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Mandelbrot Magnitudes

Project Goal:
Students will use multiplication and addition of complex numbers to code an algorithm that determines if a point in the imaginary plane is a part of the famous Mandelbrot Set.

Standards:
CCSS.MATH.CONTENT.HSN.CN.A.1

Know there is a complex number *i* such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.

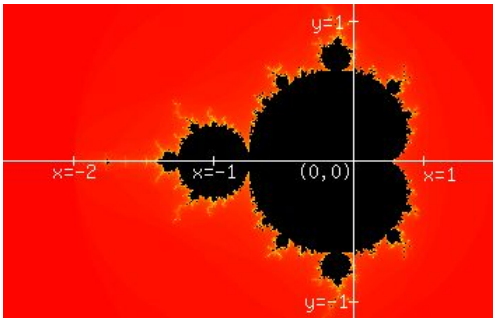
CCSS.MATH.CONTENT.HSN.CN.A.2

Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Student Guide

Teacher Guide: 2 Days
*Prerequisite: Students should have had exposure to complex numbers, graphed them in the complex plane, and understand basic arithmetic, especially multiplication.

Day 1:
10 Minutes:
Show the students a picture of the Mandelbrot set. Pick one of your favorites from a Google Search, or use the one pictured here with the the axis on it.



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20 Minutes:

Watch this Numberphile video, please do to better understand the fundamentals of the set. Have students take notes!!

20 Minutes:

Students should spend a good chunk of time hand calculating some of the values shown in the video, and you can assign some from this grid as well and decide as a class which stay bounded...they make the set!

c = -2 + 2 i	c = -1 + 2 i	c = 0 + 2 i	c = 1 + 2 i	c = 2 + 2 i
c = -2 + 1 i	c = -1 + 1 i	**c = 0 + 1 i**	c = 1 + 1 i	c = 2 + 1 i
c = -2 + 0 i	**c = -1 + 0 i**	**c = 0 + 0 i**	c = 1 + 0 i	c = 2 + 0 i
c = -2 + -1 i	c = -1 + -1 i	**c = 0 + -1 i**	c = 1 + -1 i	c = 2 + -1 i
c = -2 + -2 i	c = -1 + -2 i	c = 0 + -2 i	c = 1 + -2 i	c = 2 + -2 i
Coordinates	Birthday Labels	Labels		

50 minutes:

Complete Student Guide in Groups of 2. One student with the Guide opened, and the other on Scratch.

20 minutes:

Students verify accuracy of their program and program in their own personalized reactions to their if-else conditional.

For more fractal inspiration outside the Mandelbrot Set, consider taking a class period to watch this documentary from NOVA; Fractals: Hunting the Hidden Dimension

