HW1

Astghik

2024-10-16

```
# install.packages("readxl")
# install.packages("cli")
# install.packages("fansi")
# install.packages("minpack.lm")
# install.packages("ggplot2")
#install.packages("fastmap")
```

Innovation: The Studio Buds + (https://time.com/collection/best-inventions-2023/6327223/beats-studio-buds/) Look like product: Wire headphones The Studio Buds + offer advanced features like active noise cancellation (ANC), enhanced battery life, and wireless connectivity—making them more suited for the modern, on-the-go consumer. In contrast, traditional wired headphones rely on a direct physical connection for sound quality, which can be more reliable in certain settings (no interference or battery drain), but lack the mobility and convenience of wireless technology.

From a market impact perspective, wired headphones have been a staple for decades, appealing to audiophiles for their consistent performance. However, wireless options like the Studio Buds + dominate today's market by catering to consumers who prioritize convenience and cutting-edge features like Bluetooth, portable charging, and futuristic aesthetics. This contrast highlights how the Studio Buds + build on the foundation of wired headphones, offering more in terms of portability and innovative design.

```
library(readxl)
library(minpack.lm)

data <- read_excel("data.xlsx")
print(data)
```

```
## # A tibble: 10 x 2
##    Year  shipments
##    <chr>     <dbl>
##  1 2013       286
##  2 2014       310.
##  3 2015       331.
##  4 2016       349
##  5 2017       363
##  6 2018       381.
##  7 2019       445
##  8 2020       549
##  9 2021       548
## 10 2022       553
```

```
sales <- data$shipments
t <- 1:length(sales)

bass_m <- nlsLM(sales ~ m * (((p + q)^2 / p) * exp(-(p + q) * t)) / ((1 + (q / p) * exp(-(p + q) * t))^2
                        start = list(m = sum(sales), p = 0.02, q = 0.4),
                        control = nls.lm.control(maxiter = 100))

summary(bass_m)
```

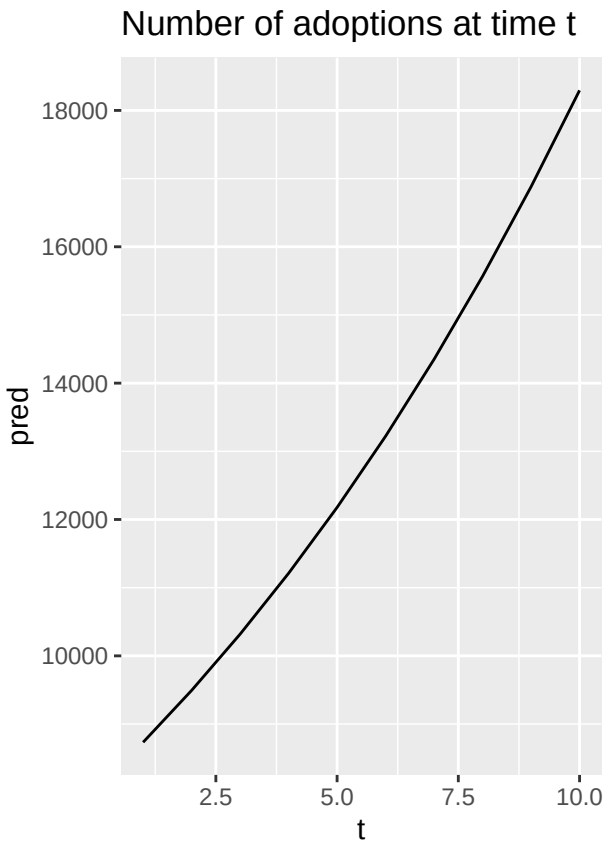
```
##
## Formula: sales ~ m * (((p + q)^2/p) * exp(-(p + q) * t))/((1 + (q/p) *
##     exp(-(p + q) * t))^2)
##
## Parameters:
##    Estimate Std. Error t value Pr(>|t|)
## m 1.768e+05  2.757e+06   0.064    0.951
## p 1.434e-03  2.224e-02   0.064    0.950
## q 8.543e-02  5.525e-02   1.546    0.166
##
## Residual standard error: 29.93 on 7 degrees of freedom
##
## Number of iterations till stop: 94
## Achieved convergence tolerance: 1.49e-08
## Reason stopped: Number of calls to `fcn' has reached or exceeded `maxfev' == 400.
```

