SAP - projekt - Milijarderi

Uspjeh učenika u nastavi

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Uvod

Pitanja:

1. Ima li neki kontinent statistički značajno više miljarda?
2. Jesu li milijarderi koji su nasljedili bogastvo statistički značajno bogatiji od onih koji nisu?
3. Možete li iz danih varijabli predvidjeti njihovo bogatstvo?
4. Kada biste birali karijeru isključivo prema kriteriju da se obogatite, koju biste industriju izabrali?

Dodatna pitanja:

5. ???

Deskriptivna analiza

```
# Pomoćna funkcija za izbacivanje stršećih vrijednosti
remove_outliers <- function(data, data_column) {
  quartiles <- quantile(data_column, probs=c(.25, .75), na.rm = FALSE)
  IQR <- IQR(data_column)
  Lower <- quartiles[1] - 1.5*IQR
  Upper <- quartiles[2] + 1.5*IQR

  return(subset(data, data_column >= Lower & data_column <= Upper))
}

cat('\n Dimenzija podataka: ', dim(bill_data))
```

```
##
##  Dimenzija podataka:  2614 22
```

```
for (col_name in names(bill_data)){
  if (sum(is.na(bill_data[,col_name])) > 0){
    cat('Ukupno nedostajućih vrijednosti za varijablu'
        ,col_name, ': ', sum(is.na(bill_data[,col_name])),'\n')
  }
}
```

```
## Ukupno nedostajućih vrijednosti za varijablu company.name :  38
## Ukupno nedostajućih vrijednosti za varijablu company.relationship :  46
## Ukupno nedostajućih vrijednosti za varijablu company.sector :  23
## Ukupno nedostajućih vrijednosti za varijablu company.type :  36
## Ukupno nedostajućih vrijednosti za varijablu demographics.gender :  34
## Ukupno nedostajućih vrijednosti za varijablu wealth.type :  22
## Ukupno nedostajućih vrijednosti za varijablu wealth.how.category :  1
## Ukupno nedostajućih vrijednosti za varijablu wealth.how.industry :  1
```

Postoje podaci koji nedostaju. Što s njima?

```
summary(bill_data)
```

```
##      name                rank             year      company.founded
##  Length:2614        Min.   :   1.0   Min.   :1996   Min.   :   0
##  Class :character   1st Qu.: 215.0   1st Qu.:2001   1st Qu.:1936
##  Mode  :character   Median : 430.0   Median :2014   Median :1963
##                     Mean   : 599.7   Mean   :2008   Mean   :1925
##                     3rd Qu.: 988.0   3rd Qu.:2014   3rd Qu.:1985
##                     Max.   :1565.0   Max.   :2014   Max.   :2012
##  company.name       company.relationship company.sector     company.type
##  Length:2614        Length:2614          Length:2614        Length:2614
##  Class :character   Class :character     Class :character   Class :character
##  Mode  :character   Mode  :character     Mode  :character   Mode  :character
##
##
##
##  demographics.age demographics.gender location.citizenship
##  Min.   :-42.00   Length:2614         Length:2614
##  1st Qu.: 47.00   Class :character    Class :character
##  Median : 59.00   Mode  :character    Mode  :character
##  Mean   : 53.34
##  3rd Qu.: 70.00
##  Max.   : 98.00
##  location.country code  location.gdp       location.region
##  Length:2614           Min.   :0.000e+00   Length:2614
##  Class :character      1st Qu.:0.000e+00   Class :character
##  Mode  :character      Median :0.000e+00   Mode  :character
##                        Mean   :1.769e+12
##                        3rd Qu.:7.250e+11
##                        Max.   :1.060e+13
##  wealth.type        wealth.worth in billions wealth.how.category
##  Length:2614        Min.   : 1.000           Length:2614
##  Class :character   1st Qu.: 1.400           Class :character
##  Mode  :character   Median : 2.000           Mode  :character
##                     Mean   : 3.532
##                     3rd Qu.: 3.500
##                     Max.   :76.000
##  wealth.how.from emerging wealth.how.industry wealth.how.inherited
##  Length:2614              Length:2614         Length:2614
##  Class :character         Class :character    Class :character
##  Mode  :character         Mode  :character    Mode  :character
##
##
##
##  wealth.how.was founder wealth.how.was political
##  Length:2614           Length:2614
##  Class :character      Class :character
##  Mode  :character       Mode  :character
##
##
##
```

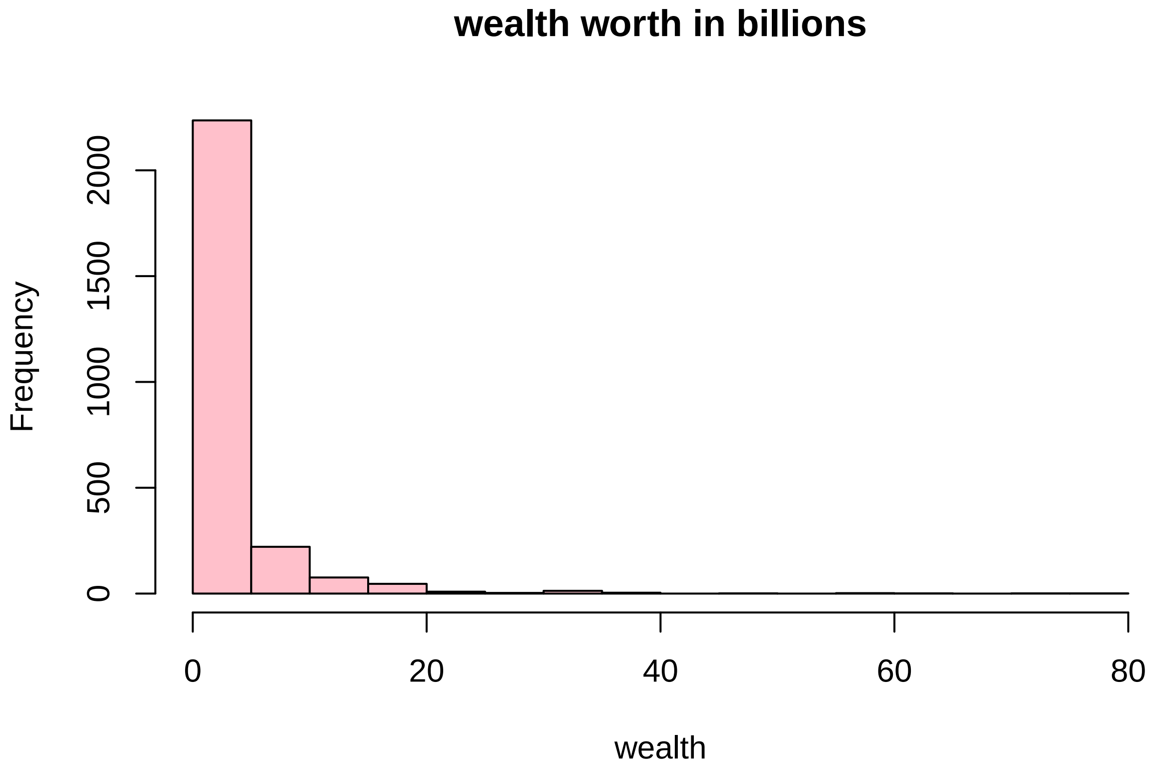
```
sapply(bill_data, class)
```

```
##                     name                     rank                     year
##              "character"                "numeric"                "numeric"
##          company.founded             company.name     company.relationship
##                "numeric"              "character"              "character"
##           company.sector             company.type         demographics.age
##              "character"              "character"                "numeric"
##      demographics.gender     location.citizenship    location.country code
##              "character"              "character"              "character"
##             location.gdp          location.region              wealth.type
##                "numeric"              "character"              "character"
## wealth.worth in billions      wealth.how.category wealth.how.from emerging
##                "numeric"              "character"              "character"
##      wealth.how.industry     wealth.how.inherited   wealth.how.was founder
##              "character"              "character"              "character"
## wealth.how.was political
##              "character"
```

