MaPP Challenge '18

Mathematical Puzzle Programs

Version 2017/09/12

MaPP Challenge ’18

Part I

Game Overview

MaPP Challenge ’18

Credits

Thanks for downloading the puzzle booklet for **MaPP Challenge ’18** by Mathematical Puzzle Programs. These puzzle materials are provided as-is for use in the classroom (or anywhere else!) to help showcase the fun of mathematical problem-solving.

When the MaPP Challenge ’18 is over, we’d love your feedback on how to improve this booklet. You can contact us by email at info@mappmath.org. Or better yet, submit an issue or pull request at our GitHub page at `https://github.com/MaPPmath` directly.

More information on Mathematical Puzzle Programs may be found at our website `http://mappmath.org` and on our Twitter @MaPPmath. Happy mathematical puzzling!

- MaPP Directors and Volunteers

Mathematical Puzzle Programs Leadership

- Steven Clontz — Director
- Braxton Carrigan — Associate Director
- PJ Couch — Associate Director
- Zachary Sarver — Assistant Director and Challenge18 Game Designer

Attribution

More information may be found on our website at

`http://mappmath.org/open/`

Part II

Main Puzzles

MaPP Challenge '18

When Push Comes to Shove

Main Puzzle 1

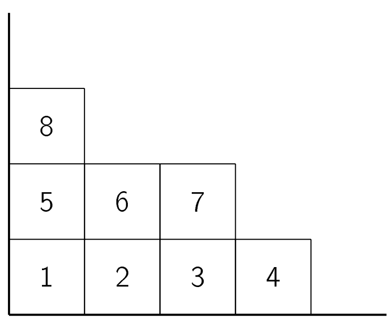
While training your Mobímon on Interstate π, you are approached by Dockworker Dave, who challenges you to a Mobímon battle! You of course accept, because turning him down would be **rude**.

It was a close match, but you won! Before he gives you your victory money, he tells you about the **vermin Mobímon Tattarat** which infest the warehouse he works in. He says if you can figure out how the Tattarats **hide in the warehouse boxes**, you should be able to catch one of your very own!

The boxes in the warehouse are always **stacked and numbered** in a certain way. Boxes are always pressed up against the **left wall** of the warehouse. The boxes have numbers painted on them according to **two simple rules**.

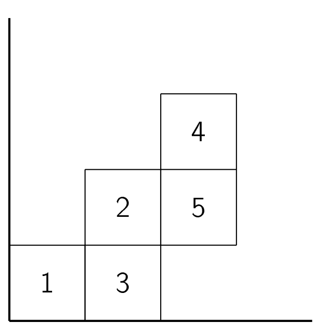
1. **No** numbers are ever **reused** within a single pile of boxes.
2. A pile of boxes has **standard numbering** if the numbers increase horizontally going towards the right **and** the numbers also increase vertically going up.

So **this pile**



is **standard**.

However **this pile**



is **not** standard, for three different reasons.

- The boxes aren't all pushed to left wall!
- The boxes aren't numbered in increasing order from bottom to top!
- Wait, boxes 4 and 5 are floating above the floor! How does that even work? That's not right.

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An Unending Enigma

Main Puzzle 2

It's time to put your training to the test by trying to befriend **Doppl**! As you might expect, the natural numbers, known as the **finite ordinals** to Mobímon Wranglers, are used to account for a finite amount of Doppl.

- $0 =$ no Doppl
- $1 =$ 
- $2 =$ 
- $3 =$ 
- $4 =$ 

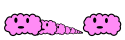
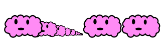
However, the problem is that **infinite** groups of Doppl are quite common out in the wild! Wranglers use the lowercase Greek letter ω ("omega") to represent the shortest possible chain of infinitely-many Doppl.

- $\omega =$ 

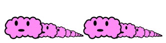
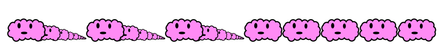
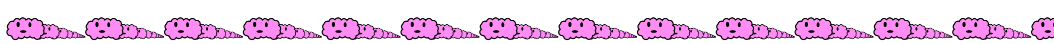
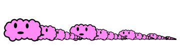
Of course, if they were all the same size, they would quickly run out of space for their Mobímon battles. That's why groups of Doppl will shrink down as necessary to fit into whatever space is available. Here's a more typical representation of ω-many Doppl.

