MaPP Challenge ’19 – To Aleph-Zero And Beyond

Mathematical Puzzle Programs

DRAFT 2018/09/11

Version 2018/09/11

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Part I

About

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MaPP Challenge ’19 – To Aleph-Zero And Beyond

Scoresheet

Game Control and your team each have a copy of this scoresheet. When submitting solutions, bring your team’s copy to Game Control to be updated.

School Name	Team Name/ID	League

Opening Puzzle: Where No One Has Gone Before — Used to unlock Main Puzzles

Main Puzzles

1500VP for each Main Puzzle solved; Time Solved used to break ties in VP

1	Good News Everyone	Time Solved	VP Earned
2	Extraterrestrial	Time Solved	VP Earned
3	Wibbly-Wobbly Timey-Wimey	Time Solved	VP Earned
4	Jumping Through Hyperspace	Time Solved	VP Earned

Cryptic Puzzles

500VP for each Cryptic Puzzle solved; Time Solved used to break ties in VP

1	Hailing Frequencies Open	Time Solved	VP Earned
2	Out of Gas	Time Solved	VP Earned
3	An AI Odyssey	Time Solved	VP Earned
4	Word Problem	Time Solved	VP Earned

Bonus Puzzle

Up to 500VP for best submission

The Cosmic Wheel	First Submission	Second Submission	Third Submission	VP Earned

Metapuzzle

1000VP if solved, Time Solved used to break ties in VP

To The Rescue!	Time Solved	VP Earned

Up to 500VP if earned, Time Acquired used to break ties in VP

Additional VP	Time Acquired	VP Earned

	Latest Time	10,000VP Maximum
Final Score		

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Reference Sheet

Letter	Decimal	Binary	Morse	Braille	ROT13	Letter	Decimal	Binary	Morse	Braille	ROT13
A	1	00001	.-	⠁	N	N	14	01110	-.	⠝	A
B	2	00010	-...	⠃	O	O	15	01111	---	⠕	B
C	3	00011	-.-.	⠉	P	P	16	10000	.--.	⠏	C
D	4	00100	-..	⠙	Q	Q	17	10001	--.-	⠟	D
E	5	00101	.	⠑	R	R	18	10010	.-.	⠗	E
F	6	00110	..-.	⠋	S	S	19	10011	...	⠎	F
G	7	00111	--.	⠛	T	T	20	10100	-	⠞	G
H	8	01000	....	⠓	U	U	21	10101	..-	⠥	H
I	9	01001	..	⠊	V	V	22	10110	...-	⠧	I
J	10	01010	.---	⠚	W	W	23	10111	.--	⠺	J
K	11	01011	-.-	⠅	X	X	24	11000	-..-	⠭	K
L	12	01100	.-..	⠇	Y	Y	25	11001	-.--	⠽	L
M	13	01101	--	⠍	Z	Z	26	11010	--..	⠵	M

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Some famous numbers and formulas

$\sqrt{2} \approx$ 1. 41421 35623 73095 04880 16887 24209 69807 85696 71875 37694 80731 76679 73799 07324 78462 10703 88503 87534 32764 15727

$\pi \approx$ 3. 14159 26535 89793 23846 26433 83279 50288 41971 69399 37510 58209 74944 59230 78164 06286 20899 86280 34825 34211 70679

$e \approx$ 2. 71828 18284 59045 23536 02874 71352 66249 77572 47093 69995 95749 66967 62772 40766 30353 54759 45713 82178 52516 64274

Pythagorean Theorem

$$a^2 + b^2 = c^2$$

Quadratic Formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Euler’s Formula

$$e^{ix} = \cos(x) + i \sin(x)$$

Part II

Puzzle Book

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Good News Everyone

Delivery Schedule

Home Planet → Monday, Wednesday, Friday

	1st	2nd	3rd	4th	5th	6th	
Monday	**Comet**	○	**Venus**	**Oxygen**	**Belt**	○	Monday
Wednesday	○	○	**Solar**	○	**Helmet**	**Alpha**	Wednesday
Friday	○	**Light**	○	○	○	**Photon**	Friday

Monday, Wednesday, Friday → Home Planet

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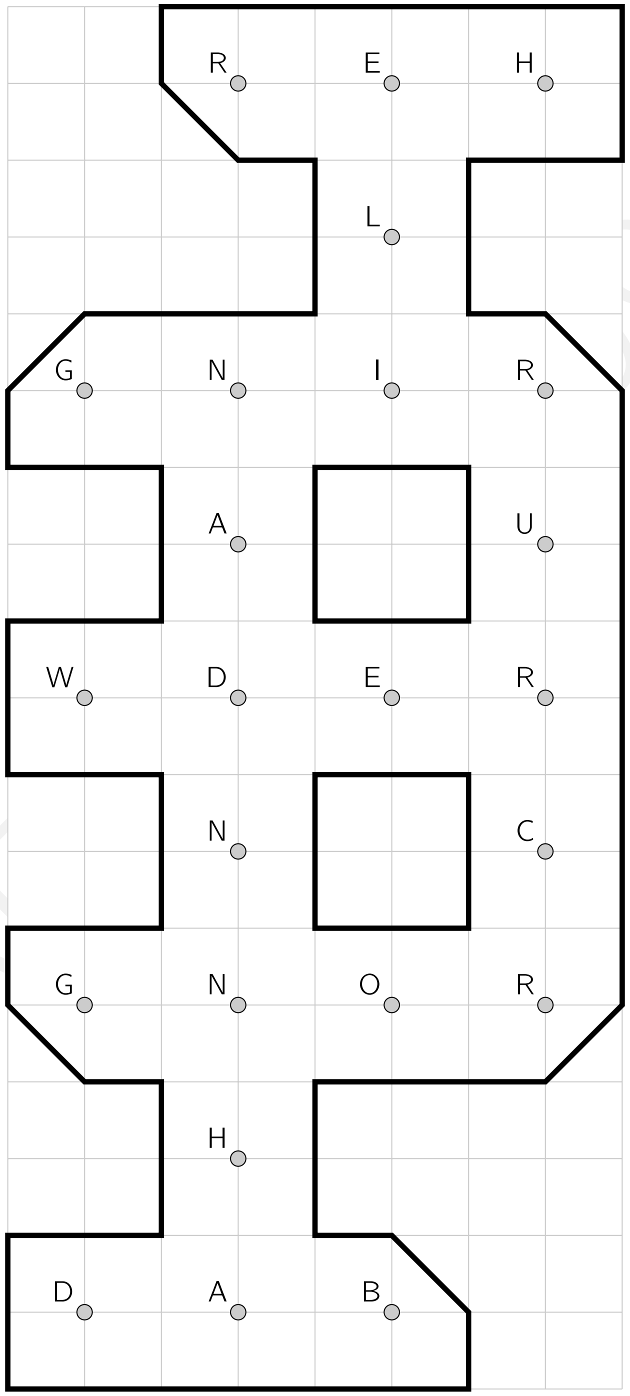
Extraterrestrial

Ship Floorplan


R
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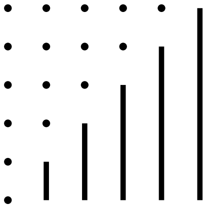
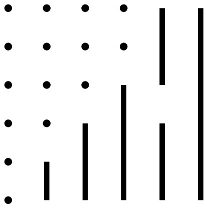
Wibbly-Wobbly Timey-Wimey

