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1 introduction

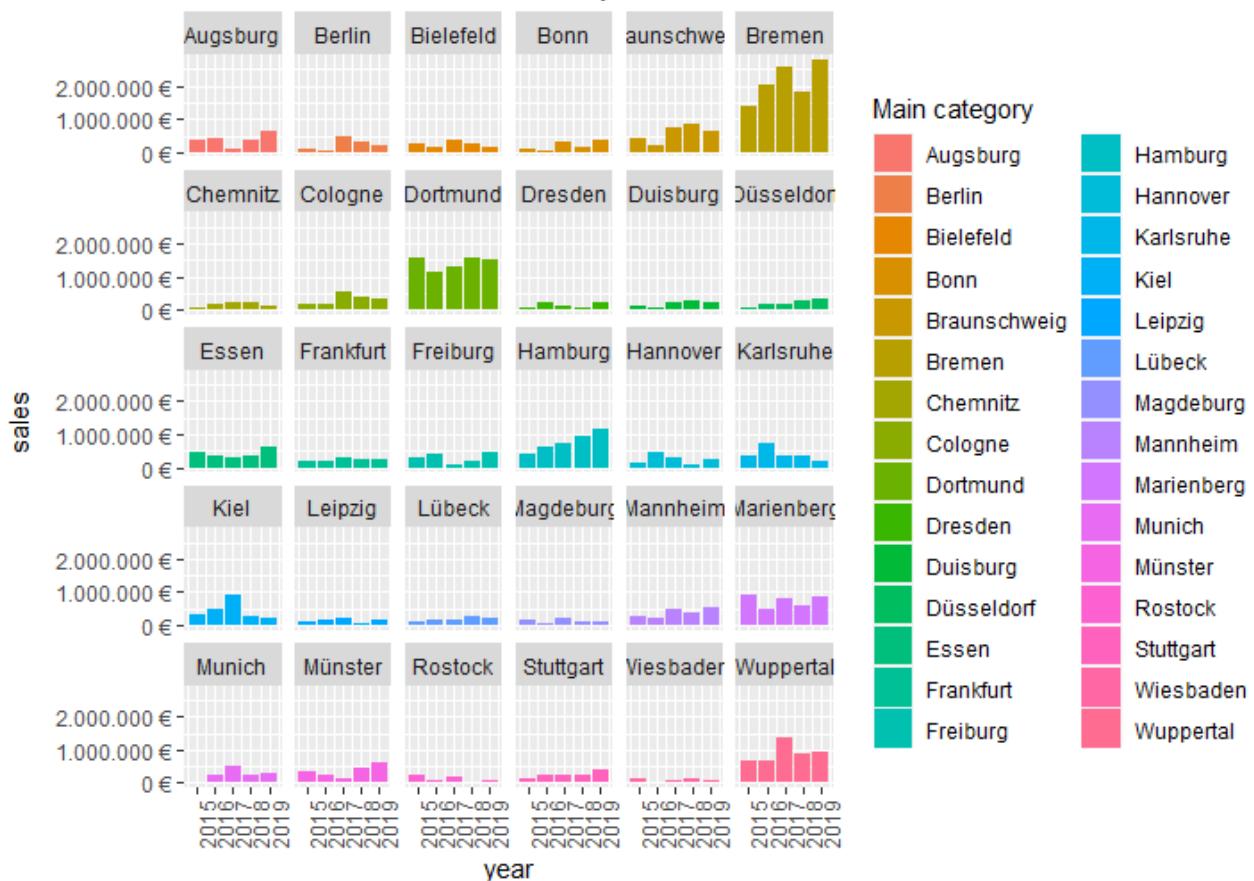
This is the Lab Journal for Business Data Science Basics 2020. In the following chapters 4 challenges were to solve. The chapters are composed of a bit of description, the figures built by the code, some example tibbles to keep track with the developing code and the codes themselves.

2 First Assignment: Bike Sales at different cities in germany

The assignment was to configure a given Dataset to analyze bike sales in germany. The dataset has been reorganized to be plotable such that the used data sets are the City of interest and the total bike sales in that specific city from 2015 to 2019. The result is given in the figure below. Especially Dortmund, Bremen and Wuppertal had a large amount of Bike sales from 2015 to 2019.

Revenue by year and cities

The Trends in different cities are very different



Revenue by year and state

The Trends in different states with North-Rhine-Westphalia leading ahead of Bremen



The result of the question which state has the highest revenue is: North-Rhine _Wesphalia.

```

# Data Science at TUHH -----
# SALES ANALYSIS ----

# 1.0 Load Libraries ----
library("tidyverse");
library("readxl");
library("lubridate")
library("writexl")

# 2.0 Importing Files ----
bike_data<-read_excel("00_Data/01_bike_sales/01_raw_data/bikes.xlsx");
shop_data<-read_excel("00_Data/01_bike_sales/01_raw_data/bikeshops.xlsx");
order_data<-read_excel("00_Data/01_bike_sales/01_raw_data/orderlines.xlsx");

# 3.0 Examining Data ----
#order_data

# 4.0 Joining Data ----
glimpse(order_data)
whole_data<-left_join(order_data,bike_data,by =c("product.id"="bike.id"));
whole_data<-left_join(whole_data,shop_data,by =c("customer.id"="bikeshop.id"));

# 5.0 Wrangling Data ----%
whole_data <-whole_data %>%
  mutate(total.price=price*quantity)%>%
  select(order.id, contains("order"), contains("model"), contains("category"), price, quantity, total.price, everything())%>%
  separate(col="category", into=c("C1", "C2", "C3"), sep = " - ")%>%
  separate(col="location", into=c("City","State"),sep =", ")

whole_data<-whole_data%>%select(-...1,-gender,-url) %>%
  rename(bikeshop = name) %>%
  set_names(names(.) %>% str_replace_all("\\.", "_"))
glimpse(whole_data)

# 6.0 Business Insights ----
#rearrange data
#goal -> have the data plottable

sb_year<-whole_data %>%
  select(order_date,total_price);

# 6.1 Sales by Year ----

# Step 1 - Manipulate
sb_year<-sb_year %>% mutate(year=year(order_date))%>%

```

```
select(-order_date)%>%  
group_by(year)%>%  
summarize(sales=sum(total_price))%>%  
mutate(sales_text = scales::dollar(sales, big.mark = ".,",  
                                    decimal.mark = ",",  
                                    prefix = "",  
                                    suffix = " €"));  
# Step 2 - Visualize
```

```
# 6.2 Sales by Year and Category 2 ----
```

```
sb_cat<-whole_data %>%  
  select(C1,total_price,order_date);
```

```
# Step 1 - Manipulate
```

```
sb_cat<-sb_cat%>%  
  mutate(year=year(order_date))%>%  
  select(-order_date)%>%
```

```
group_by(year,C1)%>%  
summarize(sales=sum(total_price))%>%  
ungroup()%>%  
mutate(sales_text = scales::dollar(sales, big.mark = ".,",  
                                    decimal.mark = ",",  
                                    prefix = "",  
                                    suffix = " €"));
```

```
# 6.3 Challenge Assignment Cities and States ----
```

```
sales_by_Cities<-whole_data %>%  
  select(City,total_price,State,order_date)%>%  
  mutate(year=year(order_date))%>%  
  select(-order_date)%>%  
  group_by(City,State,year)%>%  
  summarize(sales=sum(total_price))%>%  
  ungroup()%>%  
  mutate(sales_text = scales::dollar(sales, big.mark = ".,",  
                                    decimal.mark = ",",  
                                    prefix = "",  
                                    suffix = " €"));
```

```
sales_by_State<-whole_data%>%  
  select(total_price,State,order_date)%>%  
  mutate(year=year(order_date))%>%  
  select(-order_date)%>%
```

```
group_by(State,year)%>%  
  summarize(sales=sum(total_price))%>%  
  ungroup()%>%  
  mutate(sales_text = scales::dollar(sales, big.mark = ".",  
                                     decimal.mark = ",",  
                                     prefix = "",  
                                     suffix = " €"));  
  
# Step 2 - Visualize  
  
# Visualize the challenge task ----  
  
sales_by_Cities %>%  
  
  # Set up x, y, fill  
  ggplot(aes(x = year, y = sales, fill = City)) +  
    theme(axis.text.x = element_text(angle = 90, hjust = 1)) +  
    # Geometries  
    geom_col() + # Run up to here to get a stacked bar plot  
  
  # Facet  
  facet_wrap(~ City) +  
  
  # Formatting  
  scale_y_continuous(labels = scales::dollar_format(big.mark = ".",  
                                                    decimal.mark = ",",  
                                                    prefix = "",  
                                                    suffix = " €")) +  
  
  labs(  
    title = "Revenue by year and cities",  
    subtitle = "The Trends in different cities are very different",  
    fill = "Main category" # Changes the legend name  
  )  
  
# Visualize the challenge task ----  
  
sales_by_State %>%
```

```

# Set up x, y, fill
ggplot(aes(x = year, y = sales, fill = State)) +
  theme(axis.text.x = element_text(angle = 90, hjust = 1)) +
  # Geometries
  geom_col() + # Run up to here to get a stacked bar plot

# Facet
facet_wrap(~ State) +

# Formatting
scale_y_continuous(labels = scales::dollar_format(big.mark = ".",
                                                   decimal.mark = ",",
                                                   prefix = "",
                                                   suffix = " €")) +

labs(
  title = "Revenue by year and state",
  subtitle = "The Trends in different states with North-Rhine-Westphalia leading ahead of Bremen",
  fill = "Main category" # Changes the legend name

)

# 7.0 Writing Files ----

# 7.1 Excel ----
sb_year %>%
  write_xlsx("00_data/01_bike_sales/02_wrangled_data/sales_by_year.xlsx")
sb_cat %>%
  write_xlsx("00_data/01_bike_sales/02_wrangled_data/sales_by_year_and_Category_1.xlsx")

# 7.2 CSV ----
sb_year %>%
  write_csv("00_data/01_bike_sales/02_wrangled_data/sales_by_year.csv")
sb_cat %>%
  write_csv("00_data/01_bike_sales/02_wrangled_data/sales_by_year_and_Category_1.csv")

# 7.3 RDS ----
sb_year %>%
  write_rds("00_data/01_bike_sales/02_wrangled_data/sales_by_year.rds")
sb_cat %>%
  write_rds("00_data/01_bike_sales/02_wrangled_data/sales_by_year_and_Category_1.rds")

```

2.1 Second level header

You can add more headers by adding more hashtags. These won't be put into the table of contents

2.1.1 third level header

Here's an even lower level header

3 Data Acquisition

The Data Acquisition chapters topic is web scraping. This can be useful if the acquisition of huge data sets for competitor data is needed. R is able to communicate with html and css scripts of which websites are composed. The exercise was conducted to learn a bit about html, css and the corresponding routines in R. As the challenge, some data should be scraped from another website. This is done with the Rosebikes website. The results are shown in the following.

```
test<-readRDS("00_Data/01_bike_challenge/bikes_tbl.rds")%>%head(10)
test
```

```
## # A tibble: 10 × 6
##   position subdirectory category class_url      value     price
##       <int> <chr>        <chr>    <glue>      <chr>    <chr>
## 1          1 GROUND CONTROL mtb https://www.roseb~ /fahrräder/mtb~ "1.699,0~
## 2          2 ROOT MILLER   mtb https://www.roseb~ /fahrräder/mtb~ "1.999,0~
## 3          3 PIKES PEAK    mtb https://www.roseb~ /fahrräder/mtb~ "3.099,0~
## 4          4 THE BRUCE    mtb https://www.roseb~ /fahrräder/mtb~ "\n"
## 5          5 COUNT SOLO    mtb https://www.roseb~ /fahrräder/mtb~ "\n"
## 6          6 PSYCHO PATH   mtb https://www.roseb~ /fahrräder/mtb~ "\n ab 1~"
## 7          7 THRILL HILL   mtb https://www.roseb~ /fahrräder/mtb~ "2.599,0~
## 8          8 THRILL HILL T~ mtb https://www.roseb~ <NA>      <NA>
## 9          9 SOUL FIRE     mtb https://www.roseb~ /fahrräder/mtb~ "2.149,0~
## 10         1 PRO SL DISC   rennrad https://www.roseb~ /fahrräder/ren~ "1.599,0~
```

There has been a data tibble derived from the “rosebikes.de” website of which 10 rows can be seen above. Using the Data connected here, further investigations could be possible.

