--->>> Jupyter Notebook <<<---

R Stuff and functions to start up

```
# install.packages("reticulate")
# library(reticulate)
# use_condaenv("DataScience")

install.packages("sf", type = "binary")
install.packages("rnaturalearth", type = "binary")
install.packages("rnaturalearthdata", type = "binary")

library(tidyverse)
library(sf)
library(rnaturalearth)
library(rnaturalearthdata)

library(dplyr)
library(ggplot2)
```

```
Warning message:
"Paket 'sf' wird gerade benutzt und deshab nicht installiert"
Warning message:
"Paket 'rnaturalearth' wird gerade benutzt und deshab nicht installiert"
Warning message:
"Paket 'rnaturalearthdata' wird gerade benutzt und deshab nicht installiert"
```

Funktionen für die Analyse

```
printf <- function(...) cat(sprintf(...))

Mode <- function(x) {
  ux <- unique(x)
  tab <- tabulate(match(x, ux))
  ux[tab == max(tab)]
}

Haeufigkeit <- function(df, feature) {
  haeufigkeit <- df %>%
    group_by({{ feature }}) %>%
    summarise(absolute = n(), relative = round(n() / nrow(df), 2), prozentual =
round(relative * 100))

  haeufigkeit <- arrange(haeufigkeit, desc(absolute))
```

```
}

Gini_Simpson <- function(data) {
  sum(data * (1 - data))
}
```

Daten laden

```
df <- read.table("data\\salaries.csv", sep = ",", header = TRUE)
df
mode(df)
```

```
     work_year experience_level employment_type
1    2023      SE               FT
2    2023      MI               FT
3    2023      MI               FT
4    2023      SE               FT
5    2023      SE               FT
6    2023      SE               FT
7    2023      SE               FT
8    2023      SE               FT
9    2023      SE               FT
10   2023      EX               FT
11   2023      EX               FT
12   2023      SE               FT
13   2023      SE               FT
14   2023      SE               FT
15   2023      SE               FT
16   2023      SE               FT
17   2023      SE               FT
18   2023      SE               FT
19   2023      SE               FT
20   2023      SE               FT
21   2023      SE               FT
22   2023      SE               FT
23   2023      SE               FT
24   2023      SE               FT
25   2023      SE               FT
26   2023      SE               FT
27   2023      SE               FT
28   2023      SE               FT
29   2023      SE               FT
30   2023      SE               FT
...  ...       ...              ...
4737 2021      EN               FT
4738 2021      SE               FT
4739 2020      SE               FT
```

```
4740 2020      MI               FT
4741 2021      MI               FT
4742 2021      EN               FT
4743 2020      SE               FT
4744 2020      MI               FT
4745 2021      MI               FT
4746 2021      SE               FT
4747 2021      MI               FT
4748 2021      MI               FT
4749 2021      MI               FT
4750 2021      MI               FT
4751 2021      MI               FT
4752 2020      SE               FT
4753 2020      MI               FT
4754 2020      MI               FT
4755 2020      MI               FT
4756 2020      SE               FT
4757 2021      SE               FT
4758 2021      MI               FT
4759 2021      MI               FT
4760 2021      MI               FT
4761 2021      SE               FT
4762 2020      SE               FT
4763 2021      MI               FT
4764 2020      EN               FT
4765 2020      EN               CT
4766 2021      SE               FT
```

	job_title	salary	salary_currency	salary_in_usd
1	Software Data Engineer	210000	USD	210000
2	Machine Learning Research Engineer	90000	USD	90000
3	Data Analyst	55000	EUR	59401
4	Analytics Engineer	90000	USD	90000
5	Analytics Engineer	84000	USD	84000
6	Data Analyst	160000	USD	160000
7	Data Analyst	140000	USD	140000
8	Analytics Engineer	221300	USD	221300
9	Analytics Engineer	147500	USD	147500
10	Data Engineer	204500	USD	204500
11	Data Engineer	130000	USD	130000
12	Machine Learning Engineer	210000	USD	210000
13	Machine Learning Engineer	160000	USD	160000
14	Machine Learning Engineer	204500	USD	204500
15	Machine Learning Engineer	142200	USD	142200
16	Data Analyst	186600	USD	186600
17	Data Analyst	119800	USD	119800
18	Analytics Engineer	192000	USD	192000
19	Analytics Engineer	151000	USD	151000
20	Business Intelligence Engineer	185000	USD	185000
21	Business Intelligence Engineer	79600	USD	79600
22	Data Scientist	169000	USD	169000
23	Data Scientist	129300	USD	129300
24	Data Engineer	204500	USD	204500

```
25   Data Engineer                      142200  USD            142200
26   Data Engineer                      250000  USD            250000
27   Data Engineer                      130000  USD            130000
28   Business Intelligence Engineer     210000  USD            210000
29   Business Intelligence Engineer     170000  USD            170000
30   Analytics Engineer                 221300  USD            221300
...  ...                                   ...     ...            ...
4737 Business Data Analyst                50000 EUR             59102
4738 Principal Data Scientist            147000 EUR            173762
4739 Principal Data Scientist            130000 EUR            148261
4740 Data Scientist                       34000 EUR             38776
4741 Data Scientist                       39600 EUR             46809
4742 AI Scientist                       1335000 INR             18053
4743 Data Scientist                       80000 EUR             91237
4744 Data Scientist                       55000 EUR             62726
4745 Data Scientist                      115000 USD            115000
4746 Principal Data Scientist            235000 USD            235000
4747 Lead Data Analyst                  1450000 INR             19609
4748 Data Analyst                         75000 USD             75000
4749 Data Analyst                         62000 USD             62000
4750 Data Scientist                       73000 USD             73000
4751 Data Engineer                        38400 EUR             45391
4752 Data Science Manager                190200 USD            190200
4753 Data Scientist                      118000 USD            118000
4754 Data Scientist                      138350 USD            138350
4755 Data Engineer                       130800 USD            130800
4756 Machine Learning Engineer            40000 EUR             45618
4757 Director of Data Science            168000 USD            168000
4758 Data Scientist                      160000 SGD            119059
4759 Applied Machine Learning Scientist  423000 USD            423000
4760 Data Engineer                        24000 EUR             28369
4761 Data Specialist                     165000 USD            165000
4762 Data Scientist                      412000 USD            412000
4763 Principal Data Scientist            151000 USD            151000
4764 Data Scientist                      105000 USD            105000
4765 Business Data Analyst               100000 USD            100000
4766 Data Science Manager                7000000 INR            94665
     employee_residence remote_ratio company_location company_size
1    US                 100          US               L
2    SA                 100          SA               M
3    DE                  50          DE               L
4    US                   0          US               M
5    US                   0          US               M
6    US                 100          US               M
7    US                 100          US               M
8    US                   0          US               M
9    US                   0          US               M
10   US                   0          US               M
11   US                   0          US               M
12   US                 100          US               M
13   US                 100          US               M
14   US                   0          US               M
```

