DATA608 Homework 1

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Principles of Data Visualization and Introduction to ggplot2

```
# Required libraries
library(dplyr)
library(ggplot2)
library(scales)

# Turn off scientific notation
options(scipen=999)
```

I have provided you with data about the 5,000 fastest growing companies in the US, as compiled by Inc. magazine. lets read this in:

```
inc <- read.csv(paste0("https://raw.githubusercontent.com/charleyferrari/CUNY_DATA_608/",
                       "master/module1/Data/inc5000_data.csv"), header= TRUE)
```

And lets preview this data:

```
knitr::kable(head(select(inc, Name, Industry, Employees, City, State)))
```

Name	Industry	Employees	City	State
Fuhu	Consumer Products & Services	104	El Segundo	CA
FederalConference.com	Government Services	51	Dumfries	VA
The HCI Group	Health	132	Jacksonville	FL
Bridger	Energy	50	Addison	TX
DataXu	Advertising & Marketing	220	Boston	MA
MileStone Community Builders	Real Estate	63	Austin	TX

```
summary(inc)
```

```
##       Rank                           Name       Growth_Rate
##  Min.   :   1   (Add)ventures         :   1   Min.   :  0.340
##  1st Qu.:1252   @Properties           :   1   1st Qu.:  0.770
##  Median :2502   1-Stop Translation USA:   1   Median :  1.420
##  Mean   :2502   110 Consulting        :   1   Mean   :  4.612
##  3rd Qu.:3751   11thStreetCoffee.com  :   1   3rd Qu.:  3.290
##  Max.   :5000   123 Exteriors         :   1   Max.   :421.480
##                 (Other)               :4995
##     Revenue                                      Industry
##  Min.   :    2000000   IT Services                   : 733
##  1st Qu.:    5100000   Business Products & Services: 482
##  Median :   10900000   Advertising & Marketing     : 471
##  Mean   :   48222535   Health                        : 355
##  3rd Qu.:   28600000   Software                      : 342
##  Max.   :10100000000   Financial Services            : 260
##                        (Other)                       :2358
##    Employees                  City          State
##  Min.   :    1.0   New York     : 160   CA     : 701
```

```
##  1st Qu.:   25.0   Chicago      :  90   TX     : 387
##  Median :   53.0   Austin       :  88   NY     : 311
##  Mean   :  232.7   Houston      :  76   VA     : 283
##  3rd Qu.:  132.0   San Francisco:  75   FL     : 282
##  Max.   :66803.0   Atlanta      :  74   IL     : 273
##  NA's   :12        (Other)      :4438   (Other):2764
```

Think a bit on what these summaries mean. Use the space below to add some more relevant non-visual exploratory information you think helps you understand this data.

Maximum number of employees seems high. Consider top ten companies based on employee count.

```
knitr::kable(head(inc[order(-inc$Employees),c(2,5:8)],10))
```

	Name	Industry	Employees	City	State
2344	Integrity staffing Solutions	Human Resources	66803	Wilmington	DE
4577	Sutherland Global Services	Business Products & Services	32000	Pittsford	NY
1868	Universal Services of America	Security	20000	Santa Ana	CA
3456	The Seaton Companies	Human Resources	18887	Chicago	IL
2870	PrideStaff	Human Resources	17057	Fresno	CA
2313	Infiniti HR	Human Resources	17000	Olney	MD
4655	CareersUSA	Human Resources	14451	Boca Raton	FL
1487	Sprouts Farmers Market	Consumer Products & Services	13200	Phoenix	AZ
4140	Cornerstone Staffing Solutions	Human Resources	13071	Pleasanton	CA
3650	Genco	Logistics & Transportation	10800	Pittsburgh	PA

Check for unique company names (that companies are not duplicated in the data).

```
dupNames <- group_by(inc, Name) %>%
  summarize(Count=n()) %>%
  filter(Count>1)
cat("Number of duplicate company names:",nrow(dupNames))
```

```
## Number of duplicate company names: 0
```

