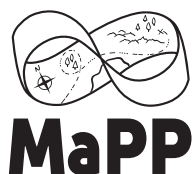




# **MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy**

*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
A	1	00001	.-	⠠
B	2	00010	-...	⠡
C	3	00011	-. .	⠢
D	4	00100	-..	⠣
E	5	00101	.	⠤
F	6	00110	..-.	⠥
G	7	00111	--.	⠦
H	8	01000	....	⠨
I	9	01001	..	⠩
J	10	01010	.-. -	⠠⠨
K	11	01011	-. -	⠠⠢
L	12	01100	.-..	⠠⠣
M	13	01101	--	⠠⠤

Letter	Decimal	Binary	Morse	Braille
N	14	01110	-. .	⠠⠤⠢
O	15	01111	---	⠠⠤⠣
P	16	10000	.-. -	⠠⠣⠤
Q	17	10001	--. -	⠠⠣⠤⠢
R	18	10010	.-. .	⠠⠣⠤⠢
S	19	10011	... -	⠠⠣⠣⠤
T	20	10100	-	⠠⠣⠣⠣
U	21	10101	..-	⠠⠣⠣⠣
V	22	10110	... -	⠠⠣⠣⠣
W	23	10111	.-. -	⠠⠣⠣⠣
X	24	11000	-. -	⠠⠣⠣⠣
Y	25	11001	-. -	⠠⠣⠣⠣
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

