F3B3D3U3L2R1D3U3F3B2
	D2L2DL'DB2F2L2R2D2U'R'UR2U2	F1B1U2F2B3R3F3B2L2R2D2U2B1L3F3B2D2F1B1
	U'F'L2D'R'F'L'FRB'R'F'D'B2R'U'	F2D3U1F2B2U3L2R3F1B3D3U3F2B3R1D2B1D3L1R3D1B3
	D2UB'R2D'B2R'D'U'L'F2U'L2F'DU2	D1U2L2R1F2D3U2R2F1B2D3U3F2B1L2D2U3B2L1R2D2U1
	DBLU2L'D'LD'U'RU'R'D2RFU	F2B3L2R1U2F3L1R1D1U2F1B2L3R2D1L2R1F3U1F3B2D3U1L3
	RFR2BU2B2RB2LB2DB2L'UB'U'	L1U1B2L1F1B2L2R1B3D3U1F1B3D1F3B2L1R3F1R1
	U'L'F'D'R'U'F'D'U'B'R'ULB'L'U'	B1L1B3D1F2B3D2U2L2R2B3D1U2L2R2F1B2R1F1
	B2F2R'D'L2R'D'L2U'F2L2RDR'D2U'	D2U3F3D1F1B2R2U3B2D3F3B2D3F3L2R2
	LUL2R2U'LULR'B'U'L'BLR'U'	F1B2L1R1D3U2L2R3F1B3D1U2F3L3R1U1L2R1D3U3F2B3
	U2L2URU'LRU'RU2RU'LRU'RU'	F2B1U1F2B1L2F1B2U1F3B3D1F2B1R2F1B2D1F1B2
	D'FLR2F2D'LR2FD'U2R'FL2RBU'	D3F1L1R2B1L3D2U3B1L2R1U3B2L2R1B1U3
	D2R'D'F'L'R2F'D'UF'U'R'B'F2R'D'U'	U2R3F3B2R3U3B3D3U1B3L3R2B3D3R3D1U1
	D'L'B2L2BDU2B2F2L2R2U'FR2F2R'U'	D2U1L3R3B3L3R3U2L2R1F3B3R1F3B3L3R3F3B3L2R3D1
	U'FD'L'F2L2D'L'D2F'U'F2R2F'U'RU'	D1L1F3B2R2F2B1L3U3L1R1D2B2D3U2L1R1F1B2
	FD2F'R2UF2D'LUBL2D2BR2F2LU'	F3B1L1F1D2U1L1B2D2R2F1D2U1L1F2B3D1U3L1R3
	U'FU'L2B2L2DRD2FDL2B2L2U'RU'	L1B2L1R2D3U3F1B1R3U2F2B1L3R3B1R1F3B1U3B2L1
	L2UL'UB'LB'UF'D'BU2BL2DFU'	D3U1L3R3B2R1F3B1R1F3B3L3R2F1B1D3U1F3B3D3L3R3F1B1
	FUL2B'R2D2BDF'R'FD2B2DL2R'U'	F3B2D1L1R1F2B3L1R3D1U1L2R2D3L1R1F1D2R1D3U3F3B2
	BFL2D2U'L2RD'L2U'R'U'B2R2D2B'FU2	L3R3D2U1L2R2F2B1D2U1B2D1U2L2R2F2L2R2B1D1U2F2L3R3
	B2R2U'F2U2RB'U'R2BL2B2FL2UB'LU'	D3U3F2L2F2L3R2D2U2F2B1U3B2D3F2B1D2U2L3R2D1U1
	F'LUR2D2LFU'LF'D'ULR2F2UF'U'	R2F1B1L2R3F3B2L1D1U3L1R1B3L3R2F3B2L3R3B2D3U2F1B2
	U2B2FDRB2RU2B'LBLBR'UL2D2U'	U3F2B3L2R3F2B3L3F3B1L2R3D3F1B1L1R1D1R2B1L2R3B2
	L2BF'D2L'D'U'F'R2U2F2R2D2B'U2L'R'U'	F1B3L1R3F2B1D3U3L2R3D3U3L1R3U2F2L3R3F1B2D3U3R3
	LUB'L'F'U'L'F2D'B'R2DB'F2U'B'FU2	D3U2R3B1D3L3R1F1D1U2F3B2L1D1U2L1R2F1L2R3F3D1
	D'L'U'FU'L2D'U2L2D2B2UF2U'BD'R'U'	D2U2L3F1B1D2R2F1D3U3L1F1B2L1R2D3F2B1D2U2F3B1U3
	UR'F2L'RB2FU'F2R2B2DB2F'R2B2L'U'	D3U1F1B1U2B1L2R1F3B3R3F1B1L2R2B3U2F3B3D1U3
	BFR2B2R'F2LBD'L'UB'R'B2D'URU	D2U3L3R1F1D3U3R1F1B2L1R3F3B3L3R1F1B2L2R3F1B3R2U2
	BLDFLBUFDBURURFUBU'	L1R2D1L3R1D3L1R3F1L1R2D3U3B1D3U3B1D2U2L1
ļ	L'B'LD'L'U'B2FL2R2DB2F2L2R2U2R'U'	U3F1B2L2R2D1U2L1D1F1U1F3R1F3B2L2R2D2U2

Symmetry Type D₃

DBDU2B2F2L2R2U'FU

B2L2D2L2U'F2UB2U2F2R2U'R2U'

D'LDUR'D'U'L'DURU'

Symmetry Type C _{3v}		
DUR2BD2U2L'D2U2RB'R2D'U'	L3R1D3F3B1D2U1L1R3D1U3L3R2F3B1R1D3U1	
URU2BFL'B2D2B2RF2RD2F'D'	D2U2L2R2F1D1U1L2F2B1D2L1U2F1B2R2D1U1F1B2	
L2R2F2L2U'BF'LD'LDFD'BD'U2	D2U1R3U1L3U3F3U1F3L1R3D1F2L2F2B2	
U2R'FDF2R'DU'BR2U'B'D2U2RU2	L2R2F3B2U1B1L2R1F2B1L3R1D2U3B1L3U3F2B1	
D'RDB'L'D'R'D'F'LUB2F2D'L'R'U'	U2B3D3U1R1D3U2F3U1L1R3F3B2R3U2B3U1	
U2L'D'FR2U2R2BD2L2F'L'DB2F'D2RU'	D3U2L1R1B1D3U2L2R2U3R2D3U3B2L3R2F3B3R2U3	
RU'RDBD'L2D2L'D2U2L'R'B'FL'F'D'	R1B1L3R3D3U3F1B3L3R3U3F2B3D2U2F1B2D3L3R1D3L3	
D2FR2U'RUL2UF'DLR'DF2R'B'D'R'U'	D1U3B3R3D1U2L2R2F1B2L3R3F3B1D3U2B3L3F3B1D3U1	
D'BL2UF2LU2BR2UB2LD'	F1B3L2R3D1U3L3F1B3L3R1F1D1U3B3D2U2L1R3	
UL'R'B2U'R2BL2D'F2L'R'U'	F3B2D1U1L2F2B1D2L1U2F1B2R2D1U1F1B2	
DFL2DR'B2F2D2U2L2R'D'L2F'D'	L2R3F1D1U2L3R2U2F2B2L2R2D2L1R2D3U2F3L2R1	
LD'FL2R2B2U'R'B2LBF'U'B'U'	D1U2B3D1F3D3L3D1L3F1B3U1L2B2D2U2	
L2R2F'L'F'LB2R'BDRD'B'F'RD2U2	D2U2F1U1B1L2R1F2B1L3R1D2U3B1L3U3F2B1	
LU2BD'LB'R'U'F2L'D'U'F2RFL2D2U'	D2U2L1R1B3U3R3U3R3F3B1D1R1D1U3L2R1F1B2	
LD'F'D'L2R'D'UFL'RB2L2F2D'R2BU'	L2R2F2B3L3R2F2L2R2U1F3B1R3D3U3F2B3R1F3B2R1U1	
L'DF2RU2FD'R'B'U2L2R2U'L'RF'D'R'U'	F1B2D1U1L2R1U1F3B1L2D1U2F1B3L2R3F2B3L1F1B1L3R1F3B2	

U1R1D2U1L2R2F2B2D3L1D1

D1U2R1D1U1L3D3U3R3D1U1L1D2U1

L2R1D2F1B1D1L1R1F3B3L1R1U1F1B1U2L1R2

	UL'F2UL'F'L'U'R2D'L'F'LFD2LR2U'	D3U1L3R2D1U3L3F1R1D3U3L1B1R3D3U1L2R3D1
	RFLB'F2L'D2UB'L'F2D'F2D'UB'R'U'	B1L1F1B1U3B3D3U2F2B3R1F2B1L3R1D3U2B1L2
	U'B'L2D2R'F2U'R2B2F2R2FLDB'R'F2U'	L1R1U1L3R2F1B1D3U1R3U1L3R1F1B3R3D2U3L1
	UL'F2D'B'F'DL2R2B'F2UL2R2D'B'LU'	L3R2B3D1U3F2B3L1F2B2D3U3F2B2R1F3B2D3U1
	LUFL2U2LBF'U2FRBU2LBDRU2	B1D3U3R1D1U1L1R2D1U1L2R2F3B2R2D1U1F1B1
	D2RUR'BFR2U'B2LRF'LBL'B'FU'	D3U3F1B2D3L2R1U2F1B1D2L3R2D3U2F1B2D1U2
	BD2L2U2R'B2U2L'FURBDB'UF2L2U'	L1R1D1F2D1L2F1B2U3L2R1F1D3F1B1L1R3D2U1F
	R2U2B'RFDB'R2BRU2R2U2F2ULFU'	L3R3F2B3D2U3L3R2D3U2R3F1B1R3B1L2D1U1F3
	DR2D'B'F'L'U'L2F2U2BR2B2U'L'F'D2U'	D2U3R3D2L1R1D1U1L3D2U3L2R3D2B1D3U2L1B2
	FRB2U'L2F'D2LBDB'RU2LDFL2U'	D2F1D3F3B1L3R3F2B3D3U2L3R2D3U2R1F3U1L1
	BUB'D'F'DBLDLD'UBDR2BF'U'	D3U1L2R1F3B1D1B3U1F2B3D3U2L3R1U1F1B1L1
	L2R2F'D2F2RF2D'B2RD2B2D2LR'F'D2U2	F1B2L2R2D3L1R2D2U1B3R3D2U2F3B2U3L2R2D1
	B'DU2L2R2B2FRFDB'F2L2R2D2U'R'U'	U3F1B2L2R2D1U2L1D1F1D2U3L2R2F2B3L3B3
	LUB2UB'F2RB'L2F2LU'L2DFDL2D2U'	D3L3R3F3B1R3U2F2L3R1F3B2L3R2U3L2D3F2B3L
	B2FD2L'F2U'BD2UB'FL2UL'F'LB2R'U2	D2U1L3R3F1B3L3R2F1R3F3B3L3R1D1L2R3F3B2D
	L'RFR2B'U'F2L2RF'L2B'UB2F'R2B2F'U'	D2U2B2D1U3F3B2D3F3B3L2R1D2U1L2R1F1B1L3
	L2BD2L2B'DF2D2B'D2L'D'R'B'L'DR'D2U'	L1R3F2D3U2L3R3F2B3D3U3B2D1L3D3U3L3R1U3
	UFL2R2F2D2R2U'BDFRFLF2UB2R'U'	L2F2B3D1U2R3F1B1D1U2F1B2L3D2U2B2L2D3U2
	BRUB'LFU2B2L2UL'FD2L2R2B'D2F'U'	R3D2U1F3B3U1F1B1D1U1F3B3U1L1R1U3F3B3L2
	D2L2F2D'UB2L'F2L'F'L'F2L'F'R2F2R2D'U'	R3D1U1F3R2D1U1B3U3L1R1D1U2L2R1D3U2F1D
	D2FU'L'F'D'U'RB'L'D'F2D'R'U2B'U'F'U'	D3L2R1D1U1L2R3D1U1F2D2U1L3R3U1F1B3D3U2
	B'F'LF2U2LU2L2F2D'UFU2FL2FLR'U'	F3B1L1R3F1B2D3U3L3R2D3U3L3R1D2F2L3R3F1B
	FU'L2U2RB2UB2DFUL'R2UR'UBDU'	L3F2L1B2R1D3U2L1R1D1U1R3F1B2U1R3F3L3F1B
	LR2BU2FDB'D'R'FL'F2DF2U2B2D'RU2	L1F3B2U1F1B1L3R2D2U2F3L1R2B1L1R2B3U2F2D
	L2F2U'L2DF2D2F'L'BRF2DRUL2FRF	F1B1R3F3D2U1L1R1F3D2L1R2D2U1R1F2B1L2R1F
	B2DU2B'L'RBU'B2FU2RD'FR'B2D2R2U'	D2U2L3R2D1F2B3U2F1B2D3R3D1U1L2F2L3R2D1
	R2UBR'U'L2U2F2R'B'F'U2R'D2BRF'R2U'	R1U1B1R2F1B1L1U3L2F2L2D2U1F2B3L2R1U1F1
	U'F2L2U'BR2DB2L'U2B'L2DF2LU'B2R2U'	B3L2R1D2U3F3B1L2R1D2U2F3L2R3F1B1D2F2B2L
	D2UR'U2B2L'B2FRB2U'B'DLB'F'R2B2U'	L3U2F3B3L2R1F2L2F2B1D1U1F2B3L1R1D3U3R2F
	D'B2DBR'D2R2U'F2D'L2U2L'B'D2L2U'F2U'	D2F1B2D3U1L1R2F1B2D1U3R1D3U2L3D3U3L3D2
	L2D2F'DB'LB'R'U'B'F2D2B2FD2L2DR'U'	F2B3L1R2F1B1L1D3U3L1F3B3L1D2U2R1D3U3L1F
	FDB2LB'FUFD2LD'B2U'B2F2RB'F2U2	L1D1U3L1R2F1B3D3L2R3F1B1L3D2F2B1L3R3F3B
	B2LR2B'F2U'LU2F'LU'R2U2L2B'F'UF'U'	L2R3D2U2B3L3R3B1D1U2L2F1B1D1U1F2B3D1U2
	B'RD2L2D'R'FDB'F2D2B'LR'FD'F2RU'	F2D2U3F2B2R2F3B2L2R3F3L2R3F2B3L1D1U2L1R
	L'F'L'FR2U2L'R2D'F2R2DRB2L'R2U'R'U'	F2L2R3F1B3D3U3L1R3B3L3R3D1U2R3F3B3R3D2U
	D2B2D'U2F2R2D2F'L2D'L'RB'D'FR2UB'U2	L3R2U2B2D1L3R1B1L2R1F3B3D1U3F2B3L1R1F2B
	DF'U2L2U2FR'U'B2U2L'F2D'F'D2B2LB2U'	L1R2D3F3L1R2U1R3F3B3L3R2U2F2B1D1U3L1R1F
	B2RDBLFR'B2U'F2DL'B2L2F2DLF'U2	F1B2D2U2L2R1D1U2F3B2L1R3B3D1U2L2D2U2L1
	UFL2DU'B2R2D2U'RUB'FLUFL2RU	D3U2F1D2L2F2B2D1U3F3D2U1L2R1F3B1D1L1R3
	UL2UFD2L'DB'D2B'DR'D2FDB2U2L2U'	U1L2R1F1B1R1D1U1L1D3U1F3B2L1R1F3L3R3D3U
	UR2D'LBL2F'D'B'D'FR'D'LDUB2R'U'	L2R2F2B2D3U2B1D3F1B3U1F3D3U1L1D3L1R2F2
	F'RD'B'FL'F2D2F2R2D'BULUB2L'RU'	D3F2B3L1R3U3L3R2D3U3F3B1U1L3R3U1F2L3U3
	BU'RU2R2F'D2B'L'U'BD'B'RB2FLF'U'	L2R3D1U1F2B1D3U3F2B1D1U1F1B3D3U3F2B2L3
	ULR2B2D'L'URU2L'D'RF'D'FL2D2R2U'	D2B1L1D1U2L1R1F3B2R3F3B1D1U3F3B1L3D3L1F
	BR'B2R'D2B2D2LD'BF'URD'L'DF2R'U2	L1R3F2B3D2U1B3D3U2L1R1F3B2D1U2F2U2R3F1
	F2UR2FLBD'U'FD'U'B'R'FUL2DR2U'	R2F3B3L1R3F2B1R3B1L1F3L2F2B3D3U2B2D1U2E
	U2FU'B'D'L2D'R2D2F'LRDFL'D2B2R'U'	L1F1B3U2R2D3F2B1L2B1L1R2D2F3L1R3F2B3D3U
	FLD'L2R2DU2RULBL'R2BLR'D'F'U'	F2B1L1R1D3U2F1B1D1L3R1B1D3U1L3R2F1B1L3F
	L2R'D2BF'R'UR'U'L'DBRD2U'L'R'D2U'	D1U3B3L3D1U2L2R2F2B1L3R3F1B3D3U2F3R3D3
	F'DR2F'L'D'FURUL2FL'U'BU2F2U2R2U'	R2F3B3U2F1B3U1L1R2F3B3D2B1L2R2D3U3F3L3F
ļ	RF'DF'R'DL2U'L2DB'F2RD'LF2U'L2R'U'	U1F3B3L2R1U2F2B1R2F1B1R2D1F3B1L3D3R1F1E
ļ	RU2BF'U2LFUF'D'RBD2BUL2RF2R'U'	L2R3B1D2U1L1R3D3U1L2R1D1U3L3R3F3B3U1L1
ļ	D'LR2BF2DF2L2U2L2FLRD2U2F'RD'R'U'	R3D3F3B3D2U1R1F1B1D3U1F3B1D2L1R2F3B2D1
	D'F'UBF'R'BLR'D'LU	B3R3F1L1R3U3L1D1U3B3D1F1
	F'D2L2D2FR'B2D2B2RU'L2B2L2U	B1U3F3D3U2B3D1U3F1B3D2U3L1R2F1L1F1B2
	URU'FD2U'B2F2L2R2U'F'UR'U'	R2D1U2L2R3D3F1B2L2R2D2U2F1D1L2R1D3U2R2
ļ	U'B2L'F2LD'U'BR2FD2F'R2DU2	L3R2F2U1L2U3F2D3L1R1B3U2B1D2R1
	DR2D'B'R2BUF'U'FUF'UF'R2U'	L3U2L2R3U2F2B3L3R3B1L1R1F2B3D2L2R1B2R1

01U3L3F1R1D3U3L1B1R3D3U1L2R3D1U3 3B3D3U2F2B3R1F2B1L3R1D3U2B1L2R3D3 2F1B1D3U1R3U1L3R1F1B3R3D2U3L1R1B3D1U2 3F2B3L1F2B2D3U3F2B2R1F3B2D3U1F3L2R3 D1U1L1R2D1U1L2R2F3B2R2D1U1F1B1D2U1F1B1R1F1 03L2R1U2F1B1D2L3R2D3U2F1B2D1U2R3F1B1L3R2 1L2F1B2U3L2R1F1D3F1B1L1R3D2U1F2B1 2U3L3R2D3U2R3F1B1R3B1L2D1U1F3B1L3D2U3 L1R1D1U1L3D2U3L2R3D2B1D3U2L1B2D2U3 1L3R3F2B3D3U2L3R2D3U2R1F3U1L1R2F3 3B1D1B3U1F2B3D3U2L3R1U1F1B1L1R3B1R1 3L1R2D2U1B3R3D2U2F3B2U3L2R2D1B3D1U2 2D1U2L1D1F1D2U3L2R2F2B3L3B3 1R3U2F2L3R1F3B2L3R2U3L2D3F2B3L1R2 1B3L3R2F1R3F3B3L3R1D1L2R3F3B2D2U1F1B3D2 U3F3B2D3F3B3L2R1D2U1L2R1F1B1L3R3F3B2D1U1F1B3 2L3R3F2B3D3U3B2D1L3D3U3L3R1U3F3B2L3R3 2R3F1B1D1U2F1B2L3D2U2B2L2D3U2L2R2F1B3L3R2 33U1F1B1D1U1F3B3U1L1R1U3F3B3L2R1D1U3F1B3D3U1 R2D1U1B3U3L1R1D1U2L2R1D3U2F1D3U3F3B1 J1L2R3D1U1F2D2U1L3R3U1F1B3D3U2L1R3F1U3 1B2D3U3L3R2D3U3L3R1D2F2L3R3F1B2D3U3R3 1D3U2L1R1D1U1R3F1B2U1R3F3L3F1B1 1B1L3R2D2U2F3L1R2B1L1R2B3U2F2D2F3 2U1L1R1F3D2L1R2D2U1R1F2B1L2R1F1D3U3 D1F2B3U2F1B2D3R3D1U1L2F2L3R2D1U1B3 1B1L1U3L2F2L2D2U1F2B3L2R1U1F1 3F3B1L2R1D2U2F3L2R3F1B1D2F2B2L3R3F3B2R2F1B2 2R1F2L2F2B1D1U1F2B3L1R1D3U3R2F2B2D1R1 J1L1R2F1B2D1U3R1D3U2L3D3U3L3D1F2B2L2D3U3 1B1L1D3U3L1F3B3L1D2U2R1D3U3L1R2D1U1F3B2 2F1B3D3L2R3F1B1L3D2F2B1L3R3F3B2L3R3F1B3L1 3L3R3B1D1U2L2F1B1D1U1F2B3D1U2F3B3L1R1D1U2L3 2R2F3B2L2R3F3L2R3F2B3L1D1U2L1R2D3U3L3R3D2U1 3D3U3L1R3B3L3R3D1U2R3F3B3R3D2U3F3B3L2F2B2 01L3R1B1L2R1F3B3D1U3F2B3L1R1F2B2D3U3L1 1R2U1R3F3B3L3R2U2F2B1D1U3L1R1F1B2U1 2R1D1U2F3B2L1R3B3D1U2L2D2U2L1D2U2F1B2D1U1 _2F2B2D1U3F3D2U1L2R1F3B1D1L1R3D3U3 1R1D1U1L1D3U1F3B2L1R1F3L3R3D3U3F3U1 3U2B1D3F1B3U1F3D3U1L1D3L1R2F2B3U1 3U3L3R2D3U3F3B1U1L3R3U1F2L3U3 2B1D3U3F2B1D1U1F1B3D3U3F2B2L3F1B3L3R1F1B2D2U1R1 J2L1R1F3B2R3F3B1D1U3F3B1L3D3L1F1D1U1 2U1B3D3U2L1R1F3B2D1U2F2U2R3F1D1U2F1B3 3F2B1R3B1L1F3L2F2B3D3U2B2D1U2B3 2D3F2B1L2B1L1R2D2F3L1R3F2B3D3U3 3U2F1B1D1L3R1B1D3U1L3R2F1B1L3F1B1L1R1F1 01U2L2R2F2B1L3R3F1B3D3U2F3R3D3U1 1B3U1L1R2F3B3D2B1L2R2D3U3F3L3R3F2B3D2U3 1U2F2B1R2F1B1R2D1F3B1L3D3R1F1B3 1L1R3D3U1L2R1D1U3L3R3F3B3U1L1R1D1F1B1R1 2U1R1F1B1D3U1F3B1D2L1R2F3B2D1U1F2B3L3R2 3U3L1D1U3B3D1F1 J2B3D1U3F1B3D2U3L1R2F1L1F1B2 R3D3F1B2L2R2D2U2F1D1L2R1D3U2R2 2U3F2D3L1R1B3U2B1D2R1