Consider all industries.

```
knitr::kable(group_by(inc, Industry) %>% summarize(Count=n()) %>% arrange(desc(Count)))
```

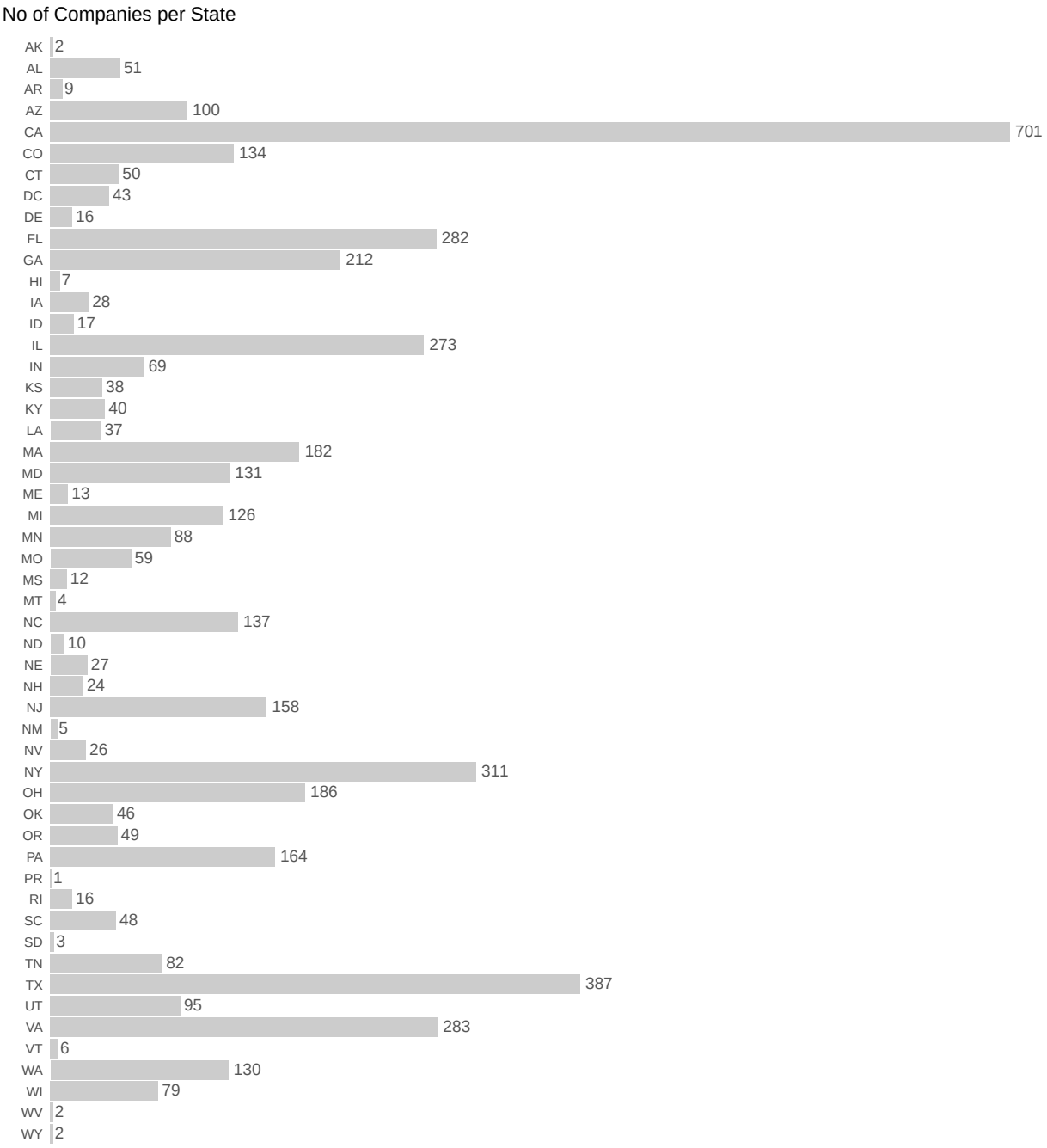
Industry	Count
IT Services	733
Business Products & Services	482
Advertising & Marketing	471
Health	355
Software	342
Financial Services	260
Manufacturing	256
Consumer Products & Services	203
Retail	203
Government Services	202
Human Resources	196
Construction	187
Logistics & Transportation	155
Food & Beverage	131
Telecommunications	129