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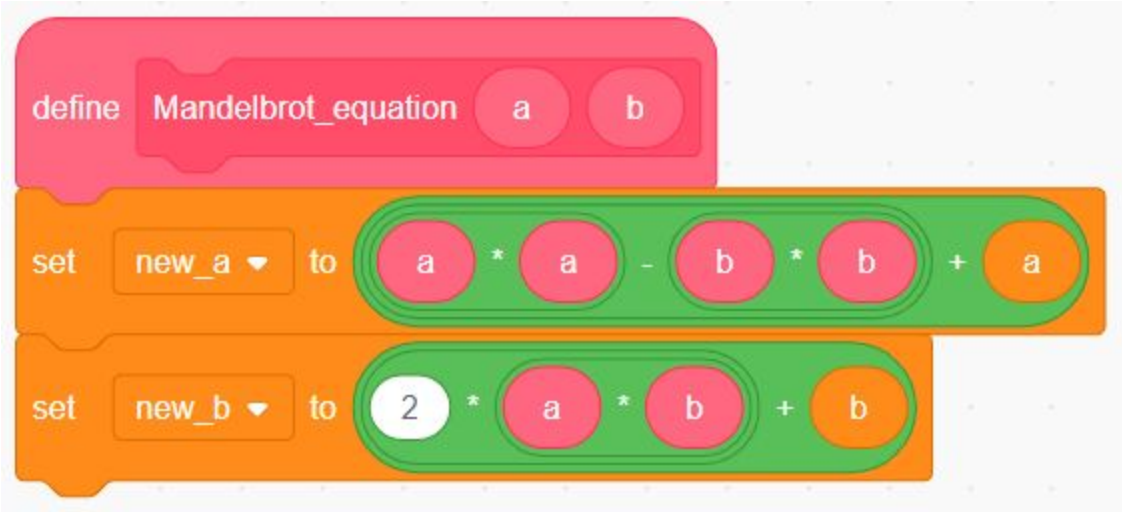
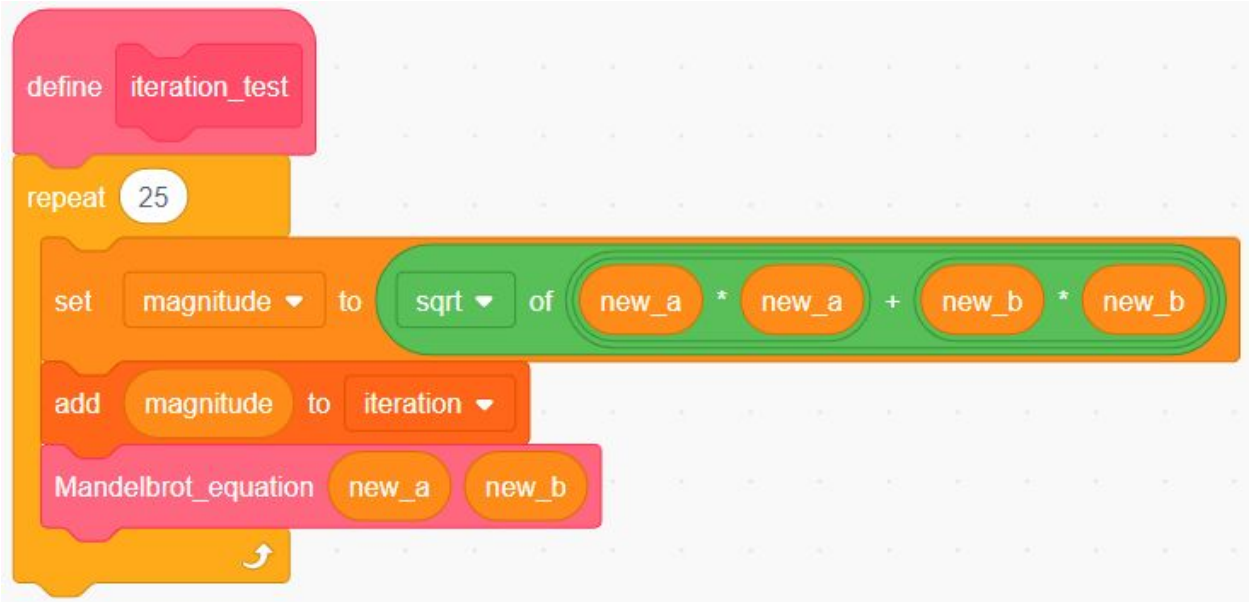
Solutions:

Task 2 Step 2:



Task 3: Pythagorean Theorem :)