L'BF2DU2L2UBR'B2R'D2L'R'B2F'U
U2F'U2B'R'B2RUR'B'UF2DU'R'D'R2U'
F'R'D'F2D2LFDB2D2B'U2LB'U'RBU'
U2L'BD'L2D'RF'LD2U'B'F'DR2D2LU'
F2DL'ULUL2F2D'R'DL'D'R'D2LR2U'
R2U'B'U2R2B'D'R2D2RF2RB2UB2R'F'U2
LD2BRB2L2U2BL'B2UBFD'U'L'R'U'
L'D'L'D2RFLR2D2B'F'UR2U2RB'F'U'
UFLF2RB2U2B2R'DULD'U'F2L'F'U'
D'F'L2R2D2FL'R'DBF'U2RU2L'D2R2U'
U2L2D'R2B'R2BLDL'F2L2B'F2U'L2F2U'
D'RD'U'LB'UF'U'LUL'DB'LR2FU'
B'D'B'D2BR2F'L2U'FDLD2B2D2L'R2U'
LF2L2D'L'F2R2B'FL'DF2U'F2LU2R'U'
L'D'L'B2F2L2R'F2D'U2LULBU2L'R2U'
DRBDBF'L'D2R'U'F'D'UB'L2RF2U'
L2DL2B'F'RBR'DL'BURB2L2B'R2F'U'
D2F2R'F'D2U'LR2D'F2URFU2FDU2L2U'
RU2FR'DU'F'U'R2U'L2R'U2BDFD'R'U'
RFR'URDBDU2B2F2L2RU'
R'D2UB2F2LR2BLURU'FU
D'U2B'L2D'R2BDUB'R2DU2B'FU'
U'FR2U'B'R2D'B2F2U'L2F'U'B'FU'
D'U2LR'U'F2LD'U'L'R2F2UB2L'U'
B'D'B'F2D2B'L2BFDBDBU'F'U
DB2F'L2RU'RDU'B'DBF'U'FU
DBD'B'FUF'D'ULD'LR2B'F2U
L2D'L2F'R2U2B'D'R2BD'BF2L'U'L'U'
DB'R2U'L2R2D2U'FR2D2R2B'R'D2B'U
URD'U2R'B'D'RD2U2R'F2LF'D'F'U'
U'F'D2L2UB'D'B'D2FLF'L2DURU'
LULUB2F'RF'D2RFL2D2BU2RU2
D'RU2BRB2U2B2L'D'B2F2D'U2B2RU'
UFDFL'F2RD2U2R'DBRDU2R'U'
R'D'R2U2F2R2D'LB2D'FR'B2D2UF2U2
R2F2L2RB2U'FL'B2DL'U2F2R2U2L'U'
URD2L2R2B'FR'B'FLDU'B'RBU
UR'DURB2R2BD2L'R'F2U'BFR2U
ULFL'DU'BL'RF'L'RB2F2D2FU
UF2LRU'R2B'F'D2LF2L2FDUF'U
BF'R'B'U2BDB'L'R'BDL2RU'LU'
U'RB'D2L2R'B2FR'U'L'BU'B2UF'U'
F'LF'L2RBDL'R'D'BDF2D'R'DU'
BR'DR2UB'DBL2U2R'DU'F'R2U2B2U'
BL'R2DF'L2UF2U'R2B'DR'D2BUF'U2
DBLRDU2B2L2DU'L2UB'F2L'R'FU
LF'R'U'B2DRFU2F2DL'R'B'L'FR'U
DBD2LD2LD2U2FLD2BUBD2U'F2U'
U'RD'BLR2B2L'DR'D2U'B2D'F2L2R2U'
F2D'B'U'LBU'L2U2F2U'FR'UL'B2F'U
DB'D'F2D2U2F2L2R'D2U'LD2R'U'RF'U
URDL'D'UFU'R'D2F'U2R'BRU2LU'
D'U'R2F2R2BR2B'R'B'R2B'L2R'DU'L2U2
B2D'L'BRD'LDB2URU2B'LB2U2L'U
ULB2DL'B'L'D2UF2D'R'F'RD2L'R2U'
D2B'URF'DB2F2RD'B'L'RFRDFU2
D'L'BFL2RD'F2DU'F2R2D2U'B'F'R'U'
L'DB'UFDUR'B2L2B'D'R'F2LDBU'

R3D3U2L2D3U3F2B1R2F3B2U3R3F2L1D3U2B1 U3R2F3B1R3U1F2B1R3F2B2D2F3D1R2D2L1R3D3U1 U1F1B3U3L3R2F2B1D1L2R1F3B2L1R2F2B1R3F3B3D1F3B3 D2U1F1L1R1D1F3B1D1U3F1L2R1D1U1L3R3D3U3R1F2B2D1 D1U2F1B1D2U1L1R3D1U3L1R2F2B3D1U1F2L3R3B1L2R2F3B2U1 D3L1F1B1D2U3L3D3U3F3U3R2U1F3B2D1U3R1U1L2R3 U1F1B1L2R3D2U1L3R1D1U3L3R2D1U1L3R3F3B2L3R3D3U3F1D2U3 F1B3L1D3F3B2D1F3D3U2F1B3R1D2U1F1B1R1D2U1F2B1 R2F2B2U2L3R3D1U2L2D2F2B1D1U3B2L2D3U2L1R3 F3B2L3R3F1B1D3U1F1B1U1L2D1U1L3R3F1B2L3R1U3F3 L2R2U3B1L2R2F3B2D2L3R3D3L3F1B1L3R3D2U3L3R1F2B3 R3D1U2L2D3U3L3R3F1L1R1F3D1U1R2D3F1B1D1L3 L3R2F3B3D1U2R2F2B3L2U1F1B1D2L1R2F3B2L2R2F2B1 L2R1F3B1D2U3F2B3D1U3L1R2B1L1F2B2U2F1L1R1F2B3D3 D3U3F3B2L3R1U2L1R2F2B1R1F3B1D2R1B3R3D3U1 D3U1L1B1D3U2F2B2L3R2F1B1L1R3D1U2R1F3B2L2R2D3U1 D1U2B1L2R2U1F1B3L1R2U3L3R1F1B1L3F3B1D3U2F2D3U2 L1R2F2B2L1R1F3L2R3D3B1D3U2B2D3U3L2R3D2U1L2R1D2 F1B1L1R3F3B3L1R1B1D2U1F3B3D2F2B3L3R3F1B1L1R3F3B3 L1D1L3B1L1F1U1F1B2D2U2L1R2B3 L3F2B1D2U2L2R1U1R1B1L1B3D1B1 L1R1D3U1L3R1D2U1F3L3R3D3U3F1L3R3F3L1 F2B1D2U3F3B3U3R2D3U3F3B2D1U1F3B1U2B3 L3F1L1R1F3D1U1L1R1F1D2U3L1R3D1U3L3R3 B1U2F1B3D3U3F1B2D1U1R2U1F1B1D2U1F2B3 D1F3B2L2R1U3R1D1U3B3D1F3B1U3F1U1 U1R1U3L1R3D1L3D1U3F1U3F1B2L2R3D1 D2U3L2R1B2D3B2L1U2B3L1D2U2R1D1U2F2B1L3R1 F2B1D1U2L3R1D1U3F1U1L2R1F1B2L3R2F2L3R1U3L2R1F2B2 R2D1U2F2B2L2R1D3L2R1U1F1L2R3U2L1R3D1B3D2U2 F1B2L3U2F3B2R2F1B1D3B2D1U3B1D1U3L1F3B2 L1R3F2B3D3U2L2R1D2U2L1R2B1U2L3B2D1B2L2R3D2U1 F2B2L2R3U1L1R3F2L1R2F3B2L2R3U3F3D3U1L1R3D3U2F2B3 D2U2B1D3L3R1U2L2R1F3U3L2R3D1L2R3F2B2D3U2R2 L3F2B1D3U3F3D3U3F1B1R3B2U2B2L2R1D3L2F2B3R3 F3L3R2B2D3F1B2L2U2L2F3L1R1D3U3R3D3U3L1R2B3 U1R1U2R3D1U3F2B3L1R3B3L1R3F1B3L1B1U1 F1U1F1B1D2U1F1B1L1R3B1R2D1U1L2R2F2R1B3 U1L1B1L3R1F3B1L3F3B1L3R2D1U3F3U2F1U1 L3F1R2F2B2D1U1F2L1F3B1L1R1D2U1L1R1U1R1 L3R1B3R3D2R1U1R3F3B3R1U1F2B1D3F1D3 F1B2L3D3U1B3D3U1B2D1F3B3R2F1B2U2L1F3B2 D3R1D3L1R2U1F1L3R3F3U1F1D2F3L3F1B3 L3R1U3L3R1F2R1U3R1F1B2D2F1B2L3R2D3R1D2U3L3R1 L1R3D3U3L3R2F3B3L1R1F3D2U1F1B2L3R3D3L2R3D1U3L2D2U2 U1R1F1B1D2U1R2F2D3U1F2D1L2R3F3B3L1D1 B1D3U3F1B1L3D1U1L2R2F3B3L2R3F1B2L1R3F3B1L3D2U1B1 U1F1B3D1U2L2R3D1U3B1U2F1R1F3B1U1L3B1L3R1 F2B3L1R2F2B2D1U1F3B3R1F1B1L3D2B3L1R3U1F3 R3D2U1F3B1L2R3F2D1U2F1B1D3U3F1B1D1U2F1B1D2U3F2B2L2R3 D2U3F2B2L2R1D3U3F3B3L3F2B3L2D1U1F1B1D3U2F3B3L2R1D1 L3R2D1L3R3F3B3R2D2U2B1U2L3F3B3L2R3B2D3U2L1R2 F2B1L2R3D3L1R1F3L2R3D2U3R2D1U1B1L1R2F3B2L1R2 F3R3F1B2D2U2F1L3B3D3U2R1B3D1U2B1D3U2F3B2 L3F1B2D2U3F1B2L1R2F1B3D3U2F1B2D1U3L1R1D3U2L2R1D2U1F2B3 D3U2L3R2D2L1R2B2D2U3L1D2U3L1R1F3B2D1U3F1B1L3R1F3 D3L3F1B1L2R1D3F2D1U3F2R2D2U3F3B3R3U3 B3D2U3L1F1B3L3R1F3B2L2R1F3B3L2R2D3U3L2R3F3B3D3U3B3

	DR'DF'DU'L2B2DL'B'F2DBF2U'BU'	F1B3D2U3F1D3F2B3L2R1D2L2R1F1U3F1R2F1B3U3F1B3
	D'LB'DBU2F'DU2BF2R2D2U2R2URU'	D3L2R3F1B1D1U2F3B3D3U3L2F2B1L1F1B1D1U1L2R3F2B2D2U1
	UL'U2R'B'RU2FD2RUF'DU'LD'R'U'	L3R2D1U2B2L2R1F1B1L1U2B3D2U2R2F1B1L1R1D3L1R2
	B'RB2U2R'UB2L'B'U2F'R'FL'U'RFU2	F1B2D1U2B3D3U2B1R3D1U2B1L1F1B2D2U2F1R1F1
	DL2DU2R'D'R'U2F'L'D2U2F'U2F'U2R'U'	L1R3B3L1U3F1B3R3F3U2B3D3U1L2R1D3U2F3B1U3
	L2D'LUR2B'RU'B2L'D2LF2D'RB2F'U	D2U2B2D1U3F3B2D3F3B3L2R1D2U1R3F1B1L3R3F2B3D3U3F3B1
	D2U'L2R2B2DF2U'RD'LB2L'R2B'DR'U	F1U3L3R1B1D2L1F3B3R3F1B1D3U3F2B2L3R2F2B1
	R'D2UBR'FU'RU2R2B2RD'B'RDLU2	L2R1F2B2D2U1F3B3D3U2F3B3D1U1F3B3D3U2F2L2R1F1B3D2U3R
	D2U2LD2U'F'R'U2B2RU2FU2R'U2L2RU'	F2B1D2U3L2R3D1U2L3R3D3U1F3B2D1U2F3B1L3R2F3B2D2U1F3B
	F2RBF'D'U2R2BLFU2L'B'FU'L2F'U'	D1U2F3B1L2R1F1B1D3U3B1L1F1B1L2D2U1F2B2D3L2R3D2U2
	LF2L'R2F'DBL2DB'D2B2F2L'F'D2F2U2	L1R3F2B2D1U2L2B2D1U3F1B2L2F3B3L1R3F2L1R1U3L1R3
	U2B2DU'B2F'L'F2L'F'L'F2LF2R2F2D'U'	F2B1L2R3F2B1L1D1U1F2D2U3F3B2R3F1B1D3F3B2L1R2
	RUB2RDU'BR2U'B'D'F2LR2D'UF'U2	D2U2L2R1D1F2B2D2U3L2F3B3L3B3D1U1F3B3L2R3F1B3D3U2
	L2B2R2BUB2F2R2FR'U2F'R'BD2UB2U'	L3R1U1L3R3F2L3R1F1B1L2F3B2D3U1B2L2D3U2F2B2L3R1
	F2U2R2F2U'F2D2B2LF2UBU2B'UB2RU'	B1D2F3B2L2R1F1L2R1F1B2L2R2D3U3F1D2U3F1L2F2B1D3U1
	FUL2BR2U2F'D2BR2B2L'B'U'F'URU'	F1D2U3F3B3D2U2L3R3B2R1F3B3R3D3U3F2D1F3
	R'U'F'D'L'D2L2R2F2L'D2FLFU2R'F'U'	U1L3F1B1L1R1F3B3L3R3F2D2U1L3R3D1F1B1L2F2B1D3
	L2F'D'BU'F'D2URF'D'BL2D2RBRU'	D3U1L1R2B2R1D2U3R1D3U3F2B2L2R1F1B2R1F1B2L2R3D2L1
	F'RFU'F'D'L'D2R2DB2U'F2R2DL2FU	R3D1R2D3U3F3L3R3F1L2F3B3D2U2L3R3D2U3R1
	D2BULBLR'F'U'LB2F2UB'LDF'U2	R3F1B3L1R1D1U3L2R3F1B1D2U3B1D2U3L2F2B1D2F2B3D3U2
	R'F'U'R2FDFL2D'F2D2U2L2D'L'F'R'U'	D3L1R2B2L1R1D1F3B3D2U1R2F3B3L3R3F1B1L1R1B3U1
	DB2D2L2F2D2F2U'BL2BU2R'F'L2D2FR	D1U1F3B3L1D1U2L2R2F3B3L1R3F1B2L1D2L3R2D3U1B3L1R3D3U3
	RB2UL2RFR2UB'FR2BURD2R'B2U	F2B3L2R3D2U1F3B2L3R3D1U1L2R2D3L3U1F2B3D2U1F2B1L3R3
	ULU2BL'R'FU'R2D'UL2F2U'FLRU	L2R1B1L3R3F3B2U3B1D1U1L1R2U1L1R2B3L2R1U3L3R2
	LBU2R2B'L'D2FR2FD'B2U2B2R2U2F2U	D3U3F3B1L3D3U1F2B3D2B1L2R1F3B1L3R3F2B2D1U2B1L3R3D1U
	RB2U'L2URBU2B'FRU2FD2URB2U	F3B3L1R2D2U1L3R2U1B3D3F2B2D1U1F3B3L2R3D2U1F3B2L3R2
	UBFRU'R2B2D'UF2U'RB'F'LU2BU	F2B3U3F1B2L3F2B1U1F2B1D1U1L1U3L2R3F3B3L1F1B2
	UR'F2D2L'R'D2UBFDU2L2BL'R'FU	B1L3D2F2L3R3F2B1D1U1F1B2R2U1L3R3D1B1
	FLR'FD'U'F2LF'UL'D'F'L'RU2FU2	D2U3L2R3D1U1F2B3L3D3U2L1R2F3L2R1F2L2U3R2D1U1
	URB'F'LB2DU2LRD2UB'F'D2R2F'U	L1D1F3B3U1F2L2R1D1U1L1R2F3B3R2D2B3L1
	F2UF2L'RU'B'L'FU'LU2B'F'ULR'U	D1U1F2U3B2R2F1B2R3F2B1D3U2B3L3R2D1U1F3B2D2U3
	FL'RBUL'D'ULFU2LU2L'B2F2U2F2U'	L3F3B3L2R1F2B2D3U1B1L1D2U3F3D2U3L1B3U3B1
	BLDBD2F'LD2L'D2F2R2BD'R'U2FLU'	B1D1U1L1U3F1B3D3U1F2B1D1U2L1R1F1B1U1L1R1D3U3F2B3
	BLULR'B2FD2R'B'R'B'LUF'L'RF'U'	D3U2F3B2U1F3L2R2D3F2B2L2R3D3U1R1D1U2B3R3D1U2
	U2F'U2L'DF2R2D2R'B'F'D'B2L'B2RF'R2U'	R1D1U3R1F2U1L3R3D2U1F1B3L3R3F3B3L3R2B2D3U2L3
	F'RDLU'F2U2R'DRBRB2FL2U'FR2U2	D2U2B1U3F3B1D1U3L3R3D1U1F2B3U2L3F3B2D1F3B1L2R1
	DB'L2DUBD2R2D2BL'D2BU2LD'U'RU'	B1D3U3F3B3R1F2B2D3U3L3R2D2F1L2D3U2L1R1U1F3
	F2D2R'F'UF'LB'L2F'DLR'FD2F'D2R2U'	R1F2D3U3F3B2L1R1F3D3U3L1R1F3D2L1R2D1U3F2B3L1
	DUR2B2DRU'B'R2D2B2L'B'UR'BL2R'U'	L3R2F1B1L2R2D2U3F1B1D3F2D3U3R1F1B1L1R2D1U3B3L1
	DB'R2UL'U'RB'F'LR2U'FU2R2F2L'D2U'	F2B3L1R2D1U1R1F2B2D3U1F1D3U3L2R2F2B1D2R1F1
	B2UBL2R'UF2U'BL2D2BD'U'B'D2LR'U'	F1U3L3R3D1U2L2F3D2L1R2D1U1F2B2R3F1B1D1U1B3
		L3F2B1D3U1L3R2D2F1L3R3D1U1F1L3R3F1B2D1U1F2R3
	BR'D'B2LFU'L2D2F2RF2R'DF2U'F'R'U'	F2B1D1U1L3R3U3F3B3L3R3D3U2F2B3D1U3F3B1U1L3D3U3B3
	BDL'RDB'R'ULULF2D'U2LR'B'R'U'	D3U2R1B1D3U2R3D1U3L2R1F2B2D1L2R2F1U3F1B2D1U2
	F2D2BL2U'B2RDF'RU2RDLD2L'U2FU2 B2R2DF'DU'BDFLURB2F'D'L2U'LU'	L1D1U2B2L1R2F1B1L1R1F3B1D2U3L1R1U3F2R3D3U1R3
	FL2U'RFLU'F'RUF2L'F'RDU'F'R'U'	L2R3F1B3D3F1B2L1U2F2B1D3U3L1R1D3U1F1B3U1B3D2U2 B3U1B1L3D2U1F1D2U1L3B3D1U3F2B2L2R3F1B1L1
	D2F'DR'F2R'FL'D'F'D2B'LR'F'LD2F'U'	
	DU2FL2B2D2L'DB2F'LRB'DFD'B2RU'	L3B1D3U1L3R2F3B3R3D1U1F2D1F3B3D2U1L2R2F3B3L1R2 F3R3D2F2B3L2R2D1U1F3D1U3F2B2R3D3U3L3R2F2B1
	R2F2D2UBL2B2ULFRDUB'R'UL2DU'	L1R3D3U1L3D3U3F1B3U3F3L2D1U2L2R3F3B3R2D3R3B2
	L2U2B2FL'U2FR'DU2R'U2LU'L2R2B'FU'	D2U3L2R1F1B1L3R2B2D2U1B2D1U1F1B1L2R3D1U1L2R3F1B1D1
	L20282FL 02FR D02R 02L0 L2R2B F0 L'R2D'RD'BL2R'D2F2R2BL'U'LR2B'F'U'	B2R1D1R2F1B1L2R1D3U2L2F1U1F3B1D1U1L1D1U3L3R1
ļ	ULU2F2L'U'FR'D2LD2L2UB'L'F'U'B2U'	D3F3B3L2R1D3U3L2R1F3B3D3U3B2D2U3B2L1R2F3B3L2R3D2U1
	UL2R'F2D'B'D'F2R2FR2U2R2U'F2R2FR'U'	B1R3F1B3L2R2D1U2L2R2F2D1U1L2R1F3B3L3R2F3B3L2R3D2U1
	D2LB'D'L2F2R'D'FR2DBDFU'B'FD2U'	L2R3D1U1L3R3F2B3L3R3F1B2D1U1R2F2B2D3L3R1D2U2F1B2L1
	L2F2L2B'U'B2RD'R2UR2B2LFU2R'DFU'	L2R3D101L3R3F2B3L3R3F1B2D101R2F2B2D3L3R1D202F1B2L1 L3R3D1F3B1U2R3D2U3F1D2U1R1D2U1L3D3U3F3B2L3R1
	D2U'R2U'LB2U'B'D'U2F'R'D'U'LD'FRU'	F1B3L2R3D3U3B3D2U1F1D2U1R1D2U1L3D3U3F3B2L3R1
		I TRAFEWARA CORPORTETINS OF LANGUAGE CONTRACTION CONTRACTICONTRACTICON CONTRACTICON CONTRACTICON CONTRACTICONTRACTICON CONTRACTICON CONTRACTIC

3U3F2B2L3R2F2B1 01U1F3B3D3U2F2L2R1F1B3D2U3R1 F3B2D1U2F3B1L3R2F3B2D2U1F3B2L1 1B1L2D2U1F2B2D3L2R3D2U2 2F3B3L1R3F2L1R1U3L1R3 3B2R3F1B1D3F3B2L1R2 3B3D1U1F3B3L2R3F1B3D3U2 D3U1B2L2D3U2F2B2L3R1 2D3U3F1D2U3F1L2F2B1D3U1 3R3D3U3F2D1F3 1L3R3D1F1B1L2F2B1D3 B2L2R1F1B2R1F1B2L2R3D2L1 2U2L3R3D2U3R1 I3B1D2U3L2F2B1D2F2B3D3U2 3B3L3R3F1B1L1R1B3U1 3F1B2L1D2L3R2D3U1B3L1R3D3U3 2R2D3L3U1F2B3D2U1F2B1L3R3 2U1L1R2B3L2R1U3L3R2 R1F3B1L3R3F2B2D1U2B1L3R3D1U1 2D1U1F3B3L2R3D2U1F3B2L3R2 1L1U3L2R3F3B3L1F1B2 2U1L3R3D1B1 R2F3L2R1F2L2U3R2D1U1 3B3R2D2B3L1 U2B3L3R2D1U1F3B2D2U3 3F3D2U3L1B3U3B1 U2L1R1F1B1U1L1R1D3U3F2B3 3D3U1R1D1U2B3R3D1U2 JR3F3B3L3R2B2D3U2L3 F2B3U2L3F3B2D1F3B1L2R1 D2F1L2D3U2L1R1U1F3 1F3D2L1R2D1U3F2B3L1 3U3R1F1B1L1R2D1U3B3L1 03U3L2R2F2B1D2R1F1 1F2B2R3F1B1D1U1B3 1F1L3R3F1B2D1U1F2R3 J2F2B3D1U3F3B1U1L3D3U3B3 B2D1L2R2F1U3F1B2D1U2 2U3L1R1U3F2R3D3U1R3 3L1R1D3U1F1B3U1B3D2U2 U3F2B2L2R3F1B1L1 01F3B3D2U1L2R2F3B3L1R2 2B2R3D3U3L3R2F2B1 1U2L2R3F3B3R2D3R3B2 D1U1F1B1L2R3D1U1L2R3F1B1D1 1F3B1D1U1L1D1U3L3R1 3B2D2U3B2L1R2F3B3L2R3D2U1 1L2R1F3B3L3R2F3B3D1U1F3B2 1U1R2F2B2D3L3R1D2U2F1B2L1 R1D2U1L3D3U3F3B2L3R1 R1D2U3F3U2L1R3D1F3B3