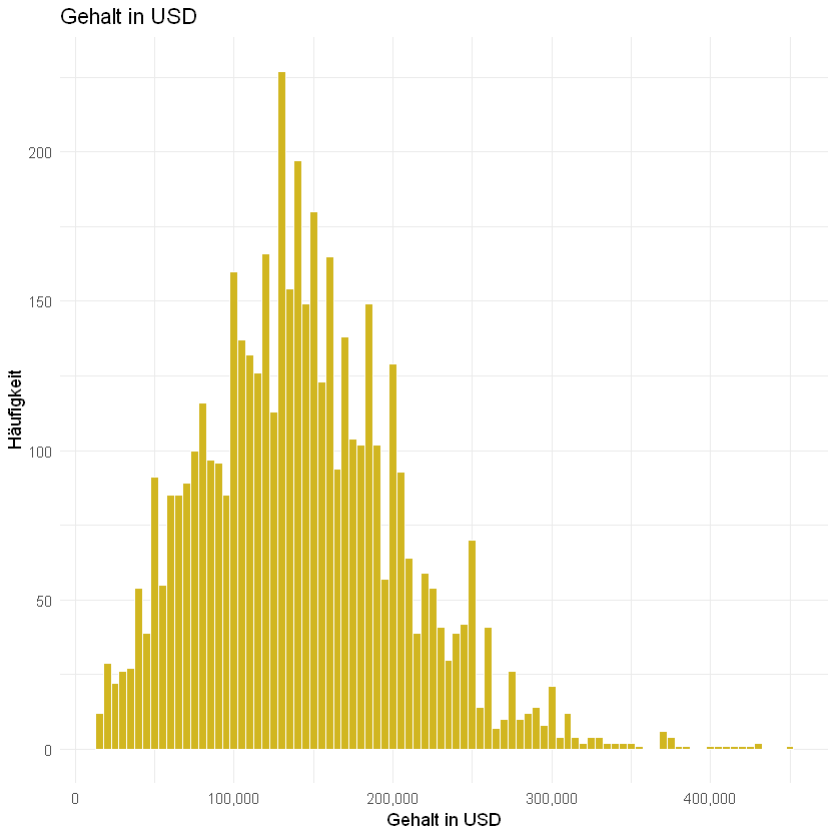
```
15   US                  0          US               M
16   US                100          US               M
17   US                100          US               M
18   US                100          US               M
19   US                100          US               M
20   US                  0          US               L
21   US                  0          US               L
22   US                  0          US               M
23   US                  0          US               M
24   US                  0          US               M
25   US                  0          US               M
26   US                  0          US               M
27   US                  0          US               M
28   US                  0          US               M
29   US                  0          US               M
30   US                  0          US               M
...  ...               ...          ...              ...
4737 LU                100          LU               L
4738 DE                100          DE               M
4739 DE                100          DE               M
4740 ES                100          ES               M
4741 ES                100          ES               M
4742 IN                100          AS               S
4743 AT                  0          AT               S
4744 FR                 50          LU               S
4745 US                 50          US               L
4746 US                100          US               L
4747 IN                100          IN               L
4748 US                  0          US               L
4749 US                  0          US               L
4750 US                  0          US               L
4751 NL                100          NL               L
4752 US                100          US               M
4753 US                100          US               M
4754 US                100          US               M
4755 ES                100          US               M
4756 HR                100          HR               S
4757 JP                  0          JP               S
4758 SG                100          IL               M
4759 US                 50          US               L
4760 MT                 50          MT               L
4761 US                100          US               L
4762 US                100          US               L
4763 US                100          US               L
4764 US                100          US               S
4765 US                100          US               L
4766 IN                 50          IN               L
     employee_residence_country_name company_location_country_name
1    United States                   United States
2    Saudi Arabia                    Saudi Arabia
3    Germany                         Germany
4    United States                   United States
```

```
5    United States                United States
6    United States                United States
7    United States                United States
8    United States                United States
9    United States                United States
10   United States                United States
11   United States                United States
12   United States                United States
13   United States                United States
14   United States                United States
15   United States                United States
16   United States                United States
17   United States                United States
18   United States                United States
19   United States                United States
20   United States                United States
21   United States                United States
22   United States                United States
23   United States                United States
24   United States                United States
25   United States                United States
26   United States                United States
27   United States                United States
28   United States                United States
29   United States                United States
30   United States                United States
...  ...                          ...
4737 Luxembourg                   Luxembourg
4738 Germany                      Germany
4739 Germany                      Germany
4740 Spain                        Spain
4741 Spain                        Spain
4742 India                        American Samoa
4743 Austria                      Austria
4744 France                       Luxembourg
4745 United States                United States
4746 United States                United States
4747 India                        India
4748 United States                United States
4749 United States                United States
4750 United States                United States
4751 Netherlands                  Netherlands
4752 United States                United States
4753 United States                United States
4754 United States                United States
4755 Spain                        United States
4756 Croatia                      Croatia
4757 Japan                        Japan
4758 Singapore                    Israel
4759 United States                United States
4760 Malta                        Malta
4761 United States                United States
```

```
4762 United States                    United States
4763 United States                    United States
4764 United States                    United States
4765 United States                    United States
4766 India                            India

[1] "list"
```

