# Homework 3

Kenigbolo Meya Stephen

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This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

1. Kernel density estimation: use these two data sets - klient1.txt and klient3.txt. Plot the density distribution of these two data sets. This represents the time of week, when two different groups of people go shopping over the entire year. Choose an informative kernel width and justify your choice. Characterise briefly these two data sets (klient1 and klient3)?
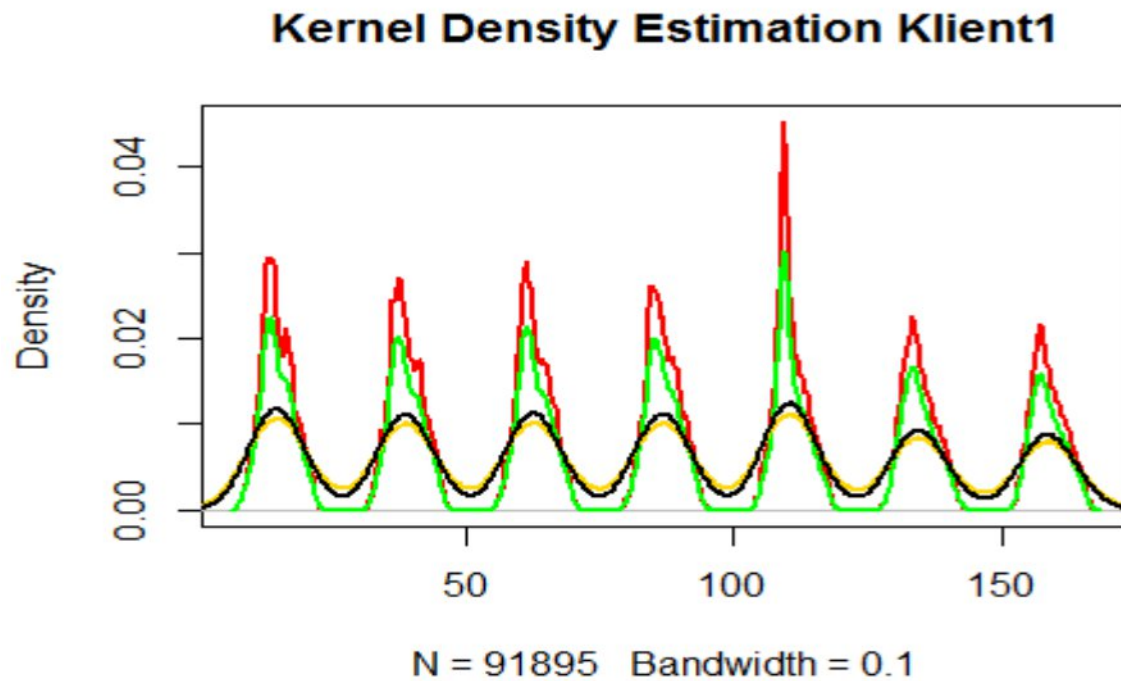
```
library(ggplot2)
klient1 <- read.table("C:/Users/Kenigbolo PC/Desktop/Data Mining/klient1.txt"
)
klient3 <- read.table("C:/Users/Kenigbolo PC/Desktop/Data Mining/klient3.txt"
)
```

*Density distribution of klient1

Density Distribution of Klient 1

N = 91895   Bandwidth = 4.293
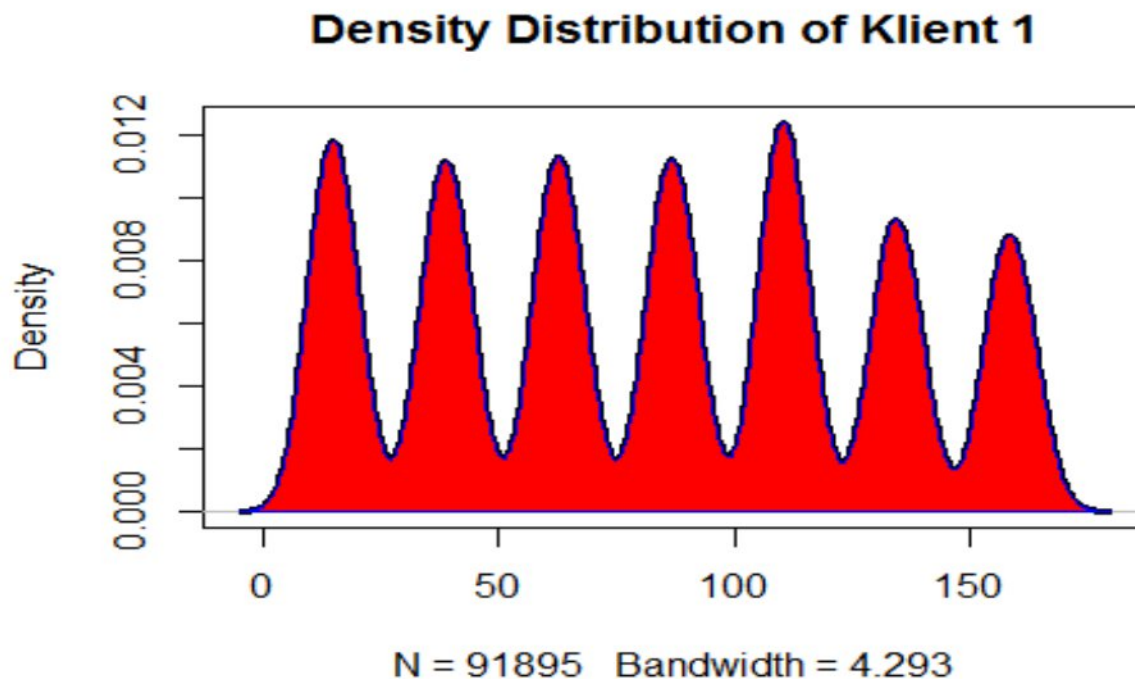
*Density distribution of klient1 (selected bin width justification)

My preferred bin width for the density estimation is 0.1 (red line)

Kernel Density Estimation Klient1

Density

N = 91895   Bandwidth = 0.1

*Density distribution of klient

Density Distribution of Klient 3

Density

N = 88970   Bandwidth = 4.319

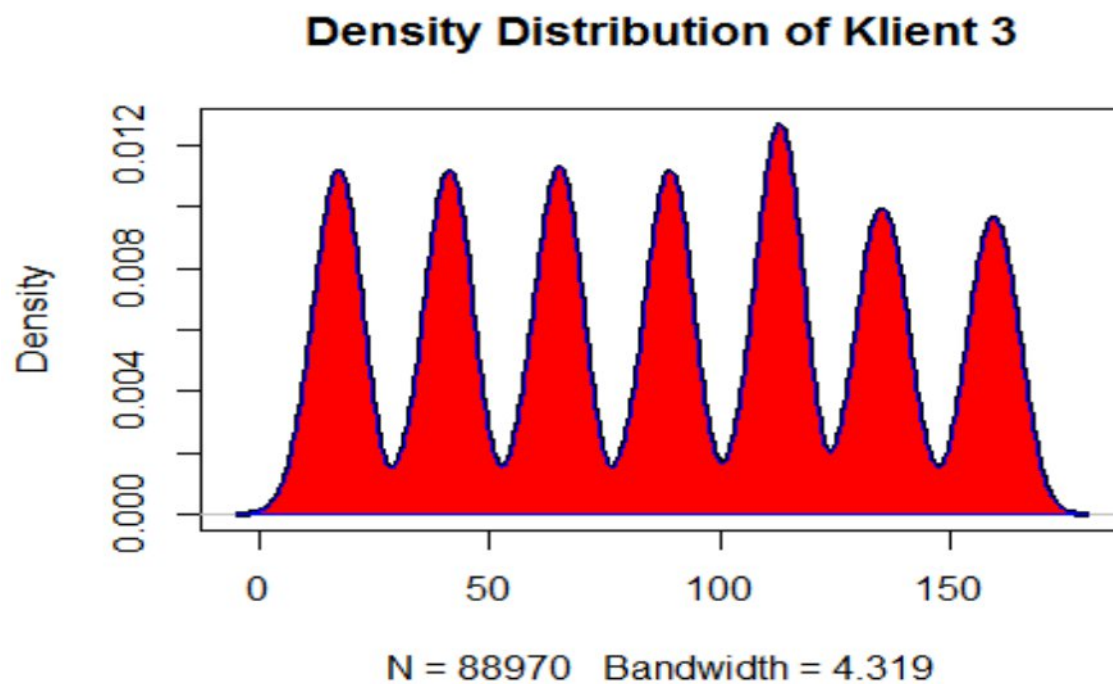*Density distribution of klient3 (selected bin width justification)

My preferred bin width for the density estimation is 0.1 (red line)

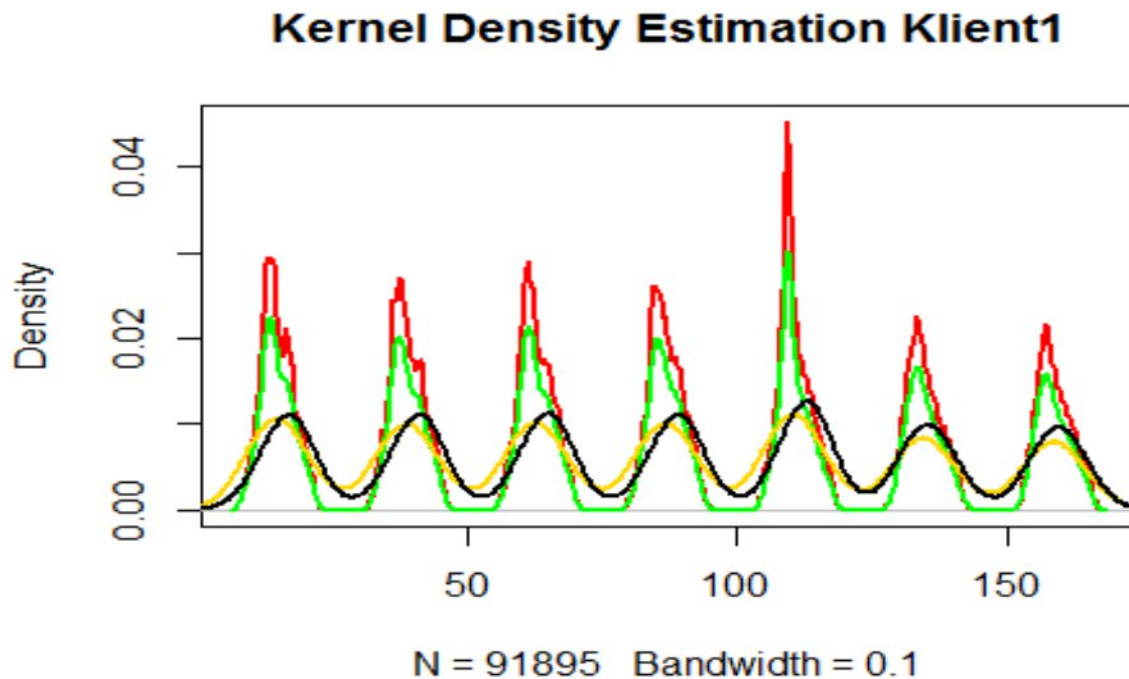**Kernel Density Estimation Klient1**

N = 91895   Bandwidth = 0.1

2. Study the data Attach:product_time_shop.txt. There is a information about a number of shops and times when particular products (items) sold through the week. Describe the data - what products, shops, how many purchases of different products in different shops?

```
product_time_shop <- read.table("C:/Users/Kenigbolo PC/Desktop/Data Mining/pr
oduct_time_shop.txt", sep = ";", header = TRUE)
product_time_shop$date = as.Date(as.character(product_time_shop$date), '%Y%m%
d')
```

Data Description The dataset contains four shops with shop_id's as 3, 4, 18, 21 and 32.

```
print(unique(product_time_shop$shop_id, incomparables = FALSE))

## [1] 18 21  3 32  4
```

The dataset also contains eleven products however they can still be further grouped into 9 by categorizing Eggs, Sour_Cream and Milk as single products but this will not be healthy in the analysis of the data.

```
print(unique(product_time_shop$product, incomparables = FALSE))

##  [1] Banana       Sour_Cream_2 Sour_Cream_1 Grapes       Coffee_Cream
##  [6] Eggs_1       Eggs_2       Milk_1       Milk_2       Whipped_Cream
## [11] Vastlakukkel
## 11 Levels: Banana Coffee_Cream Eggs_1 Eggs_2 Grapes Milk_1 ... Whipped_Cre
am
```

The dataset contains 12 unique dates

```
print(unique(product_time_shop$date, incomparables = FALSE))

## [1] "2014-01-04" "2014-01-19" "2014-02-08" "2014-03-04" "2014-04-07"
## [6] "2014-04-15" "2014-06-01" "2014-06-07" "2014-10-24" "2014-10-31"
## [11] "2014-12-23" "2014-12-31"
```

The Total frequency of all products are as follows;

```
library(plyr)
print(count(product_time_shop, 'product'))

##            product  freq
## 1           Banana 24847
## 2     Coffee_Cream 20531
## 3           Eggs_1 10089
## 4           Eggs_2   281
## 5           Grapes  3202
## 6           Milk_1 14874
## 7           Milk_2 25715
## 8     Sour_Cream_1  9704
## 9     Sour_Cream_2 15876
## 10    Vastlakukkel  4109
## 11  Whipped_Cream  9264
```

Purchases of products in shop with shop_id = 3

```
shop_3 <- subset(product_time_shop, shop_id == 3)
print(count(shop_3, 'product'))

##            product freq
## 1           Banana 6778
## 2     Coffee_Cream 4272
## 3           Eggs_1 1880
## 4           Eggs_2  100
## 5           Grapes  710
## 6           Milk_1 3568
## 7           Milk_2 5629
## 8     Sour_Cream_1 2597
## 9     Sour_Cream_2 2891
## 10    Vastlakukkel  939
## 11  Whipped_Cream 2285
```

Purchases of products in shop with shop_id = 4

```
shop_4 <- subset(product_time_shop, shop_id == 4)
print(count(shop_4, 'product'))

##            product freq
## 1           Banana 8677
## 2     Coffee_Cream 7259
## 3           Eggs_1 3704
```

```
## 4           Eggs_2  181
## 5          Grapes 1199
## 6          Milk_1 5173
## 7          Milk_2 8309
## 8    Sour_Cream_1 3206
## 9    Sour_Cream_2 5504
## 10   Vastlakukkel 1784
## 11 Whipped_Cream 3815
```

Purchases of products in shop with shop_id = 18

```
shop_18 <- subset(product_time_shop, shop_id == 18)
print(count(shop_18, 'product'))

##           product freq
## 1          Banana 4080
## 2    Coffee_Cream 4516
## 3          Eggs_1 1326
## 4          Grapes  495
## 5          Milk_1 2740
## 6          Milk_2 4968
## 7    Sour_Cream_1 1817
## 8    Sour_Cream_2 3046
## 9    Vastlakukkel  730
## 10 Whipped_Cream 1168
```

Purchases of products in shop with shop_id = 21

```
shop_21 <- subset(product_time_shop, shop_id == 21)
print(count(shop_21, 'product'))

##           product freq
## 1          Banana 1727
## 2    Coffee_Cream 1418
## 3          Eggs_1 1106
## 4          Grapes  273
## 5          Milk_1  836
## 6          Milk_2 2440
## 7    Sour_Cream_1  848
## 8    Sour_Cream_2 1569
## 9    Vastlakukkel  273
## 10 Whipped_Cream  600
```

Purchases of products in shop with shop_id = 32

```
shop_32 <- subset(product_time_shop, shop_id == 32)
print(count(shop_32, 'product'))

##           product freq
## 1          Banana 3585
## 2    Coffee_Cream 3066
## 3          Eggs_1 2073
```

```
## 4            Grapes   525
## 5            Milk_1 2557
## 6            Milk_2 4369
## 7   Sour_Cream_1 1236
## 8   Sour_Cream_2 2866
## 9    Vastlakukkel   383
## 10 Whipped_Cream 1396
```

3. Draw boxplots that would allow comparing different weekdays, shops, and product sales. Identify some meaningful illustrations to draw conclusions about

1) different weekdays,
2) different products ,
3) shops. State your hypothesis and then draw respective analysis of data.