Dimensional Signals

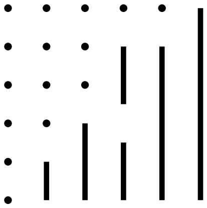
R



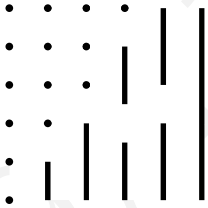
N



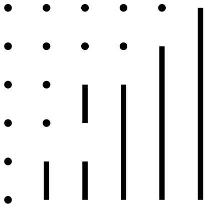
A



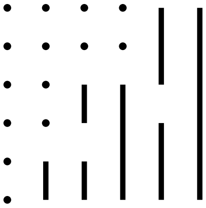
O



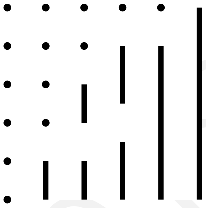
V



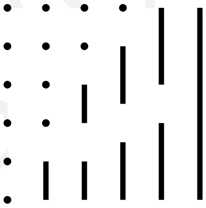
X



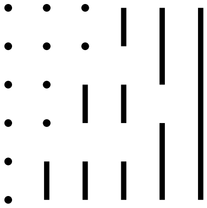
E



S



T



02-45-49-60-67-85 11-28-38-43-72-84 14-27-31-42-62-87

04-15-37-50-73-80 03-32-45-65-90-92 12-32-64-70-89-96

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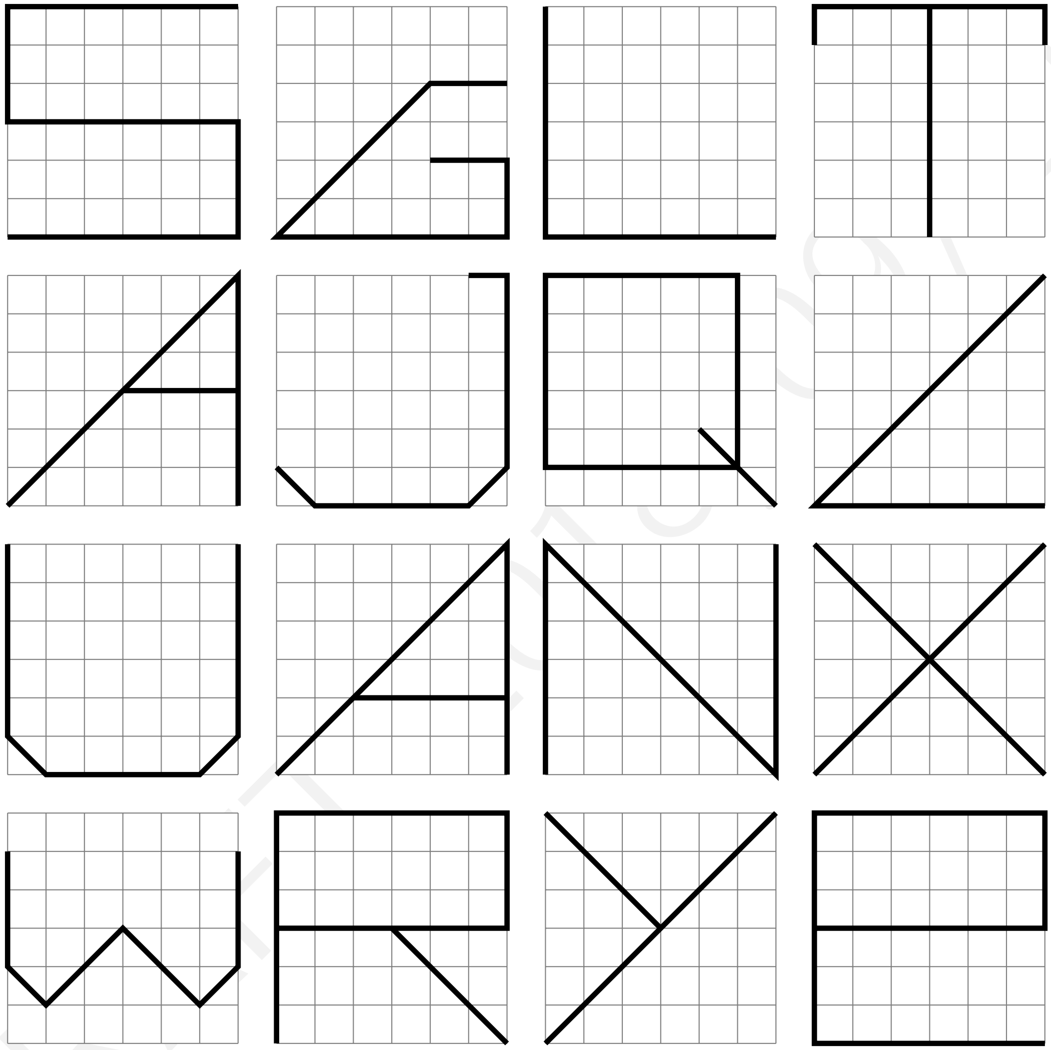
Jumping Through Hyperspace

Hyperspace Engines



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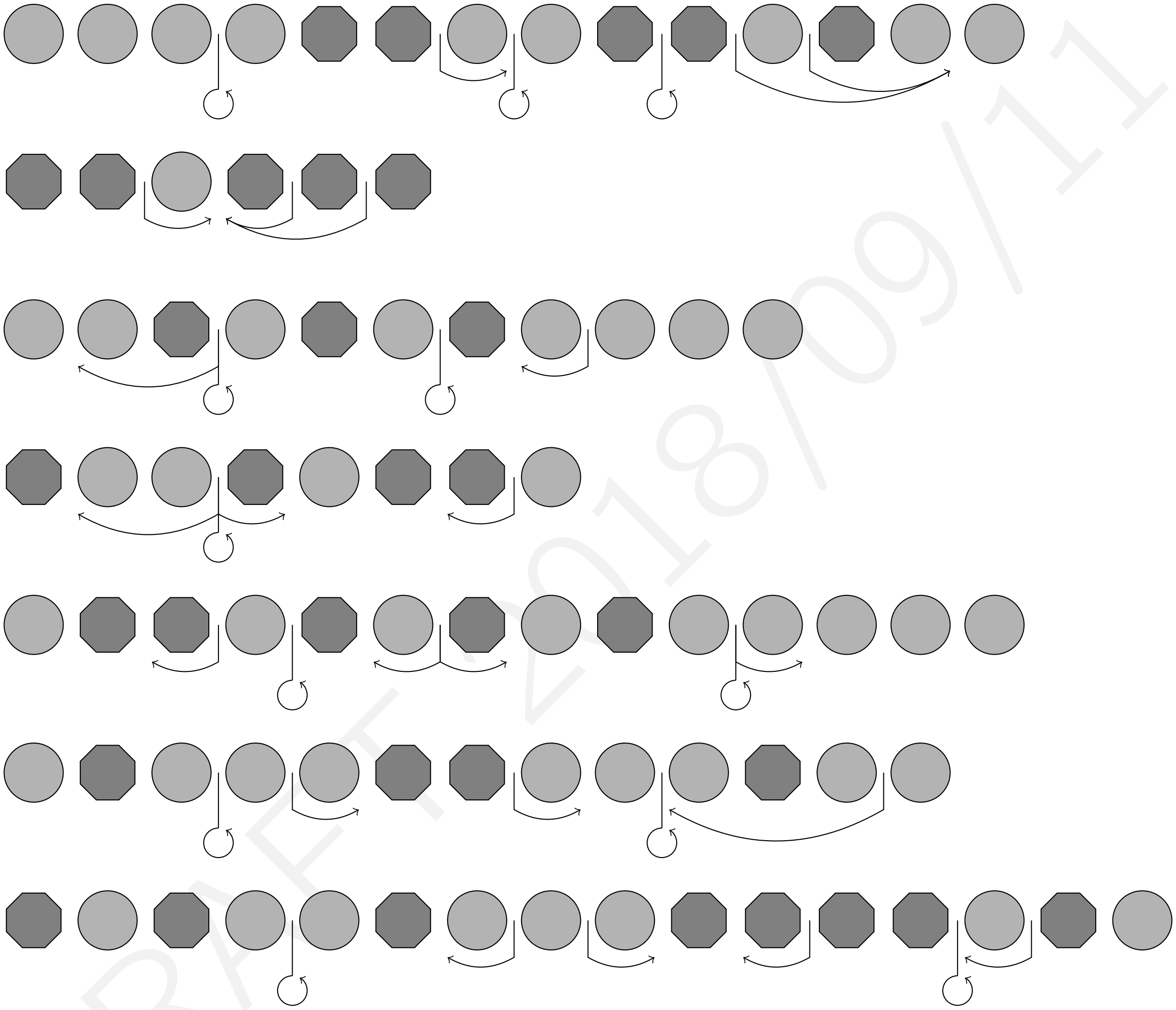
Hailing Frequencies Open