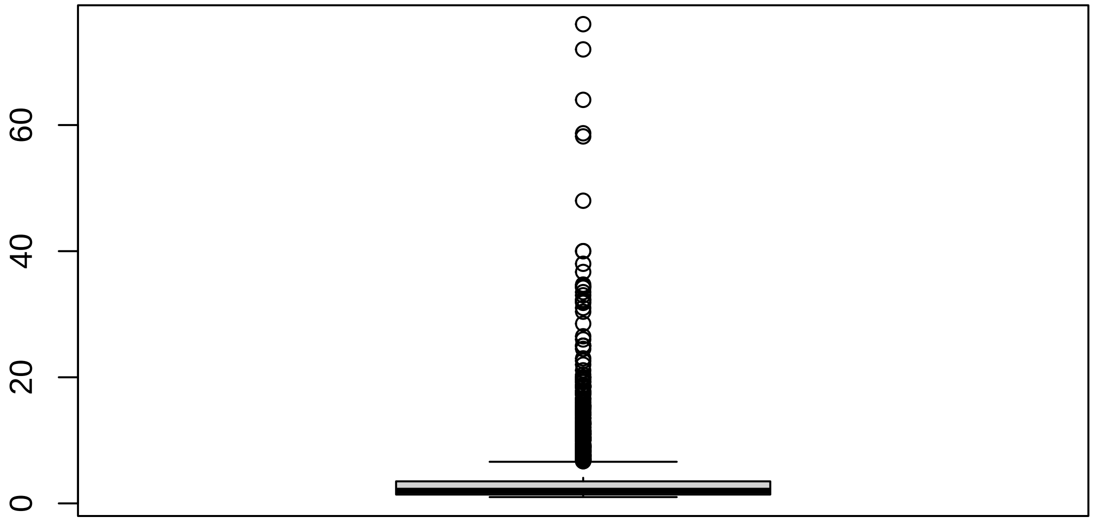
Naš dataset sastoji se od character i numeric varijabli.

Prvo promotrimo numeričke varijable.

```
hist(bill_data$`wealth.worth in billions` ,main='wealth worth in billions', xlab='wealth', ylab='Frequen
```



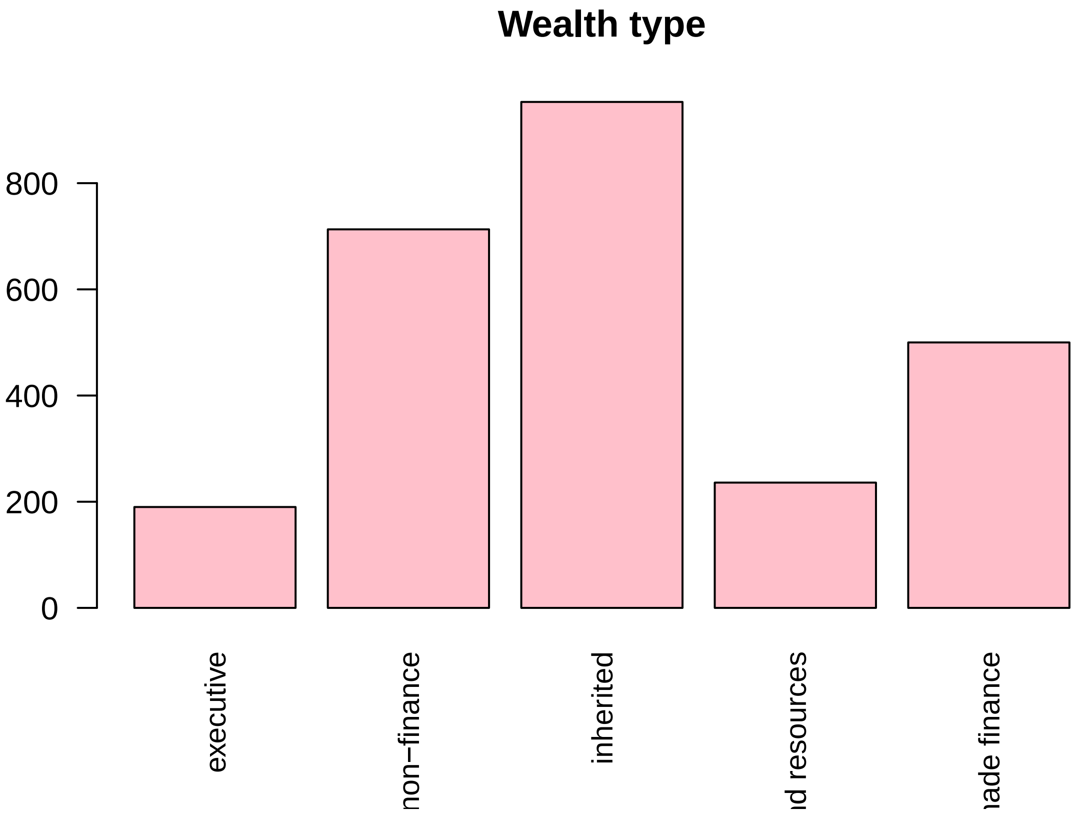
```
boxplot(bill_data$`wealth.worth in billions`)
```



