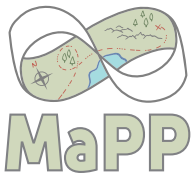
MaPP Challenge '18

Mathematical Puzzle Programs

Version 2017/09/15



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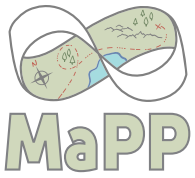
Part I

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

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Part II

Main Puzzles

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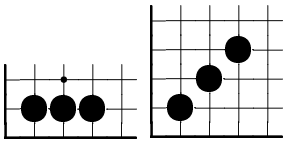
Go Get 'Em!

Main Puzzle 1

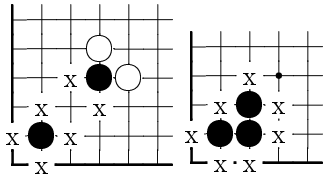
While traveling down Road 4.139π, you cross paths with a wise old Mobímon Trainer. After finally completing his **non-skippable seven-hour tutorial** on how to catch Mobímon, you try to slip away without him noticing. Alas, before you can make your excuses, he begins to tell you how Mobímon battles were fought **back in his day**.

Before Mobímon battles were limited to one-on-one matches, two trainers would send all their Mobímon into battle at once. Trainers would often practice battling by placing **black and white stones** on the **intersections of lines on a grid**, representing the positions of each trainer's Mobímon. The old man, not bothering to hide his frustration that you aren't showing any interest in this bit of history, insists on showing you the following examples.



The senile old coot explains that the left figure is an example of a single **group** because the stones are directly adjacent horizontally or vertically on the board, but the right figure represents three separate groups of stones.

To defeat a group of stones, it seems that you are required to **completely surround the group with your own stones**, as illustrated in the old man's next examples.



You haven't really been listening, but then the old man mentions that he might be able to tell you where to **find some interesting Plant-type Mobímon** if you can solve a related **puzzle**. In each of the provided **Old-School Mobímon Battle Grids**, there is exactly one position where a stone could be played (white or black) to defeat a group of opposite-colored stones. Solve his puzzle by taking the boundary letters that match the color and position of the correct stone for each grid (and then get out of there before the old man can start another long-winded conversation!).

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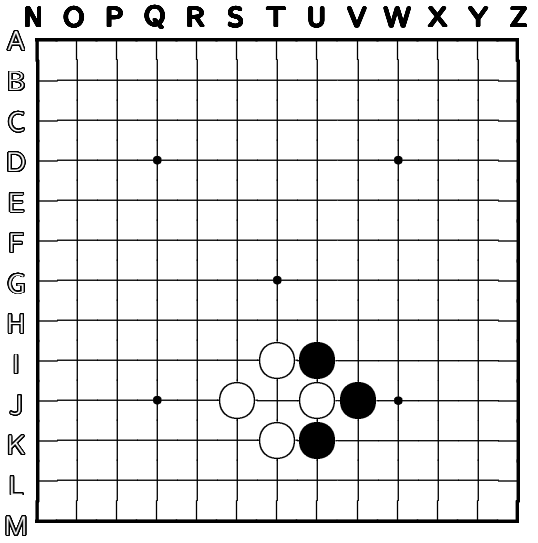
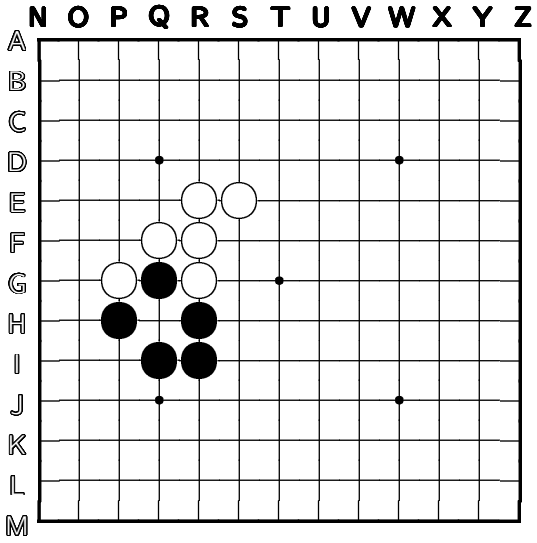
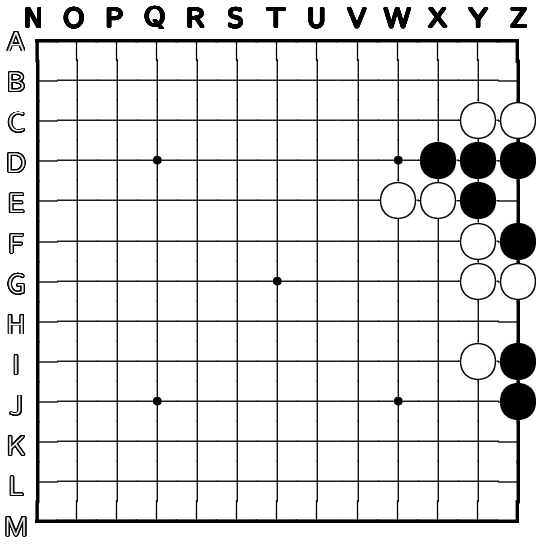
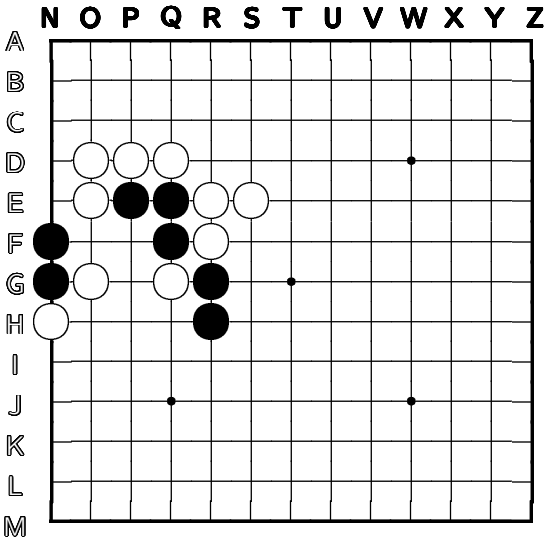
Go Get 'Em!

