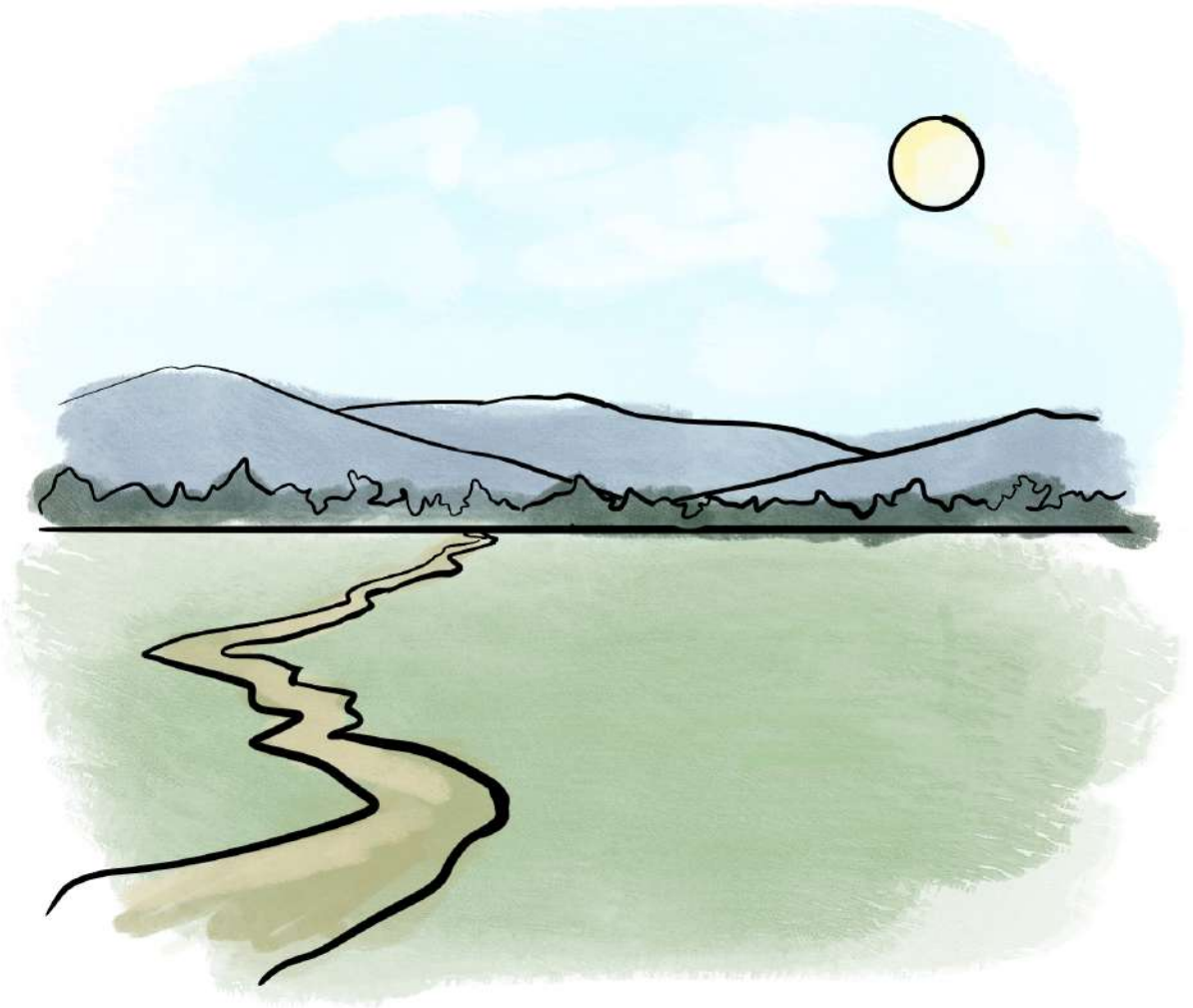


# Maps and Migration

Alice Yi - Leighton Park School - 13, Female

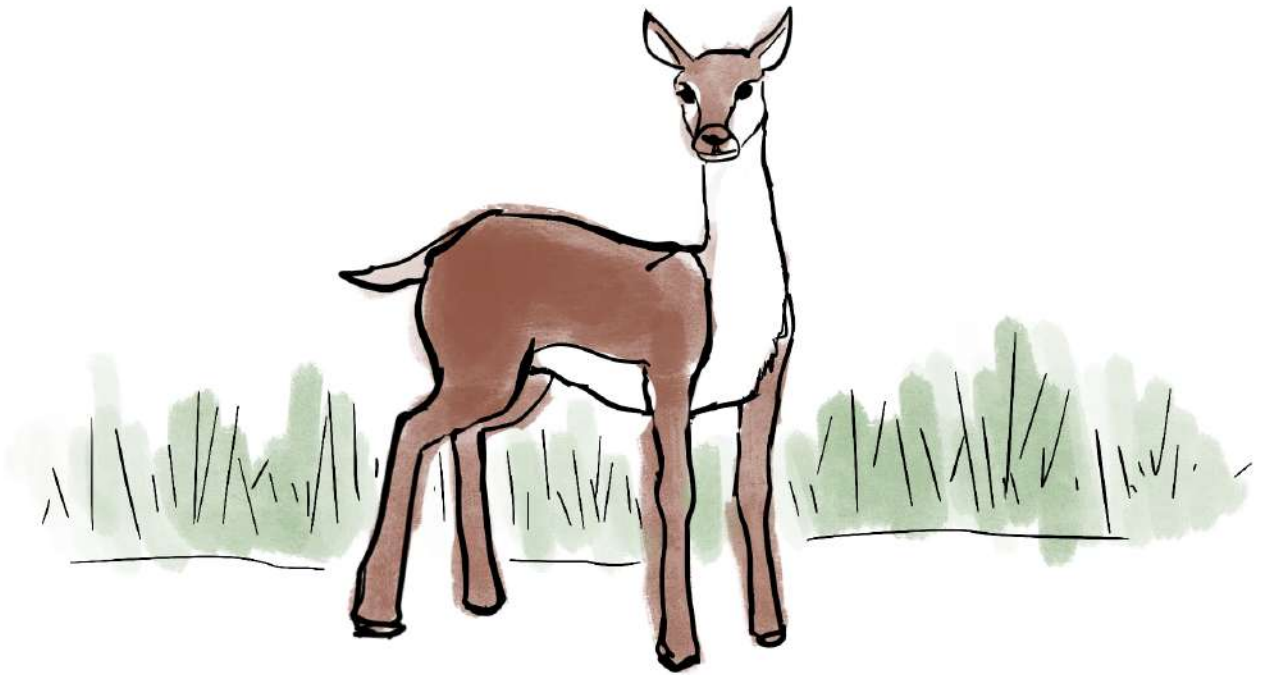
## Chapter One

It's a particularly dry season in the savanna, and water is starting to grow scarce. Most of the nearby water holes have been depleted, and some of the animals are getting worried. The sun is high in the sky, baking down to those below. The air is dry, leaving tongues parched and mud dry. It's almost. A distance away from one particular drinking spot, is a beige-white buggy. On it, sit two people.



In their cart are all sorts of tools: from cameras, to notepads, to a GPS. They are, of course, zoologists. Noticing the dry weather in the area, these two newly relocated scientists came over to monitor the animals. One of them is looking through a pair of binoculars, and the other is taking notes with a black ball point pen.

“Theo, over there! That gazelle fawn must have just been born a few months ago, during the rainy season,” exclaims the girl looking through an optical instrument. Her companion, Theo looks up from his writing to take a closer look.



“There’s also more on the left side Kota - can you see that particularly red one?” He responds, and rummages through a bag to pull out a camera. “The professor will be glad to hear the young ones are doing well.” They both grin in excitement, until Kota points something worrying out.



“We’ve scanned most of the area, but I barely saw any ponds or grass for them to drink and eat,” she comments, “It won’t be long until they run out.” Theo thinks for a moment before speaking again.