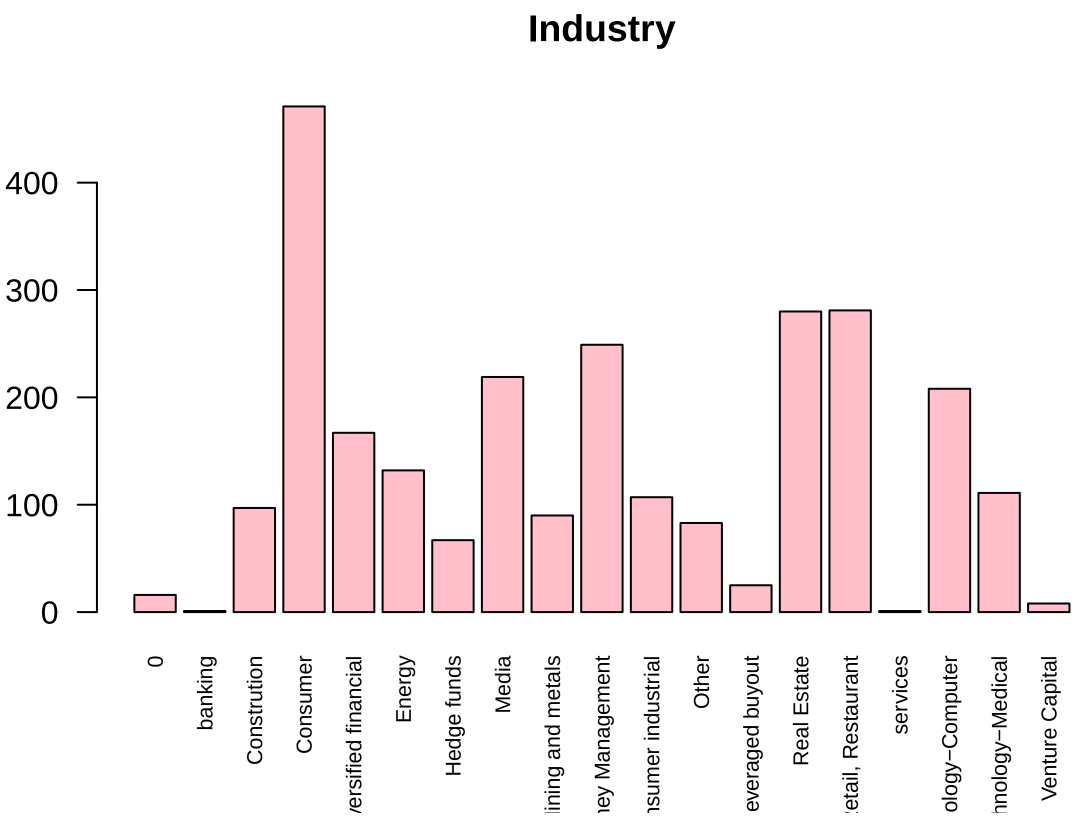
```
summary(bill_data$`wealth.worth in billions`)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
##   1.000   1.400   2.000   3.532   3.500  76.000
```

```
barplot(table(bill_data$wealth.type),las=2,cex.names=.9,main='Wealth type',col="pink")
```



```
barplot(table(bill_data$wealth.how.industry),las=2,cex.names=.7,main='Industry',col="pink")
```



```
print('Podjela po spolu: ')
```

```
## [1] "Podjela po spolu: "
```

```
table(bill_data$demographics.gender)
```

```
##
##         female           male married couple
##            249           2328              3
```

Pitanja

1. Ima li neki kontinent statistički značajno više miljarda?

```
levels(factor(bill_data$location.region))
```

```
## [1] "0"                        "East Asia"
## [3] "Europe"                   "Latin America"
## [5] "Middle East/North Africa" "North America"
## [7] "South Asia"               "Sub-Saharan Africa"
```

```
class(bill_data$location.region)
```

```
## [1] "character"
```

Treba li tip stupca biti factor?

Ima li nedostajućih vrijednosti?

```
# is.na ce nam vratiti logical vektor koji ima TRUE na mjestima gdje ima NA:
sum(is.na(bill_data$location.region))
```

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

Nema nedostajućih vrijednosti

```
table(bill_data$location.region)
```

```
##
##                        0                East Asia                   Europe
##                        1                      535                      698
##            Latin America Middle East/North Africa            North America
##                      182                      117                      992
##               South Asia       Sub-Saharan Africa
##                       69                       20
```

```
bill_data$location.citizenship[bill_data$location.region == "Middle East/North Africa"]
```

```
##   [1] "Saudi Arabia"         "Saudi Arabia"         "Saudi Arabia"
##   [4] "Saudi Arabia"         "Kuwait"               "Turkey"
##   [7] "Saudi Arabia"         "Turkey"               "Kuwait"
##  [10] "Saudi Arabia"         "Turkey"               "Israel"
##  [13] "Turkey"               "Lebanon"              "Saudi Arabia"
##  [16] "Saudi Arabia"         "Lebanon"              "Saudi Arabia"
##  [19] "Saudi Arabia"         "Turkey"               "Israel"
##  [22] "Israel"               "Saudi Arabia"         "Israel"
##  [25] "Lebanon"              "Turkey"               "Israel"
##  [28] "United Arab Emirates" "Saudi Arabia"         "Saudi Arabia"
##  [31] "Israel"               "Turkey"               "United Arab Emirates"
##  [34] "Israel"               "Turkey"               "Israel"
##  [37] "Israel"               "United Arab Emirates" "Saudi Arabia"
##  [40] "Israel"               "Israel"               "Bahrain"
##  [43] "Saudi Arabia"         "Israel"               "Israel"
##  [46] "Saudi Arabia"         "Saudi Arabia"         "Turkey"
##  [49] "Saudi Arabia"         "Turkey"               "Israel"
##  [52] "Egypt"                "Algeria"              "Egypt"
##  [55] "Saudi Arabia"         "Lebanon"              "Lebanon"
##  [58] "Israel"               "Turkey"               "Turkey"
##  [61] "Egypt"                "Morocco"              "United Arab Emirates"
##  [64] "United Arab Emirates" "Israel"               "Israel"
##  [67] "Saudi Arabia"         "Egypt"                "Saudi Arabia"
##  [70] "Egypt"                "Lebanon"              "Turkey"
##  [73] "Turkey"               "Turkey"               "Morocco"
##  [76] "Egypt"                "Saudi Arabia"         "Turkey"
##  [79] "Turkey"               "Israel"               "Egypt"
##  [82] "Israel"               "Turkey"               "Turkey"
##  [85] "Turkey"               "Turkey"               "Turkey"
##  [88] "Turkey"               "Turkey"               "Lebanon"
##  [91] "Morocco"              "Turkey"               "Israel"
##  [94] "Israel"               "Kuwait"               "Kuwait"
##  [97] "Israel"               "Kuwait"               "Turkey"
## [100] "Turkey"               "Egypt"                "Israel"
## [103] "Morocco"              "Kuwait"               "Kuwait"
## [106] "Turkey"               "Lebanon"              "Lebanon"
## [109] "Oman"                 "Israel"               "Turkey"
## [112] "Turkey"               "Oman"                 "Turkey"
## [115] "Israel"               "Israel"               "Turkey"
```

Sada možemo združiti podatke ovisno o kontinentu.

Kopirajmo najprije podatke u novi data.frame kako ne bi promijenili prave vrijednosti.

```
bill_data_copy = data.frame(bill_data)
tracemem(bill_data)==tracemem(bill_data_copy)
```

```
## [1] FALSE
```

```
untracemem(bill_data_copy)
untracemem(bill_data_copy)
```

```
# Zdruzimo Europu
for (column_name in c("Europe")){
  bill_data_copy$location.region[bill_data_copy$location.region == column_name] = "Europe";
}

# Zdruzimo Afriku
for (column_name in c("Lebanon","Egypt","Morocco","Algeria")){
  bill_data_copy$location.region[bill_data_copy$location.citizenship == column_name] = "Africa";
}

for (column_name in c("Sub-Saharan Africa")){
  bill_data_copy$location.region[bill_data_copy$location.region == column_name] = "Africa";
}

# zdruzimo Sjevernu Ameriku
for (column_name in c("North America")){
  bill_data_copy$location.region[bill_data_copy$location.region == column_name] = "North America";
}

# Zdruzimo Južnu Ameriku
for (column_name in c("Latin America")){
  bill_data_copy$location.region[bill_data_copy$location.region == column_name] = "South America";
}

# Zdruzimo Aziju
for (column_name in c("East Asia","South Asia")){
  bill_data_copy$location.region[bill_data_copy$location.region == column_name] = "Asia";
}
for (column_name in c("Saudi Arabia","Kuwait","United Arab Emirates","Israel","Turkey","Oman","Bahrain"
  bill_data_copy$location.region[bill_data_copy$location.citizenship == column_name] = "Asia";
}


bill_data_copy
```

```
tbl = table(bill_data_copy$location.region)
print(tbl)
```

```
##
##             0        Africa          Asia        Europe North America
##             1            43           699           697           992
## South America
##           182
```