The code written for this purpose is given here:

```

# Data Science at TUHH -----
# SALES ANALYSIS ----

bikeclasses_tbl<-function(url,integer,family,family_id_url){

  bike_name_tbl <- url %>%
    read_html()%>%
    html_nodes(css = ".catalog-category-bikes__title-text") %>%

    html_text() %>%
    str_remove(pattern = "\n") %>%
    str_remove(pattern = "\n") %>%
    # Convert vector to tibble
    enframe(name = "position", value = "subcategory") %>%
    mutate(category = family[integer])%>%
    mutate(class_url = family_id_url[integer])

}

# 1.0 Load Libraries ----
library("tidyverse")
library("readxl")
library("lubridate")
library("writexl")
library("RSQLite")
library("DBI")
library("httr")
library("glue")
library("jsonlite")
library("rvest")
library("purrr")
library("xopen")
library("stringi")

#gotten canyon url stuff and ready for analysis

# 1.1 COLLECT PRODUCT FAMILIES ----

url_home           <- "https://www.rosebikes.de/fahrräder"
#xopen(url_home) # Open Links directly from RStudio to inspect them

# Read in the HTML for the entire webpage
html_home          <- read_html(url_home)

# Web scrape the ids for the families
bike_family_tbl <- html_home %>%
  # Get the nodes for the families ...

```

```

html_nodes(css = ".catalog-navigation__link") %>%
# ...and extract the information of the id attribute
html_attr('href') %>%

discard(.p = ~stringr::str_detect(.x,"Sale|Finder|Kinder")) %>%

# Convert vector to tibble
enframe(name = "position", value = "family_class")%>%

# build individual urls for each category page
mutate(
  family_url = str_glue("https://www.rosebikes.de{family_class}")
)

bike_family_tbl

# 1.2 COLLECT PRODUCT CATEGORIES ----

# Combine all Ids to one string so that we will get all nodes at once
# (seperated by the OR operator ", ")
family_id_url <- bike_family_tbl %>%
  pull(family_url)

bike_family<-bike_family_tbl%>%
  pull(family_url)%>%
  str_remove(pattern = "https://www.rosebikes.de/fahrräder/")

family_id_url
url<-family_id_url[1]

bikes_tbl<-bikeclasses_tbl(family_id_url[1],1,bike_family,family_id_url)
for(i in 2:12){

  add<-bikeclasses_tbl(family_id_url[i],i,bike_family,family_id_url)
  bikes_tbl<-add_row(bikes_tbl,add)

}

#=====
#versuch mit mutate eine weitere Spalte zu bikes_tbl hinzuzufügen
for(i in 1:nrow(bike_family_tbl)){
  add<-family_id_url[i]%>%
    read_html()%>%
    html_nodes(css = ".catalog-category-bikes__content > a") %>%
    html_attr("href") %>%
    as_tibble()%>%
    mutate(Name= family_id_url[i])%>%
    read_html()%>%
    html_nodes(css = ".catalog-category-bikes__title-text") %>%
    html_text() %>%
    str_remove(pattern = "\n") %>%
    str_remove(pattern = "\n")

} %>%

```

```
mutate(price=family_id_url[i] %>%
  read_html() %>%
  html_nodes(css = ".catalog-category-bikes__price-title") %>%
  html_text() %>%
  str_remove(pattern = "\nab ")

)

if (i==1) {
  misc_bikedata<-add
} else {
  misc_bikedata<-add_row(misc_bikedata,add)
}

bikes_tbl<-left_join(bikes_tbl,misc_bikedata,by=c("subdirectory"="Name"))

bikes_tbl %>%
  write_rds("00_Data/01_bike_challenge/bikes_tbl.rds")
```

4 Data Wrangling

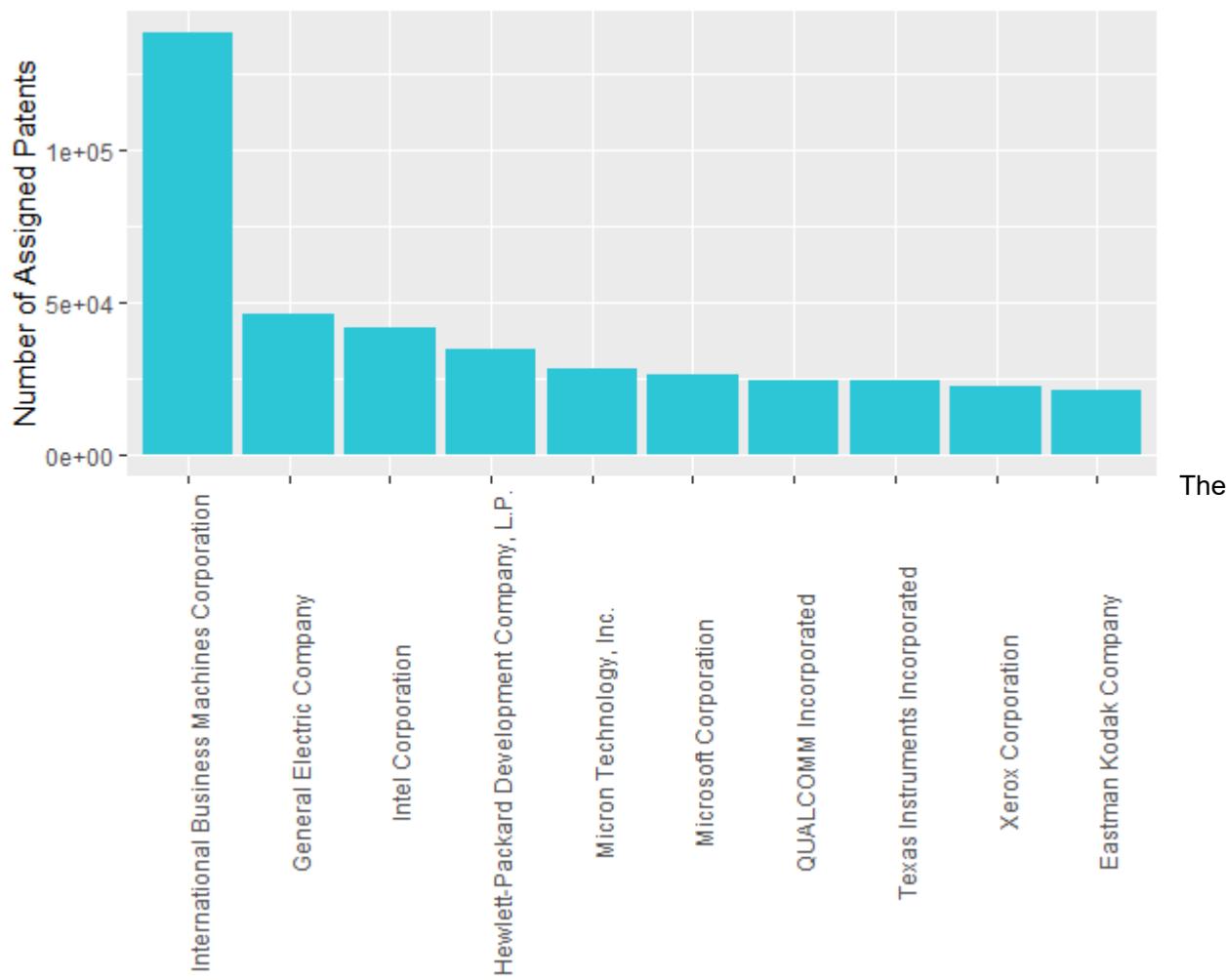
Last compiled: 2020-12-05

In the Third challenge, patents of various companies should be analyzed.

4.1 Companies with the most patent activities in the US

The task is to find the ten Companies in the US who have the highest number of assigned patents. This is done using the “assignee” and “patent_assignee” datasets provided by the institute. After a bit of data rearrangement, the following chart could be isolated

Number of Patents for different US Companies



10 most effective companies in terms of patent assignment are listed on the ordinate. The most dominant company in the US when it comes to patents is the International Business Machines Corporation

The code to this graph is the following.

```
library(vroom)
library(tidyverse)
library(data.table)

'col_types <- list(
  id = col_integer(),
  type = col_character(),
  number = col_integer(),
  country = col_character(),
  date = col_date("%Y-%m-%d"),
  abstract = col_character(),
  title = col_character(),
  kind = col_character(),
  num_claims = col_double(),
  filename = col_character(),
  withdrawn = col_character()
)
patent_tbl <- vroom(
  file      = "00_Data/03_patents/patent.tsv",
  delim    = "\t",
  col_types = col_types,
  na        = c("", "NA", "NULL")
)
#glimpse(patent_tbl)

col_types <- list(
  patent_id = col_integer(),
  assignee_id = col_character(),
  location_id = col_character()
)

patent_assignee_tbl <- vroom(
  file      = "00_Data/03_patents/patent_assignee.tsv",
  delim    = "\t",
  col_types = col_types,
  na        = c("", "NA", "NULL")
)
col_types <- list(
  id = col_character(),
  type = col_integer(),
  name_first = col_character(),
  name_last = col_character(),
  organization = col_character()
)
assignee_tbl <- vroom(
  file      = "00_Data/03_patents/assignee.tsv",
  delim    = "\t",
  col_types = col_types,
```

```

na          = c("", "NA", "NULL")
)

'col_types <- list(
  uuid = col_character(),
  patent_id = integer(),
  mainclass_id = col_integer(),
  subclass_id = col_character(),
  sequence = col_integer()
)

uspc_tbl <- vroom(
  file      = "00_Data/03_patents/uspc.tsv",
  delim    = "\t",
  col_types = col_types,
  na        = c("", "NA", "NULL")
)
glimpse(patent_assignee_tbl)
glimpse(assignee_tbl)
#1. Which US Company has the most Patents
#join data
wrangleed<-left_join(patent_assignee_tbl,assignee_tbl,by = c("assignee_id"="id"))
#only patents od US Companies shall be counted e.g. the type has to be exactly 2

wrangleed<-wrangleed%>%
  filter(type == 2)%>%
  select(organization, patent_id, everything())%>%
  select(-name_first, -name_last, -location_id, -assignee_id)%>%
  arrange(desc(organization))

Patentnumber<-wrangleed%>%
  filter(!is.na(patent_id))%>%
  count(organization)%>%
  arrange(desc(n))

head(Patentnumber,10)

Picture_table<-Patentnumber%>%
  slice(1:10)
## Visualize

Picture_table %>%

# Setup canvas with the columns year (x-axis) and sales (y-axis)
ggplot(aes(x = reorder(organization,-n),n, y = n)) +
  theme(axis.text.x = element_text(angle = 90))+

# Geometries
  geom_col(fill = "#2DC6D6") + # Use geom_col for a bar plot

# Formatting

```

```
# scale_y_continuous(labels = scales::dollar) + # Change the y-axis.
# Again, we have to adjust it for euro values
labs(
  title    = "Number of Patents for different US Companies",
  x       = "", # Override defaults for x and y
  y       = "Number of Assigned Patents"
)
```

4.2 Companies with the most granted patents in 2019

In assignment 3.2 the top ten companies with granted patents for 2019 were searched. For this task the information “withdrawn” in the patents.tsv dataset was the most important. Also as the patents which weren't granted in 2019 were subtracted the top ten was distributed differently than the query from before.

