IXIS Data Science Challenge

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```
#set working directory & load data
setwd("C:/Users/Will/Documents/IXIS_Test/Ecommerce_Data_Sci_Challenge")
#loading data
adds_df <- read.csv("DataAnalyst_Ecom_data_addsToCart.csv")
session_df <- read.csv("DataAnalyst_Ecom_data_sessionCounts.csv")
```

```
#first lets verify data types
str(adds_df)
```

```
## 'data.frame':    12 obs. of  3 variables:
##  $ dim_year  : int  2012 2012 2012 2012 2012 2012 2013 2013 2013 2013 ...
##  $ dim_month : int  7 8 9 10 11 12 1 2 3 4 ...
##  $ addsToCart: int  191504 217666 123726 139803 186572 168972 147619 135882 109797 183842 ...
```

```
str(session_df)
```

```
## 'data.frame':    7734 obs. of  6 variables:
##  $ dim_browser       : chr  "Safari" "Internet Explorer" "Chrome" "Amazon Silk" ...
##  $ dim_deviceCategory: chr  "tablet" "desktop" "tablet" "tablet" ...
##  $ dim_date          : chr  "7/1/12" "7/1/12" "7/1/12" "7/1/12" ...
##  $ sessions          : int  2928 1106 474 235 178 120 10 9 5 4 ...
##  $ transactions      : int  127 28 3 4 6 7 0 0 0 0 ...
##  $ QTY               : int  221 0 13 5 11 0 0 0 0 0 ...
```

```
#adds_df seems fine, could convert the dates into a date object
#but doesn't seem necessary

#session_df on the other hand requires some conversions, again I could convert
#the dates into a date object but I'll actually do the separate() approach
session_df <- session_df %>%
  #separating the date column into month, date, and year
  separate(dim_date, c("month","day","year"), "/", convert = TRUE)
#while we are at it, lets rename QTY to follow the naming convetions of other vairables
session_df <- session_df %>% rename(quantity = QTY)
#next dim_browser and dim_deviceCategory should be factors
session_df$dim_browser <- as.factor(session_df$dim_browser)
session_df$dim_deviceCategory <- as.factor(session_df$dim_deviceCategory)
#okay data types are all addressed except dim_browser is a factor with
#57 levels, it makes sense to condense that
```

```
#but first lets perform de-duplication since duplicates could influence
#browser frequency
setdiff(session_df %>% distinct(), session_df)
```

```
## [1] dim_browser        dim_deviceCategory month              day
## [5] year               sessions           transactions       quantity
## <0 rows> (or 0-length row.names)
```

```
#it seems there are no duplicates so we are good to proceed

#now it is time to finish addressing data type issues
#looking at counts and deciles of browser frequency to determine a cut off
session_df %>% count(dim_browser) %>% arrange(desc(n)) %>% mutate(decile = ntile(n, 10))
```

```
##                              dim_browser   n decile
## 1                                 Chrome 679     10
## 2                      Internet Explorer 673     10
## 3                                 Safari 669     10
## 4                                   Edge 535     10
## 5                                Firefox 522     10
## 6                        Safari (in-app) 476      9
## 7                                  Opera 471      9
## 8                        Android Webview 458      9
## 9                       Samsung Internet 380      9
## 10                           Amazon Silk 366      9
## 11                                 error 364      8
## 12                       Android Browser 351      8
## 13                            BlackBerry 224      8
## 14                             SeaMonkey 204      8
## 15                            Opera Mini 161      8
## 16                            UC Browser 155      7
## 17                               Mozilla 143      7
## 18                               Maxthon 127      7
## 19                             YaBrowser 121      7
## 20                                Puffin  99      7
## 21                             (not set)  98      7
## 22              Mozilla Compatible Agent  93      6
## 23                   osee2unifiedRelease  92      6
## 24                               Coc Coc  65      6
## 25                                  Iron  55      6
## 26                             BrowserNG  22      6
## 27                               DESKTOP  20      6
## 28                            Truefitbot  17      5
## 29                     DDG-Android-3.1.1  16      5
## 30                              MRCHROME  10      5
## 31                            NokiaC7-00  10      5
## 32                            NokiaE52-1   7      5
## 33                           YelpWebView   6      5
## 34                  IE with Chrome Frame   5      4
## 35                                Seznam   5      4
## 36                       Apple-iPhone7C2   3      3
## 37                    DDG-Android-3.0.14   3      4
## 38                               LG-C410   3      4
## 39                             NetFront   3      4
## 40                          TimesTablet   3      4
## 41                           Amazon.com   2      3
## 42                        Nokia Browser   2      3
## 43                    SonyEricssonK700c   2      3
## 44                            anonymous   1      1
## 45                     Chromeless 1.2.0   1      1
## 46                   DDG-Android-3.0.11   1      1
## 47                   DDG-Android-3.0.17   1      1
## 48                          FeeddlerPro   1      1
## 49 HubSpot inbound link reporting check   1      1
## 50                           Job Search   1      2
## 51                               Mobile   1      2
## 52                  NetNewsWire Browser   1      2
## 53                     Nintendo Browser   1      2
## 54                        Playstation 3   1      2
## 55                        Python-urllib   1      2
## 56                           turnaround   1      3
## 57                         X-WebBrowser   1      3
```

```
#lets just do a cut off at the top 25 browsers, and lump the rest into other
session_df$dim_browser <- fct_lump_n(session_df$dim_browser, 25)
#verifying it worked
#session_df%>% count(dim_browser) %>% arrange(desc(n))

#creating a function to check for NAs
NAcheck <- function(df) {
  names <- c()
  percent_of_missing_values <- c()
  for(i in 1:ncol(df)) { # for-loop over columns in the data frame