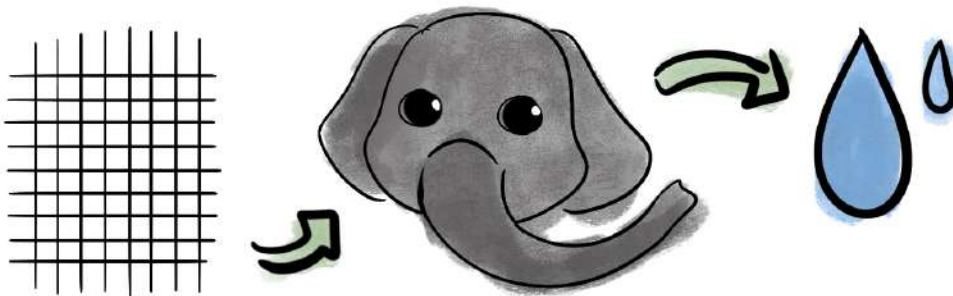
“All the wildlife here are very intelligent - I’m sure they’ll be able to find a new location! In the meantime, we can report our findings to the professor and try to predict the weather patterns.” Kota nods in agreement, and they turn away to drive back to camp.

## Chapter Two

Kota and Theo aren't the only ones who have noticed the climate changing, the animals have too! A large group of different animals have gathered around to discuss where they are going to go next. Out of these, three different creatures take the lead in the meeting. A zebra named Makena, an elephant named Gael, and a gazelle named Ao. When most of the critters had arrived, Makena spoke first.

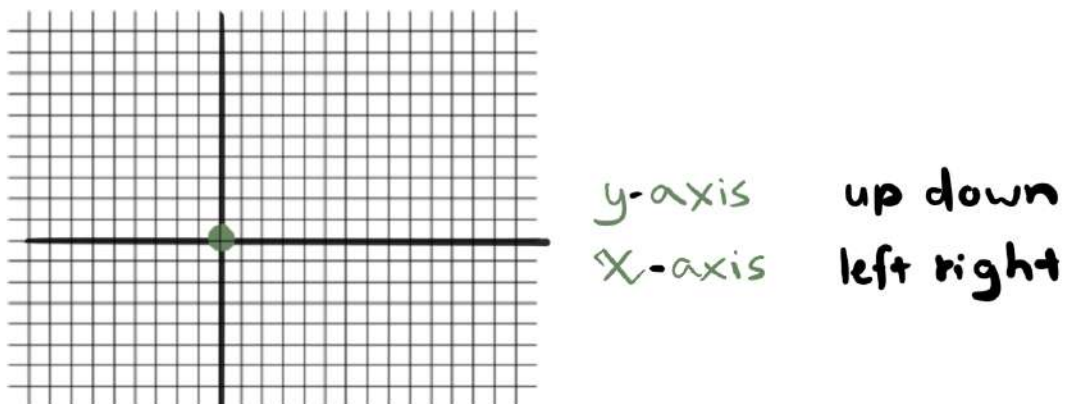
"As we all know, the rainy season is ending soon and meals are getting harder to find. Today we've gathered you all to find a new place for us all." She points a hoof to a stone slate, a rough mud map drawn on by a benevolent monkey. A murmur of agreement trickles around the room, until Gael waves his trunk for silence.

"It might seem difficult, but there's a way to find out where water is. We need to use linear inequalities to find the right area on this map here," he gestures to the grid drawn. "Using lines on a graph, we'll find the area with water." Most of the animals are confused however - What are linear inequalities?



The third member of the trio, Ao, steps out to start the explanation. "First, we need to find the equations of where not to go!" He points at the map, and draws a cross extending to its edges in the center. "This vertical line is called the y-axis, and the horizontal line is the x-axis."

He then adds a dot in the place where the two lines intersect, "And this point where they meet is the origin. You can think of the top of this graph as North, where we're facing now" A wildebeest in the audience raises the question everyone wants to ask.