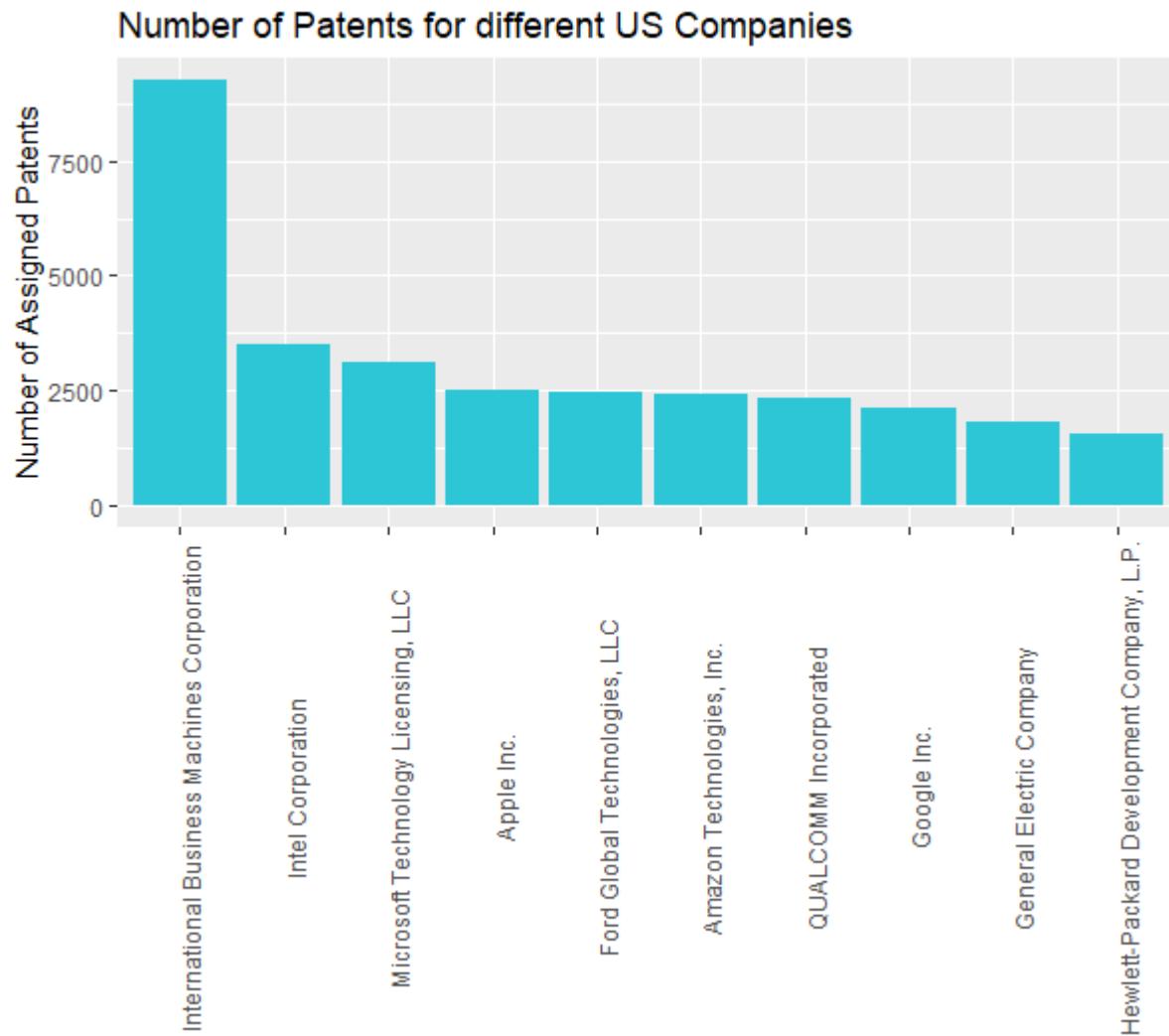


Figure: Sales for different Cities

The 10 companies which are listed in the Figure above are also listed in the tibble which created the figure which is parsed below

```
tibble<-readRDS("00_Data/03_wrangle_challenge/3_2_corporations.rds")%>%head(10)  
tibble
```

```
## # A tibble: 10 x 2  
##   organization                n  
##   <chr>                      <int>  
## 1 International Business Machines Corporation  9260  
## 2 Intel Corporation            3496  
## 3 Microsoft Technology Licensing, LLC       3104  
## 4 Apple Inc.                  2499  
## 5 Ford Global Technologies, LLC      2468  
## 6 Amazon Technologies, Inc.        2433  
## 7 QUALCOMM Incorporated          2358  
## 8 Google Inc.                 2112  
## 9 General Electric Company      1815  
## 10 Hewlett-Packard Development Company, L.P. 1558
```

The used code is given here:

```
#librarys

library(vroom)
library(tidyverse)
library(data.table)

col_types <- list(
  id = col_integer(),
  type = col_skip(),
  number = col_integer(),
  country = col_character(),
  date = col_date("%Y-%m-%d"),
  abstract = col_skip(),
  title = col_skip(),
  kind = col_skip(),
  num_claims = col_double(),
  filename = col_skip(),
  withdrawn = col_character()
)

patent_tbl <- vroom(
  file      = "00_Data/03_patents/patent.tsv",
  delim    = "\t",
  col_types = col_types,
  na        = c("", "NA", "NULL")
)

#glimpse(patent_tbl)

col_types <- list(
  patent_id = col_integer(),
  assignee_id = col_character(),
  location_id = col_character()
)

patent_assignee_tbl <- vroom(
  file      = "00_Data/03_patents/patent_assignee.tsv",
  delim    = "\t",
  col_types = col_types,
  na        = c("", "NA", "NULL")
)

col_types <- list(
  id = col_character(),
  type = col_integer(),
  name_first = col_skip(),
  name_last = col_skip(),
  organization = col_character()
)

assignee_tbl <- vroom(
```

```

file      = "00_Data/03_patents/assignee.tsv",
delim    = "\t",
col_types = col_types,
na        = c("", "NA", "NULL")
)

'col_types <- list(
  uuid = col_character(),
  patent_id = integer(),
  mainclass_id = col_integer(),
  subclass_id = col_character(),
  sequence = col_integer()
)

uspc_tbl <- vroom(
  file      = "00_Data/03_patents/uspc.tsv",
  delim    = "\t",
  col_types = col_types,
  na        = c("", "NA", "NULL")
)'

glimpse(patent_assignee_tbl)
glimpse(assignee_tbl)
#1. Which US Company has the most Patents
#aufbereitung der Daten

patent_tbl<-patent_tbl%>%
  filter(country == "US")%>%
  filter(!is.na(id))%>%
  mutate(year=year(date))%>%
  filter(year==2019)

assignee_tbl<-assignee_tbl%>%
  filter(type==2)

data<-left_join(patent_assignee_tbl,assignee_tbl,by=c("assignee_id"="id"))
data<-left_join(data,patent_tbl,by=c("patent_id"="id"))
data<-data%>%
  filter((!is.na(year))&!is.na(organization))

res<-data%>%
  count(organization)%>%
  arrange(desc(n))%>%
  slice(1:10)

## Visualize

res %>%

# Setup canvas with the columns year (x-axis) and sales (y-axis)
ggplot(aes(x = reorder(organization,-n),n, y = n)) +
  theme(axis.text.x = element_text(angle = 90))+

# Geometries
  geom_col(fill = "#2DC6D6") + # Use geom_col for a bar plot

```

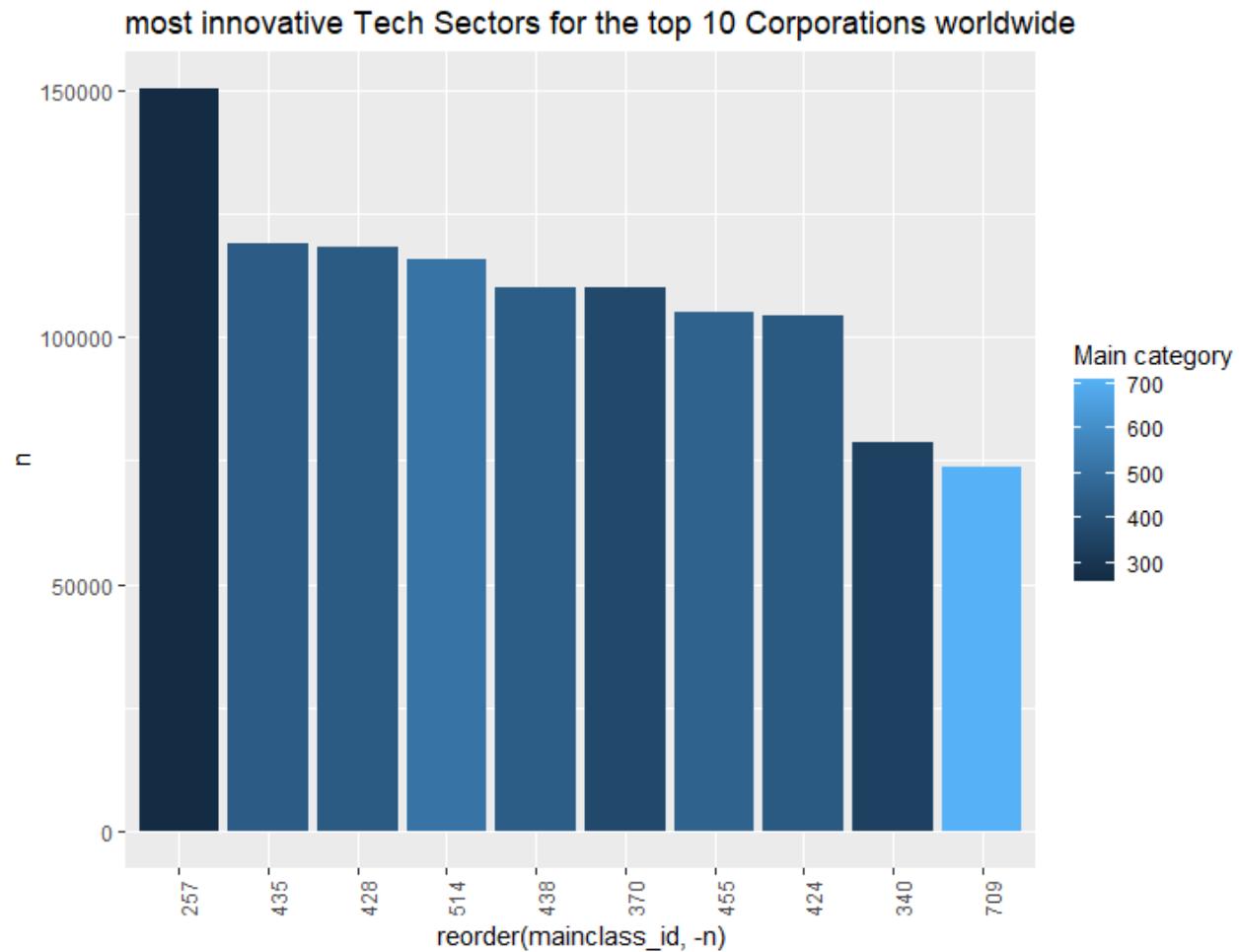
```
# Formatting
# scale_y_continuous(labels = scales::dollar) + # Change the y-axis.
# Again, we have to adjust it for euro values
labs(
  title      = "Number of Patents for different US Companies",
  x = "", # Override defaults for x and y
  y = "Number of Assigned Patents"
)
```

4.3 Assignment over usps's

in The third assignment of chapter 4 the top 5 Patent classes for the top 10 most active companies with respect to newly assigned patents had to be found. The results can be seen in the following figures. The responsible cod is displayed below.

4.3.1 Most innovative tech sectors

The most innovative tech sector is sector “257”. This can be seen in the figure below.

