

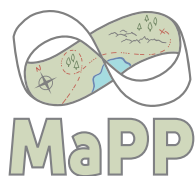


MaPP Challenge '18

Mathematical Puzzle Programs

Part I

Game Overview



MaPP Challenge '18

Story

Welcome to the world of **Mobile Monsters**, or **Mobímon** for short! Not to be confused with the similarly named video game series loved by fans the world over, Mobímon is a *completely original* concept where Trainers befriend monsters and use them to battle opponents. (Cough.)

Under the guidance of your mentor, **Dr. Treename**, you will soon set off on your adventure to befriend the Mobímon of the **Kantor region**. You'll meet many strange characters, but if you can solve their problems they just might lead you to the location of the **Dojo Masters**. By earning their respect, you'll be allowed to enter the **Mobímon Tournament** for the chance to be crowned **Mobímon Champion**! Maybe you'll even discover the location of the Legendary Mobímon μ Too?...

As you might expect, most of the challenges you'll face today won't actually be combat related. In the world of Mobímon, nothing is more important than your **problem-solving abilities**. So sharpen your minds and pencils, because you never know when a wild **puzzle** will appear!

1×1

(Original size: 200 × 200 bp)



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Rules

Leagues

Each team is registered in either the Competitive or Recreational League. If both Leagues are playing simultaneously today at your campus, then all scoring and awards are handled separately in both Leagues.

Schedule

The game officially begins at _____ and ends four hours later at _____. All solutions are due at Game Control by the end of the game; late submissions will not be considered.

Opening Puzzle

The game begins with an Opening Puzzle to warm things up. Solving this puzzle quickly will earn your team **5 Victory Points** and immediately move on to the rest of the puzzles! Don't worry about getting stuck, as all remaining teams will be allowed to move on at _____. However, you cannot earn Victory Points for this puzzle after that time.

Main Puzzles

After solving the Opening Puzzle, you will receive four Main Puzzles. While you'll be given explicit instructions on how to reveal the word or phrase that solves each Main Puzzle, you'll have to rely on your mathematical modeling and problem-solving abilities to actually make it happen. Report your solution to Game Control before the end of the game, and your team will earn **15 Victory Points each**, for a maximum total of **60 Victory Points**.

Bonus Puzzle

Along with the four Main Puzzles you will be given a Bonus Puzzle. This optimization puzzle doesn't have a unique solution, but you should still attempt to submit the best solution you can to Game Control before the game ends. That's because if your team is tied in Victory Points with another team, your scores on the Bonus Puzzle will be used to **break the tie**. You may submit up to three solutions throughout the game (including any invalid submissions), and your best solution of the three will be considered.

Cryptic Puzzles

You will be given the opportunity to solve an additional Cryptic Puzzle for every Main Puzzle you solve. These puzzles aren't as straight-forward as to their solution techniques, but your team might be able to use your critical thinking to extract a hidden word or phrase. Submitting this solution to Game Control will earn your team **5 Victory Points each**, for a maximum total of **20 Victory Points**. Teams stuck on a Main Puzzle will get their shot eventually: all Cryptic Puzzles will become available to all teams at _____, one hour before the game ends.

Metapuzzle

If your team is clever enough to solve all four Cryptic Puzzles, a final Metapuzzle will become available. A correct solution submitted to Game Control is worth **10 Victory Points**. This puzzle will become available to all teams at _____, one hour before the game ends.

Another Puzzle?

Shrewd players may discover how to earn an additional **5 Victory Points** for their team...

Hints

Recreational teams may ask for hints at Game Control at any time during the game, for any Main Puzzle, Cryptic Puzzle, or Metapuzzle. Competitive teams may only ask for hints to help with the Main Puzzles during the final hour of the game, starting at _____. Players seeking hints should be prepared to explain all work done on the puzzle so far, or the hint they receive may not be useful.

Additional Rules

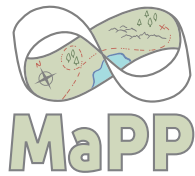
- Players should not do anything which would interfere with other teams solving puzzles. Be a good sport!
- Submissions for each puzzle, besides the Bonus Puzzle, are unlimited. Every submission for the Bonus Puzzle will be carefully graded by Game Control, so only three submissions are allowed.
- Teachers and chaperones are not allowed to help Competitive teams solve puzzles, but they may serve as a means of communication between those teams and Game Control when appropriate (e.g. for rules clarifications).
- Teams may use any resources they have brought (phones, computers, etc.) to solve puzzles, but Competitive Teams may not receive any direct assistance from outside their team (e.g. you can't Phone a Friend).
- Players must remain within any physical boundaries set by both Game Control and their teacher/chaperone at all times.
- Teachers/chaperones are responsible for their students at all times.
- Since this game will be played at different campuses on different days, please do not spoil any of today's puzzles or solutions online until the game book is released publicly on MaPPmath.org!
- Contact Game Control immediately in the case of emergency or any issues with these rules.

Game Control

Only one team is allowed at a time inside Game Control. If multiple teams wish to speak to Game Control, they must form a line outside the room and will be seen first-come, first-served. Teams that have multiple reasons to speak to Game Control must return to the line for each reason.

Winning the Game

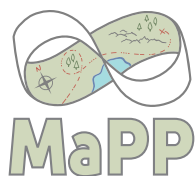
The team that earns the **most Victory Points out of 100** by the end of the game is the **winner**. If any teams are tied, their Bonus Puzzle scores will be used to break the tie. If that's not enough, then the tie will be broken based on how quickly those teams earned their Victory Points (the time each team submitted its last correct puzzle solution).



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Code Sheet

Letter	Decimal	Binary	Morse Code	Braille	Pig Pen	ROT13
A	1	00001	.-	⠠	└	N
B	2	00010	-...	⠡	┐	O
C	3	00011	-. -.	⠢	└	P
D	4	00100	-..	⠣	┐	Q
E	5	00101	.	⠤	┐	R
F	6	00110	..-. .	⠥	└	S
G	7	00111	---.	⠦	└	T
H	8	01000	⠧	┐	U
I	9	01001	..	⠨	┐	V
J	10	01010	.-. -	⠩	└	W
K	11	01011	-.-	⠪	┐	X
L	12	01100	.-..	⠬	└	Y
M	13	01101	--	⠭	┐	Z
N	14	01110	-.	⠮	┐	A
O	15	01111	---	⠯	└	B
P	16	10000	..-. .	⠰	└	C
Q	17	10001	--- -	⠱	┐	D
R	18	10010	.-.	⠲	┐	E
S	19	10011	⠳	└	F
T	20	10100	-	⠴	└	G
U	21	10101	..-	⠵	┐	H
V	22	10110	... -	⠶	└	I
W	23	10111	.-. -	⠷	┐	J
X	24	11000	-... -	⠸	└	K
Y	25	11001	-.-. -	⠹	┐	L
Z	26	11010	--- .	⠺	└	M



