Scaler_Clustering_Case_Study

June 30, 2024

1 Exploratory data analysis:

1.0.1 Importing required packages:

[4]:
```
import pandas as pd
import numpy as np
import seaborn as sns
sns.set(style='whitegrid')
from scipy import stats
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings("ignore")
from sklearn.preprocessing import MinMaxScaler
```

1.0.2 Loading data into Dataframe:

[5]:
```
df = pd.read_csv('scaler_clustering.csv')
df
```

[5]:
```
        Unnamed: 0                company_hash  \
0                0              atrgxnnt xzaxv
1                1  qtrxvzwt xzegwgbb rxbxnta
2                2               ojzwnvwnxw vx
3                3                   ngpgutaxv
4                4                  qxen sqghu
…              …                           …
205838      206918                   vuurt xzw
205839      206919                   husqvawgb
205840      206920                    vwwgrxnt
205841      206921              zgn vuurxwvmrt
205842      206922              bgqsvz onvzrtj

                                               email_hash  orgyear      ctc  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c05…   2016.0  1100000
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c10…   2018.0   449999
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e9…   2015.0  2000000
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58…   2017.0   700000
```

```
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520…   2017.0  1400000
…                                                     …     …       …
205838  70027b728c8ee901fe979533ed94ffda97be08fc23f33b…   2008.0   220000
205839  7f7292ffad724ebbe9ca860f515245368d714c84705b42…   2017.0   500000
205840  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c…   2021.0   700000
205841  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c8…   2019.0  5100000
205842  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f…   2014.0  1240000

             job_position  ctc_updated_year
0                   Other            2020.0
1       FullStack Engineer           2019.0
2         Backend Engineer           2020.0
3         Backend Engineer           2019.0
4       FullStack Engineer           2019.0
…                       …               …
205838                NaN            2019.0
205839                NaN            2020.0
205840                NaN            2021.0
205841                NaN            2019.0
205842                NaN            2016.0

[205843 rows x 7 columns]
```

Summary:

- We have 205843 data points, and 7 features. We can drop the column `Unnamed: 0` as it's the row Sr. No.
- Also, our objective is clustering, the **`email_hash`** won't be useful feature as we won't be looking at the granularity of the data, but more focused on groping the data into similar clusters. Hence droping email ids will be useful

[6]:
```
# Creating a copy of original dataframe

df_org = df.copy()
```

1.0.3 Identification of variables and data types:

[7]:
```
df.shape
```

[7]:
```
(205843, 7)
```

[8]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 205843 entries, 0 to 205842
Data columns (total 7 columns):
 #   Column             Non-Null Count   Dtype
---  ------             --------------   -----
```

```
 0   Unnamed: 0        205843 non-null  int64
 1   company_hash      205799 non-null  object
 2   email_hash        205843 non-null  object
 3   orgyear           205757 non-null  float64
 4   ctc               205843 non-null  int64
 5   job_position      153279 non-null  object
 6   ctc_updated_year  205843 non-null  float64
dtypes: float64(2), int64(2), object(3)
memory usage: 11.0+ MB
```

[9]:
```python
def feature_names(df):

    print(f"Columns with category datatypes (Categorical Features) are : \
    {list(df.select_dtypes('object').columns)}")
    print('-'*125)
    print('-'*125)
    print(f"Columns with integer and float datatypes (Numerical Features) are: \
    {list(df.select_dtypes(['int64','float64']).columns)}")
```

[10]:
```python
feature_names(df)
```

```
Columns with category datatypes (Categorical Features) are :
['company_hash', 'email_hash', 'job_position']
--------------------------------------------------------------------------------
---------------------------------------------
--------------------------------------------------------------------------------
---------------------------------------------
Columns with integer and float datatypes (Numerical Features) are:
['Unnamed: 0', 'orgyear', 'ctc', 'ctc_updated_year']
```

1.0.4 Analysing the basic metrics:

[11]:
```python
df.describe(include=[np.number]).transpose()
```

[11]:

	count	mean	std	min	25%
Unnamed: 0	205843.0	1.032739e+05	5.974131e+04	0.0	51518.5
orgyear	205757.0	2.014883e+03	6.357112e+01	0.0	2013.0
ctc	205843.0	2.271685e+06	1.180091e+07	2.0	530000.0
ctc_updated_year	205843.0	2.019628e+03	1.325104e+00	2015.0	2019.0

	50%	75%	max
Unnamed: 0	103151.0	154992.5	2.069220e+05
orgyear	2016.0	2018.0	2.016500e+04
ctc	950000.0	1700000.0	1.000150e+09
ctc_updated_year	2020.0	2021.0	2.021000e+03

[12]:
```python
df.describe(include = [object]).transpose()
```

[12]:
```
                count  unique  \
company_hash  205799   37299
email_hash    205843  153443
job_position  153279    1016

                                                        top   freq
company_hash                        nvnv wgzohrnvzwj otqcxwto   8337
email_hash    bbace3cc586400bbc65765bc6a16b77d8913836cfc98b7…     10
job_position                                 Backend Engineer  43554
```

1.0.5 Missing values:

[13]:
```
# Missing values:

def missingValue(df):
    #Identifying Missing data.
    total_null = df.isnull().sum().sort_values(ascending = False)
    percent = ((df.isnull().sum()/len(df))*100).sort_values(ascending = False)
    print(f"Total records in our data =  {df.shape[0]} where missing values are␣
 ↪as follows:")

    missing_data = pd.concat([total_null,percent.round(2)],axis=1,keys=['Total␣
 ↪Missing','In Percent'])
    return missing_data
```

[14]:
```
missing_df = missingValue(df)
missing_df[missing_df['Total Missing'] > 0]
```

```
Total records in our data =  205843 where missing values are as follows:
```

[14]:

	Total Missing	In Percent
job_position	52564	25.54
orgyear	86	0.04
company_hash	44	0.02

- Total 3 features has missing values (job, year, company)

2 Data Preprocessing

[15]:
```
# We can drop the column `Unnamed: 0` as it's the row Sr. No.
# Also, our objective is clustering, the `email_hash` won't be useful feature
#as we won't be looking at the granularity of the data, but more focused on␣
 ↪groping the data into similar clusters.
# Hence droping email ids will be useful

df.drop(columns = ['Unnamed: 0','email_hash'], inplace = True, axis = 1)
```

[16]:
```python
# Using a regex function for removing special characters

import re
def remove_special (string):
    new_string=re.sub('[^A-Za-z ]+', '', string)
    return new_string
```

[17]:
```python
#what happens here
mystring='\tAirtel\\\\&&**() X Labs'
re.sub('[^A-Za-z ]+', '', mystring)
```

[17]:
```
'Airtel X Labs'
```

[18]:
```python
# Data Cleaning on job_position

df.job_position=df.job_position.apply(lambda x: remove_special(str(x)))
df.job_position=df.job_position.apply(lambda x: x.lower())
df.job_position=df.job_position.apply(lambda x: x.strip())
df.job_position
```

[18]:
```
0                       other
1          fullstack engineer
2            backend engineer
3            backend engineer
4          fullstack engineer
                 …
205838                    nan
205839                    nan
205840                    nan
205841                    nan
205842                    nan
Name: job_position, Length: 205843, dtype: object
```

[19]:
```python
df.shape
```

[19]:
```
(205843, 5)
```

[20]:
```python
df.drop_duplicates(inplace=True)
df.shape
```

[20]:
```
(188246, 5)
```

[21]:
```python
df['company_hash'].value_counts().sort_index()
```

[21]:
```
company_hash
0                                  2
0000                               1
```

```
01 ojztqsj                      2
05mz exzytvrny uqxcvnt rxbxnta  2
1                               2
                               ..
zyvzwt wgzohrnxzs tzsxzttqo     1
zz                              2
zzb ztdnstz vacxogqj ucn rna    2
zzgato                          1
zzzbzb                          1
Name: count, Length: 37299, dtype: int64
```

[22]:
```
# Data Cleaning on company_hash

df.company_hash=df.company_hash.apply(lambda x: remove_special(str(x)))
df.company_hash=df.company_hash.apply(lambda x: x.lower())
df.company_hash=df.company_hash.apply(lambda x: x.strip())
df.company_hash
```

[22]:
```
0                     atrgxnnt xzaxv
1          qtrxvzwt xzegwgbb rxbxnta
2                      ojzwnvwnxw vx
3                          ngpgutaxv
4                         qxen sqghu
                     …
205838                     vuurt xzw
205839                     husqvawgb
205840                      vwwgrxnt
205841                zgn vuurxwvmrt
205842                bgqsvz onvzrtj
Name: company_hash, Length: 188246, dtype: object
```

[23]:
```
df['company_hash'].value_counts().sort_index()
```

[23]:
```
company_hash
                                                 85
a                                                 1
a b onttr wgqu                                    1
a j uvnxr owyggr ge tzsxzttqxzs vwvatbj vbmx      1
a ntwy ogrhnxgzo ucn rna                          2
                                                 ..
zz                                                2
zz wgzztwn mya                                    1
zzb ztdnstz vacxogqj ucn rna                      2
zzgato                                            1
zzzbzb                                            1
Name: count, Length: 37208, dtype: int64
```

[24]:
```python
print(df.shape)
print(df.drop_duplicates().shape)
df.drop_duplicates(inplace=True)
```