    #adding the name of each column to a vector
    names <- append(names, colnames(df[i]))
    #adding the amount of missing values of each column to a vector
    percent_of_missing_values <- append(percent_of_missing_values, sum(is.na(df[,i]))/nrow(df))
  }
  #using the two vectors to output a data frame
  #with the names of columns and their amount of missing values
  data.frame(names, percent_of_missing_values)
}

#checking for missing values
NAcheck(adds_df)
```

```
##        names percent_of_missing_values
## 1   dim_year                         0
## 2  dim_month                         0
## 3 addsToCart                         0
```

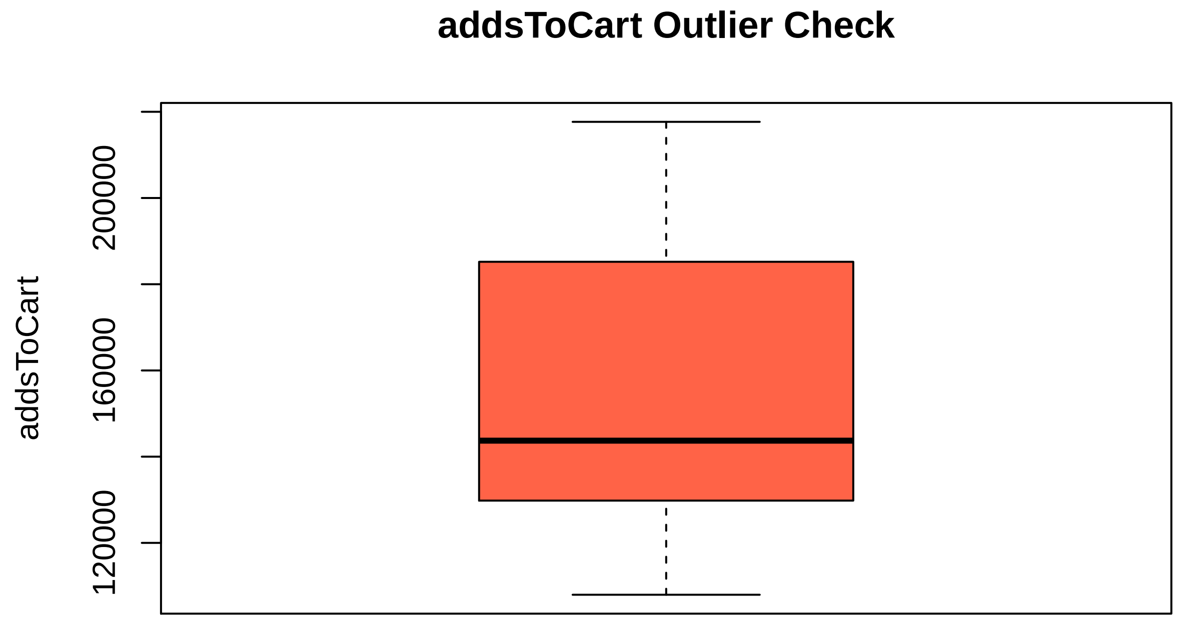
```
NAcheck(session_df)
```

```
##                 names percent_of_missing_values
## 1        dim_browser                         0
## 2 dim_deviceCategory                         0
## 3              month                         0
## 4                day                         0
## 5               year                         0
## 6           sessions                         0
## 7       transactions                         0
## 8           quantity                         0
```

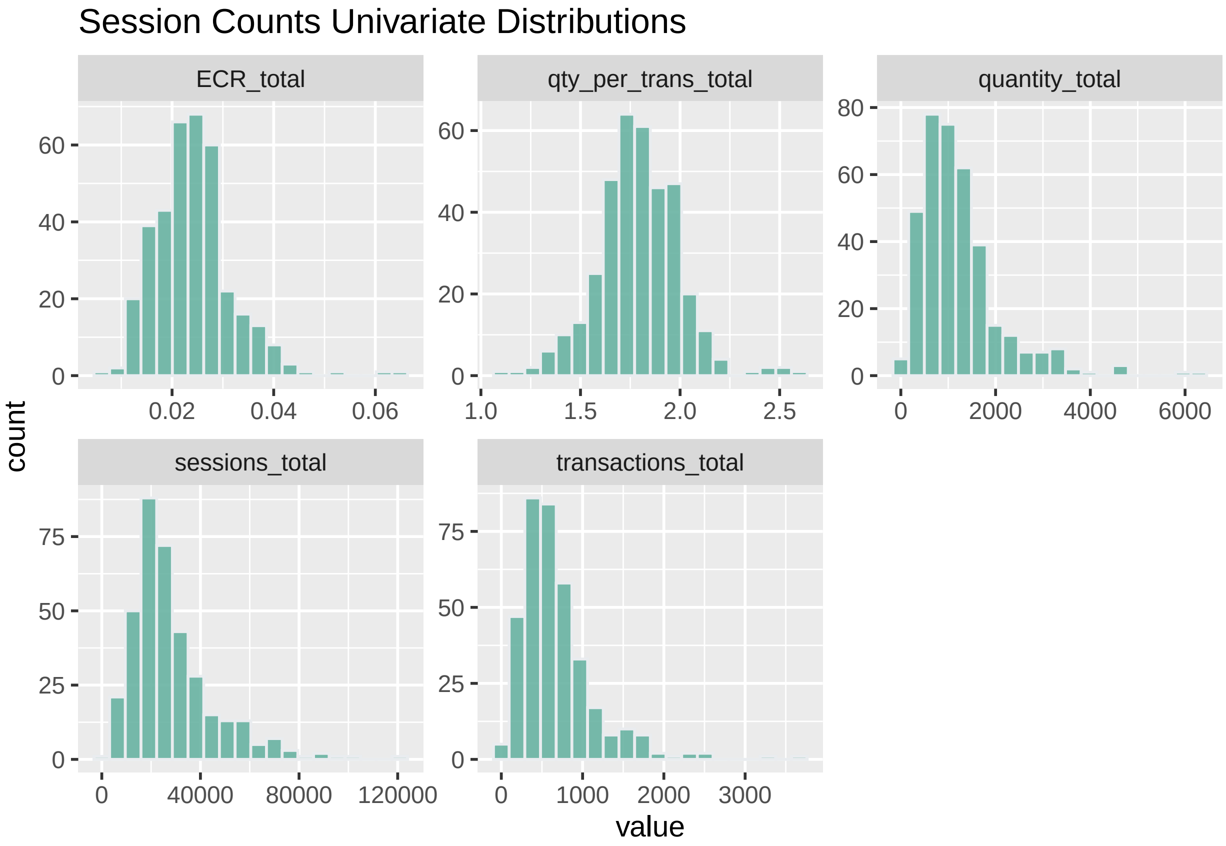
```
#seems there are no missing values

