bass_model

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It is performed a look-alike analysis with the bass diffusion model to understand the expected behavior of new product, in this case a smart watch, and particularly, Apple ultra watch 2 in the market. The aim of diffusion bass model is to take a similar product, for which there is available data and try to make predictions for the new product. In this particular example, the proportion of apple smart watches in the past, and the total number of smart watch users worldwide are taken to analyze and evaluate the role of the new apple smart watch in the market. Read further details and the sources in the readme file.

```
data<- read.csv("apple_watch.csv")
total_users = 219430000
data<-data.frame(data)
data$users = data$proportion * total_users
head(data)
```

```
##     time proportion      users
## 1 2Q ’15       20.3 4454429000
## 2 3Q ’15       17.5 3840025000
## 3 4Q ’15       14.1 3093963000
## 4 1Q ’16        7.5 1645725000
## 5 2Q ’16        7.0 1536010000
## 6 3Q ’16        4.9 1075207000
```

```
diffusion_estimate <- diffusion(data$users)
p_estimate <- as.numeric(diffusion_estimate$w[1])
q_estimate <- as.numeric(diffusion_estimate$w[2])
m_estimate <- as.numeric(diffusion_estimate$w[3])
diffusion_estimate
```

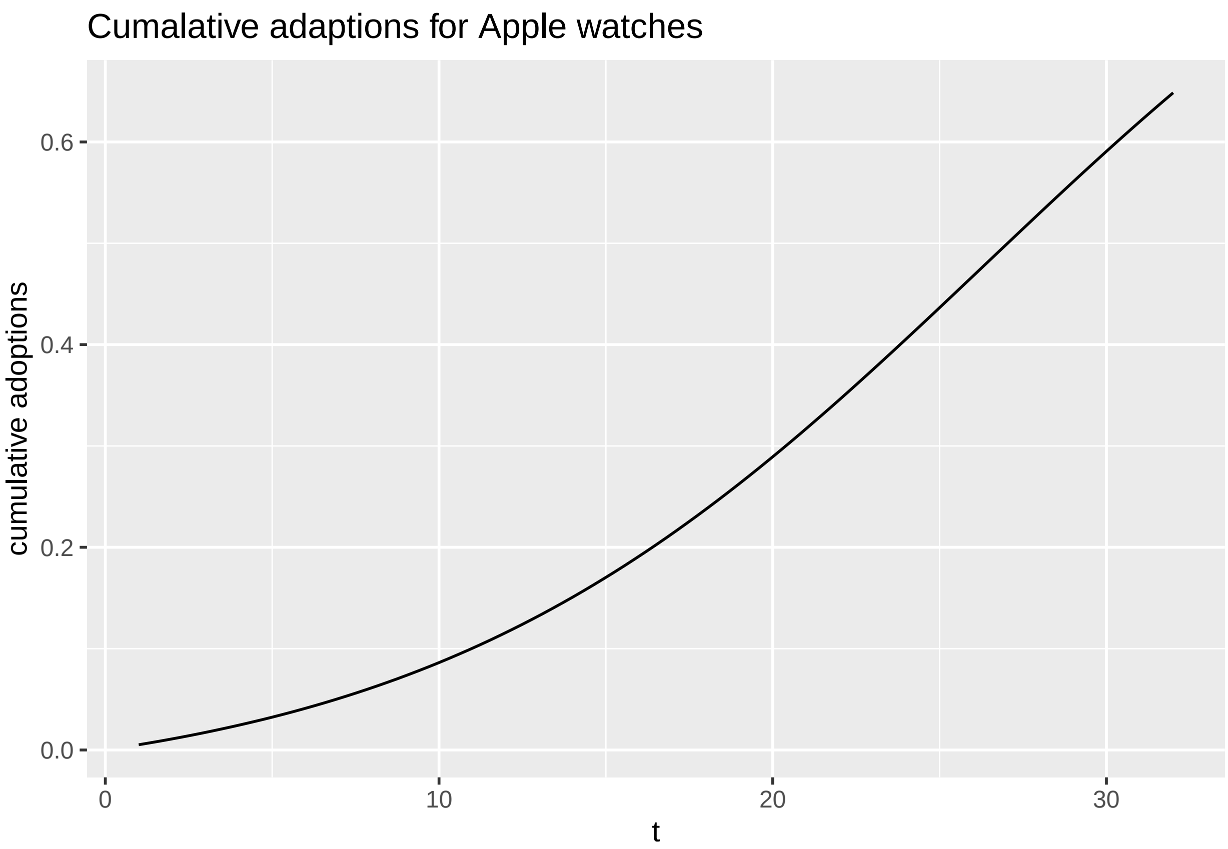
```
## bass model
##
## Parameters:
##                                    Estimate p-value
## p - Coefficient of innovation 4.900000e-03      NA
## q - Coefficient of imitation  1.149000e-01      NA
## m - Market potential          2.603881e+11      NA
##
## sigma: 1571756684.8501
```