```
(188246, 5)
(188245, 5)
```

[25]:
```python
#removing rows where company or job_position is not available

df=df[ ~((df['company_hash']=='') | (df['job_position']==''))]
```

[26]:
```python
df.shape
```

[26]:
```
(188152, 5)
```

[27]:
```python
df['orgyear'].isnull().sum()
```

[27]:
```
86
```

[28]:
```python
company_median_org_year=df.groupby('company_hash')['orgyear'].median()
company_median_org_year
```

[28]:
```
company_hash
a                                               2017.0
a b onttr wgqu                                  2019.0
a j uvnxr owyggr ge tzsxzttqxzs vwvatbj vbmx    2015.0
a ntwy ogrhnxgzo ucn rna                        2013.0
a ntwyzgrgsxto                                  2015.0
                                                 …
zz                                              2011.0
zz wgzztwn mya                                  2009.0
zzb ztdnstz vacxogqj ucn rna                    2017.0
zzgato                                          2014.0
zzzbzb                                          1990.0
Name: orgyear, Length: 37205, dtype: float64
```

[29]:
```python
#Code to impute
def null_imputation(table_from_which_we_need_to_fill, main_col, null_col):
    if np.isnan(null_col):
        return table_from_which_we_need_to_fill[main_col]
    else:
        return null_col
```

[30]:
```python
# Filling Null values using Median Target Imputation for Orgyear
```

```
df['orgyear']=df.apply(lambda x:␣
↪null_imputation(company_median_org_year,x['company_hash'],x['orgyear'] ),␣
↪axis=1)
df['orgyear']
```

[30]:
```
0         2016.0
1         2018.0
2         2015.0
3         2017.0
4         2017.0
           …
205838    2008.0
205839    2017.0
205840    2021.0
205841    2019.0
205842    2014.0
Name: orgyear, Length: 188152, dtype: float64
```

[31]:
```
#if we still have null values, we'll drop it

len(df[df['orgyear'].isnull()])
```

[31]:
```
26
```

[32]:
```
#dropping remaining null values
df=df[~df['orgyear'].isnull()]
```

[33]:
```
missing_df = missingValue(df)
missing_df[missing_df['Total Missing'] > 0]
```

```
Total records in our data =  188126 where missing values are as follows:
```

[33]:
```
Empty DataFrame
Columns: [Total Missing, In Percent]
Index: []
```

3 Outlier Detection and Treatment

- orgyear
- ctc

[34]:
```
#simple understanding
df.orgyear.value_counts().sort_values(ascending=True)
```

[34]:
```
orgyear
200.0       1
2011.5      1
```

```
1900.0       1
208.0        1
2204.0       1
           …
2019.0    18550
2015.0    19613
2017.0    21320
2016.0    21477
2018.0    22157
Name: count, Length: 79, dtype: int64
```

[35]:
```
#simple understanding
df.ctc.value_counts().sort_values(ascending=True)
```

[35]:
```
ctc
1916000      1
2664000      1
28200        1
983000       1
516000       1
            …
1200000     5623
500000      5661
800000      5917
1000000     6835
600000      6857
Name: count, Length: 3360, dtype: int64
```

[36]:
```
#removing outliers from orgyear using IQR

q1=df.orgyear.quantile(0.25)
q3=df.orgyear.quantile(0.75)
iqr=q3-q1
df=df.loc[(df.orgyear>=q1-1.5*iqr) & (df.orgyear<=q3+1.5*iqr)]

#removing outliers from ctc using IQR

q1=df.ctc.quantile(0.25)
q3=df.ctc.quantile(0.75)
iqr=q3-q1
df=df.loc[(df.ctc>=q1-1.5*iqr) & (df.ctc<=q3+1.5*iqr)]
```

[37]:
```
df.orgyear.value_counts().sort_index(ascending=True)
```

[37]:
```
orgyear
2006.0      1635
2007.0      1821
```

```
2008.0     2279
2009.0     3215
2010.0     5004
2011.0     7023
2011.5        1
2012.0     9366
2013.0    11134
2014.0    15090
2014.5        2
2015.0    18535
2016.0    20394
2017.0    20421
2018.0    21335
2019.0    17909
2020.0     9940
2021.0     2900
2022.0      739
2023.0      200
2024.0       32
2025.0       11
Name: count, dtype: int64
```

[38]:

```
print(df.shape)
print(df.drop_duplicates().shape)
df.drop_duplicates(inplace=True)
```

```
(168986, 5)
(168985, 5)
```

[39]:

```
df
```

[39]:

```
                     company_hash  orgyear      ctc        job_position  \
0                  atrgxnnt xzaxv   2016.0  1100000               other
1        qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                   ojzwnvwnxw vx   2015.0  2000000    backend engineer
3                       ngpgutaxv   2017.0   700000    backend engineer
4                      qxen sqghu   2017.0  1400000  fullstack engineer
…                               …       …        …                   …
205836                  mvqwrvjo   2011.0  2250000                 nan
205838                  vuurt xzw   2008.0   220000                 nan
205839                  husqvawgb   2017.0   500000                 nan
205840                   vwwgrxnt   2021.0   700000                 nan
205842             bgqsvz onvzrtj   2014.0  1240000                 nan

        ctc_updated_year
0                 2020.0
1                 2019.0
```

```
2                  2020.0
3                  2019.0
4                  2019.0
…                    …
205836             2019.0
205838             2019.0
205839             2020.0
205840             2021.0
205842             2016.0

[168985 rows x 5 columns]
```

[40]:
```python
#We see some 'nan's in job_position
df.loc[df['job_position']=='nan','job_position']=np.nan
```

[41]:
```python
df
```

[41]:
```
                     company_hash  orgyear      ctc        job_position  \
0                 atrgxnnt xzaxv   2016.0  1100000               other
1        qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                   ojzwnvwnxw vx   2015.0  2000000    backend engineer
3                      ngpgutaxv   2017.0   700000    backend engineer
4                     qxen sqghu   2017.0  1400000  fullstack engineer
…                            …       …        …                 …
205836                  mvqwrvjo   2011.0  2250000                 NaN
205838                 vuurt xzw   2008.0   220000                 NaN
205839                 husqvawgb   2017.0   500000                 NaN
205840                  vwwgrxnt   2021.0   700000                 NaN
205842            bgqsvz onvzrtj   2014.0  1240000                 NaN

        ctc_updated_year
0                 2020.0
1                 2019.0
2                 2020.0
3                 2019.0
4                 2019.0
…                   …
205836            2019.0
205838            2019.0
205839            2020.0
205840            2021.0
205842            2016.0

[168985 rows x 5 columns]
```

[42]:
```python
feature_names(df)
```

```
Columns with category datatypes (Categorical Features) are :
['company_hash', 'job_position']
--------------------------------------------------------------------------------
---------------------------------------------
--------------------------------------------------------------------------------
---------------------------------------------
Columns with integer and float datatypes (Numerical Features) are:
['orgyear', 'ctc', 'ctc_updated_year']
```

[43]:

```
def numerical_feat(df,colname,nrows=2,mcols=2,width=15,height=15):
    fig , ax = plt.subplots(nrows,mcols,figsize=(width,height))
    fig.set_facecolor("lightgrey")
    rows = 0
    for var in colname:
        ax[rows][0].set_title("Boxplot for Outlier Detection ",␣
 ↪fontweight="bold")
        plt.ylabel(var, fontsize=12)
        sns.boxplot(y = df[var],color='crimson',ax=ax[rows][0])

        # plt.subplot(nrows,mcols,pltcounter+1)
        sns.distplot(df[var],color='purple',ax=ax[rows][1])
        ax[rows][1].axvline(df[var].mean(), color='r', linestyle='--',␣
 ↪label="Mean")
        ax[rows][1].axvline(df[var].median(), color='m', linestyle='-',␣
 ↪label="Median")
        ax[rows][1].axvline(df[var].mode()[0], color='royalblue',␣
 ↪linestyle='-', label="Mode")
        ax[rows][1].set_title("Outlier Detection ", fontweight="bold")
        ax[rows][1].legend({'Mean':df[var].mean(),'Median':df[var].
 ↪median(),'Mode':df[var].mode()})
        rows += 1
    plt.show()
```

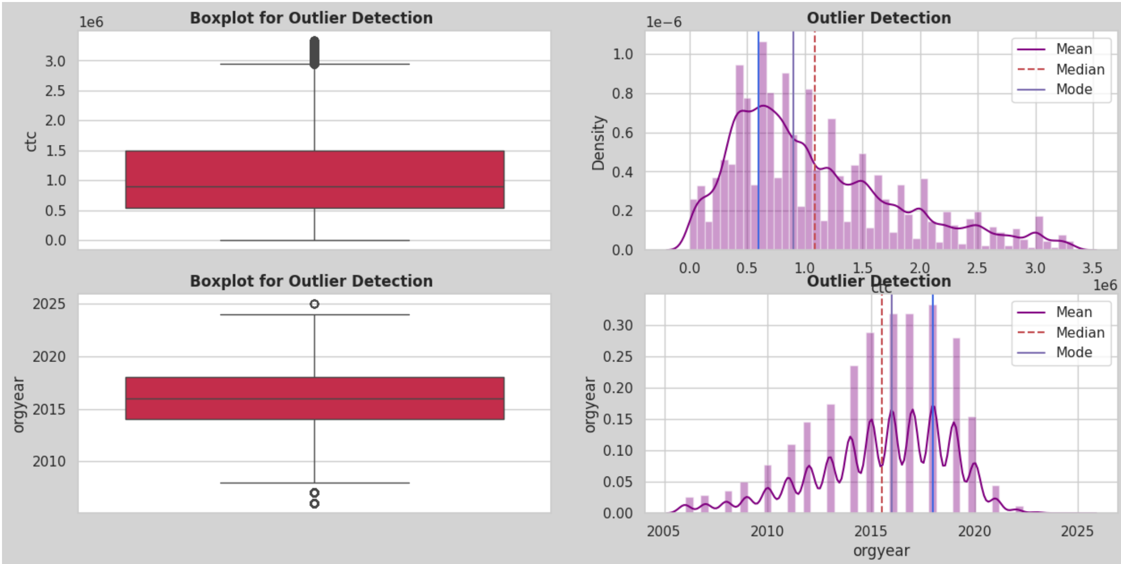
[44]:

