Unsupervised Learning

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18/02/2021

```
library(tidyverse)
library("readxl")
library("ggplot2")
```

```
#get the names of the columns
nms <- names(read_excel("US_Superstore_data.xls"))

#if the column name has "Date" in it, read the column as date data type, otherwise guess the type
ct <- ifelse(grepl("^Date", nms), "date", "guess")
data <- read_excel("US_Superstore_data.xls", col_types = ct)
```

To look at some basic statistics for this dataset:

```
summary(data)
```

```
##      Row ID       Order ID           Order Date
##  Min.   :   1   Length:9994        Min.   :2014-01-03 00:00:00
##  1st Qu.:2499   Class :character   1st Qu.:2015-05-23 00:00:00
##  Median :4998   Mode  :character   Median :2016-06-26 00:00:00
##  Mean   :4998                      Mean   :2016-04-30 00:07:12
##  3rd Qu.:7496                      3rd Qu.:2017-05-14 00:00:00
##  Max.   :9994                      Max.   :2017-12-30 00:00:00
##    Ship Date                     Ship Mode         Customer ID
##  Min.   :2014-01-07 00:00:00   Length:9994        Length:9994
##  1st Qu.:2015-05-27 00:00:00   Class :character   Class :character
##  Median :2016-06-29 00:00:00   Mode  :character   Mode  :character
##  Mean   :2016-05-03 23:06:58
##  3rd Qu.:2017-05-18 00:00:00
##  Max.   :2018-01-05 00:00:00
##  Customer Name        Segment            Country             City
##  Length:9994        Length:9994        Length:9994        Length:9994
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##     State            Postal Code       Region           Product ID
##  Length:9994        Min.   : 1040   Length:9994        Length:9994
##  Class :character   1st Qu.:23223   Class :character   Class :character
##  Mode  :character   Median :56431   Mode  :character   Mode  :character
```

```
##                     Mean   :55190
##                     3rd Qu.:90008
##                     Max.   :99301
##    Category         Sub-Category       Product Name          Sales
##  Length:9994        Length:9994        Length:9994        Min.   :    0.444
##  Class :character   Class :character   Class :character   1st Qu.:   17.280
##  Mode  :character   Mode  :character   Mode  :character   Median :   54.490
##                                                           Mean   :  229.858
##                                                           3rd Qu.:  209.940
##                                                           Max.   :22638.480
##     Quantity        Discount          Profit
##  Min.   : 1.00   Min.   :0.0000   Min.   :-6599.978
##  1st Qu.: 2.00   1st Qu.:0.0000   1st Qu.:    1.729
##  Median : 3.00   Median :0.2000   Median :    8.666
##  Mean   : 3.79   Mean   :0.1562   Mean   :   28.657
##  3rd Qu.: 5.00   3rd Qu.:0.2000   3rd Qu.:   29.364
##  Max.   :14.00   Max.   :0.8000   Max.   : 8399.976
```

To look at the dimensions of the data:

```
dim(data)
```

```
## [1] 9994   21
```

The dimensions of the dataset are 9994 by 21.

Check that the Order Date and Ship Date column type is POSIXct which is a date data type:

```
data
```

```
## # A tibble: 9,994 x 21
##    `Row ID` `Order ID` `Order Date`        `Ship Date`         `Ship Mode`
##       <dbl> <chr>      <dttm>              <dttm>              <chr>
##  1        1 CA-2016-1~ 2016-11-08 00:00:00 2016-11-11 00:00:00 Second Cla~
##  2        2 CA-2016-1~ 2016-11-08 00:00:00 2016-11-11 00:00:00 Second Cla~
##  3        3 CA-2016-1~ 2016-06-12 00:00:00 2016-06-16 00:00:00 Second Cla~
##  4        4 US-2015-1~ 2015-10-11 00:00:00 2015-10-18 00:00:00 Standard C~
##  5        5 US-2015-1~ 2015-10-11 00:00:00 2015-10-18 00:00:00 Standard C~
##  6        6 CA-2014-1~ 2014-06-09 00:00:00 2014-06-14 00:00:00 Standard C~
##  7        7 CA-2014-1~ 2014-06-09 00:00:00 2014-06-14 00:00:00 Standard C~
##  8        8 CA-2014-1~ 2014-06-09 00:00:00 2014-06-14 00:00:00 Standard C~
##  9        9 CA-2014-1~ 2014-06-09 00:00:00 2014-06-14 00:00:00 Standard C~
## 10       10 CA-2014-1~ 2014-06-09 00:00:00 2014-06-14 00:00:00 Standard C~
## # ... with 9,984 more rows, and 16 more variables: `Customer ID` <chr>,
## #   `Customer Name` <chr>, Segment <chr>, Country <chr>, City <chr>,
## #   State <chr>, `Postal Code` <dbl>, Region <chr>, `Product ID` <chr>,
## #   Category <chr>, `Sub-Category` <chr>, `Product Name` <chr>, Sales <dbl>,
## #   Quantity <dbl>, Discount <dbl>, Profit <dbl>
```

To check the data type for each column:

```
## tibble [9,994 x 21] (S3: tbl_df/tbl/data.frame)
##  $ Row ID       : num [1:9994] 1 2 3 4 5 6 7 8 9 10 ...
```

```
##  $ Order ID     : chr [1:9994] "CA-2016-152156" "CA-2016-152156" "CA-2016-138688" "US-2015-108966" .
##  $ Order Date   : POSIXct[1:9994], format: "2016-11-08" "2016-11-08" ...
##  $ Ship Date    : POSIXct[1:9994], format: "2016-11-11" "2016-11-11" ...
##  $ Ship Mode    : chr [1:9994] "Second Class" "Second Class" "Second Class" "Standard Class" ...
##  $ Customer ID  : chr [1:9994] "CG-12520" "CG-12520" "DV-13045" "SO-20335" ...
##  $ Customer Name: chr [1:9994] "Claire Gute" "Claire Gute" "Darrin Van Huff" "Sean O'Donnell" ...
##  $ Segment      : chr [1:9994] "Consumer" "Consumer" "Corporate" "Consumer" ...
##  $ Country      : chr [1:9994] "United States" "United States" "United States" "United States" ...
##  $ City         : chr [1:9994] "Henderson" "Henderson" "Los Angeles" "Fort Lauderdale" ...
##  $ State        : chr [1:9994] "Kentucky" "Kentucky" "California" "Florida" ...
##  $ Postal Code  : num [1:9994] 42420 42420 90036 33311 33311 ...
##  $ Region       : chr [1:9994] "South" "South" "West" "South" ...
##  $ Product ID   : chr [1:9994] "FUR-BO-10001798" "FUR-CH-10000454" "OFF-LA-10000240" "FUR-TA-1000057
##  $ Category     : chr [1:9994] "Furniture" "Furniture" "Office Supplies" "Furniture" ...
##  $ Sub-Category : chr [1:9994] "Bookcases" "Chairs" "Labels" "Tables" ...
##  $ Product Name : chr [1:9994] "Bush Somerset Collection Bookcase" "Hon Deluxe Fabric Upholstered Sta
##  $ Sales        : num [1:9994] 262 731.9 14.6 957.6 22.4 ...
##  $ Quantity     : num [1:9994] 2 3 2 5 2 7 4 6 3 5 ...
##  $ Discount     : num [1:9994] 0 0 0 0.45 0.2 0 0 0.2 0.2 0 ...
##  $ Profit       : num [1:9994] 41.91 219.58 6.87 -383.03 2.52 ...
```