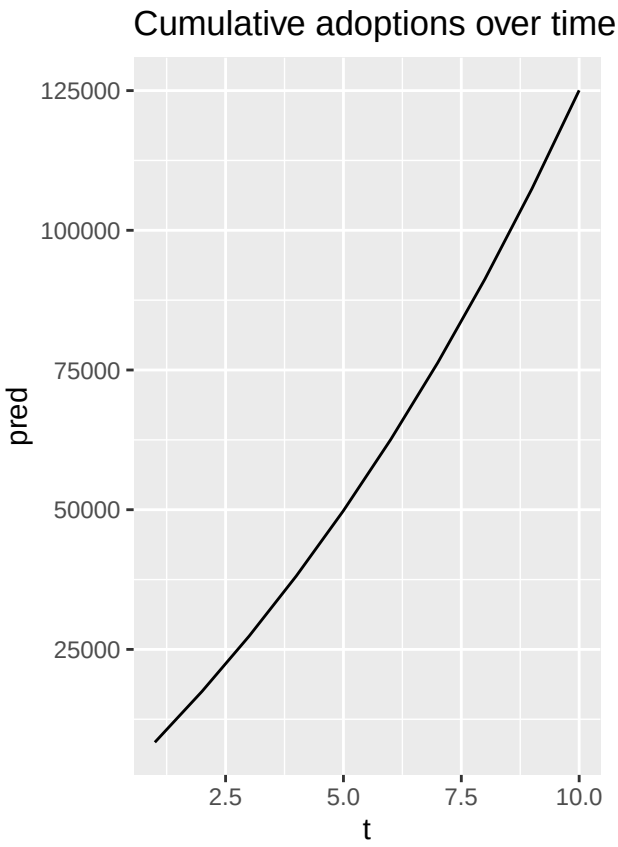
To calculate the market potential for "Stand-out Headphones," I used the estimated global headphone market size of $28 billion in 2022 and divided it by an assumed average selling price (ASP) of $100 per pair of headphones. This gave an estimate of 280 million units sold in the market. To estimate potential customers for the new headphones, I assumed this innovation could capture 1-3% market share. Applying this to the total market size will be between 2.8 to 8.4 million customers. I choose 5.6 million.

```
library(ggpubr)
```

