Preparing Salaries Data

This notebook is for preparing data for Analysis and Prediction.
Classical preparation steps are taken here:
- Uniformization of terminology/ columns/ values/ units of measurement.
- Handling missing and mistyped values.
- Detecting outliers.
- Deriving new variables.
- Reporting the data quality metrics.

A few words about the sources:
Three main sources were used for salary data; which repeated the survey yearly.
1.) Kaggle.com, a central professional social-network for anything that is data-related.
The data from Kaggle is enormous, and is filled out by individualy coming from a wide variaty of tech disccipline.
2.) AI-Jobs.net, which is also centered around data-professionals, but not exclusively. This is a private recruitment & job-listing company.
3.) Germany IT-Survey, a germany-specific survey targeting tech professionals. This is quite welcome, as I'm specifically interested in germany's IT landscape.

Table of Content:

In [1]:
```
import sys
sys.path.append('../')
from scripts.tableofcontent_generator import generate_toc, generate_toc_withanchors
notebook_path = '../notebooks/Salaries_Preparation.ipynb'
```

In [5]:
```
toc_content = generate_toc(notebook_path)
print(toc_content)
```

Import libraries & data, general settings

In [4]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import datetime as dt
from datetime import datetime
import re
from IPython.display import HTML, display

import statsmodels.api as sm
from statsmodels.formula.api import ols
import statsmodels.stats.multicomp as mc
from scipy.stats import levene, shapiro

# If the notebook is opened from the "notebooks" folder, we need to append the main directory to the "python path" so it sees all subfolders.
import sys
sys.path.append('../')
```

In [5]:
```
df_it18_ini = pd.read_csv('../data/raw/IT_Salary_Survey_EU_2018.csv', low_memory=False)
df_it19_ini = pd.read_csv('../data/raw/IT_Salary_Survey_EU_2019.csv', low_memory=False)
df_it20_ini = pd.read_csv('../data/raw/IT_Salary_Survey_EU_2020.csv', low_memory=False)
df_it21_ini = pd.read_csv('../data/raw/IT_Salary_Survey_EU_2021.csv', low_memory=False)
df_it22_ini = pd.read_csv('../data/raw/IT_Salary_Survey_EU_2022.csv', low_memory=False)
df_it23_ini = pd.read_csv('../data/raw/IT_Salary_Survey_EU_2023.csv', low_memory=False)

df_k19_ini = pd.read_csv('../data/raw/kaggle_survey_2019_responses.csv', low_memory=False)
df_k20_ini = pd.read_csv('../data/raw/kaggle_survey_2020_responses.csv', low_memory=False)
df_k21_ini = pd.read_csv('../data/raw/kaggle_survey_2021_responses.csv', low_memory=False)
df_k22_ini = pd.read_csv('../data/raw/kaggle_survey_2022_responses.csv', low_memory=False)

df_ai_ini = pd.read_csv('../data/raw/ai-jobsnet_salaries_2024.csv', low_memory=False)
```

In [6]:
```
country_salary_stats = pd.read_csv('../data/world_economic_indices/country_salary_stats.csv', sep=';', low_memory=False)
```

In [7]:
```
dfs_ini = [
    df_it18_ini,
    df_it19_ini,
    df_it20_ini,
    df_it21_ini,
    df_it22_ini,
    df_it23_ini,
    df_k19_ini,
    df_k20_ini,
    df_k21_ini,
    df_k22_ini,
    df_ai_ini,
    country_salary_stats]
```

In [8]:
```
len_it18_ini = len(df_it18_ini)
len_it19_ini = len(df_it19_ini)
len_it20_ini = len(df_it20_ini)
```

```
len_it21_ini = len(df_it21_ini)
len_it22_ini = len(df_it22_ini)
len_it23_ini = len(df_it23_ini)

len_k19_ini = len(df_k19_ini)
len_k20_ini = len(df_k20_ini)
len_k21_ini = len(df_k21_ini)
len_k22_ini = len(df_k22_ini)

len_ai_ini = len(df_ai_ini)
```

Styles

In [10]:
```
# General Display settings

# Column display is supressed by default
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', 100)

#changing the display format
pd.set_option('display.float_format', lambda x: '%.2f' % x)

# Plotting format
#print(plt.style.available)
plt.style.use('seaborn-v0_8-whitegrid')
```

In [11]:
```
style_light_theme = """
<style>
h1 {
    background-color: #0e2e3b;
    color: white;
    font-size: 40px !important;
    font-weight: 700 !important;
    padding: 10px;
}
h2 {
    background-color: #07447E;
    color: white;
    font-size: 35px !important;
    font-weight: 700 !important;
    padding: 10px;
}
h3 {
    background-color: #047c98;
    color: white;
    font-size: 30px !important;
    font-weight: 700 !important;
    padding: 10px;
}
h4 {
    background-color: #0AB89E;
    color: white;
    font-size: 25px !important;
    font-weight: 700 !important;
    padding: 5px;
}
/* ---------------------------------  Conclusion class */
.c {
    background-color: #f7fe9a;
    color: black;
    padding: 10px 10px 10px 20px;        /* Top, Right, Bottom, Left */
    font-size: 16px;
    font-style: italic;
}
/* ---------------------------------  Note class */
.note {
    background-color: #f4fcc0;
    color: black;
    padding: 2px 10px 2px 20px;        /* Top, Right, Bottom, Left */
    font-size: 14px;
    font-style: italic;
}
</style>
```

```
"""
```

In [12]:
```
#display(HTML(style_dark_theme))
display(HTML(style_light_theme))
```

Basic standardization

In [14]:
```
# Column names to lowercase
for df in dfs_ini:
    df.columns = df.columns.str.lower()

## Values to lowercase
#for i in range(len(dfs)):
#    dfs[i] = dfs[i].applymap(lambda x: x.lower() if isinstance(x, str) else x)

# Whitespaces in column names
for df in dfs_ini:
    df.columns = df.columns.str.replace(' ', '_')
```

In [15]:
```
df_it20_ini.head(2)
```

Out[15]:

	timestamp	age	gender	city	position_	total_years_of_experience	years_of_experience_in_germany	seniority_level	your_main_technology_/_programming_language	other_technologies/programming_languages_you_use_often	yearly_brutto_salary_(without_bonus_and_stocks)_in_eur	yearly_bonus_+_stocks_in_
0	24/11/2020 11:14:15	26.00	Male	Munich	Software Engineer	5	3	Senior	TypeScript	Kotlin, Javascript / Typescript	80000.00	5
1	24/11/2020 11:14:16	26.00	Male	Berlin	Backend Developer	7	4	Senior	Ruby	NaN	80000.00	N

In [16]:
```
# # Every datapoints to lowercase
#
# df_it18_ini =df_it18_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# df_it19_ini =df_it19_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# df_it20_ini =df_it20_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# df_it21_ini =df_it21_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# df_it22_ini =df_it22_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# df_it23_ini =df_it23_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# df_k19_ini = df_k19_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# df_k20_ini = df_k20_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# df_k21_ini = df_k21_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# df_k22_ini = df_k22_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# df_ai_ini =df_ai_ini.applymap(lambda x: x.lower() if isinstance(x, str) else x)
# country_salary_stats = country_salary_stats.applymap(lambda x: x.lower() if isinstance(x, str) else x)
```

In [17]:
```
for df in dfs_ini:
    str_columns = df.select_dtypes(include=['object']).columns
    df[str_columns] = df[str_columns].map(lambda x: x.lower() if isinstance(x, str) else x)
```

Downcasting data types for better memory usage

In [19]:
```
from scripts.memory_summary import memory_summary
```

In [20]:
```
?? memory_summary
```

```
Signature:  memory_summary(df, num_rows=None)
Source:
def memory_summary(df, num_rows=None):
    """ A simple function to list out the memory usage of each column.
    Inputs: (df, an integer to control how many columns should be printed)"""
    # Calculate Total memory usage:
    print("Total memory Usage:")
    print(f"\t{round(df.memory_usage(deep=True).sum() / (1024 * 1024), 2)} MB")

    # Calculate memory usage for each column
    memory_usage_per_column = {column: round(df[column].memory_usage(deep=True) / (1024 * 1024), 2) for column in df.columns}
    # Sort columns by memory usage in descending order
    sorted_columns_by_memory = sorted(memory_usage_per_column.items(), key=lambda x: x[1], reverse=True)

    # Print detailed memory usage in descending order
    print(f"Detailed memory Usage [{len(sorted_columns_by_memory)} columns] (descending order):")
    if num_rows is None:
        num_rows = len(sorted_columns_by_memory)
    for i in range(min(num_rows, len(sorted_columns_by_memory))):
        column, memory_usage = sorted_columns_by_memory[i]
        print(f"\t{column}: {memory_usage} MB")
File:      e:\_programming\_dataanalysis\salary_data_combined\scripts\memory_summary.py
Type:      function
```

Kaggle

In [22]:
```
memory_summary(df_k21_ini, 10)
```

```
Total memory Usage:
        336.53 MB
Detailed memory Usage [369 columns] (descending order):
        q4: 2.47 MB
        q41: 2.11 MB
        q23: 1.96 MB
        q11: 1.64 MB
        q24_part_1: 1.55 MB
        q5: 1.54 MB
        q15: 1.52 MB
        q6: 1.46 MB
        q42_part_6: 1.46 MB
        q3: 1.44 MB
```

In [23]:
```
df_k21_ini = df_k21_ini.astype('category')
```

In [24]:
```
memory_summary(df_k21_ini, 10)
```

```
Total memory Usage:
        9.67 MB
Detailed memory Usage [369 columns] (descending order):
        time_from_start_to_finish_(seconds): 0.4 MB
        q1: 0.03 MB
        q2: 0.03 MB
        q3: 0.03 MB
        q4: 0.03 MB
        q5: 0.03 MB
        q6: 0.03 MB
        q7_part_1: 0.03 MB
        q7_part_2: 0.03 MB
        q7_part_3: 0.03 MB
```

Categorical conversion made a significant impact on memory usage.
It's logical since the survey contained fixed-choice questions.
I proceed by converting all the remaining Kaggle datasets.

In [26]:
```
df_k19_ini = df_k19_ini.astype('category')
df_k20_ini = df_k20_ini.astype('category')
#df_k21_ini = df_k21_ini.astype('category')
df_k22_ini = df_k22_ini.astype('category')
```

Germany IT survey

In [28]:
```
memory_summary(df_it23_ini, 10)
```

```
Total memory Usage:
        1.05 MB
Detailed memory Usage [41 columns] (descending order):
        company_industry: 0.07 MB
        employment_status: 0.05 MB
        position: 0.05 MB
        other_technologies/programming_languages_you_use_often: 0.05 MB
        city: 0.04 MB
        seniority_level: 0.04 MB
        main_technology_/_programming_language: 0.04 MB
        what_languages_do_you_speak_and_use_at_work?: 0.04 MB
        company_size: 0.04 MB
        company_layoffs: 0.04 MB
```

It already requires so little memory usage, that I do not proceed with downcasting

AI-Jobs.net

In [31]:
```
memory_summary(df_ai_ini, 10)
```

```
Total memory Usage:
        6.14 MB
Detailed memory Usage [11 columns] (descending order):
        job_title: 0.99 MB
        salary_currency: 0.79 MB
        experience_level: 0.78 MB
        employment_type: 0.78 MB
        employee_residence: 0.78 MB
        company_location: 0.78 MB
        company_size: 0.76 MB
        work_year: 0.12 MB
        salary: 0.12 MB
        salary_in_usd: 0.12 MB
```

It already uses an insignificant amount of memory, but I proceed with downcasting to have consistent variable types.

In [33]:
```
df_ai_ini = df_ai_ini.astype('category')
```

Comprehending the data. Uniformization.

The different surveys store the same data under differently named columns.
Furthermore, even the same source, as it repeats the survey yearly, the format is changed up.
Uniformization requires now a lot of manual work, as there is no common structure.

Uniformization goal:
- "salary": Yearly gross salary with bonuses included [int, in USD],
- "year": Year in which the datapoint was recorded [int],
- "job_title": The title of the job eg.: "Data Engineer"[str],
- "job_group": An arbitrary grouping of similar job titles: "Data Engineer" & "Database Engineer" --> "DA" [str],

In [36]:
```
# A simple function to list out the column names and the most frequent values.

def top_5_values_per_column(df):
    # Create an empty DataFrame to store the result
    result_df = pd.DataFrame(columns=['column_name', 'top_5_values'])
```

```
    # Iterate through each column
    for column in df.columns:
        # Find the five most common values in the column
        top_5_values = df[column].value_counts().head(5).index.tolist()

        # Create a DataFrame with the current column name and top 5 values
        data_to_append = pd.DataFrame({'column_name': [column], 'top_5_values': [top_5_values]})

        # Concatenate the new DataFrame with the result DataFrame
        result_df = pd.concat([result_df, data_to_append], ignore_index=True)

    return result_df
```

Importing the Clean_Salary function

In [38]:
```
# Reloading a module
import importlib
import sys
import scripts.clean_salary

# Add the parent directory of 'scripts' to the module search path
sys.path.append('../')

# Reload the module
importlib.reload(scripts.clean_salary)
from scripts.clean_salary import clean_salary_0616
df_report = pd.DataFrame(index=[0])
```

In [39]:
```
?? clean_salary_0616
```

```
Signature:  clean_salary_0616(x, df_report, prefix)
Source:
def clean_salary_0616(x, df_report, prefix):
    """ A cleaning function for salary with reporting.
    Fills an empty df (df_report) with statistics of what modifications this function made.
    Keeps track of which column the statistics was gathered from (prefix).
    Usage example: df['cleaned_salary'] = df['dirty_salary'].apply(clean_salary, df_report=df_report, prefix='mydf_dirty_salary')

    Tip: Should be used before pd.to_numeric()
    Tip: Handling none-s should be done separately, this function skips nones.
    """
    # Initialize columns if they don't exist
    columns_to_initialize = [
        prefix + '_null_values_encountered',
        prefix + '_strings_encountered',
        prefix + '_leading_trailing_whitespace',
        prefix + '_+-_characters_removed',
        prefix + '_commas_replaced'
    ]
    for column in columns_to_initialize:
        if column not in df_report.columns:
            df_report[column] = 0

    # Increment appropriate counters based on the value of x
    if pd.isna(x):  # Skip Null values
        df_report.at[0, prefix + '_null_values_encountered'] += 1
        return None

    # Check for strings
    if isinstance(x, str):
        df_report.at[0, prefix + '_strings_encountered'] += 1

        # Remove leading and trailing whitespace
        original_x = x
        x = x.strip()
        if x != original_x:
            df_report.at[0, prefix + '_leading_trailing_whitespace'] += 1

        # Remove weird numeric characters.
        original_x = x
        x = x.replace('+', '')
        x = x.replace('-', '')
        if x != original_x:
            df_report.at[0, prefix + '_+-_characters_removed'] += 1

        # Replace commas with dots.
        # pd.to_numeric function can correctly identify '.' as decimal separators, but not ','
        original_x = x
        x = x.replace(',', '.')
        if x != original_x:
            df_report.at[0, prefix + '_commas_replaced'] += 1
        return x  # Return the cleaned string
    else:
        return x
File:      e:\_programming\_dataanalysis\salary_data_combined\scripts\clean_salary.py
Type:      function
```

AI-Jobs.net

In [41]:
```
top_5_values_per_column(df_ai_ini)
```

Out[41]:

	column_name	top_5_values
0	work_year	[2023, 2024, 2022, 2021, 2020]
1	experience_level	[se, mi, en, ex]
2	employment_type	[ft, pt, ct, fl]
3	job_title	[data engineer, data scientist, data analyst, ...
4	salary	[150000, 100000, 130000, 160000, 120000]
5	salary_currency	[usd, gbp, eur, inr, cad]
6	salary_in_usd	[150000, 100000, 130000, 160000, 140000]
7	employee_residence	[us, gb, ca, es, de]
8	remote_ratio	[0, 100, 50]
9	company_location	[us, gb, ca, es, de]
10	company_size	[m, l, s]

In [42]:
```
# Define column name mappings
column_mappings = {
    'work_year': 'year',
    'experience_level': 'seniority_level',
    'employment_type': 'employment_status',
    'employee_residence': 'country',
    'salary': 'salary_in_currency',
    'salary_in_usd': 'salary'
}

# Rename columns using the mappings
df_ai_u = df_ai_ini.rename(columns=column_mappings)
df_ai_u.head(5)
```

Out[42]:

	year	seniority_level	employment_status	job_title	salary_in_currency	salary_currency	salary	country	remote_ratio	company_location	company_size
0	2024	en	ft	data analyst	20000	usd	20000	ke	100	ke	m
1	2024	se	ft	data analyst	147500	usd	147500	us	0	us	m
2	2024	se	ft	data analyst	85000	usd	85000	us	0	us	m
3	2024	se	ft	data architect	175000	usd	175000	us	0	us	m
4	2024	se	ft	data architect	117000	usd	117000	us	0	us	m

In [43]:
```
df_ai_u['salary'] = df_ai_u['salary'].apply(clean_salary_0616, df_report=df_report, prefix='df_ai_salary')
print(df_report)
```

```
   df_ai_salary_null_values_encountered  df_ai_salary_strings_encountered  \
0                                     0                                 0

   df_ai_salary_leading_trailing_whitespace  \
0                                         0

   df_ai_salary_+-_characters_removed  df_ai_salary_commas_replaced
0                                   0                           0
```

In [44]:
```
df_ai_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 15965 entries, 0 to 15964
Series name: salary
Non-Null Count  Dtype
--------------  -----
15965 non-null  category
dtypes: category(1)
memory usage: 118.2 KB
```

There are no Null values, so we do not need to drop them.

Exchange rates

EUR --> USD exchange ratio calculations *. I'm using the ratios that AI-Jobs.net used, since I can calculate it reversely and reuse those rates.*
The rates they used was a fixed rate for the entire year, and aligns with the "Average" exchange rates for that year available online.

In [47]:
```
# Converting salary and salary_in_currency back to numeric
df_ai_u['salary'] = pd.to_numeric(df_ai_u['salary'], errors='coerce')
df_ai_u['salary_in_currency'] = pd.to_numeric(df_ai_u['salary_in_currency'], errors='coerce')

# Calculating the ratios
df_ai_u['ratio'] = df_ai_u['salary'] / df_ai_u['salary_in_currency']

#changing the display format
pd.set_option('display.float_format', lambda x: '%.6f' % x)

#listing out the calculated ratios. Within each year, they're almost the same, except the rounding error.
df_ai_u[(df_ai_u['salary_currency'] == 'eur') & (df_ai_u['year'] == 2020)].value_counts('ratio').head(10)
```

Out[47]:
```
ratio
1.140452    2
1.140473    2
1.140471    2
1.140467    2
1.140450    2
1.140429    1
1.140464    1
1.140472    1
1.140471    1
1.140470    1
Name: count, dtype: int64
```

Most probably they ***rounded*** *the values after conversion, and this resulted in the slightly different ratios above.*
For methodology's sake I calculate the exchange ratio for USD columns and take their mean.

In [49]:
```
eur2usd_2020 = df_ai_u[(df_ai_u['salary_currency'] == 'eur') & (df_ai_u['year'] == 2020)]['ratio'].mean()
eur2usd_2021 = df_ai_u[(df_ai_u['salary_currency'] == 'eur') & (df_ai_u['year'] == 2021)]['ratio'].mean()
eur2usd_2022 = df_ai_u[(df_ai_u['salary_currency'] == 'eur') & (df_ai_u['year'] == 2022)]['ratio'].mean()
eur2usd_2023 = df_ai_u[(df_ai_u['salary_currency'] == 'eur') & (df_ai_u['year'] == 2023)]['ratio'].mean()
eur2usd_2024 = df_ai_u[(df_ai_u['salary_currency'] == 'eur') & (df_ai_u['year'] == 2024)]['ratio'].mean()

# For other years that are not present in the AI-Jobs.net dataset, I use sources available online
eur2usd_2019 = 1.1199 # Source: https://www.exchangerates.org.uk/EUR-USD-spot-exchange-rates-history-2019.html
eur2usd_2018 = 1.1811 # Source: https://www.exchangerates.org.uk/EUR-USD-spot-exchange-rates-history-2018.html

#changing back the display format
pd.set_option('display.float_format', lambda x: '%.2f' % x)
```

Germany IT survey

Year: 2018

In [52]:
```
top_5_values_per_column(df_it18_ini)
```

Out[52]:

	column_name	top_5_values
0	timestamp	[14/12/2018 13:43:50, 14/12/2018 12:53:47, 14/...
1	age	[30.0, 31.0, 32.0, 33.0, 34.0]
2	gender	[m, f]
3	city	[berlin, münchen, frankfurt, köln, hamburg]
4	position	[java developer, software engineer, senior sof...
5	years_of_experience	[10.0, 5.0, 8.0, 7.0, 6.0]
6	your_level	[senior, middle, junior]
7	current_salary	[60000.0, 65000.0, 70000.0, 75000.0, 55000.0]
8	salary_one_year_ago	[65000.0, 55000.0, 60000.0, 70000.0, 50000.0]
9	salary_two_years_ago	[60000.0, 55000.0, 65000.0, 50000.0, 70000.0]
10	are_you_getting_any_stock_options?	[no, yes]
11	main_language_at_work	[english, deutsch, russian, french, polish]
12	company_size	[100-1000, 1000+, 50-100, 10-50, up to 10]
13	company_type	[product, startup, agency, outsource, consulting]

In [53]:
```
# Adding year and country
df_it18_ini['year'] = 2018
df_it18_ini['country'] = "de"

# Define column name mappings
column_mappings = {
    'position': 'job_title',
    'years_of_experience': 'experience',
    'your_level': 'seniority_level',
    'current_salary': 'salary_eur',
    'main_language_at_work': 'language_at_work'
}

# Rename columns using the mappings
df_it18_u = df_it18_ini.rename(columns=column_mappings)
df_it18_u.head(2)
```

Out[53]:

	timestamp	age	gender	city	job_title	experience	seniority_level	salary_eur	salary_one_year_ago	salary_two_years_ago	are_you_getting_any_stock_options?	language_at_work	company_size	company_type	year	country
0	14/12/2018 12:41:33	43.00	m	münchen	qa ingenieur	11.00	senior	77000.00	76200.00	68000.00	no	deutsch	100-1000	product	2018	de
1	14/12/2018 12:42:09	33.00	f	münchen	senior php magento developer	8.00	senior	65000.00	55000.00	55000.00	no	deutsch	50-100	product	2018	de

In [54]:
```
# Cleaning report
df_it18_u['salary_eur'] = df_it18_u['salary_eur'].apply(clean_salary_0616, df_report=df_report, prefix='df_it18_salary')
df_report
```

Out[54]:

	df_ai_salary_null_values_encountered	df_ai_salary_strings_encountered	df_ai_salary_leading_trailing_whitespace	df_ai_salary_+-_characters_removed	df_ai_salary_commas_replaced	df_it18_salary_null_values_encountered	df_it18_salary_strings_encountered	df_it18_salary_leading_trailing_w
0	0	0	0	0	0	16	0	

In [55]:
```
len_it18_salarydrop1 = len(df_it18_u) # For data quality report

# Comverting to numeric
df_it18_u['salary_eur'] = df_it18_u['salary_eur'].apply(pd.to_numeric, errors='raise')
# same appraoch: df_it18_u['salary_eur'] = pd.to_numeric(df_it18_u['salary_eur'], errors='raise')

# Dropping rows where salary is Null
df_it18_u.dropna(subset=['salary_eur'], inplace=True)

# Assigning 'int64' datatype. This serves as a self-check
df_it18_u['salary_eur'] = df_it18_u['salary_eur'].astype('int64')

# Create a new 'salary' column that will represent the salary in USD
df_it18_u['salary'] = df_it18_u['salary_eur'] * eur2usd_2018
```

```
len_it18_salarydrop2 = len(df_it18_u) # For data quality report

df_it18_u.head(2)
```

Out[55]:

	timestamp	age	gender	city	job_title	experience	seniority_level	salary_eur	salary_one_year_ago	salary_two_years_ago	are_you_getting_any_stock_options?	language_at_work	company_size	company_type	year	country	salary
0	14/12/2018 12:41:33	43.00	m	münchen	qa ingenieur	11.00	senior	77000	76200.00	68000.00	no	deutsch	100-1000	product	2018	de	90944.70
1	14/12/2018 12:42:09	33.00	f	münchen	senior php magento developer	8.00	senior	65000	55000.00	55000.00	no	deutsch	50-100	product	2018	de	76771.50

In [56]:
```
df_it18_u[['salary_eur','salary']].info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 757 entries, 0 to 772
Data columns (total 2 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   salary_eur  757 non-null    int64
 1   salary      757 non-null    float64
dtypes: float64(1), int64(1)
memory usage: 17.7 KB
```

Year: 2019

In [58]:
```
top_5_values_per_column(df_it19_ini)
```

Out[58]:

	column_name	top_5_values
0	zeitstempel	[02/12/2019 11:18:26, 07/12/2019 09:39:37, 07/...
1	age	[30.0, 33.0, 32.0, 31.0, 29.0]
2	gender	[male, female]
3	city	[berlin, munich, amsterdam, frankfurt, hamburg]
4	seniority_level	[senior, middle, junior, lead, head]
5	position_(without_seniority)	[backend developer, data scientist, fullstack ...
6	years_of_experience	[10, 8, 7, 5, 6]
7	your_main_technology_/_programming_language	[python, java, not relevant, javascript / type...
8	yearly_brutto_salary_(without_bonus_and_stocks)	[70000.0, 65000.0, 60000.0, 75000.0, 80000.0]
9	yearly_bonus	[0.0, 5000.0, 3000.0, 10000.0, 6000.0]
10	yearly_stocks	[1.0, 0.0, 10000.0, 2000.0, 25000.0]
11	yearly_brutto_salary_(without_bonus_and_stocks...	[60000.0, 65000.0, 55000.0, 75000.0, 70000.0]
12	yearly_bonus_one_year_ago._only_answer_if_stay...	[5000.0, 1.0, 0.0, 10000.0, 3000.0]
13	yearly_stocks_one_year_ago._only_answer_if_sta...	[0, 1, 10000, 15000, 5000]
14	number_of_vacation_days	[30.0, 28.0, 25.0, 27.0, 26.0]
15	number_of_home_office_days_per_month	[4.0, 5.0, 0.0, 20.0, 2.0]
16	main_language_at_work	[english, deutsch, russian, french, italian]
17	company_name_	[zalando, auto1, check24, ing, booking.com]
18	company_size	[100-1000, 1000+, 50-100, 10-50, up to 10]
19	company_type	[product, startup, consulting / agency, bodysh...
20	contract_duration	[unlimited, more than 1 year, 1 year, 6 months...
21	company_business_sector	[commerce, finance / insurance, transport, man...
22	0	[]

In [59]:
```
# Adding year and country
df_it19_ini['year'] = 2019
```

```
df_it19_ini['country'] = "de"