- $\omega =$ 

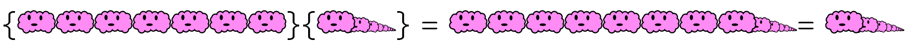
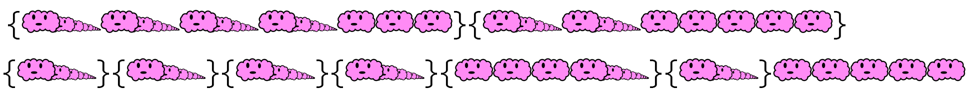
This ω is the first **infinite ordinal**, but it's not the last! You see, bizzare as it sounds, there's always room for another Doppl to join the party.

- $\omega + 1 =$ 
- $\omega + 2 =$ 
- $\omega + 3 =$ 

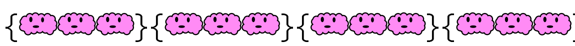
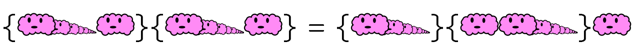
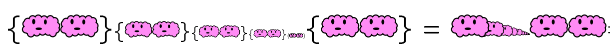
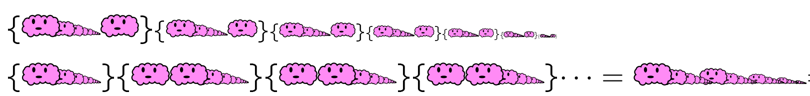
So $\omega + 1, \omega + 2, \omega + 3$ are the next three infinte ordinals. And yes, Wrangers have reported Doppl groups like these as well.

- $\omega + \omega = \omega \cdot 2 =$ 
- $\omega + \omega + \omega + 5 = \omega \cdot 3 + 5 =$ 
- $\omega + \omega + \omega + \cdots = \omega \cdot \omega = \omega^2 =$ 
  $=$ 

After the discovery of Doppl, the Mobímon community noticed that the rules of **ordinal arithmetic** behave differently when infinite ordinals are involved. Notice what happens when groups of Doppl are added together: a finite group of Doppl will attach to an infinite group to its right.

- $3 + 4 =$  $= 7$
- $7 + \omega =$  $= \omega$
- $(\omega \cdot 4 + 3) + (\omega \cdot 2 + 5) =$  $= \omega \cdot 6 + 5$

Doppl are also known to multiply. When this occurs, each Doppl in the second factor splits into a copy of the Doppl group given by the first factor. But when infinite groups are around, the normal distribution rules don't apply, so be careful!

- $3 \cdot 4 =$  $= 12$
- $(\omega + 1) \cdot 2 =$  $= \omega \cdot 2 + 1$
- $2 \cdot (\omega + 1) =$  $= \omega + 2$
- $(\omega + 1) \cdot \omega =$  $= \omega^2$

Can you find the missing values in these Doppl-inspired arithmetic problems?

$$(\omega + 3) \cdot (\omega + 5) = \omega^2 \cdot E + \omega \cdot G + S$$
$$\omega + 1 + \omega + 3 + \omega + 5 + \omega + 7 = \omega \cdot I + O$$
$$3 \cdot \omega + \omega^2 \cdot 5 + 4 \cdot (\omega^2 + 2) = \omega^2 \cdot L + \omega \cdot R + N$$
$$2 \cdot (2 + \omega \cdot 3) + (\omega \cdot 3 + 2) \cdot 2 = \omega \cdot A + M$$

If so, you should be able to decode 24007042951 into a Doppl's favorite Mobímon attack!

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The Name Rater

Main Puzzle 3

(based on https://en.wikipedia.org/wiki/MU_puzzle)

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Go Get 'Em!

Main Puzzle 4

While catching Mobímon on Interstate $\sqrt{1.73205...}$, you run across a wise old Mobímon trainer who challenges you to a Mobímon battle. But not just any Mobímon battle! This is a **puzzle battle.** The reward? The location where all the Mobímon gather.

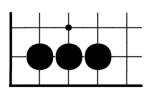
The old man tells you about a game he enjoyed in his youth called **Go.**

Go is a game of strategy played with black and white pieces on a grid. It's a bit like chess, except instead of lots of kinds of pieces, each player only has **one kind of piece, the stone.** And instead of playing on the squares, players play on the **intersections of the grid lines,** and you can play on board going from 9 by 9 up to 19 by 19. And **black goes first.** Maybe it's not all that much like chess.