```
# We won't consider 'ctc_updated_year' as numerical but istead categorical␣
 ↪features

numerical_cols = ['ctc', 'orgyear']
```

[45]:

```
numerical_feat(df,numerical_cols,len(numerical_cols),2,15,7)
```



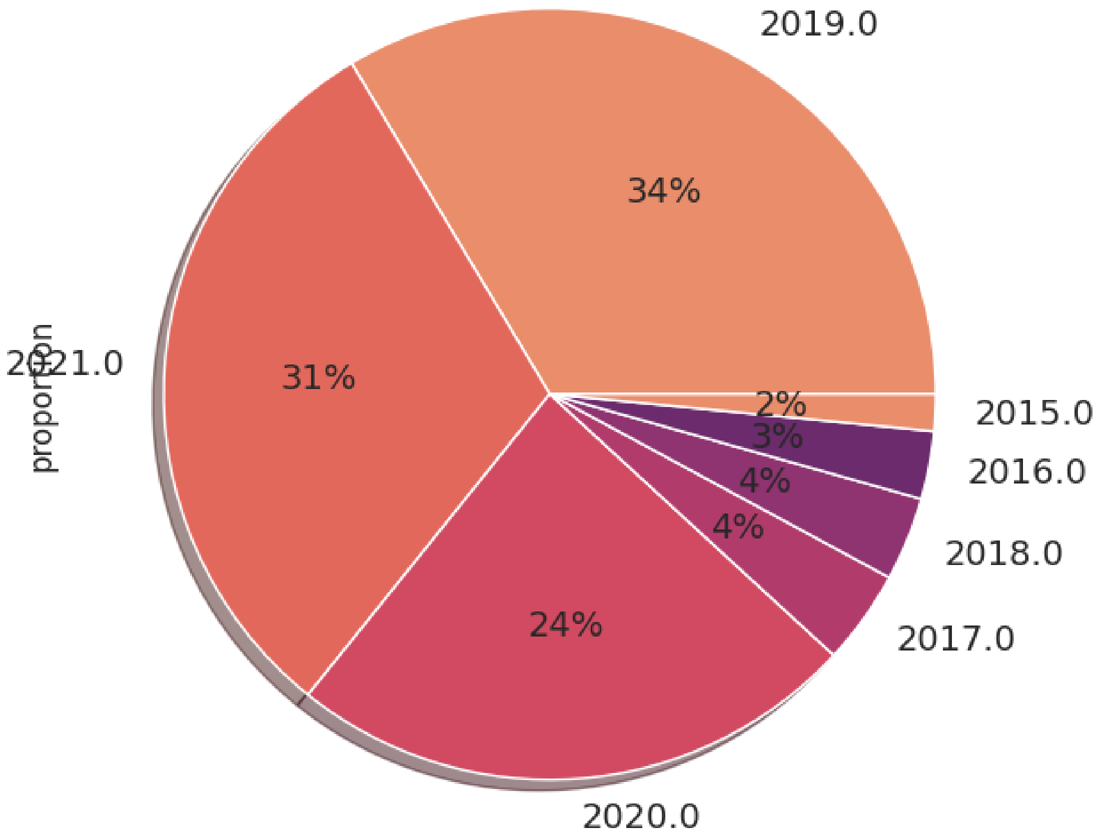
[46]:
```
categorical_cols = ['company_hash', 'job_position', 'ctc_updated_year']
```

[47]:
```
for i in categorical_cols:
    print(f" Unique values in {i} are {df[i].nunique()}")
```

```
Unique values in company_hash are 34008
Unique values in job_position are 761
Unique values in ctc_updated_year are 7
```

[48]:
```
# categorical_cols = ['ctc_updated_year']
```

[49]:
```
plt.figure(figsize = (7,8))
count = (df['ctc_updated_year'].value_counts(normalize=True)*100)
count.plot.pie(colors = sns.color_palette("flare"),autopct='%0.0f%%',
                        textprops={'fontsize': 14},shadow = True)
plt.show()
```



4 Feature Engineering:

4.0.1 Definition:

- 1. Designation: Salary an employee is getting wrt salary in the same Company, Job_Position & Years of Experience
- 2. Class: Salary an employee is getting wrt the salary in the same Company & Job_Position
- 3. Tier: Salary an employee is getting wrt the salary in the same Company

[50]:
```
# ![image.png](attachment:image.png)
df.company_hash.value_counts()
```

[50]:
```
company_hash
nvnv wgzohrnvzwj otqcxwto          4111
xzegojo                            2910
```

```
vbvkgz                                   2226
wgszxkvzn                                2115
vwwtznhqt                                1998
                                         …
wrjbxz ogenrvmo                             1
vsxrtmgn vhngbvnxgz uqxcvnt rxbxnta         1
whbhrho ztnfgqp                             1
utznvhq ntwy                                1
zxzlv cvz                                   1
Name: count, Length: 34008, dtype: int64
```

•

[51]:
```
df.company_hash.value_counts() <= 5
```

[51]:
```
company_hash
nvnv wgzohrnvzwj otqcxwto              False
xzegojo                                False
vbvkgz                                 False
wgszxkvzn                              False
vwwtznhqt                              False
                                       …
wrjbxz ogenrvmo                         True
vsxrtmgn vhngbvnxgz uqxcvnt rxbxnta     True
whbhrho ztnfgqp                         True
utznvhq ntwy                            True
zxzlv cvz                               True
Name: count, Length: 34008, dtype: bool
```

[52]:
```
df.company_hash.map(df.company_hash.value_counts()) <= 5
```

[52]:
```
0         False
1         False
2          True
3         False
4         False
          …
205836    False
205838    False
205839    False
205840    False
205842    False
Name: company_hash, Length: 168985, dtype: bool
```

[53]:
```
df[df.company_hash.map(df.company_hash.value_counts())<=5]
```

[53]:

```
                   company_hash  orgyear      ctc           job_position  \
2                ojzwnvwnxw vx   2015.0  2000000       backend engineer
9                       xrbhd   2019.0   360000                    NaN
11                 ngdor ntwy   2016.0   600000           ios engineer
16         pnw xzaxv ucn rna   2013.0   800000                  other
21                axgz srgmvr   2006.0  1550000 engineering leadership
…                          …      …       …                      …
205811    mrht onvnt axsxnvr   2013.0    85000                    NaN
205815  bvptbjnqxu td vbvkgz   2015.0  2400000                    NaN
205816    wgat ergf ntwy rru   2019.0  2200000                    NaN
205817         wxowg ojntbo   2011.0  3327000                    NaN
205834 wyvqntq wgbbhzxwvnxgzo   2020.0   100000                    NaN

        ctc_updated_year
2                 2020.0
9                 2019.0
11                2021.0
16                2020.0
21                2019.0
…                    …
205811            2016.0
205815            2019.0
205816            2020.0
205817            2019.0
205834            2019.0

[46749 rows x 5 columns]
```

[54]:

```python
df['new']=df.company_hash.mask(df.company_hash.map(df.company_hash.
 ↪value_counts())<=5)
df['new']
```

[54]:

```
0                     atrgxnnt xzaxv
1          qtrxvzwt xzegwgbb rxbxnta
2                                NaN
3                          ngpgutaxv
4                         qxen sqghu
                     …
205836                      mvqwrvjo
205838                     vuurt xzw
205839                     husqvawgb
205840                      vwwgrxnt
205842                bgqsvz onvzrtj
Name: new, Length: 168985, dtype: object
```

[55]:

```python
df
```

[55]:
```
                     company_hash  orgyear      ctc        job_position  \
0                atrgxnnt xzaxv   2016.0  1100000               other
1        qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                  ojzwnvwnxw vx   2015.0  2000000    backend engineer
3                      ngpgutaxv   2017.0   700000    backend engineer
4                     qxen sqghu   2017.0  1400000  fullstack engineer
…                            …      …        …                 …
205836                  mvqwrvjo   2011.0  2250000                 NaN
205838                 vuurt xzw   2008.0   220000                 NaN
205839                 husqvawgb   2017.0   500000                 NaN
205840                  vwwgrxnt   2021.0   700000                 NaN
205842            bgqsvz onvzrtj   2014.0  1240000                 NaN

        ctc_updated_year                        new
0                 2020.0             atrgxnnt xzaxv
1                 2019.0  qtrxvzwt xzegwgbb rxbxnta
2                 2020.0                        NaN
3                 2019.0                  ngpgutaxv
4                 2019.0                 qxen sqghu
…                    …                          …
205836            2019.0                   mvqwrvjo
205838            2019.0                  vuurt xzw
205839            2020.0                  husqvawgb
205840            2021.0                   vwwgrxnt
205842            2016.0             bgqsvz onvzrtj