Boxplot to compare weekdays and products in general
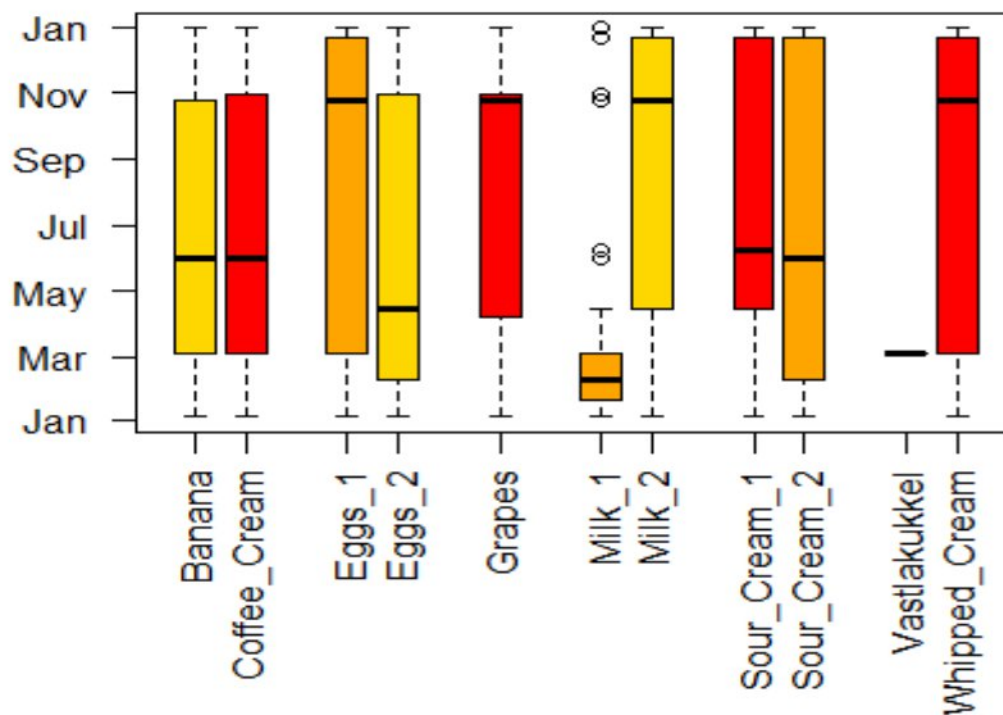
3.1 Boxplot to compare weekdays and products in shop with shop_id = 3
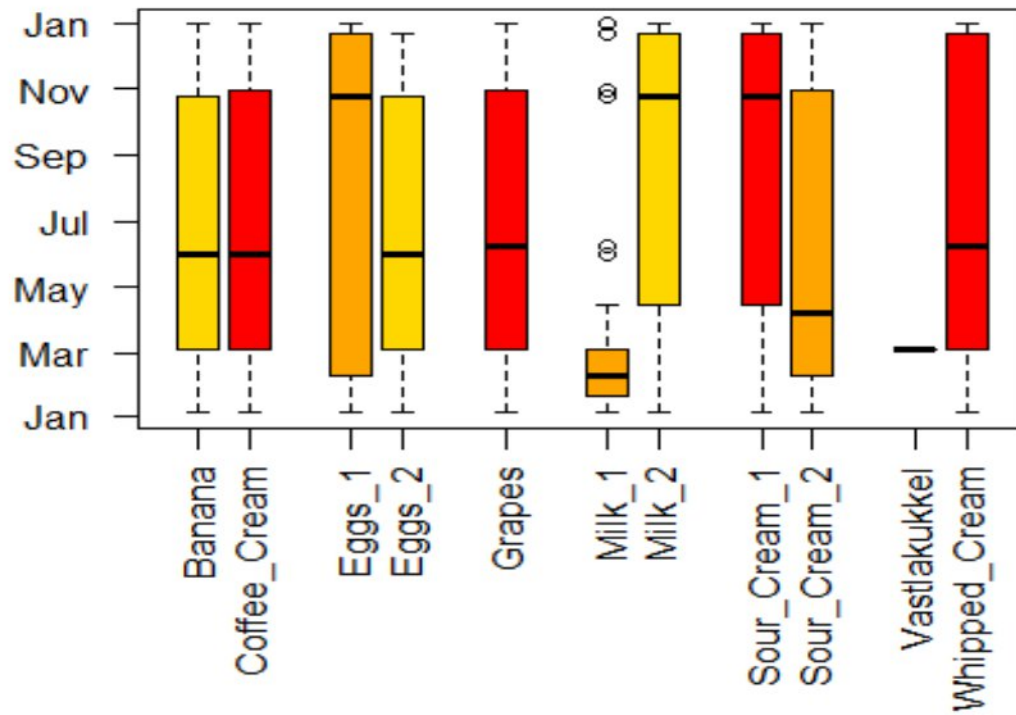
3.2 Boxplot to compare weekdays and products in shop with shop_id = 4
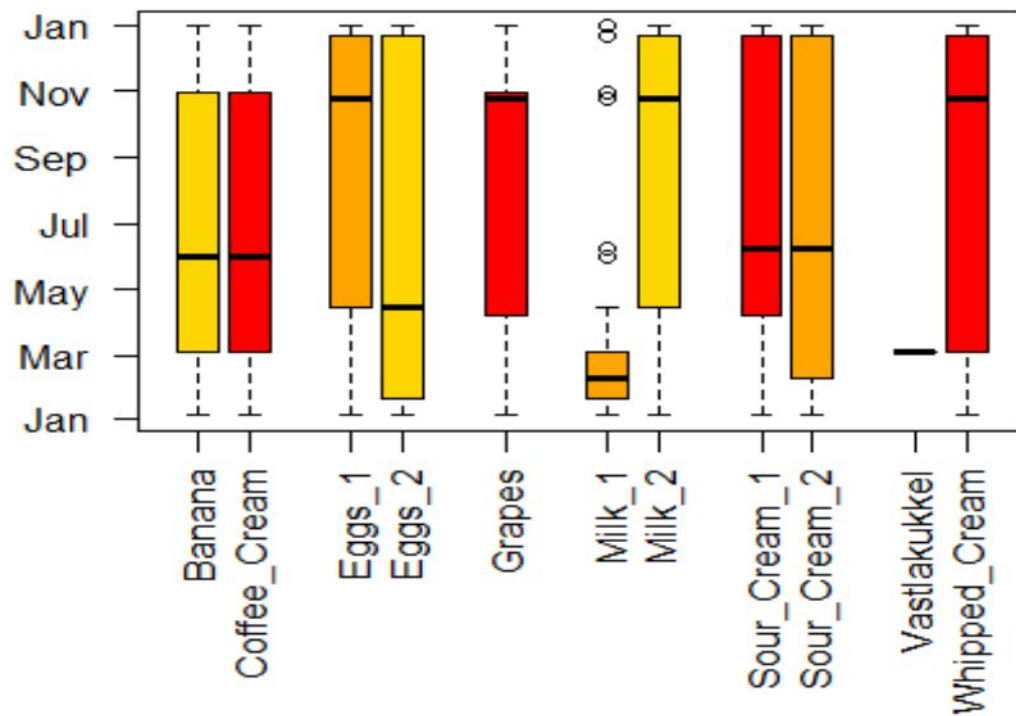
3.3 Boxplot to compare weekdays and products in shop with shop_id = 18
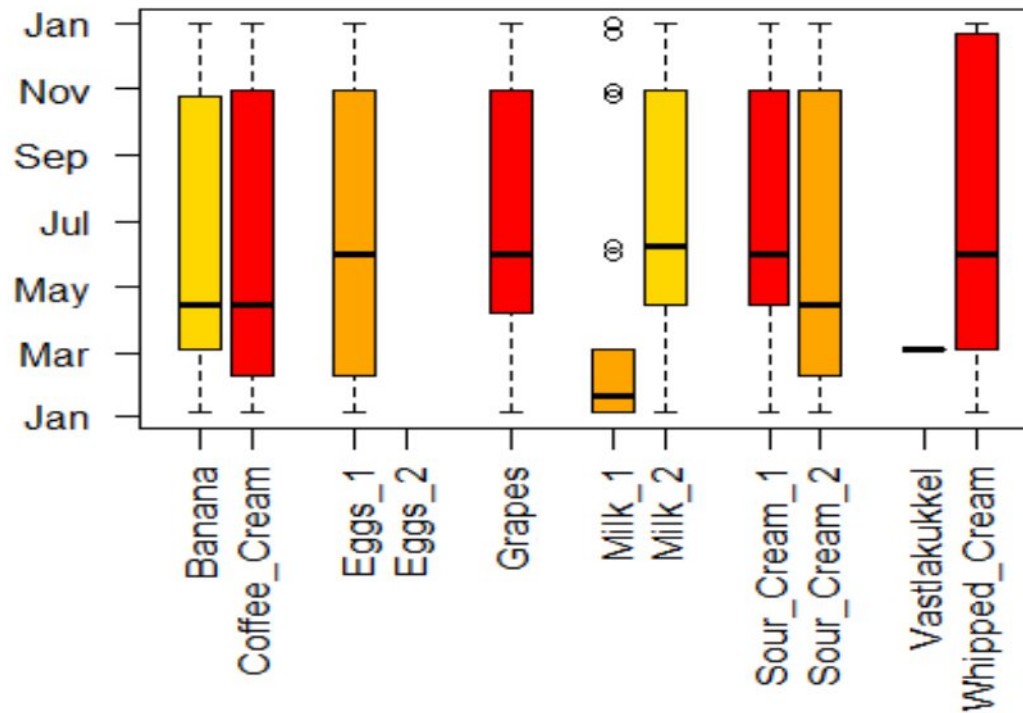
3.4 Boxplot to compare weekdays and products in shop with shop_id = 21
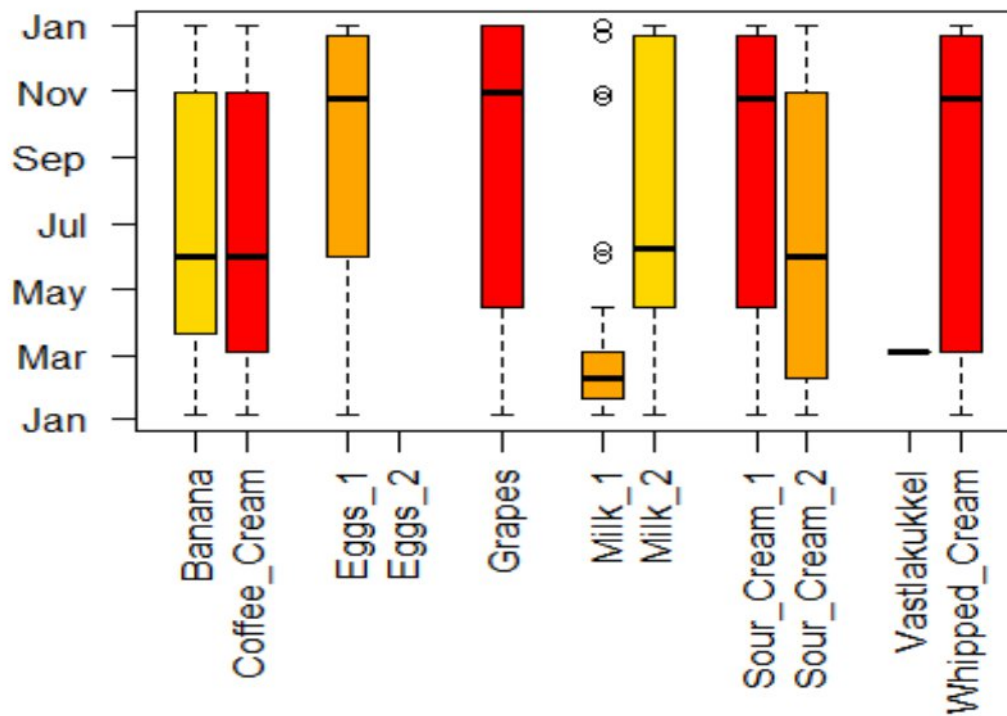
3.5 Boxplot to compare weekdays and products in shop with shop_id = 32
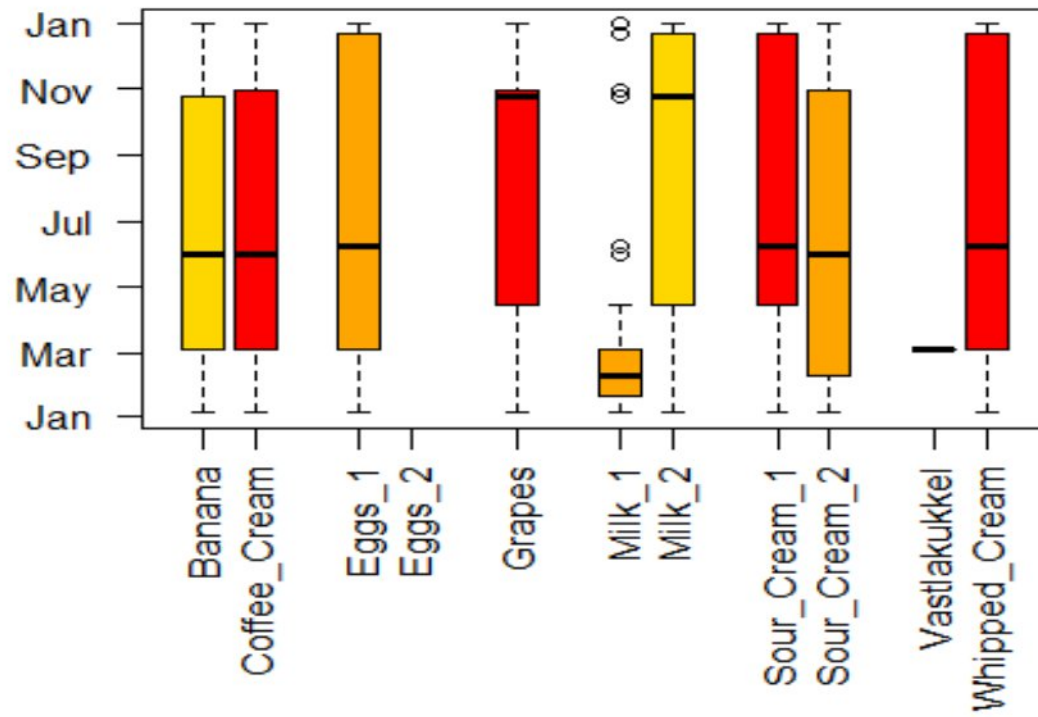
3.6.1 Boxplot for 2014-01-04
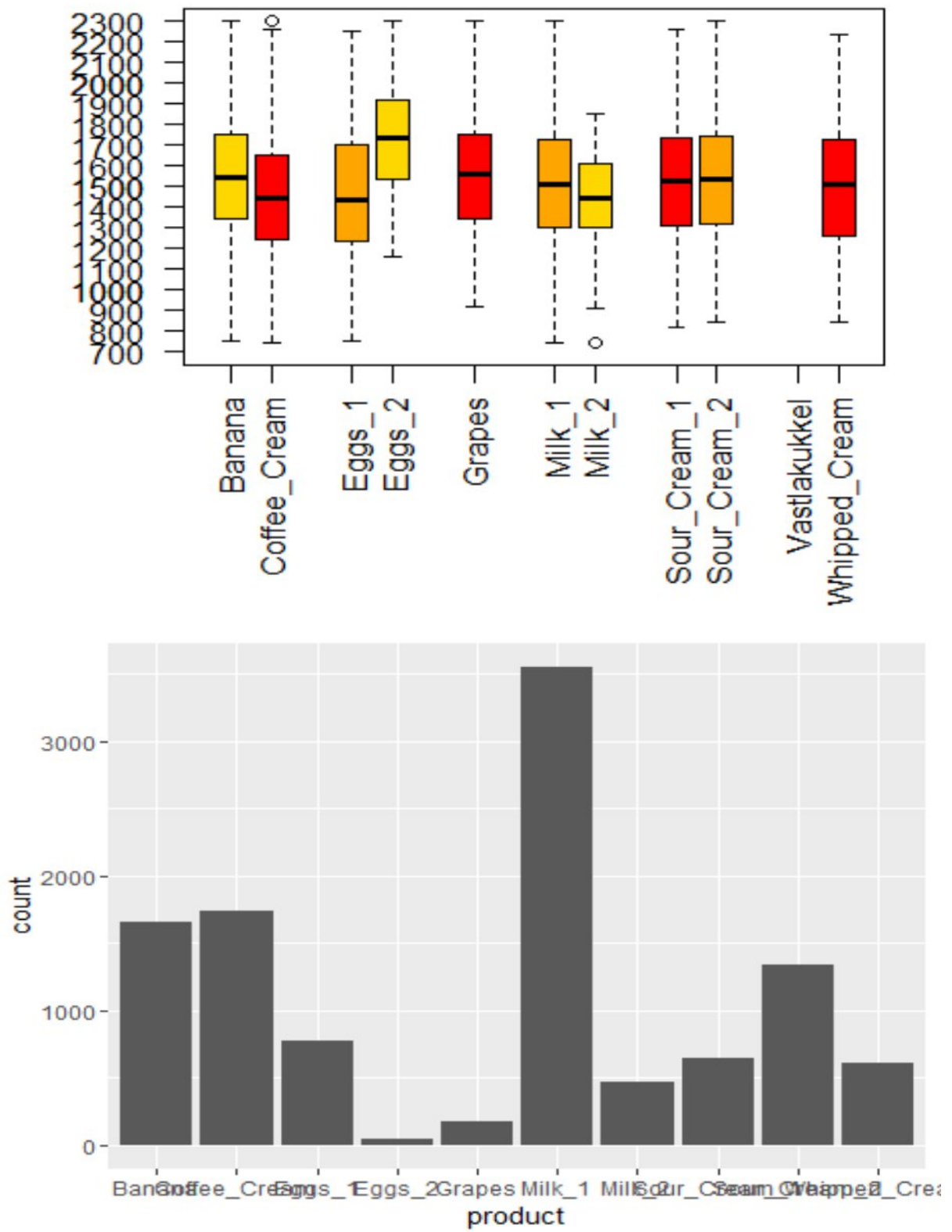
3.6.2 Boxplot for 2014-01-19
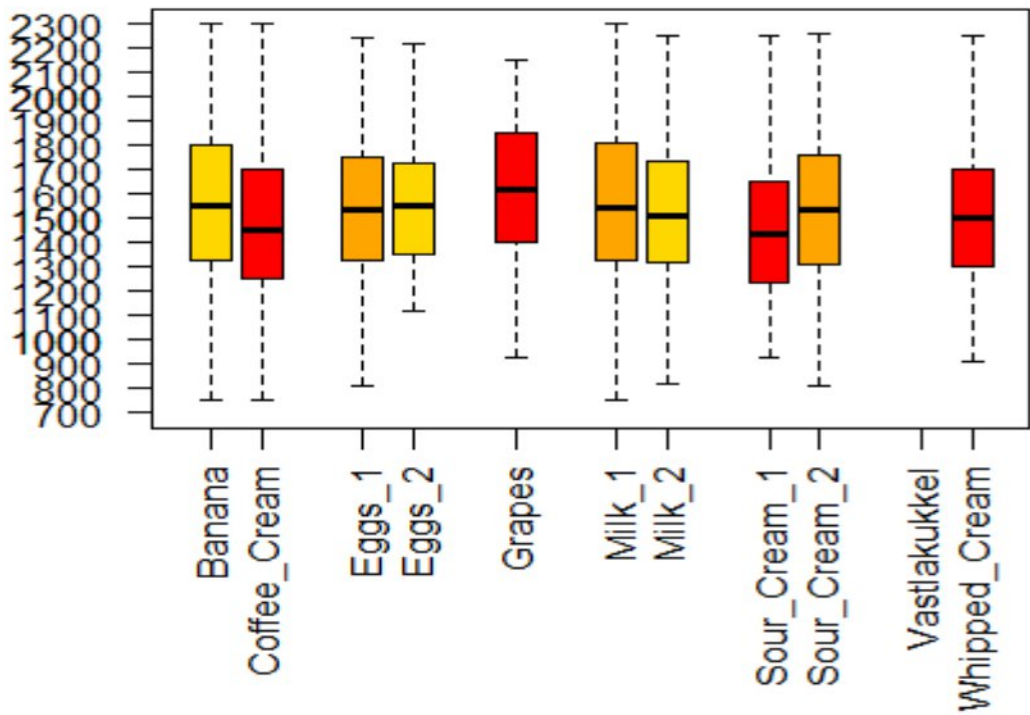
3.6.3 Boxplot for 2014-02-08
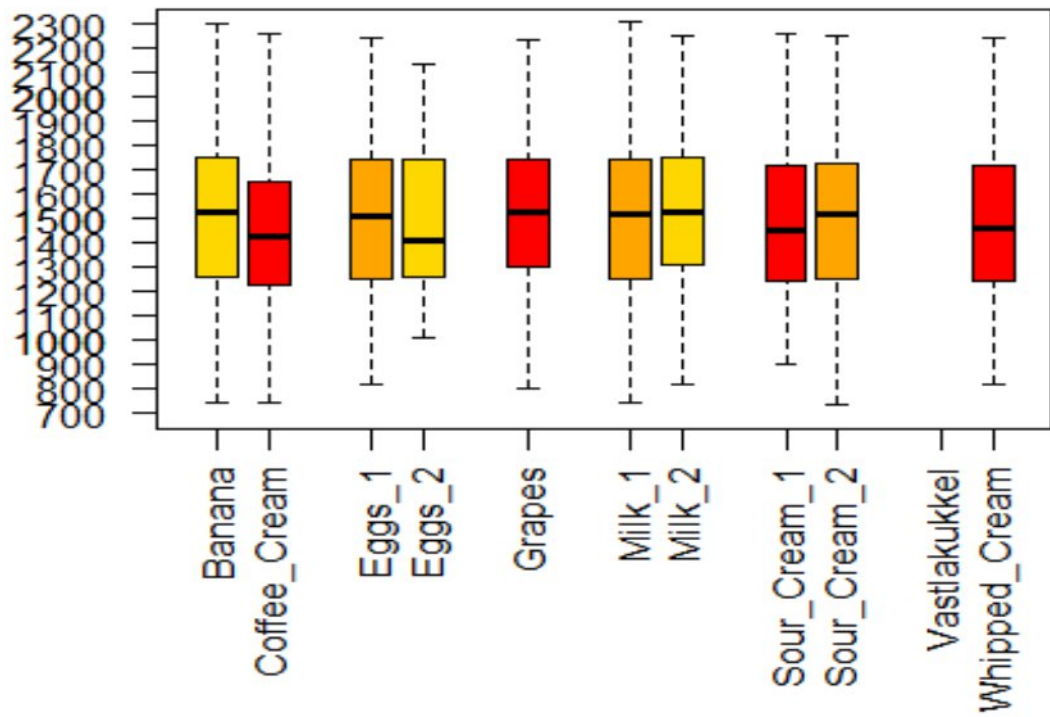
3.6.4 Boxplot for 2014-03-04
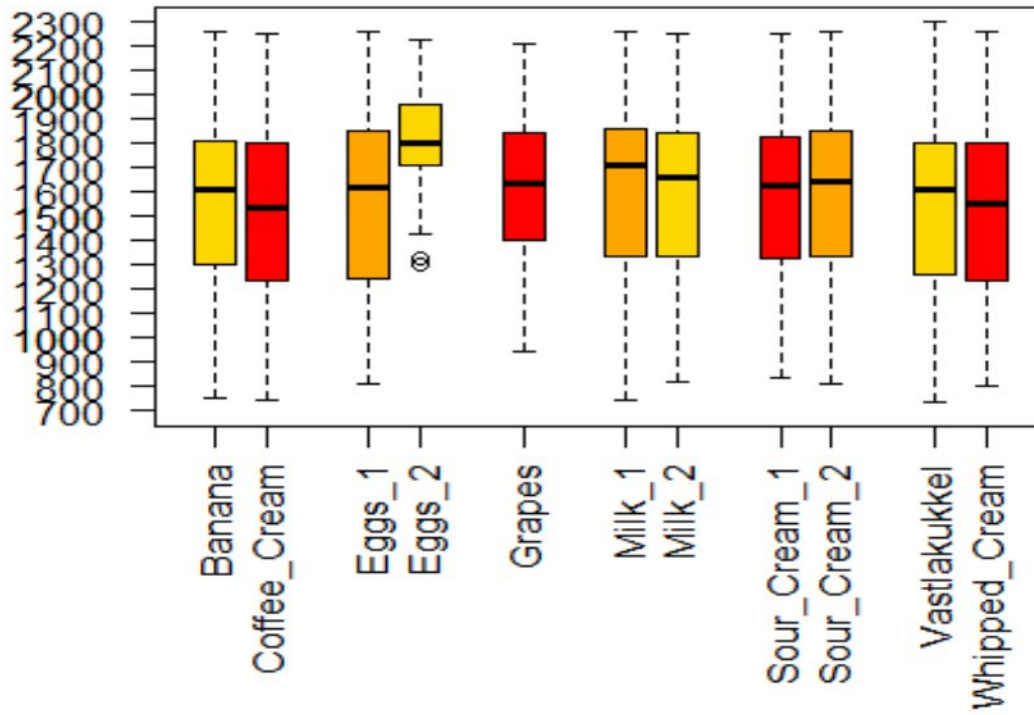
3.6.5 Boxplot for 2014-04-07