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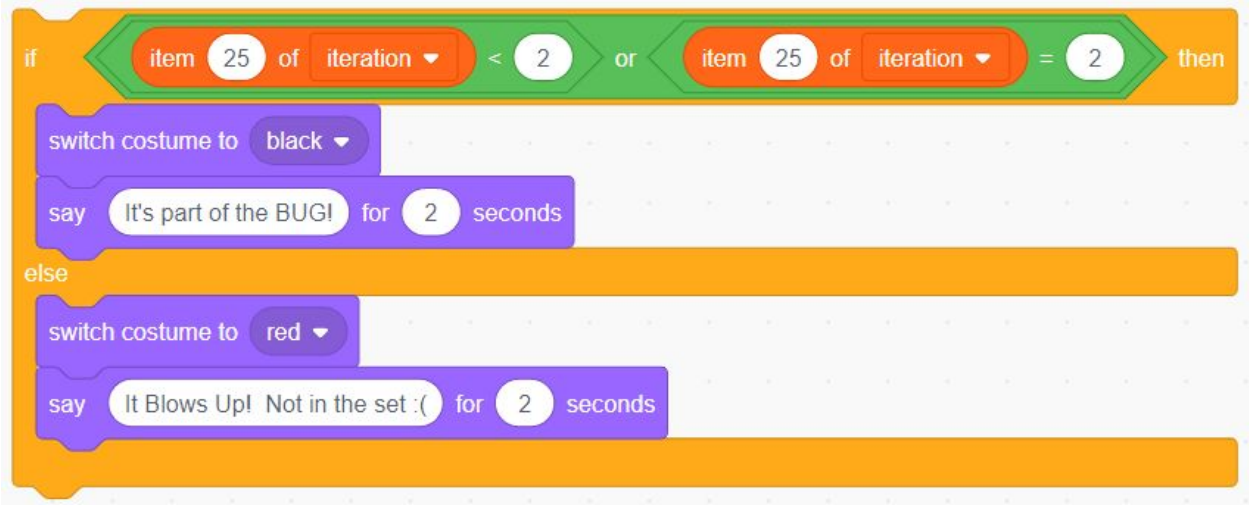
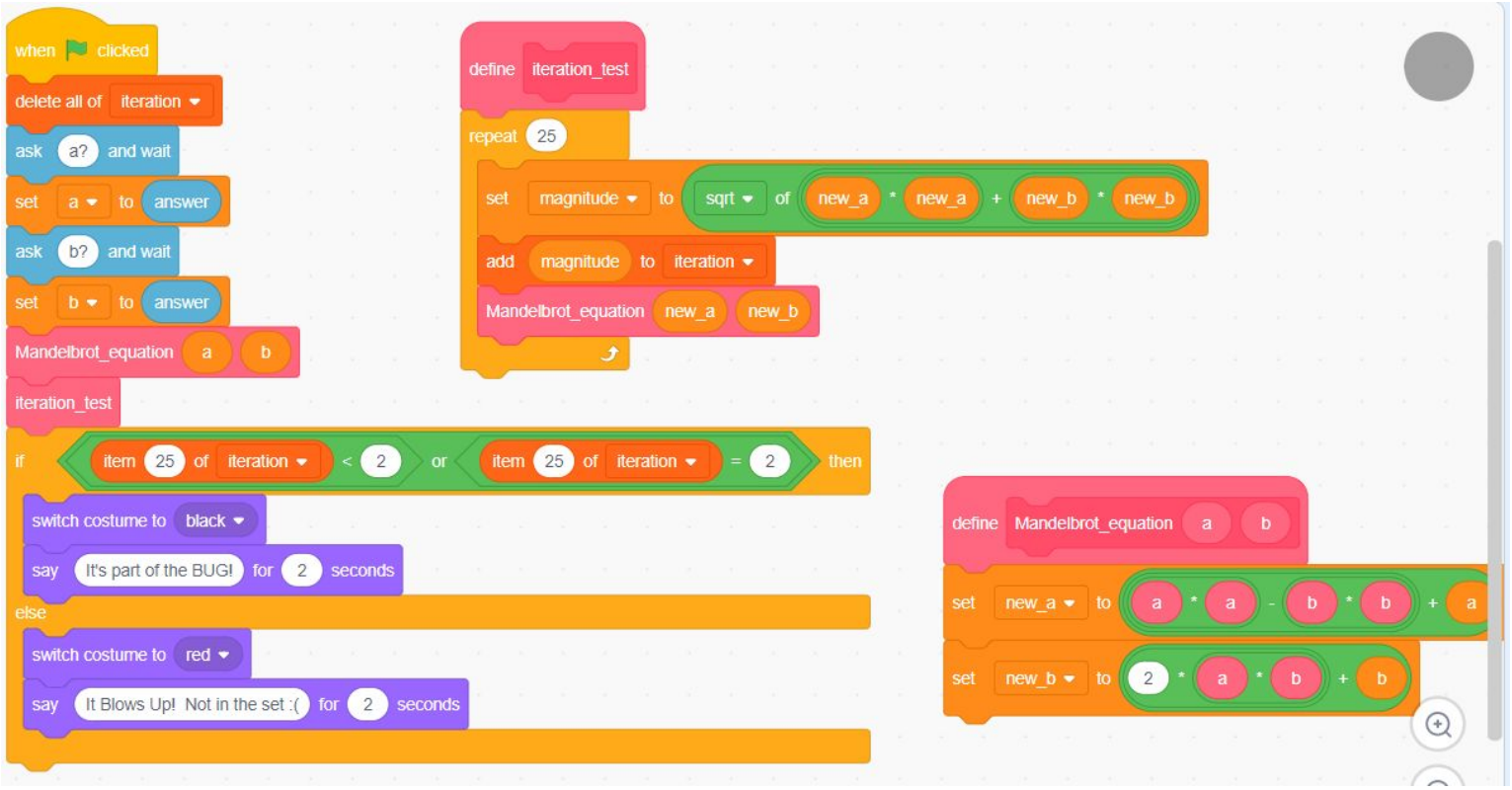
Task 4:



Final Code



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