MaPP Challenge '18 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
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Opening Puzzle

5VP if solved before deadline, Time Solved used to break ties in VP+Bonus

The Kantor Region	Time Solved	VP Earned
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Main Puzzles

15VP for each Main Puzzle solved; Time Solved used to break ties in VP+Bonus

1	Go For It	Time Solved	VP Earned
2	When Push Comes to Shove	Time Solved	VP Earned
3	The Nickname Rater	Time Solved	VP Earned
4	Endless Enigmas	Time Solved	VP Earned

Bonus Puzzle

Best submission used to break ties in VP

The Expedition Zone	First Submission	Second Submission	Third Submission
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Cryptic Puzzles

5VP for each Cryptic Puzzle solved; Time Solved used to break ties in VP+Bonus

1	???	Time Solved	VP Earned
2	???	Time Solved	VP Earned
3	???	Time Solved	VP Earned
4	???	Time Solved	VP Earned

Metapuzzle

10VP if solved, Time Solved used to break ties in VP+Bonus

???	Time Solved	VP Earned
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5VP if earned, Time Acquired used to break ties in VP+Bonus

Additional VP	Time Acquired	VP Earned
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Total VP Earned

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MaPP Challenge '18

Campus Guidelines

Here are some guidelines for local campuses on how to prepare for and run the event.

Schedule Template

- 0:00 - Registration
- 0:45 - Orientation
- 1:00 - Game Begins with Opening Puzzle
- 2:00 - Opening Puzzle due
- 4:00 - Cryptic/Meta Puzzles released
- 5:00 - Game Ends (all solutions due)
- 5:30 - Wrap-Up and Awards
- 6:00 - Dismissal

Classroom Space

A large **lecture hall** is recommended for running Registration, Orientation, and the Wrap-Up. Game Control can be stationed there during the game as well.

Each team should be given a separate **classroom** so that they may openly collaborate with teammates without spoiling puzzles for other teams. It is useful to affix **printed signs** on each classroom and Game Control to help players navigate your space, as well as any additional signage required to get around.

Team Supplies

Scissors and tape should be provided in each classroom. Some campuses choose to provide simple **calculators** to each team. In addition, **chalk or whiteboard markers** should be provided if teams will have access to chalkboards or whiteboards in their room.

Note that teams may choose to bring their own additional supplies, such as smartphones, laptops, cameras, graph paper, colored pencils, and so on. Due to the wide availability of these items (particularly phones), we discourage campuses from banning outside equipment. The puzzles are designed so that they cannot be solved using Google or brute force methods, with one exception. Programming or spreadsheets may help optimize Bonus Puzzle solutions, which is why the Bonus Puzzle is only used to break ties.

Copies

All puzzles are designed to be printed/copied in **grayscale**, both for the convenience of campuses and for accessibility by players. See below to account for how many copies are needed throughout the game. It is recommended to print copies for at least **two more teams than you expect to participate** as extras, depending on your access to last-minute copying.

Each volunteer working at **Game Control** should have a **complete copy of the game book in a binder** for their reference.

Registration

Each player should receive a **packet** containing the **Story, Rules**, and **Code Sheet** pages of the game book. They should also receive a **pencil** and **notepad** for use during the Opening Puzzle and the rest of the game.

Some campuses also choose to distribute other giveaways/swag/brochures at registration. Many bookstores are willing to provide branded disposable bags to help distribute materials.

Teams should be directed to their assigned classroom where they can drop off everything except the provided packet, pencil, and notepad. They should then return to Game Control's lecture hall to await Orientation.

Orientation

The Story and Rules should be reviewed, and any questions from players should be answered. In particular, boundaries for where players are allowed to travel during the game should be established.

Opening Puzzle

Each team should receive **three copies** of the **Opening Puzzle** and supporting documents. The deadline for completing the Opening Puzzle should be clearly communicated.

If you wish for players to **explore your campus**, then you should also provide a **Campus Map** with twenty locations labeled 1-20. The Opening Puzzle solves to four of those numbers, so players should be instructed to visit those four locations. For larger destinations, you should specify where to visit (e.g. the front door). You may choose to either place a **volunteer** at each location to distribute a token to each team that successfully finds it, or an **envelope** of tokens for teams to claim at each location. You may choose to have teams pick up a copy of one of the four **Main Puzzles** at each location to serve as this token, but these should not be the only copies of the Main Puzzles given to each team (see below).

Once this puzzle has been reviewed for all players, you may dismiss the players to begin solving. Once each team completes the puzzle, they should present their solution and/or tokens to Game Control. In return they should receive an **envelope** containing **three copies each** of **Main Puzzles 1-4** and the **Bonus Puzzle**, including supporting documents. They should also receive a **Scoresheet** to mirror the **Scoresheet copy** maintained at Game Control, updated with the results of the Opening Puzzle.

At the deadline for the puzzle, all remaining teams should return to Game Control to pick up their puzzle envelope and scoresheet, and move on to the Main/Bonus Puzzles. If additional volunteers have been organized to facilitate the exploration of campus, you may choose to dismiss them at this time.

Post-Opening Gameplay

After the Opening Puzzle, teams can remain in their provided classroom for the duration of the competition, except to submit solutions to Game Control.

A volunteer should stand at the door of Game Control to ensure at most one team is allowed in Game Control at all times. Solutions to the Main Puzzles, Cryptic Puzzles, and the Metapuzzle are all short words/phrases and may be communicated to Game Control verbally, but may be written out on paper if clarification is required. The solution to the Hidden Puzzle is also a short word/phrase and may be communicated verbally or written out, but Game Control should only confirm the existence of the Hidden Puzzle explicitly after receiving a correct solution. Players should be asked which puzzle they are attempting to solve before giving a solution.

As each Main Puzzle is solved, that team should receive a **packet** containing **three copies** of the corresponding **Cryptic Puzzle**, including supporting documents. Once each team has solved all four Cryptic Puzzles, they should receive a **packet** containing **three copies** of the **Metapuzzle**, including supporting documents. All teams are allowed to pick up an **envelope** containing all unclaimed copies of the Cryptic Puzzles and Metapuzzle during the final hour of the game.

Each time a puzzle is correctly solved, it should be updated by Game Control on both their copy and the team's copy of the Scoresheet, including a timestamp.