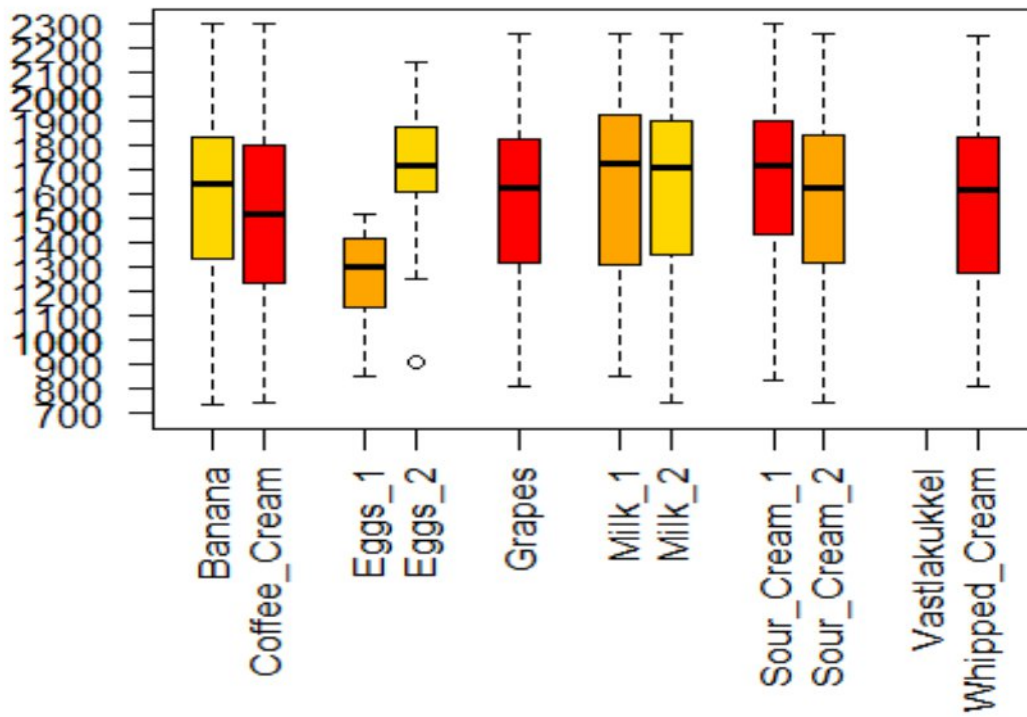
3.6.6 Boxplot for 2014-04-15
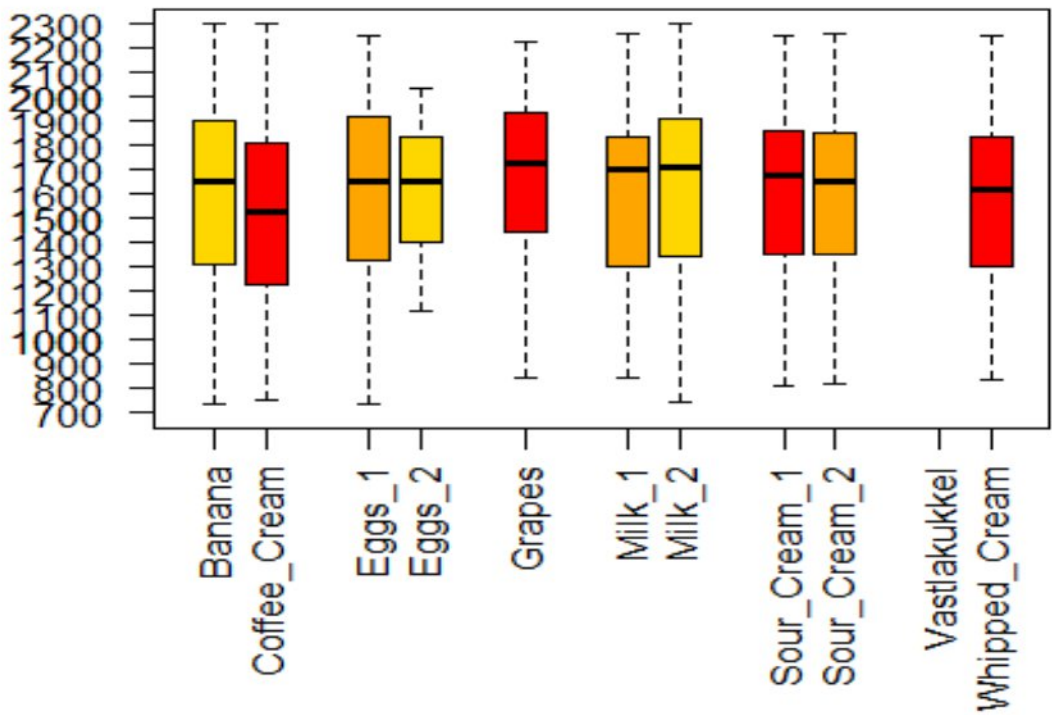
3.6.7 Boxplot for 2014-06-01
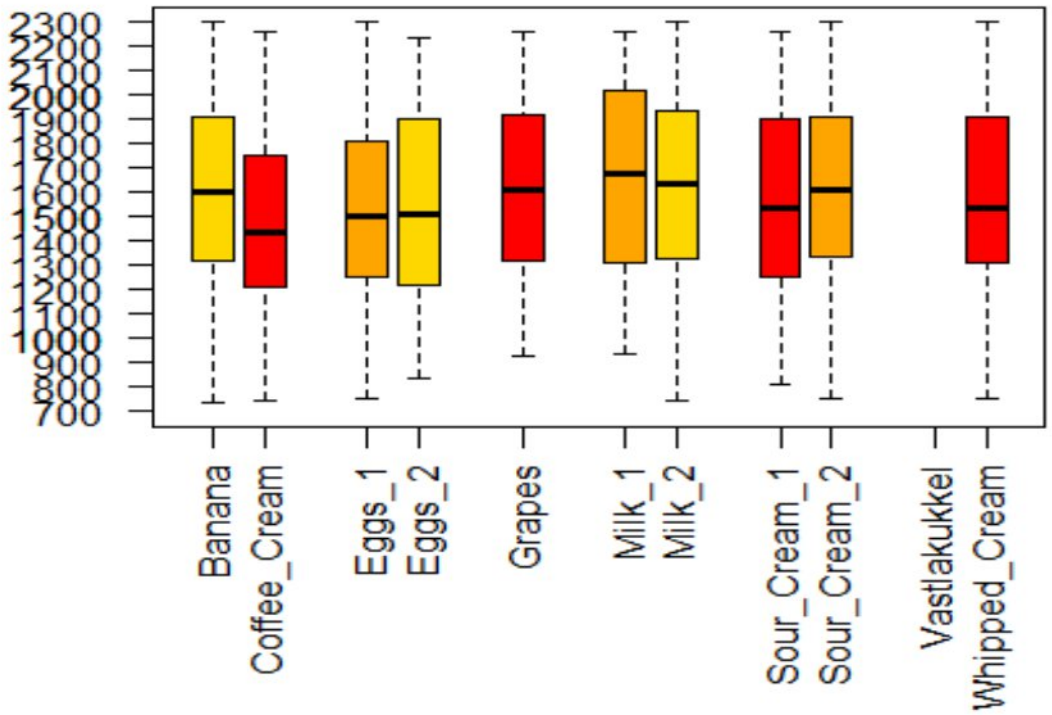
3.6.8 Boxplot for 2014-06-07
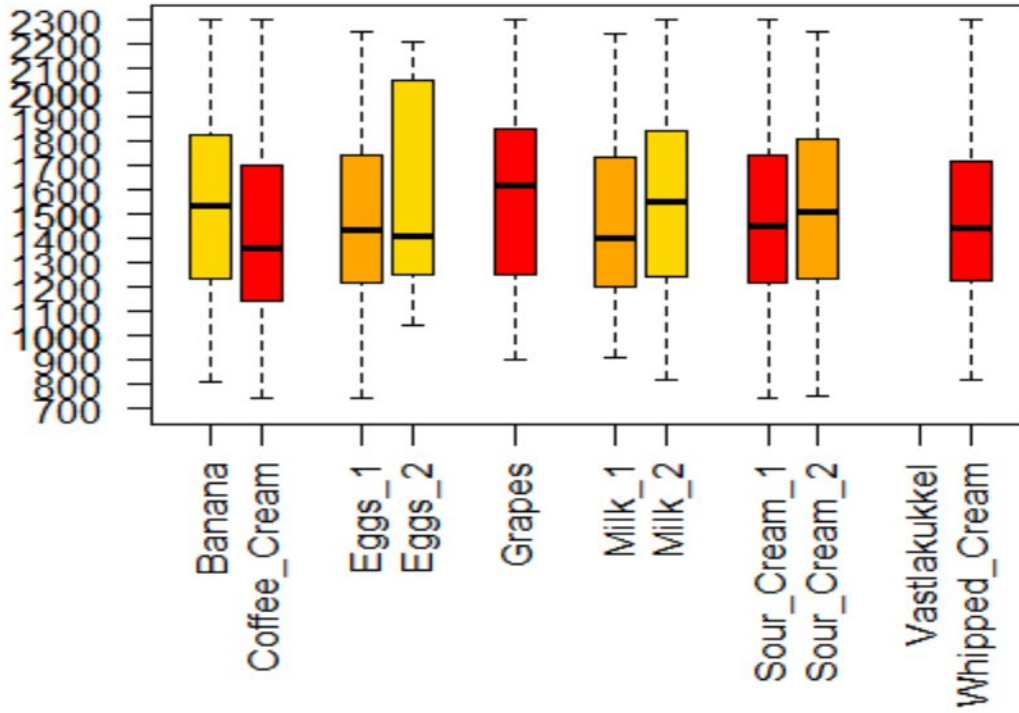
3.6.9 Boxplot for 2014-10-24
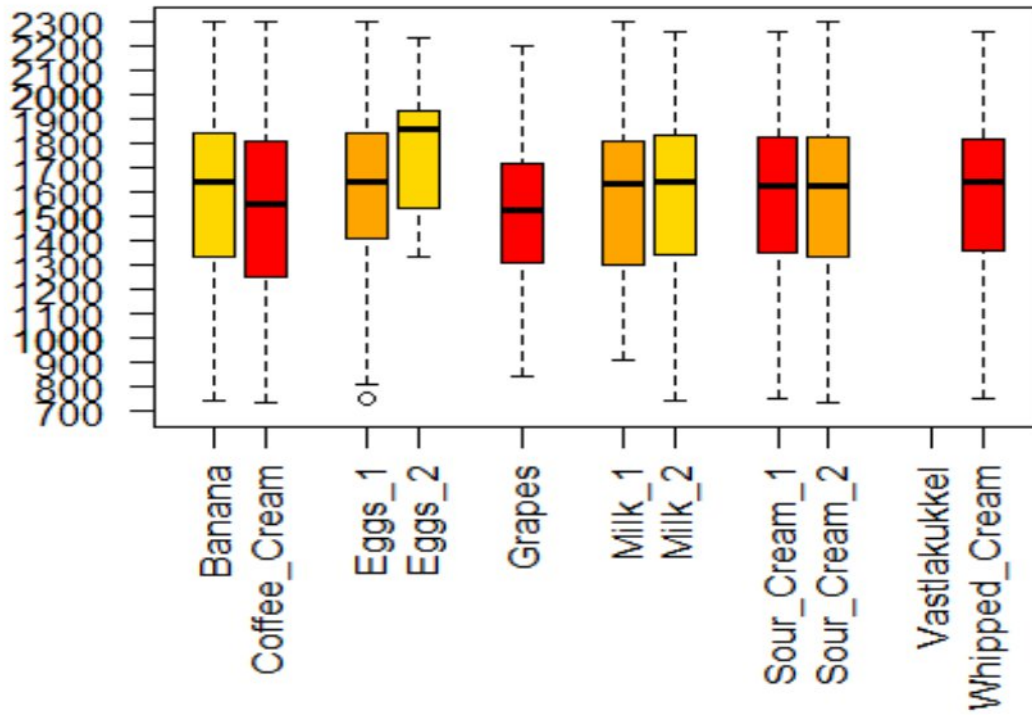
3.6.10 Boxplot for 2014-10-31
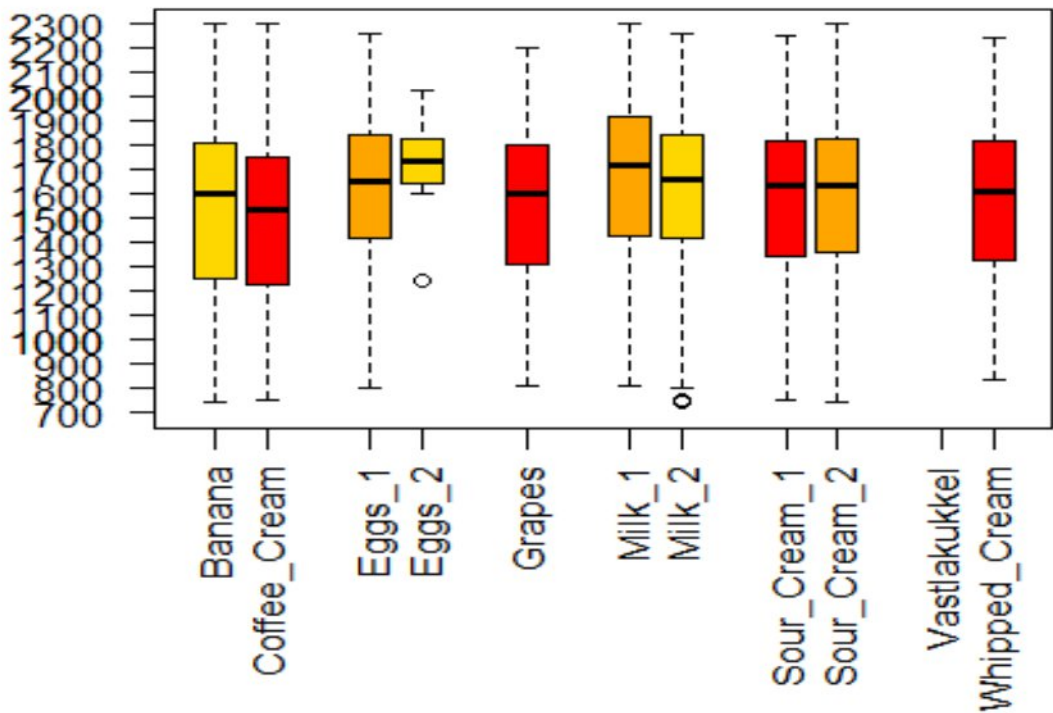
3.6.11 Boxplot for 2014-12-23
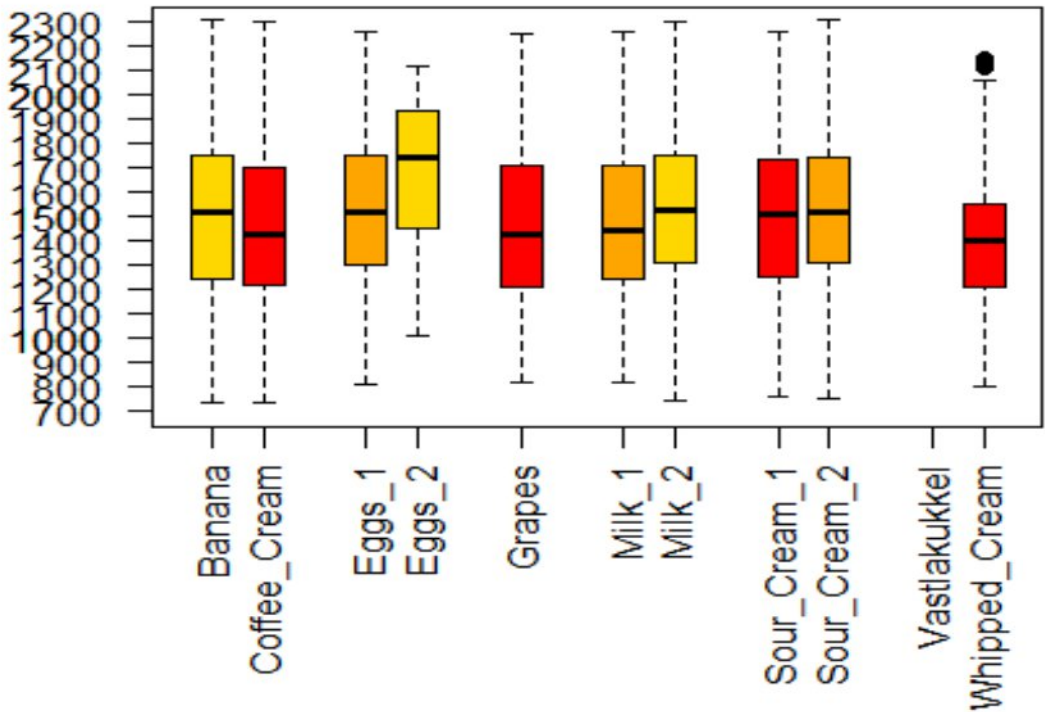
3.6.12 Boxplot for 2014-12-31
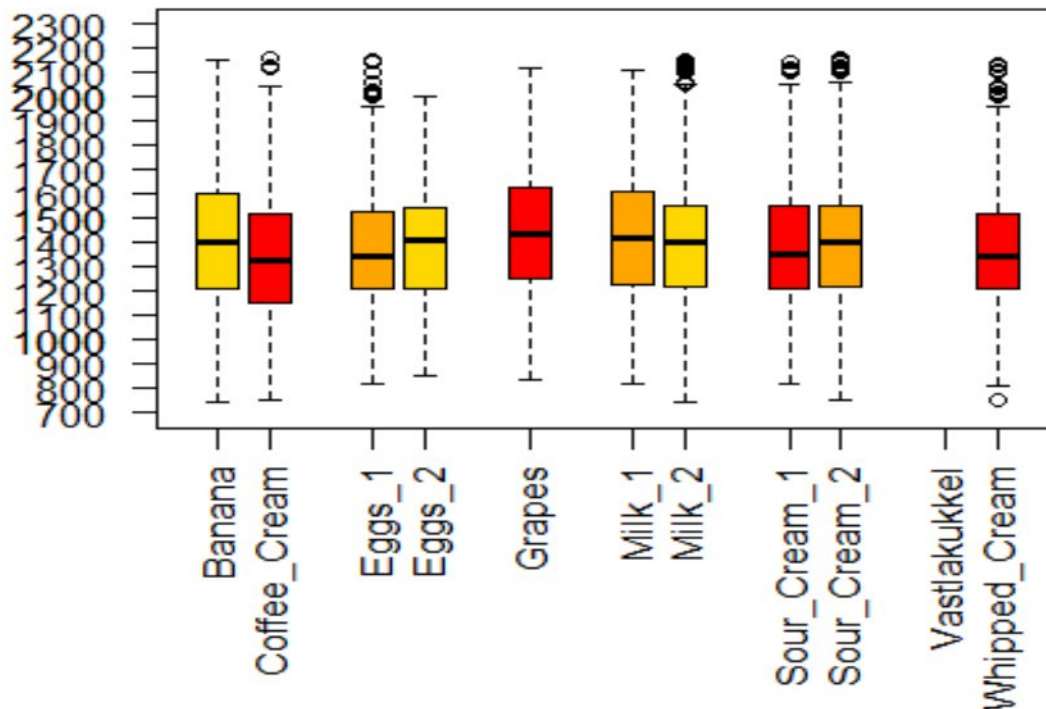
From the analysis of different weekdays and boxplot of several individual days one can deduce that certain products were not available on certain days most notably was Vastlakukkel which was notably absent all through the days except for Tuesday 4th of March 2014. A surprising one though was the Eggs2 which wasn't available most of the times too. There were other missing items sometimes that included Grapes, Eggs1 and Milk1 occasionally.

