Import Libraries

In [1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt

from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
```

Features Explaination

- `work_year` : The year the salary was paid.
- `experience_level` : The experience level in the job during the year with the following possible values: EN Entry-level / Junior MI Mid-level / Intermediate SE Senior-level / Expert EX Executive-level / Director
- `employment_type` : The type of employement for the role: PT Part-time FT Full-time CT Contract FL Freelance
- `job_title` : The role worked in during the year.
- `salary` : The total gross salary amount paid.
- `salary_currency` : The currency of the salary paid as an ISO 4217 currency code.
- `salary_in_usd` : The salary in USD (FX rate divided by avg. USD rate for the respective year via fxdata.foorilla.com).
- `employee_residence` : Employee's primary country of residence in during the work year as an ISO 3166 country code.
- `remote_ratio` : The overall amount of work done remotely, possible values are as follows: 0 No remote work (less than 20%) 50 Partially remote 100 Fully remote (more than 80%)
- `company_location` : The country of the employer's main office or contracting branch as an ISO 3166 country code.
- `company_size` : The average number of people that worked for the company during the year: S less than 50 employees (small) M 50 to 250 employees (medium) L more than 250 employees (large)

Load data

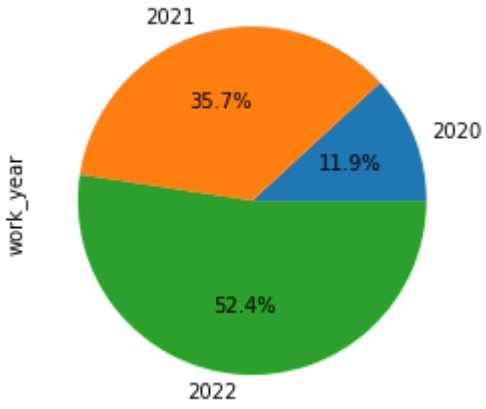
In [617…
```
df = pd.read_csv('/content/drive/MyDrive/Dibimbing/Portfolio/ds_salaries.csv
df
```

Out[617]:

	Unnamed: 0	work_year	experience_level	employment_type	job_title	salary	salary_
0	0	2020	MI	FT	Data Scientist	70000	
1	1	2020	SE	FT	Machine Learning Scientist	260000	
2	2	2020	SE	FT	Big Data Engineer	85000	
3	3	2020	MI	FT	Product Data Analyst	20000	
4	4	2020	SE	FT	Machine Learning Engineer	150000	
...	...	...	...	...	...	...	
602	602	2022	SE	FT	Data Engineer	154000	
603	603	2022	SE	FT	Data Engineer	126000	
604	604	2022	SE	FT	Data Analyst	129000	
605	605	2022	SE	FT	Data Analyst	150000	
606	606	2022	MI	FT	AI Scientist	200000	

607 rows × 12 columns

In [618…
```
df.groupby('work_year')['work_year'].count().plot.pie(autopct="%1.1f%%");
```



In [619…
```
df['work_year'].value_counts()
```

Out[619]:
```
2022    318
2021    217
2020     72
Name: work_year, dtype: int64
```

Observation:

1. Column `Unnamed: 0` needs to be removed, as it is unecessary columns.

2. The names of each column are lowercase.
3. The values of the `experience_level`, `employment_type`, `remote_ratio`, and `company_size` columns need to be redefined.
4. `work_year`, `salary`, `salary_in_usd`, and `remote_ratio` columns are numeric.
5. More than 50% of data are in 2022.

Data Cleansing

Drop unecessary columns

In [620…
```
# Drop unecessary columns
df = df.drop(columns=['Unnamed: 0'])
```

In [621…
```
# Checking data types of each column
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 607 entries, 0 to 606
Data columns (total 11 columns):
 #   Column              Non-Null Count  Dtype 
---  ------              --------------  ----- 
 0   work_year           607 non-null    int64 
 1   experience_level    607 non-null    object
 2   employment_type     607 non-null    object
 3   job_title           607 non-null    object
 4   salary              607 non-null    int64 
 5   salary_currency     607 non-null    object
 6   salary_in_usd       607 non-null    int64 
 7   employee_residence  607 non-null    object
 8   remote_ratio        607 non-null    int64 
 9   company_location    607 non-null    object
 10  company_size        607 non-null    object
dtypes: int64(4), object(7)
memory usage: 52.3+ KB
```

Handling missing values

In [622…
```
# Checking and handling missing values
df.isna().sum()
```

Out[622]:
```
work_year             0
experience_level      0
employment_type       0
job_title             0
salary                0
salary_currency       0
salary_in_usd         0
employee_residence    0
remote_ratio          0
company_location      0
company_size          0
dtype: int64
```

Handling duplicated data

In [623…
```
# Checking duplicated data
df.duplicated().sum()
```

Out[623]: 42

There are 42 duplicate rows; will be dropped later.

In [624…
```
df[df.duplicated(keep=False)].sort_values('job_title').head(6)
```

Out[624]:

	work_year	experience_level	employment_type	job_title	salary	salary_currency	sa
597	2022	SE	FT	Data Analyst	170000	USD	
406	2022	MI	FT	Data Analyst	58000	USD	
393	2022	SE	FT	Data Analyst	90320	USD	
392	2022	SE	FT	Data Analyst	112900	USD	
527	2022	SE	FT	Data Analyst	135000	USD	
528	2022	SE	FT	Data Analyst	100000	USD	

In [625…
```
# Drop duplicated rows
df = df.drop_duplicates()
```

In [626…
```
# Sanity check
df.duplicated().sum()
```

Out[626]: 0

In [627…
```
# Reset Index
df = df.reset_index(drop=True)
```

Done. Duplicated rows have gone.

Renaming the column value

In [628…
```
# Renaming the column value

# Experience Level
df.experience_level.replace(['EN','MI','SE','EX'],['Entry-level','Mid-level

# Employment Type
df.employment_type.replace(['PT','CT','FT','FL'],['Part-time','Contract','Fu

# Remote Ratio
df.remote_ratio.replace([0,50,100],['Onsite','Hybrid','Remote'], inplace=Tru

# Company Size
df.company_size.replace(['S','M','L'],['Small','Medium','Large'], inplace=Tr

df.head()
```

Out[628]:

	work_year	experience_level	employment_type	job_title	salary	salary_currency	sala
0	2020	Mid-level	Full-time	Data Scientist	70000	EUR	
1	2020	Senior-level	Full-time	Machine Learning Scientist	260000	USD	
2	2020	Senior-level	Full-time	Big Data Engineer	85000	GBP	
3	2020	Mid-level	Full-time	Product Data Analyst	20000	USD	
4	2020	Senior-level	Full-time	Machine Learning Engineer	150000	USD	

In [629…

```
# Recheck data info
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 565 entries, 0 to 564
Data columns (total 11 columns):
 #   Column              Non-Null Count  Dtype 
---  ------              --------------  ----- 
 0   work_year           565 non-null    int64 
 1   experience_level    565 non-null    object
 2   employment_type     565 non-null    object
 3   job_title           565 non-null    object
 4   salary              565 non-null    int64 
 5   salary_currency     565 non-null    object
 6   salary_in_usd       565 non-null    int64 
 7   employee_residence  565 non-null    object
 8   remote_ratio        565 non-null    object
 9   company_location    565 non-null    object
 10  company_size        565 non-null    object
dtypes: int64(3), object(8)
memory usage: 48.7+ KB
```

Checking the number of unique values

In [630…

```
# Checking the number of unique values in each column

dict = {}
for col in df.columns:
    dict[col] = df[col].value_counts().shape[0]

pd.DataFrame(dict, index=['unique value count']).transpose()
```

Out[630]:

	unique value count
work_year	3
experience_level	4
employment_type	4
job_title	50
salary	272
salary_currency	17
salary_in_usd	369
employee_residence	57
remote_ratio	3
company_location	50
company_size	3

In [631…
```
df.nunique()
```

Out[631]:
```
work_year             3
experience_level      4
employment_type       4
job_title            50
salary              272
salary_currency      17
salary_in_usd       369
employee_residence   57
remote_ratio          3
company_location     50
company_size          3
dtype: int64
```

In [632…
```
df.describe()
```

Out[632]:

	work_year	salary	salary_in_usd
count	565.000000	5.650000e+02	565.000000
mean	2021.364602	3.381160e+05	110610.343363
std	0.698138	1.599879e+06	72280.702792
min	2020.000000	4.000000e+03	2859.000000
25%	2021.000000	6.700000e+04	60757.000000
50%	2021.000000	1.109250e+05	100000.000000
75%	2022.000000	1.650000e+05	150000.000000
max	2022.000000	3.040000e+07	600000.000000

Additional Check

In [633…
```
# Separate columns into numerical and categorical
all_columns = df.columns.to_list()
numerical = ['work_year', 'salary', 'salary_in_usd']
categorical = list(set(all_columns) - set(numerical))
```

In [634…