# Define column name mappings
column_mappings = {
    'position_(without_seniority)': 'job_title',
    'years_of_experience': 'experience',
    'your_main_technology_/_programming_language': 'skills',
    'yearly_brutto_salary_(without_bonus_and_stocks)': 'base_salary',
    'yearly_bonus': 'bonus',
    'yearly_stocks': 'stocks',
    'yearly_brutto_salary_(without_bonus_and_stocks)_one_year_ago._only_answer_if_staying_in_same_country': 'salary_1y_ago',
    'yearly_bonus_one_year_ago._only_answer_if_staying_in_same_country':'bonus_1y_ago',
    'yearly_stocks_one_year_ago._only_answer_if_staying_in_same_country':'stocks_1y_ago',
    'main_language_at_work': 'language_at_work'
}

# Rename columns using the mappings
df_it19_u = df_it19_ini.rename(columns=column_mappings)
```

In [60]:
```
# Cleaning report

df_it19_u['base_salary'] = df_it19_u['base_salary'].apply(clean_salary_0616, df_report=df_report, prefix='df_it19_u_salary')
df_it19_u['bonus'] = df_it19_u['bonus'].apply(clean_salary_0616, df_report=df_report, prefix='df_it19_u_bonus')
df_it19_u['stocks'] = df_it19_u['stocks'].apply(clean_salary_0616, df_report=df_report, prefix='df_it19_u_stocks')
df_report
```

Out[60]:

	df_ai_salary_null_values_encountered	df_ai_salary_strings_encountered	df_ai_salary_leading_trailing_whitespace	df_ai_salary_+-_characters_removed	df_ai_salary_commas_replaced	df_it18_salary_null_values_encountered	df_it18_salary_strings_encountered	df_it18_salary_leading_trailing_w
0	0	0	0	0	0	16	0	

There is a Null value in 'base_salary', that will need to be dropped. The cleaning function itself does not drop Null values, so I drop it separately.
There are hundreds of null values in 'bonus' and 'stocks', I'll convert them to zeroes.

In [62]:
```
# Dropping values

len_it19_salarydrop1 = len(df_it19_u) # For data quality report

df_it19_u = df_it19_u.dropna(subset=['base_salary'])
#df_salary_conversion['base_salary'].fillna(0, inplace=True)
df_it19_u['bonus'] = df_it19_u['bonus'].fillna(0)
df_it19_u['stocks'] = df_it19_u['stocks'].fillna(0)

df_it19_u['base_salary'].apply(pd.to_numeric, errors='coerce')
df_it19_u['bonus'].apply(pd.to_numeric, errors='coerce')
df_it19_u['stocks'].apply(pd.to_numeric, errors='coerce')
df_it19_u[['base_salary','bonus','stocks']] = df_it19_u[['base_salary','bonus','stocks']].astype('int64')

# Create a new 'salary' column by adding the three columns together
df_it19_u['salary_eur'] = df_it19_u['base_salary'] + df_it19_u['bonus'] + df_it19_u['stocks']
df_it19_u['salary'] = df_it19_u['salary_eur'] * eur2usd_2019

len_it19_salarydrop2 = len(df_it19_u) # For data quality report

df_it19_u.head(2)
```

Out[62]:

	zeitstempel	age	gender	city	seniority_level	job_title	experience	skills	base_salary	bonus	stocks	salary_1y_ago	bonus_1y_ago	stocks_1y_ago	number_of_vacation_days	number_of_home_office_days_per_month	language_at_work	company_name_	compa
0	02/12/2019 11:18:26	33.00	male	berlin	senior	fullstack developer	13	php	64000	1000	0	58000.00	1000.00	NaN	29.00	4.00	english	NaN	
1	02/12/2019 11:18:35	29.00	male	berlin	middle	backend developer	3	python	55000	0	0	55000.00	NaN	NaN	22.00	4.00	english	NaN	

In [63]:
```
df_it19_u[['base_salary','bonus','stocks','salary']].info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 990 entries, 0 to 990
Data columns (total 4 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   base_salary  990 non-null    int64
 1   bonus        990 non-null    int64
 2   stocks       990 non-null    int64
 3   salary       990 non-null    float64
dtypes: float64(1), int64(3)
memory usage: 38.7 KB
```

Year: 2020

In [65]:
```
top_5_values_per_column(df_it20_ini)
```

Out[65]:

	column_name	top_5_values
0	timestamp	[25/11/2020 08:47:37, 25/11/2020 18:28:01, 24/...
1	age	[30.0, 33.0, 32.0, 29.0, 28.0]
2	gender	[male, female, diverse]
3	city	[berlin, munich, frankfurt, hamburg, stuttgart]
4	position_	[software engineer, backend developer, data sc...
5	total_years_of_experience	[10, 5, 6, 8, 7]
6	years_of_experience_in_germany	[2, 1, 3, 5, 4]
7	seniority_level	[senior, middle, lead, junior, head]
8	your_main_technology_/_programming_language	[java, python, javascript, php, c++]
9	other_technologies/programming_languages_you_u...	[javascript / typescript, python, sql, aws, do...
10	yearly_brutto_salary_(without_bonus_and_stocks...	[60000.0, 70000.0, 65000.0, 75000.0, 80000.0]
11	yearly_bonus_+_stocks_in_eur	[0, 5000, 10000, 2000, 6000]
12	annual_brutto_salary_(without_bonus_and_stocks...	[65000.0, 60000.0, 75000.0, 70000.0, 55000.0]
13	annual_bonus+stocks_one_year_ago._only_answer_...	[0, 5000, 10000, 60000, 3000]
14	number_of_vacation_days	[30, 28, 27, 25, 26]
15	employment_status	[full-time employee, self-employed (freelancer...
16	contract_duration	[unlimited contract, temporary contract, 0]
17	main_language_at_work	[english, german, russian, italian, spanish]
18	company_size	[1000+, 101-1000, 11-50, 51-100, up to 10]
19	company_type	[product, startup, consulting / agency, e-comm...
20	have_you_lost_your_job_due_to_the_coronavirus_...	[no, yes, i didn't but will be looking for new...
21	have_you_been_forced_to_have_a_shorter_working...	[0.0, 30.0, 32.0, 20.0, 40.0]
22	have_you_received_additional_monetary_support_...	[0, 500, no, 1000, 1500]

Renaming the columns

In [67]:
```
# Adding year and country
df_it20_ini['year'] = 2020
df_it20_ini['country'] = "de"

# Define column name mappings
column_mappings = {
    'position_': 'job_title',
    'total_years_of_experience': 'experience',
    'your_main_technology_/_programming_language': 'skills',
    'other_technologies/programming_languages_you_use_often': 'skills_2',
```

```
    'yearly_brutto_salary_(without_bonus_and_stocks)_in_eur': 'base_salary',
    'yearly_bonus_+_stocks_in_eur': 'bonus',
    'annual_brutto_salary_(without_bonus_and_stocks)_one_year_ago._only_answer_if_staying_in_the_same_country': 'salary_1y_ago',
    'annual_bonus+stocks_one_year_ago._only_answer_if_staying_in_same_country': 'bonus_1y_ago',
    'yearly_stocks_one_year_ago._only_answer_if_staying_in_same_country':'stocks_1y_ago',
    'main_language_at_work': 'language_at_work'
}

# Rename columns using the mappings
df_it20_u = df_it20_ini.rename(columns=column_mappings)
df_it20_u.head(2)
```

Out[67]:

	timestamp	age	gender	city	job_title	experience	years_of_experience_in_germany	seniority_level	skills	skills_2	base_salary	bonus	salary_1y_ago	bonus_1y_ago	number_of_vacation_days	employment_status	contract_duration	language_at_work	co
0	24/11/2020 11:14:15	26.00	male	munich	software engineer	5	3	senior	typescript	kotlin, javascript / typescript	80000.00	5000	75000.00	10000	30	full-time employee	unlimited contract	english	
1	24/11/2020 11:14:16	26.00	male	berlin	backend developer	7	4	senior	ruby	NaN	80000.00	NaN	82000.00	5000	28	full-time employee	unlimited contract	english	

Checking cleanliness

In [70]:
```
# Cleaning report

df_it20_u['base_salary'] = df_it20_u['base_salary'].apply(clean_salary_0616, df_report=df_report, prefix='df_it20_u_salary')
df_it20_u['bonus'] = df_it20_u['bonus'].apply(clean_salary_0616, df_report=df_report, prefix='df_it20_u_bonus')
df_report
```

Out[70]:

	df_ai_salary_null_values_encountered	df_ai_salary_strings_encountered	df_ai_salary_leading_trailing_whitespace	df_ai_salary_+-_characters_removed	df_ai_salary_commas_replaced	df_it18_salary_null_values_encountered	df_it18_salary_strings_encountered	df_it18_salary_leading_trailing_w
0	0	0	0	0	0	16	0	

Converting to USD

In [72]:
```
len_it20_salarydrop1 = len(df_it20_u)

df_it20_u = df_it20_u.dropna(subset=['base_salary'])
df_it20_u['bonus'] = df_it20_u['bonus'].fillna(0)

#df_it20_u['bonus'] = df_it20_u['bonus'].str.replace('$', '')
#df_it20_u['bonus'] = df_it20_u['bonus'].str.replace('> ', '')

df_it20_u['base_salary'] = pd.to_numeric(df_it20_u['base_salary'], errors='coerce')
df_it20_u['bonus'] = pd.to_numeric(df_it20_u['bonus'], errors='coerce')

df_it20_u['base_salary'] = df_it20_u['base_salary'].fillna(0)
df_it20_u['bonus'] = df_it20_u['bonus'].fillna(0)

#df_it20_u['base_salary'] = df_it20_u['base_salary'].astype('int64')
#df_it20_u['bonus'] = df_it20_u['bonus'].astype('int64')

# Create a new 'salary' column by adding the columns together
df_it20_u['salary_eur'] = df_it20_u['base_salary'] + df_it20_u['bonus']
df_it20_u['salary'] = df_it20_u['salary_eur'] * eur2usd_2020

len_it20_salarydrop2 = len(df_it20_u)

df_it20_u.head(2)
```

Out[72]:

	timestamp	age	gender	city	job_title	experience	years_of_experience_in_germany	seniority_level	skills	skills_2	base_salary	bonus	salary_1y_ago	bonus_1y_ago	number_of_vacation_days	employment_status	contract_duration	language_at_work	c
0	24/11/2020 11:14:15	26.00	male	munich	software engineer	5	3	senior	typescript	kotlin, javascript / typescript	80000.00	5000.00	75000.00	10000	30	full-time employee	unlimited contract	english	
1	24/11/2020 11:14:16	26.00	male	berlin	backend developer	7	4	senior	ruby	NaN	80000.00	0.00	82000.00	5000	28	full-time employee	unlimited contract	english	

In [73]:
```
df_it20_u[['base_salary','bonus','salary']].info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1306 entries, 0 to 1305
Data columns (total 3 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   base_salary  1306 non-null   float64
 1   bonus        1306 non-null   float64
 2   salary       1306 non-null   float64
dtypes: float64(3)
memory usage: 30.7 KB
```

Year: 2021

In [75]:
```
top_5_values_per_column(df_it21_ini)
```

Out[75]:

	column_name	top_5_values
0	name	[]
1	city	[berlin, munich, other, hamburg, frankfurt]
2	attachments	[]
3	status	[]
4	gender	[]
5	your_city	[bremen, hannover, würzburg, erfurt, schleswig...
6	employment_status	[full-time employee, self-employed (freelancer...
7	your_employment_status	[]
8	position	[software engineer, backend developer, tech le...
9	your_position	[data analyst, project manager, cto, sap consu...
10	total_years_of_experience	[10, 5, 15, 8, 7]
11	years_of_experience_in_germany	[3, 2, 1, 5, 0]
12	seniority_level	[senior, middle, lead, junior, head]
13	your_seniority_level	[c-level, intern, principal, staff, staff soft...
14	main_technology_/_programming_language	[python, java, javascript / typescript, other,...
15	other_technologies/programming_languages_you_u...	[other, python, react, javascript / typescript...
16	years_in_the_current_workplace	[0.0, 2.0, 1.0, 3.0, 4.0]
17	what_languages_do_you_speak_and_use_at_work?	[english, english,russian, english,german, eng...
18	have_you_completed_your_higher_education_in_ge...	[no, yes, not relevant to me]
19	your_main_technology	[kubernetes, elixir, terraform, aws, yaml]
20	just_a_few_more_general_questions	[]
21	company_size	[1000+, 101-1000, 51-100, 11-50, up to 10]
22	annual_brutto_salary_without_bonus_and_stocks_...	[80000.0, 70000.0, 75000.0, 90000.0, 60000.0]
23	annual_brutto_salary_with_bonus_and_stocks_in_eur	[0.0, 80000.0, 70000.0, 75000.0, 90000.0]
24	annual_bonus+stocks_one_year_ago.	[75000.0, 65000.0, 80000.0, 60000.0, 70000.0]
25	number_of_vacation_days	[30, 28, 25, 27, 24]
26	hourly_rate_in_eur	[90.0, 80.0, 75.0, 65.0, 85.0]
27	working_hours_for_the_last_year	[2000.0, 120.0, 2150.0, 2500.0, 1750.0]
28	number_of_days_off_in_the_last_year	[10.0, 15.0, 30.0, 5.0, 0.0]
29	third-party_income_from_small_customers_or_own...	[0.0, 100000.0, 3000.0, 20000.0]
30	about_you_(anonymously)	[]
31	working_hours_per_week	[32.0, 30.0, 35.0, 20.0, 25.0]

In [76]:
```
# In some cases the answer were given only in 'annual_brutto_salary_without_bonus_and_stocks_in_eur', and nothing in 'annual_brutto_salary_with_bonus_and_stocks_in_eur'
# Therefore I take the larger of the two
df_it21_ini['salary_eur'] = df_it21_ini[['annual_brutto_salary_without_bonus_and_stocks_in_eur', 'annual_brutto_salary_with_bonus_and_stocks_in_eur']].max(axis=1)
```

In [77]:
```
df_it21_ini['year'] = 2021
df_it21_ini['country'] = "de"

# Define column name mappings
column_mappings = {
    'position': 'job_title',
    'your_position': 'job_title_2',
    'total_years_of_experience': 'experience',
    'main_technology_/_programming_language': 'skills',
    'other_technologies/programming_languages_you_use_often': 'skills_2',
    'annual_brutto_salary_without_bonus_and_stocks_in_eur': 'base_salary',
    #'annual_brutto_salary_with_bonus_and_stocks_in_eur': 'salary_eur',
    'annual_bonus+stocks_one_year_ago.': 'salary_w_bonus_1y_ago',
```

```
    'what_languages_do_you_speak_and_use_at_work?': 'language_at_work'
}

# Rename columns using the mappings
df_it21_u = df_it21_ini.rename(columns=column_mappings)
df_it21_u.head(2)
```

Out[77]:

	name	city	attachments	status	gender	your_city	employment_status	your_employment_status	job_title	job_title_2	experience	years_of_experience_in_germany	seniority_level	your_seniority_level	skills	skills_2	years_in_the_current_work
0	NaN	NaN	NaN	NaN	NaN	NaN	full-time employee	NaN	other	product specialist	16	8	senior	NaN	nodejs	sap / abap,kubernetes,docker,javascript / type...	
1	NaN	NaN	NaN	NaN	NaN	NaN	full-time employee	NaN	software engineer	NaN	6	6	senior	NaN	c# / .net	javascript / typescript,angular,azure	

checking cleanliness

In [79]:
```
df_it21_u['salary_eur'] = df_it21_u['salary_eur'].apply(clean_salary_0616, df_report=df_report, prefix='df_it21_u_salary')
df_report
```

Out[79]:

	df_ai_salary_null_values_encountered	df_ai_salary_strings_encountered	df_ai_salary_leading_trailing_whitespace	df_ai_salary_+-_characters_removed	df_ai_salary_commas_replaced	df_it18_salary_null_values_encountered	df_it18_salary_strings_encountered	df_it18_salary_leading_trailing_w
0	0	0	0	0	0	16	0	

In [80]:
```
len_it21_salarydrop1 = len(df_it21_u)

# dropping initial Nones, that wouldn't be converted with pd.to_numeric errors='raise'
df_it21_u = df_it21_u.dropna(subset=['salary_eur'])

df_it21_u['salary_eur'].apply(pd.to_numeric, errors='raise')

# dropping Nones that is the result of pd.to_numeric
df_it21_u = df_it21_u.dropna(subset=['salary_eur'])

df_it21_u['salary_eur'] = df_it21_u['salary_eur'].astype('int64') # float64 can contain Nones, which is annoying. The data should be convertible to int64 (The only exception is if the answer was given as a float.)

# Create a new 'salary' column by adding the columns together
df_it21_u['salary'] = df_it21_u['salary_eur'] * eur2usd_2021

len_it21_salarydrop2 = len(df_it21_u)

df_it21_u.head(2)
```

Out[80]:

	name	city	attachments	status	gender	your_city	employment_status	your_employment_status	job_title	job_title_2	experience	years_of_experience_in_germany	seniority_level	your_seniority_level	skills	skills_2	years_in_the_current_work
0	NaN	NaN	NaN	NaN	NaN	NaN	full-time employee	NaN	other	product specialist	16	8	senior	NaN	nodejs	sap / abap,kubernetes,docker,javascript / type...	
1	NaN	NaN	NaN	NaN	NaN	NaN	full-time employee	NaN	software engineer	NaN	6	6	senior	NaN	c# / .net	javascript / typescript,angular,azure	

In [81]:
```
df_it21_u[['salary_eur','salary']].info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 1186 entries, 0 to 1206
Data columns (total 2 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   salary_eur  1186 non-null   int64
 1   salary      1186 non-null   float64
dtypes: float64(1), int64(1)
memory usage: 27.8 KB
```

Year: 2022

In [83]:
```
top_5_values_per_column(df_it22_ini)
```

Out[83]:

	column_name	top_5_values
0	city	[berlin, munich, other, hamburg, stuttgart]
1	your_city	[friedrichshafen, leipzig, remote, paris, schl...
2	employment_status	[full-time employee, self-employed (freelancer...
3	your_employment_status	[]
4	position	[software engineer, backend developer, data sc...
5	your_position	[data analyst, sre, support engineer, technica...
6	total_years_of_experience	[10, 15, 5, 6, 8]
7	years_of_experience_in_germany	[4, 1, 0, 3, 5]
8	seniority_level	[senior, middle, lead / staff, head / principa...
9	your_seniority_level	[working student, chief]
10	main_technology_/_programming_language	[python, java, javascript / typescript, other,...
11	other_technologies/programming_languages_you_u...	[other, sql, python, javascript / typescript, ...
12	years_in_the_current_workplace	[0.0, 1.0, 2.0, 3.0, 4.0]
13	what_languages_do_you_speak_and_use_at_work?	[english, english,russian, english,german, eng...
14	your_main_technology	[aws, kubernetes, linux, groovy, ansible]
15	just_a_few_more_general_questions	[]
16	company_size	[1000+, 101-1000, 51-100, 11-50, up to 10]
17	annual_gross_salary_without_bonus_and_stocks_i...	[80000.0, 75000.0, 85000.0, 90000.0, 60000.0]
18	annual_brutto_salary_with_bonus_and_stocks_in_eur	[0.0, 80000.0, 75000.0, 90000.0, 60000.0]
19	annual_bonus+stocks_one_year_ago.	[75000.0, 85000.0, 70000.0, 80000.0, 60000.0]
20	number_of_vacation_days	[30, 28, unlimited, 27, 25]
21	hourly_rate_in_eur	[75.0, 87.0, 110.0, 102.0, 100.0]
22	working_hours_for_the_last_year	[1200.0, 1900.0, 1760.0, 1650.0, 1800.0]
23	number_of_days_off_in_the_last_year	[25.0, 30.0, 65.0, 12.0, 40.0]
24	third-party_income_from_small_customers_or_own...	[0.0, 10000.0, 50.0]
25	working_hours_per_week	[32.0, 35.0, 20.0, 30.0]
26	layoff_affects_you	[no, yes, i am not satisfied with a severance ...
27	company_layoffs	[no, yes]
28	work_from_home_allowance	[no, 100 - 500, over 1000 euros, 500 - 1000, u...

In [84]:
```
# In some cases the answer were given only in 'annual_brutto_salary_without_bonus_and_stocks_in_eur', and nothing in 'annual_brutto_salary_with_bonus_and_stocks_in_eur'
# Therefore I take the larger of the two
df_it22_ini['salary_eur'] = df_it22_ini[['annual_gross_salary_without_bonus_and_stocks_in_eur', 'annual_brutto_salary_with_bonus_and_stocks_in_eur']].max(axis=1)
```

In [85]:
```
df_it22_ini['year'] = 2022
df_it22_ini['country'] = "de"

# Define column name mappings
column_mappings = {
    'position': 'job_title',
    'your_position': 'job_title_2',
    'total_years_of_experience': 'experience',
    'main_technology_/_programming_language': 'skills',
    'other_technologies/programming_languages_you_use_often':'skills_2',
    'your_main_technology':'skills_3',
    'annual_gross_salary_without_bonus_and_stocks_in_eur': 'base_salary',
    'annual_brutto_salary_with_bonus_and_stocks_in_eur': 'salary_w_bonus',
    'annual_bonus+stocks_one_year_ago.':'bonus_1y_ago',
    'what_languages_do_you_speak_and_use_at_work?': 'language_at_work'
}
```

```
# Rename columns using the mappings
df_it22_u = df_it22_ini.rename(columns=column_mappings)
```

In [86]:
```
df_it22_u['salary_eur'] = df_it22_u['salary_eur'].apply(clean_salary_0616, df_report=df_report, prefix='df_it22_u_salary_eur')
df_report
```

Out[86]:

	df_ai_salary_null_values_encountered	df_ai_salary_strings_encountered	df_ai_salary_leading_trailing_whitespace	df_ai_salary_+-_characters_removed	df_ai_salary_commas_replaced	df_it18_salary_null_values_encountered	df_it18_salary_strings_encountered	df_it18_salary_leading_trailing_w
0	0	0	0	0	0	16	0	

In [87]:
```
#
#
# df_it22_u = df_it22_u.dropna(subset=['salary_eur'])
# df_it22_u['salary_eur'].apply(pd.to_numeric, errors='coerce')
#
# # Create a new 'salary' column by adding the columns together
# df_it22_u['salary'] = df_it22_u['salary_eur'] * eur2usd_2022
# df_it22_u.head(2)
```

In [88]:
```
len_it22_salarydrop1 = len(df_it22_u)

# dropping initial Nones, that wouldn't be converted with pd.to_numeric errors='raise'
df_it22_u = df_it22_u.dropna(subset=['salary_eur'])
df_it22_u['salary_eur'].apply(pd.to_numeric, errors='raise')

# dropping Nones that is the result of pd.to_numeric
df_it22_u = df_it22_u.dropna(subset=['salary_eur'])

df_it22_u['salary_eur'] = df_it22_u['salary_eur'].astype('int64') # float64 can contain Nones, which is annoying. The data should be convertible to int64 (The only exception is if the answer was given as a float.)

# Create a new 'salary' column by adding the columns together
df_it22_u['salary'] = df_it22_u['salary_eur'] * eur2usd_2022
len_it22_salarydrop2 = len(df_it22_u)

df_it22_u.head(2)
```

Out[88]:

	city	your_city	employment_status	your_employment_status	job_title	job_title_2	experience	years_of_experience_in_germany	seniority_level	your_seniority_level	skills	skills_2	years_in_the_current_workplace	language_at_work	skills_3	just_a_few_r
0	berlin	NaN	full-time employee	NaN	backend developer	NaN	5	1	middle	NaN	go	javascript / typescript,nodejs, react,go,sql,k...	5.00	english	NaN	
1	other	friedrichshafen	full-time employee	NaN	tech lead / team lead	NaN	18	10	head / principal	NaN	c / c++	other	9.00	german	NaN	

In [89]:
```
df_it22_u[['salary_eur','salary']].info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 759 entries, 0 to 772
Data columns (total 2 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   salary_eur  759 non-null    int64
 1   salary      759 non-null    float64
dtypes: float64(1), int64(1)
memory usage: 17.8 KB
```

Year: 2023

In [91]:
```
top_5_values_per_column(df_it23_ini)
```

Out[91]:

	column_name	top_5_values
0	city	[berlin, munich, frankfurt, other, dusseldorf]
1	your_city	[essen, kempten, bamberg, wiesbaden, paderborn]
2	employment_status	[full/part-time employee, unemployed, self-emp...
3	position	[software engineer, backend developer, tech le...
4	your_position	[data analyst, business analyst, infrascructur...
5	total_years_of_experience	[15, 10, 5, 7, 12]
6	years_of_experience_in_germany	[1, 2, 5, 3, 4]
7	seniority_level	[senior, middle, lead / staff, head / principa...
8	your_seniority_level	[director of engineering, working student, c-l...
9	main_technology_/_programming_language	[python, java, javascript / typescript, other,...
10	your_main_technology	[aws, terraform, yaml, react, i'm manager, sql...
11	other_technologies/programming_languages_you_u...	[other, sql, python, java / scala, react]
12	years_in_the_current_workplace	[2.0, 1.0, 3.0, 0.5, 5.0]
13	what_languages_do_you_speak_and_use_at_work?	[english, english,russian, english,german, eng...
14	company_size	[1000+, 101-1000, 11-50, 51-100, up to 10]
15	annual_gross_salary_without_bonus_and_stocks_i...	[100000.0, 80000.0, 90000.0, 75000.0, 95000.0]
16	annual_gross_salary_with_bonus_and_stocks_in_eur	[0.0, 90000.0, 100000.0, 75000.0, 70000.0]
17	annual_gross_salary+bonus+stocks_one_year_ago.	[75000.0, 90000.0, 85000.0, 0.0, 100000.0]
18	number_of_vacation_days	[30, 28, 27, unlimited, 25]
19	hourly_rate_in_eur	[100.0, 130.0, 85.0, 120.0]
20	working_hours_for_the_last_year	[2200.0, 1500.0, 2904.0, 1060.0, 1150.0]
21	number_of_days_off_in_the_last_year	[10.0, 30.0, 28.0, 0.0]
22	third-party_income_from_small_customers_or_own...	[0.0]
23	working_hours_per_week	[40.0, 35.0, 39.0, 38.0, 30.0]
24	layoff_affects_you	[no, yes, i am satisfied with a severance pack...
25	company_layoffs	[no, yes, in 2023, yes, both in 2022-2023, i d...
26	work_from_home_allowance	[no, 100 - 500, up to 100 euro, 500 - 1000, ov...
27	did_you_already_find_a_new_job?	[]
28	employment_status_change_in_2023	[no, full/part-time employee, unemployed, self...
29	do_you_currently_search_for_a_job?	[yes, actively , yes, passively , no]
30	how_long_have_you_been_unemployed?_(in_months)	[10.0, 11.0, 5.0, 9.0, 8.0]
31	company_hire_in_2023	[yes, yes, but only for backfilling, no, i don...
32	company_industry	[information services, it, software developmen...
33	change_jobs	[no, yes]
34	tc_new_job	[better than it was, worse than it was, about ...
35	change_jobs_voluntary	[voluntary, it was my decision, involuntarily,...
36	how_long_find_job	[2,0, 3,0, 1,0, 6,0, 4,0]
37	ai_impact	[moderate but noticeable, invisible, great]
38	ai_use	[yes, no]
39	ai_tool	[chatgpt, chatgpt,copilot, copilot,chatgpt, co...
40	ai_other_tools	[bard, bing, jetbrains ai, codewhisperer, midj...

In [92]:
```
# In some cases the answer were given only in 'annual_brutto_salary_without_bonus_and_stocks_in_eur', and nothing in 'annual_brutto_salary_with_bonus_and_stocks_in_eur'
# Therefore I take the larger of the two
df_it23_ini['salary_eur'] = df_it23_ini[['annual_gross_salary_without_bonus_and_stocks_in_eur', 'annual_gross_salary_with_bonus_and_stocks_in_eur']].max(axis=1)
```

In [93]:
```
df_it23_ini['year'] = 2023
df_it23_ini['country'] = "de"

# Define column name mappings
column_mappings = {
    'position': 'job_title',
    'your_position': 'job_title_2',
    'total_years_of_experience': 'experience',
    'main_technology_/_programming_language': 'skills',
    'other_technologies/programming_languages_you_use_often':'skills_2',
    'your_main_technology':'skills_3',
    'annual_gross_salary_without_bonus_and_stocks_in_eur': 'base_salary',
    'annual_gross_salary_with_bonus_and_stocks_in_eur': 'salary_w_bonus',
    'annual_gross_salary+bonus+stocks_one_year_ago.':'salary_w_bonus_1y_ago',
    'what_languages_do_you_speak_and_use_at_work?': 'language_at_work'
}

# Rename columns using the mappings
df_it23_u = df_it23_ini.rename(columns=column_mappings)
```

In [94]:
```
# Cleaning & report
df_it23_u['salary_eur'] = df_it23_u['salary_eur'].apply(clean_salary_0616, df_report=df_report, prefix='df_it23_u_salary_eur')
df_report
```

Out[94]:

	df_ai_salary_null_values_encountered	df_ai_salary_strings_encountered	df_ai_salary_leading_trailing_whitespace	df_ai_salary_+-_characters_removed	df_ai_salary_commas_replaced	df_it18_salary_null_values_encountered	df_it18_salary_strings_encountered	df_it18_salary_leading_trailing_w
0	0	0	0	0	0	16	0	

In [95]:
```
len_it23_salarydrop1 = len(df_it23_u)

# dropping initial Nones, that wouldn't be converted with pd.to_numeric errors='raise'
df_it23_u = df_it23_u.dropna(subset=['salary_eur'])

df_it23_u['salary_eur'].apply(pd.to_numeric, errors='raise')

# dropping Nones that is the result of pd.to_numeric
df_it23_u = df_it23_u.dropna(subset=['salary_eur'])

df_it23_u['salary_eur'] = df_it23_u['salary_eur'].astype('int64') # float64 can contain Nones, which is annoying. The data should be convertible to int64 (The only exception is if the answer was given as a float.)

