



# **MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy**

*Mathematical Puzzle Programs*



MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

# How to Play

## 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.

### Puzzle Packets and ClueKeeper

Each team has received multiple **Puzzle Packets**. However, there is not enough information in this packet to begin solving any puzzles.

Once the game begins, clues will become available in the **ClueKeeper** app that will allow players to begin solving puzzles in the packet. Once a puzzle is solved, its solution can be submitted via the app. As time progresses, hints for unsolved puzzles will unlock, helping teams who are stuck. The game ends when your time in ClueKeeper has expired.

### Main Puzzles

Once the game begins, you'll be presented with four **Main Puzzles**. Each Main Puzzle can be solved directly using mathematical modeling and problem-solving abilities. Once the solution for the puzzle has been entered into ClueKeeper, **10 Victory Points** will be awarded, and the second part will be unlocked. This second part uses the first solution to extract a short word or phrase. Solving this second challenge is worth an additional **5 Victory Points**.

### Cryptic Puzzles

After solving the second part of each Main Puzzle, an additional **Cryptic Puzzle** will become available to solve. The way to solve these puzzles is left, well, cryptic. However, your team should still be able to use your critical thinking to extract a hidden word or phrase. Correct solutions are worth **5 Victory Points**.

### Metapuzzle

Once your team has solved two Cryptic Puzzles, the final **Metapuzzle** becomes available, worth **20 Victory Points**.

### Hints

Recreational teams may ask for hints at Game Control at any time during the game, and may receive direct assistance from their teachers/chaperones as desired. Competitive teams may ask Game Control for rules clarifications, but otherwise will only receive help via hints made available in ClueKeeper.

### 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, then the tie will be broken based on which team submitted the fewest incorrect answers in ClueKeeper, and then by how quickly those teams solved their puzzles.

## Additional Rules/Advice

- 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.
- Before visiting Game Control to ask for a hint or clarification, make sure you've read all the material accompanying the puzzle! Chances are, your question is covered there.
- Teachers and chaperones are not allowed to help Competitive teams solve puzzles.
- Teams may use any supplies they've brought and even look things up online 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, and must always travel with a teammate when leaving their headquarters.
- 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 by MaPP!
- Contact Game Control immediately in the case of emergency or any issues with these rules.



# MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

## Game Resources

### Reference Sheet

Letter	Decimal	Binary	Morse	Braille	Letter	Decimal	Binary	Morse	Braille
A	1	00001	.-	⠠	N	14	01110	-.	⠠
B	2	00010	-...	⠡	O	15	01111	---	⠠
C	3	00011	-. .	⠢	P	16	10000	.-.	⠠
D	4	00100	-..	⠣	Q	17	10001	--.	⠠
E	5	00101	.	⠣	R	18	10010	-. .	⠠
F	6	00110	..-.	⠣	S	19	10011	...	⠠
G	7	00111	--.	⠣	T	20	10100	-	⠠
H	8	01000	....	⠣	U	21	10101	..-	⠠
I	9	01001	..	⠣	V	22	10110	...-	⠠
J	10	01010	.-..	⠣	W	23	10111	.-.	⠠
K	11	01011	-. .	⠣	X	24	11000	-..-	⠠
L	12	01100	.-..	⠣	Y	25	11001	-. -.	⠠
M	13	01101	--	⠣	Z	26	11010	---.	⠠

### Some famous numbers and formulas

$\sqrt{2} \approx 1.41421\ 35623\ 73095\ 04880\ 16887\ 24209\ 69807$  Pythagorean Theorem  
 85696 71875 37694 80731 76679 73799 07324 78462  
 10703 88503 87534 32764 15727

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

$e \approx 2.71828\ 18284\ 59045\ 23536\ 02874\ 71352\ 66249$  Quadratic Formula  
 77572 47093 69995 95749 66967 62772 40766 30353  
 54759 45713 82178 52516 64274

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

$\pi \approx 3.14159\ 26535\ 89793\ 23846\ 26433\ 83279\ 50288$  Euler's Formula  
 41971 69399 37510 58209 74944 59230 78164 06286  
 20899 86280 34825 34211 70679