Recreational teams are allowed to ask for hints at Game Control at any time for any Main Puzzle, Cryptic Puzzle, or Metapuzzle. Game Control should ask players to explain the work they've done thus far, and give a single hint that should help the team make some amount of progress. Different teams may receive different hints for the same puzzle depending on their progress.

Competitive teams may receive hints for the Main Puzzles during the final hour of the game. Game Control should provide as much help as is necessary; the goal of the Main Puzzles is to expose players to new types of mathematics, so most teams should solve most of the Main Puzzles by the end of the game.

Teams cannot be given hints for the Bonus Puzzle or Hidden Puzzle.

Each team is allowed three submissions of the Bonus Puzzle. Generally this puzzle should be judged by Game Control in front of the players to confirm the validity of the submission. Each submission is recorded on both Scoresheets, including crossing out a box for an invalid submission. Only the best submission from each team is used. If the game has ended with multiple teams in line for Game Control, all submissions for all teams should be collected as quickly as possible and graded. Teams may not submit multiple Bonus Puzzle solutions after the game has ended.

Food

Campuses that will be running the event through lunchtime are encouraged to provide a **pizza lunch** for players. This lunch should not interrupt the game; rather, players should be able to grab a bite to eat to have while they continue to solve puzzles. In addition, **snacks** (fruit, granola bars, etc.) and **drinks** (bottled water) are nice for players to have access to during the game. Don't forget to provide appropriate **plates, cutlery, napkins, and trashbags**.

This food can be distributed at a **central location near Game Control** (but not inside Game Control's room).

Wrap-Up and Awards

At the end of the game, teams should straighten up their classrooms before returning to Game Control for the Wrap-Up. **Trash bags** may be provided for this purpose.

Teams should line up outside Game Control until results have been tabulated. Once all results have been determined, teams may be seated inside Game Control. **Solutions** to all puzzles should be projected and reviewed with all players.

Awards for Recreational/Competitive teams are treated completely separately if both Leagues are present. **Certificates** should be distributed in random order to all teams placing below 3rd place. A **3rd Place Certificate/Trophy** is then awarded. After reminding the 1st place team to be respectful, a **2nd Place Certificate/Trophy** is then awarded, followed by the **1st Place Certificate/Trophy**. Opportunities for photographs should be allowed during this process and after dismissal.

After awards are done, teams may be dismissed.

Shirts/Theming

Campuses may choose to provide/sell **shirts** to volunteers and players, keeping in mind that volunteers should be identifiable to players by sight. To this end, we encourage distributing shirts at Wrap-Up, or using different colors for players/volunteers.

Optionally, you may encourage teams and/or volunteers to wear school colors/shirts, or to develop a team name/theme fitting the game's theme.

Social Media

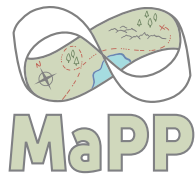
Players/teachers/volunteers should be encouraged to tag @MaPPmath and #Challenge18 on Twitter with non-spoiler posts/media during and after the event.

ClueKeeper

The **ClueKeeper** app will be piloted at select campuses for this event. All rule changes relevant to the usage of ClueKeeper's solution submissions and GPS enforcement should be made clear to players via the app. Each team must have access to an iOS or Android **smart device** with the game downloaded to participate. ClueKeeper may be downloaded from cluekeeper.com.

Part II

Opening Puzzle



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The Kantor Region

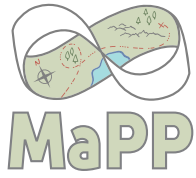
Opening Puzzle

The Mobímon Expert, Dr. Treename, has gifted you with your very first Mobímon and sent you on a journey across the **Kantor Region** to discover new Mobímon and battle other trainers! Kind of odd for a grown man to be sending other people's kids off on adventures before they've even graduated high school, but hey, at least he gave you a **Road Map**!

While visiting all twenty numbered locations would be great, you're a busy person! Upon the advice of Dr. Treename, you can skip out on visiting sixteen of them. In these clues, a neighbor is a location that can be directly accessed along a road without visiting another location first, and the cardinal directions north (N), south (S), east (E), and west (W) ignore roads unless specified.

- Flying SE would cross road connecting 8&12.
- Road leading W ends at location positioned S.
- Its integer factors less than itself add to itself.
- Locations positioned N add to 10.
- Neighboring locations add to 18.
- Roads leading N/S/E/W end at locations positioned N/S/E/W.
- Odd number tied for 2nd-most neighbors
- N-most location with no locations positioned S.
- Flying E would cross 3 locations.
- Roads exit N/S/W and lead to exactly 3 neighbors.
- Locations positioned N or W multiply to 11.
- Even number tied for 2nd-most neighbors.
- Largest prime numbered location (only factors are 1 and itself).
- Squared number x^2 that neighbors a cubed number y^3 .
- Neighboring locations multiply to 15.
- Flying SW would cross 4 locations.

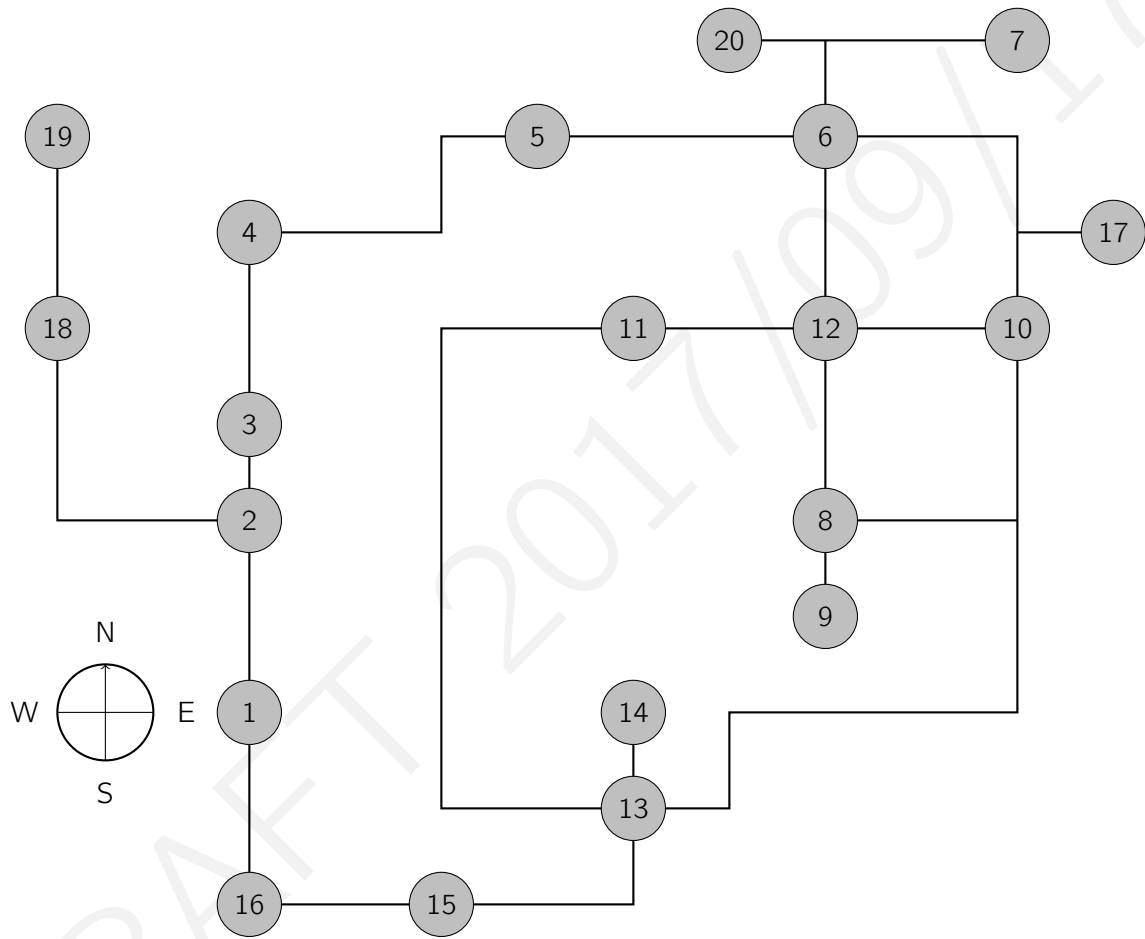
Check out the **four remaining locations**, and you'll be well on your way to starting your journey!