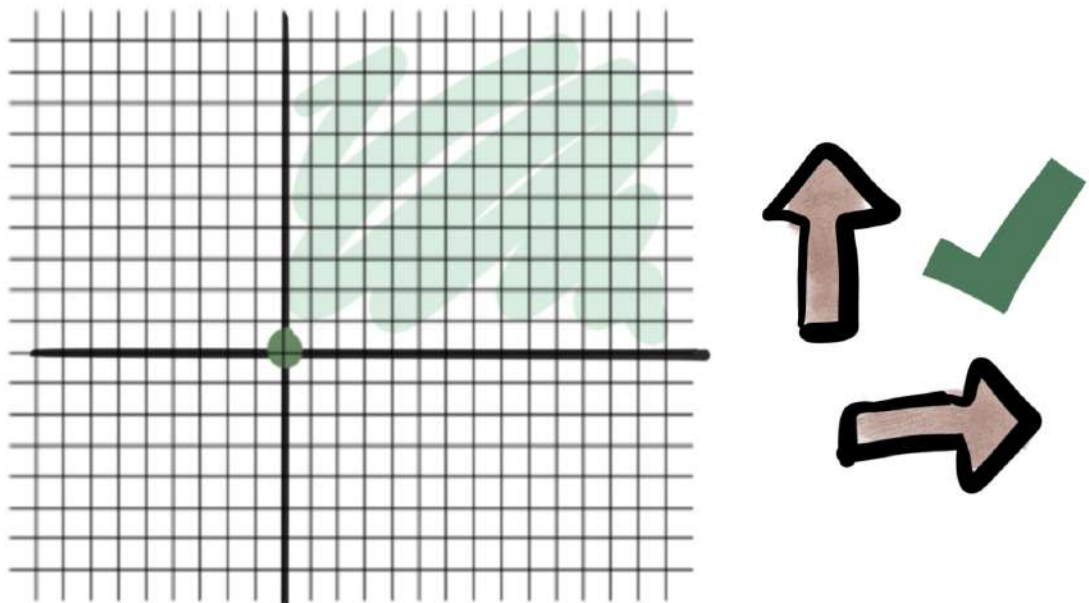


“So, where do we start from? We can’t search the entire savanna!” Now Makena directs one hoof towards the diagram.



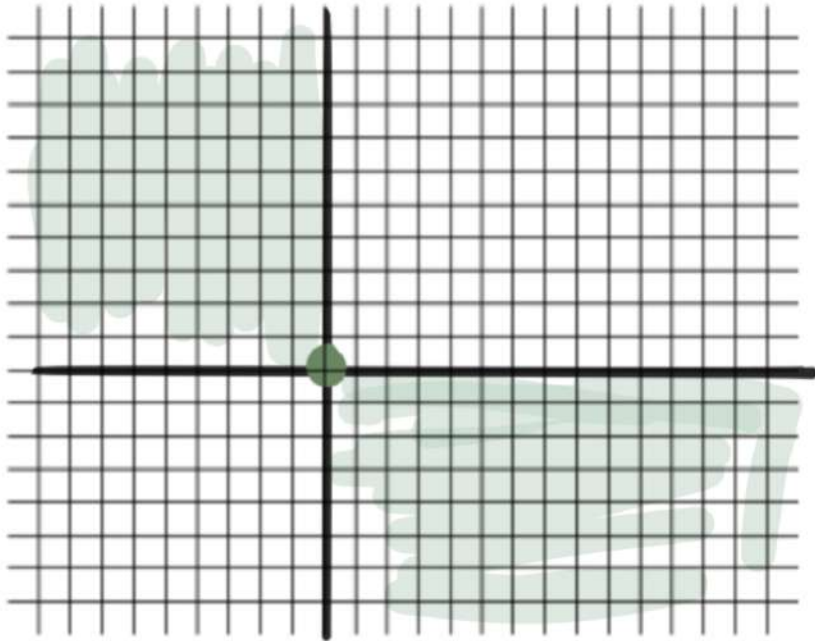
“We name points with two numbers in brackets and separated by a comma, the first for how far along the X-axis they are, and the second for where on the Y-axis they are. The origin is known as (0,0).” She pauses to write this on the side of the drawing. “Numbers to the right of it have a positive X value, and to the left negative. Numbers above have positive Y values, and below negative Y values.”