I will postulate an hypothesis in respect to this stating that the possibility of Tuesday 4th of March being a public holiday (religious, governmental etc.) or of cultural importance to the purchase of Vastlakukkel (signified by its high demand) has a probability greater than 0.5 ($P > 0.5$). Also the high purchase for Milk_2 almost everywhere (for all days and shops signifies) that there probably is a higher preference for Milk_2 either due to size or quality (how good the eggs taste). Finally on the days which were within holiday periods, shopping volume was relatively high when compared to other days in the dataset.

4. Use the same data as in 2. Explore the data and identify if any of the shops has run out of any popular product during the day (which shops, products, days?). Draw the density plots to convince the reader or shop manager. Formulate the principles of an automated procedure to identify (all) such events.

From the analysis in question two, the top three popular products are Milk-2 (purchased 25,715), Banana (purchased 24,847 times) and Coffee-Cream (purchased 20531 times). All

shops never really ran out of these popular products however there are some products with some interesting data I think is worth pointing out.

Boxplot 3.2 shows some interesting data for Vastlakukkel and Eggs. In shop 3, all products were available every day except for Vastlakukkel (which was only available on Tuesday 4th of March 2014), Eggs1(not available for Monday 7th of April 2014) and Eggs_2 which was not available on Wednesday 31st of December 2014 as can be seen below

```
##              product freq
## 1            Banana  536
## 2      Coffee_Cream  276
## 3            Eggs_1   73
## 4            Eggs_2    9
## 5            Grapes   64
## 6            Milk_1  686
## 7            Milk_2   44
## 8      Sour_Cream_1   74
## 9      Sour_Cream_2  222
## 10     Vastlakukkel  939
## 11    Whipped_Cream  223
```


Histogram showing purchases on 2014-04-04
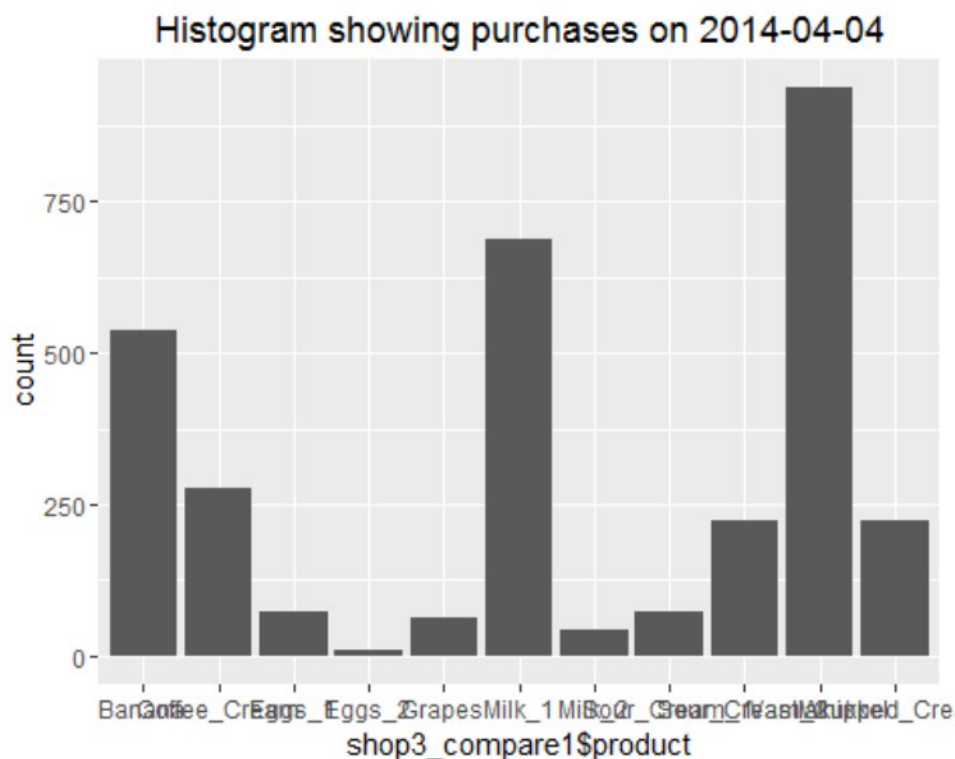
```
##              product freq
## 1            Banana  622
## 2      Coffee_Cream  317
## 3            Eggs_2   10
## 4            Grapes   60
## 5            Milk_1   88
```

```
## 6        Milk_2   652
## 7  Sour_Cream_1    96
## 8  Sour_Cream_2   295
## 9 Whipped_Cream   122
```

Histogram showing purchases on 2014-04-07
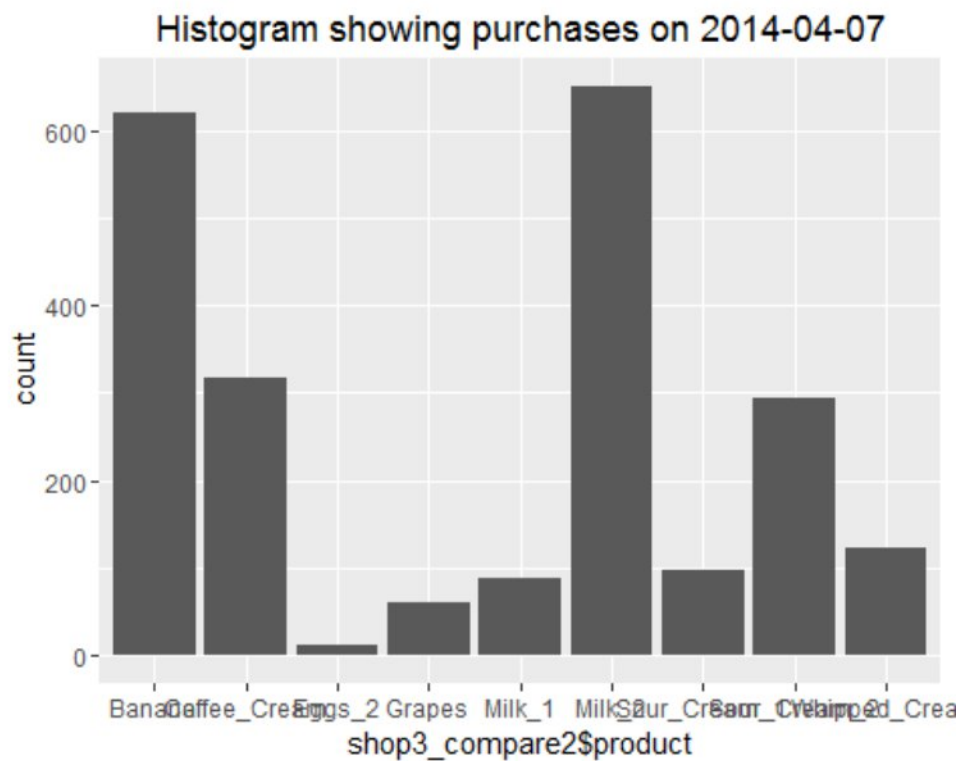

```
##         product freq
## 1        Banana  494
## 2  Coffee_Cream  426
## 3        Eggs_1  382
## 4        Grapes    7
## 5        Milk_1  114
## 6        Milk_2  730
## 7  Sour_Cream_1  410
## 8  Sour_Cream_2  277
## 9 Whipped_Cream  359
```

Histogram showing purchases on 2014-12-31
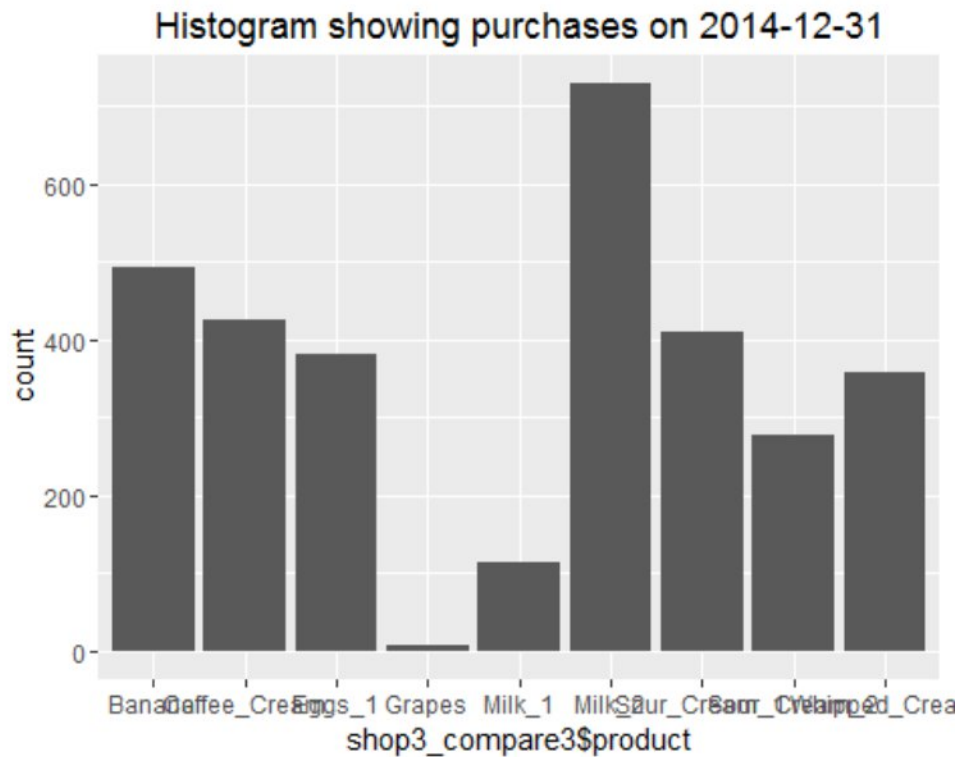
Boxplot 3.3 also holds some interesting data for Vastlakukkel. In shop 4, all products were available every day except for Vastlakukkel which was only available on Tuesday 4th of March 2014.

```
##              product  freq
## 1            Banana   553
## 2     Coffee_Cream   440
## 3           Eggs_1   285
## 4           Eggs_2     8
## 5           Grapes    69
## 6           Milk_1   931
## 7           Milk_2    83
## 8     Sour_Cream_1    96
## 9     Sour_Cream_2   319
## 10    Vastlakukkel  1784
## 11  Whipped_Cream   333
```

Histogram showing purchases on 2014-03-04
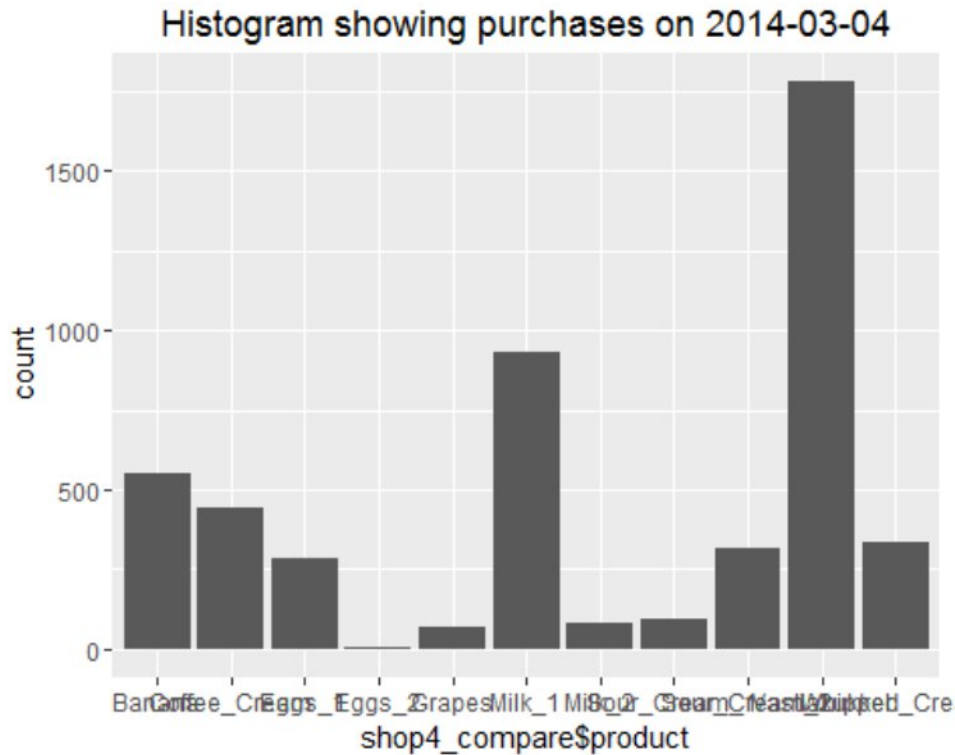
Boxplot 3.4 shows a shift in the trend, further analysis provides us with details of several missing products on Monday 7th of April 2014 in shop 18 as can be seen in the statistics below. Eggs2 was never present in the shop whereas Vastlakukkel was as usual present only on Tuesday 4th OF March 2014. Milk1 was also missing at shop 18 on Tuesday 15th April 2014.

```
##          product freq
## 1         Banana  421
## 2   Coffee_Cream  316
## 3         Eggs_1  133
## 4         Grapes   27
## 5         Milk_1  585
## 6         Milk_2   82
## 7   Sour_Cream_1   75
## 8   Sour_Cream_2  251
## 9    Vastlakukkel  730
## 10 Whipped_Cream  160
```