There are 6 numeric variables, 2 date variables, and 13 character variables.

```
glimpse(data)
```

```
## Rows: 9,994
## Columns: 21
## $ `Row ID`        <dbl> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, ...
## $ `Order ID`      <chr> "CA-2016-152156", "CA-2016-152156", "CA-2016-138688...
## $ `Order Date`    <dttm> 2016-11-08, 2016-11-08, 2016-06-12, 2015-10-11, 20...
## $ `Ship Date`     <dttm> 2016-11-11, 2016-11-11, 2016-06-16, 2015-10-18, 20...
## $ `Ship Mode`     <chr> "Second Class", "Second Class", "Second Class", "St...
## $ `Customer ID`   <chr> "CG-12520", "CG-12520", "DV-13045", "SO-20335", "SO...
## $ `Customer Name` <chr> "Claire Gute", "Claire Gute", "Darrin Van Huff", "S...
## $ Segment         <chr> "Consumer", "Consumer", "Corporate", "Consumer", "C...
## $ Country         <chr> "United States", "United States", "United States", ...
## $ City            <chr> "Henderson", "Henderson", "Los Angeles", "Fort Laud...
## $ State           <chr> "Kentucky", "Kentucky", "California", "Florida", "F...
## $ `Postal Code`   <dbl> 42420, 42420, 90036, 33311, 33311, 90032, 90032, 90...
## $ Region          <chr> "South", "South", "West", "South", "South", "West",...
## $ `Product ID`    <chr> "FUR-BO-10001798", "FUR-CH-10000454", "OFF-LA-10000...
## $ Category        <chr> "Furniture", "Furniture", "Office Supplies", "Furni...
## $ `Sub-Category`  <chr> "Bookcases", "Chairs", "Labels", "Tables", "Storage...
## $ `Product Name`  <chr> "Bush Somerset Collection Bookcase", "Hon Deluxe Fa...
## $ Sales           <dbl> 261.9600, 731.9400, 14.6200, 957.5775, 22.3680, 48....
## $ Quantity        <dbl> 2, 3, 2, 5, 2, 7, 4, 6, 3, 5, 9, 4, 3, 3, 5, 3, 6, ...
## $ Discount        <dbl> 0.00, 0.00, 0.00, 0.45, 0.20, 0.00, 0.00, 0.20, 0.2...
## $ Profit          <dbl> 41.9136, 219.5820, 6.8714, -383.0310, 2.5164, 14.16...
```

See if there are duplicates in the data and extract them:

```
data %>% distinct()
```

```
## # A tibble: 9,994 x 21
##    `Row ID` `Order ID` `Order Date`        `Ship Date`         `Ship Mode`
##       <dbl> <chr>      <dttm>              <dttm>              <chr>
##  1        1 CA-2016-1~ 2016-11-08 00:00:00 2016-11-11 00:00:00 Second Cla~
##  2        2 CA-2016-1~ 2016-11-08 00:00:00 2016-11-11 00:00:00 Second Cla~
##  3        3 CA-2016-1~ 2016-06-12 00:00:00 2016-06-16 00:00:00 Second Cla~
##  4        4 US-2015-1~ 2015-10-11 00:00:00 2015-10-18 00:00:00 Standard C~
##  5        5 US-2015-1~ 2015-10-11 00:00:00 2015-10-18 00:00:00 Standard C~
##  6        6 CA-2014-1~ 2014-06-09 00:00:00 2014-06-14 00:00:00 Standard C~
##  7        7 CA-2014-1~ 2014-06-09 00:00:00 2014-06-14 00:00:00 Standard C~
##  8        8 CA-2014-1~ 2014-06-09 00:00:00 2014-06-14 00:00:00 Standard C~
##  9        9 CA-2014-1~ 2014-06-09 00:00:00 2014-06-14 00:00:00 Standard C~
## 10       10 CA-2014-1~ 2014-06-09 00:00:00 2014-06-14 00:00:00 Standard C~
## # ... with 9,984 more rows, and 16 more variables: `Customer ID` <chr>,
## #   `Customer Name` <chr>, Segment <chr>, Country <chr>, City <chr>,
## #   State <chr>, `Postal Code` <dbl>, Region <chr>, `Product ID` <chr>,
## #   Category <chr>, `Sub-Category` <chr>, `Product Name` <chr>, Sales <dbl>,
## #   Quantity <dbl>, Discount <dbl>, Profit <dbl>
```

Another way to extract only the unique columns of the dataset:

```
data_unique <- unique(data)
```

```
dim(data_unique)
```

```
## [1] 9994   21
```

The dimensions of the dataset with only the unique rows are still 9994 by 21, so it appears there are no duplicated rows in the original dataset.