She then points to the upper right quarter of the graph. “This is the area of the savanna we haven’t been to yet. The origin point is where we are now, and since we’ve already been north and east a long way, we’re going to start drawing our first lines.”



Gael takes over at this point from Makena, picking up a stick in his trunk. “We’re going to draw two lines on the border of the land we’ve already been on- one vertical line at 0 on the X-axis, and one horizontal line on the 0 of the Y-axis. What we’re going to call these two lines, is  $X=0$  &  $Y=0$ , since that’s the same for every point on the line.”

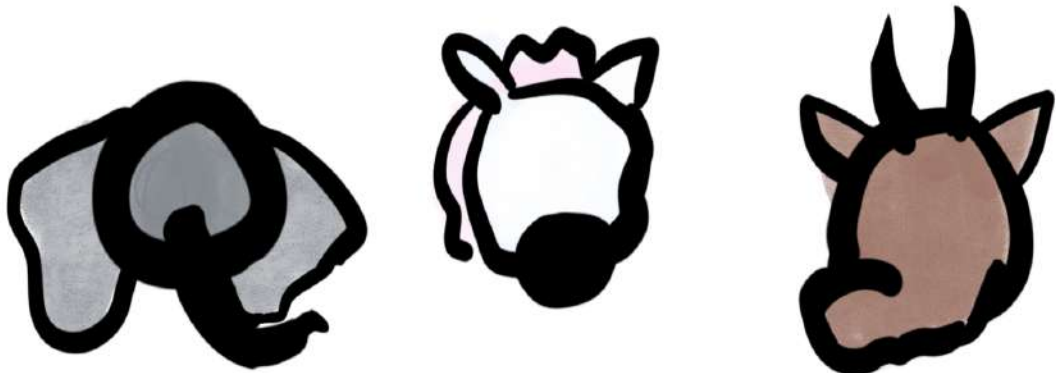
He rubs mud with his trunk over an area of the drawing: the areas below and to the left of these two lines. "Just to be clear, we're now going to shade the areas that we've already been to."



This time, an antelope asks for the next step, "That all seems to make sense so far... but how do we draw the lines to our new location? There's so many different things to consider!"

Ao smiles, and the three of them share a knowing glance. "Let's find out some of the conditions for our new place first: we can separate and come back together to draw our final graph."

Everyone nodded in agreement, keen to start moving. "Makena, you can take the zebras to find out where you need to be, Gael, you can lead the elephants, and everyone else please follow me. We're one step closer to our destination!"

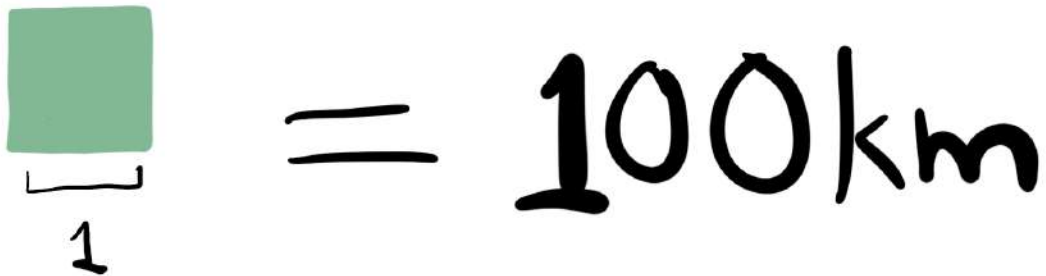


## Chapter Three

Kota and Theo are trying to find out where the animals can live too! After gathering information on each species group, they're trying to figure out where they will go. In order to watch and monitor the creatures, the two also need to find the best new location.

Watching where animals head will give them more time to set up, and not bother the animals. The professor has assigned the two on surveying the animal migration. Back in their camp, Kota is explaining to Theo how to do linear inequalities.

"Here I have a map of a 3000 x 3000 kilometer square with the animals' current water hole at the origin, and a y and x axis." She taps the chalkboard next to her, "Each grid and point on the graph corresponds to a place in real life, with a scale factor of 1 to 100 kilometers."

