IS609 - Assignment 5

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```
library(knitr)
library(ggplot2)
```

Problem 1

_	grease	sweet
grease	0.25	0.75
sweet	0.07	0.93

$$g_{n+1} = 0.25g_n + 0.07s_n$$

$$2_{n+1} = 0.93s_n + 0.75s_n$$

```
dining.model <- function(gs){
  mat.result <- matrix(data = c(0, 0), nrow = 1, ncol = 2)
  mat.result[1] <- 0.25*gs[1] + 0.07*gs[2]
  mat.result[2] <- 0.93*gs[2] + 0.75*gs[1]
  return(mat.result)
}

#Starting with 100% of the students going to Grease Dining Hall
dining.behavior <- matrix(data = c(1,0), nrow = 1, ncol = 2)
iters <- 10

for(i in 1:iters) {
 dining.behavior <- rbind(dining.behavior, dining.model(dining.behavior[i,]))}

dining.behavior <- as.data.frame(cbind(0:iters, dining.behavior))

colnames(dining.behavior) <- c("Step", "Grease", "Sweet")

kable(dining.behavior)
```

Step	Grease	Sweet
0	1.0000000	0.0000000
1	0.2500000	0.7500000
2	0.1150000	0.8850000

3	0.0907000	0.9093000
4	0.0863260	0.9136740
5	0.0855387	0.9144613
6	0.0853970	0.9146030
7	0.0853715	0.9146285
8	0.0853669	0.9146331
9	0.0853660	0.9146340
10	0.0853659	0.9146341

Problem 2

Subsystem 1

```
pwr <- 0.996
PC.unit <- 0.999

ss.1 <- pwr * PC.unit
```

Subsystem 2

```
# a far more reliable keyboard than I've ever used...
keyboard <- 0.9999
mouse <- 0.9998

ss.2 <- keyboard + mouse - (keyboard * mouse)
```

Subsystem 3

```
floppy.a <- 0.995
HD <- 0.995
CD <- 0.999

ss.3 <- 1-((1 - floppy.a) * (1 - HD) * (1 - CD))
```

Subsystem 4

```
printer <- 0.995
color.laser <- 0.999

ss.4 <- printer + color.laser - (printer * color.laser)
```
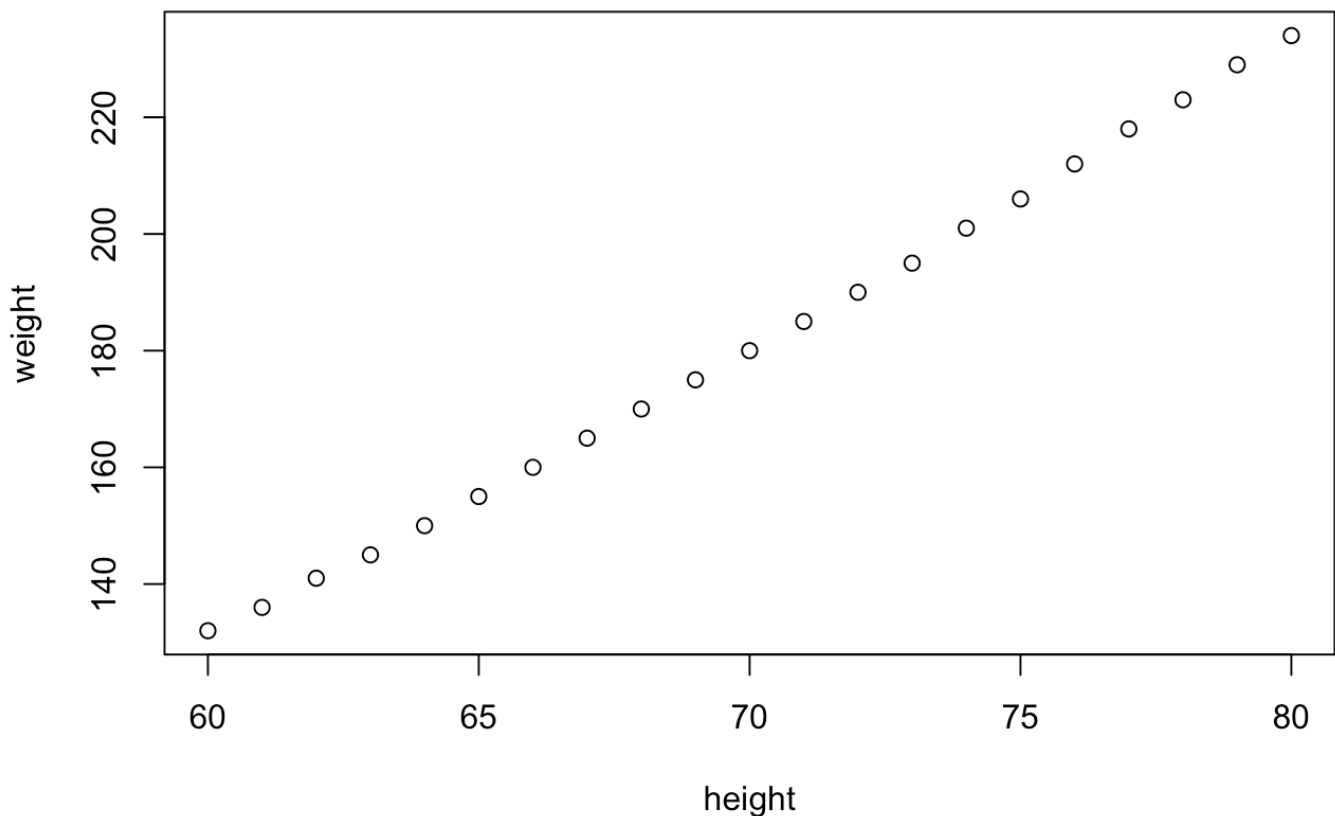
Total System Reliability

