D212 Task 3 v2

# Part I: Research Question

Do identifiable associations exist among customer purchases?

The goal in answering this research question is to better understand customer purchasing patterns and thereby to more effectively support business product marketing initiatives. By gaining insight to products frequently purchased together the organization can develop marketing strategies aimed at boosting sales by marketing the associated products in tandem. In response to increased sales, the organization would also benefit by knowing and preparing their inventory with those items likely to be increase in demand as a result of the association analysis.

The research question will be addressed using market basket analysis.

# Part II: Market Basket Justification

The market basket analysis was chosen as it functions to analyze a transaction data set and find associations between items. In this case, the data set is a 2 year history of customer purchases of technological products. The market basket, then, consists of two parts. The customer is represented by a single row (a basket). The products purchased are represented by columns (the items). In this data set, there are 7,501 baskets and 119 distinct items. As an example, the items contained in the second basket are Apple Lightning to Digital AV Adapter, TP-Link AC1750 Smart WiFi Router, and Apple Pencil.

At a high level, market basket analysis can not only identify the frequency at which each individual item is purchased, but also the ratio of baskets in which an item is included (support), how often different items are purchased together within a single basket (confidence), and even the increase in likelihood that a specific item will be purchased based on whether another specific item has been purchased in a single basket (lift). Market basket analysis does this by analyzing subsets of items purchased within the larger set of all possible items among all possible baskets in the data set. For every combination of two or more items being purchased together in a single basket, market basket analysis should be able to identify and quantify the association of those items. The underlying assumption of market basket analysis, then, is that an association exists between items appearing in the same basket.

R will be used for this analysis. R is open source software that was specifically made for statistical analysis. Using R, we can ingest the data set, and leveraging an extensive library of data manipulation packages, perform the market basket analysis steps. More information can be found on the R project website (<https://www.r-project.org/>).

The dplyr and tidyr packages will be used for data preparation and manipulation within R. More information for these package can be found on the tidyverse website (<https://tidyverse.org/>).

Algorithm construction will be done using the apriori function in the arules package. More information on the arules package can be found on the CRAN R Project website (<https://cran.r-project.org/>).

# Part III: Data Preparation and Analysis

First, the data set must be prepared. In this case, there are several rows containing junk data ("“). Rows consisting exclusively of”" values are removed. Columns having "" value are converted to NA where the first column for the row has an actual item value.

Secondly, a customer ID column is added for explicit basket identification and the data set is reshaped to one item per row to facilitate the transformation to a transaction class.

Finally, the customer ID and Product columns are converted to factors, the data set is split by the aforementioned columns, and converted to a transaction class object which is used in the apriori algorithm.

The top three item sets by the support metric are Dust-Off Compressed Gas 2 pack (Support=0.2383682), Apple Pencil (Support=0.1797094), and VIVO Dual LCD Monitor Desk mount (0.1741101).

With the apriori rules algorithm having parameters of support and confidence set to .01 and .2 respectively, the 163 rules were identified with the following being top 3 rules by the lift metric:

1. SanDisk 128GB Ultra microSDXC card => SanDisk Ultra 64GB card (lift=3.2919938)
2. Dust-Off Compressed Gas 2 pack,VIVO Dual LCD Monitor Desk mount => SanDisk Ultra 64GB card (lift=2.9079279)
3. Anker USB C to HDMI Adapter => Nylon Braided Lightning to USB cable (lift=2.4744639 ).

library(dplyr)

## Warning: package 'dplyr' was built under R version 4.0.5

##   
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':  
##   
## filter, lag

## The following objects are masked from 'package:base':  
##   
## intersect, setdiff, setequal, union

library(tidyr)

## Warning: package 'tidyr' was built under R version 4.0.5

library(arules)

## Warning: package 'arules' was built under R version 4.0.5

## Loading required package: Matrix

##   
## Attaching package: 'Matrix'

## The following objects are masked from 'package:tidyr':  
##   
## expand, pack, unpack

##   
## Attaching package: 'arules'

## The following object is masked from 'package:dplyr':  
##   
## recode

## The following objects are masked from 'package:base':  
##   
## abbreviate, write

# Load Data Set  
df<-read.csv("c:/users/shua/documents/Data Mining II\_D212/teleco\_market\_basket.csv")  
  
#Familiarize with data set  
#str(df)  
# Check for missing values  
#sapply(df, function(x) sum(is.na(x)))  
  