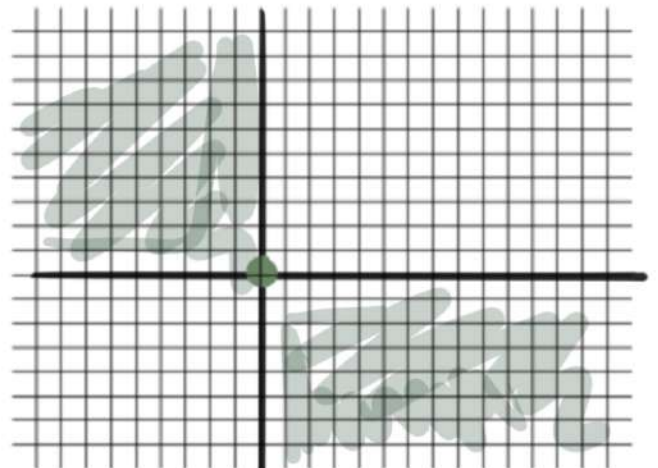


"We've already figured out that the animals have already been to  $x \leq 0$ , and  $y \leq 0$ , so now let's draw lines for each species group and shade out the other areas we don't want!"

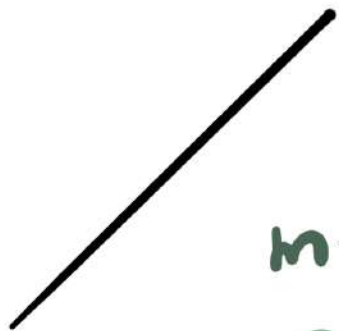
"Sounds like a plan," Theo replies in concentration, "So let's begin with the zebra herd, what do we know about them?"

"Before we do that, let's cover lines themselves," comments Kota.

● =  
ALREADY  
visited







$$mx + c$$

$m =$  gradient / slope

$c =$  y-intercept

"Well, the equation of a line is  $mx + c$ .  $M$  is the gradient of a line, and  $c$  is the Y-intercept, or where the line crosses the y axis, right?"

"That's right! All we need to find all of this information is two points on a line. In this case, the line is the upper border of where the zebras can't go. After our fieldwork, we indeed found two points:  $(0,2)$  and  $(3, 8)$ ." She draws these points on the graph in chalk,

"To find the gradient, we find  $y_2 - y_1$  divided by  $x_2 - x_1$ , so  $6$  divided by  $3$ ,  $2$ . And since our first point is  $(0, 2)$ , we know the point it intersects with the Y axis, or has  $x=0$  is  $2$ .

"Now our first line equation is  $2x+2 = y$ , and we want everything above this line, since it will satisfy our previous equations of  $x > 0$  and  $y > 0$ . We can now insert different values of  $x$ ."

$$\begin{array}{l} (0, 2) \quad (3, 8) \\ (x_1, y_1) \quad (x_2, y_2) \end{array} \quad \rightarrow$$
$$\begin{array}{l} 8 - 2 = 6 \\ 3 - 0 = 3 \end{array} \quad 6 \div 3 = 2$$