Check for missing values in data:

```
##  [1] "Row ID-1 missing values"         "Order ID-1 missing values"
##  [3] "Order Date-1 missing values"     "Ship Date-1 missing values"
##  [5] "Ship Mode-1 missing values"      "Customer ID-1 missing values"
##  [7] "Customer Name-1 missing values" "Segment-1 missing values"
##  [9] "Country-1 missing values"        "City-1 missing values"
## [11] "State-1 missing values"          "Postal Code-1 missing values"
## [13] "Region-1 missing values"         "Product ID-1 missing values"
## [15] "Category-1 missing values"       "Sub-Category-1 missing values"
## [17] "Product Name-1 missing values"  "Sales-1 missing values"
## [19] "Quantity-1 missing values"       "Discount-1 missing values"
## [21] "Profit-1 missing values"
```

This is 1 missing value in this dataset.

```
##  [1] "Row ID-0 missing values"         "Order ID-0 missing values"
##  [3] "Order Date-0 missing values"     "Ship Date-0 missing values"
```

```
##  [5] "Ship Mode-0 missing values"     "Customer ID-0 missing values"
##  [7] "Customer Name-0 missing values" "Segment-0 missing values"
##  [9] "Country-0 missing values"       "City-0 missing values"
## [11] "State-0 missing values"         "Postal Code-0 missing values"
## [13] "Region-0 missing values"        "Product ID-0 missing values"
## [15] "Category-0 missing values"      "Sub-Category-0 missing values"
## [17] "Product Name-0 missing values"  "Sales-0 missing values"
## [19] "Quantity-0 missing values"      "Discount-0 missing values"
## [21] "Profit-0 missing values"
```

list rows of data that have missing values

```
data[!complete.cases(data),]
```

```
## # A tibble: 0 x 21
## # ... with 21 variables: `Row ID` <dbl>, `Order ID` <chr>, `Order Date` <dttm>,
## #   `Ship Date` <dttm>, `Ship Mode` <chr>, `Customer ID` <chr>, `Customer
## #   Name` <chr>, Segment <chr>, Country <chr>, City <chr>, State <chr>, `Postal
## #   Code` <dbl>, Region <chr>, `Product ID` <chr>, Category <chr>,
## #   `Sub-Category` <chr>, `Product Name` <chr>, Sales <dbl>, Quantity <dbl>,
## #   Discount <dbl>, Profit <dbl>
```

Percentage of missing values

```
## [1] 0
```

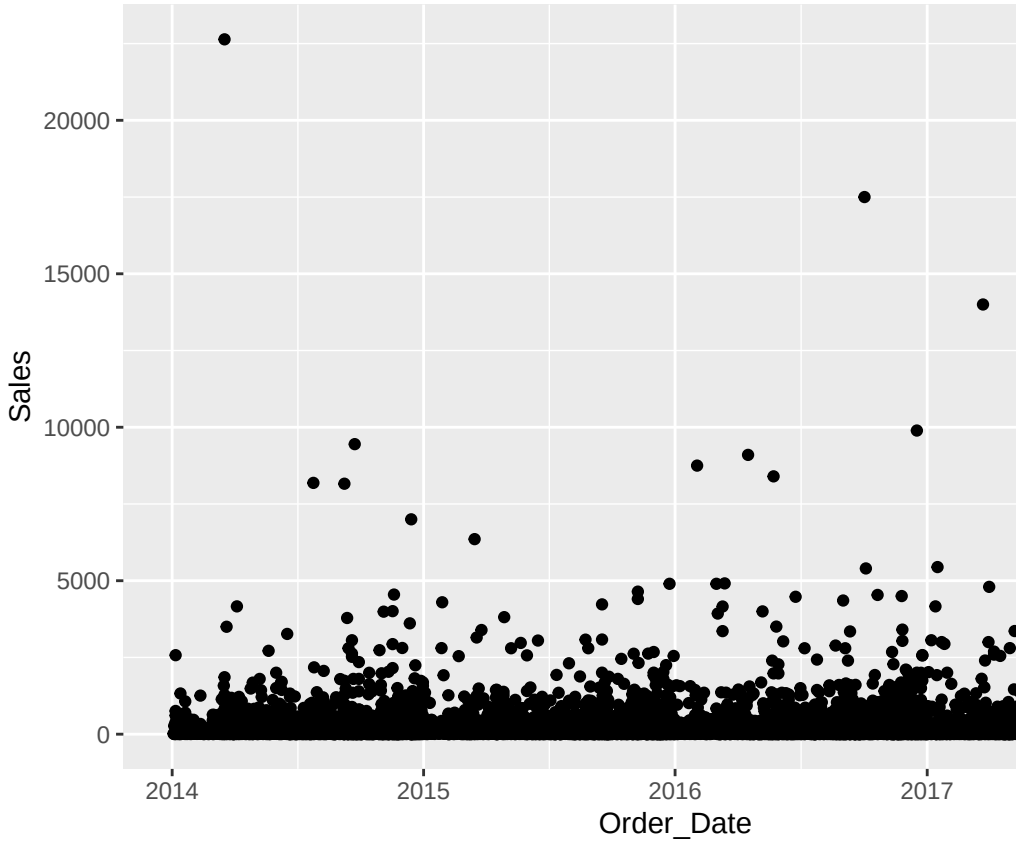
Remove the spaces in the column names and replace with "_" to make variable names easier to handle:

```
##  [1] "Row_ID"        "Order_ID"      "Order_Date"    "Ship_Date"
##  [5] "Ship_Mode"     "Customer_ID"   "Customer_Name" "Segment"
##  [9] "Country"       "City"          "State"         "Postal_Code"
## [13] "Region"        "Product_ID"    "Category"      "Sub-Category"
## [17] "Product_Name"  "Sales"         "Quantity"      "Discount"
## [21] "Profit"
```

Exploratory Data Analysis

Find the difference between Order Date and Ship Date, and store into a new column called diff_in_days:

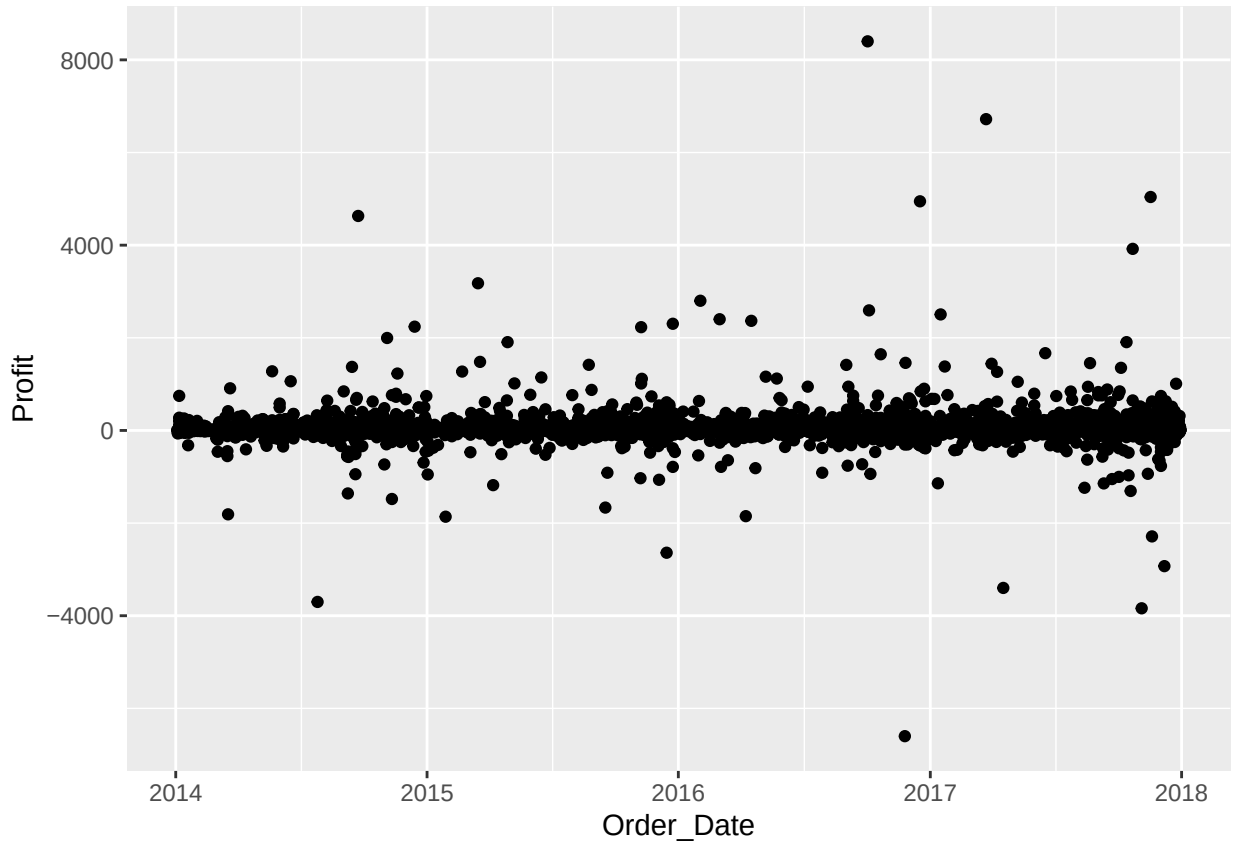
```
data$diff_in_days<- difftime(data$Ship_Date, data$Order_Date, units = c("days"))
```



Plot Sales in relation to Order Date:
Plot Profit in relation to Order Date:

```
ggplot(data = data) +
  geom_point(mapping = aes(x = Order_Date, y = Profit), xlab="Order Date", ylab="Profit")
```

```
## Warning: Ignoring unknown parameters: xlab, ylab
```



Some outliers for certain days

```
table(data$`Sub-Category`)
```

```
##
## Accessories  Appliances         Art     Binders   Bookcases      Chairs
##         775         466         796        1523         228         617
##     Copiers   Envelopes   Fasteners Furnishings      Labels    Machines
##          68         254         217         957         364         115
##       Paper      Phones     Storage    Supplies      Tables
##        1370         889         846         190         319
```

look at the time range for these transactions, ie. start date for Order_Date column:

```
min(data$Order_Date)
```

```
## [1] "2014-01-03 UTC"
```

```
#[1] "2014-01-03 UTC"
```

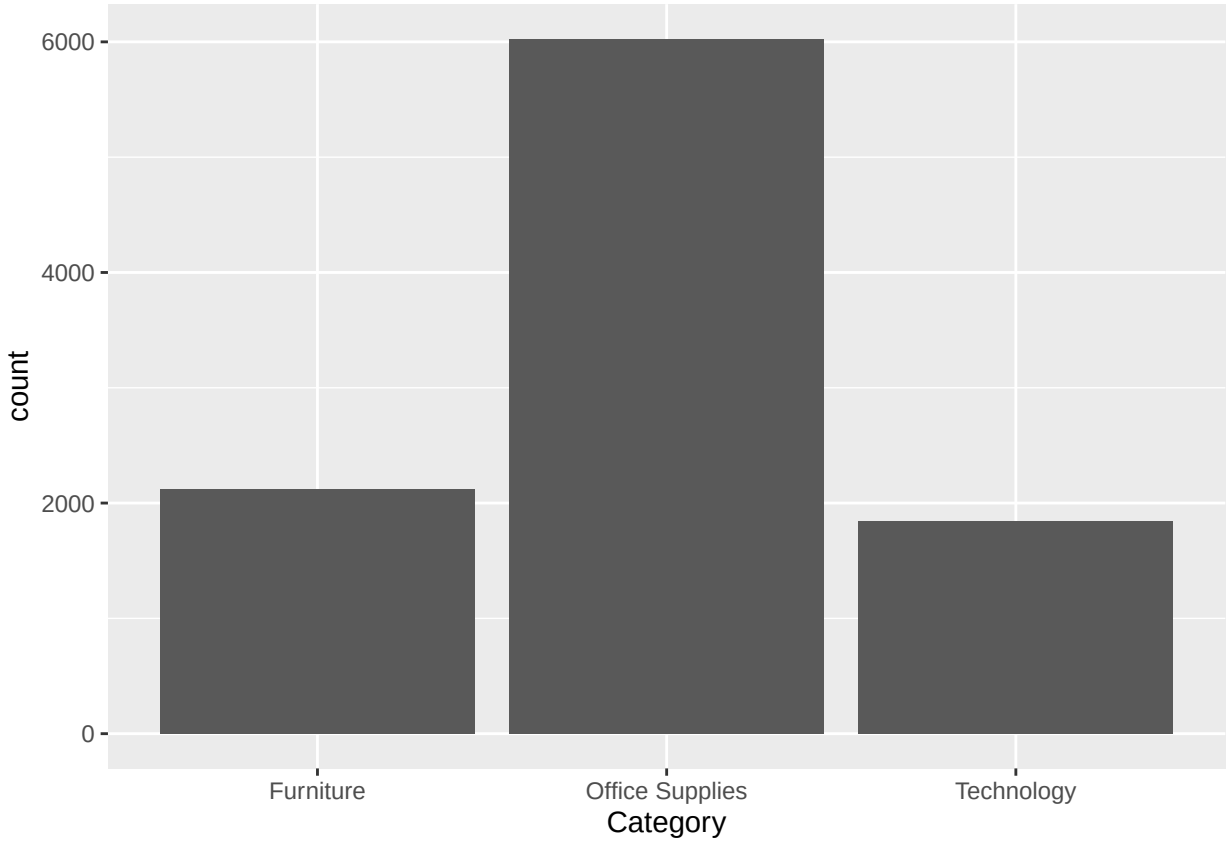
```
max(data$Order_Date)
```

```
## [1] "2017-12-30 UTC"
```

```
#[1] "2017-12-30 UTC"
```

