Week 7 class 2 - Chaos and Fractals (lab)

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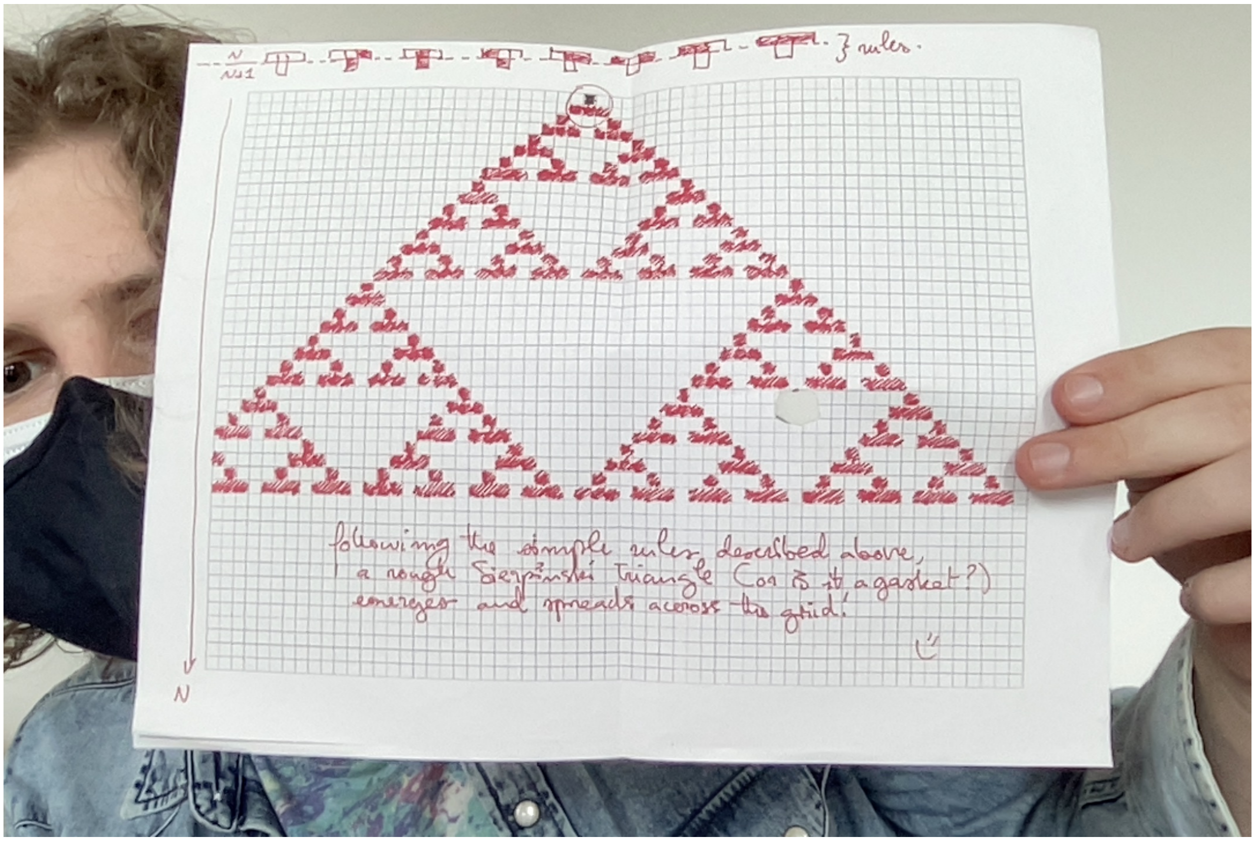