# Check distinct Items for item1   
#unique(df$Item01)  
  
#Check row count  
#nrow(df)  
#Inspect rows where item 1 = ""  
#glimpse(df[df$Item01=="",])  
  
#Remove rows where item1 = ""  
head(df[df$Item01=="",],20)

## Item01 Item02 Item03 Item04 Item05 Item06 Item07 Item08 Item09 Item10 Item11  
## 1   
## 3   
## 5   
## 7   
## 9   
## 11   
## 13   
## 15   
## 17   
## 19   
## 21   
## 23   
## 25   
## 27   
## 29   
## 31   
## 33   
## 35   
## 37   
## 39   
## Item12 Item13 Item14 Item15 Item16 Item17 Item18 Item19 Item20  
## 1   
## 3   
## 5   
## 7   
## 9   
## 11   
## 13   
## 15   
## 17   
## 19   
## 21   
## 23   
## 25   
## 27   
## 29   
## 31   
## 33   
## 35   
## 37   
## 39

df<-df[df$Item01!="",]  
  
#Re check row counts  
#nrow(df)  
  
#Confirm item 1 has no ""  
# unique(df$Item01)  
  
#Convert remaining "" to NA  
df[df==""]<-NA  
# glimpse(df)  
  
# Set cust ID variables  
df$Cust\_ID<-1:nrow(df)  
  
#Reorder columns  
df<-df[,c(21,1:20)]  
#df[2,]  
#Pivot longer for transactional shape  
long.DF<-pivot\_longer(df, -Cust\_ID, names\_to = "Item.Nbr", values\_to = "Product")  
#unique(long.DF$Product)  
#n\_distinct(long.DF$Product)  
  
#Convert to factors for transaction class prep  
long.DF$Product<-factor(long.DF$Product)  
long.DF$Cust\_ID<-factor(long.DF$Cust\_ID)  
  
write.csv(long.DF, "c:/users/shua/documents/Data Mining II\_D212/teleco\_cleaned.csv")  
  
data.list<-split(long.DF$Product, long.DF$Cust\_ID)  
  
#Create transaction class object  
trx<-as(data.list, "transactions")

## Warning in asMethod(object): removing duplicated items in transactions

#inspect(head(trx))  
  
#summary(trx)  
  
#image(trx[1:30])  
  
items<-apriori(trx, parameter = list(supp=.1, conf=.2, target="frequent itemsets"))

## Apriori  
##   
## Parameter specification:  
## confidence minval smax arem aval originalSupport maxtime support minlen  
## NA 0.1 1 none FALSE TRUE 5 0.1 1  
## maxlen target ext  
## 10 frequent itemsets TRUE  
##   
## Algorithmic control:  
## filter tree heap memopt load sort verbose  
## 0.1 TRUE TRUE FALSE TRUE 2 TRUE  
##   
## Absolute minimum support count: 750   
##   
## set item appearances ...[0 item(s)] done [0.00s].  
## set transactions ...[119 item(s), 7501 transaction(s)] done [0.00s].  
## sorting and recoding items ... [7 item(s)] done [0.00s].  
## creating transaction tree ... done [0.00s].  
## checking subsets of size 1 2 done [0.00s].  
## sorting transactions ... done [0.00s].  
## writing ... [7 set(s)] done [0.00s].  
## creating S4 object ... done [0.00s].

rules<-apriori(trx, parameter = list(supp=.01, conf=.2, minlen=2, target="rules"))

## Apriori  
##   
## Parameter specification:  
## confidence minval smax arem aval originalSupport maxtime support minlen  
## 0.2 0.1 1 none FALSE TRUE 5 0.01 2  
## maxlen target ext  
## 10 rules TRUE  
##   
## Algorithmic control:  
## filter tree heap memopt load sort verbose  
## 0.1 TRUE TRUE FALSE TRUE 2 TRUE  
##   
## Absolute minimum support count: 75   
##   
## set item appearances ...[0 item(s)] done [0.00s].  
## set transactions ...[119 item(s), 7501 transaction(s)] done [0.00s].  
## sorting and recoding items ... [75 item(s)] done [0.00s].  
## creating transaction tree ... done [0.00s].  
## checking subsets of size 1 2 3 4 done [0.00s].  
## writing ... [163 rule(s)] done [0.00s].  
## creating S4 object ... done [0.00s].