##continent_frequency=transform(bill_data_copy,continent_frequency=ave(seq(nrow(bill_data_copy)),location.region

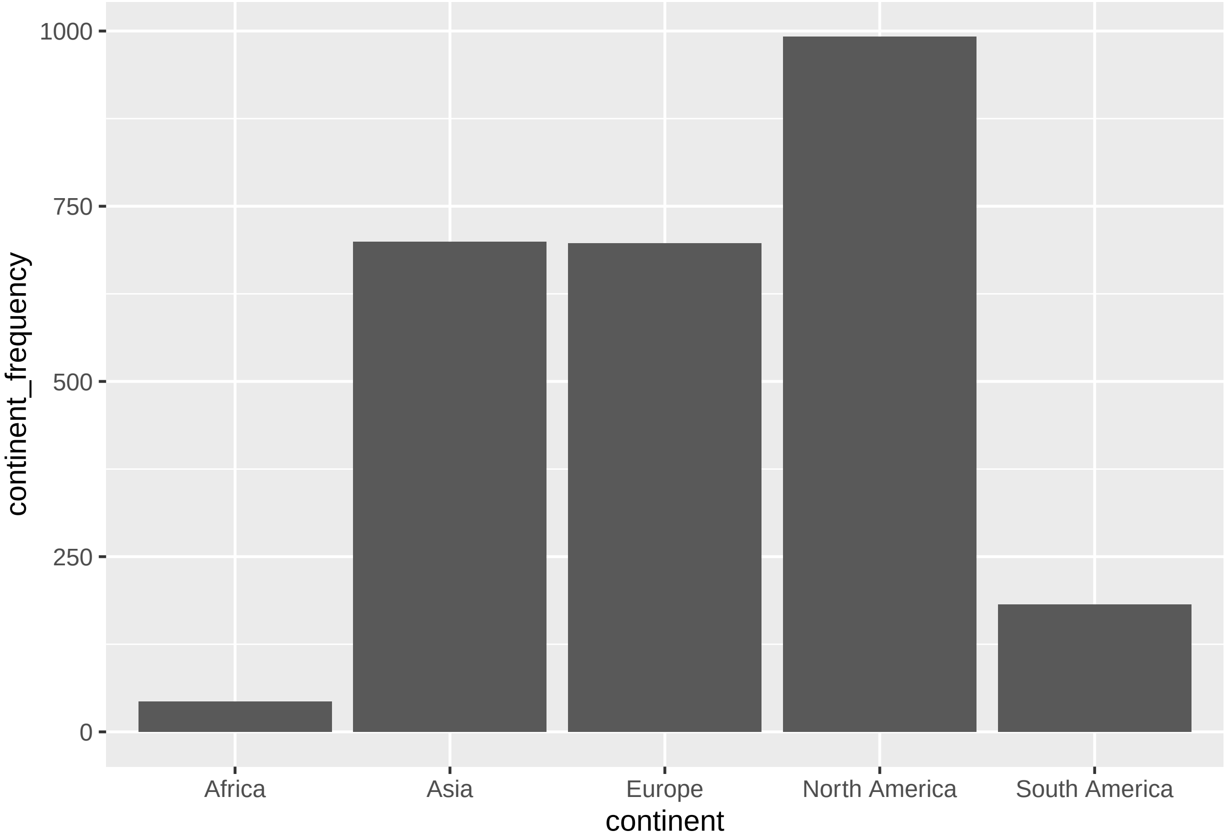
,FUN=length) df1=transform(bill_data_copy,continent_frequency=ave(seq(nrow(bill_data_copy)),location.region ,FUN=length)) df1

```
df <- data.frame(continent=c("Europe", "Asia", "Africa","North America","South America"),
                continent_frequency=c(697, 699, 43, 992, 182))
head(df)
```

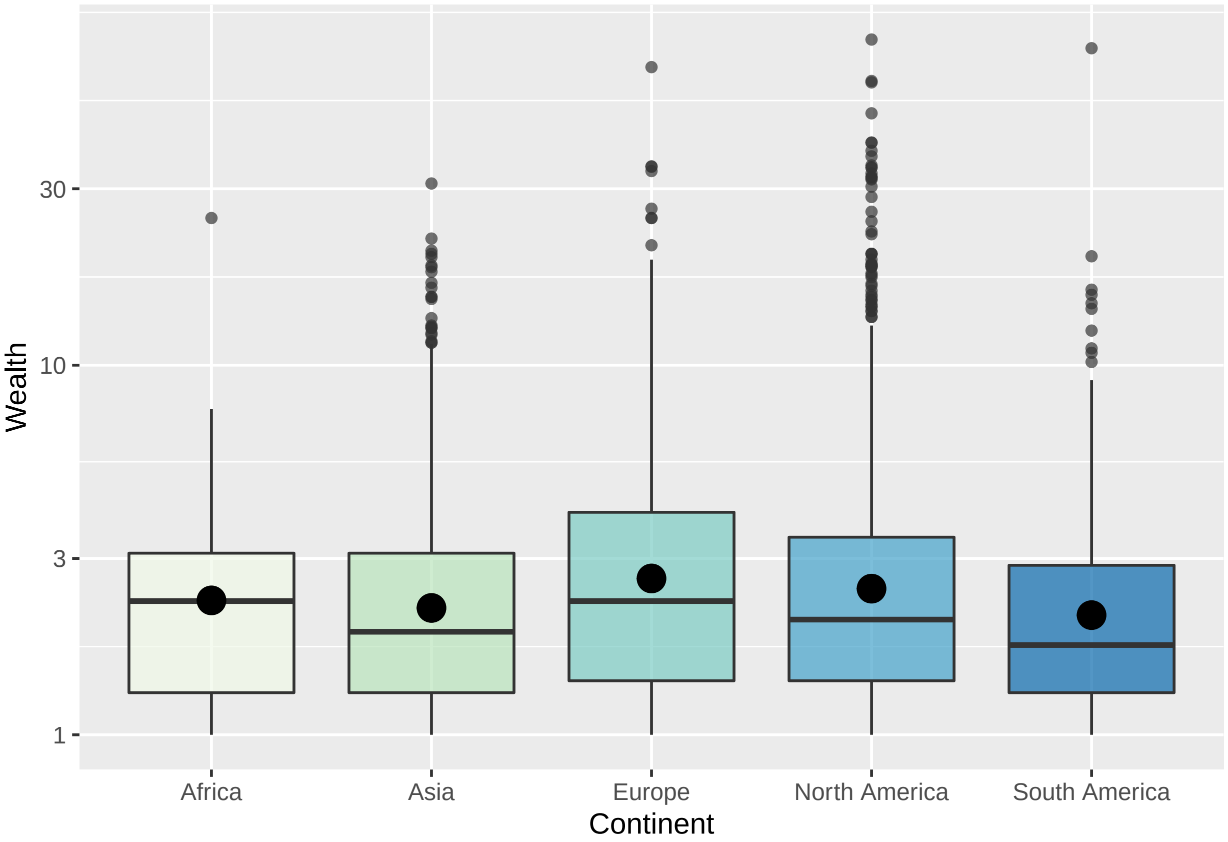
```
##       continent continent_frequency
## 1        Europe                 697
## 2          Asia                 699
## 3        Africa                  43
## 4 North America                 992
## 5 South America                 182
```

```
library(ggplot2)


# Barplot
p<-ggplot(data=df, aes(x=continent, y=continent_frequency)) +
  geom_bar(stat="identity")
p
```



```
box_edu <- ggplot(bill_data_copy %>% filter(!location.region=="0"), aes(x=location.region, y= wealth.wo
    geom_boxplot(alpha=0.7, ) + scale_y_log10() +
    stat_summary(fun=mean, geom="point", shape=20, size=7, color="black", fill="black") +
    theme(legend.position="none") + labs(x="Continent",y="Wealth")+
    scale_fill_brewer(name="Continent",palette="GnBu")
box_edu
```