Gehalt in USD

```
ggplot(data = df, aes(x = salary_in_usd)) +
  geom_histogram(binwidth = 5000, fill = "#d1b620", color = "white") +
  labs(title = "Gehalt in USD", x = "Gehalt in USD", y = "Häufigkeit") +
  scale_x_continuous(labels = scales::comma) +
  theme_minimal()
```



rechtsschief / linkssteil

```
print("Zusammenfassung:")
summary(df$salary_in_usd)
print("Standardabweichung:")
sd(df$salary_in_usd)
```

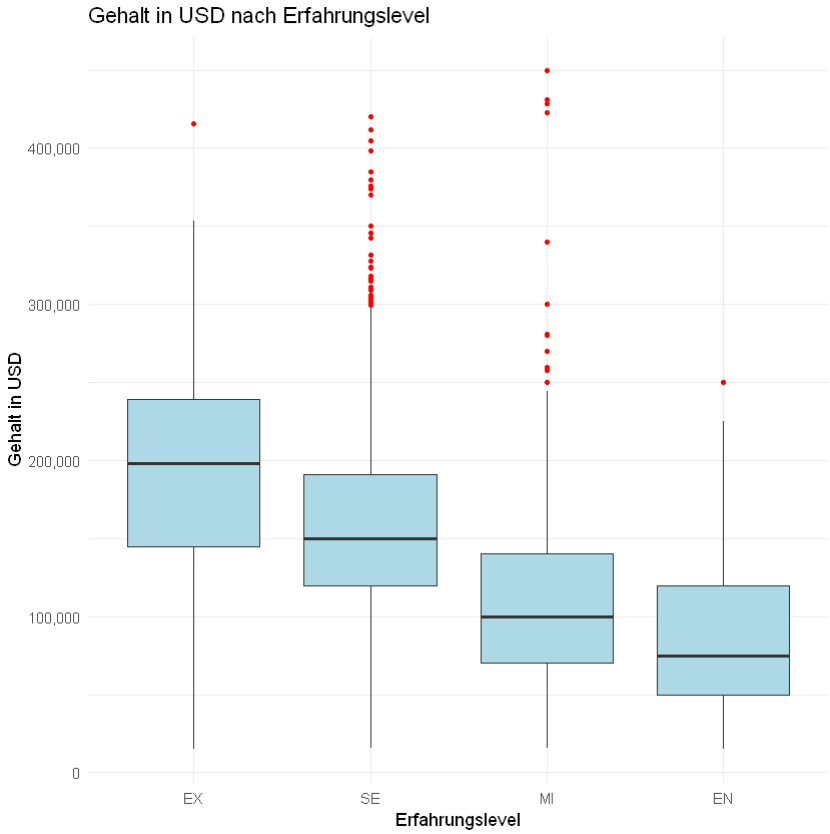
```
[1] "Zusammenfassung:"

   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  15000  100000  140000  143427  182500  450000 

[1] "Standardabweichung:"

[1] 62667.24
```

Min: Geringster Wert im Datensatz
Max: Höchster Wert im Datensatz
1st Quartil: 25 % Der Werte sind kleiner als 1st Quartil, 75 % der Werte größer
3rd Quartil: 75 % Der Werte sind kleiner als 1st Quartil, 25 % der Werte größer
Median (Zentralwert): Der Wert, der genau in der Mitte einer Datenverteilung liegt
Mean (avg, Durchschnitt, Mittelwert): 2nd Quartil, 50 % Der Werte sind kleiner als 1st Quartil, 50 % der Werte größer
Standardabweichung: durchschnittliche Abweichung vom Mittelwert

Grobe Erklärung:
https://de.statista.com/statistik/lexikon/definition/106/quantil/
https://de.statista.com/statistik/lexikon/definition/91/mittelwert_und_arithmetisches_mittel/