Here we can see that innovator’s rate is about 0.005, imitator’s rate is about 0.15, and market share is about 260 billion.

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

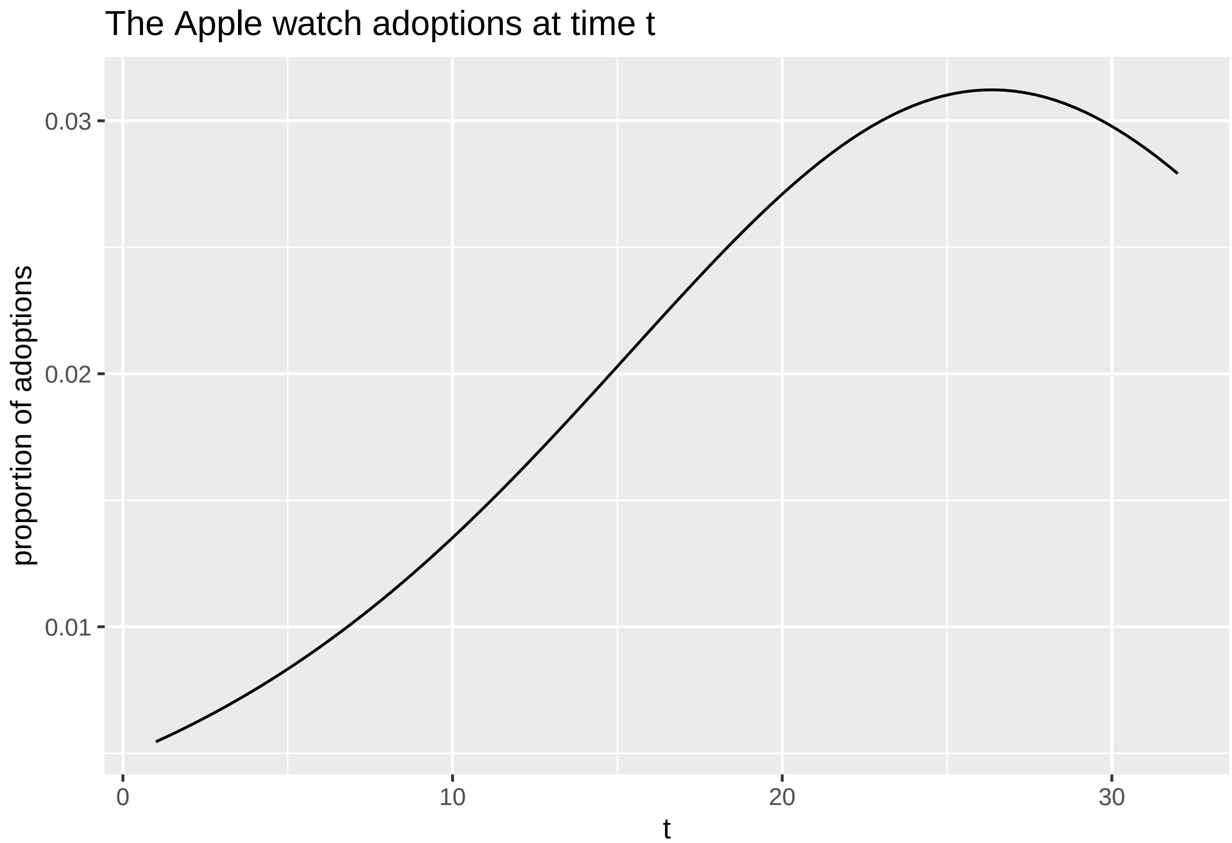
```
bass.F <- function(t,p,q){
  (1-exp(-(p+q)*t))/
    (1+(q/p)*exp(-(p+q)*t)) }
```

```
cum_ad<-ggplot(data.frame(t = c(1, 32)), aes(t)) +
stat_function(fun = bass.F, args = c(p=p_estimate, q=q_estimate)) +
  labs(title = 'Cumalative adaptions for Apple watches', y='cumulative adoptions')
cum_ad
```