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The Kantor Region

Road Map



Part III

Main Puzzles



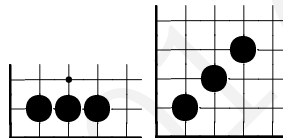
MaPP Challenge '18

Go For It!

Main Puzzle 1

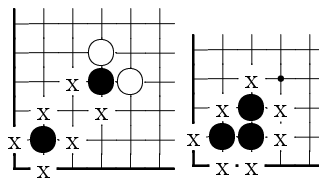
While traveling down Road 4.139π , you cross paths with a wizened Mobimon Trainer. After finally completing his **non-skippable seven-hour tutorial** on how to catch Mobímon, you try to slip away without him noticing. Alas, before you can make your excuses, he begins to tell you how Mobímon battles were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



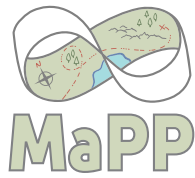
The senile old coot explains that the left figure is an example of a single **group** because the stones are directly adjacent horizontally or vertically on the board, but the right figure represents three separate groups of stones.

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, the x's mark where white stones would need to be played to capture all the black stones.



Normally you **can't play a stone if it doesn't have some empty space next to it**. The one exception is that you can play a stone if that play **creates empty space by capturing your opponent's stones**.

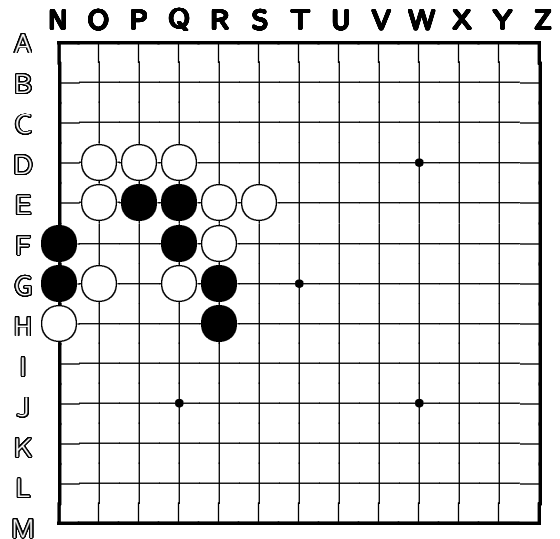
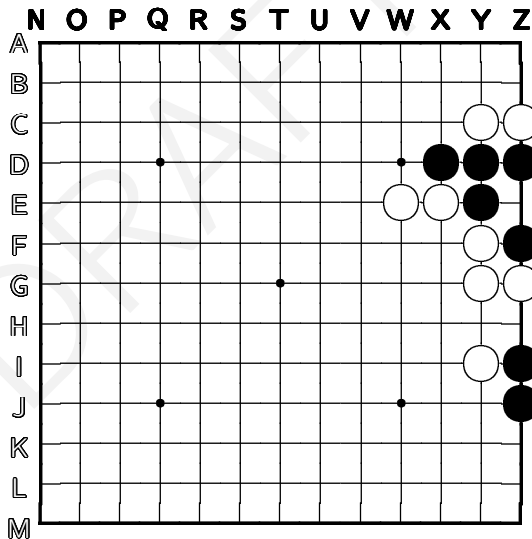
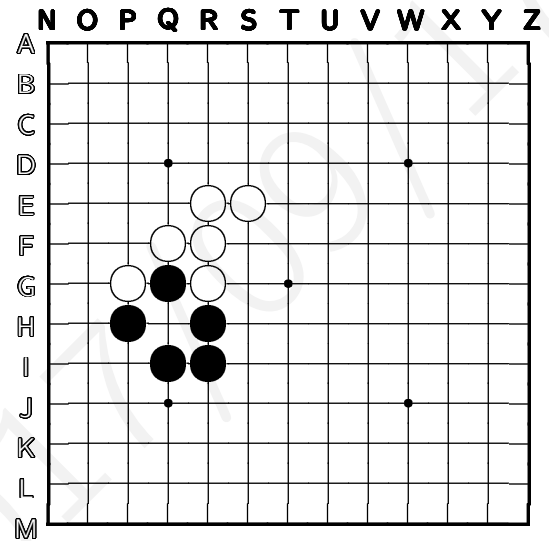
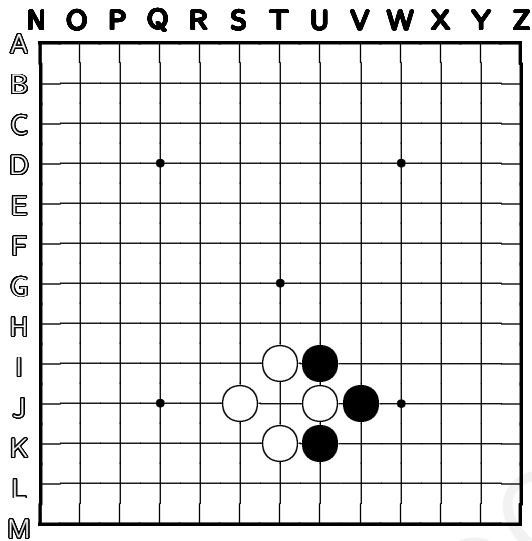
You haven't really been listening, but then the old man mentions that he might be able to tell you where to **find some interesting Plant-type Mobímon** if you can solve a related **puzzle**. In each of the provided **Old-School Mobímon Battle Grids**, there is exactly one position where a stone could 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!).