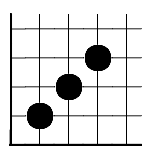
Much like chess, though, part of the strategy relies on **capturing your opponent's stones.** To capture you have to know about stones, groups of stones, and their **liberties.**

Stones typically don't stay isolated for very long from other stones of the same color. Stones form a **group** if they are **directly next to each other on the grid,** but **not diagonally.**

These stones form a group.

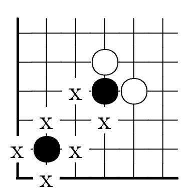


These stones **do not.** These are just three individual stones.



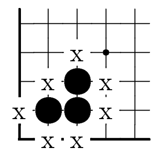
An individual stone has **liberties.** Liberties are the **empty spaces directly next to the stone on the grid,** but **not diagonally.** So a stone may have **as many as 4** liberties. If an individual stone has no liberties, **it is captured.**

The liberties of the black stones are marked with x's:



So the black stone on the lower left has **4 liberties,** and the black stone on the upper right **only has two liberties** because the other two spaces around it are occupied by white stones.

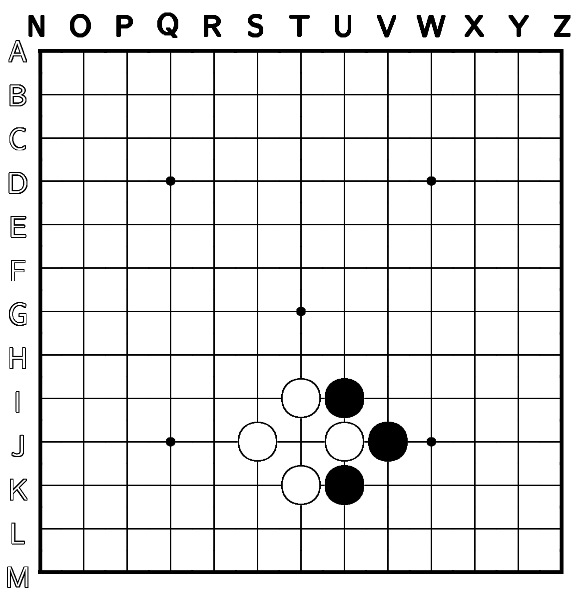
Groups of stones share liberties. A whole group of stones can be captured at the same time if the whole group has no liberties. The group of black stones below has **7 liberties.**

