

# Inspire ALL Students with Open, Creative, Mindset Mathematics



67,082,089  
views and counting!



IMTE 2024

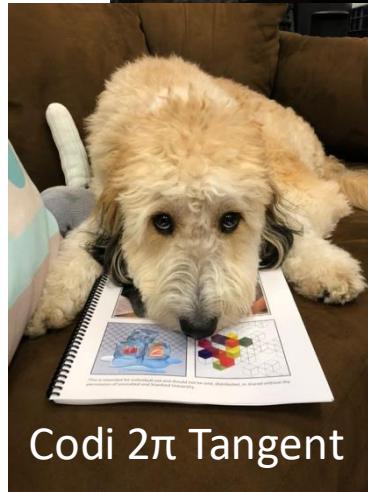
It's a Maths Party!

Cathy Williams  
Co-founder, co-director  
[cathyw11@Stanford.edu](mailto:cathyw11@Stanford.edu)  
[@chaoskeeper11](https://twitter.com/chaoskeeper11)

[www.youcubed.org](http://www.youcubed.org)

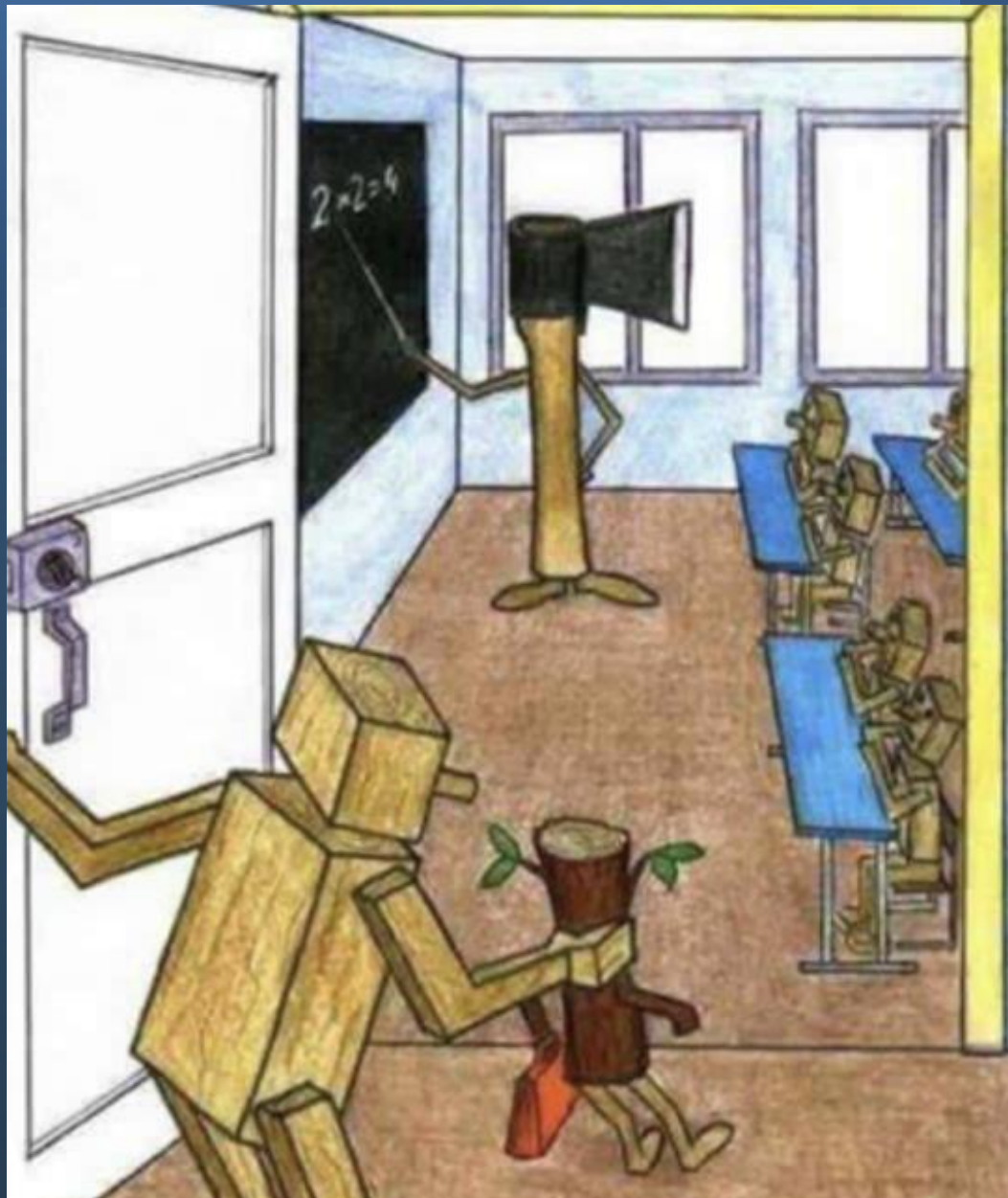


Cathy Williams  
Co-founder, co-director



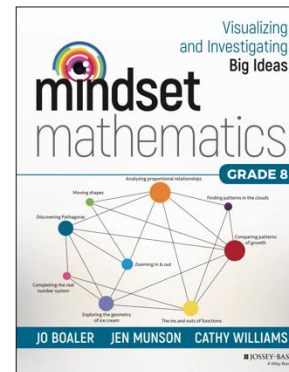
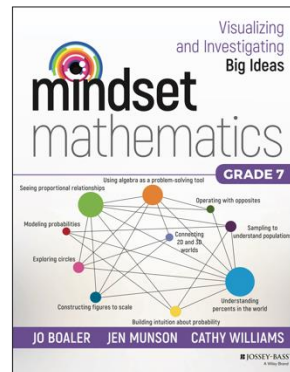
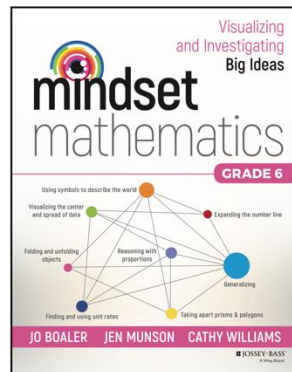
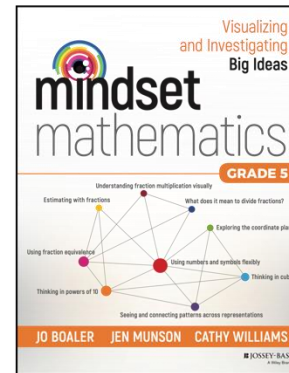
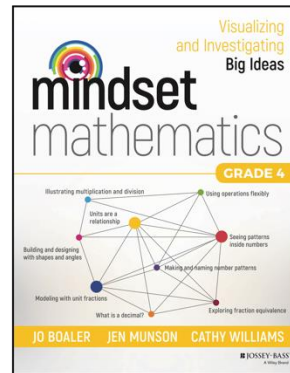
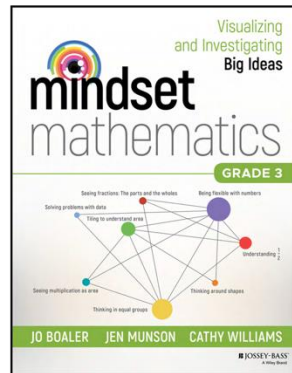
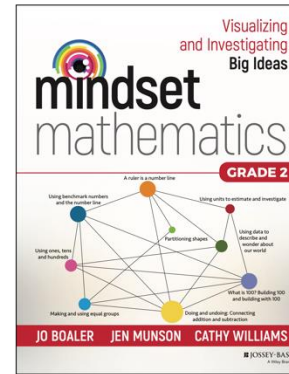
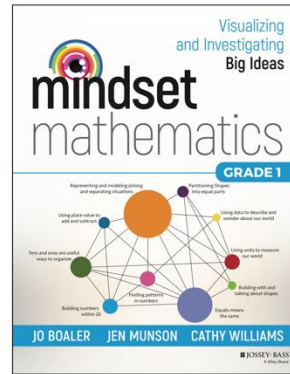
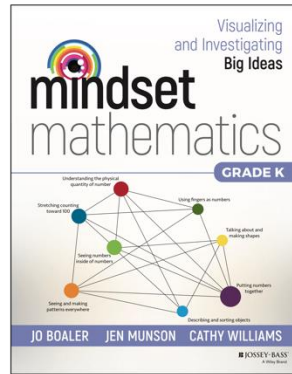
Codi  $2\pi$  Tangent