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

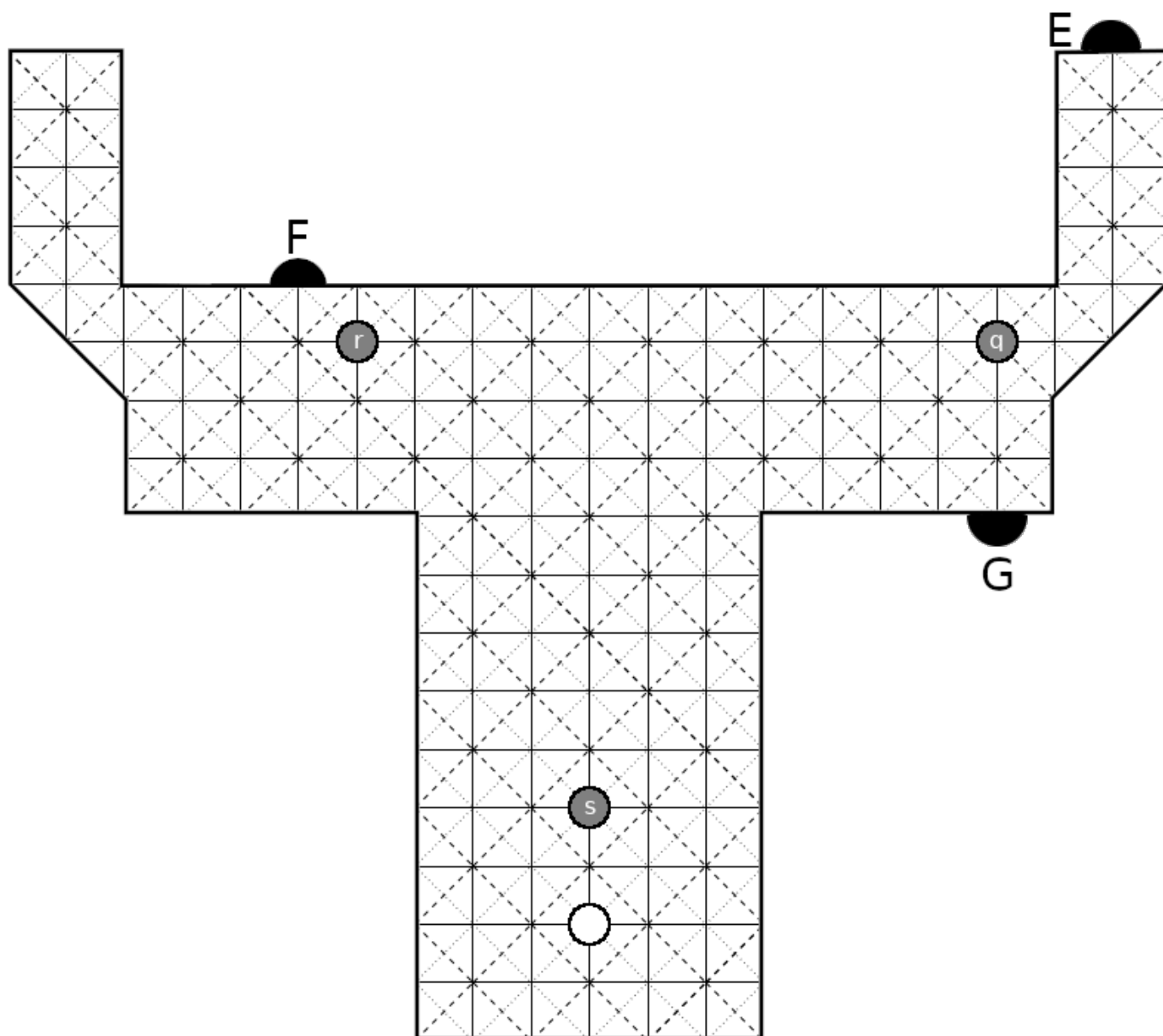
## **Part I**

# **Player Book**



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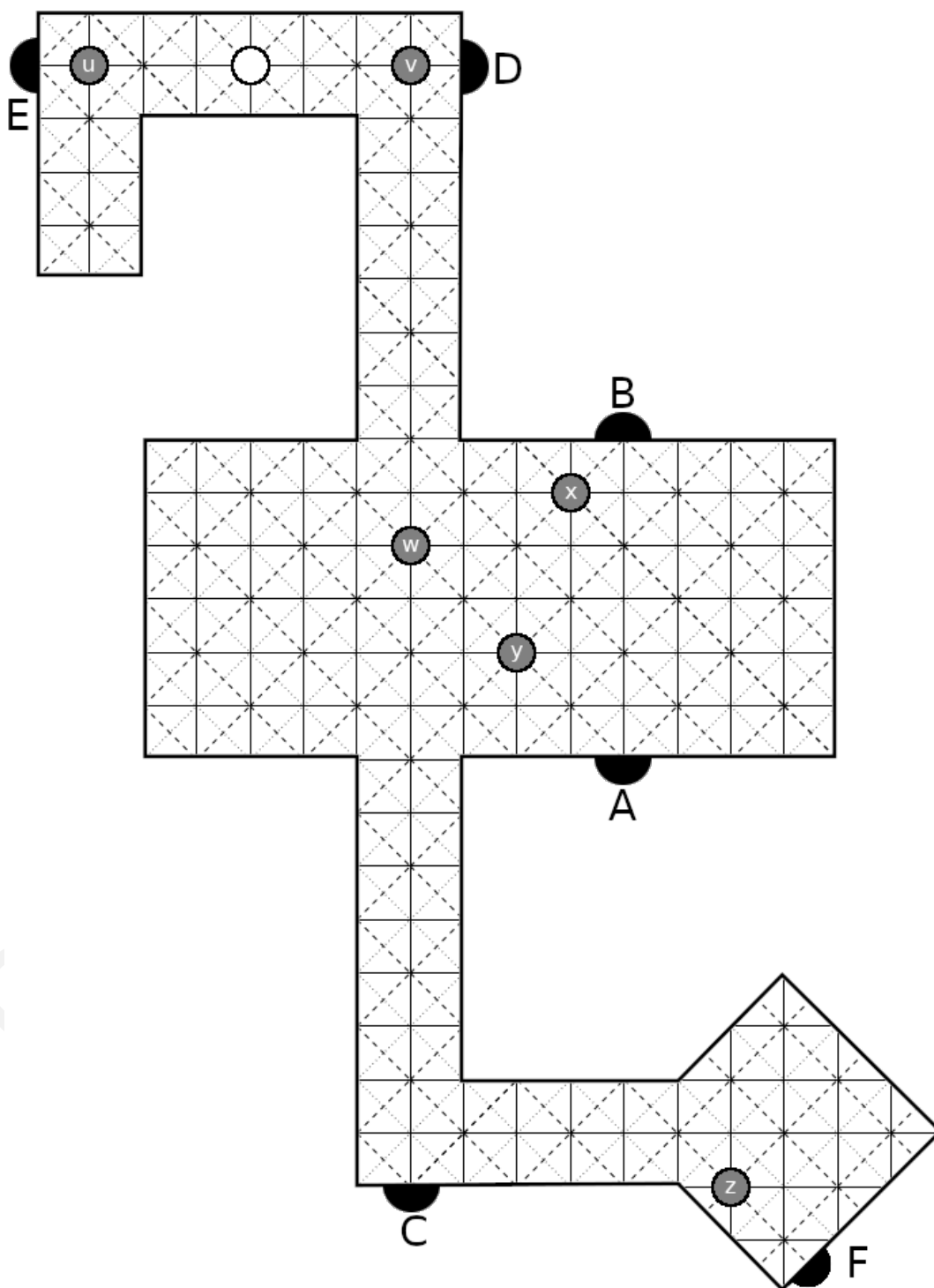
**August 03**