2. Jesu li milijarderi koji su nasljedili bogastvo statistički značajno bogatiji od onih koji nisu?

Potrebno je pripremiti podatke za obradu, razdvojiti podatke iz tablice po polju how.inherited u dva slučaja: inherited (oni koju su nasljedili bogatstvo) i non_inherited (oni koji nisu nasljedili bogatstvo).

```
inherited = bill_data[bill_data$wealth.how.inherited!="not inherited",]
```

```
## tracemem[0x600001d29340 -> 0x600001d14540]: lapply tbl_subset_row [.tbl_df [ eval eval withVisible w
```

```
print(inherited)
```

```
## # A tibble: 926 x 22
##    name             rank  year company.founded company.name     company.relation~
##    <chr>           <dbl> <dbl>           <dbl> <chr>            <chr>
##  1 Oeri Hoffman ~      3  1996            1896 F. Hoffmann-La ~ <NA>
##  2 Walter Thomas~      6  1996            1963 Sun Hung Kai Pr~ Relation
##  3 Charles Koch        6  2014            1940 Koch industries  relation
##  4 David Koch          6  2014            1940 Koch industries  relation
##  5 Jim Walton          7  2001            1962 Walmart          relation
##  6 Yoshiaki Tsut~      8  1996            1894 Seibu Corporati~ relation
##  7 John Walton         8  2001            1962 Walmart          relation
##  8 Theo and Karl~      9  1996            1913 Aldi Nord        Relation
##  9 S Robson Walt~      9  2001            1962 Walmart          relation
## 10 Christy Walton      9  2014            1962 Walmart          relation
## # ... with 916 more rows, and 16 more variables: company.sector <chr>,
## #   company.type <chr>, demographics.age <dbl>, demographics.gender <chr>,
## #   location.citizenship <chr>, location.country code <chr>,
## #   location.gdp <dbl>, location.region <chr>, wealth.type <chr>,
## #   wealth.worth in billions <dbl>, wealth.how.category <chr>,
## #   wealth.how.from emerging <chr>, wealth.how.industry <chr>,
## #   wealth.how.inherited <chr>, wealth.how.was founder <chr>, ...
```

```
non_inherited = bill_data[bill_data$wealth.how.inherited=="not inherited",]
```

```
## tracemem[0x600001d29340 -> 0x600001d18c40]: lapply tbl_subset_row [.tbl_df [ eval eval withVisible wi
```

```
print(non_inherited)
```

```
## # A tibble: 1,688 x 22
##    name              rank  year company.founded company.name    company.relatio~
##    <chr>            <dbl> <dbl>           <dbl> <chr>           <chr>
##  1 Bill Gates           1  1996            1975 Microsoft       founder
##  2 Bill Gates           1  2001            1975 Microsoft       founder
##  3 Bill Gates           1  2014            1975 Microsoft       founder
##  4 Warren Buffett       2  1996            1962 Berkshire Hath~ founder
##  5 Warren Buffett       2  2001            1962 Berkshire Hath~ founder
##  6 Carlos Slim Helu     2  2014            1990 Telmex          founder
##  7 Paul Allen           3  2001            1975 Microsoft       founder
##  8 Amancio Ortega       3  2014            1975 Zara            founder
##  9 Lee Shau Kee         4  1996            1976 Henderson Land~ founder/chairman
## 10 Larry Ellison        4  2001            1977 Oracle          founder
## # ... with 1,678 more rows, and 16 more variables: company.sector <chr>,
## #   company.type <chr>, demographics.age <dbl>, demographics.gender <chr>,
## #   location.citizenship <chr>, location.country code <chr>,
## #   location.gdp <dbl>, location.region <chr>, wealth.type <chr>,
## #   wealth.worth in billions <dbl>, wealth.how.category <chr>,
## #   wealth.how.from emerging <chr>, wealth.how.industry <chr>,
## #   wealth.how.inherited <chr>, wealth.how.was founder <chr>, ...
```

Zatim je potrebno izračunati srednju vrijednost (mean) posebno za svaki slučaj uzimajući u obzir polje worth.in billions.

```
inherited_mean = mean(inherited$`wealth.worth in billions`)
print(inherited_mean)
```

```
## [1] 3.750756
```

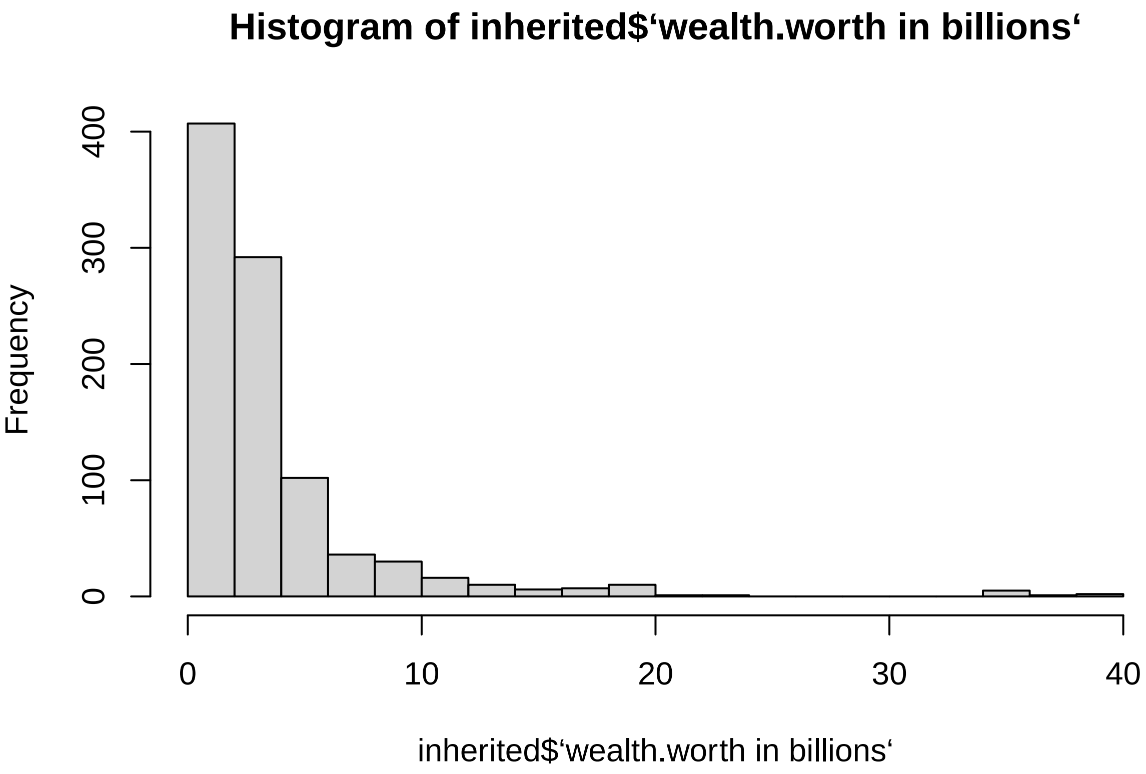
```
non_inherited_mean = mean(non_inherited$`wealth.worth in billions`)
print(non_inherited_mean)
```

```
## [1] 3.411908
```

