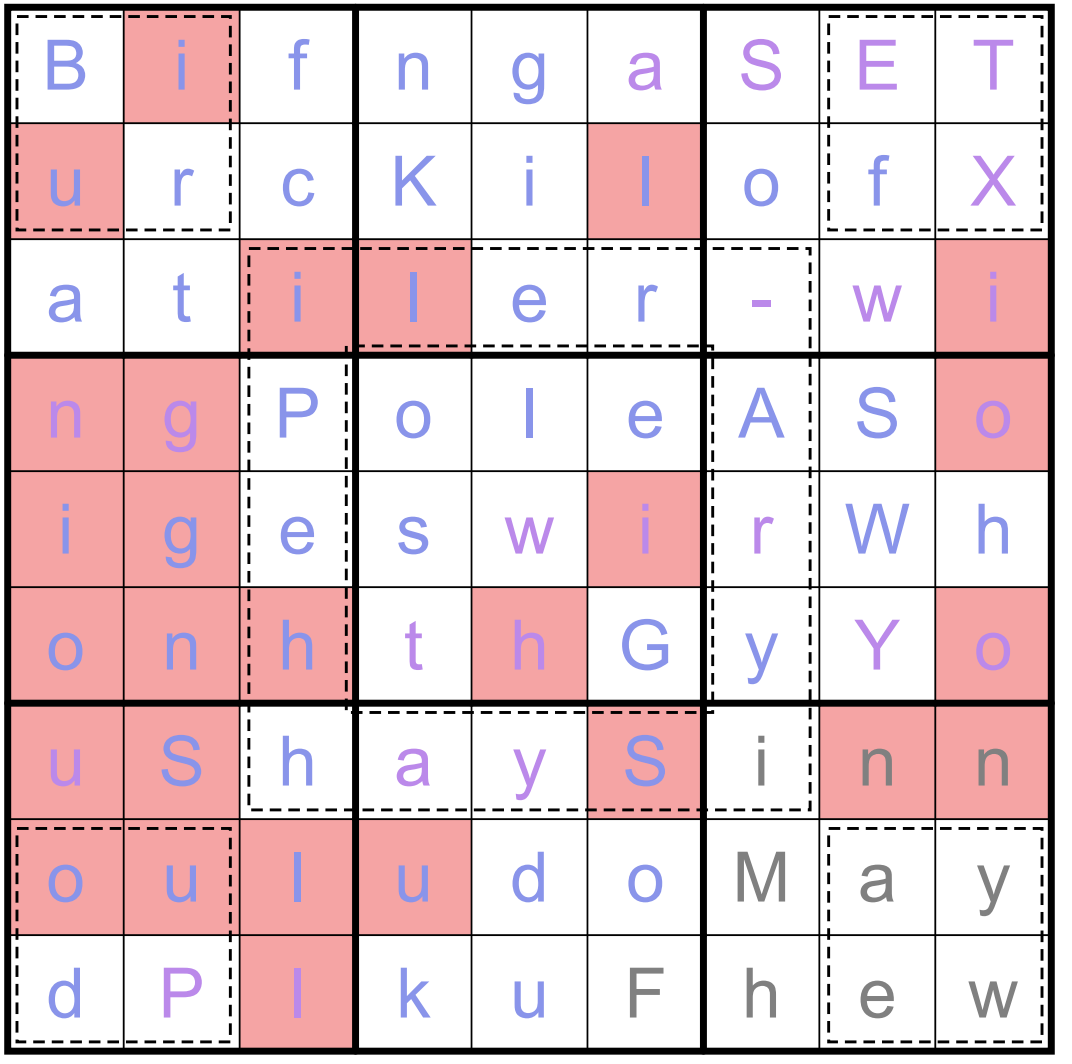
B i f n g a S E T
u r c K i l o f X
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n g P o l e A S o
i g e s w i r W h
o n h t h G y Y o
u S h a y S i n n
o u l u d o M a y
d P l k u F h e w

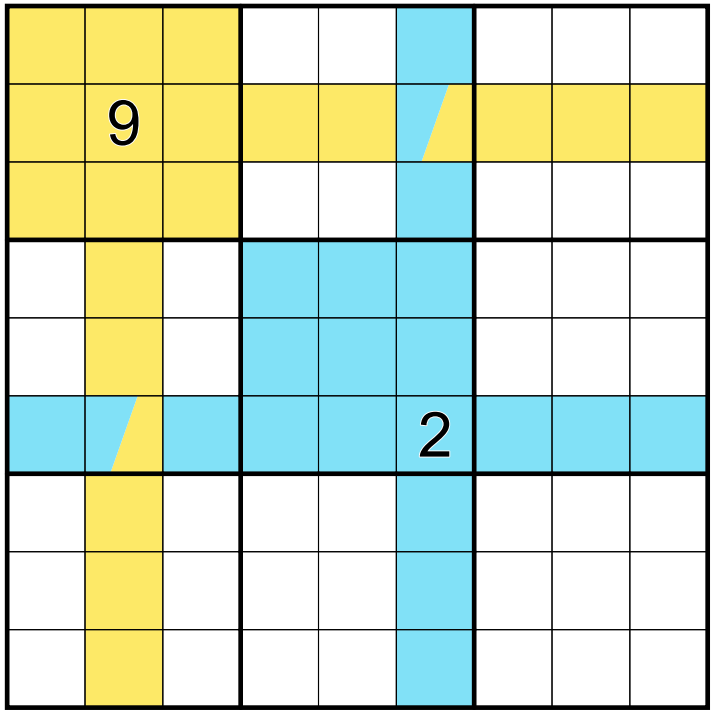
# Outline

- Intro
- Variants
- Strategy
- Setting
- Final thoughts

# Intro

# What is sudoku?

- It's a type of puzzle
- Rules: Place digits in the grid such that every **row**, **column**, and **box** contains the digits 1-9 once each
- One way to think about it is that cells containing the same digit must not "see" each other



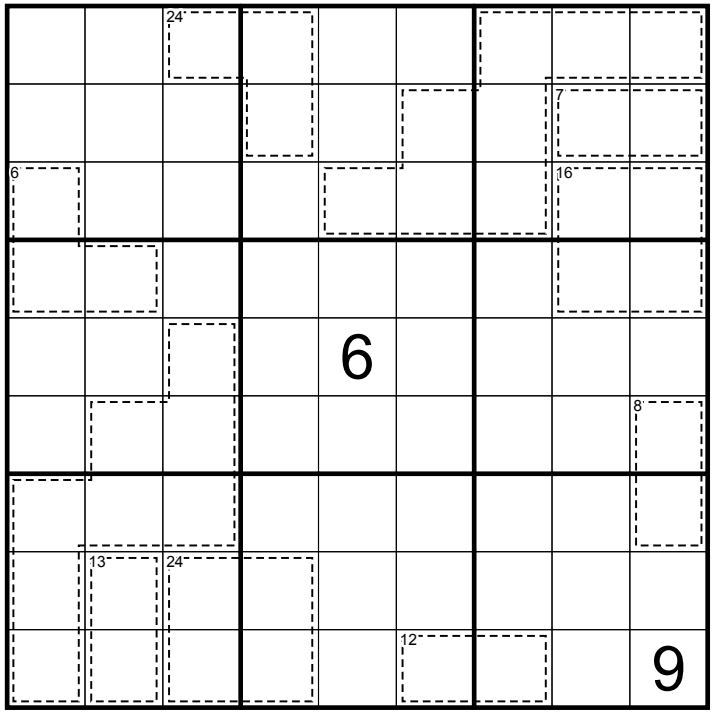
# Let’s do one

# Variants

# Killer cages

- New rule: Within each cage, digits cannot repeat and must sum to the small clue in the top-left corner of the cage (if given)

If you're looking at these slides later, you can click on a puzzle to go to a solving tool ↘




*Polar Attraction*
by Piatato

# Killer cages

- New rule: Within each cage, digits cannot repeat and must sum to the small clue in the top-left corner of the cage (if given)
- What numbers can be in a
  - 3-cell 6 cage?

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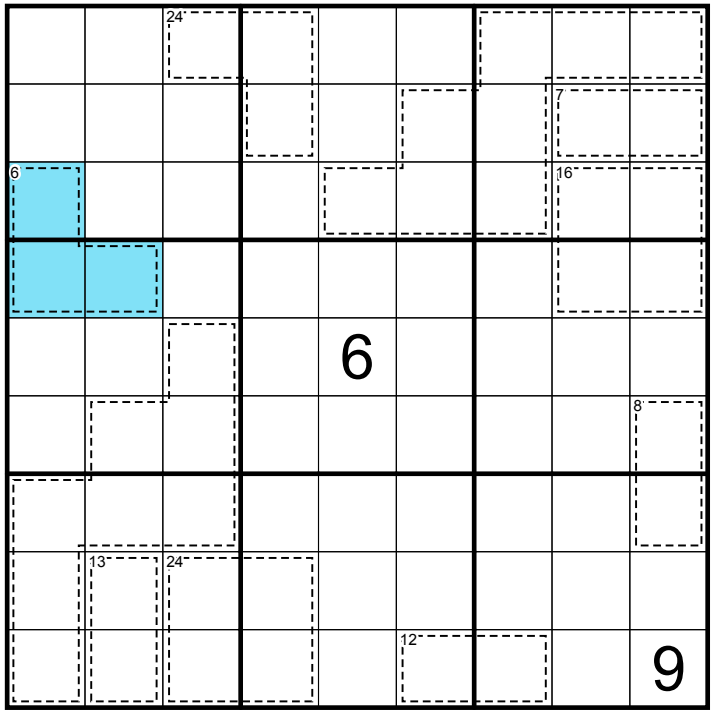


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# Killer cages

- New rule: Within each cage, digits cannot repeat and must sum to the small clue in the top-left corner of the cage (if given)
- What numbers can be in a
  - 3-cell 6 cage? 1, 2, 3

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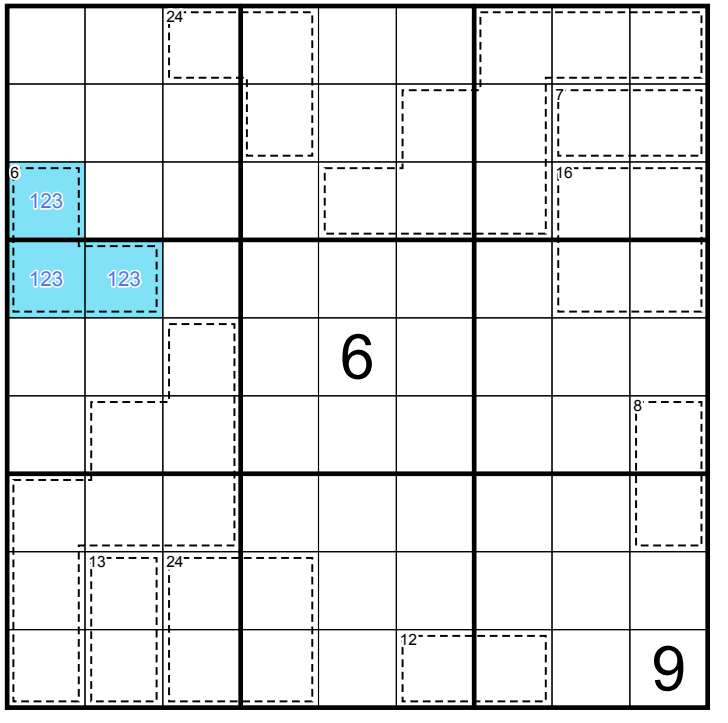


*Polar Attraction*
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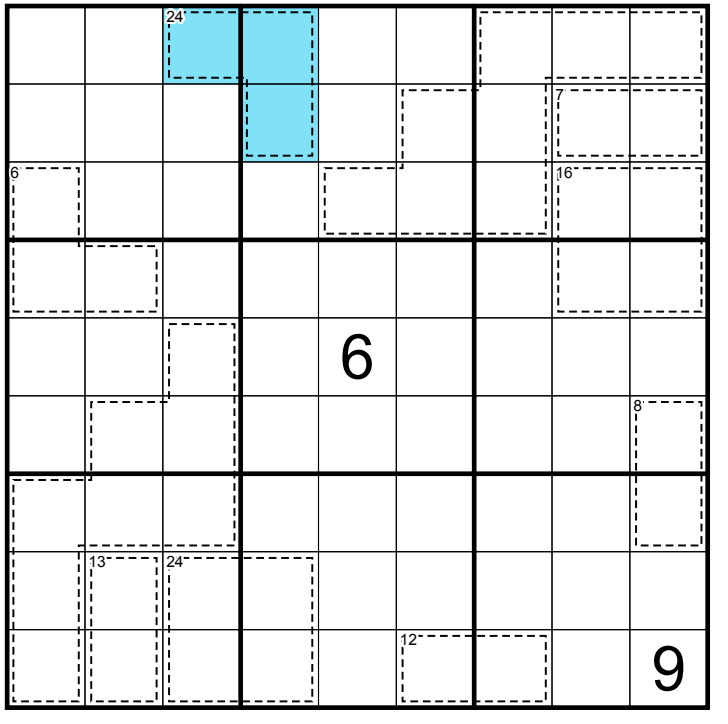
# Killer cages

- New rule: Within each cage, digits cannot repeat and must sum to the small clue in the top-left corner of the cage (if given)
- What numbers can be in a
  - 3-cell 6 cage? 1, 2, 3
  - 3-cell 24 cage?

If you're looking at these slides later, you can click on a puzzle to go to a solving tool ↘

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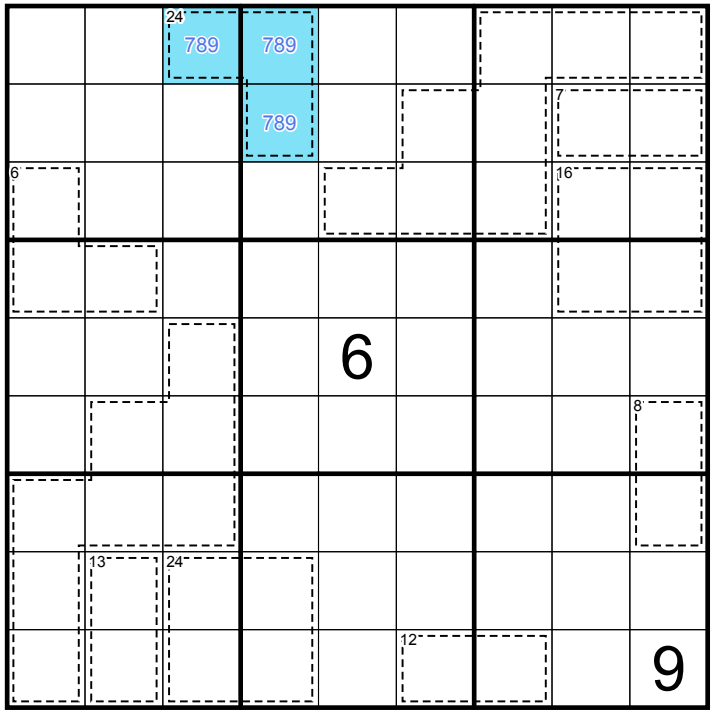
# Killer cages

- New rule: Within each cage, digits cannot repeat and must sum to the small clue in the top-left corner of the cage (if given)
- What numbers can be in a
  - 3-cell 6 cage? 1, 2, 3
  - 3-cell 24 cage? 7, 8, 9

If you're looking at these slides later, you can click on a puzzle to go to a solving tool ↘

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# Killer cages

- New rule: Within each cage, digits cannot repeat and must sum to the small clue in the top-left corner of the cage (if given)
- What numbers can be in a
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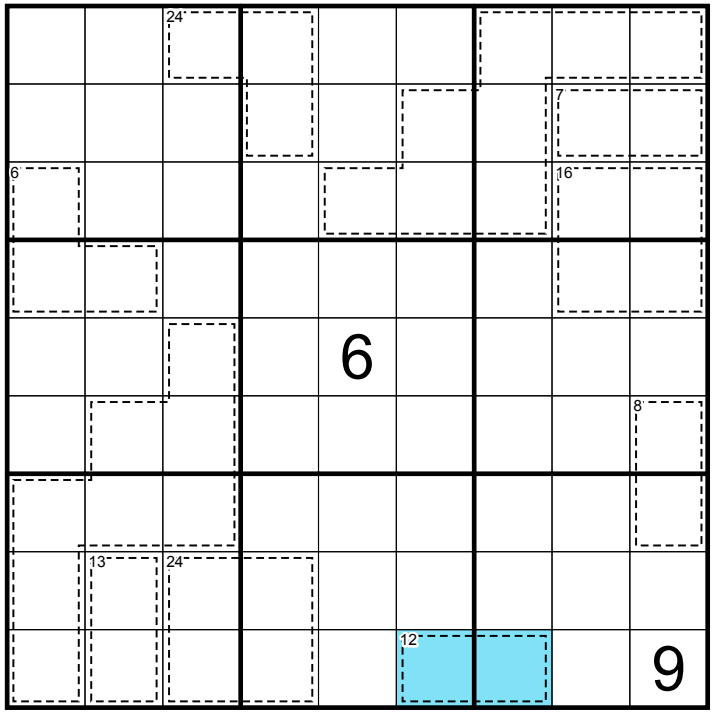
  - 3-cell 24 cage? 7, 8, 9
  - 2-cell 12 cage?