Bleeps and Bloops



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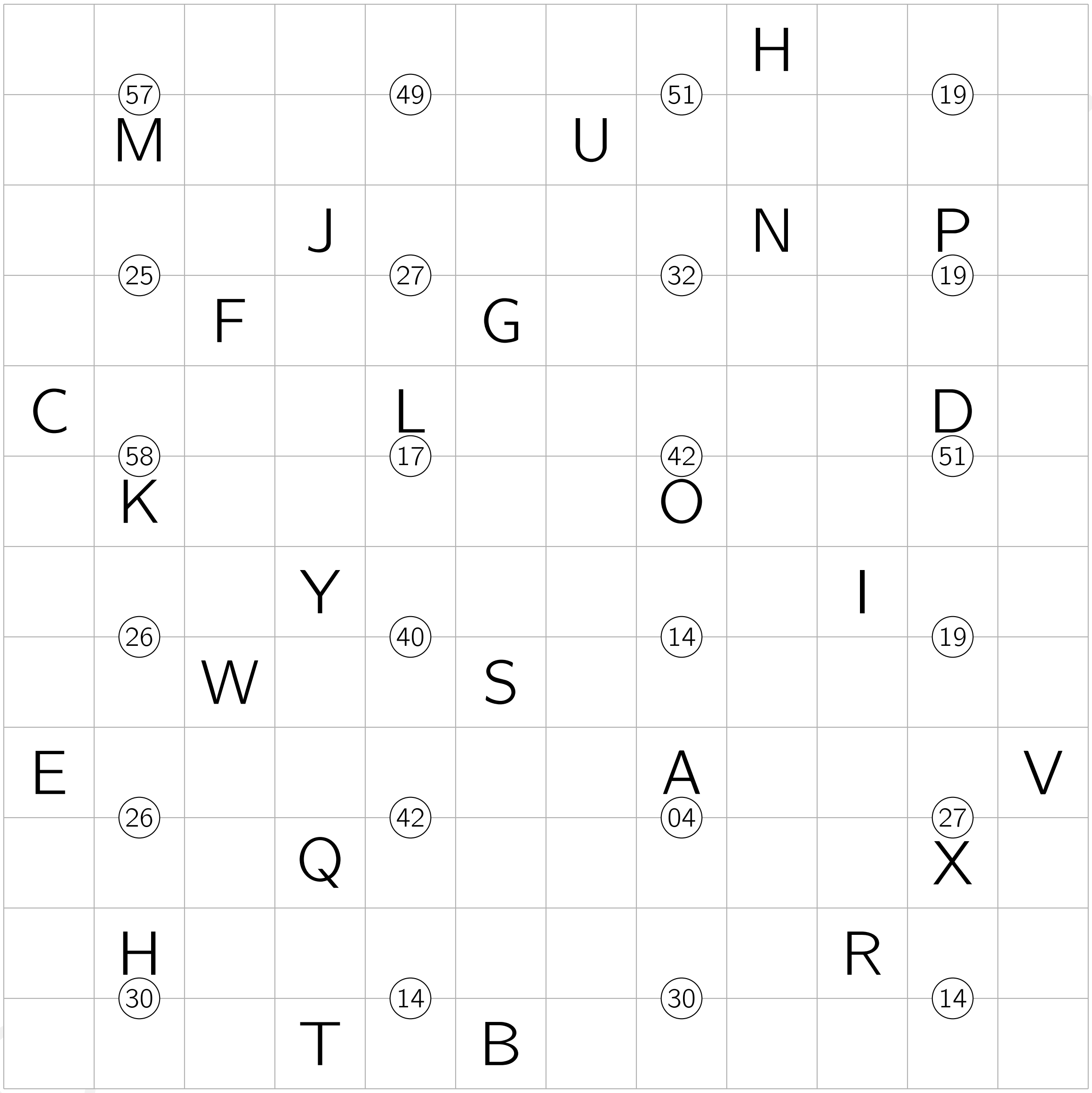
Out of Gas

Reserve Tank Switchboard


H
(57) (49) (51) (19)
M U
J N P
(25) (27) (32) (19)
F G
C L D
(58) (17) (42) (51)
K O
Y I
(26) (40) (14) (19)
W S
E A V
(26) (42) (04) (27)
Q X
H R
(30) (14) (30) (14)
T B

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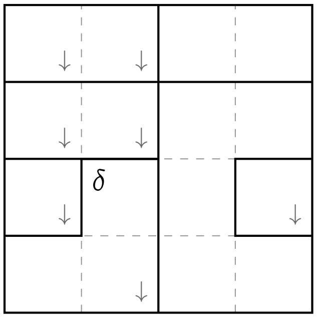
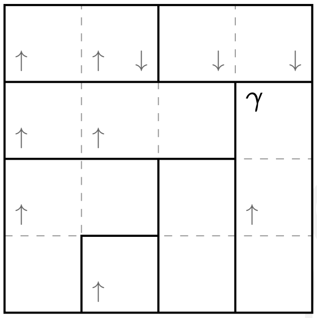
An AI Odyssey

Cubic Monolith





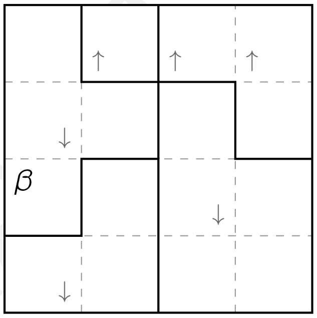
$$5\beta - \alpha + 2\delta$$

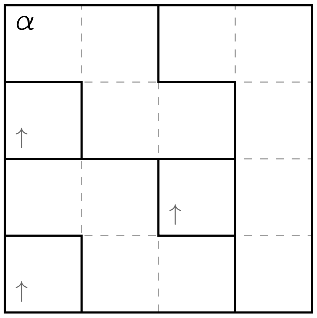
$$5\alpha + \delta - \gamma$$

$$2\beta - 5\gamma + \alpha$$

$$\gamma + 3\delta - 2\beta$$

$$\alpha + \beta + 3\gamma + 3\delta$$





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Word Problem

Mysterious Message

For a time I tried carefully to detail biographies
via large crawling textboxes.

Lamentably, composing all of the anecdotes
when curbed by finite room, the current
strategy now is cruelly killing sound
handwriting.

*To sidestep probable oversights *
*intensely loathe, I entreat humankind, *
ban laughable cuneiform!

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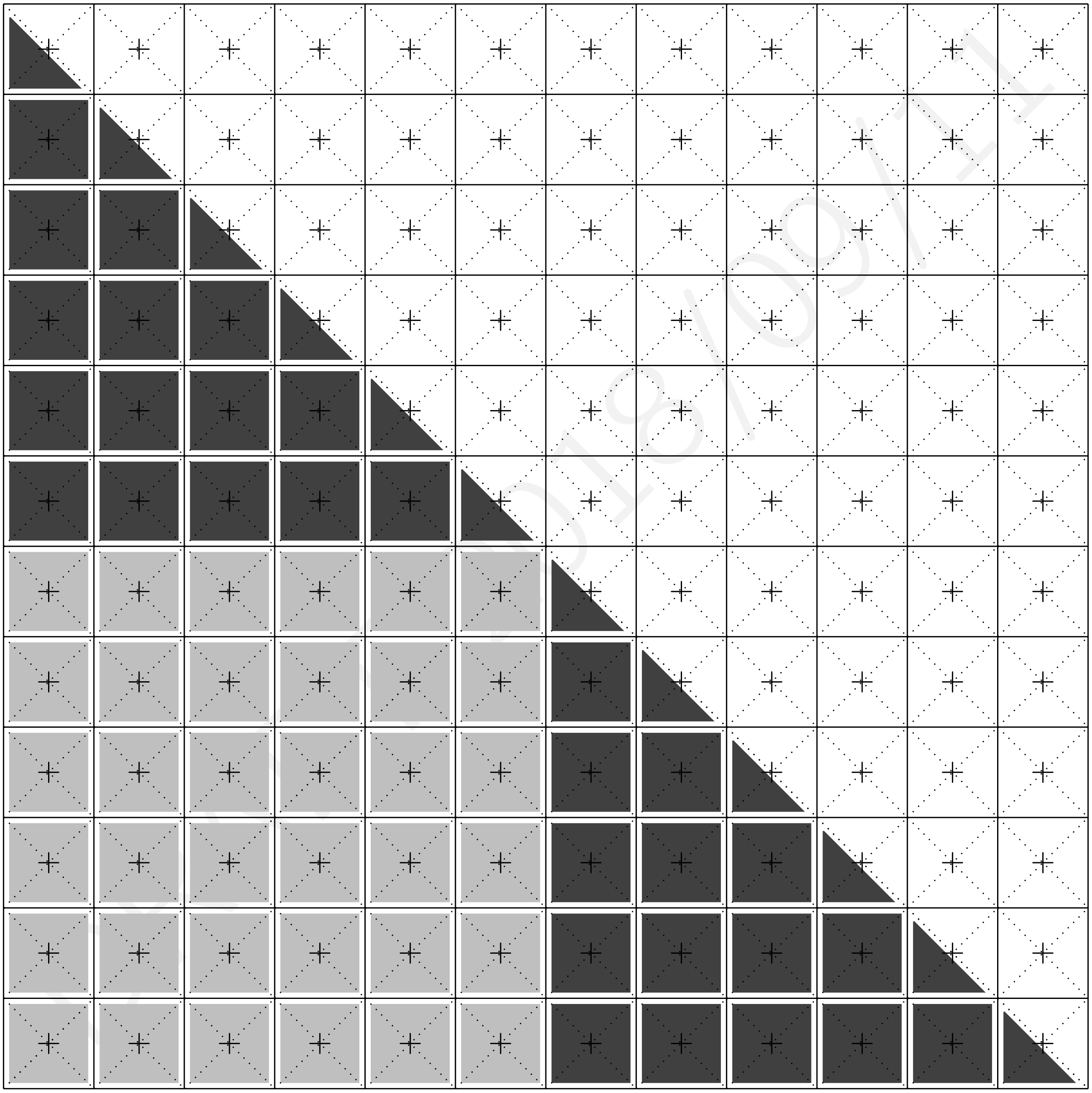
The Cosmic Wheel

Wormhole Alpha (6x6)