Industry	Count
Energy	109
Real Estate	96
Education	83
Engineering	74
Security	73
Travel & Hospitality	62
Media	54
Environmental Services	51
Insurance	50
Computer Hardware	44

Question 1

Create a graph that shows the distribution of companies in the dataset by State (ie how many are in each state). There are a lot of States, so consider which axis you should use. This visualization is ultimately going to be consumed on a 'portrait' oriented screen (ie taller than wide), which should further guide your layout choices.

```
# Get a list of counts by state
stateCount <- group_by(inc, State) %>%
  summarize(Count=n())

# Plot results
ggplot(data = stateCount, aes(x = State, y = Count)) +
  geom_bar(stat="identity", fill="#CCCCCC") +
  geom_text(aes(label=Count), hjust=-0.2, vjust=0.4, color="#555555") +
  scale_x_discrete(limits = rev(levels(stateCount$State))) +
  coord_flip() +
  ggtitle("No of Companies per State") + labs(x = "", y = "") +
  theme(panel.background = element_blank(),
        axis.ticks = element_blank(),
        axis.text.x = element_blank(),
        axis.text.y = element_text(margin = margin(r=-30)))
```



Decision points:

- The plot is sorted by state (rather than by count) since viewers may be interested in a particular state (their home state?) and it is easier to find a state this way. Additionally, viewers are generally used to seeing US states listed in alphabetical order.
- It may be interesting to know exact values, so they are added to corresponding bars.
- With values, gridlines are redundant.
- Background is not necessary.
- Tick marks are not necessary.
- Default color was too dark.
- Various color themes were considered - gradient from highest to lowest count, highlighting top 3, 5 or

10 states, etc. This was deemed unnecessary.

Quesiton 2

Lets dig in on the state with the 3rd most companies in the data set. Imagine you work for the state and are interested in how many people are employed by companies in different industries. Create a plot that shows the average and/or median employment by industry for companies in this state (only use cases with full data, use R's `complete.cases()` function.) In addition to this, your graph should show how variable the ranges are, and you should deal with outliers.

```
# Top 3 states
knitr::kable(arrange(stateCount, desc(Count)) %>% top_n(3))
```

