Homework 4

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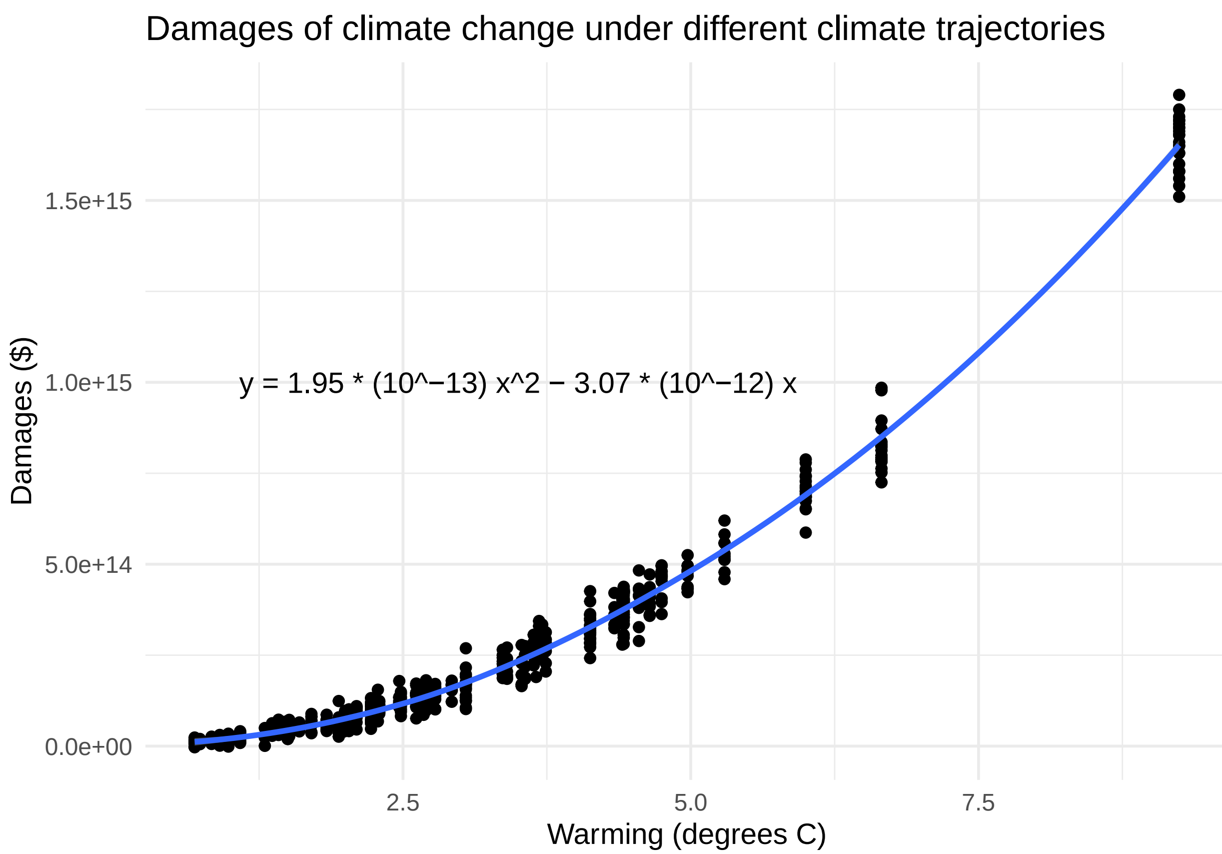
Question 1

```
#Question 1
##Read in the damages.csv file and then mutate to set up the quadratic equation
damages <- read.csv(here("data", "damages.csv")) %>%
  mutate(warm2 = warming^2)

##Create a linear model to find the estimated damage function in the damages data table
damages_lm <- lm(damages ~ warming + warm2, data = damages)
damages_lm[["coefficients"]][["(Intercept)"]] <- 0

##Create data visualization of damages.csv data
ggplot(data = damages, aes (x = warming, y = damages))+
  geom_point() +
  geom_smooth(data=damages, aes(x=warming, y=damages))+
  annotate(geom = "text", x = 3.5, y = 1000000000000000, label = "y = 1.95 * (10^-13) x^2 - 3.07 * (10^
  theme_minimal() +
  labs(x = "Warming (degrees C)", y = "Damages ($)", title = "Damages of climate change under different
```