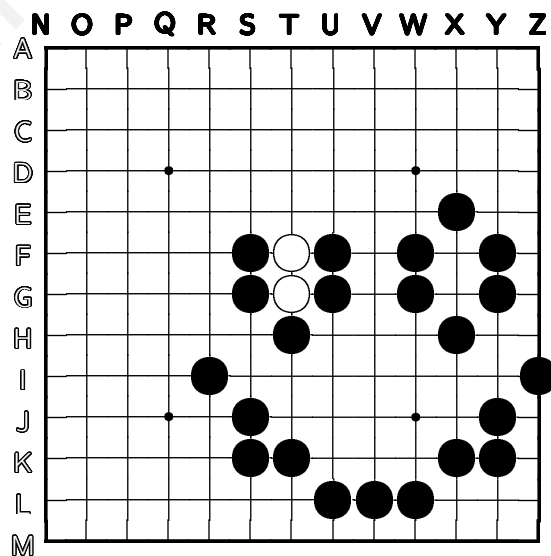
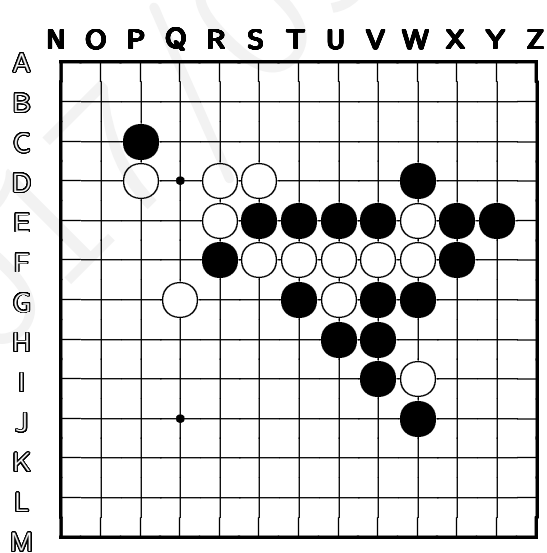
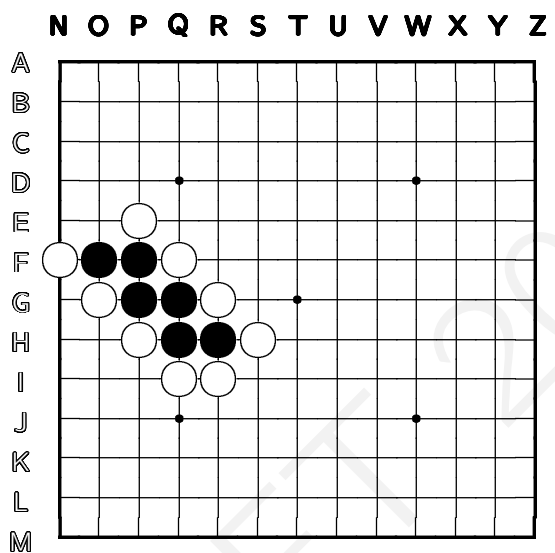
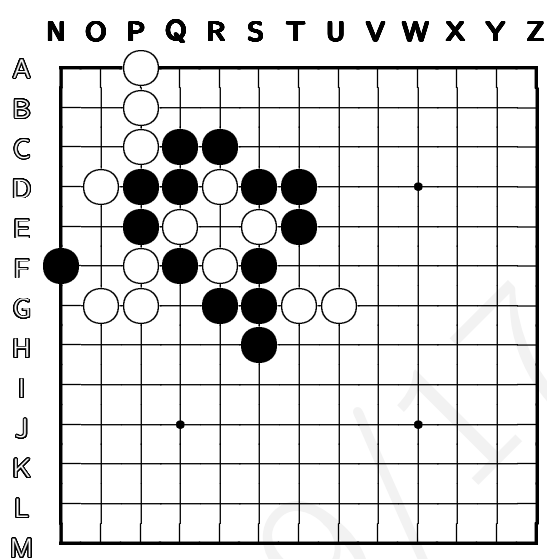
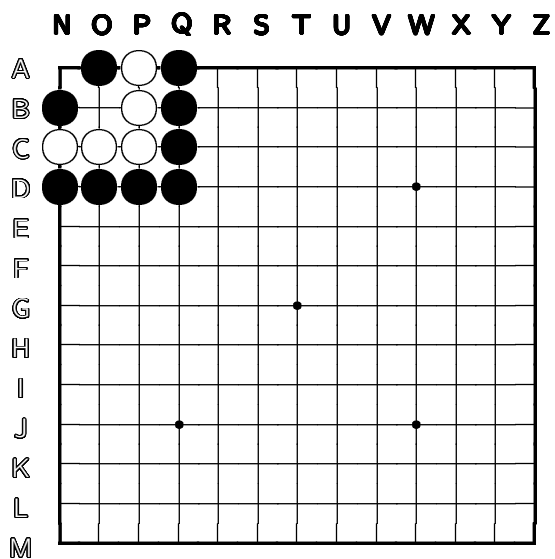


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Go For It!

Old-School Mobímon Battle Grids







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When Push Comes to Shove

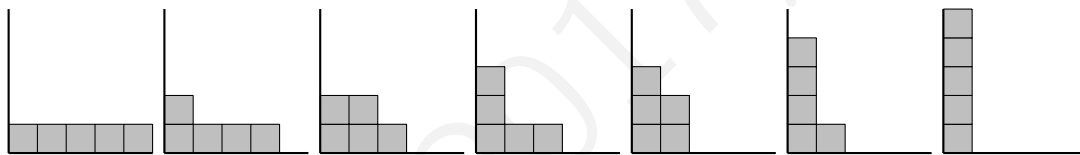
Main Puzzle 2

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

It's a close match, but you win! As Dave gives you your victory money, he tells you about a group of **Tattarat** Mobimon 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 Mobimon 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

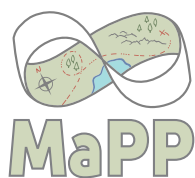
Main Puzzle 3

As your adventure continues, you find yourself in **Achromatopsia City**, located at the end of Road 20.7183—e and home of the famous Mobìmon **Nickname Rater**. She explains that while Trainers often like to give their Mobìmon cute nicknames, she's very particular about the rules for an **excellent** Mobìmon 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.
- Any nickname that cannot be created by using the above rules is not excellent.