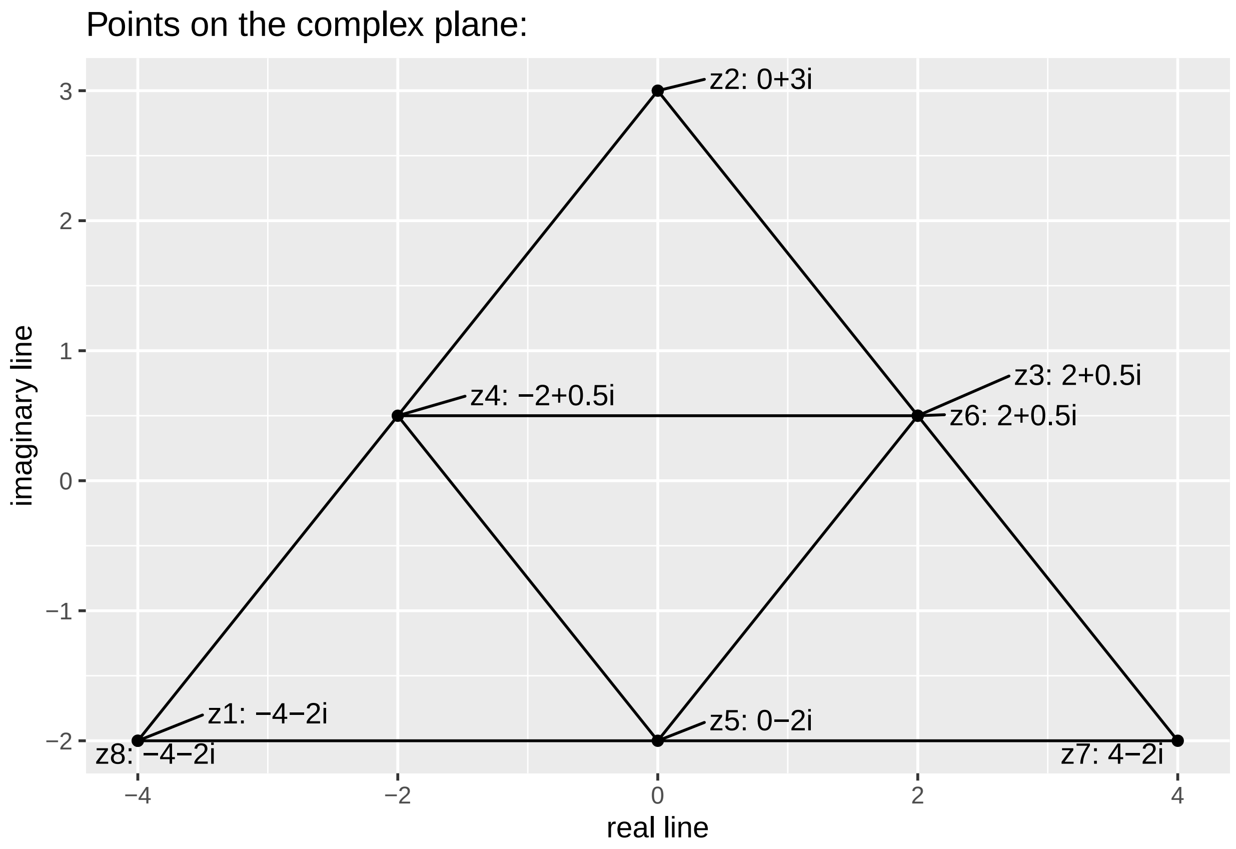
following the simple rules described above,
a rough Sierpinski triangle (or is it a gasket?)
emerges and spreads across the grid!