Here we can see the distrbution of the

```
time_ad<-ggplot(data.frame(t = c(1, 32)), aes(t)) +
stat_function(fun = bass.f, args = c(p=p_estimate, q=q_estimate)) +
  labs(title = 'The Apple watch adoptions at time t', y='proportion of adoptions')
time_ad
```



Here we can notice the proportion of adoptions change over time.

Calculating the number of adopters.

```
data$number_of_adopters = bass.f(1:32, p = p_estimate, q = q_estimate)* 219430000
data
```

```
##      time proportion      users number_of_adopters
## 1  2Q '15       20.3 4454429000            1196388
## 2  3Q '15       17.5 3840025000            1333088
## 3  4Q '15       14.1 3093963000            1483333
## 4  1Q '16        7.5 1645725000            1647947
## 5  2Q '16        7.0 1536010000            1827669
## 6  3Q '16        4.9 1075207000            2023112
## 7  4Q '16       13.6 2984248000            2234712
## 8  1Q '17       14.6 3203678000            2462668
## 9  2Q '17       13.0 2852590000            2706882
## 10 3Q '17       10.3 2260129000            2966887
## 11 4Q '17       29.6 6495128000            3241772
## 12 1Q '18        8.7 1909041000            3530115
## 13 2Q '18       17.0 3730310000            3829914
## 14 3Q '18       13.1 2874533000            4138536
## 15 4Q '18       30.2 6626786000            4452682
## 16 1Q '19       23.7 5200491000            4768384
## 17 2Q '19       14.8 3247564000            5081030
## 18 3Q '19       35.0 7680050000            5385442
## 19 4Q '19       36.5 8009195000            5675992
```