```
# check for odd values in categorical columns, such as string "-", or other
for i in df[categorical].columns:
    x = df[categorical][i].value_counts()
    print(i)
    print(x,'\n')
```

```
employment_type
Full-time    546
Part-time     10
Contract       5
Freelance      4
Name: employment_type, dtype: int64

salary_currency
USD    359
EUR     93
GBP     43
INR     27
CAD     18
JPY      3
PLN      3
TRY      3
CNY      2
MXN      2
HUF      2
DKK      2
SGD      2
BRL      2
AUD      2
CLP      1
CHF      1
Name: salary_currency, dtype: int64

company_size
Medium    290
Large     193
Small      82
Name: company_size, dtype: int64

experience_level
Senior-level    243
Mid-level       208
Entry-level      88
Expert-level     26
Name: experience_level, dtype: int64

job_title
Data Scientist                             130
Data Engineer                              121
Data Analyst                                82
Machine Learning Engineer                   39
Research Scientist                          16
Data Science Manager                        12
Data Architect                              11
Big Data Engineer                            8
Machine Learning Scientist                   8
Principal Data Scientist                     7
AI Scientist                                 7
Data Science Consultant                      7
Director of Data Science                     7
Data Analytics Manager                       7
ML Engineer                                  6
Computer Vision Engineer                     6
BI Data Analyst                              6
Lead Data Engineer                           6
Data Engineering Manager                     5
Business Data Analyst                        5
Head of Data                                 5
Applied Data Scientist                       5
Applied Machine Learning Scientist           4
```

```
Head of Data Science                          4
Analytics Engineer                            4
Data Analytics Engineer                       4
Machine Learning Developer                    3
Lead Data Scientist                           3
Computer Vision Software Engineer             3
Data Science Engineer                         3
Principal Data Engineer                       3
Machine Learning Infrastructure Engineer      3
Lead Data Analyst                             3
Cloud Data Engineer                           2
Financial Data Analyst                        2
Director of Data Engineering                  2
Product Data Analyst                          2
Principal Data Analyst                        2
Head of Machine Learning                      1
3D Computer Vision Researcher                 1
NLP Engineer                                  1
Lead Machine Learning Engineer                1
ETL Developer                                 1
Data Specialist                               1
Staff Data Scientist                          1
Big Data Architect                            1
Finance Data Analyst                          1
Marketing Data Analyst                        1
Machine Learning Manager                      1
Data Analytics Lead                           1
Name: job_title, dtype: int64

remote_ratio
Remote    346
Onsite    121
Hybrid     98
Name: remote_ratio, dtype: int64

employee_residence
US    295
GB     43
IN     30
CA     27
DE     24
FR     18
ES     15
GR     12
JP      7
PT      6
BR      6
PK      6
NL      5
PL      4
IT      4
RU      4
AE      3
AT      3
VN      3
TR      3
AU      3
RO      2
BE      2
SG      2
SI      2
DK      2
HU      2
NG      2
```

```
MX      2
BO      1
MY      1
TN      1
IE      1
DZ      1
AR      1
CZ      1
JE      1
LU      1
PR      1
RS      1
EE      1
CL      1
HK      1
KE      1
MD      1
CO      1
IR      1
CN      1
MT      1
UA      1
IQ      1
HN      1
BG      1
HR      1
PH      1
NZ      1
CH      1
Name: employee_residence, dtype: int64

company_location
US    318
GB     46
CA     28
DE     27
IN     24
FR     15
ES     14
GR     10
JP      6
NL      4
AT      4
PT      4
PL      4
LU      3
PK      3
BR      3
AE      3
MX      3
AU      3
TR      3
DK      3
IT      2
CZ      2
SI      2
RU      2
CH      2
NG      2
CN      2
BE      2
VN      1
EE      1
AS      1
```

```
DZ      1
MY      1
MD      1
KE      1
SG      1
CO      1
IR      1
CL      1
MT      1
IL      1
UA      1
IQ      1
RO      1
HR      1
NZ      1
HU      1
HN      1
IE      1
Name: company_location, dtype: int64
```

Observations:

1. Successfully drop unnecessary column : `Unnamed: 0`.
2. Dataframe has no missing values.
3. There are **42** duplicate rows, but have gone.
4. Renaming the values in columns `experience_level`, `employment_type`, `remote_ratio`, `company_size` to make it easier to understand the data.
5. After renaming the column value, the dtype of the `remote_ratio` column changes to object.

Exploratory Data Analysis

Statistical Summary of Columns

In [635…
```
# Separate columns into numerical and categorical
all_columns = df.columns.to_list()
numerical = ['work_year', 'salary', 'salary_in_usd']
categorical = list(set(all_columns) - set(numerical))
```

In [636…
```
df[numerical]
```

Out[636]:

	work_year	salary	salary_in_usd
0	2020	70000	79833
1	2020	260000	260000
2	2020	85000	109024
3	2020	20000	20000
4	2020	150000	150000
...	...	...	...
560	2022	154000	154000
561	2022	126000	126000
562	2022	129000	129000
563	2022	150000	150000
564	2022	200000	200000

565 rows × 3 columns

In [637…
```
df[numerical].describe()
```

Out[637]:

	work_year	salary	salary_in_usd
count	565.000000	5.650000e+02	565.000000
mean	2021.364602	3.381160e+05	110610.343363
std	0.698138	1.599879e+06	72280.702792
min	2020.000000	4.000000e+03	2859.000000
25%	2021.000000	6.700000e+04	60757.000000
50%	2021.000000	1.109250e+05	100000.000000
75%	2022.000000	1.650000e+05	150000.000000
max	2022.000000	3.040000e+07	600000.000000

In [638…
```
df[categorical]
```

Out[638]:

	employment_type	salary_currency	company_size	experience_level	job_title	remote_
0	Full-time	EUR	Large	Mid-level	Data Scientist	(
1	Full-time	USD	Small	Senior-level	Machine Learning Scientist	(
2	Full-time	GBP	Medium	Senior-level	Big Data Engineer	H
3	Full-time	USD	Small	Mid-level	Product Data Analyst	(
4	Full-time	USD	Large	Senior-level	Machine Learning Engineer	H
...	...	...	...	...	...	
560	Full-time	USD	Medium	Senior-level	Data Engineer	R
561	Full-time	USD	Medium	Senior-level	Data Engineer	R
562	Full-time	USD	Medium	Senior-level	Data Analyst	(
563	Full-time	USD	Medium	Senior-level	Data Analyst	R
564	Full-time	USD	Large	Mid-level	AI Scientist	R

565 rows × 8 columns

In [639…

```
df[categorical].describe()
```

Out[639]:

	employment_type	salary_currency	company_size	experience_level	job_title	remo
count	565	565	565	565	565	
unique	4	17	3	4	50	
top	Full-time	USD	Medium	Senior-level	Data Scientist	
freq	546	359	290	243	130	

Observations:

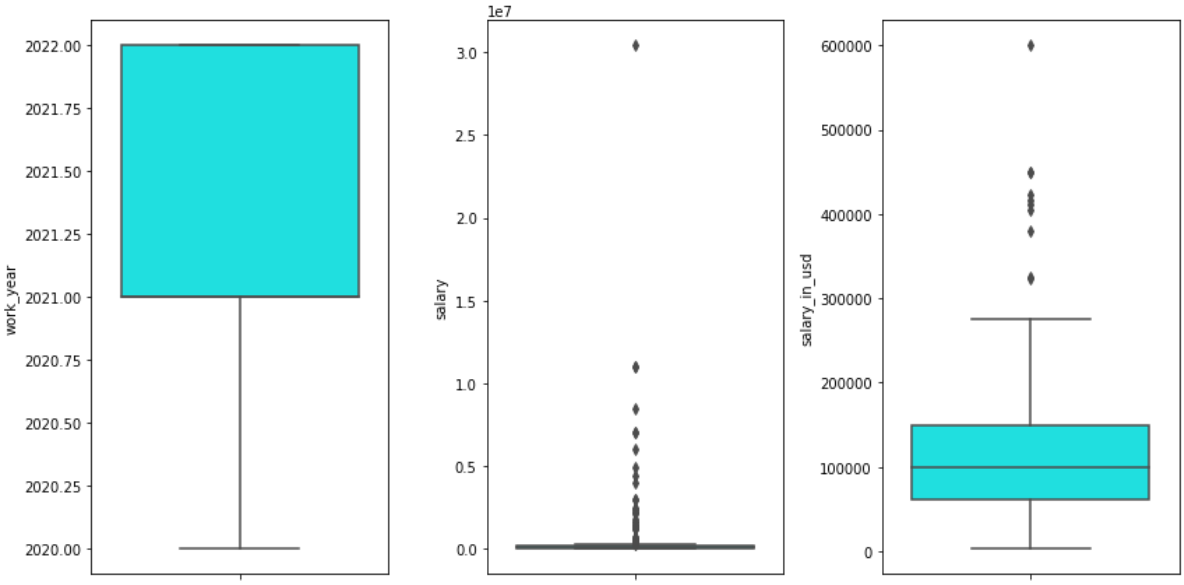
- a
- b
- c

Univariate Analysis

In [640…