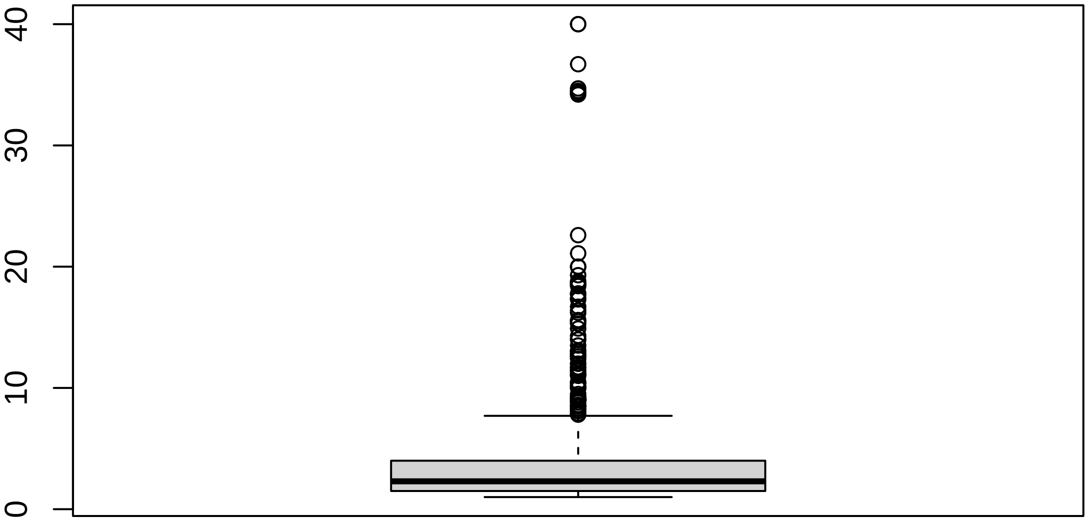
Na temelju male razlike u srednjim vrijednostima, ne postoje indikacije da su milijarderi koji su nasljedili bogatstvo statistički značajno bogatiji od onih koji nisu. No, navedeno je potrebno provjeriti.

Kako bi bolje vizualizirali podatke crtamo histogram i box plot za svaki od slučaja:

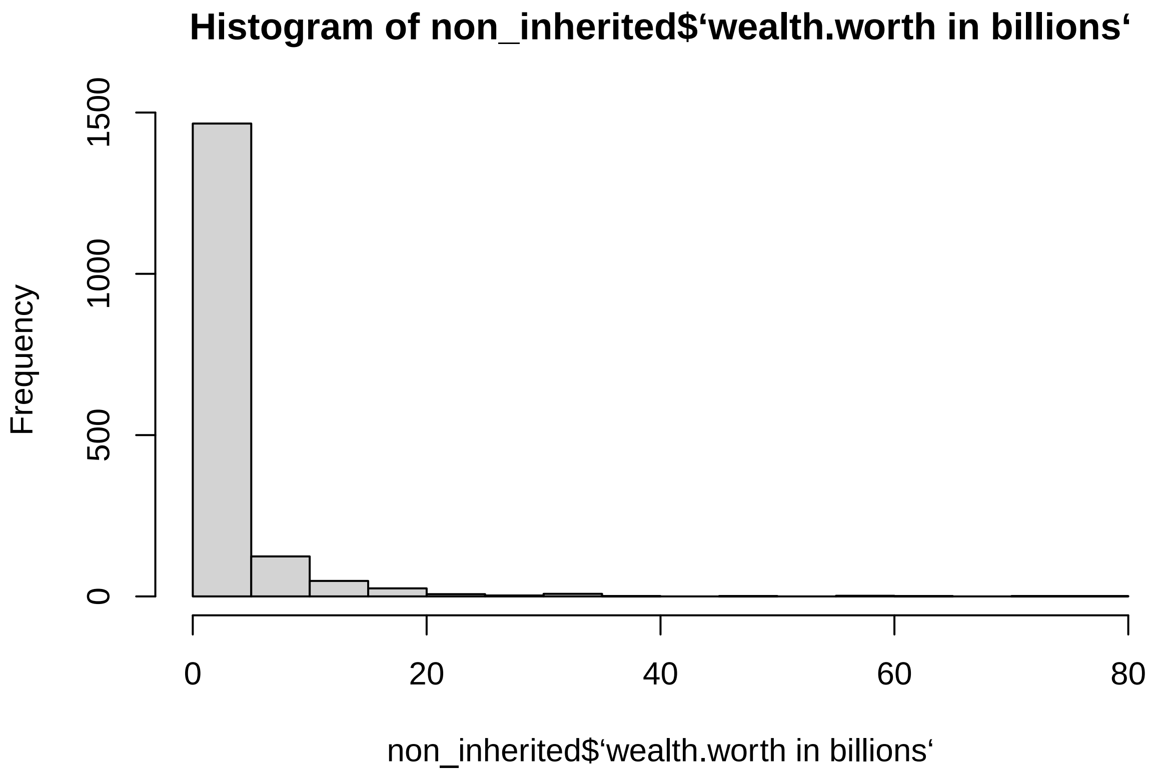
```
hist(inherited$`wealth.worth in billions`, breaks = 20)
```



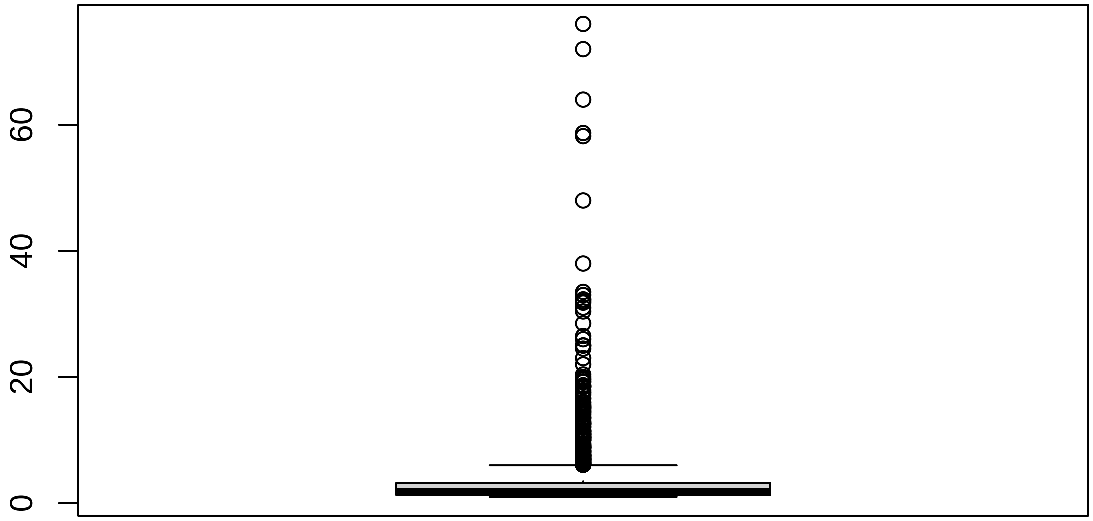
```
boxplot(inherited$`wealth.worth in billions`)
```



```
hist(non_inherited$`wealth.worth in billions`, breaks = 20)
```