[168985 rows x 6 columns]
```

[56]:
```python
df[df['new']=='Others'].company_hash.value_counts()
```

[56]:
```
Series([], Name: count, dtype: int64)
```

[57]:
```python
df=df.apply(lambda x: x.mask(x.map(x.value_counts())<=5,'Others') if x.
 ↪name=='company_hash' else x)
df
```

[57]:
```
                     company_hash  orgyear      ctc        job_position  \
0                atrgxnnt xzaxv   2016.0  1100000               other
1        qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                         Others   2015.0  2000000    backend engineer
3                      ngpgutaxv   2017.0   700000    backend engineer
4                     qxen sqghu   2017.0  1400000  fullstack engineer
…                            …      …        …                 …
205836                  mvqwrvjo   2011.0  2250000                 NaN
205838                 vuurt xzw   2008.0   220000                 NaN
205839                 husqvawgb   2017.0   500000                 NaN
205840                  vwwgrxnt   2021.0   700000                 NaN
```

```
205842             bgqsvz onvzrtj   2014.0  1240000                 NaN

        ctc_updated_year                             new
0                 2020.0                 atrgxnnt xzaxv
1                 2019.0  qtrxvzwt xzegwgbb rxbxnta
2                 2020.0                            NaN
3                 2019.0                      ngpgutaxv
4                 2019.0                     qxen sqghu
…                    …                              …
205836            2019.0                       mvqwrvjo
205838            2019.0                      vuurt xzw
205839            2020.0                      husqvawgb
205840            2021.0                       vwwgrxnt
205842            2016.0                 bgqsvz onvzrtj

[168985 rows x 6 columns]
```

[58]:
```python
df.company_hash.value_counts()
```

[58]:
```
company_hash
Others                                   46749
nvnv wgzohrnvzwj otqcxwto                 4111
xzegojo                                   2910
vbvkgz                                    2226
wgszxkvzn                                 2115
                                          …
ihvrwgbb xzw                                 6
lxgovvcz                                     6
vrsgfgqpo ntwyzgrgsxto                       6
wvbuhotvx                                    6
xzntr ntwyzgrgsj xzaxv uqxcvnt rxbxnta       6
Name: count, Length: 2943, dtype: int64
```

[59]:
```python
df.drop(columns='new',inplace=True)
```

-

[60]:
```python
df.drop_duplicates(inplace=True)
df.shape
```

[60]: (147139, 5)

[61]:
```python
#orgyear check
df['orgyear'] = df.apply(lambda x: x['orgyear'] if x['orgyear'] <= 2022 else␣
↪2022, axis=1)
```

[62]:
```
df['years_of_experience']=2022-df['orgyear']
```

[63]:
```
df.drop_duplicates(inplace=True)
df.shape
```

[63]:
```
(147100, 6)
```

[64]:
```
df=df[~df['years_of_experience'].isnull()]
```

[65]:
```
#ctc_updated_year_check
df['ctc_updated_year'] = df.apply(lambda x: x['orgyear'] if␣
↪x['ctc_updated_year'] < x['orgyear'] else x['ctc_updated_year'], axis=1)
df
```

[65]:
```
                      company_hash  orgyear      ctc        job_position  \
0                   atrgxnnt xzaxv   2016.0  1100000               other
1          qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                           Others   2015.0  2000000    backend engineer
3                        ngpgutaxv   2017.0   700000    backend engineer
4                       qxen sqghu   2017.0  1400000  fullstack engineer
…                              …        …        …                 …
205836                    mvqwrvjo   2011.0  2250000                 NaN
205838                   vuurt xzw   2008.0   220000                 NaN
205839                   husqvawgb   2017.0   500000                 NaN
205840                    vwwgrxnt   2021.0   700000                 NaN
205842              bgqsvz onvzrtj   2014.0  1240000                 NaN

        ctc_updated_year  years_of_experience
0                 2020.0                  6.0
1                 2019.0                  4.0
2                 2020.0                  7.0
3                 2019.0                  5.0
4                 2019.0                  5.0
…                   …                   …
205836            2019.0                 11.0
205838            2019.0                 14.0
205839            2020.0                  5.0
205840            2021.0                  1.0
205842            2016.0                  8.0

[147100 rows x 6 columns]
```

[66]:
```
#Filling null values with others -- if not done before
df['job_position'] = df['job_position'].fillna('Others')
df['company_hash'] = df['company_hash'].fillna('Others')
```

[67]:
```
missingValue(df)
```

Total records in our data = 147100 where missing values are as follows:

[67]:

	Total Missing	In Percent
company_hash	0	0.0
orgyear	0	0.0
ctc	0	0.0
job_position	0	0.0
ctc_updated_year	0	0.0
years_of_experience	0	0.0

[68]:
```
df.drop_duplicates(inplace=True)
df.shape
```

[68]: (146052, 6)

[69]:
```
df.describe()
```

[69]:

	orgyear	ctc	ctc_updated_year	years_of_experience
count	146052.000000	1.460520e+05	146052.000000	146052.000000
mean	2015.449384	1.129332e+06	2019.598444	6.550616
std	3.300262	7.439639e+05	1.339107	3.300262
min	2006.000000	2.000000e+00	2015.000000	0.000000
25%	2013.000000	5.700000e+05	2019.000000	4.000000
50%	2016.000000	9.600000e+05	2020.000000	6.000000
75%	2018.000000	1.560000e+06	2021.000000	9.000000
max	2022.000000	3.330000e+06	2022.000000	16.000000

4.0.2 Manual Clustering based on company, job position and years of experience

[70]:
```
grouped_c_j_y=df.
↪groupby(['years_of_experience','job_position','company_hash'])['ctc'].
↪describe()
```

[71]:
```
grouped_c_j_y
```

[71]:
```
                                                                 count  \
years_of_experience job_position     company_hash
0.0                 Others           Others                       42.0
                                     agzn fgqp xz vzj gqsvzxkvnxgz   1.0
                                     atrgxnnt                        1.0
                                     atrr                            1.0
                                     atrr ntwyzgrgsxto               2.0
…                                                                  …
16.0                support engineer xzegojo                         1.0
```

```
                                  xzegq                           1.0
                                  ywr ntwyzgrgsxto                2.0
                                  zvz                             1.0
                 team lead        utqoxontzn ojontbo              1.0

                                                                        mean  \
years_of_experience job_position     company_hash
0.0                 Others           Others                       7.058619e+05
                                     agzn fgqp xz vzj gqsvzxkvnxgz  1.600000e+06
                                     atrgxnnt                     1.000000e+06
                                     atrr                         1.000000e+06
                                     atrr ntwyzgrgsxto            1.000000e+06
…                                                                          …
16.0                support engineer xzegojo                      8.000000e+05
                                     xzegq                        9.000000e+05
                                     ywr ntwyzgrgsxto             8.500000e+05
                                     zvz                          4.000000e+05
                    team lead        utqoxontzn ojontbo           1.600000e+06

std  \
years_of_experience job_position     company_hash
0.0                 Others           Others
674812.642666
                                     agzn fgqp xz vzj gqsvzxkvnxgz
NaN
                                     atrgxnnt
NaN
                                     atrr
NaN
                                     atrr ntwyzgrgsxto
282842.712475
…
…
16.0                support engineer xzegojo
NaN
                                     xzegq
NaN
                                     ywr ntwyzgrgsxto
494974.746831
                                     zvz
NaN
                    team lead        utqoxontzn ojontbo
NaN

                                                                       min  \
years_of_experience job_position     company_hash
```

```
0.0                Others           Others                       200.0
                                    agzn fgqp xz vzj gqsvzxkvnxgz  1600000.0
                                    atrgxnnt                     1000000.0
                                    atrr                         1000000.0
                                    atrr ntwyzgrgsxto             800000.0
…                                                                   …
16.0               support engineer xzegojo                      800000.0
                                    xzegq                        900000.0
                                    ywr ntwyzgrgsxto             500000.0
                                    zvz                          400000.0
                   team lead        utqoxontzn ojontbo          1600000.0

                                                                     25%  \
years_of_experience job_position     company_hash
0.0                Others           Others                       227500.0
                                    agzn fgqp xz vzj gqsvzxkvnxgz  1600000.0
                                    atrgxnnt                     1000000.0
                                    atrr                         1000000.0
                                    atrr ntwyzgrgsxto             900000.0
…                                                                   …
16.0               support engineer xzegojo                      800000.0
                                    xzegq                        900000.0
                                    ywr ntwyzgrgsxto             675000.0
                                    zvz                          400000.0
                   team lead        utqoxontzn ojontbo          1600000.0

                                                                     50%  \
years_of_experience job_position     company_hash
0.0                Others           Others                       490000.0
                                    agzn fgqp xz vzj gqsvzxkvnxgz  1600000.0
                                    atrgxnnt                     1000000.0
                                    atrr                         1000000.0
                                    atrr ntwyzgrgsxto            1000000.0
…                                                                   …
16.0               support engineer xzegojo                      800000.0
                                    xzegq                        900000.0
                                    ywr ntwyzgrgsxto             850000.0
                                    zvz                          400000.0
                   team lead        utqoxontzn ojontbo          1600000.0