If you're looking at these slides later, you can click on a puzzle to go to a solving tool ↘

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# Killer cages

- New rule: Within each cage, digits cannot repeat and must sum to the small clue in the top-left corner of the cage (if given)
- What numbers can be in a
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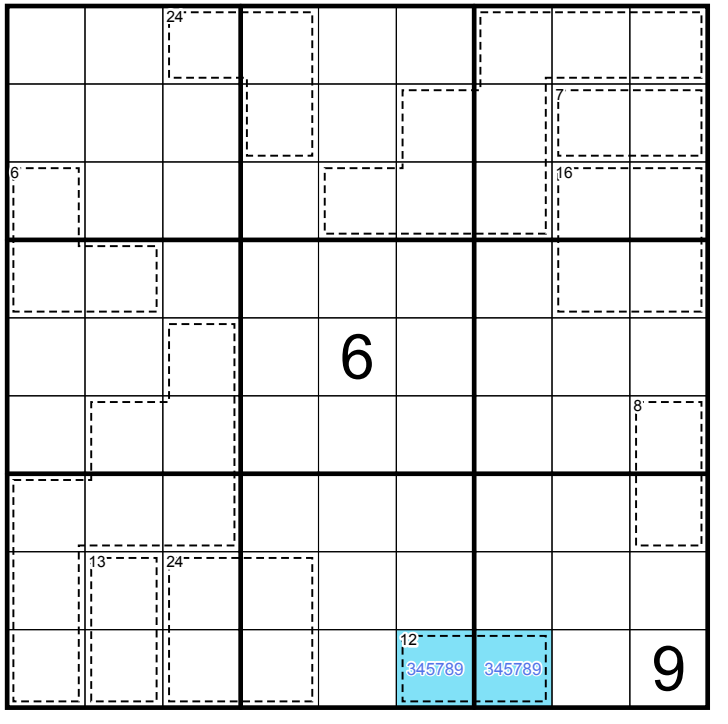
  - 2-cell 12 cage? 3+9, 4+8, 5+7

If you're looking at these slides later, you can click on a puzzle to go to a solving tool ↘




*Polar Attraction*
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# Killer cages

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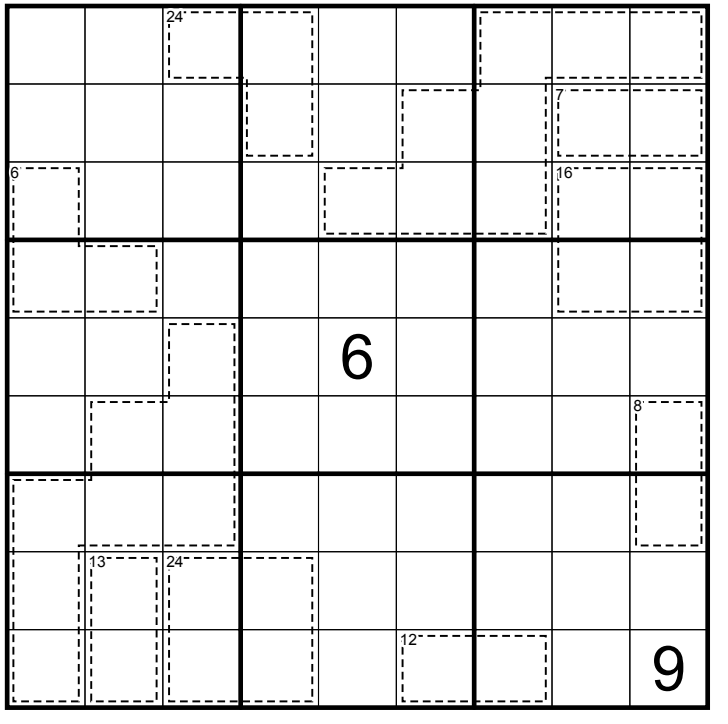
- What numbers can be in a
  - 3-cell 6 cage? 1, 2, 3
  - 3-cell 24 cage? 7, 8, 9
  - 2-cell 12 cage? 3+9, 4+8, 5+7
  - 9-cell 45 cage?

If you're looking at these slides later, you can click on a puzzle to go to a solving tool ↘

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- What numbers can be in a
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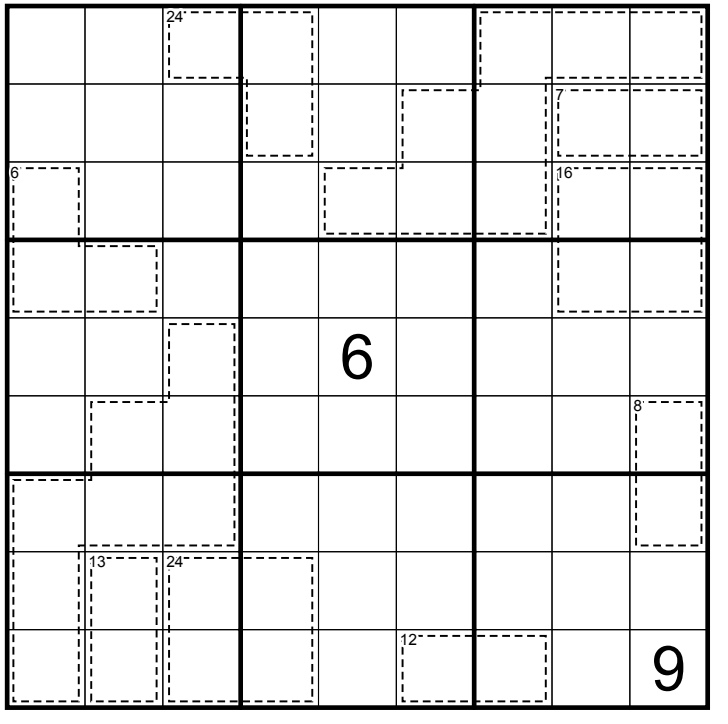
  - 3-cell 24 cage? 7, 8, 9
  - 2-cell 12 cage? 3+9, 4+8, 5+7
  - 9-cell 45 cage? All!

If you're looking at these slides later, you can click on a puzzle to go to a solving tool ↘




*Polar Attraction*
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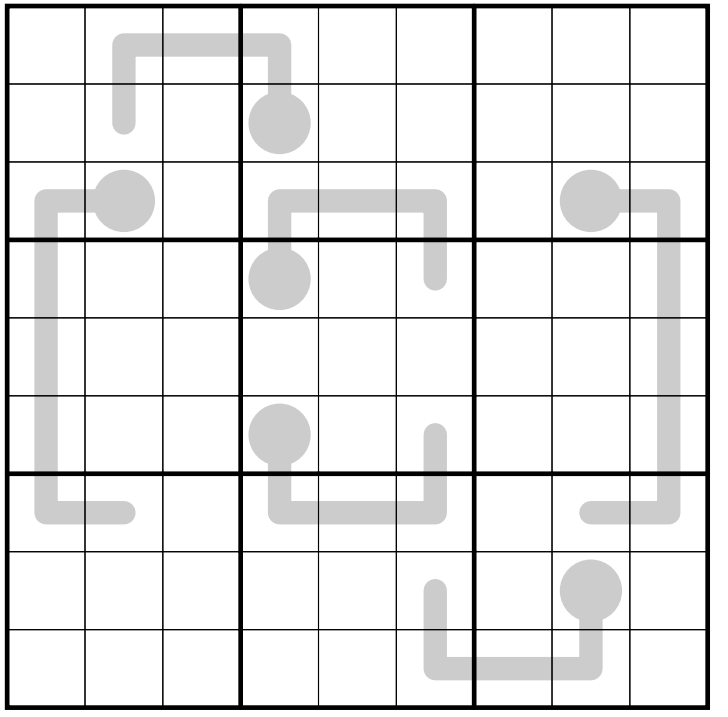
# Thermo

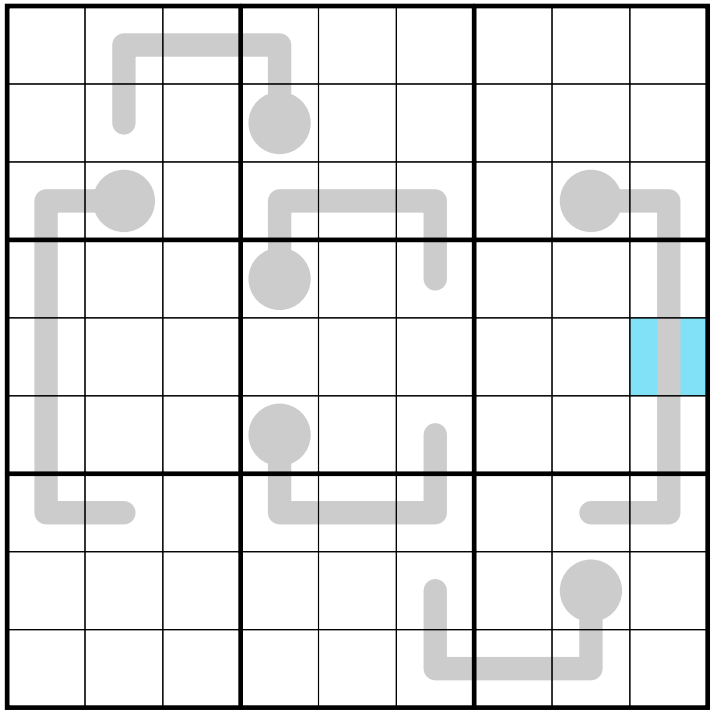
- New rule: Digits along a thermometer increase from the bulb end



*Staples*
by Florian Wortmann

# Thermo

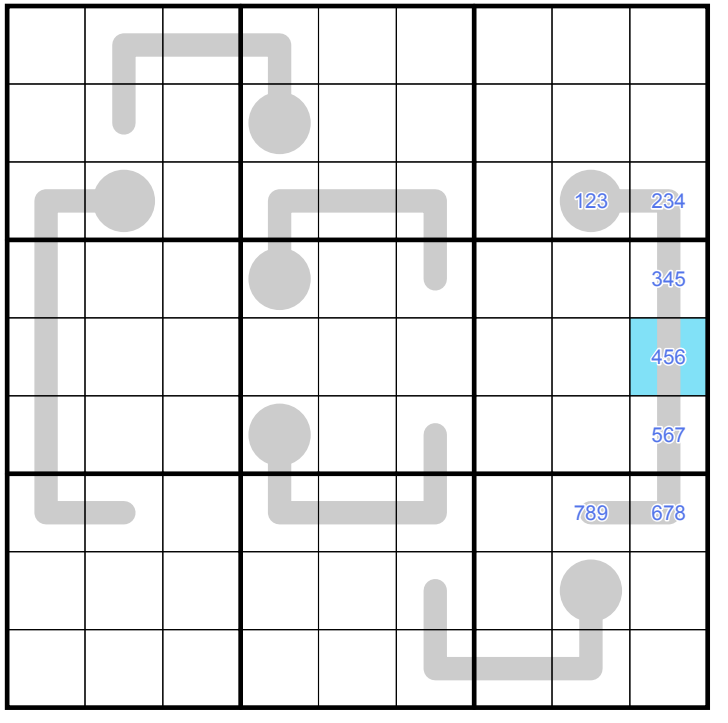
- New rule: Digits along a thermometer increase from the bulb end
- Based on its thermo, what digits can go in the highlighted cell?



*Staples*
by Florian Wortmann

# Thermo

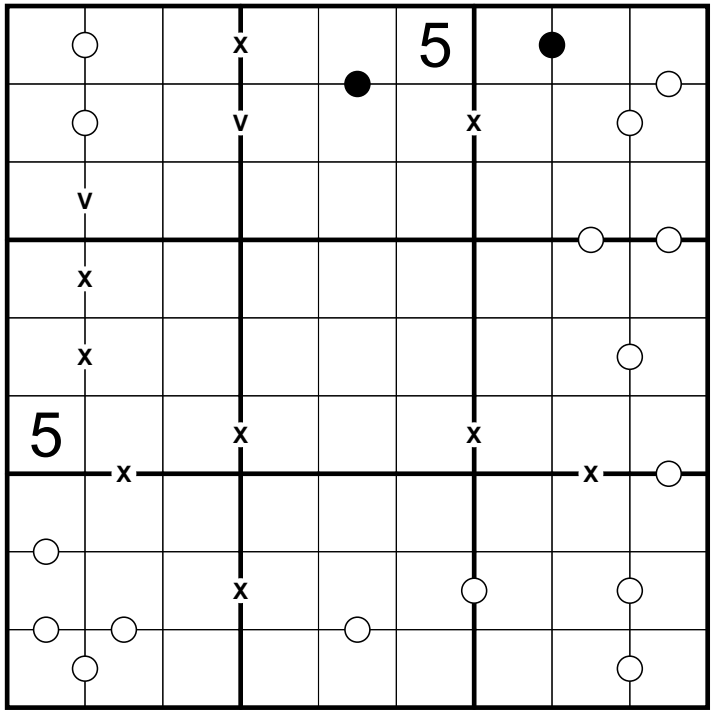
- New rule: Digits along a thermometer increase from the bulb end
- Based on its thermo, what digits can go in the highlighted cell?
  - 4, 5, 6




*Staples*
by Florian Wortmann

# Domino

- New rule:
  - ● — Digits have a 1:2 ratio
  - ○ — Digits are consecutive
  - X — Digits sum to 10
  - V — Digits sum to 5




*Kropki XV Sudoku*
by Phistomefel

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- New rule:
  - ● — Digits have a 1:2 ratio
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  - X — Digits sum to 10
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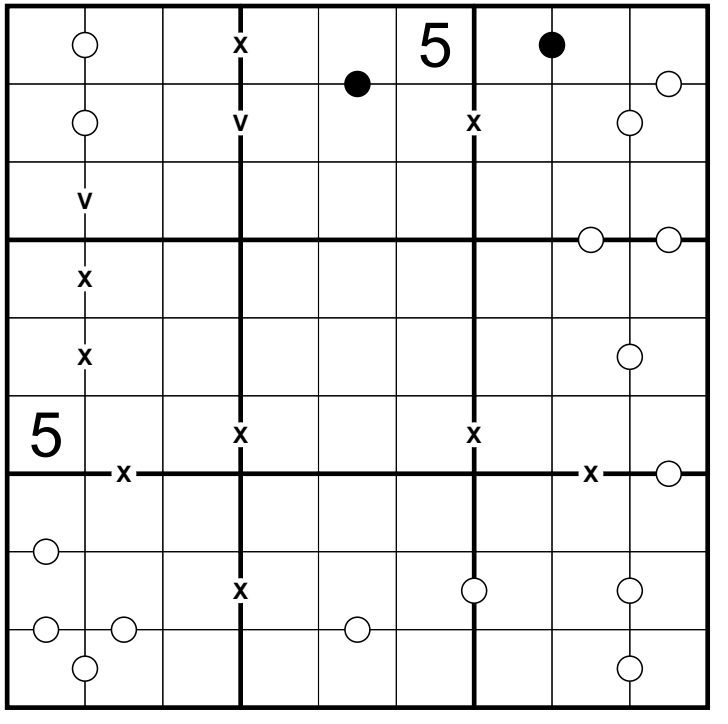
- What digits cannot touch X?

