Assignment 02 Data Exploration

BQOM 2578 | Data Mining

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0.1 Load packages

```r
library(ggplot2)
library(dplyr)
```

```

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(stringr)
library(tidyr)
```

1 Drug AMP Reporting - Quarterly

The dataset is from Medicaid Drug AMP Reporting and described there:

> *Drugs that have been reported under the Medicaid Drug Rebate Program along with an indication of whether or not the required Average Manufacturer Price (AMP) was reported for each drug. All drugs are identified in the file by the 11-digit National Drug Code, product name, labeler name, and reported (R) or not reported (NR).*

```
[1] "/Users/theresawohlever/git_repos/BQOM-2578_DataMining/BQOM-2578_DataMining_twohlever/as
```

1.0.1 Load data

Raw data from Medicaid Drug AMP Reporting: https://data.medicaid.gov/dataset/80956a7d-e343-54f3-94a7-45d41b34fc0b#data-table

```
base_FILENAME <- "DrugAMPReportingQuarterly022025" ## tiny" ## DrugAMPReportingQuarterly0220

#  read the csv into a dataframe, which we can manipulate in R.

csv_FILE <- paste(base_FILENAME, ".csv", sep = "")
raw_amp_df <- read.csv(csv_FILE, stringsAsFactors = FALSE)

csv_OUT_FILE <- paste(base_FILENAME, "_processed.csv", sep = "")
```

2 Data Discovery

```
# head displays the first rows
head(raw_amp_df)
```

```
                             Labeler.Name         NDC
1 FLUORITAB CORPORATION                   00288110601
2 FLUORITAB CORPORATION                   00288110602
3 FLUORITAB CORPORATION                   00288110610
4 FLUORITAB CORPORATION                   00288110699
5 FLUORITAB CORPORATION                   00288220101
6 FLUORITAB CORPORATION                   00288220102
                                                 FDA.Product.Name Status Year
1 SODIUM FLUORIDE I.I MG                                              NR 2013
2 SODIUM FLUORIDE 1.1 MG                                              NR 2013
3 SODIUM FLUORIDE 1.1MG                                               NR 2013
4 SODIUM FLUORIDE 1.1MG                                               NR 2013
5 SODIUM FLUORIDE 2.2MG                                               NR 2013
6 SODIUM FLUORIDE 2.2 MG                                              NR 2013
  Quarter
1       1
2       1
3       1
4       1
5       1
6       1
```

```
# tail displays the last rows
tail(raw_amp_df)
```

```
                 Labeler.Name         NDC     FDA.Product.Name Status Year
2031672 BAUSCH HEALTH US, LLC 99207030060            ZIANA GEL      R 2025
2031673 BAUSCH HEALTH US, LLC 99207046630 SOLODYN 80MG TABLETS      R 2025
2031674 BAUSCH HEALTH US, LLC 99207052510      VANOS CREAM .1%      R 2025
2031675 BAUSCH HEALTH US, LLC 99207052530      VANOS CREAM .1%      R 2025
2031676 BAUSCH HEALTH US, LLC 99207052560      VANOS CREAM .1%      R 2025
2031677 BAUSCH HEALTH US, LLC 99207085060   LUZU Cream 1% 60gm      R 2025
        Quarter
2031672       2
2031673       2
2031674       2
2031675       2
2031676       2
2031677       2
```

```r
# dim tells you how many rows by how many columns you have
dim(raw_amp_df)
```

```
[1] 2031677       6
```

```r
# names returns the names of the columns that you have
names(raw_amp_df)
```

```
[1] "Labeler.Name"     "NDC"              "FDA.Product.Name" "Status"
[5] "Year"             "Quarter"
```

```r
#summary will give you relevant summary statistics for each variable depending on its type
summary(raw_amp_df)
```

```
 Labeler.Name           NDC            FDA.Product.Name      Status
 Length:2031677     Length:2031677     Length:2031677     Length:2031677
 Class :character   Class :character   Class :character   Class :character
 Mode  :character   Mode  :character   Mode  :character   Mode  :character



      Year         Quarter
 Min.   :2013   Min.   :1.000
 1st Qu.:2016   1st Qu.:2.000
 Median :2019   Median :2.000
 Mean   :2019   Mean   :2.496
 3rd Qu.:2022   3rd Qu.:3.000
 Max.   :2025   Max.   :4.000
```

