# Week 8 class 3 - Chaos and Fractals

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## To look into

- Possible internships on exploratory mathematics with https://experiences.mathemarium.fr/
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## Julia

(J-set = Julia set, M-set = Mandelbrot set)

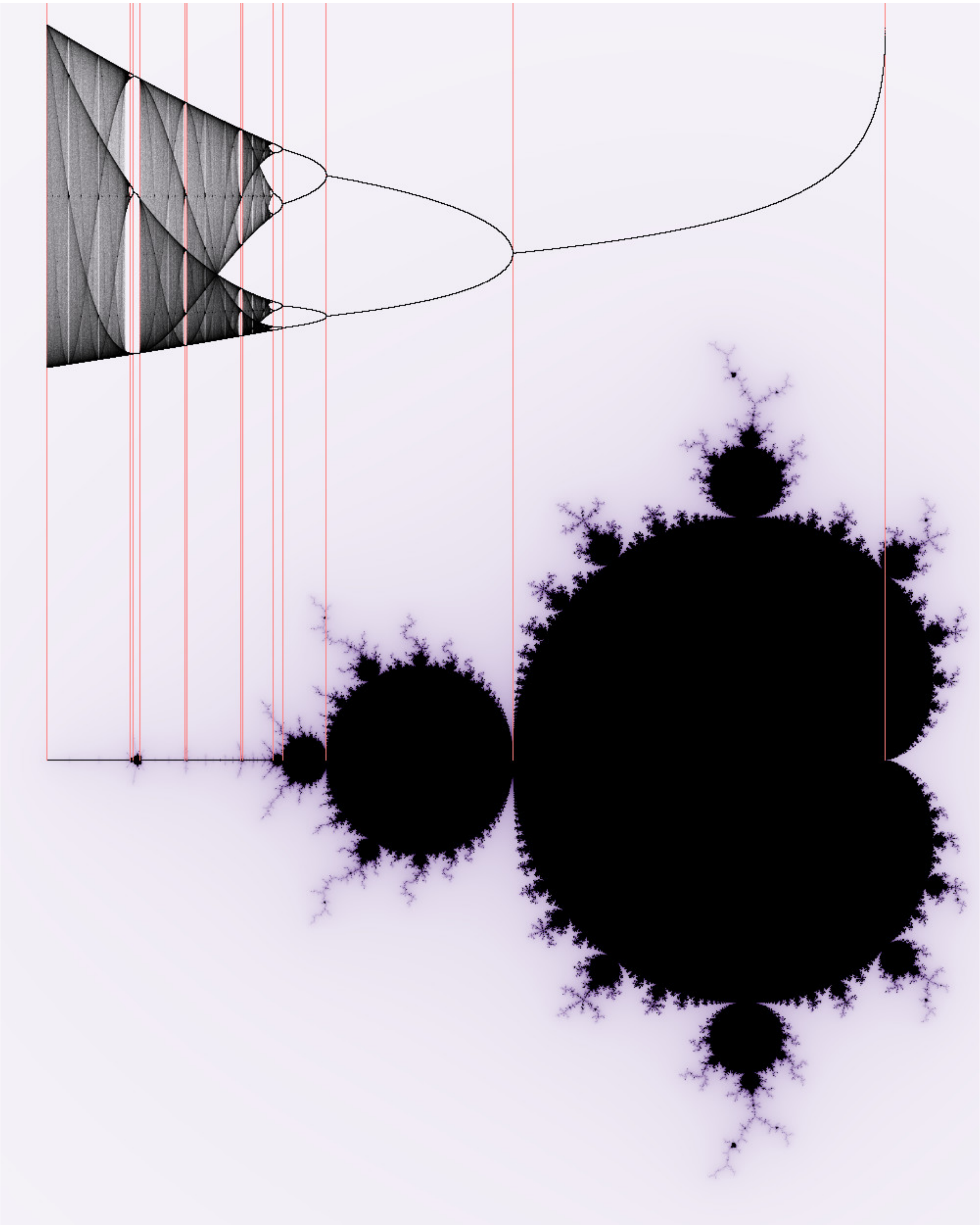
J-set for a particular c = a set of all $Z_0$'s that do not $\to \infty$ when iterated (prisoner set). J-sets are described by the function $f(z) = z^2 + c$.

M-set = set of all parameters c whose J-set is connected (J-set map, or encyclopaedia). The set of all parameters $c$ for which $Z_c = 0$ does not got to $\infty$ when iterated.