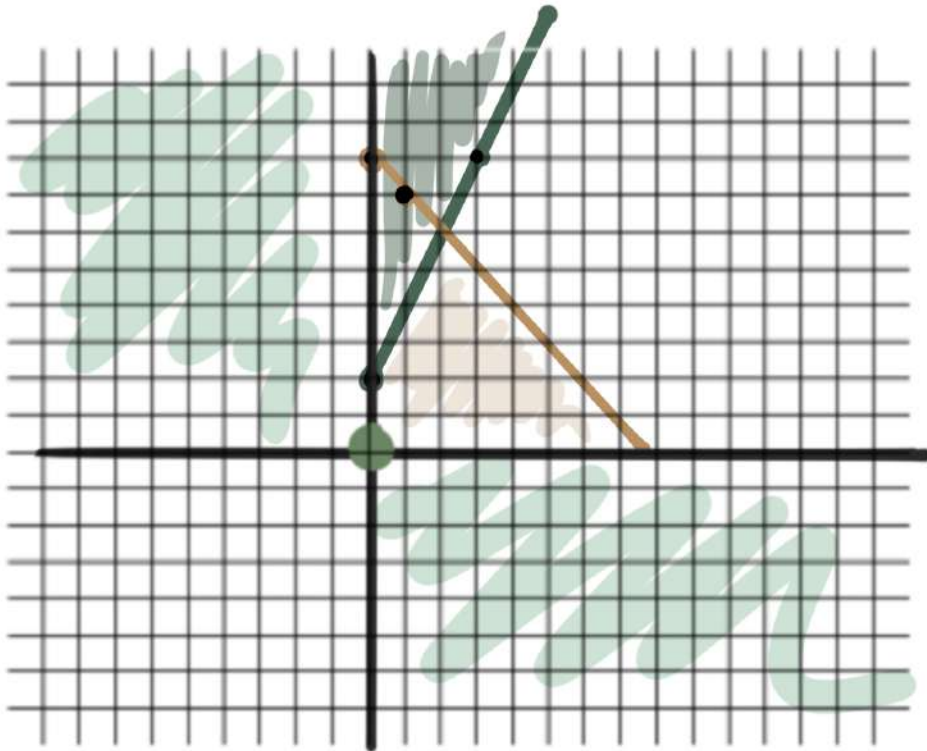
With this, Kota connects the two points with a ruler and writes ' $2x+2 = 0$ ' a short distance away. She shades the area above the line lightly in chalk. Theo is following so far, but there's something he's been wanting to ask. "Is there not an easier way to do this? What about just drawing lines?"

Kota grins, "You're exactly right! Since we're dealing with straight lines, we connect two points with a straight edge like a ruler to draw a line. Sometimes though, we might be given an equation, and need to find points before making the line."

Theo flips to another page in his notebook. "All right, I think there's an equation here:  $Y = -x + 8$  is the upper border of where the elephants can't migrate to."

Kota writes the equation on the board, "Let's start by plugging 1 as  $x$  into this equation:  $-1 + 8 = 7$ ." She notes a dot on  $(1, 7)$  on the graph, "Another number we can put in is 0. Since anything times 0 is 0, this makes  $0 \times -1 + 8 = 8$ ." She then marks out  $(0, 8)$ .

"Now we can connect these points to make a line and shade the parts we don't want!" Kota does as she says, then writes the line equation and shades the area below the line."



Theo claps at their cooperative achievement, then stands to walk over to where Kota is. "Can I try the last line for the remaining animals? I think I understand now!"

Kota steps back to allow him the space to write. "Go ahead! The information we have for the upper unavailable area is... one point on the line is  $(2, 0)$  and the line's gradient is 5." He stands at the blackboard in her place now, and begins by drawing the point  $(2, 0)$ .

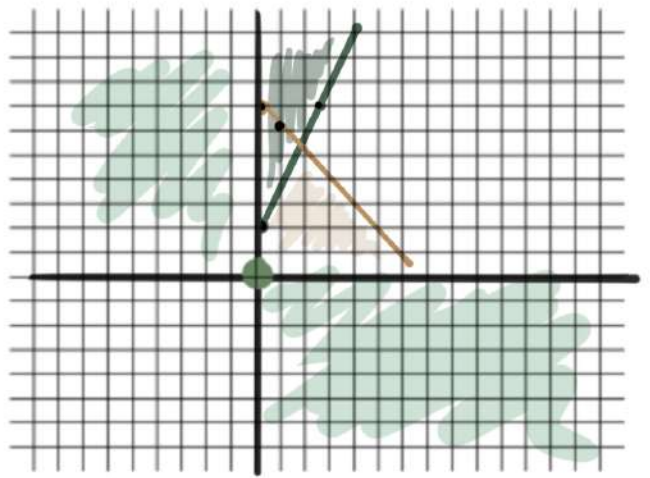
**$(2, 0)$**

**Gradient 5**

$$Y = 5x + C$$

$$(5 \times 2) + C = 0$$

$$10 + C = 0$$



"Well if the line's gradient is five, we can already fill in part of this line's equation.  $Y = 5x + c$ , or if we use the point I've just drawn,  $5 \times 2 + c = 0$ ." While he thinks out loud, Theo writes down the equation he's just spoken. "First we multiply 5 by 2 to get 10, so the equation becomes  $10 + c = 0$ "