                                                                     75%
\
years_of_experience job_position     company_hash
0.0                Others           Others                      1014999.25
                                    agzn fgqp xz vzj gqsvzxkvnxgz  1600000.00
                                    atrgxnnt                    1000000.00
                                    atrr                        1000000.00
```

```
                                   atrr ntwyzgrgsxto            1100000.00
…                                                                     …
16.0                support engineer xzegojo                     800000.00
                                     xzegq                       900000.00
                                     ywr ntwyzgrgsxto           1025000.00
                                     zvz                         400000.00
                    team lead        utqoxontzn ojontbo         1600000.00

                                                                      max
years_of_experience job_position     company_hash
0.0                 Others           Others                     3000000.0
                                     agzn fgqp xz vzj gqsvzxkvnxgz  1600000.0
                                     atrgxnnt                   1000000.0
                                     atrr                       1000000.0
                                     atrr ntwyzgrgsxto          1200000.0
…                                                                    …
16.0                support engineer xzegojo                     800000.0
                                     xzegq                       900000.0
                                     ywr ntwyzgrgsxto           1200000.0
                                     zvz                         400000.0
                    team lead        utqoxontzn ojontbo         1600000.0

[56095 rows x 8 columns]
```

[72]:
```python
df_cjy=df.merge(grouped_c_j_y,
 on=['years_of_experience','job_position','company_hash'], how = 'left')
df_cjy
```

[72]:
```
                    company_hash  orgyear      ctc        job_position  \
0                 atrgxnnt xzaxv   2016.0  1100000               other
1       qtrxvzwt xzegwgbb rxbxnta  2018.0   449999  fullstack engineer
2                         Others   2015.0  2000000    backend engineer
3                      ngpgutaxv   2017.0   700000    backend engineer
4                    qxen sqghu    2017.0  1400000  fullstack engineer
…                             …       …       …                   …
146047                  mvqwrvjo   2011.0  2250000              Others
146048                 vuurt xzw   2008.0   220000              Others
146049                 husqvawgb   2017.0   500000              Others
146050                  vwwgrxnt   2021.0   700000              Others
146051            bgqsvz onvzrtj   2014.0  1240000              Others

        ctc_updated_year  years_of_experience  count          mean  \
0                 2020.0                  6.0    1.0  1.100000e+06
1                 2019.0                  4.0    7.0  7.742856e+05
2                 2020.0                  7.0  456.0  9.609559e+05
3                 2019.0                  5.0    7.0  1.158571e+06
4                 2019.0                  5.0    1.0  1.400000e+06
```

```
…                 …                   …    …           …
146047           2019.0                 11.0   11.0  1.427273e+06
146048           2019.0                 14.0    1.0  2.200000e+05
146049           2020.0                  5.0    4.0  1.202500e+06
146050           2021.0                  1.0    3.0  6.666667e+05
146051           2016.0                  8.0    9.0  1.693333e+06

                  std        min        25%        50%        75%        max
0                 NaN  1100000.0  1100000.0  1100000.0  1100000.0  1100000.0
1       250922.324350   449999.0   610000.0   750000.0   900000.0  1200000.0
2       776546.830662     1000.0   307500.0   800000.0  1435000.0  3200000.0
3       404780.951933   700000.0   825000.0  1200000.0  1405000.0  1750000.0
4                 NaN  1400000.0  1400000.0  1400000.0  1400000.0  1400000.0
…                 …          …         …          …          …         …
146047  468638.192678   530000.0  1250000.0  1350000.0  1634999.5  2250000.0
146048            NaN   220000.0   220000.0   220000.0   220000.0   220000.0
146049  471902.179129   500000.0  1145000.0  1405000.0  1462500.0  1500000.0
146050  351188.458428   300000.0   500000.0   700000.0   850000.0  1000000.0
146051  348425.027804  1200000.0  1500000.0  1700000.0  1900000.0  2200000.0

[146052 rows x 14 columns]
```

[73]:
```python
df_cjy.sort_values(['years_of_experience','job_position','company_hash'])
```

[73]:
```
                company_hash  orgyear      ctc      job_position  \
896                   Others   2022.0   120000            Others
2599                  Others   2022.0   430000            Others
7691                  Others   2022.0   570000            Others
7870                  Others   2022.0   550000            Others
8789                  Others   2022.0   680000            Others
…                        …        …       …                …
73608                  xzegq   2006.0   900000  support engineer
11355       ywr ntwyzgrgsxto   2006.0   500000  support engineer
37161       ywr ntwyzgrgsxto   2006.0  1200000  support engineer
14265                    zvz   2006.0   400000  support engineer
59644  utqoxontzn ojontbo   2006.0  1600000         team lead

       ctc_updated_year  years_of_experience  count          mean  \
896              2022.0                  0.0   42.0  7.058619e+05
2599             2022.0                  0.0   42.0  7.058619e+05
7691             2022.0                  0.0   42.0  7.058619e+05
7870             2022.0                  0.0   42.0  7.058619e+05
8789             2022.0                  0.0   42.0  7.058619e+05
…                    …                   …     …           …
73608            2021.0                 16.0    1.0  9.000000e+05
11355            2021.0                 16.0    2.0  8.500000e+05
37161            2021.0                 16.0    2.0  8.500000e+05
```

```
14265            2021.0                 16.0     1.0  4.000000e+05
59644            2021.0                 16.0     1.0  1.600000e+06

                 std        min        25%        50%         75%        max
896    674812.642666      200.0   227500.0   490000.0  1014999.25  3000000.0
2599   674812.642666      200.0   227500.0   490000.0  1014999.25  3000000.0
7691   674812.642666      200.0   227500.0   490000.0  1014999.25  3000000.0
7870   674812.642666      200.0   227500.0   490000.0  1014999.25  3000000.0
8789   674812.642666      200.0   227500.0   490000.0  1014999.25  3000000.0
…                …          …          …          …           …          …
73608            NaN   900000.0   900000.0   900000.0   900000.00   900000.0
11355  494974.746831   500000.0   675000.0   850000.0  1025000.00  1200000.0
37161  494974.746831   500000.0   675000.0   850000.0  1025000.00  1200000.0
14265            NaN   400000.0   400000.0   400000.0   400000.00   400000.0
59644            NaN  1600000.0  1600000.0  1600000.0  1600000.00  1600000.0

[146052 rows x 14 columns]
```

[74]:

```python
df_cjy.drop_duplicates(inplace=True)
df_cjy.shape
#no change till now
```

[74]: (146052, 14)

•

[75]:

```python
def condition_designation(a,b_50,b_75):
    if a<b_50:
        return 3
    elif a>=b_50 and a<=b_75:
        return 2
    elif a>=b_75:
        return 1
```

[76]:

```python
df.head()
```

[76]:

```
                company_hash  orgyear      ctc        job_position  \
0             atrgxnnt xzaxv   2016.0  1100000               other
1  qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                     Others   2015.0  2000000    backend engineer
3                  ngpgutaxv   2017.0   700000    backend engineer
4                 qxen sqghu   2017.0  1400000  fullstack engineer

   ctc_updated_year  years_of_experience
0            2020.0                  6.0
```

```
1            2019.0                    4.0
2            2020.0                    7.0
3            2019.0                    5.0
4            2019.0                    5.0
```

[77]:
```
df_cjy['designation'] =df_cjy.apply(lambda x:␣
↪condition_designation(x['ctc'],x['50%'],x['75%']),axis = 1)
```

[78]:
```
df_cjy.head()
```

[78]:
```
                  company_hash  orgyear      ctc          job_position  \
0               atrgxnnt xzaxv   2016.0  1100000                 other
1  qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                       Others   2015.0  2000000    backend engineer
3                    ngpgutaxv   2017.0   700000    backend engineer
4                   qxen sqghu   2017.0  1400000  fullstack engineer

   ctc_updated_year  years_of_experience  count          mean            std  \
0            2020.0                  6.0    1.0  1.100000e+06            NaN
1            2019.0                  4.0    7.0  7.742856e+05  250922.324350
2            2020.0                  7.0  456.0  9.609559e+05  776546.830662
3            2019.0                  5.0    7.0  1.158571e+06  404780.951933
4            2019.0                  5.0    1.0  1.400000e+06            NaN

         min        25%        50%        75%        max  designation
0  1100000.0  1100000.0  1100000.0  1100000.0  1100000.0            2
1   449999.0   610000.0   750000.0   900000.0  1200000.0            3
2     1000.0   307500.0   800000.0  1435000.0  3200000.0            1
3   700000.0   825000.0  1200000.0  1405000.0  1750000.0            3
4  1400000.0  1400000.0  1400000.0  1400000.0  1400000.0            2
```

[79]:
```
df_cjy.shape
```

[79]:
```
(146052, 15)
```

[80]:
```
df_cjy.designation.value_counts(normalize=True)*100
```

[80]:
```
designation
2    44.118533
3    34.180977
1    21.700490
Name: proportion, dtype: float64
```

4.0.3 Manual Clustering based on company and job position

[81]:
```
grouped_c_j=df.groupby(['job_position','company_hash'])['ctc'].describe()
```

[82]:
```
grouped_c_j
```

[82]:
```
                                                                 count  \
job_position          company_hash
Others                Others                                    3159.0
                      a ntwyzgrgsxto                               5.0
                      aaqxctz avnv owxtzwto  vzvrjnxwo ucn rna     1.0
                      adw ntwyzgrgsj                              59.0
                      adw ntwyzgrgsxto                            37.0
…                                                                  …
wordpress developer   Others                                       1.0
worker                zgn vuurxwvmrt vwwghzn                       1.0
x                     Others                                       1.0
young professional ii sgctqzbtzn ge xzaxv                          1.0
zomato                kgbvng                                       1.0