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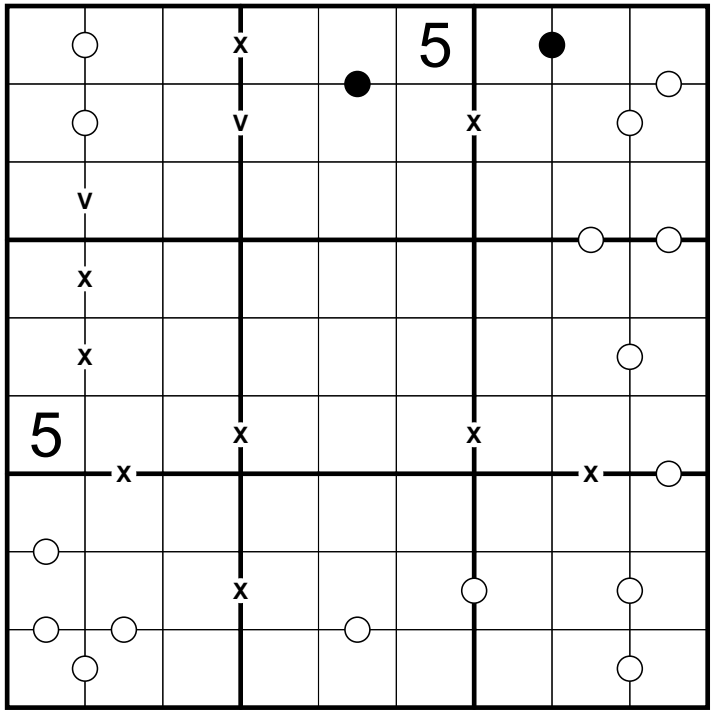


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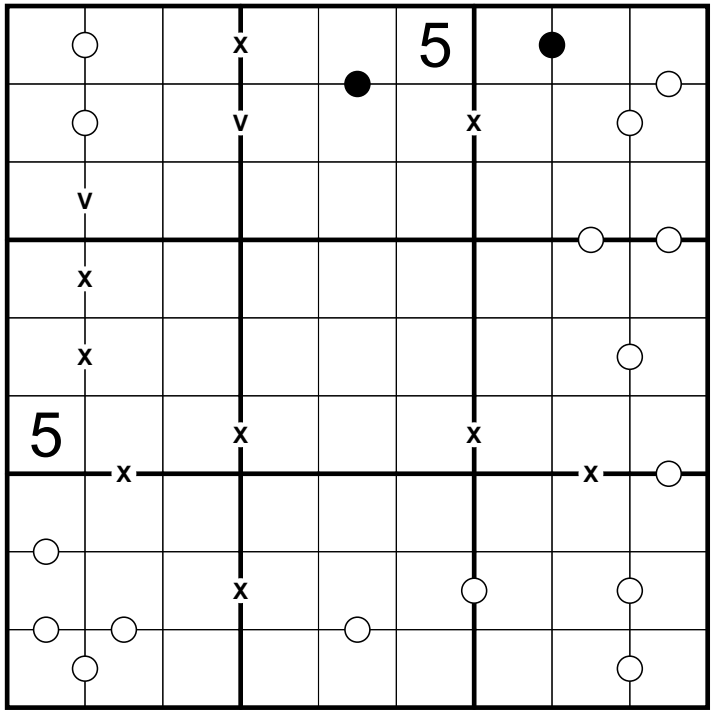
  - X — Digits sum to 10
  - V — Digits sum to 5
- What digits cannot touch X?
  - 5
- What digits cannot touch ●?

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  - ● — Digits have a 1:2 ratio
  - ○ — Digits are consecutive
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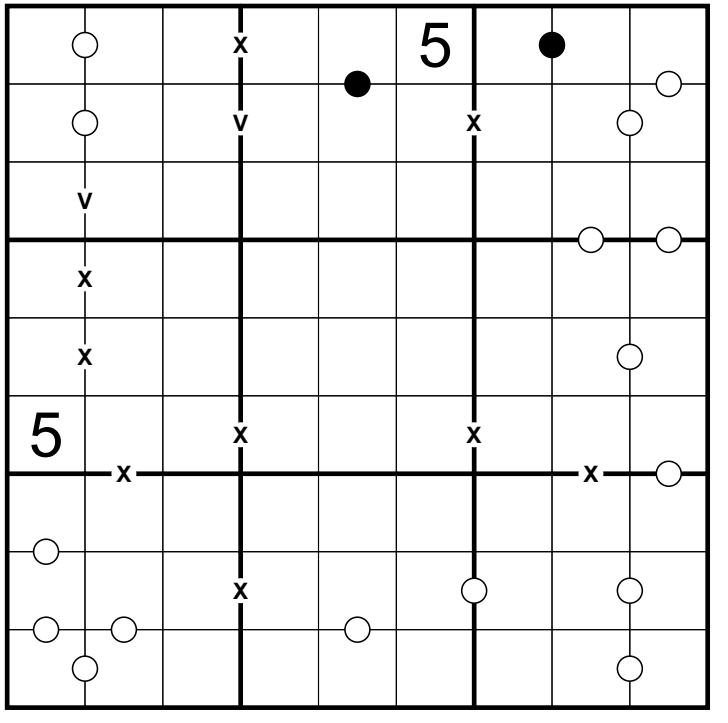
  - V — Digits sum to 5
- What digits cannot touch X?
  - 5
- What digits cannot touch ●?
  - 5, 7, 9




*Kropki XV Sudoku*
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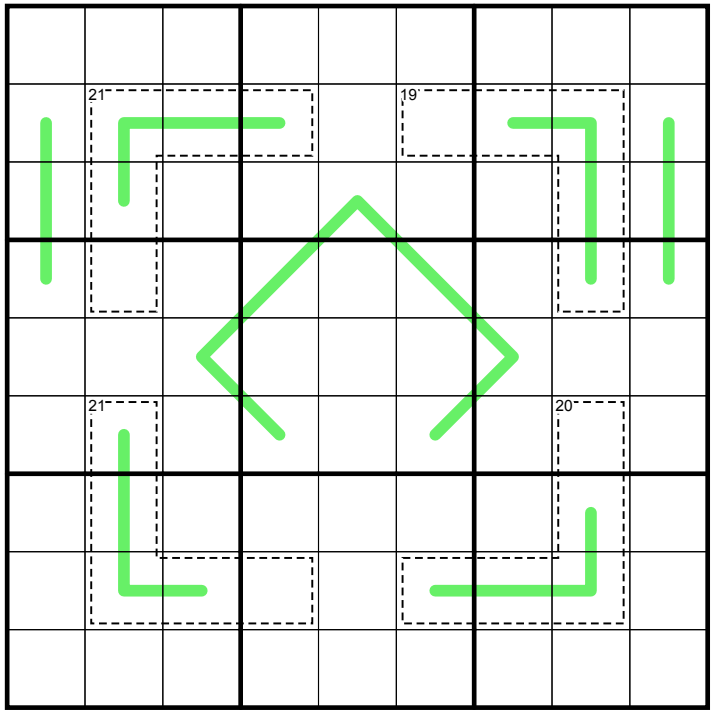
# German whispers

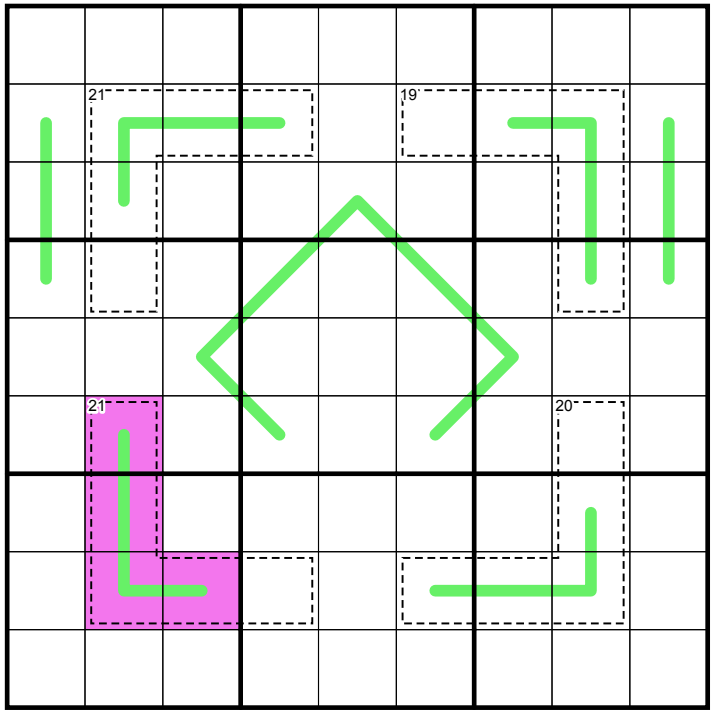
- New rule: Adjacent digits on a line have a difference of at least 5




*Tomb of Whispers*
by Nityant Agarwal, Gliperal, Botaku, and Tob Snibbob

# German whispers

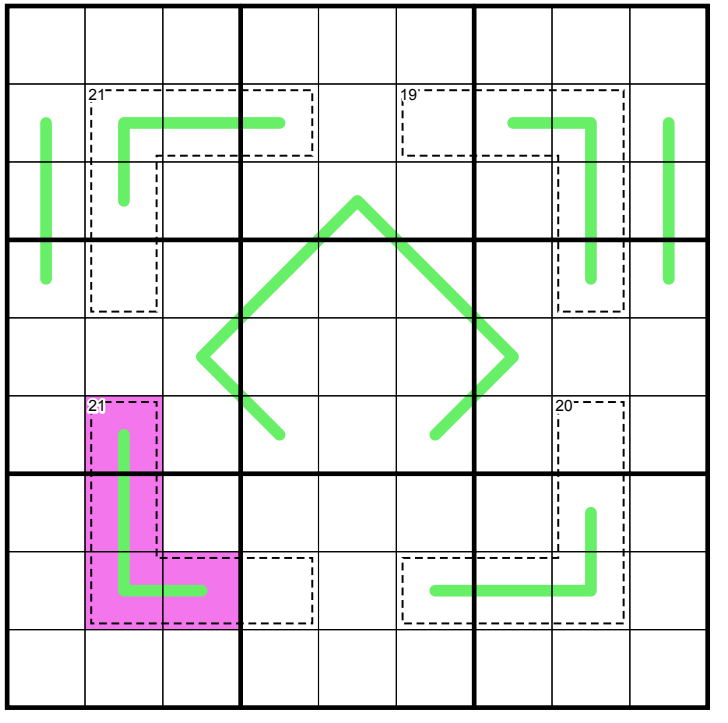
- New rule: Adjacent digits on a line have a difference of at least 5
- Considering only the German whispers rule, what's a sequence of digits that could fill the highlighted line?




*Tomb of Whispers*
by Nityant Agarwal, Gliperal, Botaku, and Tob Snibbob

# German whispers

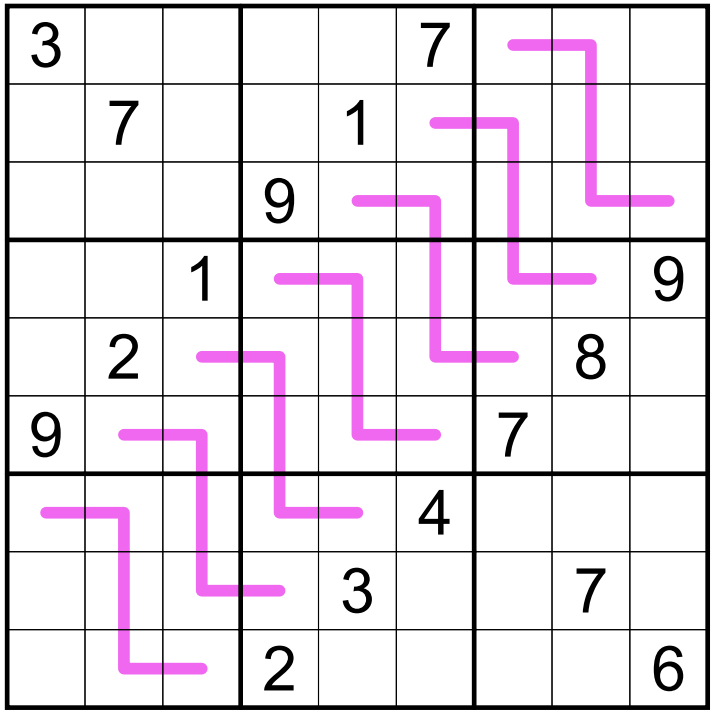
- New rule: Adjacent digits on a line have a difference of at least 5
- Considering only the German whispers rule, what's a sequence of digits that could fill the highlighted line?
- Is that set of digits possible within the **cage**?




*Tomb of Whispers*
by Nityant Agarwal, Gliperal, Botaku, and Tob Snibbob

# Renban

- New rule: Every line is occupied by a sequence of consecutive digits, not necessarily in order along the line




*Untitled*
by Gaurav Kumar Jain

# Renban

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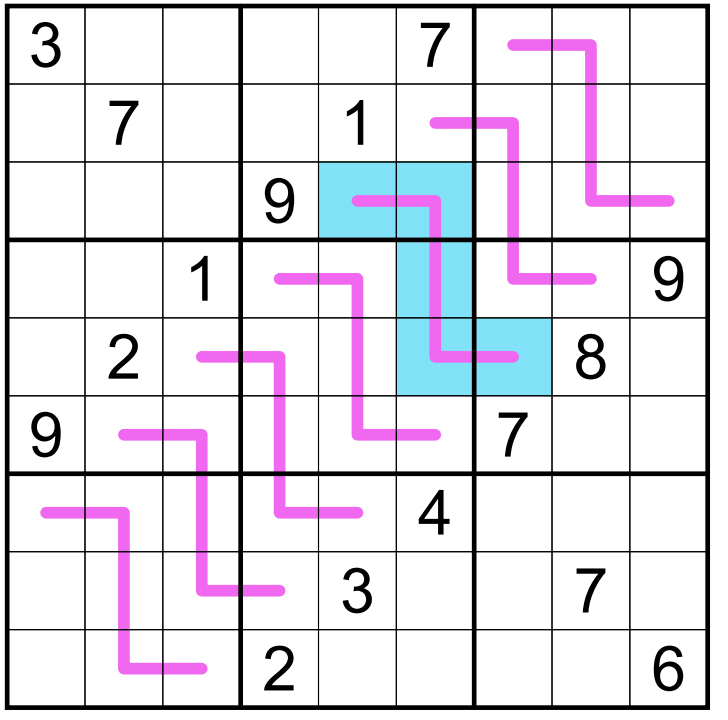
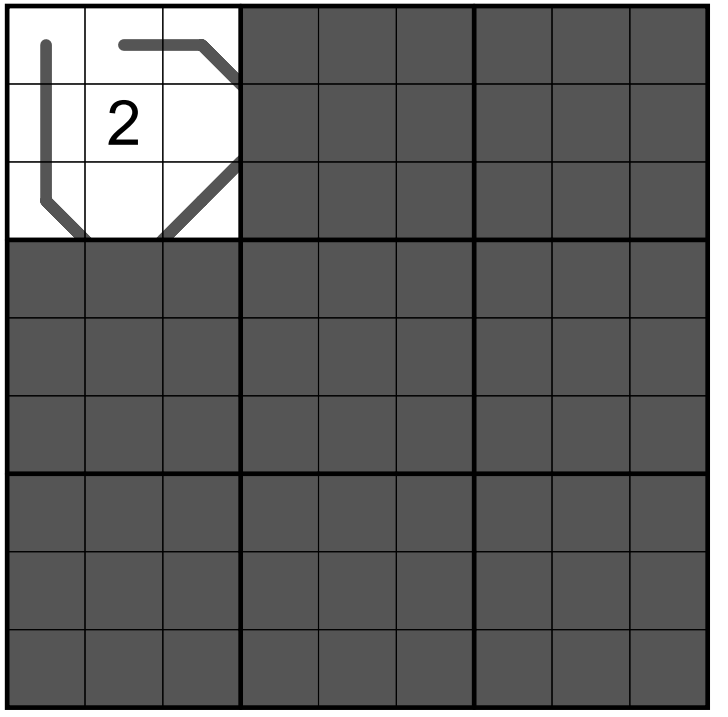
- What's a sequence of digits that could fill the highlighted line?