State	Count
CA	701
TX	387
NY	311

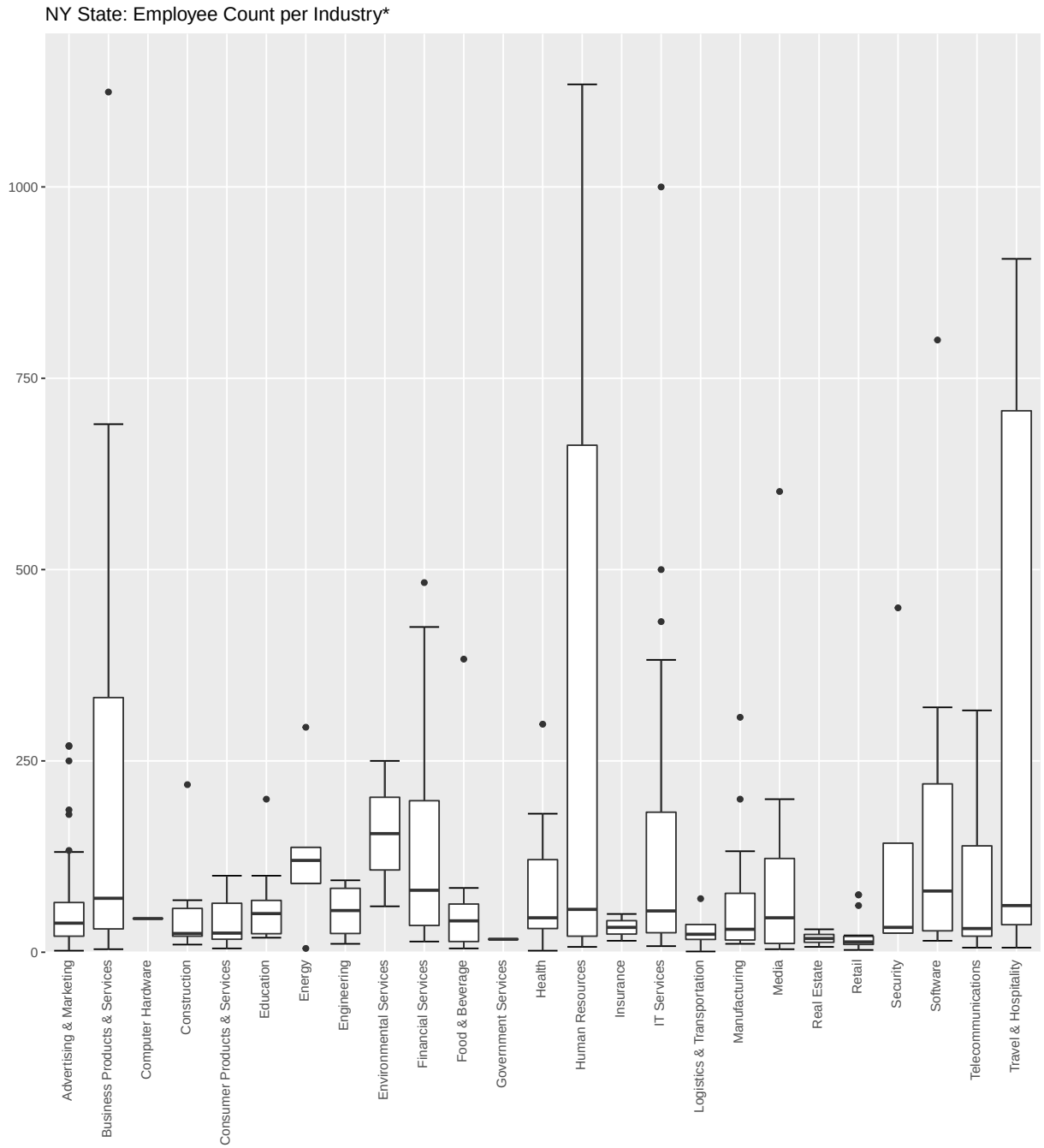
```
# Get NY industry employee counts
nyInd <- filter(inc, State=="NY") %>%
  select(Industry, Name, Employees)

# Check if any NAs
cat("Number of NAs:",sum(is.na(nyInd$Employees)))
```

```
## Number of NAs: 0
```

There are no NAs for NY data. `complete.cases()` is not necessary.

Rather than discarding a few large outliers, which skew averages, below plots display **median** values.

```
# Plot
ggplot(aes(x=Industry, y=Employees), data = nyInd) +
  stat_boxplot(geom ='errorbar') +
  geom_boxplot() +
  coord_cartesian(ylim = c(0,1200)) +
  scale_y_continuous(breaks=c(0,250,500,750,1000), expand = c(0,.05)) +
  ggtitle("NY State: Employee Count per Industry*") + labs(x = "", y = "") +
  theme(axis.text.x = element_text(angle = 90, hjust = 1, vjust=0.3),
        axis.ticks.x = element_blank(),
        panel.grid.minor.y = element_blank())
```