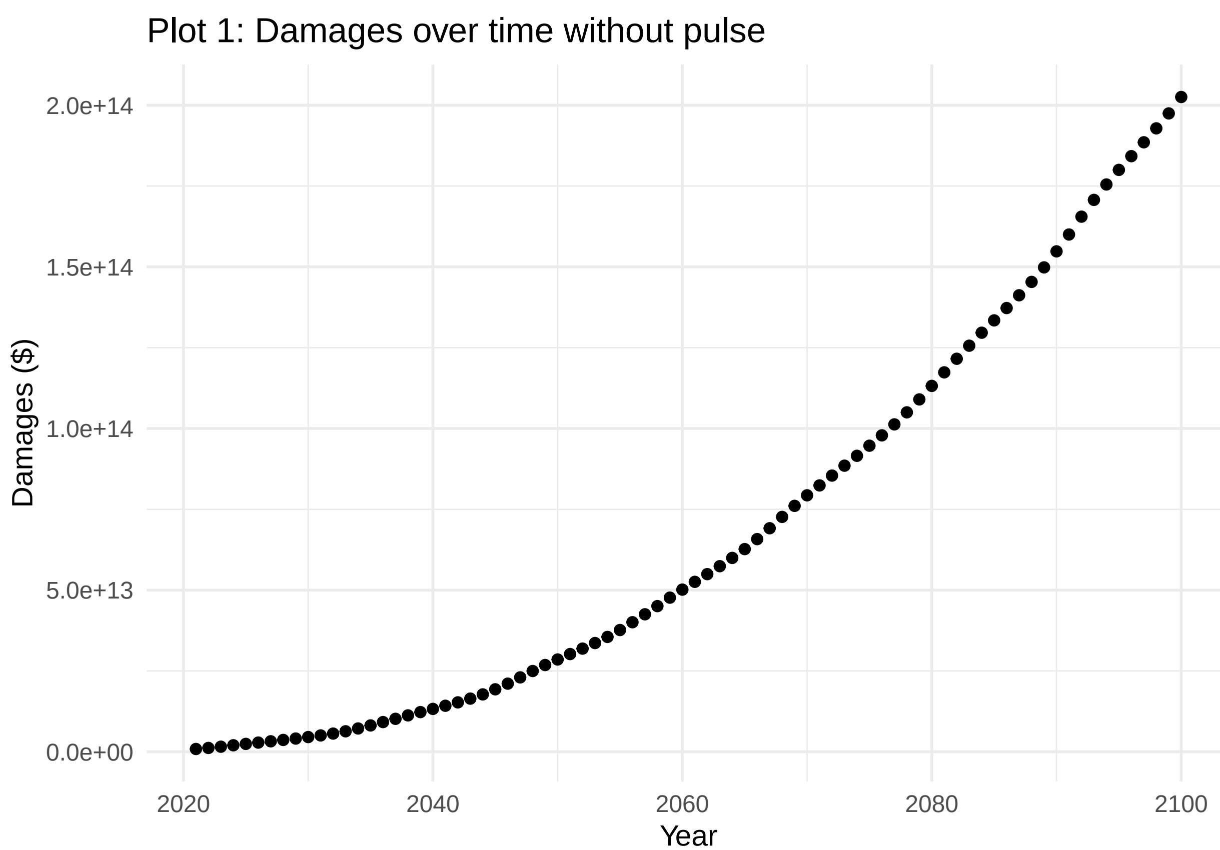


Question 2

```
#Question 2
##Read in the warming.csv file
warming <- read.csv(here("data", "warming.csv"))
```