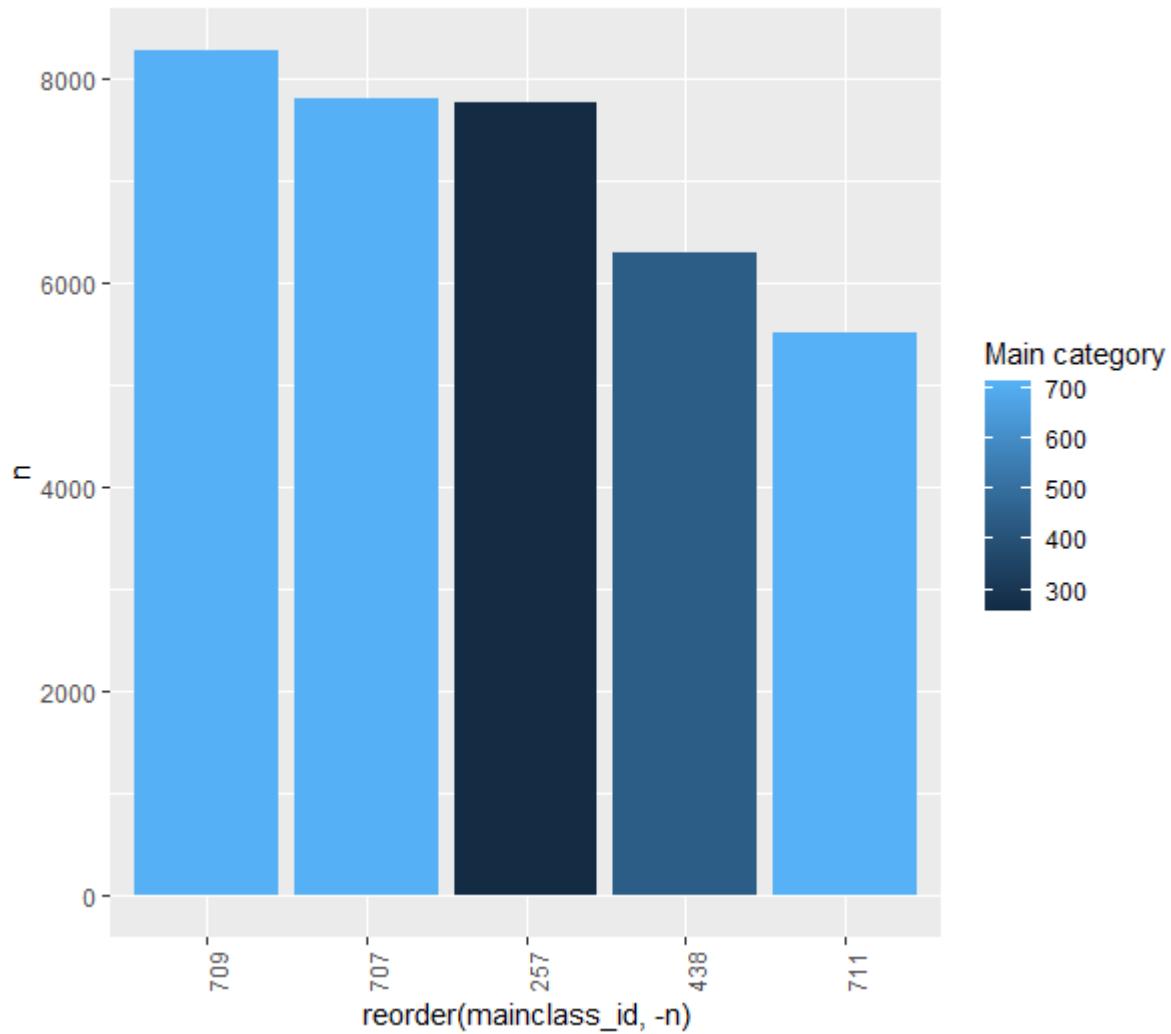


Firure: Sales for different Cities

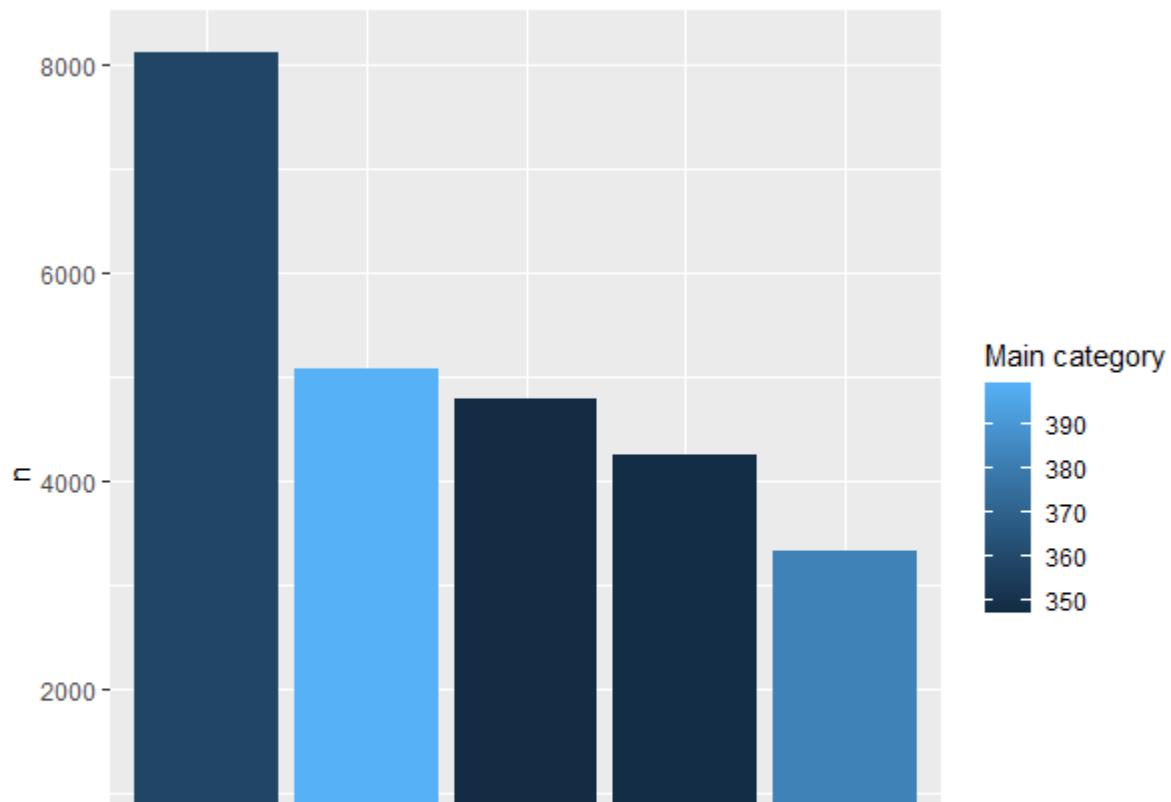
4.3.2 Most innovating tech sectors for each of the Top 10 innovative corporations worldwide

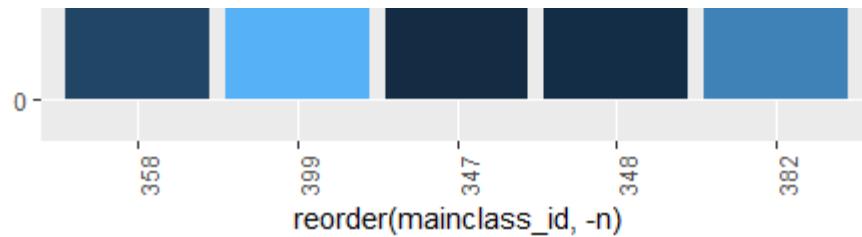
The 10 most innovative companies worldwide with their respective 5 most important tech sectors can be seen in the 10 figures below. The code is displayed underneath them. It was necessary to shorten and clean the data many times in order to be able to put them together in one tibble. The uspc data was therefore shortened rigorously after evaluating the relevant lines.