# Open, Creative Maths Tasks from Jo Boaler, Jen Munson & Cathy Williams

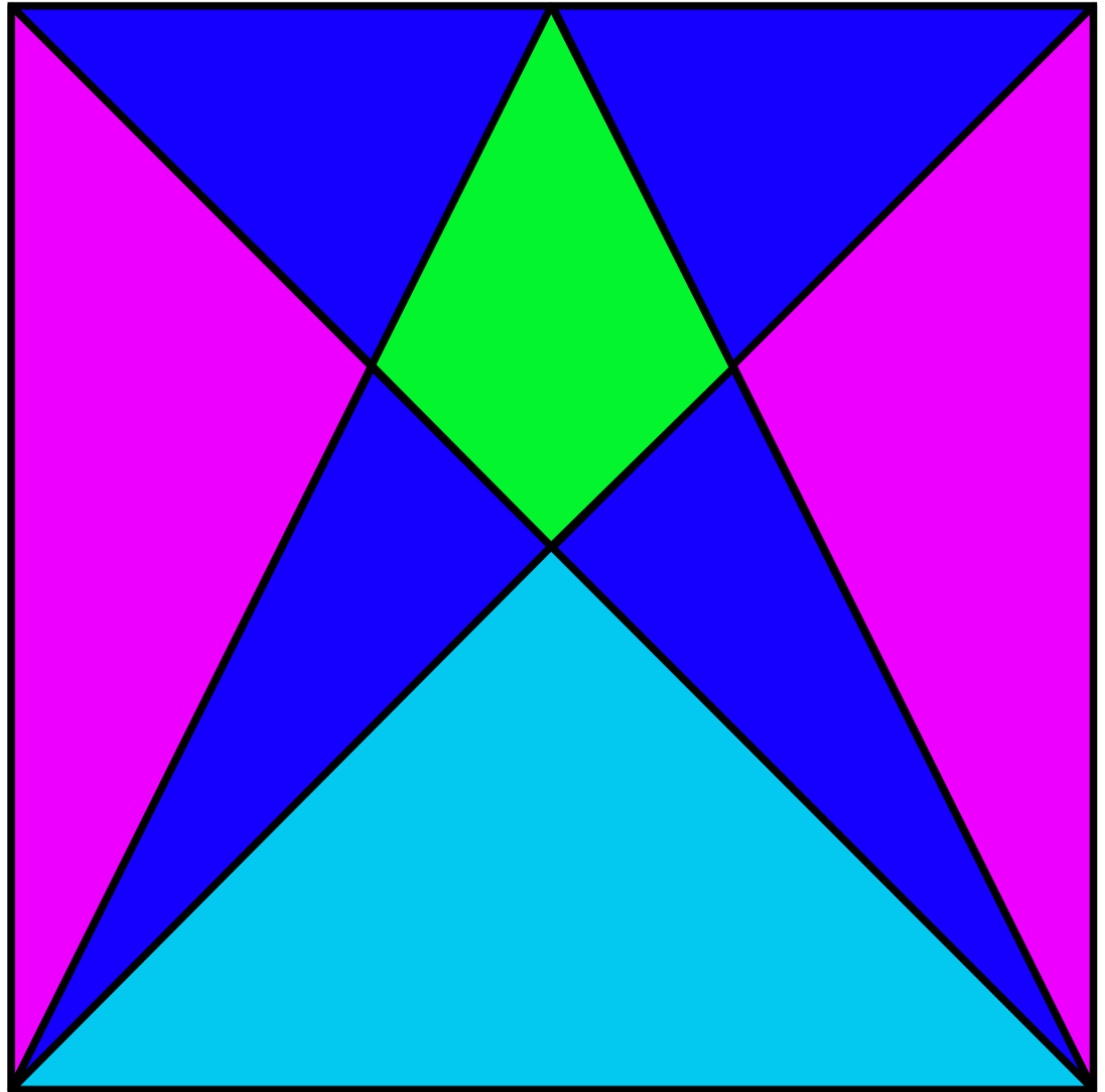




A

M

B



D

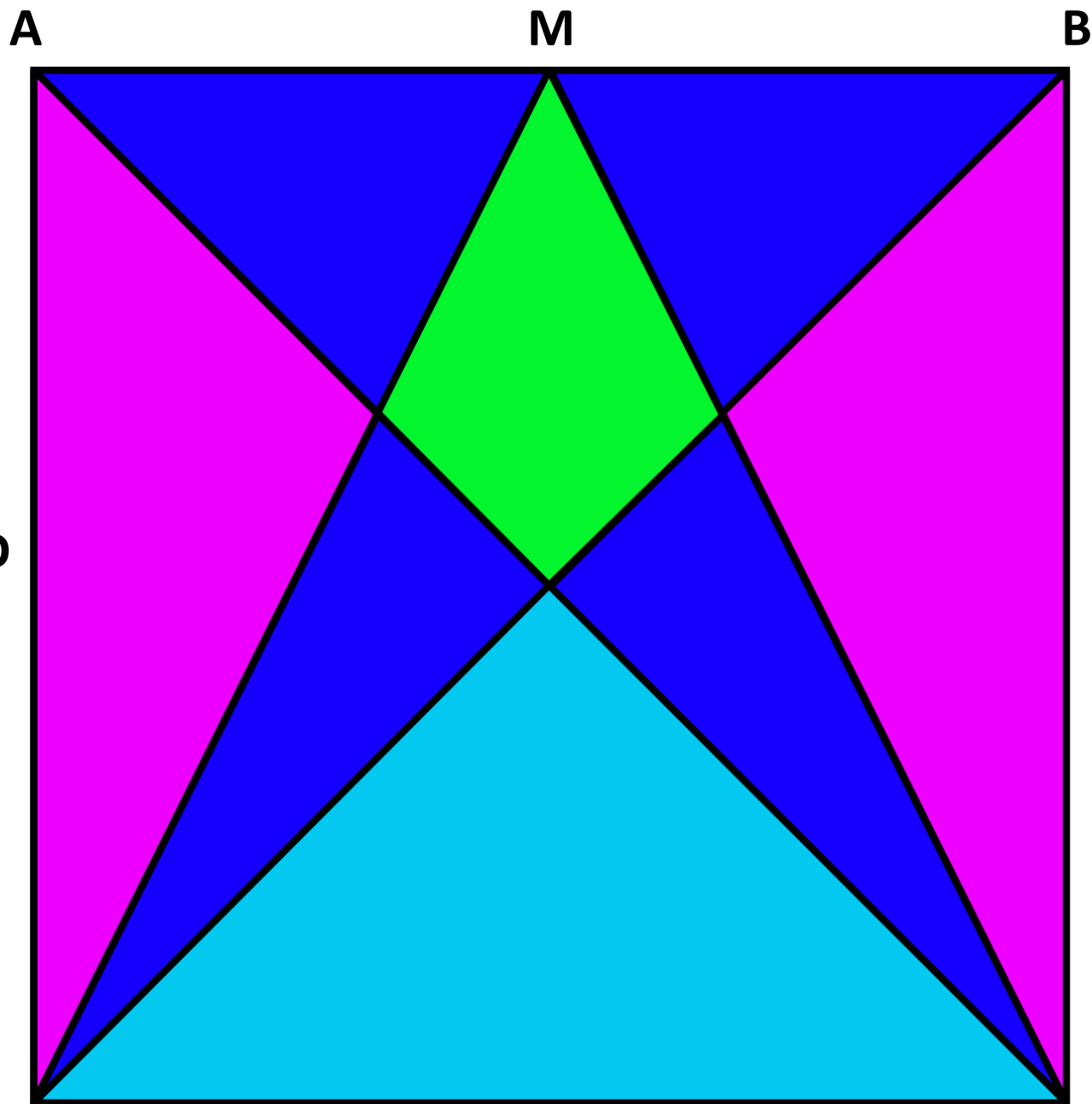
<https://www.youcubed.org/tasks/kite-in-a-square/>

C

Adapted from [nrich.maths.org](https://nrich.maths.org/) <https://nrich.maths.org/>

- ABCD is a square
- M is the midpoint of AB
- What fraction or percent of the area of ABCD is green?
- What color is the greatest area?  
Create a convincing argument





D

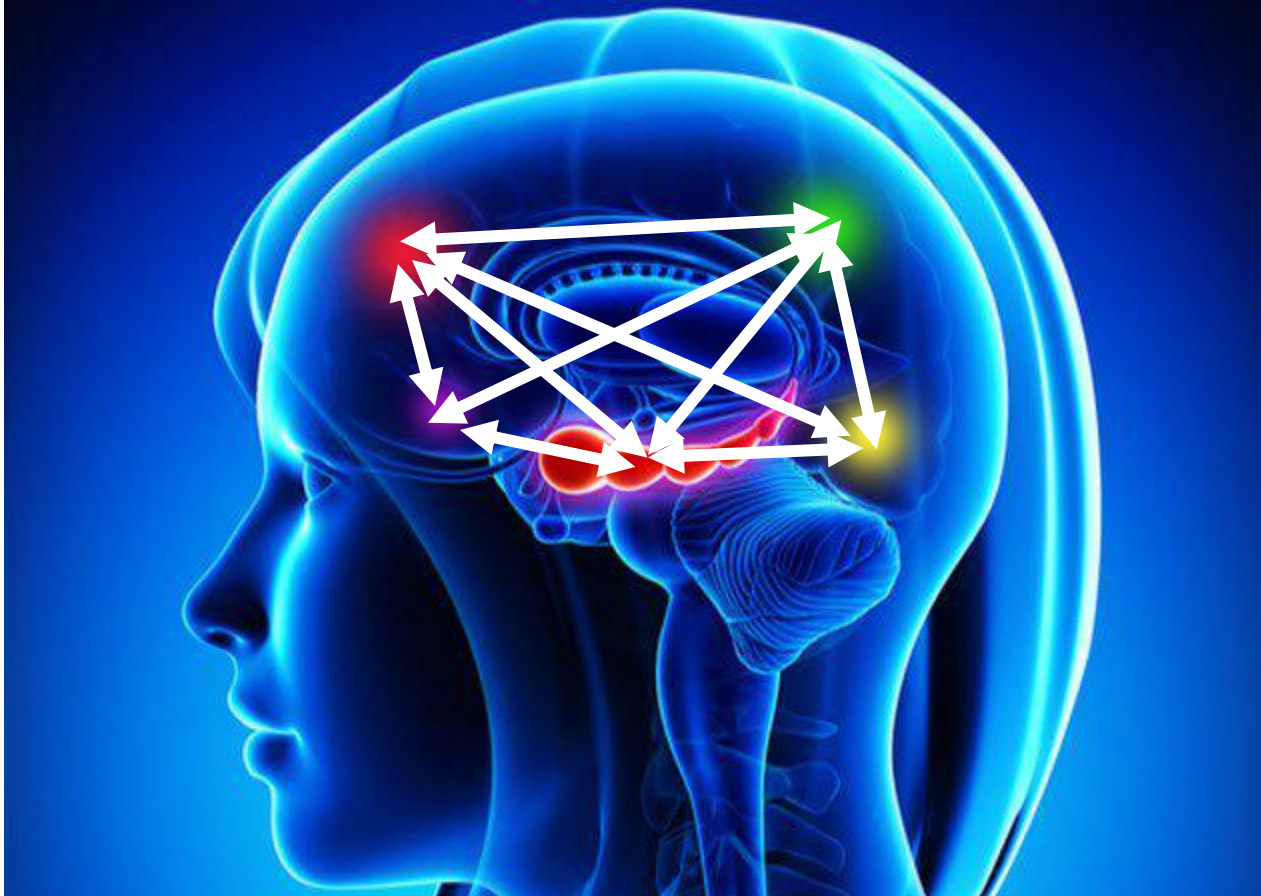
<https://www.youcubed.org/tasks/kite-in-a-square/>

C

Adapted from [nrich.maths.org](https://nrich.maths.org/) <https://nrich.maths.org/>

- ABCD is a square
- M is the midpoint of AB
- If  $AM = x$ , what fraction or percent of the area of ABCD is green?
- What color is the greatest area?
- Write a function that quantifies the area of the square as a function of  $x$ .

# Brain Connections



<https://www.youcubed.org/resource/visual-mathematics/>





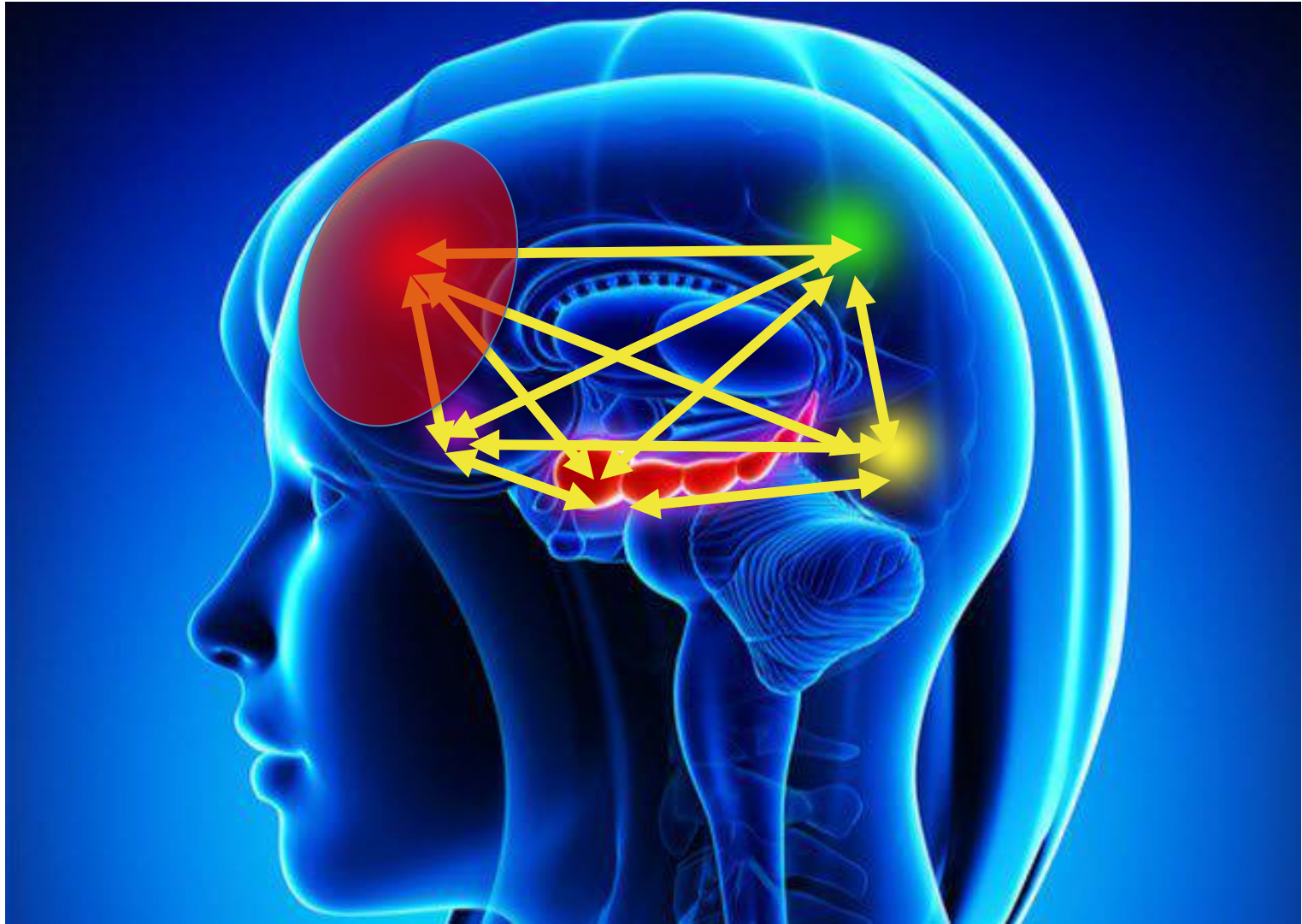
# Dividing Polynomial Expressions

$$\begin{array}{r} 2x^4 + 7x^3 - 14x^2 - 3x + 15 \\ \underline{-2x^4 - 10x^3} \phantom{- 14x^2 - 3x + 15} \\ 0 - 3x^3 - 14x^2 \phantom{- 3x + 15} \\ \phantom{0 - } \underline{3x^3 + 15x^2} \phantom{- 3x + 15} \\ \phantom{0 - } 0 + x^2 - 3x \phantom{+ 15} \\ \phantom{0 - } \phantom{0 + } \underline{-x^2 - 5x} \phantom{+ 15} \\ \phantom{0 - } \phantom{0 + } 0 - 8x + 15 \\ \phantom{0 - } \phantom{0 + } \phantom{0 - } \underline{8x + 40} \\ \phantom{0 - } \phantom{0 + } \phantom{0 - } 0 + 55 \end{array}$$