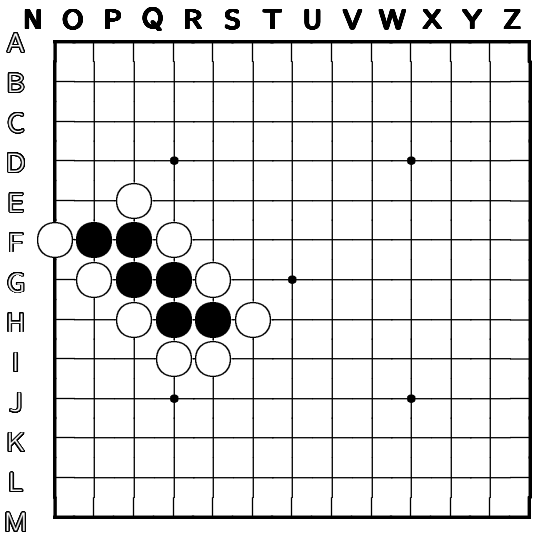
Old-School Mobímon Battle Grids

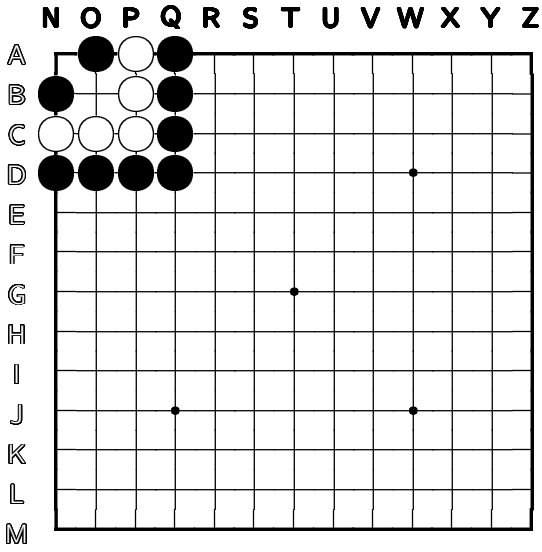









N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M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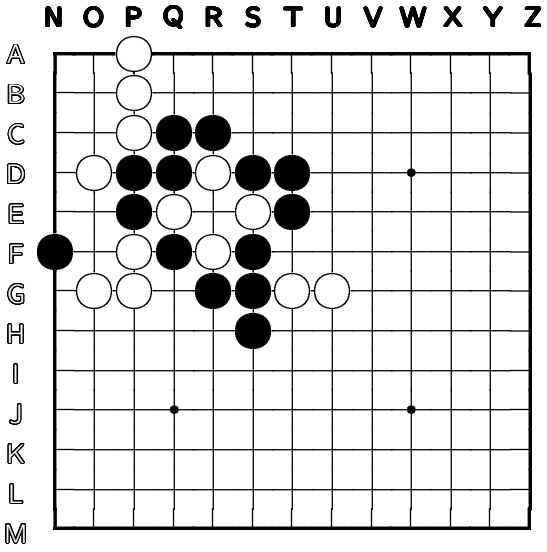
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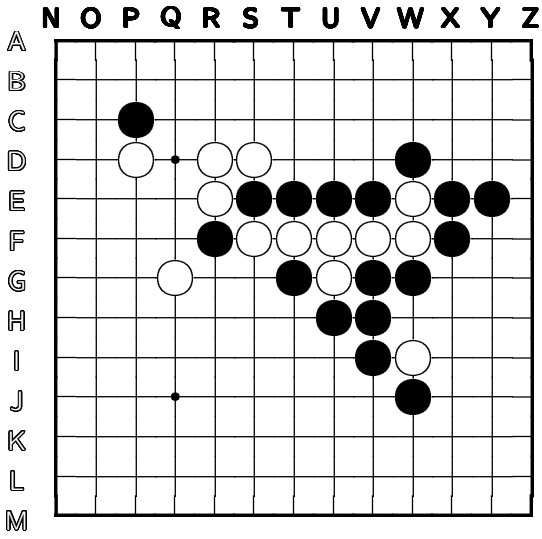
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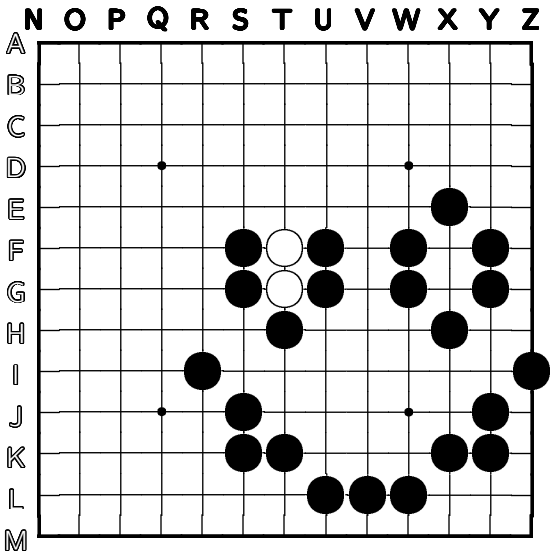
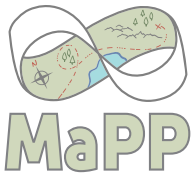

N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M



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When Push Comes to Shove

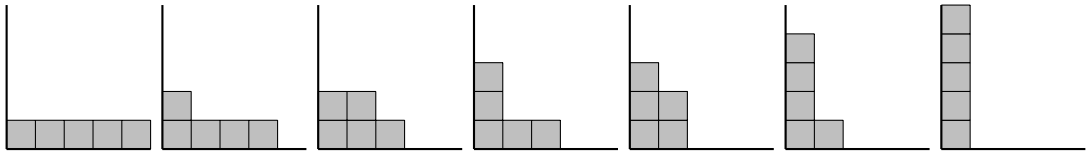
Main Puzzle 2

While training your Mobímon on Road $\sqrt{9^2 + 12^2}$, you are approached by **Dockworker Dave**, who challenges you to a Mobímon battle! Of course you accepted... turning him down would be **rude**, don't you think?

It was a close match, but you win! As Dave gives you your victory money, he tells you about a group of **Tattarat** Mobímon that infest the warehouse he works in. These obnoxious critters like to **rearrange the boxes** in his warehouse, so Dave cuts you a deal. He'll let you catch a Tattarat for your team, but only if you help him reorganize his boxes.

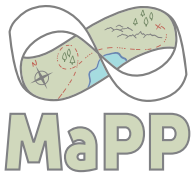
The boxes in the warehouse must be **stacked** so that each row of boxes is always pressed up against the **left wall** of the warehouse, and each row of boxes must have the **same or less boxes** than every lower row.

Other than that, it's up to you. For example, there are **seven** different ways to stack **five** boxes.



The dockworker notices your good work. "Hey, didya say you were aiming to become one of them Mobímon Champions? Maybe you're smart enough to solve this **puzzle** for me then." It seems that if you can count the following different combinations of stacked boxes, you'll be able to reveal a **hidden message** by converting the numbers to appropriate letters (A=1, B=2, and so on).