Histogram showing purchases on 2014-03-04
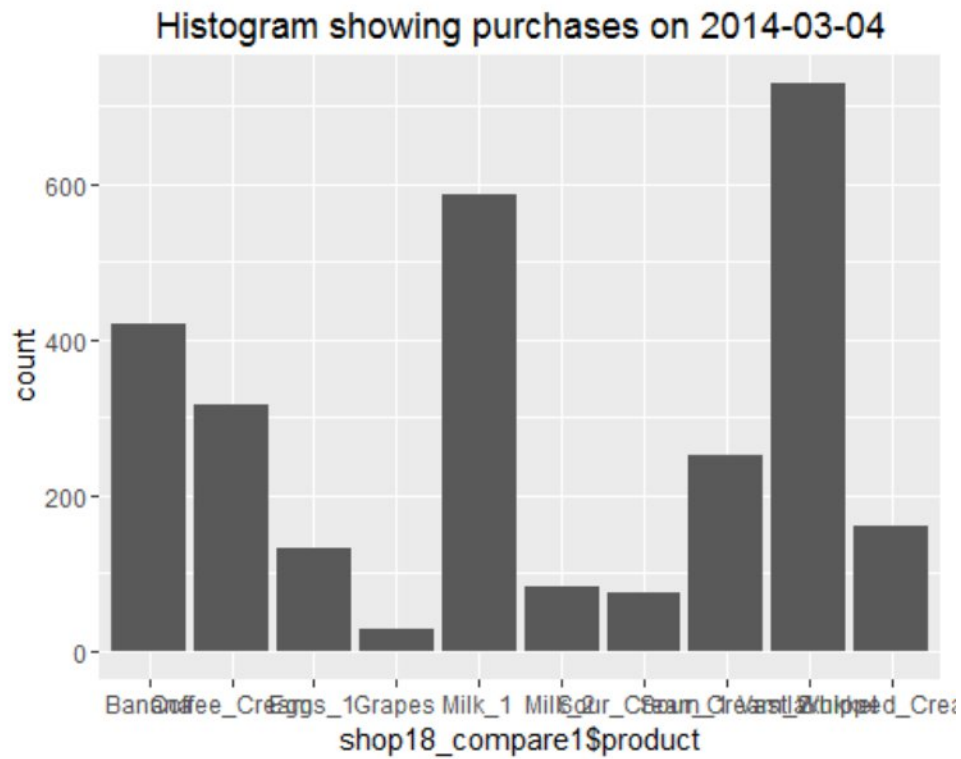

```
##           product freq
## 1          Banana  452
## 2   Coffee_Cream   401
## 3          Grapes   83
## 4          Milk_2  699
## 5   Sour_Cream_1    98
## 6   Sour_Cream_2   297
## 7  Whipped_Cream    61
```

Histogram showing purchases on 2014-04-07
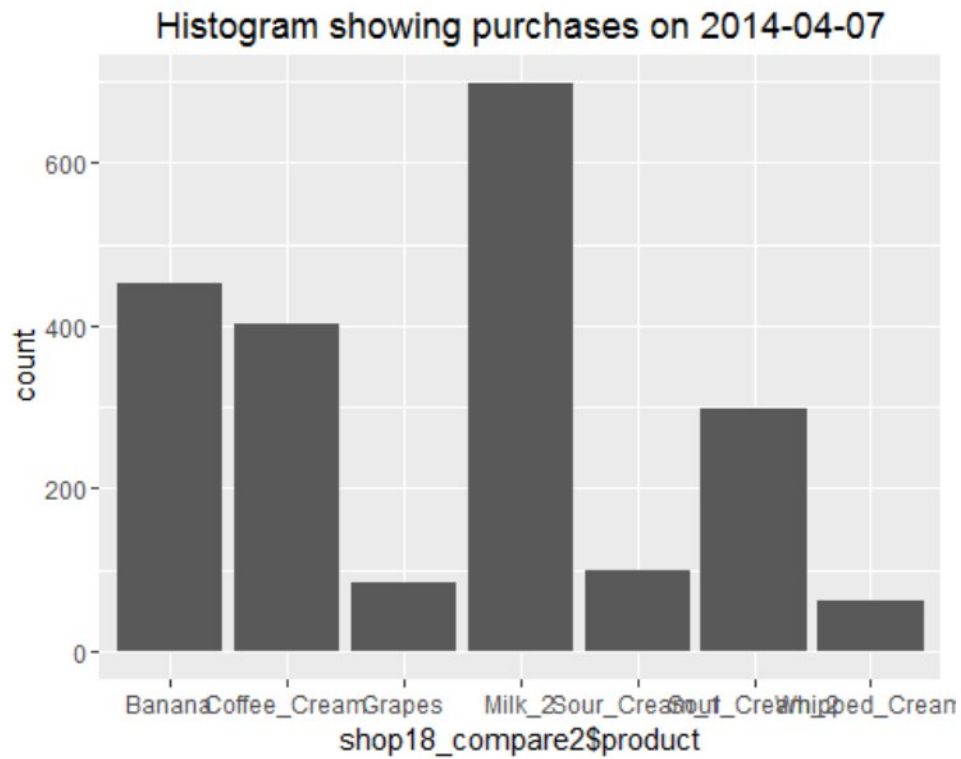
```
##           product freq
## 1          Banana  403
## 2   Coffee_Cream   388
## 3         Eggs_1   186
## 4         Grapes    23
## 5         Milk_2   611
## 6   Sour_Cream_1   203
## 7   Sour_Cream_2   128
## 8 Whipped_Cream     49
```

Histogram showing purchases on 2014-04-15
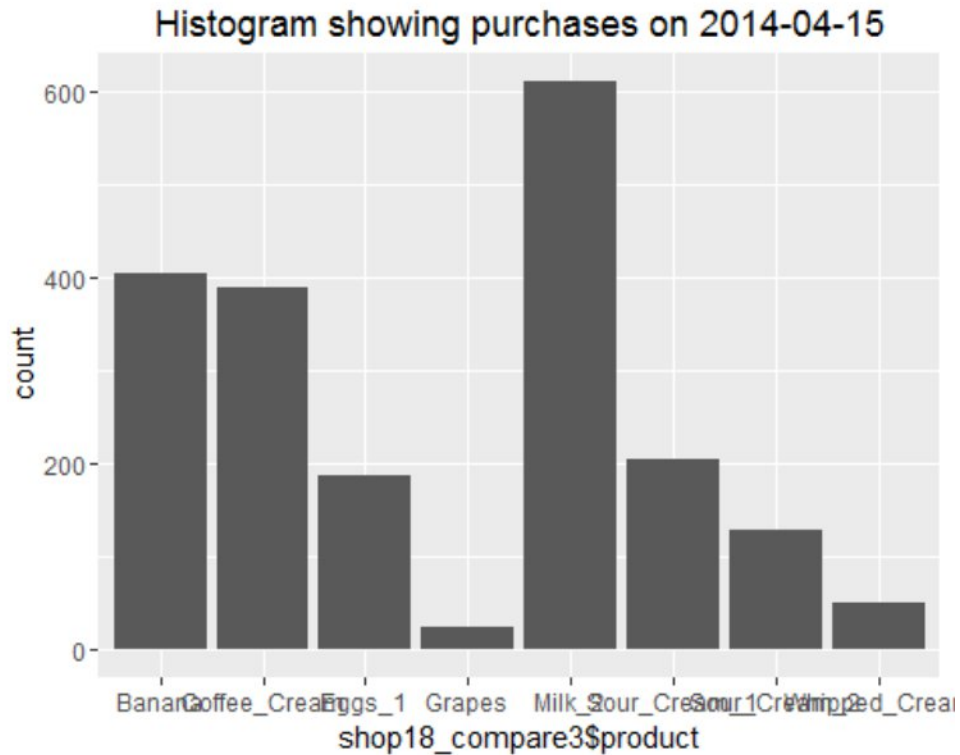
Boxplot 3.5 shows another slightly different shift in analysis provides as we continue to see several missing products on Monday 7th of April 2014 in shop 21 as per the statistics below. Eggs2 was never present in the shop whereas Vastlakukkel was as usual present only on Tuesday 4th OF March 2014. Grapes were also missing at shop 21 on Saturday 7th of June 2014.

```
##           product freq
## 1          Banana  168
## 2   Coffee_Cream   77
## 3         Eggs_1   96
## 4         Grapes    9
## 5         Milk_1  168
## 6         Milk_2   53
## 7   Sour_Cream_1   22
## 8   Sour_Cream_2  101
## 9   Vastlakukkel  273
## 10 Whipped_Cream   32
```

Histogram showing purchases on 2014-03-04
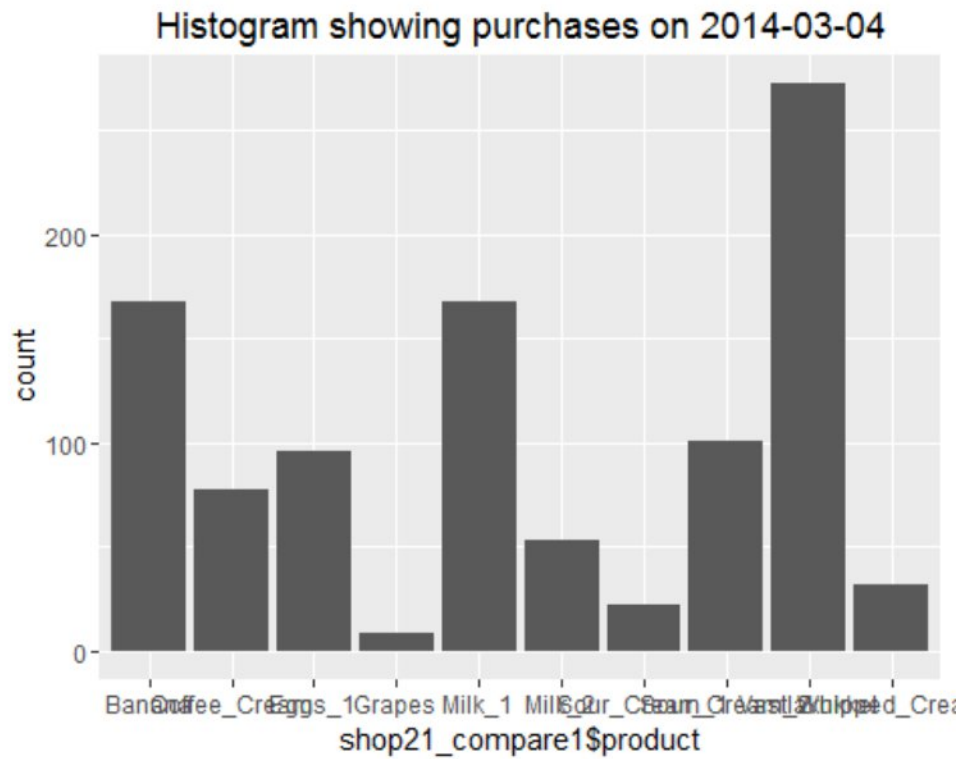

```
##          product  freq
## 1         Banana   204
## 2  Coffee_Cream   108
## 3        Grapes    15
## 4        Milk_2   244
## 5  Sour_Cream_1    34
## 6  Sour_Cream_2   140
## 7 Whipped_Cream    28
```

Histogram showing purchases on 2014-04-07
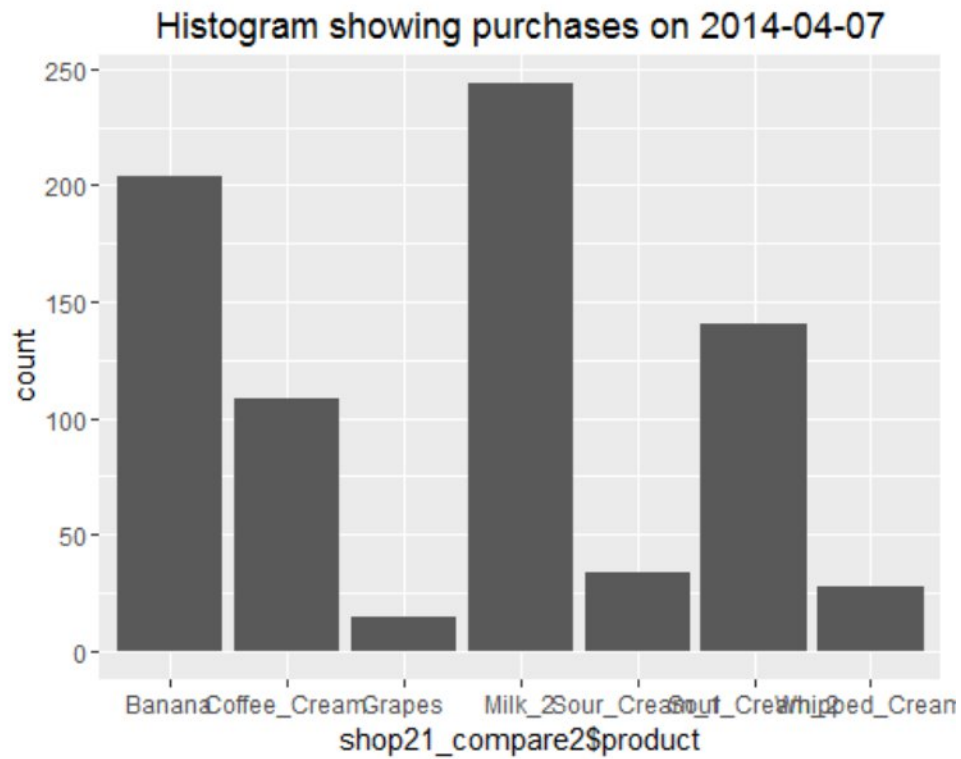

```
##           product freq
## 1         Banana   132
## 2   Coffee_Cream   140
## 3         Grapes    38
## 4         Milk_1     2
## 5         Milk_2   235
## 6   Sour_Cream_1    70
## 7   Sour_Cream_2    79
## 8 Whipped_Cream    27
```

Histogram showing purchases on 2014-04-15
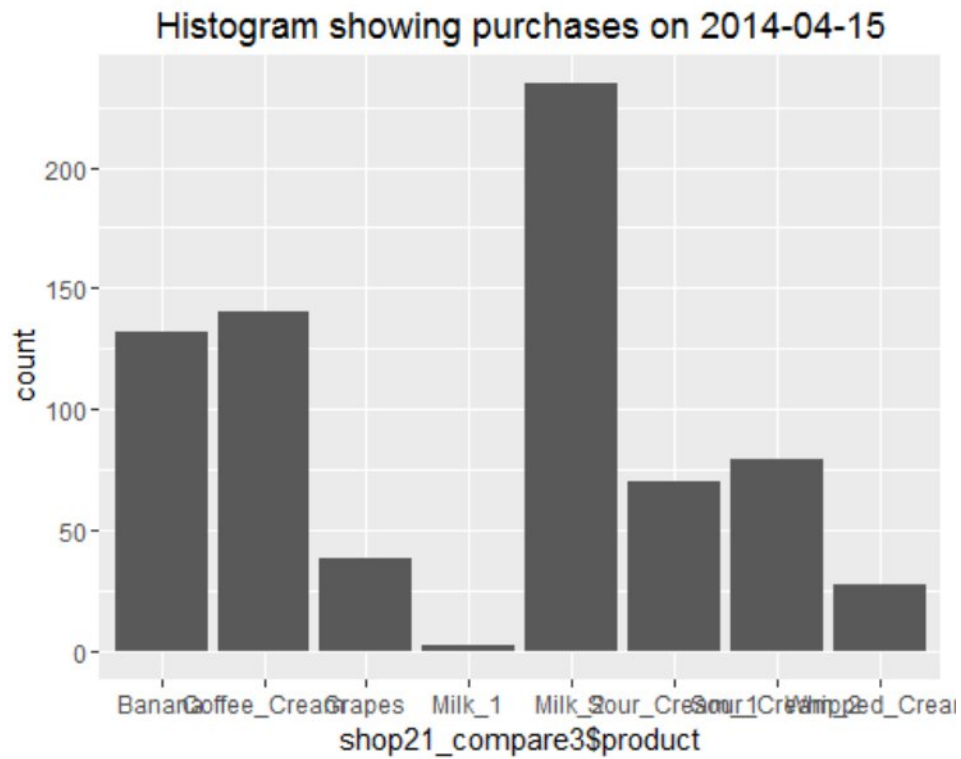

```
##          product freq
## 1         Banana  239
## 2  Coffee_Cream   120
## 3        Eggs_1   100
## 4        Milk_1    17
## 5        Milk_2   251
## 6  Sour_Cream_1   128
## 7  Sour_Cream_2   106
## 8 Whipped_Cream    31
```

Histogram showing purchases on 2014-06-07
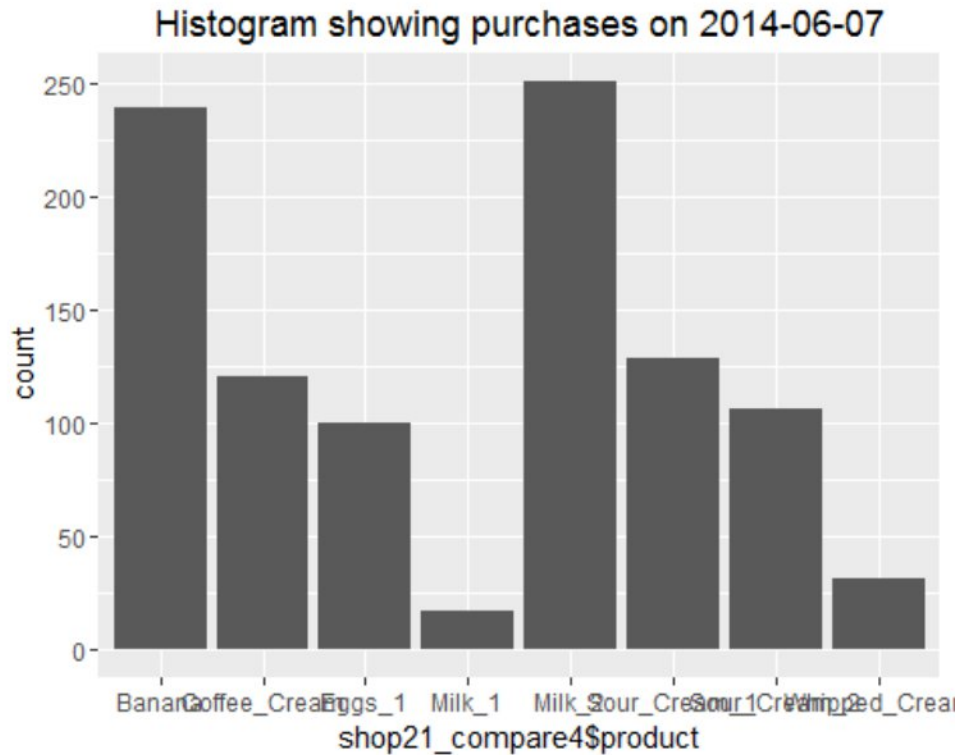
Boxplot 3.6 describes the shop with shop_id = 32. It shows a similar trend regarding the details of several missing products on Monday 7th of April 2014 albeit lesser than in shop 21 when compared. Eggs2 was never present in the shop whereas Vastlakukkel was as usual present only on Tuesday 4th OF March 2014. Eggs1 was also missing at shop on Monday 7th of April 2014.

```
##             product freq
## 1           Banana  299
## 2     Coffee_Cream  184
## 3           Eggs_1  151
## 4           Grapes    8
## 5           Milk_1  507
## 6           Milk_2   35
## 7     Sour_Cream_1   36
## 8     Sour_Cream_2  187
## 9      Vastlakukkel  383
## 10  Whipped_Cream  212
```