$$\begin{array}{r} x + 5 \\ \hline 2x^3 - 3x^2 + x - 8 \end{array}$$



# The Importance of Brain Connections



Numbers, words, pictures, graphs, algorithms, tables, models, movement

**ME DURING**



**MATH CLASS**

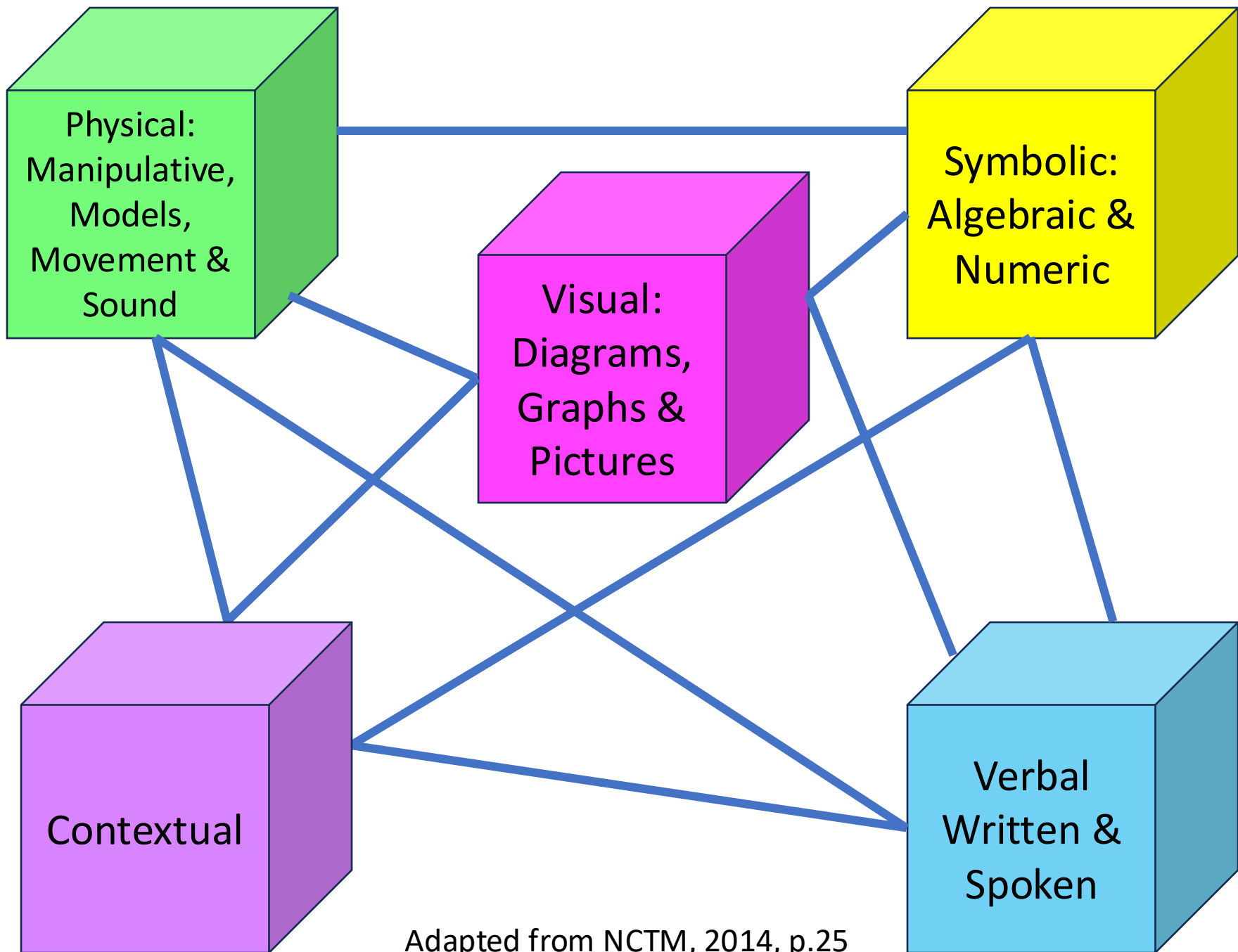


PLAYFUL

MATHS

The image features a glowing blue fingerprint being scanned on a circuit board. Above the fingerprint, vertical lines of light connect to floating binary digits (0s and 1s). The entire scene is set against a dark blue background with glowing circuit patterns.

Maths identity





# CODAP

<https://codap.concord.org/>

The screenshot displays the CODAP (Concord Observing Data Analysis Platform) interface. At the top, a toolbar includes icons for Tables, Graph, Map, Slider, Calc, Text, and Plugins. On the right, there are icons for Undo, Redo, Tiles, Options, Help, and Guide.

The main workspace is divided into several panes:

- Tracks/Measurements**: A central pane containing two tables. The left table, titled "Tracks (4 cases)", lists four elephant seals (546, 541, 536, 528) with their species and a small map icon. The right table, titled "Measurements (858 cases)", lists detailed tracking data including index, day, date, month, latitude, longitude, distance, speed, depth, and temperature.
- Map**: A map view showing the movement tracks of the elephant seals in the ocean.
- Graph**: A graph view showing the temperature of the seals over time, with a vertical line indicating a specific date.
- Getting Started**: A sidebar panel with instructions for using the platform.

The "Getting Started" panel contains the following text:

Tracking data from elephant seals 546, 541, 536, and 528 are displayed in the Table, Map, and Graph. Use these tools to start exploring how these seals are behaving in different parts of the ocean.