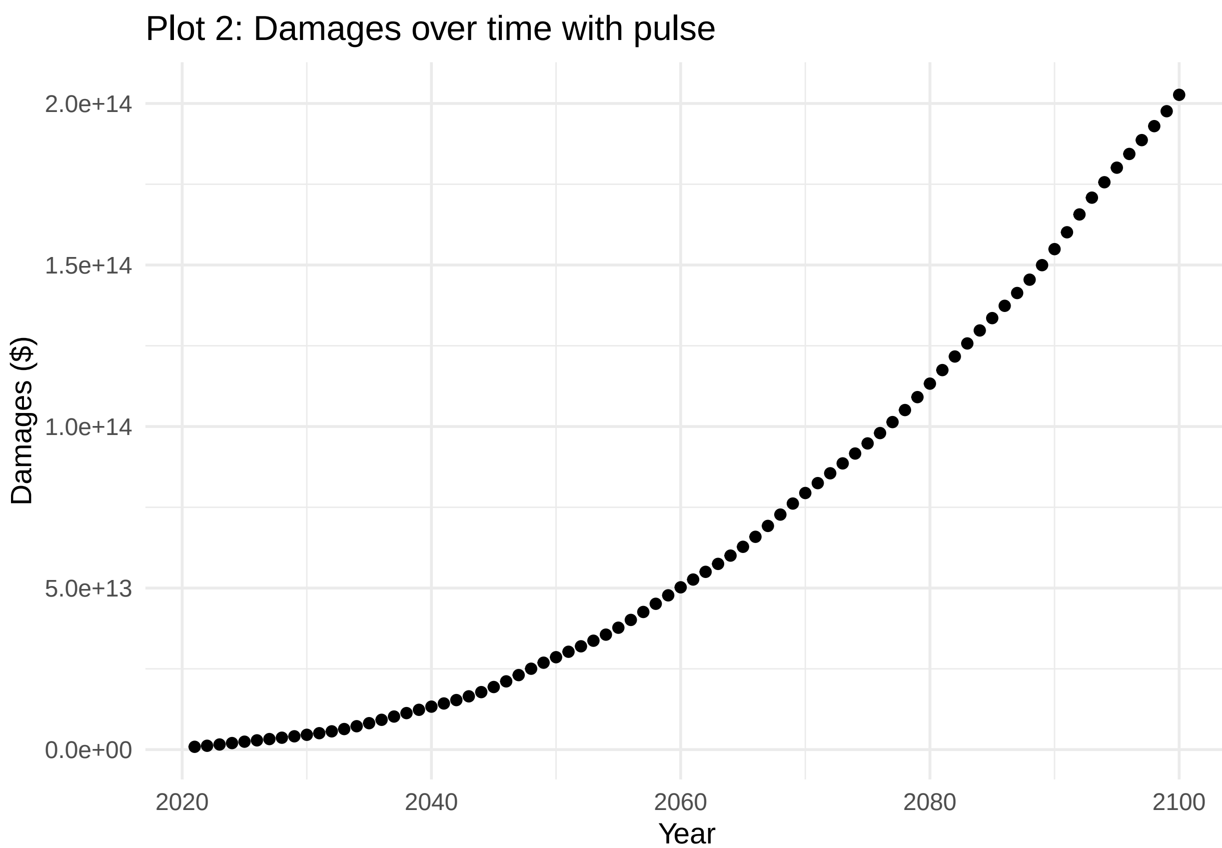
```
#Question 2
##Use the warming file and estimated damage function from Question 1 to create four plots
###Using the damages lm from Question 1, isolate the coefficient values to create this next graph.
x <- damages_lm[["coefficients"]][["warming"]]
x2 <- damages_lm[["coefficients"]][["warm2"]]
intercept <- damages_lm[["coefficients"]][["(Intercept)"]]

###Find the Difference in Damages over Time that Arise from the Pulse. After finding the difference, di
warming_difference <- warming %>%
  mutate(damage_base = (warming_baseline*x) + ((warming_baseline)^2*x2) + intercept,
         damage_high = ((warming_baseline*1.5)*x) + ((warming_baseline*1.5)^2*x2) + intercept,
         damage_pulse = (warming_pulse * x) + ((warming_pulse)^2 * x2) + intercept,
         damage_difference = damage_pulse - damage_base,
         damage_annual_cost = damage_difference/35000000000
         )
```

```r
###Damages Over Time without the Pulse
damage_plot <- ggplot(data = warming_difference, aes(x = year, y = damage_base))+
  geom_point()+
  theme_minimal() +
  labs(title = "Plot 1: Damages over time without pulse", x = "Year", y = "Damages ($)")

damage_plot
```