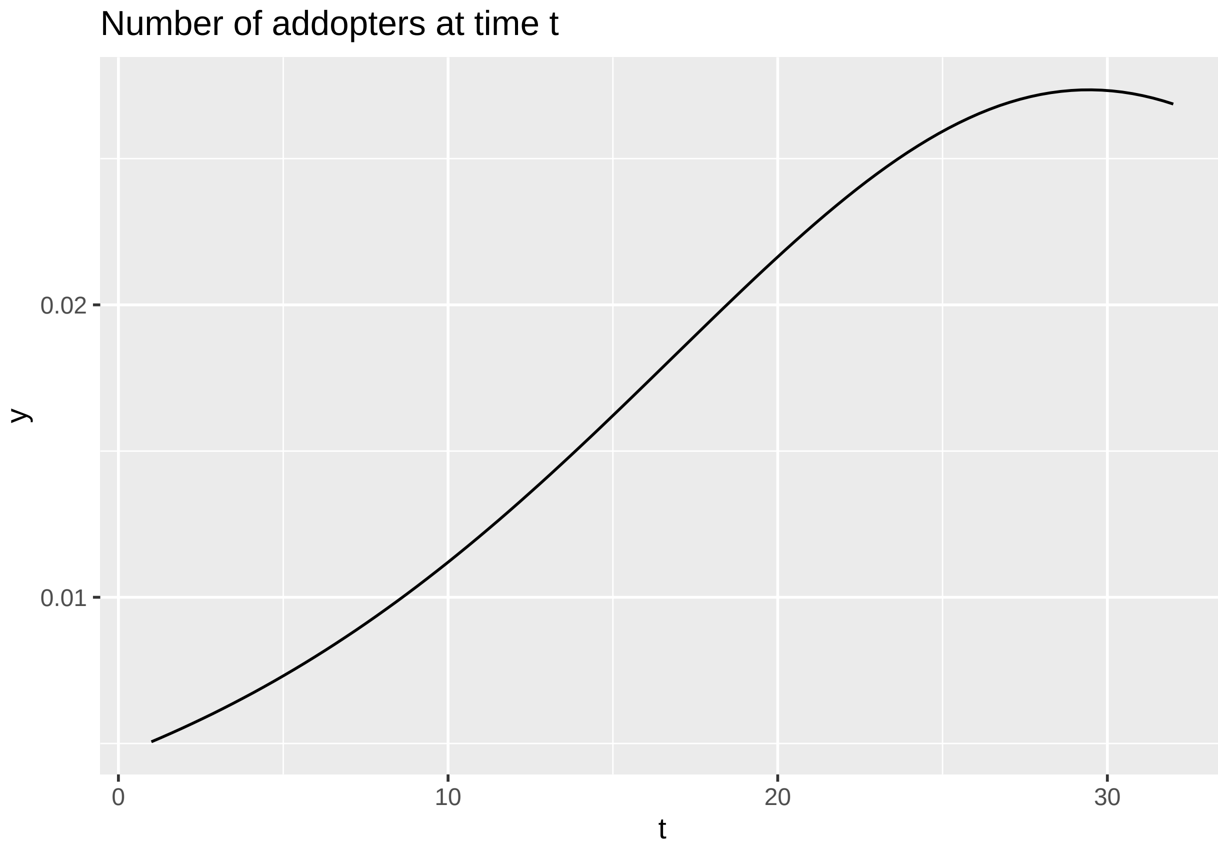
```
## 20 1Q '20       29.3 6429299000           5946769
## 21 2Q '20       34.2 7504506000           6191791
## 22 3Q '20       33.1 7263133000           6405252
## 23 4Q '20       36.2 7943366000           6581789
## 24 1Q '21       28.8 6319584000           6716752
## 25 2Q '21       34.1 7482563000           6806457
## 26 3Q '21       28.8 6319584000           6848392
## 27 4Q '21       34.9 7658107000           6841366
## 28  1Q'22       30.5 6692615000           6785578
## 29  3Q'22       29.0 6363470000           6682610
## 30  4Q'22       33.6 7372848000           6535326
## 31  1Q'23       21.5 4717745000           6347711
## 32 3Q '23       20.2 4432486000           6124646
```

```r
innovation_diffusion_estimate<-diffusion(data$number_of_adopters)
p_estimate_innovation <- as.numeric(innovation_diffusion_estimate$w[1])
q_estimate_innovation <- as.numeric(innovation_diffusion_estimate$w[2])
m_estimate_innovation <- as.numeric(innovation_diffusion_estimate$w[3])
innovation_diffusion_estimate
```