Symmetry	
D2U2	D2U2
B2F2L2R2	L2R2F2B2
D2B2F2L2R2U2	U2L2R2F2B2D2
L2F2L2R2F2R2	B2L2F2B2L2F2
U2B2F2L2R2U2	D2L2R2F2B2D2
DB2F2D'UL2R2U'	L2R2D3U1F2B2D1U3
L2F2R2B2F2R2F2R2	D1U1L2R2D3U1L2R2D2
L2R2DU'L2R2DU'	D1U3F2B2D1U3F2B2
DB2F2DU'L2R2U'	L2R2D1U3F2B2D1U3
L2R2D'UL2R2DU'	F2B2D3U1F2B2D1U3
D2L2F2L2R2F2R2U2	F2B2D2F3B3D2U2F3B3D2
U2L2R2DU'L2R2D'U'	D1U1F2B2D1U3F2B2D2
DF2R2F2D'UR2F2R2U'	F2B2L2R2U2L2R2F2B2D2
DB2L2B2DU'R2F2R2U'	F3B3D1U1L2R2D1U1F3B3
BFDULRB'F'D'U'L'R'	L3R3D1U1F3B3L3R3D1U1F3B3
B'F'D'U'L'R'B'F'D'U'L'R'	L3R3D3U3F3B3L3R3D3U3F3B3
BFDUL'R'BFD'U'L'R'	L3R3D1U1F1B1L1R1D1U1F3B3
B'F'D'U'LRBFD'U'L'R'	L3R3D3U3F1B1L1R1D3U3F3B3
UR2BFLRBFDUR2U'	D1F2D3U3L3R3F3B3L3R3F2D3
UR2B'F'L'R'B'F'D'U'R2U'	D1F2D1U1L1R1F1B1L1R1F2D3
U'BFD2R2D2R2B'F'R2D2R2U'	D2U3F3B3L2D3U3F1B3D1U1L2F1B1D3
U'BFD2L2U2L2B'F'R2D2R2U'	D1L3R3F1B1L3R3F1B1L3R3F1B1D3
UL2U2L'R'B'F'L'R'DU'R2U'	D1B2D1U3F1B1L1R1F1B1D2F2D3
D2U'R2BFLRBFDUR2U'	D3U2F2D3U3L3R3F3B3L3R3F2D3
U'BFU2R2U2R2B'F'R2U2R2U'	D2U3F3B3L2D3U3F3B1D1U1L2F1B1D3
U'BFU2L2D2L2B'F'R2U2R2U'	D1L3R3F3B3L3R3F1B1L1R1F1B1D3
DB2L'RBF'D2F2LRU2R2U'	D3U2B2D1U3F1B1L1R1F1B1D2F2D3
U'F2D2F2LRF2D2F2D2L'R'U'	D2U3F1B1L2D1U1F3B1D3U3L2F3B3D3
U'B2D2B2LRF2U2F2D2L'R'U'	D1L1R1F3B3L1R1F3B3L1R1F3B3D3
UL2D2LRBFLRDU'R2U'	D1B2D3U1F3B3L3R3F3B3D2F2D3
D2U'R2B'F'L'R'B'F'D'U'R2U'	D3U2F2D1U1L1R1F1B1L1R1F2D3
U'F2U2F2LRF2U2F2U2L'R'U'	D2U3F1B1R2D1U1F3B1D3U3R2F3B3D3
U'B2U2B2LRF2D2F2U2L'R'U'	D3U2L1R1F3B3L1R1F3B3L1R1F3B3D3
DB2U2BFL2D2L'RBF'R2U'	D3U2B2D3U1F3B3L3R3F3B3D2F2D3
D'L'RU2L2U2BFU2R2U2LR'U'	L2R2D2L3R3D1U1F1B1L3R3D1U1F3B3D2
UL'R'B'D2U2B'FD2U2FLRU'	L1R1D3U3F3B3L3R3D3U1F2B2U2F3B3
RDUF'L2U2R2D2R2U2FD'U'R'	B1L1R1U3B2L3R3U2L3R1U3L3R3U2B3
UL'R'F'R2B2F2R2D2U2FLRU'	L3R3D3U3F1B1D2U2L1R1D3U3F3B3
LU2BF'R2UL2R2U'L2BF'U2R'	R1B2D1U3R2F2B3L2R2B3L2D1U3B2L3
LB2F2L'U2BF'R2DL2B'FU2R'	L3R2F2B2L1R2U2F3B1R2D1L2F1B3U2R3
ULRBD2U2BF'D2U2F'L'R'U'	L1R1D1U1F3B3L3R3D1U3F2B2U2F3B3
ULRFR2B2F2R2D2U2F'L'R'U'	L1R1D10173B3D2U2L1R1D3U3F3B3
D'L'RD2L2U2BFD2R2U2LR'U'	L3R3D1U1F3B3L3R3D1U1F3B3D2U2
D'L'RU2R2U2B'F'U2L2U2LR'U'	L1R1D1U1F1B1L1R1D3U1F2B2D2F3B3
LUB2L2UB'D2U2FU'R2F2U'R'	F1L1R1D3L2F3B3U2F3B1D3L3R3U2B3
D'L'RU2L2D2BFD2R2U2LR'U'	L2R2D2L1R1D3U3F3B3L3R3D1U1F3B3D2
D'B2L2B2L'RBFU2R2U2LR'U'	
	L3R3D3U3F3B3L3R3D3U3F3B3D2U2
D'B2R2F2L'RB'F'D2R2U2LR'U'	L1R1D3U3F1B1L1R1D1U3F2B2D2F3B3
L'D2U2LD2BF'L2UR2BF'U2R'	L3R2D2U2L3U2F1B3L2D1L2F1B3U2R3
LR'U2L2U2BFD2L2U2LR'D'U'	
F2L2B2LR'BFU2R2U2LR'D'U'	L3R3D3U3F1B1U2L1R1D1U1F3B3D2
L2D'L2B'R2B2F2D2U2R2F'R2U'R2	F2D2U3L3R3U2F3B3U2F1B1L3R3F2B2D3B2
R2D'F2U2LRB2D2R2F2D2L'R'U'R2	F3B3L3R3F3B3L1R1F1B1L1R1U3L2R2F2B2D3
RU2B'FL2DB2F2DU2L2BF'U2R'	L2R1U2F3B1R2U1F2B2U1R2F1B3U2R3
B2L'R'BL2B2R2U2B2R2F2U2F'L'R'	L3R3F3B3L3R3F1B1L1R1F1B1D2U1L2R2F2B2D3
DBR'DF2L'BD'UR'BL2D'FR'U'	F1R2D3U1F2L3B2D1U3L2D2U2B3D2U2F1
U'B2UB2L2D2B2F2L2F2D2F2R2U'R2U'	D2U3F3B3L2D3U3F1B3D1U1L2F1B1D1U2L2R2F2B2

B2F2L2R2UR2BFLRBFDUR2U'
L2U2L2U'R2B'F'LR'B2R2BF'U'R2U2
F2D'B2F2L2R2U'F2DUL'R'B'F'L'R'
D2L'D2U2LD2BF'L2UR2BF'U2R'U2
U2LB2F2L'U2BF'R2DL2B'FU2R'U2
R'B2F2R'U2BF'R2U'L2BF'L2R2U2R'
R'D2B'FR2U'L2R2U'R2BF'L2R2U2R'
DFU2R'URF'DU'RB'U'BU2R'U'
U2L'D2U2LD2BF'L2UR2BF'U2R'U2
D2LB2F2L'U2BF'R2DL2B'FU2R'U2
L'D2BF'L2D'B2F2D'R2BF'L2R2U2R'
BF'R'DUF'U2R2F'LR'DF2D'R2U'
BF'L'F2R'B2LD'UF'R2U2F'LRU'
F2D'B2F2L2R2U'F2D'U'L'R'B'F'L'R'
L2D2L2UF2D2B'FL'R'BFR2U'R2U2
R'D2B'FL2U'L2BF'U2R'U2L2R2U2R'
L2U2R2UB2U2B'FL'R'BFR2U'R2U2
U2B'FLD2LU2L'DU'FL2U2FL'R'U'
F2L'RU2F'DURB'FL'RF'U2L'R'U'
R'D2R2DFD2B2L2F2R2F2U2FUR2U2R'
F2D'LRFL'RBF'L'B2D'U'F'U2LR'
U'B2U2L2R2D'F2R2U2L2F2U2F2R2U'R2U'
U'B2D2L2R2D'B2L2D2L2F2U2F2R2U'R2U'
LR'D'UR'D2B'F'UB2LR'U2F'L'R'U'
D2R2DB2F2L2R2UR2DU'L'R'B'F'L'R'
RBD2U'LR'B'L'BF'DLBF'U'F'R'
D2B'FLD2LU2L'DU'FL2U2FL'R'U'
D2B'FRF2LB2R'DU'FL2U2FL'R'U'
LR'D'UR'U2B'F'DB2L'RD2F'L'R'U'
UL2R2U2F2DF2R2U2L2F2U2F2R2U'R2U'
F2LR'D2B'DULB'FLR'F'U2L'R'U'
UL2R2U2F2DB2L2U2L2F2D2F2R2U'R2U'
U2R2DB2F2L2R2UR2DU'L'R'B'F'L'R'
B2U'L'R'U2B'L'RBF'RDUB'U2LR'
BF'DU'B'L2D'U'LF2DU'R2F'L'R'U'
B'FLR2DUB'L2U2B'LR'UL2U'R2U'
L2BF'D2R'BFR2UBF'DU'F'L'R'U'
U2LR'DU'LU2BFDF2L'RU2F'LRU'
B'F2UR'F'L2U2B'D2FDLU'FUF2R2U'
F2U'L'R'U2BF2LR'BF'LDUB'U2LR'
F2LR'D2BF2DULB'FLR'F'U2L'R'U'
R2UL2D'B'FRU2B2RD'U'BD2U2LR'U'
B2DF2D'BF'RD2F2RD'U'FD2U2LR'U'
B'F'L'D'F'UF2D2L'D'U'R'U2B2DB'U'R'
LU'B'F'R'F2DU'R2FU2B2DU'R'DU'R'
RU'B'F'L'F2D'UL2FU2B2DU'R'DU'R'
D2LR'DU'LU2BFDF2L'RU2F'LRU'
U2BF'DU'BLRDL2BF'D2R'BFR2U'
LR'D'UL2RD2B'F'UB2LR'U2F'L'R'U'
B2LR'U2BF2DUF2LB'FLR'F'L'R'U' BF'R2U2L'D'UBR2BL2R2F'D2B'LR'U'
B2L2DB'F'LDU'L2R2F'U2B'D2FLR'U'
LD2L2DBR2BF2L2D2L2F'L2FU'R2U2R' F2R2F2U2BF'R'BFDBF'D'UF'L'R'U'
B2U'L'R'U2F'LR'B'FL'R2DUB'U2LR' BF'D'UB2FL'R'UR2B'FD2R'B'F'R2U'
L2B2L2D'U'BF'L'BFUBF'DU'F'L'R'U'
B'FDU'F'R2B'F'DUR'F2DU'R2F'L'R'U'
ο Γυυ Γ ΚΖΒ Γ ΟυΚ ΓΖΟΟ ΚΖΕ L Κ Ο

L2R2F2B2D3F2D1U1L1R1F1B1L1R1F2D1 D3U1F2B2U3B2D1U1L1R1F1B1L1R1B2D1F2B2 F2B2L2R2D1U2F2D3U3L3R3F3B3L3R3F2D1 D2U2F2B3L1R1D2U3F1B3D3U1F3B2D1U3L2F1B3L3R3F3 B3D3U3F1B3D2L1R3F1L1R3F1B3L1D1U1B1 F2B1R2D1U3B2L3F2D1U3F2B2R2F3D2U2B3 R1D2U2F1B1R2D1U2F1B3L1R3F3B1U1L2F1B1L1R2 F1L1R1D3F2L3R3D2L3R1D3L3R3D2F3D2U2 L1R2F3B3L1R3B2D3U1L3R2D1U3L1R3D3U2F1B1R1 D2U2F3B2D1U1R1F3B1L3R1B1L3R1U2F3B1D3U3F1B2 F3D1U1L3R2F3B1D3U1F3B1L3D1U1R2D2U2R2F3B2 R2F3B1U2R3F3B3U3F3B1D3U1B1D2L1R1U3 F2L3R1U2B3D3U3L3F1B3L3R1B1D2L1R1D1U2 L2R2F2B2U3F2D3U3L3R3F3B3L3R3F2U1 F2B2L2R2D2U1F2D1U1L1R1F1B1L1R1F2U1 F1B2R2D3U1F2L3F2D1U3F2B2R2F3D2U2B3 D1U3F2B2U3B2D1U1L1R1F1B1L1R1B2D1F2B2 B2D2U1L1R1F1L1R3F3B1L2R1F2D3U3B3D2L3R1 R2U3F1B1L3R2F1B3L3R1F2B1L2D3U3R3D2F1B3 D1L1R1F1D3U1F1B3U3F2B2L2F1B1L1U2F1B3R2 F3B1D2L3F1B1U1F1B3D1U3B3D2L3R3U3L2 F1B1L1R1F1B1L3R3F3B3L3R3D2U1L2R2F2B2D3 D2U3F1B1R2D1U1F3B1D3U3R2F3B3D1U2L2R2F2B2 D3U2R2F1B1R3U2F3B1L2U1L1R1F2B3D3U1F3B1 D3U1L2R2D3R2D3U3F3B3L3R3F3B3R2U1L2R2 F3B1L1R2B2L1R1D1U1B1U2L3R1B2U1L3R3F1B2L1R3 R2F3B1U2L1F3B3D3F3B1D1U3B1U2L1R1D1 B2L1R3U2F1D1U1B2L3R2F3B1L1R3F2B1L3R3D3U2 D2U3B2L1R1B3U2L1R3F2U1F1B1L2R3D1U3L3R1 F2B2L2R2D2U1L3R3F1B1L3R3F1B1L3R3F1B1U1 L1R3D1U3R3F3B3D1U2B2L3R1D2F3B2L3R3F2D3 F2B2L2R2U1F1B1L2D1U1F3B1D3U3L2F3B3D3 D3U1F2B2U3B2D3U3L3R3F3B3L3R3B2D1F2B2 L1R3D2F1B2D3U3B2L1R2F1B3L3R1F2B3L1R1D2U1B2 L3R1D1U3L3F3B3U3F2L3R1U2B1L3R3B2D3 F2L1R3D2B3D3U3L2R1F3B1L1R3F3B2U2L1R1D2U1 R2F1B3D2L3D3U3B3L3R1F1B3L1U2F1B1U3 D1B2L3R3B3D2L1R3B2U1F3B3L1R2D3U1L3R1D1U1 D3U2R2F3B3R3U2F1B3R2D1L3R3B3D3U1F1B3D3U3 F3B1D2L1R2F1B1D2U3F3B1D1U3F3D2L3R3U3L2 F3B1D3U1F2B1R2D3U3R1B2D1U3L2B3L3R3D3 F2B2D1L1R1F1D1U3F1B3D3L2F3B3L3R2U2F1B3L2 L2R2D3U2F1B1L3R2D3U1L1R3D2U1B2L3R3F2B3U2L1R3B2 F1B3D3U1B3U2F3B3L1R1D1L2F3B1D2L3R2F3B3D2U1 L1R3D3U1R3D2L1R1F1B1D3U2F2L1R3D2F3B2L3R3D2U1 L1F3B2L1R3F1B3L3F3B3U3R2F1B3D2L1D3U3R3 F3B1R1F3B3L2R2U3F1B1D1U1L3R3U3F1B1R1F1B3D3U1 D1L2F3B3D2U2L1U2F3B1L2D3L1R1F2B3D3U1F3B1 F1B3D1U3F1B2D3U3L3F2D1U3R2F1L3R3B2U3 F2L3R1U2F2B3D1U1F2R1F1B3L3R1F3L3R3D1 R2F3B1D2L3F3B3D2U1F3B1D3U1F2B3U2L1R1D3F2B2 L3R1F2B1L3R3D2U1F2L3R1D2L2R2F2B3D3U3F2R3F1B3 L2F2R2D3U3F3B1L1F1B1D2U3F1B3D1U3F2B1L3R3D1 F3B3D1U1L1R1D3F1B1D2U2L3R2F1B3D3U1F1B3L3F3B3D2U3 L3R1D2F3B2D3U3L1R2F1B3L3R1B1D2L1R1D3U2F2 D1R2F1B1R3D2F1B3L2D1L1R1F2B3D3U1F3B1 D2U3L1R1F3B2D3U1F1B3D2U1F2B2R2F1B1R1D2F1B3L2

F1B3L1R2B2L3R3D1U1F1U2L1R3F2D2U3L3R3F2B1L1R3

D'BFR'F2DU'R2F'D'U'L'DU'LR'U'R2U'	D2R1D3U1L3R1D3U2L1R1B3U2L3R1B2U3F1B1L1R1
D'B'LR'DF2L2UR2U'BF'R'U2B2R2U2R'U'	F3B3R2F1D3U1F3B1U1L1R1B3R2D3U1F2L3D3U3
L'RD'UL'U2L'R'BFD'B2LR'U2F'L'R'U'	F3B3R2F1D3U1F3B1U1L1R1B3L2D1U3F2R3D1U1
R'DLD'B'R'F2DU'BRFU'BR2B2F2U2R'	B2L3R2F3B1L1R3F3B2L1R1D2U1B2L1R3U2B3D1U1L1R1
LFRBDL'RB'DU'L'R2D'UR'D'F'R'U'	F2R1F1B3L3R1F2B3L1R1U3B2L1R3U2B3D1U1L1R1
F2R2B2R'F2R'BF'DB2R2DB2L'R'B'DU'R'	F2R1F3B1L3R1F1L1R1D2U1B2L1R3U2B3D1U1L1R1
D'BFL'F2D'UL2F'D'U'L'DU'LR'U'R2U'	B2D3L1R3D1U3L2R1F3B3D1U2F2L1R3D2F3L3R3D1U1
D'F2DB'FDU'BDURF2DU'R2FL'R'U'	F1B2L3R2D2U1F1B3L3R2F3L1R3D3U2B3L3R1D2U3L1R2F2B3
DL2F2R2B'D2LRU'R2U'F2D'R2U'B'F'D2R'U'	L3R1B2D1U2L1R1F3B3L2R2D2F3B2L1R3F3B1L1D1U1F2B1U2

Symmetry Type D₄		
D'U'	D3U3	
DB2F2L2R2U	U1L2R2F2B2D1	
B2F2D'UL2R2U2	L2R2D1U3F2B2D2	
DU2B2F2L2R2U'	D2U1L2R2F2B2D3	
DL2F2L2R2F2R2U	B2R2F2B2R2F2D1U1	
UL2R2DU'L2R2U	D1F2B2D3U1F2B2D1	
U'L2R2DU'L2R2U'	D1U2F2B2D1U3F2B2D3	
B2L2B2DU'R2F2R2U2	L2R2D3U3F1B1D2U2F1B1	
B2F2L2R2UB2F2L2R2U'	U3F2B2L2R2U1L2R2F2B2	
B2F2L2R2D'B2F2L2R2U'	L2R2F2B2U3L2R2F2B2D3	
L2R2UB2F2L2R2UL2R2U2	F2B2D1F2B2L2R2D1F2B2D2	
D2B2F2L2R2DB2F2L2R2U'	F2B2L2R2D2U3L2R2F2B2D1	
D2B2F2L2R2U'B2F2L2R2U'	F2B2L2R2D1U2L2R2F2B2D1	
L2R2D'B2F2L2R2D'L2R2U2	L2R2D3U1L2R2D2U1L2R2F2B2D1	
B2L'RBF'D2F2LRU2R2U2	D1U1B2D3U1F3B3L3R3F3B3D2F2	
R2BFLRBFDUR2D'U'	D3U3F2D1U1L1R1F1B1L1R1F2	
B2U2BFL2D2L'RBF'R2U2	D1U1B2D3U1F1B1L1R1F1B1U2F2	
R2B'F'L'R'B'F'D'U'R2D'U'	F3B3L3R3D1U1F3B3D1U1F1B1D1U1	
B2F2L2R2U'L2R2D'UL2R2U'	F2B2D1U3F2B2D3L2R2F2B2D3	
B2L2B2L'RBFU2R2U2LR'	L1R1D1U1F1B1L1R1D1U1F1B1D3U3	
B2R2F2L'RB'F'D2R2U2LR'	F3B3U2F3B3L3R1F3B3D2L1R1F2	
DL2R2DB2F2L2R2DL2R2U'	L2R2D3U1L2R2D3U2L2R2F2B2D1	
L'RD2L2U2BFD2R2U2LR'	L1R1D3U3F1B1L1R1D3U3F1B1D3U3	
L'RU2R2U2B'F'U2L2U2LR'	L2R2U2L1R1D3U3F3B3L1R1D3U3F1B1D3U1	
L2F2U2L2F2R2B2U2L2DU'R2U2	D2F3B3L2D3U3F1B3D1U1L2F1B1	
R2F2U2L2B2R2F2U2R2DU'R2U2	L1R1F3B3L1R1F3B3L1R1F3B3D1U1	
L2B2F2LR'F'L2R2D2U2FL'R'	F3B3R1F2B2D2U2R3F1B3L2R2F2	
R2U'B2F2L2R2ULRBFLR'	U1L3R3D3U3F1B1L3R3D1U1F1B1D1	
LRB2L2R2FL2R2D2U2FL'R'	F3B3L1R3F2B2L1F2B2D2U2R3F1B1	
L2F2D2L2F2R2B2D2L2DU'R2U2	D2F1B1R2D1U1F1B3D3U3R2F3B3	
R2F2D2L2B2R2F2D2R2DU'R2U2	D1U1L1R1F3B3L1R1F3B3L1R1F3B3	
ULR'U2L2U2BFD2L2U2LR'U'	F3B3L1R2F2B2L1R3F2B2R1F1B1D3U3	
UF2L2B2LR'BFU2R2U2LR'U'	F1B1L3R2F2B2L3R1F2B2R3F3B3D3U3	
UF2R2F2LR'B'F'D2R2U2LR'U'	U1L1R1D1U1F3B3L3R3D1U1F1B1D1	
LRF'R2B2F2R2D2U2FD2U2L'R'	F1B1L3F2B2D2U2L1F3B1L2R2F2D2U2	
D2LRB'L2R2D2U2B'L2R2F2L'R'U2	F1B1L2R3D2U2F2B2R3F1B1R2D2U2R2	
D'LR'D2U2R2FL2R2D2U2F'L'R'U'	F1B1R3F2B2D2U2R1F3B1L2R2F2D3U3	
DLRB2L2R2FL2R2D2U2FL'R'U	F3B3L1R3F2B2L1F2B2D2U2R3F1B1D1U1	
BR'DF2L'BD'UR'BL2D'FR'U2	L3R2D3U3L1R3U2F1B3L2R3F1B3L3R1F3B2D1U1L2R1D1U1	
BU2L'ULB'D'URB'U'BU2R'U2	L1D3U3L1R3D2F3B1R1F1B3L3R1F1D1U1L3D3U3	
D'L2B2F2LR'F'L2R2D2U2FL'R'U'	F3B3R1F2B2D2U2R3F1B3L2R2F2D3U3	
DLRB'L2R2D2U2B'L2R2F2L'R'U	F1B1L1R3F2B2R3F2B2D2U2L1F3B3D1U1	
BFR'D2B2R'DU'BD2B'U2B'LR'U	D1F2L1R3D2B3L1R1B2D3U2L1R3D3U1L2R1F3B3	
BFR'D2B2R'DU'FL2B'R2F'LR'U	R2B3D3U1F3B1D1U2L3R3F3L2D3U1F2D2U2L1	
DL'D2U2LD2BF'L2UR2BF'U2R'U	U3L3F3B3L1R3B2D3U1L3R2D1U3L1R3D3U2F1B1L2R3D1U2	
D'LU2BF'R2UL2R2U'L2BF'U2R'U'	B2U2L1R3D3U3L1R2D3U3F3L3R1F3B1L2R3D1U1F3L1R1	