**Note the following about Julia sets: When varying C, the splitting point of a Julia set is always in the middle.**

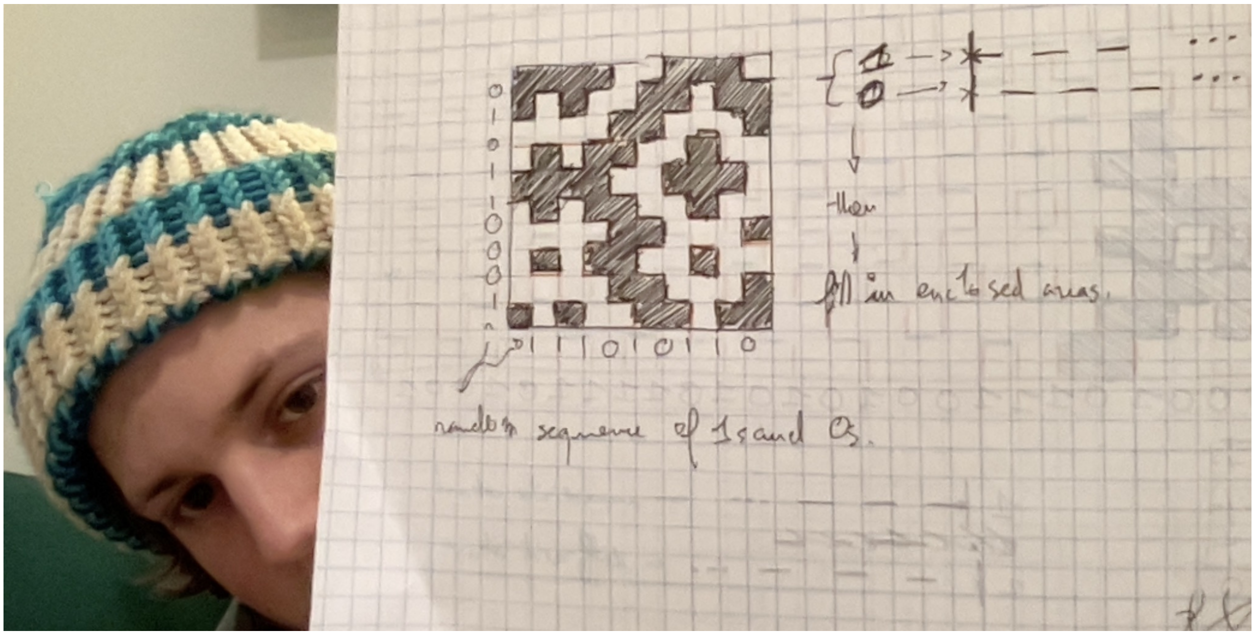
This is really useful, because we can query the point $z_c = 0 + 0i$ to determine if a $c$ value is part of the Mandelbrot set. If the orbit of $z_{n+1} = z_n^2 + c$ goes to infinity for $z_0 = 0 + 0i$, (or, since an orbit cannot return if it goes beyond 4 units from the origin, trust me, Dave told me so), then the value of $c$ is not part of the Mandelbrot set.

Also note: The period of orbits on the Mandelbrot set aligns with the bifurcation diagram of the logistic map.



### Dashed line (knitting pattern game)

Let's try a game where we make knitting patterns:



Okay, how does that look in code?

```r
# canvas settings
len <- 50
number <- 2 # desired number of unique patterns

for(i in 1:number){
  row_values <- sample(c(0, 1), len, replace=T) # 0 or 1 values
  col_values <- sample(c(0, 1), len, replace=T) # 0 or 1 values

  # paste(c("row values: ", row_values), collapse=" ")
  # paste(c("col values: ", col_values), collapse=" ")

  zero <- seq(1, by=2, length=(len %/% 2))
  one <- seq(0, by=2, length=(len %/% 2))

  # paste(c("zero sequence: ", zero), collapse=" ")
  # paste(c("one sequence: ", one), collapse=" ")

  dash_line_coords <- function(values){
    ticks <- c()
    for(v in values){
      if(v == 0){ticks <- c(ticks, zero)}
      else if(v == 1){ticks <- c(ticks, one)}
    }
    return(ticks)
  }

  x <- c(); y <-c() # ticks
  x <- dash_line_coords(row_values) # x ticks
  y <- dash_line_coords(col_values) # y ticks

  # x y xend yend format for geom_segment:
  hx <- x; hy <- rep(1:(len), each=(len %/% 2))
  hxend <- x+1; hyend <- hy

  vx <- rep(1:(len), each=(len %/% 2)); vy <- y
  vxend <- vx; vyend <- y+1

  plot <- tibble(hx, hy, hxend, hyend,
         vx, vy, vxend, vyend) %>%
    ggplot() +
    geom_segment(aes(x=hx, y=hy, xend=hxend, yend=hyend)) +
    geom_segment(aes(x=vx, y=vy, xend=vxend, yend=vyend)) + clear_theme + coord_equal()

  # when in a for loop, you have to explicityl print your plots:
  print(plot)
}
```