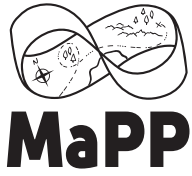




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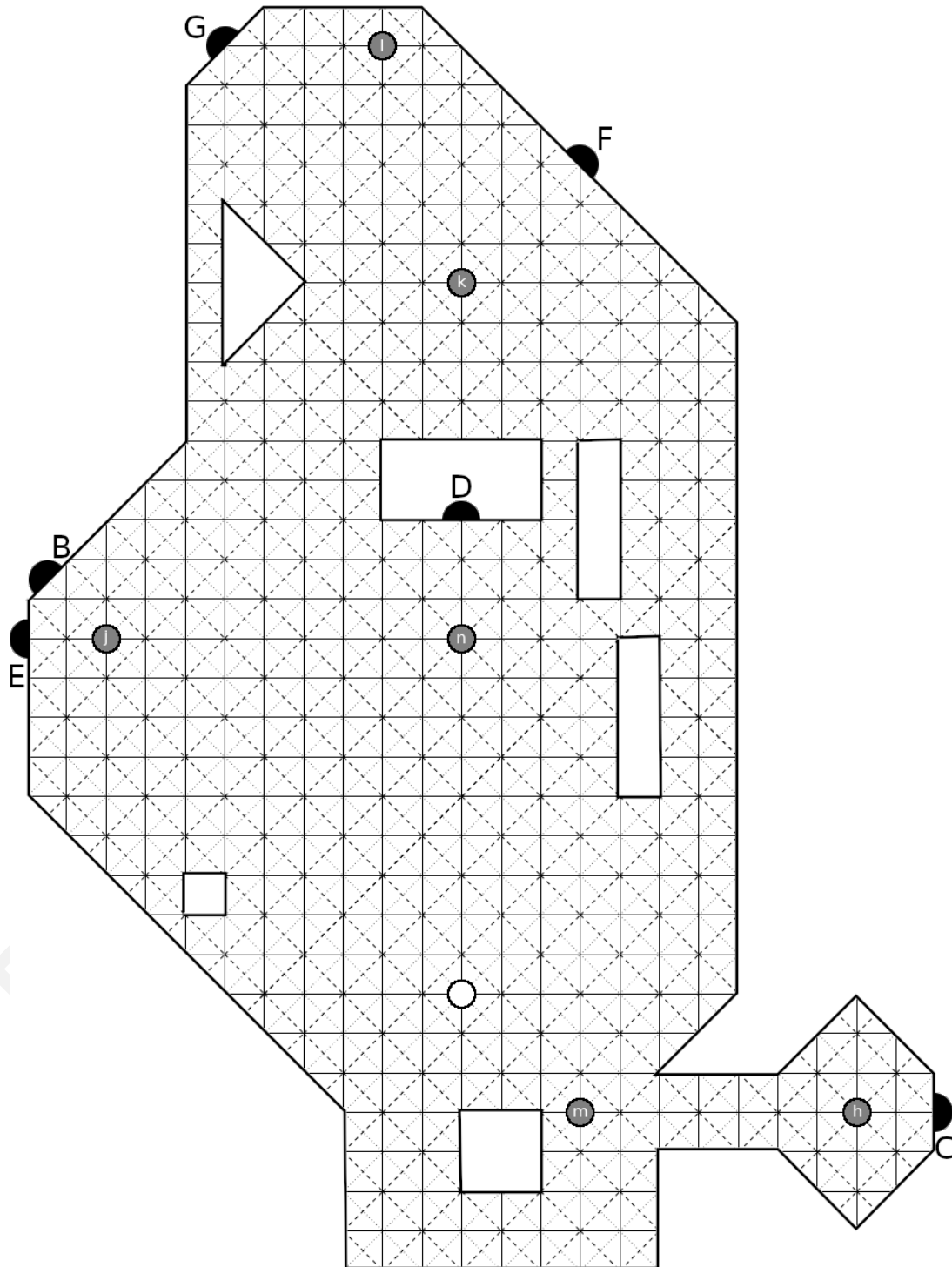
**August 07**





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**August 11**

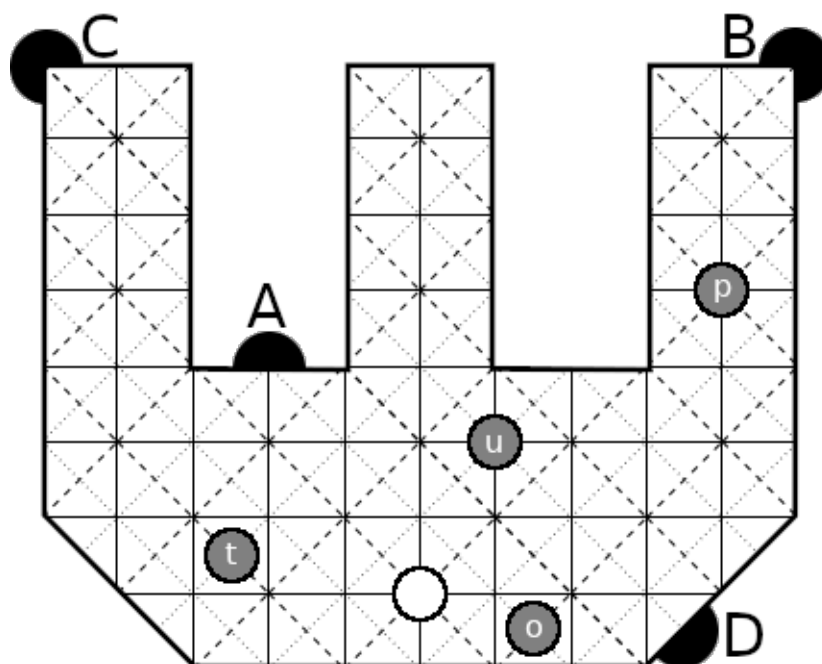






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**August 17**





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**November 12**

Village market:

1. A to 2A?
2. 2A to 2L?
3. A to 3A?
4. A to 3A and M?
5. A to L?

Market square:

1. 2T and Q to T?
2. T to 50T?
3. T to T and F?
4. T to Q?
5. T to 3T?

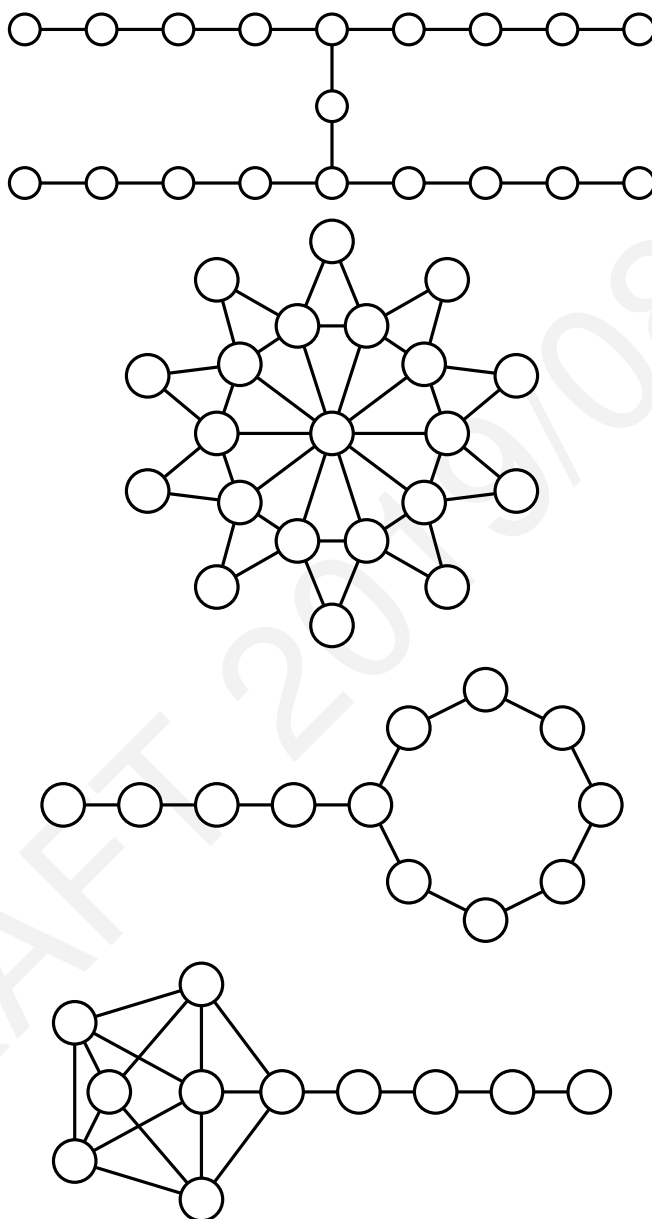
Black market:

1. S to 2S?
2. 2S to S and 2B?
3. 3S to 3C?
4. S to B and 2C?
5. 4S to 2S, 2B, and 5C?



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**February 5**

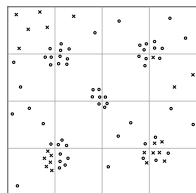




# MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

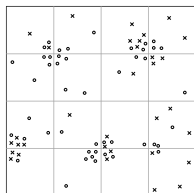
## May 27

Year 1



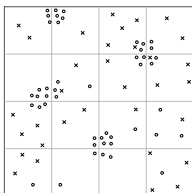
Total Vote Count  
X - 22  
O - 58

Year 2



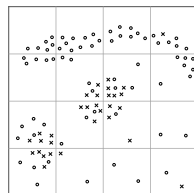
Total Vote Count  
X - 33  
O - 47

Year 3



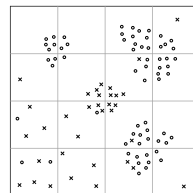
Total Vote Count  
X - 33  
O - 47

Year 1



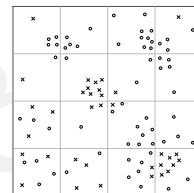
Total Vote Count  
X - 31  
O - 69

Year 2



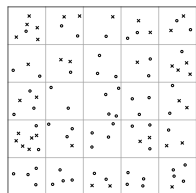
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O - 66

Year 3



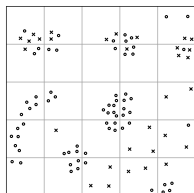
Total Vote Count  
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O - 65

Year 1



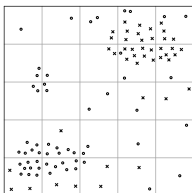
Total Vote Count  
X - 38  
O - 62

Year 2



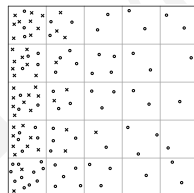
Total Vote Count  
X - 31  
O - 69

Year 3



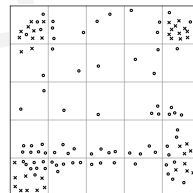
Total Vote Count  
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O - 56

Year 1



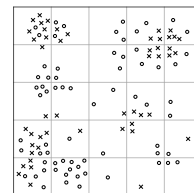
Total Vote Count  
X - 45  
O - 75

Year 2



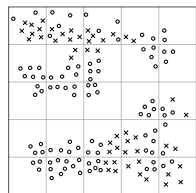
Total Vote Count  
X - 40  
O - 80

Year 3



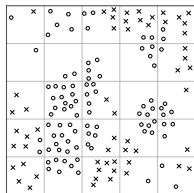
Total Vote Count  
X - 50  
O - 70

Year 1



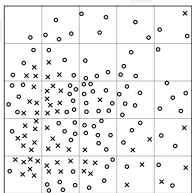
Total Vote Count  
X - 50  
O - 100

Year 2

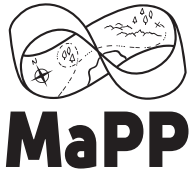


Total Vote Count  
X - 56  
O - 96

Year 3



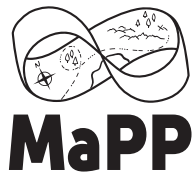
Total Vote Count  
X - 58  
O - 92



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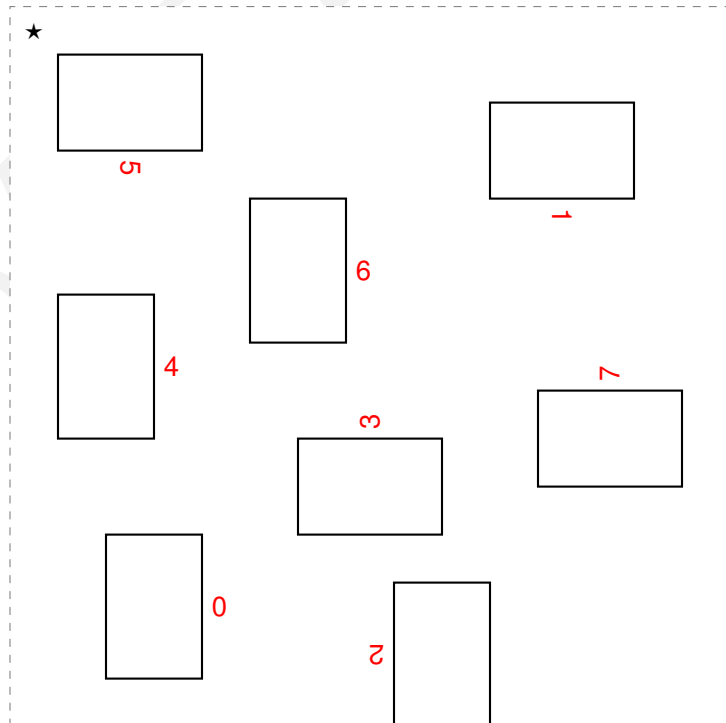
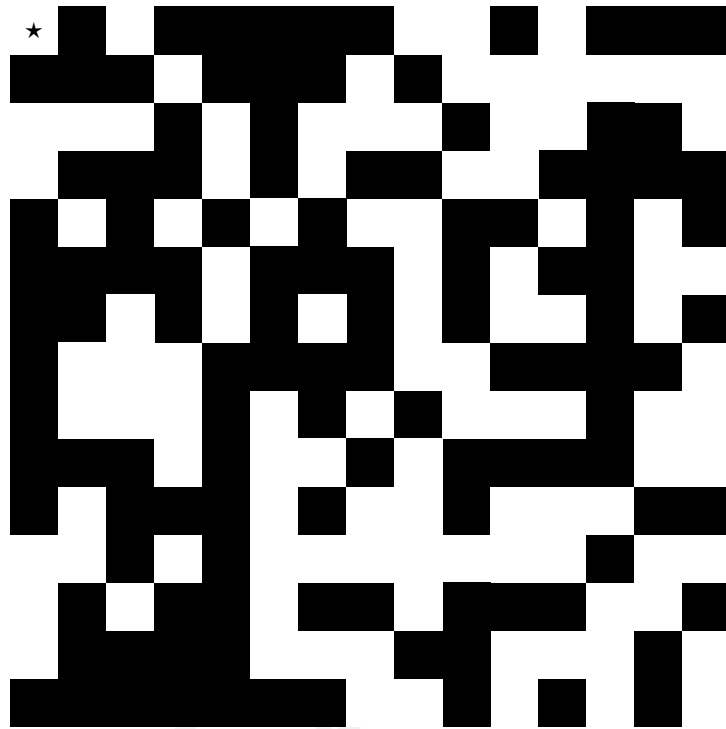
**June 28**

Journal	entry	June	28,	3513		
	Successful	dig	today.	We	found	a
lot	of	pot	shards,	some	with	remarkably
intact	artwork.	Like	in	the	tomb,	there
are	scenes	of	men	with	circles	around
their	heads,	looking	to	the	sky.	We
believe	these	represent	past	kings,	deities	, or
maybe	both.	I	recall	my	advisor's	words,
"people	are	not	pots."	I	should	be
careful	before	drawing	any	firm	conclusions.	On
the	other	end	of	the	site	from
the	tomb	we	found	a	burial	site.
It	was	lined	with	red	ochre,	the
bodies	were	facing	east	with	their	arms
folded.	Already	this	site	has	yielded	so
much.	If	only	the	university	understood.	They
want	to	save	money	so	badly,	but
what	is	it	for	if	not	this?