	1
D'LB2F2L'U2BF'R2DL2B'FU2R'U'	B2D2L3R1D3U3R3D3U3F1B2L3R1F3B1L2R3D1U1F3L1R1
BFLB2DU'L2F'DUF2RDU'LR'U'	L1R3F3L3R3D3L3R3D3U3F1B1D3L1R1B1L3R1D2
F2DB2D'B'FLD2B2LD'U'B'F2LR'U'	D3U2B2L1R3U2B3L3R3B2D1U2L1R3D1U3L3R2F1B1
U2BFR'D2B2R'DU'FL2B'R2F'LR'U'	D1R2F1B3D2L3D3U3R2F2B1L1R3F1B3L2R3F1B1
BFRF2DU'R2FDURD'ULR'UR2	F1B1R1F2D1U3R2F1D1U1R1D3U1L1R3U1R2
B2U'BF'DU'B'D'U'R'F2DU'R2F'L'R'	F3B3R3F2D1U3R2F3D3U3L3D1U3L1R3U3L2
B'LR'DF2L2UR2U'BF'R'U2B2R2U2R'	L3R2D2F3B1R2U1F1B1L2R3F3B1L1R3F2B3L2F3B3
BDLDB'L'R'DF'L'B'D'UF'D'U'R2	L1R2B2D1U3L2B3L3R3D3F1B3D3U1F3L2F1B1
DLB2F2L'U2BF'R2DL2B'FU2R'D2U'	D2U1R3F3B3L3R1B2D1U3L1D1U3L1R3D3U2F1B1L2R3D1U2
BFL'F2D'UL2F'D'U'L'DU'LR'U'R2	F2U3L1R3D3U1R3F3B3D2U3F2L3R1U2F1L1R1
F2DB'FDU'BDURF2DU'R2FL'R'	B2D3U2L3R1D3U1L2R3F1B1D2U1F2L3R1U2F3L3R3
L'R'FD2L'RF2U'B'F'D2R'DU'LR'U	U2L3R1F2B1L3R3D1U2F3B3D3U3L1R1D1U2L1R1F2B3L3R1
U2L'R'FD2L'RF2U'B'F'D2R'DU'LR'U'	F1B3L1R2F3B3U3L3R3D3U3F1B1U3F1B1L3R2F1B3D2
LD'U2B2R'UBDB'F'UFDL'F2D2U'R	R2F3B1U2R3F3B3D3U3R2U1F3B1D1U3F2B3L1R1U3
B2U2R2F2ULRBR2DU'B2R'B'F'R2U'R2	F1B1R3F2D3U1L2B3D1U1L2R3D3U1L1R3U1R2
R2B'D2F2U2L'RU'R2B'F'R'F2R'U2L'F2R'	L2R2F2D1L1R3D3U1L1F1B1D2U1F2L1R3D2B3L1R1
F2D'LR'DU'L2RB'F'UF2L'RU2FL'R'	F3B3R1F2D3U1L2B1D3U3L1R2D1U3L1R3U3L2
D'L'D2BF'L2D'B2F2D'R2BF'L2R2U2R'U'	B3D2L1R3F2L2R2D2U3F3B3L3F3B1L1R3B3D1U3R2
D'R'D2B'FL2U'L2BF'U2R'U2L2R2U2R'U'	B2D3U1L1D1U3L1R3D1F1B1R3F3B3L1R3D3U3F2B2L2R3
BFLF2DU'R2BD'U'LR2DU'LR'U'R2	F2D2U1L3R1D3U1L3F3B3U1F2L3R1U2F1L1R1
B2DLR'D'UL'R2BFU'F2L'RU2F'L'R'	B2D1L1R3D3U1L3R2F1B1U3F2L3R1U2F3L3R3
B2L'R'BU2LR'F2U'B'F'R'DU'LR'D2U'	L1R2U2F1B3L2F2B2D1U2L1R1F3B2D1U3F1B3U1L3R1
R2B'FD2L'BFDB'FD'UFD2BFL'R'U'	F3B2D3U3F1D3U3F2B3L1R1D2U2F2B1L1R1B3D3U3F3L3R3
D'B2D'L'RDU'L'B'F'D'B2LR'U2F'L'R'U'	D3U3R2D3F1B3D1U3B3L3R3D3R2F3B1U2L3F3B3
F2R2U2F2D'B'F'L'DU'BR2D2FU2F'LR'U'	L3F1B1L1D3U3L3R2D1U1F2B2L2R3F3B3R3F3B3L2R1F3B3
B2U2F2D2LR'D2BLRDBF'DU'F'L'R'U'	F2U2L1R3D3U3R1D1U1F1L3R1F1B3L1R2D3U3F1L3R3
B2LR'U2FDUL'R'F2R'B'FLR'F'L'R'U'	F2D2L3R1D3U3L3R2D1U1F3B2L3R1F1B3L1R2D3U3F1L3R3
L2B2R2F'U2LRD'R2D'B2U'R2D'B'F'U2R'U2	L2R2F2D3U2L3R1D3U1R1F1B1U3F2L1R3D2B3L1R1
B2U2B2U2LR'U2BLRDBF'DU'F'L'R'U'	F2L3R1U2F2B3L3R3D1U1F2U1L3R1D1U3R1F1B1D2U1
R2B2U'B2D2L'R'U2B'R2D'UF2R'BFUR2U2	F2L3R1U2F2B3L3R3D3U3B2D2U3L3R1D1U3R1F1B1D2U1
F2L'RF2D2F2U2B'LRUBF'D'UF'L'R'U'	D1U2B2L1R3U2F3L1R1D3U3B2U3L1R3D3U1R3F3B3
F2L'RU2F'DUL'R'F2L'B'FL'RF'L'R'U'	D2U1F2L3R1U2F3D1U1L1R1B2L3F3B1L3R1F2B1L3R3
R2B2D'BFRDU'F'L2U2FR2F2R2F'LR'U'	B2U1L1R3D1U3L3R2F1B1D1F2L3R1U2F2B3L1R1D1U1
B2D'F2L2U'BF'RDUFD2B2L2D2F'LR'U'	B2D2U3L3R1D1U3L2R3F1B1D3U2F2L3R1U2F2B3L1R1D1U1
	D1L2R2F2B2D3
U'B2F2L2R2D2U' D'L2R2D'UL2R2U	D1U2L2R2F2B2D1
	D2U1L2R2D3U1L2R2D1
DL2R2D'UL2R2U'	U1F2B2D1U3F2B2D3 F2D1U1L1R1F1B1L1R1F2
	B2D1U3F1B1L1R1F1B1D2F2
LRBD2U2BF'D2U2F'L'R' LRFR2B2F2R2D2U2F'L'R'	F1B1L2R3F2B2L1R3F2B2L3F3B3 F1B1R1D2U2F2L2R2F2R3F3B3
L'R'B'L'RB2F2LR'FLR	F3B3R3F1B3L2R2F3B1L1F1B1
F2R2DUR2F2R2F2D'U'F2R2	L1R1D1U3L3R3F2D3U3L1R3D1U1F2
F2R2DUL2B2L2B2DUF2R2	L1R1F1B1L1R1F3B3L3R3F3B3
F2R2DUL2F2R2B2D'U'F2R2	D3U1F3B3R2D3U3F1B3D1U1R2F1B1
F2R2D0L2F2R2B2D0F2R2	L3R3F1B1L3R3F1B1L3R3F1B1
D2R2B'F'L'R'B'F'D'U'R2U2	F1B1L1R1D3U3F1B1D3U3F3B3
B2L2DUR2B2R2B2D'U'F2R2	L1R1F3B3L3R3F1B1L1R1F3B3
B2L2D'U'L2F2L2F2DUF2R2	L1R1D3U1L1R1B2D1U1L3R1D3U3F2
B2F2L2BFLRBFDUR2	L2R2B2D3U3L3R3F3B3L3R3F2
B2L2DUL2B2R2F2D'U'F2R2	L3R3F3B3L1R1F3B3L1R1F1B1
B2L2D'U'R2F2L2B2DUF2R2	L3R3U2F2B2L1R1F2D3U3L2D1U1F2
L2BFLRB'F'L2R2DUR2	B2L3R3F1B1D2U2L3R3D1U1F2
R2F2D2R2F2R2F2U2R2DU'R2U2	D3U3L3R3F3B3L1R1F3B3L1R1F1B1
L2F2D2R2B2R2B2U2L2DU'R2U2	F1B3D3U3F1B3D1U1F1B2R2D2U2L2F3
B2U2BFD2LR'F2L2BFR2U2	D1U1L2R2B2L3R3F3B3L3R3D3U3F2
L2U2LRD2BF'U2L'R'U2R2U2	B2L1R1F1B3L3R3F2B3R2D2U2L2F3