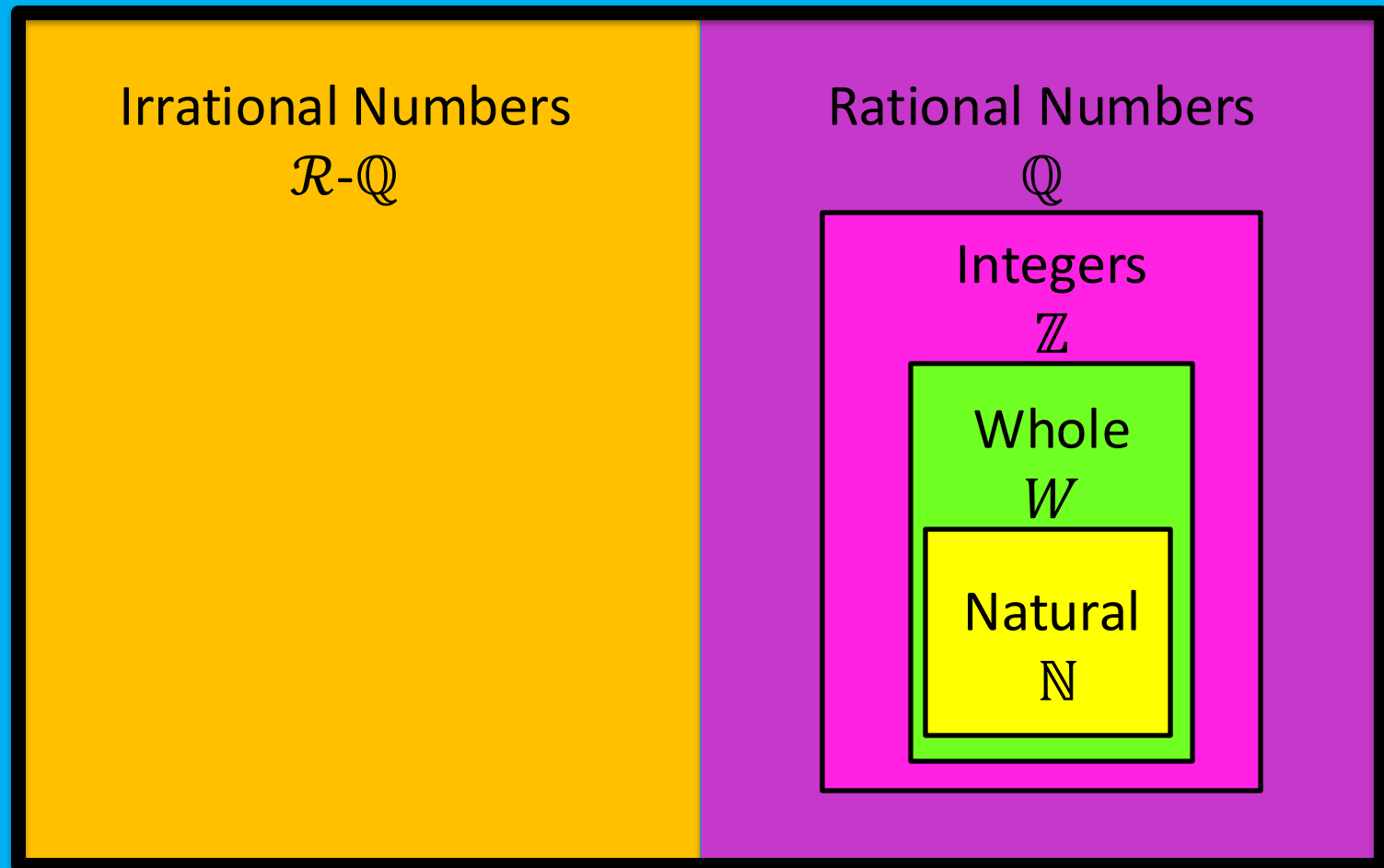
The Table

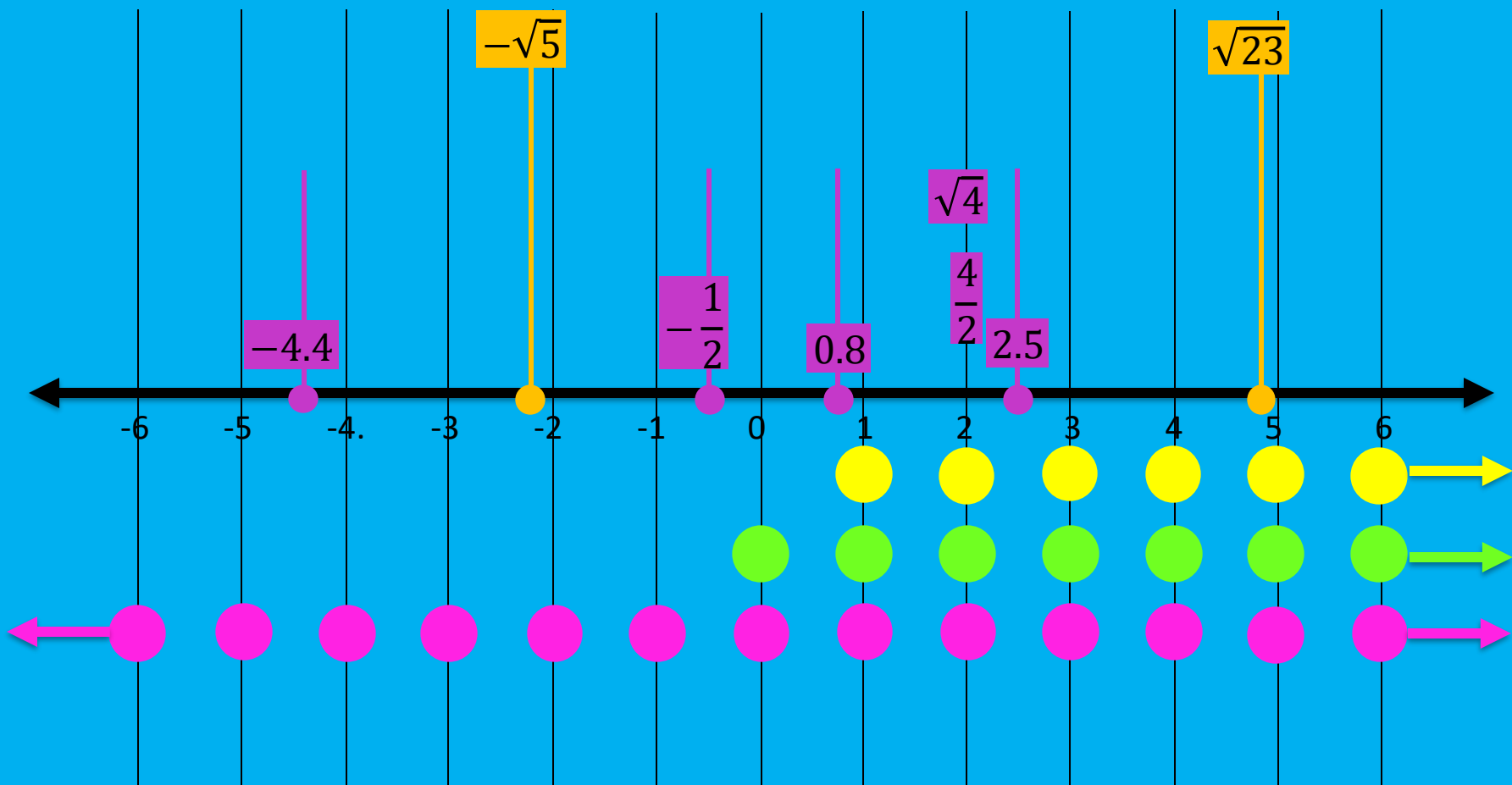
1. Take a look at how the table is organized, including the column headings on the left and right sides of the table. What happens when you click on the "+" or "-" symbols in the middle?
2. On the left side of the table, click on elephant seal #528. Notice that the points from this seal's track are now highlighted in the Map and Graph. What happens if you click on a row on the right side of the table?

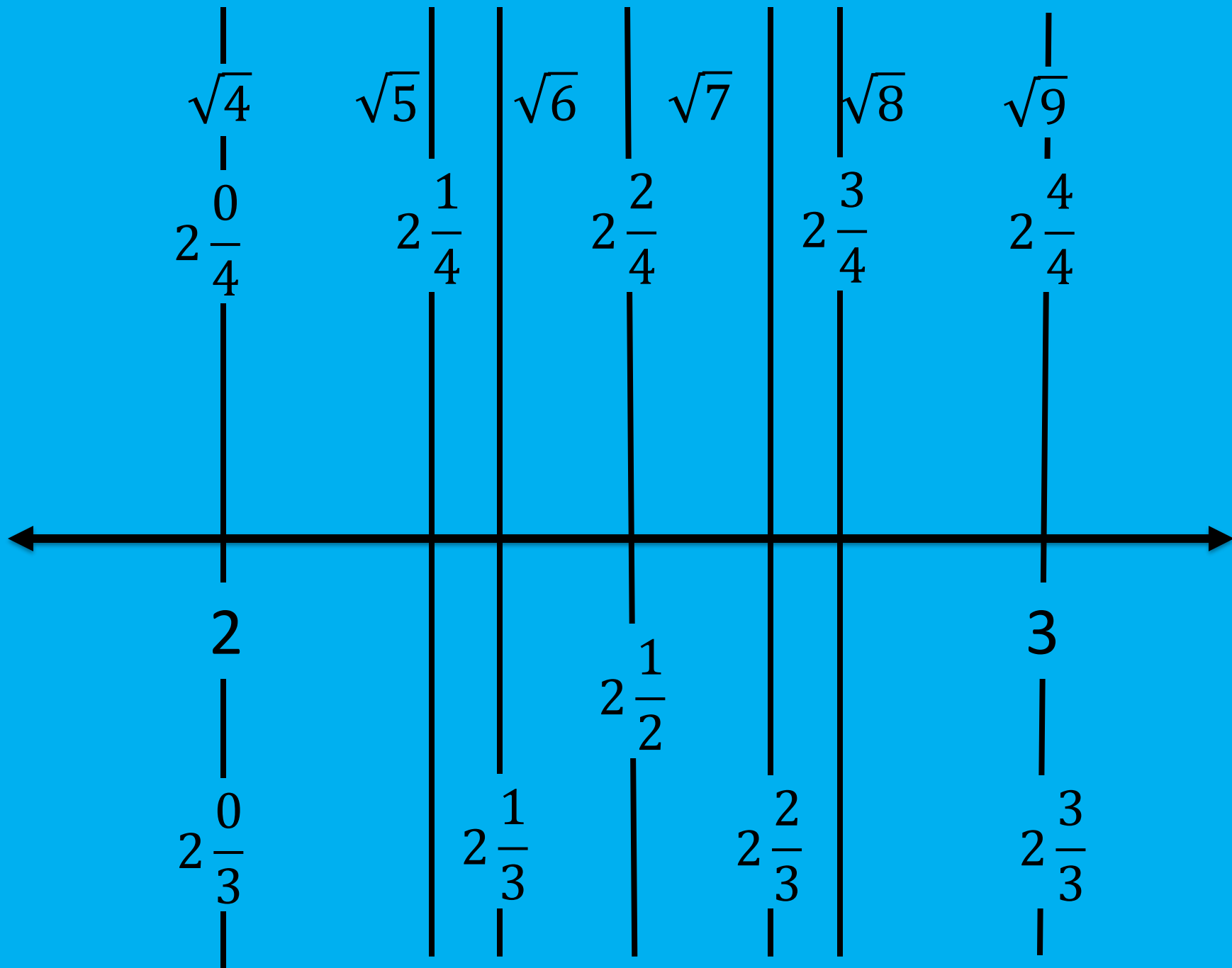
The "Sonify" panel is also visible, showing options for Play, Loop, Speed, and ConnectBy collection selected... It includes a dropdown for Dataset (Tracks/Measurements), Pitch (date), Time (temperature), and a Connect by dropdown. A "create graph" button is at the bottom.

# $\mathcal{R}$

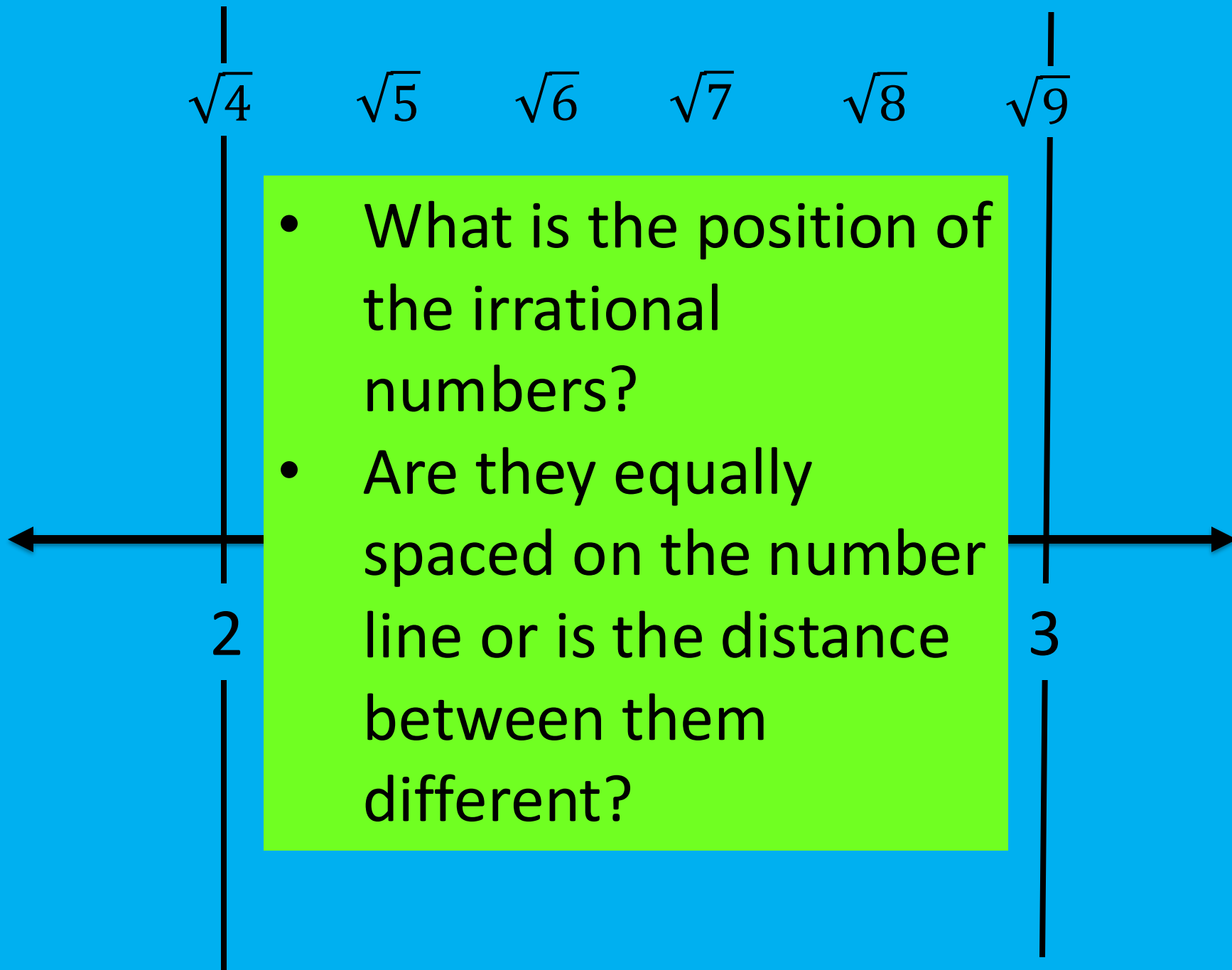
## Real numbers





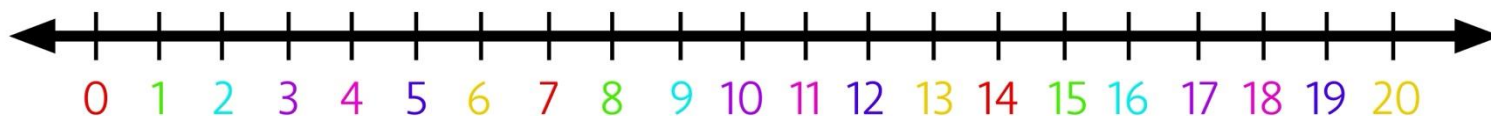
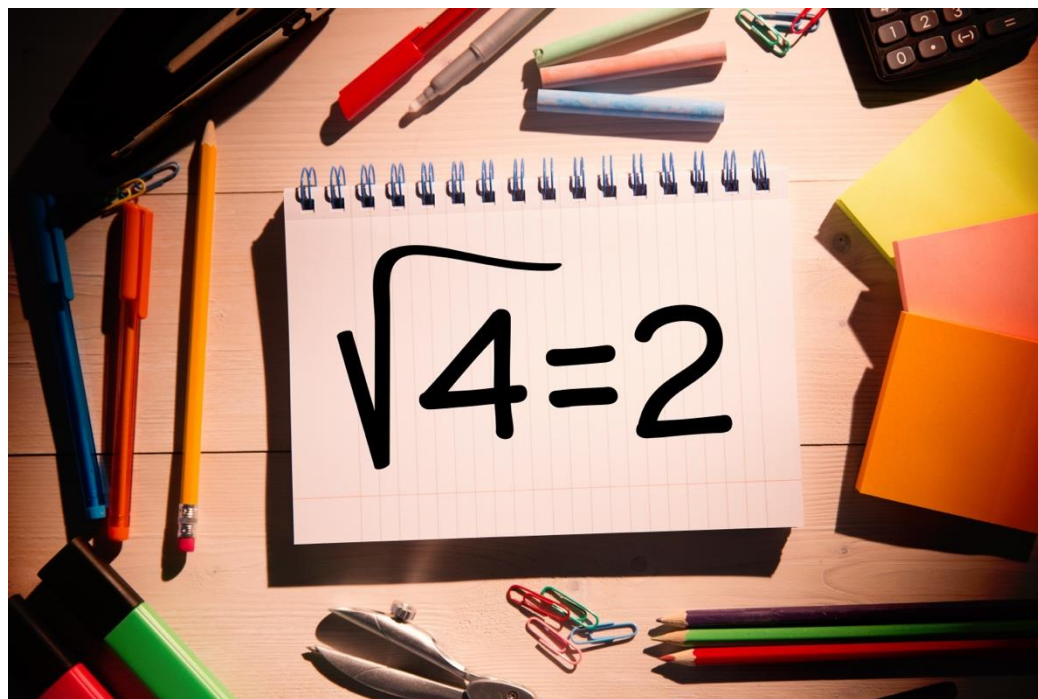
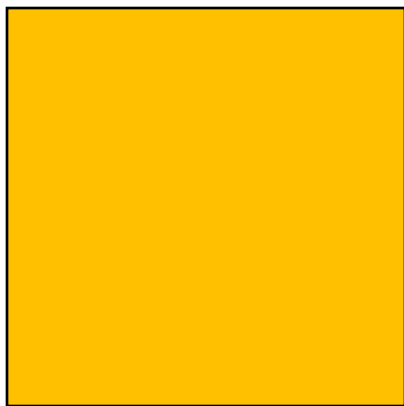