*Untitled*
by Gaurav Kumar Jain

# Fog of war

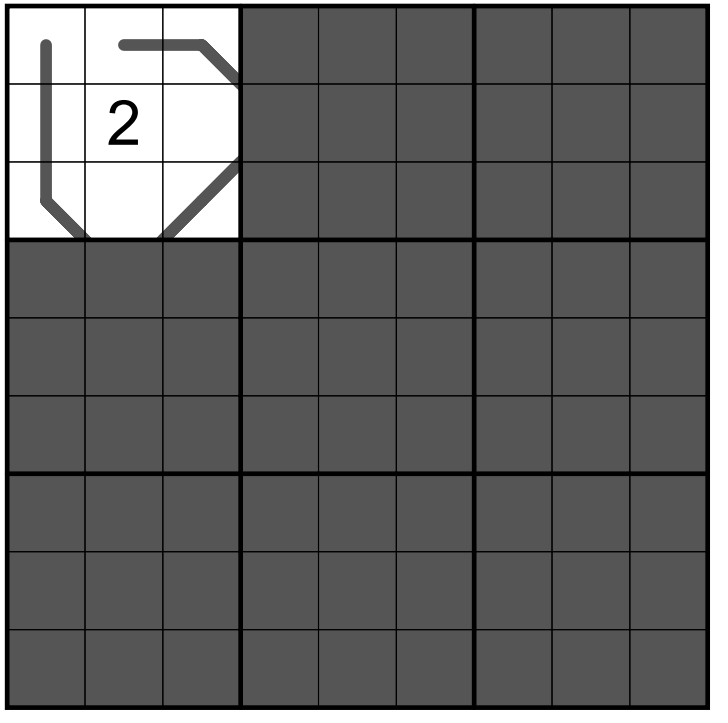
- New rule: Place digits to clear fog in the surrounding cells




*Ancient Artifacts*
by Scojo

# Fog of war

- New rule: Place digits to clear fog in the surrounding cells
  - Also in this puzzle: every line is either a German whispers, a renban, or has the same sum in every box visited




*Ancient Artifacts*
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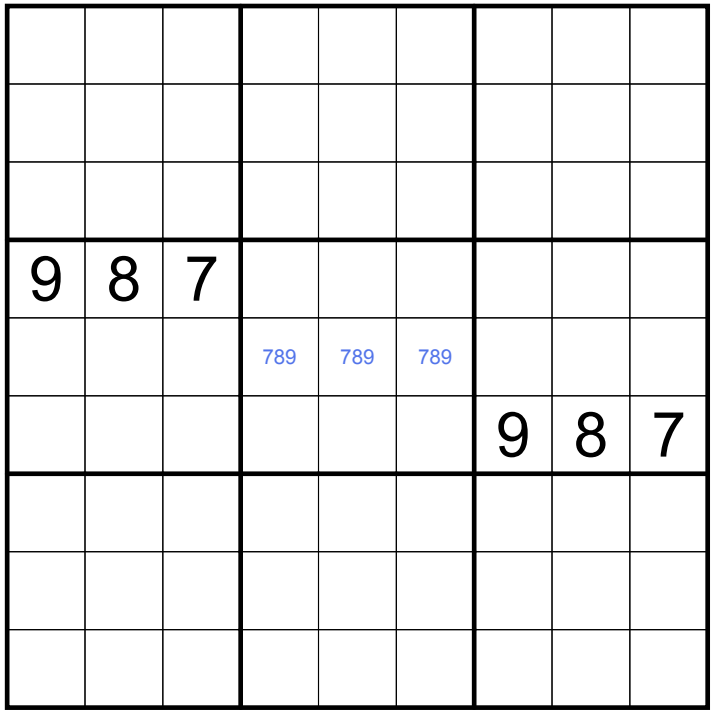
# Strategy

# Pencilmarking: center marks

- Used to indicate a set of digits from which a cell's digit in the solved puzzle must be drawn



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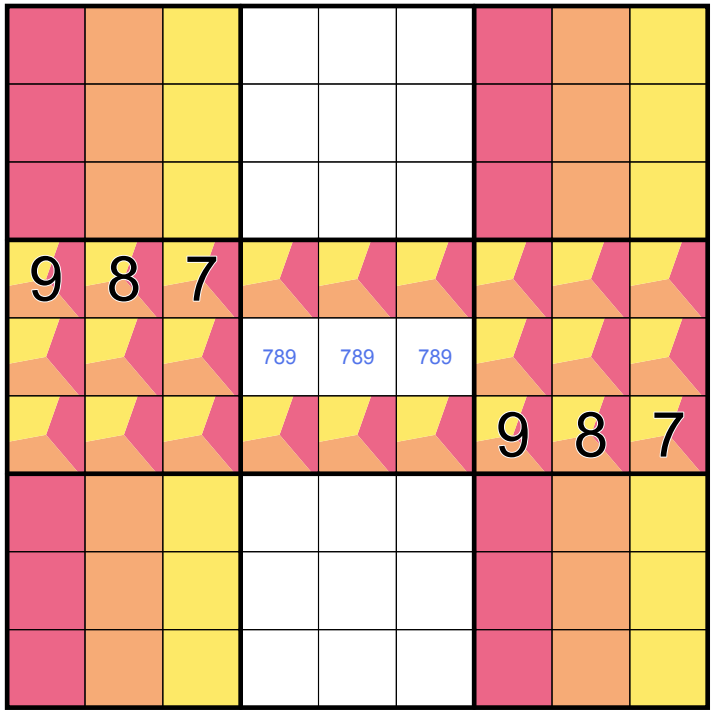
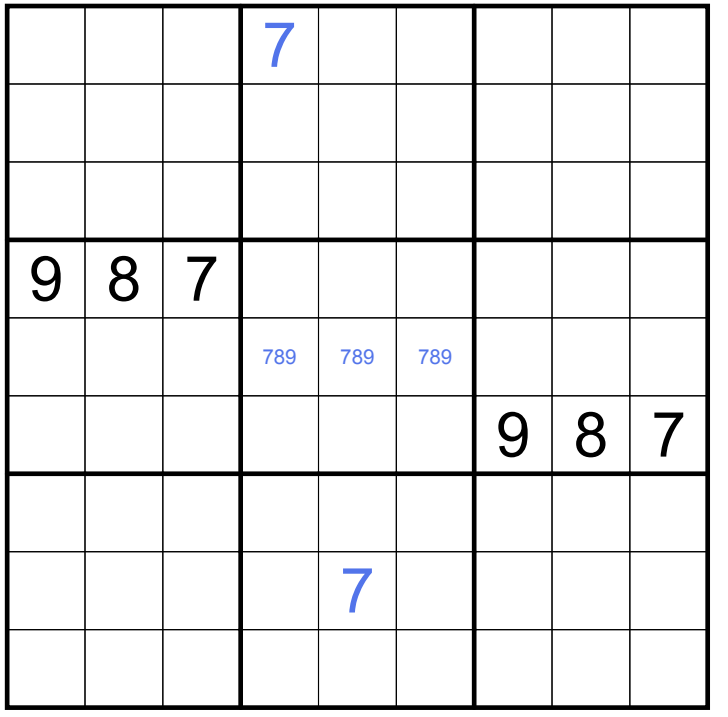


# Pencilmarking: center marks

- Used to indicate a set of digits from which a cell's digit in the solved puzzle must be drawn
- As you progress through the puzzle, you whittle away at your center marks



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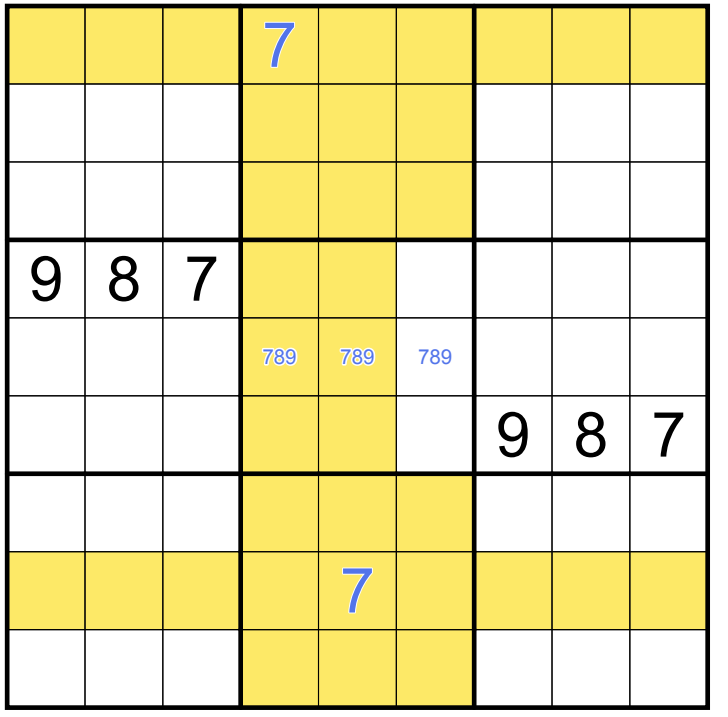

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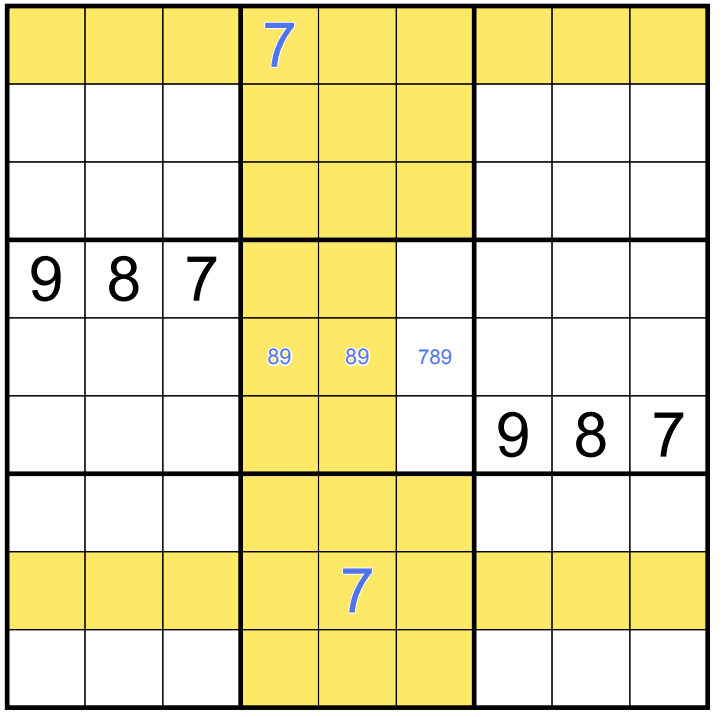

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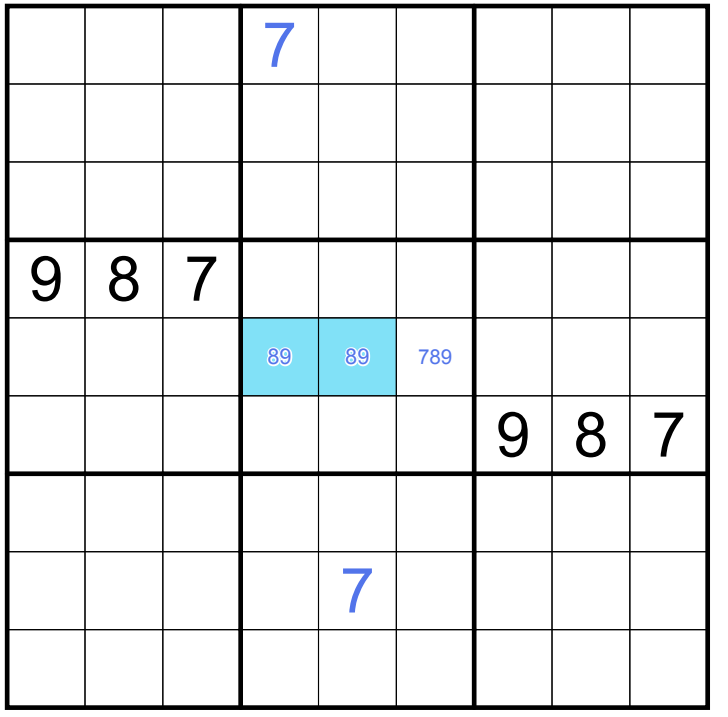

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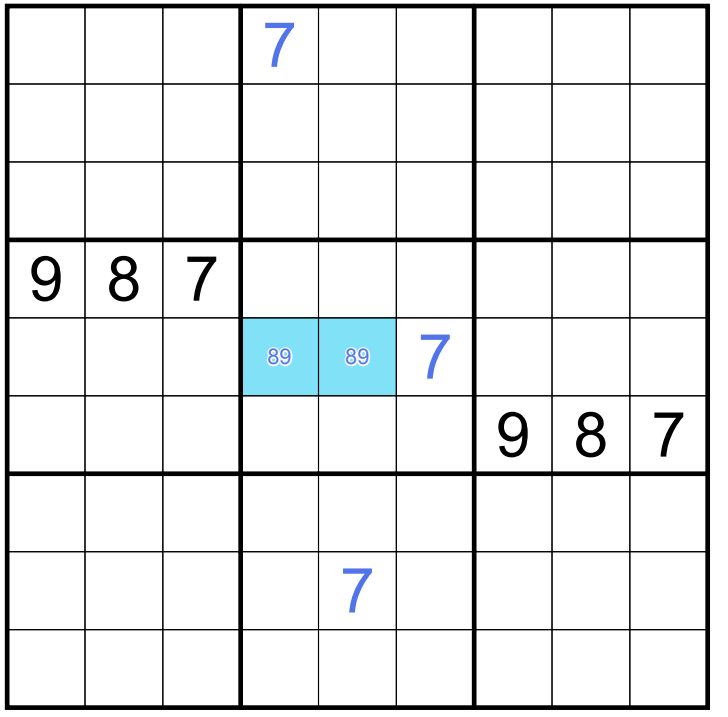
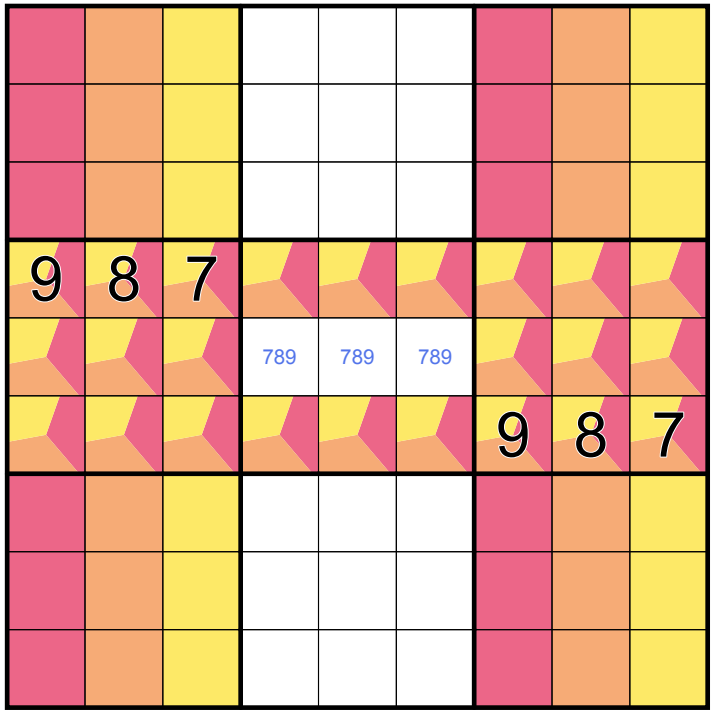


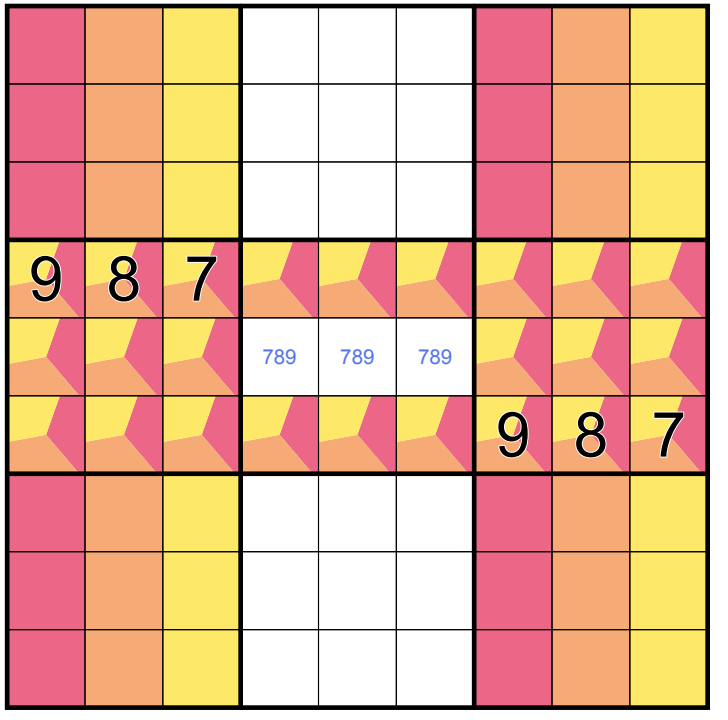
# The pigeonhole principle

- Something sneaky happened here — any guesses?