3 Data Structure

3.1 Date Column Creation

- Combines Year and Quarter columns into a proper Date column for better temporal analysis
- Converts quarters to actual dates (Q1 = January 1st, Q4 = October 1st)

```r
df <- raw_amp_df

# Create a meaningful Date column by combining Year and Quarter
# Convert quarter to actual dates for better temporal analysis
df$Date <- as.Date(paste(df$Year, (df$Quarter - 1) * 3 + 1, "01", sep = "-"))
```

3.2 Drug Category Classification

- Creates meaningful drug categories by analyzing FDA Product Names
- Categories include: Fluoride Supplements, Pain Management, Antibiotics, Topical Treatments, Respiratory, OTC Pain Relief, and Other
- Cleans up labeler company names by removing excessive spacing

```r
# Create drug category classification from FDA Product Name
# Extract drug categories and clean up labeler names
df$Drug_Category <- case_when(
  str_detect(toupper(df$FDA.Product.Name), "SODIUM FLUORIDE|FLUORITAB") ~ "Fluoride Supplemen
  str_detect(toupper(df$FDA.Product.Name), "VICODIN|PAIN") ~ "Pain Management",
  str_detect(toupper(df$FDA.Product.Name), "ANTIBIOTIC|OXACILLIN|PENICILLIN") ~ "Antibiotics"
  str_detect(toupper(df$FDA.Product.Name), "CREAM|LOTION|OINTMENT") ~ "Topical Treatments",
  str_detect(toupper(df$FDA.Product.Name), "COUGH|EXPECTORANT") ~ "Respiratory",
  str_detect(toupper(df$FDA.Product.Name), "ASPIRIN|IBUPROFEN|ACETAMINOPHEN|NAPROXEN") ~ "OTC
  TRUE ~ "Other"
)

# Clean up labeler names (remove excessive spacing and formatting)
df$Labeler_Clean <- str_trim(str_replace_all(df$Labeler.Name, "\\s+", " "))
```

3.3 Grouping

```r
CategoryAndStatus <- group_by(df, Status, Drug_Category) %>%
    summarise(count = n())
```

```
`summarise()` has grouped output by 'Status'. You can override using the
`.groups` argument.
```

3.4 C. Cleaning: Data Types and Missing Values

3.4.1 Handling Missing Values

```
# We'll drop all Markdown values with select( - ...)
# and replace NA values with the mean of Unemployment and CPI.
# features2<-features%>%select(-c(MarkDown1:MarkDown5))%>%
  # mutate(Unemployment = replace_na(Unemployment,mean(Unemployment, na.rm = TRUE)),
        #CPI = replace_na(CPI,mean(CPI, na.rm = TRUE)))

# summary(features2)
```