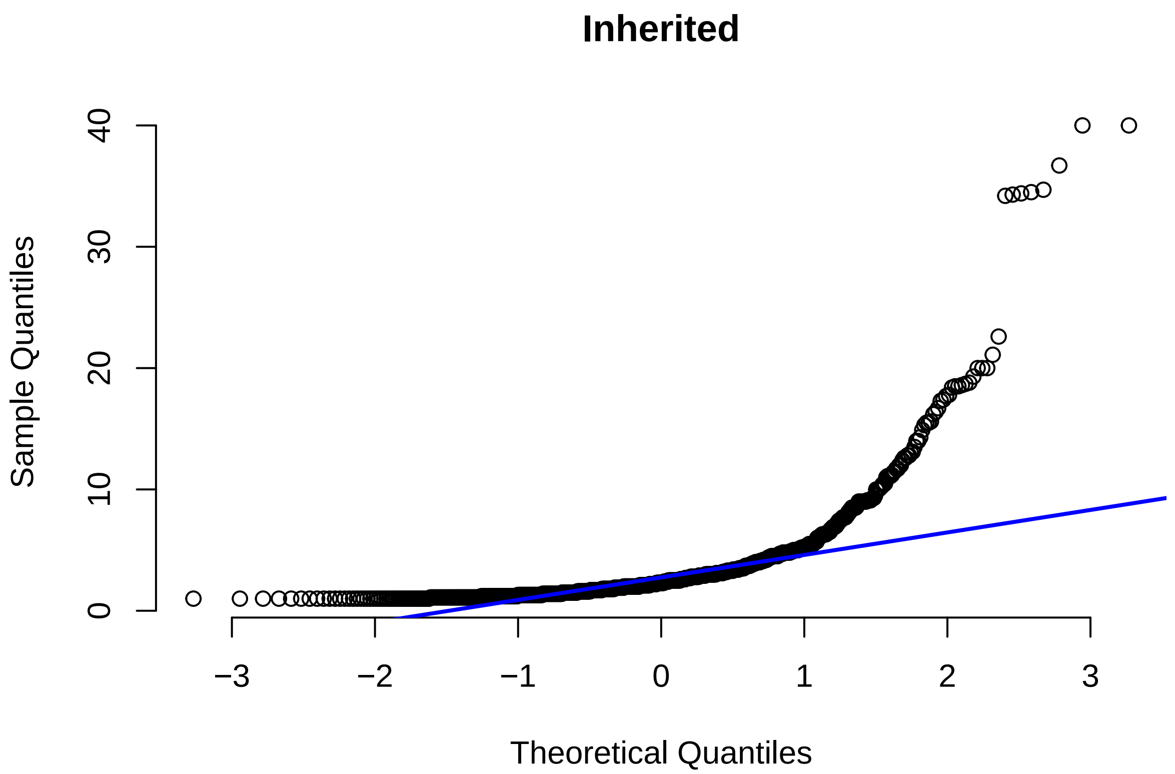
```
boxplot(non_inherited$`wealth.worth in billions`)
```



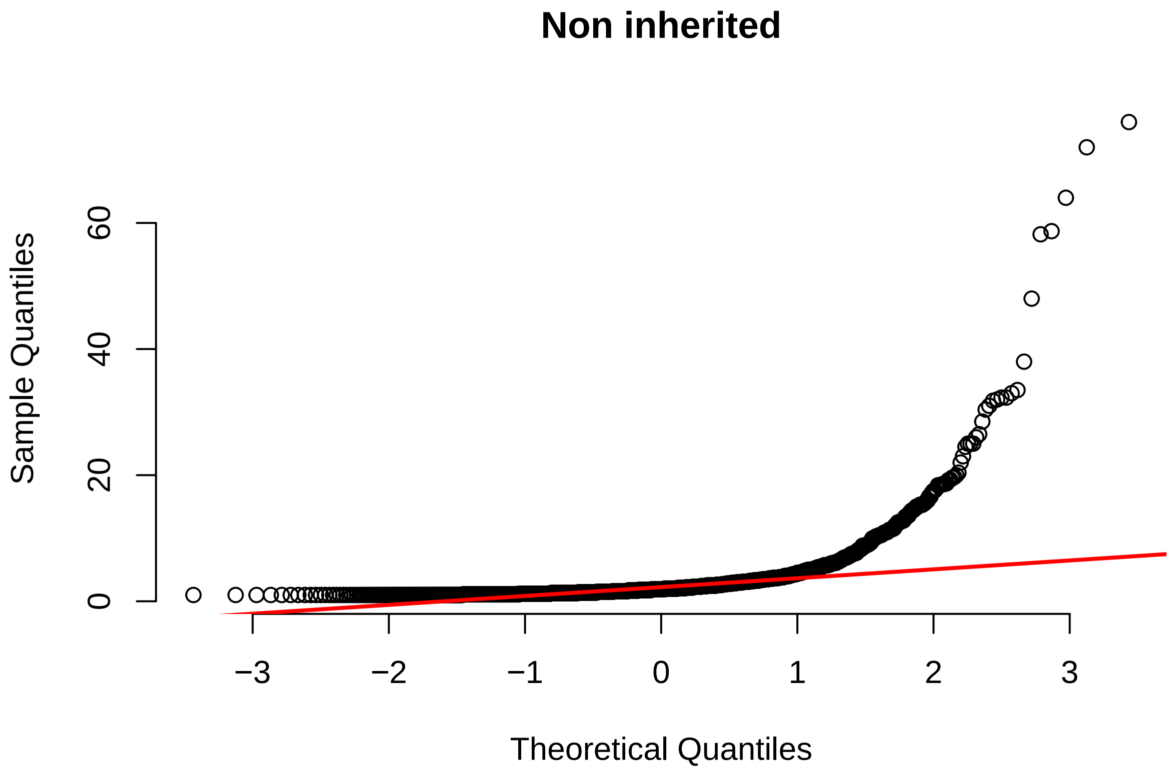
Iz prikazane vizualizacije uočavamo kako se podaci ne ravnaju po normalnoj distribuciji.