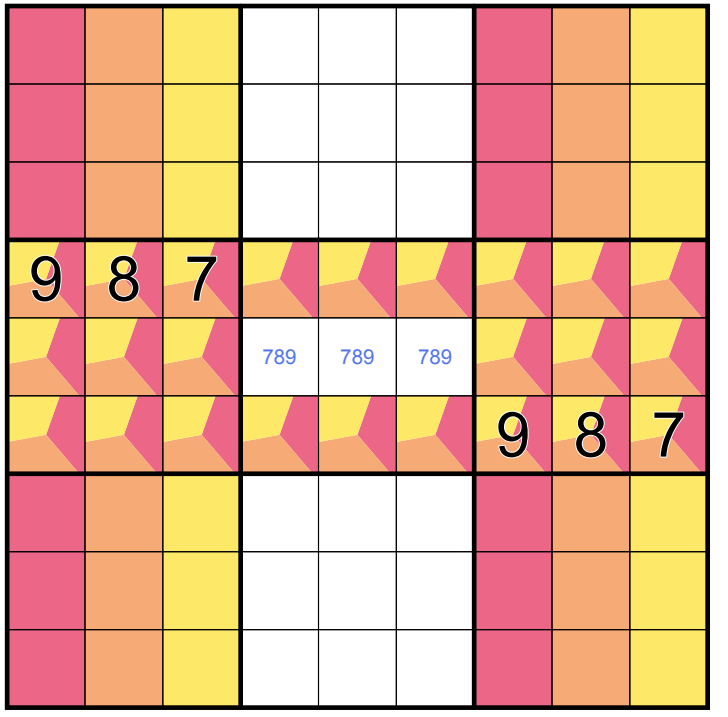
# The pigeonhole principle

- Something sneaky happened here — any guesses?
- We saw that 7, 8, 9 cannot be in the top or bottom row in the box
- But what we marked implied that we had eliminated 1-6 from the center row
- How did we do this?



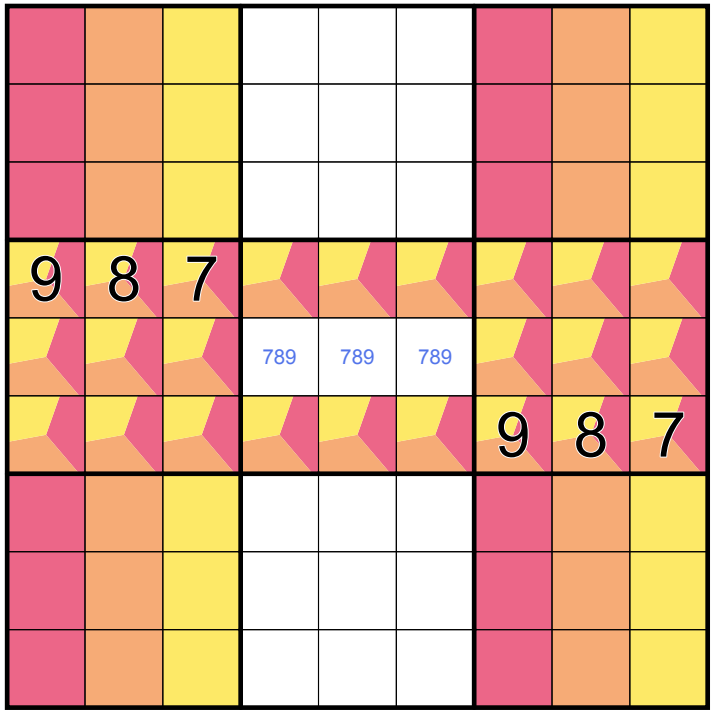
# The pigeonhole principle

- We used the pigeonhole principle
- Can anyone state it?



# The pigeonhole principle

- We used the pigeonhole principle
- Relevant statement: If $n$ items are placed into $n$ bins and each bin contains one item, then the bins contain exactly the items



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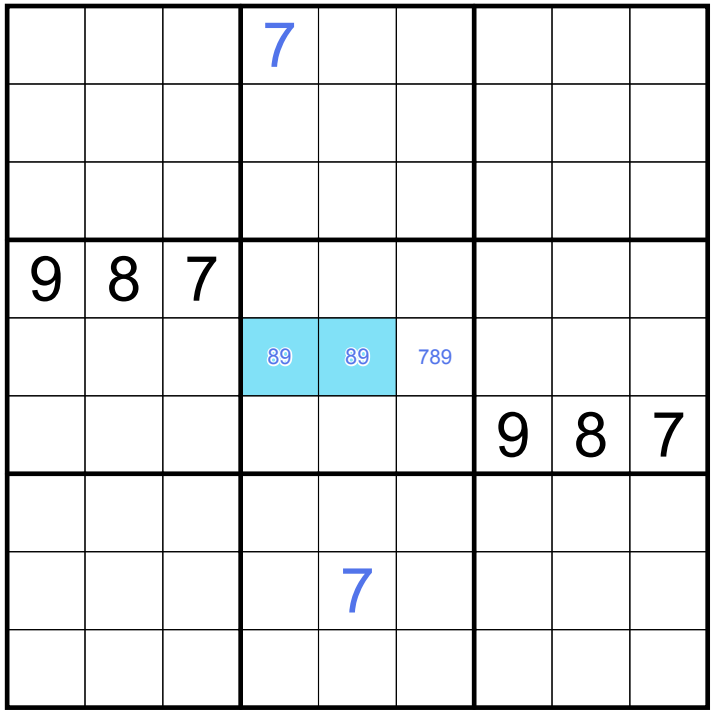
- We also implicitly used it in the step where we placed the 7



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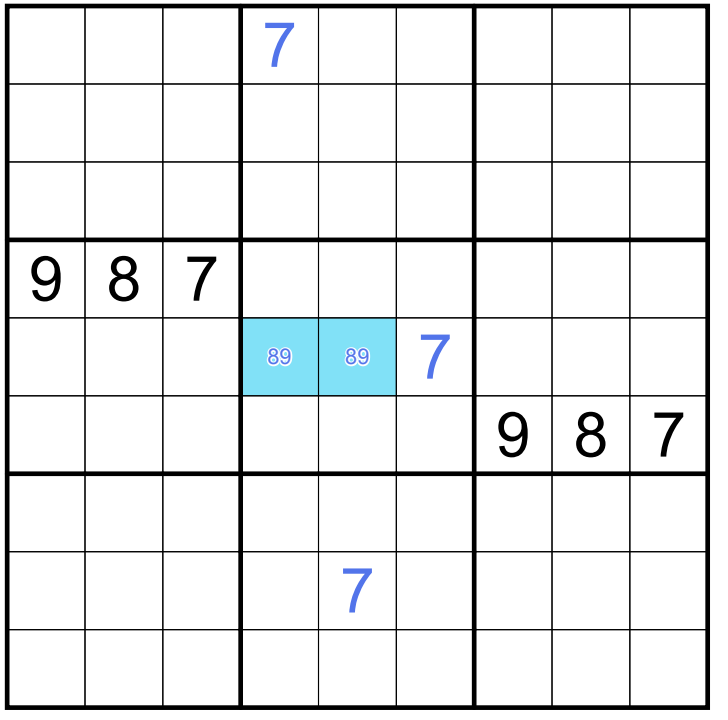
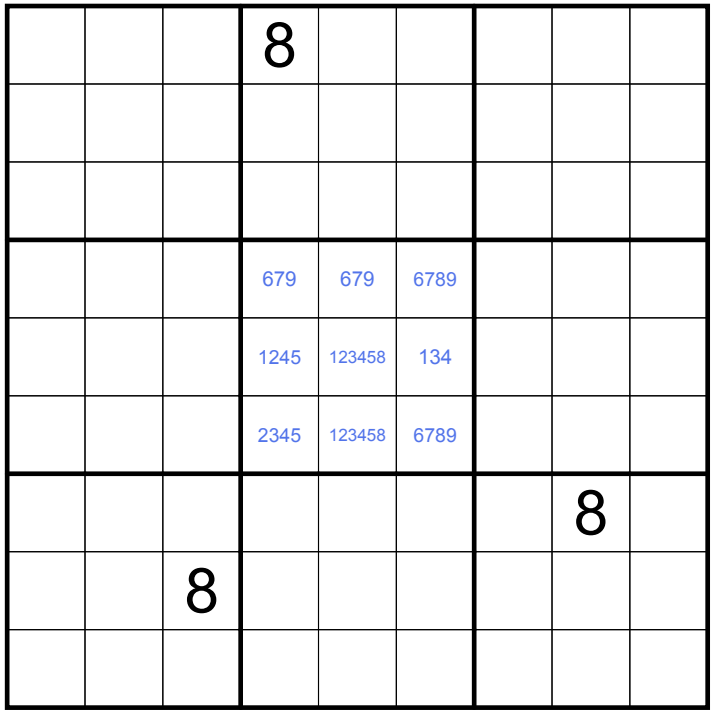


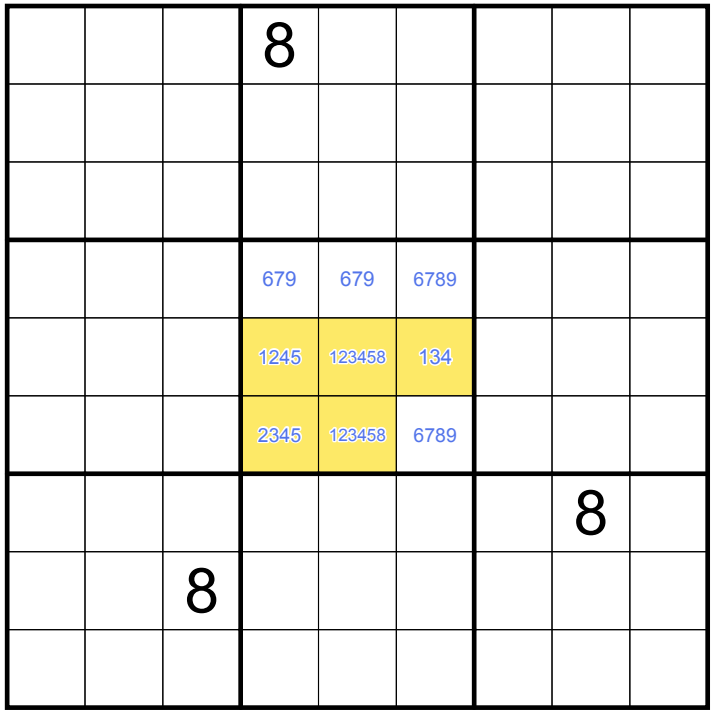
# The pigeonhole principle

- While the statement may be obvious, applications are often not
- Let's use the pigeonhole principle to place 8 in the lower center box



# The pigeonhole principle

- While the statement may be obvious, applications are often not
- Let's use the pigeonhole principle to place 8 in the lower center box



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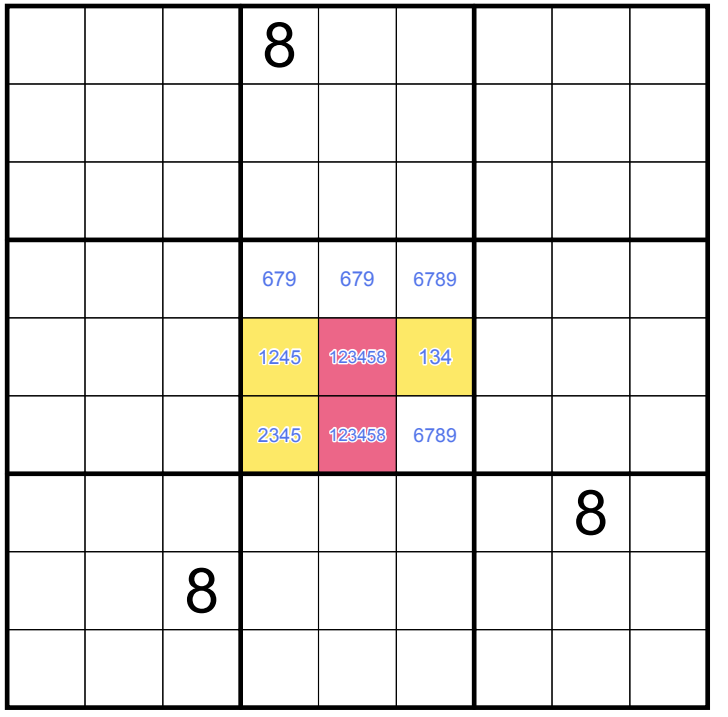

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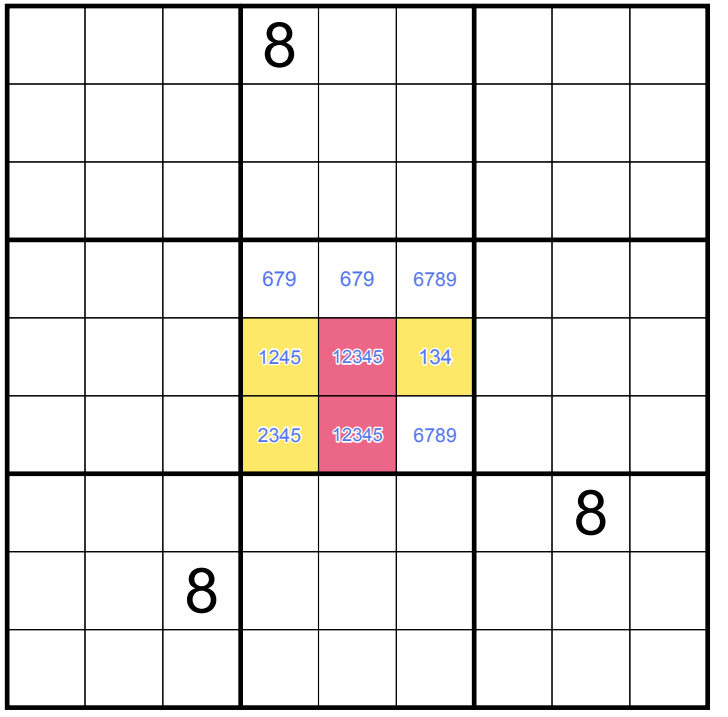