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**September 07**





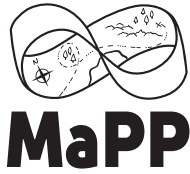
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**January 17**



Site Adjustment:

1. Site 1:  $(?, ?) + (-4, -16)$
2. Site 2:  $(?, ?) + (6, -15)$
3. Site 3:  $(?, ?) + (5, -1)$
4. Site 4:  $(?, ?) + (-3, -1)$



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**March 16**

It seems that the legendary rulers of the Skolem people were each associated with a compass direction. Fascinating!

Oystein Apo Skolem (N)

Engstrom Apo Ore (NNE)

Throralf Apo Thue (NE)

Shanok Apo Ore (ENE)

Trowa Apo Ore (E)

Mawort Apo Ore (ESE)

Berkov Apo Kel (SE)

Knutten Apo Kel (SSE)

Erbach Apo Kel (S)

Guabis Apo Kel (SSW)

Zabala Apo Dheub (SW)

Renfrow Apo Dheub (WSW)

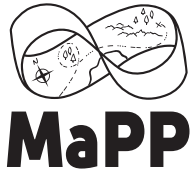
Frakov Apo Dheub (W)

Gangolli Apo Dheub (WNW)

Ramkunar Apo Lewo (NW)

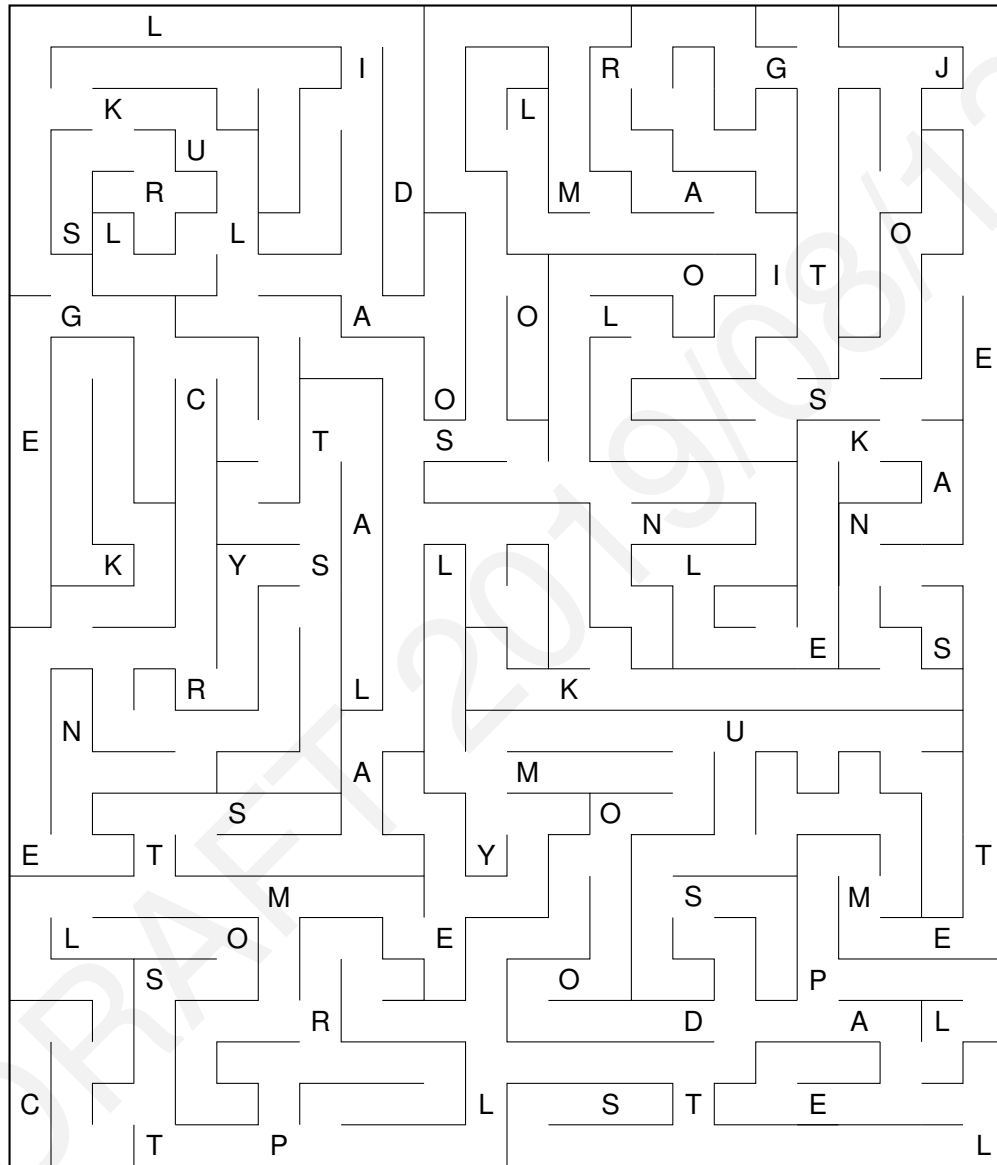
Skraba Apo Lewo (NNW)





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**October 22**

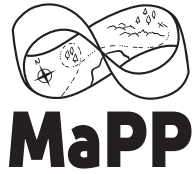




# April 04

$+\rightarrow\downarrow\Diamond+\Delta\nabla-=+$  ●  
 $+\nabla\bigcirc\nabla\times\times\downarrow\Box\Diamond+$  ●  
 $\times\bigcirc\Diamond--\times\bigcirc\nabla\rightarrow\Box\times$  ●  
 $\times\Rightarrow\Box\bigcirc\times\times\rightarrow\uparrow\Box\times$  ●  
 $+\downarrow\Box\times\times\Diamond\leftrightarrow+$  ●  
 $\times\nabla\bigcirc\nabla\times\times\downarrow\Box\Diamond+$  ●  
 $+-\downarrow++\bigcirc\Delta\Diamond+$  ●  
 $\times\Box\bigcirc\Delta\times+\equiv\Delta\bigcirc\Box\times$  ●  
 $\times\Diamond\nabla\bigcirc\nabla+\Box\bigcirc\Delta\uparrow\times$  ●  
 $+\bigcirc\Delta\swarrow++\Box\bigcirc\uparrow\times\times$  ●