# Create a new 'salary' column by adding the columns together
df_it23_u['salary'] = df_it23_u['salary_eur'] * eur2usd_2023

len_it23_salarydrop2 = len(df_it23_u)

df_it23_u.head(2)
```

Out[95]:

	city	your_city	employment_status	job_title	job_title_2	experience	years_of_experience_in_germany	seniority_level	your_seniority_level	skills	skills_3	skills_2	years_in_the_current_workplace	language_at_work	company_size	base_salary	salary_w_bonu
0	berlin	NaN	full/part-time employee	software engineer	NaN	15	1	senior	NaN	kotlin	NaN	sql,python,java / scala	4.00	english	1000+	100000.00	110000.0
1	berlin	NaN	full/part-time employee	software engineer	NaN	14	4	senior	NaN	go	NaN	kubernetes,docker	1.50	english	1000+	95000.00	95000.0

In [96]:
```
df_it23_u[['salary_eur','salary']].info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 694 entries, 0 to 713
Data columns (total 2 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   salary_eur  694 non-null    int64
 1   salary      694 non-null    float64
dtypes: float64(1), int64(1)
memory usage: 16.3 KB
```

Kaggle

In [99]:
```
def kaggle_summary(df):
    # Create an empty DataFrame to store the result
    result_df = pd.DataFrame(columns=['column_name', 'second_row_values', 'top_5_values'])

    # Iterate through each column
    for column in df.columns:
        # Find the five most common values in the column
        top_5_values = df[column].value_counts().head(5).index.tolist()

        # Get the value of the second row for the current column
        second_row_value = df.iloc[0][column]

        # Create a DataFrame with the current column name, top 5 values, and second row value
        data_to_append = pd.DataFrame({'column_name': [column],
                                       'second_row_values': [second_row_value],
                                       'top_5_values': [top_5_values]
                                       })

        # Concatenate the new DataFrame with the result DataFrame
        result_df = pd.concat([result_df, data_to_append], ignore_index=True)

    return result_df
```

Year: 2019

In [101…
```
result_df = kaggle_summary(df_k19_ini)
result_df.to_csv('../results/df_k19_structure.txt', sep='\t', index=True)
result_df.head(10)
```

Out[101…

	column_name	second_row_values	top_5_values
0	time_from_start_to_finish_(seconds)	duration (in seconds)	[450, 434, 462, 398, 335]
1	q1	what is your age (# years)?	[25-29, 22-24, 30-34, 18-21, 35-39]
2	q2	what is your gender? - selected choice	[male, female, prefer not to say, prefer to se...
3	q2_other_text	what is your gender? - prefer to self-describe...	[-1, 0, 1, 9, 30]
4	q3	in which country do you currently reside?	[india, united states of america, other, brazi...
5	q4	what is the highest level of formal education ...	[master's degree, bachelor's degree, doctoral ...
6	q5	select the title most similar to your current ...	[data scientist, student, software engineer, o...
7	q5_other_text	select the title most similar to your current ...	[-1, 34, 46, 64, 7]
8	q6	what is the size of the company where you are ...	[0-49 employees, > 10,000 employees, 1000-9,99...
9	q7	approximately how many individuals are respons...	[20+, 1-2, 3-4, 0, 5-9]

In [102…
```
# Select only the relevant columns
df_k19_u1 = df_k19_ini[['q1', 'q3', 'q4', 'q5', 'q5_other_text', 'q6', 'q10', 'q15',]]
# Drop the first row as it's only an elaboration on the questionnaire.
df_k19_u1 = df_k19_u1.drop(df_k19_u1.index[0])

# Define column name mappings
column_mappings = {
    'q1': 'age',
    'q3': 'country',
    'q4': 'education_level',
    'q5': 'job_title',
    'q5_other_text': 'job_title_2',
    'q6': 'company_size',
    'q10': 'salary_range',
    'q15': 'experience'
}

# Rename columns using the mappings
```

```
df_k19_u = df_k19_u1.rename(columns=column_mappings)
#df_k19_u = df_k19_u1.drop(df_k19_u1.index[0])
df_k19_u['year'] = 2019
df_k19_u.head(3)
```

Out[102…

	age	country	education_level	job_title	job_title_2	company_size	salary_range	experience	year
1	22-24	france	master's degree	software engineer	-1	1000-9,999 employees	30,000-39,999	1-2 years	2019
2	40-44	india	professional degree	software engineer	-1	> 10,000 employees	5,000-7,499	i have never written code	2019
3	55-59	germany	professional degree	NaN	-1	NaN	NaN	NaN	2019

In [103…

```
len_k19_salarydrop1 = len(df_k19_u)

df_k19_u['salary_range'] = df_k19_u['salary_range'].str.replace('$', '', regex=False)
df_k19_u['salary_range'] = df_k19_u['salary_range'].str.replace('> ', '', regex=False)

# Dropping rows where salary is Null
df_k19_u.dropna(subset=['salary_range'], inplace=True)

# Split the salary_range column on the dash ('-') and convert to numeric values
df_k19_u[['lower_salary', 'upper_salary']] = df_k19_u['salary_range'].str.split('-', expand=True)
df_k19_u['lower_salary'] = df_k19_u['lower_salary'].str.replace(',', '').astype(float)
df_k19_u['upper_salary'] = df_k19_u['upper_salary'].str.replace(',', '').astype(float)

df_k19_u['salary'] = df_k19_u[['lower_salary', 'upper_salary']].mean(axis=1)

len_k19_salarydrop2 = len(df_k19_u)
df_k19_u.head()
```

Out[103…

	age	country	education_level	job_title	job_title_2	company_size	salary_range	experience	year	lower_salary	upper_salary	salary
1	22-24	france	master's degree	software engineer	-1	1000-9,999 employees	30,000-39,999	1-2 years	2019	30000.00	39999.00	34999.50
2	40-44	india	professional degree	software engineer	-1	> 10,000 employees	5,000-7,499	i have never written code	2019	5000.00	7499.00	6249.50
4	40-44	australia	master's degree	other	0	> 10,000 employees	250,000-299,999	1-2 years	2019	250000.00	299999.00	274999.50
5	22-24	india	bachelor's degree	other	1	0-49 employees	4,000-4,999	< 1 years	2019	4000.00	4999.00	4499.50
6	50-54	france	master's degree	data scientist	-1	0-49 employees	60,000-69,999	20+ years	2019	60000.00	69999.00	64999.50

Year: 2020

In [105…

```
result_df = kaggle_summary(df_k20_ini)
result_df.to_csv('../results/df_k20_structure.txt', sep='\t', index=True)
result_df.head(10)
```

Out[105…

	column_name	second_row_values	top_5_values
0	time_from_start_to_finish_(seconds)	duration (in seconds)	[565, 469, 491, 478, 641]
1	q1	what is your age (# years)?	[25-29, 22-24, 18-21, 30-34, 35-39]
2	q2	what is your gender? - selected choice	[man, woman, prefer not to say, prefer to self...
3	q3	in which country do you currently reside?	[india, united states of america, other, brazi...
4	q4	what is the highest level of formal education ...	[master's degree, bachelor's degree, doctoral ...
5	q5	select the title most similar to your current ...	[student, data scientist, software engineer, o...
6	q6	for how many years have you been writing code ...	[3-5 years, 1-2 years, < 1 years, 5-10 years, ...
7	q7_part_1	what programming languages do you use on a reg...	[python, what programming languages do you use...
8	q7_part_2	what programming languages do you use on a reg...	[r, what programming languages do you use on a...
9	q7_part_3	what programming languages do you use on a reg...	[sql, what programming languages do you use on...

In [106…

```
# Select only the important columns
df_k20_u1 = df_k20_ini[['q1', 'q3', 'q4', 'q5', 'q6', 'q20', 'q24']]

# Drop the first row as it's only an elaboration on the questionnaire.
```

```
df_k20_u1 = df_k20_u1.drop(df_k20_u1.index[0])

# Define column name mappings
column_mappings = {
    'q1': 'age',
    'q3': 'country',
    'q4': 'education_level',
    'q5': 'job_title',
    'q6': 'experience',
    'q20': 'company_size',
    'q24': 'salary_range'
}

# Rename columns using the mappings
df_k20_u = df_k20_u1.rename(columns=column_mappings)
df_k20_u['year'] = 2020
df_k20_u.head(2)
```

Out[106…

	age	country	education_level	job_title	experience	company_size	salary_range	year
1	35-39	colombia	doctoral degree	student	5-10 years	NaN	NaN	2020
2	30-34	united states of america	master's degree	data engineer	5-10 years	10,000 or more employees	100,000-124,999	2020

In [107…

```
len_k20_salarydrop1 = len(df_k20_u)

df_k20_u['salary_range'] = df_k20_u['salary_range'].str.replace('$', '', regex=False)
df_k20_u['salary_range'] = df_k20_u['salary_range'].str.replace('> ', '', regex=False)

# Dropping rows where salary is Null
df_k20_u.dropna(subset=['salary_range'], inplace=True)

# Split the salary_range column on the dash ('-') and convert to numeric values
df_k20_u[['lower_salary', 'upper_salary']] = df_k20_u['salary_range'].str.split('-', expand=True)
df_k20_u['lower_salary'] = df_k20_u['lower_salary'].str.replace(',', '').astype(float)
df_k20_u['upper_salary'] = df_k20_u['upper_salary'].str.replace(',', '').astype(float)

df_k20_u['salary'] = df_k20_u[['lower_salary', 'upper_salary']].mean(axis=1)

len_k20_salarydrop2 = len(df_k20_u)
df_k20_u.head(2)
```

Out[107…

	age	country	education_level	job_title	experience	company_size	salary_range	year	lower_salary	upper_salary	salary
2	30-34	united states of america	master's degree	data engineer	5-10 years	10,000 or more employees	100,000-124,999	2020	100000.00	124999.00	112499.50
3	35-39	argentina	bachelor's degree	software engineer	10-20 years	1000-9,999 employees	15,000-19,999	2020	15000.00	19999.00	17499.50

Year: 2021

In [109…

```
result_df = kaggle_summary(df_k21_ini)
result_df.to_csv('../results/df_k21_structure.txt', sep='\t', index=True)
result_df.head(10)
```

Out[109…

	column_name	second_row_values	top_5_values
0	time_from_start_to_finish_(seconds)	duration (in seconds)	[484, 394, 512, 481, 498]
1	q1	what is your age (# years)?	[25-29, 18-21, 22-24, 30-34, 35-39]
2	q2	what is your gender? - selected choice	[man, woman, prefer not to say, nonbinary, pre...
3	q3	in which country do you currently reside?	[india, united states of america, other, japan...
4	q4	what is the highest level of formal education ...	[master's degree, bachelor's degree, doctoral ...
5	q5	select the title most similar to your current ...	[student, data scientist, software engineer, o...
6	q6	for how many years have you been writing code ...	[1-3 years, < 1 years, 3-5 years, 5-10 years, ...
7	q7_part_1	what programming languages do you use on a reg...	[python, what programming languages do you use...
8	q7_part_2	what programming languages do you use on a reg...	[r, what programming languages do you use on a...
9	q7_part_3	what programming languages do you use on a reg...	[sql, what programming languages do you use on...

In [110…

```
# Select only the relevant columns
df_k21_u1 = df_k21_ini[['q1', 'q3', 'q4', 'q5', 'q6', 'q20', 'q21', 'q25']]

# Drop the first row as it's only an elaboration on the questionnaire.
df_k21_u1 = df_k21_u1.drop(df_k21_u1.index[0])

# Define column name mappings
column_mappings = {
    'q1': 'age',
    'q3': 'country',
    'q4': 'education_level',
    'q5': 'job_title',
    'q6': 'experience',
    'q20': 'industry',
    'q21': 'company_size',
    'q25': 'salary_range'
}

# Rename columns using the mappings
df_k21_u = df_k21_u1.rename(columns=column_mappings)
df_k21_u['year'] = 2021
df_k21_u.head(2)
```

Out[110…

	age	country	education_level	job_title	experience	industry	company_size	salary_range	year
1	50-54	india	bachelor's degree	other	5-10 years	manufacturing/fabrication	50-249 employees	25,000-29,999	2021
2	50-54	indonesia	master's degree	program/project manager	20+ years	manufacturing/fabrication	1000-9,999 employees	60,000-69,999	2021

In [111…

```
len_k21_salarydrop1 = len(df_k21_u)

df_k21_u['salary_range'] = df_k21_u['salary_range'].str.replace('$', '', regex=False)
df_k21_u['salary_range'] = df_k21_u['salary_range'].str.replace('>', '', regex=False)

# Dropping rows where salary is Null
df_k21_u.dropna(subset=['salary_range'], inplace=True)

# Split the salary_range column on the dash ('-') and convert to numeric values
df_k21_u[['lower_salary', 'upper_salary']] = df_k21_u['salary_range'].str.split('-', expand=True)
df_k21_u['lower_salary'] = df_k21_u['lower_salary'].str.replace(',', '').astype(float)
df_k21_u['upper_salary'] = df_k21_u['upper_salary'].str.replace(',', '').astype(float)

df_k21_u['salary'] = df_k21_u[['lower_salary', 'upper_salary']].mean(axis=1)

len_k21_salarydrop2 = len(df_k21_u)
df_k21_u.head(3)
```

Out[111…

	age	country	education_level	job_title	experience	industry	company_size	salary_range	year	lower_salary	upper_salary	salary
1	50-54	india	bachelor's degree	other	5-10 years	manufacturing/fabrication	50-249 employees	25,000-29,999	2021	25000.00	29999.00	27499.50
2	50-54	indonesia	master's degree	program/project manager	20+ years	manufacturing/fabrication	1000-9,999 employees	60,000-69,999	2021	60000.00	69999.00	64999.50
3	22-24	pakistan	master's degree	software engineer	1-3 years	academics/education	1000-9,999 employees	0-999	2021	0.00	999.00	499.50

Year: 2022

In [113…
```
result_df = kaggle_summary(df_k22_ini)
result_df.to_csv('../results/df_k22_structure.txt', sep='\t', index=True)
result_df.head(10)
```

Out[113…

	column_name	second_row_values	top_5_values
0	duration_(in_seconds)	duration (in seconds)	[272, 264, 252, 303, 230]
1	q2	what is your age (# years)?	[18-21, 25-29, 22-24, 30-34, 35-39]
2	q3	what is your gender? - selected choice	[man, woman, prefer not to say, nonbinary, pre...
3	q4	in which country do you currently reside?	[india, united states of america, other, brazi...
4	q5	are you currently a student? (high school, uni...	[no, yes, are you currently a student? (high s...
5	q6_1	on which platforms have you begun or completed...	[coursera, on which platforms have you begun o...
6	q6_2	on which platforms have you begun or completed...	[edx, on which platforms have you begun or com...
7	q6_3	on which platforms have you begun or completed...	[kaggle learn courses, on which platforms have...
8	q6_4	on which platforms have you begun or completed...	[datacamp, on which platforms have you begun o...
9	q6_5	on which platforms have you begun or completed...	[fast.ai, on which platforms have you begun or...

In [114…
```
# Select only the relevant columns
df_k22_u1 = df_k22_ini[['q2', 'q4', 'q5', 'q8', 'q11', 'q23', 'q24', 'q25', 'q29']]

# Drop the first row as it's only an elaboration on the questionnaire
df_k22_u1 = df_k22_u1.drop(df_k22_u1.index[0])

# Define column name mappings
column_mappings = {
    'q2': 'age',
    'q4': 'country',
    'q5': 'are_you_student',
    'q8': 'education_level',
    'q11': 'experience',
    'q23': 'job_title',
    'q24': 'industry',
    'q25': 'company_size',
    'q29': 'salary_range'
}

# Rename columns using the mappings
df_k22_u = df_k22_u1.rename(columns=column_mappings)
df_k22_u['year'] = 2022
df_k22_u.head(3)
```

Out[114…

	age	country	are_you_student	education_level	experience	job_title	industry	company_size	salary_range	year
1	30-34	india	no	NaN	NaN	NaN	NaN	NaN	NaN	2022
2	30-34	algeria	no	master's degree	1-3 years	NaN	NaN	NaN	NaN	2022
3	18-21	egypt	yes	bachelor's degree	1-3 years	NaN	NaN	NaN	NaN	2022

In [115…
```
len_k22_salarydrop1 = len(df_k22_u)

df_k22_u['salary_range'] = df_k22_u['salary_range'].str.replace('$', '', regex=False)
df_k22_u['salary_range'] = df_k22_u['salary_range'].str.replace('>', '', regex=False)

# Dropping rows where salary is Null
df_k22_u.dropna(subset=['salary_range'], inplace=True)

# Split the salary_range column on the dash ('-') and convert to numeric values
df_k22_u[['lower_salary', 'upper_salary']] = df_k22_u['salary_range'].str.split('-', expand=True)
df_k22_u['lower_salary'] = df_k22_u['lower_salary'].str.replace(',', '').astype(float)
df_k22_u['upper_salary'] = df_k22_u['upper_salary'].str.replace(',', '').astype(float)

df_k22_u['salary'] = df_k22_u[['lower_salary', 'upper_salary']].mean(axis=1)
```

```
len_k22_salarydrop2 = len(df_k22_u)
df_k22_u.head(3)
```

Out[115…

	age	country	are_you_student	education_level	experience	job_title	industry	company_size	salary_range	year	lower_salary	upper_salary	salary
4	55-59	france	no	some college/university study without earning ...	10-20 years	data scientist	online service/internet-based services	0-49 employees	25,000-29,999	2022	25000.00	29999.00	27499.50
8	30-34	germany	no	bachelor's degree	10-20 years	software engineer	insurance/risk assessment	250-999 employees	100,000-124,999	2022	100000.00	124999.00	112499.50
9	70+	australia	no	doctoral degree	20+ years	research scientist	government/public service	1000-9,999 employees	100,000-124,999	2022	100000.00	124999.00	112499.50

Final checking uniformity

In [117…
```
df_ai_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 15965 entries, 0 to 15964
Series name: salary
Non-Null Count  Dtype
--------------  -----
15965 non-null  int64
dtypes: int64(1)
memory usage: 124.9 KB
```

In [118…
```
df_it18_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 757 entries, 0 to 772
Series name: salary
Non-Null Count  Dtype
--------------  -----
757 non-null    float64
dtypes: float64(1)
memory usage: 11.8 KB
```

In [119…
```
df_it19_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 990 entries, 0 to 990
Series name: salary
Non-Null Count  Dtype
--------------  -----
990 non-null    float64
dtypes: float64(1)
memory usage: 15.5 KB
```

In [120…
```
df_it20_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 1306 entries, 0 to 1305
Series name: salary
Non-Null Count  Dtype
--------------  -----
1306 non-null   float64
dtypes: float64(1)
memory usage: 10.3 KB
```

In [121…
```
df_it21_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 1186 entries, 0 to 1206
Series name: salary
Non-Null Count  Dtype
--------------  -----
1186 non-null   float64
dtypes: float64(1)
memory usage: 18.5 KB
```

In [122…
```
df_it22_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 759 entries, 0 to 772
Series name: salary
Non-Null Count  Dtype
--------------  -----
759 non-null    float64
dtypes: float64(1)
memory usage: 11.9 KB
```

In [123…
```
df_it23_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 694 entries, 0 to 713
Series name: salary
Non-Null Count  Dtype
--------------  -----
694 non-null    float64
dtypes: float64(1)
memory usage: 10.8 KB
```

In [124…
```
df_k19_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 12497 entries, 1 to 19717
Series name: salary
Non-Null Count  Dtype
--------------  -----
12497 non-null  float64
dtypes: float64(1)
memory usage: 195.3 KB
```

In [125…
```
df_k20_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 10729 entries, 2 to 20036
Series name: salary
Non-Null Count  Dtype
--------------  -----
10729 non-null  float64
dtypes: float64(1)
memory usage: 167.6 KB
```

In [126…
```
df_k21_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 15391 entries, 1 to 25973
Series name: salary
Non-Null Count  Dtype
--------------  -----
15391 non-null  float64
dtypes: float64(1)
memory usage: 240.5 KB
```

In [127…
```
df_k22_u['salary'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 8136 entries, 4 to 23996
Series name: salary
Non-Null Count  Dtype
--------------  -----
8136 non-null   float64
dtypes: float64(1)
memory usage: 127.1 KB
```

There are no null values in any of the 'salary' columns in any dataframe.
Also, they're all float64, which means that all values are recognized as numbers.
Brief note:
Python's Dtypes in relation to NaN and mixed values:
-> NaN can be contained in everything without the dtype reflecting it.
-> When a column contains mixed values (eg.: string and int/float), it is stored as ***object*** *dtype.*

Final cleaning report

In [130…
```
df_report_t = df_report.T
df_report_t.rename(columns={0: 'Occurrence'}, inplace=True)
df_report_t.to_csv('../results/Cleaning_report.txt', sep='\t', index=True)
```

In [131…
```
len_it18_u = len(df_it18_u)
len_it19_u = len(df_it19_u)
len_it20_u = len(df_it20_u)
len_it21_u = len(df_it21_u)
len_it22_u = len(df_it22_u)
len_it23_u = len(df_it23_u)

len_k19_u = len(df_k19_u)
len_k20_u = len(df_k20_u)
len_k21_u = len(df_k21_u)
len_k22_u = len(df_k22_u)

len_ai_u = len(df_ai_u)
```

In [132…
```
print(len_it18_u / len_it18_ini),
print(len_it19_u / len_it19_ini),
print(len_it20_u / len_it20_ini),
print(len_it21_u / len_it21_ini),
print(len_it22_u / len_it22_ini),
print(len_it23_u / len_it23_ini),
print(len_k19_u  / len_k19_ini ),
print(len_k20_u  / len_k20_ini ),
print(len_k21_u  / len_k21_ini ),
print(len_k22_u  / len_k22_ini ),
print(len_ai_u   / len_ai_ini  )
```