B2U2BFU2DLYBFF2DU* F2D3UJLRFFB1U3HD2U2R2F2 B2U2BFU2L2RFDU*R F2D2L2RFU2LUJLRFDU*R2 L2BFU2FU2L2RFDU*R2 D3UJLRFFB1U3R3FB3UD2F2 B2U2RFU2L2RF22DUR2DU*R2U D3UJLRFFB1U3R3FB3USF2 B2U2RFU2RFDU*R2DUR2DU*R2U D3UJLRFFB1U3R2DUULLRSDUWLRSP3B3 B2UFFU2RFDUR2RUZ D1ULRZDUULRSDUWLRSP3B3USF2 B2UFFU2RFURZPUZRUR2 D3UJLRFFB1U3R2DUULLRSDUWLRSP3B3USF2 L2U2(RVU3FF02LRU2R2U2F D3UJLRFFB1U3R2DUULRSB3USF2 D7UR2DESFEDRZUZLF2 L2D3UJRP2FB3UZF3B3USF2 L2D01DB2F2LRZUFRZUUFZ L2D3UJRP2FB3UZF3B3USF2 L2RDDF2D2RFUZRUR2 L2D3UJRP2FB3UZF3B3USF2 L2RDDF2D2RFUZRUR2 L2D3UJRP2FB3UZF3B3USF2 L2RDDF2D2R2UZFZUFZZUFZZUFZZUFZ L2D3UJRP2FB3UZF3B3UZF3B3USF2 L2RDDF2D2LRZUZFZUFZZUFZZUFZZUFZZUFZZUFZZUFZZUFZZUF				
128F/FX2D2U28F0/VIR2 L28F2D3UFF8L38F3813F38D2F2 1272U78F78F2D3R2D0/VIR2 D3U31RFF8L38F38138F383 12F2U78F78F2D3R2D0/VIR2 D3U31RFF8L38F38138F383 12F2U78F78D3R2D12D0/R3U2 D1U11R101031REDD1U11R6D2014F2 12U21RV28F72D3R2D742U78U D3U31R7F2D1U3F1811RFF8LD21F18D2V2 12F12U78V28F72D3R2D74R2D3R2D742U2 L28F38338F37D17282L78F32UF383D3F2 12U21RV28F72D3U2F72D3F2R2VR2 L28F383358F2D17282L783D3F2 12R022F2D72R2U21FV1R2 L28F383158F2D17282L78303F2 12R022F2D72D22U2F2D2FR2VR2 L28F38202F383D2F23B3U2F383D3F2 12R022F2D22U21F2D2FR2VR2 L28F382D2U28F393D2F3B3U2F383D3F2 12R022F2D22U21F2D2FR2VR2 L28F382D2U28F393D2F3B3U2F3B31A87D011F3B31A8F1B1 1R8F382D3U28F0F4D28F024 L28F382D2U28F028F32F3 12R022F2D3F2R2D022F9F L28F2F2D102F872D103F28F2D312F81D3487D201 10U28F12D28FF12U78F0 D3U3RF3833R82D20113R16D30J2F1B112R3D1U2 10U28F21D28FF12U78F0 D3U3RF3833R872D1131101031R5930JF1B12R3D1U2 10U28F21D28F012W2F1 D3U3RF3833R82D20113R16D30JF1B112R50D12 10U28F21D28F012W2F1 D3U3F28501JF1B111R71B1030JF383UF3830JF383UF383D12 10U28F21D28F012W2F1 D3U3F38511R82D10131R73B30JF1B12R5D201 10U28F21D28F012W2F12W2F7	B2U2BFL2D2L'RBF'R2DU'	F2D3U3L1R1F1B1L3R1D2U2R2F2		
1272/02/07/78/72/07/00 D303114/F1B1L38/F1B1J38/F3B3 1272/07/78/72/07/00 D1011181D1011118/D30197 1272/07/78/72/07/00 D1011181D1011118/D30197 1272/07/78/72/07/00 D30312/07/7010311181/F1B102/0 1272/07/78/72/07/20 D30312/07/70103118114/F1B102/2 1272/07/78/70/07/78/07/72 D38312/07/78/2380372 1270/78/76/76/78/07/72 L2031372/02012/82/78/30372 1270/78/76/76/78/07/72 L2031372/02012/82/78/30372 1270/78/76/76/78/07/72 L78776/78/302013/8376380372 1270/78/76/76/77/77 L78776/78/302013/8376380372 1270/78/76/76/77/77 L78776/78/30201178/8302013/837630372 1270/78/76/72/78/2020/27/77/72 L78776/78/30201178/8320013/837630372 1270/72/76/72/78/2020/77/72/72 L78776/78/38200113/837630314781387191 1270/72/76/70/72/72/72 L78776/78/38200113/81620113/837803147810201 1270/72/76/72/72/72 D104283781820013/8378383148201013/818030478112/80102 1270/72/72/72/72 D278770/72/72 1280/72/72/72/72 D27877 1290/72/72/72/72 D27877 1290/72/72/72/72 D27877 1290/72/72/72 D27877 1290/72/72/72				
I_F2U2R20R2820212DUR2U2 D1111R4D10131R1B2D111L1R0303F2 02RF2L2F01RVLR2U2 D1111R4D10131R1B2D111L1R0303F2 02RF2L2F01RVLR2U2 D3U312R2F2D1U3FB1L1R1F1B1D2F2 0F2L821RF02RVLR2U2 D3U312R2F2D1U3FB1L1R1F1B1D2F2 0F2L821RF02RVLR2UR2 L3R5485813872D122L2R2U712 12R502F2DF2R2VL212FVD2FXR2VR2 L2R54758302F2B302F2B305F2 12R202F2DF2R2VL212FVD2FXR2VR2 L2R7F282D03F2F8303F2 12R202F2DF2R2VL212FVC21KVR2 L2R7F282D03F58303F2 12R202F2D5F2VF2V21KV7 L2R7F282D03F58303F1B113R371B113R3D2U3 12R202F2D5F2V22V22F2V22FX2VR2 L2R7F282D03F783313R3F1B11 1R85282D0122FFV2F2V2FV21KV L2R7F282D012F58303F8313R3F201 12R52F2V22FV2F2V2FV22KVK L2R7F282D012F58313R3F201 12V12FVFCV10FU2R2V2C2V2KV R2D011FB11R2D013F83032F8112R301UF 12V12FVFCV10FU2R2V2KV D013F8511R32D011F8313F181 1V12BF21C04F72V2FV0FV D013F8511R32D011F8313F181 1V12BF21C04F72V2CVFV D013F8512D011F8513F18102FF1812D011F8313F181 1V12BF21C04F812A04FF12C04F7 L2D301F2B3011R1F31A1F182D0112R5783030F581012R5780112 1V12BF21C04F812A04F7F20U2FF L2D301F2B3011R1F51512D11F5152D113F5152D1013F5152D112F5502F57872F512D12F512D11F515501F5555500112 1V12BF21C0F04F72D1				
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B2U2B2DR2BFU*/BFU2F2U*/R2 R2D1U1F1B11R2U2F3B312D1U1F1B313F1B1 U*U2BFR2U2BFR2D12BFR2D12BFU2R*U D13F3B31R3R2D1031R3D3U2F1B112R3D1U2 U*U2BFR2U2BFR2D12BFR2D12BFV2R*U D337B3B31R32D1031R3D3U2F1B112R3D1U2 U*U2BF2U2U2D12BF12U2BFU2R*U D203R1D2U213R2D1031R3D3U2F1B112R3D1U2 U*U2D12DF12UR2BFU2R*U D203R1D2U213R2D103R2F1B212D103F2B12R3D303F2B1 B72V2BF72U2R*UUFK*U D102B21R1D2B31R3B32D22 F2D7R2DBF7F2U2R*UUFK*U D102B21R1D2B31R3B32D12F1B3U11R1F3B3D303F2B1 B72V2F2K7U9B12FR2B*LRU*U L1R1D2U12F1B3U213F3B3D102H38D33F3B31R3D101 B72V2F2K7U9B12FR2B*L2UV*U U11D22C8B2D30112F1B3U31R3F3B31F3B1 B7U22B172D72D1*D1042F1*RV*UR2 D302F3B313R3D101187F811D1F1B31RF3B1 B7U22D212BF12D72D21*BF12R*U2R* F1B1011F3B31B3D101187F811B37B111F81B30113 B7U22D212BF12D*C101F*U F3B17F83U3F3B303U31R1013F8111F81B3013 B7U22F12D*D*D01FVER*U F1B31R7F83U3F3B303U31R1013F8112F81B13031 B7U22F12D*D*D*D01F*K* F1B317F1B1017F8312M31F83112F81D1013 B7F122F12D*D*D*D*D*FK* F1B317F1B1017F8317M11F8211A11875B3111A1 B7F122F12D*D*D*D*FK* F1B317F1B1017F8317M11F8211A11875B311A1 B7F122F12D*D*D*D*FK* F1B317F1B1017F18317H3117F8311A14157B211A14157B211A14157B211A14157B21A14157B21A14157B21A14157B21A14157B21A14157B21A14157B21				
UU2BEFR2UL2REFU2U2BFV2RU D113F3B311R3B2D3U11R3D1U3L1R3D3U2F1B112R3D1U2 UV12D21D2BF72U28FV2RV D3U2R3F3B313R182D1U3L1R3D3U2F1B112R3D1U2 UV12D21D2BF12UR2BFV2RV D3U2R3F3B313R182D1U3L1R1B3U2DF1B12R3D1U2 BV12F2UV2BFV2UR2V D1U2B112D213B2D1U3F1B3U2D13F2R1B3D3U5F1B112R3D3U5F2B1 BV12F2U2DVF8VUF12VRV D1U2B213R1D2B313R3B2D2U113R1D3U112R3F1B1 BFV12F2VDVFLRVV L1R1D2U12F1B3U2J3F3B301U2F1B31D31F3B3D02 BV70F82LF2L2DVF8VDVLFVV T1R1D2U12F1B3U2J3F3B301U2F1B31D31F3B3D02 BV70F82LF2L2DV2BFVRVV T1R1D2U7AB2D30112F1B31D21F1B31D3F1B1D3F1B31B3F3B102 BV70F82LF2L2DV2BFVRVV U11D2V7AB2D30112F1B21D31F3B1D3011 B212UB2U2BFR72DV2LFVVV2RV F1B3117F3B3U3R5B030111R75B311387F1B31B31D31 F2LV2LF2DV2RV12UF0VVLRVRV F1B31R7F3B3U3R5B030111R103F1B11387F1B30301 F2LV2LF2DV2RV2UF0VVLRVV F3B1R3F3B303F3B303011R10311R2F3B3 F2LV2LF2DV2RV2UF0VV D3U2F21R302F1D303R3F3B3F3B10301 F2LV2LDV2RV1VFRVV F3B1R3F1B103F1B1033R303F3B37B37B10301 F2LV2LDV2RV1VFRVV F3B1R3F1B103F1B1033R303F3B37B10203 F2LV2LDV2RV1VFRVV F3B1R3F1B103F1B1033R303F3B312R7F3B1033 F2LV2LP0VR2B0F0FV2LV2FV F3B1R3F1B103F1B1033R303F3B30131R17F3B1033 F2LV2LDV2RV1V2FRVVVV F3B1R37F1B103R37F3B				
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B*U2F2DU*RB*FU*B2D*F2PB*R L2D3U1F2B1D3U1F1B3U1LR1F3L1R1F1B3D3U3F2B1 F2D*R2DB*FK*2U2P*DU*FR*U* D1U2B2L3R1D2B3L3R3B2D2U113R1D3U1LR3F3B1 BFRU752R*U*DU*FK*D*U* D1U2B2L3R1D2B3L3R3B2D2U113R1D3U1LR3F3B1 BFRU752R*U*DU*FK*D*U* F1B3L1F1B3U2L3F1B3D3U1F2B3D1U2F1B3D1U3F3B3D2 B'DURB2L*F2L*DU*B'D*UR2U2R* F1B3L1F1B3U2L7B3D3B3B3U2F1B3D1U2F1B3D1U3F3B3D12 URU2B*FL2DB2F2DU2L2B*URU* U1L1D2/U2R3B2D3U12F1B3U1L7F3B3B3B3F3B1U2 URU2B*FL2DF2D2L*RU*U* F1B3L1F1B3U1L7F3B3L3R3F3B11A3D1 B'DUU2L2F2U2L*DU*B2FK72DU2L2R*U*RU*U* F1B3L1R2F3B3U3F3B3D33U3F1B1U3F1B1D1F1B3D3U3 B'DUU2L2F2U2L*DU*B2FK72DU2K2* F1B3L1R2F3B3U3F3B3D3U3F1B1U3F1B1L1F1B3D1U3 B'FLU2D*DU*B*CFU*U*F*U* F3B1R3F3B1U3E1B1D3B3D3U3F3B3L1R3F3B113D3 B'FLU2D*DU*B*CFU*U*F*U* F3B1R3F3B1U3E1B1D3B3D3U3F3B3B1R3F3B1D3U1 L*B*FDB*FD0*D*B*D*F* F1B313R2F1B1U3F1B1D3U31SR3U3F3B3B12R1F3B1D103 B'FLU2D2DUR2E*D*U2B*D*F*U*F* F1B313R2F1B1U3F1B1D3U31SR3U3F3B3B12R1F3B1D103 L2B*FD2L8F1D2B*D0*U*L*K*U F2B133R2F1B1U3F1B1D211B3R3F3B3B12R1F3B1D103 L2B*FD2L9FD2*D2*D2*D*U*E* F1B31R2F3B3U2AF1F3B1U31E3B2D2023 L2B*FD2*D2*D2*D2*D*U*E* F1B313R2F1B1U3F1B1D11F1B32U3F3B3D2R2D23 L2B*FD2*D2*D2*D2*D2*C*C*Z*Z*D2*D*E*C*C*X*E* F1B31R2F3B3U2AF1F3B1U32R3F3B3D1111				
F2D'R2DBF'R'F2U2R'DUF'LR'U' D1U2B2L3R1D2B3L3R3B2D2U1L3R1D3U12R3F1B1 BFR'U2F2R'D'UBL2FR2B'LR'U' L1R1D2U1L2F1B3U2L3F3B3D1U3F3B3U3F3B3U3F3B3U3 BF'UWR3L'F2LD'D'B'D'UR2U2R'' F1B3L1F1B1U3L1R1D3U3F3B3U3F3B3U3F3B3U3 URU2B'FL2DB2F2DU2L2BF'U2R'U' U1L1D2U2R3B2D3U1L2F1B2L2D1U3F2R1D2U1 B2L2UB2U2BF'RF2D'UL2F'UR'U'R2 D3U2F3B3R3F3B3L3R3D1UR3F1B1D1F1B3L3R1F3B1 F2RV2BF'L2D'D'EDZ'UR'U'R2R2F'U2R F1B3L1F1B1D2R1D1UF3B3L1R3F3B113D3U1 B'DULU2L2F2U2L'D'U'B2L7Q2F'U2R2 F1B3L1R2F3B3U3L3R3D3U3F1B1U3F1B1L3R1F3B1 B'DULU2L2F2U2L'D'U'B2L7Q2F'U2R2 F1B3L1R2F3B3U3F3B3D3U3LR1U3F1B1L1F1B3D1U3 B'DULU2L2F2U2L'D'U'B2LDU'R'U F3BL3F3F3B3U3F3B3D3U3LR1U3F1B1L1F1B3D1U3 B'FLU2F2UDU'B2LFQDU'B2L'DU'R'U F3BL3R2F1B1U1F1B11J1E3B11R1B2D133F3B33F3B1D3U1 L'EFFOR'FLOW'L'F'R'U' F3BL3R2F1B1U1F1B101U31R3D3U3F3B33B3F3B1D3U1 L'EFFOR'FUDU'EL'R'U F1B3L3R2F1B1U1F1B101U113R3U1F3B312R3F3B1D3U1 L'EFFOR'FUDU'EL'R'U F3BL3R2F1B1U1F1B101U113R3U1F3B312R3D2U3 L'EFFOR'FUDU'EL'R'U F3BL3R2F1B1U1F1B101U113R3U1F3B312R3D2U3 L'EFFOR'FUDU'EL'R'U F1B3L3R2F1B1U1F1B101U113R3U12F3B312R3D2U3 L'EFFOR'FUBUF'DU'F'LR'U F1B3L3R2F1B1U2F3B11U3F3B103B3D2U3 L'EFFOR'FUBUF'DU'F'LR'U F1B3L3R2F1B1U2F3B11U1F3B1D1U3F3B3D2U3		D2U3R1D2U2L3B2D1U3R2F1B2L2D1U3F2R1D2U1		
BFR'U2F2R'D'UBL2F'R2B'LR'U' L1R1D2U1L2F1B3UL2F3B3D1U2F1B3D1U3F3B2D2 B'D'UR'B2L'F2L'DU'B'D'UR2U2R' F1B3L1F1B1U3L1R1D3U3F3B3U3F3B3R37B1U2 URU2B'FL2DDZDB27D02L2EFU2R'U' U1LD2U2R8D2001L2F1B2L2D1U3F2R1D2U1 B2L2UB2U2BFR'F2D'UL2F'L'R'U'R2 D3U2F3B3R3F3B3U3R3D1U1R3F1B1D1F1B3L3R1F3B1 F2R'U2F1D'F2D'UL2F'L'R'U'R2 F1B3L1R2F3B3U3L3R30J3F3B1U3F1B113F1B31E13B31 F2UU2F12U2'D'U'LEFKP2'R2 F1B3L1R2F3B3U3L3R30J3F3B1L37B1L3F1B3D1 F2URF2L2U2'D'U'LEFKP2'R2 F1B3L3R2F3B3U3R303U3F1B1U3F1B11AF1B3D1U3 F2LRFURFL'DU'L'R'U' F3B1R3F3B3U3F3B3D3F3B31B11B3F1D2L1R1 F2LB2D'UR2B'DU'B'R2'U'LF2RUENDU' D3U2F2LR3D2F1D3U3R73B31LR3F1D2U3R1 B'F'L02F2DU'B'R2'U'LF2RUENDU'R'U' F3B1R3F1B1U3L1F1B1D1U13R3U1F3B1D1U3R3UF3B3L2R1F3B1D1U3 F2D2BFD'DU'B'R2'U'LF2RUED'B'R' F1B3L3R2F1B1U3L1F1B1D1L1R3U1F3B1D1U3 L2BF'D2LBFL2UBFDU'F'R'U' F3B13R2F1B1U3L1F1B1D1L3R3UF3B3D2U3 L2BF'D2LBFL2UBFDU'F'R'U F3B13R2F1B1U3L1F1B1D1L3R3UF3B3D2U3 L2BF'D2LBFL2UBFDU'F'R'U F1B3L1R2F3B3U12R3T3B3B3D1U3 L2BF'D2LBFL2UBFDU'F'R'U F1B3L3R2F1B1D3G3U3L3R3D3F3B3D1LR1 LD'FR2BFL2RZFL2FZ2L2F2DUVR' F1B3L3R2F1B1D3F1B1D3G3U3R3D3F3B3D1L1R1 LD'FR2BFL2RZFL2FZ2FZ2L2FUZE F1B3L3R2F1B1D3F1B1D3G3U3R3D3F3B3D1L1R1 <td< td=""><td></td><td></td></td<>				
B*D*UR*B2L*F2L*DU*B*D*UR*DU2R* F1B3L1F1B1U3L1R1D3U3F3B3U3F3B3R3F3B1U2 URU2B*F12D02F2D0212B*U2R*U* U111D2U2R3B2D3U112F1B2L2D1U3F2R1D2U1 B212UB2U2B*F12D0U212F1*R*U* D3U2F3B3R5F3B313R3D1U18F1B1D3F1B313R1F3B1 F2R*U2D*F12D1*U*U* F1B3L1R2F3B3U31R3D3U3F1B113R2F1B3D3U1 F2R*U2D*F12D*U*U*U*U* F1B3L1R2F3B3U31R3D3U3F1B113R2F1B3D3U1 F2LRF02L*F2D*LDU*U*U* F1B3L3F3B3U3F3B3U3R3D3U3F1B113R2F1B3D3U1 F2LRF02L*F2D*LDU*U*U*U* F3B1R3F3B3U3F3B3U3R3D3U3F1B113R31D21R1 F2LF12D*ED*DU*D*U*U*U* F3B1R3F3B3U3F3B3U3F3B11ASF1D21R1 B*F*LB2D*DU*B2L*DU*R*U F3B1R3F1B1U31R1D3U313R3U3F3B31R3F3B103U1 L*B*F02B*DU*D*D*F1** F1B313R2F1B1U31R1D3U313R3U3F3B31R3F3B103U1 L*B*D2D*F02B*D*D*F1** F1B313R2F1B1U31R1D3U313R3U3F3B31R3F3B103U1 L2B*D21B*L2UBFD*D*F1** F1B313R2F1B103U313R2D1U31F3B31ZR1F3B1D1U3 L2B*D21B*L2UBFD*D*F1*** F1B311R2F3B3U12R1F1B3D113B2D1U31F3B31ZR3B2D2U3 L2B*D21B*L2UBFD*D*F1**** F1B311R2F3B3U12R1F1B3D113B3D1U31F3B31ZR3F3B3D3F3B3D11R1 LDU*FR2B2F12R2F12R2F1D2V1*** F1B311R2F3B3U12R1F1B3D1U3F3B3D3F3B3D11R1 LDU*FR2B2F12R2*** F1B311R2F3B3U2A3F3B11R2F3B3D1U3F3B3 S2F0212**** F2B13R7F3B112*** B2F1**** F1B**** F1B*				
URU2B'FL2DB2F2DU2L2BF'U2R'U' U1L1D2U2R3B2D3U1L2F1B2L2D1U3F2R1D2U1 B2L2UB2U2BF'KF2D'UL2F'UR'U'R2 D3U2F3B3R3F3B3L3R3D1U1R3F1B1D1F1B3L3R1F3B1 F2R'U2BF'L2DF'U2R2'W12R2' F1B1U112F3B1L3R3F3B1D3D1 B'DULU2LF2U2L'D'UB12FR2FR2 F1B1U112F3B1L3R3F3B1D3D3U3 F2R'U2F'L2D'W1'FR'U' D1U2F2L3R1U2B3L1R1B1B1L1F1B3D1U3 F2L'FLV2R'F2D'BLDU'LR'U F3B1R3F3B3U3F3B3D3U3L1R115F1B112F3B3 B'FLU2F2LDU'B'R2FL2BLR'D2U' D3U2F2L1R3D2F1D3U3R3F3B1L1R3F1D2L1R1 B'FLU2F2LDU'B'R2FL2BLR'D2U' D3U2F2L1R3D2F1D3U3R3F3B3L3R3F3B1D3U3 L'B'FDB'FDUZBDRF'DB'D'F'R' F1B313R2F1B1U3F1B1D3U3L3R3U3F3B3R3F3B1D3U3 L'B'FD2D'BD'FD'U'B'LR'U' F3B17B111F1B1D1U31R3D1F3B3L2R1F3B1D1U3 L'BFD2L'BFL2UBF'DU'F'LR'U' F3B133R2F1B1U3F1B1D2U113R3U1F3B3B2L2R1F3B1D1U3 L2BF'D2L'BFUBF'DU'F'LR'U' F3B130U3L3R1U2F3L1R1B3B1D3U3L3R3D2U3 L2BF'D2L'BFUBF'DU'F'LR'U' F1B31R2F3B3U2L3R1E3D1U31L1R1UF3B31D3F3B3U11R1 LDU'FR2B2F12R2L2R2F'L2F2R2DUZ'R'U'F'R' F1B311R2F3B3U2AR1B3B3D1U31L1R1 L2BF'D2L'BFUBF'DU'F'LR'U' R2F1B3D2CU3L1R1UF4B2L1R1U3F3B3D1U31L1F1B3 B2U'U'F'U'R'BLR'BFUDUFLR' L2B2R2D2U3L1R1UF2B2L1R1D35F3B3U31L1R1 B2U'U'F'U'R'BLR'BFUUFUR' F2B311R2F3B1112F3F3B111R3F2D35F1B1382 B2L2B2U'L'R'B'L2F2D'UL2B'				
B2L2UB2U2BF'R'F2D'UL2F'L'R'U'R2 D3U2F3B3R3F3B3L3R3D1U1R3F1B1D1F1B3L3R1F3B1 F2R'U2BF'L2D'F2D2'N8'L2RF2F'U2R2 F1B1U1L2F3B1D2R1D1U1F2B3L1R3F3B1L3R3F1B3D3U1 B'DULU2L2FR2FV2 F1B3L1R3F3B3U3F3B3D3U3F1B1U3F1B1L3R5F1B3D3U3 F2LRFU2RF2D2U'N'W1CFR'U' F1B3L1R3F3B3U3F3B3D3U3F1B1U3F1B1L3R5F1B3D3U3 F2LFRU2RF2D'BFLDU'LR'U F3B1R3F3B3U3F3B3D3U3F1B103F1B1L3R5F1B3D3U3 B'FL02D'UB'R2F12BLR'D2U' D3U2F2L1R3D2F1D3U3R3F3B1L3R5F1B1U3F1B1D13L3R2F3B3 B'FL02D'UR2B'D'B'R2' F1B3L3R2F1B1U3F1B1D3U3L3R1D3B3B3B3F3B3L2R1F3B1D1U3 L'B'FDB'F'DU2BDRF'DB'D'F'R' F1B3L3R2F1B1U3F1B1D1U1L3R3U1F3B3L2R1F3B1D1U3 R'F2D2BFD2UBF2UBC'DF'R' F1B3L3R2F1B1U3F1B1D1F1B1D1U1L3R3U1F3B3L2R1F3B1D1U3 L2BF'D2LBFL2UBF'DU'F'LR'U R2F1B3D2L2R1F1B1U1F1B1D11B3D3U2L3R3D2U3 R2D B'F'L2R2CV2RU2L'D'UF'LR' D1U2F3B3D2U3L1R1UF2B2L1R1U3F3B3D3U3 DU'F'R2ECLR2F1C2FL2R2FUC'R' F1B3L1R2F3B3U1F3B3D1U1LR1UF1B1L3R2F3B3D1U1 B2FU2L2F'D'URB2L'F2R'BF'U'L'R' L1R1U1R2F3B1D2R1FB1U1F3B1D1U3F1B2U2 B2L2B2D'L'R'B'LDUFLR' C2BR2D2U3F1B1L2R3F3B11LR3F2B3D1U1L1R1UF1B1 B2FU2L2F'D'UL2B'L2R2CU2F2RU'L'R' R2BR2D2U3F1B1D3F1B1D3U3A3R3D3F3B3L12L3F3B1 B2FU2L2F'D'UL2B'L2R2CU2F2RU'L'R' R2BR2D2U3F1B1U1F2B2L1R1B3B3B3D1U2L3R5D3U3L3R3B3D2U3 B2LU2F'D'URB2L'F2R2'BFULR'R'				
F2R'U2BF'L2D'F2D2L'RB'L2R2F'U2R2 F1B1U1L2F3B1D2R1D1U1F2B3L1R3F3B1L3D3U1 B'DULU2L2F2U2L'D'U'BL2F02F'R2 F1B3L1R2F3B3U3L3R3D3U3E1B1U3F1B1L3F1B3D3U1 F2LRFU2LR'F2D'BFLDU'LR'U F3B1R3F3B3U3F3B3D3U3L1R1U3F1B1L3F1B3D1U3 F2LRFU2LR'FD'BFLDU'LR'U F3B1R3F3B3U3F3B3D3U3L1R1U3F1B1L3F1B1D3U3 B'F'LU2F2DU'RB'FD'U'FR'U D102F2L3R102B3LTR1B2D2U3L3R3F3B3L1R3F1D2L1R1 B'F'LD2DU'R2L'DU'R'U' F3B1R1F1B1U3F1B1D3U3F3B3U3F3B3L2R1F3B1D1U3 L'BF'DE'DU2BDRFDB'D'F'R' F1B3L3R2F1B1U3L1R1D3U3F3B3U3F3B3L2R1F3B1D1U3 R'F2D2BFD'R2U'L2F2R2UB2'BF'R' F1B3L3R2F1B1U3L1R1B3D3U3F3B3L2R1F3B1D1U3 L2BF'D2LBFL2UBF'DU'F'L'R'U F3B1D3U1B3D3U3L1B2D1U3L2F3L3R3B2D2U3 L2BF'D2LBFL2UBF'DU'F'L'R'U F3B1D3U1B3D3U3L1B2D1U3LF3B3D1U3F3B3D1L1R1 LDU'FR2BFL2LRE'DUF'L'R' F1B3L1R2F3B3D1F3B3D1U3F3B3D1U3 B2FU2L2F'D'URB2'F2R'BF'U'R' F1B3L1R2F3B3D1F3B3D1U3F3B3D1U3 B2FU2L2F'D'URB2'F2R'BF'U'R' F1B3L1R2F3B3D1F3B3D1U3F3B3D1U3 B2L2B2DL'R'B'LRSF'BULR'R K2B2R2D2U3F1B1L3R3F3B3D3J1R3F3B3D1U3 B2L2B2DL'R'B'LRSF'BULR'R R2B2R2D2U3F1B1L2R3F3B1L1R3F1B2D3U3L2R3F3B31 B2L2B2DL'R'B'LRSF'LDUF'LR' R2B1R3F3B3D1F1R1 B2L2B2DL'R'B'LRSF'LDUF'LR' F2B1L3R3F3B1D3F1B1D3U31A5F3B3D3L2 B2L2R2DL'R'B'L2R'BUFUR'R'R </td <td></td> <td></td>				
B'DULU2L2F2U2L'D'U'BL2FR2F'R2 F1B3L1R2F3B3U3L3R3D3U3F1B1U3F1B1L3R2F1B3D3U1 F2LFRU2IR'P2D'BFLD'U'R'U F3B1R3F3B3U3L3R3D3U3F1B1U3F1B1L3R2F1B3D1U3 F2L'FL'URB'FL'D'R'U'L'FR'U' D1U2F2L3R1U2B3L1R1B2D2U3L3R1D1U3L1R2F3B3 B'FLU2F2LDU'B'R2FL2BLR'D2U' D3U2F2L1R3D2F1D3U3R3F3B1L1R3F1D2L1R1 B'FLU5PL'DU'BZPCL2BL'DU'LR'U' F3B1R1F1B1U31F1B1D3U3L3R3U3F3B3R3F3B1D3U1 L'B'FDB'FDU2BDR'DB'D'F'R' F1B3L3R2F1B1U311R1D3U3F3B3U3F3B3L2R1F3B1D1U3 R'F2D2BFD'ZU'L2F2R2UB2D'B'R' F1B3L3R2F1B1U311R1D3U3F3B3U3F3B3L2R1F3B1D1U3 L2BF'D2L'BFUBUF'DU'F'L2R'U F3B1D3U1B3D3U311B2D1U312F313R3B2D2U3 L2BF'D2LBFL2UBF'DU'F'L2R'U R2F1B3D2L2R1F1B1U1F1B3D1U3F3B3D3F3B3D111R1 DU'FR2BFL2R2F12F2LF2LR2PLU'R' F1B3L3R7F3B3U1F3B3D1U1L3F1B3D3U3 B2FU2L2FD'URB2L'F2R'BFU'LR' L1R1U1R2F3B1U2R1F1B1U1F3B3D1U3F1B2U2 B2FU2L2FD'URB2L'F2R'BFUU'R' L1R1U1R2F3B1U2R1F1B1U1F3B3D1U3F1B2U2 B2FU2L2FD'U'R'B'KB'FLDUF'LR' R2BR2D2U3S1E112R3F3B3U1R3F2B31L2R5F3B11 B2R2U'B2U'F'B'FUBFLR' R2BR2D2U3F1E12D2T11R3F1B2D3U312R3F3B1 B2R2U'B2UB'F'F2PU'L2B'KRRP2 F3B1L3R2F1B1D3U313R3F3B3L2R3F3B1 B2R2U'B2UB'F'F'F''R' F2L3R1U2F3B2L1R1D3U332R3F3B3L2R3F3B1 B2R2U'B2UB'F'F'F''R''F''R' F2L3R1U2F3B2L1R1D3U313F3B3D3U313				
F2LRFU2LR'F2D'BFLDU'LR'U F3B1R3F3B3U3F3B3D3U3L1R1U3F1B1L1F1B3D1U3 F2L'FLR'URB'FL'D'R'U'L'F'R'U' D1U2F2L3R1U2B3LR1B2D2U3L3R1D1U3L1R2F3B3 B'FLU2F2LDU'B'R2FL2BLR'D2U' D3U2F2L1R3D2F1D3U3R3F3B3L1R3F1D2L1R1 B'FLB2D'U'B2L'DU'LR'U' F3B1R3F3B1U3L1R3F1B1U3F1B1D3U3L3R3U3F3B3R3F3B1D3U1 L'B'FDB'FDU2BDR'DB'D'F'R' F1B3L3R2F1B1U3L1R1D3U3F3B3U3F3B3L2R1F3B1D1U3 L'B'FDB'FDU2ERC2UBF'D'U'R'U' F3B1R31B2D11B2D1U3L7B3L3R3U57B3L2R1F3B1D1U3 L2BF'D2L'BFUUBF'DU'F'LR'U' F3B1D3U1B2D2U3L2R1F3B1D2U3L3R3U3F3B3D2U3 L2BF'D2L'BFUBF'DU'F'LR'U' F3B1D3U1B2D2U3L1R2D1U32F3L3R3B2D2U3 L2BF'D2L'BFUBF'DU'F'L2L'R'U R2F1B3D1B2D2U3LR2LR1UF3B3D1U1L1R1U1F3B3D3U2L3R3D2U3 R2U'BF'LF2LD2LR'U2'D'U'FLR' D1U7F3B3D2U3LR1F1B1U1F1B3D1U3F3B3D1U3 B2FU2L2F'D'URB2L'F2R'BF'U'L'R' L1R1U1R2F3B1U2R1F1B1U1F3B1D13F1B2U2 B2L2B2D'L'R'B'LR'BF'LDUF'LR' L1B2R2D3U2F3B3L1R2F3B1L1R3F1B2D3U3L2R5F3B1 B2FU2L2F'D'URB2'FRB'FULR' R2B2R2D2U3F1B1L2R3F3B1L3R3F1B2D3U3L2R5F3B1 B2R2U'B2U'LR'B'LBF'UF'LR' R3D1U3L1R3D2U3U3LR7F3B1U2 B2R2U'B2U'LR'B'LBF'UF'LR' R3D1U3L1R3D2U3L2R5F3B1U2 B2R2U'B2'LR'L2RUL'F'R' F2B1L3R1F3B1D3F1B1D3U3L3R5F3B3U12 B2L'D'U'FD'UR B2R'F2RB'FU'LR' R3D1U3L1R3D2U3L3R1AF2B3U3L3R5F3B3U12 B2L'D'U'LR'BL'LBF'U'R' F2L3R1U2F3B2L1				
F2L'FLR'URB'FL'D'R'U'L'F'R'U' D1U2F2L3R1U2B3L1R1B2D2U3L3R1D1U3L1R2F3B3 B'F'LU2F2LDU'B'R2FL2BLR'D2U' D3U2F2L1R3D2F1D3U3R3F3B1L1R3F1D2L1R1 B'FLB2D'UR2B'D'U'B2L'DU'LR'U' F3B1R1F1B1U3F1B1D3U3L3R3U3F3B3L3F3B1D3U1 L'B'FDB'FDU2BDF'DU'B2L'DU'LR'U' F3B1R1F1B1U3F1B1D3U3L3R3U3F3B3L2R1F3B1D1U3 L'B'FDB'FDU2BDF'DU'F'LR'U' F1B3L3R2F1B1U3L1R1D3U3F3B3U2F3B3L2R1F3B1D1U3 L2B'D2L'BFUBF'DU'F'LR'U' R2F1B3D2L2R1F1B1U1F1B3D1U3B2D3U3L3R3D2U3 L2B'D2L'BFUBF'DU'F'LR'U' R2F1B3D2U12R1H1UF2B2L1R1U3F3B3D2U3 L2B'D2L'BFUBF'DU'F'LR'U' R2F1B3D2U2R1F1B1U1F1B3D1U3B3D3U3L3R3D2U3 B2FU2L2F'D'URB2L'F2R'BF'U'L'R' L1R1U7R2F3B1U2R1H1UF2B2L1R1U3F3B3D1U1LF1 LDU'FR2B2FL2R2F'L2FL2R2DU'R' F1B3L1R2F3B3U1F3B3D1U1L1R1UF3B1D1U3F1B2U2 B2L2B2D'L'R'B'LR'BFLDUF'LR' L2B2R2D3U2F3B3L1R2F3B1L1R3F1B2D3U3L2R3F3B1 B2FU2L2F'D'URB2L'F2R'BF'U'L'R' L2B2R2D3U2F3B3L1R2F3B1L1R3F1B2D3U3L2R3F3B1 B2R2U'B2U'B'FL'F2D'UL2B'LRUR2 F3B1L3R2F1B1D3F1B1D3U3L3R3D3F3B3L1R2F3B1D2U B2L2B2D'L'R'B'LR'BF'LDUFLR' R2B2R2D2U3F1B12R3F1B1D3U3L3F3F3B3D2U3 RUFU'R'R'BL'RE'F2R2U'L'F'R' F2L3R1U2F3B2L1R1D1D11F3B3U3L3R3F3B3D2U3 B2RU'B2FL2P2U'L'R'B'LE'F2U'L'F'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U113F3B3D2U3 B2D'L'FD'BLZF2L2U2L2D2UZFZRU'L'F'R' F2L3R1U2F3B3L1L1R1D3U3B2U3L3R1D3U113F3B3D2U3				
B'F'LUZF2LDU'B'R2FL2BLR'D2U' D3U2F2L1R3D2F1D3U3R3F3B1L1R3F1D2L1R1 B'F'LB2D'UR2B'D'U'B2L'DU'LR'U' F3B1R1F1B1U3F1B1D3U3L3R3U3F3B3R3F3B1D3U1 L'B'DB'FDU2BDR'DB'D'F'R' F1B3L3R2F1B1U3L1R1D3U3F3B3U2R3F3B3L2R1F3B1D1U3 R'F2D2BFD'R2U'L2F2R2UB2D'BF'R' F1B3L3R2F1B1U3L1R1D3U3F3B3U2R3F3B3L2R1F3B1D1U3 L2BF'D2L'BFLUBF'DU'F'L'R'U' F3B1D3U1B3D3U3L1B2D1U3L2F3L3R3B2D2U3 L2BF'D2L'BFUBF'DU'F'L'R'U' R2F1B3D2L2R1F1B1U1F1B3D1U3B3U2L3R3D2U3 R2U'BF'LF2LD2U2R'U2L'D'U'F'LR' D1UZF3B3D2U3L1R1U1F2B2L1R1U3F3B3D3F3B3D1L1R1 LDU'FR2B2FL2R2F1'L2FL2R2DU'R' F1B3L1R2F3B3U1F3B3D1U1L1R1U1F1B1L3R2F1B3D3U1 B2FU2L2F'D'UR82L'F2R'BF'U'L'R' L1R1U1R2F3B1U2R1F1B1U1F1B3L1R2F1B3D3U1 B2FU2LZFD'U'RB'LR'BF'DUFLR' R2B2R2D2U3F1B1L2R5F3B1L1R3F1B2D3U3L2R3F3B1 B2R2U'BU'ER'F2RB'FULR' R3B1L3R2F1B1D3F1B1D3U3L3R3D3F3B31R2F3B11 B2R2U'BU'EF1'E2D'UL2B'RUR2 F3B1L3R2F1B1D3F1B1D3U3L3R3D3F3B31R2F3B1D3U1 B2L'D'U'FD'W'B2F12RE'FU'LR' R3D1U3LR3F2B2L1R1D1U1F2D2U1L3R152D3U3L2R3F3B1 B2CU'FD'BL2F2L2DL2U2F2RU'L'F'R' F2L3R1U2F3B2L1R1D1U1F2D2U13R1D3U1L3F3B3D2U3 RUFU'LR'BLR'BF'LBF'U'L'R' R3D1U3L1R3F3B3L1R3F5B1D3U1 B2D'L'FD'BL2F2L2B'L2RUZU2F2RU'L'F'R' F2L3R1U2F3B2L1R1D1U1F2B2L1R1D3U3R3F3B3D2U3 RUFU'L'R'BLR'BF'LBF'U'LR' R3D				
B'F'LB2D'UR2B'D'U'B2L'DU'LR'U' F3B1R1F1B1U3F1B1D3U3L3R3U3F3B3R3F3B1D3U1 L'B'FDB'F'DU2BDRF'DB'D'F'R' F1B3L3R2F1B1U3L1R1D3U3F3B3U2R15B3L2R15B3LD1U3 R'F2D2BFD'U2L2F2R2UB2D'BF'R' F1B3L3R2F1B1U1F1B1D1U1L3R3U1F3B3L2R15B1D1U3 L2BF'D2LBFL2UBFD'F'L'R'U' F3B1D3U1B3D3U3L1B2D1U3L2F3L3R3B2D2U3 L2BF'D2L'BFLB'DU'F'U2L'R'U R2F1B3D2L2R1F1B1U1F1B3D1U3B3U2L3R3D2U3 R2U'BF'LF2LD2U2R'U2L'D'UF'R' F1B3L1R2F3B3U1F3B3D1U11R1U1F1B1L3R2F1B3D3U3 B2FU2L2F'D'URB2F'L2R_L2R2DU'R' F1B3L1R2F3B3U1F3B3D1U11R1U1F1B1L3R2F1B3D3U3 B2FU2L2F'D'URB2F'L2R'BF'U'L'R' L1R1U1R2F3B1U2R1F1B1U1F3B1D1U3F1B2U2 B2L2B2D'L'R'B'LRBF'RDUFLR' L182R2D3U2F3B3L1R2F3B1L1R3F1B2D3U3L2R3F3B1 F2R2B2UL'R'B'L'F2D'UL2B'RLRRZ F3B113R2F1B1D3F1B1D3U3L3R3D3F3B3L1R2F3B1D4 B2L'D'U'R'BLR'BF'LBF'U'L'R' R2B2R2D2U3F1B1L2R3F3B1L1R3F1B2D3U3L2R3F3B1 B2ZL'D'U'R'BLR'BF'LBF'U'L'R' F3L3R2F1B1D3F1B1D3U3L3R3D3F3B3L1R2F3B104 B2L'D'U'R'BLR'BFLBF'U'R' F3L3R12F1B1D4F3B1D3U3L3R3D3F3B3L1R2F3B104 B2L'L'R'B'FLBF'U'R' F2L3R1U2F3B2L1R1D3U3L3R3D3F3B3D2U3 RUFU'R'BLR'BFLBF'U'R' F2L3R1U2F3B2L1R1D3U3L3R3D3F3B3D2U3 RUFU'R'BLR'BFLBF'U'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U3L3F3B3D2U3 RUFU'R'BLR'BFLBF'U'F'U'R' F2L3R1U2F3B2U1L3R1D3U3L3R1F3B3D2U3				
L'B'FDB'F'DU2BDRF'DB'D'F'R' F1B3L3R2F1B1U3L1R1D3U3F3B3U3F3B3L2R1F3B1D1U3 R'F2D2BFD'R2U'L2F2R2UB2D'BF'R' F1B3L3R2F1B1U1F1B1D1U1L3R3U1F3B3L2R1F3B1D1U3 L2BF'D2L'BFUDF'DU'F'L'R'U' F3B1D3U1B3D3U3L1B2D1U3L2F3L3R3B2D2U3 L2BF'D2L'BFUBF'DU'F'L'R'U R2F1B3D2L2R1F1B1U1F1B3D1U3B3U2L3R3D2U3 R2U'BF'LF2LD2U2R'U2L'D'UF'LR' D1U2F3B3D2U3LR1U1F2B2L1R1U3F3B3D3F3B3D11R1 LDU'FR2B2FL2R2F'L2FL2R2DU'R' F1B3L1R2F3B3U1F3B3D1U1L1R1U1F1B1L3R2F1B3D3U1 B2FU2L2F'D'URB2L'F2R'BF'U'LR' L1R1U1R2F3B1U2R1F3B1L1R3F2B3D1U1LF1B3 B2R2U'R'B'L'RBF'LDUFLR' L2B2R2D2U3F1B1L2R3F3B1L1R3F2B3D1U2R3F3B1 B2R2U'R'B'L'RBF'RDUFLR' R2BR2D2U3F1B1D3J3L3R3F3B3L1R2F3B1U2 B2R2U'B2U2B'FL'F2D'UL2B'LRUR2 F3B113R2F1B1D3F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2R2U'R'B'LB'UF'U'R' R2BR2D2U3F1B112R3F3B1L1R3F1B2D3U3L2R3F3B1 B2R2U'R'B2U2B'FL'F2R'BF'U'LR' R3D1U3L1R3D2U3L1R1F2B1U2L1R3F2D3F1B1D3U1 B2R2U'R'B2U2B'FL'F2R'B'FU'LR' R2B1032113R3D2U3 B2L'D'UF'D'R'B2R'F2RB'U'LR' R2D1U3L1R3D2U3L1R1F2B1U2L1R3F2D3F1B1D3U1 B2D'L'FO'BL2F2L2BFU2R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U3L3F3B3D2U3 B2D'L'FD'UR'B2B'FLB'U'L''R' F2L3R1U2F3B1U1AF3F3B12D1U1F1B3L3R3F2B1 B2D'F1'D2BU2D2U2L2B'CU2R'U' F3B13R3F3B3D1U1L1R1D2UF3B2L2D2U13F3B3D3U3 B2DF2LR'DU'B'N'B'U'LR'FL2R'U2				
R'F2D2BFD'R2U'L2F2R2UB2'D'BF'R' F1B3L3R2F1B1U1F1B1D1U1L3R3U1F3B3L2R1F3B1D1U3 L2BF'D2LBFL2UBF'DU'F'L'R'U' F3B1D3U1B3D3U3LB2D1U3L2F3L3R3B2D2U3 L2BF'D2L'BFUBF'DU'F'L'R'U R2F1B3D2L2R1F1B1U1F1B3D1U3B3U2L3R3D2U3 R2U'BF'LF2LD2U2R'U2L'D'UF'LR' D1U2F3B3D2U3L1R1U1F2B2L1R1U3F3B3D3F3B3D1L1R1 LDU'FR2B2FL2R2F'L2FL2R2DU'R' F1B3L1R2F3B3U1F3B3D1U1L1R1U1F1B1L3R2F1B3D3U1 B2FU2L2F'D'URB2L'F2R'BF'U'L'R' L1R1U1R2F3B1U2R1F1B1U1F3B1D1U3F1B2U2 B2L2B2D'L'R'B'LBF'EDFUFLR' R2B2R2D3U2F3B3L1R2F3B1L1R3F2B3D1U1L1F1B3 F2R2B2UL'R'B'LBF'LDFUFLR' R2B2R2D2U3F1B1L2R3F3B1L1R3F1B2D3U3L2R3F3B1 B2R2U'B2U2B'FL'F2D'UL2B'LRUR2 F3B1L3R2F1B1D3F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2L'D'U'FD'UR'B2R'F2RB'FU'LR' R2B2R2D2U3F1B1L2R3F3B1L1R3F1B2D3U3L3R3D3F3B3D2U3 B2L'D'U'FD'UR'B2R'F2RB'FU'R' F2L3R1U2F3B2L1R1D3U3L3R3D3F3B3D2U3 B2L'D'U'FD'UR'B2R'F2RB'FU'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 B2L'D'U'R'BLR'BF'U'FU'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U113F3B3D2U3 B2L'D'U'L'B'LR'B'FU'FU'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U113F3B3D2U3 B2D'L'FD'UL2B'L2U2L2U2F2RU'L'FR' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U113F3B3D2U3 B2D'L'FD'UR'BU'L2F2U2R'U' F3B12A3F3B11L3F3B3B2D1U2L1R1D1UF1B3L3R3F2B1 B'FD'B2L'RDZ'B'UZR'U'L'R'U D1F3B3D2U1L1R1U1UF1B3U2L3R1B2D2U1L1R1U2				
L2BF'D2LBFL2UBF'DU'F'L'R'U F3B1D3U1B3D3U3L1B2D1U3L2F3L3R3B2D2U3 L2BF'D2L'BFUBF'DU'F'L'R'U R2F1B3D2L2R1F1B1U1F1B3D1U3B3U2L3R3D2U3 R2U'BFLF2LD2U2R'U2L'D'UFLR' D1U2F3B3D2U3L1R1U1F2B2L1R1U3F3B3D3F3B3D1L1R1 LDU'FR2B2FL2R2F'L2FL2R2DU'R' F1B3L1R2F3B3D1U3L1R1U1F7B3D1U3F1B2U2 B2FU2L2F'D'URB2L'F2R'BF'U'L'R' L2B2R2D3U2F3B3L1R2F3B1D1U3F1B2U2 B2L2B2D'L'R'B'L'BF'DUF'LR' L2B2R2D3U2F3B3L1R2F3B1L1R3F1B2D3U3L2R3F3B1 F2R2B2U'R'B'L'F2D'UL2B'LRRP2 F3B113R2F1B1D3151B1D3U3L3R3D3F3B3L1R2F3B1U2 B2L2D'U'R'B'L'F2D'UL2B'LRRP2 F3B113R2F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2CU'B2U2B'FL'F2D'UL2B'LRRP2 F3B113R2F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2L'B2U'B'L'F2D'UL2B'LRUR2 F3B113R2F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2L'B2U'B'L'F2D'UL2B'LRUR2 F3B113R2F1B1D3U3L3R3D3F3B3L3F3B3D3U2 B2L'FD'U'D'U'B2R'F2RB'FU'LR' R3D1U3L1R3D2U3L1R1F2B1U2L1R3F2D3F1B1D3U1 B2D'L'F'D'B2LF2L2U2L2U2F2RU'L'F'R' F2L3R1U2F3B2L1R1D3U3E3R2D3U3L3R3D3U13F3B3D2U3 B2D'L'FD'U'B2R'F2RB'DU'L2V2R'U F3L3R1U2F3B2D1U113R3F3B1L3R3B1D1U1F3B3U73B3 B2D'L'FD'UR'U'L2B'FU'L'R' F2L3R1U2F3B2L3R1D3U3L3R1D3U13F3B3D1U2R3 B'FD'B2L'RD2U'LR'B'DU'L2UR'U' F3L3R2F3B1 B'FD'12B'FU2R'U'L'R'D'L2R'U2 F1F3B3D1U3F3B3D1U2LR1D1UF3B3U73B3B3D1L1R1 B2D'L2R2U2U2B'FK'F2R2DU'FLR'U' <				
L2BF'D2L'BFUBF'DU'F'U2L'R'U R2F1B3D2L2R1F1B1U1F1B3D1U3B3U2L3R3D2U3 R2U'BF'LF2LD2U2R'U2L'D'UF'LR' D1U2F3B3D2U3L1R1U1F2B2L1R1U3F3B3D3F3B3D1L1R1 LDU'FR2B2FL2R2F'L2FL2R2DU'R' F1B3L1R2F3B3D1F3B3D1U1L1R1U1F1B1L3R2F1B3D3U1 B2FU2L2F'D'URB2L'F2R'BF'U'L'R' L1R1U1R2F3B1U2R1F1B1U1F3B1D1J3F1B2U2 B2L2B2D'L'R'B'RBF'LDUF'LR' L2B2R2D3U2F3B311R2F3B1L1R3F2B3D1U1L1F1B3 F2R2B2UL'R'B'RBF'RDUFLR' L2B2R2D3U2F3B311R2F3B1L1R3F1B2D3U3L2R3F3B1 B2R2U'B2U2B'FL'F2D'UL2B'LRUR2 F3B113R2F1B1D3V3L3R3D3F3B3L1R2F3B1U2 B2R2U'B2U2B'FL'F2D'UL2B'LRUR2 F3B113R2F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2R2U'B2U2B'FL'F2D'UL2B'LRUR2 F3B113R2F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2R2U'B2U2B'FL'F2D'UL2B'LRUR2 F3B113R2F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2L'D'U'FD'UR'B2R'F2RB'FU'LR' R3D1U3L1R3D2U3L1R1F2B1U2L1R3F3D3U1L3F3B3D2U3 RUFU'R'BLR'BF'LBF'U'F'U'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 RUFU'R'BLR'BF'LBF'U'R'U' F3L2R2F3D1U113R3F3B11R1B1B1D3U113F3B3D2U3 B2F'D'L2D'R2U'LR'B'U'R'U'L2UZ'U' F3L2R2F3D1U113R3F3B110U1F1B3L3R3F2B1 B'F'D'L2B'FU2R'U'LR'DU'L2UZ'U' F3B113R3F1B1D1118B12D2U111R15B2D2U12R3 B'F'D'2B'L'RD2B'LVR'U'L2UZ'U' L1F3B1D13F3B113F3B1R1D1U1B3U2L3R3B3D3F3B3D1L1R1 B'F'D'2B'LAR'DU'LR'U'L'U' D1F3B3D2U1L1R1D2U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1				
R2U'BF'LF2LD2U2R'U2L'D'UF'LR' D1U2F3B3D2U3L1R1U1F2B2L1R1U3F3B3D3F3B3D1L1R1 LDU'FR2B2FL2R2F'L2FL2R2DU'R' F1B3L1R2F3B3U1F3B3D1U1L1R1U1F1B1L3R2F1B3D3U1 B2FU2L2F'D'URB2L'F2R'BF'U'L'R' L1R1U1R2F3B1U2R3F3B1L1R3F1B3D1U3F1B2U2 B2L2B2D'L'R'B'LR'BF'LDUF'LR' L2B2R2D3U2F3B1L1R3F2B3D1U1L1F1B3 F2R2B2UL'R'B'LR'BF'DUFLR' R2B2R2D2U3F1B1L2R3F3B1L1R3F1B2D3U3L2R3F3B1 B2R2U'B2B'FL'F2D'UL2B'LRUR2 F3B1L3R2F1B1D3F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2L'D'U'FD'UR'B2R'F2RB'FU'R' R3D1U3L1R3D2U3L1R1F2B1U2L1R3F2D3F1B1D3U1 B2D'L'F'D'BL2F2L2U2L2U2F2RU'L'F'R' F2L3R1U2F3B2L1R1D1U1F2D2U1L3R1D3U1L3F3B3D2U3 RUFU'LR'BLR'BF'LBF'U'F'U'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 RUFU'LR'BLR'BF'LBF'U'F'U'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 B2F'D'L2D'R2U'LR'B'DU'L2U2R'U' F3L5R2F3D1U1L3R3F3B1L3F3B3D1U2L1R3F3B12D2U3 B'F'D'B2L'RD2B'L'R'DU'L2U'RU' F3L3R12F3B1U1L3F3B3D1U2L1R1D1U1F3B3U1F3B3 B'F'D'L2B'FU2R'DU'LR'U' D1F3B3D2U1L1R1D2U1F2B2L1R1U3F3B3D3F3B3D1L1R1 B'F'D'L2B'FU2R'DU'B'LR'B'FL2R'U2 F2B1L3R1F3B1R1B2D1U1F2B2L3R1F3B1 B'FD'L2BFDU'R'DW'L2F2R2U' U3F3B3L1D3U3L1R1F1B1L1F1B1D1F1B3L3R1F3B1 B'FD'L2BFU2R'DZ'L'R'DU'R'U2 F2B1L3R1F3B1R1B2D1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'L2RFDU'B'U'L'R'U'U'U2F3B3U3L3R3F3B3D2U1L1R1D2U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1				
LDU'FR2B2FL2R2F'L2FL2R2DU'R' F1B3L1R2F3B3U1F3B3D1U1L1R1U1F1B1L3R2F1B3D3U1 B2FU2L2F'D'URB2L'F2R'BF'U'L'R' L1R1U1R2F3B1U2R1F1B1U1F3B1D1U3F1B2U2 B2L2B2D'L'R'B'LR'BF'LDUF'LR' L2B2R2D3U2F3B3L1R2F3B1L1R3F2B3D1U1L1F1B3 F2R2B2UL'R'B'L'RBF'RDUFLR' R2B2R2D2U3F1B1L2R3F3B1L1R3F1B2D3U3L2R3F3B1 B2R2U'B2U2B'EL'F2D'UL2B'LRUR2 F3B1L3R2F1B1D3U1B3F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2L'D'U'FD'UR'B2R'F2RB'FU'LR' R3D1U3L1R3D2U3L1R1F2B1U2L1R3F2D3F1B1D3U1 B2D'L'FD'BL2F2L2U2U2D2F2RU'L'F'R' F2L3R1U2F3B2L1R1D1U1F2D2U1L3R15P3B3D2U3 RUFU'LR'BLR'BFLBF'U'LR' R2F1D3U1F3B1U1L1R1F3B2R2D1U3F2B3D2U3 RUFU'LR'BLR'BFLBF'U'F'U'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 UB'L'RD'L2D'R2U'LR'B'DU'L2U2R'U F3L2R2F3D1UL1AR3F3B1U2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 UB'L'RD'L2D'R2U'LR'B'DU'L2U2R'U' F3L2R2F3D1UL3R3F3B1L3R3B1D1U1F1B3L3R3F2B1 UB'L'RD'L2D'R2U'LR'B'DU'L2U2R'U' F3L2R2F3D1U1L3R3F3B1L3R3B1D1U1F1B3L3R3F2B1 B'F'D'B2L'RD2B'LR'D'U'BU'L2P2RU' L1F3B1D1U3F3B1L1F1B1D1F1B3L3R3F2B1 B'F'D'L2B'FU2R'D'U'B'LR'B'FL2R'U2 F2B1L3R1F3B1R1D1U1B3U2L3R1B2D2U1L1R1U2 B2D'L2RD2U'LR'DU'R'U'U' D1F3B3D2U3L1R1F1B1L1F1B1D1F1B3L3R1F3B1 B'F'D'L2B'FU2R'U'U'U'D'F1L'R'U' D1F3B3D2U3L1R1F1B2D1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'L2RD2U'LR'DU'R'UZ F2B1L3R1F3B1R1B2D1U1F2B2L1R1D				
B2FU2L2F'D'URB2L'F2R'BF'U'L'R' L1R1U1R2F3B1U2R1F1B1U1F3B1D1U3F1B2U2 B2L2B2D'L'R'B'LR'BF'LDUF'LR' L2B2R2D3U2F3B3L1R2F3B1L1R3F2B3D1U1L1F1B3 F2R2B2UL'R'B'L'RBF'RDUFLR' R2B2R2D2U3F1B1L2R3F3B1L1R3F1B2D3U3L2R3F3B1 B2R2U'B2U2B'FL'F2D'UL2B'LRUR2 F3B1L3R2F1B1D3F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2L'D'U'FD'UR'B2R'F2RB'FU'LR' R3D1U3L1R3D2U3L1R1F2B1U2L1R3F2D3F1B1D3U1 B2D'L'F'D'BL2F2L2U2L2U2F2RU'L'F'R' F2L3R1U2F3B2L1R1D1U1F2D2U1L3R1D3U1L3F3B3D2U3 RUFU'LR'BLR'BF'UF'U'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 RUFU'L'R'BLR'BF'LBF'U'F'U'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 UB'L'RD'L2D'R2U'LR'B'U'L'U' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 UB'L'RD'L2D'R2U'LR'B'UL2U2R'U' F3B1D101F3B1U1L7B3E3D2D103F2D2U2R3 UB'L'RD'L2D'R2U'LR'B'DU'L2U2R'U' F3L3R1F3B1U1L3F3F3B1D101F1B3L3R3F2B1 B'FD'B2L'RD2B'L'RDU'L2U2R'U' F3L3R1F3B11D101B3U2L3R1B2D2U1L1R1D2 B'FD'L2B'FU2R'D'U'B'L'R'B'FL2R'U2 L1F3B1D103F1B11F1B11F1B101F1B3L3R1F3B3 B'FD'L2B'FU2R'D'U'B'LR'B'FL2R'U2 F2B1L3R1F3B1R1D2D1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 R'D'B'L'U2LBEDU'R'BU'LR'U2 D1F3B3D2U1L1R1D2U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2P2C'LRDE'DU'LR'BFU'L'R'U2 D14F3B3D2U1L1R1D2U3F3B3D3D453B3D1L1R1 L2P2C'LRDB'FDU'LR'FL2F2LR' D1U2F3B3D2U1L1R1D2U3F3B3D3F3B3D1L1R1				
B2L2B2D'L'R'B'LR'B'LDUF'LR' L2B2R2D3U2F3B3L1R2F3B1L1R3F2B3D1U111F1B3 F2R2B2UL'R'B'L'RBF'RDUFLR' R2B2R2D2U3F1B1L2R3F3B1L1R3F1B2D3U3L2R3F3B1 B2R2U'B2U2B'FL'F2D'UL2B'LRUR2 F3B1L3R2F1B1D3F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2L'D'U'FD'UR'B2R'F2RB'FU'LR' R3D1U3L1R3D2U3L1R1F2B1U2L1R3F2D3F1B1D3U1 B2D'L'F'D'BL2F2L2U2L2U2F2RU'L'F'R' F2L3R1U2F3B2L1R1D1U1F2D2U1L3R1D3U1L3F3B3D2U3 RUFU'LR'BLR'BF'LBF'U'F'U'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 L2FL'RB'FLBFD'U2B2F2L2BF'U2R' R2F1D3U1F3B1U1L1R1F3B2R2D1U3F2D2U2R3 UB'L'RD'L2D'R2U'LR'BDU'L2R'U' F3L2R2F3D1U113R3F3B1L3F3B3D1U2L1R1D1U1F3B3UF3B3 B'FD'B2L'RD2B'L'R'D'L'R'U' F3L3R1F3B1U3F3B3D1U2L1R1D1U1F3B3UF3B3 B'FD'L2B'FU2R'D'U'B'LR'B'FL2R'U2 F2B1L3R1F3B1R1D1U1B3U2L3R1B2D2U1L1R1U2 B2D'L'RZUL2UB'FR'F2R2DU'FLR'U' D1F3B3D2U1L1R1D2U1F2B2L1R1U3F3B3D3F3B3D1L1R1 R'D'B'L'U2LBFDU'R'DBU'L2F2R2U' U3F3B3L1D3U3L1R1F1B1L1F1B1D1F1B3L3R1F3B1 BFDF2LR'D2FLRD2U'LR'DU'R'U2 F2B1L3R1F3B1R1B2D1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'LRBD'UB'FU'L'R'FL2F2LR' D112F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'LRBD'UB'FU'LR'U'L' D1F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'LRBD'UB'FU'LR'U'L' D1F3B3D2U3L3R3F3R2D1U3F2D2U2L2R3 B2LR'F2U2F2U2F'LRDBF'DU'FL'R'U L2F3D1U3F1B3U3L3R3F3R2D1U3F2D2U2L2R3 <td></td> <td></td>				
F2R2B2UL'R'B'L'RBF'RDUFLR'R2B2R2D2U3F1B1L2R3F3B1L1R3F1B2D3U3L2R3F3B1B2R2U'B2U2B'FL'F2D'UL2B'LRUR2F3B1L3R2F1B1D3F1B1D3U3L3R3D3F3B3L1R2F3B1U2B2L'D'U'FD'UR'B2R'F2RB'FU'LR'R3D1U3L1R3D2U3L1R1F2B1U2L1R3F2D3F1B1D3U1B2D'L'F'D'BL2F2L2U2L2U2F2RU'L'F'R'F2L3R1U2F3B2L1R1D1U1F2D2U1L3R1D3U1L3F3B3D2U3RUFU'LR'BLR'BF'LBF'U'FU'R'F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3L2FL'RB'FLBFD'U2B2F2L2BF'U2R'R2F1D3U1F3B1U1L1R1F3B2R2D1U3F2D2U2R3UB'L'RD'L2D'R2U'LR'B'DU'L2U2R'U'F3L2R2F3D1U113R3F3B113R3B1D1U1F1B3L3R3F2B1B'FD'B2L'RD2B'L'R'DL'RDU'L2R'U2L1F3B1D1U13F3B3D1U2L1R1D1U1F3B3U1F3B3B'FD'L2B'FU2R'DU'B'LR'B'FL2R'U2F2B1L3R1F3B1L3F3B1D1U2L1R1D2U1F3B3U1F3B3B'FD'L2B'FU2R'DU'B'LR'BFL2R'U2F2B1L3R1F3B1L1D2U1F2B2L1R1U3F3B3D3F3B3D1L1R1R'D'B'L'U2LBFDU'R'DBU'L2F2R2U'U3F3B3L1D3U3L1R1F1B1L1F1B1D1F1B3L3R1F3B1B'FD'L2B'LRD2U'LR'DU'R'U2F2B1L3R1F3B1R1B2D1U1F2B2L1R102U3F3B3D3F3B3D1L1R1L2U'LRBD'UBF'D'B2L'R'B'U2LR'U2D1F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1L2U'LRBD'UBF'D'B2L'R'B'U2LR'U2D1F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1L2P2D'LRFDU'B'FU'L'R'FL2F2LR'D1U2F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1L2P2D'LRFDU'B'FU'L'R'FL2F2LR'D1U2F3B3D2U3L1R102U3F2B2U2L2R3B2LR'F2U2F2U2F'LRDBF'DU'F'LR'U'F2D1U2L1R3D1U3R3F3B3D1F2L1R3D2F1L1R1D3U3D'BLR'BF'RD2LRB'FU'R2BF'U2R'U'F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3B2F2L2R2DUL2R2F2B2D1U1				
B2R2U'B2U2B'FL'F2D'UL2B'LRUR2 F3B1L3R2F1B1D3F1B1D3U3L3R3D3F3B3L1R2F3B1U2 B2L'D'U'FD'UR'B2R'F2RB'FU'LR' R3D1U3L1R3D2U3L1R1F2B1U2L1R3F2D3F1B1D3U1 B2D'L'F'D'BL2F2L2U2L2U2F2RU'L'F'R' F2L3R1U2F3B2L1R1D1U1F2D2U1L3R1D3U1L3F3B3D2U3 RUFU'LR'BLR'BF'LBF'U'F'U'R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 L2FL'RB'FLBFD'U2B2F2L2BF'U2R' F2L3R1U2F3B2L1R1D3U3B2U3L3R1D3U1L3F3B3D2U3 UB'L'RD'L2D'R2U'LR'B'DU'L2U2R'U' F3L2R2F3D1U1L3R3F3B1L3R3B1D1U1F1B3L3R3F2B1 B'F'D'B2L'RD2B'L'R'DU'L2R'U2 L1F3B1D1U3F3B1L3F3B3D1U2L1R1D1U1F3B3U1F3B3 B'F'D'L2B'FU2R'D'U'B'LR'B'FL2R'U2 F2B1L3R1F3B1R1D1U1B3U2L3R1B2D2U1L1R1U2 B2D'L2R2UL2UB'FR'F2R2DU'FLR'U' D1F3B3D2U1L1R1D2U1F2B2L1R1U3F3B3D3F3B3D1L1R1 R'D'B'L'U2LBFDU'R'DBU'L2F2R2U' U3F3B3L1D3U3L1R1F1B1L1F1B1D1F1B3L3R1F3B1 BFDF2LR'D2FLRD2U'LR'DU'R'U2 F2B1L3R1F3B1R1B2D1U1F2B1D2L3R1F2U3L1R1 L2V'LRBD'UBF'D'B2L'R'B'U2LR'U2 D1F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'LRFDU'B'FU'L'R'FL2F2LR' D1U2F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2P2U'B'FLD2B2LDUL2R2F'LR'U L2F3D1U3F1B3U3L3R3F3R2D1U3F2D2U2L2R3 B2LR'F2U2F2U2F'LRDBF'DU'F'L'R'U' F2D1U2L1R3D1U3R3F3B3D1F2L1R3D2F1L1R1D3U3 D'BLR'BF'RD2LRB'F'U'R2BF'U2R'U' F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3 B2F2L2R2DU L2R2F2B2D1U1				
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B'F'D'L2B'FU2R'D'U'B'LR'B'FL2R'U2 F2B1L3R1F3B1R1D1U1B3U2L3R1B2D2U1L1R1U2 B2D'L2R2UL2UB'FR'F2R2DU'FLR'U' D1F3B3D2U1L1R1D2U1F2B2L1R1U3F3B3D3F3B3D1L1R1 R'D'B'L'U2LBFDU'R'DBU'L2F2R2U' U3F3B3L1D3U3L1R1F1B1L1F1B1D1F1B3L3R1F3B1 BFDF2LR'D2FLRD2U'LR'DU'R'U2 F2B1L3R1F3B1R1B2D1U1F2B1D2L3R1F2U3L1R1 L2U'LRBD'UBF'D'B2L'R'B'U2LR'U2 D1F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'LRFDU'B'FU'L'R'FL2F2LR' D1U2F3B3D2U1L1R1D2U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2DR2U'B'FLD2B2LDUL2R2F'LR'U L2F3D1U3F1B3U3L3R3F3R2D1U3F2D2U2L2R3 B2LR'F2U2F2U2F'LRDBF'DU'F'L'R'U' F2D1U2L1R3D1U3R3F3B3D1F2L1R3D2F1L1R1D3U3 D'BLR'BF'RD2LRB'F'U'R2BF'U2R'U' F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3 B2F2L2R2DU L2R2F2B2D1U1				
B2D'L2R2UL2UB'FR'F2R2DU'FLR'U' D1F3B3D2U1L1R1D2U1F2B2L1R1U3F3B3D3F3B3D1L1R1 R'D'B'L'U2LBFDU'R'DBU'L2F2R2U' U3F3B3L1D3U3L1R1F1B1L1F1B1D1F1B3L3R1F3B1 BFDF2LR'D2FLRD2U'LR'DU'R'U2 F2B1L3R1F3B1R1B2D1U1F2B1D2L3R1F2U3L1R1 L2U'LRBD'UBF'D'B2L'R'B'U2LR'U2 D1F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'LRFDU'B'FU'L'R'FL2F2LR' D1U2F3B3D2U1L1R1D2U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2DR2U'B'FLD2B2LDUL2R2F'LR'U L2F3D1U3F1B3U3L3R3F3R2D1U3F2D2U2L2R3 B2LR'F2U2F2U2F'LRDBF'DU'F'L'R'U' F2D1U2L1R3D1U3R3F3B3D1F2L1R3D2F1L1R1D3U3 D'BLR'BF'RD2LRB'F'U'R2BF'U2R'U' F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3 B2F2L2R2DU L2R2F2B2D1U1				
R'D'B'L'U2LBFDU'R'DBU'L2F2R2U' U3F3B3L1D3U3L1R1F1B1L1F1B1D1F1B3L3R1F3B1 BFDF2LR'D2FLRD2U'LR'DU'R'U2 F2B1L3R1F3B1R1B2D1U1F2B1D2L3R1F2U3L1R1 L2U'LRBD'UBF'D'B2L'R'B'U2LR'U2 D1F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'LRFDU'B'FU'L'R'FL2F2LR' D1U2F3B3D2U1L1R1D2U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2DR2U'B'FLD2B2LDUL2R2F'LR'U L2F3D1U3F1B3U3L3R3F3R2D1U3F2D2U2L2R3 B2LR'F2U2F2U2F'LRDBF'DU'F'L'R'U' F2D1U2L1R3D1U3R3F3B3D1F2L1R3D2F1L1R1D3U3 D'BLR'BF'RD2LRB'F'U'R2BF'U2R'U' F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3 B2F2L2R2DU L2R2F2B2D1U1				
BFDF2LR'D2FLRD2U'LR'DU'R'U2 F2B1L3R1F3B1R1B2D1U1F2B1D2L3R1F2U3L1R1 L2U'LRBD'UBF'D'B2L'R'B'U2LR'U2 D1F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'LRFDU'B'FU'L'R'FL2F2LR' D1U2F3B3D2U1L1R1D2U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2DR2U'B'FLD2B2LDUL2R2F'LR'U L2F3D1U3F1B3U3L3R3F3R2D1U3F2D2U2L2R3 B2LR'F2U2F2U2F'LRDBF'DU'F'L'R'U' F2D1U2L1R3D1U3R3F3B3D1F2L1R3D2F1L1R1D3U3 D'BLR'BF'RD2LRB'F'U'R2BF'U2R'U' F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3 B2F2L2R2DU L2R2F2B2D1U1				
L2U'LRBD'UBF'D'B2L'R'B'U2LR'U2 D1F3B3D2U3L1R1U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2F2D'LRFDU'B'FU'L'R'FL2F2LR' D1U2F3B3D2U1L1R1D2U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2DR2U'B'FLD2B2LDUL2R2F'LR'U L2F3D1U3F1B3U3L3R3F3R2D1U3F2D2U2L2R3 B2LR'F2U2F2U2F'LRDBF'DU'F'L'R'U' F2D1U2L1R3D1U3R3F3B3D1F2L1R3D2F1L1R1D3U3 D'BLR'BF'RD2LRB'F'U'R2BF'U2R'U' F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3 B2F2L2R2DU L2R2F2B2D1U1				
L2F2D'LRFDU'B'FU'L'R'FL2F2LR' D1U2F3B3D2U1L1R1D2U1F2B2L1R1D2U3F3B3D3F3B3D1L1R1 L2DR2U'B'FLD2B2LDUL2R2F'LR'U L2F3D1U3F1B3U3L3R3F3R2D1U3F2D2U2L2R3 B2LR'F2U2F2U2F'LRDBF'DU'F'L'R'U' F2D1U2L1R3D1U3R3F3B3D1F2L1R3D2F1L1R1D3U3 D'BLR'BF'RD2LRB'F'U'R2BF'U2R'U' F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3 B2F2L2R2DU L2R2F2B2D1U1				
L2DR2U'B'FLD2B2LDUL2R2F'LR'U L2F3D1U3F1B3U3L3R3F3R2D1U3F2D2U2L2R3 B2LR'F2U2F2U2F'LRDBF'DU'F'L'R'U' F2D1U2L1R3D1U3R3F3B3D1F2L1R3D2F1L1R1D3U3 D'BLR'BF'RD2LRB'F'U'R2BF'U2R'U' F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3 B2F2L2R2DU L2R2F2B2D1U1				
B2LR'F2U2F2U2F'LRDBF'DU'F'L'R'U' F2D1U2L1R3D1U3R3F3B3D1F2L1R3D2F1L1R1D3U3 D'BLR'BF'RD2LRB'F'U'R2BF'U2R'U' F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3 B2F2L2R2DU L2R2F2B2D1U1				
D'BLR'BF'RD2LRB'F'U'R2BF'U2R'U' F2D3L3R1D1U3L3F3B3D3U2F2L1R3D2F1L1R1D3U3 B2F2L2R2DU L2R2F2B2D1U1				
B2F2L2R2DU L2R2F2B2D1U1				
DUBZFZLZKZ D1U1LZK2F2B2				
	DOR5F5F5K5	DIUILZKZFZBZ		