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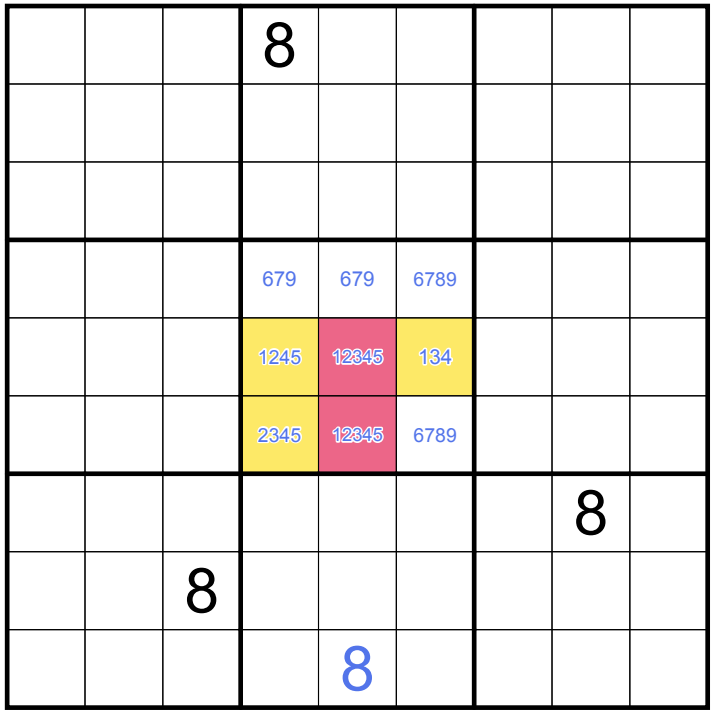
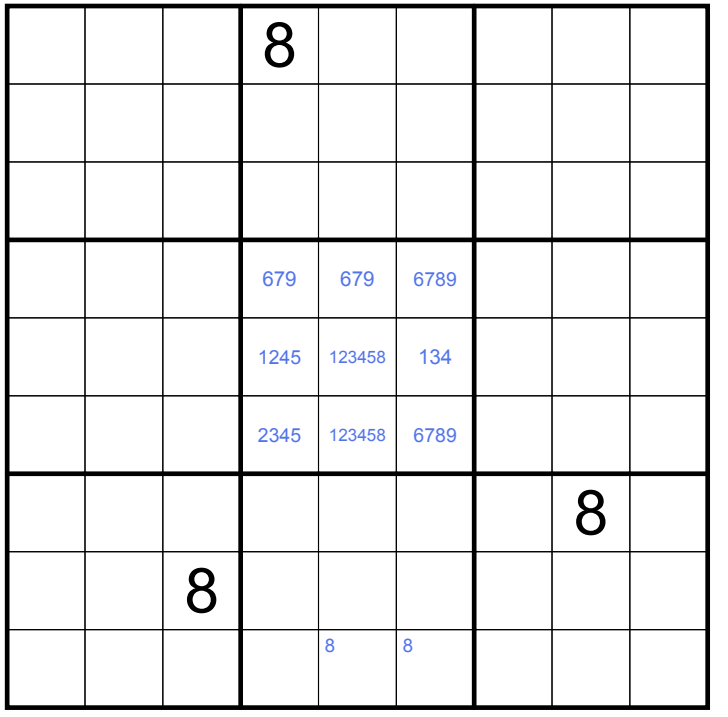


# Pencilmarking: corner marks

- Used to indicate a set of cells within a box within which a particular number appears in the solved puzzle



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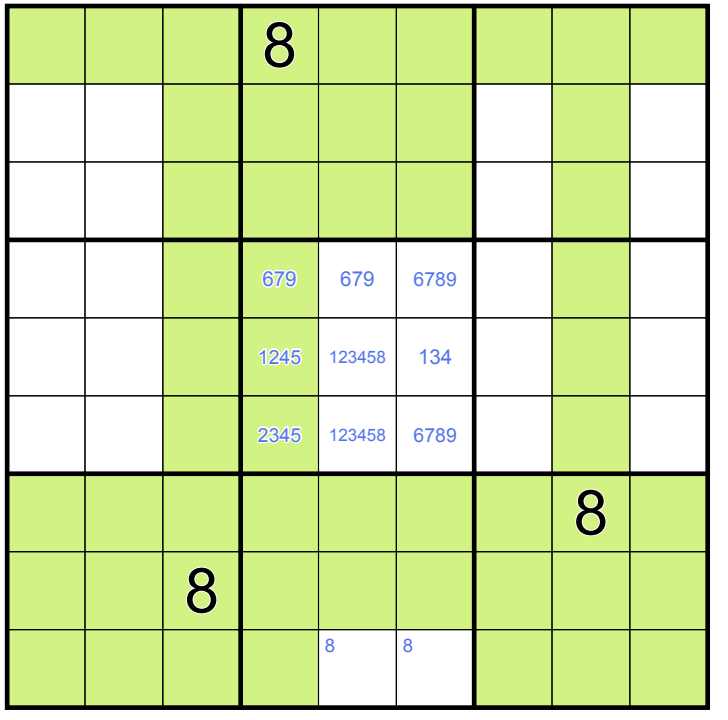
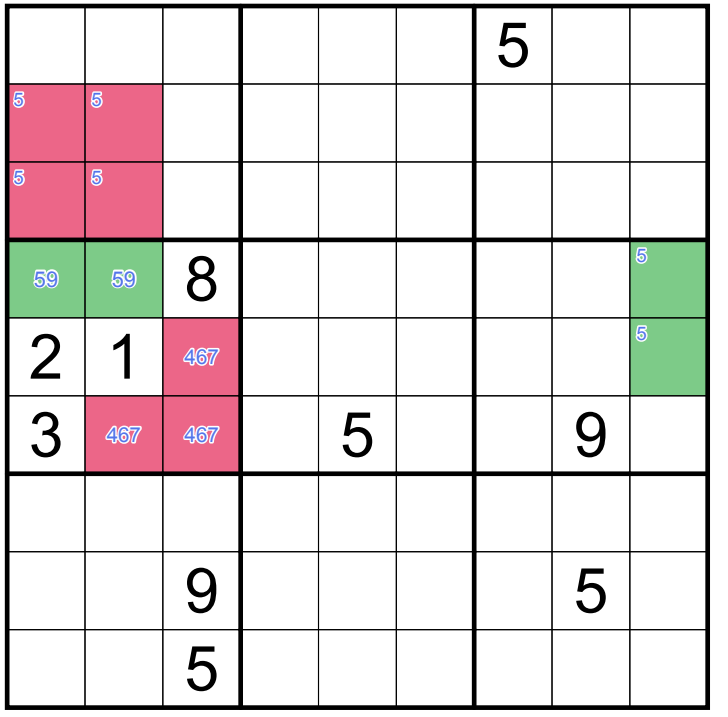


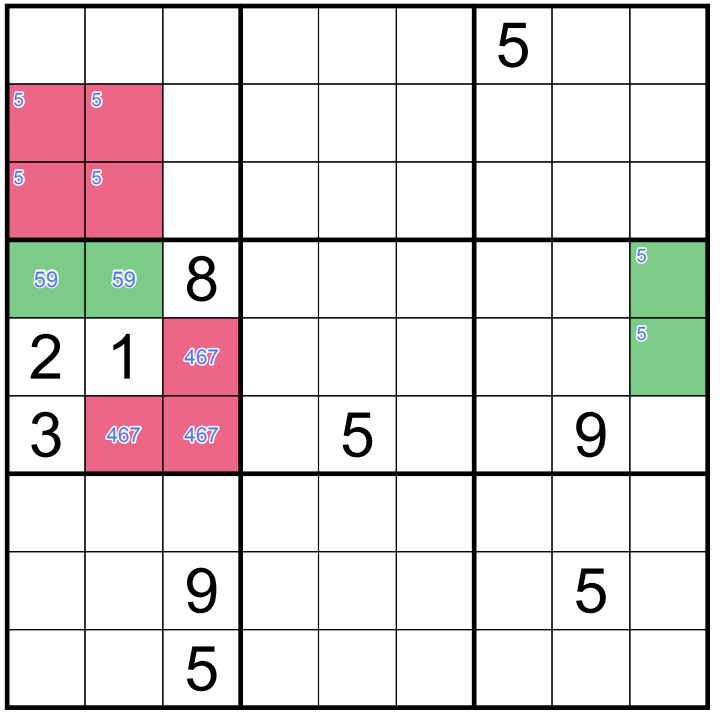
# Pencilmarking: Snyder notation

- Corner mark a digit in a box only if it is restricted to exactly two positions within the box
- Center mark a cell only if it contains exatly two candidates



# Pencilmarking: Snyder notation

- Corner mark a digit in a box only if it is restricted to exactly two positions within the box
- Center mark a cell only if it contains exatly two candidates
- Points you towards the parts of the puzzle that are currently most restricted



# X-wings

- If a digit is restricted to the same two columns in two rows, it does not appear in any other rows in those columns
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- Let's use this to place 3 in column 4

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 2 | 3 | 9 | 48 | 1 | 48 | 7 | 56 | 56 |
| | | | | | | | | |
| 1 | 34 | 2 | 689 | 5 | 89 | 69 | 7 | 34 |
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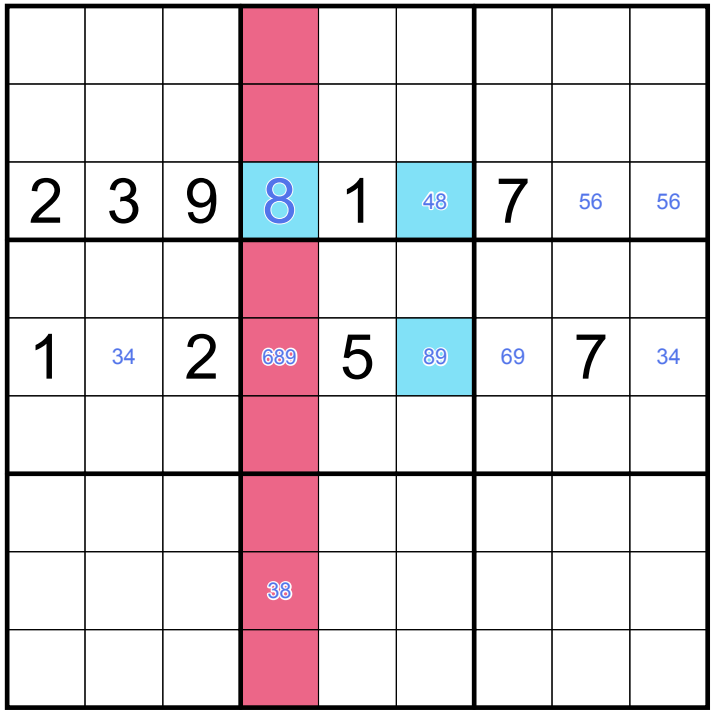

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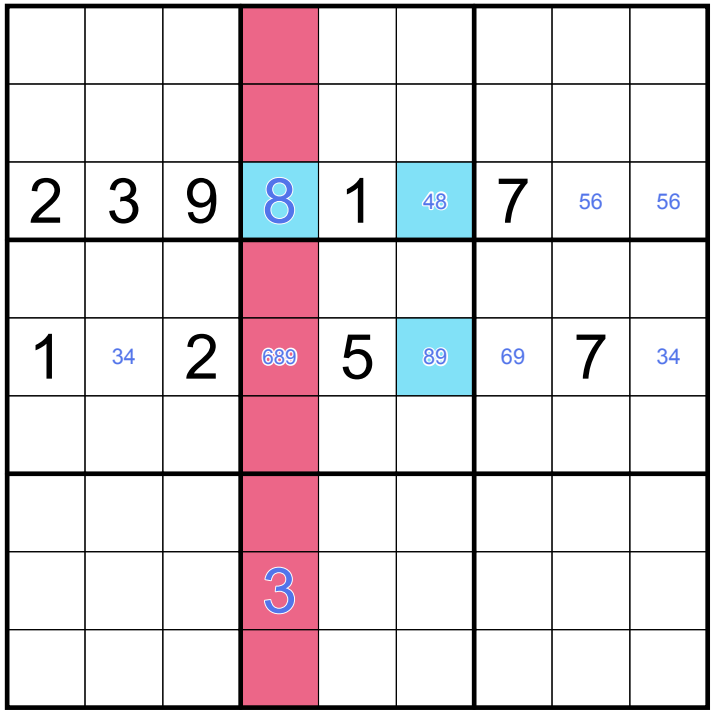

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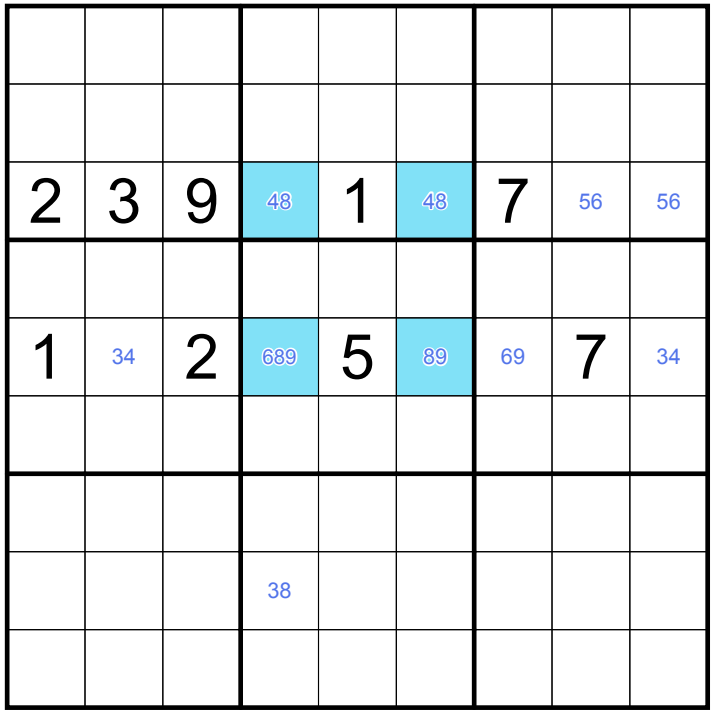

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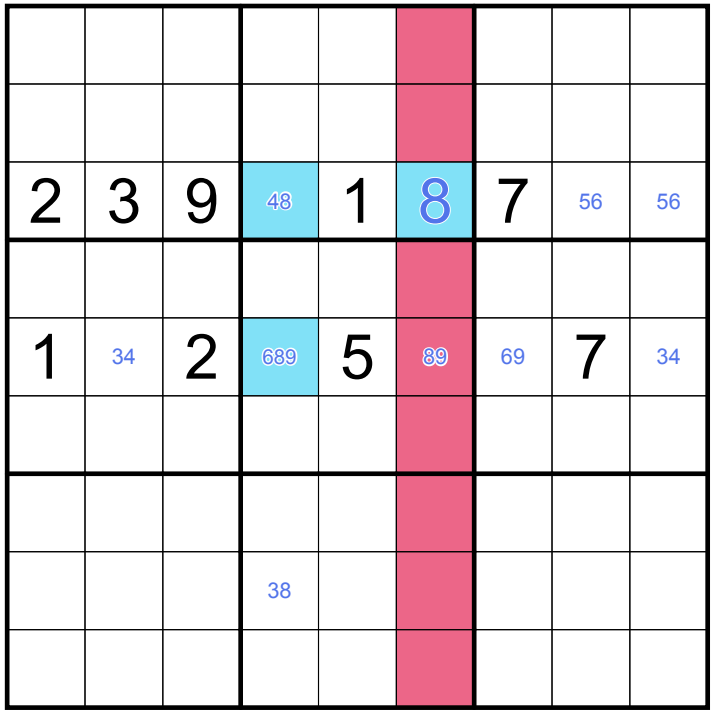