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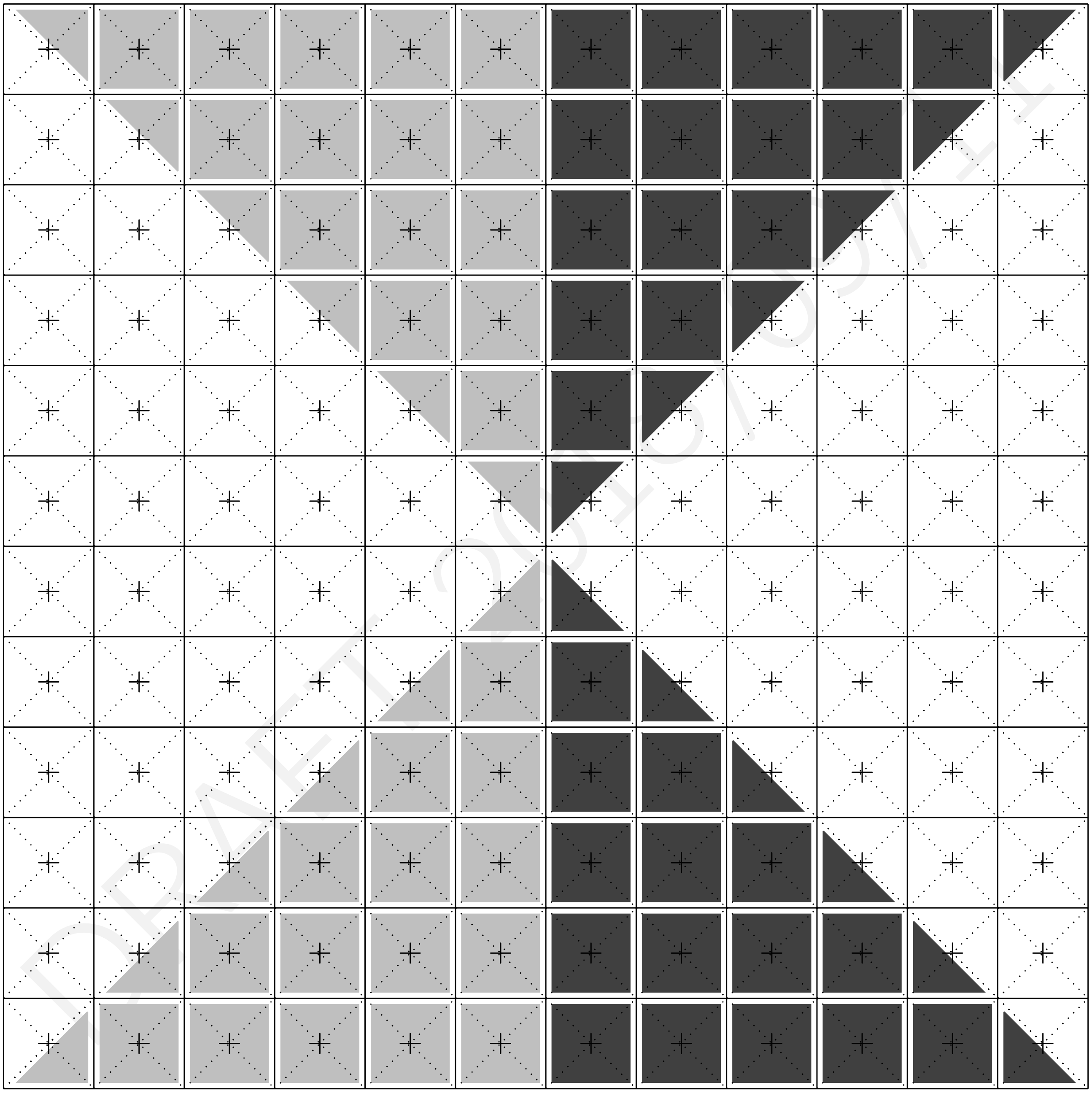
The Cosmic Wheel

Wormhole Beta (6x6)



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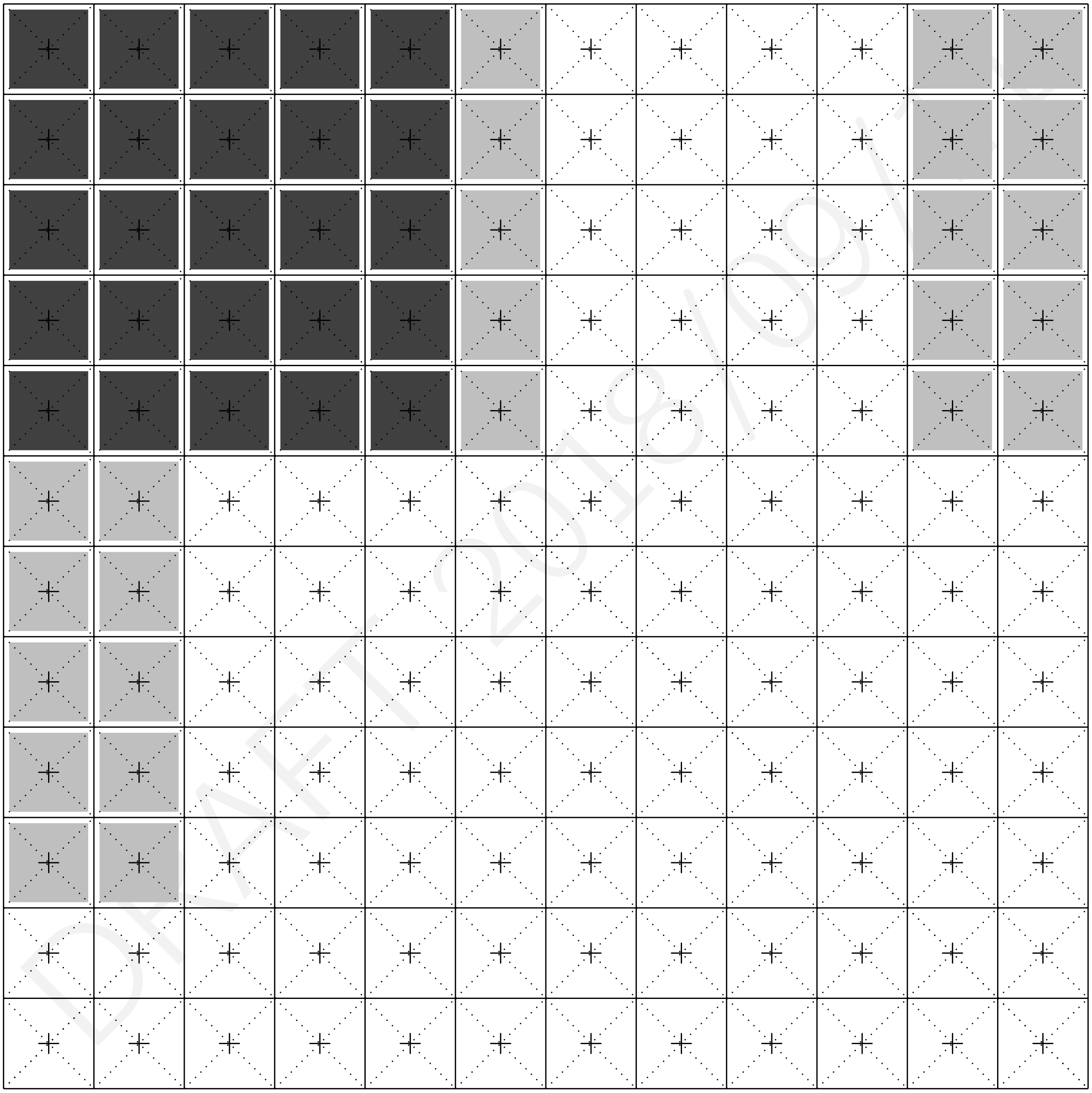
The Cosmic Wheel

Wormhole Gamma (5x5)



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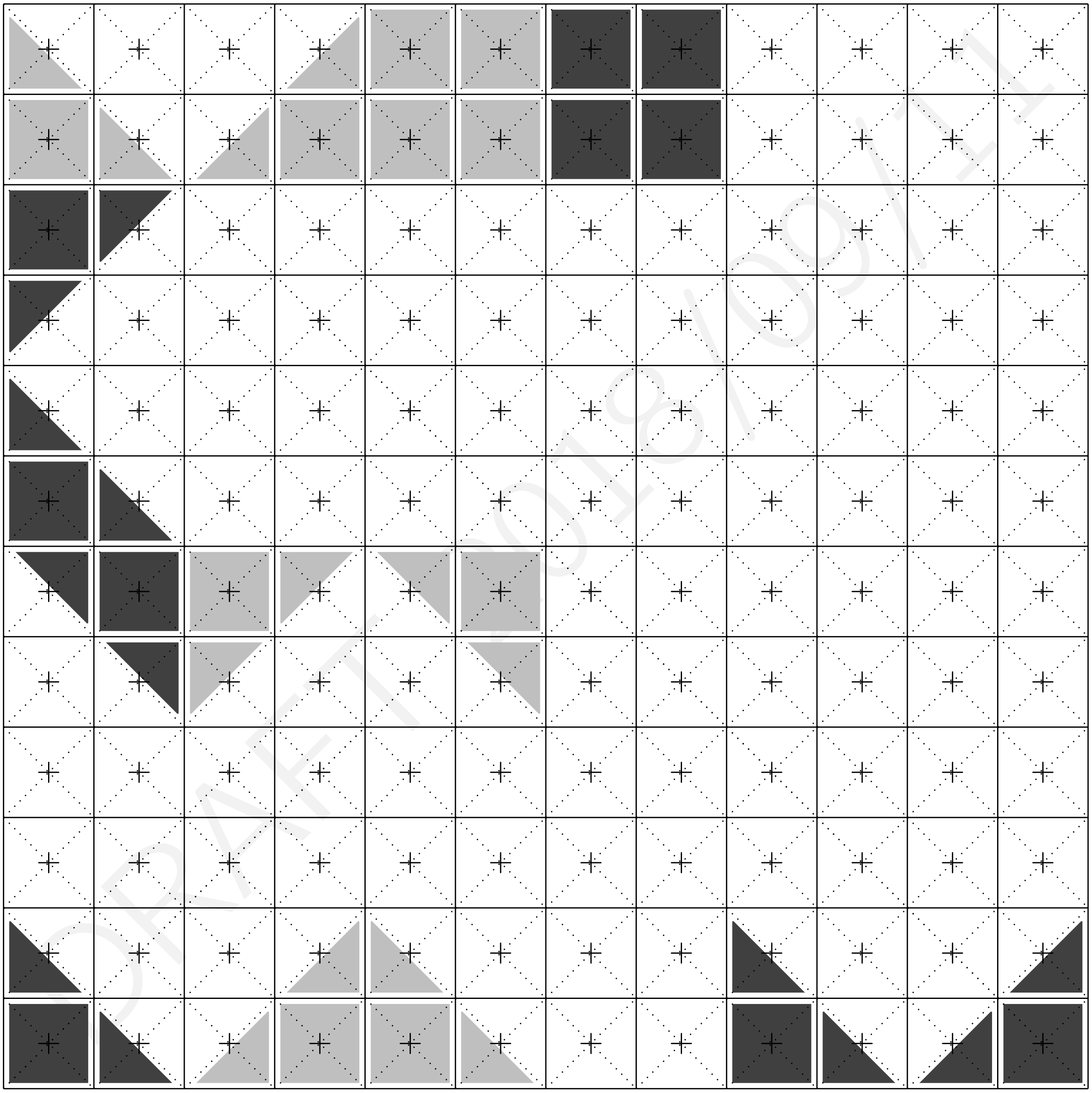
The Cosmic Wheel

