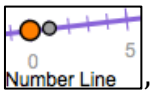
Connect to Cartesian Name:

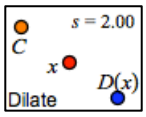
In this activity you will compose a function on the number line, similar to the Dynagraph construction from a previous activity. However, this time you will make the dependent variable's axis vertical instead of horizontal. This will give you a different way to look at the relative rate of change of your independent and dependent variables.

DILATE

Begin by constructing the input axis.

1. Open http://geometricfunctions.org/links/connect-to-cartesian/ and go to page 2.

2. Construct a 

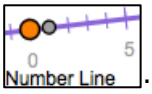
, make it horizontal, and construct a 

function on the number line.

Q1 Each row in this table describes the relative motion of x and $D(x)$. Find a scale factor that creates the given motion, and write it down. Check your result by varying x.

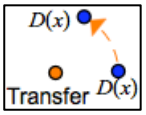
Relative speed	Relative direction	*Scale factor s*
$D(x)$ goes the same speed as x.	$D(x)$ goes the opposite direction as x.	***s* =**
$D(x)$ goes slower than x.	$D(x)$ goes the same direction as x.	***s* =**
$D(x)$ goes the same speed as x.	$D(x)$ goes the same direction as x.	***s* =**
$D(x)$ goes faster than x.	$D(x)$ goes the opposite direction as x.	***s* =**

CREATE THE OUTPUT AXIS

3. Make sure your input axis is horizontal, and add a second 

. Attach the number lines to each other by their origins.

4. Drag the gray point on the second number line to make it vertical.

5. Use the 

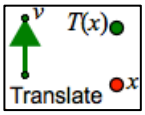
tool to transfer variable $D(x)$ to the output axis. After you finalize the tool, drag the rotated $D(x)$ all the way to the vertical axis.

Q2 Vary x, and stop at several different places. In the places where you stopped, how does the value of $D(x)$ on the vertical axis compare to $D(x)$ on the horizontal axis?

TRANSLATE

On the vertical axis you'll compose translation with dilation, producing $T(D(x))$.

Video

6. Tap 

and attach the tail of the vector to the origin. Also attach $D(x)$ to the point $D(x)$ on the vertical axis.

Q3 For each row of the table below, edit s and drag v and x to the values shown. Then record the values for $D(x)$ and $T(D(x))$.

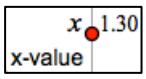
s	v	x	$D(x)$	$T(D(x))$
2.50	–3.00	–2.00		
–2.00	1.00	–3.00		
0.50	2.50	2.00		

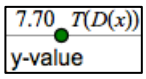
Q4 You will soon be asked whether x and $T(D(x))$ are moving in the same direction or different directions—but x moves left and right, and $T(D(x))$ moves up and down! The only solution is to think about whether the numbers are getting bigger (increasing) or smaller (decreasing). Fill in the blanks in this table.

x varies	$T(D(x))$ varies	Is x increasing or decreasing?	Is $T(D(x))$ increasing or decreasing?	Same direction or different?
right	up			
right	down			
left	up			
left	down			

TRACK THE VARIABLES

Now you'll add lines to track the horizontal location of x and the vertical location of $T(D(x))$.

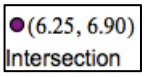
7. Use 

to construct a vertical line through x, and use 

to construct a horizontal line through $T(D(x))$.

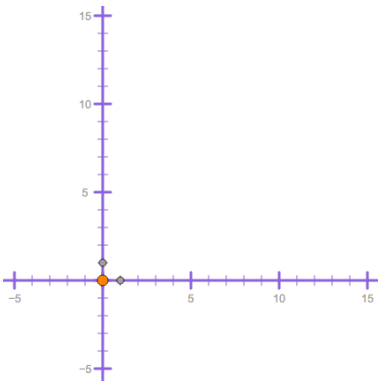
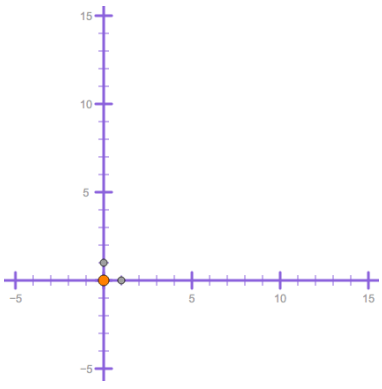
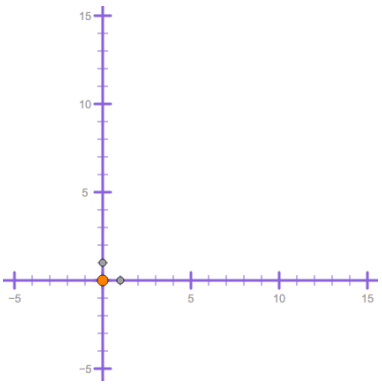
Q5 Drag x. What do you notice about the lines when you vary x?

INVESTIGATE

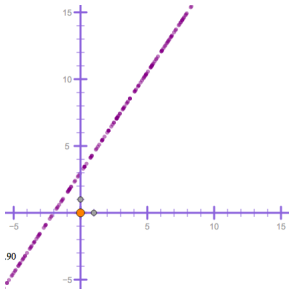
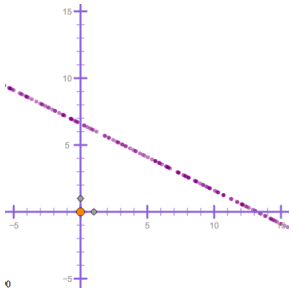
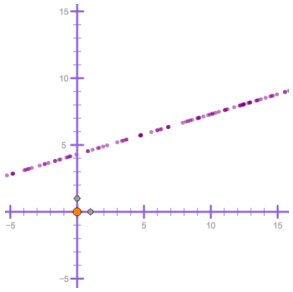
8. Tap the 

tool and use it to construct a point at the intersection of the lines.

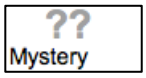
Q6 For ***a*** below, set the dilation scale factor (s) and the translation vector (v) as shown. Vary x and draw the shape made by the traced intersection. Then do **b** and **c.**

a	***b***	***c***
$s = 2.0$	$s = -3.0$	$s = 0.5$
$v = -3.0$	$v = 5.0$	$v = 2.0$
		

Q7 For the traces on the left, circle the correct words on the right, and tell how you know.

	$T(D(x))$ is moving **| faster | slower | at the same speed |** as x. $T(D(x))$ is moving in the **| same | opposite |** direction as x. I know this because:
	$T(D(x))$ is *moving* **| faster | slower | at the same speed |** as x. $T(D(x))$ is moving in the **| same | opposite |** direction as x. I know this because:
	$T(D(x))$ is *moving* **| faster | slower | at the same speed |** as x. $T(D(x))$ is moving in the **| same | opposite |** direction as x. I know this because:

SOLVE A MYSTERY

Q8 On page 5, construct $T(D(x))$ as you did earlier. Then use the 

tool to create a mystery function. Your job is to study the behavior of the mystery function and change your values of s and v to exactly match the mystery function. Your challenge: try a variety of mystery functions, think hard, and master the skills to become a Level 4 functionista. Describe what you discovered as you practiced.