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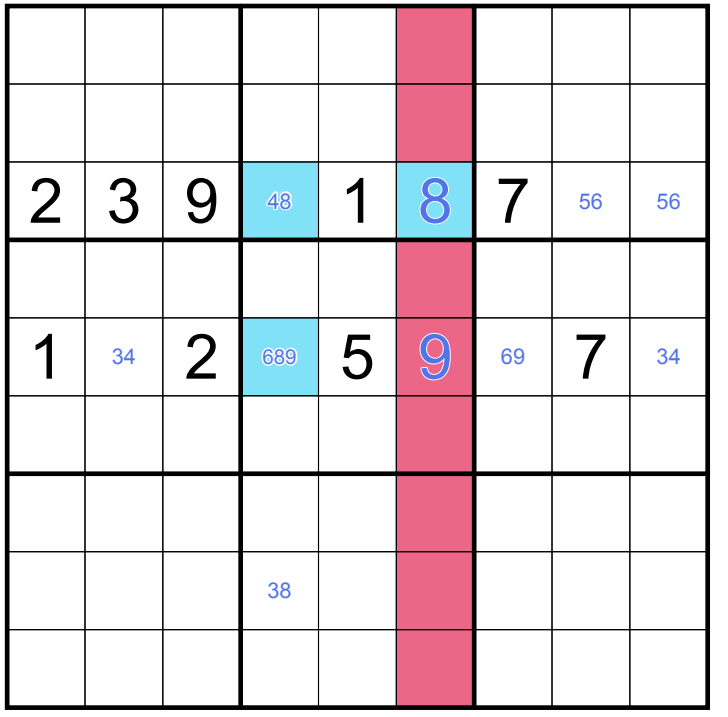

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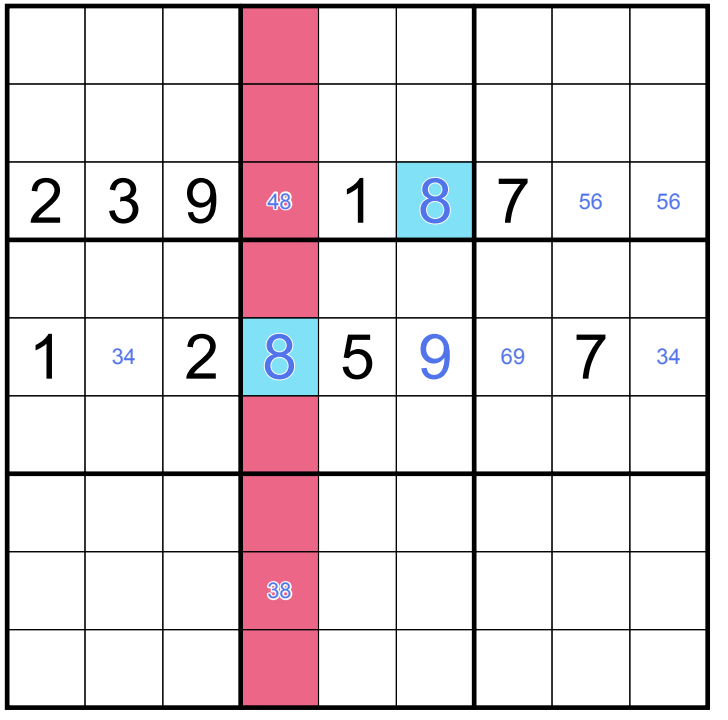

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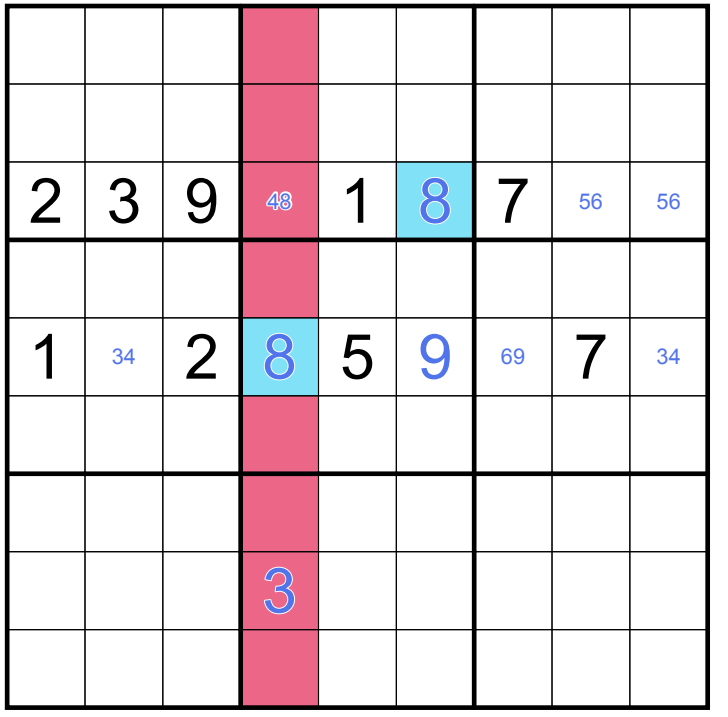

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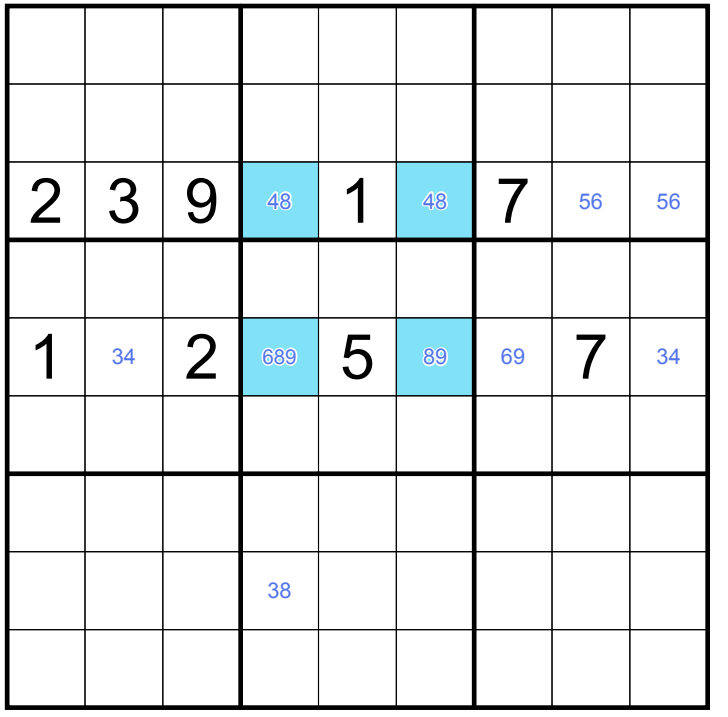

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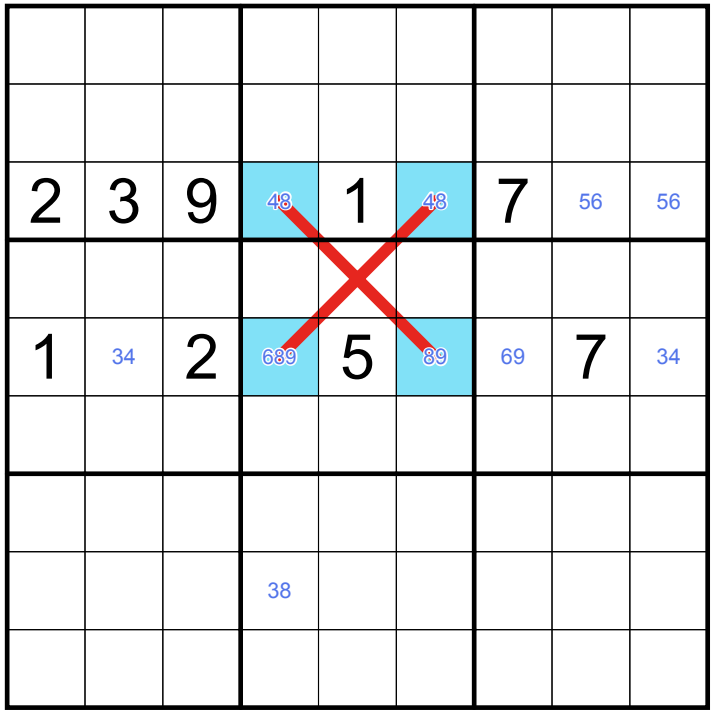

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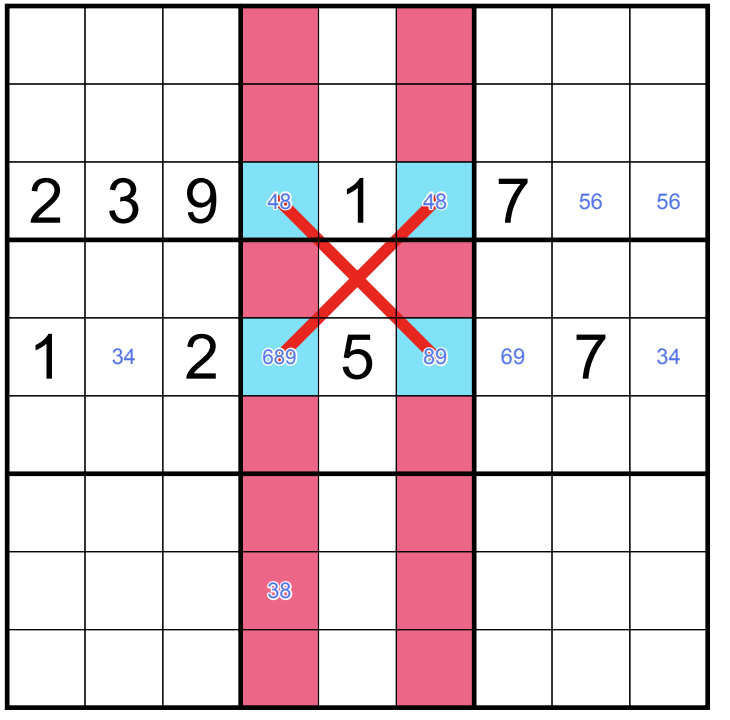

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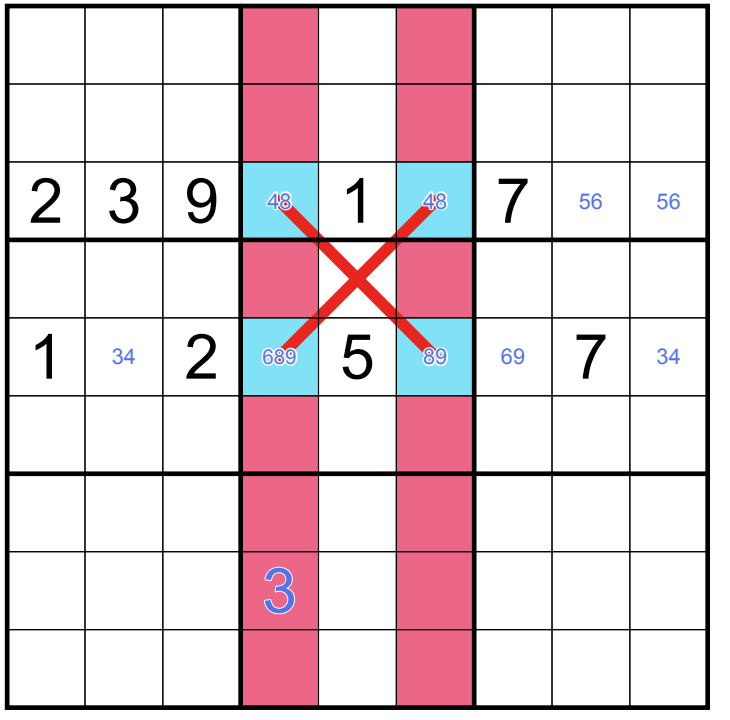
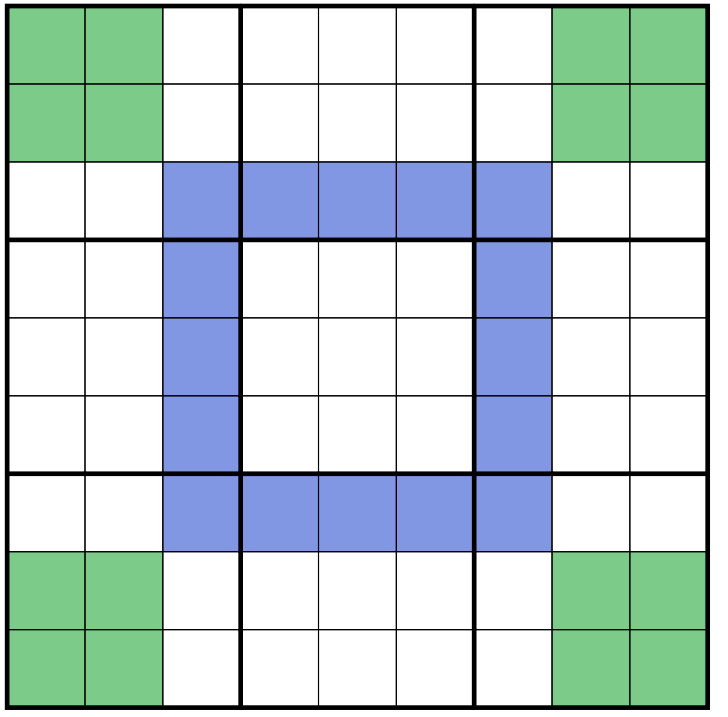


# SET

- “Set Equivalence Theory”
- Statment: Two sets that are at first equivalent remain equivalent when equivalent subsets are removed from each



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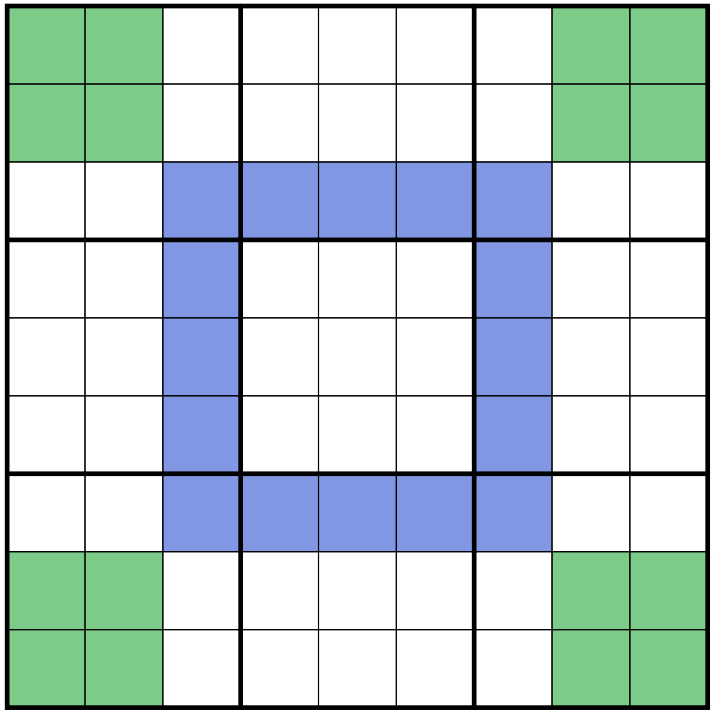