Histogram showing purchases on 2014-03-04
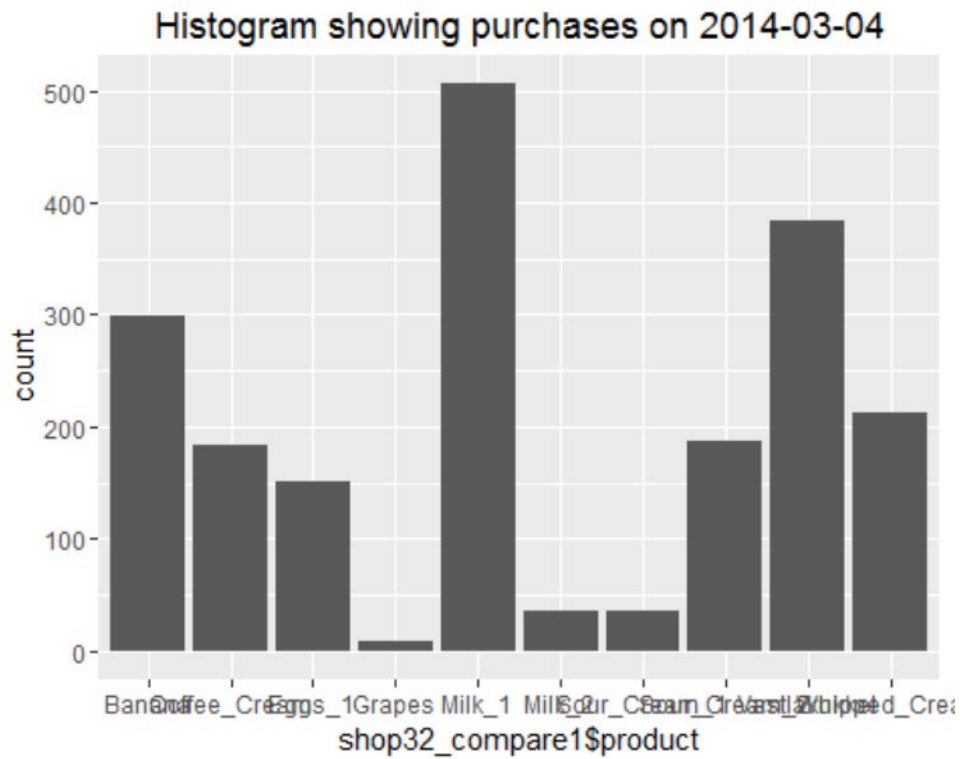

```
##          product freq
## 1         Banana  296
## 2   Coffee_Cream  214
## 3         Grapes   51
## 4         Milk_1   34
## 5         Milk_2  513
## 6   Sour_Cream_1   76
## 7   Sour_Cream_2  195
## 8  Whipped_Cream   44
```

Histogram showing purchases on 2014-04-07
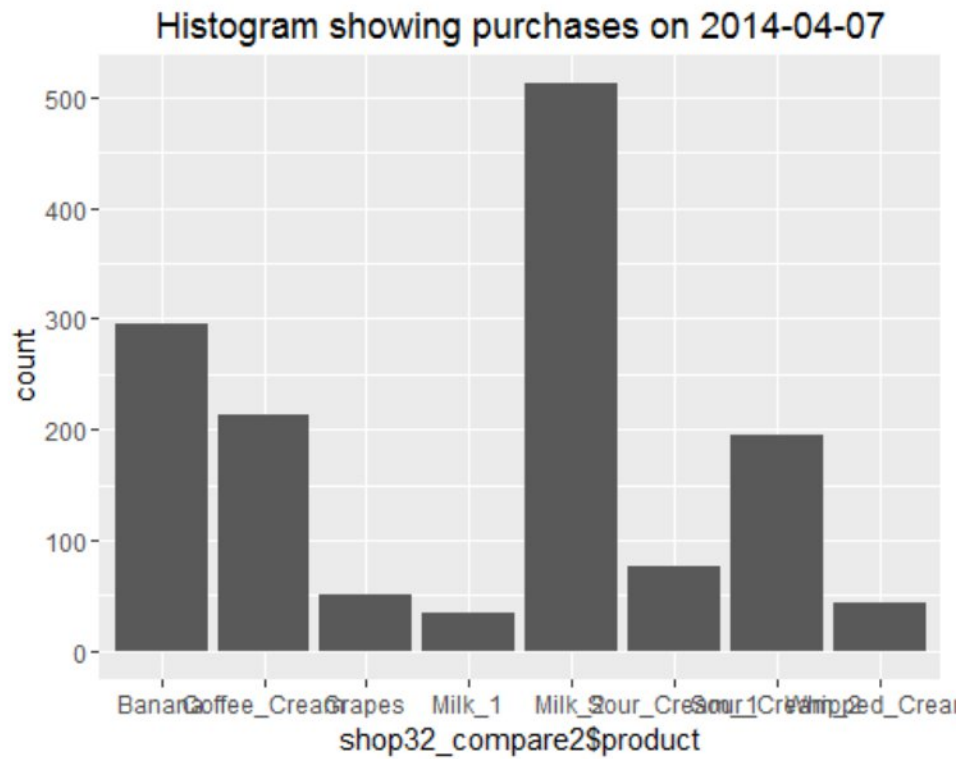


```
##          product freq
## 1         Banana  275
## 2   Coffee_Cream  241
## 3         Eggs_1  150
## 4         Grapes   41
## 5         Milk_1   31
## 6         Milk_2  423
## 7   Sour_Cream_1   73
## 8   Sour_Cream_2  151
## 9  Whipped_Cream   48
```

Histogram showing purchases on 2014-04-15
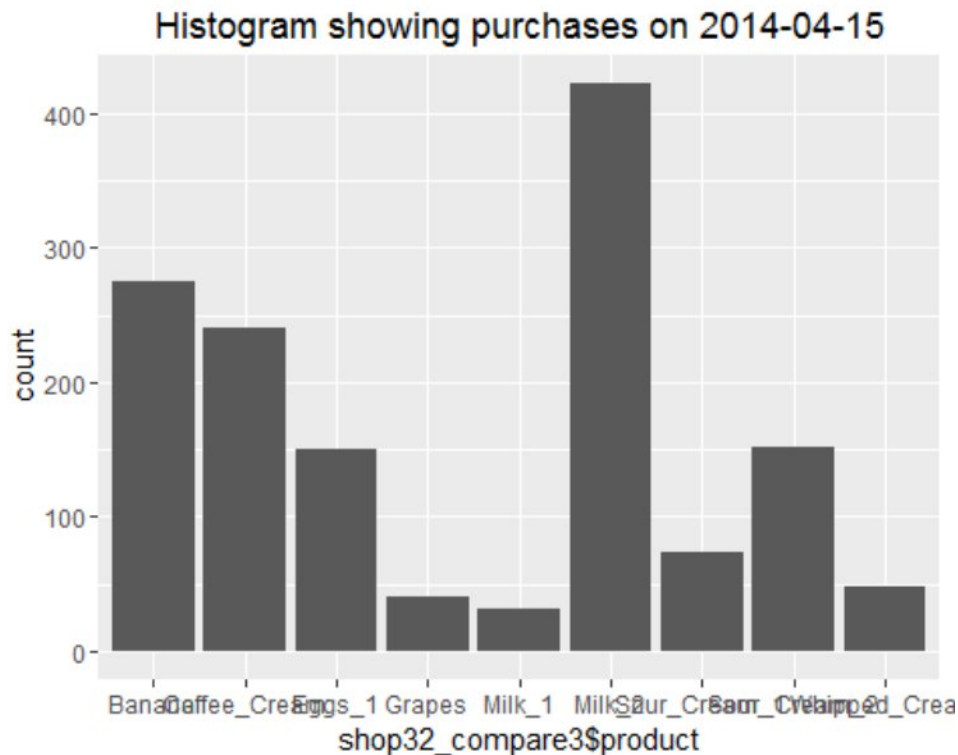
5. Calculate the nr of purchases of each product during every hour in each shop. Make a table with a product in particular shop as rows and time by hour as columns; In each cell a nr of purchases in that hour. Draw an heatmap version of the sales data. E.g. use Excel "Conditional formatting" => "Color Scales"

Purchases Between 07:00 and 08:00

```
## [1] product freq
## <0 rows> (or 0-length row.names)

##          product freq
## 1         Banana   50
## 2 Coffee_Cream    6
## 3         Milk_1    1
## 4         Milk_2    1
## 5 Sour_Cream_2     2
## 6 Vastlakukkel     3

##          product freq
## 1         Banana    6
## 2  Coffee_Cream   13
## 3         Eggs_1    4
## 4         Milk_1    1
## 5         Milk_2    4
## 6  Sour_Cream_1    3
## 7  Sour_Cream_2    1
```

```
## 8   Vastlakukkel     2
## 9 Whipped_Cream     5

##          product freq
## 1         Banana     5
## 2         Eggs_1     1
## 3 Sour_Cream_2     1

##          product freq
## 1         Banana    14
## 2   Coffee_Cream    11
## 3         Eggs_1     3
## 4         Milk_1     5
## 5         Milk_2    13
## 6   Sour_Cream_1     1
## 7   Sour_Cream_2     6
## 8 Whipped_Cream     3
```

Purchases Between 08:00 and 09:00

```
##          product freq
## 1         Banana     9
## 2   Coffee_Cream    13
## 3         Eggs_1     2
## 4         Milk_1     2
## 5         Milk_2     3
## 6   Sour_Cream_2     2
## 7   Vastlakukkel     3
## 8 Whipped_Cream     3

##          product freq
## 1         Banana   113
## 2   Coffee_Cream    89
## 3         Eggs_1    30
## 4         Eggs_2     2
## 5         Grapes     3
## 6         Milk_1    26
## 7         Milk_2    50
## 8   Sour_Cream_1    23
## 9   Sour_Cream_2    42
## 10  Vastlakukkel    36
## 11 Whipped_Cream    35

##          product freq
## 1         Banana    49
## 2   Coffee_Cream    93
## 3         Eggs_1    18
## 4         Grapes     2
## 5         Milk_1    29
## 6         Milk_2    94
## 7   Sour_Cream_1    27
## 8   Sour_Cream_2    27
```

```
## 9     Vastlakukkel    10
## 10 Whipped_Cream     7

##           product freq
## 1          Banana   20
## 2    Coffee_Cream   23
## 3          Eggs_1   13
## 4          Grapes    2
## 5          Milk_1    5
## 6          Milk_2   24
## 7    Sour_Cream_1    6
## 8    Sour_Cream_2   11
## 9     Vastlakukkel   23
## 10 Whipped_Cream     9

##           product freq
## 1          Banana   64
## 2    Coffee_Cream   44
## 3          Eggs_1   21
## 4          Grapes    5
## 5          Milk_1   21
## 6          Milk_2   50
## 7    Sour_Cream_1   12
## 8    Sour_Cream_2   19
## 9     Vastlakukkel   10
## 10 Whipped_Cream    18
```

Purchases Between 09:00 and 10:00

```
##           product freq
## 1          Banana  128
## 2    Coffee_Cream   99
## 3          Eggs_1   36
## 4          Eggs_2    2
## 5          Grapes   10
## 6          Milk_1   56
## 7          Milk_2  111
## 8    Sour_Cream_1   40
## 9    Sour_Cream_2   36
## 10    Vastlakukkel   30
## 11 Whipped_Cream    44

##           product freq
## 1          Banana  233
## 2    Coffee_Cream  188
## 3          Eggs_1   61
## 4          Grapes   28
## 5          Milk_1   64
## 6          Milk_2  115
## 7    Sour_Cream_1   64
## 8    Sour_Cream_2   86
```

```
## 9     Vastlakukkel     97
## 10 Whipped_Cream     86

##            product freq
## 1          Banana  115
## 2    Coffee_Cream  170
## 3          Eggs_1   35
## 4          Grapes    3
## 5          Milk_1   76
## 6          Milk_2  131
## 7    Sour_Cream_1   45
## 8    Sour_Cream_2   64
## 9     Vastlakukkel   33
## 10 Whipped_Cream     23

##            product freq
## 1          Banana   54
## 2    Coffee_Cream   73
## 3          Eggs_1   25
## 4          Grapes    8
## 5          Milk_1   16
## 6          Milk_2   87
## 7    Sour_Cream_1   33
## 8    Sour_Cream_2   47
## 9     Vastlakukkel   13
## 10 Whipped_Cream     16

##            product freq
## 1          Banana   95
## 2    Coffee_Cream   87
## 3          Eggs_1   51
## 4          Grapes   13
## 5          Milk_1   59
## 6          Milk_2  118
## 7    Sour_Cream_1   25
## 8    Sour_Cream_2   67
## 9     Vastlakukkel   19
## 10 Whipped_Cream     29
```

Purchases Between 10:00 and 11:00

```
##            product freq
## 1          Banana  289
## 2    Coffee_Cream  260
## 3          Eggs_1  103
## 4          Eggs_2    5
## 5          Grapes   30
## 6          Milk_1  117
## 7          Milk_2  245
## 8    Sour_Cream_1  139
## 9    Sour_Cream_2  121
```

```
## 10    Vastlakukkel      35
## 11 Whipped_Cream     120

##            product freq
## 1           Banana  412
## 2     Coffee_Cream  394
## 3           Eggs_1  188
## 4           Eggs_2    5
## 5           Grapes   45
## 6           Milk_1  224
## 7           Milk_2  319
## 8     Sour_Cream_1  121
## 9     Sour_Cream_2  219
## 10    Vastlakukkel   93
## 11 Whipped_Cream   189

##            product freq
## 1           Banana  190
## 2     Coffee_Cream  325
## 3           Eggs_1   76
## 4           Grapes   12
## 5           Milk_1  141
## 6           Milk_2  249
## 7     Sour_Cream_1   89
## 8     Sour_Cream_2  146
## 9     Vastlakukkel   35
## 10 Whipped_Cream    64

##            product freq
## 1           Banana  148
## 2     Coffee_Cream  134
## 3           Eggs_1   77
## 4           Grapes   19
## 5           Milk_1   71
## 6           Milk_2  129
## 7     Sour_Cream_1   78
## 8     Sour_Cream_2  100
## 9     Vastlakukkel   25
## 10 Whipped_Cream    52

##            product freq
## 1           Banana  215
## 2     Coffee_Cream  244
## 3           Eggs_1  111
## 4           Grapes   27
## 5           Milk_1  184
## 6           Milk_2  224
## 7     Sour_Cream_1   82
## 8     Sour_Cream_2  133
## 9     Vastlakukkel   36
## 10 Whipped_Cream    87
```

Purchases Between 11:00 and 12:00

```
##           product freq
## 1         Banana  447
## 2   Coffee_Cream  358
## 3         Eggs_1  148
## 4         Eggs_2    5
## 5         Grapes   53
## 6         Milk_1  252
## 7         Milk_2  393
## 8   Sour_Cream_1  182
## 9   Sour_Cream_2  193
## 10  Vastlakukkel   52
## 11 Whipped_Cream  192

##           product freq
## 1         Banana  611
## 2   Coffee_Cream  669
## 3         Eggs_1  270
## 4         Eggs_2    8
## 5         Grapes   74
## 6         Milk_1  319
## 7         Milk_2  550
## 8   Sour_Cream_1  282
## 9   Sour_Cream_2  402
## 10  Vastlakukkel   92
## 11 Whipped_Cream  366

##           product freq
## 1         Banana  285
## 2   Coffee_Cream  460
## 3         Eggs_1   93
## 4         Grapes   22
## 5         Milk_1  204
## 6         Milk_2  347
## 7   Sour_Cream_1  135
## 8   Sour_Cream_2  195
## 9   Vastlakukkel   35
## 10 Whipped_Cream   89

##           product freq
## 1         Banana  163
## 2   Coffee_Cream  190
## 3         Eggs_1   91
## 4         Grapes   33
## 5         Milk_1   99
## 6         Milk_2  215
## 7   Sour_Cream_1  112
## 8   Sour_Cream_2  173
## 9   Vastlakukkel   16
## 10 Whipped_Cream   90
```

```
##          product freq
## 1         Banana  228
## 2   Coffee_Cream  307
## 3         Eggs_1  177
## 4         Grapes   46
## 5         Milk_1  201
## 6         Milk_2  291
## 7   Sour_Cream_1  123
## 8   Sour_Cream_2  215
## 9   Vastlakukkel   24
## 10 Whipped_Cream  147
```