```
# adjust the figure size for better readability
plt.figure(figsize=(12,6))

# plotting
```

```
features = numerical
for i in range(0, len(features)):
    plt.subplot(1, len(features), i+1)
    sns.boxplot(y=df[features[i]], color='cyan')
    plt.tight_layout()
```

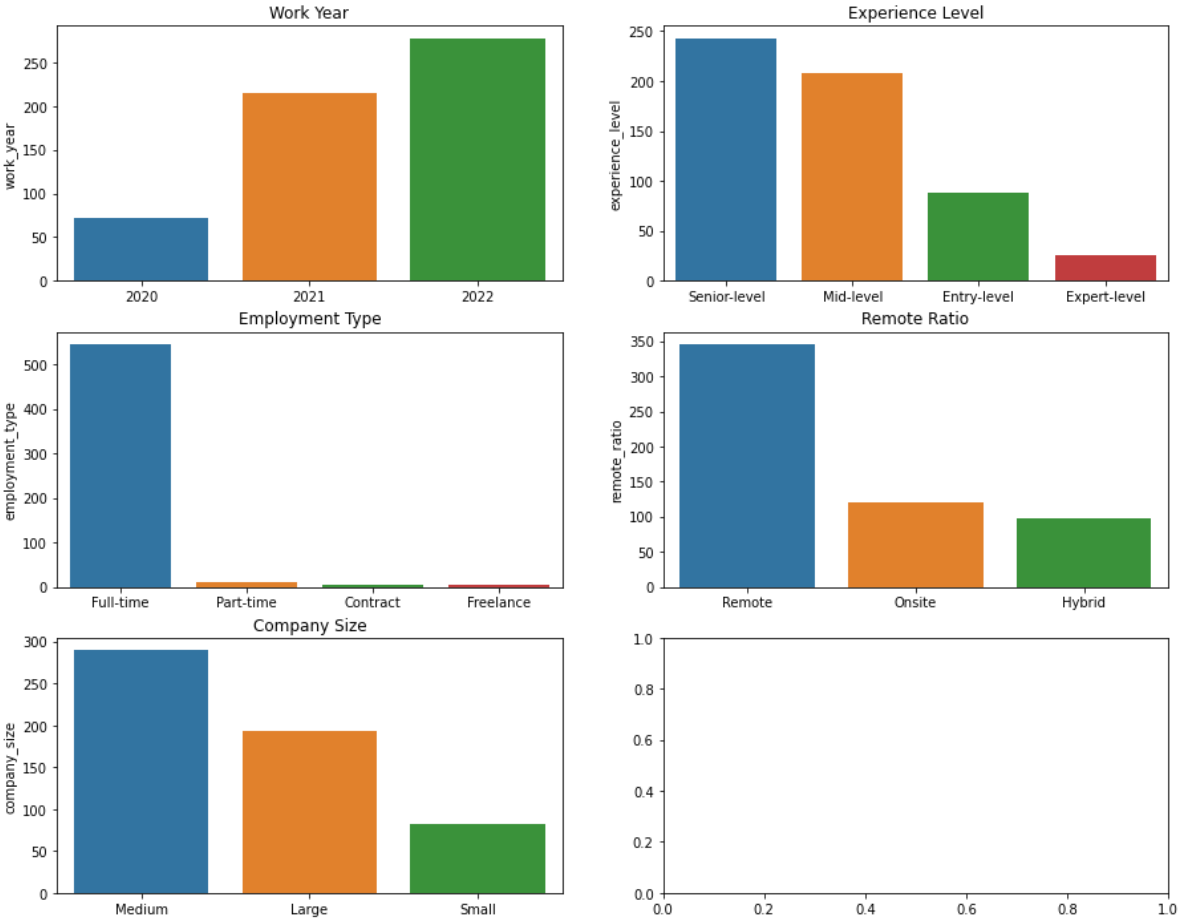


Observation:

1. There is no outlier in `work_year` column.
2. There are some outliers in the `salary` and `salary_in_usd` columns.

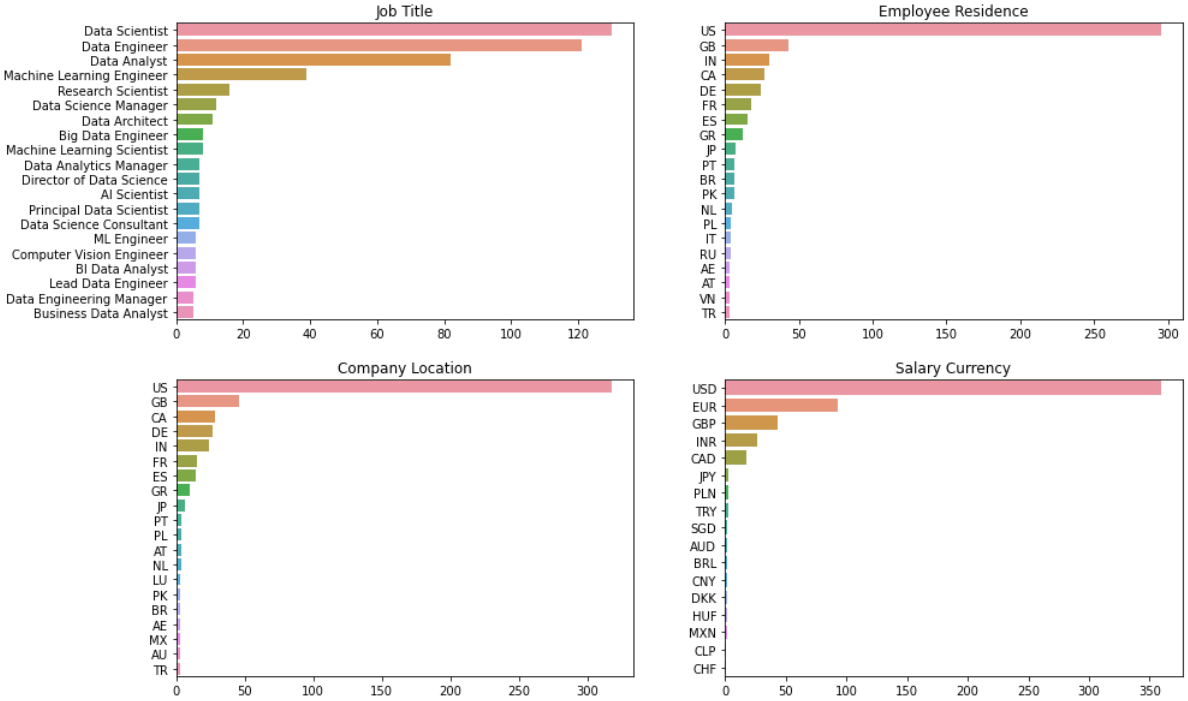
In [641…

```
fig, axes = plt.subplots(3, 2, figsize = (15, 12))

sns.barplot(x = df["work_year"].value_counts().sort_values(ascending = False
axes[0][0].set_title("Work Year")

sns.barplot(x = df["experience_level"].value_counts().sort_values(ascending
axes[0][1].set_title("Experience Level")

sns.barplot(x = df["employment_type"].value_counts().sort_values(ascending =
axes[1][0].set_title("Employment Type")

sns.barplot(x = df["remote_ratio"].value_counts().sort_values(ascending = Fa
axes[1][1].set_title("Remote Ratio")

sns.barplot(x = df["company_size"].value_counts().sort_values(ascending = Fa
axes[2][0].set_title("Company Size");
```



In [642…