- The number of ways you can stack either 2 or 6 boxes.
- The number of ways you can stack 12 boxes, if every row must contain an odd number.
- The number of ways you can stack 8 boxes, if every row must contain less than eight.
- The number of ways you can stack up to 5 boxes. (An empty room counts as one way...)
- The number of ways you can stack 4 boxes.
- The number of ways you can stack 8 boxes, if every row must contain less than seven.
- The number of ways you can stack 13 boxes, if every row must have less boxes than the row below it.
- The number of ways you can stack 42 boxes, if you can only use one row.
- The number of ways you can stack 1 or 12 boxes, if every row must have a unique number of boxes.



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The Nickname Rater

Main Puzzle 3

As your adventure continues, you find yourself in **Achromatopsia City**, located at the end of Road 20.7183$-e$ and home of the famous **Nickname Rater**. She explains that while Trainers often like to give their Mobímon cute nicknames, she's very particular about the rules for an **excellent** nickname. For clarity, you can assume that a **vowel** is any of the letters `A/E/I/O/U`, and a **consonant** is any other English letter.

- Nicknames that contain **exactly one vowel**, that is, `A`, `E`, `I`, `O`, and `U` are excellent.
- **Adding a consonant to the end** of an excellent nickname that **previously ended with a vowel** creates a new excellent nickname.
  - Examples: If `GOLE` is excellent, then `GOLEN` and `GOLEK` are excellent also.
- **Doubling** an excellent nickname creates a new excellent nickname.
  - Example: If `PIKA` is excellent, then `PIKAPIKA` is excellent also.
- **Replacing three consecutive vowels** in an excellent nickname **with a consonant** creates a new excellent nickname.
  - Example: If `QUEUEBONE` is excellent, then `QTEBONE` and `QURBONE` are excellent also.
- **Removing any double consonant** from an excellent nickname creates a new excellent nickname.
  - Example: If `DOUGTRIO` is excellent, then `DOUGIO` and `DOURIO` are excellent also.

The Nickname Rater, not one to shy away from a good **puzzle**, offers you the chance to rate the following nicknames yourself. You'll know when you've done it correctly, because if you **use the first letters of the excellent nicknames below**, you will spell **another good word for a nickname** (even if it's not particularly **excellent** itself).

- `MANKAY`
- `ULTRAMON`
- `OMASTARE`
- `VOLTEON`
- `GENGASKHAN`
- `EEVOL`
- `NOHTYP`
- `BLASTMOIST`
- `ICHU`
- `KADABARA`
- `AERODYCTL`
- `PARACENT`
- `EARSEA`
- `DRAGONAT`
- `RAGMAR`

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An Unending Enigma

Main Puzzle 4

As you make your way down Road $\frac{6.4984}{\sin(20°)}$, you find a group of **Doppl** Mobímon in a patch of tall grass. At first the size of the group is **finite**, so you can count them in the usual way.

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

However, before you know it, the size of the group grows to be literally **infinite**! Your Mobídex (an electronic guide used by most trainers) informs you that the lowercase Greek letter ω ("omega") is used to represent the shortest possible chain of infinitely-many Doppl.

- $\omega =$

As soon as they appeared, most of the Doppl **shrink** down to fill the available space. Now, there's still an ω-length chain of Doppl, but they look a little more like this.

- $\omega =$

Your Mobídex points out that while ω is the first **infinite number**, but it's not the only one! You see, bizzare as it sounds, there's always room for another Doppl to join the party.

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

Suddenly, it gets really weird as you notice more infinite-length families of Doppl in the surrounding area. Your Mobídex is able to count a few of these groups.

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

Your Mobídex points out that the rules of **arithmetic** behave differently when the numbers involved aren't all finite. (You suddenly remember your math teacher pleading with you to not use ∞ like it's a real number, and now realize why!)

When chains of Doppl are added together, a finite chain of Doppl will be absorbed into an infinite chain on its right, but not its left.

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

The Mobídex informs you that Doppl chains can also be multiplied. When this occurs, each Doppl in the second factor splits into a copy of the Doppl chain given by the first factor.