The Nickname Rater, not one to shy away from a good **puzzle**, offers you the chance to rate the following Mobìmon 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 | • EEVOL | • AERODYCTL |
| • ULTRAMON | • NOHTYP | • PARACENT |
| • OMASTARE | • BLASTMOIST | • EARSEA |
| • VOLTEON | • ICHU | • DRAGONAT |
| • GENGASKHAN | • KADABARA | • RAGMAR |







MaPP Challenge '18

Endless Enigmas

Main Puzzle 4


As you make your way down Road $\frac{6.4984}{\sin(20^\circ)}$, you find a group of **Doppl** Mobimon 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 Mobidex (an electronic guide used by most Mobimon 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 Mobidex points out that while ω is the first **infinite number**, but it's not the only one! You see, bizarre 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 Mobidex is able to count a few of these groups.

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

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.

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

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.

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

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 Mobimon attack is 24007042951, but you'll need to solve the following Doppl arithmetic problems to figure out what that means in English!

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

Part IV

Bonus Puzzle



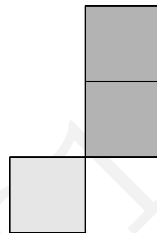
MaPP Challenge '18

The Expedition Zone

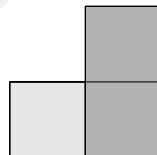
Bonus Puzzle

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

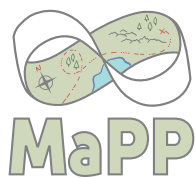
1. You may set up your nets in any order, but your first net must cover the **upper left corner** of the Zone.
2. All subsequent nets **must be connected at a corner** to a previous net, as in this example.



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 Mobimon 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 Mobimon Champion!



MaPP Challenge '18

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

-

Sum of numbers not in Nets

=

Score:

Sum of numbers in Nets

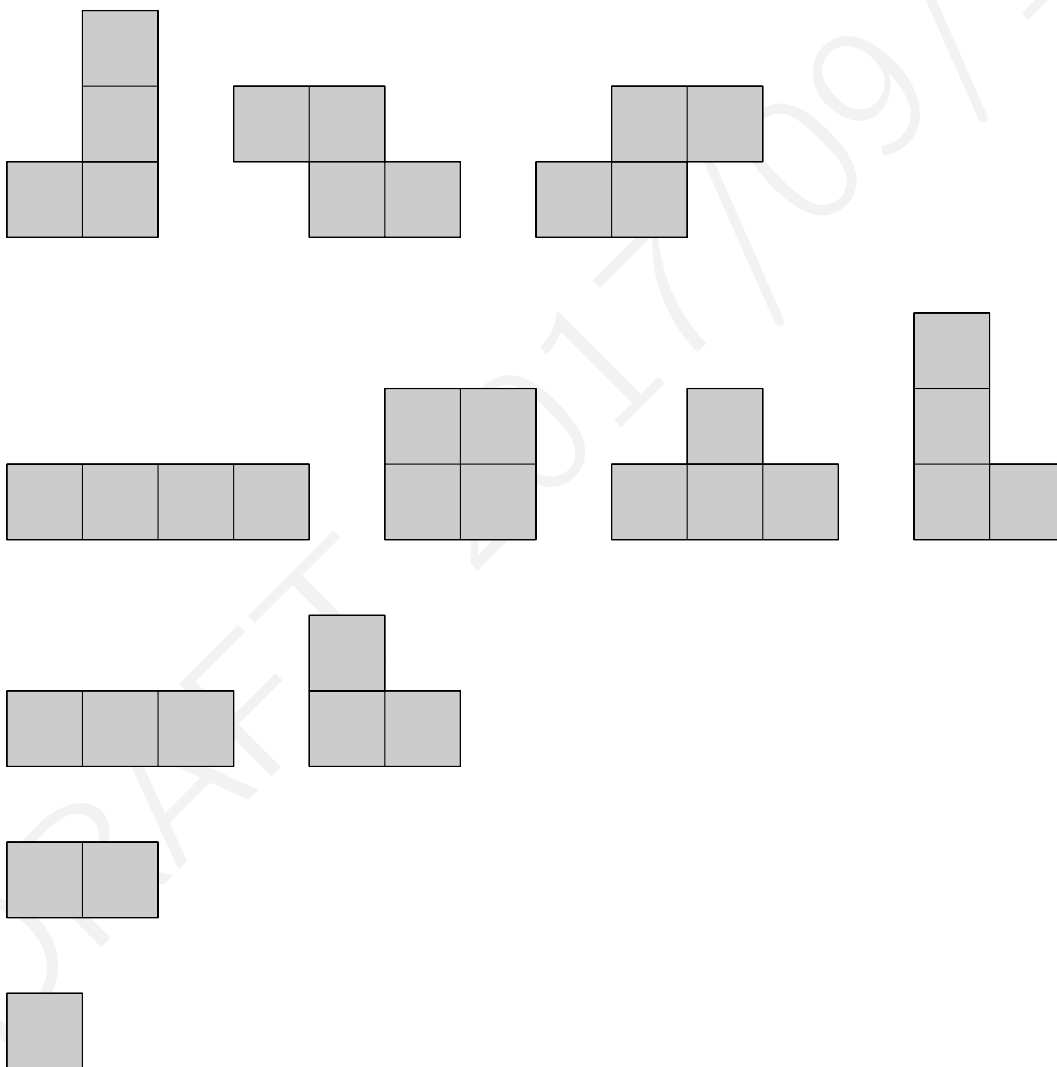


MaPP Challenge '18

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 V

Cryptic Puzzles



MaPP Challenge '18

Civic Duty

Cryptic Puzzle 1

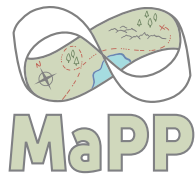
You finally slip away from the rambling Tutorial Man, but just your luck! A pack of Mobímon are blocking the path through Road In(148.45).

- 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.



MaPP Challenge '18

Cross Product

Cryptic Puzzle 2

Impressed with your problem-solving ability, the dockworker suggests you head to the Mobimon Dojo at the end of Road $\tan(87.4094^\circ)$. 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 HIPCONAM.”

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 Mobimon Master’s scroll?



