HW1

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2023-09-29

Innovation: Smart sunglasses https://time.com/collection/best-inventions-2022/6229141/deepoptics-32n-adaptive-focus-sunglasses/

DeepOptics originally wanted to make goggles for 3D television. But when the founders realized that more people have aging eyes than 3D TVs, they decided to use their vision tech to help people over 45 see both close and far, outside and in. Their first product, named for the latitude of DeepOptics' hometown of Tel Aviv, has tinted liquid-crystal lenses that realign into magnifying "readers" when the wearer swipes the temple with a finger. (A companion phone app allows users to set a specific reading magnification level.) A version with transparent lenses, switching between a distance Rx and close-up magnification, is planned.

Look-alike Innovation: Usual sunglasses

Smart sunglasses is a groundbreaking advancement in eyewear technology, addressing the needs people with vision changes. Unlike traditional sunglasses that simply provide UV protection, DeepOptics' innovation incorporates liquid-crystal lenses that dynamically adjust to meet the wearer's specific visual requirements. With a simple swipe of the temple, these sunglasses transition into magnifying "readers," making it convenient for users to read fine print or text up close. Additionally, the companion phone app allows for precise customization of the magnification level, ensuring a tailored and comfortable viewing experience. In contrast, traditional sunglasses serve primarily as a sun-blocking accessory, offering no vision correction capabilities. While they excel in shielding the eyes from harmful UV rays and reducing glare, smart sunglasses represents a better way of doing that due to incorporating that with aiding individuals who require both distance and near vision correction. In summary, DeepOptics' smart sunglasses offer a superior and more adaptive eyewear experience compared to conventional sunglasses, catering specifically to the needs of an aging population with vision challenges.

Data

The data was obtained from Statista.com. The statistic shows the smart glass market revenue worldwide in 2018 with projections until 2027. In 2027, the global smart glass market revenue is expected to reach 11.73 billion U.S. dollars. The predictions were made for the worldwide scope, as the data describes the worldwide sales. For the look alike I fount Revenue of eyewear in the United States from 2014 to 2027, by product type from statista. There were a few product types, I chose sunglasses specifically.

Loading the libraries.

```
libs<-c('ggplot2','ggpubr','knitr','diffusion', 'readxl')
load_libraries<-function(libs){
new_libs <- libs[!(libs %in% installed.packages()[,"Package"])]
```

```
if(length(new_libs)>0) {install.packages(new_libs)}
lapply(libs, library, character.only = TRUE)
}
load_libraries(libs)
```

```
## [[1]]
## [1] "ggplot2"   "stats"     "graphics"  "grDevices" "utils"     "datasets"
## [7] "methods"   "base"
##
## [[2]]
## [1] "ggpubr"    "ggplot2"   "stats"     "graphics"  "grDevices" "utils"
## [7] "datasets"  "methods"   "base"
##
## [[3]]
##  [1] "knitr"     "ggpubr"    "ggplot2"   "stats"     "graphics"  "grDevices"
##  [7] "utils"     "datasets"  "methods"   "base"
##
## [[4]]
##  [1] "diffusion" "knitr"     "ggpubr"    "ggplot2"   "stats"     "graphics"
##  [7] "grDevices" "utils"     "datasets"  "methods"   "base"
##
## [[5]]
##  [1] "readxl"    "diffusion" "knitr"     "ggpubr"    "ggplot2"   "stats"
##  [7] "graphics"  "grDevices" "utils"     "datasets"  "methods"   "base"
```

Defining f(t), F(t) functions.

```
bass.f <- function(t,p,q){
((p+q)**2/p)*exp(-(p+q)*t)/
(1+(q/p)*exp(-(p+q)*t))**2
}

bass.F <- function(t,p,q){
(1-exp(-(p+q)*t))/
(1+(q/p)*exp(-(p+q)*t))
}
```