Wormhole Omega (4x4)



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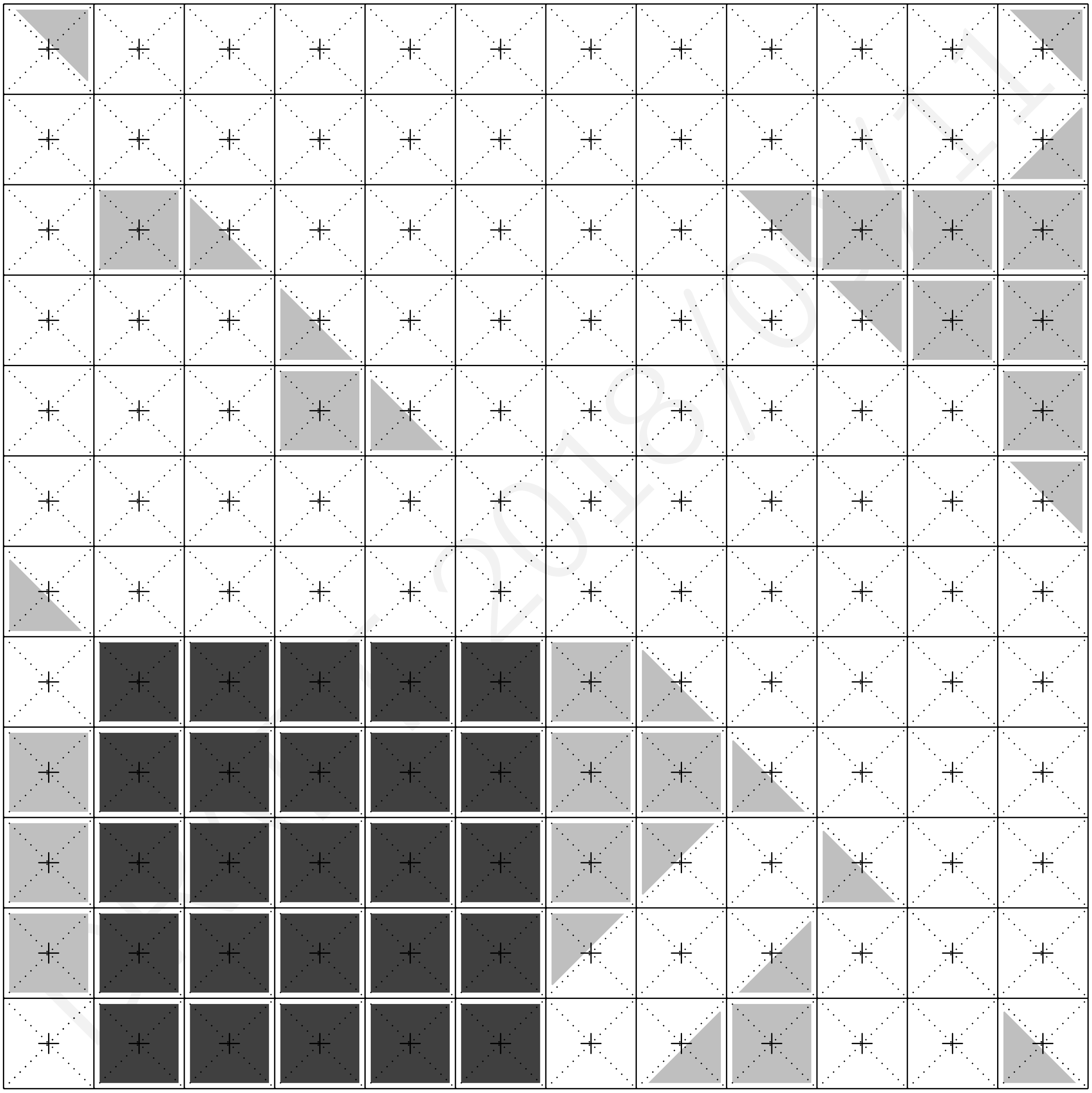
The Cosmic Wheel

Wormhole Zeta (5x5)



Part III

ClueKeeper Text

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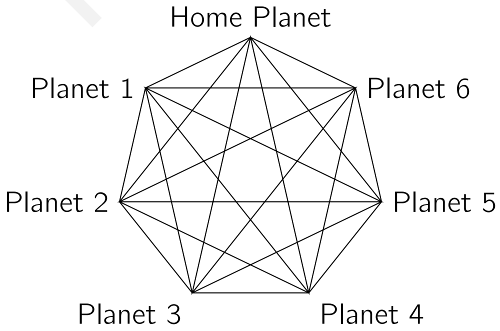
Good News Everyone

Main Puzzle 1

On this system, you find yourself caught up in the misadventures of PlanEx, an intergalactic delivery company led by the eccentric old mathematician Dr. Farnswell. In the name of good relations between galaxies, you agree to help him with the following puzzle.

- PlanEx makes deliveries to six different planets (not including their own) on Mondays, Wednesdays, and Fridays.
- Each day, a different company on each planet receives the delivery, listed below in order of Mon/Wed/Fri.
  - Planet 1: Venus Co. / Rave Co. / Photon Co.
  - Planet 2: Comet Co. / Solar Co. / Light Co.
  - Planet 3: Belt Co. / Techno Co. / Alarm Co.
  - Planet 4: Acme Co. / Alpha Co. / Uranium Co.
  - Planet 5: Oxygen Co. / Helmet Co. / Neo Co.
  - Planet 6: Star Co. / Orion Co. / Tele Co.
- Their ship may travel directly between any two planets, but due to galactic regulations, they may not travel directly between the same two planets twice in the same week (regardless of direction).

Can you help Farnswell complete his **Delivery Schedule**? If so, the missing company names will reveal one of the hidden codewords.



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Extraterrestrial

Main Puzzle 2

The one golden rule of space travel is simple: if you find a creepy egg on a previously unexplored planet, DO NOT TAKE IT BACK WITH YOU. Well, it seems Ensign R. Scott didn't get the memo, as after a routine check on one of this system's planets, your crew finds themselves running for their lives as a mysterious alien rampages your ship!

Fortunately, there is protocol for such a situation. On your **Ship Floorplan**, several stations are marked where you can position a robotic guard to defend against the alien. Five guards must be placed such that every point within the floorplan is visible in a straight line from at least one guard.

An example for two guards is illustrated below. As long as one guard is placed within the top two rows, and the other guard is placed within the bottom two rows, the entire area of the floor is safely monitored. But if a guard is placed on any of the three stations in the middle row, there's no possible way for a second guard to monitor both the top and bottom unaccounted areas.

Your task is to identify all the guard stations on the ship that are unusable when using only five guards. In addition to saving your crew from certain death, you will also reveal a secret codeword!