Week 7 Homework code:

```r
numbers <- c(-4-2i, 3i, 2+0.5i, -2+0.5i, -2i, 2+0.5i, 4-2i, -4-2i)
numbers_sq <- numbers^2

# let's split the complex numbers into real and imaginary parts to feed to ggplot
real <- Re(numbers)
imaginary <- Im(numbers)
name <- numbers
name2 <- c("z1", "z2", "z3", "z4", "z5", "z6", "z7", "z8")
```

```
tibble(real, imaginary, name=paste0(name2, sep=": ", as.character(name))) %>% ggplot(aes(real,
  geom_point() +
  geom_path() +
  geom_text_repel(aes(label=name), hjust = -0.5, vjust = -0.5) +
  labs(title= "Points on the complex plane:", x="real line", y = "imaginary line") +
  coord_equal()
```



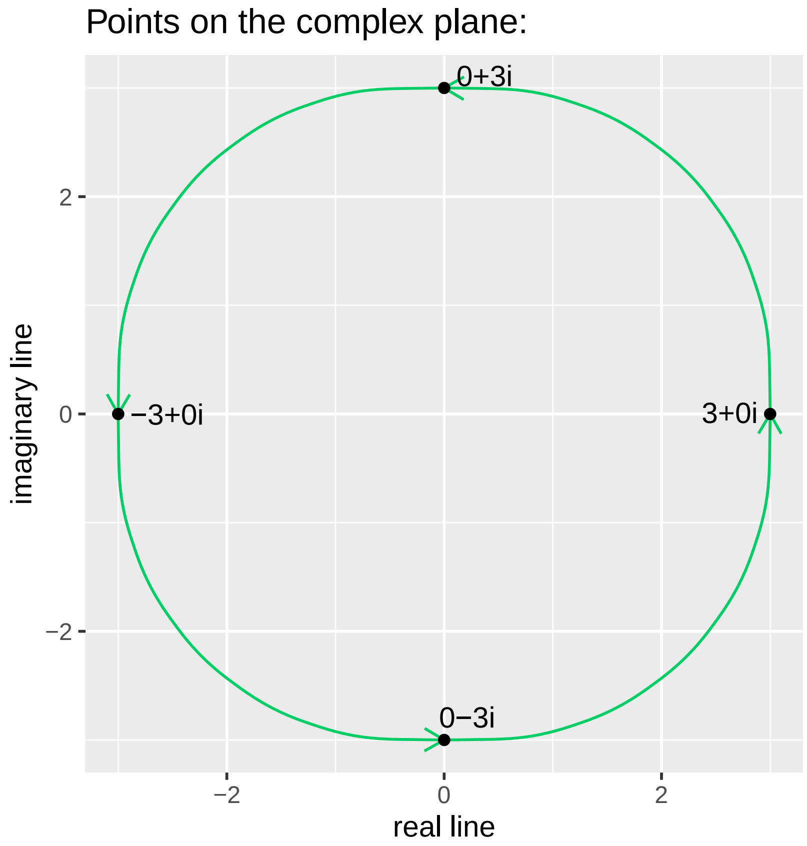
```
n <- 4
z_0 <- 3
funky <- function(z){return(z*1i)}

z_n <- z_0
for(i in 1:(n-1)){
  z_n <- c(z_n, funky(tail(z_n, 1)))
}
z_n
```

```
## [1]  3+0i  0+3i -3+0i  0-3i
```

```
tibble(real=Re(z_n), imaginary=Im(z_n), name=z_n) %>% ggplot(aes(real, imaginary)) +
  geom_curve(aes(x=real, y=imaginary, xend=shift(real, -1), yend=shift(imaginary, -1)),
             arrow = arrow(length = unit(0.3, "cm")), curvature = 0.5,
             colour = "springgreen3") +
  geom_point() +
  geom_text_repel(aes(label=name)) +
  labs(title= "Points on the complex plane:", x="real line", y = "imaginary line") +
  coord_equal()
```

```
## Don’t know how to automatically pick scale for object of type complex. Defaulting to continu
```



```
z_0 <- 2i
z_n <- z_0
for(i in 1:(n-1)){
  z_n <- c(z_n, funky(tail(z_n, 1)))
}
z_n
```

```
## [1]  0+2i -2+0i  0-2i  2+0i
```

```
tibble(real=Re(z_n), imaginary=Im(z_n), name=z_n) %>% ggplot(aes(real, imaginary)) +