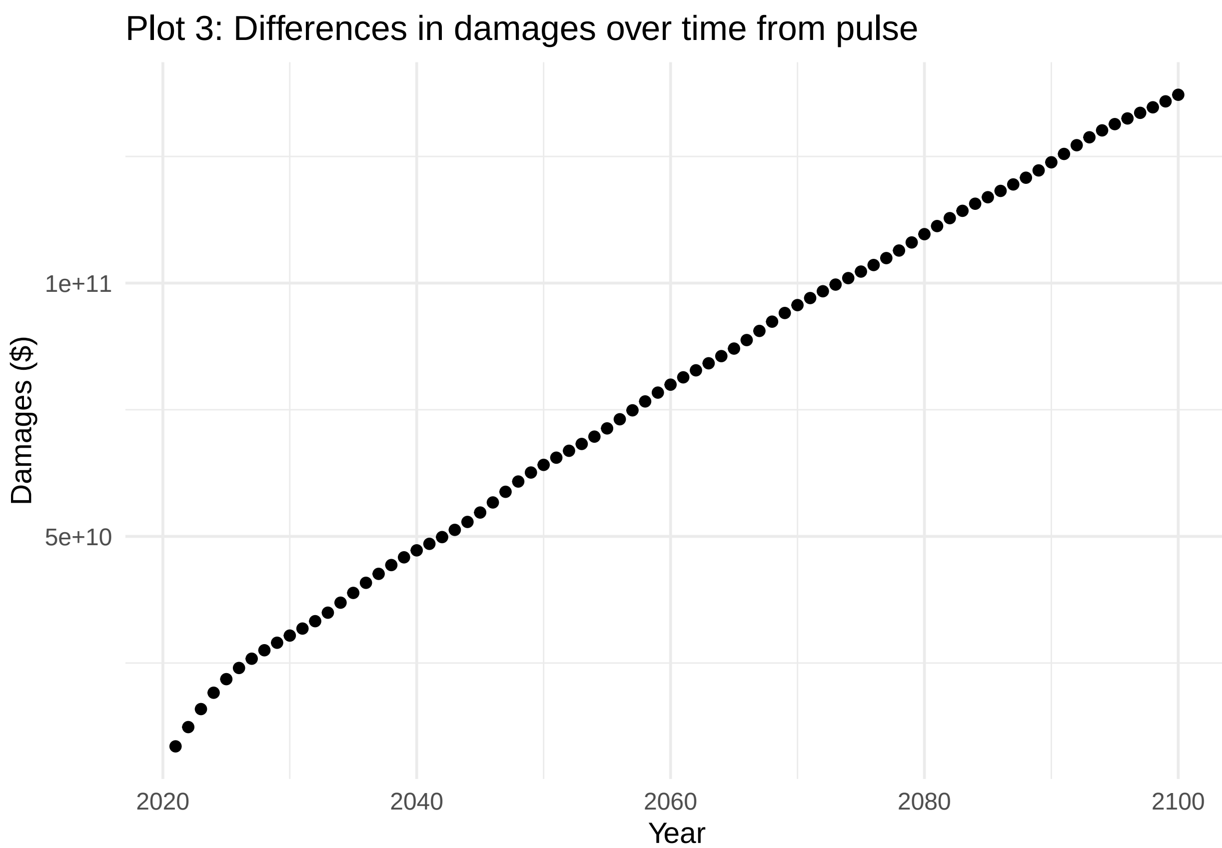


Plot 1-4

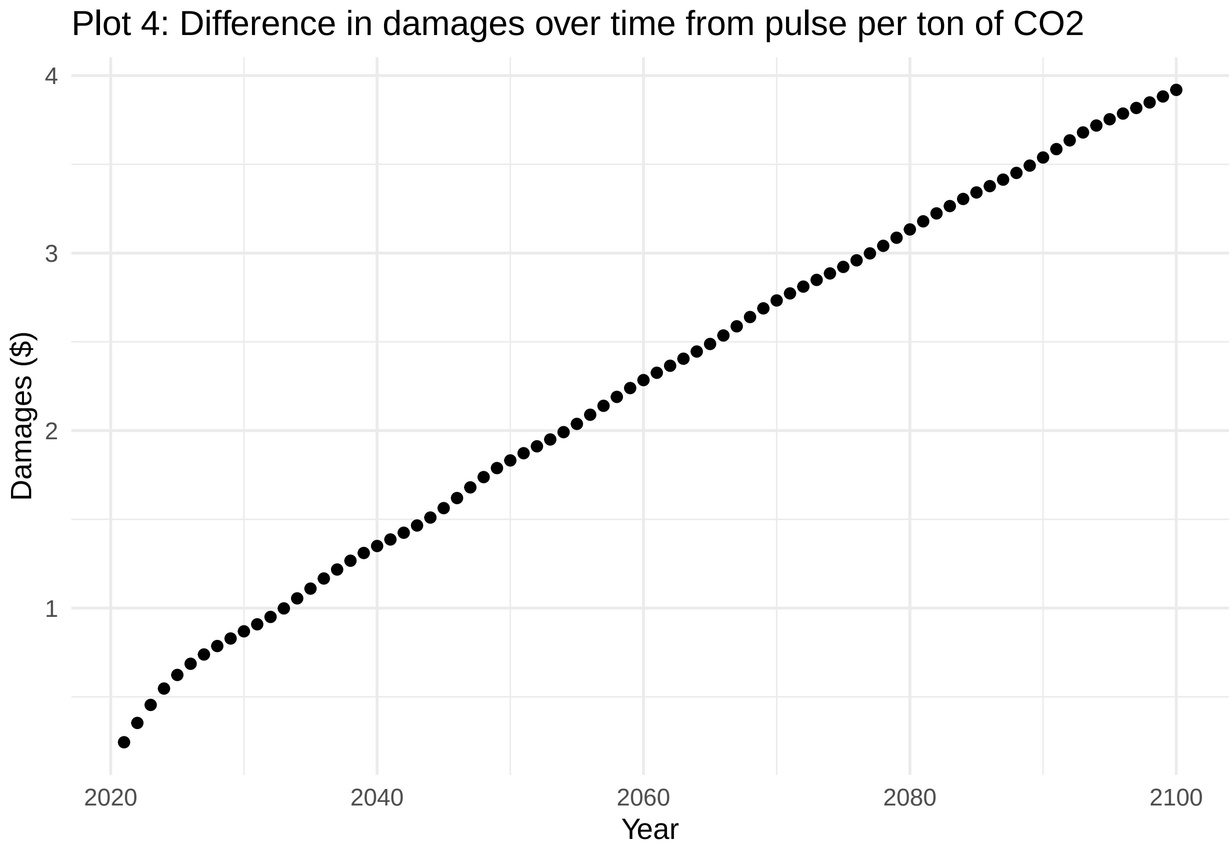
```r
###Damages Over Time with the Pulse
damage_pulse_plot <- ggplot(data = warming_difference, aes(x = year, y = damage_pulse))+
  geom_point()+
  theme_minimal() +
  labs(title = "Plot 2: Damages over time with pulse", x = "Year", y = "Damages ($)")

damage_pulse_plot
```




```
###Damage difference Over Time without the Pulse
damage_difference_plot <- ggplot(data = warming_difference, aes(x = year, y = damage_difference))+
  geom_point()+
  theme_minimal() +
  labs(title = "Plot 3: Differences in damages over time from pulse", x = "Year", y = "Damages ($)")

damage_difference_plot
```




```r
###Damage difference over time per ton of carbon
damage_ton_plot <- ggplot(data = warming_difference, aes(x = year, y = damage_annual_cost)) +
  geom_point() +
  theme_minimal() +
  labs(title = "Plot 4: Difference in damages over time from pulse per ton of CO2", x = "Year", y = "Dam

damage_ton_plot
```