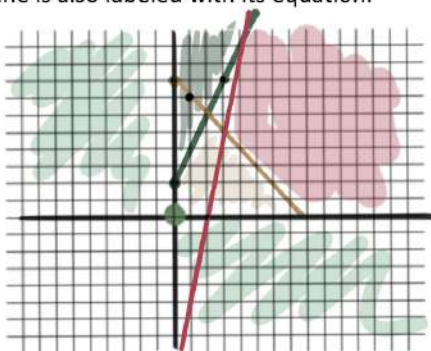
$$y = mx + c$$

$$y = 5x + c$$



After promptly adding this below, he keeps going. "Taking away 10 from both sides, our result is  $-10 = c$ , the y intercept. This means that where  $x = 0$ ,  $y = -10$ : the second point on the line is  $(0, -10)$ ."

The chalk notation follows shortly after, and he connects this dot with the previous ruler. The third line is also labeled with its equation.



$$y = 5x - 10$$

$$y = 2x + 2$$

$$y = x + 8$$

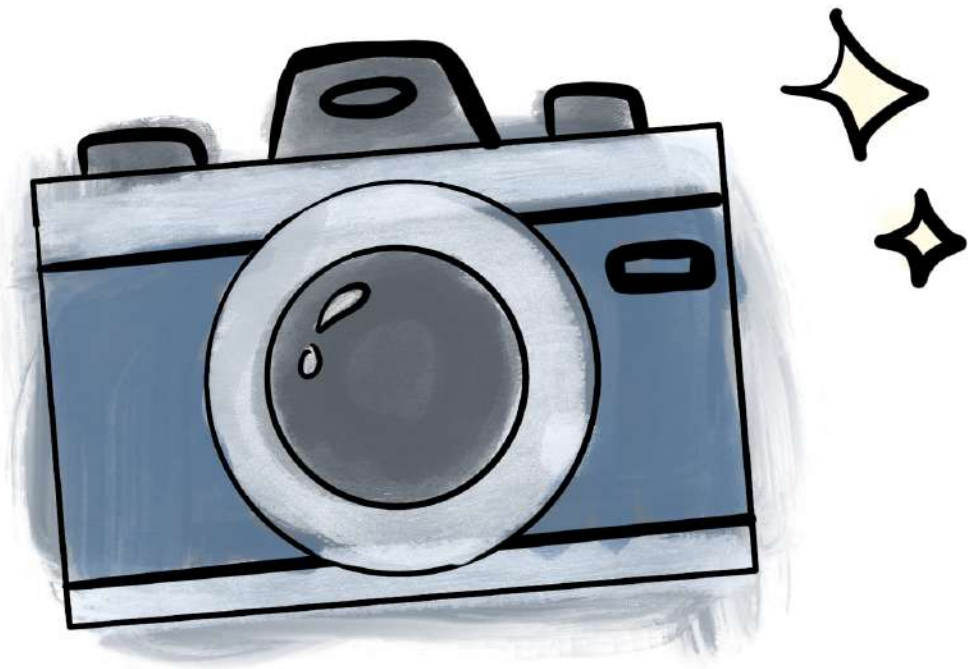
"Since this is the top of the area we don't want, I'm now going to shade everything below the line."

"Brilliant!" Exclaims Kota, "Now we have a triangle of where the creatures are going to migrate to next."

## Chapter Four

Kota and Theo arrive just a few minutes before the animal herds at their destination. It doesn't take long before wildlife arrives in droves to drink from the waterhole. They could see wildebeest, gazelle, elephants, there had to be hundreds of animals!

The duo and creatures alike had taken a journey of hundreds of kilometers to find this place. Thankfully most of the young animals made the journey, and their hard work was now being rewarded. The two scientists also were able to witness an incredible gathering of critters great and small. Along the way, Theo even learned a new technique to use with graphs.



This certainly was an experience that couldn't be forgotten!

Kota and Theo celebrate their success, photographing the moment.

"Until next time!"