#next lets verify the dates span a 12 month period
#and there isn't any odd overlap we would have to take into account
session_df %>%
  select(month, year) %>%
  distinct() %>%
  arrange(month)
```

```
##    month year
## 1      1   13
## 2      2   13
## 3      3   13
## 4      4   13
## 5      5   13
## 6      6   13
## 7      7   12
## 8      8   12
## 9      9   12
## 10    10   12
## 11    11   12
## 12    12   12
```

```
#seems the date range of the sent data is correct

#next lets check for anomalous values/outliers
#adds_df is so small I manually reviewed it for errors
#but to be diligent lets make a quick and dirty box plot
boxplot(adds_df$addsToCart,
        main = "addsToCart Outlier Check",
        ylab = "addsToCart",
        col = "tomato")
```



```
#the data seems plausible with no egregious outliers

#now sessions_df is much larger and must be assessed through code and visualizations
#lets start by looking at daily data
daily_s_df <- session_df %>%
  #grouping by day and month so we can summarize each statistic by day
  group_by(month, day) %>%
  #removing year
  dplyr::select(-c(year)) %>%
  #summarizing the daily average and standard deviation for each statistic
  summarise_if(is.numeric, list(total = sum)) %>%
  #calculating ECR to look at that as well
  mutate(ECR_total = transactions_total/sessions_total) %>%
  mutate(qty_per_trans_total = quantity_total/transactions_total)
#un-grouping data
daily_s_df <- daily_s_df %>% ungroup

#looking at univariate distributions to assess for anomalies
ggplot(gather(daily_s_df %>%
                #since we are looking at data summarized by day and month
                #it doesn't make sense to look at these variables
                dplyr::select(-c(day, month)) %>%
                dplyr::select(where(is.numeric))),
       aes(value)) +
    geom_histogram(fill="#69b3a2", color="#e9ecef", alpha=0.9, bins = 20) +
    facet_wrap(~key, scales = 'free') +
    labs(title = "Session Counts Univariate Distributions")
```



```
#there is a slight chance for an outlier in sessions avg per day
#and a significant chance for an outlier in transactions avg per day
#maybe something went viral, or there was a sale, let's investigate

#seems Jan 12th and June 8th are the odd ones out
daily_s_df %>% arrange(desc(transactions_total))
```

```
## # A tibble: 365 x 7
##    month   day sessions_total transactions_total quantity_total ECR_total
##    <int> <int>          <int>              <int>          <int>     <dbl>
##  1     6     8          96162               3721           6376    0.0387
##  2     5    25         123562               3222           5910    0.0261
##  3     5    19         103443               2599           4581    0.0251
##  4     1    12          55110               2577           4480    0.0468
##  5     5    29          91723               2288           4524    0.0249
##  6     6    20          74372               2236           3542    0.0301
##  7     4    12          53373               2117           4071    0.0397
##  8     6     1          83964               1957           3554    0.0233
##  9     5    16          70390               1877           3413    0.0267
## 10     6    19          75439               1816           3342    0.0241
## # ... with 355 more rows, and 1 more variable: qty_per_trans_total <dbl>
```

```r
#it is quite odd that they are one off days
#sessions are at the high end of their distribution these days
#but more significantly it corresponds with a max for Quantity
#which may seem obvious but this led me to discover there can be transactions
#with a corresponding quantity of zero, indicating maybe transactions are recorded
#before a purchase is finalized, this may be something that should be addressed
#in terms of improving data collection or leveraged with additional data assets
#to discover why prospective customers start but do not complete transactions

#looking at mean, median, quantiles, max, min etc. of the variables
summary(daily_s_df)
```

```
##      month             day        sessions_total   transactions_total
##  Min.   : 1.000   Min.   : 1.00   Min.   :  2701   Min.   :  54
##  1st Qu.: 4.000   1st Qu.: 8.00   1st Qu.: 17635   1st Qu.: 396
##  Median : 7.000   Median :16.00   Median : 24716   Median : 558
##  Mean   : 6.526   Mean   :15.72   Mean   : 28545   Mean   : 684
##  3rd Qu.:10.000   3rd Qu.:23.00   3rd Qu.: 34759   3rd Qu.: 846
##  Max.   :12.000   Max.   :31.00   Max.   :123562   Max.   :3721
##  quantity_total   ECR_total        qty_per_trans_total
##  Min.   :  85   Min.   :0.006711   Min.   :1.112
##  1st Qu.: 703   1st Qu.:0.019003   1st Qu.:1.680
##  Median :1038   Median :0.023920   Median :1.783
##  Mean   :1235   Mean   :0.024176   Mean   :1.793
##  3rd Qu.:1541   3rd Qu.:0.027974   3rd Qu.:1.923
##  Max.   :6376   Max.   :0.065355   Max.   :2.609
```