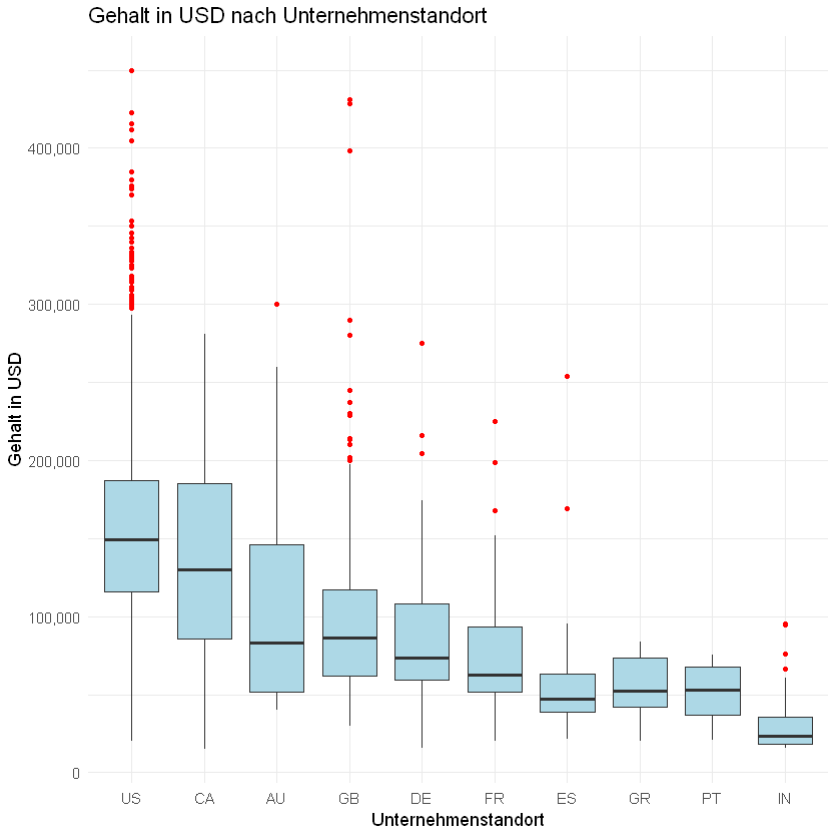
Nach experience_level

```
df_ex <- df %>%
  group_by(experience_level) %>%
  mutate(mean_salary = mean(salary_in_usd)) %>%
  ungroup() %>%
  mutate(experience_level = reorder(experience_level, -mean_salary))


ggplot(df_ex, aes(x = experience_level, y = salary_in_usd)) +
  geom_boxplot(fill = "lightblue", outlier.colour = "red", outlier.size = 1) +
  labs(title = "Gehalt in USD nach Erfahrungslevel", x = "Erfahrungslevel", y =
"Gehalt in USD") +
  scale_y_continuous(labels = scales::comma) +
  theme_minimal()
```



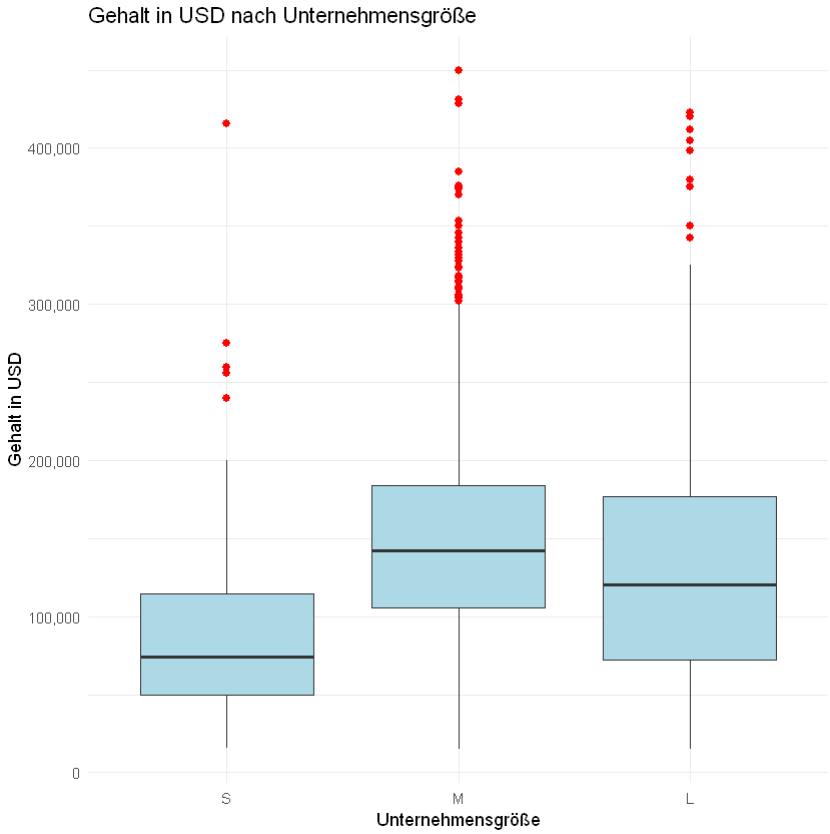
Nach company_location 10 länder mit den meisten unternehmen

```
df_top_countries <- df %>%
  group_by(company_location) %>%
  count() %>%
  arrange(desc(n)) %>%
  head(10)

df_counties <- df %>%
  group_by(company_location) %>%
  filter(company_location %in% df_top_countries$company_location) %>%
  mutate(mean_salary = mean(salary_in_usd)) %>%
  ungroup() %>%
  mutate(company_location = reorder(company_location, -mean_salary))

ggplot(df_counties, aes(x = company_location, y = salary_in_usd)) +
  geom_boxplot(fill = "lightblue", outlier.colour = "red", outlier.size = 1) +
  labs(title = "Gehalt in USD nach Unternehmenstandort", x =
"Unternehmenstandort", y = "Gehalt in USD") +
  scale_y_continuous(labels = scales::comma) +
  theme_minimal()
```