3.5 F. Publishing

```
summary(df)
```

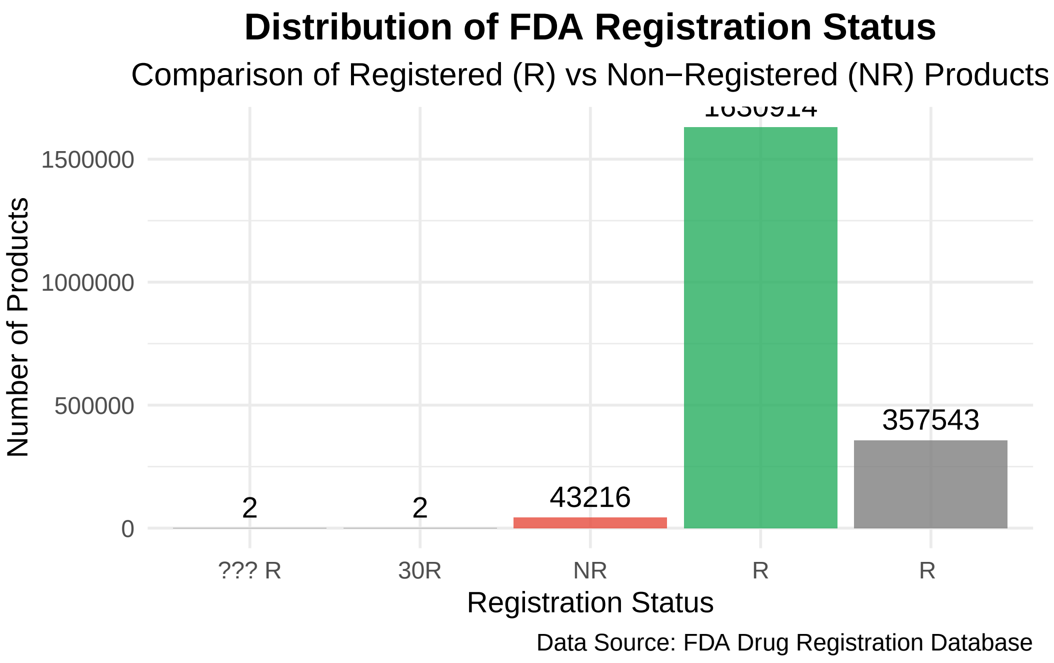
```
 Labeler.Name           NDC             FDA.Product.Name       Status         
 Length:2031677     Length:2031677     Length:2031677     Length:2031677    
 Class  :character  Class  :character  Class  :character  Class  :character  
 Mode   :character  Mode   :character  Mode   :character  Mode   :character  
                                                                             
                                                                             
                                                                             
      Year         Quarter           Date            Drug_Category     
 Min.   :2013   Min.   :1.000   Min.   :2013-01-01   Length:2031677    
 1st Qu.:2016   1st Qu.:2.000   1st Qu.:2016-04-01   Class  :character  
 Median :2019   Median :2.000   Median :2019-07-01   Mode   :character  
 Mean   :2019   Mean   :2.496   Mean   :2019-05-20                     
 3rd Qu.:2022   3rd Qu.:3.000   3rd Qu.:2022-07-01                     
 Max.   :2025   Max.   :4.000   Max.   :2025-04-01                     
 Labeler_Clean     
 Length:2031677    
 Class  :character  
 Mode   :character  
```

```r
df%>%write.csv(csv_OUT_FILE,row.names = FALSE)
```

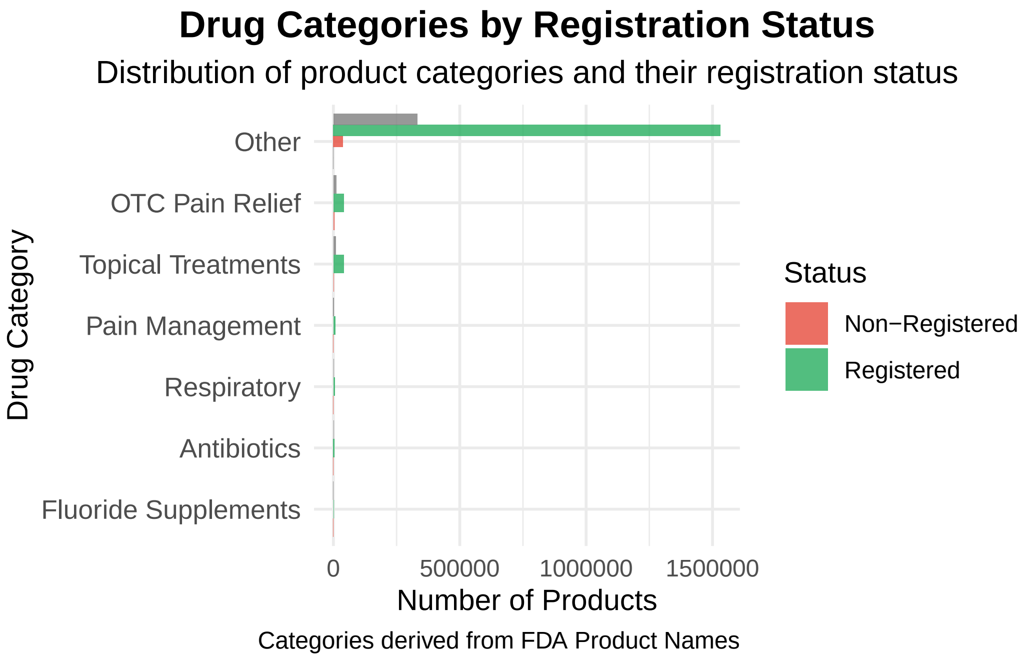
3.6 E. Verifying / Exploring

3.6.1 Distribution of Registration Status

```r
p1 <- ggplot(df, aes(x = Status, fill = Status)) +
  geom_bar(stat = "count", alpha = 0.8) +
  geom_text(stat = "count", aes(label = after_stat(count)), vjust = -0.5) +
  labs(title = "Distribution of FDA Registration Status",
       subtitle = "Comparison of Registered (R) vs Non-Registered (NR) Products",
       x = "Registration Status",
       y = "Number of Products",
       caption = "Data Source: FDA Drug Registration Database") +
  scale_fill_manual(values = c("NR" = "#E74C3C", "R" = "#27AE60")) +
  theme_minimal() +
  theme(plot.title = element_text(hjust = 0.5, size = 14, face = "bold"),
        plot.subtitle = element_text(hjust = 0.5, size = 12),
        legend.position = "none")

print(p1)
```