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U2L2R2DU'L2R2	U2F2B2D1U3F2B2
L2R2DU'L2R2U2	F2B2D3U1F2B2D2
LR'U2L2U2BFD2L2U2LR'	F3B3D3U3L1R1D3U1L3R3D1U1F1B1D2
LR'D2R2U2B'F'U2R2U2LR'	L1R1D3U3F3B3L3R3D3U3F1B1D1U1
D'R2B'F'L'R'B'F'D'U'R2U'	U3F2D1U1L1R1F1B1L1R1F2D3
DR2B'F'L'R'B'F'D'U'R2U	D2U1F2D3U3L3R3F3B3L3R3F2D3
F2L2B2LR'BFU2R2U2LR'	F3B3D3U3L1R1D3U1L1R1D3U3F3B3D2
F2R2F2LR'B'F'D2R2U2LR'	L3R3D3U3F1B1L1R1D3U3F3B3D1U1
DF2D2F2LRF2D2F2D2L'R'U'	D1F3B3L2D3U3F1B3D1U1L2F1B1D1
DB2D2B2LRF2U2F2D2L'R'U'	U3L1R1F1B1L1R1F3B3L3R3F3B3D3
U'B2U2BFL2D2L'RBF'R2U'	D1B2D1U3F1B1L1R1F1B1D2F2U1
DBFU2R2U2R2B'F'R2U2R2U'	D1U2F3B3L2D3U3F1B3D1U1L2F1B1D3
DBFU2L2D2L2B'F'R2U2R2U'	U3L3R3F1B1L3R3F1B1L3R3F1B1D3
D'L2U2L'R'B'F'L'R'DU'R2U'	U3B2D3U1F1B1L1R1F1B1U2F2D3
DUL'D2U2LD2BF'L2UR2BF'U2R'	F1L1R1F3B1L2D3U1F1B2D1U3F3B1D2U1L3R3F2B1D1U1
LB2F2L'U2BF'R2DL2B'FU2R'D'U'	F2B3L2R2F2B1D1U1F3B1L1R1F3D3U3F1B3L1R1B1D3U3
DF2D'R2DBF'R'F2U2R'DUF'LR'	D1U2L3R3D2B3D1U3F1B3U1F1B1R1U2F1B3R2
UBFR'D2B2R'DU'FL2B'R2F'LR'	D3L3R3U2B3L3R1F3B1R1D1U1B1D2L3R1F2
B'FRU2RD2R'D'UFR2D2FL'R'U'	R2F3B1U2R3F3B3U3F3B1D3U1B1D2L1R1D3U2
D'U'LB2F2L'U2BF'R2DL2B'FU2R'	D3U3B1L1R1F1B3D3U3F3L1R1F3B1D1U1B3L2R2B1
B'FLF2RB2L'D'UFR2D2FL'R'U'	F2L1R3D2B3D3U3R3F1B3L1R3B1U2L1R1D1
LU2BF'R2UL2R2U'L2BF'U2R'D'U'	D1U1F2B3L1R1D2U3F1B3D3U1F3B2D1U3L2F1B3L3R3F3
B2L'F'R'D2U'L2FD2LDBD'F2RU2R2	B2D2U3L1R3D1U3L3R2F1B1U1F2L3R1U2F1L1R1
F2D'L'RDU'L'B'F'U'F2L'RU2F'L'R'	B2U1L3R1D1U3L2R3F1B1D2U3F2L3R1U2F1L1R1
UL'R'FD2L'RF2U'B'F'D2R'DU'LR'	U1F3B3R3U2F3B1L2U1L3R3D2B3D1U3F1B3
U'BFLB2DU'L2F'DUF2RDU'LR'	D2U1B2L1R1F1R2D1U3B2R3D1U1F3B2D1U3F3B1
BF'DU'FR2DURB2D'UR2F'LRU'	F3B1D3U1B1D2L1R1U3L2F1B3U2R1F1B1U3
BF'D'UB'R2D'U'RF2D'UL2F'L'R'U	F1B3D3U1F1B2D3U3R1B2D3U1R2F3L3R3B2D2U3
B2U2BL2D'RDFD2LF2D2U'B'L'F'R2	L1R1F1U2L1R3F2U1F1B1L2R3D1U3L3R1D2U3B2
BLR'BF'RD2LRB'F'U'R2BF'U2R'	L1R1F1U2L1R3F2D2U3F1B1L3R2D1U3L1R3U1B2
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Symmetry Type D _{2d} (face)		
U'LRB2F2L'R'U'	D1U1F3B3L2R2F1B1	
U'LRD2B2F2U2L'R'U'	D3U3F2L3R1F2B2L3R1F2	
U'B2L2U2B2F2U2R2F2U'	L2R2D1U1B2D2U2L2R2F2	
U'B2L2R2U2B2F2U2F2U'	L2R2D1U1B2L2D2U2L2F2	
B2F2U'B2F2L2R2UL2R2	L2R2U1L2R2F2B2U3F2B2	
L2R2U2L2R2U'B2F2L2R2U'	L2R2D2U3F2B2D3U1F2B2D3F2B2	
B2F2D2U'B2F2L2R2U'L2R2	L2R2D2U1F2B2L2R2U1F2B2	
B2F2D2B2F2U'B2F2L2R2U'	F2B2U2F2B2D3F2B2L2R2D3	
UL'R'U2B'F'U2B'F'LRU'	D3U1F3B3L2D3U3F2D1U1R2F1B1	
UL'R'U2BFD2BFLRU'	D3U3L1R1F1B1L1R1F1B1L3R3F1B1	
U'B'F'R2U2BFR2U2F2R2U'	D2U3F3B3L2R2U2F3B3L3R3U2L3R3U1	
DB2R2BFLR'D2B'F'R2U'	F1B1L1F2B2D2U2L3F3B1L2R2F2	
L2B2F2R2D'B2F2R2D2U2R2U'	U1F2B2L2R2D1F2L2R2D2U2F2	
L2B2F2R2D'F2D2U2F2L2R2U'	F2L2R2B2D1F2B2L2D2U2L2U1	
DB2R2B'F'LR'U2B'F'R2U'	D2U1L3R3D1U3F1B1L1R1D1U3F3B3U1	
ULRU2BFU2BFL'R'U'	D1U3F1B1L2D1U1F2D3U3R2F3B3	
ULRU2B'F'D2B'F'L'R'U'	D1U1L3R3F1B1L3R3F3B3L3R3F3B3	
D'B2L'R'U2BFR2D2L'R'U'	D3U2L3R3D3U1L3R3D1U3F1B1L1R1D3	
D'F2LRD2B'F'R2U2L'R'U'	D1L3R3D3U1L1R1D3U1F3B3L1R1D3	
F2L'R'B2R2B'FU2LRU2R2U2	R2F1B1L3R3F2L3R3U2F2B2L3R3F3B1	
R2D2LRD2BF'U2LRU2R2U2	F2B2D3U3B2D1U1L1R1F1B1L1R1F2	
B2L2R2F2DU2F2D2U2F2L2R2U'	D1U2L2R2F2B2U3F2D2U2L2R2F2	
U'F2R2D'ULR'B'FL'R'F2U'	D2U3L1R1F3B3D3U1L3R3D1U3L3R3U1	
U'F2L2DU'L'RB'FL'R'F2U'	D2U3L3R3D3U1L3R3D1U3F3B3L1R1U1	
R2B'F'L2F2L'RB2R2B'F'R2U2	B2L3R3F3B1L3R3F2B1D2L2R2U2F1	