Nach company_size

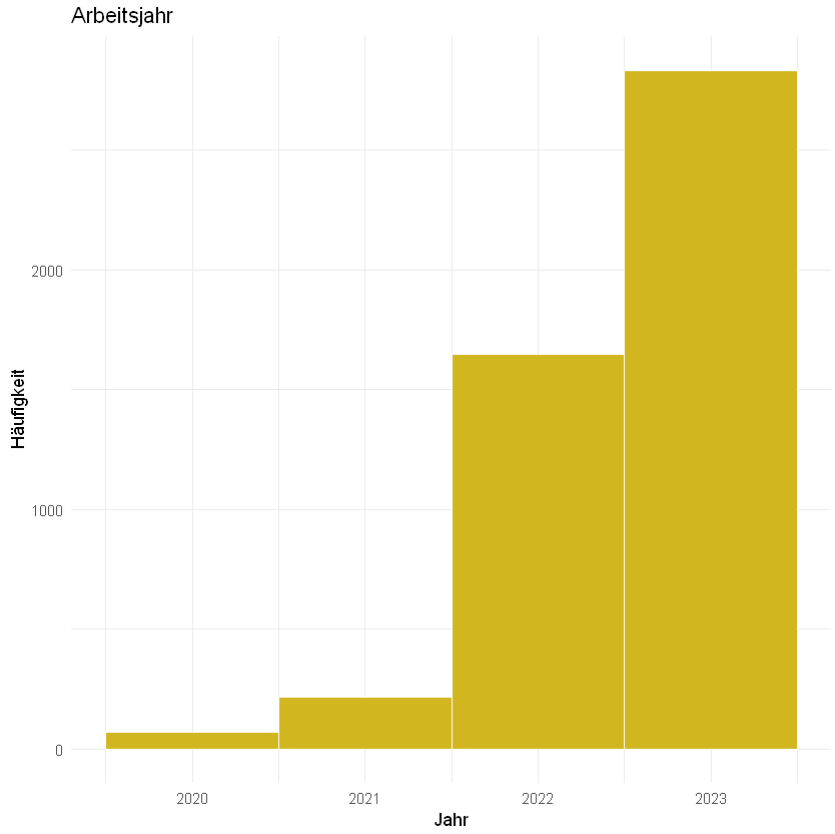
```
size_order <- c('S', 'M', 'L')

df_cz <- df %>%
  mutate(company_size = factor(company_size, levels = size_order)) %>%
  group_by(company_size)

ggplot(df_cz, aes(x = company_size, y = salary_in_usd)) +
  geom_boxplot(fill = "lightblue", outlier.colour = "red", outlier.size = 2) +
  labs(title = "Gehalt in USD nach Unternehmensgröße", x = "Unternehmensgröße", y
= "Gehalt in USD") +
  scale_y_continuous(labels = scales::comma) +
  theme_minimal()
```



Spearman Correlation

Work Year

```
ggplot(data = df, aes(x = work_year)) +
  geom_histogram(binwidth = 1, fill = "#d1b620", color = "white") +
  labs(title = "Arbeitsjahr", x = "Jahr", y = "Häufigkeit") +
  theme_minimal()
```



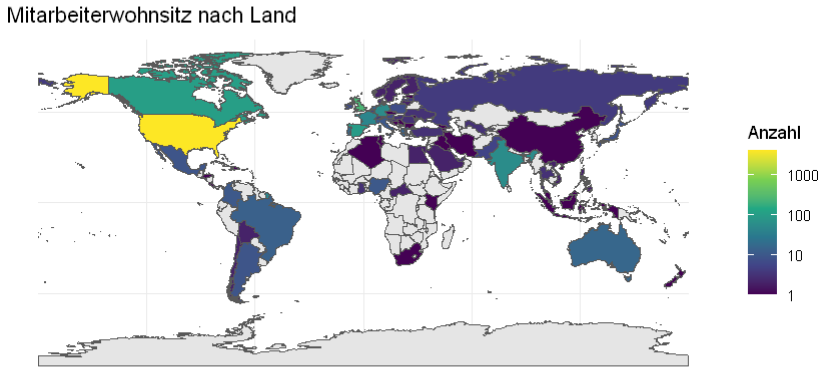

```
print("Zusammenfassung:")
summary(df$work_year)
print("Standardabweichung:")
sd(df$work_year)
```

```
[1] "Zusammenfassung:"

   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
   2020    2022    2023    2023    2023    2023 

[1] "Standardabweichung:"

[1] 0.6549009
```

employee_residence

```
world <- ne_countries(scale = "medium", returnclass = "sf")
agg_emp_data <- df %>%
    group_by(employee_residence) %>%
    summarise(emp_count = n())

# Join employee data with world map data
world_with_emp_data <- world %>%
    left_join(agg_emp_data, by = c("iso_a2" = "employee_residence"))
```

```
ggplot(data = world_with_emp_data) +
    geom_sf(aes(fill = emp_count)) +
    scale_fill_viridis_c(
        option = "viridis", trans = "log10",
        na.value = "gray90", guide = guide_colorbar(title = "Anzahl")
    ) +
    labs(title = "Mitarbeiterwohnsitz nach Land") +
    theme_minimal()
```



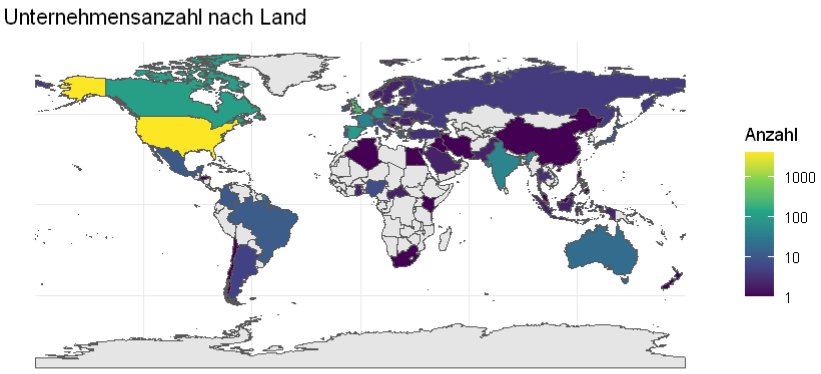

```
m <- Mode(df$employee_residence_country_name)
printf("Mode: %s\n", m)
```

```
Mode: United States
```

company_location

```
agg_company_data <- df %>%
    group_by(company_location) %>%
    summarise(comp_count = n())

# Join employee data with world map data
world_with_company_data <- world %>%
```

```
    left_join(agg_company_data, by = c("iso_a2" = "company_location"))

ggplot(data = world_with_company_data) +
    geom_sf(aes(fill = comp_count)) +
    scale_fill_viridis_c(
        option = "viridis", trans = "log10",
        na.value = "gray90", guide = guide_colorbar(title = "Anzahl")
    ) +
    labs(title = "Unternehmensanzahl nach Land") +
    theme_minimal()
```