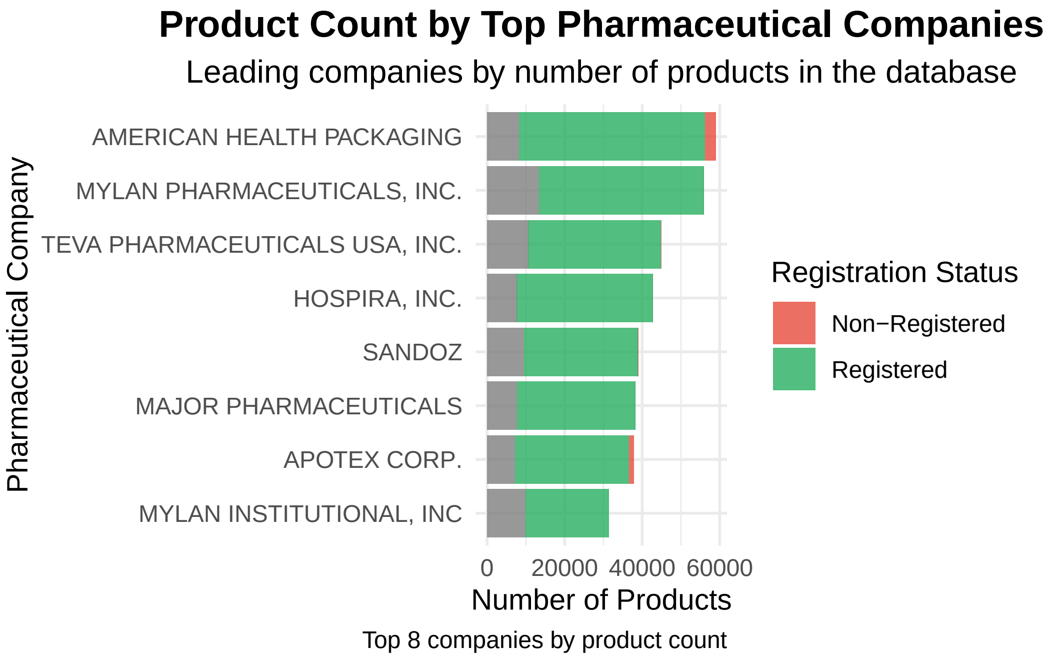


```
# Graph 2: Drug Categories by Registration Status
p2 <- ggplot(df, aes(x = reorder(Drug_Category, Drug_Category, function(x) length(x)),
                     fill = Status)) +
  geom_bar(position = "dodge", alpha = 0.8) +
  coord_flip() +
  labs(title = "Drug Categories by Registration Status",
       subtitle = "Distribution of product categories and their registration status",
       x = "Drug Category",
       y = "Number of Products",
       fill = "Status",
       caption = "Categories derived from FDA Product Names") +
  scale_fill_manual(values = c("NR" = "#E74C3C", "R" = "#27AE60"),
                    labels = c("NR" = "Non-Registered", "R" = "Registered")) +
  theme_minimal() +
  theme(plot.title = element_text(hjust = 0.5, size = 14, face = "bold"),
        plot.subtitle = element_text(hjust = 0.5, size = 12),
        axis.text.y = element_text(size = 10))

print(p2)
```