```
fig, axes = plt.subplots(2, 2, figsize = (15, 10))

sns.barplot(x = df["job_title"].value_counts().sort_values(ascending = False
            y = df["job_title"].value_counts().sort_values(ascending = False
axes[0][0].set_title("Job Title")
axes[0][0].set_xlabel("")

sns.barplot(x = df["employee_residence"].value_counts().sort_values(ascendi
            y = df["employee_residence"].value_counts().sort_values(ascendi
axes[0][1].set_title("Employee Residence")
axes[0][1].set_xlabel("")

sns.barplot(x = df["company_location"].value_counts().sort_values(ascending
            y = df["company_location"].value_counts().sort_values(ascending
axes[1][0].set_title("Company Location")
axes[1][0].set_xlabel("")

sns.barplot(x = df["salary_currency"].value_counts().sort_values(ascending =
            y = df["salary_currency"].value_counts().sort_values(ascending =
axes[1][1].set_title("Salary Currency")
axes[1][1].set_xlabel("");
```



Multivariate Analysis

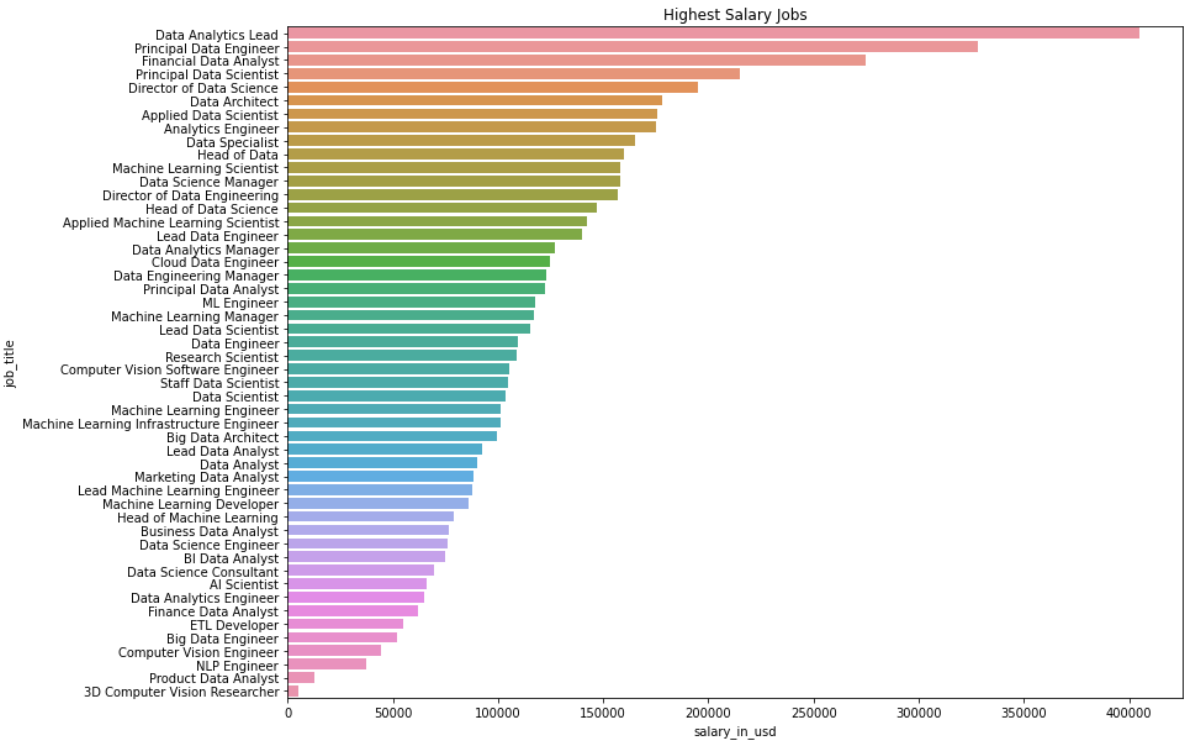
Analysis 1: What is job with the highest salary in Data Science?

In [643…

```
# Set the figure size
plt.figure(figsize = (13,10))

# plot a hist chart
sns.barplot(x = df.groupby("job_title")["salary_in_usd"].mean().sort_values(
            y = df.groupby("job_title")["salary_in_usd"].mean().sort_values(
plt.xlabel = ("Salary in USD")
# plt.xticks(rotation='vertical')
plt.title("Highest Salary Jobs")
```

Out[643]:

```
Text(0.5, 1.0, 'Highest Salary Jobs')
```



In [644…
```
dftopsalary = ['salary_in_usd', 'job_title']
df[dftopsalary].max()
```

Out[644]:
```
salary_in_usd                  600000
job_title        Staff Data Scientist
dtype: object
```

In [645…
```
df[dftopsalary].min()
```

Out[645]:
```
salary_in_usd                               2859
job_title        3D Computer Vision Researcher
dtype: object
```

Observations :

- The chart shows that the highest salary by **Data Analytics Lead** is > 400,000 USD and the lowest by **3D Computer Vision Researcher** is < 3,000 USD.
- The average salary of workers in the Data Science field is 100,000 USD.

Analysis 2: What are the top 10 data science jobs in 2022?

In [646…
```
df.groupby(['work_year']).agg(
    job_title = ('job_title','count')
).reset_index()
```

Out[646]:

	work_year	job_title
0	2020	72
1	2021	215
2	2022	278

In [647…
```
df.salary.value_counts()
```

Out[647]:
```
80000      18
100000     16
120000     15
60000      14
150000     14
           ..
39600       1
1335000     1
52500       1
31000       1
129000      1
Name: salary, Length: 272, dtype: int64
```

In [648…
```
df22 = df[df["work_year"] == 2022]
df22.head()
```

Out[648]:

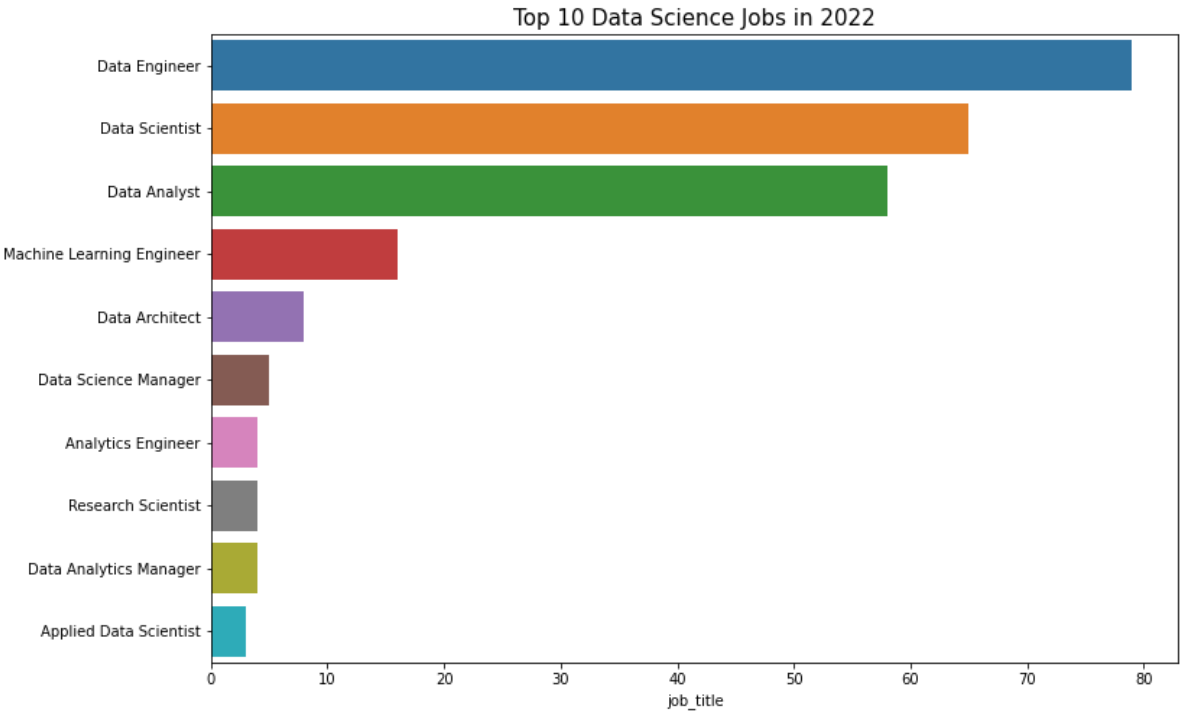
	work_year	experience_level	employment_type	job_title	salary	salary_currency	sa
287	2022	Senior-level	Full-time	Data Engineer	135000	USD	
288	2022	Senior-level	Full-time	Data Analyst	155000	USD	
289	2022	Senior-level	Full-time	Data Analyst	120600	USD	
290	2022	Mid-level	Full-time	Data Scientist	130000	USD	
291	2022	Mid-level	Full-time	Data Scientist	90000	USD	

In [649…
```
df22.job_title.value_counts().head(10)
```

Out[649]:
```
Data Engineer                79
Data Scientist               65
Data Analyst                 58
Machine Learning Engineer    16
Data Architect                8
Data Science Manager          5
Analytics Engineer            4
Research Scientist            4
Data Analytics Manager        4
Applied Data Scientist        3
Name: job_title, dtype: int64
```

In [650…
```
# Set the figure size
plt.figure(figsize = (12, 8))