***The following companies are not displayed on above plot, but are included in industry representation:**

Industry	Name	Employees
Business Products & Services	Sutherland Global Services	32000
Consumer Products & Services	Coty	10000
IT Services	Westcon Group	3000
Travel & Hospitality	Denihan Hospitality Group	2280
Business Products & Services	TransPerfect	2218
Human Resources	Sterling Infosystems	2081

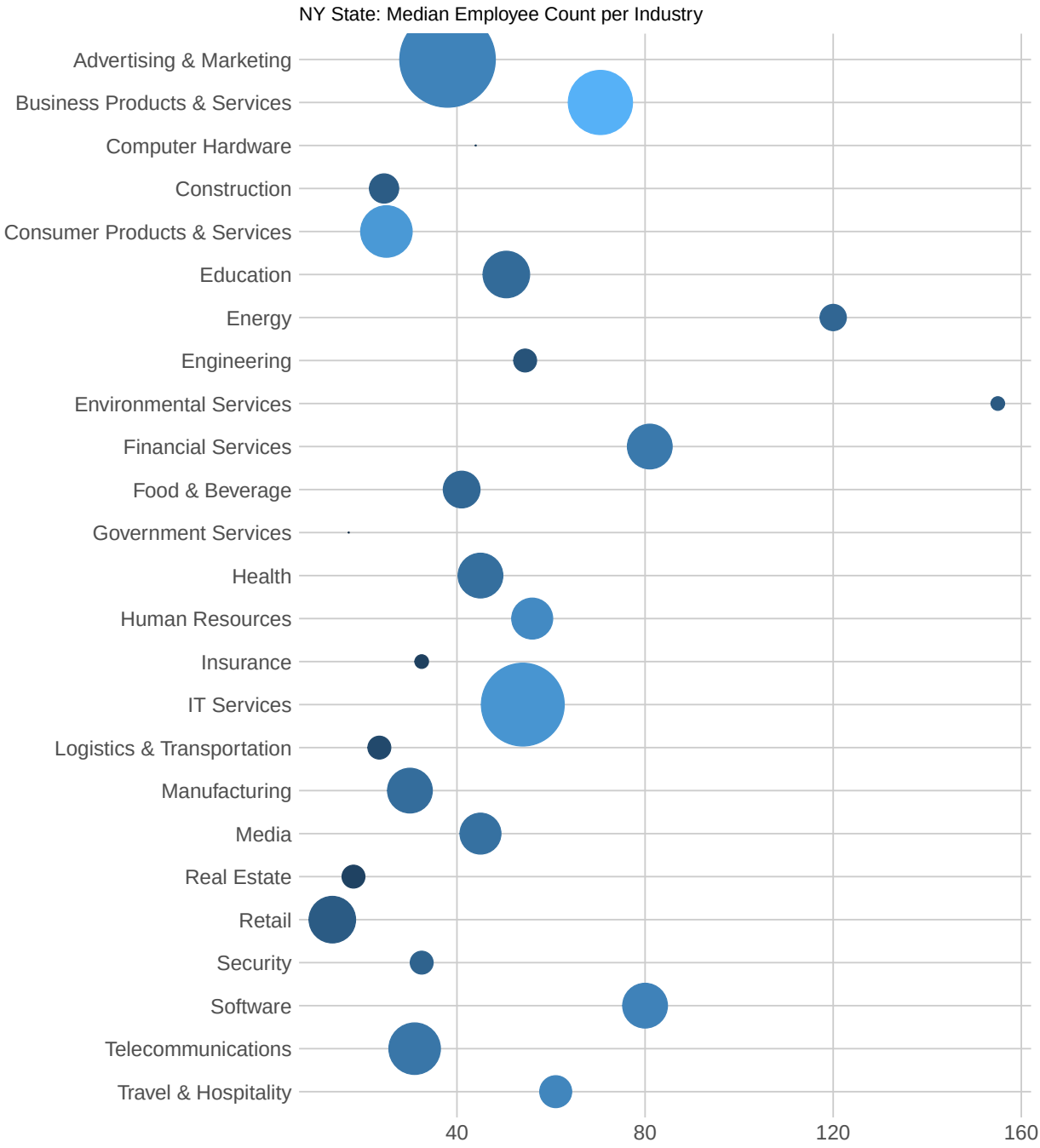
Industry	Name	Employees
Software	OpenLink	1271