```
system <- ss.1 * ss.2 * ss.3 * ss.4
system
```

```
## [1] 0.994999
```

A good primer on this topic: https://src.alionscience.com/pdf/S&PSYSREL.pdf
(https://src.alionscience.com/pdf/S&PSYSREL.pdf)

Problem 3

```
height <- 60:80
weight <- c(132, 136, 141, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195,
201, 206, 212, 218, 223, 229, 234)
plot(x = height, y = weight)
```


Slope

```
m <- length(height)
slope.num <- m * sum(height * weight) - (sum(height) * sum(weight))
slope.den <- m * sum(height ** 2) - sum(height) ** 2

slope = slope.num / slope.den
slope
```

```
## [1] 5.136364
```
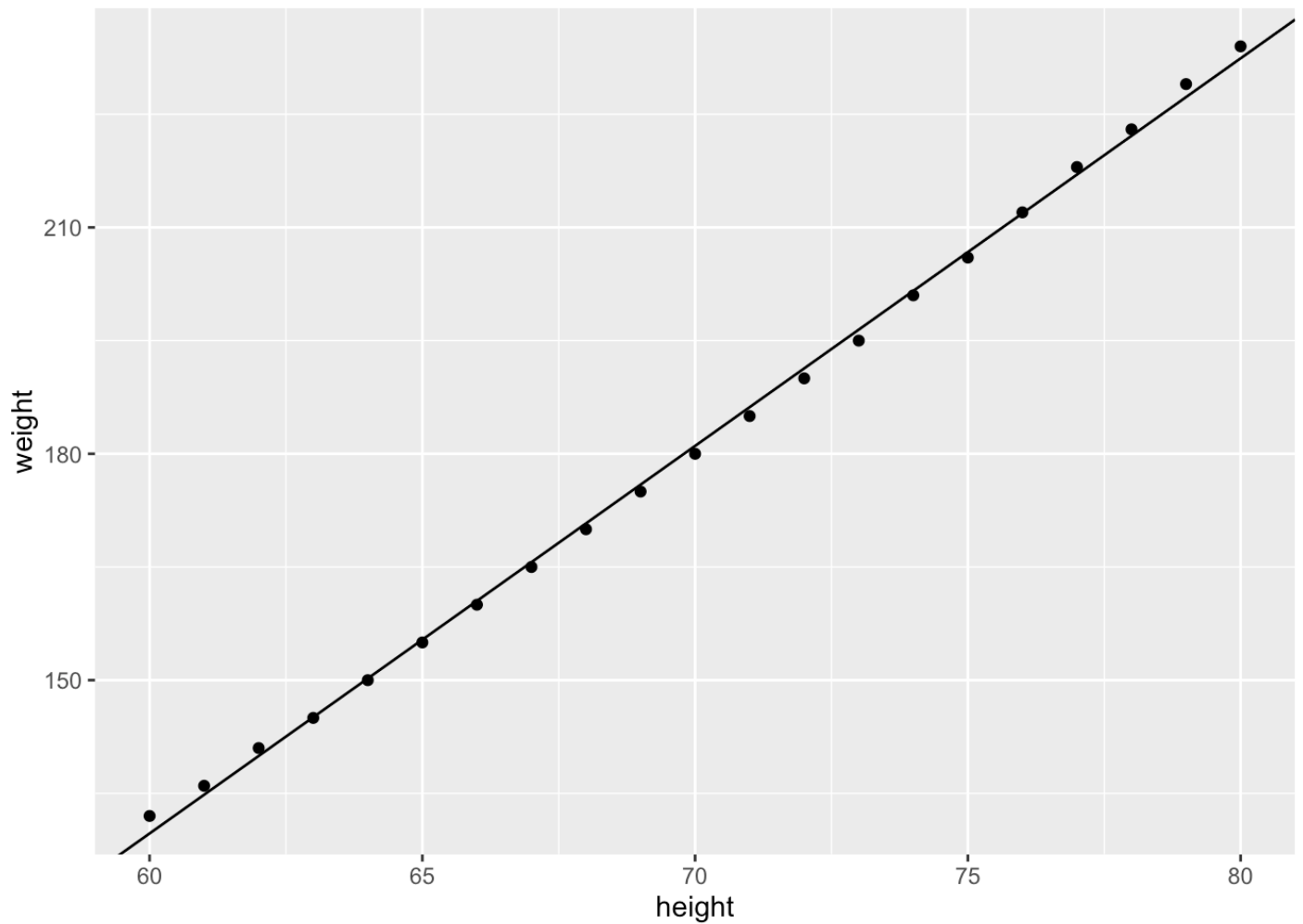
Intercept

```
intercept.num <- (sum(height **2)  * sum(weight)) - (sum(height * weight) * sum(he
ight))
intercept.den <- m* sum(height **2) - sum(height) ** 2
intercept <- intercept.num / intercept.den
intercept
```

```
## [1] -178.4978
```

$weight = -178.49 + 5.13636 height$

```
HW.data <- as.data.frame(cbind(height, weight))

ggplot(HW.data, aes(x = height, y = weight)) + geom_point() + geom_abline(intercep
t = intercept, slope = slope)
```

SSE

```
sse <- sum(weight - (slope * height + intercept)) ** 2
sse
```

```
## [1] 2.916135e-25
```

SST

```
mean.weight <- mean(weight)