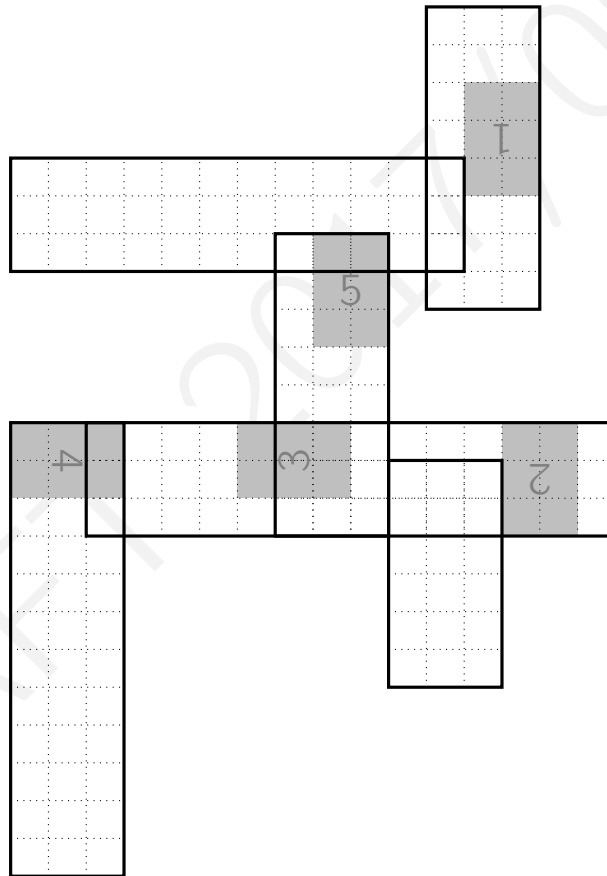
MaPP Challenge '18

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 Mobimon 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 Mobimon mystery...



MaPP Challenge '18

Pin it Down

Cryptic Puzzle 4

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

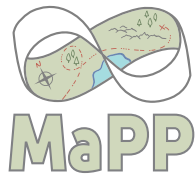
Sure enough, at the end of Road $\frac{19!}{18!}$, you find the **Dojo**. Its **Master** doesn't hesitate; as soon as you enter her lair, she sends out two of the most ferocious Mobìmon you've faced yet!



She laughs arrogantly at your hesitation. "There's **something you must first become** before you can defeat Mobìmon like Nohtyp and Doppl!" Mesmerized, you look for a clue in the arena, anything that can reveal what you want, no, need to be...

Part VI

Metapuzzle

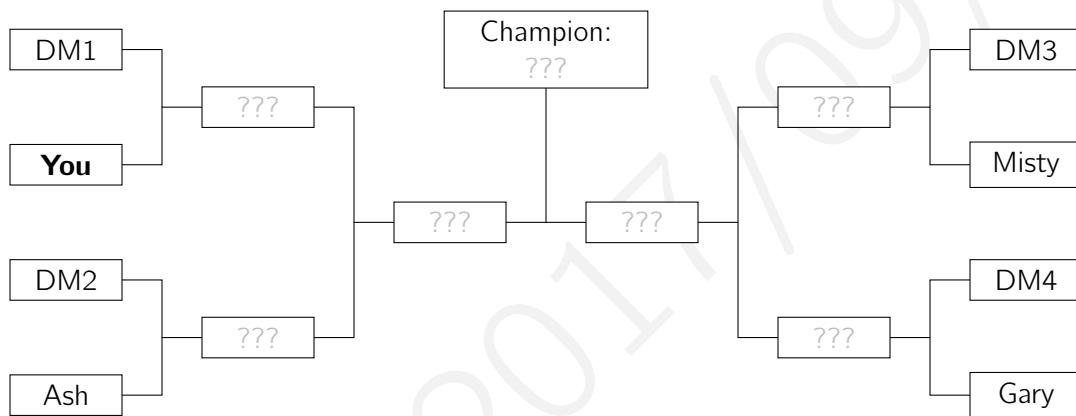


MaPP Challenge '18

Route to Victory

Metapuzzle

You've finally reached the end of your journey, having been honored by the four **Dojo Masters** with the opportunity to compete with them and three other trainers in the **Mobímon Tournament**! You've each been ranked according to your previous battle experience; unfortunately, that means you'll have to work your way up from the bottom!

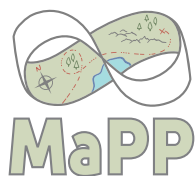


- Dojo Master 1 (Rank 1) will use _____.
- Dojo Master 2 (Rank 2) will use _____.
- Dojo Master 3 (Rank 3) will use _____.
- Dojo Master 4 (Rank 4) will use _____.
- Gary (Rank 5) will use Glowmage.
- Misty (Rank 6) will use Squidiny.
- Ash (Rank 7) will use Steinape.
- You (Rank 8) will use _____.

- 1st place Mobímon: _____
- 2nd place Mobímon: _____
- 3rd place Mobímon: _____
- 4th place Mobímon: _____
- 5th place Mobímon: _____
- 6th place Mobímon: _____
- 7th place Mobímon: _____
- 8th place Mobímon: _____

Your task is no simple one, so be sure to read over the **Mobímon Battling Overview** to learn the ins and outs of the tournament.

- You should be able to **figure out which Mobímon** each of the Dojo Masters will use in this tournament based upon your previous experiences with them and the provided **Mobímon List**.
- You'll also need to **choose a Mobímon for yourself**. Luckily, there's exactly one Mobímon on the provided list that can beat every trainer you'll face in the tournament!
- Finally, if you **rank the participating Mobímon** according to the tournament results, you might be able to identify an alternate title for the Mobímon Champion, solving today's final puzzle!



MaPP Challenge '18

Route to Victory

Mobímon Battling Overview

The *PWR* of a Mobímon move is based on the Mobímon's *LV*, but modified by a couple rules.

Each Mobímon has one or two of these types: Ordinary, Flame, Aqua, Plant, Magic, Undead, and Lightning. In addition, each Mobímon move has one of those types as well. If the type of the move matches one of its user's types, then the *PWR* of that move is multiplied by 1.5. Otherwise the Mobímon type does not affect the *PWR* of the move at all.

Secondly, the type(s) of the opponent Mobímon also affect the move's *PWR*, according to the following chart. For each of the opponent's types, consider the cell found in the intersection of that column and the row given by the move type. If the cell isn't empty, multiply the move's *PWR* by that number.

	O	F	A	P	M	U	L
O					1/2	0	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	0			2	2		
L	1/2		2			2	

For example, a Flame-type move used against a Plant/Magic-type Mobímon is modified by a factor of 2, but it would be modified by $\frac{1}{4}$ instead if used against a Flame/Aqua-type Mobímon. (If the user has the Flame type, then the total modifiers would be 3 and $\frac{3}{8}$, respectively.)