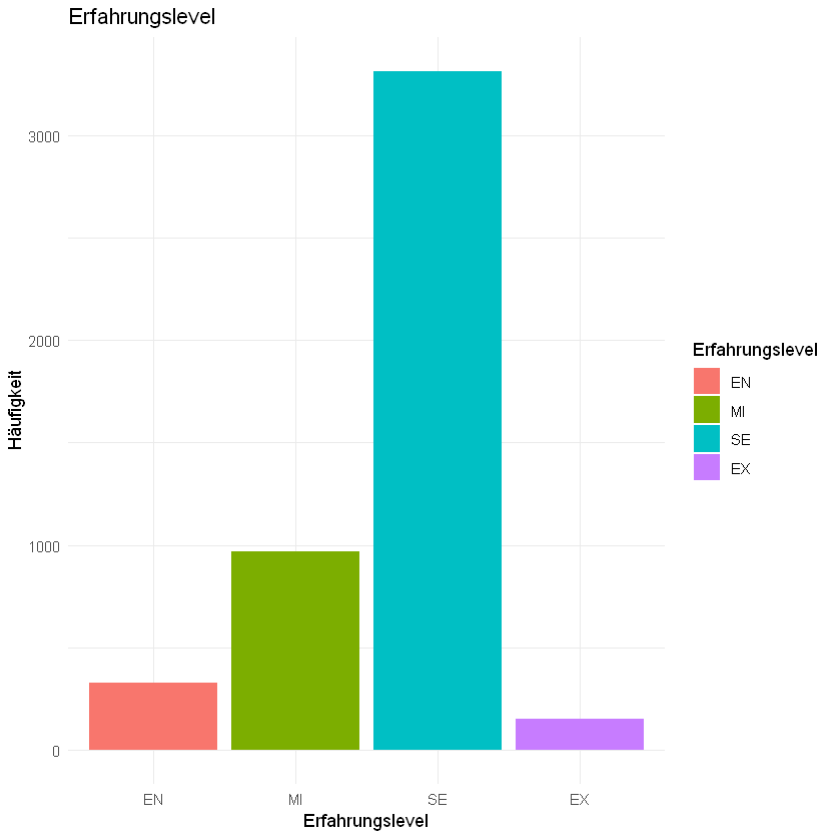

```
m <- Mode(df$company_location_country_name)
printf("Mode: %s\n", m)
```

```
Mode: United States
```

Experience Level

```
exp_order <- c('EN', 'MI', 'SE', 'EX')

df_exp_ordered <- df %>%
  mutate(experience_level = factor(experience_level, levels = exp_order))
```

```
ggplot(data = df_exp_ordered, aes(x = experience_level, fill = experience_level))
+
  geom_bar() +
  labs(title = "Erfahrungslevel", x = "Erfahrungslevel", y = "Häufigkeit", fill =
"Erfahrungslevel") +
  theme_minimal()
```



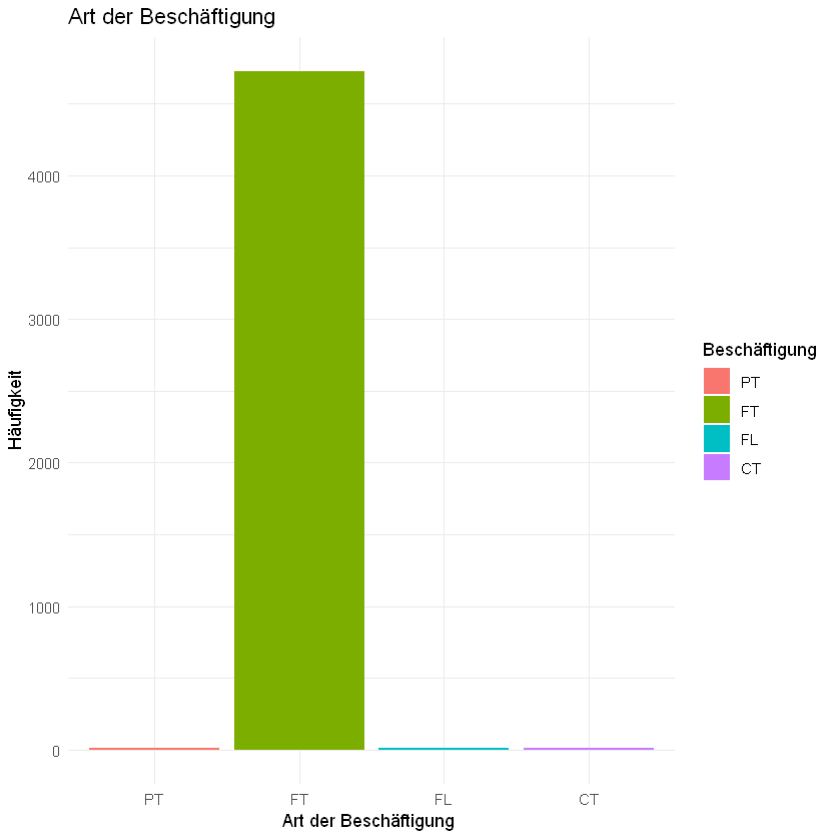

```
m <- Mode(df$experience_level)
printf("Mode: %s\n", m)
```

```
Mode: SE
```

employment_type

```
emp_order <- c('PT', 'FT', 'FL', 'CT')

df_emp_ordered <- df %>%
  mutate(employment_type = factor(employment_type, levels = emp_order))

ggplot(data = df_emp_ordered, aes(x = employment_type, fill = employment_type)) +
  geom_bar() +
  labs(title = "Art der Beschäftigung", x = "Art der Beschäftigung ", y =
```

```
"Häufigkeit", fill = "Beschäftigung") +
  theme_minimal()
```