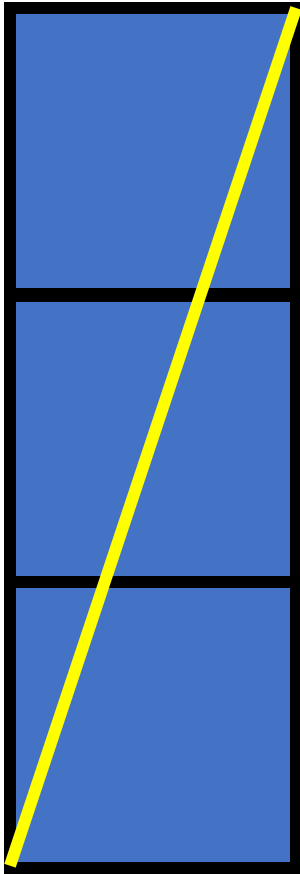


# A visual proof, numbers on a line

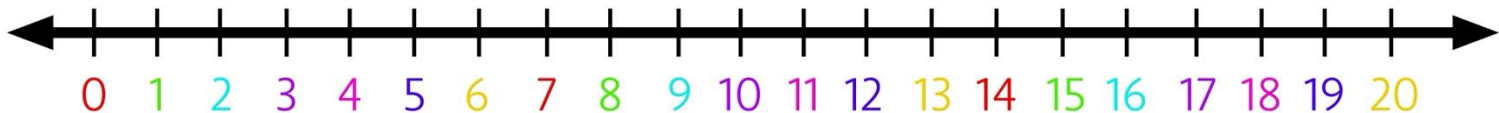
Using a square piece of paper, make a visual proof through folding to show the location of  $\sqrt{1}$  through the  $\sqrt{10}$  on a number line.

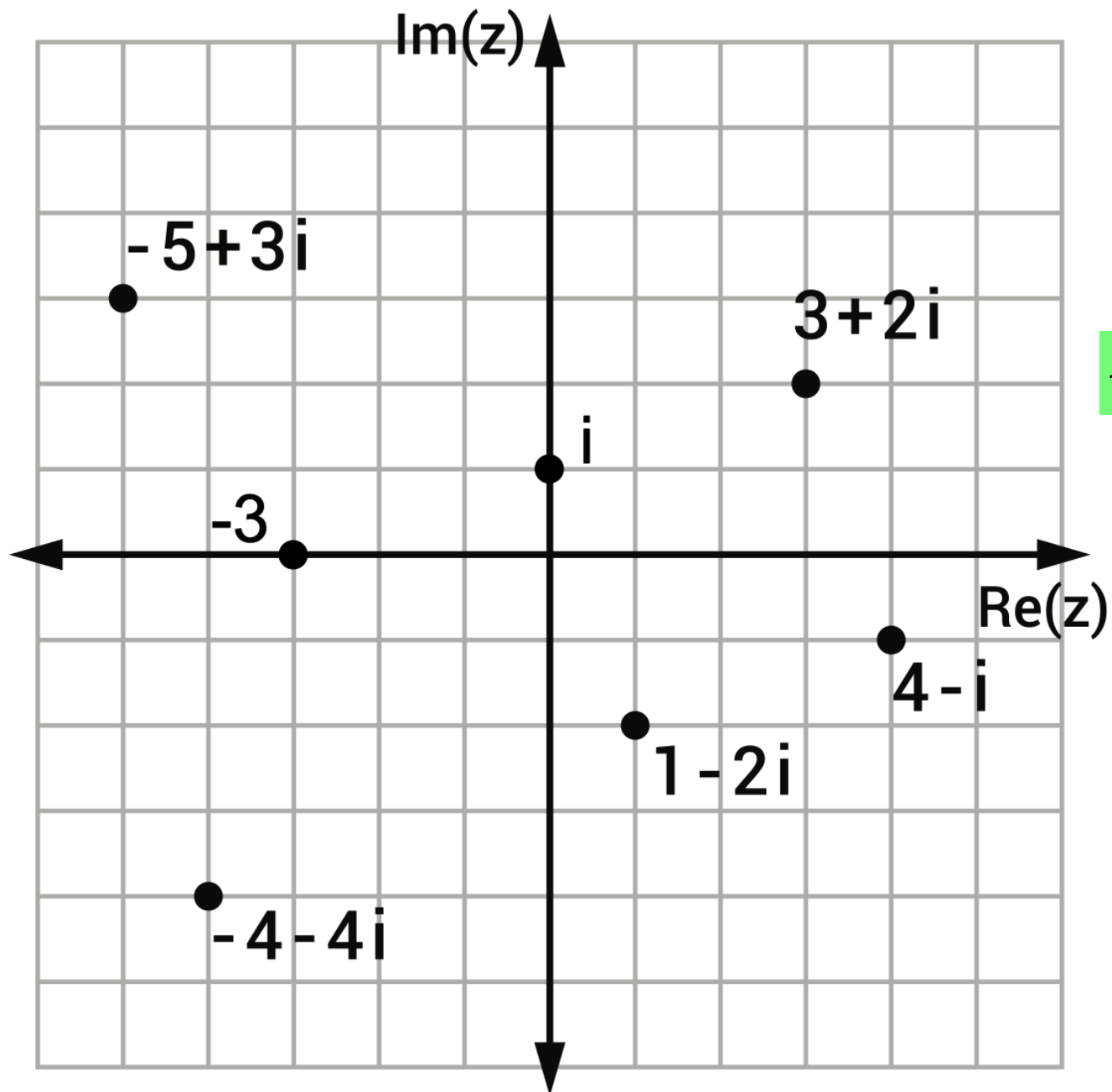


# Rectangles



- Draw rectangles where their diagonals represent the lengths of  $\sqrt{1}$  through  $\sqrt{10}$ .
- Using a square piece of paper, fold it to make a visual proof showing the location of  $\sqrt{1}$  through the  $\sqrt{10}$  on a number line.