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

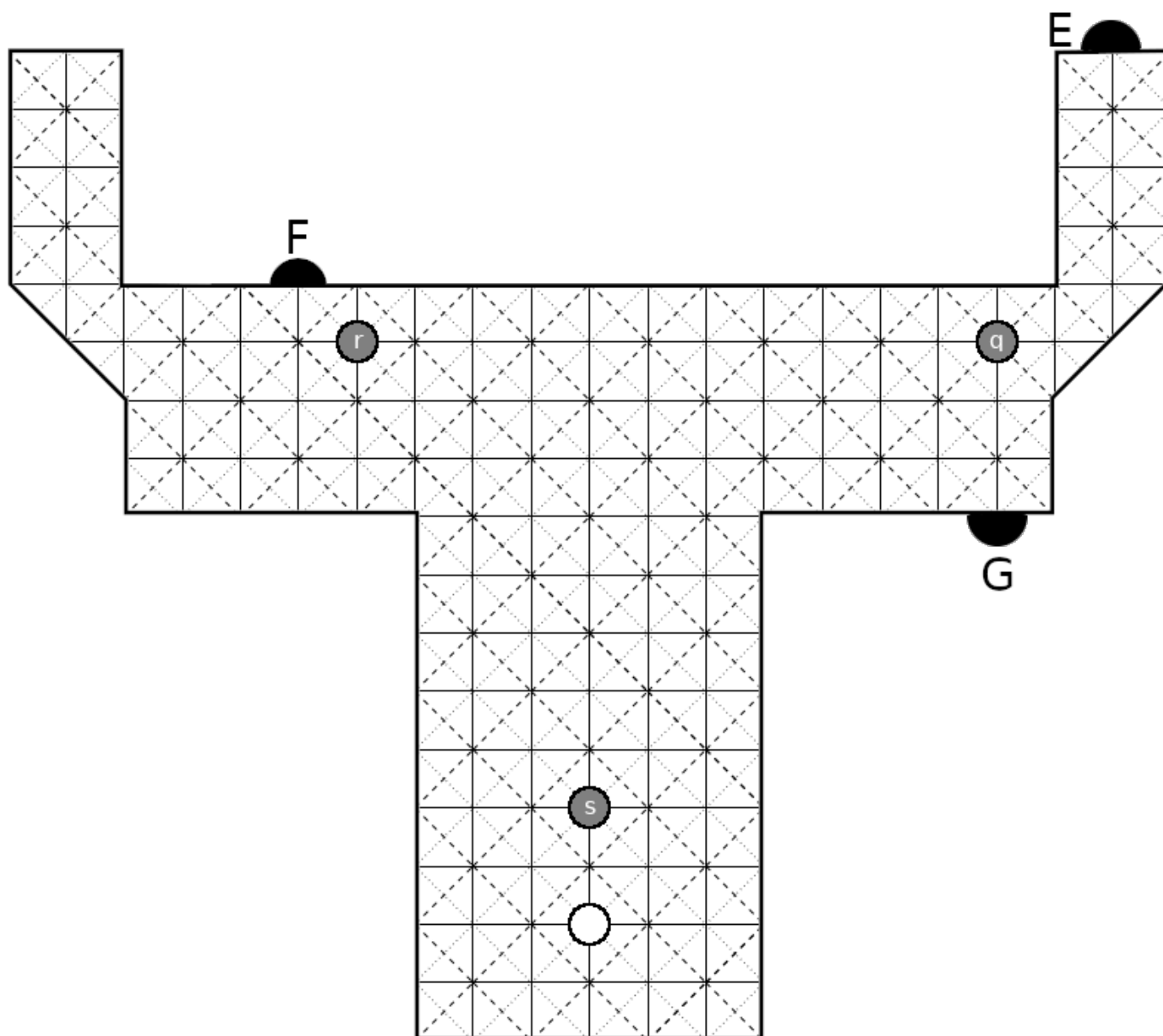
## **Part I**

# **Player Book**



MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

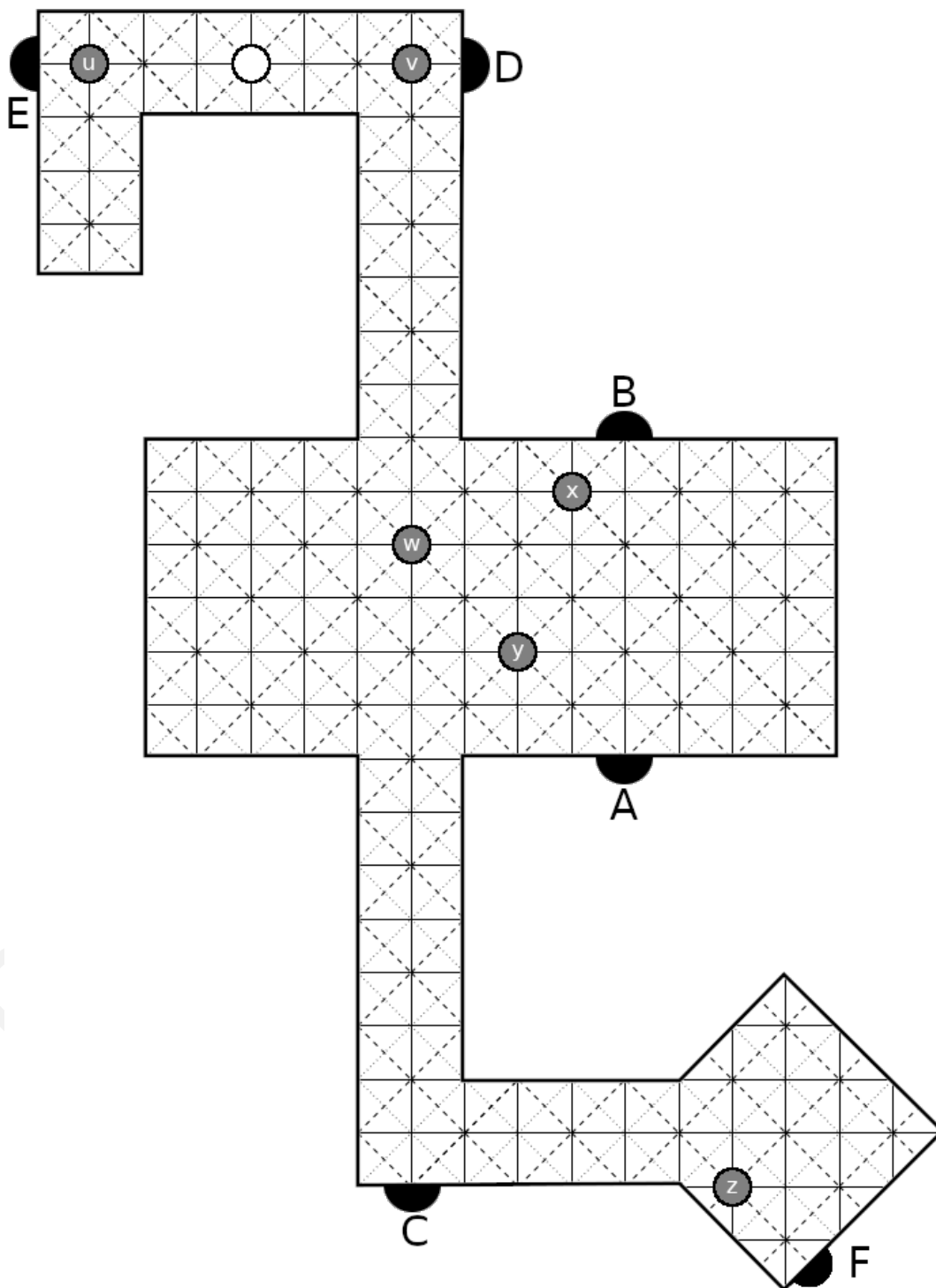
**August 03**





MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