sst <- sum((weight - mean.weight) ** 2)
sst
```

```
## [1] 20338.95
```

SSR

```
ssr <- sst - sse
ssr
```

```
## [1] 20338.95
```
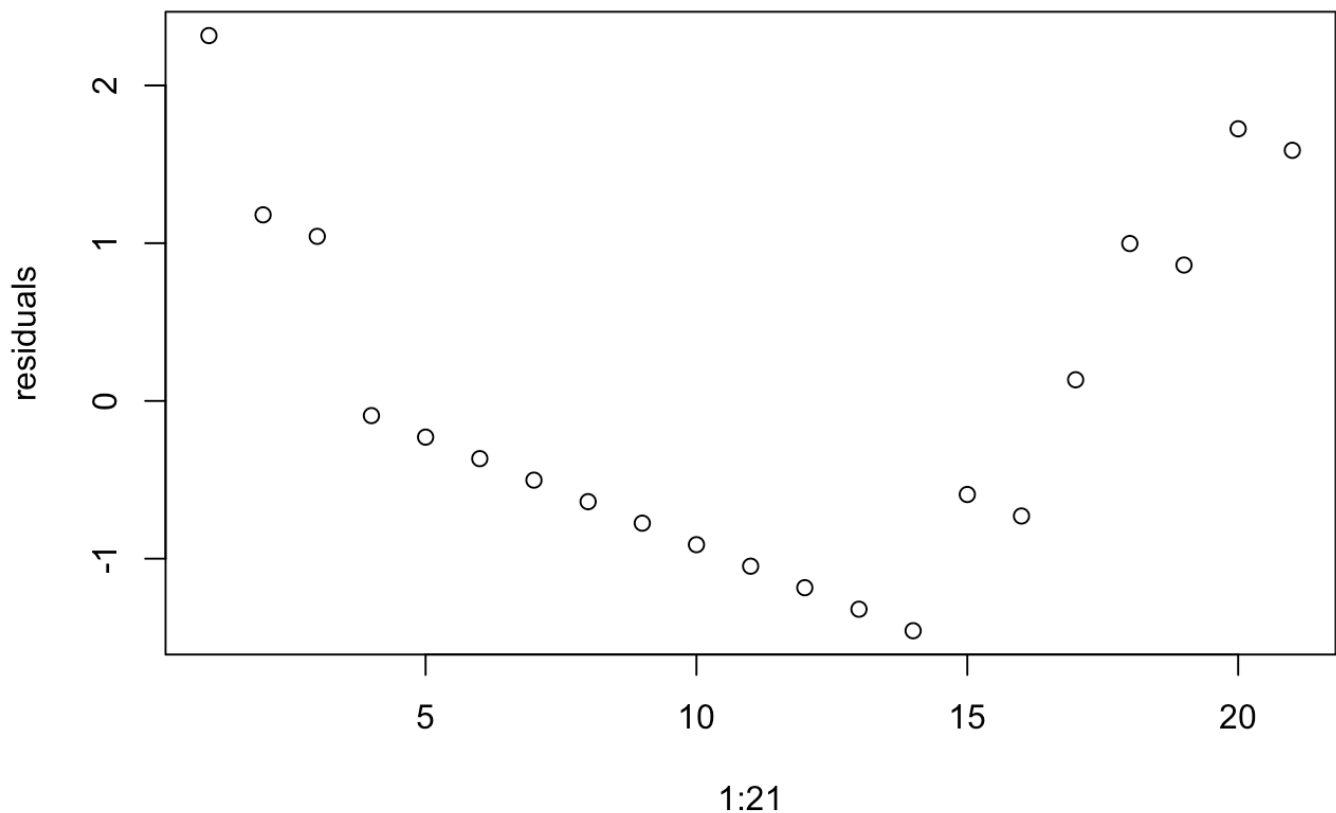
Coefficient of Determination

```
r2 <- 1 - (sse / sst)
r2
```

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

Residuals

```
residuals <- weight - (slope * height + intercept)

plot(x = 1:21, y = residuals)
```


These residuls follow a strange angled pattern. This indicates a poorly fitting model.

Problem 4

```
height.cubed <- height ** 2
```

Slope

```
m <- length(height.cubed)
slope.num <- m * sum(height.cubed * weight) - (sum(height.cubed) * sum(weight))
slope.den <- m * sum(height.cubed ** 2) - sum(height.cubed) ** 2