Decision points:

- Boxplots by definition display meadian values as well as give general idea about outliers and the spread and variability of data. However, they require the viewer to have general idea about boxplots.
- Number of industries is not too high and it is more common to have numbers on the y axis, so boxplots are drawn vertically.
- Major gridlines and light background help define the plot.
- The plot is zoomed in to 0 to 1200 range (leaving a few outliers off the plot) in order to make information more legible.

One problem with boxplots is that they do not give a sense of how many data points there are for each industry. 25 industries range from 1 to 57 companies each and employee count ranges from 17 to 38,804. The plot below tries to address it. It represents median values. **Size is relative to number of companies per industry and color is relative to number of employees per idustry.** Consider *Human Resources* industry. A smaller point indicates few companies (in fact 11), but lighter color indicates relatively large number of employees (4,813). Because the plot is meant to be illutrative, legends are omitted. Perhaps, hover functionality to display actual values would be a good addition.

```
# Summarize NY data
nyIndSum <- group_by(nyInd, Industry) %>%
  summarise(Median = median(Employees), TotalEmp = sum(Employees), Count = n())

# Plot
ggplot(aes(x = Industry, y = Median, size = Count, color = log(TotalEmp)),
       data = nyIndSum) +
  geom_point(show.legend = FALSE) +
  scale_size(range = c(0, 30)) +
  scale_x_discrete(limits = rev(levels(nyIndSum$Industry))) +
  coord_flip() +
  ggtitle("NY State: Median Employee Count per Industry") + labs(x = "", y = "") +
  theme(axis.ticks = element_blank(),
        axis.text = element_text(size = 14),
        panel.grid.major = element_line(color = "#CCCCCC"),
        panel.background = element_blank(),
        panel.grid.minor.x = element_blank())
```