                                                                        mean  \
job_position          company_hash
Others                Others                                    1.025099e+06
                      a ntwyzgrgsxto                            6.750000e+05
                      aaqxctz avnv owxtzwto  vzvrjnxwo ucn rna  5.000000e+05
                      adw ntwyzgrgsj                            6.451864e+05
                      adw ntwyzgrgsxto                          6.230000e+05
…                                                                        …
wordpress developer   Others                                    6.000000e+05
worker                zgn vuurxwvmrt vwwghzn                    2.000000e+05
x                     Others                                    4.000000e+05
young professional ii sgctqzbtzn ge xzaxv                       5.000000e+05
zomato                kgbvng                                    5.000000e+05

                                                                          std  \
job_position          company_hash
Others                Others                                    837191.520717
                      a ntwyzgrgsxto                            389711.431703
                      aaqxctz avnv owxtzwto  vzvrjnxwo ucn rna            NaN
                      adw ntwyzgrgsj                            449039.606370
                      adw ntwyzgrgsxto                          323412.705035
…                                                                         …
wordpress developer   Others                                              NaN
worker                zgn vuurxwvmrt vwwghzn                              NaN
x                     Others                                              NaN
young professional ii sgctqzbtzn ge xzaxv                                 NaN
zomato                kgbvng                                              NaN
```

```
                                                                      min  \
job_position           company_hash
Others                 Others                                        15.0
                       a ntwyzgrgsxto                            350000.0
                       aaqxctz avnv owxtzwto  vzvrjnxwo ucn rna  500000.0
                       adw ntwyzgrgsj                             80000.0
                       adw ntwyzgrgsxto                          100000.0
…                                                                    …
wordpress developer    Others                                    600000.0
worker                 zgn vuurxwvmrt vwwghzn                    200000.0
x                      Others                                    400000.0
young professional ii sgctqzbtzn ge xzaxv                       500000.0
zomato                 kgbvng                                    500000.0

                                                                      25%  \
job_position           company_hash
Others                 Others                                    358500.0
                       a ntwyzgrgsxto                            500000.0
                       aaqxctz avnv owxtzwto  vzvrjnxwo ucn rna  500000.0
                       adw ntwyzgrgsj                            374000.0
                       adw ntwyzgrgsxto                          400000.0
…                                                                    …
wordpress developer    Others                                    600000.0
worker                 zgn vuurxwvmrt vwwghzn                    200000.0
x                      Others                                    400000.0
young professional ii sgctqzbtzn ge xzaxv                       500000.0
zomato                 kgbvng                                    500000.0

                                                                      50%  \
job_position           company_hash
Others                 Others                                    800000.0
                       a ntwyzgrgsxto                            575000.0
                       aaqxctz avnv owxtzwto  vzvrjnxwo ucn rna  500000.0
                       adw ntwyzgrgsj                            500000.0
                       adw ntwyzgrgsxto                          525000.0
…                                                                    …
wordpress developer    Others                                    600000.0
worker                 zgn vuurxwvmrt vwwghzn                    200000.0
x                      Others                                    400000.0
young professional ii sgctqzbtzn ge xzaxv                       500000.0
zomato                 kgbvng                                    500000.0

                                                                       75%  \
job_position           company_hash
Others                 Others                                    1525000.0
                       a ntwyzgrgsxto                             600000.0
```

```
                      aaqxctz avnv owxtzwto  vzvrjnxwo ucn rna   500000.0
                      adw ntwyzgrgsj                             800000.0
                      adw ntwyzgrgsxto                           830000.0
…                                                                    …
wordpress developer   Others                                     600000.0
worker                zgn vuurxwvmrt vwwghzn                     200000.0
x                     Others                                     400000.0
young professional ii sgctqzbtzn ge xzaxv                        500000.0
zomato                kgbvng                                     500000.0

                                                                      max
job_position          company_hash
Others                Others                                    3327000.0
                      a ntwyzgrgsxto                            1350000.0
                      aaqxctz avnv owxtzwto  vzvrjnxwo ucn rna   500000.0
                      adw ntwyzgrgsj                            2100000.0
                      adw ntwyzgrgsxto                          1500000.0
…                                                                    …
wordpress developer   Others                                     600000.0
worker                zgn vuurxwvmrt vwwghzn                     200000.0
x                     Others                                     400000.0
young professional ii sgctqzbtzn ge xzaxv                        500000.0
zomato                kgbvng                                     500000.0

[21595 rows x 8 columns]
```

[83]:
```
df.drop_duplicates().shape
```

[83]:
```
(146052, 6)
```

[84]:
```
df_cj=df.merge(grouped_c_j, on=['job_position','company_hash'], how='left')
df_cj
```

[84]:
```
                     company_hash  orgyear      ctc        job_position  \
0                  atrgxnnt xzaxv   2016.0  1100000               other
1        qtrxvzwt xzegwgbb rxbxnta  2018.0   449999  fullstack engineer
2                          Others   2015.0  2000000    backend engineer
3                       ngpgutaxv   2017.0   700000    backend engineer
4                      qxen sqghu   2017.0  1400000  fullstack engineer
…                             …      …        …                 …
146047                   mvqwrvjo   2011.0  2250000              Others
146048                  vuurt xzw   2008.0   220000              Others
146049                  husqvawgb   2017.0   500000              Others
146050                   vwwgrxnt   2021.0   700000              Others
146051             bgqsvz onvzrtj   2014.0  1240000              Others

        ctc_updated_year  years_of_experience   count          mean  \
```

```
0              2020.0                   6.0     2.0  1.085000e+06
1              2019.0                   4.0    25.0  9.882000e+05
2              2020.0                   7.0  3871.0  1.001007e+06
3              2019.0                   5.0    24.0  1.416667e+06
4              2019.0                   5.0     3.0  8.466667e+05
…                 …                   …     …           …
146047         2019.0                  11.0    64.0  1.259969e+06
146048         2019.0                  14.0    16.0  1.568312e+06
146049         2020.0                   5.0    13.0  1.000769e+06
146050         2021.0                   1.0    35.0  1.200371e+06
146051         2016.0                   8.0   105.0  1.801581e+06

                 std        min        25%        50%        75%        max
0       2.121320e+04  1070000.0  1077500.0  1085000.0  1092500.0  1100000.0
1       4.874998e+05   300000.0   600000.0   850000.0  1380000.0  2000000.0
2       8.124658e+05     1000.0   300000.0   830000.0  1530000.0  3300000.0
3       5.453413e+05   520000.0  1047500.0  1375000.0  1792500.0  2600000.0
4       4.801389e+05   540000.0   570000.0   600000.0  1000000.0  1400000.0
…                …          …          …          …          …          …
146047  5.777488e+05   500000.0   800000.0  1020000.0  1607500.0  3200000.0
146048  1.231984e+06    60000.0   216250.0  2275000.0  2550000.0  3000000.0
146049  3.300369e+05   500000.0   750000.0  1000000.0  1200000.0  1500000.0
146050  5.635221e+05   300000.0   771500.0  1100000.0  1400000.0  2700000.0
146051  6.903383e+05   100000.0  1450000.0  1800000.0  2300000.0  3240000.0

[146052 rows x 14 columns]
```

[85]:
```python
df_cj.sort_values(['company_hash','job_position','years_of_experience'])
```

[85]:
```
       company_hash  orgyear      ctc                         job_position  \
896          Others   2022.0   120000                               Others
2599         Others   2022.0   430000                               Others
7691         Others   2022.0   570000                               Others
7870         Others   2022.0   550000                               Others
8789         Others   2022.0   680000                               Others
…               …        …        …                                    …
122134    zxztrtvuo   2013.0  1200000                         ios engineer
53733     zxztrtvuo   2016.0  1200000  member of technical staff at nineleaps
9189      zxztrtvuo   2020.0   450000                                other
133203    zxztrtvuo   2019.0   450000                                other
37242     zxztrtvuo   2016.0  1200000              software developer intern

        ctc_updated_year  years_of_experience   count          mean  \
896               2022.0                  0.0  3159.0  1.025099e+06
2599              2022.0                  0.0  3159.0  1.025099e+06
7691              2022.0                  0.0  3159.0  1.025099e+06
7870              2022.0                  0.0  3159.0  1.025099e+06
```