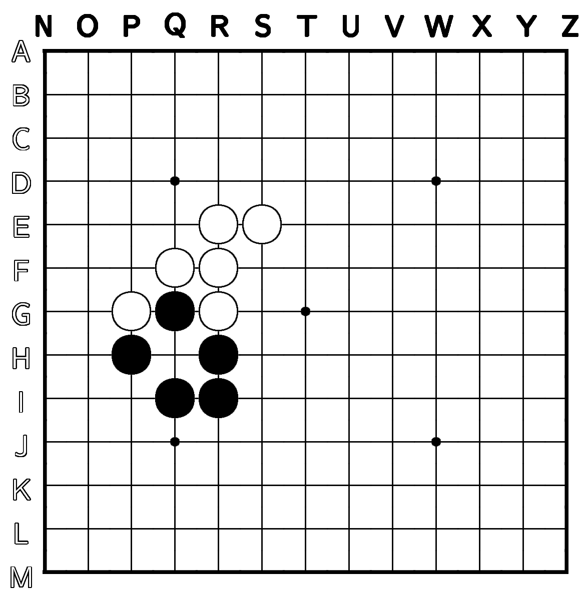


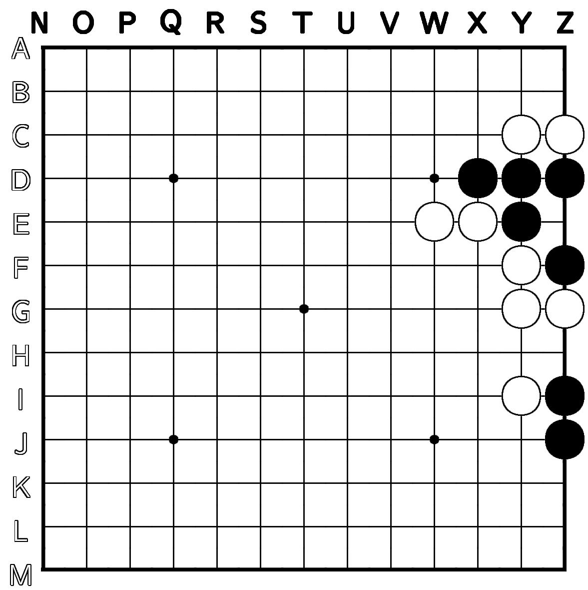
A stone can normally **not** be played in a space where it has no liberties, with **one important exception.** A stone can be placed into a space where it would have no liberties only if doing so **captures one or more enemy stones.**

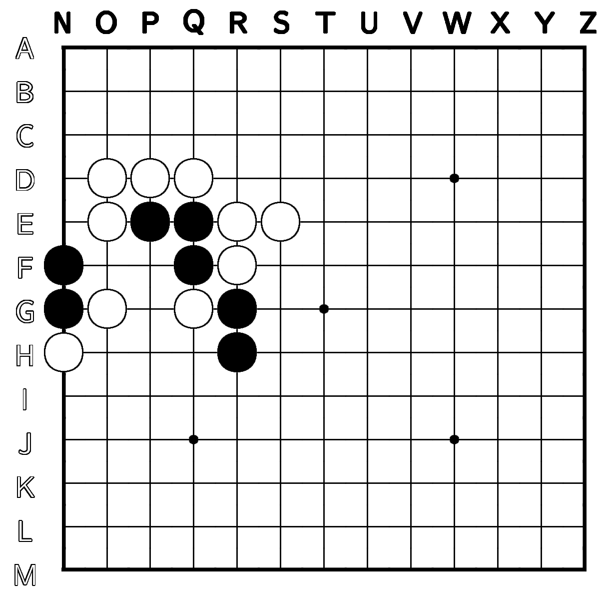
The old man lays out several boards in an intermediate size, then says, “In each of the Go boards below, there is exactly one stone you can play, white or black, that will allow you to make a capture. You need to figure out **what color stone** to play and **where to play it** in order to make a capture. Do that, and you will already know where all the Mobímon gather.”

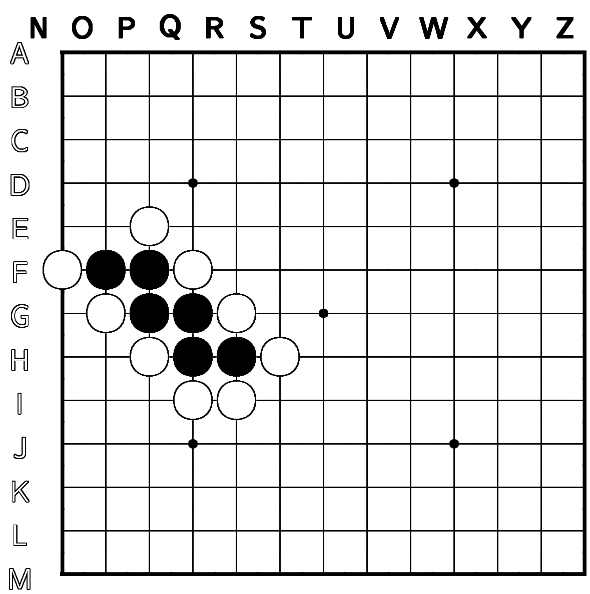
You notice that each of the boards the old man shows you is **13 by 13.** There are also **26 letters in the alphabet.** Hmmm...