```
0.9793014230271668
0.9989909182643795
1.0
0.9826014913007457
0.981888745148771
0.9719887955182073
0.6337863880718125
0.5354594001097969
0.5925540925540925
0.33902825235436285
1.0
```

Conclusion:
Throghout the cleaning process, the 'clean_salary' function was used, which not only cleaned irregularities in data,
but upon encountering those irregularities, a counter increased in a reporting dataframe.
Those counters are exported as a ***cleaning report*** *to the 'results' folder.*

Union of the yearly dataframes

The survey data have been cleaned and prepared now for merging.
These dataframes may contain many interesting and nuanced questions, but for this project, only the common questions will be kept and merged.
Therefore some columns will need to be dropped.

In [136…
```
top_5_values_per_column(df_it23_u)
```

Out[136...

	column_name	top_5_values
0	city	[berlin, munich, frankfurt, other, dusseldorf]
1	your_city	[essen, kempten, bamberg, wiesbaden, paderborn]
2	employment_status	[full/part-time employee, founder, working stu...
3	job_title	[software engineer, backend developer, tech le...
4	job_title_2	[data analyst, business analyst, hardware engi...
5	experience	[15, 10, 5, 7, 12]
6	years_of_experience_in_germany	[1, 2, 5, 3, 4]
7	seniority_level	[senior, middle, lead / staff, head / principa...
8	your_seniority_level	[director of engineering, working student, c-l...
9	skills	[python, java, javascript / typescript, other,...
10	skills_3	[aws, terraform, drupal, no, react]
11	skills_2	[other, sql, python, java / scala, react]
12	years_in_the_current_workplace	[2.0, 1.0, 3.0, 0.5, 5.0]
13	language_at_work	[english, english,russian, english,german, eng...
14	company_size	[1000+, 101-1000, 11-50, 51-100, up to 10]
15	base_salary	[100000.0, 80000.0, 90000.0, 75000.0, 95000.0]
16	salary_w_bonus	[0.0, 90000.0, 100000.0, 75000.0, 70000.0]
17	salary_w_bonus_1y_ago	[75000.0, 90000.0, 85000.0, 0.0, 100000.0]
18	number_of_vacation_days	[30, 28, 27, unlimited, 25]
19	hourly_rate_in_eur	[]
20	working_hours_for_the_last_year	[]
21	number_of_days_off_in_the_last_year	[]
22	third-party_income_from_small_customers_or_own...	[]
23	working_hours_per_week	[40.0, 39.0, 38.0, 35.0, 30.0]
24	layoff_affects_you	[no, yes, i am satisfied with a severance pack...
25	company_layoffs	[no, yes, in 2023, yes, both in 2022-2023, i d...
26	work_from_home_allowance	[no, 100 - 500, up to 100 euro, 500 - 1000, ov...
27	did_you_already_find_a_new_job?	[]
28	employment_status_change_in_2023	[no, full/part-time employee, unemployed, work...
29	do_you_currently_search_for_a_job?	[]
30	how_long_have_you_been_unemployed?_(in_months)	[]
31	company_hire_in_2023	[yes, yes, but only for backfilling, no, i don...
32	company_industry	[information services, it, software developmen...
33	change_jobs	[no, yes]
34	tc_new_job	[better than it was, about the same, worse tha...
35	change_jobs_voluntary	[voluntary, it was my decision, involuntarily,...
36	how_long_find_job	[2,0, 3,0, 1,0, 6,0, 4,0]
37	ai_impact	[moderate but noticeable, invisible, great]
38	ai_use	[yes, no]
39	ai_tool	[chatgpt, chatgpt,copilot, copilot,chatgpt, co...
40	ai_other_tools	[bard, bing, jetbrains ai, midjourney, codewhi...
41	salary_eur	[90000, 100000, 75000, 70000, 95000]

	column_name	top_5_values
42	year	[2023]
43	country	[de]
44	salary	[97170.56315684487, 107967.29239649429, 80975....

Germany IT Survey

In [138…
```
df_it18_u = df_it18_u[['age', 'city', 'job_title', 'seniority_level', 'language_at_work', 'company_size', 'company_type', 'salary', 'year', 'country']]

df_it19_u = df_it19_u[['age', 'city', 'job_title', 'seniority_level', 'experience', 'language_at_work', 'company_size', 'company_type', 'salary', 'year', 'country'
                       , 'skills']]

df_it20_u = df_it20_u[['age', 'city', 'job_title', 'seniority_level', 'experience', 'language_at_work', 'company_size', 'company_type', 'salary', 'year', 'country'
                       , 'skills', 'skills_2', 'employment_status', 'years_of_experience_in_germany']]

df_it21_u = df_it21_u[['city', 'job_title', 'job_title_2', 'seniority_level', 'experience', 'language_at_work', 'company_size', 'salary', 'year', 'country'
                       , 'skills', 'skills_2', 'employment_status', 'years_of_experience_in_germany', 'your_seniority_level']]

df_it22_u = df_it22_u[['city', 'job_title', 'job_title_2', 'seniority_level', 'experience', 'language_at_work', 'company_size', 'salary', 'year', 'country'
                       , 'skills', 'skills_2', 'skills_3', 'employment_status', 'years_of_experience_in_germany', 'your_seniority_level']]

df_it23_u = df_it23_u[['city', 'job_title', 'job_title_2', 'seniority_level', 'experience', 'language_at_work', 'company_size', 'salary', 'year', 'country'
                       , 'skills', 'skills_2', 'skills_3', 'employment_status', 'years_of_experience_in_germany', 'your_seniority_level', 'company_industry']]
```

In [139…
```
df_it_uni = pd.concat([df_it18_u, df_it19_u, df_it20_u, df_it21_u, df_it22_u, df_it23_u])  #concat creates a copy
df_it_uni['survey'] = 'it'
df_it_uni = df_it_uni.reset_index(drop=True)
len_it_uni = len(df_it_uni)
```

In [140…
```
df_it_uni.head(2)
```

Out[140…

	age	city	job_title	seniority_level	language_at_work	company_size	company_type	salary	year	country	experience	skills	skills_2	employment_status	years_of_experience_in_germany	job_title_2	your_seniority_level	skills_3	company_industry	survey
0	43.00	münchen	qa ingenieur	senior	deutsch	100-1000	product	90944.70	2018	de	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	it
1	33.00	münchen	senior php magento developer	senior	deutsch	50-100	product	76771.50	2018	de	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	it

Kaggle

In [142…
```
df_k_uni = pd.concat([df_k19_u, df_k20_u, df_k21_u, df_k22_u]) #concat creates a copy
df_k_uni['survey'] = 'k'
len_k_uni = len(df_k_uni)
```

In [143…
```
df_k_uni.head(2)
```

Out[143…

	age	country	education_level	job_title	job_title_2	company_size	salary_range	experience	year	lower_salary	upper_salary	salary	industry	are_you_student	survey
1	22-24	france	master's degree	software engineer	-1	1000-9,999 employees	30,000-39,999	1-2 years	2019	30000.00	39999.00	34999.50	NaN	NaN	k
2	40-44	india	professional degree	software engineer	-1	> 10,000 employees	5,000-7,499	i have never written code	2019	5000.00	7499.00	6249.50	NaN	NaN	k

AI-Jobs.net

In [145…
```
df_ai_uni = df_ai_u.copy() #For naming convention's sake, I create a copy, since for the previous surveys I needed a concat method, which also created copies.
df_ai_uni['survey'] = 'ai'
len_ai_uni = len(df_ai_uni)
```

Transformations after union

Dropping values based on project scope

Uknown salary values were dropped already.
*But furthermore, we need to know the **Country, Seniority, Job title**. If any of those is missing, I'll drop the row from further investigation.*

Employment status

AI-Jobs.net

In [151…
```
df_ai_uni['employment_status'].unique()
```

Out[151…
```
['ft', 'pt', 'fl', 'ct']
Categories (4, object): ['ct', 'fl', 'ft', 'pt']
```

In [152…
```
len_ai_employmentdrop1 = len(df_ai_uni)
df_ai_uni = df_ai_uni[df_ai_uni['employment_status'] == 'ft']
len_ai_employmentdrop2 = len(df_ai_uni)
```

There are no students in this dataset, therefore I set the dropped student counter to 0.

In [154…
```
len_ai_studentdrop1 = 0
len_ai_studentdrop2 = 0
```

DE IT-Survey

Dropping Nulls

In [157…
```
df_it_uni['employment_status'][df_it_uni['year'] == 2020].unique()
```

Out[157…
```
array(['full-time employee', 'self-employed (freelancer)',
       'company director', nan, 'founder', 'part-time employee',
       'working student',
       'full-time position, part-time position, & self-employed (freelancing, tutoring)',
       'intern',
       "full-time, but 32 hours per week (it was my request, i'm a student)",
       'werkstudent'], dtype=object)
```

In [158…
```
len_it_employmentdrop1 = len(df_it_uni)

# Define the years to filter
years_to_filter = [2020, 2021, 2022, 2023]

# Separate the rows where the year is in the specified range
df_filtered_years = df_it_uni[df_it_uni['year'].isin(years_to_filter)]

# Drop rows with NaN employment_status in the filtered subset
df_filtered_years = df_filtered_years.dropna(subset=['employment_status'])

# Combine back the filtered rows with the rest of the DataFrame
df_it_uni = pd.concat([df_filtered_years, df_it_uni[~df_it_uni['year'].isin(years_to_filter)]], ignore_index=True)
```

```
len_it_employmentdrop2 = len(df_it_uni)
```

In [159…]
```
df_it_uni['employment_status'][df_it_uni['year'] == 2020].unique()
```

Out[159…]
```
array(['full-time employee', 'self-employed (freelancer)',
       'company director', 'founder', 'part-time employee',
       'working student',
       'full-time position, part-time position, & self-employed (freelancing, tutoring)',
       'intern',
       "full-time, but 32 hours per week (it was my request, i'm a student)",
       'werkstudent'], dtype=object)
```

Dropping freelance, parttime, student

In [161…]
```
df_it_uni['employment_status'].unique()
```

Out[161…]
```
array(['full-time employee', 'self-employed (freelancer)',
       'company director', 'founder', 'part-time employee',
       'working student',
       'full-time position, part-time position, & self-employed (freelancing, tutoring)',
       'intern',
       "full-time, but 32 hours per week (it was my request, i'm a student)",
       'werkstudent', 'other', 'full/part-time employee', nan],
      dtype=object)
```

In [162…]
```
df_it_uni = df_it_uni.reset_index(drop=True)
```

In [163…]
```
len_it_studentdrop1 = len(df_it_uni)
df_it_uni = df_it_uni[df_it_uni['employment_status'].isin(['full-time employee', 'founder', 'full-time position, part-time position, & self-employed (freelancing, tutoring)', 'full/part-time employee']) | df_it_uni['employment_status'].isna()]
len_it_studentdrop2 = len(df_it_uni)
```

In [164…]
```
df_it_uni['employment_status'].unique()
```

Out[164…]
```
array(['full-time employee', 'founder',
       'full-time position, part-time position, & self-employed (freelancing, tutoring)',
       'full/part-time employee', nan], dtype=object)
```

Kaggle

In [166…]
```
df_k_uni['are_you_student'].unique()
```

Out[166…]
```
[NaN, 'no']
Categories (3, object): ['are you currently a student? (high school, un..., 'no', 'yes']
```

In [167…]
```
#df_k_uni[ (df_k_uni['are_you_student'].notna()) & (df_k_uni['are_you_student'] != 'no') ].head()
```

In [168…]
```
# This drops row number 70k --> 10k !
# df_k_uni = df_k_uni[(df_k_uni['are_you_student'] == 'no')]

# By manual inspection it seems that many people left it unanswered. It's better to just filter out the explicit 'yes'.
```

In [169…]
```
df_k_uni[df_k_uni['are_you_student'] == 'yes'].head()
```

Out[169…]

age	country	education_level	job_title	job_title_2	company_size	salary_range	experience	year	lower_salary	upper_salary	salary	industry	are_you_student	survey

*The dedicated 'are_you_student' column is **not** filled properly, therefore I omit this counter.*
Furthermore, there is no dedicated employment status category, therefore I also omit this counter.

In [171…]
```
#len_k_studentdrop1 =
#df_k_uni = df_k_uni[df_k_uni['are_you_student'].isin(['yes'])]
#len_k_studentdrop2 =
```

Dropping from 'experience' column

In [173…]
```
df_k_uni['experience'].unique()
```

Out[173…
```
array(['1-2 years', 'i have never written code', '< 1 years', '20+ years',
       '3-5 years', '5-10 years', '10-20 years', nan, '1-3 years'],
      dtype=object)
```

In [174…
```
len_k_noncoderdrop1 = len(df_k_uni)
df_k_uni = df_k_uni[df_k_uni['experience'] != 'i have never written code']
len_k_noncoderdrop2 = len(df_k_uni)
```

Country

AI-Jobs

In [177…
```
df_ai_uni['country'].sort_values().unique()
```

Out[177…
```
['ad', 'ae', 'am', 'ar', 'at', ..., 'ug', 'us', 'uz', 'vn', 'za']
Length: 83
Categories (88, object): ['ad', 'ae', 'am', 'ar', ..., 'us', 'uz', 'vn', 'za']
```

In [178…
```
len_ai_countrydrop1 = len(df_ai_uni)
df_ai_uni.dropna(subset=['country'], inplace=True)
len_ai_countrydrop2 = len(df_ai_uni)
```

Kaggle

In [180…
```
df_k_uni['country'].sort_values().unique()
```

Out[180…
```
array(['algeria', 'argentina', 'australia', 'austria', 'bangladesh',
       'belarus', 'belgium', 'brazil', 'cameroon', 'canada', 'chile',
       'china', 'colombia', 'czech republic', 'denmark', 'ecuador',
       'egypt', 'ethiopia', 'france', 'germany', 'ghana', 'greece',
       'hong kong (s.a.r.)', 'hungary',
       'i do not wish to disclose my location', 'india', 'indonesia',
       'iran, islamic republic of...', 'iraq', 'ireland', 'israel',
       'italy', 'japan', 'kazakhstan', 'kenya', 'malaysia', 'mexico',
       'morocco', 'nepal', 'netherlands', 'new zealand', 'nigeria',
       'norway', 'other', 'pakistan', 'peru', 'philippines', 'poland',
       'portugal', 'republic of korea', 'romania', 'russia',
       'saudi arabia', 'singapore', 'south africa', 'south korea',
       'spain', 'sri lanka', 'sweden', 'switzerland', 'taiwan',
       'thailand', 'tunisia', 'turkey', 'uganda', 'ukraine',
       'united arab emirates',
       'united kingdom of great britain and northern ireland',
       'united states of america', 'viet nam', 'zimbabwe'], dtype=object)
```

In [181…
```
len_k_countrydrop1 = len(df_k_uni)
df_k_uni = df_k_uni[df_k_uni['country'] != 'i do not wish to disclose my location']
df_k_uni = df_k_uni[df_k_uni['country'] != 'other']
len_k_countrydrop2 = len(df_k_uni)
```

Germany IT-Survey

This is a germany-specific survey, therefore I just set the counter to 0.

In [184…
```
len_it_countrydrop1 = 0
len_it_countrydrop2 = 0
```

Seniority_level

Ai-Jobs

In [187…
```
len_ai_senioritydrop1 = len(df_ai_uni)
```

```
df_ai_uni.dropna(subset=['seniority_level'], inplace=True)
len_ai_senioritydrop2 = len(df_ai_uni)
```

Germany IT-Survey

In [189…
```
len_it_senioritydrop1 = len(df_it_uni)
df_it_uni.dropna(subset=['seniority_level'], inplace=True)
len_it_senioritydrop2 = len(df_it_uni)
```

Kaggle

I'll later transform 'experience' into seniority, therefore, for the counter I add this to the seniioritydrop

In [192…
```
len_k_seniioritydrop1 = len(df_k_uni)
df_k_uni.dropna(subset=['experience'], inplace=True)
len_k_seniioritydrop2 = len(df_k_uni)
```

Job-title

AI-jobs.net

In [195…
```
len_ai_jobtitledrop1 = len(df_ai_uni)
df_ai_uni.dropna(subset=['job_title'], inplace=True)
len_ai_jobtitledrop2 = len(df_ai_uni)
```

Germany IT-Survey

In [197…
```
len_it_jobtitledrop1 = len(df_it_uni)
df_it_uni.dropna(subset=['job_title'], inplace=True)
len_it_jobtitledrop2 = len(df_it_uni)
```

Kaggle

In [199…
```
len_k_jobtitledrop1 = len(df_k_uni)
df_k_uni.dropna(subset=['job_title'], inplace=True)
len_k_jobtitledrop2 = len(df_k_uni)
```

Uniformization

Country Codes

Kaggle

In [203…
```
df_k_uni['country'].sort_values().unique()
```

Out[203…

```
array(['algeria', 'argentina', 'australia', 'austria', 'bangladesh',
       'belarus', 'belgium', 'brazil', 'cameroon', 'canada', 'chile',
       'china', 'colombia', 'czech republic', 'denmark', 'ecuador',
       'egypt', 'ethiopia', 'france', 'germany', 'ghana', 'greece',
       'hong kong (s.a.r.)', 'hungary', 'india', 'indonesia',
       'iran, islamic republic of...', 'iraq', 'ireland', 'israel',
       'italy', 'japan', 'kazakhstan', 'kenya', 'malaysia', 'mexico',
       'morocco', 'nepal', 'netherlands', 'new zealand', 'nigeria',
       'norway', 'pakistan', 'peru', 'philippines', 'poland', 'portugal',
       'republic of korea', 'romania', 'russia', 'saudi arabia',
       'singapore', 'south africa', 'south korea', 'spain', 'sri lanka',
       'sweden', 'switzerland', 'taiwan', 'thailand', 'tunisia', 'turkey',
       'uganda', 'ukraine', 'united arab emirates',
       'united kingdom of great britain and northern ireland',
       'united states of america', 'viet nam', 'zimbabwe'], dtype=object)
```

In [204…

```python
# Dictionary to map country names to 2-letter country codes
country_to_code = {
    'france': 'fr',
    'india': 'in',
    'indonesia': 'id',
    'united states of america': 'us',
    'australia': 'au',
    'mexico': 'mx',
    'germany': 'de',
    'turkey': 'tr',
    'netherlands': 'nl',
    'nigeria': 'ng',
    'canada': 'ca',
    'greece': 'gr',
    'belgium': 'be',
    'singapore': 'sg',
    'italy': 'it',
    'ireland': 'ie',
    'taiwan': 'tw',
    'russia': 'ru',
    'brazil': 'br',
    'south africa': 'za',
    'poland': 'pl',
    'iran, islamic republic of...': 'ir',
    'ukraine': 'ua',
    'pakistan': 'pk',
    'chile': 'cl',
    'japan': 'jp',
    'egypt': 'eg',
    'south korea': 'kr',
    'belarus': 'by',
    'viet nam': 'vn',
    'colombia': 'co',
    'israel': 'il',
    'china': 'cn',
    'united kingdom of great britain and northern ireland': 'gb',
    'sweden': 'se',
    'bangladesh': 'bd',
    'portugal': 'pt',
    'tunisia': 'tn',
    'argentina': 'ar',
    'czech republic': 'cz',
    'spain': 'es',
    'hong kong (s.a.r.)': 'hk',
    'cameroon': 'cm',
    'saudi arabia': 'sa',
    'austria': 'at',
    'kenya': 'ke',
    'morocco': 'ma',
    'romania': 'ro',
    'hungary': 'hu',
    'republic of korea': 'kr',
    'norway': 'no',
    'ethiopia': 'et',
    'philippines': 'ph',
    'thailand': 'th',
    'denmark': 'dk',
    'switzerland': 'ch',
    'peru': 'pe',
    'sri lanka': 'lk',
    'ghana': 'gh',
```

```
    'malaysia': 'my',
    'united arab emirates': 'ae',
    'nepal': 'np',
    'iraq': 'iq',
    'new zealand': 'nz',
    'algeria': 'dz',
    'ecuador': 'ec',
    'uganda': 'ug',
    'kazakhstan': 'kz',
    'zimbabwe': 'zw',
    'latvia': 'lv'
}
```

In [205…
```
# Transform country names to 2-Letter country codes
df_k_uni['country'] = df_k_uni['country'].map(country_to_code)
df_k_uni['country'].unique()
```

Out[205…
```
array(['fr', 'au', 'in', 'us', 'nl', 'de', 'ie', 'ru', 'gr', 'ua', 'pk',
       'jp', 'br', 'kr', 'by', 'ng', 'gb', 'se', 'mx', 'ca', 'pt', 'pl',
       'id', 'it', 'cz', 'es', 'cl', 'hk', 'za', 'ar', 'tr', 'il', 'tw',
       'eg', 'ma', 'hu', 'co', 'no', 'th', 'ch', 'vn', 'sg', 'bd', 'ir',
       'pe', 'ke', 'ro', 'cn', 'be', 'at', 'dz', 'nz', 'tn', 'ph', 'my',
       'dk', 'sa', 'ae', 'np', 'lk', 'gh', 'et', 'iq', 'ec', 'kz', 'ug',
       'cm', 'zw'], dtype=object)
```

Seniority level

De-IT

In [208…
```
df_it_uni['seniority_level'].unique()
```

Out[208…
```
array(['senior', 'junior', 'middle', 'lead', 'head', 'no level', 'vp',
       'manager', 'work center manager', 'cto', 'director', 'key',
       'c-level executive manager', 'principal', 'intern',
       'no idea, there are no ranges in the firm ', 'c-level',
       'entry level', '800', 'other', 'head / principal', 'lead / staff'],
      dtype=object)
```

In [209…
```
# Define the mapping dictionary
seniority_mapping_it = {
    'head / principal': 'executive',
    'lead / staff': 'executive',
    'c-level executive manager': 'executive',
    'head': 'executive',
    'lead': 'executive',
    'director': 'executive',
    'manager': 'executive',
    'vp': 'executive',
    'c-level executive manager':'executive',
    'cto': 'executive',  # direCTOr
    'principal': 'executive',
    'c-level': 'executive',
    'middle': 'medior',
    'entry level': 'junior',
    'intern': 'other',
    'working student': 'other',
    'student': 'other',
    '800': 'other',
    'key': 'other',
    'no idea, there are no ranges in the firm ': 'other',
    'self employed': 'other',
    'work center executive': 'other',
    'no level ': 'other',
    'no level': 'other',
    'work center manager':'other'
}
```

In [210…
```
# Replace the seniority levels using the mapping dictionary
df_it_uni['seniority_level'] = df_it_uni['seniority_level'].replace(seniority_mapping_it)
df_it_uni['seniority_level'].unique()
```

Out[210… array(['senior', 'junior', 'medior', 'executive', 'other'], dtype=object)

AI-Jobs.net

In [212…
```
df_ai_uni['seniority_level'].unique()
```

Out[212…
```
['en', 'se', 'mi', 'ex']
Categories (4, object): ['en', 'ex', 'mi', 'se']
```

In [213…
```
# Define the mapping dictionary
seniority_mapping_ai = {
    'mi':'medior',
    'en': 'junior',
    'se': 'senior',
    'ex': 'executive'
}
```

In [214…
```
# Replace the seniority levels using the mapping dictionary
df_ai_uni['seniority_level'] = df_ai_uni['seniority_level'].replace(seniority_mapping_ai)
#df_ai_uni['seniority_level'] = df_ai_uni['seniority_level'].cat.rename_categories(seniority_mapping_ai)
df_ai_uni['seniority_level'].unique()
```

```
C:\Users\Viktor\AppData\Local\Temp\ipykernel_17208\1934354632.py:2: FutureWarning: The behavior of Series.replace (and DataFrame.replace) with CategoricalDtype is deprecated. In a future version, replace will only be used for cases that preserve the categories. To change the categories, use ser.cat.rename_categories instead.
  df_ai_uni['seniority_level'] = df_ai_uni['seniority_level'].replace(seniority_mapping_ai)
```

Out[214…
```
['junior', 'senior', 'medior', 'executive']
Categories (4, object): ['junior', 'executive', 'medior', 'senior']
```

Kaggle

In [216…
```
df_k_uni['experience'].unique()
```

Out[216…
```
array(['1-2 years', '< 1 years', '20+ years', '3-5 years', '5-10 years',
       '10-20 years', '1-3 years'], dtype=object)
```

In [217…
```
# Mapping of experience intervals to seniority levels
experience_to_seniority = {
    '< 1 years': 'junior',
    '1-2 years': 'junior',
    '1-3 years': 'junior',
    '3-5 years': 'medior',
    '5-10 years': 'senior',
    '10-20 years': 'senior',
    '20+ years': 'executive'
}
```

In [218…
```
# Create the seniority_level column
df_k_uni['seniority_level'] = df_k_uni['experience'].map(experience_to_seniority)
df_k_uni.head()
```

Out[218…

	age	country	education_level	job_title	job_title_2	company_size	salary_range	experience	year	lower_salary	upper_salary	salary	industry	are_you_student	survey	seniority_level
1	22-24	fr	master's degree	software engineer	-1	1000-9,999 employees	30,000-39,999	1-2 years	2019	30000.00	39999.00	34999.50	NaN	NaN	k	junior
4	40-44	au	master's degree	other	0	> 10,000 employees	250,000-299,999	1-2 years	2019	250000.00	299999.00	274999.50	NaN	NaN	k	junior
5	22-24	in	bachelor's degree	other	1	0-49 employees	4,000-4,999	< 1 years	2019	4000.00	4999.00	4499.50	NaN	NaN	k	junior
6	50-54	fr	master's degree	data scientist	-1	0-49 employees	60,000-69,999	20+ years	2019	60000.00	69999.00	64999.50	NaN	NaN	k	executive
7	22-24	in	master's degree	data scientist	-1	50-249 employees	10,000-14,999	3-5 years	2019	10000.00	14999.00	12499.50	NaN	NaN	k	medior

Additonal cleaning

Germany-IT

In [221…
```
df_it_uni.head(1)
```

Out[221…

	age	city	job_title	seniority_level	language_at_work	company_size	company_type	salary	year	country	experience	skills	skills_2	employment_status	years_of_experience_in_germany	job_title_2	your_seniority_level	skills_3	company_industry	sur
0	26.00	munich	software engineer	senior	english	51-100	product	96939.28	2020	de	5	typescript	kotlin, javascript / typescript	full-time employee	3	NaN	NaN	NaN	NaN	

'experience' and 'years_of_experience_in_germany'

'experience' and 'years_of_experience_in_germany' columns are filled with unclean answers

In [224…
```
df_it_uni['experience'].unique()
```

Out[224…
```
array(['5', '7', '4', '17', '6', '8', '15', '2', nan, '14', '11', '18',
       '13', '30', '10', '12', '25', '3', '40', '26', '9', '19', '20',
       '5.5', '22', '16', '0.8', '1', '1.5', '6.5', '21', '7.5', '2.5',
       '28', '29', '23', '1,5', '24', '0', '4.5', '27',
       '1 (as qa engineer) / 11 in total', '2,5', '15, thereof 8 as cto',
       '31', '6 (not as a data scientist, but as a lab scientist)', '3.5',
       '7,5', '5000', '800', 16, 6, 2, 5, 17, 12, 7, 20, 9, 10, 8, 11, 15,
       13, 14, 18, 23, 60000, 4, 75300, 30, 3, 1, 0, 21, 19, 25, 140000,
       27, 22, 24, 32, 28, 31, 33, 26, 45, 65], dtype=object)
```

In [225…
```
df_it_uni['years_of_experience_in_germany'].unique()
```

Out[225…
```
array(['3', '4', '1', '6', '0.4', '2', nan, '5', '9', '30', '7', '15',
       '11', '10', '18', '0', '8', '2.5', '1,5', '1.5', '0.5', '13', '14',
       '4,5', '3.5', '0.8', '1,7', '12', '3,5', '20', '0.9', '25', '< 1',
       '0.25', '4 (in switzerland), 0 (in germany)', '16', '17',
       '4 month', '19', '2,5', '0,5', '26', '3 months', '4.5', '0.1',
       '2.6', '3 (in poland)', '<1', '0,3', '-',
       '6 (not as a data scientist, but as a lab scientist)', '800', 8, 6,
       2, 5, 3, 10, 1, 4, 7, 9, 45, 12, 0, 13, 15, 16, 25, 11, 14, 20, 23,
       22, 21, 30, 17, 18, 19, 31, 24], dtype=object)
```

In [226…
```
df_report_additional = pd.DataFrame(index=[0])
```

In [227…
```
df_it_uni['experience'] = df_it_uni['experience'].apply(clean_salary_0616, df_report=df_report_additional, prefix='experience')
df_report_additional
```

Out[227…

	experience_null_values_encountered	experience_strings_encountered	experience_leading_trailing_whitespace	experience_+-_characters_removed	experience_commas_replaced
0	746	1223	0	0	6

In [228…
```
df_it_uni['experience'] = df_it_uni['experience'].apply(pd.to_numeric, errors='coerce')
df_it_uni['experience'] = df_it_uni['experience'][(df_it_uni['experience'] <= 100)]
```

In [229…
```
df_it_uni['years_of_experience_in_germany'] = df_it_uni['years_of_experience_in_germany'].apply(clean_salary_0616, df_report=df_report_additional, prefix='experience_in_de')
df_report_additional
```

Out[229…

	experience_null_values_encountered	experience_strings_encountered	experience_leading_trailing_whitespace	experience_+-_characters_removed	experience_commas_replaced	experience_in_de_null_values_encountered	experience_in_de_strings_encountered	experience_in_de_leading_tra
0	746	1223	0	0	6	1735	1208	

In [230…
```
df_it_uni['years_of_experience_in_germany'] = df_it_uni['years_of_experience_in_germany'].apply(pd.to_numeric, errors='coerce')
df_it_uni['years_of_experience_in_germany'] = df_it_uni['years_of_experience_in_germany'][(df_it_uni['years_of_experience_in_germany'] <= 100)]
```

In [231…
```
df_it_uni['experience'].describe()
```

Out[231…
```
count   4778.00
mean       9.39
std        5.46
min        0.00
25%        5.00
50%        9.00
75%       13.00
max       65.00
Name: experience, dtype: float64
```

City

In [233…
```
df_it_uni.groupby('city')['salary'].count().sort_values(ascending=False).head(6)
```

Out[233…
```
city
berlin       2877
munich       1064
münchen       242
frankfurt     196
hamburg       168
stuttgart     109
Name: salary, dtype: int64
```

In [234…
```
df_it_uni.loc[df_it_uni['city'] == 'münchen', 'city'] = 'munich'
```

In [235…
```
df_it_uni.groupby('city')['salary'].count().sort_values(ascending=False).head(6)
```

Out[235…
```
city
berlin       2877
munich       1306
frankfurt     196
hamburg       168
stuttgart     109
amsterdam     104
Name: salary, dtype: int64
```

In [236…
```
# Define the major cities to keep
major_cities = ['berlin', 'munich', 'frankfurt', 'hamburg', 'stuttgart']

# Create the 'city_category' column
df_it_uni['city_category'] = df_it_uni['city'].apply(lambda x: x if x in major_cities else 'other')
```

Language at work

In [238…
```
df_it_uni['language_at_work'].unique()
```

Out[238…
```
array(['english', 'german', nan, 'english and german', 'russian',
       'polish', 'русский', 'czech', 'italian', 'french', 'both',
       'spanish', 'russian, english', 'russian ', 'german,english',
       'english,german', 'english,russian', 'english,german,russian',
       'russian,english', 'german,russian', 'russian,german,english',
       'english,russian,german', 'german,english,russian',
       'russian,german', 'german,russian,english',
       'russian,english,german', 'english,russian,other',
       'english,other,russian', 'english,german,other', 'english,other',
       'english,german,russian,other', 'deutsch',
       'team - russian; cross-team - english;', 'deutsch/englisch',
       'english+deutsch', 'dutch', 'polish+english', 'ukrainian'],
      dtype=object)
```

In [239…
```
def categorize_language(language_entry, categories):
    language_entry = str(language_entry).lower()  # Convert language_entry to lower case string
    for category, keywords in categories.items():
        for keyword in keywords:
            pattern = re.escape(keyword.lower())  # Create regex pattern for keyword
            if re.search(pattern, language_entry):
                return category
    return 'Only other languages'  # For entries that don't match any category
```

In [240…
```
language_categories = {
    'German-speaking': ['german', 'deutsch'],
    'English-speaking (but not german)': ['english']
}
```

```
df_it_uni['language_category'] = df_it_uni['language_at_work'].apply(lambda x: categorize_language(x, language_categories))
```

In [241…
```
df_it_uni['language_category'].unique()
```

Out[241…
```
array(['English-speaking (but not german)', 'German-speaking',
       'Only other languages'], dtype=object)
```

In [242…
```
df_it_uni.groupby('language_category')['salary'].count().sort_values(ascending=False).head(6)
```

Out[242…
```
language_category
English-speaking (but not german)    4167
German-speaking                      1229
Only other languages                  136
Name: salary, dtype: int64
```

company_size

In [244…
```
df_it_uni.groupby('company_size')['salary'].count().sort_values(ascending=False)
```

Out[244…
```
company_size
1000+       2132
101-1000    1262
100-1000     621
11-50        433
51-100       429
50-100       249
10-50        217
up to 10     167
Name: salary, dtype: int64
```

In [245…
```
df_it_uni['company_size'] = df_it_uni['company_size'].replace({'10-50': '11-50'})
df_it_uni['company_size'] = df_it_uni['company_size'].replace({'50-100': '51-100'})
df_it_uni['company_size'] = df_it_uni['company_size'].replace({'100-1000': '101-1000'})
```

In [246…
```
df_it_uni.groupby('company_size')['salary'].count().sort_values(ascending=False)
```

Out[246…
```
company_size
1000+       2132
101-1000    1883
51-100       678
11-50        650
up to 10     167
Name: salary, dtype: int64
```

In [247…
```
def categorize_company_size(size):
    """
    Categorize company size into small (s), medium (m), or large (l).
    Handles NaN values and unknown categories.