International Business Machines Corporation

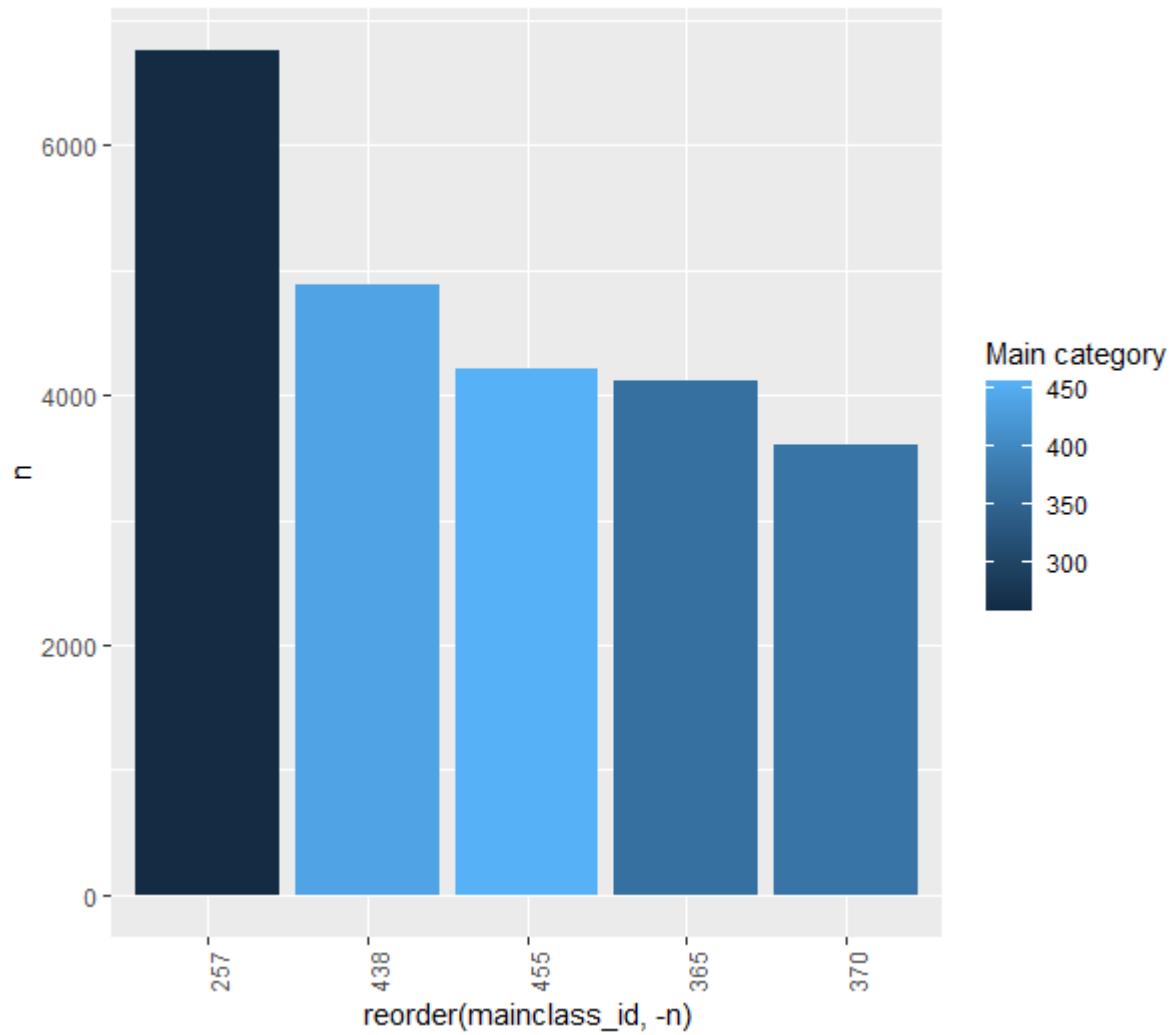


Canon Kabushiki Kaisha

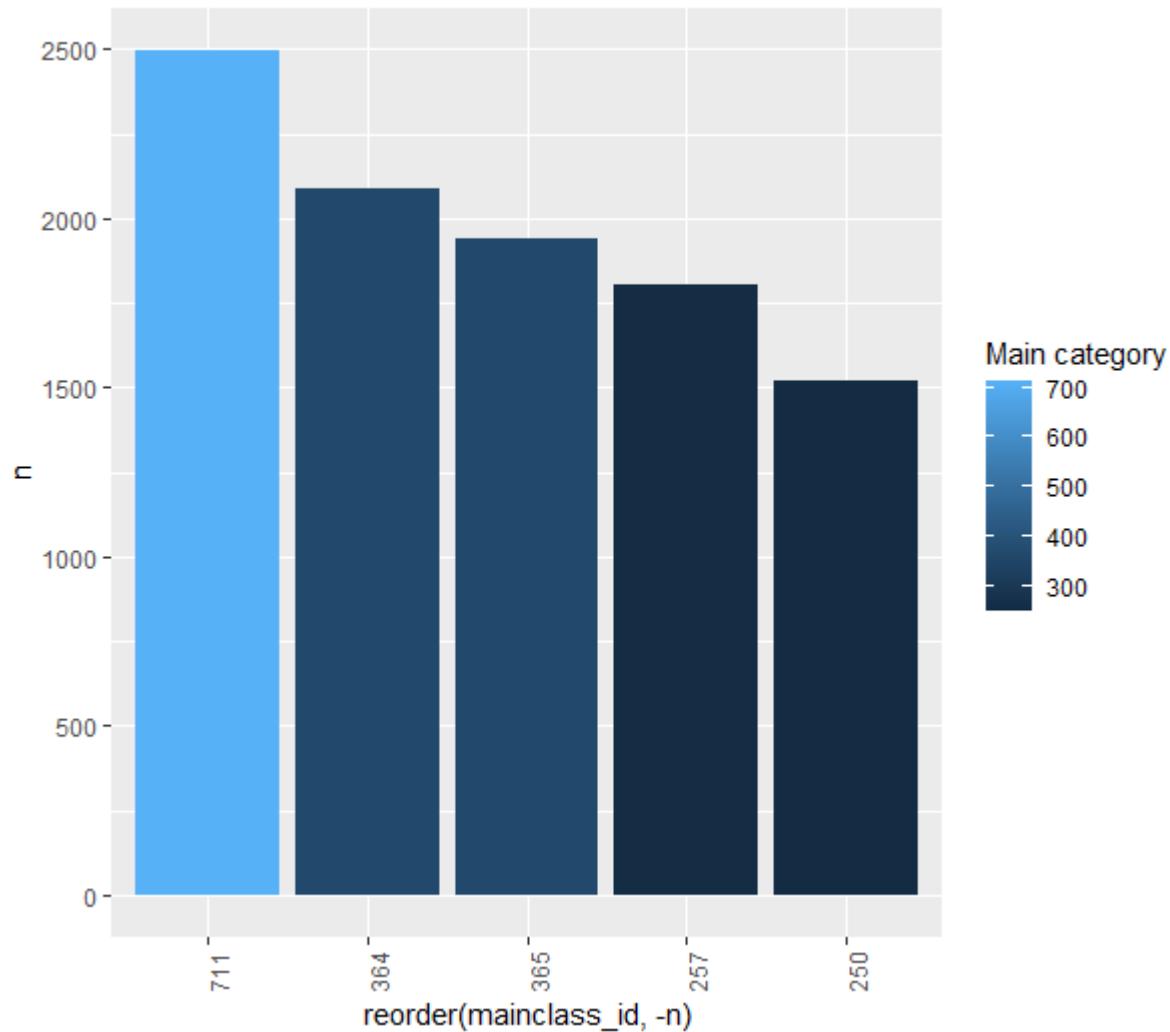




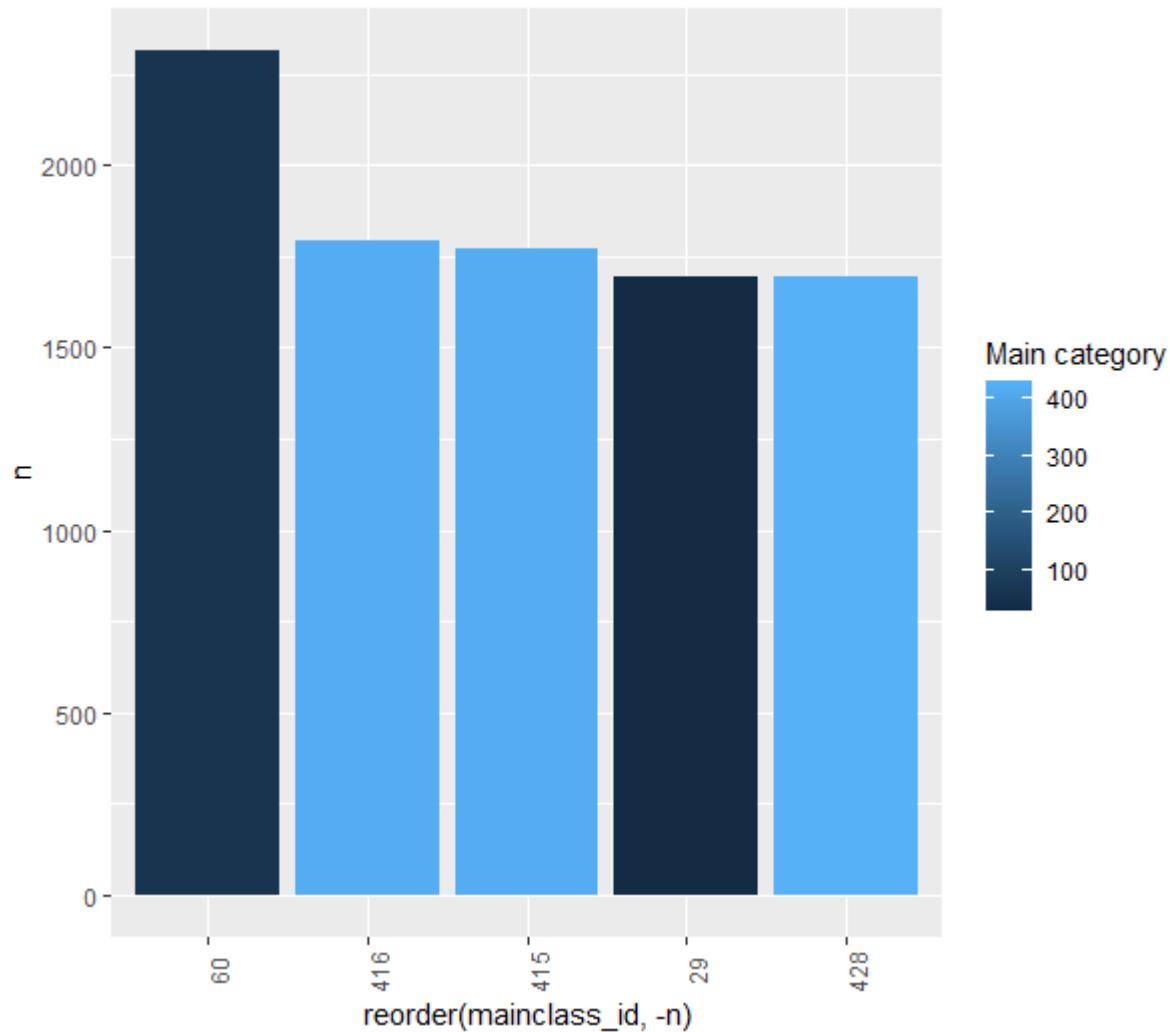
Samsung Electronics Co., Ltd.



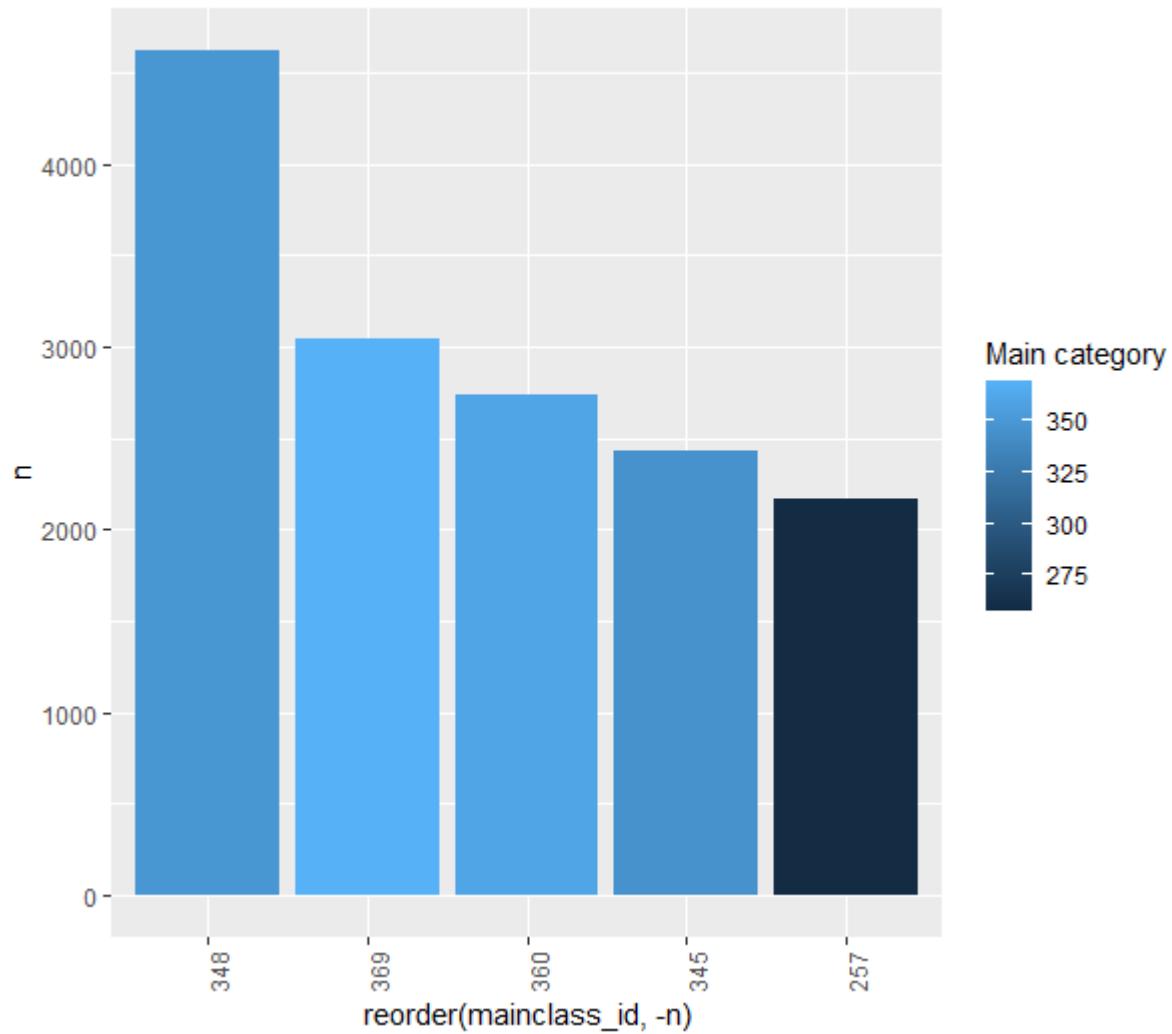
Hitachi, Ltd.



