GeoGebra – Lesson 14

Title: Reduced Fractions and Coefficients

http://mathcasts.org/mtwiki/GgbHelp/FractionsReduce2

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http://math247.pbwiki.com/GeoGebra

GeoGebra 3.2 Lesson – Pre-release 2008, Release 2009

Key Concepts from GeoGebra

- Already discussed:  ,  ,  ,  , Point capturing to grid
- Math function: sgn() and ggb function GCD[,]
- "is it equal" - the conditional operator ≟
- ggb function If[,,]
- LaTeX – mixing dynamic text and numbers

Note: Drawing Pad is now called Graphics Window.

Key Concepts from Math

Reduced Fractions – what a reduced fraction looks like

Start with whole numbers *numer* and *denom* (possibly negative integers): $\frac{numer}{denom}$.

Calculate the greatest common divisor GCD(numer, denom).

Divide GCD out of both the numerator and the denominator.

Construct conditional: If the divided denominator is 1, then we just want the divided numerator, else we want the reduced fraction.

Coefficients and Numbers

When you use this, you must first look at your stuff and decide what kind of coefficient you need. The GeoGebra isn't tricky – deciding what you need is.

There are 4 types of **non-zero** "coefficients" ☺

1. Number - You want the number, but the sign only if the number is negative.
2. Constant coefficient - You want sign and number.
3. Middle coefficient - You want sign, but the number only if different from 1.
4. First coefficient - You want sign if negative and number if different than 1.

So both sign and presentation are important.

Note: Mixed Fractions are NOT covered here; and 0 will show up as a coefficient.

The Plan

We are going to look at slope and the equations of lines since this gives us good sampling.

The slope – by itself - is a number.

The slope in the equation of the line is a first coefficient.

The *y*-intercept is a constant coefficient.

Slope using GeoGebra notation:

Given two points A and B (with different x-coordinates or we'll get a 0 denominator)

Equation of line: $y = mx + b$ with formula: $y = \frac{y(B) - y(A)}{x(B) - x(A)} \cdot (x - x(A)) + y(A)$.

Slope = m = $\frac{y(B) - y(A)}{x(B) - x(A)} = \frac{\text{deltaY}}{\text{deltaX}}$ and

y-intercept = b = $-m \cdot x(A) + y(A) = \frac{-\text{deltaY} \cdot x(A) + \text{deltaX} \cdot y(A)}{\text{deltaX}}$

Script-o-matic

1. Setup GeoGebra.
   a. Open GeoGebra.
   b. If not open, open the Algebra Window
      i. Click View -> Algebra Window.
      ii. The Algebra window will appear at left.

We need all coordinates to be whole numbers. So we use Point Capturing.

2. Make point capturing to 1x1 grid –
   a. Point Capturing to Grid
      i. Click Options -> Point Capturing -> on (Grid)
   b. Check grid is 1x1 – usually not necessary!
      i. Right-click in blank part of Graphics window and select Properties (see right 1)
      ii. Click on second tab "grid" (see right 2)

(By default the grid should be 1x1. Select distance to change.)

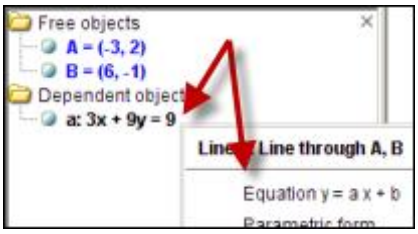
      iii. Click on close.
      iv. Zoom and move the drawing pad so that (-3,2) and (6,-1) are visible.
      (Use  with click & drag on graphics window, mouse scroll to zoom.)

3. Make 2 points and the line through them.

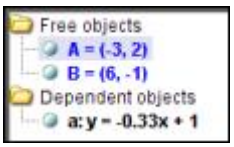
   a. Select  and click near (-3,2) and then near (6,-1) - point A and point B will be drawn at these grid points with whole number coordinates.

   b. Select  and click on A and then on B – line a through A and B will be drawn.

   c. Look in the Algebra window at line a. Probably the line is written in "standard" form. For our two points, we have: 3x+9y=9.



   d. Right-click on a and then click on Equation y=ax+b in the drop-down menu.



   The equation will change to slope-intercept form; the coefficients will be decimals. We see that the slope is -0,33 or $-\frac{1}{3}$ and the y-intercept is 1. So our goal is a text: $y = -\frac{1}{3}x + 1$

Find the non-reduced numerators and denominators.

