

# Making Mandelbrot's Masterpiece

## Project Goal:

You and our students are going to draw the Mandelbrot set using Scratch!

Students will break down the complex Mandelbrot set into manageable pieces and use the algorithm they created in the Mandelbrot Magnitudes lesson to test thousands of points in the complex plane.

## 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](#)

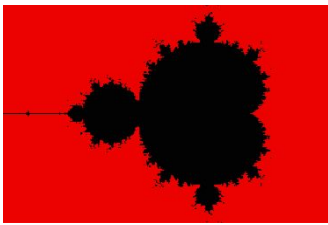
Use the relation  $i^2 = -1$  and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

## Student Guide

#CSandMath



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## Teacher Guide:

This lesson will take about one 60 minute class period. It is best if students work in pairs, one with the student guide open and the other modifying the code from the previous lesson ([Mandelbrot Magnitudes](#)). There are a handful of GIFs for the tricky steps, so printed handouts will be difficult.

## Solutions:

### Final Code after challenge 1

```
when clicked
  delete all of iteration
  erase all
  pen up
  set a to -2
  set b to -1
  go to x: a * 100 y: b * 100
  pen down
  set pen size to 1
  repeat until b > 1
    repeat until a > 1
      go to x: a * 100 y: b * 100
      iteration_test a b
      change a by .01
    set a to -2
    change b by .01
  pen up
  go to x: a * 100 y: b * 100
  pen down

define iteration_test a b
  Mandelbrot_equation a b
  repeat 25
    set magnitude to sqrt of new_a * new_a + new_b * new_b
    add magnitude to iteration
    Mandelbrot_equation new_a new_b
  if item 25 of iteration < 2 or item 25 of iteration = 2 then
    switch costume to black
    set pen color to yellow
  else
    switch costume to red
    set pen color to green
  delete all of iteration

define Mandelbrot_equation a b
  set new_a to a * a - b * b + a
  set new_b to 2 * a * b + b
```