```r
#visualizing all variable pairs
session_df %>%
  #grouping by device and month so we can summarize each statistic
  group_by(dim_deviceCategory, month) %>%
  #removing year and day
  dplyr::select(-c(year, day)) %>%
  #summarizing the daily average and standard deviation for each statistic
  summarise_if(is.numeric, list(total = sum)) %>%
  #calculating ECR to look at that as well
  mutate(ECR_total = transactions_total/sessions_total) %>%
  #also assessing quantity sold per transaction
  mutate(qty_per_trans_total = quantity_total/transactions_total) %>%
  ungroup() %>%
  #removing month from the pairwise assessment
  dplyr::select(-c(month)) %>%
  #finally conducting a pairwise visualization
  GGally::ggpairs(aes(colour = dim_deviceCategory, alpha = 0.4))
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
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## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```
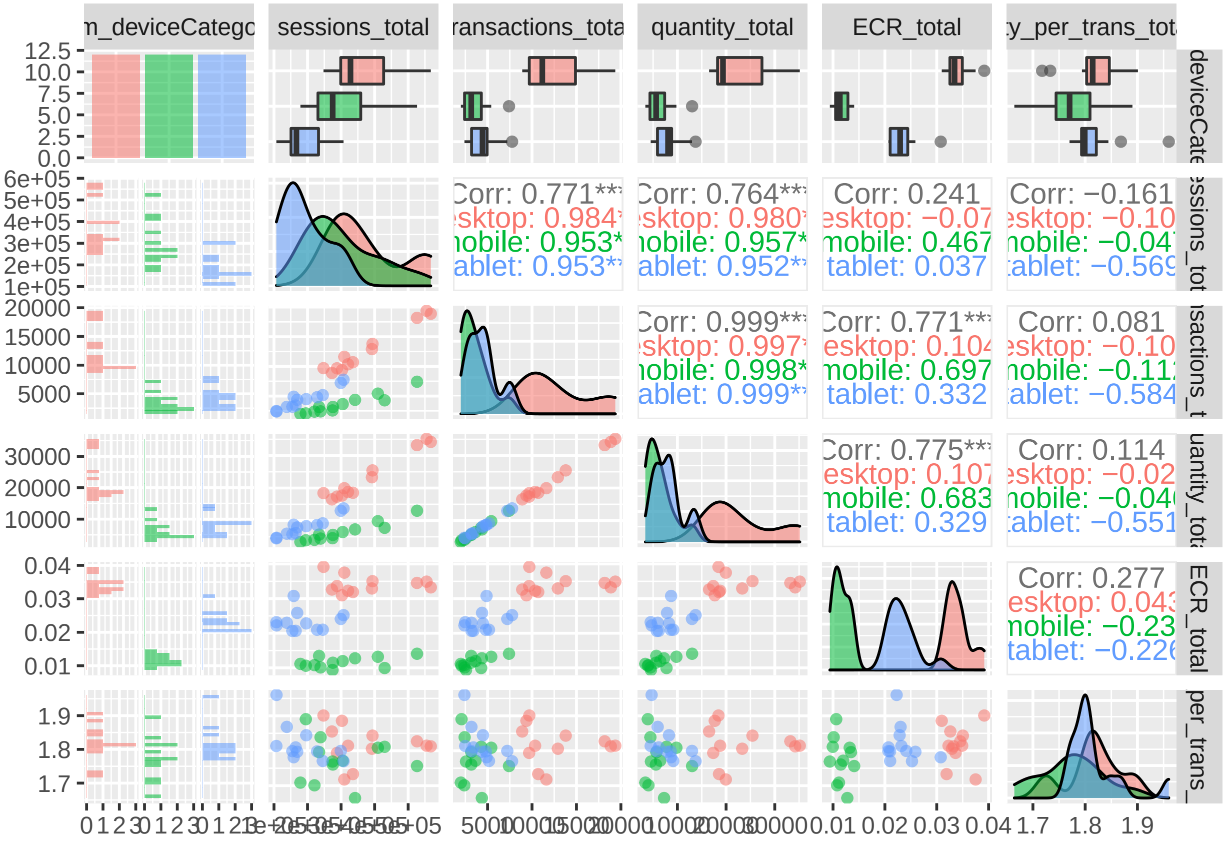
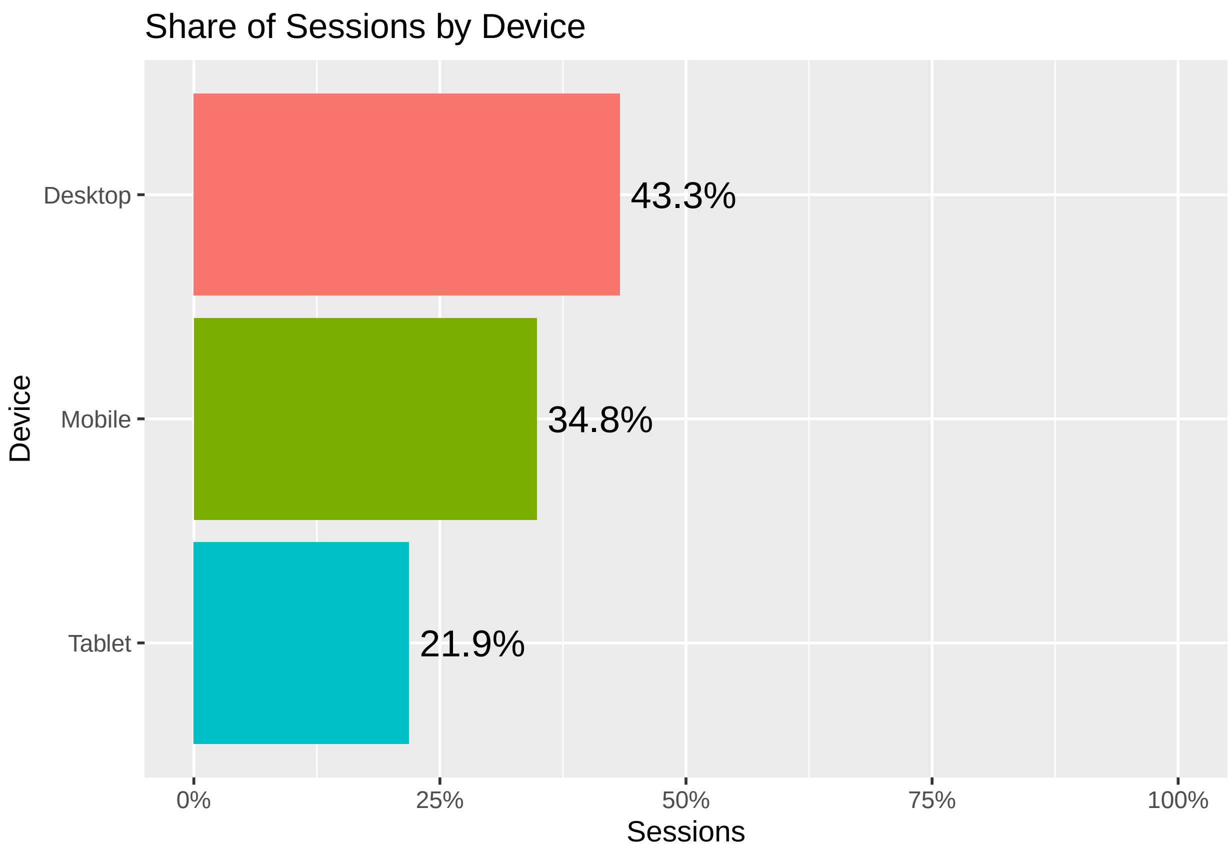



```
#transactions and quantity sold are extremely correlated
```