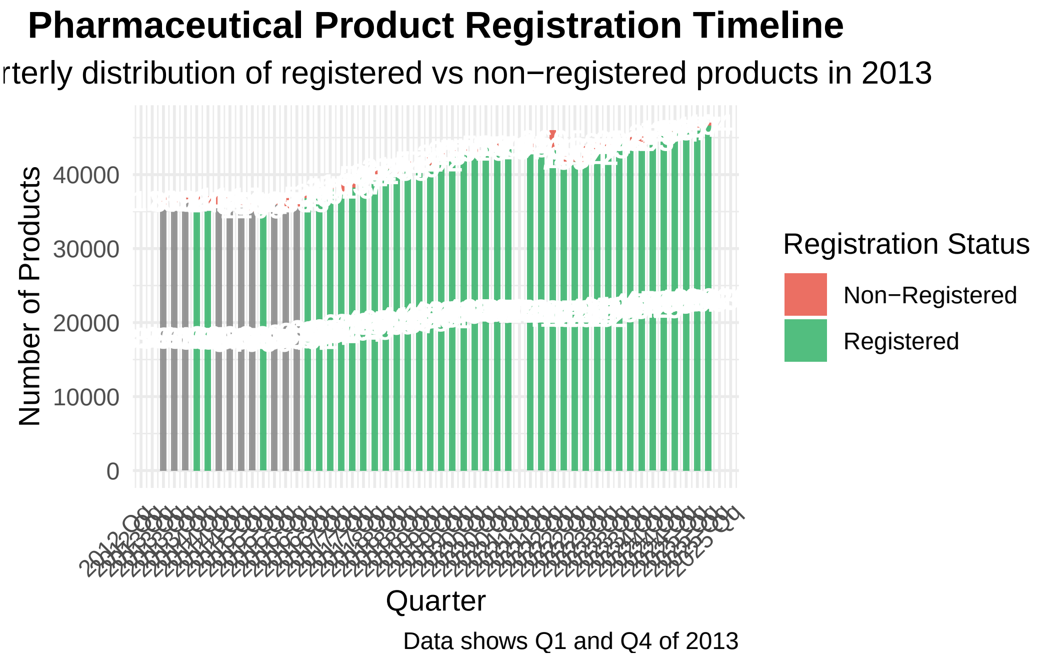


```
# Graph 3: Top Pharmaceutical Companies (Top 8)
top_labelers <- names(head(sort(table(df$Labeler_Clean), decreasing = TRUE), 8))
df_top <- df[df$Labeler_Clean %in% top_labelers, ]
```

```r
p3 <- ggplot(df_top, aes(x = reorder(Labeler_Clean, Labeler_Clean, function(x) length(x)),
                         fill = Status)) +
  geom_bar(stat = "count", alpha = 0.8) +
  coord_flip() +
  labs(title = "Product Count by Top Pharmaceutical Companies",
       subtitle = "Leading companies by number of products in the database",
       x = "Pharmaceutical Company",
       y = "Number of Products",
       fill = "Registration Status",
       caption = "Top 8 companies by product count") +
  scale_fill_manual(values = c("NR" = "#E74C3C", "R" = "#27AE60"),
                    labels = c("NR" = "Non-Registered", "R" = "Registered")) +
  theme_minimal() +
  theme(plot.title = element_text(hjust = 0.5, size = 14, face = "bold"),
        plot.subtitle = element_text(hjust = 0.5, size = 12),
        axis.text.y = element_text(size = 9))

print(p3)
```



```r
# Graph 4: Quarterly Registration Timeline
quarterly_summary <- df %>%
  group_by(Date, Status) %>%
  summarise(count = n(), .groups = 'drop')

p4 <- ggplot(quarterly_summary, aes(x = Date, y = count, fill = Status)) +
  geom_col(position = "stack", alpha = 0.8, width = 50) +
  geom_text(aes(label = count), position = position_stack(vjust = 0.5),
            color = "white", size = 4, fontface = "bold") +
  labs(title = "Pharmaceutical Product Registration Timeline",
       subtitle = "Quarterly distribution of registered vs non-registered products in 2013",
       x = "Quarter",
       y = "Number of Products",
       fill = "Registration Status",
       caption = "Data shows Q1 and Q4 of 2013") +
  scale_fill_manual(values = c("NR" = "#E74C3C", "R" = "#27AE60"),
                    labels = c("NR" = "Non-Registered", "R" = "Registered")) +
  scale_x_date(date_labels = "%Y Q%q", date_breaks = "3 months") +
  theme_minimal() +
  theme(plot.title = element_text(hjust = 0.5, size = 14, face = "bold"),
        plot.subtitle = element_text(hjust = 0.5, size = 12),
        axis.text.x = element_text(angle = 45, hjust = 1))

print(p4)
```


Pharmaceutical Product Registration Timeline
rterly distribution of registered vs non−registered products in 2013
Number of Products
Quarter
Registration Status
🟥 Non−Registered
🟩 Registered
Data shows Q1 and Q4 of 2013