```
8789             2022.0                  0.0   3159.0   1.025099e+06
…                 …                …      …               …
122134           2017.0                  9.0      1.0   1.200000e+06
53733            2020.0                  6.0      1.0   1.200000e+06
9189             2020.0                  2.0      2.0   4.500000e+05
133203           2020.0                  3.0      2.0   4.500000e+05
37242            2020.0                  6.0      1.0   1.200000e+06

                  std        min        25%        50%        75%        max
896     837191.520717       15.0   358500.0   800000.0  1525000.0  3327000.0
2599    837191.520717       15.0   358500.0   800000.0  1525000.0  3327000.0
7691    837191.520717       15.0   358500.0   800000.0  1525000.0  3327000.0
7870    837191.520717       15.0   358500.0   800000.0  1525000.0  3327000.0
8789    837191.520717       15.0   358500.0   800000.0  1525000.0  3327000.0
…                 …          …          …          …          …          …
122134            NaN  1200000.0  1200000.0  1200000.0  1200000.0  1200000.0
53733             NaN  1200000.0  1200000.0  1200000.0  1200000.0  1200000.0
9189         0.000000   450000.0   450000.0   450000.0   450000.0   450000.0
133203       0.000000   450000.0   450000.0   450000.0   450000.0   450000.0
37242             NaN  1200000.0  1200000.0  1200000.0  1200000.0  1200000.0

[146052 rows x 14 columns]
```

[86]:
```python
df_cj.shape
```

[86]:
```
(146052, 14)
```

[87]:
```python
df_cj.drop_duplicates(inplace=True)
```

[88]:
```python
df_cj.shape
```

[88]:
```
(146052, 14)
```

-

[89]:
```python
def condition_classs(a,b_50,b_75):
    if a<b_50:
        return 3
    elif a>=b_50 and a<=b_75:
        return 2

    elif a>=b_75:
        return 1
```

```
[90]: df_cj['classs'] =df_cj.apply(lambda x:␣
      ↪condition_classs(x['ctc'],x['50%'],x['75%']),axis = 1)
      df_cj
```

```
[90]:                      company_hash  orgyear      ctc        job_position  \
0                     atrgxnnt xzaxv   2016.0  1100000               other
1       qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                            Others   2015.0  2000000    backend engineer
3                         ngpgutaxv   2017.0   700000    backend engineer
4                       qxen sqghu   2017.0  1400000  fullstack engineer
…                              …        …      …                 …
146047                    mvqwrvjo   2011.0  2250000              Others
146048                   vuurt xzw   2008.0   220000              Others
146049                   husqvawgb   2017.0   500000              Others
146050                    vwwgrxnt   2021.0   700000              Others
146051              bgqsvz onvzrtj   2014.0  1240000              Others

        ctc_updated_year  years_of_experience   count          mean  \
0                 2020.0                  6.0     2.0  1.085000e+06
1                 2019.0                  4.0    25.0  9.882000e+05
2                 2020.0                  7.0  3871.0  1.001007e+06
3                 2019.0                  5.0    24.0  1.416667e+06
4                 2019.0                  5.0     3.0  8.466667e+05
…                    …                    …     …           …
146047            2019.0                 11.0    64.0  1.259969e+06
146048            2019.0                 14.0    16.0  1.568312e+06
146049            2020.0                  5.0    13.0  1.000769e+06
146050            2021.0                  1.0    35.0  1.200371e+06
146051            2016.0                  8.0   105.0  1.801581e+06

                 std        min        25%        50%        75%        max  \
0       2.121320e+04  1070000.0  1077500.0  1085000.0  1092500.0  1100000.0
1       4.874998e+05   300000.0   600000.0   850000.0  1380000.0  2000000.0
2       8.124658e+05     1000.0   300000.0   830000.0  1530000.0  3300000.0
3       5.453413e+05   520000.0  1047500.0  1375000.0  1792500.0  2600000.0
4       4.801389e+05   540000.0   570000.0   600000.0  1000000.0  1400000.0
…                …          …          …          …          …          …
146047  5.777488e+05   500000.0   800000.0  1020000.0  1607500.0  3200000.0
146048  1.231984e+06    60000.0   216250.0  2275000.0  2550000.0  3000000.0
146049  3.300369e+05   500000.0   750000.0  1000000.0  1200000.0  1500000.0
146050  5.635221e+05   300000.0   771500.0  1100000.0  1400000.0  2700000.0
146051  6.903383e+05   100000.0  1450000.0  1800000.0  2300000.0  3240000.0

        classs
0            1
1            3
2            1
```

```
3                3
4                1
…            …
146047           1
146048           3
146049           3
146050           3
146051           3

[146052 rows x 15 columns]
```

[91]:
```
df_cj.classs.value_counts(normalize=True)*100
```

[91]:
```
classs
3    43.736477
2    31.831129
1    24.432394
Name: proportion, dtype: float64
```

[92]:
```
# job position that has the highest class
df_cj[df_cj['classs']==1][['job_position','ctc']].
 ↪groupby('job_position')['ctc'].describe()
```

[92]:
```
                                 count          mean            std  \
job_position
Others                          8217.0  1.931143e+06  695531.136886
android engineer                 913.0  1.784897e+06  638704.770985
application developer              1.0  1.150000e+06            NaN
application developer analyst      1.0  6.000000e+05            NaN
application development analyst    2.0  8.150000e+05  233345.237792
…                                  …           …              …
support engineer                 683.0  1.190779e+06  552019.578789
system engineer                   10.0  8.420000e+05  373118.986086
teaching assistant                 1.0  1.800000e+06            NaN
team lead                          2.0  1.800000e+06  565685.424949
technology analyst                 3.0  8.966667e+05  351046.055858

                                      min        25%        50%        75%  \
job_position
Others                           100000.0  1400000.0  1900000.0  2500000.0
android engineer                  14000.0  1320000.0  1700000.0  2200000.0
application developer           1150000.0  1150000.0  1150000.0  1150000.0
application developer analyst    600000.0   600000.0   600000.0   600000.0
application development analyst  650000.0   732500.0   815000.0   897500.0
…                                     …          …          …          …
support engineer                 350000.0   830000.0  1000000.0  1400000.0
system engineer                  400000.0   550000.0   775000.0  1100000.0
```

```
teaching assistant              1800000.0  1800000.0  1800000.0  1800000.0
team lead                       1400000.0  1600000.0  1800000.0  2000000.0
technology analyst               660000.0   695000.0   730000.0  1015000.0

                                      max
job_position
Others                          3330000.0
android engineer                3300000.0
application developer           1150000.0
application developer analyst    600000.0
application development analyst  980000.0
…                                     …
support engineer                3310000.0
system engineer                 1500000.0
teaching assistant              1800000.0
team lead                       2200000.0
technology analyst              1300000.0

[107 rows x 8 columns]
```

[93]:
```
df_cjy.head()
```

[93]:
```
                 company_hash  orgyear      ctc       job_position  \
0              atrgxnnt xzaxv   2016.0  1100000              other
1  qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                      Others   2015.0  2000000    backend engineer
3                   ngpgutaxv   2017.0   700000    backend engineer
4                  qxen sqghu   2017.0  1400000  fullstack engineer

   ctc_updated_year  years_of_experience  count          mean            std  \
0            2020.0                  6.0    1.0  1.100000e+06            NaN
1            2019.0                  4.0    7.0  7.742856e+05  250922.324350
2            2020.0                  7.0  456.0  9.609559e+05  776546.830662
3            2019.0                  5.0    7.0  1.158571e+06  404780.951933
4            2019.0                  5.0    1.0  1.400000e+06            NaN

         min        25%        50%        75%        max  designation
0  1100000.0  1100000.0  1100000.0  1100000.0  1100000.0            2
1   449999.0   610000.0   750000.0   900000.0  1200000.0            3
2     1000.0   307500.0   800000.0  1435000.0  3200000.0            1
3   700000.0   825000.0  1200000.0  1405000.0  1750000.0            3
4  1400000.0  1400000.0  1400000.0  1400000.0  1400000.0            2
```

[94]:
```
df_cj.head()
```

[94]:
```
                 company_hash  orgyear      ctc       job_position  \
0              atrgxnnt xzaxv   2016.0  1100000              other
```

```
1  qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                     Others   2015.0  2000000    backend engineer
3                  ngpgutaxv   2017.0   700000    backend engineer
4                 qxen sqghu   2017.0  1400000  fullstack engineer

   ctc_updated_year  years_of_experience   count          mean            std  \
0            2020.0                  6.0     2.0  1.085000e+06   21213.203436
1            2019.0                  4.0    25.0  9.882000e+05  487499.789590
2            2020.0                  7.0  3871.0  1.001007e+06  812465.827695
3            2019.0                  5.0    24.0  1.416667e+06  545341.270627
4            2019.0                  5.0     3.0  8.466667e+05  480138.868801

         min        25%        50%        75%        max  classs
0  1070000.0  1077500.0  1085000.0  1092500.0  1100000.0       1
1   300000.0   600000.0   850000.0  1380000.0  2000000.0       3
2     1000.0   300000.0   830000.0  1530000.0  3300000.0       1
3   520000.0  1047500.0  1375000.0  1792500.0  2600000.0       3
4   540000.0   570000.0   600000.0  1000000.0  1400000.0       1
```

[95]:
```python
df_cj.shape
```

[95]: (146052, 15)

[96]:
```python
df_cjy.shape
```

[96]: (146052, 15)

[97]:
```python
df_cj.
 ↪drop(columns=['count','mean','std','min','25%','50%','75%','max'],inplace=True)
df_cjy.
 ↪drop(columns=['count','mean','std','min','25%','50%','75%','max'],inplace=True)
```

[98]:
```python
df_cj.drop_duplicates().shape
```

[98]: (146052, 7)

[99]:
```python
df_cjy.drop_duplicates().shape
```

[99]: (146052, 7)

[100]:
```python
df_cjy
```

[100]:
```
                  company_hash  orgyear      ctc        job_position  \
0               atrgxnnt xzaxv   2016.0  1100000               other
1     qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                       Others   2015.0  2000000    backend engineer
3                    ngpgutaxv   2017.0   700000    backend engineer
```