    Parameters:
    size: Company size value (string or NaN)

    Returns:
    string: 's', 'm', 'l', or 'unknown'
    """
    # Handle NaN values first using pandas.isna()
    if pd.isna(size):
        return 'unknown'

    # Convert to string to handle any numeric inputs
    size = str(size).lower().strip()

    # Direct mapping for known categories
    if size in ['s', 'm', 'l']:
        return size

    # Large companies
    elif size in ['1000+', '1000-9,999 employees', '10,000 or more employees',
                  '> 10,000 employees', '>1000', '1000 or more employees']:
        return 'l'

    # Medium companies
    elif size in ['101-1000', '250-999 employees', '50-249 employees', '51-100',
                  '100-999', '51-1000']:
```

```
        return 'm'

    # Small companies
    elif size in ['11-50', 'up to 10', '0-49 employees', '<50', '1-50',
                  '0-50', 'under 50 employees']:
        return 's'

    # Any other value is considered unknown
    return 'unknown'
```

In [248…
```
# Apply the function to both DataFrames
df_it_uni['company_size_category'] = df_it_uni['company_size'].apply(categorize_company_size)
df_it_uni['company_size_category'].unique()
```

Out[248…
```
array(['m', 's', 'l', 'unknown'], dtype=object)
```

'company_industry'

In [250…
```
df_it_uni.groupby('company_industry')['salary'].count().sort_values(ascending=False)
```

Out[250…
```
company_industry
information services, it, software development, or other technology    408
financial services                                                     74
retail and consumer services                                           66
other                                                                  42
manufacturing, transportation, or supply chain                         38
healthcare                                                             23
advertising services                                                   15
insurance                                                              11
higher education                                                        3
legal services                                                          3
oil & gas                                                               3
wholesale                                                               3
Name: salary, dtype: int64
```

In [251…
```
# Define the function to categorize industries
def categorize_industry(industry):
    if industry in ['information services, it, software development, or other technology']:
        return 'information technology'
    elif industry in ['financial services', 'insurance']:
        return 'financial services'
    elif industry == 'retail and consumer services':
        return 'retail and consumer services'
    elif industry == 'manufacturing, transportation, or supply chain':
        return 'manufacturing, transportation, or supply chain'
    elif industry == 'healthcare':
        return 'healthcare'
    else:
        return 'other'

# Create the 'industry_category' column
df_it_uni['industry_category'] = df_it_uni['company_industry'].apply(categorize_industry)
```

company_type

In [253…
```
len(df_it_uni['company_type'].unique())
```

Out[253…
```
97
```

This is a free-string cell. I will not try to make sense of it;
Feel free to look inside... the required effort for this is out of scope now.

Kaggle

In [256…
```
df_k_uni.head(1)
```

Out[256…

	age	country	education_level	job_title	job_title_2	company_size	salary_range	experience	year	lower_salary	upper_salary	salary	industry	are_you_student	survey	seniority_level
1	22-24	fr	master's degree	software engineer	-1	1000-9,999 employees	30,000-39,999	1-2 years	2019	30000.00	39999.00	34999.50	NaN	NaN	k	junior

Education level

In [258…
```
df_k_uni['education_level'].unique()
```

Out[258…
```
array(['master's degree', 'bachelor's degree', 'doctoral degree',
       'some college/university study without earning a bachelor's degree',
       'i prefer not to answer', 'professional degree',
       'no formal education past high school', 'professional doctorate'],
      dtype=object)
```

In [259…
```
df_k_uni['education_level'] = df_k_uni['education_level'].str.replace('no formal education past high school','no degree')
df_k_uni['education_level'] = df_k_uni['education_level'].str.replace('some college/university study without earning a bachelor's degree','no degree')
df_k_uni = df_k_uni[(df_k_uni['education_level'] == 'bachelor's degree') | (df_k_uni['education_level'] == 'master's degree') | (df_k_uni['education_level'] == 'doctoral degree') | (df_k_uni['education_level'] == 'no degree')]
```

company_size

In [261…
```
df_k_uni.groupby('company_size')['salary'].count().sort_values(ascending=False)
```

Out[261…
```
company_size
0-49 employees              11017
1000-9,999 employees         7433
10,000 or more employees     6371
50-249 employees             6012
250-999 employees            5034
> 10,000 employees           2317
Name: salary, dtype: int64
```

In [262…
```
df_k_uni['company_size_category'] = df_k_uni['company_size'].apply(categorize_company_size)
df_k_uni['company_size_category'].unique()
```

Out[262…
```
array(['l', 's', 'm'], dtype=object)
```

experience

In [264…
```
df_k_uni.groupby('experience')['salary'].count().sort_values(ascending=False)
```

Out[264…
```
experience
3-5 years      8084
5-10 years     6612
< 1 years      6121
10-20 years    4826
1-3 years      4631
1-2 years      4088
20+ years      3822
Name: salary, dtype: int64
```

In [265…
```
df_k_uni['experience'] = df_k_uni['experience'].replace({'1-2 years': '1-3 years'})
```

industry

In [267…
```
df_k_uni.groupby('industry')['salary'].count().sort_values(ascending=False)
```

Out[267…
```
industry
computers/technology                    5138
academics/education                     3384
accounting/finance                      1769
other                                   1343
manufacturing/fabrication               1130
medical/pharmaceutical                   962
government/public service                884
online service/internet-based services   845
retail/sales                             724
energy/mining                            659
insurance/risk assessment                554
marketing/crm                            473
broadcasting/communications              402
shipping/transportation                  353
non-profit/service                       343
online business/internet-based sales     223
military/security/defense                168
hospitality/entertainment/sports         137
Name: salary, dtype: int64
```

AI-jobs

Company size

In [270…
```
# Remove rows where all columns are NaN
df_ai_uni = df_ai_uni.dropna(how='all')
```

In [271…
```
df_ai_uni['company_size_category'] = df_ai_uni['company_size'].apply(categorize_company_size)
df_ai_uni['company_size_category'].unique()
```

Out[271…
```
['m', 'l', 's']
Categories (3, object): ['l', 'm', 's']
```

In [272…
```
df_ai_uni[df_ai_uni['company_size'].isna()].head()
```

Out[272…

year	seniority_level	employment_status	job_title	salary_in_currency	salary_currency	salary	country	remote_ratio	company_location	company_size	ratio	survey	company_size_category

Deriving new variables

I create new categories to simplify the analysis later.
For example, the country-standardization by GDP-per-capita might flatten out the huge variance when it comes to country dependencies.
This is all in hope that I might be able to drop the country parameter.
The idea for this chapter, chronologically was born deep in the analysis/ prediction phase. But was inserted here for the sake of project flow.

Country-standardized salary

In [276…
```
# GDP per capita data (in USD)
gdp_per_capita = {
    'fr': 40886, 'in': 2016, 'au': 65099, 'us': 76329, 'nl': 57025,
    'de': 48717, 'ie': 87947, 'ru': 15270, 'gr': 19829, 'ua': 4533,
    'pk': 1491, 'jp': 40066, 'br': 8697, 'kr': 31961,
    'by': 7888, 'ng': 2229, 'gb': 46125, 'se': 53755, 'mx': 10657,
    'ca': 54917, 'pt': 23758, 'pl': 17939, 'id': 4289, 'it': 34776,
    'cz': 23906, 'es': 31688, 'cl': 14938, 'hk': 46544, 'za': 6001,
    'ar': 10461, 'tr': 10674, 'il': 44162, 'tw': 34166, 'eg': 3801,
    'ma': 3585, 'hu': 18390, 'co': 6214, 'no': 89111, 'th': 7775,
```

```
    'ch': 93259, 'vn': 3704, 'sg': 59806, 'bd': 1964, 'ir': 2273,
    'pe': 7002, 'ke': 2066, 'ro': 15786, 'cn': 12710, 'be': 50126,
    'at': 52084, 'dz': 4094, 'nz': 45380, 'tn': 3840, 'ph': 3593,
    'my': 11109, 'dk': 61612, 'sa': 20619, 'ae': 43103, 'np': 1192,
    'lk': 3841, 'gh': 2396, 'et': 936, 'iq': 4922, 'ec': 6245,
    'kz': 10153, 'ug': 817, 'cm': 1500, 'zw': 1098,
    'lv': 21779, 'ge': 4804, 'lt': 25064, 'fi': 53012, 'hr': 15647, 'om': 25056, 'ba': 7568, 'ee': 28247,
    'mt': 34127, 'lb': 4136, 'si': 28439, 'mu': 10256, 'am': 7018, 'qa': 87661, 'ad': 41992, 'md': 5714,
    'uz': 2255, 'cf': 427, 'kw': 41079, 'cy': 32048, 'as': 19673, 'cr': 13365, 'pr': 35208, 'bo': 3600,
    'do': 8793, 'hn': 2736, 'bg': 12623, 'je': 55820, 'rs': 9260,  'lu': 125006
}
```

In [277…
```
country_salary_stats
```

Out[277…

	country_code	country	median_income_2020_usd	mean_income_2020_usd	gdp_ppp_usd	glassdoor_software_engineer_usd	alternative_gdp_ppp?
0	lu	luxembourg	26321	31376	143342	77777.00	NaN
1	ie	ireland	14520	17938	127623	72221.00	NaN
2	no	norway	22684	25272	104460	68233.00	NaN
3	ch	switzerland	21490	25787	92980	131900.00	NaN
4	ae	united arab emirates	24292	27107	83903	NaN	NaN
...	...	...	...	...	...	...	...
170	hk	hong kong	17985	22890	75128	NaN	71481.00
171	sg	singapore	24525	32700	84734	NaN	141500.00
172	kw	kuwait	14715	17985	49736	NaN	56386.00
173	pr	puerto rico	13080	16350	49594	NaN	47699.00
174	je	jersey	21255	26160	56600	NaN	56600.00

175 rows × 7 columns

In [278…
```
#df_ai_uni.drop(['country_code', 'median_income_2020_usd', 'mean_income_2020_usd', 'gdp_ppp_usd', 'glassdoor_software_engineer_usd','salary_normmed','salary_normmean','salary_normgdp','salary_normse'], axis=1, inplace=True)
```

In [279…
```
#df_k_uni.drop(['country_code', 'median_income_2020_usd', 'mean_income_2020_usd', 'gdp_ppp_usd', 'glassdoor_software_engineer_usd','salary_normmed','salary_normmean','salary_normgdp','salary_normse'], axis=1, inplace=True)
```

In [280…
```
#df_it_uni.drop(['country_code', 'median_income_2020_usd', 'mean_income_2020_usd', 'gdp_ppp_usd', 'glassdoor_software_engineer_usd','salary_normmed','salary_normmean','salary_normgdp','salary_normse'], axis=1, inplace=True)
```

In [281…
```
df_name = df_ai_uni

# Merge df with country_salary_stats to get the median income for each country
df_name = df_name.merge(
    country_salary_stats[['country_code', 'median_income_2020_usd', 'mean_income_2020_usd', 'gdp_ppp_usd', 'glassdoor_software_engineer_usd']],
    left_on='country',
    right_on='country_code',
    how='left'
)

# Calculate the normalized salaries
df_name['salary_normmed'] = df_name['salary'] / df_name['median_income_2020_usd']
df_name['salary_normmean'] = df_name['salary'] / df_name['mean_income_2020_usd']
df_name['salary_normgdp'] = df_name['salary'] / df_name['gdp_ppp_usd']
df_name['salary_normse'] = df_name['salary'] / df_name['glassdoor_software_engineer_usd']

df_ai_uni = df_name
```

In [282…
```
df_name = df_k_uni

# Merge df with country_salary_stats to get the median income for each country
df_name = df_name.merge(
    country_salary_stats[['country_code', 'median_income_2020_usd', 'mean_income_2020_usd', 'gdp_ppp_usd', 'glassdoor_software_engineer_usd']],
    left_on='country',
    right_on='country_code',
    how='left'
)

# Calculate the normalized salaries
df_name['salary_normmed'] = df_name['salary'] / df_name['median_income_2020_usd']
df_name['salary_normmean'] = df_name['salary'] / df_name['mean_income_2020_usd']
```

```
df_name['salary_normgdp'] = df_name['salary'] / df_name['gdp_ppp_usd']
df_name['salary_normse'] = df_name['salary'] / df_name['glassdoor_software_engineer_usd']

df_k_uni = df_name
```

In [283…]
```
df_name = df_it_uni

# Merge df with country_salary_stats to get the median income for each country
df_name = df_name.merge(
    country_salary_stats[['country_code', 'median_income_2020_usd', 'mean_income_2020_usd', 'gdp_ppp_usd', 'glassdoor_software_engineer_usd']],
    left_on='country',
    right_on='country_code',
    how='left'
)

# Calculate the normalized salaries
df_name['salary_normmed'] = df_name['salary'] / df_name['median_income_2020_usd']
df_name['salary_normmean'] = df_name['salary'] / df_name['mean_income_2020_usd']
df_name['salary_normgdp'] = df_name['salary'] / df_name['gdp_ppp_usd']
df_name['salary_normse'] = df_name['salary'] / df_name['glassdoor_software_engineer_usd']

df_it_uni = df_name
```

Approach 2

In [285…]
```
df_ai_uni['country'][~(df_ai_uni['country'].isin(gdp_per_capita))].unique()
```

Out[285…]
```
array([], dtype=object)
```

In [286…]
```
# Normalize the salary - Kaggle
df_k_uni['salary_norm'] = df_k_uni.apply(lambda x: x['salary'] / gdp_per_capita[x['country']], axis=1)
df_k_uni.head(2)
```

Out[286…]

	age	country	education_level	job_title	job_title_2	company_size	salary_range	experience	year	lower_salary	upper_salary	salary	industry	are_you_student	survey	seniority_level	company_size_category	country_code	median_income_2020_usd	mean_i
0	22-24	fr	master's degree	software engineer	-1	1000-9,999 employees	30,000-39,999	1-3 years	2019	30000.00	39999.00	34999.50	NaN	NaN	k	junior	l	fr	16372	
1	40-44	au	master's degree	other	0	> 10,000 employees	250,000-299,999	1-3 years	2019	250000.00	299999.00	274999.50	NaN	NaN	k	junior	l	au	17076	

In [287…]
```
# Normalize the salary - AI-Jobs.net
df_ai_uni['salary_norm'] = df_ai_uni.apply(lambda x: x['salary'] / gdp_per_capita[x['country']], axis=1)
df_ai_uni.head()
```

Out[287…]

	year	seniority_level	employment_status	job_title	salary_in_currency	salary_currency	salary	country	remote_ratio	company_location	company_size	ratio	survey	company_size_category	country_code	median_income_2020_usd	mean_income_2020_usd	gdp_ppp
0	2024	junior	ft	data analyst	20000	usd	20000	ke	100	ke	m	1.00	ai	m	ke	874	1197	
1	2024	senior	ft	data analyst	147500	usd	147500	us	0	us	m	1.00	ai	m	us	19306	25332	8
2	2024	senior	ft	data analyst	85000	usd	85000	us	0	us	m	1.00	ai	m	us	19306	25332	8
3	2024	senior	ft	data architect	175000	usd	175000	us	0	us	m	1.00	ai	m	us	19306	25332	8
4	2024	senior	ft	data architect	117000	usd	117000	us	0	us	m	1.00	ai	m	us	19306	25332	8

In [288…]
```
# Normalize the salary - Germany IT-Survey
df_it_uni['salary_norm'] = df_it_uni.apply(lambda x: x['salary'] / gdp_per_capita[x['country']], axis=1)
df_it_uni.head()
```

Out[288…

	age	city	job_title	seniority_level	language_at_work	company_size	company_type	salary	year	country	experience	skills	skills_2	employment_status	years_of_experience_in_germany	job_title_2	your_seniority_level	skills_3	company_industry
0	26.00	munich	software engineer	senior	english	51-100	product	96939.28	2020	de	5.00	typescript	kotlin, javascript / typescript	full-time employee	3.00	NaN	NaN	NaN	NaN
1	26.00	berlin	backend developer	senior	english	101-1000	product	91236.97	2020	de	7.00	ruby	NaN	full-time employee	4.00	NaN	NaN	NaN	NaN
2	28.00	berlin	frontend developer	junior	english	51-100	startup	61584.96	2020	de	4.00	javascript	NaN	full-time employee	1.00	NaN	NaN	NaN	NaN
3	37.00	berlin	backend developer	senior	english	101-1000	product	70708.65	2020	de	17.00	c# .net	.net, sql, aws, docker	full-time employee	6.00	NaN	NaN	NaN	NaN
4	32.00	berlin	devops	senior	english	11-50	startup	92377.44	2020	de	5.00	aws, gcp, python,k8s	python, aws, google cloud, kubernetes, docker	full-time employee	1.00	NaN	NaN	NaN	NaN

Year-Standardized salary

In [290…

```
inflation_rates = {
    2018: 1.019,  # USD inflation from 2018 to 2019 (22.66% increase from 2018 to 2024)
    2019: 1.018,  # USD inflation from 2019 to 2020 (20.37% increase from 2019 to 2024)
    2020: 1.012,  # USD inflation from 2020 to 2021 (18.25% increase from 2020 to 2024)
    2021: 1.040,  # USD inflation from 2021 to 2022 (16.84% increase from 2021 to 2024)
    2022: 1.070,  # USD inflation from 2022 to 2023 (12.35% increase from 2022 to 2024)
    2023: 1.050,  # USD inflation from 2023 to 2024 (5.00% increase from 2023 to 2024)
    2024: 1.000   # base year, no inflation adjustment for 2024,
}

# Calculate cumulative inflation adjustment factor
def calculate_cumulative_inflation(start_year, end_year=2024):
    if start_year >= end_year:
        return 1.0
    inflation_factors = [inflation_rates[year] for year in range(start_year, end_year)]
    cumulative_inflation = 1.0
    for factor in inflation_factors:
        cumulative_inflation *= factor
    return cumulative_inflation

# Apply inflation adjustment to the salary column
def salary_to_2024(row):
    return row['salary'] * calculate_cumulative_inflation(row['year'])

# Apply inflation adjustment to the salary column
def salarynorm_to_2024(row):
    return row['salary_norm'] * calculate_cumulative_inflation(row['year'])
```

In [291…

```
# Apply inflation adjustment directly to the 'salary' and 'salary_norm' columns
df_it_uni['salary_2024'] = df_it_uni.apply(lambda row: row['salary'] * calculate_cumulative_inflation(row['year']), axis=1)
df_it_uni['salary_norm_2024'] = df_it_uni.apply(lambda row: row['salary_norm'] * calculate_cumulative_inflation(row['year']), axis=1)
df_it_uni['salary_normmed_2024'] = df_it_uni.apply(lambda row: row['salary_normmed'] * calculate_cumulative_inflation(row['year']), axis=1)
df_it_uni['salary_normmean_2024'] = df_it_uni.apply(lambda row: row['salary_normmean'] * calculate_cumulative_inflation(row['year']), axis=1)
df_it_uni['salary_normgdp_2024'] = df_it_uni.apply(lambda row: row['salary_normgdp'] * calculate_cumulative_inflation(row['year']), axis=1)
df_it_uni['salary_normse_2024'] = df_it_uni.apply(lambda row: row['salary_normse'] * calculate_cumulative_inflation(row['year']), axis=1)

#df_it_uni['salary_2024'] = df_it_uni.apply(salary_to_2024, axis=1)
#df_it_uni['salary_norm_2024'] = df_it_uni.apply(salarynorm_to_2024, axis=1)
#df_it_uni['salary_normmed_2024'] = df_it_uni.apply(salarynorm_to_2024, axis=1)
#df_it_uni['salary_normmean_2024'] = df_it_uni.apply(salarynorm_to_2024, axis=1)
#df_it_uni['salary_normgdp_2024'] = df_it_uni.apply(salarynorm_to_2024, axis=1)
#df_it_uni['salary_normse_2024'] = df_it_uni.apply(salarynorm_to_2024, axis=1)

# Display the updated dataframe
df_it_uni[['year', 'salary', 'salary_2024', 'salary_norm', 'salary_norm_2024', 'salary_normmed_2024', 'salary_normmean_2024', 'salary_normgdp_2024', 'salary_normse_2024']].head()
```

Out[291…

	year	salary	salary_2024	salary_norm	salary_norm_2024	salary_normmed_2024	salary_normmean_2024	salary_normgdp_2024	salary_normse_2024
0	2020	96939.28	114626.95	1.99	2.35	6.80	5.81	1.65	1.38
1	2020	91236.97	107884.19	1.87	2.21	6.40	5.47	1.56	1.29
2	2020	61584.96	72821.83	1.26	1.49	4.32	3.69	1.05	0.87
3	2020	70708.65	83610.25	1.45	1.72	4.96	4.24	1.21	1.00
4	2020	92377.44	109232.74	1.90	2.24	6.48	5.54	1.58	1.31

In [292…

```
# Apply inflation adjustment directly to the 'salary' and 'salary_norm' columns
df_k_uni['salary_2024'] = df_k_uni.apply(lambda row: row['salary'] * calculate_cumulative_inflation(row['year']), axis=1)
df_k_uni['salary_norm_2024'] = df_k_uni.apply(lambda row: row['salary_norm'] * calculate_cumulative_inflation(row['year']), axis=1)
df_k_uni['salary_normmed_2024'] = df_k_uni.apply(lambda row: row['salary_normmed'] * calculate_cumulative_inflation(row['year']), axis=1)
df_k_uni['salary_normmean_2024'] = df_k_uni.apply(lambda row: row['salary_normmean'] * calculate_cumulative_inflation(row['year']), axis=1)
df_k_uni['salary_normgdp_2024'] = df_k_uni.apply(lambda row: row['salary_normgdp'] * calculate_cumulative_inflation(row['year']), axis=1)
df_k_uni['salary_normse_2024'] = df_k_uni.apply(lambda row: row['salary_normse'] * calculate_cumulative_inflation(row['year']), axis=1)

# Display the updated dataframe
df_k_uni[['year', 'salary', 'salary_2024', 'salary_norm', 'salary_norm_2024', 'salary_normmed_2024', 'salary_normmean_2024', 'salary_normgdp_2024', 'salary_normse_2024']].head()
```

Out[292…

	year	salary	salary_2024	salary_norm	salary_norm_2024	salary_normmed_2024	salary_normmean_2024	salary_normgdp_2024	salary_normse_2024
0	2019	34999.50	42130.49	0.86	1.03	2.57	2.17	0.69	0.72
1	2019	274999.50	331029.43	4.22	5.09	19.39	15.52	4.79	4.05
2	2019	4499.50	5416.25	2.23	2.69	1.39	4.12	0.53	NaN
3	2019	64999.50	78242.86	1.59	1.91	4.78	4.03	1.28	1.33
4	2019	12499.50	15046.22	6.20	7.46	3.86	11.45	1.48	NaN

In [293…