R2D2L'R'U2BF'D2L'R'U2R2U2	D3U3B2L3R3F1B1D2U2L1R1D1U1F2				
DF2LRB2F2D2B'F'R2U2L'R'U'	U1L1R1F1B1D1U3L1R1D1U3L3R3U1				
DB2L'R'U2BFR2B2F2U2L'R'U'	U1L3R3D3U1L1R1D3U1F1B1L1R1U1				
L2U2B2F2U2R2U'L'RD2U2LR'U'	F2B2U2L2R2U3F2B2L1R1F2B2L1R1U1				
L'R'BD2U2B'FD2U2F'LRD'U'	D1U1F3B3R1F2B2L1R3F2B2L3F1B1				
R2D2U'B2F2L2R2U'LRBFLR'	F1B3L3R3F3B3D3U2F2B2L2R2D3F2				
LR'U2R2B2F2D2BFU2R2U2LR'	D1U1L1R1D1U1F1B1L1R1D1U1L2R2F1B1				
LR'U2B2F2L2D2BFU2R2U2LR'	F3B3U2F3B3L3R1F3B3D2F2B2L1R1F2				
F2L2R2F2L2R2D'B2F2R2D2U2R2U'	L2R2U2F2B2U3F2B2L3R3F2B2L3R3U1				
F2L2R2F2L2R2D'F2D2U2F2L2R2U'	L2R2D1U1L2R2D3F2B2L3R3F2B2L3R3U1				
LRB'D2U2BF'D2U2FL'R'D'U'	D1U1F1B1R3D2U2L3R1D2U2L1F3B3				
RD2B2F2U2R'BFRB2D2U2F2R'	F1B1D1U1L1R1D3U3L1R1D1U1L2R2F1B1				
B2L2D2U2F2LR'B'F'U2R2U2LR'	F1B1D2L2R2F1B1L3R1F3B3D2L1R1F2				
L2R2U2B2F2UR2B2F2U2B2F2U2R2U'	F2B2D1U1F2B2D3F2B2L1R1F2B2L1R1U1				
LRF'R2B2F2R2D2U2B2F'L'R'D'U'	D3U3F1B1L2R1F1B3L2R2F3B1L1F3B3				
R2UB'FR'DUB'R2D2FLR'D'R2U'	U2F3B2L3R1D3L3R3B1D3U1L1F3B3U3F3B1L3				
R2F'LFLF2R'U'F'DU'L'B'FUR'	D3U1L2R3F3B1L1R3F3D3U3L2R1U2F3B1L2D3F3B3				
U'LD2L2BF'UB2F2D'B'FR2U2R'U'	L3R1D2U3L3R1D3U1L2R1D3U3B3L2D3U1B2R1				
U'LDL2F'URB2F2L'D'FR2U'R'U'	L1R3D1U2L1R3D3U1L2R3D1U1B1R2D1U3B2L3				
F'R'BL'D'UBR'F2DRF2L'U'F'R	R2D3U2L3R1D1U3L2R1D3U3F3L2D1U3F2R1F3B3				
U'LB2F2L'U2L2U2B'FUR2BF'U2R'U'	L3R1D1U2L1R3D3U1L3D3U3F1L2D3U1F2D2U2L2R3				
B'D'RFLU'BRF2RFLF'L'R'F'U'	L1R1D2U1L3R3D2U3F3B3D3U2L2R2D1L1R1D1U2F1B1D1F3B3				
D'R'B'DU2L2DUR'BFR'D'U2B'R'U'	U3B1R1D2U1B3L1R1F3B3D2U2F1D1U2R1B1D1U2				
F2L2RU2FUL'FD'UL'BU'LU2F'R2	L2R1D3U3F1B2D3U1L1R3D1U3B3L2R2F2D3U3R1D1U1				
B2LR2D2BD'RB'DU'LB'DLD2F'R2	R3D3U3F3D1U3L1R3D1U3F3L2R2B2D3U3L3R2D3U3				
L'U'B2DU'B'FUF'L'D2F'LR2B'U'R'	F1B2D2L3R1F2D3L1R1F1L3R1F3B1L2R3F2L1R1				
B'F'R2FL'RB'FLBFU'R2BF'U2R'	F2B1D2L3R1F2U3L3R3F3L1R3F1B3R3B2L1R1				
U'LR2D'UFD2BL2R2FU2BDU'R'U'	L1R3D3U2F3B1D3U1B1L1R1D3R2F1B3U2F2B2L2R1				
L2BL2U2FL'R'DBF'U2RU2F2L'U2R'	L2B3D3U1F3B1D1U2L3R3F3R2D1U3F2D2U2L2R3				
RFRD'B'FLD'F'U'L'RU'F2L2F2U'	L2R3D3U1L3R1U3L3R3B1D2L3R1F2U1F3B3D3U1				
D'RBDU2RB'F'RD'U'L2D'U2BRU'	D2U1F1R1D1U2F3L1R1F1B1D2U2F2B3D2U1R1F1D1U2				
LFLU'B'FRU'F'D'LR'D2UR2F2R2U'	L2B1D3U1F1B3D2U3L1R1F3B2L2D3U1F2D2U2L3				
R'D2B'FR2ULB2F2D2U2RDR2B'FU2R'	L2D2U1F1B3D3U1B3L3R3D1F2B2L2F1B3D2L2R3F3B3				
D'B2F'D'UR'BFUL'RF'L2FD'UR'U'	L1R1U1L3R3U3F3B3U3F2B2U1L1R1D1U2F1B1D1F3B3				
D'BR2B'F'L'RD'BF'D2B2U2LF2U2R'U'	L2D2F3B1D3U3F1B2D3U3L3F1B3L3R1F1D1U1L1R2F3B3				
DF'LR'DUR2D'R2B2R2B'FR'F2U2R'U'	B2L1R3U2F1B2L3R3D3U3F2D3U2L1R3D3U1L1F1B1D1U2				
DF2R'F2U2B2R'U'FUR'BF'UL'F'R'U'	L1R1U1L3R3U3F3B3D3U2L2R2D3L1R1D1U2F1B1D1F3B3				
L2D'F2L'FRDRBU'F'L'RU2LBR'U2	L3R3D2U3F1B1D1L1R1D1U2L2R2D1U2F3B3U3L3R3D3F1B1				
B2U2R2F2ULRFR2D'UF2R'B'F'R2U'R2	D1F1B1D1L3R3D1U2F2B2L3R3D1U2F1B1U1F1B1U3L3R3				
LU'R'D'F'LR2F2U'R2FD2UB'R'F'R2U2	D3F1B1D3L3R3D1F2B2L3R3D1U2F1B1U1F1B1U3L3R3				
R'B2FUR'F2R2D2B'F'U2L2F2R'UBF2R'	F2B2L2D3F3B1D1U3F3L3R3U1L2F3B1D2R1F3B3				
F2LB2D2L2B2R'B'F'DLR'F'R2F'D2F'R2	F2B2L2D1U2F1B3D1U3B3L3R3D2U3L2F3B1D2R1F3B3				
LD'F'R2U'FD2L'DU2LR2B2U'F'U2F'U'	L3R3D2U3F1B1D1L1R1U1F2B2U1F3B3U3L3R3D3F1B1				
LDUF2UL2U2BD2L2DB'UR'UB2F'U'	L3R3D2U1F1B1D1U2L1R1D2U3F2B2D2U1F3B3U3L3R3D3F1B1				
B2D2F2D'R2B'F'LB2DU'L2B'U2L'R'U'R2	R2D2F3B1D3U3F3D3U3L3F1B3L3R1F3B2D1U1L2R1F1B1				
L2BLFD2U'B'L2UB2L2R'BDLUR'U2	R2U2F1B3D3U3F2B1D3U3L1R2F1B3L3R1F3B2D1U1L2R1F1B1				
L'U'R2F'L2U'R2F2R2FD'L2RD'RU'R'U'	L1R3D1U1L3D3U3F1B1L2B1L1R3D1U3L1R3F3B2D1U1R3F1B1				
L'U2B2U'B'D'U'B'UF2R2D2RUR2FU'R'	F1B3D1U1F1B2L1R1D3U3B2D3F1B3L3R1F3B1D1U2L3R3F1B2L1R1				
D'L'B'D'U2L'B2D2BFU2F2R'D2U'F'R'U'	L2D1U1F3B3L2R1U2F1B3R2U3L3R3F3D3U1F3B1U3				
U'R'B2D'UL2D2U2B'L2B2L2DU'R'D2U2R'U'	F1B2D3U3F1B2D3U3B3L1R1D2U2B1L1R1B1D3U3F3B2L3R3				
D'F'D2L'R'U2F2DF2L'RU2BD2R2DU'R'U'	D1U1R3F2B2D2U3F1L1R3D1U2F3B1U3L1R3F3B2D2U1L2R3				
DL2U2BU2F2LRB2U'B2LR'U2B'DUR'U'	R2D2F3B1D3U3F1B2D3U3R3F3B1L1R3B1D1U1L3F3B3				
URB2F2LD2L2D2BF'U'B2F2R2B'FU2R'U'	R2U2F1B3D3U3B3D3U3L2R1F3B1L1R3B1D1U1L3F3B3				
B2U2F2D2L'RU2BLRDBF'DU'F'L'R'U'	L2D2F3B1D3U3F3D3U3R3F3B1L1R3F2B3D1U1R3F1B1				
D'L2D2FDUF2R'B2D'UR2F'D'U'R2U2R'U'	L2R3D3U3L2R1F3B3L3R2D2U2F1B1D2U2L3R2F3B3L2R1D3U3R1D1U1				
UL2B'L2D2U2R2F'R2U'	D3F3B3U2L3R3U2L1R1F1B1D3				
R2B'F'LRBFD'U'R2	L2D1U1F3B3L3R3F1B1L2				
L2R2U'B2F2L2R2UL2R2	L2R2D3L2R2F2B2D1L2R2				