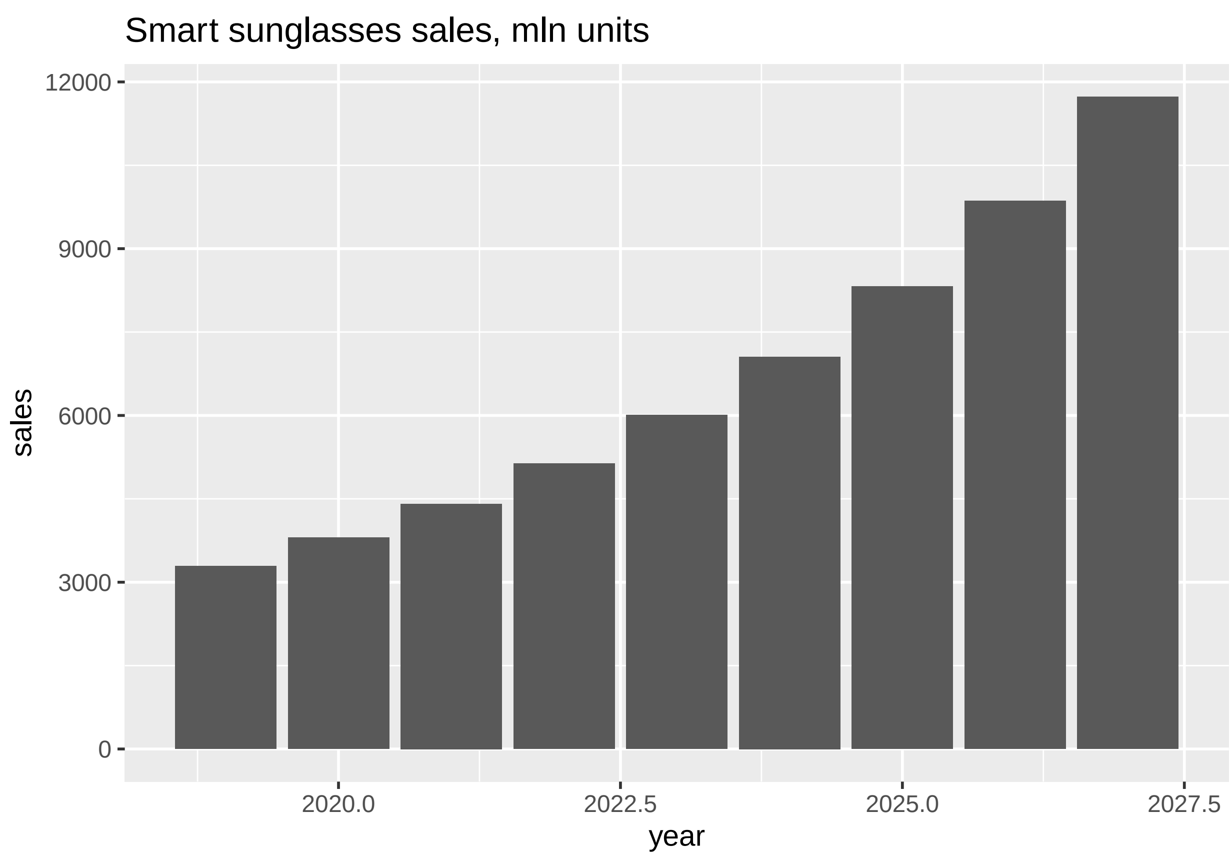
Importing the data and doing post-processing.

```
ss <- read_excel("C:/Users/anush/Desktop/statistic_id1015498_global-smart-glass-market-size-2018-2027.x
colnames(ss) <- c("year", "sales")
names(ss)[1] <- "year"
names(ss)[2] <- "sales"
ss$year = as.numeric(ss$year)
ss$sales = as.numeric(ss$sales)
ss
```

```
## # A tibble: 9 x 2
##    year  sales
##   <dbl>  <dbl>
## 1  2019  3290.
## 2  2020  3802.
```

```
## 3  2021  4410.
## 4  2022  5137.
## 5  2023  6008.
## 6  2024  7056.
## 7  2025  8323.
## 8  2026  9860.
## 9  2027 11734.
```

```
ggplot(data = ss, aes(x = year, y = sales)) +
  geom_bar(stat = 'identity') +
  ggtitle('Smart sunglasses sales, mln units')
```