Purchases Between 12:00 and 13:00

```
##          product freq
## 1         Banana  552
## 2   Coffee_Cream  466
## 3         Eggs_1  176
## 4         Eggs_2   11
## 5         Grapes   60
## 6         Milk_1  332
## 7         Milk_2  467
## 8   Sour_Cream_1  234
## 9   Sour_Cream_2  265
## 10  Vastlakukkel   62
## 11 Whipped_Cream  270
```

```
##          product freq
## 1         Banana  692
## 2   Coffee_Cream  718
## 3         Eggs_1  356
## 4         Eggs_2   15
## 5         Grapes  119
## 6         Milk_1  410
## 7         Milk_2  605
## 8   Sour_Cream_1  277
## 9   Sour_Cream_2  478
## 10  Vastlakukkel  132
## 11 Whipped_Cream  411
```

```
##          product freq
## 1         Banana  336
## 2   Coffee_Cream  514
## 3         Eggs_1  123
## 4         Grapes   43
## 5         Milk_1  213
## 6         Milk_2  407
## 7   Sour_Cream_1  155
## 8   Sour_Cream_2  272
## 9   Vastlakukkel   63
## 10 Whipped_Cream  105
```

```
##          product freq
## 1         Banana  212
## 2   Coffee_Cream  198
## 3         Eggs_1  128
## 4         Grapes   33
## 5         Milk_1  119
## 6         Milk_2  226
## 7   Sour_Cream_1  124
## 8   Sour_Cream_2  206
## 9    Vastlakukkel  23
## 10 Whipped_Cream  102

##          product freq
## 1         Banana  366
## 2   Coffee_Cream  392
## 3         Eggs_1  206
## 4         Grapes   45
## 5         Milk_1  283
## 6         Milk_2  398
## 7   Sour_Cream_1  133
## 8   Sour_Cream_2  291
## 9    Vastlakukkel  43
## 10 Whipped_Cream  162
```

Purchases Between 13:00 and 14:00

```
##          product freq
## 1         Banana  621
## 2   Coffee_Cream  429
## 3         Eggs_1  217
## 4         Eggs_2    6
## 5         Grapes   57
## 6         Milk_1  337
## 7         Milk_2  479
## 8   Sour_Cream_1  259
## 9   Sour_Cream_2  284
## 10   Vastlakukkel  75
## 11 Whipped_Cream  264

##          product freq
## 1         Banana  769
## 2   Coffee_Cream  751
## 3         Eggs_1  379
## 4         Eggs_2   17
## 5         Grapes  138
## 6         Milk_1  464
## 7         Milk_2  699
## 8   Sour_Cream_1  262
## 9   Sour_Cream_2  572
## 10   Vastlakukkel 161
## 11 Whipped_Cream  441
```

```
##            product freq
## 1          Banana  317
## 2     Coffee_Cream  493
## 3          Eggs_1  121
## 4          Grapes   42
## 5          Milk_1  226
## 6          Milk_2  370
## 7     Sour_Cream_1  170
## 8     Sour_Cream_2  288
## 9     Vastlakukkel   48
## 10  Whipped_Cream   88

##            product freq
## 1          Banana  164
## 2     Coffee_Cream  153
## 3          Eggs_1  112
## 4          Grapes   27
## 5          Milk_1  100
## 6          Milk_2  289
## 7     Sour_Cream_1   81
## 8     Sour_Cream_2  184
## 9     Vastlakukkel   24
## 10  Whipped_Cream   60

##            product freq
## 1          Banana  349
## 2     Coffee_Cream  368
## 3          Eggs_1  225
## 4          Grapes   62
## 5          Milk_1  276
## 6          Milk_2  416
## 7     Sour_Cream_1  148
## 8     Sour_Cream_2  289
## 9     Vastlakukkel   31
## 10  Whipped_Cream  165
```

Purchases Between 14:00 and 15:00

```
##            product freq
## 1          Banana  573
## 2     Coffee_Cream  410
## 3          Eggs_1  212
## 4          Eggs_2    3
## 5          Grapes   55
## 6          Milk_1  366
## 7          Milk_2  479
## 8     Sour_Cream_1  268
## 9     Sour_Cream_2  276
## 10    Vastlakukkel   54
## 11  Whipped_Cream  279
```

```
##             product  freq
## 1           Banana   776
## 2      Coffee_Cream   808
## 3            Eggs_1   367
## 4            Eggs_2    18
## 5            Grapes   141
## 6            Milk_1   481
## 7            Milk_2   750
## 8      Sour_Cream_1   313
## 9      Sour_Cream_2   559
## 10     Vastlakukkel   111
## 11    Whipped_Cream   443

##             product  freq
## 1           Banana   385
## 2      Coffee_Cream   478
## 3            Eggs_1   137
## 4            Grapes    36
## 5            Milk_1   246
## 6            Milk_2   381
## 7      Sour_Cream_1   181
## 8      Sour_Cream_2   287
## 9      Vastlakukkel    71
## 10    Whipped_Cream   128

##             product  freq
## 1           Banana   161
## 2      Coffee_Cream   167
## 3            Eggs_1   137
## 4            Grapes    26
## 5            Milk_1   109
## 6            Milk_2   247
## 7      Sour_Cream_1    66
## 8      Sour_Cream_2   172
## 9      Vastlakukkel    27
## 10    Whipped_Cream    78

##             product  freq
## 1           Banana   308
## 2      Coffee_Cream   309
## 3            Eggs_1   196
## 4            Grapes    54
## 5            Milk_1   259
## 6            Milk_2   413
## 7      Sour_Cream_1   115
## 8      Sour_Cream_2   272
## 9      Vastlakukkel    39
## 10    Whipped_Cream   140
```

Purchases Between 15:00 and 16:00

```
##          product freq
## 1         Banana  643
## 2    Coffee_Cream  404
## 3         Eggs_1  209
## 4         Eggs_2    6
## 5         Grapes   60
## 6         Milk_1  343
## 7         Milk_2  518
## 8   Sour_Cream_1  227
## 9   Sour_Cream_2  336
## 10   Vastlakukkel   65
## 11 Whipped_Cream  279

##          product freq
## 1         Banana  860
## 2    Coffee_Cream  711
## 3         Eggs_1  311
## 4         Eggs_2   22
## 5         Grapes  156
## 6         Milk_1  518
## 7         Milk_2  781
## 8   Sour_Cream_1  350
## 9   Sour_Cream_2  593
## 10   Vastlakukkel  141
## 11 Whipped_Cream  417

##          product freq
## 1         Banana  344
## 2    Coffee_Cream  432
## 3         Eggs_1  112
## 4         Grapes   44
## 5         Milk_1  212
## 6         Milk_2  371
## 7   Sour_Cream_1  169
## 8   Sour_Cream_2  293
## 9    Vastlakukkel   40
## 10 Whipped_Cream  127

##          product freq
## 1         Banana  171
## 2    Coffee_Cream   90
## 3         Eggs_1  142
## 4         Grapes   19
## 5         Milk_1   66
## 6         Milk_2  243
## 7   Sour_Cream_1   81
## 8   Sour_Cream_2  147
## 9    Vastlakukkel   21
## 10 Whipped_Cream   54
```

```
##          product freq
## 1         Banana  346
## 2   Coffee_Cream  252
## 3         Eggs_1  191
## 4         Grapes   47
## 5         Milk_1  248
## 6         Milk_2  375
## 7   Sour_Cream_1  123
## 8   Sour_Cream_2  309
## 9    Vastlakukkel   33
## 10 Whipped_Cream  140
```

Purchases Between 16:00 and 17:00

```
##          product freq
## 1         Banana  732
## 2   Coffee_Cream  436
## 3         Eggs_1  180
## 4         Eggs_2   11
## 5         Grapes   69
## 6         Milk_1  407
## 7         Milk_2  510
## 8   Sour_Cream_1  260
## 9   Sour_Cream_2  284
## 10   Vastlakukkel   96
## 11 Whipped_Cream  214
```

```
##          product freq
## 1         Banana  842
## 2   Coffee_Cream  717
## 3         Eggs_1  346
## 4         Eggs_2   18
## 5         Grapes  144
## 6         Milk_1  575
## 7         Milk_2  943
## 8   Sour_Cream_1  379
## 9   Sour_Cream_2  603
## 10   Vastlakukkel  195
## 11 Whipped_Cream  381
```

```
##          product freq
## 1         Banana  379
## 2   Coffee_Cream  395
## 3         Eggs_1  124
## 4         Grapes   45
## 5         Milk_1  257
## 6         Milk_2  457
## 7   Sour_Cream_1  192
## 8   Sour_Cream_2  295
## 9    Vastlakukkel   60
## 10 Whipped_Cream  115
```

```
##             product freq
## 1           Banana  169
## 2      Coffee_Cream  123
## 3            Eggs_1  114
## 4            Grapes   31
## 5            Milk_1   64
## 6            Milk_2  244
## 7      Sour_Cream_1   77
## 8      Sour_Cream_2  126
## 9       Vastlakukkel   26
## 10    Whipped_Cream   43

##             product freq
## 1           Banana  320
## 2      Coffee_Cream  266
## 3            Eggs_1  209
## 4            Grapes   50
## 5            Milk_1  252
## 6            Milk_2  442
## 7      Sour_Cream_1  108
## 8      Sour_Cream_2  299
## 9       Vastlakukkel   70
## 10    Whipped_Cream  129
```

Purchases Between 17:00 and 18:00

```
##             product freq
## 1           Banana  655
## 2      Coffee_Cream  361
## 3            Eggs_1  168
## 4            Eggs_2   11
## 5            Grapes  100
## 6            Milk_1  400
## 7            Milk_2  554
## 8      Sour_Cream_1  239
## 9      Sour_Cream_2  285
## 10      Vastlakukkel  149
## 11    Whipped_Cream  201

##             product freq
## 1           Banana  898
## 2      Coffee_Cream  654
## 3            Eggs_1  369
## 4            Eggs_2   14
## 5            Grapes  113
## 6            Milk_1  549
## 7            Milk_2  959
## 8      Sour_Cream_1  344
## 9      Sour_Cream_2  558
## 10      Vastlakukkel  260
## 11    Whipped_Cream  371
```

```
##           product freq
## 1          Banana  408
## 2    Coffee_Cream  330
## 3          Eggs_1  113
## 4          Grapes   66
## 5          Milk_1  283
## 6          Milk_2  548
## 7    Sour_Cream_1  160
## 8    Sour_Cream_2  314
## 9     Vastlakukkel 112
## 10  Whipped_Cream  104

##           product freq
## 1          Banana  167
## 2    Coffee_Cream  112
## 3          Eggs_1   81
## 4          Grapes   33
## 5          Milk_1   67
## 6          Milk_2  307
## 7    Sour_Cream_1   71
## 8    Sour_Cream_2  145
## 9     Vastlakukkel  48
## 10  Whipped_Cream   31

##           product freq
## 1          Banana  366
## 2    Coffee_Cream  223
## 3          Eggs_1  208
## 4          Grapes   58
## 5          Milk_1  265
## 6          Milk_2  423
## 7    Sour_Cream_1  106
## 8    Sour_Cream_2  276
## 9     Vastlakukkel  76
## 10  Whipped_Cream  134
```

Purchases Between 18:00 and 19:00

```
##           product freq
## 1          Banana  748
## 2    Coffee_Cream  341
## 3          Eggs_1  132
## 4          Eggs_2   14
## 5          Grapes   72
## 6          Milk_1  367
## 7          Milk_2  582
## 8    Sour_Cream_1  237
## 9    Sour_Cream_2  279
## 10    Vastlakukkel 141
## 11  Whipped_Cream  153
```

```
##          product freq
## 1         Banana  867
## 2   Coffee_Cream  529
## 3         Eggs_1  326
## 4         Eggs_2   19
## 5         Grapes   83
## 6         Milk_1  490
## 7         Milk_2  860
## 8   Sour_Cream_1  273
## 9   Sour_Cream_2  466
## 10   Vastlakukkel  197
## 11 Whipped_Cream  243

##          product freq
## 1         Banana  355
## 2   Coffee_Cream  275
## 3         Eggs_1  125
## 4         Grapes   64
## 5         Milk_1  243
## 6         Milk_2  528
## 7   Sour_Cream_1  168
## 8   Sour_Cream_2  268
## 9   Vastlakukkel  103
## 10 Whipped_Cream  112

##          product freq
## 1         Banana  121
## 2   Coffee_Cream   63
## 3         Eggs_1   59
## 4         Grapes   16
## 5         Milk_1   61
## 6         Milk_2  163
## 7   Sour_Cream_1   38
## 8   Sour_Cream_2  110
## 9   Vastlakukkel   18
## 10 Whipped_Cream   30

##          product freq
## 1         Banana  316
## 2   Coffee_Cream  199
## 3         Eggs_1  147
## 4         Grapes   49
## 5         Milk_1  218
## 6         Milk_2  399
## 7   Sour_Cream_1  100
## 8   Sour_Cream_2  233
## 9   Vastlakukkel    2
## 10 Whipped_Cream  107
```

Purchases Between 19:00 and 20:00

```
##            product freq
## 1          Banana  537
## 2    Coffee_Cream  282
## 3          Eggs_1  114
## 4          Eggs_2   13
## 5          Grapes   63
## 6          Milk_1  209
## 7          Milk_2  514
## 8   Sour_Cream_1  205
## 9   Sour_Cream_2  209
## 10   Vastlakukkel   90
## 11 Whipped_Cream  120

##            product freq
## 1          Banana  658
## 2    Coffee_Cream  436
## 3          Eggs_1  261
## 4          Eggs_2   14
## 5          Grapes   67
## 6          Milk_1  414
## 7          Milk_2  681
## 8   Sour_Cream_1  205
## 9   Sour_Cream_2  393
## 10   Vastlakukkel  130
## 11 Whipped_Cream  177

##            product freq
## 1          Banana  319
## 2    Coffee_Cream  221
## 3          Eggs_1   90
## 4          Grapes   46
## 5          Milk_1  203
## 6          Milk_2  325
## 7   Sour_Cream_1  127
## 8   Sour_Cream_2  251
## 9    Vastlakukkel   51
## 10 Whipped_Cream   70

##            product freq
## 1          Banana   78
## 2    Coffee_Cream   45
## 3          Eggs_1   64
## 4          Grapes   12
## 5          Milk_1   35
## 6          Milk_2  124
## 7   Sour_Cream_1   36
## 8   Sour_Cream_2   70
## 9    Vastlakukkel    9
## 10 Whipped_Cream   15
```

```
##         product freq
## 1        Banana  240
## 2  Coffee_Cream  157
## 3        Eggs_1  128
## 4        Grapes   32
## 5        Milk_1  139
## 6        Milk_2  326
## 7  Sour_Cream_1   67
## 8  Sour_Cream_2  218
## 9 Whipped_Cream   67
```

Purchases Between 20:00 and 21:00

```
##          product freq
## 1         Banana  428
## 2   Coffee_Cream  183
## 3         Eggs_1   71
## 4         Eggs_2    6
## 5         Grapes   41
## 6         Milk_1  190
## 7         Milk_2  369
## 8   Sour_Cream_1  157
## 9   Sour_Cream_2  148
## 10   Vastlakukkel   55
## 11 Whipped_Cream   90
```

```
##          product freq
## 1         Banana  449
## 2   Coffee_Cream  321
## 3         Eggs_1  212
## 4         Eggs_2   11
## 5         Grapes   49
## 6         Milk_1  302
## 7         Milk_2  502
## 8   Sour_Cream_1  158
## 9   Sour_Cream_2  276
## 10   Vastlakukkel   82
## 11 Whipped_Cream  136
```

```
##          product freq
## 1         Banana  258
## 2   Coffee_Cream  140
## 3         Eggs_1   71
## 4         Grapes   34
## 5         Milk_1  159
## 6         Milk_2  325
## 7   Sour_Cream_1   85
## 8   Sour_Cream_2  148
## 9    Vastlakukkel   31
## 10 Whipped_Cream   58
```

```
##          product freq
## 1         Banana   59
## 2   Coffee_Cream   26
## 3         Eggs_1   26
## 4         Grapes    9
## 5         Milk_1   17
## 6         Milk_2   65
## 7   Sour_Cream_1   27
## 8   Sour_Cream_2   39
## 9  Whipped_Cream   13
```

```
##          product freq
## 1         Banana  177
## 2   Coffee_Cream  112
## 3         Eggs_1   97
## 4         Grapes   25
## 5         Milk_1   86
## 6         Milk_2  237
## 7   Sour_Cream_1   46
## 8   Sour_Cream_2  132
## 9  Whipped_Cream   32
```

Purchases Between 21:00 and 22:00

```
##           product freq
## 1          Banana  272
## 2    Coffee_Cream  151
## 3          Eggs_1   68
## 4          Eggs_2    5
## 5          Grapes   29
## 6          Milk_1  113
## 7          Milk_2  243
## 8    Sour_Cream_1  101
## 9    Sour_Cream_2  113
## 10    Vastlakukkel   23
## 11  Whipped_Cream   39
```

```
##           product freq
## 1          Banana  244
## 2    Coffee_Cream  172
## 3          Eggs_1  131
## 4          Eggs_2   12
## 5          Grapes   23
## 6          Milk_1  195
## 7          Milk_2  310
## 8    Sour_Cream_1   97
## 9    Sour_Cream_2  162
## 10    Vastlakukkel   42
## 11  Whipped_Cream   75
```

```
##            product freq
## 1          Banana  203
## 2    Coffee_Cream   99
## 3          Eggs_1   67
## 4          Grapes   27
## 5          Milk_1  140
## 6          Milk_2  260
## 7    Sour_Cream_1   66
## 8    Sour_Cream_2  123
## 9     Vastlakukkel  27
## 10  Whipped_Cream   51

##            product freq
## 1          Banana   28
## 2    Coffee_Cream   15
## 3          Eggs_1   32
## 4          Grapes    5
## 5          Milk_1    6
## 6          Milk_2   69
## 7    Sour_Cream_1   17
## 8    Sour_Cream_2   30
## 9   Whipped_Cream    5

##            product freq
## 1          Banana  122
## 2    Coffee_Cream   62
## 3          Eggs_1   77
## 4          Grapes    7
## 5          Milk_1   43
## 6          Milk_2  151
## 7    Sour_Cream_1   33
## 8    Sour_Cream_2   82
## 9   Whipped_Cream   26
```

Purchases Between 22:00 and 23:00

```
##            product freq
## 1          Banana  138
## 2    Coffee_Cream   77
## 3          Eggs_1   44
## 4          Eggs_2    2
## 5          Grapes   11
## 6          Milk_1   75
## 7          Milk_2  162
## 8    Sour_Cream_1   48
## 9    Sour_Cream_2   59
## 10   Vastlakukkel    9
## 11  Whipped_Cream   17

##            product freq
## 1          Banana  199
```

```
##  2    Coffee_Cream    91
##  3          Eggs_1    96
##  4          Eggs_2     6
##  5          Grapes    15
##  6          Milk_1   134
##  7          Milk_2   181
##  8    Sour_Cream_1    57
##  9    Sour_Cream_2    90
## 10   Vastlakukkel    12
## 11  Whipped_Cream    43

##            product freq
##  1          Banana   126
##  2    Coffee_Cream    76
##  3          Eggs_1    17
##  4          Grapes     8
##  5          Milk_1   107
##  6          Milk_2   164
##  7    Sour_Cream_1    45
##  8    Sour_Cream_2    74
##  9    Vastlakukkel     8
## 10  Whipped_Cream    22

##            product freq
##  1          Banana     7
##  2    Coffee_Cream     6
##  3          Eggs_1     3
##  4          Milk_1     1
##  5          Milk_2     8
##  6    Sour_Cream_1     1
##  7    Sour_Cream_2     8
##  8  Whipped_Cream     2

##            product freq
##  1          Banana    59
##  2    Coffee_Cream    32
##  3          Eggs_1    26
##  4          Grapes     5
##  5          Milk_1    18
##  6          Milk_2    93
##  7    Sour_Cream_1    14
##  8    Sour_Cream_2    25
##  9  Whipped_Cream    10
```

Purchases Between 23:00 and 00:00

```
##          product freq
##  1        Banana    6
##  2  Coffee_Cream    2
##  3        Milk_1    2
```

```
## 4 Sour_Cream_1     1
## 5 Sour_Cream_2     1

##           product freq
## 1         Banana    4
## 2  Coffee_Cream     5
## 3        Eggs_1     1
## 4        Grapes     1
## 5        Milk_1     7
## 6        Milk_2     3
## 7  Sour_Cream_1     1
## 8  Sour_Cream_2     3
## 9 Whipped_Cream     1

##          product freq
## 1        Banana     5
## 2 Coffee_Cream     2
## 3       Grapes     1
## 4       Milk_2     7
## 5 Vastlakukkel     1

##   product freq
## 1  Eggs_1    1

##          product freq
## 1 Coffee_Cream     1
```

N/B - Between 12:00 and 13:00 the purchases of Milk-1 was at its highest with the value going as high as 119, 336 purchases.