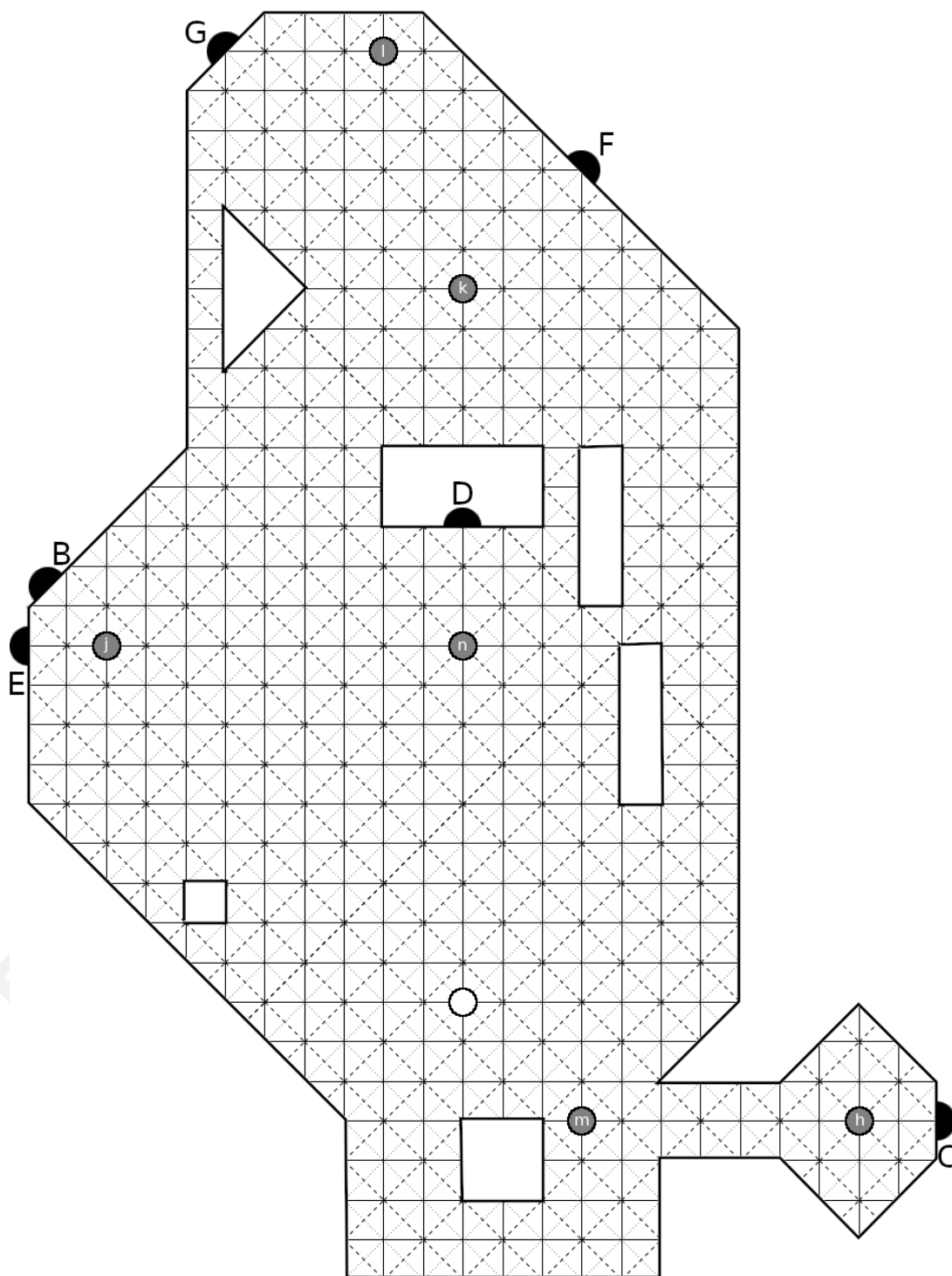
**August 07**





MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

**August 11**

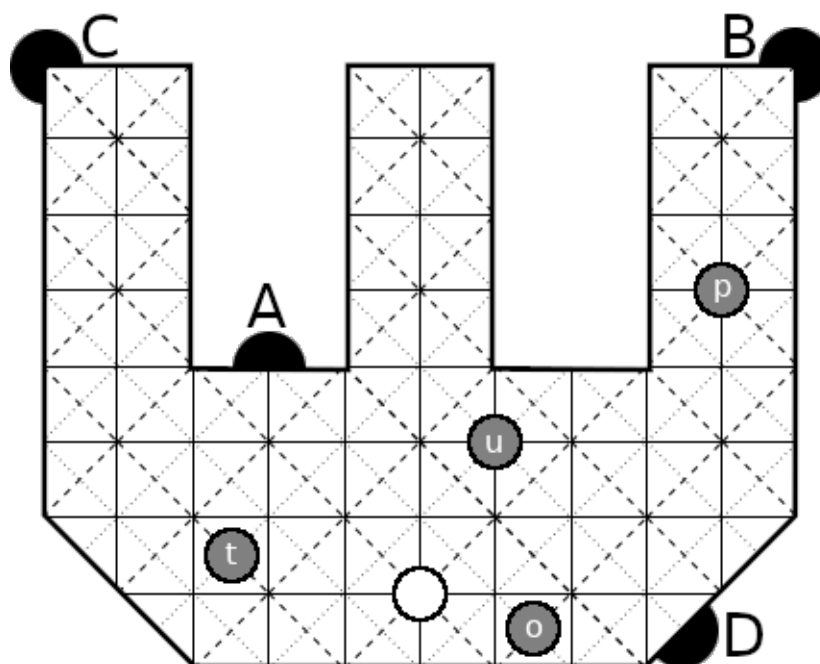






MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