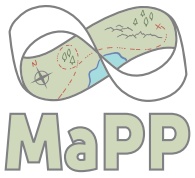
- $3 \cdot 4 = \{\}\{\}\{\}\{\} = 12$
- $(\omega + 1) \cdot 2 = \{\}\{\} = \{\}\{\} = \omega \cdot 2 + 1$
- $2 \cdot (\omega + 1) = \{\}\{\} = \; = \omega + 2$
- $(\omega + 1) \cdot \omega = \{\}\{\}$
  $= \{\}\{\} = \; = \omega^2$

Somehow you're not too shocked when your Mobídex tells you that there's a **puzzle** associated with counting Doppl. It's said that a Doppl's favorite Mobímon attack is 24007042951, but you'll need to solve the following Doppl arithmetic problems to figure out what that means in English!

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

Part III

Bonus Puzzle



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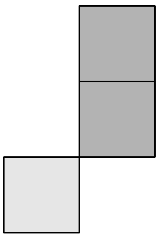
The Expedition Zone

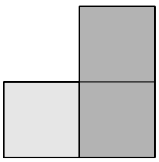
Bonus Puzzle

The **Expedition Zone**, found off the side of Road $6 + i^2$, is a great place to catch some rare Mobímon! You've been provided elevent **Mobí Nets** to set up in the Zone. There are a few rules to consider, however.

1. You may set up your nets in any order, but your first net must cover the **upper left corner** of the Zone.
2. All subsequent nets **must be connected at a corner** to a previous net, as in this example.



3. Nets **cannot connect along an edge** to other nets, as in this example.



You've been provided with an **Expedition Zone Map**. Each square on this map that contains a number represents a Mobímon with that much strength. **Maximize the sum of the numbers covered by your Nets**, and you'll prove you have what it takes to become a Mobímon Champion!

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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

500 - [ ] = [ ] Score:

Sum of numbers not in Nets

Sum of numbers in Nets

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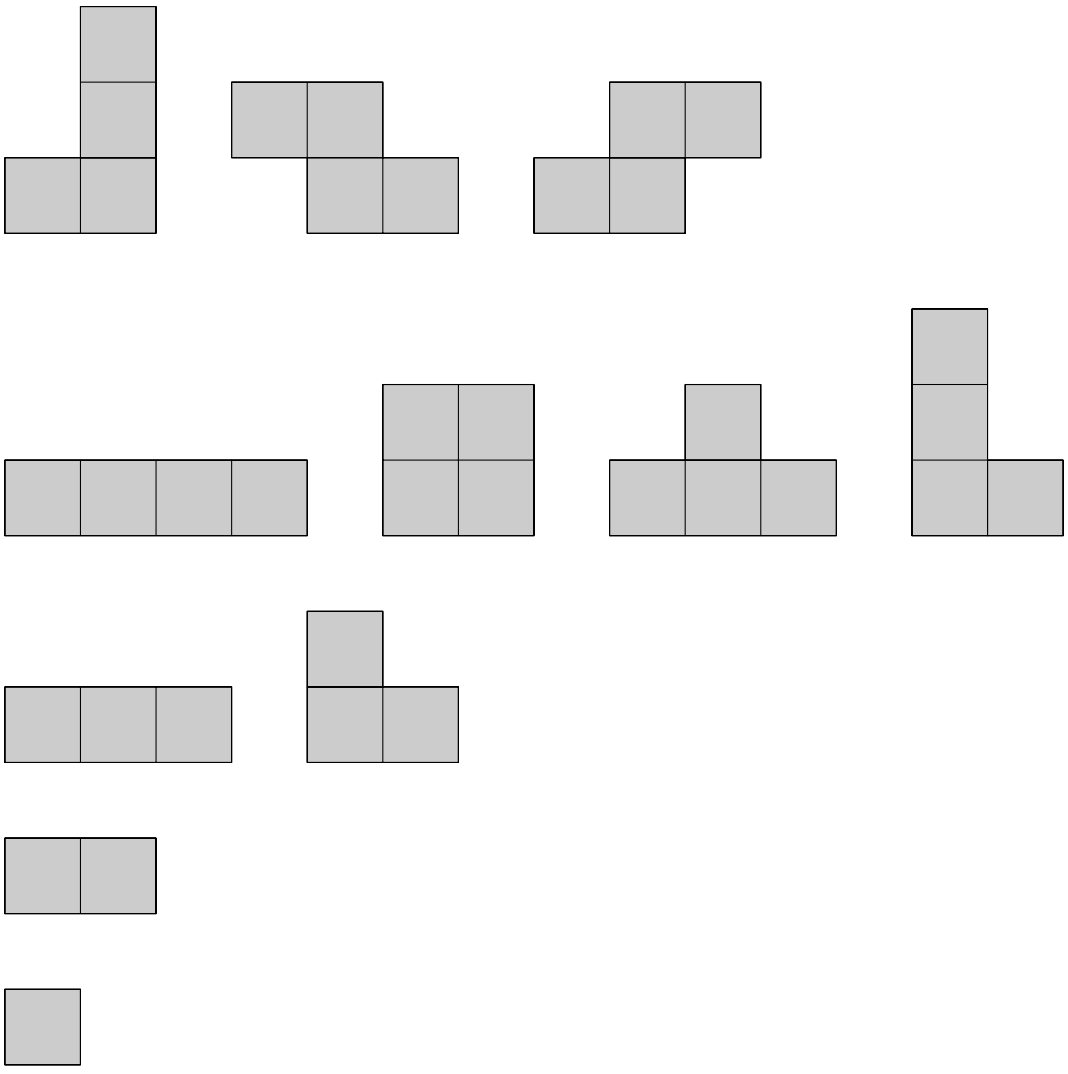
The Expedition Zone