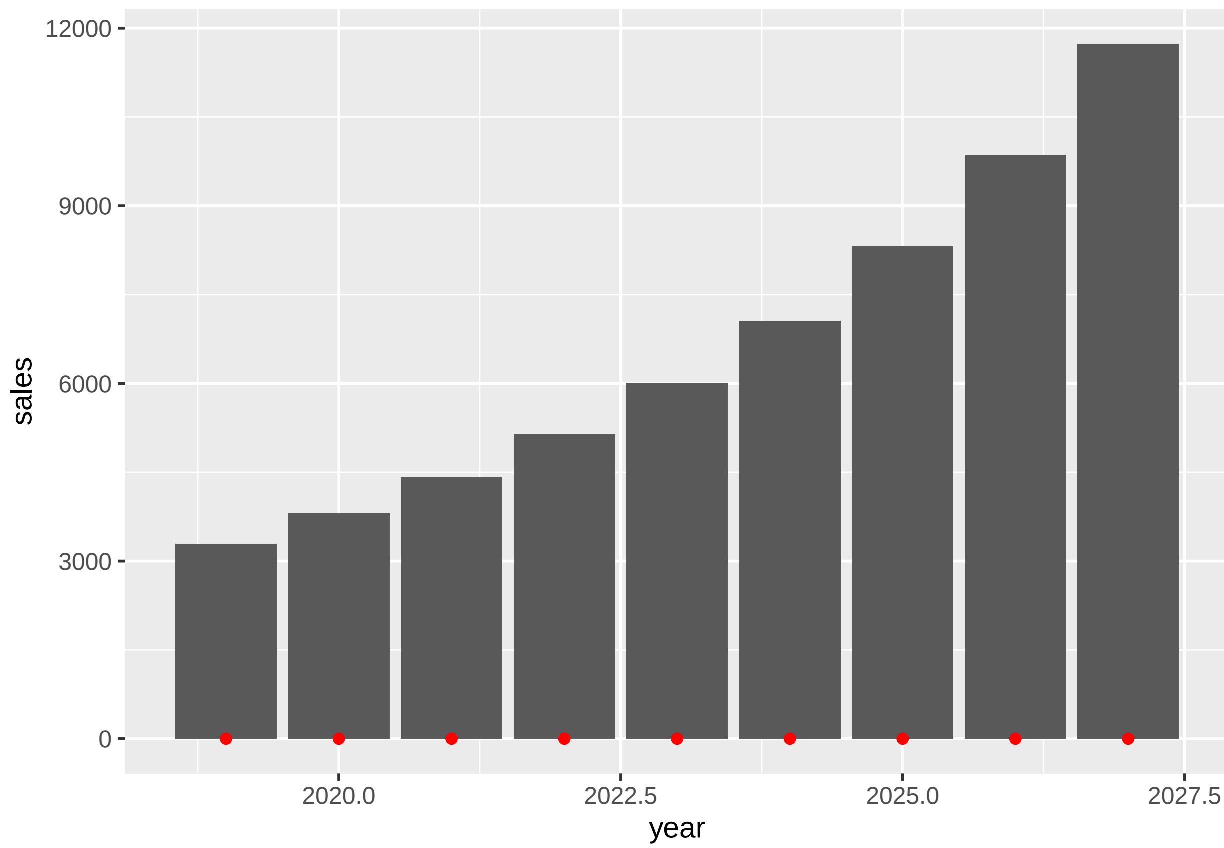
Estimate p and q.

```
parameters <- diffusion(ss$sales)
p <- parameters$w['p']
q <- parameters$w['q']
m <- parameters$w['m']

parameters
```

```
## bass model
##
## Parameters:
##                                  Estimate p-value
```

```
## p - Coefficient of innovation  17.7275      NA
## q - Coefficient of imitation    0.7623      NA
## m - Market potential           39.4983      NA
##
## sigma: 7156.3509
```

```
ss$pred_diffusion <- bass.f(1:9, p = p, q = q)*m

ggplot(data = ss, aes(x = year, y = sales)) + geom_bar(stat = 'identity') +
  geom_point(aes(x=year, y = pred_diffusion), col = 'red')
```