**August 17**





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

# 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  $3T$ ?

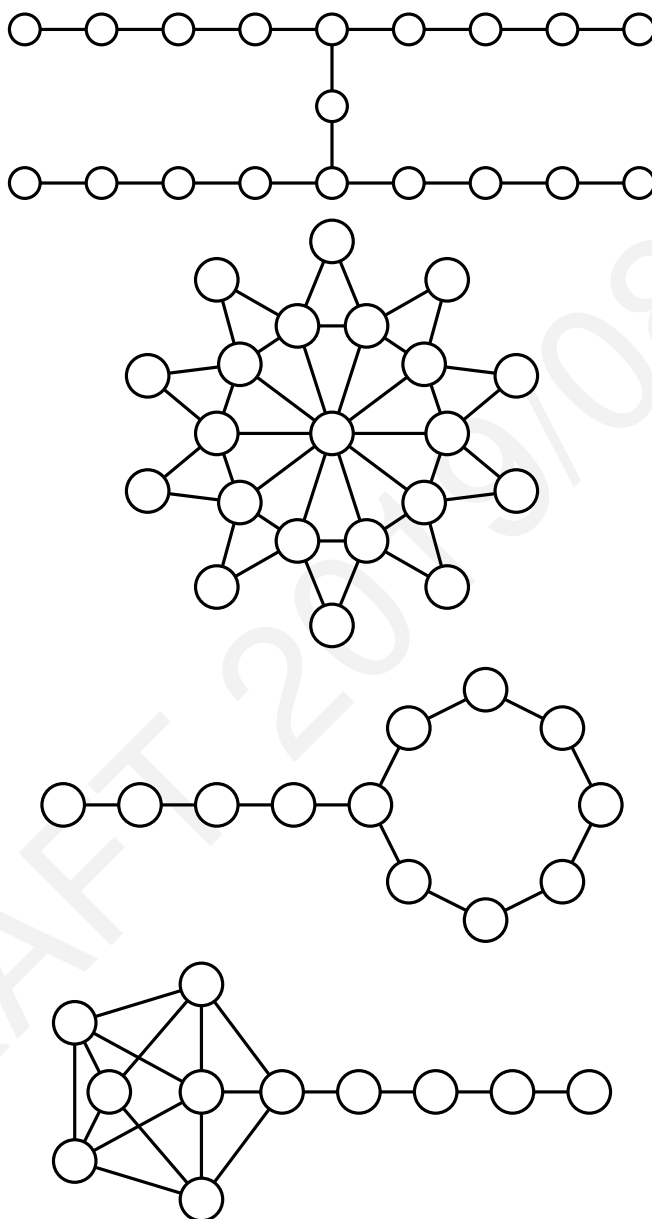
*Black market:*

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  $5C$ ?



MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

**February 5**

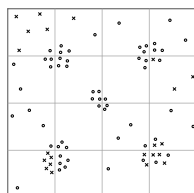




# MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

## May 27

Year 1

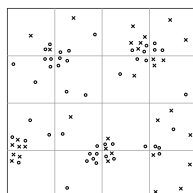


Total Vote Count

X - 22

O - 58

Year 2

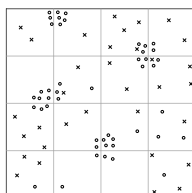


Total Vote Count

X - 33

O - 47

Year 3

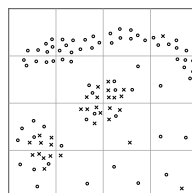


Total Vote Count

X - 33

O - 47

Year 1

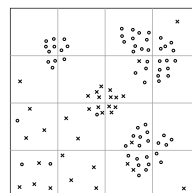


Total Vote Count

X - 31

O - 69

Year 2

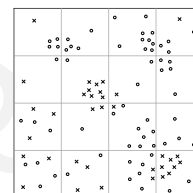


Total Vote Count

X - 34

O - 66

Year 3

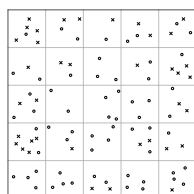


Total Vote Count

X - 35

O - 65

Year 1

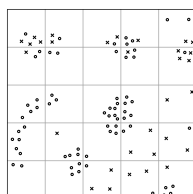


Total Vote Count

X - 38

O - 62

Year 2

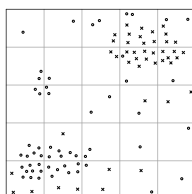


Total Vote Count

X - 31

O - 69

Year 3

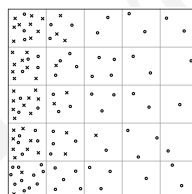


Total Vote Count

X - 44

O - 56

Year 1

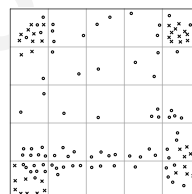


Total Vote Count

X - 45

O - 75

Year 2

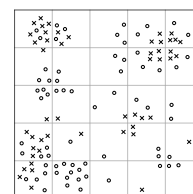


Total Vote Count

X - 40

O - 80

Year 3

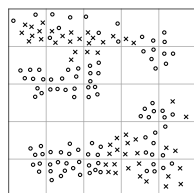


Total Vote Count

X - 50

O - 70

Year 1

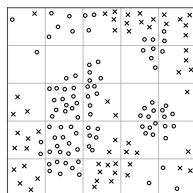


Total Vote Count

X - 50

O - 100

Year 2

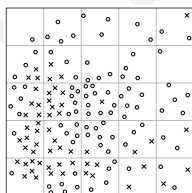


Total Vote Count

X - 56

O - 96

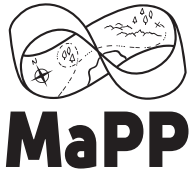
Year 3



Total Vote Count

X - 58

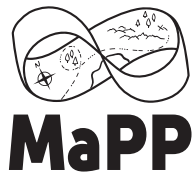
O - 92



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

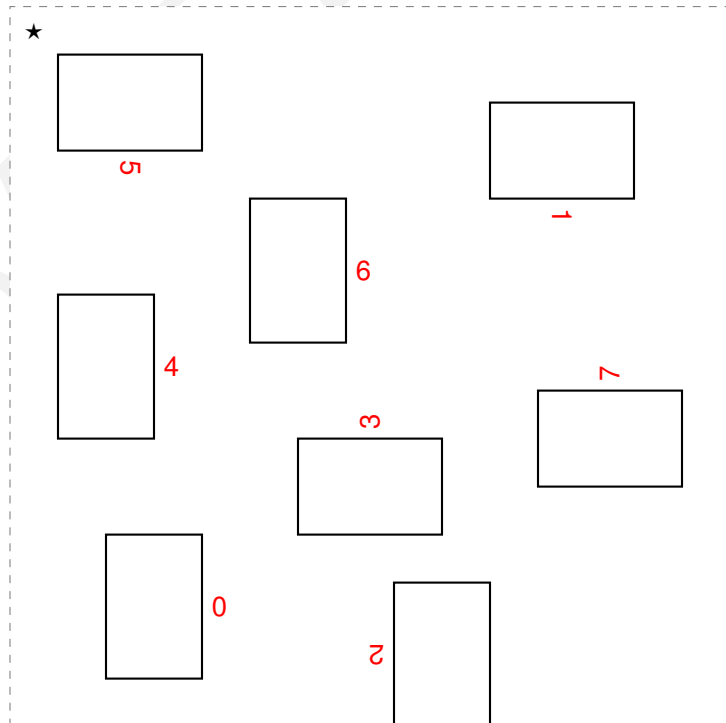
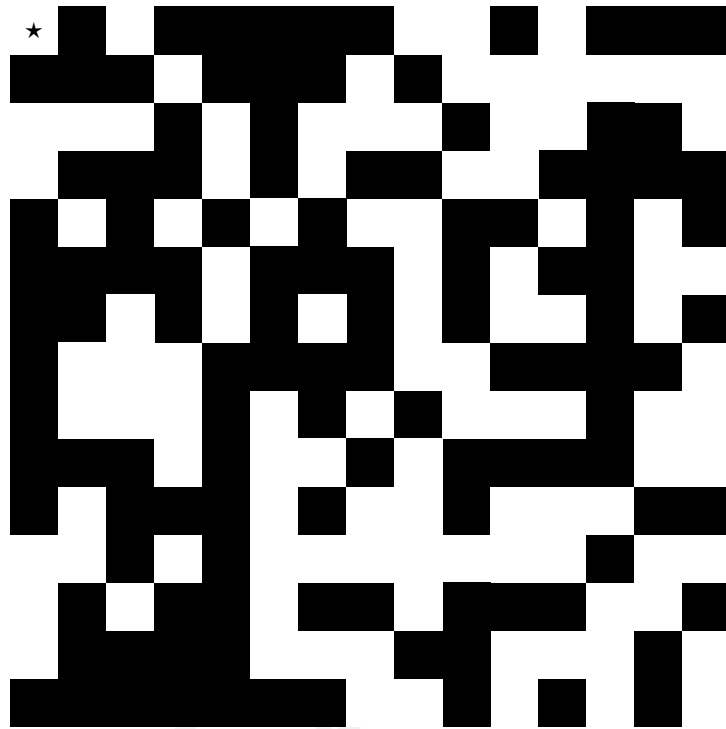
## June 28

Journal	entry	June	28,	1995		
	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?



MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

**September 7**





MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

**January 17**



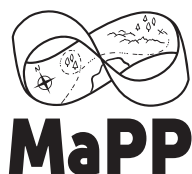
*Site Adjustment:*

1. Site 1:  $(?, ?) + (-4, -16)$

2. Site 2:  $(?, ?) + (6, -15)$

3. Site 3:  $(?, ?) + (5, -1)$

4. Site 4:  $(?, ?) + (-3, -1)$



MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

**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)*

*Marwort 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 Lerwo (NW)*

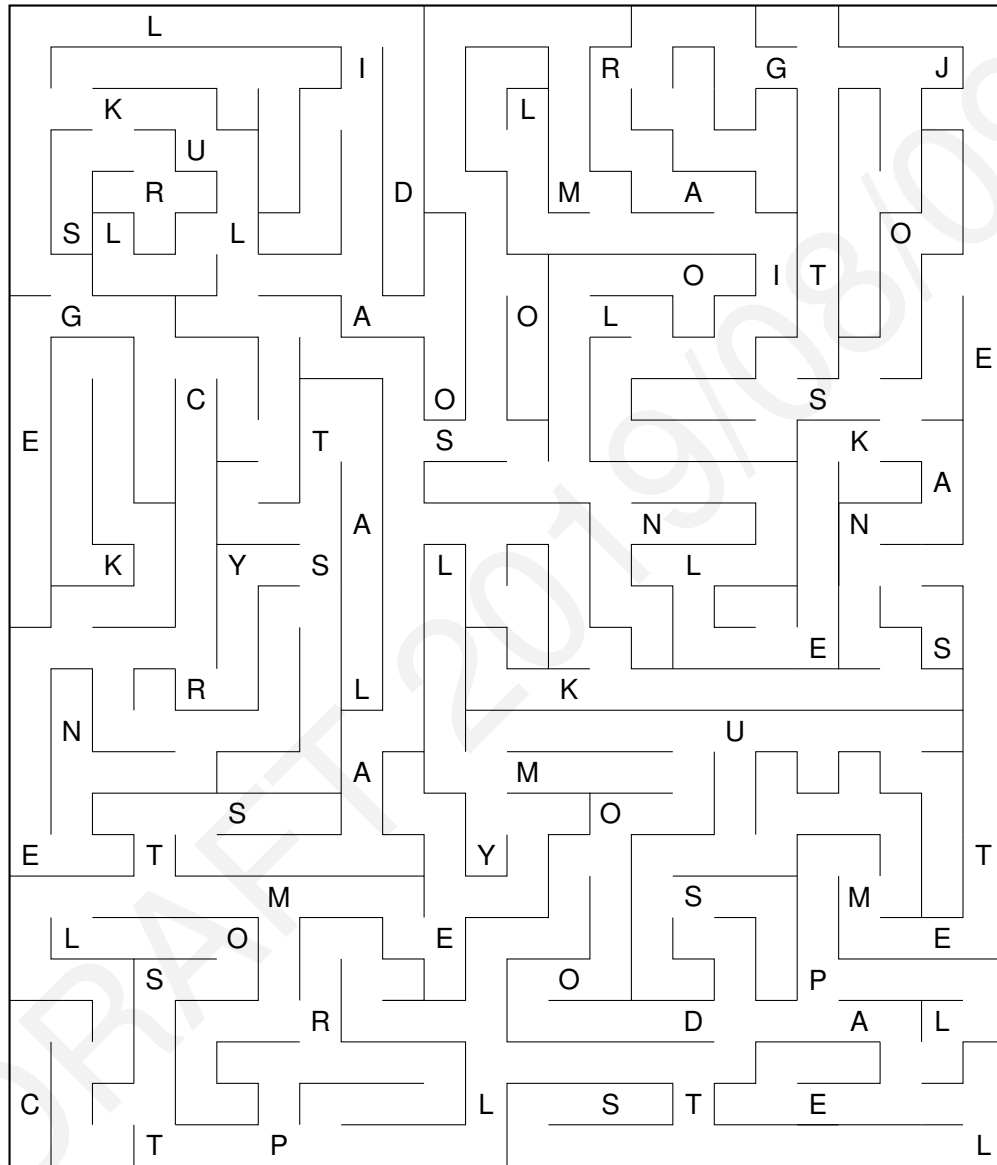
*Skraba Apo Lerwo (NNW)*



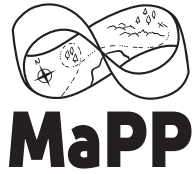


MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

**December 22**






























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

# October 8

   ~~Saturday, November 30, 1986~~

   Sunday, December First, Nineteen Eighty Six, Five AM

 What an exhilarating day! Every 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 not only discovered an intact arena, but found a stone  
 tablet with text. We haven't been able to fully translate it yet  
 but on first glance it seems to contain detailed rules for the  
 game. Everyone thought that the wall paintings were  
 exaggerating or showing scenes from myths, but the Fregians  
 really did play the game with boulders! I know because one  
 nearly crushed me. After recovering my breath (and my hat)  
 I had to marvel at the engineering and artistry of these orbs.  
 They are so perfectly round and smooth, we have no idea how  
 the Fregians built them with the tools they had. The arena  
 itself was still largely intact. Based on the form of the writing,  
 The site is likely from the second dynasty. I checked the star  
 chart for that era, and if you connect a line from the arena to  
 the palace, it fits very closely to the trajectory of the north  
 star. We should use ground penetrating radar to check other  
 astronomical alignments. At last, I've got some good luck.



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

### July 21

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

<i>Topic</i>	<i>Detail</i>	<i>Budget Code</i>	<i>Cost</i>
Field work salary	Dr. M. Jonas	J	\$12,718
Field work salary	B. Fraiser	A	\$1,982
Travel expenditures	Lodging	G	\$3,290
Travel expenditures	Airfare	J	\$1,307
Excavation	Digging equipment	M	\$20,183
Excavation	Artifact cleaning and cataloging	Q	\$8,216
Research	Osteology consultant	R	\$6,499
Research	Ceramic analysis	Q	\$7,211
Research	Floral analysis	Q	\$5,525
Research	Faunal analysis	J	\$5,524

## **Part II**

### **ClueKeeper Info**



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

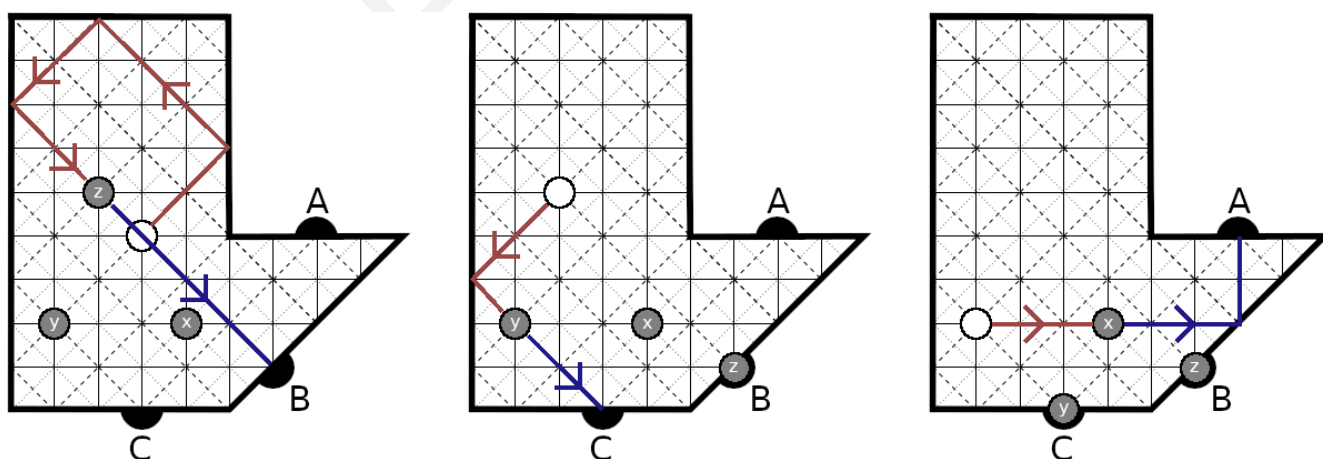
# Main Puzzle 1

## The Fox and the Rabbits

Dr. Mindy Jonas' first major discovery was the remarkable boulder game of the Fregian people. The Fregian kings build massive arenas with a fantastic variety of shapes and sizes. After surviving a harrowing encounter with a boulder in a long-lost temple, Dr. Jonas found an ancient tablet. On that tablet, the rules to the game were literally written in stone:

- 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 fox to hit the rabbits into the holes at the edge of the arena. Exactly one rabbit would be hit into each hole.
- The fox could only be launched along the marked vertical, horizontal, and diagonal trajectories. When it collided with a rabbit, the fox would take the place of the rabbit and the rabbit would continue in the direction it was hit.
- The rabbits 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.