L2R2D2B2F2U'B2F2L2R2U'	D1U2F2B2L2R2D3L2R2D2F2B2		
D2U'L2F'L2D2U2R2B'R2U'	D3F3B3D2L3R3D2L1R1F1B1D3		
UR2FL2R2F2L2R2F'R2U'	F3B3L1R1F3B3L3R3F1B1L3R3		
L2R2D2U'B2F2L2R2U'L2R2	L2R2D3U2F2B2L2R2D3L2R2		
R2F2D'U'BFLRBF'R2	L2F3B1L3R3F3B3D1U1B2L2		
B2F2U2L2R2U'B2F2L2R2U'	F2B2D2L2R2D3F2B2L2R2D3		
R2B'F'L'R'BFD'U'R2D'U'	D3U3F2L1R1F1B1L3R3D1U1F2		
F2U2BFR2U2L'RBF'R2U2	D2L1R1F1B3L1R1D2F3B3L2F3B3		
R2BFLRB'F'DUR2D'U'	D3U3F2D1U1L3R3F1B1L1R1F2		
F2LR'B'FU2F2LRU2R2U2	F3B3L1R3F3B3D2L1R1B2L1R1D2		
L2BFL'R'BFL2R2DUR2	R2F1B1L3R3F1B1L2R2D1U1L2		
D'L2F2U2B2R2U2L2DU'R2U'	F1B1L1R1F1B1L1R1F1B1L1R1		
B2F2L2BFL'R'B'F'DUR2	F2B2R2F1B1L3R3F3B3D1U1L2		
LRB'D2U2B'FD2U2FL'R'	F3B3L3R2F2B2L3R1F2B2R3F1B1		
F2R2D'U'L2F2R2B2D'U'F2R2	F3B3L3R3F1B1L1R1F3B3L3R3		
F2R2DUR2B2L2F2DUF2R2	F3B3U2F3B3R2D3U3F2D1U1L2		
U2R2B'F'LRBFD'U'R2U2	L1R1F1B1D1U1L3R3D3U3L3R3		
LRF'R2B2F2R2D2U2FL'R'	F3B3L1F1B3L2R2F3B1R3F1B1D2U2		
F2R2D'U'R2F2R2F2D'U'F2R2	F1B1L3R3F3B3L3R3F3B3L1R1		
F2R2DUL2B2L2B2DUF2R2	L1R1F2L2R2D1U1R2D1U1F2L1R1D2		
L'R'BL'RB2F2LR'F'LR	L3R3F1L3R1F2B2L1R3B3L1R1		
R2B2D2L2F2R2F2U2L2DU'R2U2	D1U1L1R1F3B3L3R3F3B3L1R1F1B1		
L2B2D2L2B2R2B2U2R2DU'R2U2	B3L2R2D2U2F3D3U3R3F2B2D2U2L3		
L2BFLRB2D2U2BF'D'U'R2	R2F1B3L1R1D2U2F3B3D3U3B2L2		
B2D2B'F'U2F2L'RB'F'D'U'R2	L2F3B3L1R1F3B3D3U1F2B2D2L2		
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F2LR'B'FU2B2LRU2R2DU'	L1R1D3U1L3R3D1U1F1B1D2L3R3		
R2B2U2L2F2R2F2D2L2DU'R2U2	D1U1L3R3F1B1L1R1F1B1L3R3F3B3		
L2B2U2L2B2R2B2D2R2DU'R2U2	F3B1D3U3F1B3D1U1F3B2R2D2U2L2F1		
BFL'R'BFR2D'B2F2L2R2U'R2	L3R3F1B1L3R3B2U1L2R2F2B2D1B2		
D2L'R'BD2U2BF'D2U2F'LRU2	L3R3F2B3L2R2F1B3L2R2F3L1R1D2U2		
LRF2R2BD2U2L2BF'U2FU2L'R'	L1R1F3B3L1R1F2D1U2F2B2D1U3F2B2D3B2		
F2D'F2L'R'B'F'LU2R2DU2R2U2R'	L2R2F2B2D1B2D3U3L3R3F1B1L3R3B2D1		
B2D2B2U'R2B'F'L'RB2R2BF'U'R2	D1U2B2L3R1F1B1L3R3D3U3L2B2D1U2F2B2L2R2		
L'U'R'D'F2UBLBF'DBF'R'F'R2	F3B3U1L2F3B1D2R1D1U1B1L3R1F3B1R3D1U3		
FU'FR'B'FDBF2UBD'LR'F'R2	U3F3B3D3U3L1R1U3F1B1R1F1B3D1U3F1B3L2R1F3B3		
B2L2R2D'U'L2DB'F'D2B'F'L2R2U'R2	F1B1D3U3F3B3D3U3L2R1F1B3L2R2F3B1R3F3B3		
L2R2F2DUR2D'B2F2L'R'D2L'R'UR2	F1B1L1R3F3B3D1U1F3B3R3D2U2F2B2R3F3B3		
BFL'DU'BD2FU2B'LR'DF2R2U'	B1D2U2F1L3R3D3U3F1B1D1U1B1D1U1F1B1L3R3F3B2		
F2L2FL'RU'B2D'B2F2D'L2D'BF'R'U2	D1U2L1R1D3U3F3B3D3F3B3R3F1B3D3U1F1B3L2R3F1B1		
L2U'BF'LD'U'BL2D2B2FL'RUR2U' R2B'F'RF2D'UL2F'DURDU'LR'U'	L1R1F3B2L1R1F3B3D3U3F1L1R1D2U3F1B3L1R3F1B3D1F2B2		
	D3F1B3D3U1B1D1U1R3F2D1U3R2B1L3R3B2		
F'L'RU'B2D'B2F2D'L2D'BF'RF2R2U2	D2U3F3B3D1U1L1R1U1F1B1L1F3B1D1U3F3B1L1R2F3B3		
	L1R1F3B2L1R1F3B3D3U3F1L1R1D2U3L1R3F1B3L1R3D1F2B2		
R'U'B'F2D'L2R'U2B2F2U2R'DBF2UR B2D'LR'BD'U'RD2B2L'B'FD2U'R2U'	B2L1R3U2F1L1R1D3U3B2D1U2L1R3D1U3L2R1F3B3D1		
L2U2LBF'UL'R'FU2R2FDU'R'U2R'	F1B1L2R3F1B1L3R3D3U3R1F1B1U1L1R3F3B1L1R3D1L2R2 U1F3B3D3U3L1R1D3F1B1L2R3F1B3D1U3F1B3L2R1F3B3		
B2L'R'BL2DU'F2L'DUFDU'BF'U'			
BD'F2L'R'FD'LRU'BL'R'B2U'FD'U'	U3L1R3D1U3R1D1U1B3R2D1U3B2L1F3B3L2		
U2R2BFRB2D'UR2F'D'U'L'D'ULR'U'	L2F3B1D2R3F3B3D3U3R2U1F3B1D1U3F2B3L1R1U3 L1R3U3F3B1D3U1F3L3R3U1R2F3B1D2F2B2L2R3		
BRDF'DFUF'L'B'R'D'LD'U'R2F2U'	L3R1D1U3R1B2D2F1B3U3L2F3B1D2L3R2F3B3D2U1		
BFLU2LD2RDU'F'LRU'R2F2UR2U2 B2L'RD2FDUB2L2R'B'FL'RF'L'R'U'	D2U1L2B2L1R3F1U2L3R1B2D2U1L1R1B1D1U3F3B1		
L2BF'D2RBFD2U'BF'DU'F'U2L'R'U'	L1R3D3U1R1D1U1F2B1R2D1U3B2L1F1B1R2D2U1 B2L3R1D2B1L3R3D1U2L3R1D1U3R1D2F1B1D1U2		
R2U'B2F2LR'FD'U'LF2D2LBF'U'R2U'	F1B3D1U3F3B2D2L1R1D2U1F2B2R2F3B1D2L1F1B1U3		
F2D2LR'FD'ULB2RD2U2L'U2L'BF'U'	L3R1D1U3F3B2D2L1R1D2U1F2B2R2F3B1D2L1F1B1U3		
B2D'L2B2DB'F'LDU'B'U2F'D2F'L'R'U2	B2L3R1D2F1D2U2L1R1D2U1L3R1D3U1R1D2F1B1D2U1		
	ΒΥΓ3ΝΤΩΣΕΙΝΣΩΣΕΙΝΙΩΣΟΙΕΝΙΟΣΟΙΚΙΟΣΕΙΒΙΟΣΟΙ		

F2L2B2D'BFL2R'D'UL'RU'L'R'F'LR'	L2F2R2D2U3F3B3L1R2F1B3L1R3F1D1U1R1F3B1	
BFL'DU'L2F'L2B'D2B'U2LR'D'F2R2U'	L2B2R2D2U3L3R3F3D1U3F3B1D2U3F1B1L1F1B3	
BD2L'R2F2U'L2B'R'B'U'B'U'B'RFL'R'	F3B3D3U3F2B3R2D1U3B2L3F3B3U3L1R3D1U3L1R2F3B1	
FD2L2BU'R2F2U2RUL2F'DL'DL'F'U'	F1B2L2R2B3D1U1F3B3D1U1L3R3B1L3R3F3B3D1U1F1	
L2B2RU2B2R'D2F2U2BF'U'L2D2BF'R'U2	F3B3L2R3D1U1L3R3F3B3R1F1B1D2U3L1R3F1B3L3R1D2U3	
L2D'B'FD2R'DUF'D2L2BU2LR'UR2U'	U3F3B3D1U1L1R1D1F1B1L2R3F1B3D1U3F1B3L2R1F3B3	
BF'D2R'D2R'U2R'B2DU'F'D2R2FL'R'U'	D1F3B1L3R1F3B1U1F1B1L2R1F3B3L1R1D1U1R3F3B3	
L2BFL'B2D'UR2B'F2D'U'L'DU'LR'U'	L3R3F2B3D1U1F3B3L3R3B1L1R1U1F3B1L1R3F1B3D2U3	
B'F'U2L'B'FLR'B2F'DUR'U2B'FR2U'	D3U2L1R1D1U1F3B3U3F1B1L2R3F1B3D1U3F1B3L2R1F3B3	
LDFDB'F2RB'L2R2BL'BF2U'F'U'R'	L1R2B3D3R3D1U3F3B2L3R1F3L3R1D1B1L3R1B1L3R2	
BFL2R'B'FLR'B'R2D'U'R'U2B'FR2U'	D1U2L1R1D3U3F3B3U1F1B1L2R3F1B3D1U3F1B3L2R1F3B3	
B'DF2LRF'DL'R'UB'LRB2UF'D'U'	D2U3L2F1B3U2L1D1U1F1B1L2B3L3R1F1B3L2R1F3B3	
U2LRFU2L'RB2U'B'F'U2R'DU'LR'U'	L1R3D2U3L1R3D3U1L2R3D1U1F3R2D1U3F2D2U2L1R2	
UR2U2F2LB'F'ULR'B2R2U2R2B'D'U'R'U'	D3U1L2F2B3D2U2L1R1B2D2U1F1B3D1U3B1D1U1L1R2B2	
L2D2RB'R'B'R2F'L'D'BUL2F'L2F'LR'U'	L3R3D3U3L2R3B2D3U1R2F3L3R3U3F1B3D1U3F1B2L1R3	
B2DR2UB'FLD'U'L2F2D2F'L2U2FLR'U'	F1D3U3B1L3R3F1B2L2R2D3U3F1B1L3R3B3L1R1F2B3D1U1F1B2	
R2F'R2F'D2R'U'B'DU'RU'L'D2U'RF'R2U'	D1U2R2F3B1U2L3F3B3D1U1L2U1F3B1D1U3B1L1R1	
B2R2DF2D2R2BFR'D'UB'L2F'U2FLR'U'	L1R1F1B2L3R3F1B2L3R3F1B2D1U1F1B2D3U3L2R2B3L1R1B3	
R2U2R2DR2F2U'LR'BDUL'U2F2R'BF'U'	L2R3D2U2F1B1R1D3L1R3F3B1L1R3D3U2L2F2B2R1F3B3L1R2	
D'U'R2B2F2U2B2F2U2R2	U2F2B2D3U1F1B1L2R2F1B1	
B2D2R2B2F2R2U2F2D'U'	D3U3L2R2F1B1L2R2F1B1	
R2B2F2U2B2F2U2R2D'U'	F2B2D3U1F3B3L2R2F3B3D2	
R2F2U2B2F2U2F2R2D'U'	L2R2F3B3L2R2F3B3D3U3	
U'F2L'R'BFL'R'D'U'F2U'	D3B2D1U1L1R1F3B3L1R1B2D3	
U'R2BFL'R'BFDUR2U'	D1U2B2D3U3L3R3F1B1L3R3B2D3	
UF2U2F2LRB2D2F2D2L'R'U'	D1F3B3L1R1F3B3U2F3B3L3R3F3B3D3	
UB2U2B2LRB2U2F2D2L'R'U'	D3L1R1F3B3L1R1F3B3L3R3F3B3D3	
U'L2D2LRB'F'LRDU'R2U'	D1F2D1U3F1B1L3R3F1B1D2B2D1	
UBFU2R2U2L2B'F'R2D2R2U'	D2U1F3B3R2D3U3F3B1D1U1L2F1B1D3	
UBFU2L2D2R2B'F'R2D2R2U'	D3L3R3F3B3L3R3F1B1L3R3F1B1D3	
U'R2B2DUBFL'R'BF'R2U'	D1U2B2L3R1F1B1L3R3D3U3L2B2D3	
U'LRBD2U2B'FD2U2F'L'R'U'	D2U3L3R3F2B1D2U2F1B3D2U2F1L1R1U1	
R2U2R2F2L'RBFL2F2R2U2LR'	F1B1L2R2D1U1L3R3D1U1L3R3D3U3F1B1	
U'L'R'B'D2U2BF'D2U2FLRU'	D1L1R1B1D2U2F1B3D2U2F3L3R3D3U2	
L'RU2L2B2F2U2B'F'U2R2U2LR'	F3B3D1U1L1R1D1U1L1R1D3U3L2R2F3B3	
D'U'RB2F2R'U2BF'R2UR2BF'U2R'	B3U2L3R1B2D1F1B1L1D1U3L1R3D1U2F1B3	
D'U'RDU'F'D2FD2U2B'U2BDU'R'	B1U2L3R1B2D3F3B3L1R2D1U3L3R1U1F1B3	
RB2F2R'U2BF'R2UR2BF'U2R'D'U'	F1B3D2U1L1R3D3U1L1F1B1U3F2L3R1U2B1	
RDU'F'D2FD2U2B'U2BDU'R'D'U'	F1B3D1L3R1D3U1L1R2F3B3U1F2L3R1U2B3	
R2F'U2R2F'LR'UL2DF2D2F2DBF'R	F3B2L1R3F1B3L2R3U2L1R1F3B3D2U3R2F3B1U2R1	
L2FD2R2B'L'RU'R2U2R2U'L2UBF'R'	B3L3R1F1B3R3D2L3R3F1B1D1U2R2F1B3D2R3	
RBF'UF2U2F2UL2DLR'F'R2D2F'R2	R1D2F3B1R2D1F3B3L3R3U2L3R2F1B3L3R1F1	
F'D'B'L'B2L'ULFD2U2LBDU'RU'	R3U2F1B3R2D2U1F1B1L3R3U2R3F1B3L3R1B3	
U'B2UL2U'BF'LB2D2L'R2D'U'FLR'	D1U2F3B3D2R3D1U3L1R3D2U3L1R1B1D2L1R3B2	
DR2DU2R2UB'FL'D2F2L'DUF'LR'	D3F3B3U2R3F1B3L3R1F3B2D1U1L1U2F1B3R2	
B'FLD2LU2L'DU'FL2U2B2F'L'R'U'	B2L3R1D2B3L3R3D2U1L3R1D3U1R1D2F1B1D3U2	
B'FRF2LB2R'DU'FL2U2B2F'L'R'U'	R2F3B1U2L3D3U3F1B2L1R3F3B1R1U2F1B1D1	
DL'R'B2F'D2L'RF2U'B'F'D2R'DU'LR'	D2U3F2L3R3B3R2D3U1F2L2R3D3U3F1B2D1U3F1B3	
U'R2U2B'D'B'R'U'RBR'B2D2F'R'DFR'	U3L3R1F3B1L1R3U3L3R3F1B2L3R3F3B3D1U1F3L1R1	
BF'D'UFDULU2F2U2R2DU'F'LRU'	F3B1D3U1F3B2D1U1L2R1F2D1U3R2B1L1R1F2D2U1	
R2F2DB'F'RDU'R2FD2BU2FD2LR'U'	L3R3F3B2D3U3F1B1L1R1F1L1R1U1F3B1L1R3F1B3D2U3	

Curriculum Vitae

Education

PhD, Mathematics UW-Milwaukee Advisor: Hans Volkmer	Milwaukee, WI, USA	December 2017
MS, Mathematics UW-Milwaukee	Milwaukee, WI, U	JSA May 2007
BS, Applied Mathematics, Engineering, and Physics UW-Madison	Madison, WI, L	JSA May 2004

Assistant Teaching at UW-Milwaukee 2007-2012

Math 095, Introductory Algebra 3 semesters with 2 sections each (students never saw course coordinator)

Math 105, Intermediate Algebra 2 semesters with 2 sections each (students never saw course coordinator)

Math 211, Survey in Calculus and Analytic Geometry 1 semester with 3 discussion sections

Research

MATLAB programming:

Sudoku solver

Slow and limited Rubik's Cube optimal solver compatible with both FTM and SPTM

Twist counter for the 2×2×2×2 Cube (partly compatible with higher dimensions)

C++ programming:

Good-speed Rubik's Cube optimal solver in SPTM