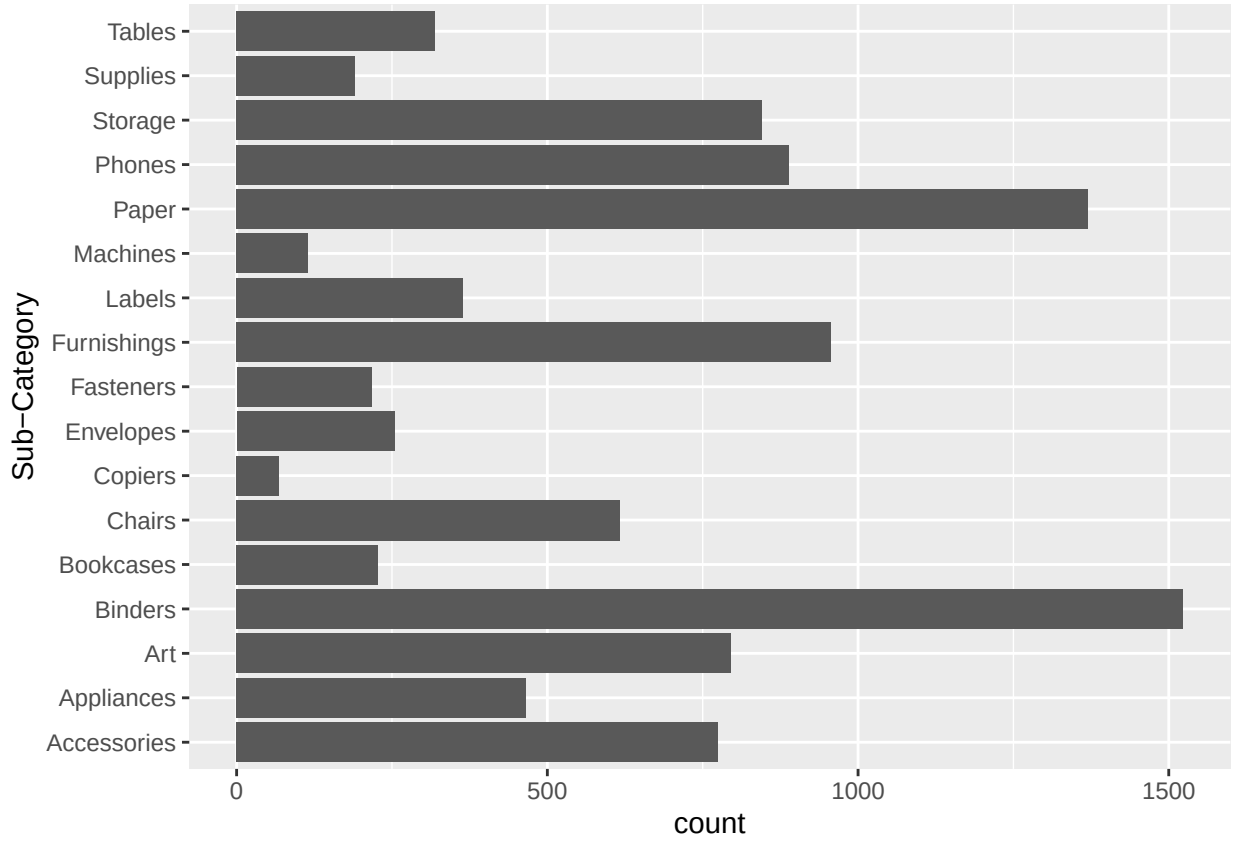
Basically this dataset covers transactions ranging from 2014-01-03 to 2017-12-30.

```
ggplot(data = data) +
  geom_bar(mapping = aes(x = Category))
```



Most type of products sold belong to the Office supplies category.

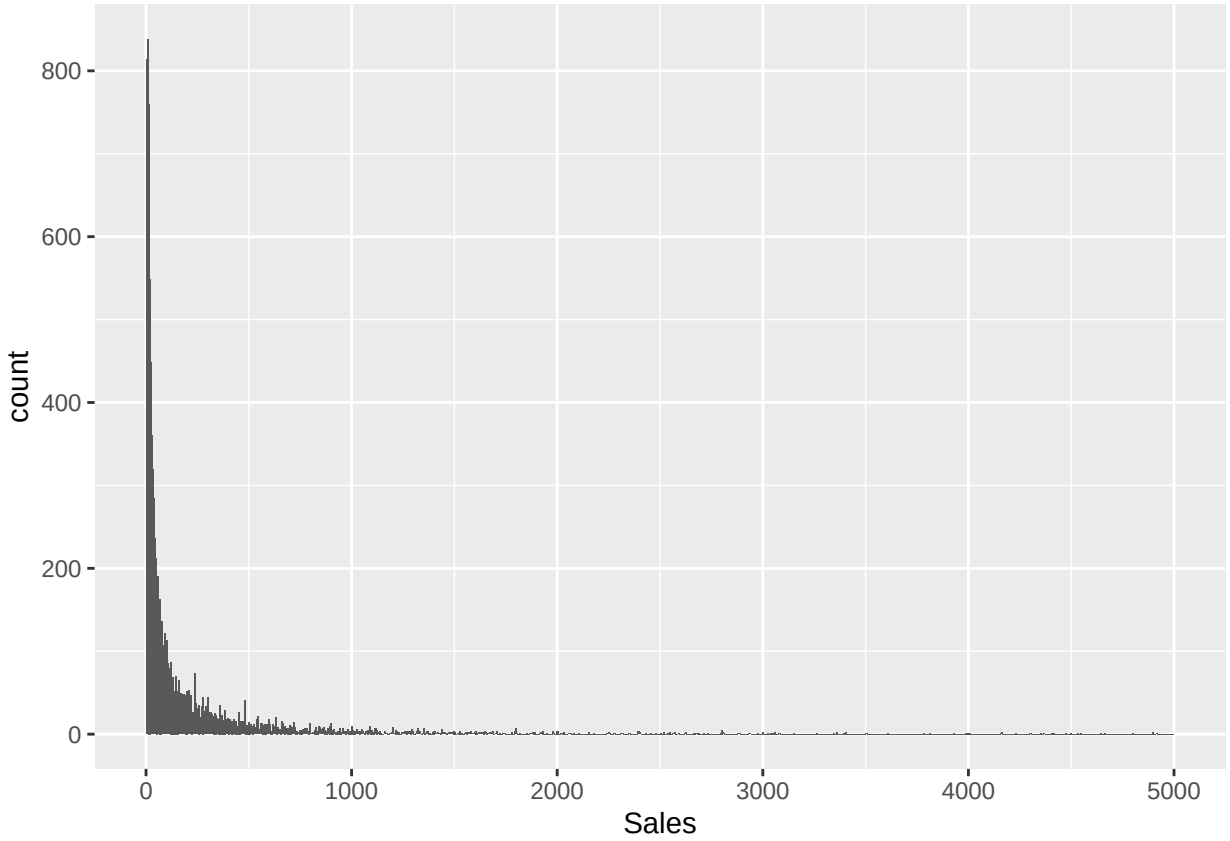
```
ggplot(data = data) +
  geom_bar(mapping = aes(y = `Sub-Category`))
```




```
ggplot(data = data, mapping = aes(x = Sales)) +
  xlim(0, 5000) +
  geom_histogram(binwidth = 5)
```