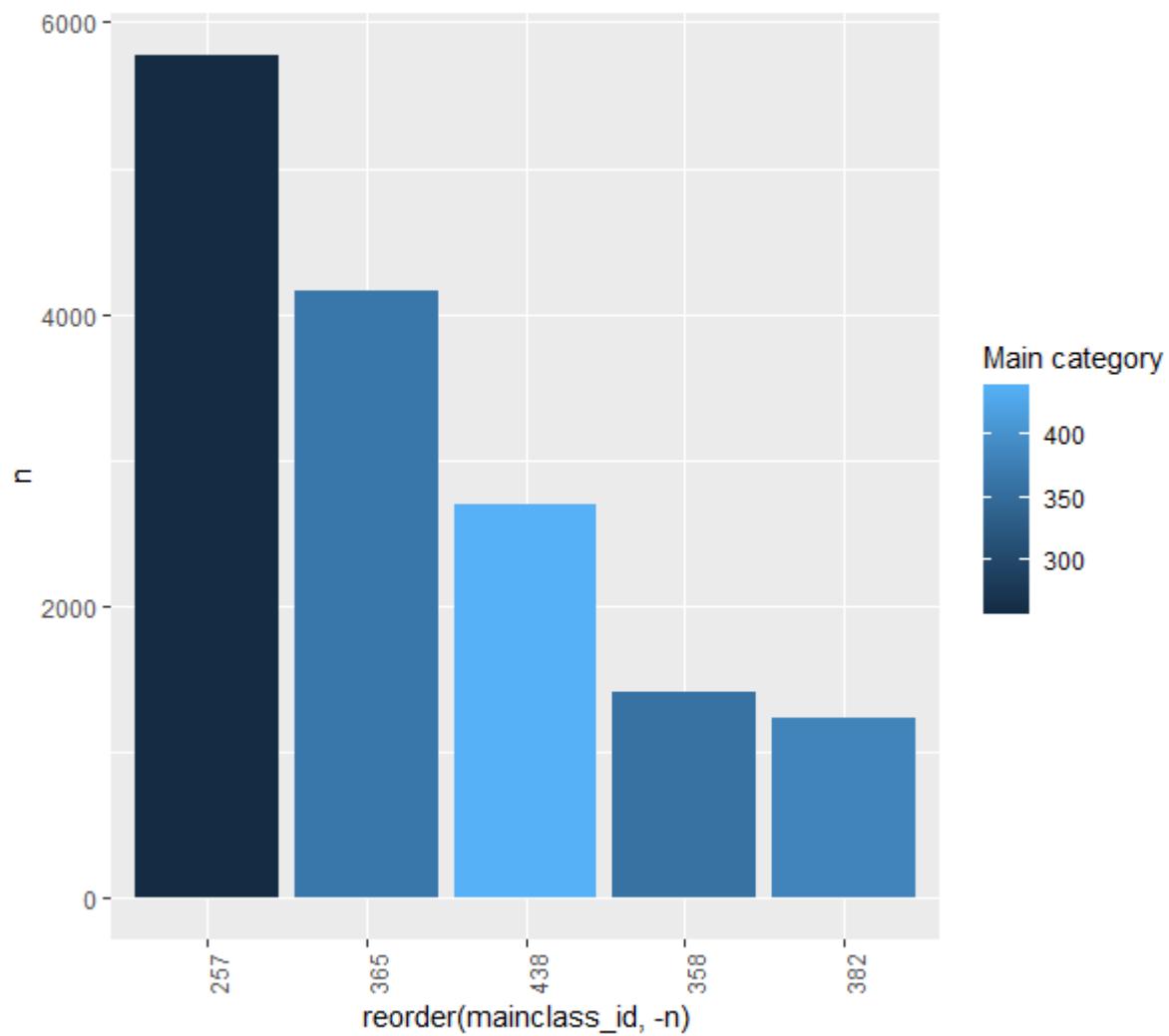
General Electric Company



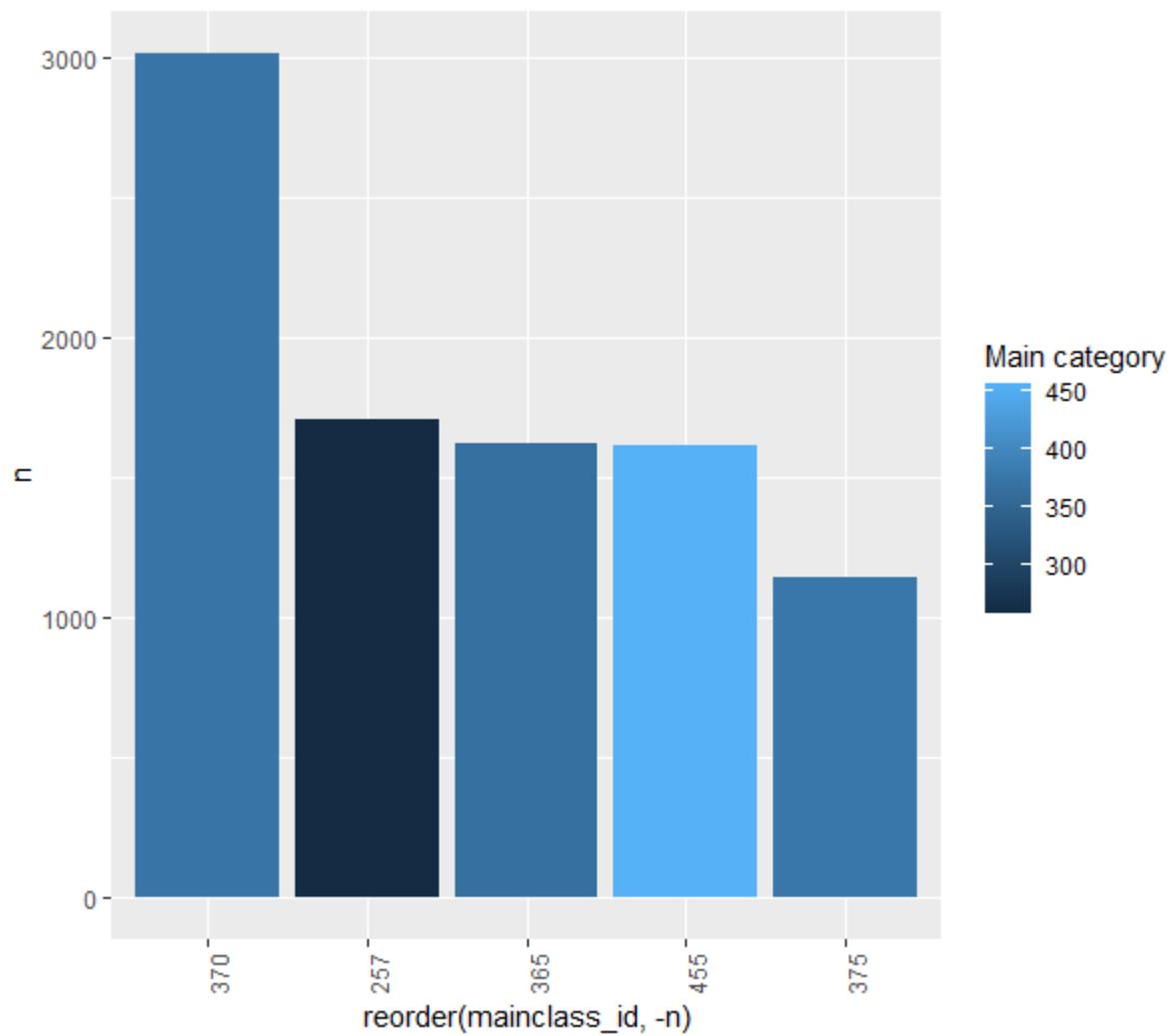
Sony Corporation



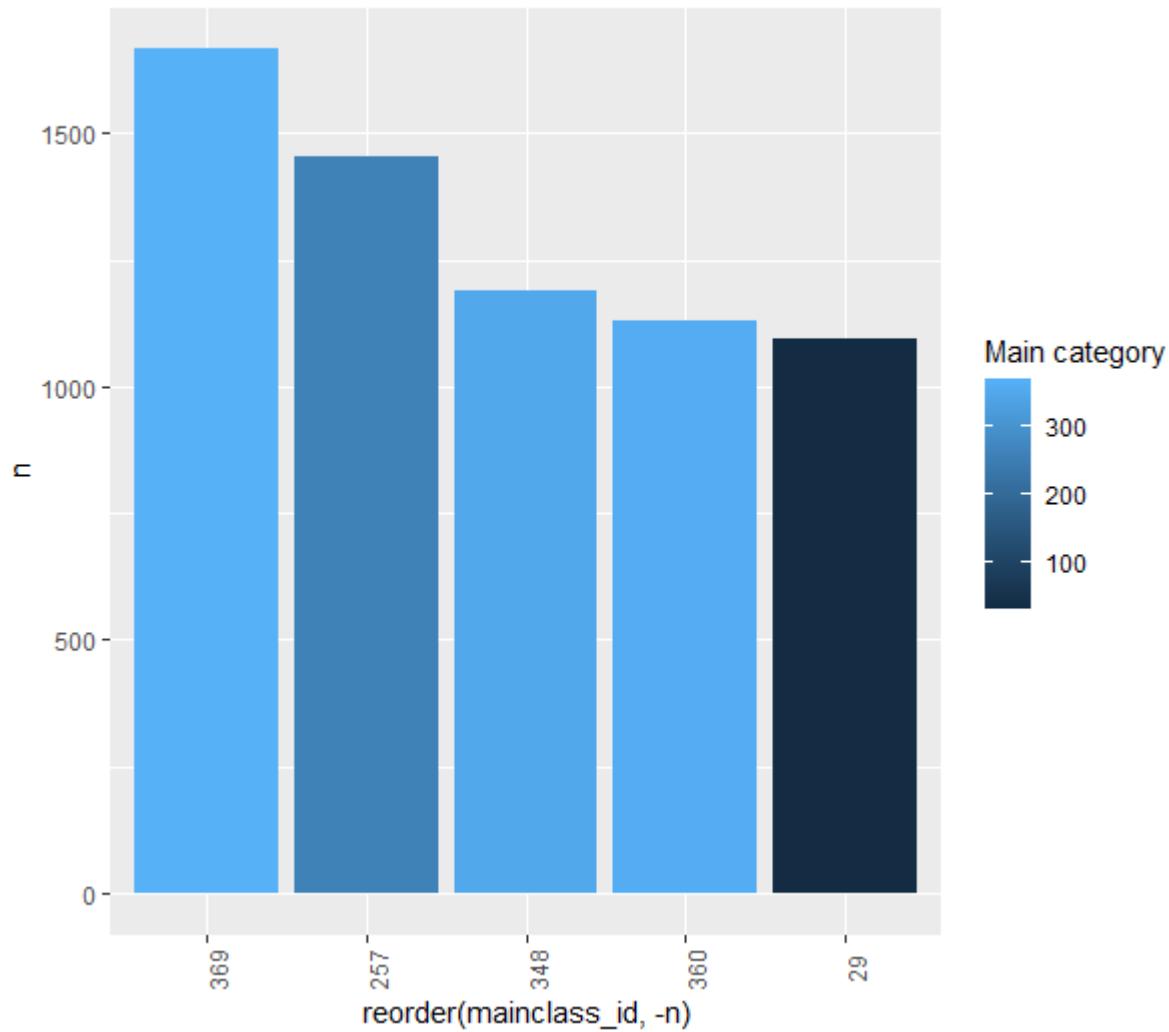
Kabushiki Kaisha Toshiba



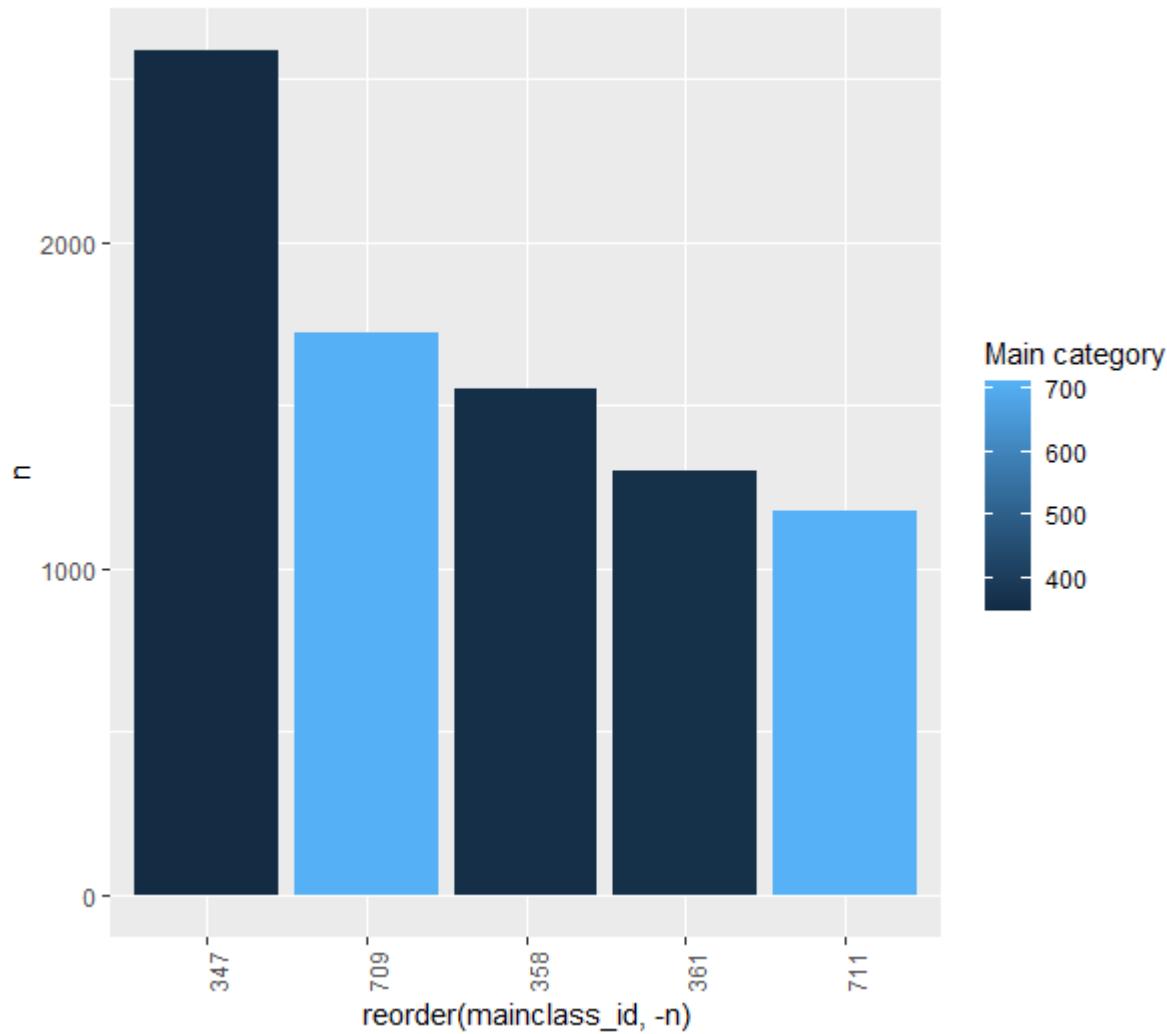
Fujitsu Limited



Matsushita Electric Industrial Co., Ltd.



Hewlett-Packard Development Company, L.P.



```

#librarys
get_patent_classes <- function(tbl,companie){

  tbl%>%
    filter(organization %in% companie)%>%
    count(mainclass_id)%>%
    arrange(desc(n))%>%
    slice(1:5)
}

build_figure <- function(list,i,j){

  as_tibble(list[c(i,i+1)]) %>%

  # Set up x, y, fill
  ggplot(aes(x = reorder(mainclass_id,-n),n, y = n, fill = mainclass_id)) +
  theme(axis.text.x = element_text(angle = 90))+

  # Geometries
  geom_col() + # Run up to here to get a stacked bar plot
  geom_smooth(method = "lm", se = FALSE) + # Adding a trendline

  # Formatting
  labs(
    title = relevant_companies[j],
    fill = "Main category" # Changes the legend name
  )
}

library(vroom)
library(tidyverse)
library(data.table)

'col_types <- list(
  id = col_integer(),
  type = col_character(),
  number = col_integer(),
  country = col_character(),
  date = col_date("%Y-%m-%d"),

```

```
abstract = col_character(),
title = col_character(),
kind = col_character(),
num_claims = col_double(),
filename = col_character(),
withdrawn = col_character()
)

patent_tbl <- vroom(
  file      = "00_Data/03_patents/patent.tsv",
  delim    = "\t",
  col_types = col_types,
  na        = c("", "NA", "NULL")
)

#glimpse(patent_tbl)

col_types <- list(
  patent_id = col_integer(),
  assignee_id = col_character(),
  location_id = col_skip()
)

patent_assignee_tbl <- vroom(
  file      = "00_Data/03_patents/patent_assignee.tsv",
  delim    = "\t",
  col_types = col_types,
  na        = c("", "NA", "NULL")
)

col_types <- list(
  id = col_character(),
  type = col_integer(),
  name_first = col_skip(),
  name_last = col_skip(),
  organization = col_character()
)

assignee_tbl <- vroom(
  file      = "00_Data/03_patents/assignee.tsv",
  delim    = "\t",
  col_types = col_types,
  na        = c("", "NA", "NULL")
)

col_types <- list(
  uuid = col_skip(),
  patent_id = col_integer(),
  mainclass_id = col_integer(),
  subclass_id = col_skip(),
  sequence = col_skip()
)

uspc_tbl <- vroom(
```

```

file      = "00_Data/03_patents/uspc.tsv",
delim    = "\t",
col_types = col_types,
na        = c("", "NA", "NULL")
)

#Cleaning the data before joining
#only companies are important, therefore everything except companies is cleaned from the assignee_tbl which would mean only type 2 and 3 are considered

#derive best 2 companies world wide

assignee_tbl<-assignee_tbl%>%
  filter((type==2)|(type==3))

relevant_patents_tbl<-left_join(assignee_tbl,patent_assignee_tbl,by=c("id"="assignee_id"))