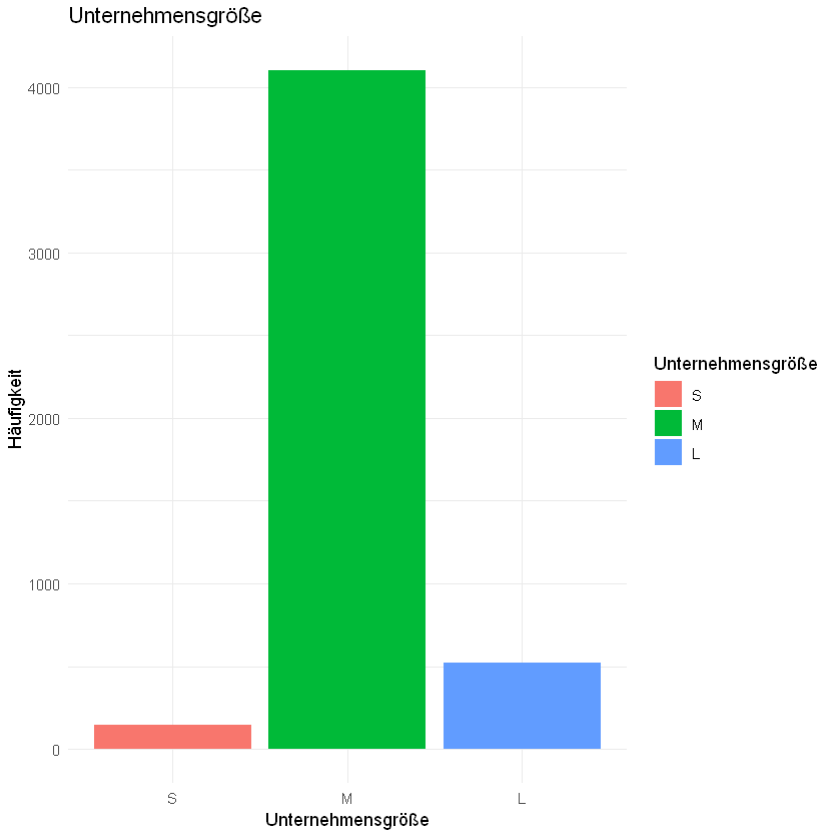



```
m <- Mode(df$employment_type)
printf("Mode: %s\n", m)
```

```
Mode: FT
```

company_size

```
size_order <- c('S', 'M', 'L')

df_cs <- df %>%
  mutate(company_size = factor(company_size, levels = size_order)) %>%
  group_by(company_size)

ggplot(data = df_cs, aes(x = company_size, fill = company_size)) +
  geom_bar() +
  labs(title = "Unternehmensgröße", x = "Unternehmensgröße", y = "Häufigkeit",
fill = "Unternehmensgröße") +
  theme_minimal()
```



salary_currency

```
modalwert <- Mode(df$salary_currency)
printf("Mode: %s\n", modalwert)

haeufigkeit <- Haeufigkeit(df, salary_currency)
"Häufigkeiten:"
haeufigkeit

gini <- Gini_Simpson(haeufigkeit$relative)
printf("Gini: %f", gini)
```

```
Mode: USD

[1] "Häufigkeiten:"

   salary_currency absolute relative prozentual
1  USD              4200     0.88     88
2  EUR               250     0.05      5
3  GBP               198     0.04      4
4  INR                43     0.01      1
5  CAD                26     0.01      1
6  AUD                10     0.00      0
7  PLN                 6     0.00      0
8  SGD                 6     0.00      0
9  CHF                 4     0.00      0
```

```
10 JPY                4     0.00      0
11 DKK                3     0.00      0
12 HUF                3     0.00      0
13 BRL                2     0.00      0
14 NOK                2     0.00      0
15 THB                2     0.00      0
16 TRY                2     0.00      0
17 CLP                1     0.00      0
18 HKD                1     0.00      0
19 ILS                1     0.00      0
20 MXN                1     0.00      0
21 ZAR                1     0.00      0

Gini: 0.211300
```

company_size

```
m <- Mode(df$company_size)
printf("Mode: %s\n", m)
```

```
Mode: M
```

Korrelationen

Skalen

muss in zahlen ausdrückbar sein

```
newdf <- df %>% select(where(is.numeric))
```

Pearson's correlation between salary and work_year (nicht gut für Skalen Kardinalskala, wie hier!)

salary_in_usd ist verhältnis, work_year ordninal

Intervall: -1 < r < 1 [-1 (Antikorrelation), 1 (Korrelation)]

```
correlation <- cor(df$salary_in_usd, df$work_year)
correlation
```

```
[1] 0.2172535
```

Calculate Spearman's rank correlation between remote_ratio and salary

Intervall: -1 < r < 1 [-1 (Antikorrelation), 1 (Korrelation)]

```
correlation <- cor(df$salary_in_usd, df$work_year, method = "spearman")
correlation
```

```
[1] 0.204063
```