Each Mobímon knows two different moves, so it's up to the trainer to decide which move would have greater *PWR* against their opponent. The Mobímon that uses the move with greater *PWR* than their opponent wins the battle and moves on in the tournament, and the loser is knocked out.

During a tournament, each trainer must use the same Mobímon for all battles, and each Mobímon cannot be used by more than one trainer. At the conclusion of the tournament, the trainers and their Mobímon are ranked according to how many battles were won: 1st place for 3 wins, 2nd place for 2 wins, 3rd-4th place for 1 win, and 5th-8th place for no wins. The rankings each trainer entered the tournament with are used to sort 3rd-4th and 5th-8th places.



MaPP Challenge '18

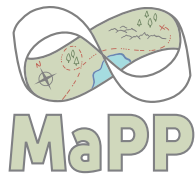
Route to Victory

Mobímon List

Name	Type(s)	LV	1st Move	2nd Move	Mobídex Description
Ariafire	Flame	50	Flame	Lightning	Works well with other firey Mobímon.
Burnezam	Flame/Magic	49	Flame	Magic	Known for its caution and level-headedness.
Dawnoduh	Ordinary/Undead	56	Ordinary	Flame	Your run-of-the-mill zombie.
Emaphant	Ordinary	52	Ordinary	Magic	Tramples over the competition.
Finfanta	Magic	54	Magic	Flame	Moody, it creates clouds of strife.
Glowmage	Magic/Lightning	55	Magic	Undead	A shining example of magical prowess.
Planktin	Aqua/Plant	51	Plant	Ordinary	Well, it grows on you at least.
Scorchar	Flame/Lightning	58	Flame	Undead	It can run a marathon in under 38 minutes.
Steinape	Undead/Lightning	47	Lightning	Ordinary	It's alive with passion for battling.
Squidiny	Aqua	57	Aqua	Ordinary	A lot of fun to go surfing with.
Thundora	Lightning	53	Lightning	Plant	Incredibly profecient, like no one ever was.
Zomtreed	Plant/Undead	43	Undead	Magic	This extreme Mobímon pushes it to the limit.

Part VII

Appendix



MaPP Challenge '18

Solutions

Opening Puzzle - The Kantor Region

The locations not ruled out are 3,7,8,15.

Main Puzzle 1 - Go For It

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-→BABBBAB
- *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-→BABBBAB

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

Main Puzzle 4 - Endless Enigmas

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

Thus 24007042951 yields the solution MIRRORIMAGE.

Cryptic Puzzle 1 - Civic Duty

This puzzle is solved by ordering the Mobímon alphabetically, then converting the required number of trainers for each 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 HIPCONAM.” HIPCONAM 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

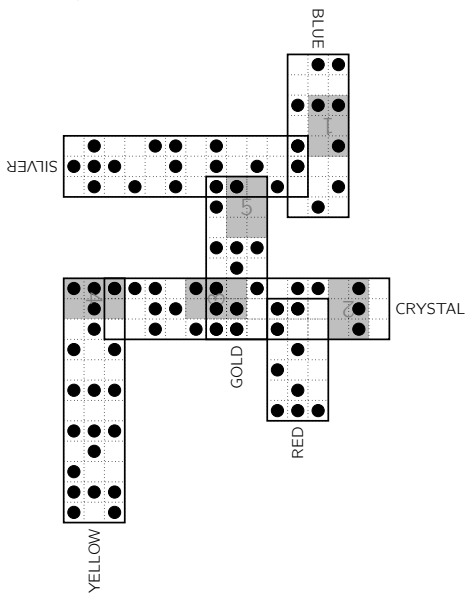
Each “cross product” represents the letter where the two words cross in the grid, yielding the following.

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. (To get started, note that there is only one option for RED, and if you choose the wrong orientation then CRYSTAL cannot fit.)



The numbered regions 12345 yield the solution ULTRA in Braille.

Cryptic Puzzle 4 - Pin It Down

Overlaying the mirror images of the monsters reveals a message using the Pig Pen cipher (where the open circles represent no dot, and the filled-in circles represent a dot).



The solution is VERYBEST.

Metapuzzle - Route to Victory

The four Dojo Master Mobímon are determined by comparing the Cryptic Puzzle solutions to the Mobídex descriptions.

- DM1: PRUDENCE ⇒ “Known for its caution and level-headedness.” ⇒ Burnezam
- DM2: TEAM ⇒ “Works well with other firey Mobímon.” ⇒ Ariafire
- DM3: ULTRA ⇒ “This extreme Mobímon pushes it to the limit.” ⇒ Zomtreed
- DM4: VERYBEST ⇒ “Incredibly profecient, like no one ever was.” ⇒ Thundora

The tournament may then be calculuated, assuming the player wins their battles. To do so, the player’s Mobímon must defeat Burnezam, Zomtreed, and Glowmage. It follows that the only possible choice to win the tournament is Emaphant. This results in the following rankings.

- | | |
|---|--|
| 1. Emaphant (You, originally ranked 8) | 5. burnEzam (DM1, originally ranked 1) |
| 2. gLowmage (Gary, originally ranked 5) | 6. thund0ra (DM4, originally ranked 4) |
| 3. arIafire (DM2, originally ranked 2) | 7. squidiNy (Misty, originally ranked 6) |
| 4. zomTreed (DM3, originally ranked 3) | 8. steinapE (Ash, originally ranked 7) |

The solution ELITEONE may be found by reading down the diagonal of the ranked Mobímon; that is, the first letter from first place, the second letter from second place, etc.

Hidden Puzzle

Each of the Roads referenced in Main Puzzles 1-4, the Bonus Puzzle, and Cryptic Puzzles 1-4 approximate to an integer between 1 and 26.

- $4.139\pi \approx 13 = M$
- $\frac{6.4984}{\sin(20^\circ)} \approx 19 = S$
- $\tan(87.4094^\circ) \approx 25 = Y$
- $\sqrt{9^2 + 12^2} = 15 = O$
- $6 + i^2 = 5 = E$
- $500\% = 5 = E$
- $20.7183 - e \approx 18 = R$
- $\ln(148.45) \approx 5 = E$
- $\frac{19!}{18!} = 19 = S$

MORSEEEYES is not the solution, but a hint on how to find it. In Main Puzzles 1-4, the Bonus Puzzle, and Cryptic Puzzles 1-4, occasionally the accented í in Mobímon is replaced with ì or î. Interpreting ì as “dit” and î as “dah”, these accented characters decode to the solution SECRETLAB (the location of the Legenday Mobímon).



MaPP Challenge '18

Credits

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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!

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