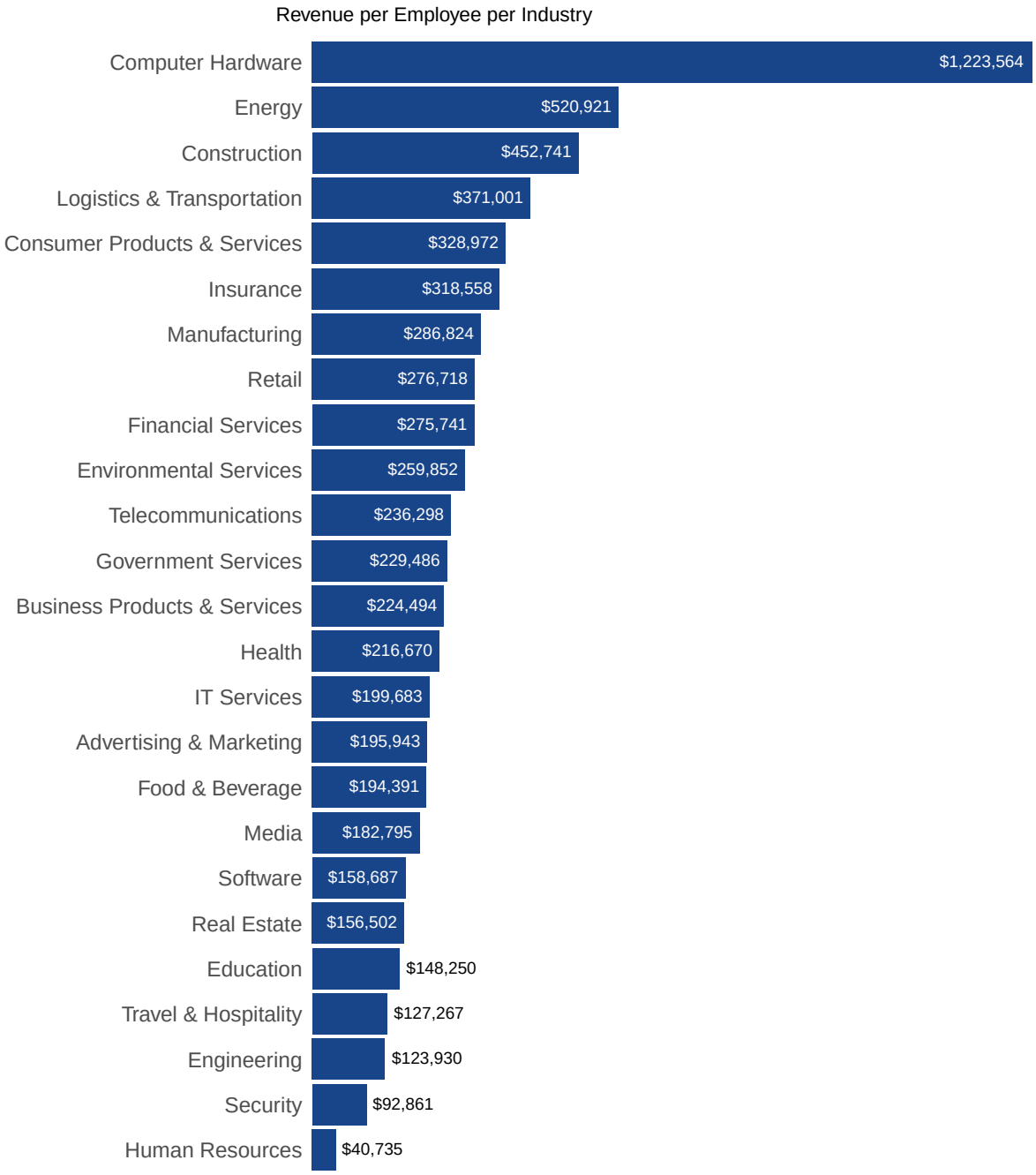
Question 3

Now imagine you work for an investor and want to see which industries generate the most revenue per employee. Create a chart that makes this information clear. Once again, the distribution per industry should be shown.

Based on the summary statistics above there are no missing, negative or zero values in the `Revenue` column.

```
# Get data
revenue <- select(inc, Industry, Revenue, Employees) %>%
```

```
  na.omit() %>%
  group_by(Industry) %>%
  summarise(TotalRev = sum(Revenue), TotalEmp = sum(Employees)) %>%
  mutate(RevEmployee = TotalRev / TotalEmp)

# Plot results
ggplot(data = revenue, aes(x = reorder(Industry, RevEmployee), y = RevEmployee)) +
  geom_bar(stat="identity", fill="#184489") +
  geom_text(data = filter(revenue, RevEmployee>150000),
            aes(x = Industry, y = RevEmployee, label=dollar_format()(RevEmployee)),
            hjust=1.1, vjust=0.4, color="#FFFFFF") +
  geom_text(data = filter(revenue, RevEmployee<150000),
            aes(x = Industry, y = RevEmployee, label=dollar_format()(RevEmployee)),
            hjust=-0.1, vjust=0.4, color="#000000") +
  coord_flip() +
  ggtitle("Revenue per Employee per Industry") + labs(x = "", y = "") +
  theme(panel.background = element_blank(),
        axis.ticks = element_blank(),
        axis.text.x = element_blank(),
        axis.text.y = element_text(size = 14, margin = margin(r=-20)))
```



Decision points:

- Similar to plot from question 1.
- Sorted by amount since the focus is likely to be on top/bottom industries.
- Additional embellishments were considered, but deemed unnecessary. Those include varying bar colors or bringing another dimension to show total number of employees. The idea is to have a simple display of revenue per employee. Further analysis of interesting industries can be done to break it up by state or city, average employees per company, etc.