# plot a bar chart
sns.barplot(x = df22["job_title"].value_counts().sort_values(ascending = Fal
            y = df22["job_title"].value_counts().sort_values(ascending = Fal
plt.title('Top 10 Data Science Jobs in 2022', fontsize = 15)
```

Out[650]:
```
Text(0.5, 1.0, 'Top 10 Data Science Jobs in 2022')
```



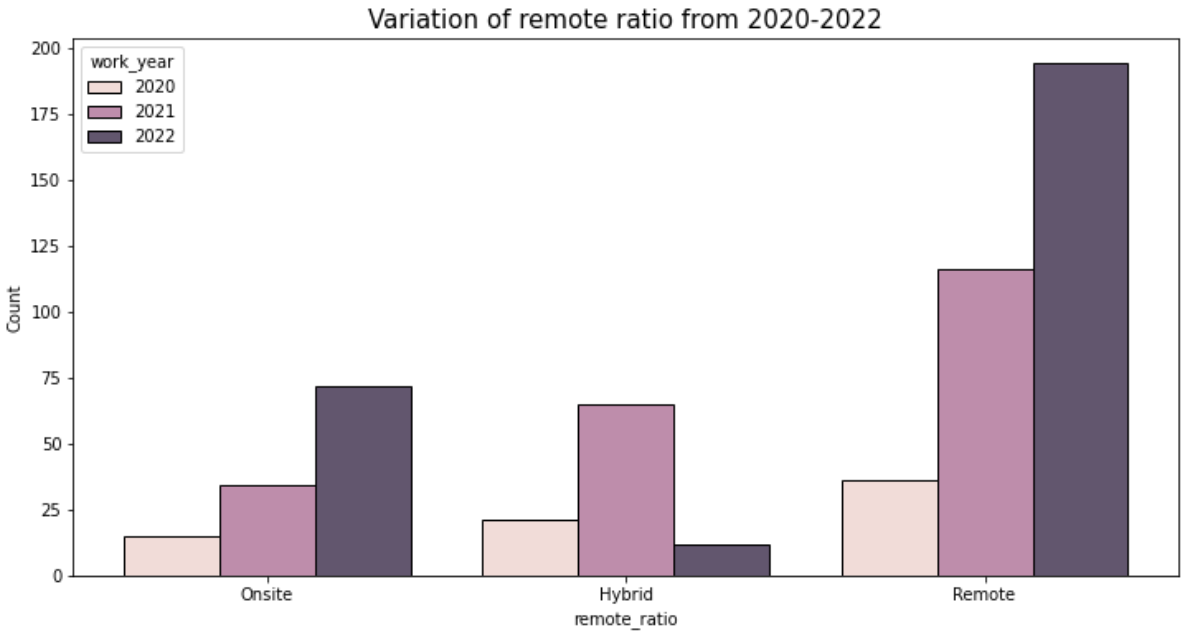
Observations:

- In 2022, the top 10 popular data science jobs are shown on the chart and the most popular is **Data Engineer**.
- **Data Scientist**, **Data Engineer**, **Data Analyst** are the top 3 most popular jobs based on the data.

Analysis 3: How does the remote-ratio vary from year 2020 -2022?

In [651…
```
# Set the figure size
plt.figure(figsize = (12,6))

# plot a hist chart
sns.histplot(data = df, x = 'remote_ratio', hue = 'work_year', multiple = '
plt.title('Variation of remote ratio from 2020-2022', fontsize = 15)
```

Out[651]:
```
Text(0.5, 1.0, 'Variation of remote ratio from 2020-2022')
```



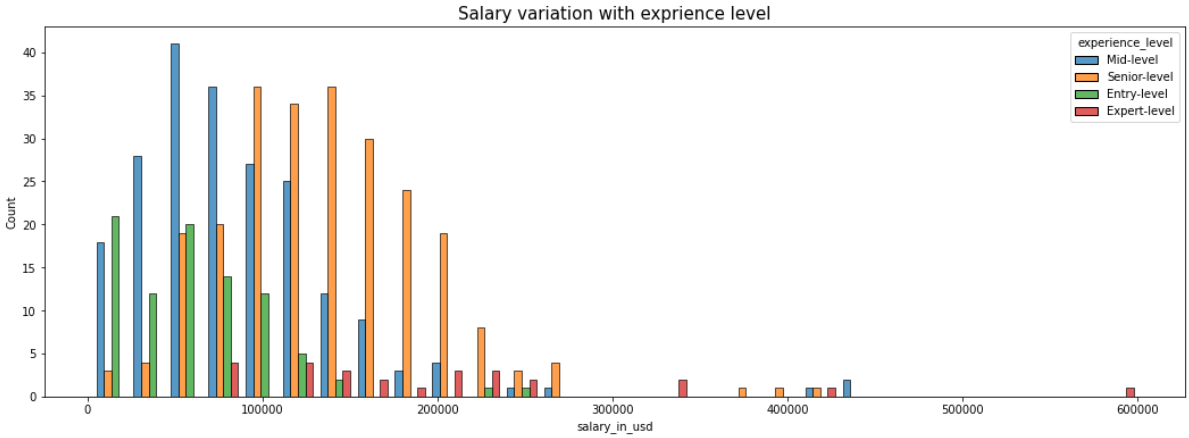
Observations:

- From 2020 to 2022 there will be an increase in the rate of remote work by Data Science workers.
- The chart shows the existence of a new culture that is most favored by Data Science workers, namely remote / work from home.

Analysis 4: Does salary of employees (salary_in_usd) depends on the exprience level?

In [652…
```
# Set the figure size
plt.figure(figsize = (18,6))

# plot a hist chart
sns.histplot(data = df, x = df.salary_in_usd, hue = 'experience_level', mul
plt.title('Salary variation with exprience level', fontsize = 15)
```

Out[652]:
```
Text(0.5, 1.0, 'Salary variation with exprience level')
```



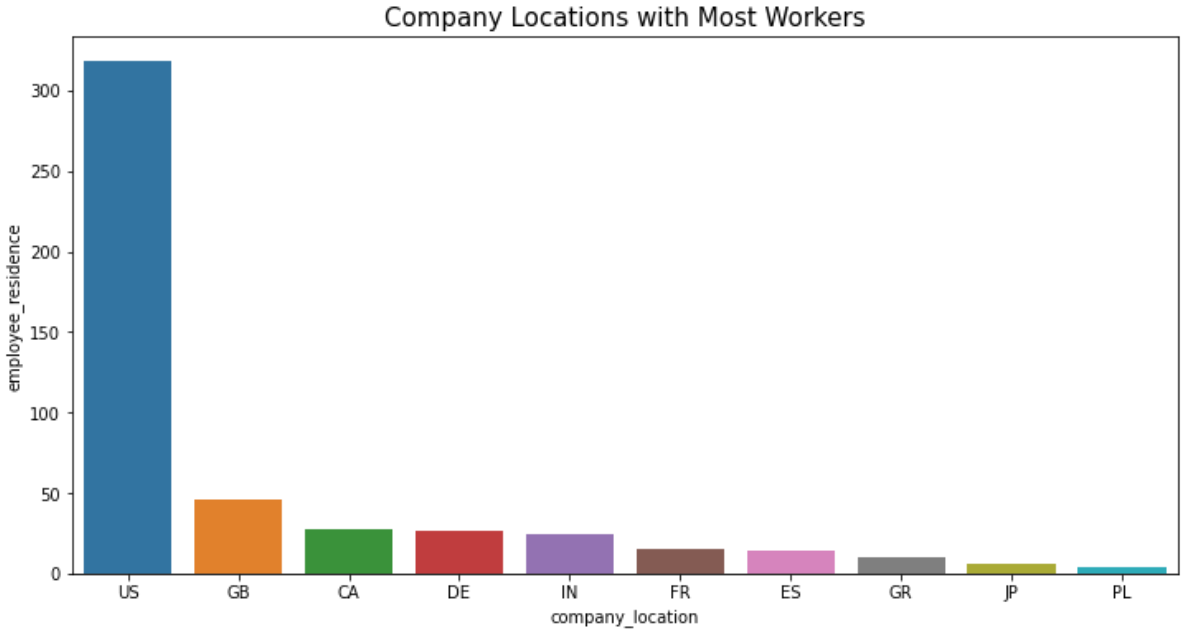
Observations :

- Experience level highly effects the amount of salary.

Analysis 5: How is the distribution of Data Science worker locations?

In [653…
```
# Set the figure size
plt.figure(figsize = (12,6))