relevant_patents_tbl<-relevant_patents_tbl%>%
  filter(!is.na(patent_id))

#get all patent ids which are relevant for this process because they are left in the relevant dataset
patent_vec<-pull(relevant_patents_tbl,patent_id)

#filter the uspc tibble to reduce its size
uspc_tbl<-uspc_tbl%>%
  filter(patent_id %in% (patent_vec))%>%
  distinct() # the patents are still saved multiple times because of the sub classes which are not necessary here. Distinct to get rid of that problem

relevant_patents_tbl<-left_join(relevant_patents_tbl,uspc_tbl,by=c("patent_id"="patent_id"))
#filter to get rid of each patent which does not have a main class ID
relevant_patents_tbl<-relevant_patents_tbl%>%
  filter((!is.na(mainclass_id))&(!is.na(organization)))

#find the most innovative tech sector
tech<-relevant_patents_tbl%>%
  count(mainclass_id)%>%
  arrange(desc(n))%>%
  slice(1:10)
#found most innovative tech sectors

#find the top ten most innovative countries worldwide
number_of_patents<- relevant_patents_tbl%>%
  group_by(organization)%>%
  summarize(
    count=n()
  )%>%

```

```
ungroup()%>%  
arrange(desc(count))%>%  
slice(1:10)  
  
relevant_companies<-pull(number_of_patents,organization)  
  
c1<-get_patent_classes(relevant_patents_tbl,relevant_companies[1])  
  
c2<-get_patent_classes(relevant_patents_tbl,relevant_companies[2])  
  
c3<-get_patent_classes(relevant_patents_tbl,relevant_companies[3])  
  
c4<-get_patent_classes(relevant_patents_tbl,relevant_companies[4])  
  
c5<-get_patent_classes(relevant_patents_tbl,relevant_companies[5])  
  
c6<-get_patent_classes(relevant_patents_tbl,relevant_companies[6])  
  
c7<-get_patent_classes(relevant_patents_tbl,relevant_companies[7])  
  
c8<-get_patent_classes(relevant_patents_tbl,relevant_companies[8])  
  
c9<-get_patent_classes(relevant_patents_tbl,relevant_companies[9])  
  
c10<-get_patent_classes(relevant_patents_tbl,relevant_companies[10])  
  
c_vec<-c(c1,c2,c3,c4,c5,c6,c7,c8,c9,c10)  
  
build_figure(c_vec,1,1)  
build_figure(c_vec,3,2)  
build_figure(c_vec,5,3)  
build_figure(c_vec,7,4)  
build_figure(c_vec,9,5)  
build_figure(c_vec,11,6)  
build_figure(c_vec,13,7)  
build_figure(c_vec,15,8)  
build_figure(c_vec,17,9)  
build_figure(c_vec,19,10)  
  
tech %>%  
  
  # Set up x, y, fill  
  ggplot(aes(x = reorder(mainclass_id,-n),n, y = n, fill = mainclass_id)) +  
    theme(axis.text.x = element_text(angle = 90))+  
  
  # Geometries  
  geom_col() + # Run up to here to get a stacked bar plot  
  geom_smooth(method = "lm", se = FALSE) + # Adding a trendline  
  
  # Formatting
```

```

  labs(
    title = "most innovative Tech Sectors for the top 10 Corporations worldwide",
    fill = "Main category" # Changes the Legend name
  )

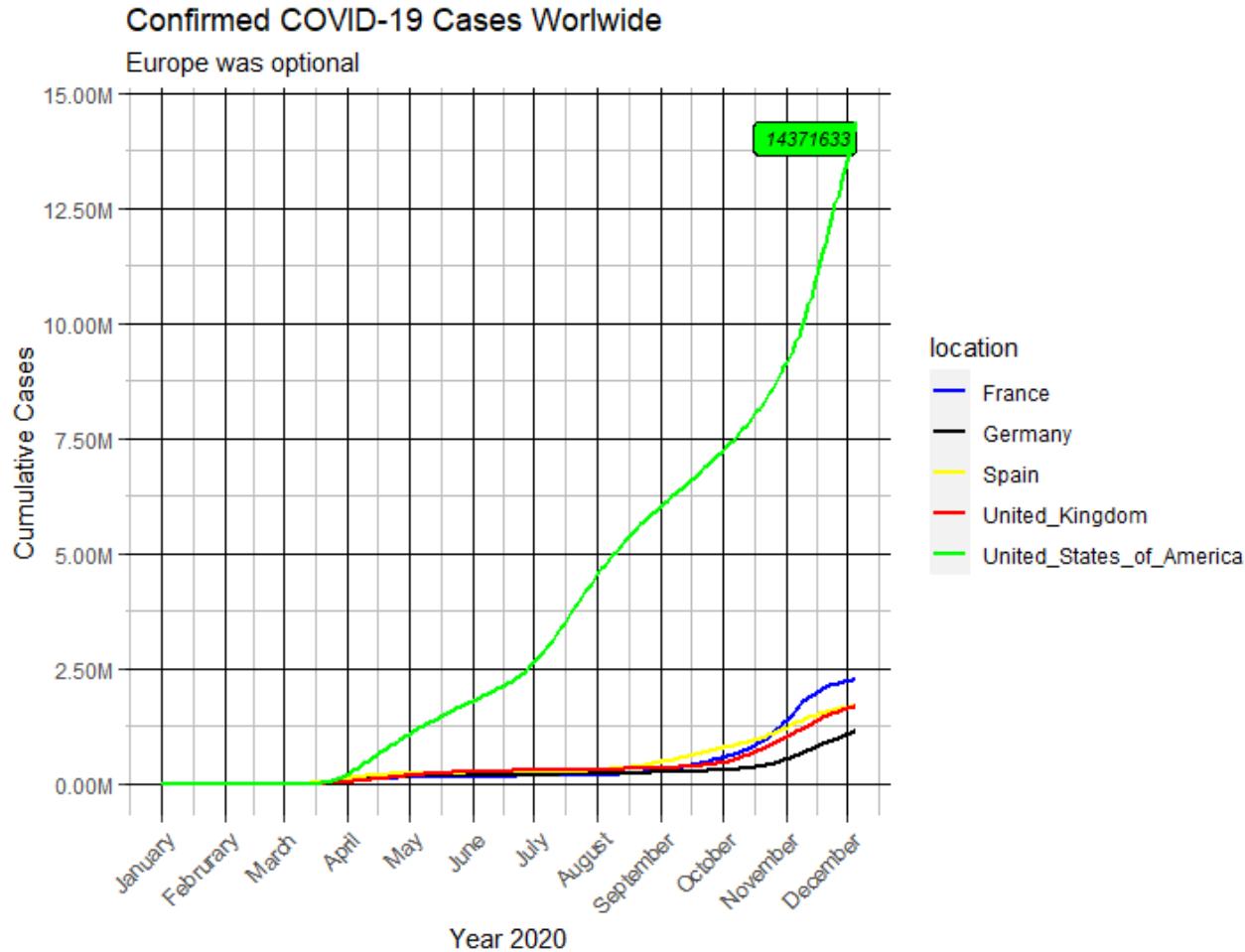
```

5 Visualization

The last chapter should teach to visualize different data sets.