$\begin{smallmatrix}\cdot\cdot\cdot\end{smallmatrix} +\bigcirc\Box=\times\bigcirc\nabla\rightarrow\Box+$   
 $\begin{smallmatrix}\cdot\cdot\cdot\end{smallmatrix} \times\downarrow\downarrow\Diamond+\Box\leftrightarrow\times$   
 $\begin{smallmatrix}\cdot\cdot\cdot\end{smallmatrix} +\Box\nabla\bigcirc\nabla\times\times\times-=\Delta\bigcirc\Box+$   
 $\begin{smallmatrix}\cdot\cdot\cdot\end{smallmatrix} \times\searrow\Box\times\times\Delta\nabla---\times$   
 $\begin{smallmatrix}\cdot\cdot\cdot\end{smallmatrix} +\rightarrow\rightarrow\Diamond\bigcirc\times\times\swarrow\Diamond+$   
 $\begin{smallmatrix}\cdot\cdot\cdot\end{smallmatrix} \times-\downarrow++\nabla\bigcirc\nabla\Box+$   
 $\begin{smallmatrix}\cdot\cdot\cdot\end{smallmatrix} \times\bigcirc\Delta+\downarrow\downarrow\Box\Box+$   
 $\begin{smallmatrix}\cdot\cdot\cdot\end{smallmatrix} +\nabla\bigcirc\nabla\leftarrow\downarrow+\times\times\Diamond\uparrow\times\times$   
 $\begin{smallmatrix}\cdot\cdot\cdot\end{smallmatrix} \times\bigcirc\Delta+\downarrow\Box\Box\times$   
 $\begin{smallmatrix}\cdot\cdot\cdot\end{smallmatrix} +\Diamond\bigcirc\Delta\times\times\Diamond\nabla\bigcirc\nabla\uparrow+$

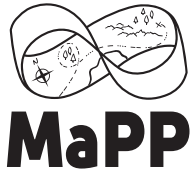


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## December 01

❁ What a splendid day! Ever since Champollion  
❁ discovered the wall paintings in the third  
❁ dynasty tomb, we've known that like other  
❁ ancient peoples, the Fregians had a ball  
❁ game, yet no arenas or equipment had  
❁ ever been found. That changed today. I  
❁ have very high confidence that the ruins  
❁ we discovered are indeed the remains of  
❁ one of these ancient collusiums. While everyone  
❁ thought that the wall paintings were exaggerated,  
❁ boulders over **five** meters in diameter were  
❁ used in this **sacred** game! How fascinating!

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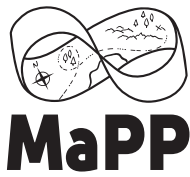
# July 21

Budgeting and begging for grants isn't the most exciting aspect of archaeology, but I suppose it's a necessary evil.

Topic	Detail	Budget Code	Cost
Field work salary	Dr. M. Jonas	N	\$12,717
Field work salary	B. Fraiser	P	\$1,982
Travel expenditures	Lodging	F	\$3,291
Travel expenditures	Airfare	R	\$1,307
Excavation	Digging equipment	Q	\$20,183
Excavation	Artifact cleaning and cataloging	A	\$8,215
Research	Osteology consultant	C	\$6,499
Research	Ceramic analysis	Q	\$7,211
Research	Floral analysis	K	\$5,525
Research	Faunal analysis	Q	\$5,527

## **Part II**

### **ClueKeeper Info**



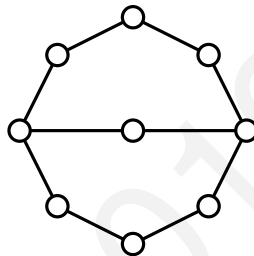
## MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

# Main Puzzle 1

## Searching the Tombs

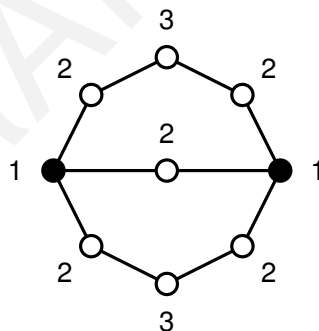
The necropolis of Ramsey is a complex of underground mausoleums, buried by earth and time. It is also where Dr. Jonas almost got fired. After finding her first mummy, she seemed to be cursed. Whenever she entered a new crypt, the mummy inside of it would be as far away from her team as possible. It's not that they had a hard time finding the mummies, in fact the walls had directions on them leading straight to the sarcophagus. Still, she had of run of impossibly bad luck.

Once the university realized how much resources Dr. Jonas was spending on her digs, they demanded she stop “wasting” their money. She needed to minimize the number of rooms her team was exploring. Using ground penetrating radar, Dr. Jonas was able to scout out possible sarcophagus locations and the passages between them. For instance, one site looked like



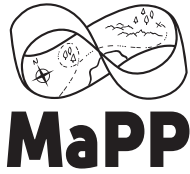
where the circles represent rooms and the lines represent the passages connecting them.

Dr. Jonas could send 9 people out to the site and find the mummy immediately, but that's not very efficient. Instead, she can send down just 2 people, and have the maximum number of rooms they have to explore be three 3. Following the Univeristy accounting scheme, this has a cost of 5 as opposed to 9. This is the best that Dr. Jonas can do.



$$\begin{array}{r} 2 \text{ people} \\ +3 \text{ rooms} \\ \hline 5 \text{ total cost} \end{array}$$

There are four more site diagrams in Dr. Jonas' notes. If you can figure out the minimum cost of exploring these crypts, B. Fraiser will be able to tell you how to decipher the next journal page.



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## Main Puzzle 1

### Searching the Tombs - Part 2

Nice Job! If you look at the cost along with the total number of chambers, you should get coordinates corresponding to all of the sites.

- Site 1: (7, 19)
- Site 2: (4, 21)
- Site 3: (6, 12)
- Site 4: (5, 11)

With this information we should be able to plot the correct coordinates on journal entry 3. The hidden message is then the combination of two of the following words: BACKPACK, COMPASS, FLASHLIGHT, HAT, MAP, ROPE.



## MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

# Main Puzzle 2

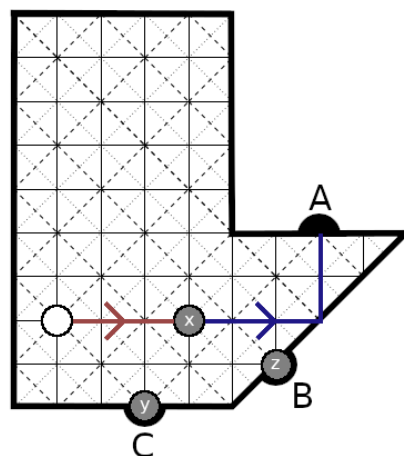
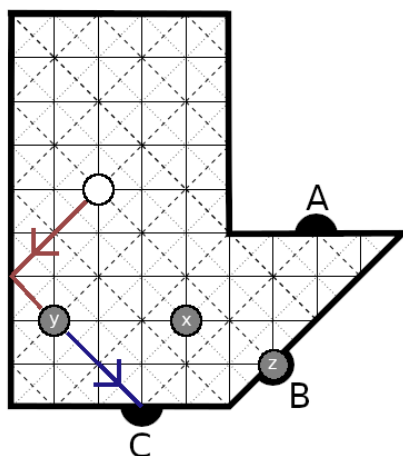
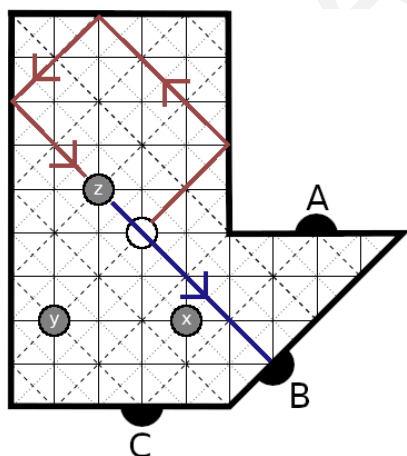
## The Fox and the Rabbits