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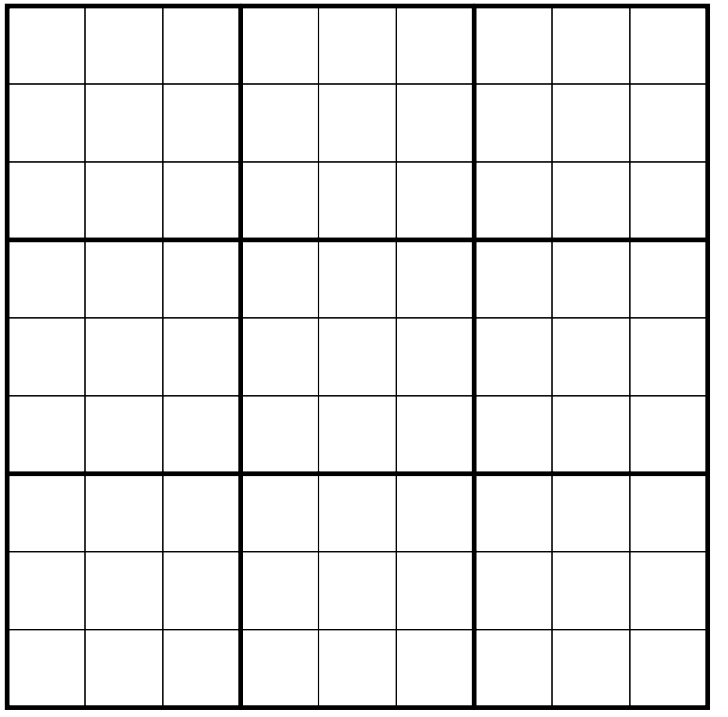

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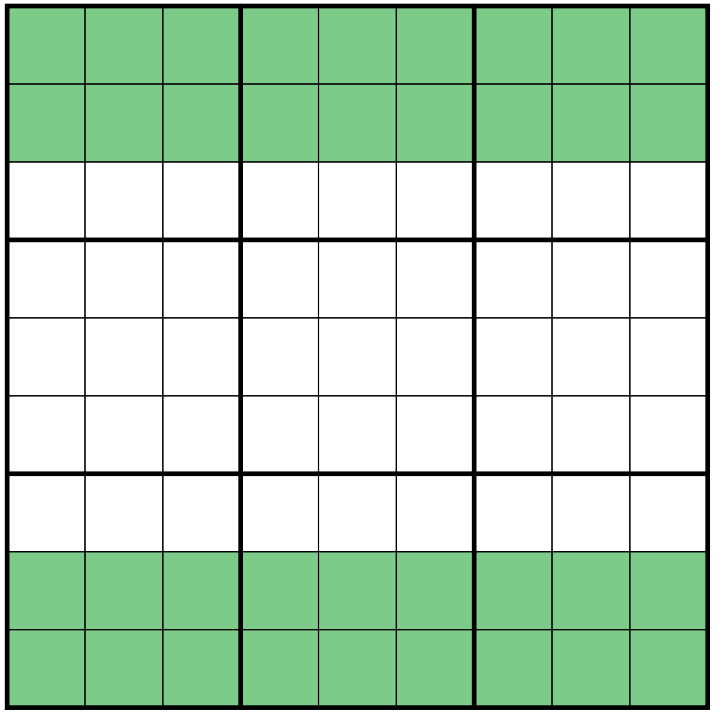

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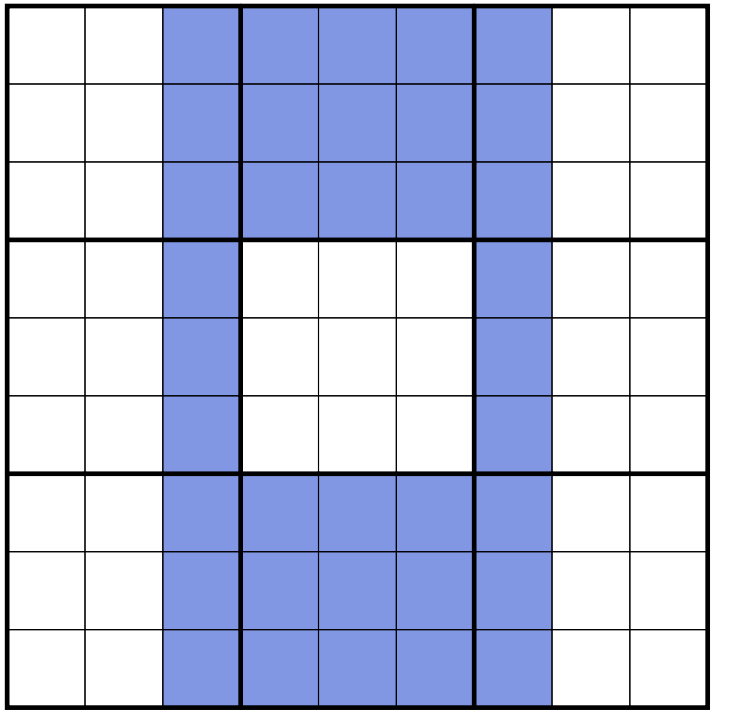

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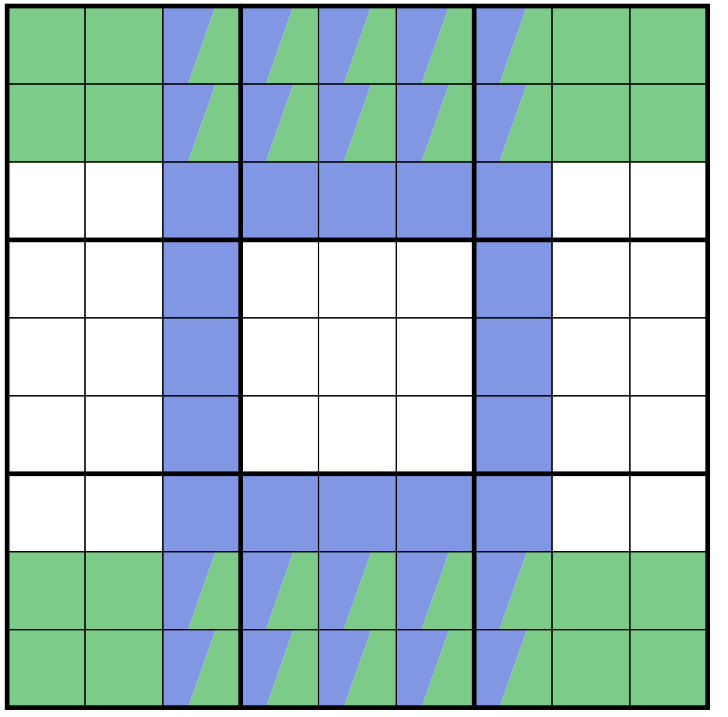

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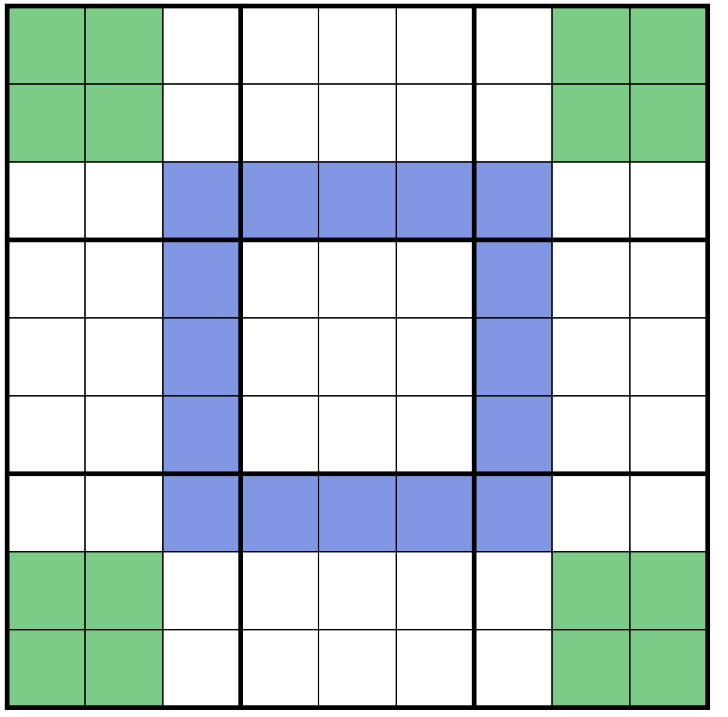

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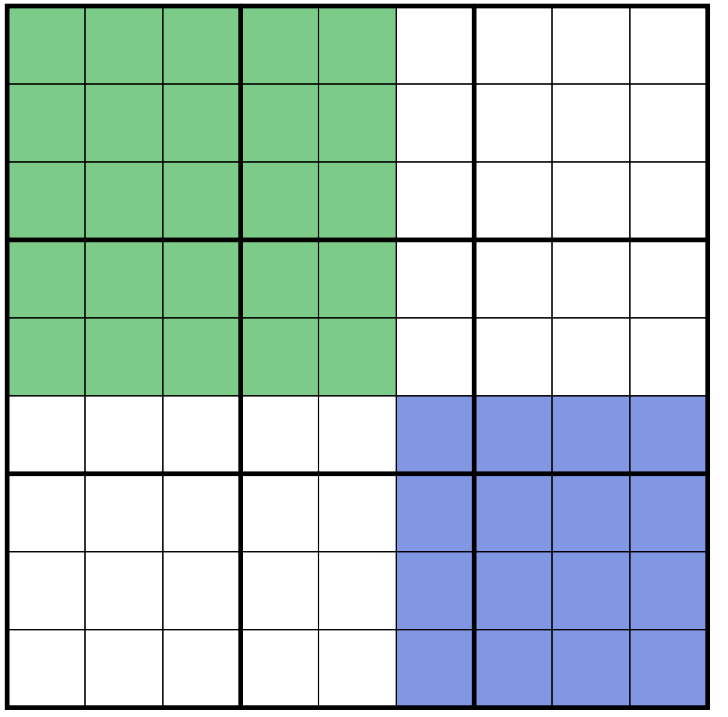
- Other SET equivalent regions



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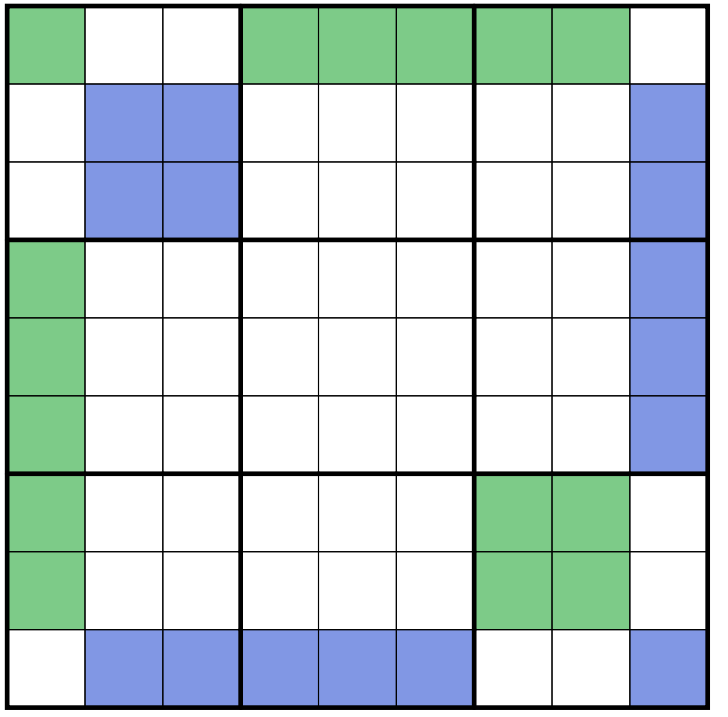

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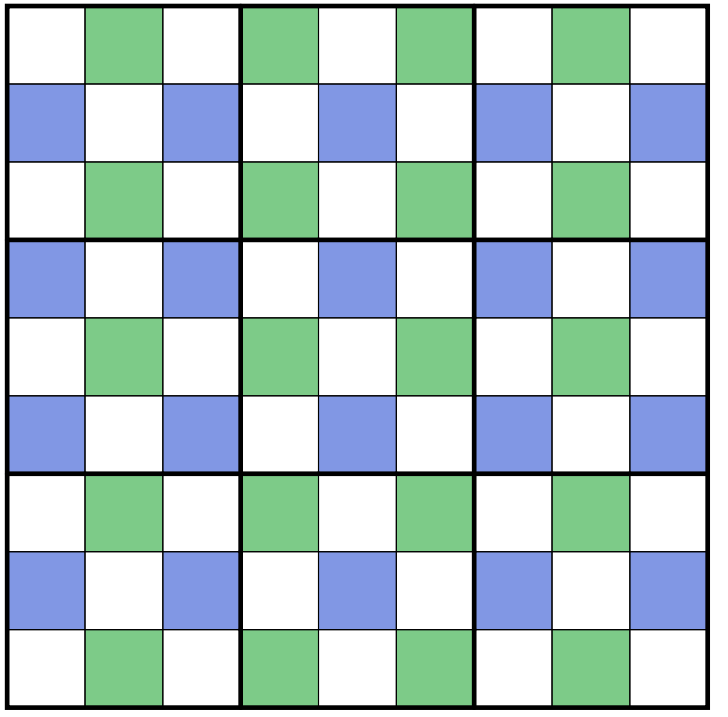
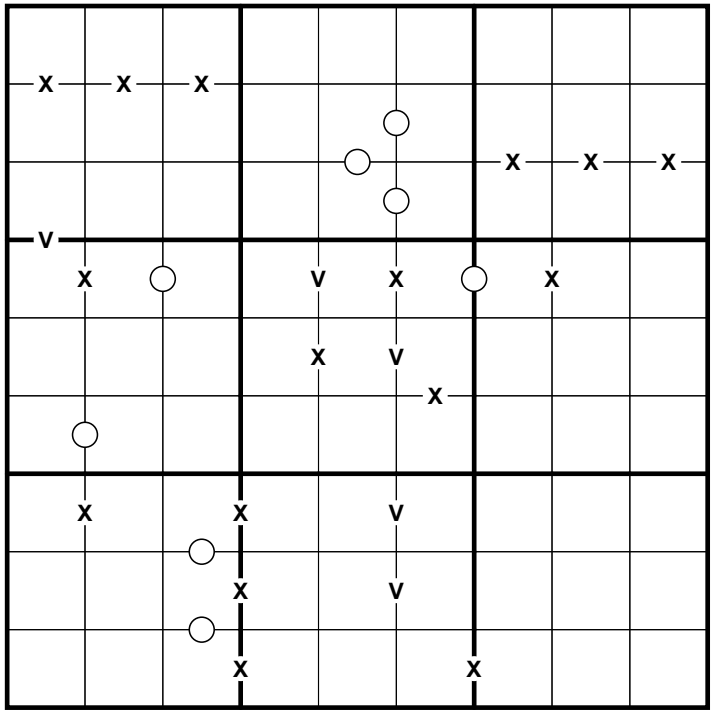


# Setting

# My qualifications

- Not much, I have only gotten into setting in the last two weeks
- Have set two sudokus
  - Comment from a friend on the first one: “I’m not gonna lie, it’s really rough”
  - Solve them here
- But I still have thoughts



*Domino Tree*
by me

# Strategy

- One idea: to **set** a sudoku, **solve** one that doesn't exist yet
  - Start with something in the grid
  - Try to solve
  - Get stuck
  - Add something that will get you unstuck
  - Repeat
- There are other strategies but they seem like magic to me

# Philosophies

- Make puzzles that are fun to **set**
- Use principles from game design
- Teach the solver something and let them use the knowledge they just learned
  - My game-designer friend Kevin, paraphrased: “Learning is one of the most fun things you can do”
- Use algorithmic solvers with intention
  - Puzzles made by humans are more fun than puzzles made by computers

# Resources

- SudokuMaker by sirxemic
  - Allows you to share your puzzles via a link! (with free hosting courtesy of Sven Neumann)
- Setting videos (list courtesy of Pallando)
- Cracking the Cryptic Discord
  - For getting feedback on your puzzles

# Final thoughts

# Bifurcation, puzzles, and mazes

- (This is a framework)
- Bifurcation is the strategy of heading down a path based on an arbitrary choice
- **Puzzles** are designed to be solved with **logic**
- **Mazes** are designed to be solved with **bifurcation**
- It's fun to think about their differences, and what each gives to the player
- What games combine the two?

# Cracking the Cryptic

- They solve really difficult puzzles with a lot of joy on their YouTube channel
- Very good community
- If you want to get links for low-to-medium-difficulty variant puzzles, try out their featured GASes ("Genuinely Approachable Sudokus")
- Here's their Discord link again
- If we have time, here's the singular YTP that exists of them