# plot a bar chart
sns.barplot(x = df.groupby("company_location")["employee_residence"].count()
            y = df.groupby("company_location")["employee_residence"].count()
plt.title("Company Locations with Most Workers", fontsize = 15)
```

Out[653]:
```
Text(0.5, 1.0, 'Company Locations with Most Workers')
```

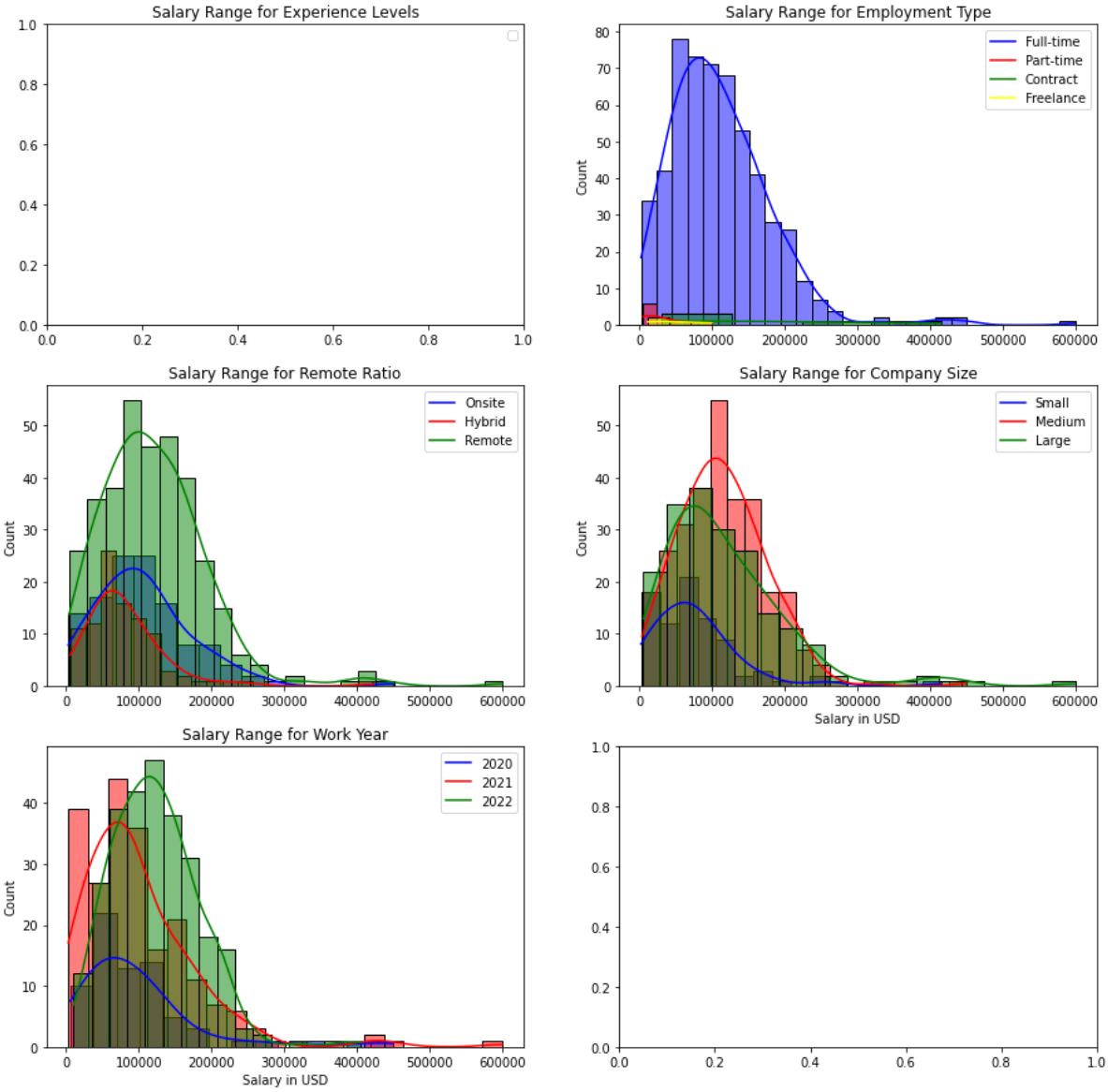


Observation:

- Workers mostly are from american (US) companies.

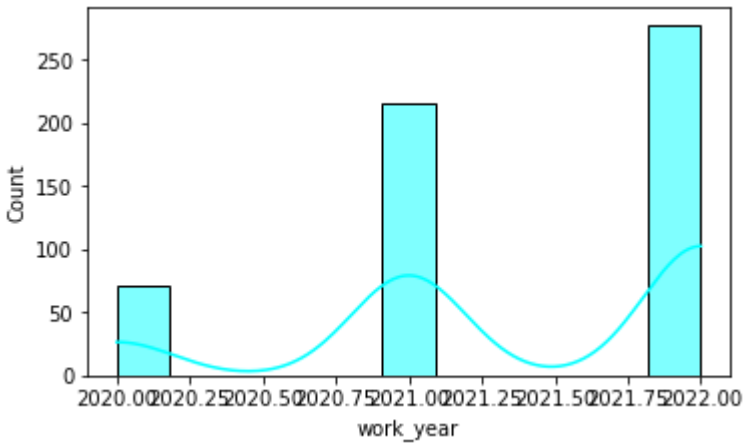
In [654…
```
fig, axes = plt.subplots(3, 2, figsize = (15, 15))

sns.histplot(df.query("experience_level == 'Entry'")["salary_in_usd"], kde =
sns.histplot(df.query("experience_level == 'Junior'")["salary_in_usd"], kde
sns.histplot(df.query("experience_level == 'Senior'")["salary_in_usd"], kde
sns.histplot(df.query("experience_level == 'Expert'")["salary_in_usd"], kde
axes[0][0].legend(labels = ["Entry", "Junior", "Senior", "Expert"])
```

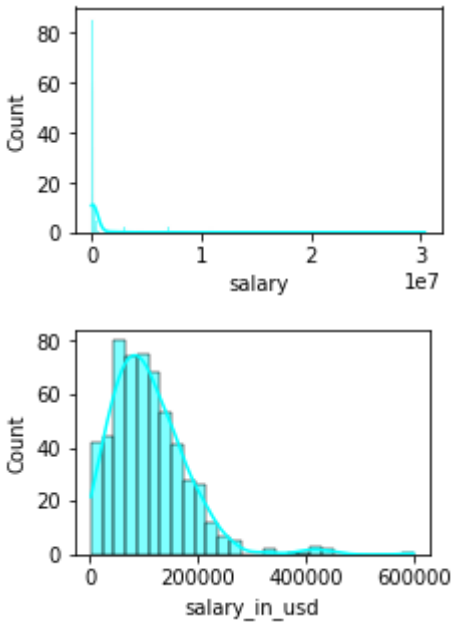
```
axes[0][0].set_xlabel("")
axes[0][0].set_title("Salary Range for Experience Levels")

sns.histplot(df.query("employment_type == 'Full-time'")["salary_in_usd"], kd
sns.histplot(df.query("employment_type == 'Part-time'")["salary_in_usd"], kd
sns.histplot(df.query("employment_type == 'Contract'")["salary_in_usd"], kde
sns.histplot(df.query("employment_type == 'Freelance'")["salary_in_usd"], kd
axes[0][1].legend(labels = ["Full-time", "Part-time", "Contract", "Freelance
axes[0][1].set_xlabel("")
axes[0][1].set_title("Salary Range for Employment Type")

sns.histplot(df.query("remote_ratio == 'Onsite'")["salary_in_usd"], kde = Tr
sns.histplot(df.query("remote_ratio == 'Hybrid'")["salary_in_usd"], kde = Tr
sns.histplot(df.query("remote_ratio == 'Remote'")["salary_in_usd"], kde = Tr
axes[1][0].legend(labels = ["Onsite", "Hybrid", "Remote"])
axes[1][0].set_xlabel("")
axes[1][0].set_title("Salary Range for Remote Ratio")

sns.histplot(df.query("company_size == 'Small'")["salary_in_usd"], kde = Tru
sns.histplot(df.query("company_size == 'Medium'")["salary_in_usd"], kde = Tr
sns.histplot(df.query("company_size == 'Large'")["salary_in_usd"], kde = Tru
axes[1][1].legend(labels = ["Small", "Medium", "Large"])
axes[1][1].set_xlabel("Salary in USD")
axes[1][1].set_title("Salary Range for Company Size")

sns.histplot(df.query("work_year == 2020")["salary_in_usd"], kde = True, co
sns.histplot(df.query("work_year == 2021")["salary_in_usd"], kde = True, co
sns.histplot(df.query("work_year == 2022")["salary_in_usd"], kde = True, co
axes[2][0].legend(labels = ["2020", "2021", "2022"])
axes[2][0].set_xlabel("Salary in USD")
axes[2][0].set_title("Salary Range for Work Year");
```



In [655…

```
# adjust the figure size for better readability
plt.figure(figsize=(10,6))

features = numerical
for i in range(0, len(features)):
    plt.subplot(2, len(features)//2 + 1, i+1)
    sns.histplot(x=df[features[i]], color='cyan', kde=True)
    # plt.xlabel(features[i])
    plt.tight_layout()
    plt.show()
```





In [656…
```
# # adjust the figure size for better readability
# plt.figure(figsize=(12,6))