#summary(rules)  
#rules2<-apriori(trx, parameter = list(supp=.05, conf=.2, minlen=2, target="rules"), appearance=list(rhs="Dust-Off Compressed Gas 2 pack", default="lhs"), control=list(verbose=F))  
#inspect(head(sort(items, by="support"),10))  
inspect(sort(head(rules,10)), by="lift")

## lhs rhs support confidence coverage lift count  
## [1] {3A USB Type C Cable 3 pack 6FT} => {Dust-Off Compressed Gas 2 pack} 0.01706439 0.4012539 0.04252766 1.683336 128  
## [2] {3A USB Type C Cable 3 pack 6FT} => {VIVO Dual LCD Monitor Desk mount} 0.01346487 0.3166144 0.04252766 1.818472 101  
## [3] {SanDisk 128GB microSDXC card} => {Dust-Off Compressed Gas 2 pack} 0.01333156 0.3095975 0.04306093 1.298820 100  
## [4] {HyperX Cloud Stinger Headset} => {VIVO Dual LCD Monitor Desk mount} 0.01186508 0.2500000 0.04746034 1.435873 89  
## [5] {USB Type C Cable} => {HP 61 ink} 0.01159845 0.2478632 0.04679376 1.512793 87  
## [6] {HP 65 ink} => {Dust-Off Compressed Gas 2 pack} 0.01159845 0.3480000 0.03332889 1.459926 87  
## [7] {VicTsing Wireless mouse} => {Dust-Off Compressed Gas 2 pack} 0.01093188 0.3886256 0.02812958 1.630358 82  
## [8] {3A USB Type C Cable 3 pack 6FT} => {HP 61 ink} 0.01066524 0.2507837 0.04252766 1.530617 80  
## [9] {iPhone Charger Cable Anker 6ft} => {Dust-Off Compressed Gas 2 pack} 0.01026530 0.3989637 0.02572990 1.673729 77  
## [10] {VicTsing Wireless mouse} => {VIVO Dual LCD Monitor Desk mount} 0.01026530 0.3649289 0.02812958 2.095966 77

#inspect(sort(head(rules2,10)), by="lift")  
#summary(rules)  
  
#Inspect Rules Association Table  
inspect(head(sort(rules, by="lift"), 15))

## lhs rhs support confidence coverage lift count  
## [1] {SanDisk 128GB Ultra microSDXC card} => {SanDisk Ultra 64GB card} 0.01599787 0.3234501 0.04946007 3.291994 120  
## [2] {Dust-Off Compressed Gas 2 pack,   
## VIVO Dual LCD Monitor Desk mount} => {SanDisk Ultra 64GB card} 0.01706439 0.2857143 0.05972537 2.907928 128  
## [3] {Anker USB C to HDMI Adapter} => {Nylon Braided Lightning to USB cable} 0.01613118 0.2358674 0.06839088 2.474464 121  
## [4] {Logitech M510 Wireless mouse} => {Nylon Braided Lightning to USB cable} 0.01666444 0.2332090 0.07145714 2.446574 125  
## [5] {Dust-Off Compressed Gas 2 pack,   
## Screen Mom Screen Cleaner kit} => {Nylon Braided Lightning to USB cable} 0.01106519 0.2305556 0.04799360 2.418737 83  
## [6] {Dust-Off Compressed Gas 2 pack,   
## SanDisk Ultra 64GB card} => {VIVO Dual LCD Monitor Desk mount} 0.01706439 0.4169381 0.04092788 2.394681 128  
## [7] {Dust-Off Compressed Gas 2 pack,   
## Nylon Braided Lightning to USB cable} => {Screen Mom Screen Cleaner kit} 0.01106519 0.3097015 0.03572857 2.389991 83  
## [8] {Dust-Off Compressed Gas 2 pack,   
## Screen Mom Screen Cleaner kit} => {SanDisk Ultra 64GB card} 0.01106519 0.2305556 0.04799360 2.346536 83  
## [9] {10ft iPHone Charger Cable 2 Pack} => {Screen Mom Screen Cleaner kit} 0.01519797 0.3007916 0.05052660 2.321232 114  
## [10] {SanDisk Ultra 64GB card} => {VIVO Dual LCD Monitor Desk mount} 0.03919477 0.3989145 0.09825357 2.291162 294  
## [11] {VIVO Dual LCD Monitor Desk mount} => {SanDisk Ultra 64GB card} 0.03919477 0.2251149 0.17411012 2.291162 294  
## [12] {SAMSUNG EVO 32GB card} => {SanDisk Ultra 64GB card} 0.01133182 0.2162850 0.05239301 2.201294 85  
## [13] {FEIYOLD Blue light Blocking Glasses} => {SanDisk Ultra 64GB card} 0.01413145 0.2145749 0.06585789 2.183889 106  
## [14] {HP 61 ink,   
## VIVO Dual LCD Monitor Desk mount} => {Screen Mom Screen Cleaner kit} 0.01093188 0.2789116 0.03919477 2.152382 82  
## [15] {Dust-Off Compressed Gas 2 pack,   
## FEIYOLD Blue light Blocking Glasses} => {VIVO Dual LCD Monitor Desk mount} 0.01026530 0.3719807 0.02759632 2.136468 77