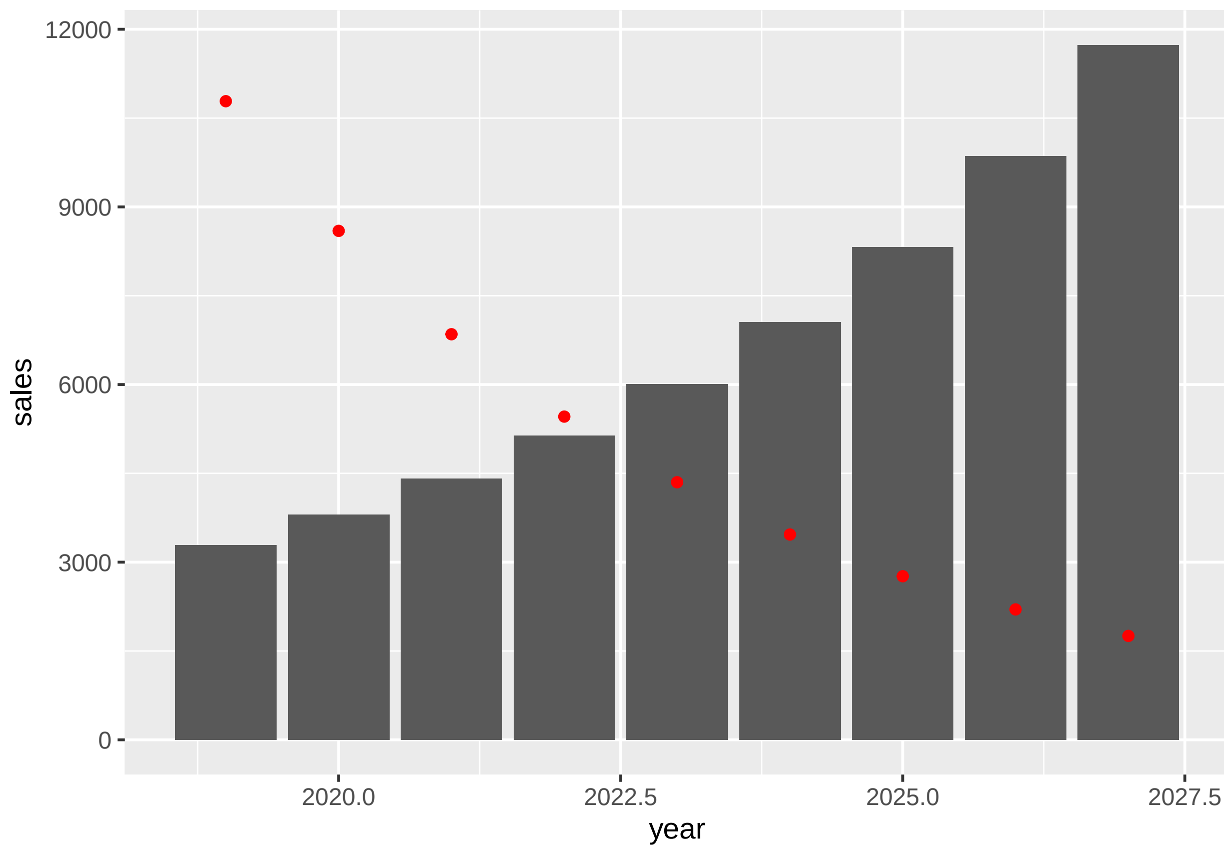
Trying another method of estimating the parameters.

```
sales = ss$sales
t = 1:length(sales)
bass_m = nls(sales ~ m*(((p+q)**2/p)*exp(-(p+q)*t))/(1+(q/p)*exp(-(p+q)*t))**2,
             start=c(list(m=sum(sales),p=0.227,q=0.0)), control = list(maxiter=5000, tol = 8))

bass_m
```

```
## Nonlinear regression model
##   model: sales ~ m * (((p + q)^2/p) * exp(-(p + q) * t))/(1 + (q/p) *     exp(-(p + q) * t))^2
##    data: parent.frame()
##         m         p         q
## 59619.500     0.227     0.000
##  residual sum-of-squares: 2.9e+08
```

```
##
## Number of iterations to convergence: 0
## Achieved convergence tolerance: 4.933
```

```
p <- bass_m$m$getPars()['p']
q <- bass_m$m$getPars()['q']
m <- bass_m$m$getPars()['m']

ss$pred_nls <- bass.f(1:9, p = p, q = q)*m

ggplot(data = ss, aes(x = year, y = sales)) + geom_bar(stat = 'identity') +
  geom_point(aes(x=year, y = pred_nls), col = 'red')
```



Will use this estimation for the prediction.