$$\sqrt{-1} = i$$

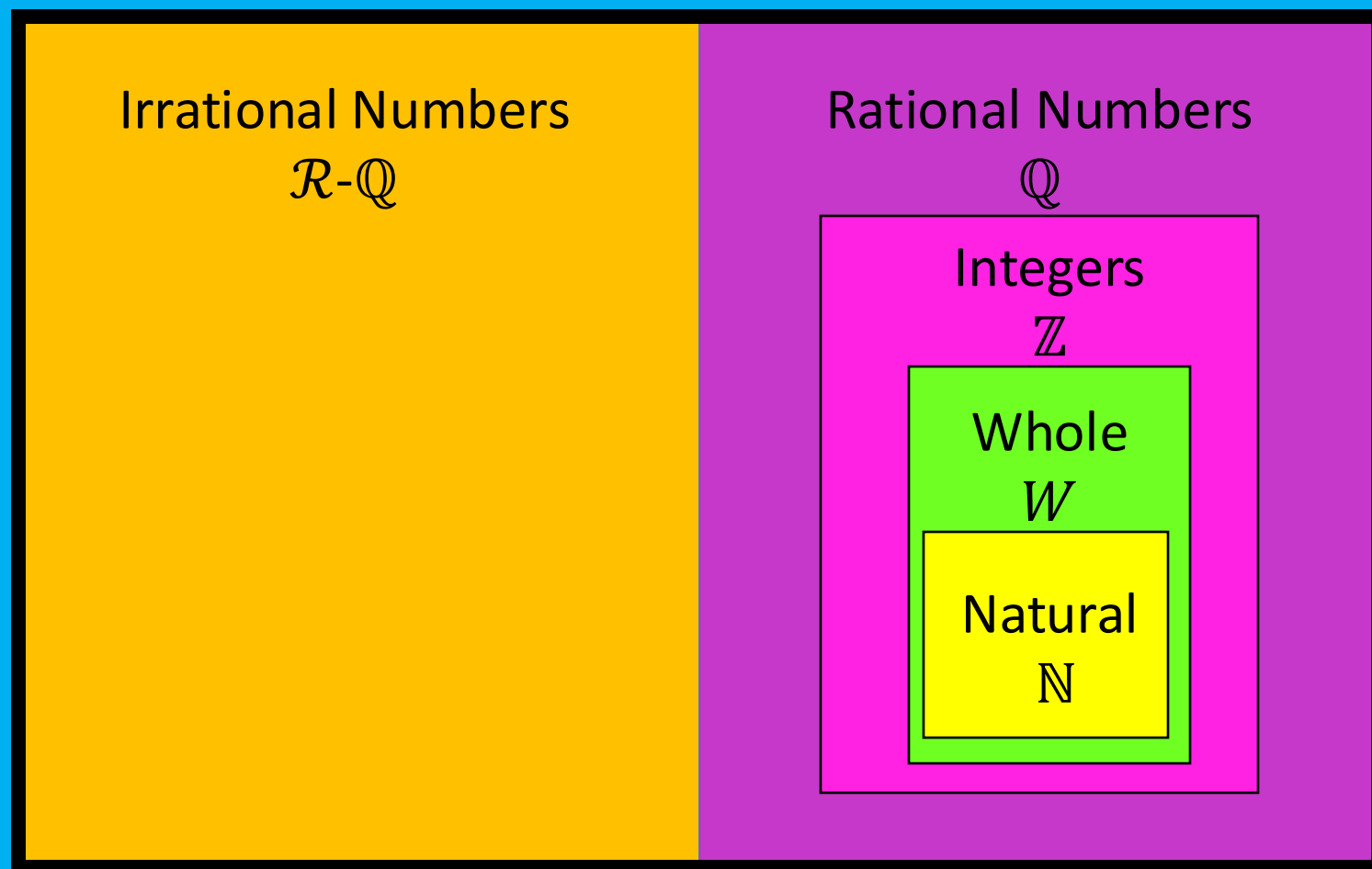


$$\sqrt{-1} = i$$

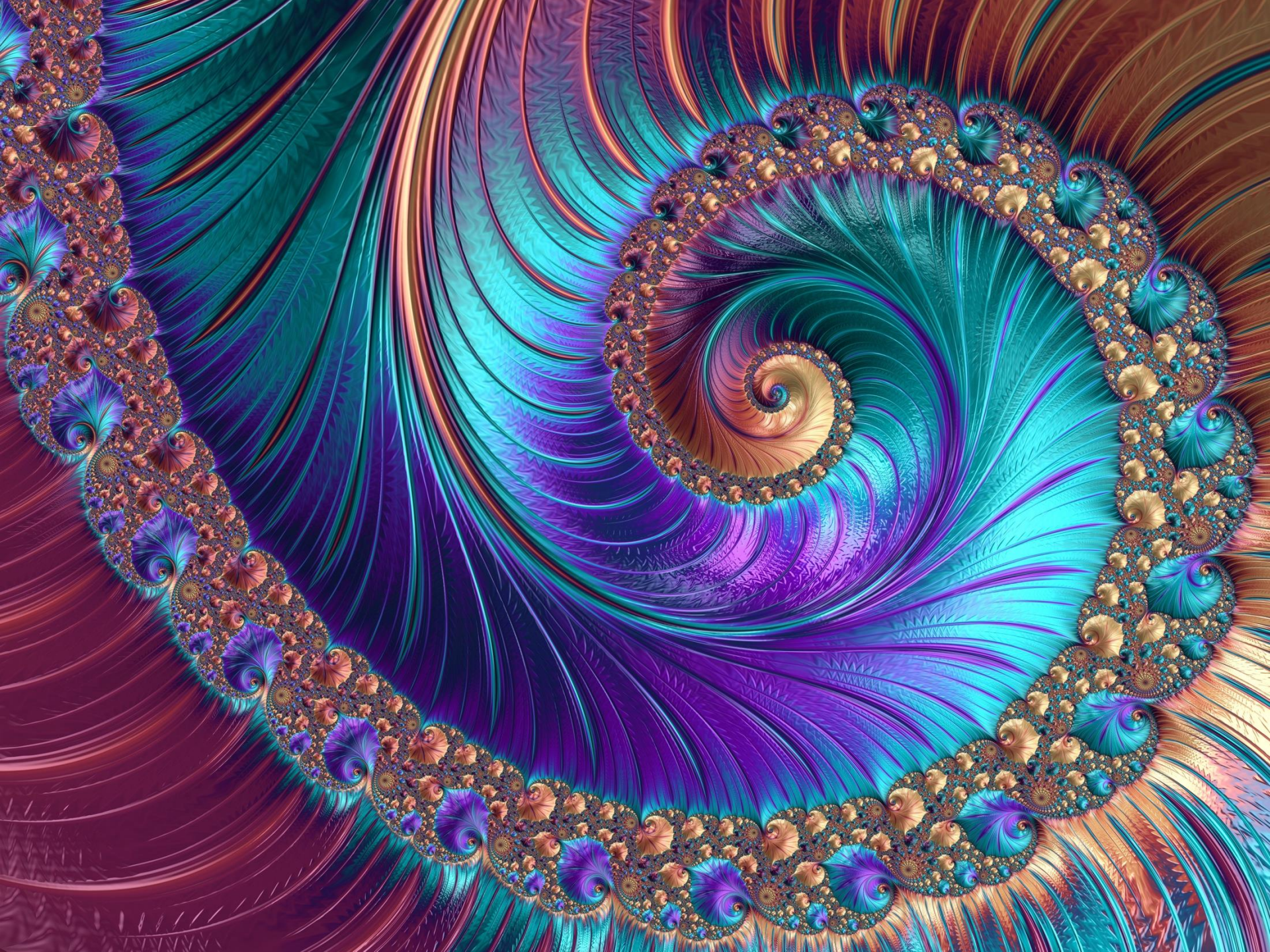
 $\mathcal{R}$ 

Complex numbers

Real numbers

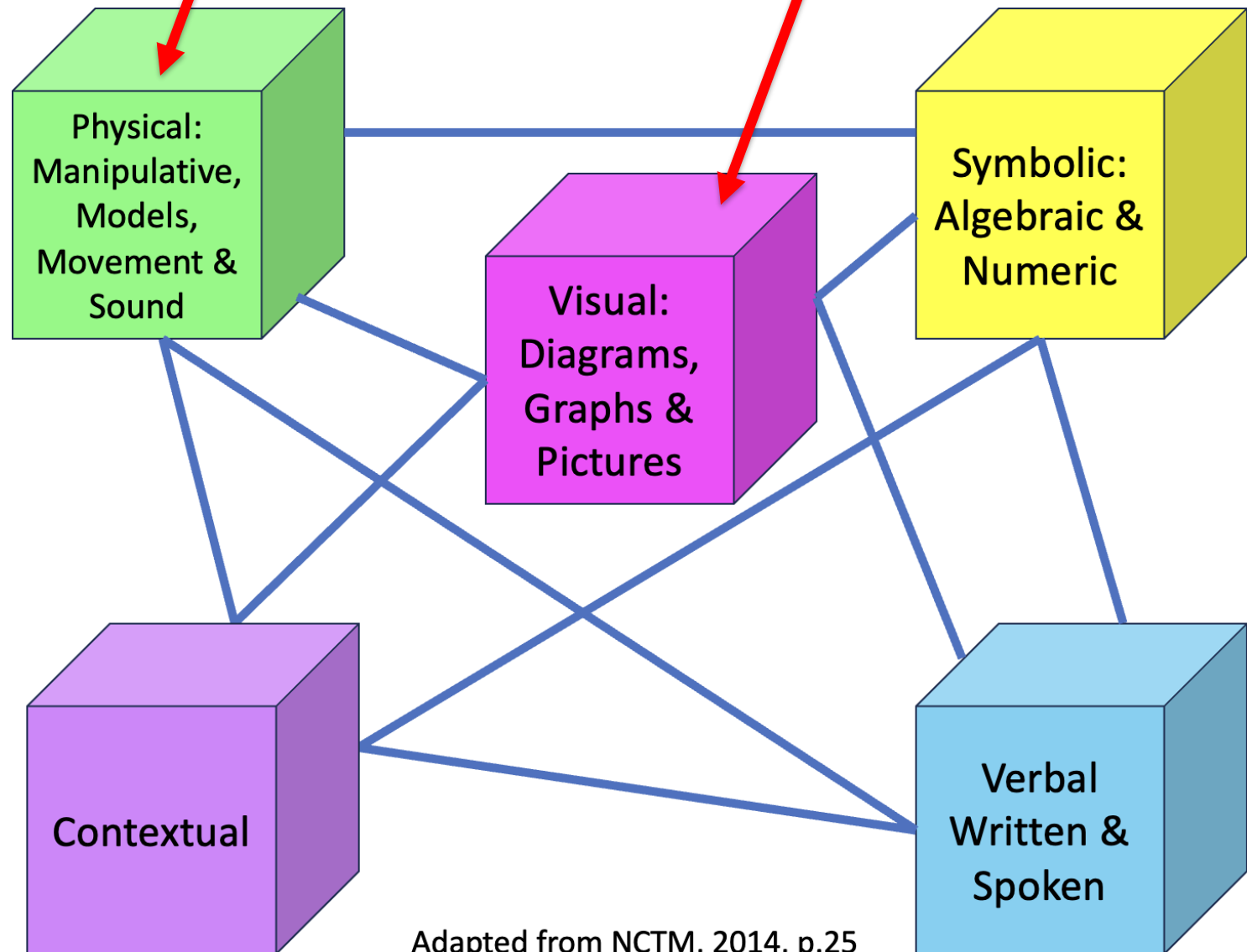








# The Real Number System, $\mathcal{R}$



Adapted from NCTM, 2014, p.25

**Give a visual  
solution**

**Give a  
different  
visual  
solution**

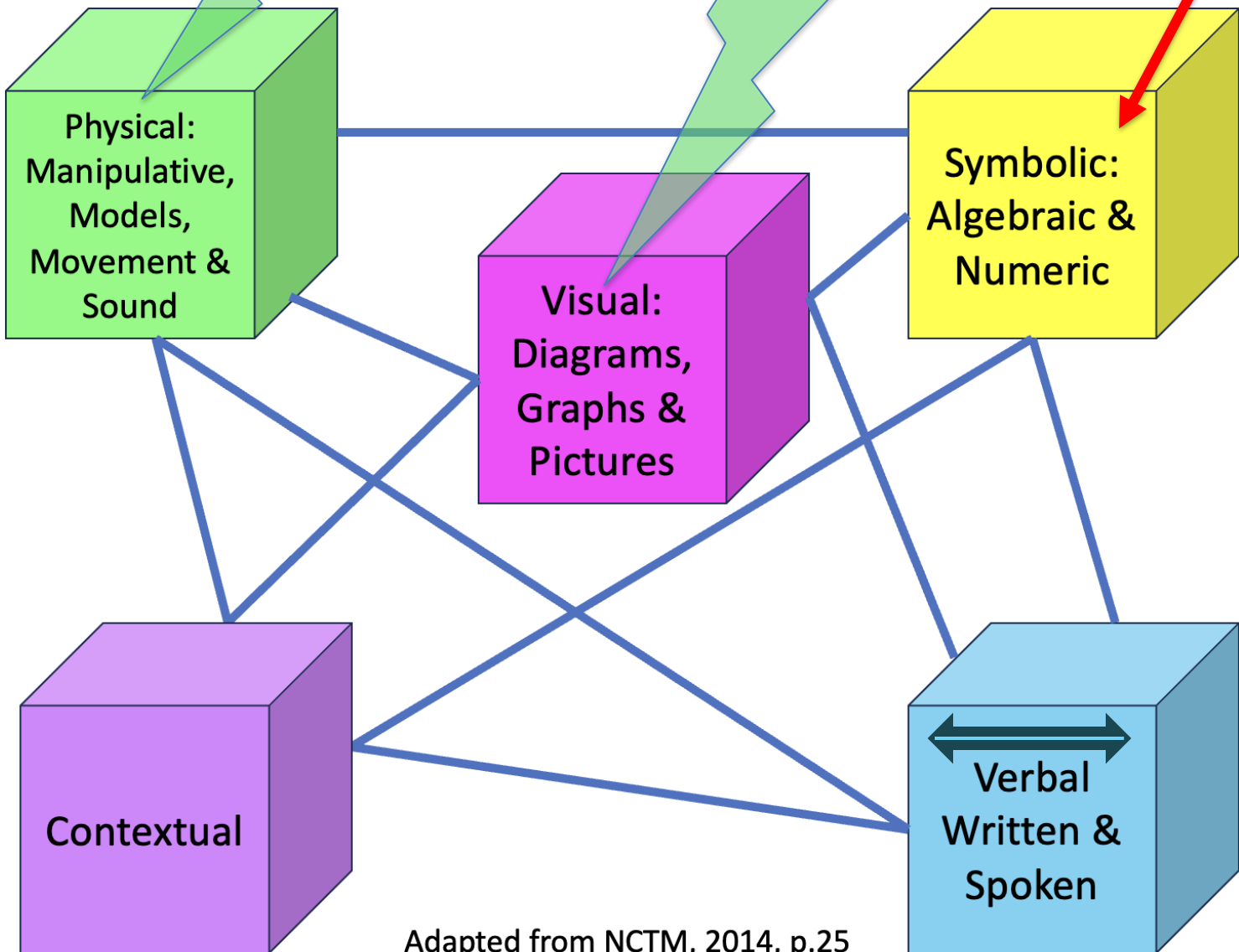
$$\sqrt{x} + \sqrt{x + 15} = 15$$

**Solve it  
numerically**

**Solve it another  
way**

What numbers that add to 15 are possible?

# Linear Functions



Adapted from NCTM, 2014, p.25

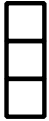
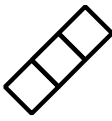
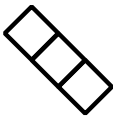
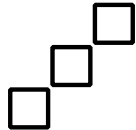
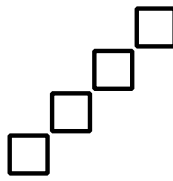
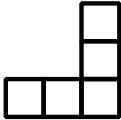
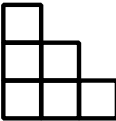
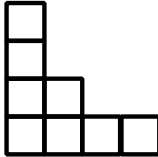
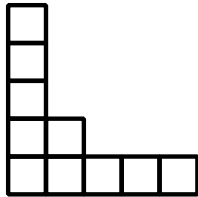


# Mathematical Mindset Algebra



## Task Cards

How do you see the shapes change as the case number increases? Where do you see the new squares? How do you see the shapes change as the case number decreases? What would the 15th case look like? What would the -3 case look like?