Dr. Mindy Jonas' first major discovery was the remarkable boulder game of the Fregian people. The Fregian kings built massive arenas with a fantastic variety of shapes and sizes. After surviving her own harrowing encounter with a boulder in a long-lost temple, Dr. Jonas found an ancient tablet describing the rules to this game.

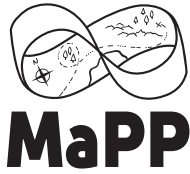
- The game was played with two kinds of boulders: a white one called the fox and several darker ones, called the rabbits.
- The goal of the game was for the the fox boulder to hit the rabbit boulders into the holes at the edge of the arena. Exactly one rabbit boulder' would be hit into each hole.
- The fox boulder could only be launched along the marked vertical, horizontal, and diagonal trajectories. When it collided with a rabbit boulder, the fox boulder would take the place of the rabbit and the rabbit would continue in the direction it was hit.
- The rabbit boulders were not allowed to strike each other, and no boulder was allowed to hit a sharp corner in the arena.
- Once moving, a boulder would continue to move around the arena indefinitely, bouncing off walls until it struck another boulder or sunk into a hole.

I believe the August entries in Jonas's journal are records of five such arenas, and there is a unique way to win each game. I've attached an example arena below to show you what I mean.

Can you solve the five arenas in her journal for me by entering how each boulder and hole matches up into ClueKeeper? Use the format zB-yC-xA, making sure to keep the same order as the boulders are used in each puzzle. -BF







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## Main Puzzle 2

### The Fox and the Rabbits - Part 2

Good work finding all four solutions:

- Arena 1: sG-rF-qE
- Arena 2: uE-vD-wC-xB-yA-zF
- Arena 3: nD-jE-kF-lG-mB-hC
- Arena 4: tC-uD-oA-pB

Looking at the June journal entry, I can't help but notice the strange year used: 3513. Here's an idea: label the columns of this entry with the letters A through G, and the rows h through z. Then maybe you can use the arena solutions and the number 3513 to extract a hidden message? -BF



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## Main Puzzle 3

### Bazaar Trades

The Skolem people of Mesopotamia had many myths and legends. Dr. Jonas was particularly interested in the story of Queen Noether, famed for her ability to barter with traders and merchants. Legend has it, she had no trouble making some fantastic trades. Even if some seem like bad deals, Noether could make any of the following trades, and their opposite trades as well.

- One apple for one piece of meat:  $A \leftrightarrow M$
- One bottle for one magic crystal and one spice bag:  $B \leftrightarrow C + S$
- One magic crystal for two magic crystals:  $C \leftrightarrow 2C$
- One flag for one flag and one tapestry:  $F \leftrightarrow F + T$
- One loaf of bread for one apple and one piece of meat:  $L \leftrightarrow A + M$
- One piece of meat for one apple, one loaf of bread, and one piece of meat:  $M \leftrightarrow A + L + M$
- One quilt for one quilt and one tapestry:  $Q \leftrightarrow Q + T$
- One spice bag for one bottle:  $S \leftrightarrow B$
- One tapestry for one flag and one quilt:  $T \leftrightarrow F + Q$

Despite this, even Noether had her limits. Sure, she could certainly exchange two bottles for two spice bags and two magic crystals, since  $B + B \rightarrow B + C + S \rightarrow S + S + C \rightarrow S + S + C + C$ . But there's no way she could exchange one spice bag for two bottles by using those trades alone.

I think Dr. Jonas was investigating these limits in the November entry of her journal. For each of the three markets, decide if each trade is possible (P) or impossible (I). Submit your solution to ClueKeeper using the format PIPIP for each market. -BF



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## Main Puzzle 3

### Bazaar Trades - Part 2

Nicely done! You figured out which of the trades were possible (P) or impossible (I) for each market. What if we organize that information like this, letting  $P = 1$  and  $I = 0$ :

	Village M.	M. Square	Black M.	Binary
#1	P	P	I	110
#2	I	P	I	
#3	P	I	I	
#4	I	I	P	
#5	I	P	P	

Each binary number with three digits is equal to a number between 0 and 7, and those are the exact numbers found in the September journal entry. That's not a QR code - it's another hidden message from Dr. Jonas!

I'll leave it to you to figure out how to use the five numbers from the chart above to solve the September puzzle, but I have a feeling that binary isn't the only code involved here...



## MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

# Main Puzzle 4

## Ancient Gerrymandering

One of Dr. Jonas' greatest discoveries was the Heyting people, a democratic collection of 6 tribes that lived on the Eurasian steppes. They kept meticulous records of their elections and their rulers. Strangely, even though the Heyting people were democratic, the voting records indicated that many of their leaders received far less than the majority of the votes. How could this happen?

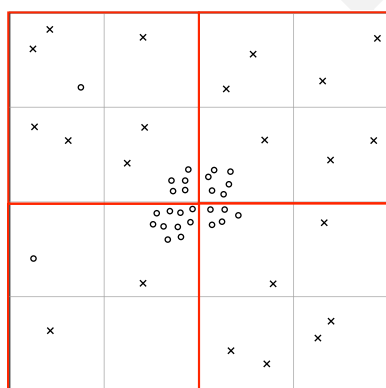
Well, to simplify the voting process, the tribes had broken their land up into provinces. Each province had one vote for the next ruler of that tribe, which was based upon the majority vote from within the province. However, since the tribe leaders were allowed to redraw the boundaries of the provinces each year using the following guidelines, the minority party was able to keep power.

1. The number of provinces in each tribe had to stay the same each year.
2. Each province had to be a single connected region.
3. The difference in population between any two provinces had to be 5 or less.
4. All province boundary lines had to follow the horizontal and vertical grid lines provided.

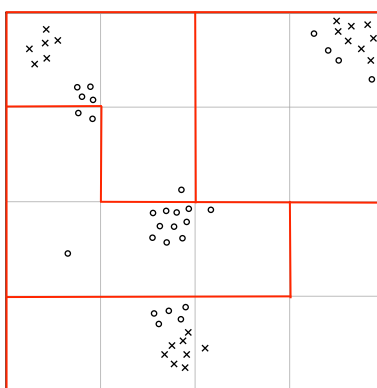
Determine the number of provinces for each Tribe A-E from Dr. Jonas's journal that allowed the minority party to win the majority of provinces each year. Enter this into ClueKeeper using the format A#-B#-C#-D#-E#. To help, an example is given below.