#Remove redundant rules  
redundant.rules<-is.redundant(rules)  
non\_redundant.rules<-rules[!redundant.rules]  
rulesDF<-as(non\_redundant.rules, "data.frame")  
  
  
#Top 3 Items by Support  
inspect(head(sort(items, by="support"),3))

## items support count  
## [1] {Dust-Off Compressed Gas 2 pack} 0.2383682 1788   
## [2] {Apple Pencil} 0.1797094 1348   
## [3] {VIVO Dual LCD Monitor Desk mount} 0.1741101 1306

#Rules Association Table by Lift  
head(rulesDF[order(rulesDF$lift, decreasing=T),],20)

## rules  
## 12 {SanDisk 128GB Ultra microSDXC card} => {SanDisk Ultra 64GB card}  
## 137 {Dust-Off Compressed Gas 2 pack,VIVO Dual LCD Monitor Desk mount} => {SanDisk Ultra 64GB card}  
## 51 {Anker USB C to HDMI Adapter} => {Nylon Braided Lightning to USB cable}  
## 61 {Logitech M510 Wireless mouse} => {Nylon Braided Lightning to USB cable}  
## 123 {Dust-Off Compressed Gas 2 pack,Screen Mom Screen Cleaner kit} => {Nylon Braided Lightning to USB cable}  
## 136 {Dust-Off Compressed Gas 2 pack,SanDisk Ultra 64GB card} => {VIVO Dual LCD Monitor Desk mount}  
## 122 {Dust-Off Compressed Gas 2 pack,Nylon Braided Lightning to USB cable} => {Screen Mom Screen Cleaner kit}  
## 129 {Dust-Off Compressed Gas 2 pack,Screen Mom Screen Cleaner kit} => {SanDisk Ultra 64GB card}  
## 20 {10ft iPHone Charger Cable 2 Pack} => {Screen Mom Screen Cleaner kit}  
## 90 {SanDisk Ultra 64GB card} => {VIVO Dual LCD Monitor Desk mount}  
## 91 {VIVO Dual LCD Monitor Desk mount} => {SanDisk Ultra 64GB card}  
## 16 {SAMSUNG EVO 32GB card} => {SanDisk Ultra 64GB card}  
## 56 {FEIYOLD Blue light Blocking Glasses} => {SanDisk Ultra 64GB card}  
## 140 {HP 61 ink,VIVO Dual LCD Monitor Desk mount} => {Screen Mom Screen Cleaner kit}  
## 118 {Dust-Off Compressed Gas 2 pack,FEIYOLD Blue light Blocking Glasses} => {VIVO Dual LCD Monitor Desk mount}  
## 133 {Apple Pencil,SanDisk Ultra 64GB card} => {Dust-Off Compressed Gas 2 pack}  
## 132 {Dust-Off Compressed Gas 2 pack,HP 61 ink} => {SanDisk Ultra 64GB card}  
## 127 {SanDisk Ultra 64GB card,Screen Mom Screen Cleaner kit} => {Dust-Off Compressed Gas 2 pack}  
## 126 {Dust-Off Compressed Gas 2 pack,VIVO Dual LCD Monitor Desk mount} => {Nylon Braided Lightning to USB cable}  
## 2 {VicTsing Wireless mouse} => {VIVO Dual LCD Monitor Desk mount}  
## support confidence coverage lift count  
## 12 0.01599787 0.3234501 0.04946007 3.291994 120  
## 137 0.01706439 0.2857143 0.05972537 2.907928 128  
## 51 0.01613118 0.2358674 0.06839088 2.474464 121  
## 61 0.01666444 0.2332090 0.07145714 2.446574 125  
## 123 0.01106519 0.2305556 0.04799360 2.418737 83  
## 136 0.01706439 0.4169381 0.04092788 2.394681 128  
## 122 0.01106519 0.3097015 0.03572857 2.389991 83  
## 129 0.01106519 0.2305556 0.04799360 2.346536 83  
## 20 0.01519797 0.3007916 0.05052660 2.321232 114  
## 90 0.03919477 0.3989145 0.09825357 2.291162 294  
## 91 0.03919477 0.2251149 0.17411012 2.291162 294  
## 16 0.01133182 0.2162850 0.05239301 2.201294 85  
## 56 0.01413145 0.2145749 0.06585789 2.183889 106  
## 140 0.01093188 0.2789116 0.03919477 2.152382 82  
## 118 0.01026530 0.3719807 0.02759632 2.136468 77  
## 133 0.01013198 0.5066667 0.01999733 2.125563 76  
## 132 0.01093188 0.2075949 0.05265965 2.112849 82  
## 127 0.01106519 0.5030303 0.02199707 2.110308 83  
## 126 0.01199840 0.2008929 0.05972537 2.107549 90  
## 2 0.01026530 0.3649289 0.02812958 2.095966 77