Question 3

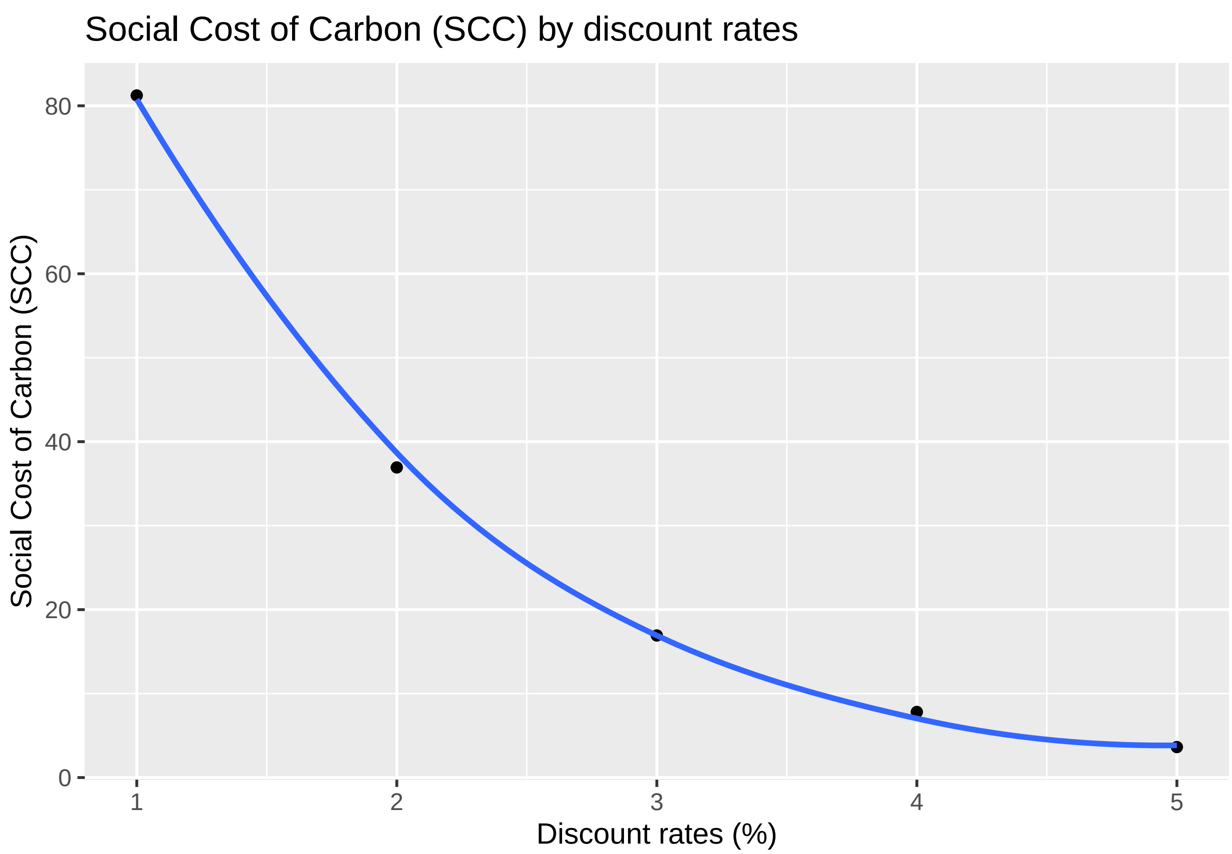
```
#Question 3
##Create a plot of SCC vs. Discount Rate
warming_scc <- warming_difference

warming_scc <- warming_difference %>%
  mutate(Discount1 = ((sum(warming_scc$damage_annual_cost))/(1+0.01)^80),
         Discount2 = ((sum(warming_scc$damage_annual_cost))/(1+0.02)^80),
         Discount3 = ((sum(warming_scc$damage_annual_cost))/(1+0.03)^80),
         Discount4 = ((sum(warming_scc$damage_annual_cost))/(1+0.04)^80),
         Discount5 = ((sum(warming_scc$damage_annual_cost))/(1+0.05)^80))

scc_table <- warming_scc %>%
  select("Discount1", "Discount2", "Discount3", "Discount4", "Discount5") %>%
  slice(1)

scc_table
```

```
##   Discount1 Discount2 Discount3 Discount4 Discount5
## 1  81.23011  36.93288  16.92189  7.811956  3.633147
```

```r
trans_scc_table <- t(scc_table)

discount_scc = data.table(
  SCC = c(81.2301056376792, 36.9328804024112, 16.9218929850311, 7.8119557882259, 3.6331472085021),
  Discount_rate = c(1, 2, 3, 4, 5)
)

discount_scc
```

```
##          SCC Discount_rate
## 1: 81.230106             1
## 2: 36.932880             2
## 3: 16.921893             3
## 4:  7.811956             4
## 5:  3.633147             5
```

```r
ggplot(data = discount_scc, aes(x = Discount_rate, y = SCC)) +
  geom_point() +
  geom_smooth(data = discount_scc, aes(x = Discount_rate, y = SCC), span = 1, se = FALSE) +
  labs(title = "Social Cost of Carbon (SCC) by discount rates", x = "Discount rates (%)", y = "Social Co
```