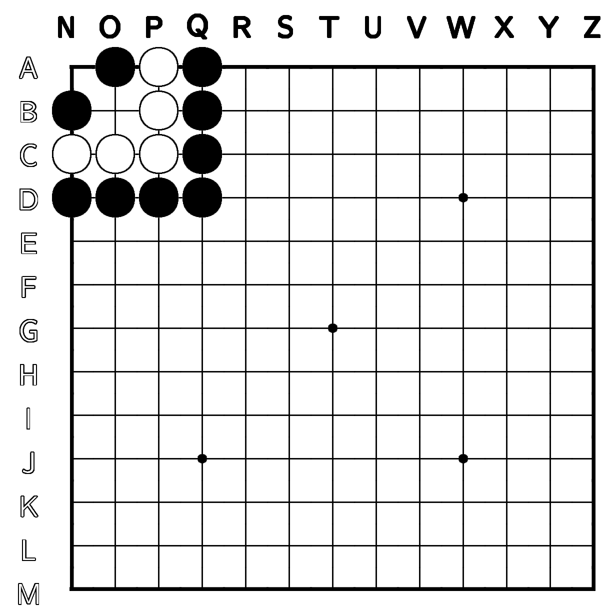


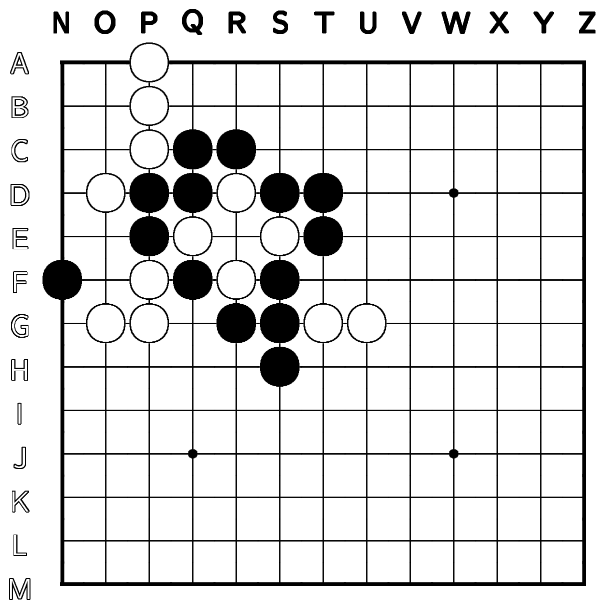


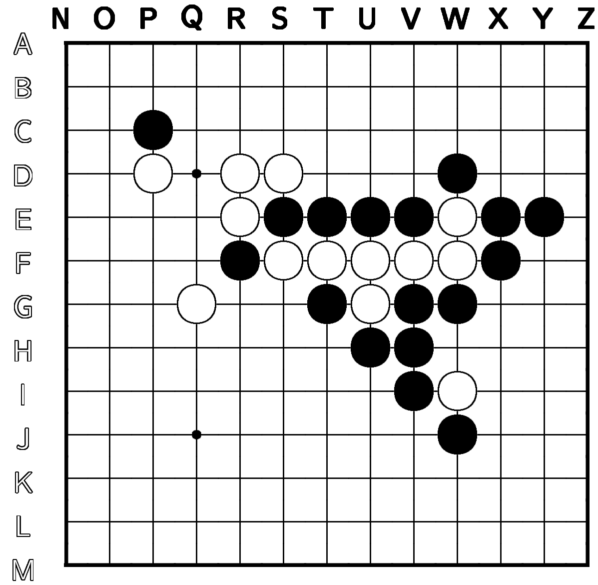

N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M

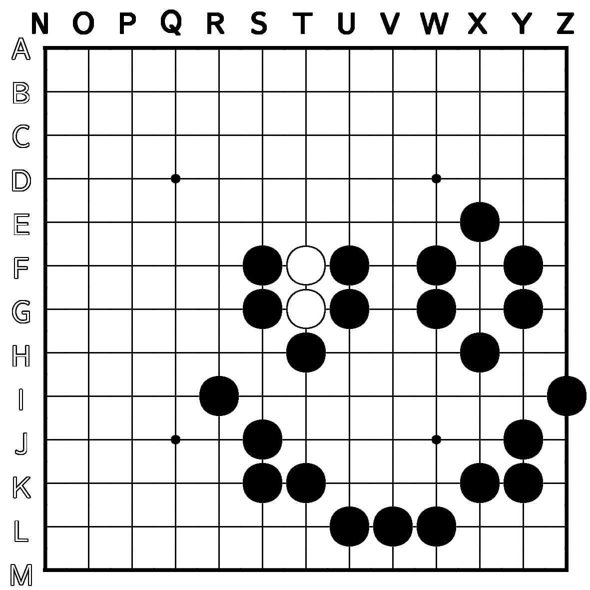

N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M


N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M


N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M







Where should you find the Mobímon?