Dr. Jonas recorded five arenas for this game in her journal. In each one there is a unique way to win the game. Dr. Jonas' assistant, Brandon Fraiser, thinks that the solution to these puzzles will help you find the hidden message in Dr. Jonas' journal page. Thankfully, Fraiser has already solved one of the arenas as an example:



The solution to this arena is zB-yC-xA. Solve each of the four other provided arenas, and enter each solution into ClueKeeper using this format.



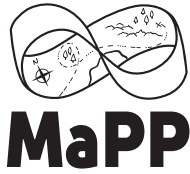
MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

## Main Puzzle 1

### The Fox and the Rabbits - Part 2

Good Work! Notice that the text of the journal entry appears in neat columns and rows. Label the columns A, B, C, D, E, F, G from left to right and label the rows h, i, j, k, ..., z from top to bottom. Then look at the third boulder from arena 1, the fifth boulder from arena 2, the first boulder from arena 3, and the third boulder from arena 4.

DRAFT 2019/08/09



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

# Main Puzzle 2

## Bazaar Trades

The Skolem people of Mesopotamia had many myths and legends. Of great interest to Dr. Jonas was the story of queen Noether, famed for her ability to barter with traders and merchants. You may have met a good haggler or two in your day, but they didn't have to deal with the strange ways of the Skolem Bazaar. The Skolem people had no money, instead goods were exchanged for other goods. Moreover, at the start of each day the shopkeepers would declare their exchange rates. They were notoriously stubborn and would not change these rates no matter what happened.

Dr. Jonas believed that Noether was real, and wanted to learn as much about her as possible. Unfortunately, over time every story about Noether split into multiple versions. In one, Noether entered the marketplace with one bag of spice.

- The first shopkeeper declared that 1 bag of spice is equivalent to 4 shell bracelets and 1 clay cup.  
( $S \leftrightarrow 4B + C$ )
- The second shopkeeper declared that 1 shell bracelet is equivalent to 3 bags of spice and 3 clay cups.  
( $B \leftrightarrow 3S + 3C$ )
- The third shopkeeper declared that 1 clay cup is equivalent to 1 bag of spice and 1 shell bracelet.  
( $C \leftrightarrow S + B$ )

There are two versions of the story:

1. Noether entered the bazaar with 1 bag of spice and left with exactly 7 clay cups and nothing else.
2. Noether entered the bazaar with 1 bag of spice and left with exactly 7 shell bracelets and nothing else.

Dr. Jonas reasoned that the first version was possible and that the second was impossible. Version one could happen the following way:

1. Go to shopkeeper 1:  $S \rightarrow 4B + C$
2. Go to shopkeeper 2 and use 1 shell bracelet:  $4B + C = B + 3B + C = 3S + 3C + 3B + C = 3S + 3B + 4C$
3. Go to shopkeeper 3 to get a clay cups:  $3S + 3B + 4C = 3C + 4C = 7C$

There are many more stories about Noether. If you can figure out which ones are possible and which are impossible, you might be able to decipher the message hidden in Dr. Jonas' journal.





MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

## Main Puzzle 2

### Bazaar Trades - Part 2

Great work on Main Puzzle 2! I think we can use your answer to extract a hidden password from Journal Entry 2.

In each story, you figured out which of the statements 1-5 were Possible (P) or Impossible (I). What if we organize that information like this, using  $I = 0$ ,  $P = 1$ :

	Story 1	Story 2	Story 3	Binary	Decimal
Statement 1	P	P	I	110	6
Statement 2	I	P	I		
Statement 3	P	I	I		
Statement 4	I	I	P		
Statement 5	I	P	P		

I think we're supposed to cut out the lower square, and then further cut out the rectangles that match those numbers. What will happen if we place that cut-out on the barcode-looking thing above it? Maybe the Code Sheet will help us decipher the resulting  $2 \times 3$  rectangles?



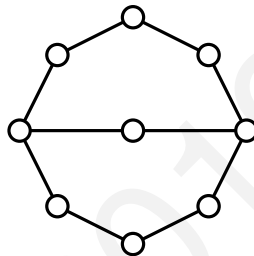
## MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

### Main Puzzle 3

#### Searching the Tombs

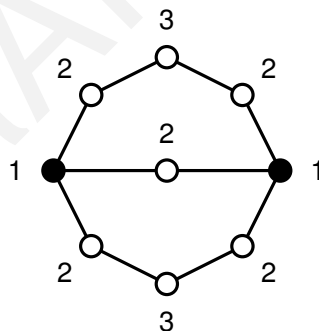
The necropolis of Ramsey is a complex of underground mausoleums, buried by earth and time. It is also where Dr. Jonas almost got fired. After finding her first mummy, she seemed to be cursed. Whenever she entered a new crypt, the mummy inside of it would be as far away from her team as possible. It's 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 a 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. Following the University 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 3

### 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 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?

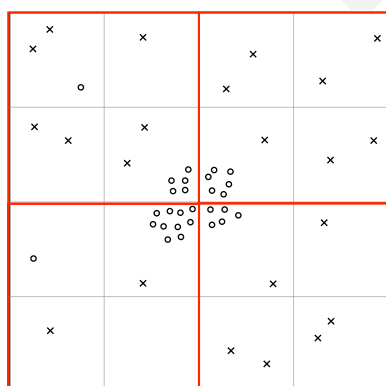
Well, to simplify the voting process, the tribes had broken their land up into provinces. Each province had one vote for the next ruler of that tribe, which was based upon the majority vote from within the province. However, since the tribe leaders were allowed to redraw the boundaries of the provinces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

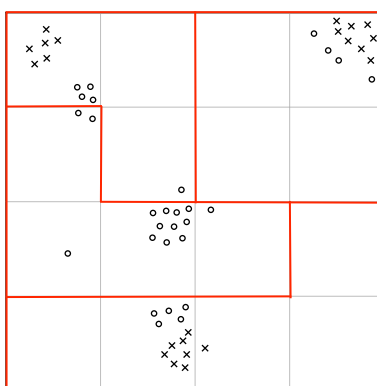
Determine the number of provinces for each Tribe A-E from Dr. Jonas's journal that allowed the minority party to win the majority of provinces each year. Enter this into ClueKeeper using the format A#-B#-C#-D#-E#. To help, an example is given below.