4. Find the numerator and denominator of the slope.

   a. The numerator of the slope is the change in y-coordinates from B to A.

      i. Click in the input field (bottom left).

      ii. Type deltaY=y(B)-y(A) and hit Enter. (If onscreen, use copy & paste.)

      iii. The dependent object "deltaY" will appear in your Algebra Window, - nothing in the drawing pad. It is a number.

   b. Type deltaX=x(B)-x(A) and hit Enter.

      i. The dependent object "deltaX" will appear in your Algebra Window, - nothing in the drawing pad. It is a number.

5. Find the numerator of the y-intercept. (The denominator is deltaX.)

   a. Type numerYint=-deltaY*x(A)+deltaX*y(A) and hit Enter.

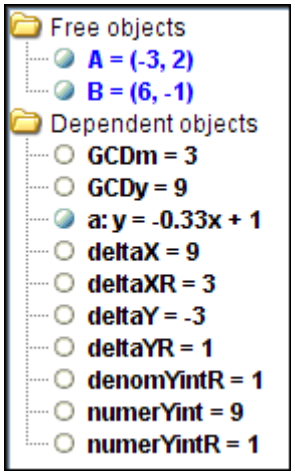
   b. The dependent object "numerYint" will appear in your Algebra Window, - nothing in the drawing pad. It is a number.

We are ready to find GCDs and then the reduced numerators and denominators. There will be 2 GCDs: one for the slope and one for the y-intercept and 4 reductions: 2 numerators and 2 denominators.

The GCD[,] function in GeoGebra is new in 3.2.

- The two numbers must be integers (positive or negative whole numbers).
- The result is always a positive integer.

Because of the different types of coefficients, we will make all the reductions positive using the absolute value function: abs().



6. In the input field:
   a. Type: GCDm=GCD[deltaY,deltaX] and hit Enter.
   b. Type: deltaYR=abs(deltaY/GCDm) and hit Enter.
   c. Type: deltaXR=abs(deltaX/GCDm) and hit Enter.
   d. Type: GCDy=GCD[numerYint,deltaX] and hit Enter.
   e. Type: numerYintR=abs(numerYint/GCDy) and hit Enter.
   f. Type: denomYintR=abs(deltaX/GCDy) and hit Enter.

We are ready to find signs.

For the slope as a number and the slope as a first coefficient, we want the sign ONLY if it is a negative number. The y-intercept is a constant coefficient, so we want the sign whether it is positive or negative!

We are going to use the

math function sgn()	Inside the parenthesis must be a number and you get **1** or **0** or **-1** depending on whether the number is **positive** or **0** or **negative**
ggb function If[,,]	Inside brackets is ***condition.*** The condition must be **true** or **false** [**condition**, result if **true**, result if **false**]

7. In the input field:
   a. Type: textSignN=If[sgn(deltaY/deltaX)>0,"","-"] and hit enter.

This gives a text object "textSignN".

The condition here is "sign of deltaY/deltaX > 0" (positive slope)

If true, the result is ***nothing***. If false, the result is - .

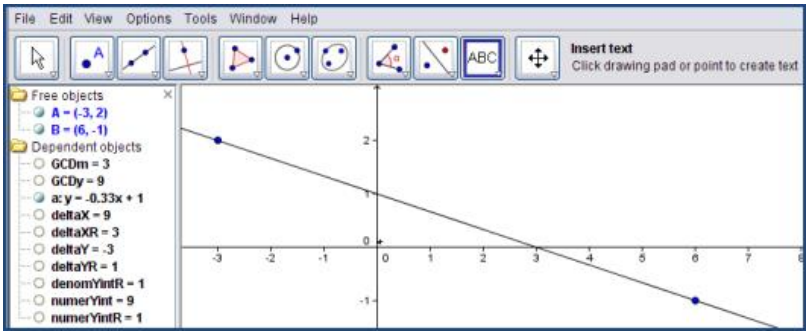
   b. Type: textSign=If[sgn(numerYint / deltaX)>0,"+","-"] and hit enter.

This gives a text object "textSign".

The condition here is "sign of numerYint/ deltaX > 0" (positive y-intercept)

If true, the result is + . If false, the result is - .

Note: These text objects will "appear" around (0,0). We will get rid of them in step 12, that is we will "fix" all our text objects together. This avoids many problems (like forgetting ☺).



We are ready to find our numbers as reduced fractions.

Remember - we will want to know if our reduced denominator = 1.

We are going to use the "is it equal" ≟ .

You CANNOT use = in a condition. You must always use ≟.

All conditional operators can be found at the bottom of the drop-down menu 

This ≟ is the only "weird" conditional operator in GeoGebra. All other conditional operators are just the operators themselves.