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>A</b></p>  <p>Case 1</p>  <p>Case 2</p>  <p>Case 3</p>  <p>Case 4</p>  <p>Case 5</p> | <p><b>B</b></p>  <p>Case 1</p>  <p>Case 2</p>  <p>Case 3</p>  <p>Case 4</p> |
| <p><b>C</b></p>  <p>Case 1</p>  <p>Case 2</p>  <p>Case 3</p>                                                                                                                                                                                                 | <p><b>D</b></p>  <p>Case 1</p>  <p>Case 2</p>  <p>Case 3</p>                                                                                                |

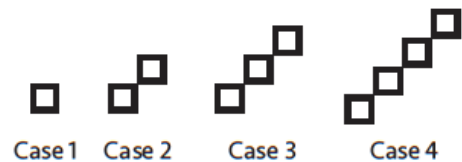
<https://www.youcubed.org/algebra/>





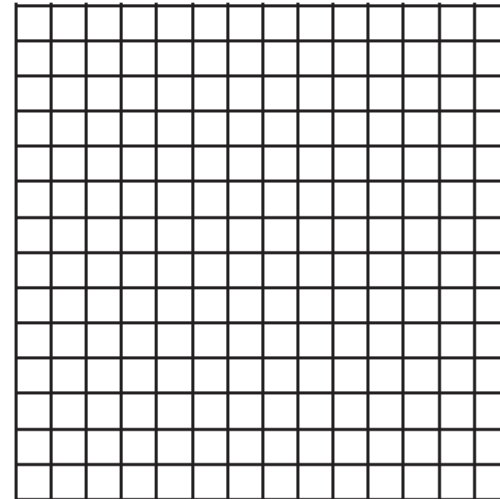
Wait  
there's  
more....

- What would case  $2\frac{1}{2}$  look like?
  - What would case 3.7 look like?
  - What would case  $\sqrt{5}$  look like?
- 



Make a table using numbers.

Make a coordinate graph to illustrate the pattern.



Describe the way the pattern is increasing or decreasing.

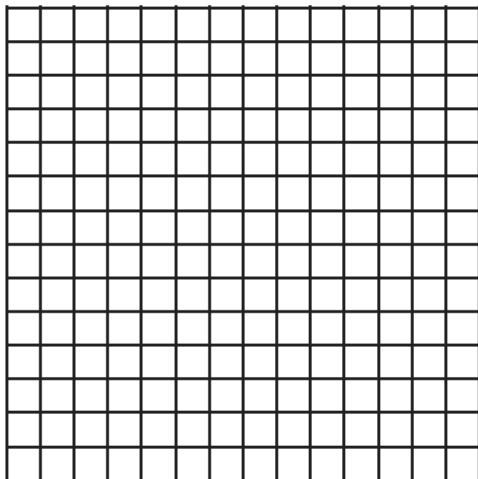
Describe your function using an algebraic expression that shows the number of blocks in any case number.



Draw your pattern. Include at least 3 representations and label them by case number.

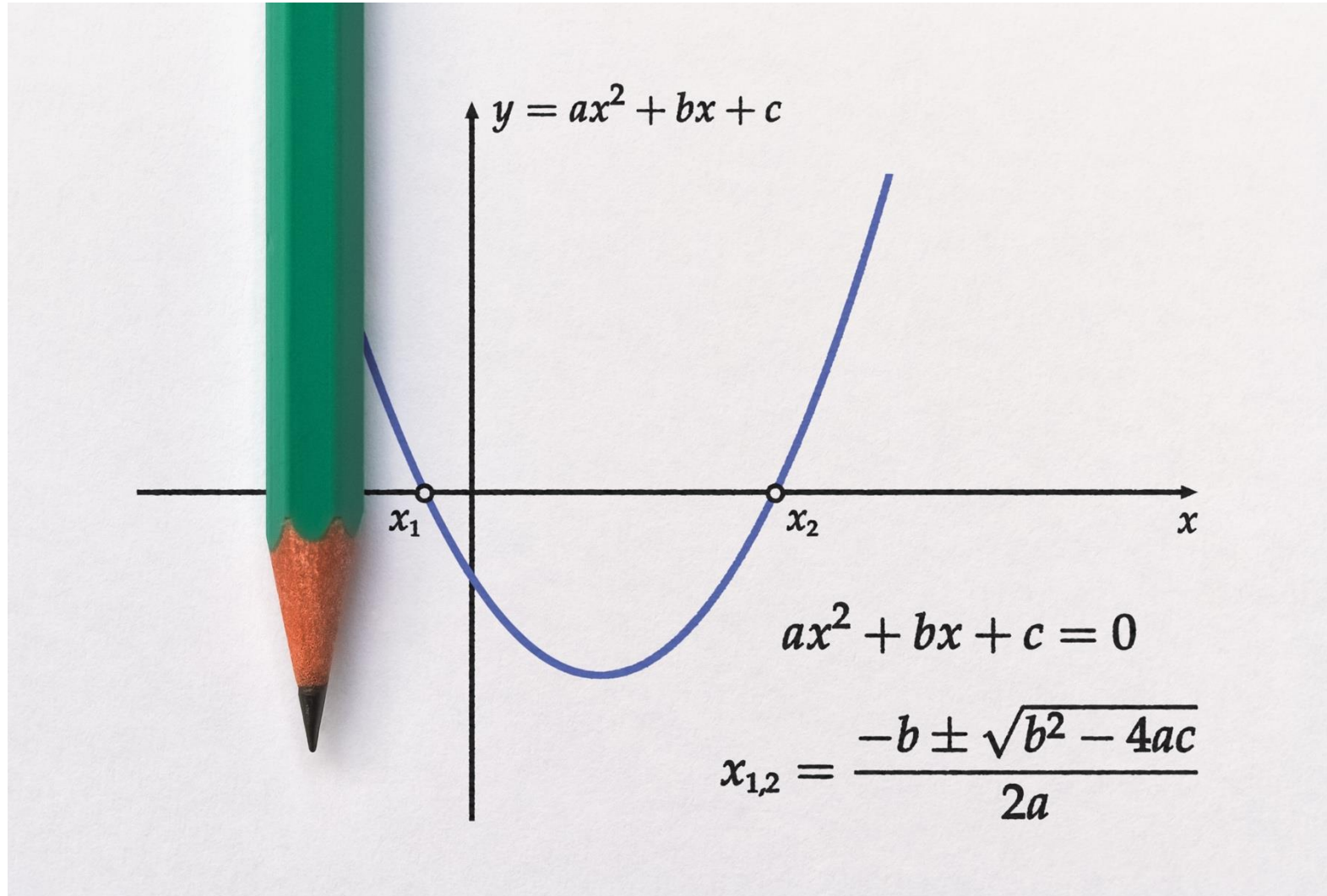
Make a table using numbers.

Make a coordinate graph to illustrate the pattern.

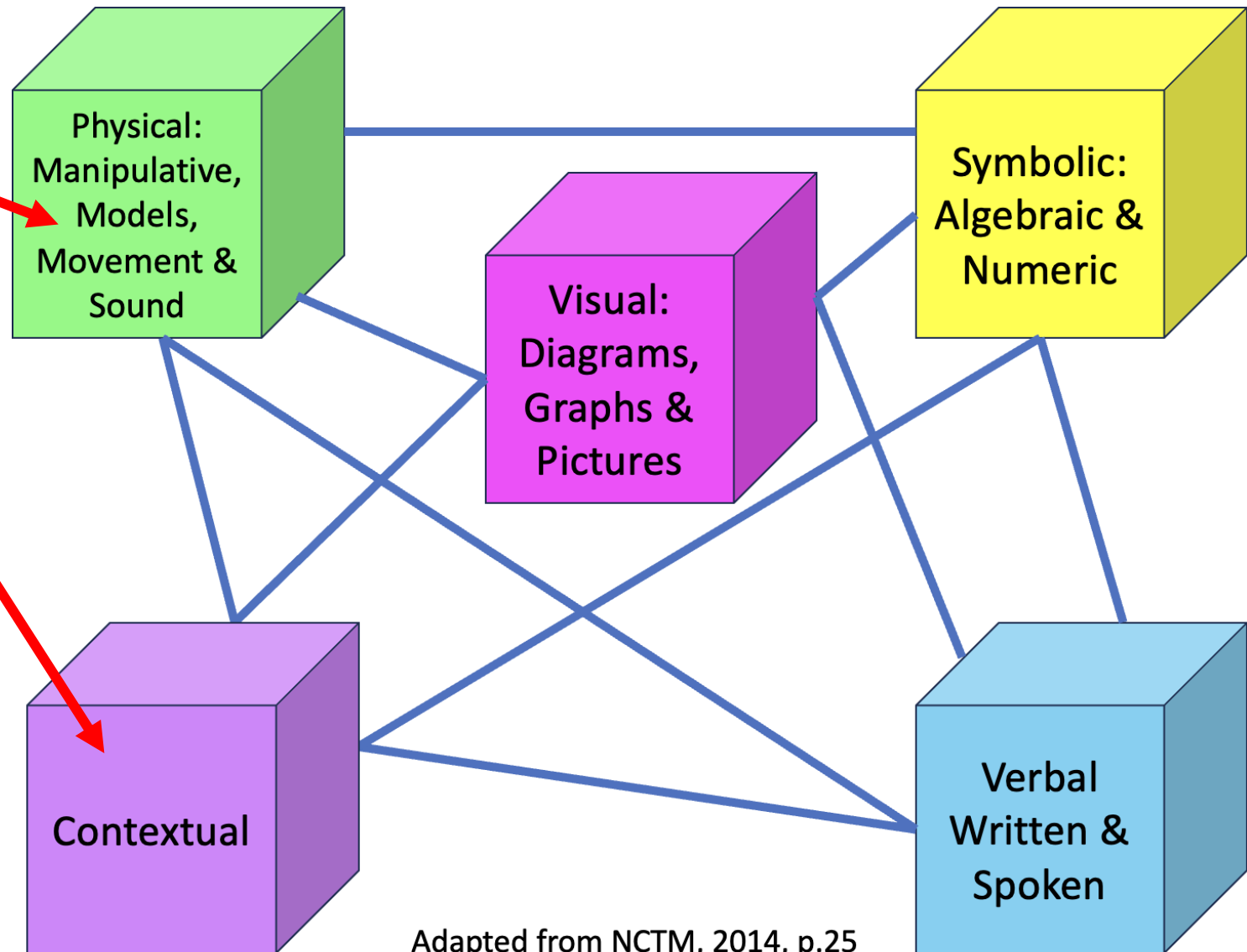


Describe your function using an algebraic expression that shows the number of blocks in any case number.

# Let's investigate quadratic functions



# Quadratic Functions



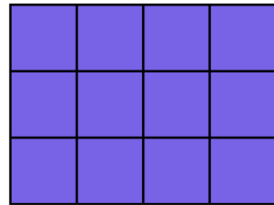
Adapted from NCTM, 2014, p.25

What do you notice?

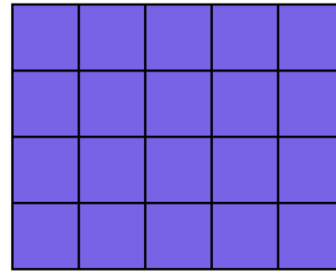
Where do you see the extra squares?

What would Case 7 look like?

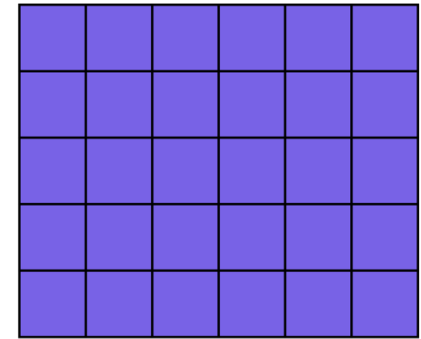
What would Case 0 look like?