  geom_curve(aes(x=real, y=imaginary, xend=shift(real, -1), yend=shift(imaginary, -1)),
             arrow = arrow(length = unit(0.3, "cm")), curvature = 0.5,
             colour = "springgreen3") +
  geom_point() +
  geom_text_repel(aes(label=name)) +
  labs(title= "Points on the complex plane:", x="real line", y = "imaginary line") +
  coord_equal()
```

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## Don’t know how to automatically pick scale for object of type complex. Defaulting to continu
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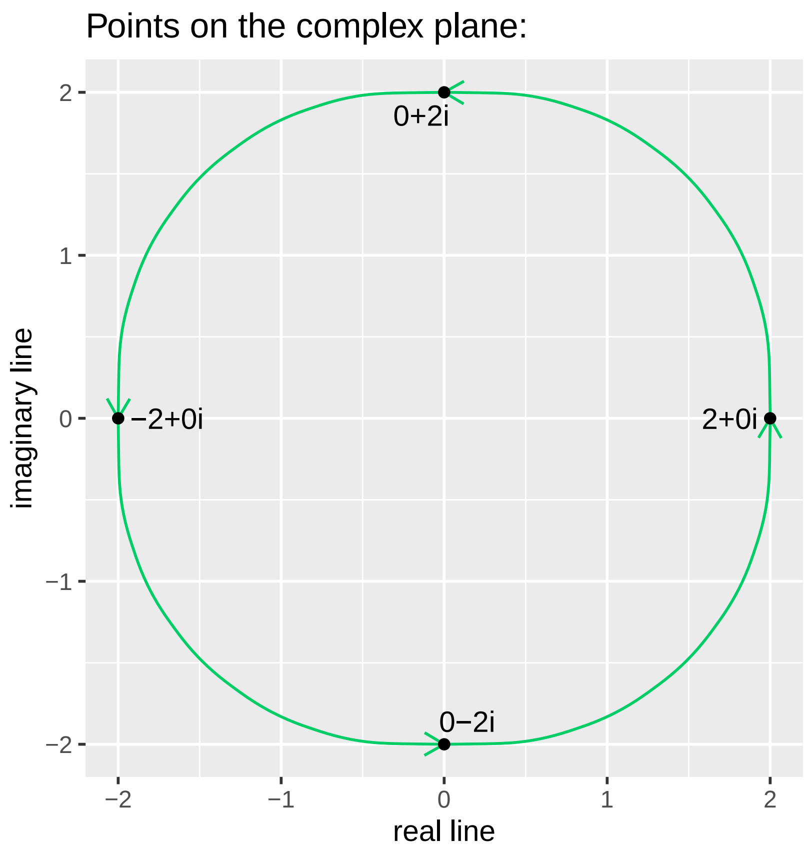


```
n <- 4
z_0 <- 3
funky <- function(z){return(z*1i)}

z_n <- z_0
for(i in 1:(n-1)){
  z_n <- c(z_n, funky(tail(z_n, 1)))
}
z_n
```

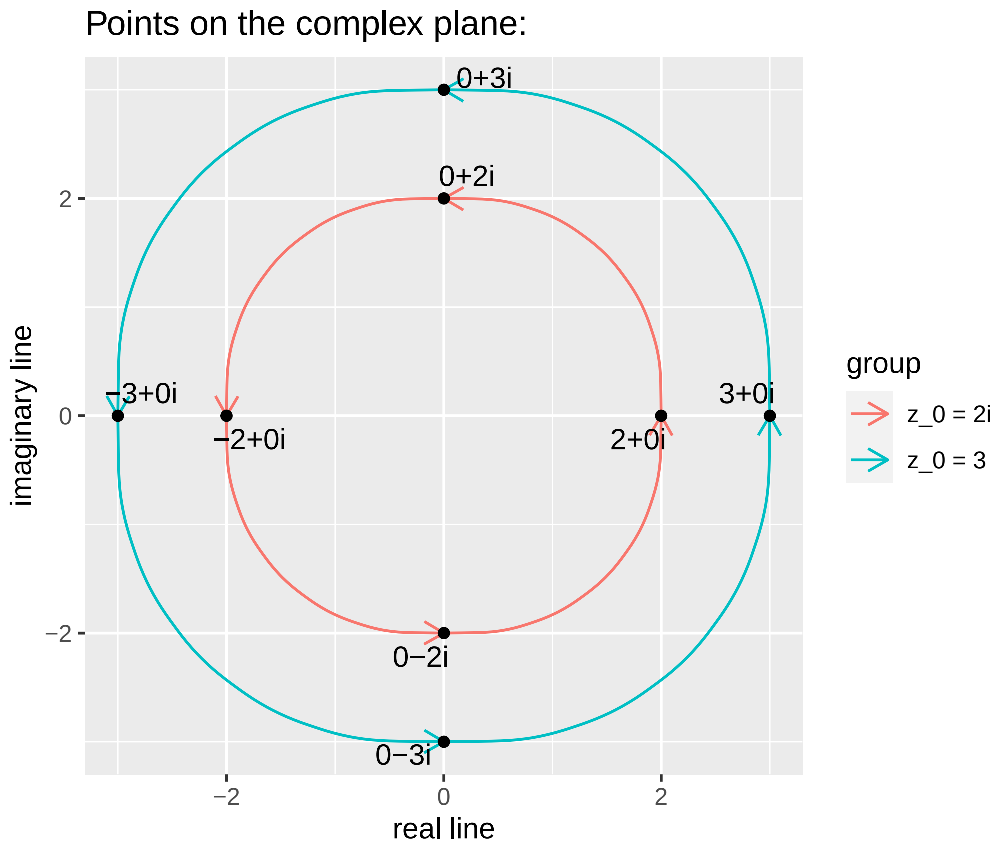
```
## [1]  3+0i  0+3i -3+0i  0-3i
```

```
data <- z_n

z_0 <- 2i
z_n <- z_0
for(i in 1:(n-1)){
  z_n <- c(z_n, funky(tail(z_n, 1)))
}
z_n
```

```
## [1]  0+2i -2+0i  0-2i  2+0i
```

```
data <- c(data, z_n)
group <- c(rep("z_0 = 3", 4), rep("z_0 = 2i", 4))

tibble(real=Re(data), imaginary=Im(data), name=data, group=group) %>% ggplot(aes(real, imagina
  geom_curve(aes(x=real, y=imaginary, xend=c(shift(real[1:4], -1), shift(real[5:8], -1)),
                 yend=c(shift(imaginary[1:4], -1), shift(imaginary[5:8], -1)),
                 colour = group),
             arrow = arrow(length = unit(0.3, "cm")), curvature = 0.5) +
  geom_point() +
  geom_text_repel(aes(label=name)) +
  labs(title= "Points on the complex plane:", x="real line", y = "imaginary line") +
  coord_equal()
```

```
## Don't know how to automatically pick scale for object of type complex. Defaulting to contin
```



```