For example, for the condition:

- Is number1 *less than* number2, input number1 < number2

But, if your condition is:

- Is number1 equal to number2, you must input number1 ≟ number2

8. Dynamic text – Copy and paste the following 4 text objects into the input.

textslopeN=If[deltaXR ≟ 1, textSignN + deltaYR, textSignN + "\, \frac{" + deltaYR + "}{" + deltaXR + "}"]	number
textslopeC=If[deltaXR ≟ 1, If[deltaYR ≟ 1, textSignN, textSignN + deltaYR], textSignN + "\frac{" + deltaYR + "}{" + deltaXR + "}"]	first coefficient
textYint= If[denomYintR ≟ 1, textSign + numerYintR, textSign + "\frac{" + numerYintR + "}{" + denomYintR + "}"]	constant coefficient
textMID= If[denomYintR ≟ 1, If[numerYintR ≟ 1, textSign, textSign + numerYintR], textSign + "\frac{" + numerYintR + "}{" + denomYintR + "}"]	middle coefficient

Notes: Junk will appear around (0,0). In step 12, we will "clean-up".
Notice that GeoGebra allows us to append dynamic text and numbers. Way cool!

Tiny disclaimer: We have been "clever" here and are using the first fraction both as a number and first coefficient and the second fraction as a constant and middle coefficient. This is saving us the trouble of having to calculate 4 text signs – one for each display. Probably you will not be so lucky and for each display, you will need to calculate the appropriate text sign.

9. Dynamic text in graphics window: Slope=$-\frac{1}{3}$

   a. Select ABC and click where you want the text to appear.
   b. Copy and paste into the text window: "Slope \,=\, " + textslopeN
   c. Select the LaTeX formula (bottom left of window).
   d. Click on OK. This object is "text1".
   e. If the text looks like what you pasted, then you forgot to select LaTeX formula. Just double-click on the text and select LaTex formula.

Trick: To move these text objects to any position, right-click and select Absolute Position. Then they aren't caught by point capturing and as an added bonus, they will always be there on the graphics window regardless of its position.

10. Dynamic text in graphics window: $y = -\frac{1}{3}x + 1$

   a. Click where you want the text to appear.

   b. Copy and paste: "y \,=\, " + textslopeC + "x \," + textYint

   c. Select "LaTeX formula" and click on OK. This object is "text2".

Extra: And just so we know how to do a middle coefficient, we will "multiply" this last function by x to get dynamic text object: $g(x) = x(-\frac{1}{3}x + 1) = -\frac{1}{3}x^2 + x$

   a. Click where you want the text to appear.

   b. Copy and paste: "g(x) \,=\, x(" + textslopeC + "x \," + textYint + ") \,=\," + textslopeC + "x^2 \," + textMID + "x"

   c. Select "LaTeX formula" and click on OK. This object is "text3".

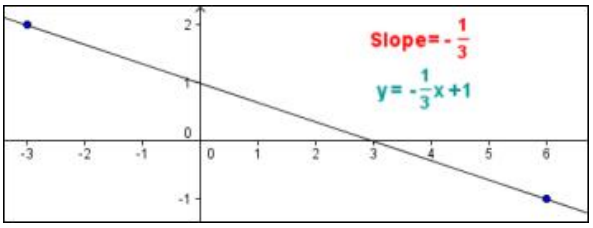
11. Testing, testing ….

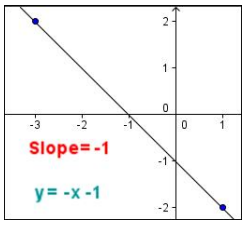
   a. Click on the move icon and click and drag point B to (1,-2).

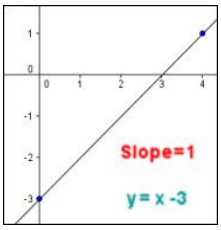
   b. You should see: Slope=-1, $y=-x-1$, $g(x)=x(-x-1)=-x^2-x$

   c. Click and drag A to (0,-3) and B to (4,1).

   d. You should see: Slope=1, $y=x-3$, $g(x)=x(x-3)=x^2-3x$







12. Clean-up

   a. Right-click on any object and choose Properties.

   b. In the left pane of the Properties window, click on + Text to see the text objects and then on textSign.

   c. In the right pane, under the Basic tab, deselect "Show Object"

   d. Do this for all text objects except text1 and text2.

   e. This will hide all the "junk" around 0.

13. Decorate

   a. In the left pane, click on text1. If you want, rename it "textslope", change its color and size, etc.

   b. In the left pane, click on text1. If you want, rename it "texteqn", change its color and size, etc.

   c. Click on Close.

14. Final steps

a. Decide whether you want to close the Algebra window.

b. Save your file.

c. If you want, export the file to an html.

Hint: In GeoGebra 3.2, exporting to an html will create an additional ggb file with worksheet_ appended to the beginning of the name. So if you change your ggb file, you must save it and then re-export it !