Case 1



Case 2

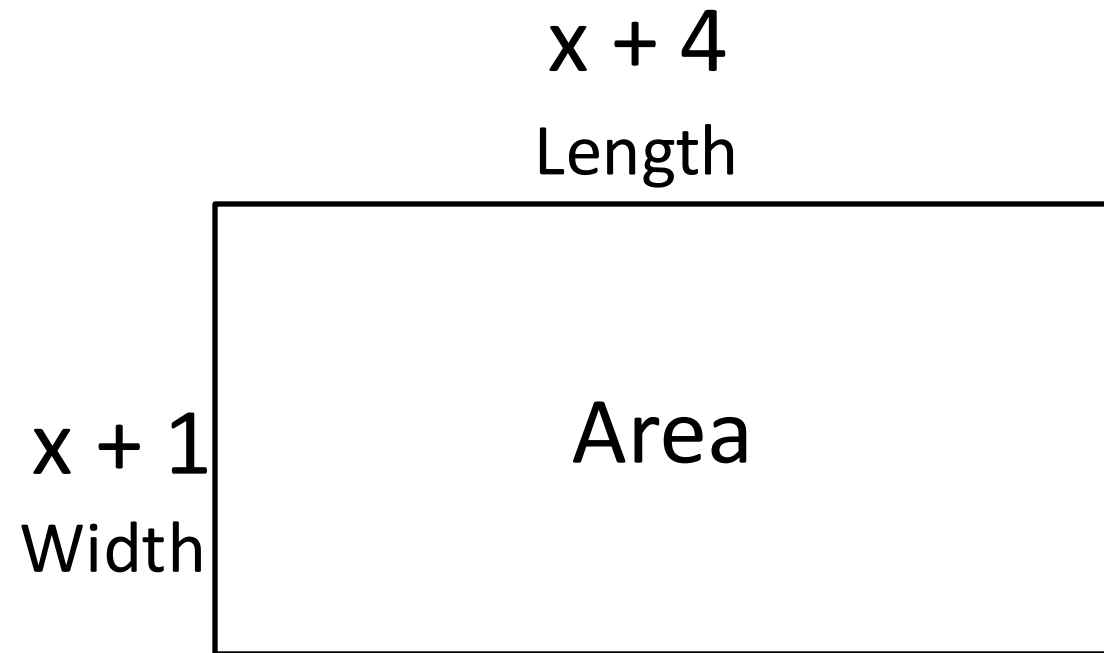


Case 3

Case 0



What is the area of the rectangle when....



| x | WxL | LxW | A |
|---|-----|-----|---|
| 1 | 2x5 |     |   |
|   |     |     |   |
|   |     |     |   |
|   |     |     |   |
|   |     |     |   |

What do these rectangles look like?

What function represents the area?

# Your linear functions for the width and length

Width

Length

$x$

$x+1$

$x+1$

$x+2$

$x+2$

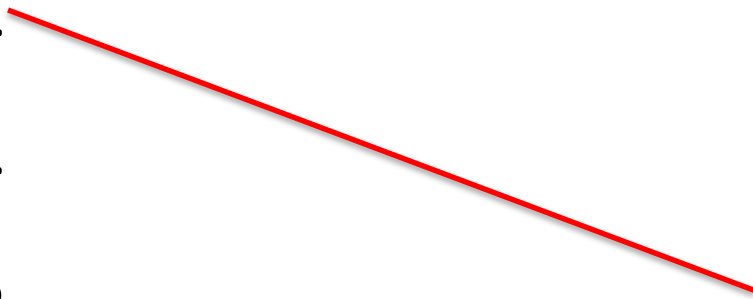
$x+3$

$x+3$

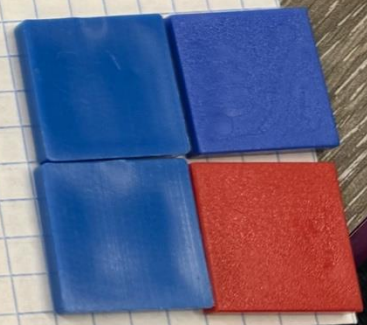
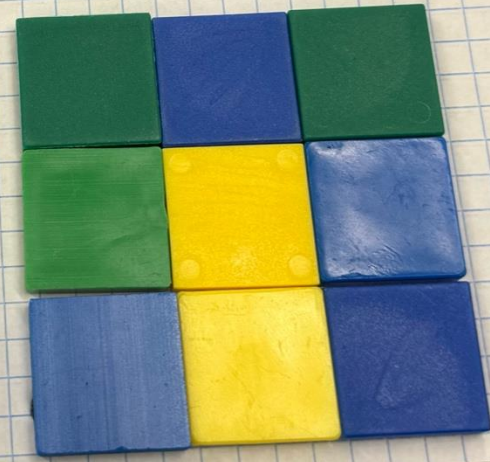
$x+4$

$x+4$

$x+5$



Generate a table and draw the rectangles for a domain of 1,2,3,4,5...



Let's add an old (x) x = friend

$x + 4$

$x + 1$

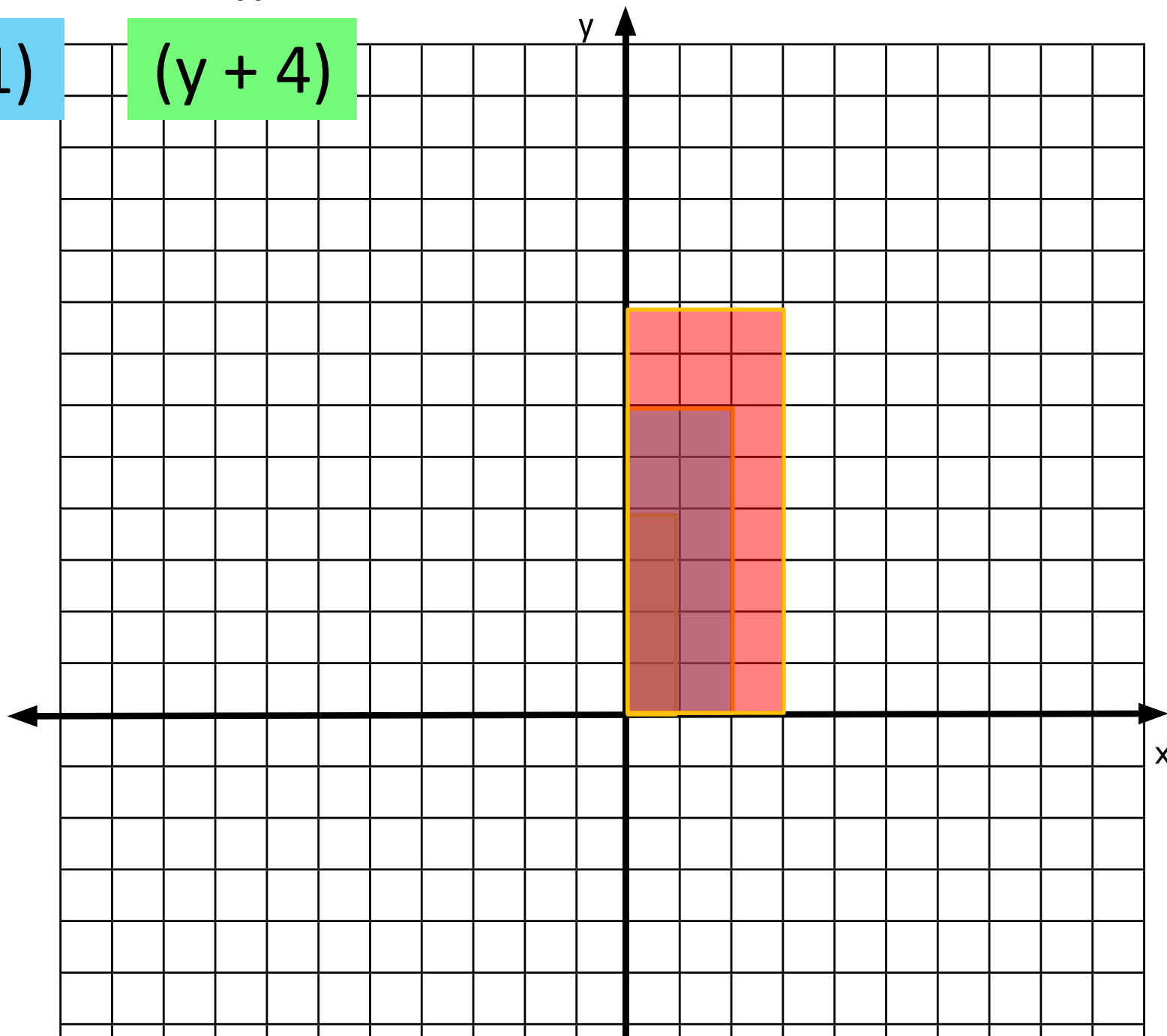
| x  | 1  | 2  | 3  | 4  | 5  | 6  | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  |
|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1  | 1  | 2  | 3  | 4  | 5  | 6  | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  |
| 2  | 2  | 4  | 6  | 8  | 10 | 12 | 14  | 16  | 18  | 20  | 22  | 24  | 26  | 28  | 30  | 32  |
| 3  | 3  | 6  | 9  | 12 | 15 | 18 | 21  | 24  | 27  | 30  | 33  | 36  | 39  | 42  | 45  | 48  |
| 4  | 4  | 8  | 12 | 16 | 20 | 24 | 28  | 32  | 36  | 40  | 44  | 48  | 52  | 56  | 60  | 64  |
| 5  | 5  | 10 | 15 | 20 | 25 | 30 | 35  | 40  | 45  | 50  | 55  | 60  | 65  | 70  | 75  | 80  |
| 6  | 6  | 12 | 18 | 24 | 30 | 36 | 42  | 48  | 54  | 60  | 66  | 72  | 78  | 84  | 90  | 96  |
| 7  | 7  | 14 | 21 | 28 | 35 | 42 | 49  | 56  | 63  | 70  | 77  | 84  | 91  | 98  | 105 | 112 |
| 8  | 8  | 16 | 24 | 32 | 40 | 48 | 56  | 64  | 72  | 80  | 88  | 96  | 104 | 112 | 120 | 128 |
| 9  | 9  | 18 | 27 | 36 | 45 | 54 | 63  | 72  | 81  | 90  | 99  | 108 | 117 | 126 | 135 | 144 |
| 10 | 10 | 20 | 30 | 40 | 50 | 60 | 70  | 80  | 90  | 100 | 110 | 120 | 130 | 140 | 150 | 160 |
| 11 | 11 | 22 | 33 | 44 | 55 | 66 | 77  | 88  | 99  | 110 | 121 | 132 | 143 | 154 | 165 | 176 |
| 12 | 12 | 24 | 36 | 48 | 60 | 72 | 84  | 96  | 108 | 120 | 132 | 144 | 156 | 168 | 180 | 192 |
| 13 | 13 | 26 | 39 | 52 | 65 | 78 | 91  | 104 | 117 | 130 | 143 | 156 | 169 | 182 | 195 | 208 |
| 14 | 14 | 28 | 42 | 56 | 70 | 84 | 98  | 112 | 126 | 140 | 154 | 168 | 182 | 196 | 210 | 224 |
| 15 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 | 240 |
| 16 | 16 | 32 | 48 | 64 | 80 | 96 | 112 | 128 | 144 | 160 | 176 | 192 | 208 | 224 | 240 | 256 |

Length

width

$$(x + 1)$$

$$(y + 4)$$







# Keep+Flip+Turn

On our tasks page there are links to google slide decks & handouts

<https://www.youcubed.org/tasks/keep-flip-turn-k-12/>



## WINTER/SPRING 2025 WORKSHOPS

Join us at Stanford or Online

### NEW! MATH-ISH WORKSHOP FOR K-16 TEACHERS

- In Person at Stanford: January 28 & 29

### TEACHING THE YOCUBED DATA SCIENCE COURSE

- 10 online sessions, 3:45-5:45 pm Pacific Time
- Select Wednesdays, March 19– June 4

### TEACHING THE SUMMER CAMP CURRICULUM

- In Person at Stanford: April 14 & 15
- Live Online: April 28 & 29



[youcubed.org/PD](https://youcubed.org/PD)