P/S – HeatMap (excel) can be found at the end of the document

6. Bonus (2p). Clearly, people visit shops more frequently at certain times. This can obscure analysis.

describe the overall visiting behavior of customers based on data from 2. normalise frequency of purchases to reflect a relative share of purchasing that product. (state how) identify if different products are purchased in different relative frequency over the weekdays does this normalisation help in task 4, to identify when shop has ran out of products?

*Describe the overall visiting behavior of customers based on data from 2 Behavioural pattern (visiting of shops) From the analysis of data in Question 2, I can summarize the general customer behaviour by looking at the following analysis below

```
##    shop_id freq
## 1       3 2318
## 2       4 3835
## 3      18 2200
## 4      21  884
## 5      32 1765
```

```
##   shop_id freq
## 1       3 2493
## 2       4 3442
## 3      18 1954
## 4      21  596
## 5      32 1594

##   shop_id freq
## 1       3 2453
## 2       4 4010
## 3      18 1980
## 4      21  807
## 5      32 1584

##   shop_id freq
## 1       3 3146
## 2       4 4901
## 3      18 2780
## 4      21  999
## 5      32 2002

##   shop_id freq
## 1       3 2262
## 2       4 3100
## 3      18 2091
## 4      21  773
## 5      32 1423

##   shop_id freq
## 1       3 2114
## 2       4 2795
## 3      18 1991
## 4      21  723
## 5      32 1433

##   shop_id freq
## 1       3 2012
## 2       4 3644
## 3      18 2100
## 4      21  764
## 5      32 1861

##   shop_id freq
## 1       3 2638
## 2       4 3130
## 3      18 1715
## 4      21  992
## 5      32 1949

##   shop_id freq
## 1       3 2765
## 2       4 4037
```

```
## 3         18 2154
## 4         21  907
## 5         32 1721

##    shop_id freq
## 1        3 2943
## 2        4 4242
## 3       18 2170
## 4       21 1068
## 5       32 1941

##    shop_id freq
## 1        3 3306
## 2        4 6414
## 3       18 1771
## 4       21 1382
## 5       32 2417

##    shop_id freq
## 1        3 3199
## 2        4 5261
## 3       18 1980
## 4       21 1195
## 5       32 2366
```

From the analysis of shops visited on different days, we can conclude authoritatively based on this data that the highest visits and purchases took place in shop 4 on all days while the lowest purchases on all days was at shop 21. This could be due to several factors amongst which could be the proximity to city center of living areas (shop 4 might be closer to the city center or residential areas while shop 21 might possibly be in the outskirt of town). The population in residential areas and/or city center is definitely higher than in the outskirts of the city or villages hence could play in relatively important role in the frequency of visits and purchases in this case. There is also the possibility of the shop size where shop 4 might be a huge departmental shop located in a shopping plaza or mall while shop 21 might just be a small supermarket located on a street or somewhere. Lastly (but not limited to just my three points), it might be a situation for both prize and quality of goods. Where the prize might be cheaper and/or quality better in Shop 4 than in shop 21 which invariably makes shop 4 more desirable than shop 21 for shoppers.

```
##           date  freq
## 1   2014-01-04 11002
## 2   2014-01-19 10079
## 3   2014-02-08 10834
## 4   2014-03-04 13828
## 5   2014-04-07  9649
## 6   2014-04-15  9056
## 7   2014-06-01 10381
## 8   2014-06-07 10424
## 9   2014-10-24 11584
## 10  2014-10-31 12364
```

```
## 11 2014-12-23 15290
## 12 2014-12-31 14001
```

On this data above I can also clearly see that the highest number of purchases occurred on Tuesday 23rd of December 2014 and it was closely followed by Wednesday 31st of December 2014. This I believe was greatly influenced by the Christmas holiday shopping which is usually done around this period. The holiday season definitely helped in enhancing sales. There is also the possibility that there were a higher amount of discounts in products and this might have resulted in the higher number of purchases during the festive season. The low sales were however recorded between Tuesday 4th of March 2014 and Monday 7th of April 2014 though a certain product Vastlakukkel made significant gains during one day (Tuesday 4th of March 2014) this period whilst being almost insignificant almost all through the year. This might be due to a cultural reason (maybe the easter period in a country that isn't religious at all or celebrates the easter by having and sharing Vastlakukkel).

*Identify if different products are purchased in different relative frequency over the weekdays

```
##            product freq
## 1          Banana 1653
## 2    Coffee_Cream 1737
## 3          Eggs_1  771
## 4          Eggs_2   41
## 5          Grapes  178
## 6          Milk_1 3554
## 7          Milk_2  470
## 8    Sour_Cream_1  648
## 9    Sour_Cream_2 1335
## 10 Whipped_Cream  615

##            product freq
## 1          Banana 1771
## 2    Coffee_Cream 1568
## 3          Eggs_1  569
## 4          Eggs_2   17
## 5          Grapes   82
## 6          Milk_1 3154
## 7          Milk_2  448
## 8    Sour_Cream_1  398
## 9    Sour_Cream_2 1553
## 10 Whipped_Cream  519

##            product freq
## 1          Banana 2000
## 2    Coffee_Cream 1782
## 3          Eggs_1  521
## 4          Eggs_2   22
## 5          Grapes  237
## 6          Milk_1 3105
```

```
## 7              Milk_2   378
## 8       Sour_Cream_1   422
## 9       Sour_Cream_2  1686
## 10   Whipped_Cream    681

##             product freq
## 1           Banana  1977
## 2     Coffee_Cream  1293
## 3           Eggs_1   738
## 4           Eggs_2    17
## 5           Grapes   177
## 6           Milk_1  2877
## 7           Milk_2   297
## 8     Sour_Cream_1   303
## 9     Sour_Cream_2  1080
## 10    Vastlakukkel  4109
## 11   Whipped_Cream   960

##             product freq
## 1           Banana  2470
## 2     Coffee_Cream  1523
## 3           Eggs_1   106
## 4           Eggs_2    19
## 5           Grapes   292
## 6           Milk_1   204
## 7           Milk_2  2939
## 8     Sour_Cream_1   499
## 9     Sour_Cream_2  1194
## 10   Whipped_Cream   403

##             product freq
## 1           Banana  2137
## 2     Coffee_Cream  1475
## 3           Eggs_1   554
## 4           Eggs_2    31
## 5           Grapes   195
## 6           Milk_1   187
## 7           Milk_2  2628
## 8     Sour_Cream_1   768
## 9     Sour_Cream_2   666
## 10   Whipped_Cream   415

##             product freq
## 1           Banana  2379
## 2     Coffee_Cream  1374
## 3           Eggs_1   824
## 4           Eggs_2    29
## 5           Grapes   228
## 6           Milk_1   248
## 7           Milk_2  2797
## 8     Sour_Cream_1  1045
```

```
## 9     Sour_Cream_2  942
## 10  Whipped_Cream  515

##           product freq
## 1          Banana 2748
## 2    Coffee_Cream 1508
## 3          Eggs_1  794
## 4          Eggs_2   20
## 5          Grapes  150
## 6          Milk_1  197
## 7          Milk_2 2499
## 8    Sour_Cream_1 1001
## 9    Sour_Cream_2  992
## 10  Whipped_Cream  515

##           product freq
## 1          Banana 1766
## 2    Coffee_Cream 1882
## 3          Eggs_1 1240
## 4          Eggs_2    9
## 5          Grapes  457
## 6          Milk_1  314
## 7          Milk_2 3179
## 8    Sour_Cream_1  876
## 9    Sour_Cream_2 1228
## 10  Whipped_Cream  633

##           product freq
## 1          Banana 2553
## 2    Coffee_Cream 1843
## 3          Eggs_1 1137
## 4          Eggs_2   11
## 5          Grapes  602
## 6          Milk_1  321
## 7          Milk_2 3190
## 8    Sour_Cream_1  821
## 9    Sour_Cream_2 1218
## 10  Whipped_Cream  668

##           product freq
## 1          Banana 1499
## 2    Coffee_Cream 2521
## 3          Eggs_1 1408
## 4          Eggs_2   43
## 5          Grapes  168
## 6          Milk_1  370
## 7          Milk_2 3654
## 8    Sour_Cream_1 1628
## 9    Sour_Cream_2 2128
## 10  Whipped_Cream 1871
```

```
##           product freq
## 1          Banana 1894
## 2    Coffee_Cream 2025
## 3          Eggs_1 1427
## 4          Eggs_2   22
## 5          Grapes  436
## 6          Milk_1  343
## 7          Milk_2 3236
## 8    Sour_Cream_1 1295
## 9    Sour_Cream_2 1854
## 10 Whipped_Cream 1469
```

From the data above we can see that the frequency of products were a bit stable during weekdays except in some certain cases. Between January and March 2014, Milk-1 was the most purchased product however this changed for the rest of the year begining from April when Milk-2 took over as the highest purchased product. This can be attributed to several factors including (but not limited to) price and/or quality. On Tuesday 4th of March Vastlakukkel was the highest purchased product (as earlier mentioned) however it was notably absent for the rest of the year. The least purchased product amongst the available products in shops was Eggs-2 and this remained as the least purchased (and probably less desired) product all year round.

Normalise frequency of purchases to reflect a relative share of purchasing that product.

Distribution for volume of total purchases of all prod
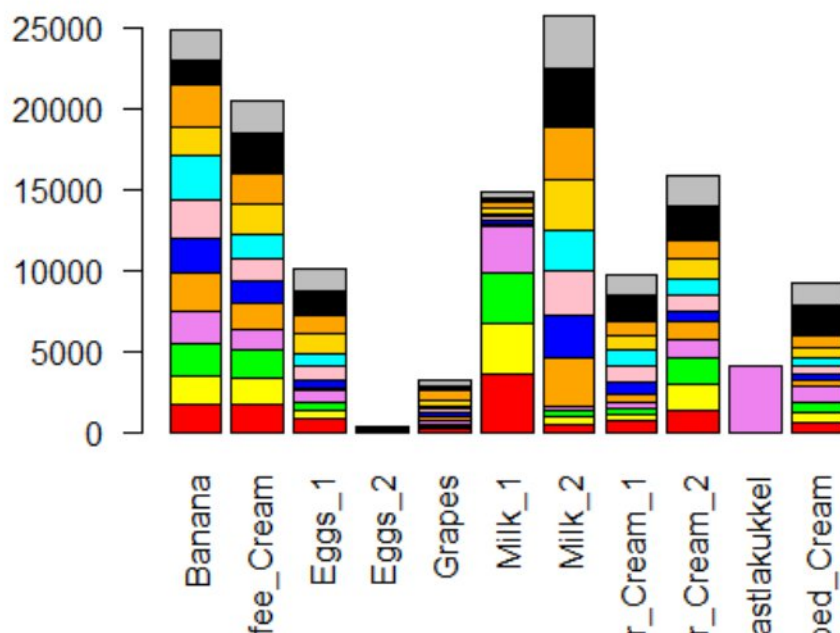
Does this normalisation help in task 4, to identify when shop has ran out of products?

In my opinion it does help

Shop 3	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00	19:00 - 20:00	20:00 - 21:00	21:00 - 22:00	22:00 - 23:00	23:00 - 00:00
Banana		9	128	289	447	552	621	573	643	732	655	748	537	428	272	138	6
Coffee_Cream		13	99	260	358	466	429	410	404	436	361	341	282	183	151	77	2
Eggs_1		2	36	103	148	176	217	212	209	180	168	132	114	71	68	44	
Eggs_2			2	5	5	11	8	3	6	11	11	14	13	6	5	2	
Grapes			10	30	53	60	57	55	60	69	100	72	63	41	29	11	2
Milk_1		2	56	117	252	332	337	366	343	407	400	367	209	190	113	75	
Milk_2		3	111	245	393	467	479	479	518	510	554	582	514	369	243	162	
Sour_Cream1		40	139	182	234	259	268	227	260	239	237	205	157	103	48	1	
Sour_Cream2		2	38	121	193	265	284	276	336	284	285	279	209	148	113	59	
Vastlakukkel		3	30	35	52	62	75	54	65	96	149	141	90	55	23	9	
Whipped_ Cream		3	44	120	192	270	264	279	279	214	201	153	120	90	35	17	

Shop 4	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00	19:00 - 20:00	20:00 - 21:00	21:00 - 22:00	22:00 - 23:00	23:00 - 00:00
Banana	50	113	233	412	611	692	769	776	860	842	898	867	658	449	244	199	4
Coffee_Cream	6	89	188	394	669	718	751	808	711	717	654	529	436	321	172	91	5
Eggs_1		30	61	188	270	356	379	367	311	346	369	326	261	212	131	96	1
Eggs_2		2		5	8	15	17	18	22	18	14	19	14	11	12	6	
Grapes		3	23	45	74	119	138	141	156	144	113	83	67	49	23	15	1
Milk_1	1	26	64	224	319	410	464	481	518	575	549	490	414	302	195	134	7
Milk_2	1	50	115	319	550	605	699	750	781	943	959	860	681	502	310	181	3
Sour_Cream1		23	64	121	282	277	262	313	350	379	344	273	205	158	97	57	
Sour_Cream2	2	42	86	219	402	478	572	559	593	603	558	466	393	276	162	90	3
Vastlakukkel		3	38	97	93	92	132	161	111	141	195	260	197	130	82	42	12
Whipped_ Cream		35	86	189	366	411	441	443	417	381	371	243	117	136	75	43	1

Shop 18	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00	19:00 - 20:00	20:00 - 21:00	21:00 - 22:00	22:00 - 23:00	23:00 - 00:00
Banana	8	48	115	190	285	336	317	385	344	379	408	355	319	258	203	126	5
Coffee_Cream	13	93	170	325	460	514	493	478	432	395	330	275	221	140	99	76	2
Eggs_1	4	18	35	76	93	123	121	137	112	124	113	125	90	71	67	17	
Eggs_2																	
Grapes		2	3	12	22	43	42	38	44	45	66	64	46	34	27	8	1
Milk_1	1	28	76	141	204	213	226	246	212	257	283	243	203	159	140	107	
Milk_2	4	94	131	249	347	407	370	381	371	457	548	528	325	325	260	164	7
Sour_Cream1	3	27	45	89	135	155	170	181	169	192	160	168	127	85	66	45	
Sour_Cream2	1	27	64	146	195	272	288	287	293	295	314	268	251	148	123	74	
Vastlakukkel	2	10	33	35	35	63	49	71	40	60	112	103	51	31	27	8	1
Whipped_ Cream	5	7	23	64	89	105	88	128	127	115	104	112	70	58	51	22	

Shop 21	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00	19:00 - 20:00	20:00 - 21:00	21:00 - 22:00	22:00 - 23:00	23:00 - 00:00
Banana	5	20	54	148	163	212	164	161	171	169	167	121	78	59	28	7	
Coffee_Cream		23	73	134	190	198	153	167	90	123	112	63	45	29	15	6	
Eggs_1	1	13	25	77	91	128	112	137	142	114	81	59	64	26	32	3	1
Eggs_2																	
Grapes		2	8	19	33	33	27	28	19	31	33	16	12	9	5		
Milk_1		5	16	71	99	119336	100	109	66	64	67	61	35	17	6	1	
Milk_2		24	87	129	215	226	289	247	243	244	307	163	124	65	69	8	
Sour_Cream1		6	33	78	112	124	81	66	81	77	71	36	36	27	17	1	
Sour_Cream2	1	11	47	100	173	206	184	172	147	126	145	110	70	39	30	8	
Vastlakukkel		23	13	25	16	23	24	27	21	26	48	18	9				
Whipped_ Cream		9	16	52	90	102	60	78	54	43	31	30	15	13	5	2	

Shop 32	07:00 - 08:00	08:00 - 09:00	09:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	17:00 - 18:00	18:00 - 19:00	19:00 - 20:00	20:00 - 21:00	21:00 - 22:00	22:00 - 23:00	23:00 - 00:00
Banana	14	64	95	215	228	366	349	308	346	320	366	316	240	117	122	59	
Coffee_Cream	11	44	87	244	307	392	368	309	252	266	223	199	157	112	62	32	
Eggs_1	3	21	51	111	177	206	225	196	191	209	208	147	128	97	77	26	
Eggs_2																	
Grapes		5	13	27	46	45	62	54	47	50	58	49	32	25	7	5	
Milk_1	5	21	59	184	201	283	276	259	248	252	265	218	139	86	43	18	
Milk_2	13	50	118	224	291	398	416	413	375	442	423	399	326	237	151	93	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sour_Cream1	1	12	25	82	123	133	148	115	123	108	106	100	67	40	33	14
Sour_Cream2	6	19	67	133	215	291	289	272	309	299	276	223	218	132	82	25
Vastlakukkel		10	19	36	24	43	31	39	33	70	76	2				
Whipped_ Cream	3	18	29	87	147	162	165	140	140	129	134	107	67	32	26	18

KEY	PURCHASES
	0
	> 0 && <= 50
	> 50 && <= 100
	> 100 && <= 200
	> 200