Part III

Bonus Puzzle

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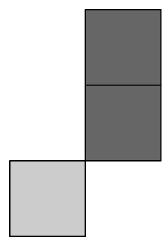
The Expedition Zone

Bonus Puzzle

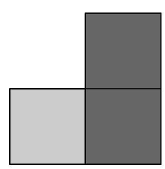
Take a trip through the **Expedition Zone** to catch as many Mobimon as you can! Theres a catch, though: your path through the Expedition Zone has to follow certain **expedition pieces.** Here are the rules:

1. Two expedition pieces are adjacent if any of their **corners** are touching, but **no other parts touch**.

These pieces are adjacent.



These pieces are not.



2. You must have a expedition piece in the **lower left corner**.
3. You may not have any breaks in your path. It must be an **unbroken collection** of adjacent pieces.

You may notice several Mobimon inhabiting the Expedition Zone! These Mobimon are represented by **numbers,** and each number is its **strength.** To catch a Mobimon, you must

1. make sure your path goes over that Mobimon, and
2. a piece on that Mobimon must have **more squares than that Mobimon’s strength**.

Your score is the **sum of the strengths of the Mobimon you catch**. The teams with the two highest scores get **Victory Points**! Good luck!

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The Expedition Zone

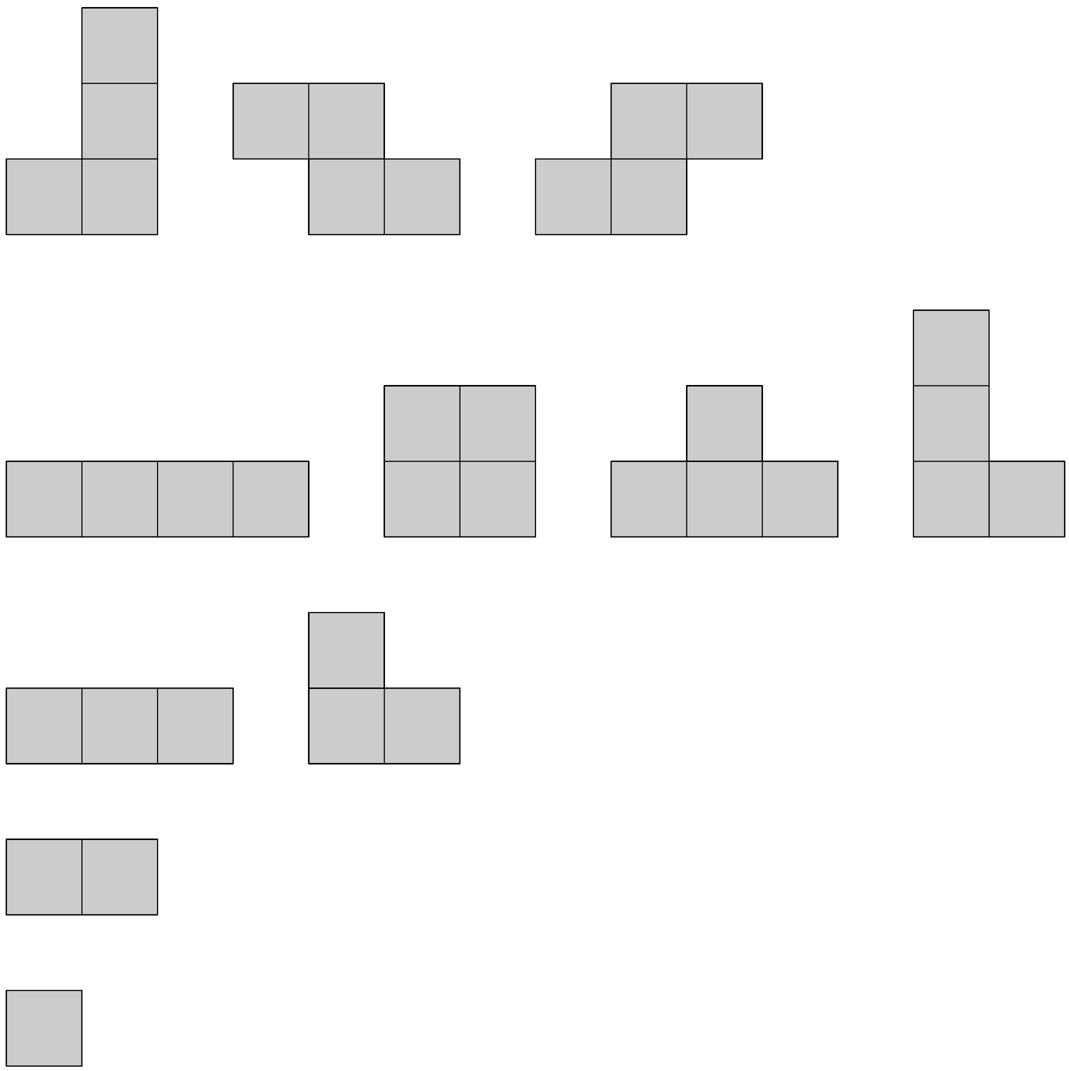
Expedition Zone Map

		3	9	9	9		1		6	1	
1	3		6	1	4	5	1	8	1		3
6	3	6	6	3	5	1		3	8	9	
	9		1	1	9	8	4	9	3		
5		5	8			4	8	7	6		7
	9		7	3		8	1		1	9	5
	4					1		6	5	5	
	5		6	9	2		9	8		5	4
	3			3	1	1	6	9	7		2
	6	8	7	3	5	2	1	3		8	5
2		5	1	9	9				9	2	6
7	6	5	4	4	3	8	1	9	2		1

MaPP Challenge ’18

The Expedition Zone

Path Pieces



Part IV

Cryptic Puzzles

MaPP Challenge '18

Civic Duty

Cryptic Puzzle 1

The Mobimon in **Wenge** are running wild! All of the city utilities that are powered by Mobimon are offline. The citizens of Wenge don't have electricity, clean water, or even cell phone signal! **Eight utilities** have been disrupted in total.

1. Electricity, powered by the lightning Mobimon **Electrumble**,
2. water, powered by the moisture Mobimon **Floobles**,
3. traffic lights, controlled by the temporal Mobimon **Tiktok**,
4. garbage, incinerated by the flame Mobimon **Burnie**,
5. cell phone access, routed by the data Mobimon **Ayepey**,
6. sewage, treated by the filter Mobimon **Stankgunk**,