slope = slope.num / slope.den
slope
```

```
## [1] 0.03668112
```

Intercept

```
intercept.num <- (sum(height.cubed **2)  * sum(weight)) - (sum(height.cubed * weig
ht) * sum(height.cubed))
intercept.den <- m* sum(height.cubed **2) - sum(height.cubed) ** 2
intercept <- intercept.num / intercept.den
intercept
```
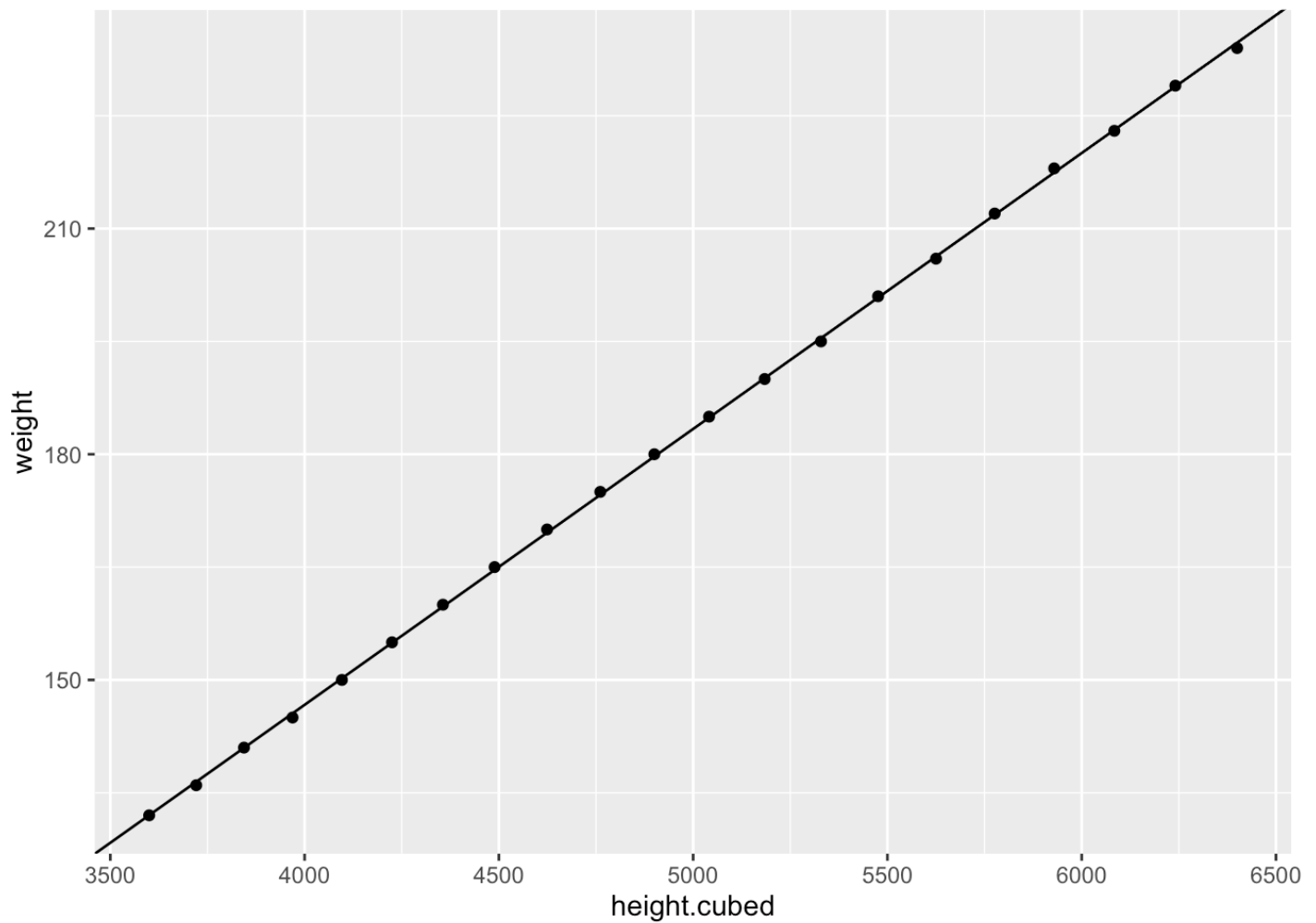
```
## [1] -0.03484824
```

$$weight = -0.03484824 + 0.03668112 height^2$$

```
HW.data <- as.data.frame(cbind(height.cubed, weight))

ggplot(HW.data, aes(x = height.cubed, y = weight)) + geom_point() + geom_abline(in
tercept = intercept, slope = slope)
```

SSE