# Rules Association Table by Confidence  
head(rulesDF[order(rulesDF$confidence, decreasing=T),],20)

## rules  
## 133 {Apple Pencil,SanDisk Ultra 64GB card} => {Dust-Off Compressed Gas 2 pack}  
## 127 {SanDisk Ultra 64GB card,Screen Mom Screen Cleaner kit} => {Dust-Off Compressed Gas 2 pack}  
## 130 {HP 61 ink,SanDisk Ultra 64GB card} => {Dust-Off Compressed Gas 2 pack}  
## 121 {Nylon Braided Lightning to USB cable,Screen Mom Screen Cleaner kit} => {Dust-Off Compressed Gas 2 pack}  
## 23 {10ft iPHone Charger Cable 2 Pack} => {Dust-Off Compressed Gas 2 pack}  
## 119 {Stylus Pen for iPad,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 117 {FEIYOLD Blue light Blocking Glasses,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 147 {Screen Mom Screen Cleaner kit,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 141 {HP 61 ink,Screen Mom Screen Cleaner kit} => {Dust-Off Compressed Gas 2 pack}  
## 135 {SanDisk Ultra 64GB card,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 124 {Nylon Braided Lightning to USB cable,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 144 {Apple Pencil,Screen Mom Screen Cleaner kit} => {Dust-Off Compressed Gas 2 pack}  
## 60 {FEIYOLD Blue light Blocking Glasses} => {Dust-Off Compressed Gas 2 pack}  
## 136 {Dust-Off Compressed Gas 2 pack,SanDisk Ultra 64GB card} => {VIVO Dual LCD Monitor Desk mount}  
## 92 {SanDisk Ultra 64GB card} => {Dust-Off Compressed Gas 2 pack}  
## 155 {Apple Pencil,HP 61 ink} => {Dust-Off Compressed Gas 2 pack}  
## 158 {HP 61 ink,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 9 {3A USB Type C Cable 3 pack 6FT} => {Dust-Off Compressed Gas 2 pack}  
## 1 {iPhone Charger Cable Anker 6ft} => {Dust-Off Compressed Gas 2 pack}  
## 90 {SanDisk Ultra 64GB card} => {VIVO Dual LCD Monitor Desk mount}  
## support confidence coverage lift count  
## 133 0.01013198 0.5066667 0.01999733 2.125563 76  
## 127 0.01106519 0.5030303 0.02199707 2.110308 83  
## 130 0.01093188 0.4739884 0.02306359 1.988472 82  
## 121 0.01106519 0.4689266 0.02359685 1.967236 83  
## 23 0.02306359 0.4564644 0.05052660 1.914955 173  
## 119 0.01146514 0.4550265 0.02519664 1.908923 86  
## 117 0.01026530 0.4476744 0.02293028 1.878079 77  
## 147 0.01573124 0.4436090 0.03546194 1.861024 118  
## 141 0.01399813 0.4356846 0.03212905 1.827780 105  
## 135 0.01706439 0.4353741 0.03919477 1.826477 128  
## 124 0.01199840 0.4306220 0.02786295 1.806541 90  
## 144 0.01306492 0.4242424 0.03079589 1.779778 98  
## 60 0.02759632 0.4190283 0.06585789 1.757904 207  
## 136 0.01706439 0.4169381 0.04092788 2.394681 128  
## 92 0.04092788 0.4165536 0.09825357 1.747522 307  
## 155 0.01346487 0.4056225 0.03319557 1.701663 101  
## 158 0.01586455 0.4047619 0.03919477 1.698053 119  
## 9 0.01706439 0.4012539 0.04252766 1.683336 128  
## 1 0.01026530 0.3989637 0.02572990 1.673729 77  
## 90 0.03919477 0.3989145 0.09825357 2.291162 294