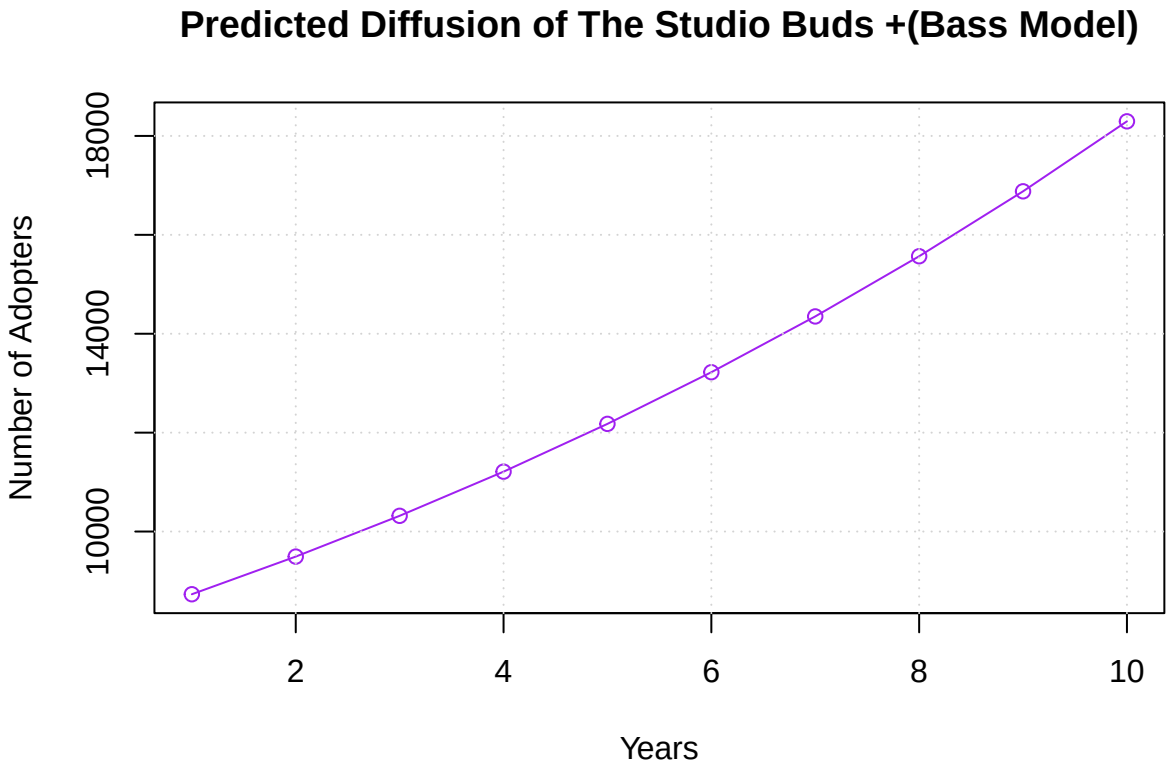
```
##               : ggplot2
```

```
m <- 5600000
p <- coef(bass_m)["p"]
q <- coef(bass_m)["q"]

pred <- m * (((p + q)^2 / p) * exp(-(p + q) * t)) / ((1 + (q / p) * exp(-(p + q) * t))^2)
pred_df <- data.frame(t = t, pred = pred)

pred1 <- m * (1 - exp(-(p + q) * t)) / (1 + (q / p) * exp(-(p + q) * t))
pred1_df <- data.frame(t = t, pred = pred1)

p1 <- ggplot(pred_df, aes(x = t, y = pred)) + geom_line() + ggtitle("Number of adoptions at time t")

p2 <- ggplot(pred1_df, aes(x = t, y = pred)) + geom_line() + ggtitle("Cumulative adoptions over time")

ggarrange(p1, p2)
```






```r
bass_model <- function(t, p, q, M) {
  exp_term <- exp(-(p + q) * t)
  return(m * (((p + q)^2 / p) * exp_term) / (1 + (q / p) * exp_term)^2)
}

m <- 5600000
p <- coef(bass_m)["p"]
q <- coef(bass_m)["q"]
years <- 1:10

adopters <- bass_model(years, p, q, M)

df <- data.frame(Year = years, Adopters = round(adopters))

plot(df$Year, df$Adopters, type = "o", col = "purple", xlab = "Years", ylab = "Number of Adopters",
     main = "Predicted Diffusion of The Studio Buds +(Bass Model)")
grid()
```




```
print(df)
```

```
##    Year Adopters
## 1     1     8732
## 2     2     9493
## 3     3    10318
## 4     4    11211
## 5     5    12177
## 6     6    13222
## 7     7    14350
## 8     8    15567
## 9     9    16880
## 10   10    18295
```

```
df$Cumulative_Adopters <- cumsum(df$Adopters)

print(df)
```

```
##    Year Adopters Cumulative_Adopters
## 1     1     8732                8732
## 2     2     9493               18225
## 3     3    10318               28543
## 4     4    11211               39754
## 5     5    12177               51931
```

```
## 6      6    13222              65153
## 7      7    14350              79503
## 8      8    15567              95070
## 9      9    16880             111950
## 10    10    18295             130245
```