7. street lights, controlled by the photosensitive Mobimon **Forluxi**,
8. and ambulance sirens, controlled by the noisy Mobimon **Sonitus**.

Luckily Wenge has 86 Mobimon tamers on staff and they will need **all of them** to restore service. They've picked up a few tricks for **how many tamers** should work with each different utility Mobimon.

- Forluxi needs the fewest tamers.
- Tiktok needs the most tamers.
- Ayepey and Sonitus need the same number of tamers. No other two Mobimon need the same number of tamers.
- The number of tamers needed by Burnie and Forluxi differ by one.
- Burnie and Ayepey need 9 trainers between the two of them.

The four strongest of the utility Mobimon need some **extra tricks**!

- Each of Electrumble, Floobles, Tiktok, and Stankgunk need a two-digit number of tamers.
- Eletrumble is particularly picky, and needs a perfect square number of tamers.
- Electrumble, Floobles, and Stankgunk each need an even number of tamers.
- The number of tamers needed by Electrumble and the number of tamers needed by Floobles has something in **common**.

- The number of tamers needed by Floobles and the number of tamers needed by Tiktok also has something in **common**.
- The number of tamers needed by Tiktok and the number of tamers needed by Stankgunk also has something in **common**!
- But the number of tamers needed by Tiktok and the number of tamers needed by Electrumble doesn't have much in common.

Every Mobimon adventure is about becoming the very best, and helping out the city of Wenge should tell you something about **what kind of trait a Mobimon champion should have**. Also, the mayor promised to give you his **strongest Mobimon** as a reward! Sweet!

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Cross Products

Cryptic Puzzle 2

(angry Dojo Master has a mixed up word search like Puzzle A in VBPuzzlehunt)

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Blind Luck

Cryptic Puzzle 3

(a Braille criss-cross like Puzzle D in VBPuzzlehunt)

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Pin it Down

Cryptic Puzzle 4

(sketches of Mobimon that include pigpen symbols)

Part V

Metapuzzle

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Faceoff with the Ultimiate Quartet

Metapuzzle

(use the Mobimon names uncovered in the Cryptics to compute winners of tournaments)