Tribe X, Population = 50, Provinces = 4

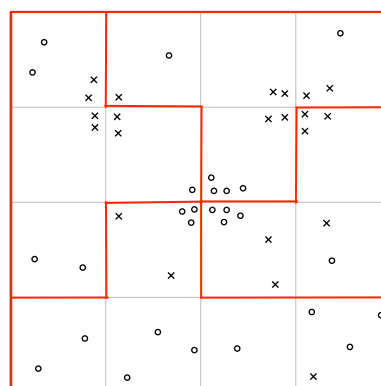
Year 1



Year 2



Year 3



Total Vote Count

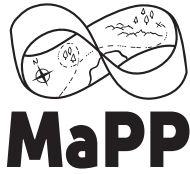
X - 22 people, **3 provinces won**  
O - **28 people**, 1 province won

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

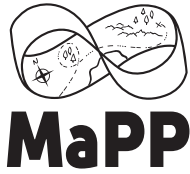
### Ancient Gerrymandering

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?



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## Cryptic Puzzle 1

### Word Maze

Cryptic Journal 1 contains a diagram of an ancient tomb. While there doesn't seem to be an entrance or exit to this ancient labyrinth, solving the maze isn't the point of this puzzle. Instead, you should see if you can find the following words.

SKULL LOST GRAIL DOOM TEMPLE CRYSTAL SNAKE

DRAFT 2019/08/09

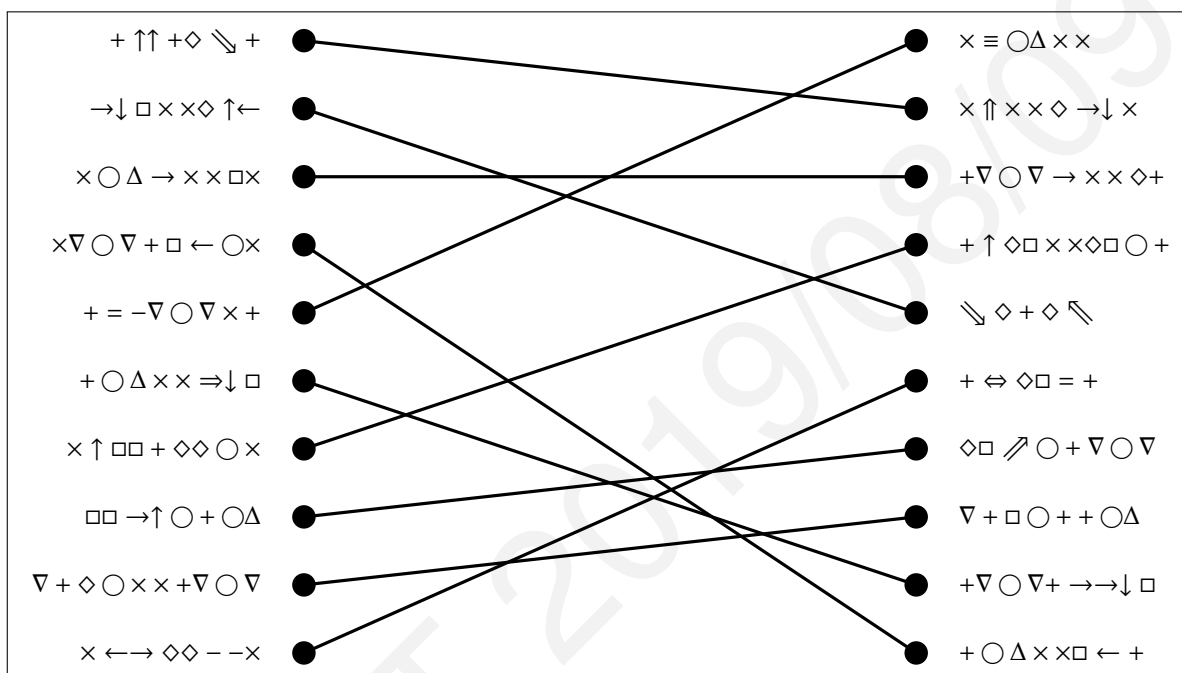


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## Cryptic Puzzle 2

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

This mostly ordinary journal has strange doodles at the start of each line. In fact these are pictures of early dice from the Heyting people, or at least some of them are. Dr. Jonas was a Heyting expert, so there is no way she drew incorrect dice on accident. Both of the dates at the beginning look wrong as well. Dr. Jonas must have put them there for some other purpose.

DRAFT 2019/08/09





MaPP Challenge '20 – Mindy Jonas and the Enigmatic Legacy

## Cryptic Puzzle 4

### Budgeting Woes

We found the following email tucked away in Dr. Jonas's hard drive:

*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.*

Funding Agency	Amount	Budget Code Adjustment
National Science Foundation	\$36,191	+5
National Endowment for the Humanities	\$14,006	+1
Archaeological Institute of America	\$22,258	-8