# features = numerical
# for i in range(0, len(features)):
#     plt.subplot(2, len(features)//2 + 1, i+1)
#     #plt.subplot(1, len(features), i+1)
#     sns.distplot(x=df[features[i]], color='skyblue')
#     plt.xlabel(features[i])
#     plt.tight_layout()
```

Data Preprocessing

Features Selection

We will predict salaries only for the top 10 data science jobs: **Data Engineer, Data Scientist, Data Analyst**.

In [657…
```
df2 = df[df['job_title'].isin(['Data Engineer', 'Data Scientist', 'Data Ana
```

In [658…
```
df2['job_title'].value_counts()
```

Out[658]:
```
Data Scientist    130
Data Engineer     121
Data Analyst       82
Name: job_title, dtype: int64
```

Remove Redundant columns.

In [659…
```
df2 = df2.drop(['work_year', 'salary_currency', 'salary'],axis=1)
```

Add New Columns

In [660…
```
# is the working country same as residence country?
df2['same_working_country'] = df2.apply(lambda x:  'Local Worker'
                                        if x['employee_residence'] == x['compa
                                        else 'Expatriate', axis=1)
```

```
df2 = df2.drop(['employee_residence','company_location'],axis=1)

print("STATUS: Added column same_working_country")
```

```
STATUS: Added column same_working_country
```

In [661…
```
df2['same_working_country'].value_counts()
```

Out[661]:
```
Local Worker    314
Expatriate       19
Name: same_working_country, dtype: int64
```

In [662…
```
# Reset Index
df2 = df2.reset_index(drop=True)
```

In [663…
```
df2
```

Out[663]:

	experience_level	employment_type	job_title	salary_in_usd	remote_ratio	company_s
0	Mid-level	Full-time	Data Scientist	79833	Onsite	La
1	Entry-level	Full-time	Data Analyst	72000	Remote	La
2	Mid-level	Full-time	Data Scientist	35735	Hybrid	La
3	Entry-level	Full-time	Data Scientist	51321	Onsite	Sr
4	Mid-level	Full-time	Data Scientist	40481	Onsite	La
...	...	...	...	...	...	
328	Entry-level	Full-time	Data Analyst	52000	Onsite	Med
329	Senior-level	Full-time	Data Engineer	154000	Remote	Med
330	Senior-level	Full-time	Data Engineer	126000	Remote	Med
331	Senior-level	Full-time	Data Analyst	129000	Onsite	Med
332	Senior-level	Full-time	Data Analyst	150000	Remote	Med

333 rows × 7 columns

One Hot Encoding

In [664…
```
newdf = df2.copy()
newdf = pd.get_dummies(data=newdf, columns=['experience_level', 'employment_
newdf
```

Out[664]:

	salary_in_usd	experience_level_Entry-level	experience_level_Expert-level	experience_level_Mi lev
0	79833	0	0	
1	72000	1	0	
2	35735	0	0	
3	51321	1	0	
4	40481	0	0	
...	...	...	...	
328	52000	1	0	
329	154000	0	0	
330	126000	0	0	
331	129000	0	0	
332	150000	0	0	

333 rows × 19 columns

Split the data

In [665…

```
# split train test
from sklearn.model_selection import train_test_split

feature = newdf.drop(columns='salary_in_usd')
target = newdf[['salary_in_usd']]

#80:20
feature_train, feature_test, target_train, target_test = train_test_split(fe
```

Multicollinearity Study

In [666…

```
# calculate VIF scores for each feature
from statsmodels.stats.outliers_influence import variance_inflation_factor a
from statsmodels.tools.tools import add_constant

X = add_constant(feature_train)

vif_df = pd.DataFrame([vif(X.values, i)
               for i in range(X.shape[1])],
              index=X.columns).reset_index()
vif_df.columns = ['feature','vif_score']
vif_df = vif_df.loc[vif_df.feature!='const']
vif_df
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/tsa/tsatools.py:142: Fut
ureWarning: In a future version of pandas all arguments of concat except fo
r the argument 'objs' will be keyword-only
  x = pd.concat(x[::order], 1)
/usr/local/lib/python3.7/dist-packages/statsmodels/regression/linear_model.
py:1715: RuntimeWarning: divide by zero encountered in double_scalars
  return 1 - self.ssr/self.centered_tss
/usr/local/lib/python3.7/dist-packages/statsmodels/stats/outliers_influenc
e.py:193: RuntimeWarning: divide by zero encountered in double_scalars
  vif = 1. / (1. - r_squared_i)
```

Out[666]:

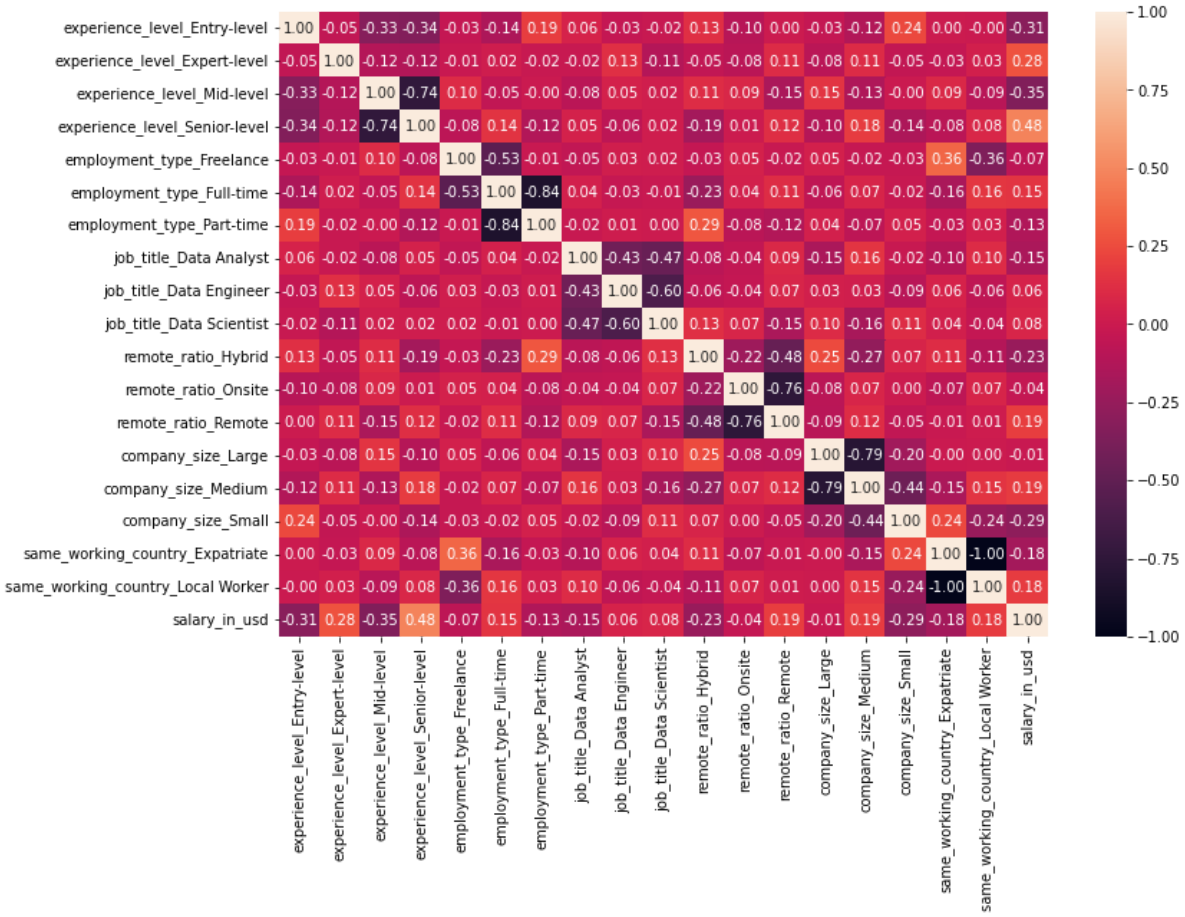
	feature	vif_score
1	experience_level_Entry-level	inf
2	experience_level_Expert-level	inf
3	experience_level_Mid-level	inf
4	experience_level_Senior-level	inf
5	employment_type_Freelance	inf
6	employment_type_Full-time	inf
7	employment_type_Part-time	inf
8	job_title_Data Analyst	inf
9	job_title_Data Engineer	inf
10	job_title_Data Scientist	inf
11	remote_ratio_Hybrid	inf
12	remote_ratio_Onsite	inf
13	remote_ratio_Remote	inf
14	company_size_Large	inf
15	company_size_Medium	inf
16	company_size_Small	inf
17	same_working_country_Expatriate	inf
18	same_working_country_Local Worker	inf

Column with multicollinearity :

- `employment_type_Full-time`
- `employment_type_Part-time`

In [667…