options(scipen = 100)

base_n_val <- 0.01 # in this case, let's say the base is 10
goal_base <- 2 # we are converting notation to base 2

value <- 0:-14
value <- 2^value

presence <- c(0,0,0,0,0,0,0,0,0,0,1,0,0,0,1)

tibble("Decimal value"=value, "Presence/Absence"=presence)
```

```
## # A tibble: 15 x 2
##    `Decimal value` `Presence/Absence`
##              <dbl>              <dbl>
##  1       1                          0
##  2       0.5                        0
##  3       0.25                       0
##  4       0.125                      0
##  5       0.0625                     0
##  6       0.0312                     0
##  7       0.0156                     0
##  8       0.00781                    0
##  9       0.00391                    0
## 10       0.00195                    0
## 11       0.000977                   1
## 12       0.000488                   0
## 13       0.000244                   0
## 14       0.000122                   0
## 15       0.0000610                  1
```

```
data <- tibble(value, presence)
data
```

```
## # A tibble: 15 x 2
##        value presence
##        <dbl>    <dbl>
##  1 1                0
##  2 0.5              0
##  3 0.25             0
##  4 0.125            0
##  5 0.0625           0
##  6 0.0312           0
##  7 0.0156           0
##  8 0.00781          0
##  9 0.00391          0
## 10 0.00195          0
## 11 0.000977         1
## 12 0.000488         0
## 13 0.000244         0
## 14 0.000122         0
## 15 0.0000610        1
```

```
data %>% filter(presence == 1) %>% summarise(sum(value))
```

```
## # A tibble: 1 x 1
##   `sum(value)`
##          <dbl>
## 1      0.00104
```