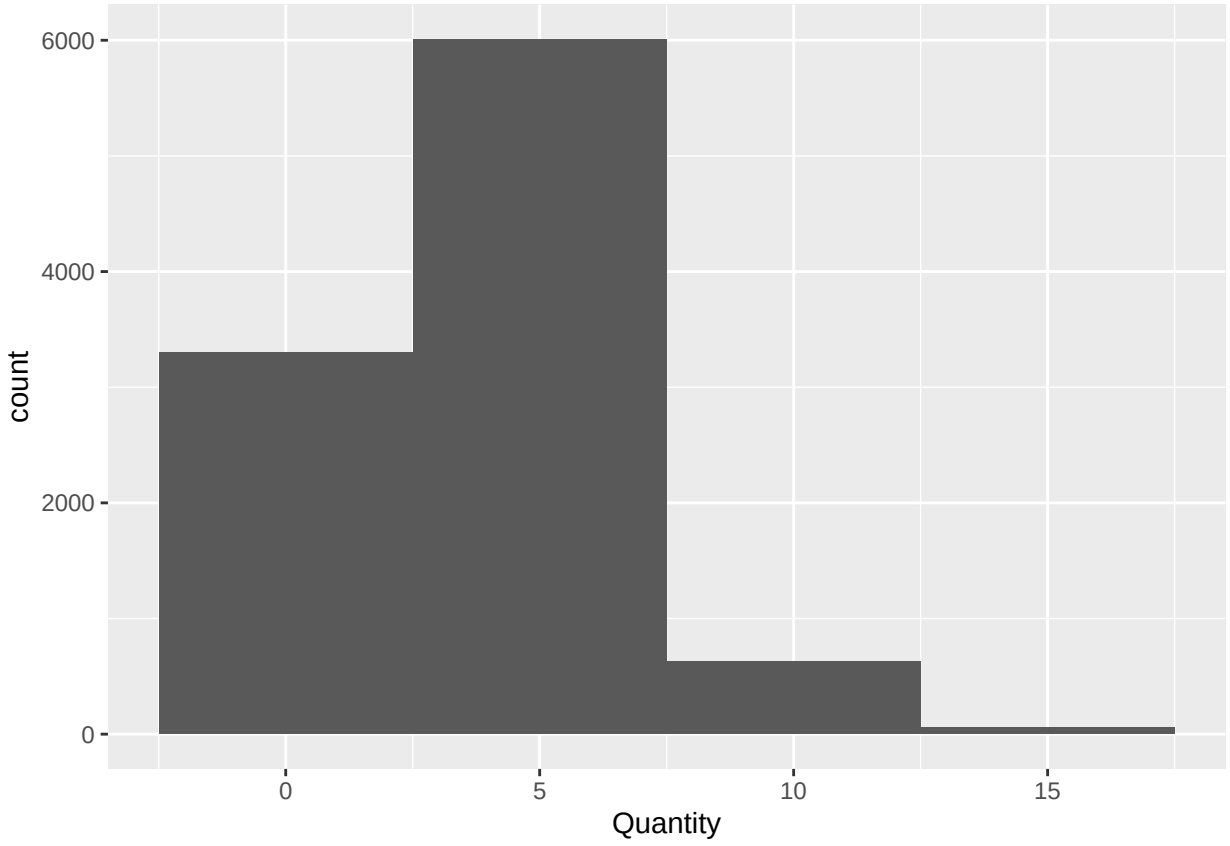
```
## Warning: Removed 19 rows containing non-finite values (stat_bin).
```

```
## Warning: Removed 2 rows containing missing values (geom_bar).
```



Most sales are very few items (<500).

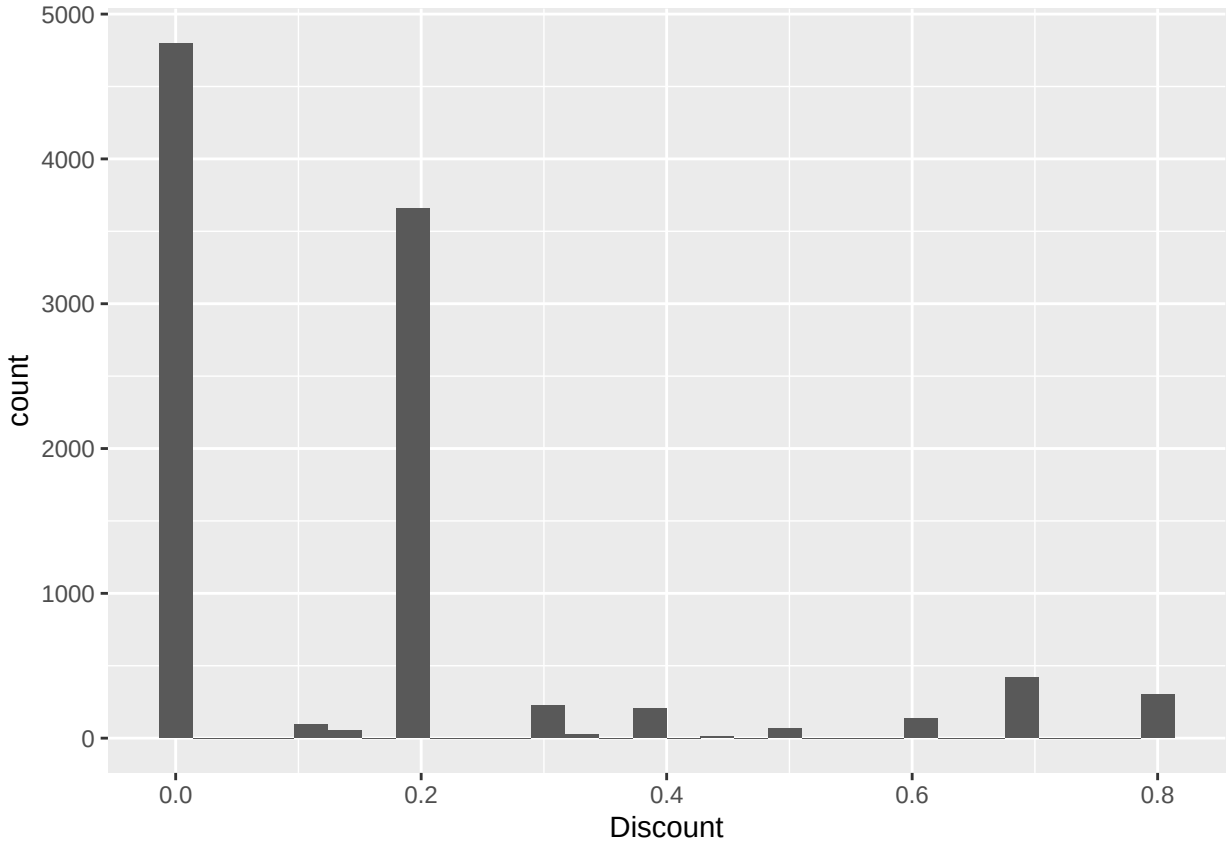
```
ggplot(data = data, mapping = aes(x = Quantity)) +
  geom_histogram(binwidth = 5)
```




```
ggplot(data = data) +
  geom_histogram(mapping = aes(x = Discount), xlab="Discount")
```

```
## Warning: Ignoring unknown parameters: xlab
```