```
df_ai_uni.dropna(subset=['year'], inplace=True)
```

In [294…

```
df_ai_uni['year'] = df_ai_uni['year'].astype('int64')
```

In [295…

```
# Apply inflation adjustment directly to the 'salary' and 'salary_norm' columns
df_ai_uni['salary_2024'] = df_ai_uni.apply(lambda row: row['salary'] * calculate_cumulative_inflation(row['year']), axis=1)
df_ai_uni['salary_norm_2024'] = df_ai_uni.apply(lambda row: row['salary_norm'] * calculate_cumulative_inflation(row['year']), axis=1)
df_ai_uni['salary_normmed_2024'] = df_ai_uni.apply(lambda row: row['salary_normmed'] * calculate_cumulative_inflation(row['year']), axis=1)
df_ai_uni['salary_normmean_2024'] = df_ai_uni.apply(lambda row: row['salary_normmean'] * calculate_cumulative_inflation(row['year']), axis=1)
df_ai_uni['salary_normgdp_2024'] = df_ai_uni.apply(lambda row: row['salary_normgdp'] * calculate_cumulative_inflation(row['year']), axis=1)
df_ai_uni['salary_normse_2024'] = df_ai_uni.apply(lambda row: row['salary_normse'] * calculate_cumulative_inflation(row['year']), axis=1)

# Display the updated dataframe
df_ai_uni[['year', 'salary', 'salary_2024', 'salary_norm', 'salary_norm_2024', 'salary_normmed_2024', 'salary_normmean_2024', 'salary_normgdp_2024', 'salary_normse_2024']].head()
```

Out[295…

	year	salary	salary_2024	salary_norm	salary_norm_2024	salary_normmed_2024	salary_normmean_2024	salary_normgdp_2024	salary_normse_2024
0	2024	20000	20000.00	9.68	9.68	22.88	16.71	3.16	NaN
1	2024	147500	147500.00	1.93	1.93	7.64	5.82	1.81	0.92
2	2024	85000	85000.00	1.11	1.11	4.40	3.36	1.04	0.53
3	2024	175000	175000.00	2.29	2.29	9.06	6.91	2.14	1.09
4	2024	117000	117000.00	1.53	1.53	6.06	4.62	1.43	0.73

Categorizing Job-titles

In [297…

```
#df_it['job_category_kw'] = df_it['job_title'].apply(categorize_by_keywords, category_keywords)
## df_it['job_category_kw'] = df_it['job_title'].apply(lambda x: categorize_by_keywords_1627(x, category_keywords))
#df_it['job_category'] = df_it['job_title'].apply(lambda x: categorize_job_title(x, categories))
```

In [298…

```
# Function to categorize job titles based on keyword match
def categorize_job_title_1945(job_title, categories):
    job_title = str(job_title).lower()  # Convert job_title to lower case string
    for category, keywords in categories.items():
```

```
        for keyword in keywords:
            pattern = re.escape(keyword.lower())  # Create regex pattern for keyword
            if re.search(pattern, job_title):
                return category
    return 'Uncategorized'  # For job titles that don't match any category
```

In [299…

```
job_categories = {
    'Project managers': [
        'project manager', 'pm' , 'program manager', 'project manager ', 'projectingenieur', 'project manager (pm)', 'program/project manager', 'technical lead',
        'project manager & scrum master', 'technical project manager', 'digital project manager', 'it project manager',
        'scrum master', 'scrum master / agile coach', 'sr project manager', 'senior project manager', 'senior program manager', 'engineering project manager',
        'agile project manager', 'project leader', 'director of engineering', 'director of project management', 'director of technology', 'director of operations',
        'project consultant', 'project coordinator', 'project supervisor', 'project assistant', 'project administrator', 'project management officer',
        'program manager (technical)', 'construction project manager', 'it program manager', 'it project coordinator', 'it project management consultant',
        'it project manager ', 'associate project manager', 'project portfolio manager', 'project office manager', 'product manager',
        'technical program manager', 'digital transformation project manager', 'technical program manager (tpm)', 'digital project lead', 'delivery manager',
        'global project manager', 'global program manager', 'business program manager', 'service delivery manager', 'it delivery manager', 'operations project manager',
        'customer project manager', 'implementation project manager', 'senior delivery manager', 'business development manager operations', 'project & operations manager',
        'it operations manager', 'manager (program, project, operations, executive-level, etc)', 'project & operations manager', 'technical project lead'
    ],
    'Team leaders': ['team lead', 'team leader'],
    'Leaders': ['head of', 'lead', 'principal', 'staff', 'vp', 'cto'],
    'Other managers': ['manager'],
    'Full Stack Developers': ['full stack', 'full-stack', 'fullstack'],
    'Architects': ['architect', 'data modeler', 'architekt'],
    'Cloud': ['cloud engineer', 'cloud consulting', 'cloud platform engineer', 'cloud infrastructure engineer', 'cloud automation engineer'],

    'PHP Developers': ['php'],
    'SAP Specialists': ['sap'],
    'NET Developers': ['.net', 'c#'],
    'C++ Developers': ['c++'],
    'Mobile': ['ios','mobile', 'android','application'],
    'Java/Scala Developers': ['java', 'scala','javascript','js', 'angular'],
    'Other languages': ['python', 'ruby', 'oracle', 'erlang', 'go', 'golang', 'pyhon'],

    'Embedded Engineers': ['embedded'],
    'Front End': ['front end', 'front-end','frontend','frontent'],
    'Back End': ['back end','back-end', 'backend'],
    'Web developer': ['web developer', 'webdev', 'web-entwickler'],
    'Game': ['unreal','game','unity','unity3d'],
    'Hardware':['hardware'],
    'Security':['security'],
    'Database Dev & Admin':['dba', 'database developer', 'database engineer', 'database administrator', 'database manager', 'databengineer', 'data administrator'],
    'System admin': ['sys admin', 'sysadmin', 'system administrator', 'systems administrator', 'it administration', 'it admin', 'network administrator'],
    'Statisticians': ['statistician'],
    'Consultant': ['consultant', 'berater', 'consulter', 'consulting'],

    'Researcher': ['researcher'],
    'Prompt Engineer': ['prompt'],
    'Bioinformatics': ['bioinformatics', 'biostatistics', 'computational biologist'],

    'Business Analyst': [
        'business analyst', 'business intelligence analyst', 'bi analyst', 'bi specialist',
        'business insights analyst', 'financial data analyst', 'compliance data analyst', 'product data analyst', 'marketing data analyst', 'business data analyst',
        'data analyst (business, marketing, financial, quantitative, etc)', 'business intelligence manager', 'business intelligence engineer', 'business intelligence specialist',
        'business intelligence data analyst', 'business analyst/re', 'business analyst ', 'business analyst / business development manager operations',
        'business development manager operations'
    ],

    'Data Analyst': [
        'data analyst', 'business intelligence developer', 'bi developer', 'research analyst', 'analytics engineer', 'data management analyst', 'data visualization',
        'data strategist',
        'data analytics associate', 'product analyst', 'marketing analyst', 'dana analyst', 'data reporting analyst', 'data quality analyst', 'finance data analyst',
        'compliance data analyst', 'product data analyst', 'marketing data analyst', 'financial data analyst', 'data analytics consultant', 'data integration analyst',
        'insight analyst', 'data analyst (business, marketing, financial, quantitative, etc)', 'business data analyst', 'data modeller', 'data analytics manager',
        'data operations analyst', 'data quality manager', 'data science analyst', 'data specialist', 'data strategy manager', 'data management consultant',
        'data analytics lead', 'data analytics specialist', 'data operations manager', 'data product analyst', 'data product owner', 'data quality engineer',
        'data visualization analyst', 'data visualization specialist'
    ],

    'Business Analyst': [
        'business intelligence',
    ],

    'Data Engineer': [
        'ml ops engineer', 'data engineer', 'database engineer', 'big data engineer', 'etl developer', 'etl engineer', 'big data developer', 'data operations',
        'machine learning operations engineer','machine learning infrastructure engineer', 'machine learning developer',
```

```
        'data integration', 'data processing', 'data developer', 'data integration engineer', 'data pipeline engineer', 'cloud data engineer', 'data infrastructure engineer',
        'data warehouse engineer', 'data migration engineer', 'etl/data engineer', 'data platform engineer', 'data ops engineer', 'data services engineer',
        'data solutions engineer', 'data systems engineer', 'data automation engineer', 'data engineering manager', 'data engineer lead', 'data engineering consultant',
        'data operations engineer', 'data modeling engineer', 'data engineering analyst', 'data warehouse developer', 'data engineer/scientist', 'data quality engineer',
        'data mining engineer', 'data software engineer', 'data engineering specialist'
    ],

    'Data Scientist/ ML Engineer': [
        'ai developer', 'deep learning engineer', 'data science', 'data scientist', 'machine learning engineer', 'ai engineer', 'ml engineer', 'research scientist', 'deep learning engineer',
        'machine learning specialist', 'ai programmer', 'ai scientist', 'decision scientist',
        'nlp engineer', 'computer vision engineer', 'applied scientist', 'ai/ml engineer', 'data scientist/analyst', 'data science engineer', 'data science analyst',
        'data science manager', 'machine learning scientist', 'applied ml engineer', 'ai/ml scientist', 'research engineer', 'mlops engineer', 'data scientist lead',
        'data scientist manager', 'senior data scientist', 'principal data scientist', 'staff machine learning engineer', 'staff data scientist', 'machine learning software engineer',
        'machine learning manager', 'machine learning ops engineer', 'principal machine learning engineer', 'applied machine learning engineer', 'ml engineer/analyst',
        'data & applied scientist', 'machine learning research engineer', 'machine learning modeler', 'ai/ml researcher', 'mlops/data scientist', 'ai/ ml research engineer',
        'ml engineer/research scientist', 'ai/ml engineer/researcher', 'machine learning engineet'
    ],

    'Data Governance & Compliance': [
        'data governance specialist', 'data governance manager', 'compliance data analyst', 'data quality manager', 'data quality analyst', 'data quality engineer', 'data management analyst', 'data management consultant', 'data management speci
    ],

    'Software Engineer':[
        'software engineer', 'software developer'
    ],

    'DevOps Engineer': [
        'devops engineer', 'devops', 'devops engineer ',
        'software engineer (devops)', 'system engineer', 'system administrator', 'systems engineer',
        'it infrastructure consultant', 'it consultant', 'solution engineer', 'lead devops', 'lead devops engineer', 'technical lead devops',
        'sr. devops', 'sr. engineer', 'sre', 'sre engineer', 'site reliability engineer', 'site reliability engineer '
    ],

    'UI/UX Designers': [
        'ux designer', 'ui designer', 'ux/ui designer', 'designer (ui, ux)', 'designer (ui/ux)', 'product designer', 'interaction designer', 'user experience designer', 'visual designer', 'frontend designer', 'creative designer', 'web designer'
    ],

    'QA/Test Engineers': [
        'qa', 'testing', 'tester', 'test', 'qa test engineer', 'qa engineer', 'qa automation engineer', 'automation qa', 'test automation engineer', 'manual qa',
        'qa automation', 'qa consultant', 'qa analyst', 'software test engineer', 'quality engineer', 'test engineer', 'test manager', 'testautomation',
        'automation test engineer', 'quality assurance', 'quality assurance engineer', 'qa specialist', 'qa automation specialist', 'qa automation'
    ],

    'Other Engineers': [
        'platform engineer', 'engineer (non-software)', 'network engineer', 'support engineer', 'electrical engineer', 'firmware engineer', 'robotics engineer', 'it engineer', 'reporting engineer', 'ta engineer', 'cisco engineer'
    ],

    'Other Developers': [
        'web developer', 'sw developer', 'softwaredeveloper', 'xr', 'crypto', 'rpa developer', 'sharepoint developer', 'nav developer', 'dwh developer', 'web deleloper', 'erp developer'
    ],

    'Out of scope': [
        'teacher', 'professor', 'lawyer', 'sales', 'pcb designer', 'coach', 'producer', 'recruiter', 'agile', 'banker', 'quant'
    ],
    'System...': [
        'system'
    ],
    'Advocacy':['developer advocate', 'developer relations/advocacy', ],

    'Too vague answers': [
        'engineer', 'developer', 'designer', 'support', 'operations', 'analyst', 'spezialist', 'specialist'
    ],
    '"Other"': ['other']

}
```

DE IT-Survey

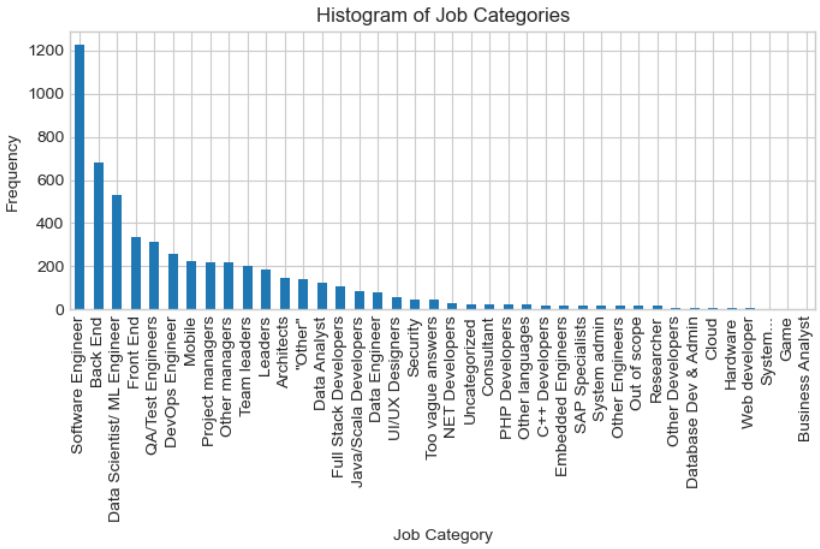
In [301…

```
df_it_uni['job_title'] = df_it_uni['job_title'].str.replace('senior', '', case=False, regex=False)
df_it_uni['job_title'] = df_it_uni['job_title'].str.replace('sr.', '', case=False, regex=False)
df_it_uni['job_title'] = df_it_uni['job_title'].str.strip()
```

In [302…

```
df_it_uni['job_category'] = df_it_uni['job_title'].apply(lambda x: categorize_job_title_1945(x, job_categories))
```

In [303…
```
# Plot histogram for the 'job_category' column
plt.figure(figsize=(8, 3))
df_it_uni['job_category'].value_counts().plot(kind='bar')
plt.title('Histogram of Job Categories')
plt.xlabel('Job Category')
plt.ylabel('Frequency')
plt.xticks(rotation=90)
plt.show()
```



In [304…
```
df_it_uni['job_title'][df_it_uni['job_category'] == 'Uncategorized'].tail(50)
#df_it_uni['job_title'][df_it_uni['job_category'] == 'Too vague answers'].tail(50)
```

Out[304…
```
89                    account manager
260                         stuttgart
535             chief research officer
795                    tech recruiting
908                      ai management
967                           beikoch
1048            computational linguist
3896                             sdet
3942                              sde
3951                              mts
3977            computational linguist
4079                               pd
4256                              sse
4349                               db
4367                        dwh expert
4399                               1c
4409    ml/research (30 hours weekly)
4476                             sdet
4507                      it специалист
4541                               32
4546                softwareentwickler
4557                               ba
4616                     localization
4954                        mainframe
5514                          desktop
Name: job_title, dtype: object
```

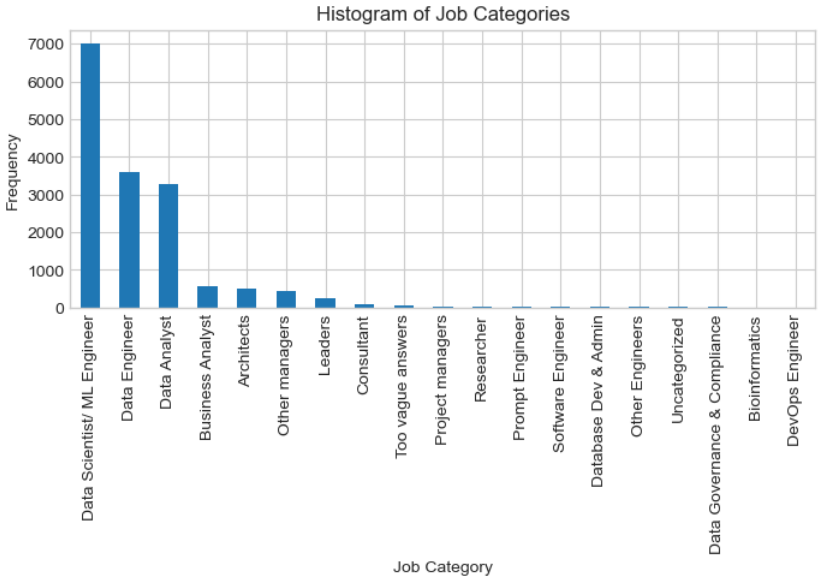
In [305…
```
df_it_uni['job_title'][df_it_uni['job_category'] == 'Database Development/ Admininistration'].head(50)
```

Out[305…
```
Series([], Name: job_title, dtype: object)
```

In [307…
```
df_ai_uni['job_title'] = df_ai_uni['job_title'].str.replace('senior', '', case=False, regex=False)
df_ai_uni['job_title'] = df_ai_uni['job_title'].str.replace('sr.', '', case=False, regex=False)
df_ai_uni['job_title'] = df_ai_uni['job_title'].str.strip()
```

In [308…
```
df_ai_uni['job_category'] = df_ai_uni['job_title'].apply(lambda x: categorize_job_title_1945(x, job_categories))
```

In [309…
```
# Plot histogram for the 'job_category' column
plt.figure(figsize=(8, 3))
df_ai_uni['job_category'].value_counts().plot(kind='bar')
plt.title('Histogram of Job Categories')
plt.xlabel('Job Category')
plt.ylabel('Frequency')
plt.xticks(rotation=90)
plt.show()
```



In [310…
```
df_ai_uni['job_title'][df_ai_uni['job_category'] == 'Uncategorized'].head(50)
#df_ai_uni['job_title'][df_ai_uni['job_category'] == 'Too vague answers'].tail(50)
```

Out[310…
```
21       encounter data management professional
22       encounter data management professional
101      encounter data management professional
102      encounter data management professional
755                              bear robotics
756                              bear robotics
1203     encounter data management professional
1204     encounter data management professional
11964            autonomous vehicle technician
Name: job_title, dtype: object
```

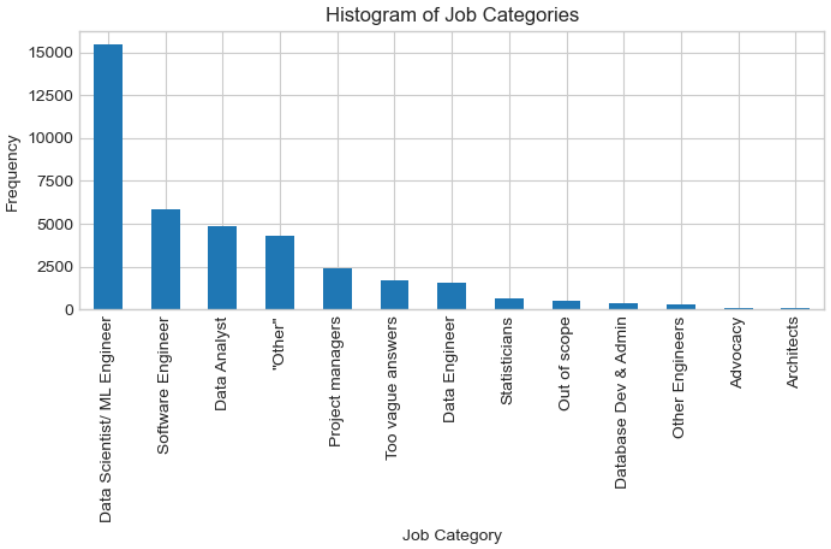
Kaggle

In [312…
```
df_k_uni['job_title'] = df_k_uni['job_title'].str.replace('senior', '', case=False, regex=False)
df_k_uni['job_title'] = df_k_uni['job_title'].str.replace('sr.', '', case=False, regex=False)
df_k_uni['job_title'] = df_k_uni['job_title'].str.strip()
```

In [313…
```
df_k_uni['job_category'] = df_k_uni['job_title'].apply(lambda x: categorize_job_title_1945(x, job_categories))
```

In [314…
```
# Plot histogram for the 'job_category' column
plt.figure(figsize=(8, 3))
df_k_uni['job_category'].value_counts().plot(kind='bar')
plt.title('Histogram of Job Categories')
plt.xlabel('Job Category')
plt.ylabel('Frequency')
```

```
plt.xticks(rotation=90)
plt.show()
```



In [315…
```
df_k_uni['job_title'][df_k_uni['job_category'] == 'Uncategorized'].tail(50)
#df_k_uni['job_title'][df_k_uni['job_category'] == 'Too vague answers'].head(50)
```

Out[315…
```
Series([], Name: job_title, dtype: object)
```

Optional: Check how these categories got populated actually

In [317…
```
#for category in job_categories:
#    unique_titles = df_it_uni['job_title'][df_it_uni['job_category'] == category].unique()
#    print(f"{category}: {unique_titles}")
```

In [318…
```
#for category in job_categories:
#    unique_titles = df_ai_uni['job_title'][df_ai_uni['job_category'] == category].unique()
#    print(f"{category}: {unique_titles}")
```

In [319…
```
#for category in job_categories:
#    unique_titles = df_k_uni['job_title'][df_k_uni['job_category'] == category].unique()
#    print(f"{category}: {unique_titles}")
```

Western Countries

In [321…
```
western_countries = [
    'al', 'ad', 'am', 'at', 'az', 'by', 'be', 'ba', 'bg', 'hr',
    'cy', 'cz', 'dk', 'ee', 'fi', 'fr', 'ge', 'de', 'gr', 'hu',
    'is', 'ie', 'it', 'kz', 'xk', 'lv', 'li', 'lt', 'lu', 'mt',
    'md', 'mc', 'me', 'nl', 'mk', 'no', 'pl', 'pt', 'ro', 'ru',
    'sm', 'rs', 'sk', 'si', 'es', 'se', 'ch', 'tr', 'ua', 'gb',
    'va', 'ca', 'au', 'us'
]
```

In [322…
```
developed_countries = ['de', 'gb', 'nl', 'se', 'dk', 'be', 'fi', 'at', 'ch', 'ie', 'ca', 'au', 'us']
```

Log-transformed salary

The reasonability of this step was assessed later, in the Analysis part, and iteratively added back to here.

In [325…
```
dataframes = [df_k_uni, df_it_uni, df_ai_uni]
columns_to_transform = ['salary', 'salary_2024', 'salary_norm', 'salary_norm_2024', 'salary_normmed_2024', 'salary_normmean_2024', 'salary_normgdp_2024', 'salary_normse_2024']

for df in dataframes:
    for col in columns_to_transform:
        df[f'{col}_log'] = np.log(df[col])
```

*Log-transformation was later discovered to be a not just a practical but also a **necessary** step.*
But of course, this realization was born later, and the transformation step inserted here to give the project a more logically followable structure.

Outlier detection

To detect outliers, besides Z-score, the literature often advises the use of modified Z-score, which is basically its nonparameteric counterpart, operating with medians instead of means.
Furthermore, a signed-modified-Z-score is also calculated, as the modified-Z-score loses the sign-dependence (will not distinguish between outliers that are too-low or too-high).
Another popular approach can be the 1.5 IQR interval. Using Z-scores was a design choice.

In [329…
```
def add_z_scores(data, numerical_column):
    # Calculate Z-scores
    mean = data[numerical_column].mean()
    std = data[numerical_column].std()
    z_scores = (data[numerical_column] - mean) / std
    data['z_score'] = z_scores

    # Calculate modified Z-scores
    # 0.6745 * (xi - median)/MAD, where xi is the actual row that the Z-score will be calculated to. MAD is the median absolute deviation.
    median = data[numerical_column].median()
    mad = np.median(np.abs(data[numerical_column] - median))
    modif_z_scores = 0.6745 * np.abs(data[numerical_column] - median) / mad
    data['modif_z_score'] = modif_z_scores

    modif_z_scores_signed = 0.6745 * (data[numerical_column] - median) / mad
    data['modif_z_score_signed'] = modif_z_scores_signed

    return data
```

In [330…
```
def detect_outliers(data):
    threshold = 10  # Adjust threshold as needed
    median = data.median()
    median_absolute_deviation = np.median(np.abs(data - median))
    modified_z_scores = 0.6745 * np.abs(data - median) / median_absolute_deviation
    return modified_z_scores > threshold
```

In [331…
```
def detect_outliers_1006_2035(data, numerical_column, lower_threshold=-3, upper_threshold=10):
    median = data[numerical_column].median()
    mad = np.median(np.abs(data[numerical_column] - median))
    modif_z_scores_signed = 0.6745 * (data[numerical_column] - median) / mad
    outliers = data[(modif_z_scores_signed < lower_threshold) | (modif_z_scores_signed > upper_threshold)]
    return outliers
```

Based on Normalized, Log-transformed salary

Kaggle

In [334…
```
df_k_uni_copy = df_k_uni.copy()
df_ai_uni_copy = df_ai_uni.copy()
df_it_uni_copy = df_it_uni.copy()
```

In [335…
```
# grouped DF
df_k_g = df_k_uni.groupby(['experience'])
```

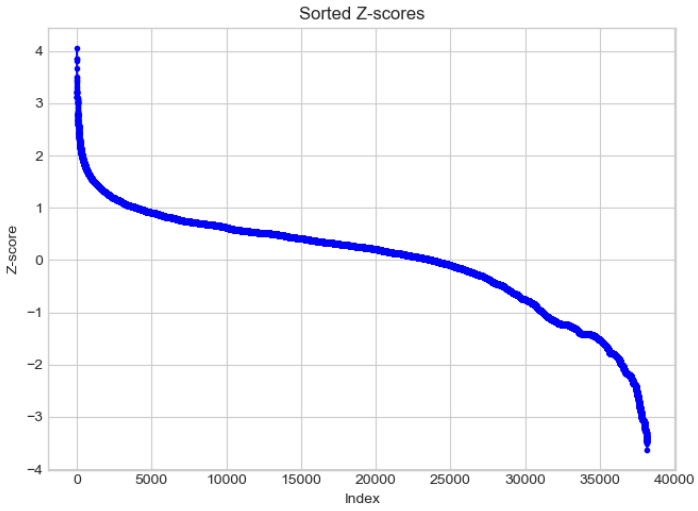
```
# adding Z-scores
df_k_gz = df_k_g.apply(lambda x: add_z_scores(x, 'salary_normmed_2024_log'), include_groups=False).reset_index(drop=True)