```
# heatmap correlation
train = pd.concat([feature_train, target_train], axis=1)
corr = train.corr()

plt.figure(figsize=(12,8))
sns.heatmap(corr, annot=True, fmt='.2f')
plt.show()
```



Because columns `employment_type_Full-time` and `employment_type_Part-time` come from the same column, we need to drop.

In [668…
```
# feature_train = feature_train.drop(columns=['employment_type_Full-time',
# feature_test = feature_test.drop(columns=['employment_type_Full-time', 'em
# target_train = target_train.drop(columns=['employment_type_Full-time', 'em
# target_test = target_test.drop(columns=['employment_type_Full-time', 'empl
```

In [669…
```
# Recheck VIF
from statsmodels.stats.outliers_influence import variance_inflation_factor a
from statsmodels.tools.tools import add_constant

X = add_constant(feature_train)

vif_df = pd.DataFrame([vif(X.values, i)
               for i in range(X.shape[1])],
              index=X.columns).reset_index()
vif_df.columns = ['feature','vif_score']
vif_df = vif_df.loc[vif_df.feature!='const']
vif_df
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/tsa/tsatools.py:142: Fut
ureWarning: In a future version of pandas all arguments of concat except fo
r the argument 'objs' will be keyword-only
  x = pd.concat(x[::order], 1)
/usr/local/lib/python3.7/dist-packages/statsmodels/regression/linear_model.
py:1715: RuntimeWarning: divide by zero encountered in double_scalars
  return 1 - self.ssr/self.centered_tss
/usr/local/lib/python3.7/dist-packages/statsmodels/stats/outliers_influenc
e.py:193: RuntimeWarning: divide by zero encountered in double_scalars
  vif = 1. / (1. - r_squared_i)
```

Out[669]:

	feature	vif_score
1	experience_level_Entry-level	inf
2	experience_level_Expert-level	inf
3	experience_level_Mid-level	inf
4	experience_level_Senior-level	inf
5	employment_type_Freelance	inf
6	employment_type_Full-time	inf
7	employment_type_Part-time	inf
8	job_title_Data Analyst	inf
9	job_title_Data Engineer	inf
10	job_title_Data Scientist	inf
11	remote_ratio_Hybrid	inf
12	remote_ratio_Onsite	inf
13	remote_ratio_Remote	inf
14	company_size_Large	inf
15	company_size_Medium	inf
16	company_size_Small	inf
17	same_working_country_Expatriate	inf
18	same_working_country_Local Worker	inf

Modeling

Linear Regression Model

In [670…

```
from sklearn.linear_model import LinearRegression

# define the model
multi_reg = LinearRegression()

# convert to numpy
X_train = feature_train.to_numpy()
y_train = target_train.to_numpy()

# train the model
multi_reg.fit(X_train, y_train)
```

Out[670]:

```
LinearRegression()
```

In [671…

```
# retrieve the coefficients
# show as a nice dataframe

data = feature_train
model = multi_reg

coef_df = pd.DataFrame({
    'feature':['intercept'] + data.columns.tolist(),
    'coefficient':[model.intercept_[0]] + list(model.coef_[0])
```

```
})

coef_df
```

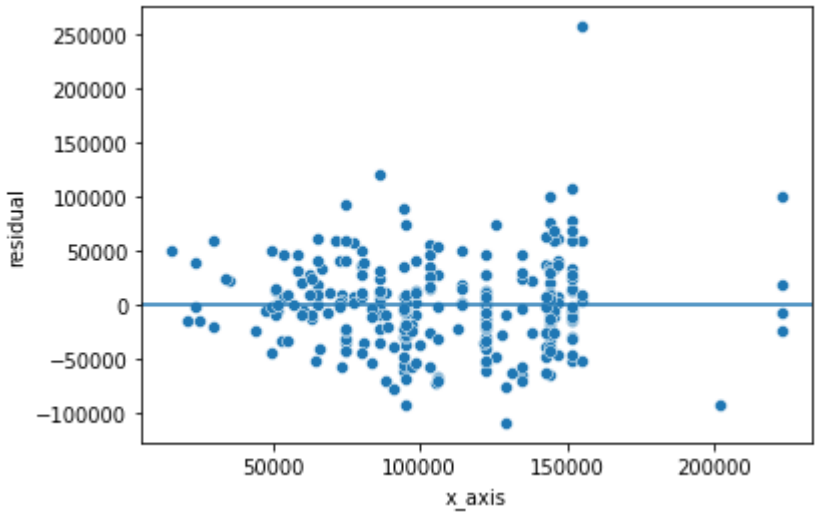
Out[671]:

	feature	coefficient
0	intercept	1.249898e+18
1	experience_level_Entry-level	-8.913208e+17
2	experience_level_Expert-level	-8.913208e+17
3	experience_level_Mid-level	-8.913208e+17
4	experience_level_Senior-level	-8.913208e+17
5	employment_type_Freelance	1.701962e+17
6	employment_type_Full-time	1.701962e+17
7	employment_type_Part-time	1.701962e+17
8	job_title_Data Analyst	7.354423e+17
9	job_title_Data Engineer	7.354423e+17
10	job_title_Data Scientist	7.354423e+17
11	remote_ratio_Hybrid	-3.998501e+17
12	remote_ratio_Onsite	-3.998501e+17
13	remote_ratio_Remote	-3.998501e+17
14	company_size_Large	-8.376891e+17
15	company_size_Medium	-8.376891e+17
16	company_size_Small	-8.376891e+17
17	same_working_country_Expatriate	-2.667675e+16
18	same_working_country_Local Worker	-2.667675e+16

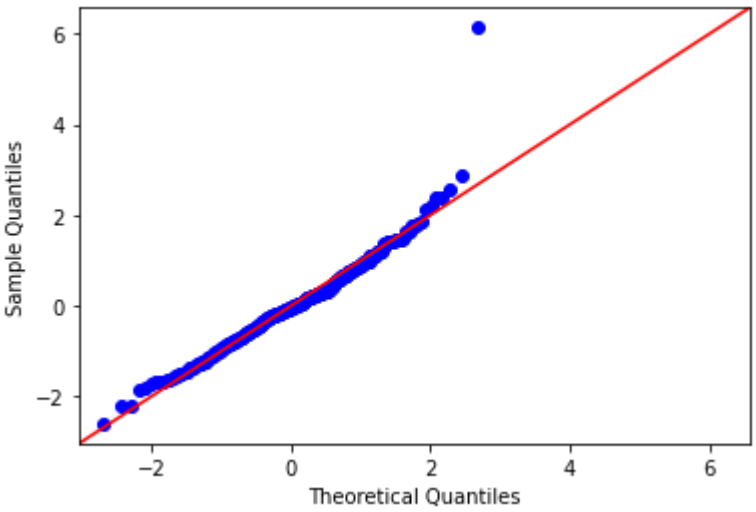
Model Diagnostic

In [672…

```
# calculate residuals
y_predict_train = multi_reg.predict(X_train)
residual = y_train - y_predict_train

#preprocess shape
y_predict_train = np.array([value for nested_array in y_predict_train for va
residual = np.array([value for nested_array in residual for value in nested_

# prepare dataframe
# >1 predictor --> predicted value VS residual
df_resid = pd.DataFrame({
    'x_axis': y_predict_train,
    'residual': residual
})

# residual plot
sns.scatterplot(data=df_resid, x="x_axis", y="residual")
plt.axhline(0)
plt.show()
```



In [673…
```
# QQplot
from sklearn.preprocessing import StandardScaler

std_resid = StandardScaler().fit_transform(residual.reshape(-1,1))
std_resid = np.array([value for nested_array in std_resid for value in neste

import statsmodels.api as sm
sm.qqplot(std_resid, line='45')
plt.show()
```



Model Evaluation

Training Error

In [674…
```
from sklearn.metrics import r2_score
from sklearn.metrics import mean_squared_error

print('R-squared for training data is {}'.format(r2_score(y_predict_train, y
print('RMSE for training data is {}'.format(np.sqrt(mean_squared_error(y_pre
```

```
R-squared for training data is -0.2276682386607738
RMSE for training data is 41911.72198298404
```

Testing Error

In [675…
```
# prepare prediction result on test data
X_test = feature_test.to_numpy()
```

```
y_predict_test = multi_reg.predict(X_test)

# ground truth target
y_test = target_test.to_numpy()
```

In [676…

```
from sklearn.metrics import mean_squared_error

print('RMSE for testing data is {}'.format(np.sqrt(mean_squared_error(y_tes
```

```
RMSE for testing data is 48214.51938727865
```