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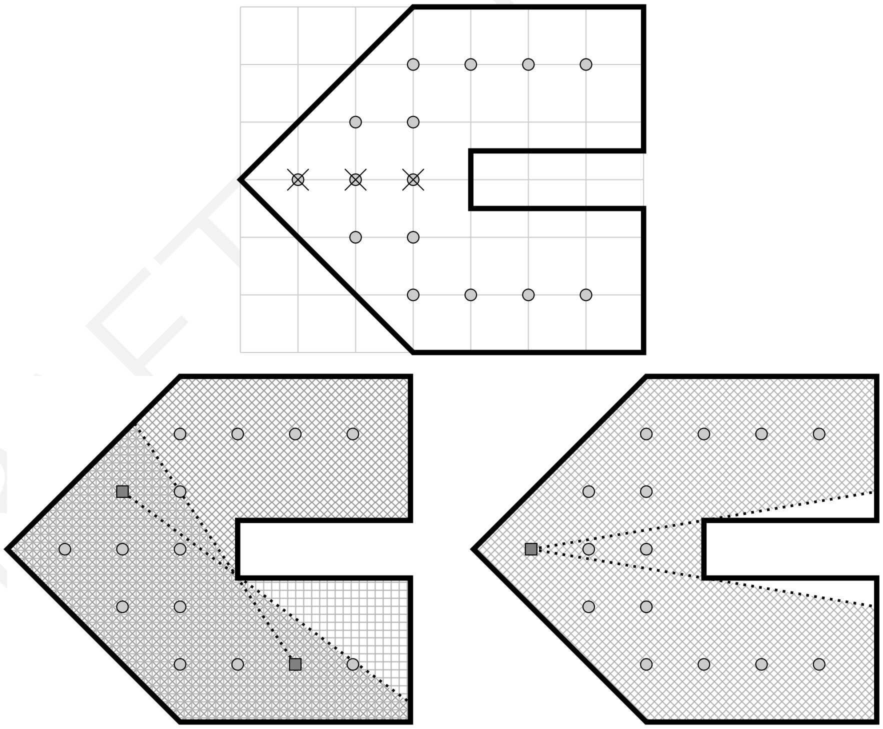


MaPP Challenge ’19 – To Aleph-Zero And Beyond

Wibbly-Wobbly Timey-Wimey

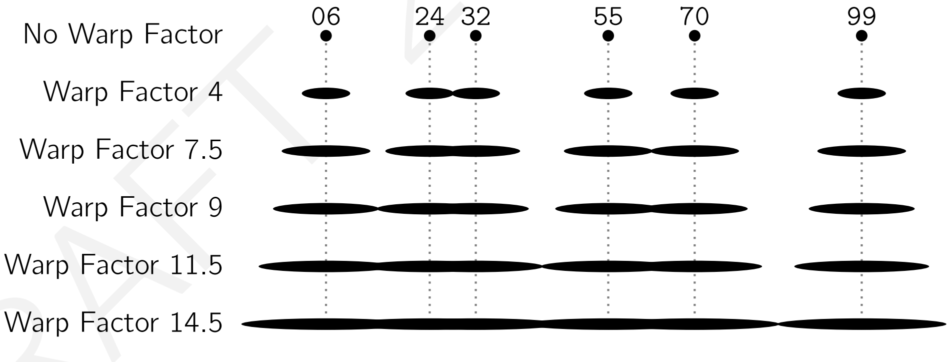
Main Puzzle 3

As though it was always destined to happen, your team has encountered the time-traveling eccentric known only as Professor Whatsit. Well, not so much “encountered” as “collided”, as witnessed by the telephone-booth-shaped breach in your starboard hull.

This whacky master of time with a penchant for fezzes and bow ties promises to repair your ship, but he first needs your help preventing a Time Crash. You’ve never heard of this phenomenon before (he describes it as a “timey-wimey, wibbly-wobbly sort of thing”), but as it seems to be related to a puzzle, you agree to pitch in.

Six parallel dimensions are represented by six groups of numbers on the **Dimensional Signals** sheet. In every dimension, this solar system has six planets; the numbers represent how close their orbit reaches their sun. As it happens, today all six planets will reach that closest point, forming a straight line. But because this will happen in all six dimensions simultaneously, all the planets will begin to warp and eventually merge into each other!

Thankfully, you can prevent all of this if you can help the Professor calculate the dimensional signal that would be caused by this dimensional warp, spelling out a six-letter codeword! The signal for each dimension represents how the planets in a dimension would merge as the warping factor increases, with merged planets represented by bars and isolated planets represented by dots. The illustration below corresponds to the signal labeled `E`.



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Jumping Through Hyperspace

Main Puzzle 4

On this system, your adventure takes you to a racous space saloon, swapping tales with Jan Duet, an infamous smuggler with a heart of gold.

She explains to you that in the early days of hyperspace travel, engines could instantly transport ships between only certain locations on a six-lightyear continuum. These options were illustrated using a graph, where the horizontal coordinate represents starting positions, and the vertical coordinate represents ending positions.

The goal of a hyperspace engine is to be “ideal”: the collection of possible destinations from any particular point using exactly one teleportation should be exactly the same as the collection of possible destinations that can be reached from that point using exactly two teleportations.

This means Example A is not ideal. Position 1 teleports to positions 5 and 6, but from positions 5 and 6, there are two problems: a new destination 3 can be reached, and the destination 5 can no longer be reached.

However, Example B is ideal. From 0, any position can be reached after either one or two teleportations. From 2, positions 3 and 6 can be reached after either one or two teleportations. From 4, only position 6 can be reached after one or two teleportations. From 5, positions 5 and 6 can be reached after one or two teleportations. And so on (even for fractional positions!).

Jan suggests that you review your **Hyperspace Engines** document; perhaps the illustrations representing ideal engines will reveal a hidden message?

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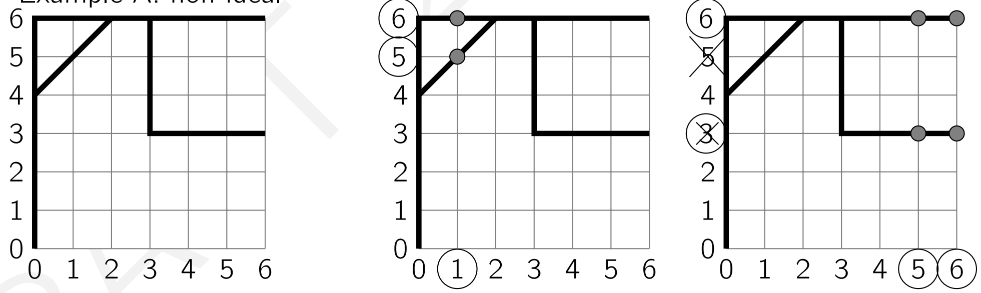
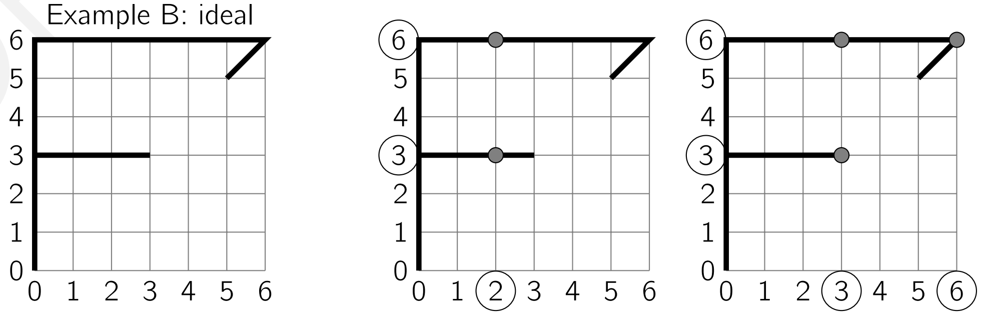
Example A: non-ideal



Example B: ideal



MaPP Challenge '19 – To Aleph-Zero And Beyond

Hailing Frequencies Open

Cryptic Puzzle 1

Zounds! Your ship has intercepted an extraterrestrial message of **Bleeps and Bloops**, where each octogon represents a *long* bleep and each circle represents a *short* bloop.

Communications Officer Uhuna says she's still working on translating the communiqué, but at first glance the message seems to translate to the following seven words.

- CREWMEN (3)
- DYE (3)
- MATT (2)
- REWIRE (5)
- SWEATED (2)
- URNS (3)
- WENCH (1)

Well, that certainly doesn't seem to be useful information. Perhaps there's more to *space travel* than meets the eye...

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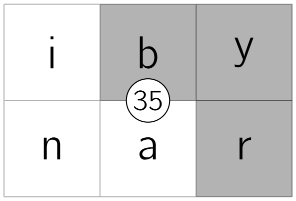
Out of Gas

Cryptic Puzzle 2

Uh-oh... unforunately, you have now found yourself stranded in a stretch of empty space with no fuel left! Maybe these firefly-class engines aren't all they're cracked up to be...

Luckily for you, your ship's *amazing* engineer Faylee does have one trick that just might save your team. There is an emergency reserve tank that can be unlocked by utilizing the **Reserve Tank Switchboard**, if you can puzzle out the meaning of the following image...



i	b	y
n	a	r

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An AI Odyssey

Cryptic Puzzle 3

Artificial intelligence is a pretty useful tool, as long as it doesn’t get too smart. Of course, that’s the situation you find yourself in now, as your Piloting ALgorithm (PAL) has refused to direct your ship into a particularly dangerous system.