Tribe X, Population = 50, Provinces = 4

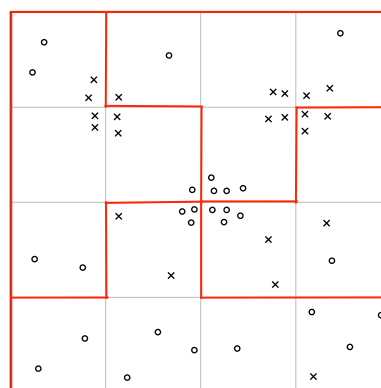
Year 1



Year 2



Year 3



Total Vote Count

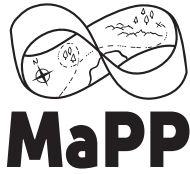
X - 22 people, **3 provinces won**  
O - **28 people**, 1 province won

Total Vote Count

X - 22 people, **3 provinces won**  
O - **28 people**, 1 province won

Total Vote Count

X - 22 people, **3 provinces won**  
O - **28 people**, 1 province won



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## Main Puzzle 4

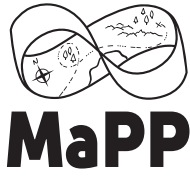
### Ancient Gerrymandering - Part 2

Amazing!

While you were working, I managed to find the general locations of the tribes in Dr. Jonas's notes. I've added the information you found counting the number of provinces within each tribe.

- Tribe A (7 provinces): North-by-Northeast
- Tribe B (5 provinces): East-by-Southeast
- Tribe C (5 provinces): South-by-Southwest
- Tribe D (6 provinces): West-by-Southwest
- Tribe E (3 provinces): West-by-Northwest

I'm betting this is another one of Dr. Jonas's codes. Can you use another journal page to find the ruler of each tribe, and use the number of provinces to choose a letter from the first name of each ruler?



MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

## Cryptic Puzzle 1

A Timely Text

Okay, this is weird. I just received the following text from Dr. Jonas's phone!

*i must be out of my SKULL. i thought that i had LOST it in October, back at that TEMPLE. that SNAKE must have found the CRYSTAL. this truly is my holy GRAIL. i'll follow it to my DOOM.*

Frankly, it seems like nonsense, but maybe it's the clue to understanding another journal entry? -BF

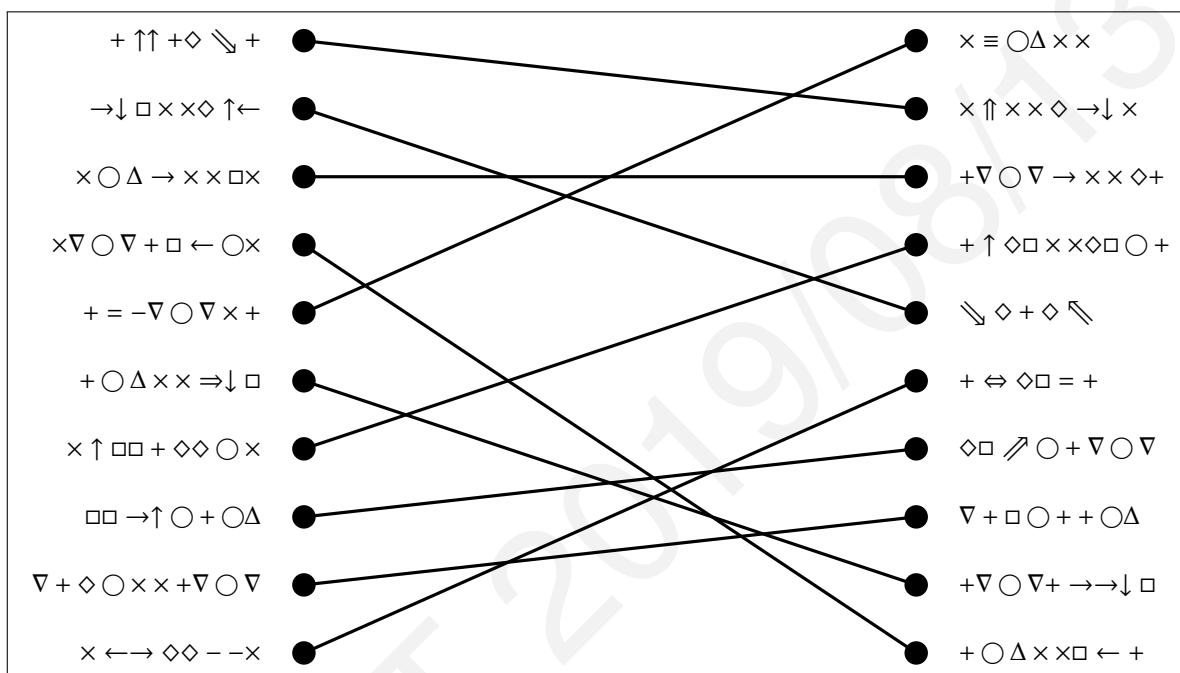


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## Cryptic Puzzle 2

Linguistic Drift

Language changes over time, sometimes in strange ways. In the example below, Dr. Jonas was considering the changes in an ancient script over a period of 450 years.



In the attached journal page, Dr. Jonas was looking at changes in that same script over a period of 600 years. It looks like she hid a message in the connections between the words. Here is a brief crash course in linguistics: you can expect a major change to occur every 150 years. Keep an eye out for changes in boundaries, contractions, and expansions. Good luck!



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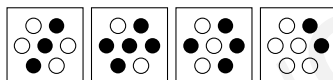
## Cryptic Puzzle 3

Simon Says

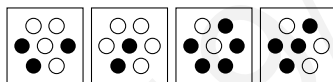
Shortly before she disappeared, Dr. Jonas was obsessed with studying the designs found on the dice used by the ancient Heyting people. It seems that between one and seven pips would be handcarved into the sides of a cube. While the position of the pips wouldn't affect the value of the roll (two pips always has a value of 2, no matter how they are arranged), some pip designs were considered sacred, while the rest were known as profane.

I don't know the rules for what makes a pip design sacred or not, but I've attached some examples from Dr. Jonas's notes. Maybe they'll be of some use in understanding one of her journal entires. -BF

Sacred:



Profane:







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## Cryptic Puzzle 4

It All Adds Up

Maybe it's nothing, but looking through my emails from Dr. Jonas, this one stuck out to me in particular as being possibly related to her journal... -BF

*Great news, we got funded! I put in requests to three different funding agencies, and they each agreed to cover the exact cost of three or four expenses from our budget.*

<b>Funding Agency</b>	<b>Amount</b>	<b>Budget Code Adjustment</b>
National Science Foundation	\$36,191	+5
National Endowment for the Humanities	\$14,006	+2
Archaeological Institute of America	\$22,260	-1