#Dust Off RHS  
dust.rules<-apriori(trx, parameter = list(supp=.01, conf=.2, minlen=2, target="rules"), appearance=list(rhs="Dust-Off Compressed Gas 2 pack", default="lhs"))

## Apriori  
##   
## Parameter specification:  
## confidence minval smax arem aval originalSupport maxtime support minlen  
## 0.2 0.1 1 none FALSE TRUE 5 0.01 2  
## maxlen target ext  
## 10 rules TRUE  
##   
## Algorithmic control:  
## filter tree heap memopt load sort verbose  
## 0.1 TRUE TRUE FALSE TRUE 2 TRUE  
##   
## Absolute minimum support count: 75   
##   
## set item appearances ...[1 item(s)] done [0.00s].  
## set transactions ...[119 item(s), 7501 transaction(s)] done [0.00s].  
## sorting and recoding items ... [75 item(s)] done [0.00s].  
## creating transaction tree ... done [0.00s].  
## checking subsets of size 1 2 3 4 done [0.00s].  
## writing ... [44 rule(s)] done [0.00s].  
## creating S4 object ... done [0.00s].

redundant.dust<-is.redundant(dust.rules)  
non\_redundant.dust<-dust.rules[!redundant.dust]  
dustDF<-as(non\_redundant.dust, "data.frame")  
head(dustDF[order(dustDF$lift, decreasing=T),],20)