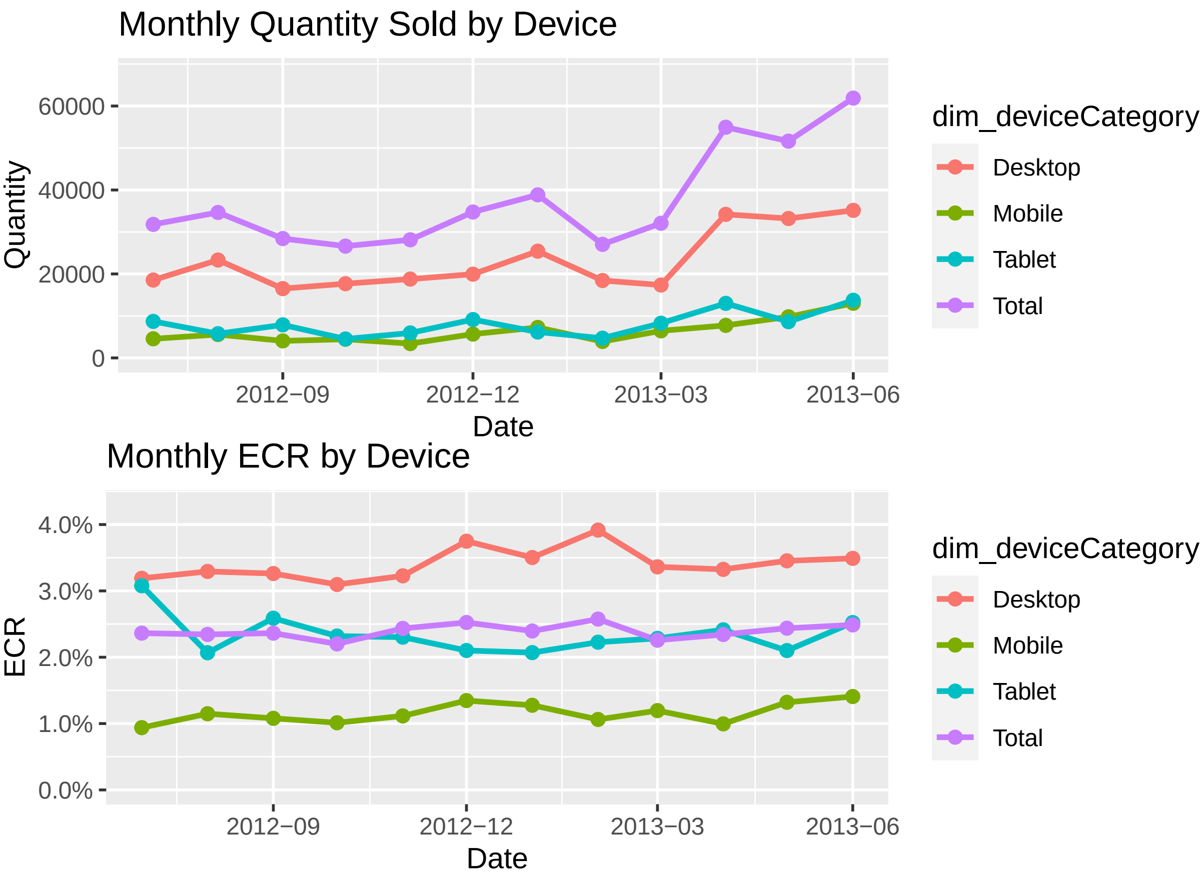
```
device_ag_df <- session_df %>%
  #using the group_by() and summarize() functions to calculate the totals of
  #numeric variables by device category and month
  #I also include year for clarity about the past 12 month period being analyzed
  group_by(dim_deviceCategory, month, year) %>%
  summarise_if(is.numeric, sum) %>%
  #adding a column for the effective conversion rate
  mutate(ECR = transactions/sessions) %>%
  #mutating year just for clarification
  mutate(year = year + 2000) %>%
  #capitalizing device names for plotting
  mutate(dim_deviceCategory = str_to_title(dim_deviceCategory)) %>%
  dplyr::select(-c(day))
#ungrouping
device_ag_df <- device_ag_df %>% ungroup()

#arranging the data for intuitive display
device_ag_df <- device_ag_df %>% arrange(dim_deviceCategory, year, month)
#seems this part of the deliverable displays correctly
device_ag_df
```

```
## # A tibble: 36 x 7
##    dim_deviceCategory month  year sessions transactions quantity    ECR
##    <chr>              <int> <dbl>    <int>        <int>    <int>  <dbl>
##  1 Desktop                7  2012   335429        10701    18547 0.0319
##  2 Desktop                8  2012   392079        12912    23316 0.0329
##  3 Desktop                9  2012   272771         8898    16507 0.0326
##  4 Desktop               10  2012   302682         9373    17675 0.0310
##  5 Desktop               11  2012   320717        10350    18778 0.0323
##  6 Desktop               12  2012   309718        11613    19947 0.0375
##  7 Desktop                1  2013   393723        13793    25424 0.0350
##  8 Desktop                2  2013   247632         9699    18437 0.0392
##  9 Desktop                3  2013   287837         9679    17362 0.0336
## 10 Desktop                4  2013   567510        18868    34200 0.0332
## # ... with 26 more rows
```

```
#creating a visualization of avg monthly session share by device
device_ag_df %>% group_by(dim_deviceCategory) %>%
  dplyr::select(-c(month, year)) %>%
  #calculating the monthly average
  summarize_if(is.numeric, list(monthly_avg = mean)) %>%
  #calculating the percent of monthly average sessions each device accounts for
  mutate(prc_ses_m_avg = sessions_monthly_avg/sum(sessions_monthly_avg)) %>%
  #making a bar plot ordered by device share of avg monthly sessions
  #which is the same as the share of total sessions, which is a
  #much more intuitive framing for stakeholders
  ggplot(aes(reorder(dim_deviceCategory, prc_ses_m_avg),
             prc_ses_m_avg, fill=dim_deviceCategory)) +
  geom_col(show.legend = FALSE) +
  scale_y_continuous(labels = scales::percent, limits = c(0,1)) +
  #assigning colors that correspond to each device, will be used consistently