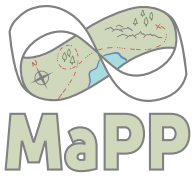
Mobí Nets

Cut out these figures and tape them to the **Expedition Zone Map**, following the rules outlined in the **Bonus Puzzle**.



Part IV

Cryptic Puzzles



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Civic Duty

Cryptic Puzzle 1

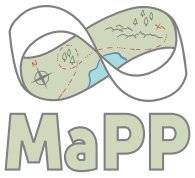
You finally slip away from the rambling Tutorial Man, but just your luck! A pack of Mobímon are blocking the path through Road ln(148.45)!

- Dankgunk
- Burnie
- Glooble
- Electrumble
- Corporil
- Ayepey
- Hearit
- Forluxi

Luckily, the nearby Mobímon Center has **86 trainers** on staff, because they need **all of them** to tame these wild Mobímon.

- Glooble needs the fewest trainers.
- Corporil needs the most trainers.
- Electrumble and Hearit are the only pair that require the same number of tamers.
- The number of trainers needed by Dankgunk and Glooble differ by one.
- The number of trainers needed by Dankgunk and Electrumble differ by one, and add to nine.
- Ayepey, Burnie, Corporil, and Forluxi each need at least ten trainers.
- Ayepey needs a perfect square number of trainers.
- Ayepey, Burnie, and Forluxi each need an even number of trainers.
- Ayepey and Burnie's required trainer numbers share a prime factor.
- Burnie and Corporil's required trainer numbers share a prime factor.
- Corporil and Forluxi's required trainer numbers share a prime factor.
- But Corporil and Ayepey's required trainer numbers do not share a prime factor.

You start to offer your help, but are quickly rebuffed by the Mobímon Center's leader, a famous **Dojo Master**! "Hang on, young trainer! I'm afraid there's yet a certain **quality** you need to learn before you get yourself hurt." You're not sure what she means, but figure that the best way to find out is to start by calculating how many trainers each Mobímon requires.



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Cross Product

Cryptic Puzzle 2

Impressed with your problem-solving ability, the dockworker suggests you head to the Mobímon Dojo at the end of Road tan(87.4094°). There, the **Dojo Master** agrees to battle you, but only on one condition. He presents you a scroll with the following clues...

"Only a trainer that has one of these can possibly become CHIPONAM."

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

Lightning × Plant Undead × Flame Aqua × Ordinary Flame × Magic

A voice belonging to your mentor echoes in your head... "The key to winning Mobimon battles is understanding how types match up." You know that some Mobimon types are weak against some types, while super effective against others. But you're not convinced that's what this scroll is referring to. Can you **unscramble** the meaning of the Master's scroll?