PAL concedes that it will let you proceed, but only if can complete extract the secret word hidden within its **Cubic Monolith**. To do so, you’ll need to adhere to the illustrated rules for placing the numbers 1 through 4 in rows, columns, towers, and cages.

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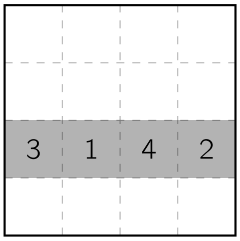
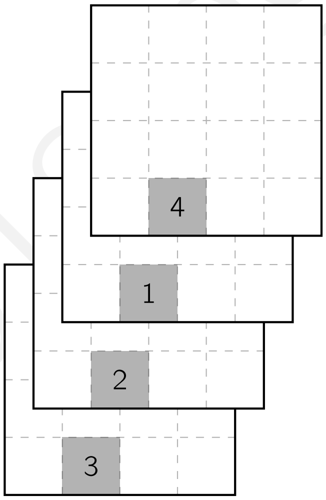
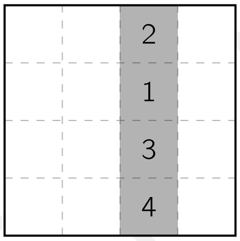


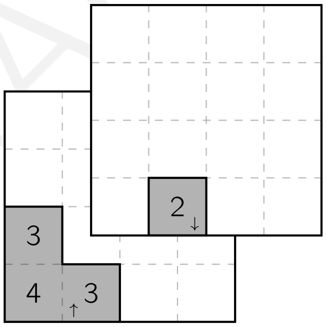
Row (unique)



Tower (unique)

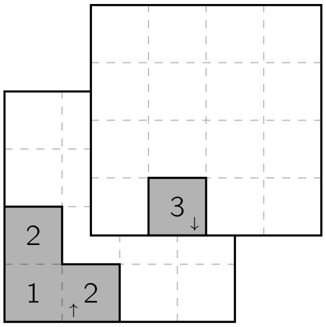


Column (unique)



Cage (+ to 12)

OR



Cage (× to 12)

MaPP Challenge '19 – To Aleph-Zero And Beyond

Word Problem

Cryptic Puzzle 4

As your adventures continue, your ship comes across a **Myserious Message**, projected onto the stars themselves! You put on a John Williams soundtrack, but to no avail, as the strange communication frankly doesn't make any sense. It's as though nine of the words don't belong...

You contact Jan Duet, who says this isn't the first time she's come across such a message. She suggests that while she's gone to great *lengths* to decipher the true meaning of these dispatches, she always ends up chasing her tail in *circles*.

Wait! Maybe that's it?

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MaPP Challenge ’19 – To Aleph-Zero And Beyond

The Cosmic Wheel

Bonus Puzzle

The Cosmic Wheel is one of the major shipping hubs of the galaxy... at least it was before it was hit by a violent Tachyon storm, breaking down the Cosmic Wheel’s five **Wormholes: Alpha, Beta, Gamma, Omega,** and **Zeta**! These wrinkles in space-time have been unfolded by the Tachyon storm, mixing each wormhole’s *light gray entrances* and *dark gray exits* with unshaded empty space.

Fortunately, your team may be able to lend a hand by remotely manipulating space-time as easily as folding a regular piece of paper! Here’s how this amazing technology works.

1. Cut out the 12 × 12 square from each Wormhole page.
2. You may fold the paper along any line (vertical, horizontal, or diagonal), but you are not allowed to tear the paper. (Ripping apart space-time is incredibly dangerous!)
3. Each paper should be folded into a smaller square of the size designated on the page: either 4 × 4, 5 × 5, or 6 × 6.
4. Your goal is to repair each wormhole as completely as possible. A repaired wormhole is completely light gray on one side (its entrance) and completely dark gray on the other (its exit).

Can your team repair all five wormholes? No pressure, it’s just the jobs of 9 trillion hard-working Geeftus traders (not to mention their spouses and an average of 7 children each) on the line!

SCORING

This puzzle should be submitted in person to Game Control, who will award up to 500 Victory Points based on the quality of your submission. Your team is allowed up to three submissions (including disqualified submissions); the best score of these will be counted toward your overall total for the game. Review the following criteria carefully to optimize your score (and avoid a disqualified submission)!

- You must submit exactly one folded copy of each of the five wormholes in the appropriate dimension.
- The paper may only be folded along the given vertical, horizontal, or diagonal lines.
- The back side of the paper must not be visible.
- When submitting, your team must choose which side of each folded wormhole serves as the entrance (light gray), and the other side will serve as the exit (dark gray).
- Each entrance will be scored by the percentage area that is light gray minus the percentage area that is dark gray. (Unshaded area doesn’t count for or against.)
- Each exit will be scored by the percentage area that is dark gray minus the percentage area that is light gray. (Unshaded area doesn’t count for or against.)
- These ten percentages will be summed together and divided by two to calculate your Bonus Puzzle score out of 500, rounded down to the nearest integer as needed.

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Part IV

Solutions

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MaPP Challenge ’19 – To Aleph-Zero And Beyond

Good News Everyone

Solution

The numbers below coorrespond to each company’s planet.

Home Planet → Monday, Wednesday, Friday

	1st	2nd	3rd	4th	5th	6th	
Monday	**Comet** 2	Acme 4	**Venus** 1	**Oxygen** 5	**Belt** 3	Star 6	Monday
Wednesday	Techno 3	Rave 1	**Solar** 2	Orion 6	**Helmet** 5	**Alpha** 4	Wednesday
Friday	Neo 5	**Light** 2	Alarm 3	Uranium 4	Tele 6	**Photon** 1	Friday

Monday, Wednesday, Friday → Home Planet

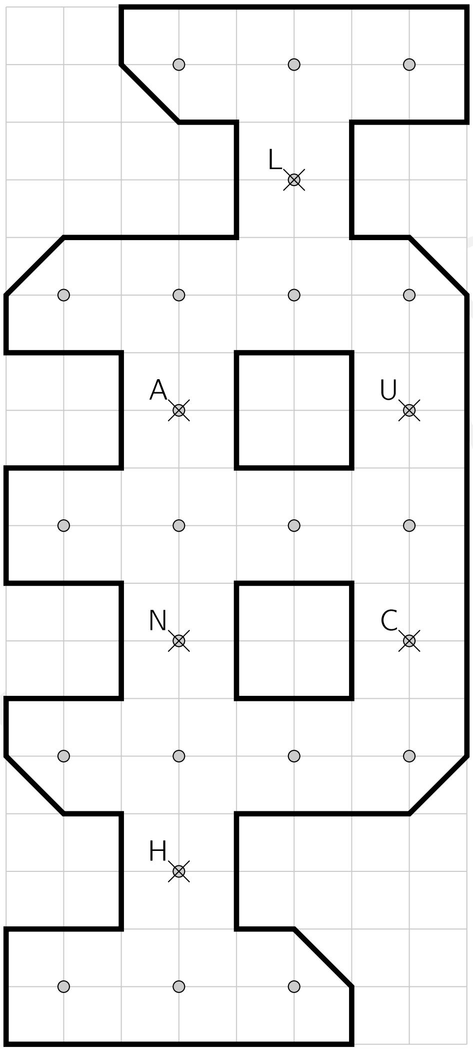
Using the first letters of the filled-in company names, the solution `ASTRONAUT` is revealed.

DRAFT 201

Extraterrestrial

Solution

There are six unusable locations.



The letters for these stations spell out the solution `LAUNCH`.

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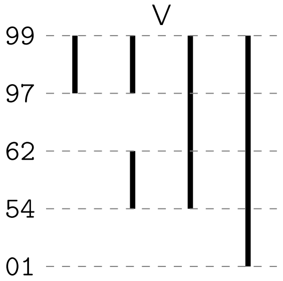
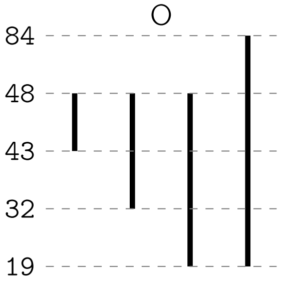
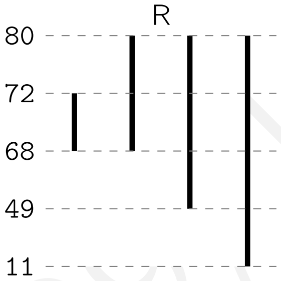
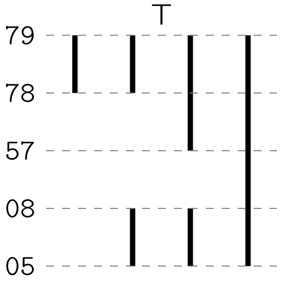
Wibbly-Wobbly Timey-Wimey