  scale_fill_manual(values = c("Desktop" = "#F8766D",
                               "Mobile"="#7CAE00",
                               "Tablet"="#00BFC4",
                               "Total"="#C77CFF")) +
  coord_flip() +
  #adding a label to the bar plot
  geom_text(size = 5,
            aes(label = scales::percent(round(prc_ses_m_avg, 3)),
                y = prc_ses_m_avg),
            hjust = -.1) +
  labs(title = "Share of Sessions by Device",
       x = "Device",
       y = "Sessions")
```



```
#this simply adds 12 new rows corresponding to the monthly
#totals across all devices for each statistic
device_ag_df <- rbind(device_ag_df, session_df %>%
  #using the group_by() and summarize() functions to calculate the totals of
  #numeric variables by device category and month
  #I also include year for clarity about the past 12 month period being analyzed
  group_by(year, month) %>%
  dplyr::select(-c(day)) %>%
  summarise_if(is.numeric, sum) %>%
  #adding a column for the effective conversion rate
  mutate(ECR = transactions/sessions) %>%
  #mutating year just for clarification
  mutate(year = year + 2000) %>%
  mutate(dim_deviceCategory = "Total"))

#adding a column for a formal date object for ggplot visualizations
device_ag_df$Date<-as.Date(with(device_ag_df,paste(year,month,1,sep="-")),"%Y-%m-%d")

#plotting monthly quantity by device
p1 <- ggplot(device_ag_df, aes(x=Date, y = quantity, color = dim_deviceCategory)) +
  geom_line(size = 1) +
  geom_point(size = 2) +
  scale_fill_manual(values = c("Desktop" = "#F8766D",
                               "Mobile"="#7CAE00",
                               "Tablet"="#00BFC4",
                               "Total"="#C77CFF")) +
  scale_x_date(date_labels= "%Y-%m", date_breaks = "3 months") +
  scale_y_continuous(limits = c(0, max(device_ag_df$quantity*1.1))) +
  labs(x ="Date",
       y ="Quantity",
       title ="Monthly Quantity Sold by Device") +
  theme(plot.margin = margin(0,.5,0,0, "cm"))

#plotting monthly ECR by device
p2 <- ggplot(device_ag_df, aes(x=Date, y = ECR, color = dim_deviceCategory)) +
  geom_line(size = 1) +
  geom_point(size = 2) +
  scale_fill_manual(values = c("Desktop" = "#F8766D",
                               "Mobile"="#7CAE00",
                               "Tablet"="#00BFC4",
                               "Total"="#C77CFF")) +
  scale_x_date(date_labels= "%Y-%m", date_breaks = "3 months") +
  scale_y_continuous(labels = scales::percent, limits = c(0, max(device_ag_df$ECR*1.1))) +
  labs(x ="Date",
       y ="ECR",
       title ="Monthly ECR by Device") +
  theme(plot.margin = margin(0,.5,0,0, "cm"))

#plotting all the visuals in a grid
multiplot <- grid.arrange(p1, p2, nrow = 2)
```