## rules  
## 36 {Apple Pencil,SanDisk Ultra 64GB card} => {Dust-Off Compressed Gas 2 pack}  
## 34 {SanDisk Ultra 64GB card,Screen Mom Screen Cleaner kit} => {Dust-Off Compressed Gas 2 pack}  
## 35 {HP 61 ink,SanDisk Ultra 64GB card} => {Dust-Off Compressed Gas 2 pack}  
## 32 {Nylon Braided Lightning to USB cable,Screen Mom Screen Cleaner kit} => {Dust-Off Compressed Gas 2 pack}  
## 9 {10ft iPHone Charger Cable 2 Pack} => {Dust-Off Compressed Gas 2 pack}  
## 31 {Stylus Pen for iPad,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 30 {FEIYOLD Blue light Blocking Glasses,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 40 {Screen Mom Screen Cleaner kit,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 38 {HP 61 ink,Screen Mom Screen Cleaner kit} => {Dust-Off Compressed Gas 2 pack}  
## 37 {SanDisk Ultra 64GB card,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 33 {Nylon Braided Lightning to USB cable,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 39 {Apple Pencil,Screen Mom Screen Cleaner kit} => {Dust-Off Compressed Gas 2 pack}  
## 18 {FEIYOLD Blue light Blocking Glasses} => {Dust-Off Compressed Gas 2 pack}  
## 24 {SanDisk Ultra 64GB card} => {Dust-Off Compressed Gas 2 pack}  
## 42 {Apple Pencil,HP 61 ink} => {Dust-Off Compressed Gas 2 pack}  
## 43 {HP 61 ink,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## 5 {3A USB Type C Cable 3 pack 6FT} => {Dust-Off Compressed Gas 2 pack}  
## 1 {iPhone Charger Cable Anker 6ft} => {Dust-Off Compressed Gas 2 pack}  
## 10 {Premium Nylon USB Cable} => {Dust-Off Compressed Gas 2 pack}  
## 44 {Apple Pencil,VIVO Dual LCD Monitor Desk mount} => {Dust-Off Compressed Gas 2 pack}  
## support confidence coverage lift count  
## 36 0.01013198 0.5066667 0.01999733 2.125563 76  
## 34 0.01106519 0.5030303 0.02199707 2.110308 83  
## 35 0.01093188 0.4739884 0.02306359 1.988472 82  
## 32 0.01106519 0.4689266 0.02359685 1.967236 83  
## 9 0.02306359 0.4564644 0.05052660 1.914955 173  
## 31 0.01146514 0.4550265 0.02519664 1.908923 86  
## 30 0.01026530 0.4476744 0.02293028 1.878079 77  
## 40 0.01573124 0.4436090 0.03546194 1.861024 118  
## 38 0.01399813 0.4356846 0.03212905 1.827780 105  
## 37 0.01706439 0.4353741 0.03919477 1.826477 128  
## 33 0.01199840 0.4306220 0.02786295 1.806541 90  
## 39 0.01306492 0.4242424 0.03079589 1.779778 98  
## 18 0.02759632 0.4190283 0.06585789 1.757904 207  
## 24 0.04092788 0.4165536 0.09825357 1.747522 307  
## 42 0.01346487 0.4056225 0.03319557 1.701663 101  
## 43 0.01586455 0.4047619 0.03919477 1.698053 119  
## 5 0.01706439 0.4012539 0.04252766 1.683336 128  
## 1 0.01026530 0.3989637 0.02572990 1.673729 77  
## 10 0.02013065 0.3942559 0.05105986 1.653978 151  
## 44 0.01426476 0.3905109 0.03652846 1.638268 107

# Part IV: Data Summary and Implications

By using the support metric, the market basket analysis has concluded that the most popular item among the baskets was the Dust-Off Compressed Gas 2 pack.

Interestingly, using the confidence metric the top 13 association rules all include the same item Dust-Off Compressed Gas 2 pack on the right hand side of the rule. This means that the Dust Off item is a popular subsequent purchased item.

Having targeted the Dust Off item as a common subsequent purchased item, and isolated the market basket analysis with the Dust Off item on the right hand side, the analysis concludes the following item combinations have a lift of around 2 (when rounding) indicating that a customer is twice as likely to purchase a Dust Off item after previously purchasing any of the following item combinations:

1. Apple Pencil,SanDisk Ultra 64GB card
2. SanDisk Ultra 64GB card,Screen Mom Screen Cleaner kit
3. HP 61 ink,SanDisk Ultra 64GB card

Simply having insight to popularly selling items is beneficial to an organization and market basket analysis certainly provides this information. Even more beneficial however are the association rules that market basket analysis also provides. The ability to identify customer shopping patterns, anticipate customer needs, and make informed and relevant shopping suggestions to the customer base can be a powerful capability to boost sales, revenue, and operational efficiency. In this case, the Dust Off items proved to be the most popularly selling item in terms of support. However, upon further inspection the market basket analysis revealed that this item is often a subsequent purchase instead of the initial purchase. Additionally, the market basket analysis revealed which item combinations often precede the purchase of the Dust Off item.

With this information, it is recommended that the organization develop the apparatus for dynamic customer product recommendations in their online storefront. For example, when a customer adds an Apple Pencil to their shopping cart then the customer should also receive a promotion for SanDisks and Dust Off items. For brick and mortar storefronts, the products can be rearranged to be placed beside each other effecting a product suggestion by proximity. With these efforts an increase in sales should be expected. Therefore, it is further recommended that inventory planning be adjusted accordingly. This will ensure these items remain well stocked thereby minimizing any opportunity loss by product unavailability. Finally, market basket analysis should not be limited to a one time effort. Instead, the analysis should be iterative, repeating at an appropriate interval of time for earliest detection of new customer purchasing patterns.