# outputting with descending Modified-Z-score order
df_k_gz.sort_values('modif_z_score_signed', ascending=True).head(5)
```

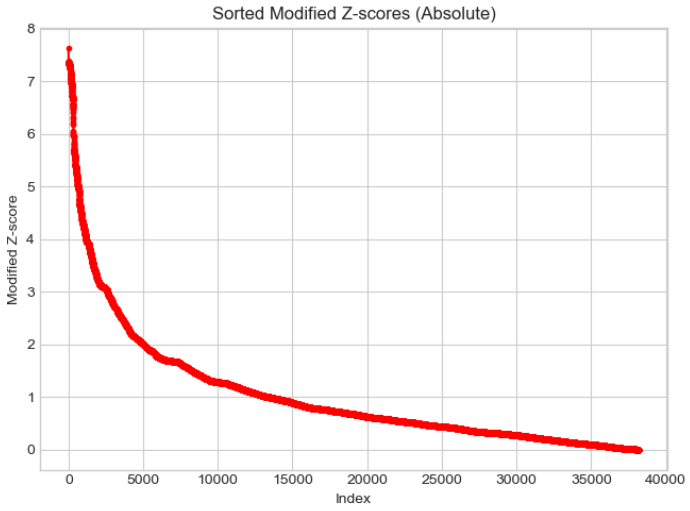
Out[335…

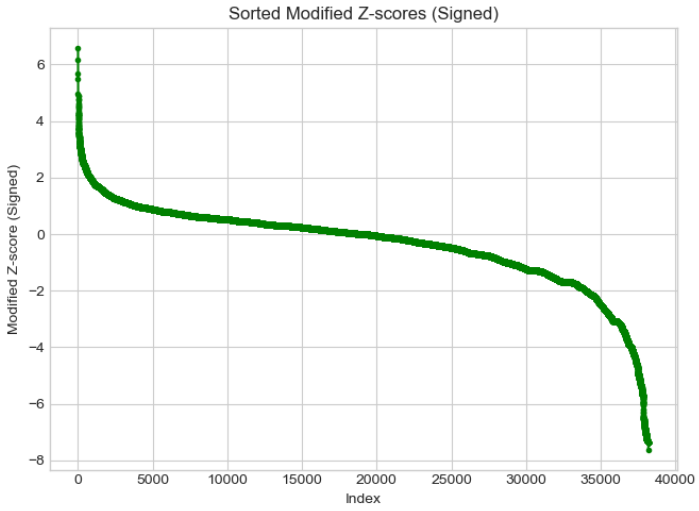
	age	country	education_level	job_title	job_title_2	company_size	salary_range	year	lower_salary	upper_salary	salary	industry	are_you_student	survey	seniority_level	company_size_category	country_code	median_income_2020_usd	mean_incom
14130	55-59	sg	master's degree	other	NaN	1000-9,999 employees	0-999	2020	0.00	999.00	499.50	NaN	NaN	k	executive	l	sg	24525	
11674	30-34	sg	bachelor's degree	dba/ database engineer	NaN	10,000 or more employees	0-999	2021	0.00	999.00	499.50	computers/ technology	NaN	k	senior	l	sg	24525	
16652	50-54	us	master's degree	data analyst (business, marketing, financial, ...	NaN	10,000 or more employees	0-999	2022	0.00	999.00	499.50	broadcasting/ communications	no	k	executive	l	us	19306	
16696	70+	us	doctoral degree	research scientist	NaN	0-49 employees	0-999	2022	0.00	999.00	499.50	medical/ pharmaceutical	no	k	executive	s	us	19306	
16730	60-69	us	master's degree	teacher / professor	NaN	0-49 employees	0-999	2022	0.00	999.00	499.50	academics/ education	no	k	executive	s	us	19306	

In [336…

```
# Sorting the dataframes for plotting
df_k_gzs = df_k_gz['z_score'].sort_values(ascending=False).reset_index(drop=True)
df_k_gmzs = df_k_gz['modif_z_score'].sort_values(ascending=False).reset_index(drop=True)
df_k_gmzs_signed = df_k_gz['modif_z_score_signed'].sort_values(ascending=False).reset_index(drop=True)

# Plotting
plt.figure(figsize=(20, 5))

plt.subplot(1, 3, 1)
plt.plot(df_k_gzs, marker='.', linestyle='-', color='b')
plt.title('Sorted Z-scores')
plt.xlabel('Index')
plt.ylabel('Z-score')

plt.subplot(1, 3, 2)
plt.plot(df_k_gmzs, marker='.', linestyle='-', color='r')
plt.title('Sorted Modified Z-scores (Absolute)')
plt.xlabel('Index')
plt.ylabel('Modified Z-score')

plt.subplot(1, 3, 3)
plt.plot(df_k_gmzs_signed, marker='.', linestyle='-', color='g')
plt.title('Sorted Modified Z-scores (Signed)')
plt.xlabel('Index')
plt.ylabel('Modified Z-score (Signed)')

plt.tight_layout()
plt.show()
```







In [337…

```
# Start with the initial DataFrame
len_k_initial = len(df_k_gz)

# Define thresholds
lower_threshold = -0.5
upper_threshold = 3.0

# Boolean masks for outliers
mask_k_small = df_k_gz['modif_z_score_signed'] < lower_threshold
mask_k_large = df_k_gz['modif_z_score_signed'] > upper_threshold

# Count outliers
len_k_outlierdrop_small = mask_k_small.sum()
len_k_outlierdrop_large = mask_k_large.sum()

# Remove outliers
df_k = df_k_gz[~(mask_k_small | mask_k_large)].copy()

# Print results
print(f"{len_k_outlierdrop_small + len_k_outlierdrop_large} outliers removed out of {len_k_initial} rows:")
print(f" - Too small: {len_k_outlierdrop_small} rows removed")
print(f" - Too large: {len_k_outlierdrop_large} rows removed")

# Display the top rows sorted by 'modif_z_score'
df_k.sort_values('modif_z_score', ascending=False).head(2)
```

```
13193 outliers removed out of 38184 rows:
 - Too small: 13028 rows removed
 - Too large: 165 rows removed
```

Out[337…

	age	country	education_level	job_title	job_title_2	company_size	salary_range	year	lower_salary	upper_salary	salary	industry	are_you_student	survey	seniority_level	company_size_category	country_code	median_income_2020_usd	mean_incom
15254	35-39	cn	master's degree	software engineer	NaN	0-49 employees	125,000-149,999	2021	125000.00	149999.00	137499.50	accounting/ finance	NaN	k	executive	s	cn	2525	
13697	50-54	za	bachelor's degree	other	237	50-249 employees	80,000-89,999	2019	80000.00	89999.00	84999.50	NaN	NaN	k	executive	m	za	1624	

In [338…

```
df_k[df_k['country'].isin(developed_countries)].sort_values('modif_z_score_signed', ascending=True).head(10)
```

Out[338…

	age	country	education_level	job_title	job_title_2	company_size	salary_range	year	lower_salary	upper_salary	salary	industry	are_you_student	survey	seniority_level	company_size_category	country_code	median_income_2020_usd	mean_income
14574	55-59	ca	master's degree	software engineer	NaN	50-249 employees	70,000-79,999	2020	70000.00	79999.00	74999.50	NaN	NaN	k	executive	m	ca	18652	
14963	50-54	ca	bachelor's degree	data scientist	NaN	0-49 employees	70,000-79,999	2020	70000.00	79999.00	74999.50	NaN	NaN	k	executive	s	ca	18652	
19119	22-24	gb	master's degree	data scientist	-1	0-49 employees	25,000-29,999	2019	25000.00	29999.00	27499.50	NaN	NaN	k	medior	s	gb	14793	
15057	50-54	at	no degree	software engineer	NaN	1000-9,999 employees	70,000-79,999	2021	70000.00	79999.00	74999.50	shipping/ transportation	NaN	k	executive	l	at	18405	
65	22-24	gb	master's degree	data analyst	-1	250-999 employees	10,000-14,999	2019	10000.00	14999.00	12499.50	NaN	NaN	k	junior	m	gb	14793	
26598	25-29	be	doctoral degree	data engineer	-1	> 10,000 employees	40,000-49,999	2019	40000.00	49999.00	44999.50	NaN	NaN	k	senior	l	be	16157	
11499	25-29	ch	doctoral degree	data scientist	NaN	0-49 employees	80,000-89,999	2021	80000.00	89999.00	84999.50	academics/ education	NaN	k	senior	s	ch	21490	
18223	22-24	ca	bachelor's degree	data scientist	-1	> 10,000 employees	30,000-39,999	2019	30000.00	39999.00	34999.50	NaN	NaN	k	medior	l	ca	18652	
17737	25-29	ca	doctoral degree	other	121	0-49 employees	30,000-39,999	2019	30000.00	39999.00	34999.50	NaN	NaN	k	medior	s	ca	18652	
28415	35-39	us	master's degree	data scientist	NaN	250-999 employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	m	us	19306	

DE-IT

In [340…

```
# grouped DF
df_it_g = df_it_uni.groupby(['seniority_level'])

# adding Z-scores
df_it_gz = df_it_g.apply(lambda x: add_z_scores(x, 'salary_normmed_2024_log'), include_groups=False).reset_index()

# outputting with descending Modified-Z-score order
df_it_gz.sort_values('modif_z_score', ascending=False).head()
```

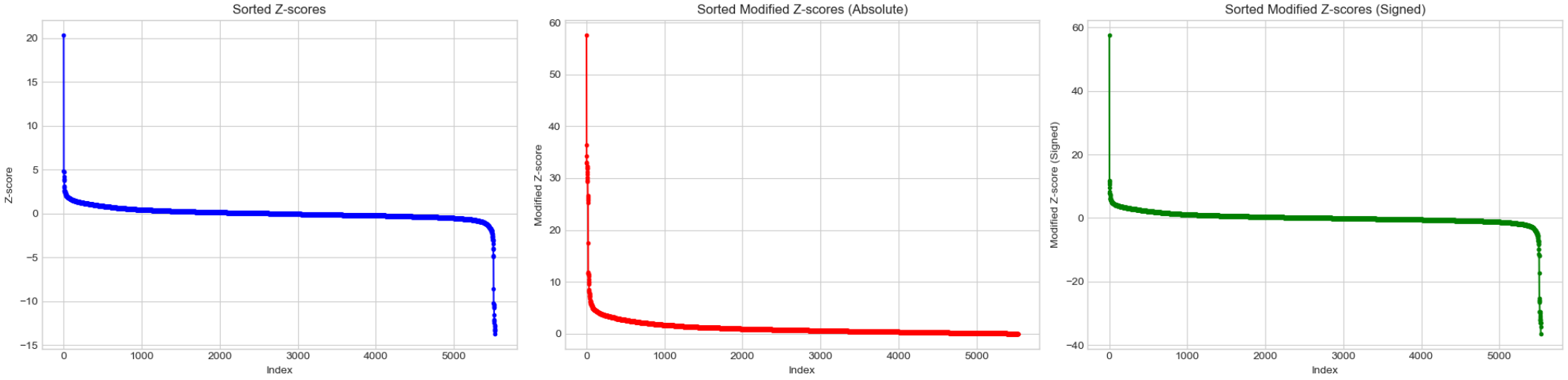
Out[340…

	seniority_level	level_1	age	city	job_title	language_at_work	company_size	company_type	salary	year	country	experience	skills	skills_2	employment_status	years_of_experience_in_germany	job_title_2	y
1434	medior	812	29.00	cologne	ml engineer	english	up to 10	startup	6272541915.89	2020	de	1.00	julia	NaN	full-time employee	1.00	NaN	
1892	medior	2534	NaN	munich	backend developer	german,russian	11-50	NaN	57.79	2022	de	4.00	other	java / scala,other	full-time employee	4.00	NaN	
2175	medior	3811	NaN	munich	ml engineer	german,english	1000+	NaN	95.01	2023	de	1.00	python	azure,kubernetes,terraform,docker,other,python	full/part-time employee	1.00	NaN	
4301	senior	3510	NaN	other	network / security engineer / system administr...	english,russian	11-50	NaN	77.74	2023	de	15.00	bash	docker,aws	full/part-time employee	2.00	NaN	
1989	medior	2893	NaN	berlin	software engineer	english	1000+	NaN	115.57	2022	de	10.00	c / c++	python,php,swift,rust	full-time employee	4.00	NaN	

In [341…

```
# Sorting the dataframes for plotting
df_it_gzs = df_it_gz['z_score'].sort_values(ascending=False).reset_index(drop=True)
df_it_gmzs = df_it_gz['modif_z_score'].sort_values(ascending=False).reset_index(drop=True)
df_it_gmzs_signed = df_it_gz['modif_z_score_signed'].sort_values(ascending=False).reset_index(drop=True)
```

```
# Plotting
plt.figure(figsize=(20, 5))

plt.subplot(1, 3, 1)
plt.plot(df_it_gzs, marker='.', linestyle='-', color='b')
plt.title('Sorted Z-scores')
plt.xlabel('Index')
plt.ylabel('Z-score')

plt.subplot(1, 3, 2)
plt.plot(df_it_gmzs, marker='.', linestyle='-', color='r')
plt.title('Sorted Modified Z-scores (Absolute)')
plt.xlabel('Index')
plt.ylabel('Modified Z-score')

plt.subplot(1, 3, 3)
plt.plot(df_it_gmzs_signed, marker='.', linestyle='-', color='g')
plt.title('Sorted Modified Z-scores (Signed)')
plt.xlabel('Index')
plt.ylabel('Modified Z-score (Signed)')

plt.tight_layout()
plt.show()
```



In [342…

```
# Start with the initial DataFrame
len_it_initial = len(df_it_gz)

# Define thresholds
lower_threshold = -3.0
upper_threshold = 3.0

# Boolean masks for outliers
mask_it_small = df_it_gz['modif_z_score_signed'] < lower_threshold
mask_it_large = df_it_gz['modif_z_score_signed'] > upper_threshold

# Count outliers
len_it_outlierdrop_small = mask_it_small.sum()
len_it_outlierdrop_large = mask_it_large.sum()

# Remove outliers
df_it = df_it_gz[~(mask_it_small | mask_it_large)].copy()

# Print results
print(f"{len_it_outlierdrop_small + len_it_outlierdrop_large} outliers removed out of {len_it_initial} rows:")
print(f" - Too small: {len_it_outlierdrop_small} rows removed")
print(f" - Too large: {len_it_outlierdrop_large} rows removed")

# Display the top 2 rows sorted by 'modif_z_score'
df_it.sort_values('modif_z_score', ascending=False).head(2)
```

```
369 outliers removed out of 5532 rows:
 - Too small: 103 rows removed
 - Too large: 266 rows removed
```

Out[342…

	seniority_level	level_1	age	city	job_title	language_at_work	company_size	company_type	salary	year	country	experience	skills	skills_2	employment_status	years_of_experience_in_germany	job_title_2	your_seniority_level	skills_3	company_indust
3777	senior	2409	NaN	berlin	engineering manager	english,russian	1000+	NaN	176511.16	2022	de	11.00	other	NaN	full-time employee	0.00	NaN	NaN	NaN	Na
1885	medior	2513	NaN	berlin	engineering manager	english	101-1000	NaN	138687.34	2022	de	15.00	php	go	full-time employee	7.00	NaN	NaN	NaN	Na

AI-Jobs.net

In [344…

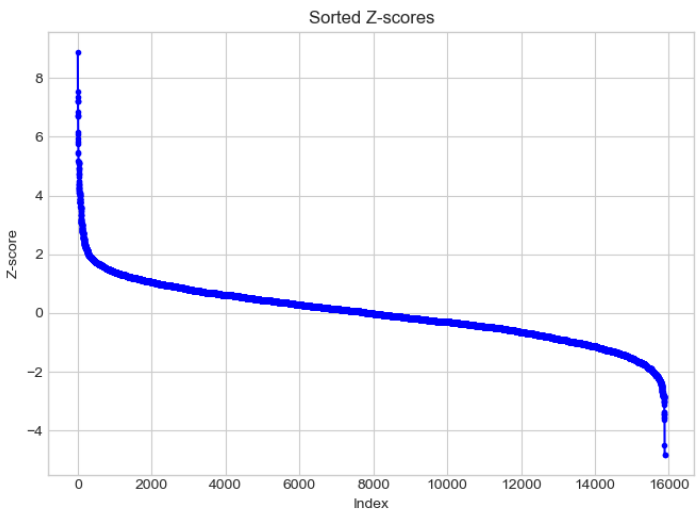
```python
# grouped DF
df_ai_g = df_ai_uni.groupby(['seniority_level'], observed=False)

# adding Z-scores
df_ai_gz = df_ai_g.apply(lambda x: add_z_scores(x, 'salary_normmed_2024_log'), include_groups=False).reset_index()

# outputting with descending Modified-Z-score order
df_ai_gz.sort_values('modif_z_score_signed', ascending=True).head()
```

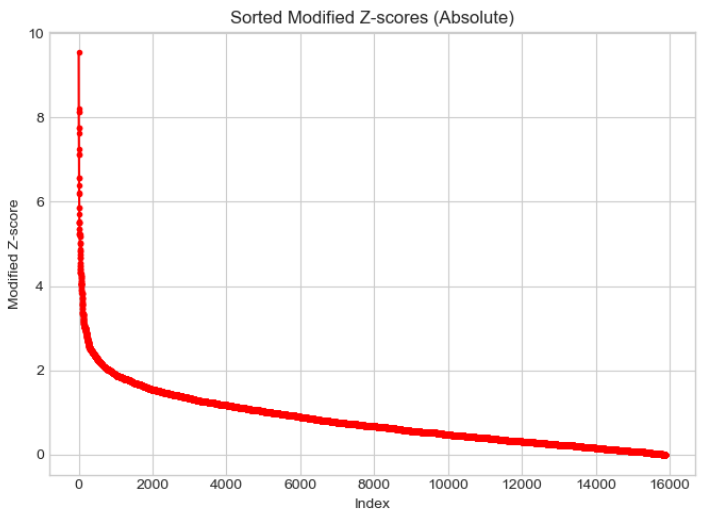
Out[344…

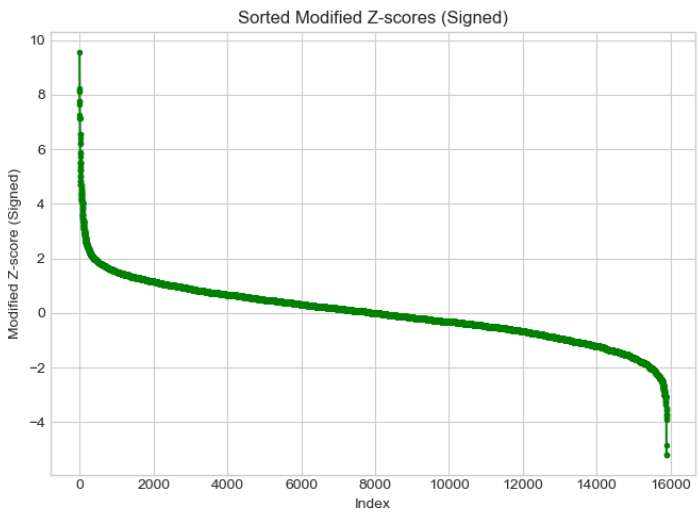
	seniority_level	level_1	year	employment_status	job_title	salary_in_currency	salary_currency	salary	country	remote_ratio	company_location	company_size	ratio	survey	company_size_category	country_code	median_income_2020_usd	mean_income_2020_u
5814	senior	444	2024	ft	data architect	25000	usd	25000	us	0	us	m	1.00	ai	m	us	19306	253
6514	senior	1696	2024	ft	data quality engineer	25000	usd	25000	us	0	us	m	1.00	ai	m	us	19306	253
15767	senior	15555	2022	ft	data engineer	25000	usd	25000	us	100	us	m	1.00	ai	m	us	19306	253
11985	senior	10402	2023	ft	data lead	38000	usd	38000	us	0	us	m	1.00	ai	m	us	19306	253
5848	senior	524	2024	ft	data scientist	25000	gbp	31250	gb	0	gb	m	1.25	ai	m	gb	14793	181

In [345…

```python
# Sorting the dataframes for plotting
df_ai_gzs = df_ai_gz['z_score'].sort_values(ascending=False).reset_index(drop=True)
df_ai_gmzs = df_ai_gz['modif_z_score'].sort_values(ascending=False).reset_index(drop=True)
df_ai_gmzs_signed = df_ai_gz['modif_z_score_signed'].sort_values(ascending=False).reset_index(drop=True)

# Plotting
plt.figure(figsize=(20, 5))

plt.subplot(1, 3, 1)
plt.plot(df_ai_gzs, marker='.', linestyle='-', color='b')
plt.title('Sorted Z-scores')
plt.xlabel('Index')
plt.ylabel('Z-score')

plt.subplot(1, 3, 2)
plt.plot(df_ai_gmzs, marker='.', linestyle='-', color='r')
plt.title('Sorted Modified Z-scores (Absolute)')
plt.xlabel('Index')
plt.ylabel('Modified Z-score')

plt.subplot(1, 3, 3)
plt.plot(df_ai_gmzs_signed, marker='.', linestyle='-', color='g')
plt.title('Sorted Modified Z-scores (Signed)')
plt.xlabel('Index')
plt.ylabel('Modified Z-score (Signed)')

plt.tight_layout()
plt.show()
```







In [346…

```
# Start with the initial DataFrame
len_ai_initial = len(df_ai_gz)

# Define thresholds
lower_threshold = -3.0
upper_threshold = 3.0

# Boolean masks for outliers
mask_ai_small = df_ai_gz['modif_z_score_signed'] < lower_threshold
mask_ai_large = df_ai_gz['modif_z_score_signed'] > upper_threshold

# Count outliers
len_ai_outlierdrop_small = mask_ai_small.sum()
len_ai_outlierdrop_large = mask_ai_large.sum()

# Remove outliers
df_ai = df_ai_gz[~(mask_ai_small | mask_ai_large)].copy()

# Print results
print(f"{len_ai_outlierdrop_small + len_ai_outlierdrop_large} outliers removed out of {len_ai_initial} rows:")
print(f" - Too small: {len_ai_outlierdrop_small} rows removed")
print(f" - Too large: {len_ai_outlierdrop_large} rows removed")

# Display the top 2 rows sorted by 'modif_z_score'
df_ai.sort_values('modif_z_score', ascending=False).head(2)
```

```
181 outliers removed out of 15891 rows:
 - Too small: 54 rows removed
 - Too large: 127 rows removed
```

Out[346…

	seniority_level	level_1	year	employment_status	job_title	salary_in_currency	salary_currency	salary	country	remote_ratio	company_location	company_size	ratio	survey	company_size_category	country_code	median_income_2020_usd	mean_income_202
15889	senior	15887	2020	ft	data scientist	412000	usd	412000	us	100	us	l	1.00	ai	l	us	19306	
8892	senior	6027	2023	ft	business intelligence analyst	33000	gbp	40603	gb	0	gb	m	1.23	ai	m	gb	14793	

Final check

In [348…

```
df_k[df_k['country'].isin(developed_countries)].sort_values('modif_z_score_signed', ascending=True).head(20)
```

Out[348...

	age	country	education_level	job_title	job_title_2	company_size	salary_range	year	lower_salary	upper_salary	salary	industry	are_you_student	survey	seniority_level	company_size_category	country_code	median_income_2020_usd	mean_income
14574	55-59	ca	master's degree	software engineer	NaN	50-249 employees	70,000-79,999	2020	70000.00	79999.00	74999.50	NaN	NaN	k	executive	m	ca	18652	
14963	50-54	ca	bachelor's degree	data scientist	NaN	0-49 employees	70,000-79,999	2020	70000.00	79999.00	74999.50	NaN	NaN	k	executive	s	ca	18652	
19119	22-24	gb	master's degree	data scientist	-1	0-49 employees	25,000-29,999	2019	25000.00	29999.00	27499.50	NaN	NaN	k	medior	s	gb	14793	
15057	50-54	at	no degree	software engineer	NaN	1000-9,999 employees	70,000-79,999	2021	70000.00	79999.00	74999.50	shipping/ transportation	NaN	k	executive	l	at	18405	
65	22-24	gb	master's degree	data analyst	-1	250-999 employees	10,000-14,999	2019	10000.00	14999.00	12499.50	NaN	NaN	k	junior	m	gb	14793	
26598	25-29	be	doctoral degree	data engineer	-1	> 10,000 employees	40,000-49,999	2019	40000.00	49999.00	44999.50	NaN	NaN	k	senior	l	be	16157	
11499	25-29	ch	doctoral degree	data scientist	NaN	0-49 employees	80,000-89,999	2021	80000.00	89999.00	84999.50	academics/ education	NaN	k	senior	s	ch	21490	
18223	22-24	ca	bachelor's degree	data scientist	-1	> 10,000 employees	30,000-39,999	2019	30000.00	39999.00	34999.50	NaN	NaN	k	medior	l	ca	18652	
17737	25-29	ca	doctoral degree	other	121	0-49 employees	30,000-39,999	2019	30000.00	39999.00	34999.50	NaN	NaN	k	medior	s	ca	18652	
28415	35-39	us	master's degree	data scientist	NaN	250-999 employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	m	us	19306	
28523	22-24	us	master's degree	research scientist	NaN	250-999 employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	m	us	19306	
28625	25-29	us	bachelor's degree	software engineer	NaN	0-49 employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	s	us	19306	
27351	25-29	us	master's degree	data scientist	NaN	0-49 employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	s	us	19306	
27665	35-39	us	master's degree	data analyst	NaN	0-49 employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	s	us	19306	
27468	25-29	us	master's degree	software engineer	NaN	10,000 or more employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	l	us	19306	
28487	40-44	us	doctoral degree	research scientist	NaN	10,000 or more employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	l	us	19306	
27102	22-24	us	master's degree	machine learning engineer	NaN	10,000 or more employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	l	us	19306	
28501	30-34	us	doctoral degree	research scientist	NaN	10,000 or more employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	l	us	19306	
28232	30-34	us	doctoral degree	other	NaN	10,000 or more employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	l	us	19306	
28464	30-34	us	master's degree	business analyst	NaN	10,000 or more employees	50,000-59,999	2020	50000.00	59999.00	54999.50	NaN	NaN	k	senior	l	us	19306	

In [349...