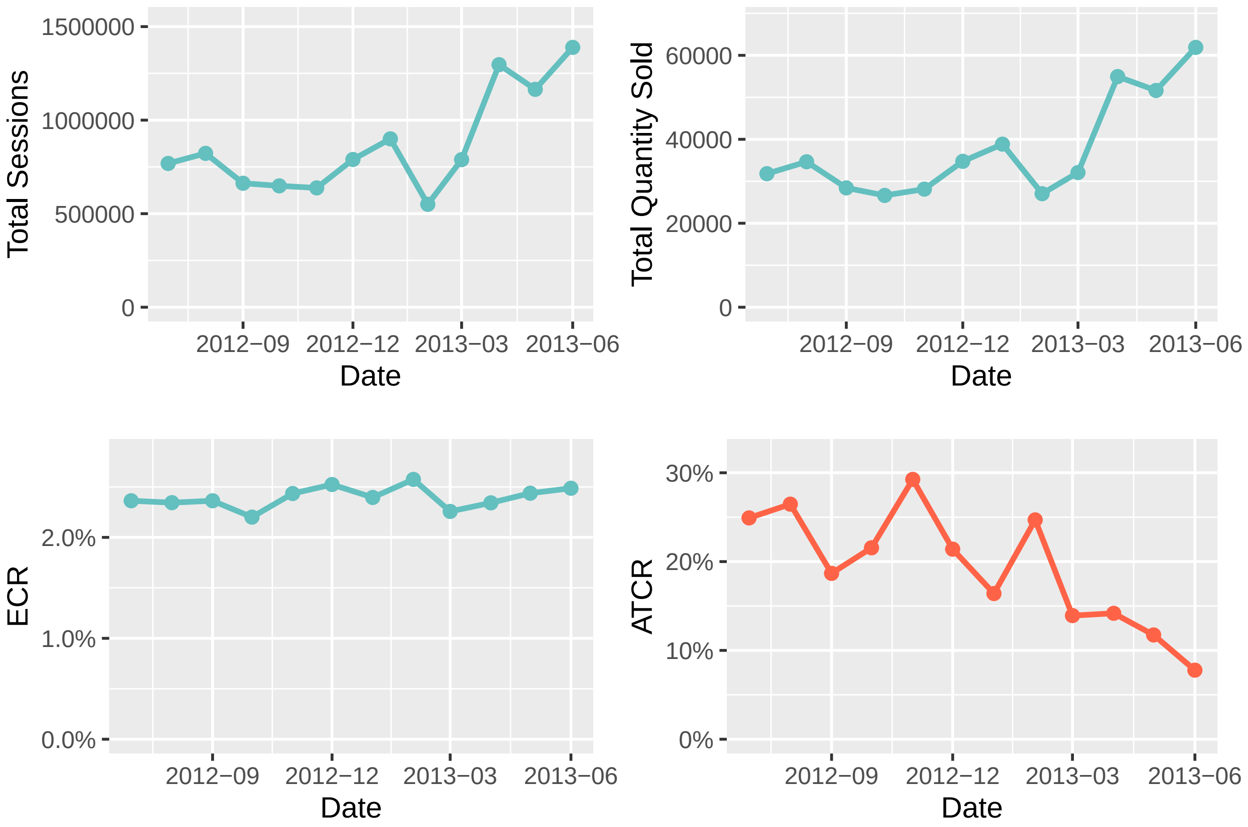


```
#removing date column to reduce redundancy in the final deliverable,
#could remove month and year columns instead
device_ag_df <- device_ag_df %>% dplyr::select(-c(Date)) %>%
  #removing the rows for totals across all devices
  filter(dim_deviceCategory != "Total")
```

```
#creating the second deliverable

month_ag_df <- session_df %>%
  #using the group_by() and summarize() functions to calculate the totals of
  #numeric variables by device category and month
  #I also include year for clarity about the past 12 month period being analyzed
  group_by(year, month) %>%
  dplyr::select(-c(day)) %>%
  summarise_if(is.numeric, sum) %>%
  #adding a column for the effective conversion rate
  mutate(ECR = transactions/sessions) %>%
  #mutating year just for clarification
  mutate(year = year + 2000)
#ungrouping
month_ag_df <- month_ag_df %>% ungroup()

#now adding addsToCart and ATCR
month_ag_df <- month_ag_df %>%
  left_join(adds_df %>% dplyr::select(-c(dim_year)), by = c("month" = "dim_month")) %>%
  #calculating ATCR
  #small chance this is incorrect since I presume addsToCart is on a per session basis
  mutate(ATCR = addsToCart/sessions)
#verifying the data frame is processed correctly
month_ag_df
```

```
## # A tibble: 12 x 8
##     year month sessions transactions quantity    ECR addsToCart   ATCR
##    <dbl> <int>    <int>        <int>    <int>  <dbl>      <int>  <dbl>
##  1  2012     7   768589        18161    31804 0.0236     191504 0.249
##  2  2012     8   822493        19279    34648 0.0234     217666 0.265
##  3  2012     9   662653        15658    28426 0.0236     123726 0.187
##  4  2012    10   648639        14275    26626 0.0220     139803 0.216
##  5  2012    11   637780        15527    28132 0.0243     186572 0.293
##  6  2012    12   789634        19929    34752 0.0252     168972 0.214
##  7  2013     1   899992        21560    38846 0.0240     147619 0.164
##  8  2013     2   550227        14166    27048 0.0257     135882 0.247
##  9  2013     3   788820        17804    32082 0.0226     109797 0.139
## 10  2013     4  1296613        30369    54946 0.0234     183842 0.142
## 11  2013     5  1164639        28389    51629 0.0244     136720 0.117
## 12  2013     6  1388834        34538    61891 0.0249     107970 0.0777
```

```
#adding a column for a formal date object for ggplot visualizations
month_ag_df$Date<-as.Date(with(month_ag_df,paste(year,month,1,sep="-")),"%Y-%m-%d")

#plotting monthly sessions in the past year
p1 <- ggplot(month_ag_df, aes(x=Date, y = sessions)) +
  geom_line(colour = "#64bfbf", size = 1) +
  geom_point(colour = "#64bfbf", size = 2) +
  scale_x_date(date_labels= "%Y-%m", date_breaks = "3 months") +
  scale_y_continuous(limits = c(0, max(month_ag_df$sessions*1.1))) +
  labs(x ="Date",
       y ="Total Sessions",
       title ="") +
  theme(plot.margin = margin(0,.5,0,0, "cm"))
#plotting monthly quantity sold in the past year
p2 <- ggplot(month_ag_df, aes(x=Date, y = quantity)) +
  geom_line(colour = "#64bfbf", size = 1) +
  geom_point(colour = "#64bfbf", size = 2) +
  scale_x_date(date_labels= "%Y-%m", date_breaks = "3 months") +
  scale_y_continuous(limits = c(0, max(month_ag_df$quantity*1.1))) +
  labs(x ="Date",
       y ="Total Quantity Sold",