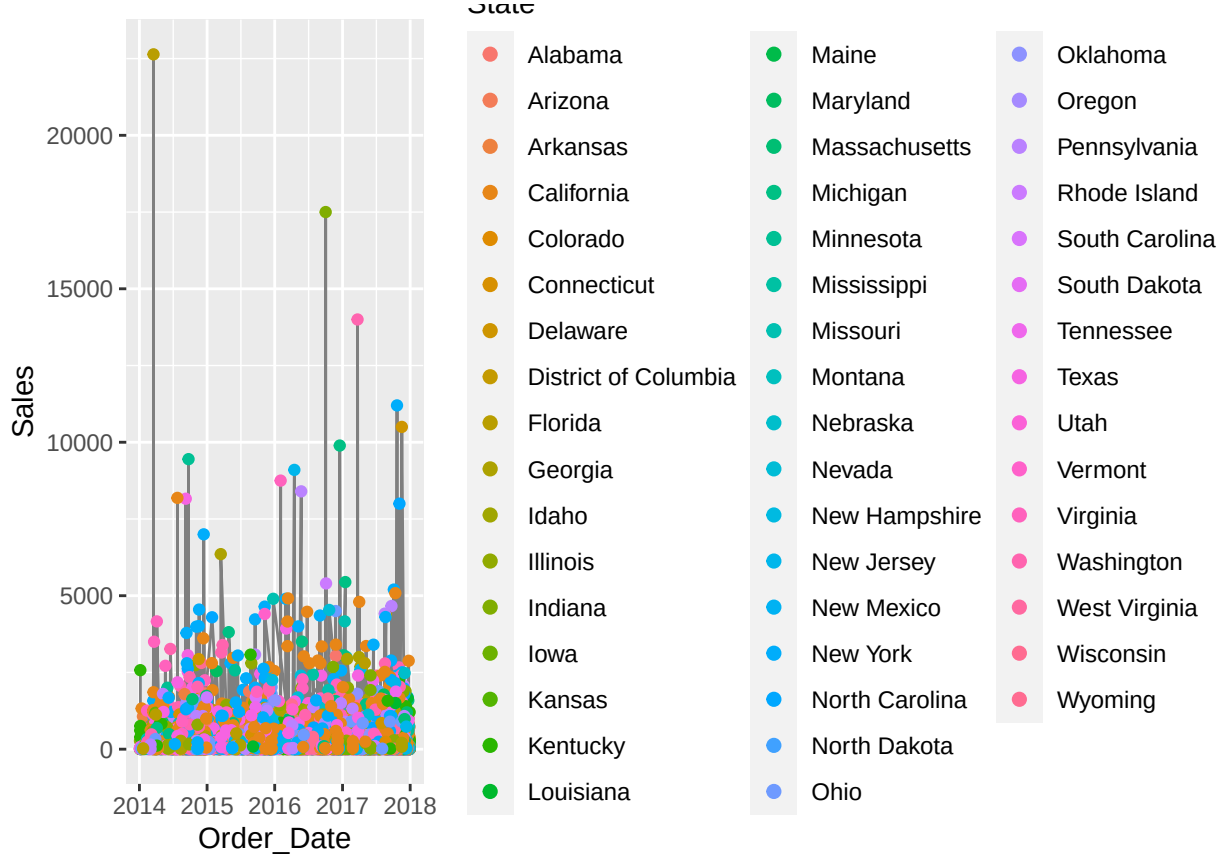
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



Sales transactions mostly do not involve discounts.