```
df_ai.sort_values('modif_z_score', ascending=False).head(5)
```

Out[349…

	seniority_level	level_1	year	employment_status	job_title	salary_in_currency	salary_currency	salary	country	remote_ratio	company_location	company_size	ratio	survey	company_size_category	country_code	median_income_2020_usd	mean_income_202
15889	senior	15887	2020	ft	data scientist	412000	usd	412000	us	100	us	l	1.00	ai	l	us	19306	
8892	senior	6027	2023	ft	business intelligence analyst	33000	gbp	40603	gb	0	gb	m	1.23	ai	m	gb	14793	
5751	senior	355	2024	ft	research engineer	485000	usd	485000	us	0	us	m	1.00	ai	m	us	19306	
6841	senior	2295	2024	ft	data operations specialist	55720	usd	55720	us	100	us	m	1.00	ai	m	us	19306	
5037	medior	13689	2023	ft	machine learning engineer	50000	usd	50000	am	0	am	s	1.00	ai	s	am	2216	

In [350…

```
df_it.sort_values('modif_z_score', ascending=False).head(5)
```

Out[350…

	seniority_level	level_1	age	city	job_title	language_at_work	company_size	company_type	salary	year	country	experience	skills	skills_2	employment_status	years_of_experience_in_germany	job_title_2	your_seniority_level	skills_3	comp
3777	senior	2409	NaN	berlin	engineering manager	english,russian	1000+	NaN	176511.16	2022	de	11.00	other	NaN	full-time employee	0.00	NaN	NaN	NaN	
1885	medior	2513	NaN	berlin	engineering manager	english	101-1000	NaN	138687.34	2022	de	15.00	php	go	full-time employee	7.00	NaN	NaN	NaN	
2564	medior	5247	22.00	amsterdam	frontend developer	english	1000+	product	129348.45	2019	de	5.00	javascript / typescript	NaN	NaN	NaN	NaN	NaN	NaN	
2369	medior	4511	26.00	berlin	qa	english	51-100	product	38976.30	2018	de	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
5496	senior	5465	30.00	berlin	sre	english	1000+	product	164401.32	2019	de	11.00	kubernetes	NaN	NaN	NaN	NaN	NaN	NaN	

Conclusion:
The commonly used modified-Z-score loses the sign-dependence, which is a crucial information here (so it will not distinguish between a too-low and a too-high salary).
Sign dependence gives significant information here, as no matter log-transformation or not, the distribution of salaries will always be closed in one-end (the lower end) and open by the higher end.
Manual inspection shows that with a symmetric modif-Z-score cutoff, the irrealistically low answers are not dropped.
This is most notable for the Kaggle surveys:
As the survey did not clearly specify whether the salary question is asking a yearly or a monthly value! This is an trivial yet enormous error in survey design

To counteract this, I used a strict cutoff limit for the lower outlier for Kaggle. This was done iteratively paired with careful manual inspection.

Data Quality Metrics

Through the cleaning steps, several 'len_' variables were introduced which tracked the length of each survey as the cleaning step was applied.
In this chapter, these counters are collected.

This is not done quite elegantly, but this ugly approach enables enormous flexibility in reorganizing the cleaning steps, and injecting new steps.

Germany-It Survey

In [355…

```
cleaning_steps = [
    'Salary-nulls',
    'Employment-nulls',
    'Students',
    'Never have coded',
    'Country-nulls',
    'Seniority-nulls',
    'Job-title-nulls',
    'Outliers: Too small salary',
    'Outliers: Too large salary'
]
```

In [356…

```
len_it_ini = sum([
    len_it18_ini,
    len_it19_ini,
    len_it20_ini,
    len_it21_ini,
    len_it22_ini,
    len_it23_ini
])

len_it18_salarydrop = len_it18_salarydrop1 - len_it18_salarydrop2
len_it19_salarydrop = len_it19_salarydrop1 - len_it19_salarydrop2
len_it20_salarydrop = len_it20_salarydrop1 - len_it20_salarydrop2
len_it21_salarydrop = len_it21_salarydrop1 - len_it21_salarydrop2
len_it22_salarydrop = len_it22_salarydrop1 - len_it22_salarydrop2
len_it23_salarydrop = len_it23_salarydrop1 - len_it23_salarydrop2

len_it_salarydrop = sum([
    len_it18_salarydrop,
    len_it19_salarydrop,
    len_it20_salarydrop,
    len_it21_salarydrop,
    len_it22_salarydrop,
    len_it23_salarydrop
])

len_it_employmentdrop  = len_it_employmentdrop1  - len_it_employmentdrop2
len_it_studentdrop     = len_it_studentdrop1     - len_it_studentdrop2
len_it_noncoderdrop    = 0
len_it_countrydrop     = len_it_countrydrop1     - len_it_countrydrop2
len_it_seniorityдrop   = len_it_seniorityдrop1   - len_it_seniorityдrop2
len_it_jobtitledrop    = len_it_jobtitledrop1    - len_it_jobtitledrop2
#len_it_outlierdrop     = len_it_outlierdrop1     - len_it_outlierdrop2
#len_it_outlierdropnorm = len_it_outlierdropnorm1 - len_it_outlierdropnorm2

len_it_clean = (len(df_it))

it_difference  = len_it_ini - len_it_clean
it_cleanedaway = [
    len_it_salarydrop,
    len_it_employmentdrop,
    len_it_studentdrop,
    len_it_noncoderdrop,
    len_it_countrydrop,
    len_it_seniorityдrop,
    len_it_jobtitledrop,
    len_it_outlierdrop_small,
    len_it_outlierdrop_large
]
```

In [357…

```
print(f'Initial survey length: {len_it_ini}')
# Printing each variable in the list
for idx, value in enumerate(it_cleanedaway):
    print(f'Cleaning step {idx + 1}: {value}')

print(f'Final survey length: {len_it_clean}')
print(f'The difference between final and initial: {it_difference}')
print(f'Summing the individual cleaning steps: {sum(it_cleanedaway)}')
```

```
Initial survey length: 5764
Cleaning step 1: 72
Cleaning step 2: 17
Cleaning step 3: 84
Cleaning step 4: 0
Cleaning step 5: 0
Cleaning step 6: 41
Cleaning step 7: 18
Cleaning step 8: 103
Cleaning step 9: 266
Final survey length: 5163
The difference between final and initial: 601
Summing the individual cleaning steps: 601
```

Kaggle

In [359…

```
len_k_ini = sum([
    len_k19_ini,
    len_k20_ini,
    len_k21_ini,
    len_k22_ini
])

len_k19_salarydrop = len_k19_salarydrop1 - len_k19_salarydrop2
len_k20_salarydrop = len_k20_salarydrop1 - len_k20_salarydrop2
len_k21_salarydrop = len_k21_salarydrop1 - len_k21_salarydrop2
len_k22_salarydrop = len_k22_salarydrop1 - len_k22_salarydrop2

len_k_salarydrop = sum([
    len_k19_salarydrop,
    len_k20_salarydrop,
    len_k21_salarydrop,
    len_k22_salarydrop
])

len_k_employmentdrop  = 0
len_k_studentdrop     = 0
len_k_noncoderdrop    = len_k_noncoderdrop1    - len_k_noncoderdrop2
len_k_countrydrop     = len_k_countrydrop1     - len_k_countrydrop2
len_k_seniorityдrop   = len_k_seniorityдrop1   - len_k_seniorityдrop2
len_k_jobtitledrop    = len_k_jobtitledrop1    - len_k_jobtitledrop2
#len_k_outlierdrop     = len_k_outlierdrop1     - len_k_outlierdrop2
#len_k_outlierdropnorm = len_k_outlierdropnorm1 - len_k_outlierdropnorm2

len_k_clean = (len(df_k))

k_difference  = len_k_ini - len_k_clean
k_cleanedaway = [
    len_k_salarydrop,
    len_k_employmentdrop,
    len_k_studentdrop,
    len_k_noncoderdrop,
    len_k_countrydrop,
    len_k_seniorityдrop,
    len_k_jobtitledrop,
    len_k_outlierdrop_small,
    len_k_outlierdrop_large
]

k_salarydrops = [
    len_k19_salarydrop,
    len_k20_salarydrop,
    len_k21_salarydrop,
    len_k22_salarydrop
]
```

In [360…

```
print(f'Initial survey length: {len_k_ini}')
# Printing each variable in the list
for idx, value in enumerate(k_cleanedaway):
    print(f'Cleaning step {idx + 1}: {value}')

print(f'Final survey length: {len_k_clean}')
print(f'The difference between final and initial: {k_difference}')
```

```
print(f'Summing the individual cleaning steps: {sum(k_cleanedaway)}')
```

```
Initial survey length: 89727
Cleaning step 1: 42970
Cleaning step 2: 0
Cleaning step 3: 0
Cleaning step 4: 2758
Cleaning step 5: 2698
Cleaning step 6: 993
Cleaning step 7: 0
Cleaning step 8: 13028
Cleaning step 9: 165
Final survey length: 24991
The difference between final and initial: 64736
Summing the individual cleaning steps: 62612
```

AI-Jobs.net

In [362…

```
#len_ai_ini
len_ai_salarydrop = 0

len_ai_employmentdrop  = len_ai_employmentdrop1  - len_ai_employmentdrop2
len_ai_studentdrop     = len_ai_studentdrop1     - len_ai_studentdrop2
len_ai_noncoderdrop    = 0
len_ai_countrydrop     = len_ai_countrydrop1     - len_ai_countrydrop2
len_ai_senioritydrop   = len_ai_senioritydrop1   - len_ai_senioritydrop2
len_ai_jobtitledrop    = len_ai_jobtitledrop1    - len_ai_jobtitledrop2
#len_ai_outlierdrop     = len_ai_outlierdrop1     - len_ai_outlierdrop2
#len_ai_outlierdropnorm = len_ai_outlierdropnorm1 - len_ai_outlierdropnorm2

len_ai_clean = (len(df_ai))

ai_difference  = len_ai_ini - len_ai_clean
ai_cleanedaway = [
    len_ai_salarydrop,
    len_ai_employmentdrop,
    len_ai_studentdrop,
    len_ai_noncoderdrop,
    len_ai_countrydrop,
    len_ai_senioritydrop,
    len_ai_jobtitledrop,
    len_ai_outlierdrop_small,
    len_ai_outlierdrop_large
]
```

In [363…

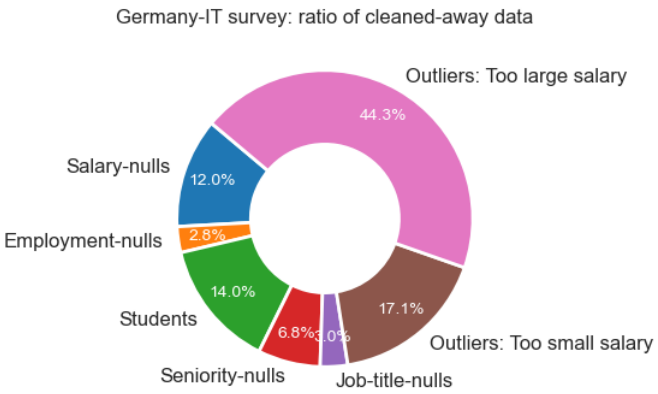
```
print(f'Initial survey length: {len_ai_ini}')
# Printing each variable in the list
for idx, value in enumerate(ai_cleanedaway):
    print(f'Cleaning step {idx + 1}: {value}')

print(f'Final survey length: {len_ai_clean}')
print(f'The difference between final and initial: {ai_difference}')
print(f'Summing the individual cleaning steps: {sum(ai_cleanedaway)}')
```

```
Initial survey length: 15965
Cleaning step 1: 0
Cleaning step 2: 74
Cleaning step 3: 0
Cleaning step 4: 0
Cleaning step 5: 0
Cleaning step 6: 0
Cleaning step 7: 0
Cleaning step 8: 54
Cleaning step 9: 127
Final survey length: 15710
The difference between final and initial: 255
Summing the individual cleaning steps: 255
```

Plots

In [365…

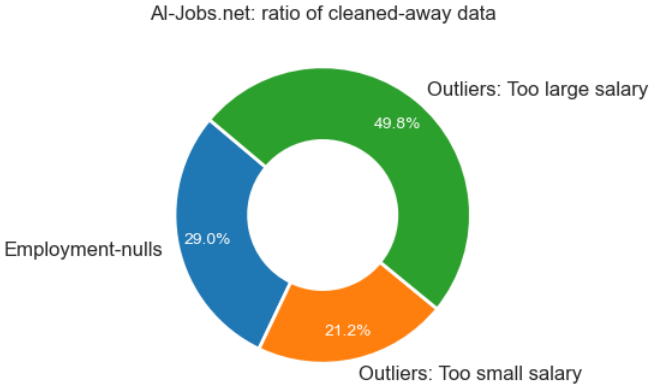
```
# Data to plot
labels = cleaning_steps
sizes = it_cleanedaway

# Filter out zero segments
non_zero_indices = [i for i, size in enumerate(sizes) if size > 0]
filtered_labels = [labels[i] for i in non_zero_indices]
filtered_sizes = [sizes[i] for i in non_zero_indices]

# Create an explode list to separate slices for better readability
explode = [0.1] * len(filtered_sizes)  # Explode all slices for visibility

# Create the pie chart
plt.figure(figsize=(4, 4))
wedges, texts, autotexts = plt.pie(
    filtered_sizes,
    #explode=explode,
    labels=filtered_labels,
    autopct='%1.1f%%',
    #shadow=True,
    startangle=140,
    pctdistance=0.8,  # Distance of percentage from the center
    labeldistance=1.1,  # Distance of labels from the center
    wedgeprops=dict(width=0.5, edgecolor='white', linewidth=2)  # This creates the ring effect
)

# Formatting labels and percentages
for text in texts:
    text.set_fontsize(12)
for autotext in autotexts:
    autotext.set_fontsize(10)
    autotext.set_color('white')

plt.title('Germany-IT survey: ratio of cleaned-away data')
plt.show()
```



In [366…

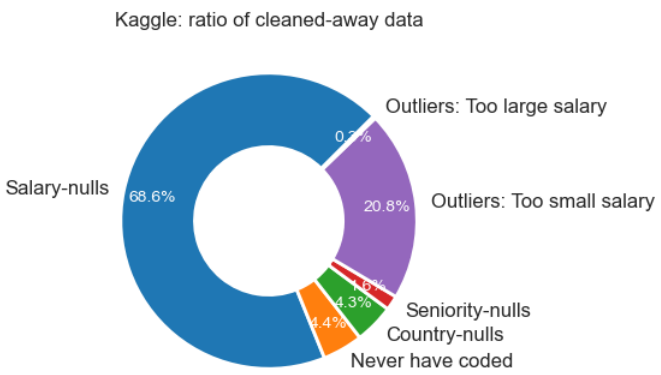
```
# Data to plot
labels = cleaning_steps
sizes = ai_cleanedaway

# Filter out zero segments
non_zero_indices = [i for i, size in enumerate(sizes) if size > 0]
filtered_labels = [labels[i] for i in non_zero_indices]
filtered_sizes = [sizes[i] for i in non_zero_indices]

# Create an explode list to separate slices for better readability
explode = [0.1] * len(filtered_sizes)  # Explode all slices for visibility

# Create the pie chart
plt.figure(figsize=(4, 4))
wedges, texts, autotexts = plt.pie(
    filtered_sizes,
    #explode=explode,
    labels=filtered_labels,
    autopct='%1.1f%%',
    #shadow=True,
```

```
    startangle=140,
    pctdistance=0.8,  # Distance of percentage from the center
    labeldistance=1.1,
    wedgeprops=dict(width=0.5, edgecolor='white', linewidth=2)
)

# Formatting labels and percentages
for text in texts:
    text.set_fontsize(12)
for autotext in autotexts:
    autotext.set_fontsize(10)
    autotext.set_color('white')

plt.title('AI-Jobs.net: ratio of cleaned-away data')
plt.show()
```



In [367…

```
# Data to plot
labels = cleaning_steps
sizes = k_cleanedaway

# Filter out zero segments
non_zero_indices = [i for i, size in enumerate(sizes) if size > 0]
filtered_labels = [labels[i] for i in non_zero_indices]
filtered_sizes = [sizes[i] for i in non_zero_indices]

# Create an explode list to separate slices for better readability
explode = [0.1] * len(filtered_sizes)  # Explode all slices for visibility

# Create the pie chart
plt.figure(figsize=(4, 4))
wedges, texts, autotexts = plt.pie(
    filtered_sizes,
    #explode=explode,
    labels=filtered_labels,
    autopct='%1.1f%%',
    #shadow=True,
    startangle=45,
    pctdistance=0.8,  # Distance of percentage from the center
    labeldistance=1.1,  # Distance of labels from the center
    wedgeprops=dict(width=0.5, edgecolor='white', linewidth=2)
)

# Formatting labels and percentages
for text in texts:
    text.set_fontsize(12)
for autotext in autotexts:
    autotext.set_fontsize(10)
    autotext.set_color('white')

plt.title('Kaggle: ratio of cleaned-away data')
plt.show()
```

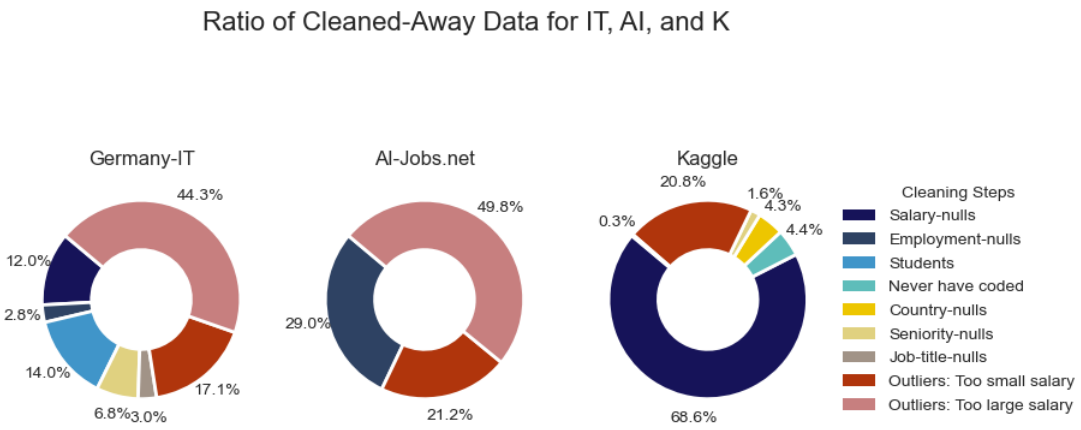


In [368…
```
cleaning_steps
```

Out[368…
```
['Salary-nulls',
 'Employment-nulls',
 'Students',
 'Never have coded',
 'Country-nulls',
 'Seniority-nulls',
 'Job-title-nulls',
 'Outliers: Too small salary',
 'Outliers: Too large salary']
```

In [369…
```
import matplotlib.pyplot as plt
from matplotlib.patches import Patch
import numpy as np

# Assuming your data is defined as follows:
# cleaning_steps = ['Step1', 'Step2', 'Step3', 'Step4', 'Step5', 'Step6', 'Step7']
# it_cleanedaway = [...]
# ai_cleanedaway = [...]
# k_cleanedaway = [...]

labels = cleaning_steps
sizes_it = it_cleanedaway
sizes_ai = ai_cleanedaway
sizes_k = k_cleanedaway

# Define manual colors for each cleaning step
step_colors = {
    'Salary-nulls': '#161359',           # Blue
    'Employment-nulls': '#2e4263',       # Orange
    'Students': '#4095c9',               # Green
    'Never have coded': '#5ebdba',       # Red
    'Country-nulls': '#edc600',          # Purple
    'Seniority-nulls': '#e0d180',        # Brown
    'Job-title-nulls': '#a19387',        # Pink
    'Outliers: Too small salary': '#b0350c',  # Cyan
    'Outliers: Too large salary': '#c77f7f'   # Olive
}

def filter_data(labels, sizes):
    non_zero_indices = [i for i, size in enumerate(sizes) if size > 0]
    filtered_labels = [labels[i] for i in non_zero_indices]
    filtered_sizes = [sizes[i] for i in non_zero_indices]
    return filtered_labels, filtered_sizes

# Filter data for each dataframe
labels_it, sizes_it = filter_data(labels, sizes_it)
labels_ai, sizes_ai = filter_data(labels, sizes_ai)
labels_k, sizes_k = filter_data(labels, sizes_k)

fig, axes = plt.subplots(1, 3, figsize=(8, 5))

# Function to plot pie charts
def plot_pie(ax, sizes, labels, title):
    colors_list = [step_colors[label] for label in labels]
```

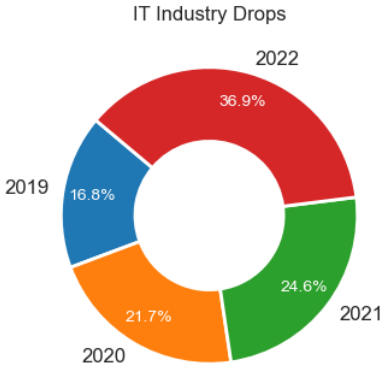
```
    wedges, _ = ax.pie(
        sizes,
        colors=colors_list,
        startangle=140,
        wedgeprops=dict(width=0.5, edgecolor='white', linewidth=2)
    )
    ax.set_title(title)
    # Add percentages next to the pie
    total = sum(sizes)
    angles = [wedge.theta2 - (wedge.theta2 - wedge.theta1) / 2. for wedge in wedges]
    for i, angle in enumerate(angles):
        x = np.cos(np.deg2rad(angle))
        y = np.sin(np.deg2rad(angle))
        ax.text(1.2 * x, 1.2 * y, f'{(sizes[i] / total) * 100:.1f}%', ha='center', va='center', fontsize=10)

# Plot for IT Cleaned Away
plot_pie(axes[0], sizes_it, labels_it, 'Germany-IT')

# Plot for AI Cleaned Away
plot_pie(axes[1], sizes_ai, labels_ai, 'AI-Jobs.net')

# Plot for K Cleaned Away
plot_pie(axes[2], sizes_k, labels_k, 'Kaggle')

# Create a vertical legend
legend_elements = [Patch(facecolor=step_colors[label], label=label) for label in labels]
fig.legend(
    handles=legend_elements,
    loc='center right',
    bbox_to_anchor=(1.15, 0.5),
    ncol=1,
    title="Cleaning Steps"
)

# Adjust layout to make space for legend
plt.tight_layout(rect=[0, 0, 0.9, 1])  # Leave space on the right for the legend

# Set the overall title
fig.suptitle('Ratio of Cleaned-Away Data for IT, AI, and K', fontsize=16)

plt.show()
```



In [370…

```
# Data to plot
labels = [2019,2020,2021,2022]
sizes = k_salarydrops

# Filter out zero segments
non_zero_indices = [i for i, size in enumerate(sizes) if size > 0]
filtered_labels = [labels[i] for i in non_zero_indices]
filtered_sizes = [sizes[i] for i in non_zero_indices]

# Create an explode list to separate slices for better readability
explode = [0.1] * len(filtered_sizes)  # Explode all slices for visibility

# Create the pie chart
```

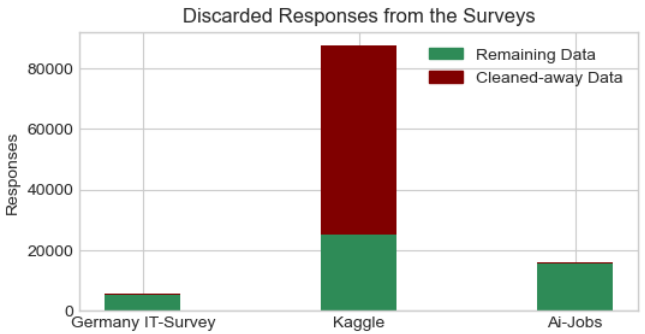
```
plt.figure(figsize=(4, 4))
wedges, texts, autotexts = plt.pie(
    filtered_sizes,
    #explode=explode,
    labels=filtered_labels,
    autopct='%1.1f%%',
    #shadow=True,
    startangle=140,
    pctdistance=0.8,  # Distance of percentage from the center
    labeldistance=1.1,  # Distance of labels from the center
    wedgeprops=dict(width=0.5, edgecolor='white', linewidth=2)
)

# Formatting labels and percentages
for text in texts:
    text.set_fontsize(12)
for autotext in autotexts:
    autotext.set_fontsize(10)
    autotext.set_color('white')

plt.title('IT Industry Drops')
plt.show()
```



In [371…

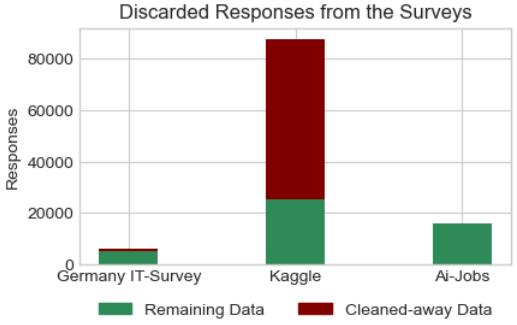
```
# Data
categories = ['Germany IT-Survey', 'Kaggle', 'Ai-Jobs']
data_points_1 = [len_it_clean, sum(it_cleanedaway)]
data_points_2 = [len_k_clean, sum(k_cleanedaway)]
data_points_3 = [len_ai_clean, sum(ai_cleanedaway)]

# Create the figure and axis
fig, ax = plt.subplots(figsize=(6, 3))
bar_width = 0.35  # Width of the bars

# Colors for the stacks
colors = ['green', 'red']
colors = ['darkgreen', 'firebrick']
colors = ['olive', 'maroon']
colors = ['forestgreen', 'crimson']
colors = ['seagreen', 'darkred']
colors = ['teal', 'darkred']
colors = ['seagreen', 'maroon']

# Plot each bar category
bottom = [0] * len(categories)
for i, category in enumerate(categories):
    for j, value in enumerate([data_points_1, data_points_2, data_points_3][i]):
        ax.bar(category, value, bar_width, bottom=bottom[i], color=colors[j])
        bottom[i] += value

# Adding labels and title
ax.set_ylabel('Responses')
ax.set_title('Discarded Responses from the Surveys')

# Create custom legend
handles = [plt.Rectangle((0,0),1,1, color=color) for color in colors]
labels = ['Remaining Data', 'Cleaned-away Data']
```

```
ax.legend(handles, labels, loc='upper right')

# Show plot
plt.show()
```



In [372…

```
# Create the figure and axis with specified size
fig, ax = plt.subplots(figsize=(4.5, 3))  # Set the figure size here
bar_width = 0.35  # Width of the bars

# Colors for the stacks
colors = ['seagreen', 'maroon']

# Plot each bar category
bottom = [0] * len(categories)
for i, category in enumerate(categories):
    for j, value in enumerate([data_points_1, data_points_2, data_points_3][i]):
        ax.bar(category, value, bar_width, bottom=bottom[i], color=colors[j])
        bottom[i] += value

# Adding labels and title
ax.set_ylabel('Responses')
ax.set_title('Discarded Responses from the Surveys')

# Create custom legend
handles = [plt.Rectangle((0, 0), 1, 1, color=color) for color in colors]
labels = ['Remaining Data', 'Cleaned-away Data']
ax.legend(handles, labels, loc='upper center', bbox_to_anchor=(0.5, -0.1), ncol=2)

# Adjust layout to fit legend outside the plot
plt.tight_layout()

# Show plot
plt.show()
```



Conclusion:
There is a significant disparity in the data quality between the three main sources of surveys.
This can be expected, as Kaggle asked a tremendous amount of questions, and by its nature is targeting the masses.
In contrast, Germany-IT survey seems to have been distributed more personally (or let's say it is not tied to an international social-network).
About AI-Jobs.net's methodology, we do not know much. It is surprisingly clean.

Exporting the cleaned data

In [375…
```
import os

# Dictionary of DataFrames and their corresponding filenames
dataframes = {
    'df_k': df_k,
    'df_it': df_it,
    'df_ai': df_ai
    # Add more DataFrames and filenames as needed
}
# Path to the cleaned data folder
cleaned_data_folder = '../data/cleaned/'

# Ensure the folder exists
os.makedirs(cleaned_data_folder, exist_ok=True)

# Loop through the dictionary and export each DataFrame to a CSV file
for filename, dataframe in dataframes.items():
    full_path = os.path.join(cleaned_data_folder, f'{filename}.csv')
    dataframe.to_csv(full_path, index=False)

print(f'Individual DataFrames and combined DataFrame exported to {cleaned_data_folder}')
```

```
Individual DataFrames and combined DataFrame exported to ../data/cleaned/
```

In [376…
```
# Combine DataFrames into one
df_combined = pd.concat(dataframes.values(), ignore_index=True)

# Path to the cleaned data folder
cleaned_data_folder = '../data/cleaned/'

# Ensure the folder exists
os.makedirs(cleaned_data_folder, exist_ok=True)

# Export the combined DataFrame to CSV
combined_path = os.path.join(cleaned_data_folder, 'df_combined_tableau.csv')
df_combined.to_csv(combined_path, index=False, encoding='utf-8')

print(f'Individual DataFrames and combined DataFrame exported to {cleaned_data_folder}')
```

```
Individual DataFrames and combined DataFrame exported to ../data/cleaned/
```