       title ="") +
  theme(plot.margin = margin(0,.5,0,0, "cm"))
#plotting monthly ECR in the past year
p3 <- ggplot(month_ag_df, aes(x=Date, y = ECR)) +
  geom_line(colour = "#64bfbf", size = 1) +
  geom_point(colour = "#64bfbf", size = 2) +
  scale_x_date(date_labels= "%Y-%m", date_breaks = "3 months") +
  scale_y_continuous(labels = scales::percent,
                     limits = c(0, max(month_ag_df$ECR*1.1))) +
  labs(x ="Date",
       y ="ECR",
       title ="") +
  theme(plot.margin = margin(0,.5,0,0, "cm"))
#plotting monthly ATCR in the past year
p4 <- ggplot(month_ag_df, aes(x=Date, y = ATCR)) +
  geom_line(colour = "tomato", size = 1) +
  geom_point(colour = "tomato", size = 2) +
  scale_x_date(date_labels= "%Y-%m", date_breaks = "3 months") +
  scale_y_continuous(labels = scales::percent,
                     limits = c(0, max(month_ag_df$ATCR*1.1))) +
  labs(x ="Date",
       y ="ATCR",
       title ="") +
  theme(plot.margin = margin(0,.5,0,0, "cm"))

#plotting all the visuals in a grid
multiplot <- grid.arrange(p1, p2, p3, p4, nrow = 2)
```



```r
#finalizing the second deliverable by switching the rows and columns of the data frame
#and adding two additional columns for absolute and relative changes between the past
#2 months
two_month_ag_df <- month_ag_df %>%
  #filtering the two most recent months
  filter(month > 4 & month < 7) %>%
  #removing unnecessary columns
  dplyr::select(-c(year, Date)) %>%
  #reshaping the data to be in a longer format (besides month)
  pivot_longer(cols = -month) %>%
  #then widening the data and using month as the new columns
  pivot_wider(names_from = month) %>%
  #renaming columns with clearer names
  rename("statistic" = 1, "5/2013" = 2, "6/2013" = 3) %>%
  #mutating new columns for absolute and relative changes
  mutate("absolute change" = cur_data()[['6/2013']] - cur_data()[['5/2013']]) %>%
  mutate("relative change" = `absolute change`/`5/2013`) %>%
  as.data.frame()
#verifying the second deliverable is correctly formatted
two_month_ag_df
```

```
##      statistic       5/2013       6/2013 absolute change relative change
## 1     sessions 1.164639e+06 1.388834e+06    2.241950e+05      0.19250171
## 2 transactions 2.838900e+04 3.453800e+04    6.149000e+03      0.21659798
## 3     quantity 5.162900e+04 6.189100e+04    1.026200e+04      0.19876426
## 4          ECR 2.437579e-02 2.486834e-02    4.925491e-04      0.02020648
## 5   addsToCart 1.367200e+05 1.079700e+05   -2.875000e+04     -0.21028379
## 6         ATCR 1.173926e-01 7.774147e-02   -3.965113e-02     -0.33776514
```

```
#creating an Excel workbook object
wb = createWorkbook()
#adding two worksheets
sheet1 = addWorksheet(wb, "Month*Device Aggregation")
sheet2 = addWorksheet(wb, "2_Month_Comparison")
#writing the deliverable data to the workbook
writeData(wb, sheet1, device_ag_df)
writeData(wb, sheet2, two_month_ag_df)
#styling relative change as a percentage
addStyle(wb, sheet2, style = createStyle(numFmt = "0%"), cols=5, rows=2:(nrow(month_ag_df)+1), gridExpar
#set column widths so cells fit the data
setColWidths(wb, sheet1, cols = 1:ncol(device_ag_df), widths = "auto")
setColWidths(wb, sheet2, cols = 1:ncol(two_month_ag_df), widths = "auto")

#writing the deliverable
saveWorkbook(wb, "Deliverable.xlsx", overwrite = TRUE)
```