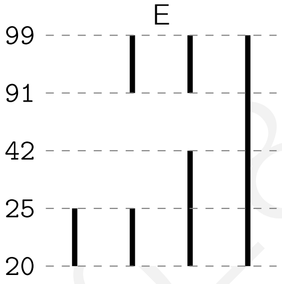
Solution

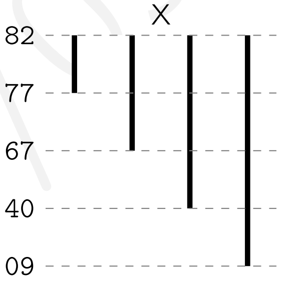

V
99
97
62
54
01


O
84
48
43
32
19


R
80
72
68
49
11


T
79
78
57
08
05


E
99
91
42
25
20


X
82
77
67
40
09

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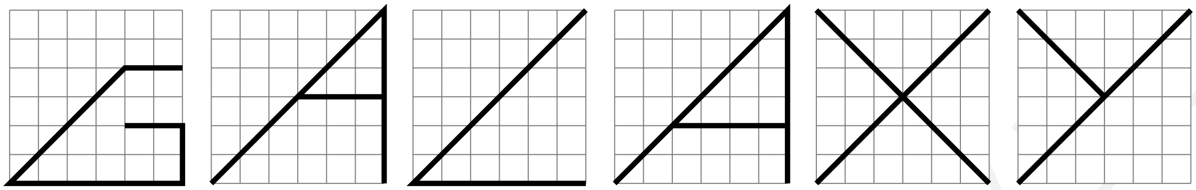
Jumping Through Hyperspace

Solution



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Hailing Frequencies Open

Solution

Two Morse code messages are given: one when using the tail end of each arrow as a space, and another when using the arrow end of each arrow as a space:

- SWEATED/S(P)ACE
- MATT/G(O)
- URNS/EA(R)TH
- DYE/TI(T)AN
- WENCH/(A)NTARES
- REWIRE/RIGE(L)
- CREWMAN/CA(S)TOR

The marked letters are given by the numbers in the flavortext; they spell the solution `PORTALS`.

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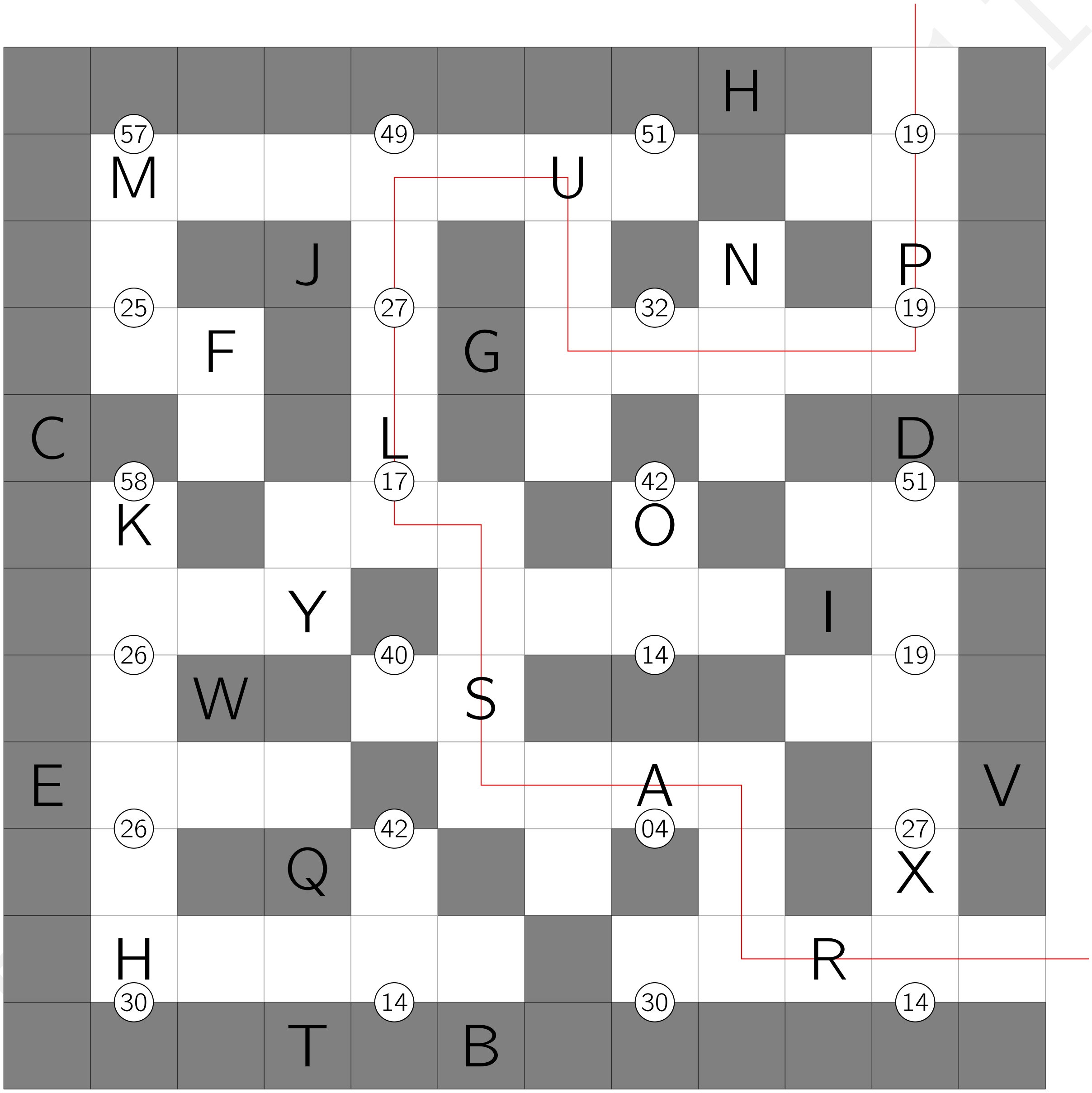
Out of Gas

Solution

Using binary to fill in the grid as in the attachment, a maze is revealed.


H
57
49
51
19
M
U
J
N
P
25
27
32
19
F
G
C
L
D
58
17
42
51
K
O
Y
I
26
40
14
19
W
S
E
A
V
26
42
04
27
Q
X
H
R
30
14
30
14
T
B

The solution is the letters appearing on the unique solution to the maze: `PULSAR`

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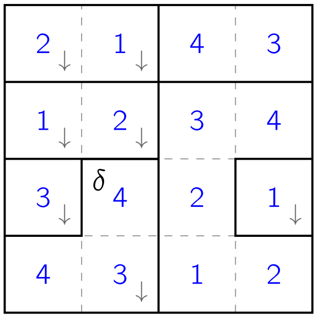
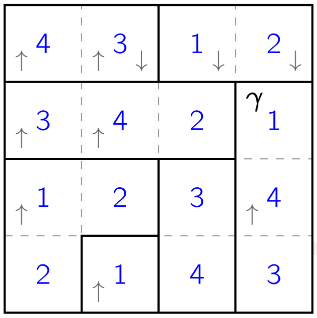
An AI Odyssey

Solution



2 ↓	1 ↓	4	3
1 ↓	2 ↓	3	4
3 ↓	δ 4	2	1 ↓
4	3 ↓	1	2



↑ 4	↑ 3 ↓	1 ↓	2 ↓
↑ 3	↑ 4	2	γ 1
↑ 1	2	3	↑ 4
2	↑ 1	4	3

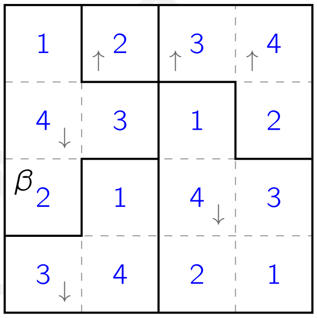
$$5\beta - \alpha + 2\delta = 15 = \mathtt{O}$$

$$5\alpha + \delta - \gamma = 18 = \mathtt{R}$$

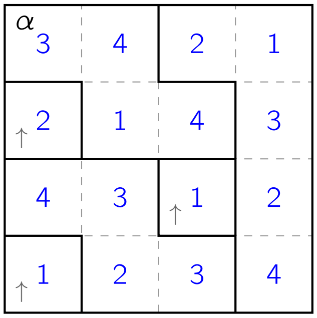
$$2\beta - 5\gamma + \alpha = 2 = \mathtt{B}$$

$$\gamma + 3\delta - 2\beta = 9 = \mathtt{I}$$

$$\alpha + \beta + 3\gamma + 3\delta = 20 = \mathtt{T}$$



1	↑ 2	↑ 3	↑ 4
4 ↓	3	1	2
β 2	1	4 ↓	3
3 ↓	4	2	1



α 3	4	2	1
↑ 2	1	4	3
4	3	↑ 1	2
↑ 1	2	3	4

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Word Problem

Solution

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The word *lengths* mostly adhere to the digits of *pi* (as clued by the flavor text).

However, certain words do not fit this pattern:

- BIOGRAPHIES
- LAMENTABLY
- ANECDOTES
- CURRENT
- KILLING
- HANDWRITING
- OVERSIGHTS
- LOATHE
- ENTREAT

Their first letters spell out the solution: BLACK HOLE.

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The Cosmic Wheel

Grading

To assist with grading, make a copy of the Google Spreadsheet at:

⟨https://docs.google.com/spreadsheets/d/1BUvckRgpEZF9VasgydSCGx8XX9tttl5akRpPDwERzjk/edit?usp=sharing⟩

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