Što se može bolje vidjeti sa sljedećih prikaza:

```
qqnorm(inherited$`wealth.worth in billions`, pch = 1, frame = FALSE,main='Inherited')
qqline(inherited$`wealth.worth in billions`, col = "blue", lwd = 2)
```



```
qqnorm(non_inherited$`wealth.worth in billions`, pch = 1, frame = FALSE,main='Non inherited')
qqline(non_inherited$`wealth.worth in billions`, col = "red", lwd = 2)
```



Ipak, uočeno je potrebno dodatno ispitati koristeći Kolmogorov–Smirnov test kojim se utvrđuje ravna li se distribucija po normalnoj razdiobi.

```
ks.test(inherited$`wealth.worth in billions`, y="pnorm")
```

```
## Warning in ks.test(inherited$`wealth.worth in billions`, y = "pnorm"): ties
## should not be present for the Kolmogorov-Smirnov test
```

```
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  inherited$`wealth.worth in billions`
## D = 0.84134, p-value < 2.2e-16
## alternative hypothesis: two-sided
```

```
ks.test(non_inherited$`wealth.worth in billions`, y="pnorm")
```

```
## Warning in ks.test(non_inherited$`wealth.worth in billions`, y = "pnorm"): ties
## should not be present for the Kolmogorov-Smirnov test
```

```
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  non_inherited$`wealth.worth in billions`
## D = 0.84134, p-value < 2.2e-16
## alternative hypothesis: two-sided
```

Iz dobivenih p vrijednosti u oba slučaja odbacujemo mogućnost da se distribucije ravnaju po normalnoj razdiobi.

Time je potvrđena pretpostavka da se podaci ne ravnaju po normalnoj distribuciji.

Potrebno je koristiti neparametarski test Mann–Whitney U test, koji se koristi kada se podaci se ravnaju po istim distribucijama (obje distribucije su nakošene u desno) i uzorci su nezavisni iz jedne i druge populacije (jedna osoba ne može nasljediti i nenasljediti bogatstvo).

Hipoteze glase:

$$H_0 : \mu_1 = \mu_2$$
$$H_1 : \mu_1 > \mu_2$$

```
wilcox.test(inherited_mean, non_inherited_mean, alt = "greater")
```

```
##
##  Wilcoxon rank sum exact test
##
## data:  inherited_mean and non_inherited_mean
## W = 1, p-value = 0.5
## alternative hypothesis: true location shift is greater than 0
```

Zbog p-vrijednost jednake 0.5, na temelju značajnosti od 50% ne možemo odbaciti H_0 hipotezu o jednakosti prosječnih vrijednosti bogatstva u korist H_1, odnosno možemo reći da milijarderi koji su nasljedili bogatstvo nisu statistički značajno bogatiji od onih koji nisu.

3. Možete li iz danih varijabli predvidjeti njihovo bogatstvo?

- je li dobro tu koristiti sve milijardere s popisa 2014 + milijarderi s prethodnih popisa (ako nisu na popisu iz 2014. godine)

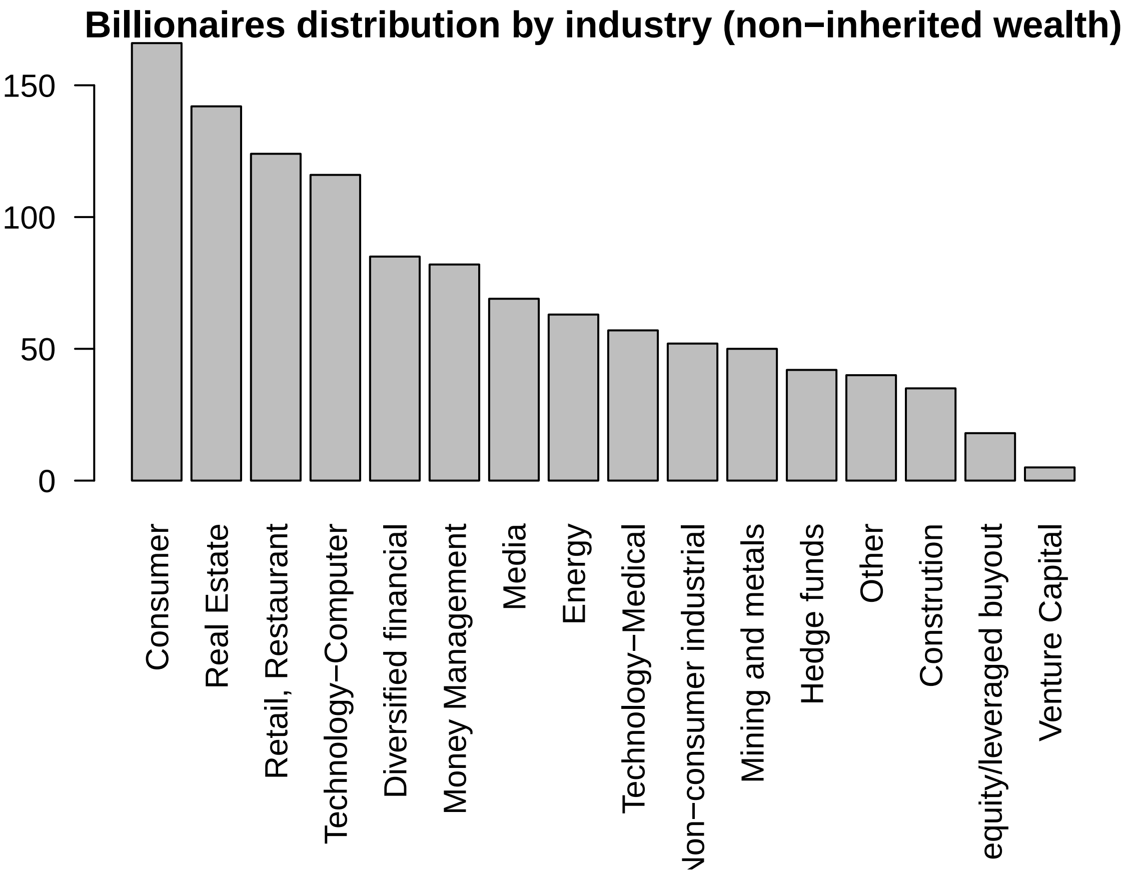
4. Kada biste birali karijeru isključivo prema kriteriju da se obogatite, koju biste industriju izabrali?

Pretpostavljamo da karijerom u određenoj industriji, a ne nasljedstvom zarađujemo novac. Zbog toga gledamo samo milijardere koji nisu naslijedili svoje bogatstvo. Također, zanimaju nas samo najnoviji milijarderi odnosno oni s popisa iz 2014. godine.

- kako prikazati trend kroz godine na grafu (dijagram paralelnih koordinata?)
- možda gledati razliku iz popisa 2014 i 2001, odnosno nove milijardere - pa napraviti raspodjelu industrija novonastalih milijardera

```
#
non_inherited_2014 <- non_inherited[non_inherited$year == 2014,]

par(mar=c(10,5,1,1))
barplot(sort(table(subset(non_inherited_2014$wealth.how.industry, non_inherited_2014$wealth.how.industr
        main = "Billionaires distribution by industry (non-inherited wealth)",
        las = 2)
```


Billionaires distribution by industry (non−inherited wealth)
Consumer
Real Estate
Retail, Restaurant
Technology−Computer
Diversified financial
Money Management
Media
Energy
Technology−Medical
on−consumer industrial
Mining and metals
Hedge funds
Other
Constrution
equity/leveraged buyout
Venture Capital