5.1 Visualizing The COVID-19 Cases in 5 different countries for the year 2020

The first challenge is to visualize different cumulative COVID-19 trajectories for States. The resulting figure is displayed below. The Maximum Value of the United States of America is highlighted with a Tag.



The code to build this one is displayed here:

```

# Load Librarys
toDate <- function(year, month, day) {
  ISOdate(year, month, day)
}

toNumerics <- function(Date) {
  stopifnot(inherits(Date, c("Date", "POSIXt")))
  day <- as.numeric(strftime(Date, format = "%d"))
  month <- as.numeric(strftime(Date, format = "%m"))
  year <- as.numeric(strftime(Date, format = "%Y"))
  list(year = year, month = month, day = day)
}

library("tidyverse");
library("readxl");
library("lubridate")
library("writexl")
library("ggthemes")

#Get covid data

url <- "https://opendata.ecdc.europa.eu/covid19/casedistribution/csv"
covid_data_dt <- fread(url)%>%
  as_tibble

relevant_locations<-c("Germany","United_Kingdom","France","Spain","United_States_of_America")

covid_data_dt<-covid_data_dt%>%
  rename(location=countriesAndTerritories)%>%
  filter((location %in% relevant_locations)&(year==2020))%>%
  mutate(Report_date = toDate(year,month,day)) %>%
  select(Report_date,cases,location,month)%>%
  group_by(location)%>%
  arrange(Report_date)%>%
  mutate(cumulative_cases=cumsum(cases))%>%
  ungroup()

#Objective: Plot covid cummulative cases over time
#Objective: customize plot

dates<-covid_data_dt%>%
  pull(Report_date)%>%
  as_tibble%>%
  unique()

months<-covid_data_dt%>%
  pull(month)%>%
  as_tibble%>%
  unique()%>%
  #mutate(Date=toDate(2020,month,1))

```

```

xmin <- first(dates)
xmax <- last(dates)

#Testplot

covid_data_dt %>%
  # Put the aes color mapping here, to apply it to geom_line and geom_point
  ggplot(aes(Report_date, cumulative_cases, color = location)) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  labs(
    title = "Confirmed COVID-19 Cases Worldwide",
    subtitle = "Europe was optional",
    x = "Year 2020",
    y = "Cumulative Cases"
  ) +
  theme(
    panel.background = element_rect(fill = "transparent",
                                     colour = "transparent",
                                     size = 0.5, linetype = "solid"),
    panel.grid.major = element_line(size = 0.5, linetype = 'solid',
                                    colour = "black"),
    panel.grid.minor = element_line(size = 0.25, linetype = 'solid',
                                    colour = "grey")
  ) +
  scale_x_continuous(breaks = toDate(2020,unique(covid_data_dt$month),1),labels= c("January","February","March","April","May","June","July","August","September","October","November","December"))
  ) +
  geom_label(label = covid_data_dt%>%
    filter((location=="United_States_of_America")&(Report_date==xmax))%>%
    select(cumulative_cases)%>%
    as.numeric(),
    vjust = "inward",
    hjust = "inward",
    size = 3,
    fill = 'green',
    color = "black",
    fontface = "italic",
    data = covid_data_dt %>%
    filter((location %in% c("United_States_of_America"))&Report_date==last
(dates))) +
  # Or you could do it locally in each geom
  # (aes mapping only necessary if you map it to a column)
  geom_line(size = 1)+scale_colour_manual(values=c("blue","black","yellow","red","green")) +
  scale_y_continuous(breaks= seq(0, 15e6, by = 25e5),labels = scales::dollar_format(scale = 1/1e6,

```

```
prefix = "",  
suffix = "M"))
```

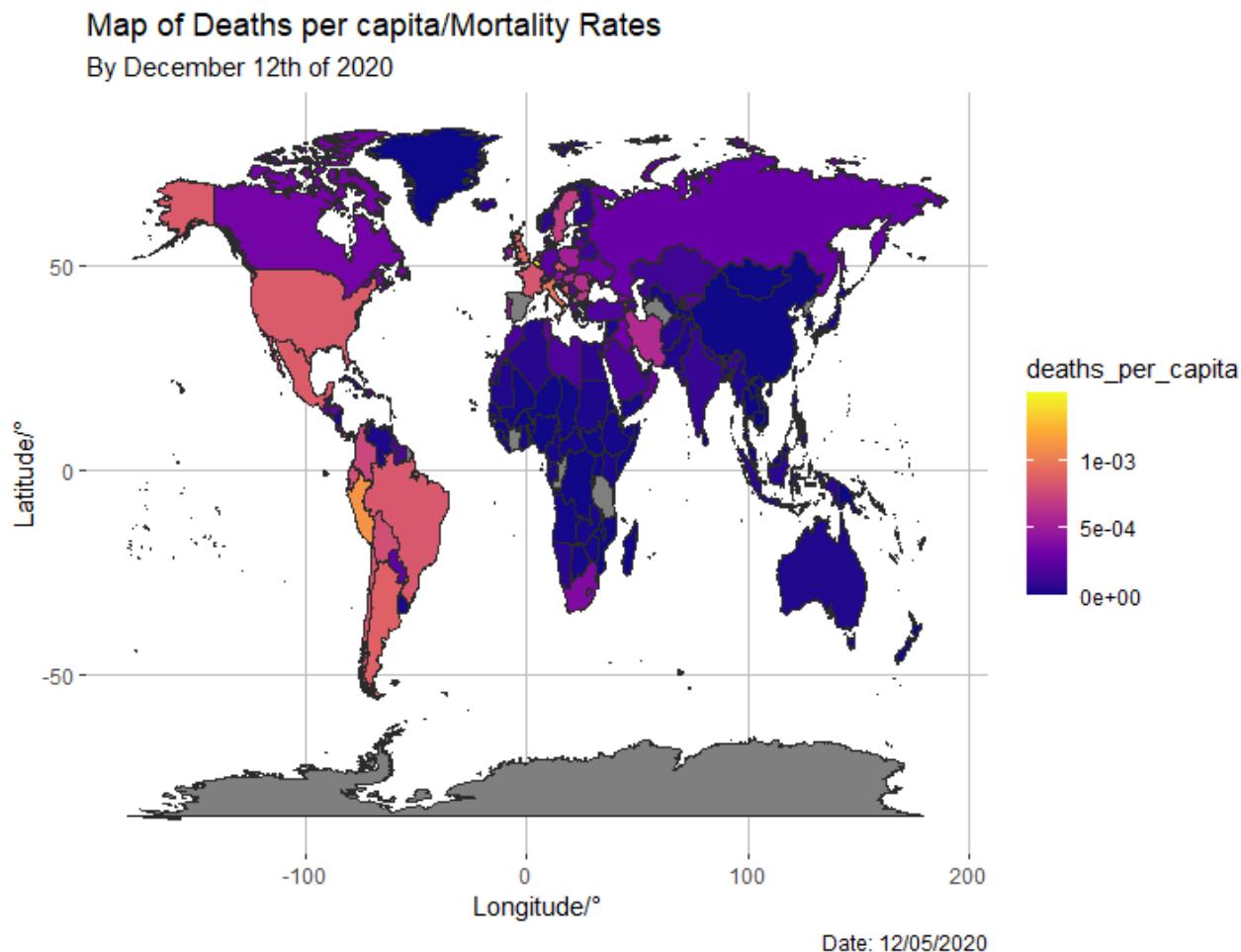
```
coord_cartesian(ylim = c(0, 1.5e7), xlim = c(xmin, xmax))
```

5.2 Map of covid mortality rates

The last challenge was to build a map of the world wide COVID-19 mortality rates. This was done using world map data and information from

[“https://opendata.ecdc.europa.eu/covid19/casedistribution/csv”](https://opendata.ecdc.europa.eu/covid19/casedistribution/csv)

(<https://opendata.ecdc.europa.eu/covid19/casedistribution/csv>). The resulting figure is the following one.



The color map used is a pre defined one illustrating the countries with the highest mortality rates in bright yellow and the countries with the lowest mortality rates in deep blue.

```

toDate <- function(year, month, day) {
  ISOdate(year, month, day)
}

toNumerics <- function(Date) {
  stopifnot(inherits(Date, c("Date", "POSIXt")))
  day <- as.numeric(strftime(Date, format = "%d"))
  month <- as.numeric(strftime(Date, format = "%m"))
  year <- as.numeric(strftime(Date, format = "%Y"))
  list(year = year, month = month, day = day)
}

library("tidyverse");
library("readxl");
library("lubridate")
library("writexl")
library("ggthemes")
library("stringr")

world <- map_data("world")
url <- "https://opendata.ecdc.europa.eu/covid19/casedistribution/csv"
covid_data_tbl <- fread(url)%>%
  as_tibble

date<-covid_data_tbl%>%
  select(day,month,year)%>%
  mutate(Date=toDate(year,month,day))%>%
  arrange(desc(Date))%>%
  slice(1:1)

covid_data_tbl<-covid_data_tbl%>%
  mutate(across(countriesAndTerritories, str_replace_all, "_", " ")) %>%
  mutate(countriesAndTerritories = case_when(
    countriesAndTerritories == "United Kingdom" ~ "UK",
    countriesAndTerritories == "United States of America" ~ "USA",
    countriesAndTerritories == "Czechia" ~ "Czech Republic",
    TRUE ~ countriesAndTerritories
  ))%>%
  rename(location=countriesAndTerritories)%>%
  mutate(Report_date = toDate(year,month,day)) %>%
  select(Report_date,deaths,location,month,popData2019)%>%
  group_by(location)%>%
  arrange(Report_date)%>%
  mutate(total_deaths=sum(deaths))%>%

```

```
mutate(deaths_per_capita=total_deaths/popData2019)%>%
filter(Report_date==date>Date)%>%
select(-deaths,-month,-popData2019)%>%
arrange(desc(deaths_per_capita))

world<- left_join(world,covid_data_tbl,by=c("region"="location"))

world %>% ggplot() +
  geom_map(aes(long,lat,fill=deaths_per_capita, map_id = region ), map = world,
           color="#2b2b2b", size=0.15)+

  scale_fill_viridis_c(option = "C")+
  labs(
    title = "Map of Deaths per capita/Mortality Rates",
    subtitle = "By December 12th of 2020",
    x = "Longitude/°",
    y = "Latitude/°",
    caption = "Date: 12/05/2020"

  )+
  theme(
    panel.background = element_rect(fill = "transparent",
                                    colour = "transparent",
                                    size = 0.5, linetype = "solid"),
    panel.grid.major = element_line(size = 0.5, linetype = 'solid',
                                    colour = "gray"),
    panel.grid.minor = element_line(size = 0.25, linetype = 'solid',
                                    colour = "white")
  )
}
```