Question 4

```r
# Question 4 Ramsey Rule
p = .001
n = 2
g = 0.01

r = p + n*g

r
```

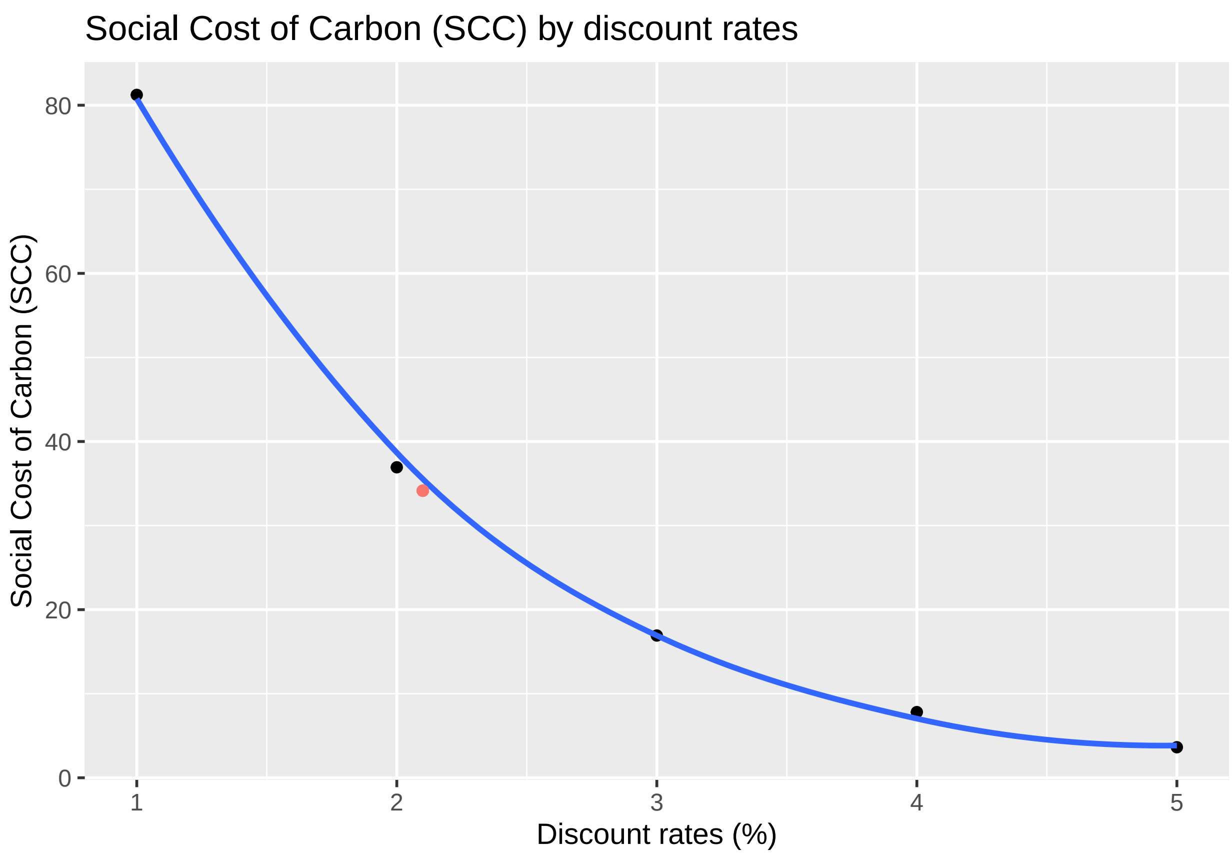
The SCC with a discount rate of 2.1% is $34.15 calculated using the Ramsey Rule. This value is represented on the plot below, shown in coral.

```
## [1] 0.021
```

```r
SCC2.1 = ((sum(warming_scc$damage_annual_cost))/(1+0.021)^80)
SCC2.1
```

```
## [1] 34.14818
```

```r
# Add 2.1% discount rate SCC point on plot
ggplot(data = discount_scc, aes(x = Discount_rate, y = SCC)) +
  geom_point() +
  geom_smooth(data = discount_scc, aes(x = Discount_rate, y = SCC), span = 1, se = FALSE) +
  labs(title = "Social Cost of Carbon (SCC) by discount rates", x = "Discount rates (%)", y = "Social Co
  geom_point(aes(x = 2.1, y = 34.14818, color = "coral12"), show.legend = FALSE)
```



Question 5

The expected present value of damages up to 2100 under Policy A is $1,869,052,186,623,438.

The expected present value of damages up to 2100 under Policy B is $1,422,733,591,966,428.

The difference between damages under Policy A and Policy B given X costs for Policy B is $446,318,594,657,010.

```
# Question 5
## Expected present value of damages up to 2100 under Policy A

p1 = 0.5
x_1 = sum(warming_difference$damage_base)/(1+0.02)^80
p2 = 0.5
x_2 = sum(warming_difference$damage_high)/(1+0.02)^80

E = (p1 * x_1) + (p2 * x_2)

E
```

A risk-averse population would be inclined to favor Policy B because Policy A has a 50% probability that the damages will be greater than under Policy B. Despite Policy B having associated costs, unlike under Policy A, it still is more economically stable.

```
## [1] 1.869052e+15
```

```
## Expected present value of damages up to 2100 under Policy B
policy_b_2050 <- warming_difference %>%
  filter(year < 2051)

a = sum(warming_difference$damage_base)
b = (2.853968e+13)*50
a + b
```

```
## [1] 6.936451e+15
```

```
E_policy_b = (a + b)/(1+0.02)^80
E_policy_b
```

```
## [1] 1.422734e+15
```

```
## Find the difference between damages under Policy A and Policy B given X costs for Policy B
X_cost = E - E_policy_b
X_cost
```

```
## [1] 4.463186e+14
```

```
## A risk-averse population would be inclined to favor Policy B because Policy A has a 50% probability t
```