Pearson Correlation

```
cor(newdf)
```

```
              work_year   salary       salary_in_usd remote_ratio
work_year      1.00000000 -0.092195886  0.217253523  -0.21299049
salary        -0.09219589  1.000000000 -0.004254672   0.02551045
salary_in_usd  0.21725352 -0.004254672  1.000000000  -0.07687290
remote_ratio  -0.21299049  0.025510451 -0.076872897   1.00000000
```

```
cor(newdf, method = "spearman")
```

```
              work_year  salary      salary_in_usd remote_ratio
work_year      1.0000000  0.15960528  0.20406301   -0.22426536
salary         0.1596053  1.00000000  0.92301437   -0.04436938
salary_in_usd  0.2040630  0.92301437  1.00000000   -0.07305041
remote_ratio  -0.2242654 -0.04436938 -0.07305041    1.00000000
```

Regression

```
summary(lm(salary_in_usd ~ work_year, data = df))
```

```
Call:
lm(formula = salary_in_usd ~ work_year, data = df)
```

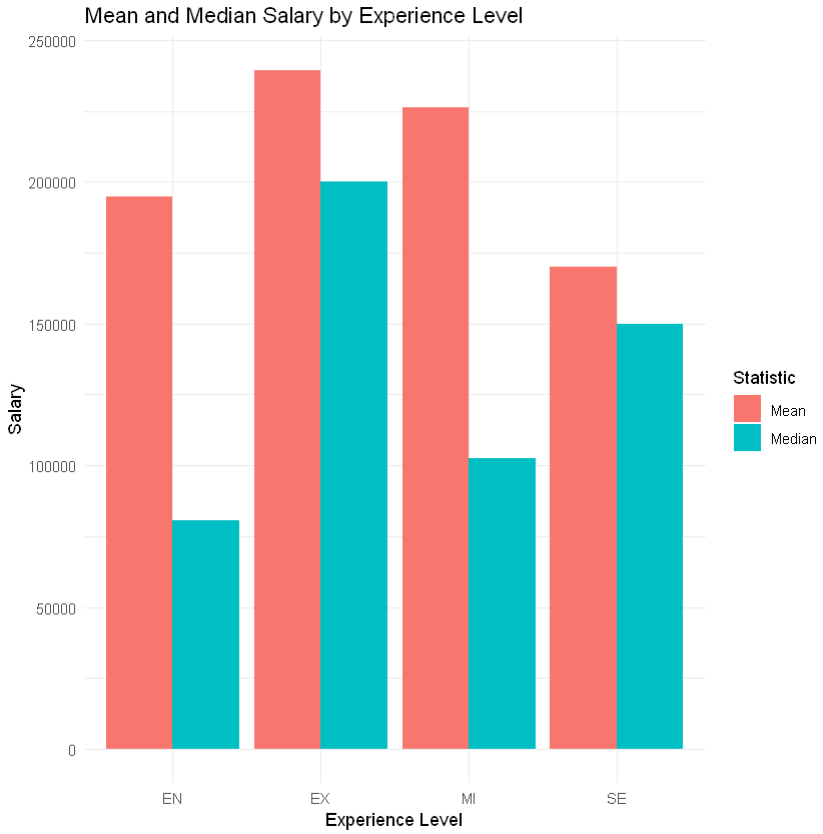
```
Residuals:
    Min      1Q  Median      3Q     Max
-137595  -43172   -3416   36584  358951

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -41902560    2736988  -15.31   <2e-16 ***
work_year       20789       1353   15.36   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 61180 on 4764 degrees of freedom
Multiple R-squared:  0.0472,    Adjusted R-squared:  0.047
F-statistic:   236 on 1 and 4764 DF,  p-value: < 2.2e-16
```

Anderes

```
df_summary <- df %>%
  group_by(experience_level) %>%
  summarize(mean_salary = mean(salary), median_salary = median(salary)) %>%
  gather(key = "statistic", value = "value", mean_salary, median_salary)
df_summary
```

```
  experience_level statistic     value
1 EN               mean_salary   194632.1
2 EX               mean_salary   239449.3
3 MI               mean_salary   226226.7
4 SE               mean_salary   169895.5
5 EN               median_salary  80500.0
6 EX               median_salary 200000.0
7 MI               median_salary 102500.0
8 SE               median_salary 150000.0
```

```
ggplot(data = df_summary, aes(x = experience_level, y = value, fill = statistic))
+
    geom_bar(stat = "identity", position = "dodge") +
    theme_minimal() +
    labs(y = "Salary", x = "Experience Level", title = "Mean and Median Salary by
Experience Level") +
    scale_fill_discrete(name = "Statistic", labels = c("Mean", "Median"))
```




```
chisq.test(df$work_year, df$company_size, simulate.p.value = TRUE)
```

```
    Pearson's Chi-squared test with simulated p-value (based on 2000
    replicates)

data:  df$work_year and df$company_size
X-squared = 1140.4, df = NA, p-value = 0.0004998
```

Setup

install miniconda / anaconda install R, add R to path "C:\Program Files\R\R-4.3.0\bin\x64"

create new env (named DataScience)

```
conda config --add channels conda-forge
conda config --set channel_priority strict
conda search r-base
conda create -n your_name_here python=3.X
conda activate your_name_here
conda install -c conda-forge r-base=4.X.X
conda install r r-essentials --channel conda-forge
conda install jupyter
```

In console type "R", R Console opens, install jupyter notebook

```
install.packages('IRkernel')
install.packages(c("tidyverse", "sf", "rnaturalearth", "rnaturalearthdata"))
IRkernel::installspec()
```

create requirments.txt `pip list --format=freeze > requirements.txt` in conda env

Datenaufbereitung

Führe `iso3166_to_countryName.py` aus damit aus dem Ländercode der Ländername erzeugt werden kann, wird im JupyterNotebook benötigt.