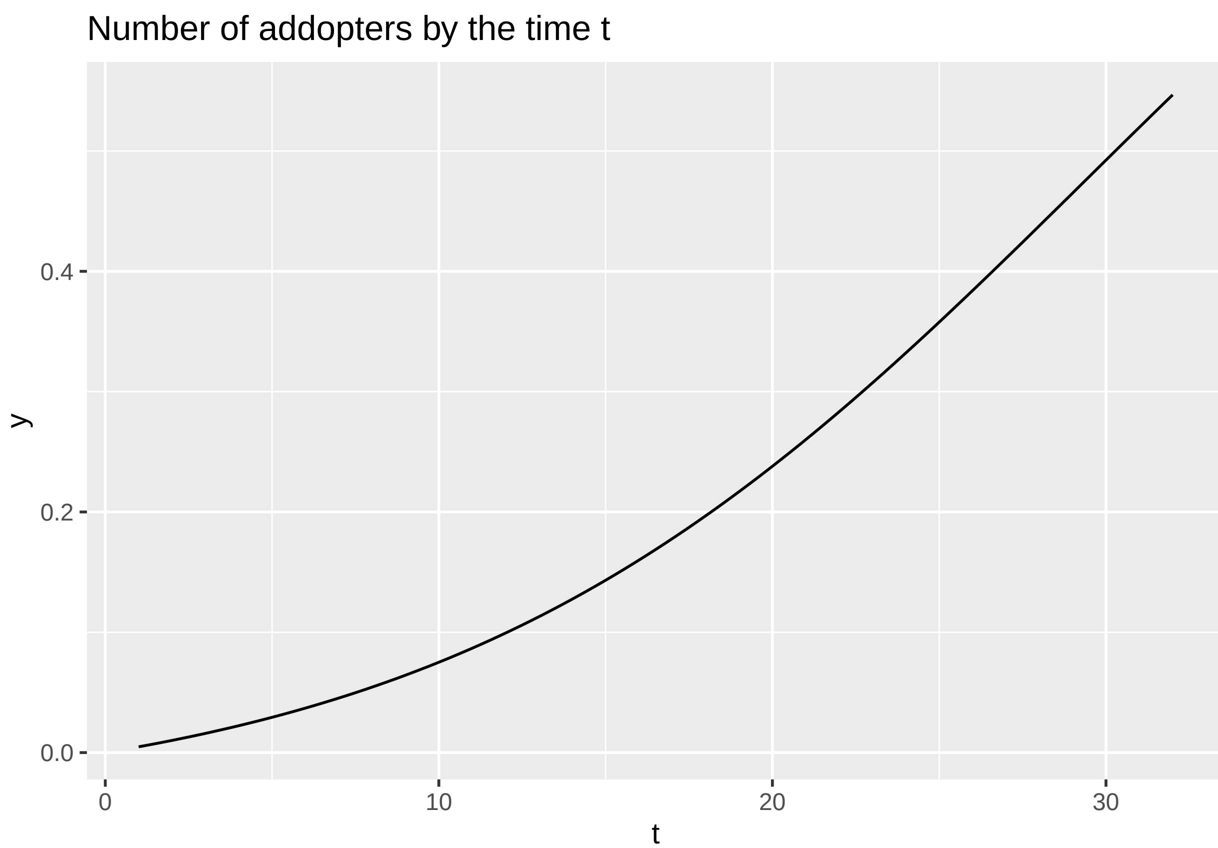
```
## bass model
##
## Parameters:
##                                  Estimate p-value
## p - Coefficient of innovation 4.6000e-03      NA
## q - Coefficient of imitation  1.1160e-01      NA
## m - Market potential          2.3962e+08      NA
##
## sigma: 270188.3928
```

Now, as we can see the numbers are about 0.0046 rate of innovators, about 0.1 of imitator's rate, and 270188 market size for the new product at this point of time.

```r
time_ad<-ggplot(data.frame(t = c(1, 32)), aes(t)) +
stat_function(fun = bass.f, args = c(p=0.0046, q=0.1)) +
  labs(title = 'Number of addopters at time t')
time_ad
```




```r
cum_ad<-ggplot(data.frame(t = c(1, 32)), aes(t)) +
stat_function(fun = bass.F, args = c(p=0.0046, q=0.1)) +
  labs(title = 'Number of addopters by the time t')
cum_ad
```



Here we can see how the results are changed for the new product, which is logical to have less proportion of the market at the beginning.