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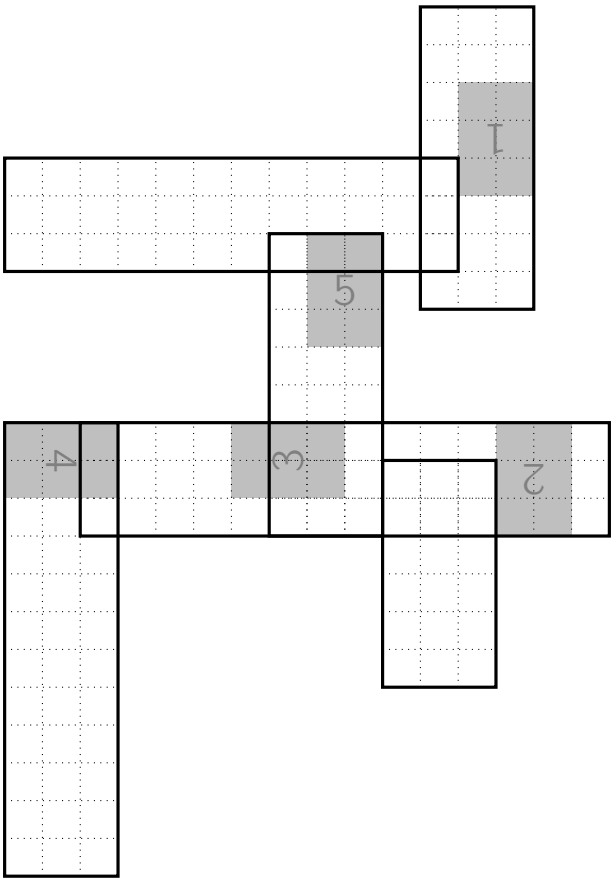
Blind Luck

Cryptic Puzzle 3

The Nickname Rater suggests you continue your journey down Road 500%, where an elusive **Dojo Master** is known to battle up-and-coming trainers. You arrive at the dojo, but it seems that a secret password is required to enter, and your only clue is the following image.

RED BLUE YELLOW GOLD SILVER CRYSTAL



You'd move the **sun and moon** to figure out that password and battle the Dojo Master! Calmly, you **shut your eyes** and begin to ponder the solution to this mystery...

MaPP Challenge '18

Pin it Down

Cryptic Puzzle 4

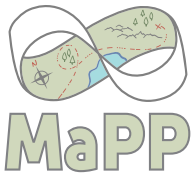
After figuring out the mysteries of the Doppl Mobímon, you realize that they are **trying to tell you something**. Could it be the location of a Mobímon Dojo?! (Of course it is.)

Sure enough, at the end of Road $\frac{19!}{18!}$, you find the Dojo. The **Dojo Master** doesn't even hestiate; as soon as you enter her lair, she sends out two of the most ferocious Mobímon you've faced yet!

She laughs arrogantly at your hesitation facing the **mirrored monsters**. "There's something you must first become before you can defeat my Mobímon!" Mesmerized, you look for a clue in the arena, anything that can reveal what you want, no, need to be...

Part V

Metapuzzle



MaPP Challenge '18

Faceoff with the Ultimiate Quartet

Metapuzzle

Before you head into the arena, your Mobímon mentor, Dr. Treetype, suggests that you review this chart of advantages each Mobímon type (Ordinary, Flame, Aqua, Plant, Magic, Undead, and Lightning) has against each other type.

	O	F	A	P	M	U	L
O					1/2	1/2	1/2
F		1/2	1/2	2		2	
A		2	1/2	1/2	2		
P		1/2	2	1/2			2
M	1/2	2					2
U	1/2			2	2		
L	1/2		2			2	

Part VI

Solutions

MaPP Challenge '18

Solutions

Main Puzzle 1 - Go Get 'Em

The correct stones are laid as follows.

- Black on JT - `T`
- White on HQ - `H`
- White on EZ - `E`
- White on FP - `F`
- Black on BO - `O`
- Black on ER - `R`
- White on EO - `E`
- Black on GS - `S`
- Black on ET - `T`

The solution is `THEFOREST`.

Main Puzzle 2 - When Push Comes to Shove

- `M=13=2+11` The number of ways you can stack either 2 or 6 boxes.
- `O=15` The number of ways you can stack 12 boxes, if every row must contain an odd number.
- `U=21=22-1` The number of ways you can stack 8 boxes, if every row must contain less than eight.
- `S=19=1+1+2+3+5+7` The number of ways you can stack up to 5 boxes. (An empty room counts as one way...)
- `E=5` The number of ways you can stack 4 boxes.
- `T=20=22-2` The number of ways you can stack 8 boxes, if every row must contain less than seven.
- `R=18` The number of ways you can stack 13 boxes, if every row must have less boxes than the row below it.
- `A=1` The number of ways you can stack 42 boxes, if you can only use one row.
- `P=16=1+15` The number of ways you can stack 1 or 12 boxes, if every row must have a unique number of boxes.

The solution is `MOUSETRAP`.

Main Puzzle 3 - The Name Rater

Since vowels are always doubled or subtracted by 3 when creating excellent nicknames, and the basic excellent nicknames have exactly one vowel, it is impossible for an excellent nickname to have a multiple of 3 vowels in a word. Thus all the words that have 3 vowels are not excellent (and the others can be verified to be excellent).