```
sse <- sum(weight - (slope * (height **2) + intercept)) ** 2
sse
```

```
## [1] 1.29247e-26
```

SST

```
mean.weight <- mean(weight)

sst <- sum((weight - mean.weight) ** 2)
sst
```

```
## [1] 20338.95
```

SSR

```
ssr <- sst - sse
ssr
```

```
## [1] 20338.95
```

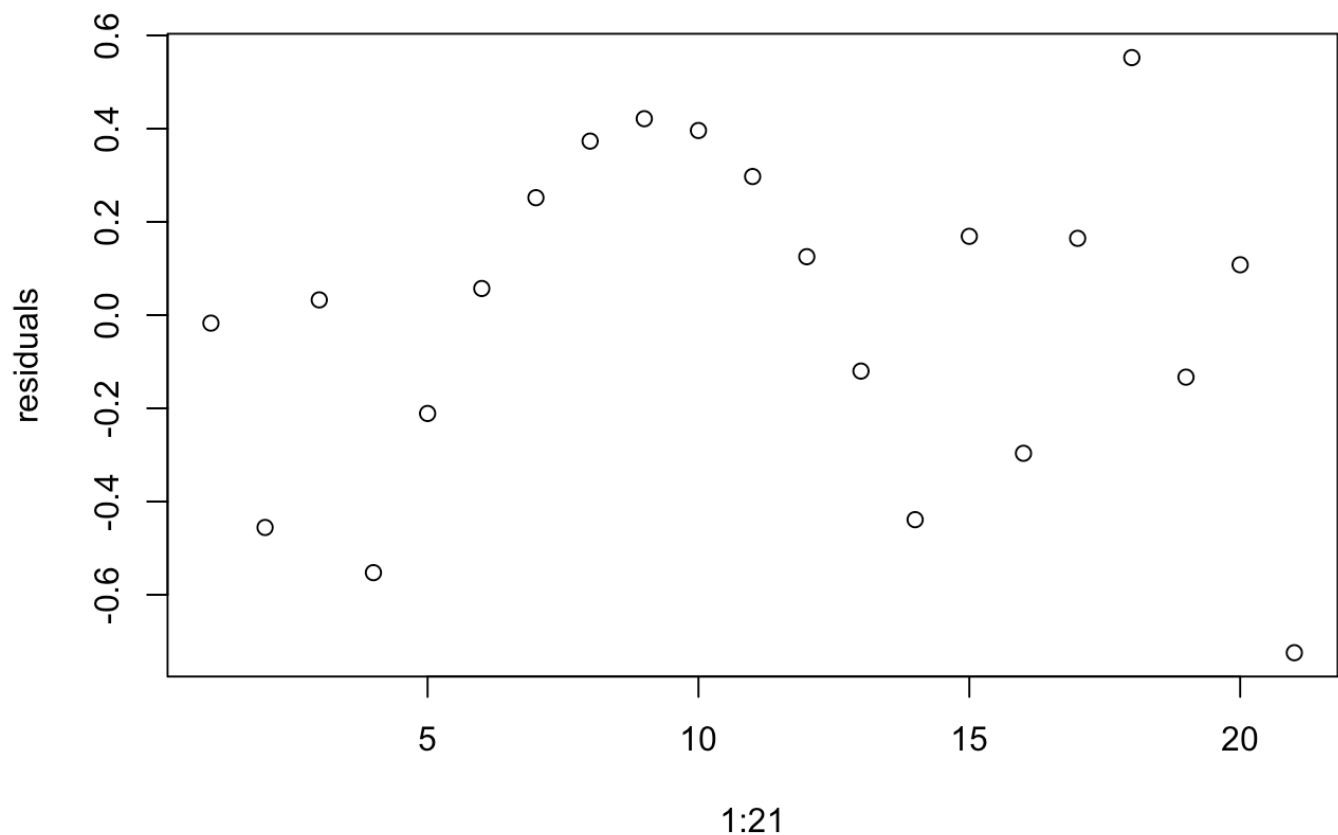## Coefficient of Determination

```
r2 <- 1 - (sse / sst)
r2
```

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

Residuals

```
residuals <- weight - (slope * (height **2) + intercept)

plot(x = 1:21, y = residuals)
```


The residuals are more random. This indicates a better model than in the previous question.