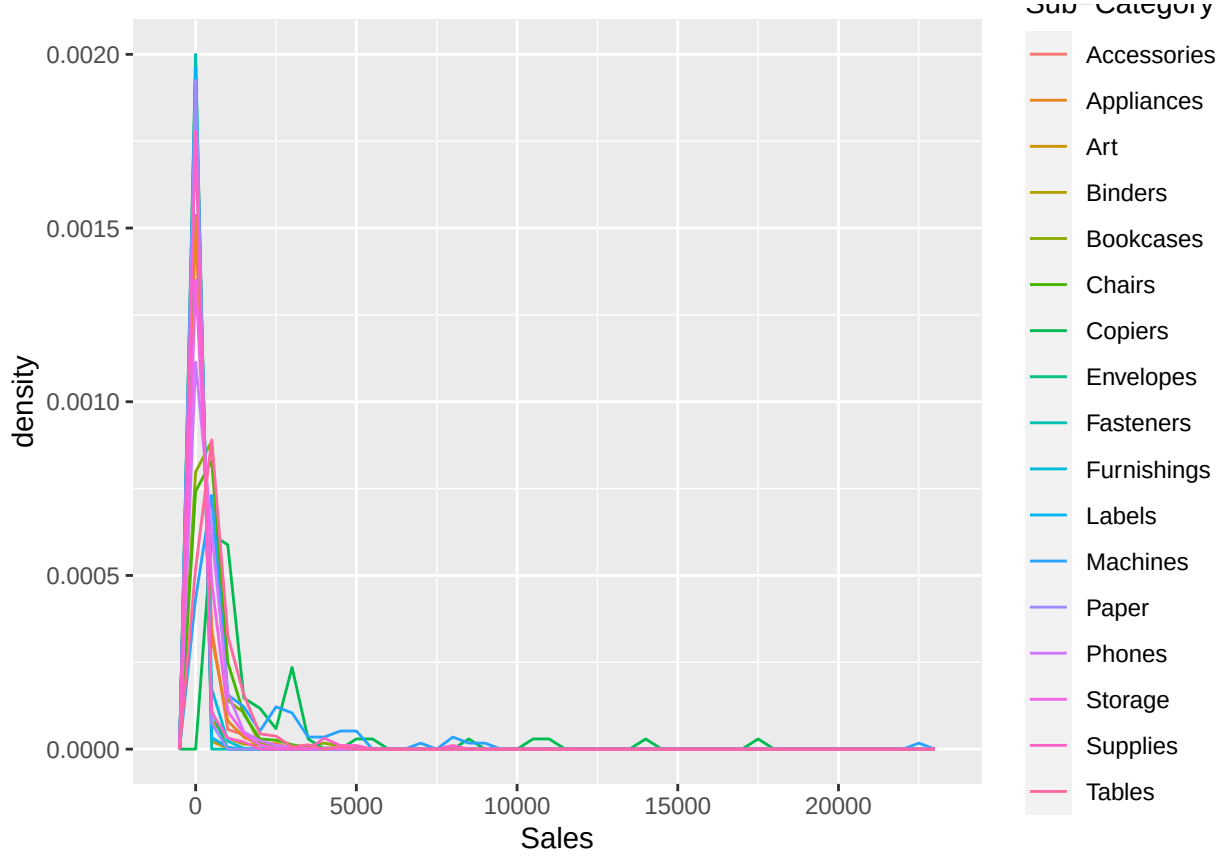
Visualise sales transactions by state over time (order date).

```
p <- ggplot(data, aes(Order_Date, Sales)) +
      geom_line(aes(group = State), colour = "grey50") +
      geom_point(aes(colour = State))
p <- p + guides(shape = guide_legend(override.aes = list(size = 0.5)),  #this is to make legend smaller
                color = guide_legend(override.aes = list(size = 2)))
p
```



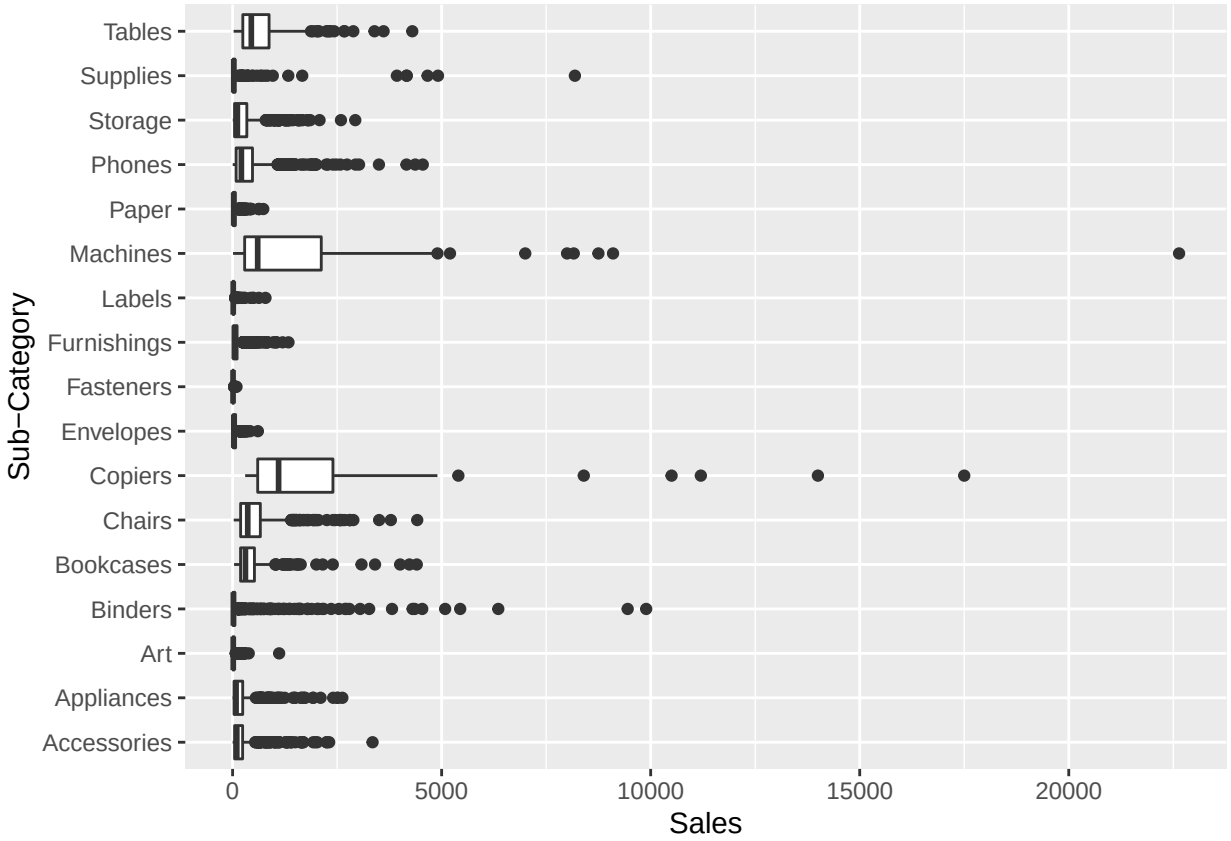
How does profit change with sub-category?

```
 #density plot where the count is standardized,area under each frequency is 1
ggplot(data = data, mapping = aes(x = Sales, y = ..density..)) +
  geom_freqpoly(mapping = aes(colour = `Sub-Category`), binwidth = 500)
```



It looks like some categories of items ie. supplies or accessories have negative sales values.

```
ggplot(data = data, mapping = aes(x = Sales, y = `Sub-Category` )) +
  geom_boxplot()
```


Sub−Category
Tables
Supplies
Storage
Phones
Paper
Machines
Labels
Furnishings
Fasteners
Envelopes
Copiers
Chairs
Bookcases
Binders
Art
Appliances
Accessories
0
5000
10000
15000
20000
Sales