- **MANKAY** `4As->BA->B->BABBAB`
- *ULTRAMON* (3 vowels)
- **OMASTARE** `16As->ABABBABA`
- *VOLTEON* (3 vowels)
- *GENGASKHAN* (3 vowels)
- *EEVOL* (3 vowels)
- **NOHTYP** `16As->BABBBB`
- *BLASTMOIST* (3 vowels)
- **ICHU** `8As->ABBA`
- **KADABARA** `4As->BA->BABABABA`
- *AERODYCTL* (3 vowels)
- *PARACENT* (3 vowels)
- **EARSEA** `16As->AABBAABB->AABBAA`
- *DRAGONAT* (3 vowels)
- **RAGMAR** `4As->BA->BAB->BABBAB`

The solution `MONIKER` is another word for nickname (but is not excellent as a nickname, because it has 3 vowels).

Main Puzzle 4 - An Unending Enigma

$$\begin{aligned}(\omega+3)\cdot(\omega+5) &= \omega^2\cdot E+\omega\cdot G+S = \omega^2\cdot 1+\omega\cdot 5+3\\ \omega+1+\omega+3+\omega+5+\omega+7 &= \omega\cdot I+O = \omega\cdot 4+7\\ 3\cdot\omega+\omega^2\cdot 5+4\cdot(\omega^2+2) &= \omega^2\cdot L+\omega\cdot R+N = \omega^2\cdot 6+\omega\cdot 0+8\\ 2\cdot(2+\omega\cdot 3)+(\omega\cdot 3+2)\cdot 2 &= \omega\cdot A+M = \omega\cdot 9+2\end{aligned}$$

This yields the solution `24007042951=MIRRORIMAGE`.

Cryptic Puzzle 1 - Civic Duty

This puzzle is solved by ordering the Mobímon alphabetically, then converting the required number of trainers using A=1,B=2, etc.

- Ayepey: $P = 16$
- Burnie: $R = 18$
- Corporil: $U = 21$
- Dankgunk: $D = 4$
- Electrumble: $E = 5$
- Forluxi: $N = 14$
- Glooble: $C = 3$
- Hearit: $E = 5$

The solution is `PRUDENCE`.

Cryptic Puzzle 2 - Cross Product

"Only a trainer that has one of these can possibly become CHIPONAM." `CHIPONAM` is an anagram of `CHAMPION`, hinting players to search for anagrams of the seven given words within the grid.

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

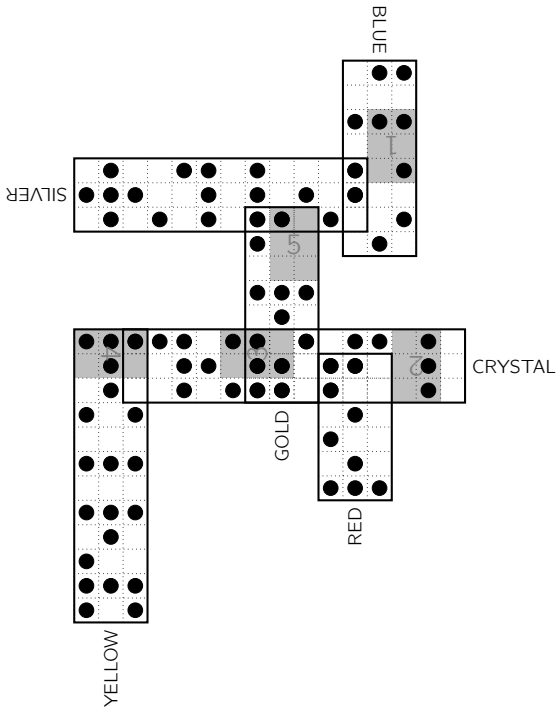
Each "cross product" represents the letter where the two words cross in the grid, yielding the following.

Lightning × Plant = T Undead × Flame = E Aqua × Ordinary = A Flame × Magic = M

The solution is `TEAM`.

Cryptic Puzzle 3 - Blind Luck

The blind/sight clues suggest to find a way to criss-cross the given words in the grid using Braille. There is exactly one way to do this, involving various orientations for each word.



The numbered regions yield `12345=ULTRA` in Braille.

Cryptic Puzzle 4 - Pin It Down

Overlaying the mirror images of the monsters reveals a message using the Pig Pen cipher.

The solution is VERYBEST.

Metapuzzle - The Ultimate Quartet