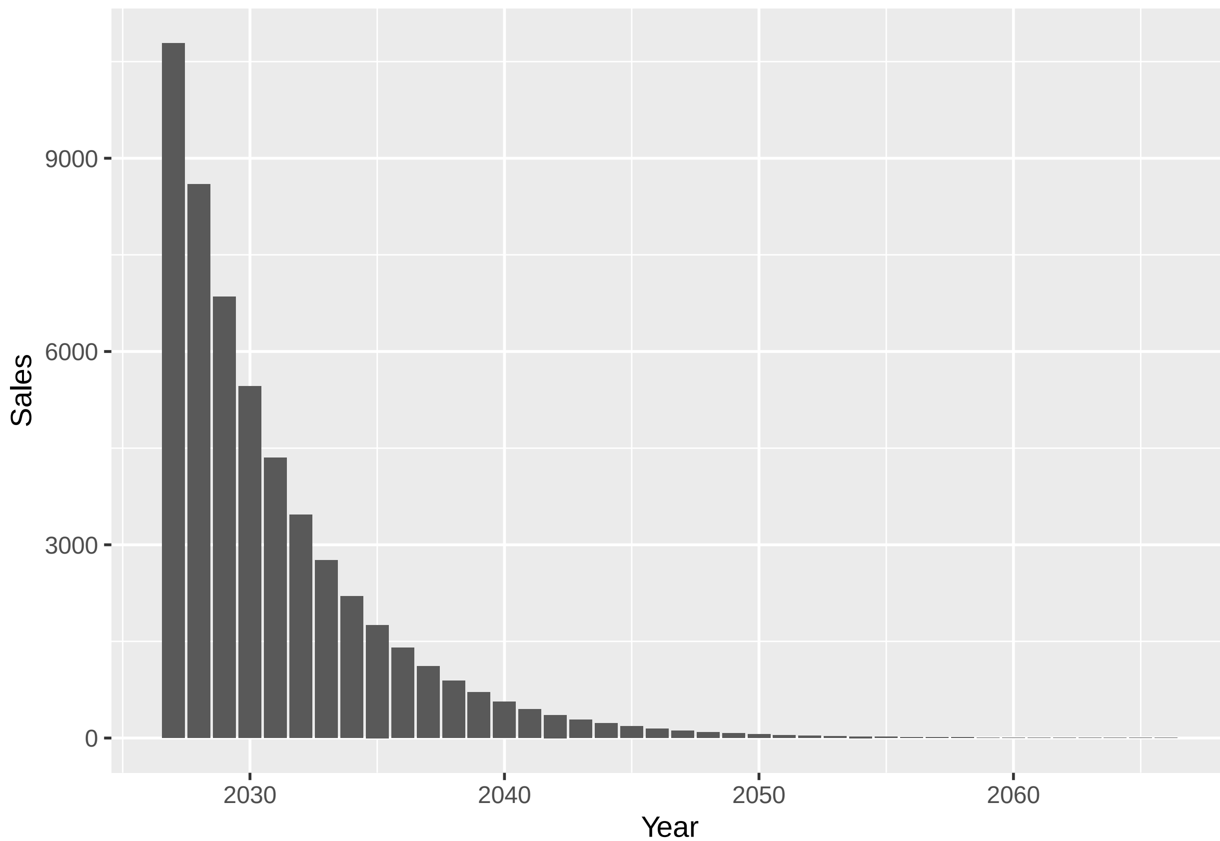
Prediction

```
future_years <- 40

prediction <- bass.f(1:future_years, p = p, q = q)*m

years <- seq(from = 2027, to = 2027 + future_years - 1, by = 1)
```

```r
innovation_df <- data.frame(Year = years, Sales = prediction)
prediction
```

```
##  [1] 10785.228218  8594.972508  6849.512215  5458.518633  4350.006939
##  [6]  3466.610933  2762.614296  2201.584746  1754.488638  1398.188458
## [11]  1114.245440   887.965348   707.638039   563.931460   449.408700
## [16]   358.143133   285.411706   227.450520   181.260046   144.449898
## [21]   115.115126    91.737636    73.107629    58.260989    46.429393
## [26]    37.000548    29.486506    23.498409    18.726371    14.923434
## [31]    11.892795     9.477615     7.552908     6.019070     4.796722
## [36]     3.822607     3.046315     2.427672     1.934662     1.541772
```

```r
ggplot(data = innovation_df, aes(x = Year, y = Sales)) +
  geom_bar(stat='identity')
```




```r
innovation_df[which.max(innovation_df$Sales),]
```

```
##   Year    Sales
## 1 2027 10785.23
```

As we see from the data, the maximum sales were seen in the year 2027, and in the future years the sales will decrease.