```
4                   qxen sqghu   2017.0  1400000  fullstack engineer
…                            …      …       …                 …
146047                mvqwrvjo   2011.0  2250000              Others
146048               vuurt xzw   2008.0   220000              Others
146049               husqvawgb   2017.0   500000              Others
146050                vwwgrxnt   2021.0   700000              Others
146051          bgqsvz onvzrtj   2014.0  1240000              Others

        ctc_updated_year  years_of_experience  designation
0                 2020.0                  6.0            2
1                 2019.0                  4.0            3
2                 2020.0                  7.0            1
3                 2019.0                  5.0            3
4                 2019.0                  5.0            2
…                    …                    …          …
146047            2019.0                 11.0            1
146048            2019.0                 14.0            2
146049            2020.0                  5.0            3
146050            2021.0                  1.0            2
146051            2016.0                  8.0            3

[146052 rows x 7 columns]
```

[101]:
```
df_cj
```

[101]:
```
                      company_hash  orgyear      ctc        job_position  \
0                   atrgxnnt xzaxv   2016.0  1100000               other
1        qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                           Others   2015.0  2000000    backend engineer
3                        ngpgutaxv   2017.0   700000    backend engineer
4                       qxen sqghu   2017.0  1400000  fullstack engineer
…                                …      …       …                 …
146047                    mvqwrvjo   2011.0  2250000              Others
146048                   vuurt xzw   2008.0   220000              Others
146049                   husqvawgb   2017.0   500000              Others
146050                    vwwgrxnt   2021.0   700000              Others
146051              bgqsvz onvzrtj   2014.0  1240000              Others

        ctc_updated_year  years_of_experience  classs
0                 2020.0                  6.0       1
1                 2019.0                  4.0       3
2                 2020.0                  7.0       1
3                 2019.0                  5.0       3
4                 2019.0                  5.0       1
…                    …                    …     …
146047            2019.0                 11.0       1
146048            2019.0                 14.0       3
```

```
146049            2020.0                  5.0       3
146050            2021.0                  1.0       3
146051            2016.0                  8.0       3

[146052 rows x 7 columns]
```

[102]:
```python
df_cjy_cj=df_cj.merge(df_cjy,
 on=['company_hash','orgyear','ctc','job_position','years_of_experience','ctc_updated_year']
 how = 'right')
df_cjy_cj
```

[102]:
```
                        company_hash  orgyear      ctc        job_position  \
0                      atrgxnnt xzaxv   2016.0  1100000               other
1        qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                              Others   2015.0  2000000    backend engineer
3                           ngpgutaxv   2017.0   700000    backend engineer
4                          qxen sqghu   2017.0  1400000  fullstack engineer
…                                   …        …        …                   …
146047                       mvqwrvjo   2011.0  2250000              Others
146048                      vuurt xzw   2008.0   220000              Others
146049                      husqvawgb   2017.0   500000              Others
146050                       vwwgrxnt   2021.0   700000              Others
146051                 bgqsvz onvzrtj   2014.0  1240000              Others

        ctc_updated_year  years_of_experience  classs  designation
0                 2020.0                  6.0       1            2
1                 2019.0                  4.0       3            3
2                 2020.0                  7.0       1            1
3                 2019.0                  5.0       3            3
4                 2019.0                  5.0       1            2
…                      …                    …     …           …
146047            2019.0                 11.0       1            1
146048            2019.0                 14.0       3            2
146049            2020.0                  5.0       3            3
146050            2021.0                  1.0       3            2
146051            2016.0                  8.0       3            3

[146052 rows x 8 columns]
```

[103]:
```python
df_cjy_cj.shape
```

[103]: (146052, 8)

[104]:
```python
df_cjy_cj.drop_duplicates().shape
```

[104]: (146052, 8)

4.0.4 Manual Clustering based on company

[105]:
```
grouped_c=df.groupby(['company_hash'])['ctc'].describe()
```

[106]:
```
df_c=df.merge(grouped_c, on=['company_hash'], how='left')
```

[107]:
```
df_c.head(5)
```

[107]:
```
                company_hash  orgyear      ctc         job_position  \
0             atrgxnnt xzaxv   2016.0  1100000                other
1  qtrxvzwt xzegwgbb rxbxnta   2018.0   449999   fullstack engineer
2                     Others   2015.0  2000000     backend engineer
3                  ngpgutaxv   2017.0   700000     backend engineer
4                 qxen sqghu   2017.0  1400000   fullstack engineer

   ctc_updated_year  years_of_experience    count          mean  \
0            2020.0                  6.0      9.0  1.115667e+06
1            2019.0                  4.0    384.0  1.055291e+06
2            2020.0                  7.0  24489.0  9.675951e+05
3            2019.0                  5.0     59.0  1.455508e+06
4            2019.0                  5.0      6.0  9.400000e+05

             std       min        25%        50%        75%        max
0  458111.885897  500000.0   800000.0  1070000.0  1500000.0  1771000.0
1  636095.670307   10000.0   600000.0   850000.0  1500000.0  3200000.0
2  761666.853194      15.0   390000.0   800000.0  1400000.0  3329999.0
3  655423.458086  200000.0  1075000.0  1300000.0  1850000.0  3160000.0
4  389871.773792  540000.0   625000.0   850000.0  1300000.0  1400000.0
```

[108]:
```
#verify
df_c.sort_values(['company_hash'])
```

[108]:
```
        company_hash  orgyear      ctc         job_position  ctc_updated_year  \
73025         Others   2017.0    65000               Others            2019.0
66471         Others   2017.0  1210000     backend engineer            2019.0
66479         Others   2015.0   220000          qa engineer            2019.0
66480         Others   2018.0   650000          qa engineer            2019.0
66482         Others   2017.0  1140000   fullstack engineer            2019.0
…                  …       …    …                    …               …
68659      zxztrtvuo   2019.0  1000000     backend engineer            2021.0
115889     zxztrtvuo   2017.0  1000000     backend engineer            2019.0
23629      zxztrtvuo   2018.0  1360000     backend engineer            2020.0
82842      zxztrtvuo   2018.0   710000   fullstack engineer            2020.0
129354     zxztrtvuo   2018.0   650000     backend engineer            2019.0
```

```
        years_of_experience    count          mean            std       min  \
73025                   5.0  24489.0  967595.092940  761666.853194      15.0
66471                   5.0  24489.0  967595.092940  761666.853194      15.0
66479                   7.0  24489.0  967595.092940  761666.853194      15.0
66480                   4.0  24489.0  967595.092940  761666.853194      15.0
66482                   5.0  24489.0  967595.092940  761666.853194      15.0
…                      …        …             …             …        …
68659                   3.0     68.0  964676.455882  565370.795931  400000.0
115889                  5.0     68.0  964676.455882  565370.795931  400000.0
23629                   4.0     68.0  964676.455882  565370.795931  400000.0
82842                   4.0     68.0  964676.455882  565370.795931  400000.0
129354                  4.0     68.0  964676.455882  565370.795931  400000.0

             25%       50%        75%        max
73025   390000.0  800000.0  1400000.0  3329999.0
66471   390000.0  800000.0  1400000.0  3329999.0
66479   390000.0  800000.0  1400000.0  3329999.0
66480   390000.0  800000.0  1400000.0  3329999.0
66482   390000.0  800000.0  1400000.0  3329999.0
…            …         …          …          …
68659   515000.0  784999.5  1200000.0  2700000.0
115889  515000.0  784999.5  1200000.0  2700000.0
23629   515000.0  784999.5  1200000.0  2700000.0
82842   515000.0  784999.5  1200000.0  2700000.0
129354  515000.0  784999.5  1200000.0  2700000.0

[146052 rows x 14 columns]
```

[109]:
```python
print(df.drop_duplicates().shape)
print(df_c.shape)
print(df_c.drop_duplicates().shape)
```

```
(146052, 6)
(146052, 14)
(146052, 14)
```

-

[110]:
```python
def condition_tier(a,b_50,b_75):
    if a<b_50:
        return 3
    elif a>=b_50 and a<=b_75:
        return 2
    elif a>=b_75:
```

```
        return 1
```

[111]:
```
df_c['tier'] =df_c.apply(lambda x:␣
 ↪condition_tier(x['ctc'],x['50%'],x['75%']),axis = 1)
df_c
```

[111]:
```
                          company_hash  orgyear      ctc        job_position  \
0                       atrgxnnt xzaxv   2016.0  1100000               other
1           qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                               Others   2015.0  2000000    backend engineer
3                            ngpgutaxv   2017.0   700000    backend engineer
4                          qxen sqghu   2017.0  1400000  fullstack engineer
…                                    …        …        …                   …
146047                        mvqwrvjo   2011.0  2250000              Others
146048                       vuurt xzw   2008.0   220000              Others
146049                       husqvawgb   2017.0   500000              Others
146050                        vwwgrxnt   2021.0   700000              Others
146051                  bgqsvz onvzrtj   2014.0  1240000              Others

        ctc_updated_year  years_of_experience    count          mean  \
0                 2020.0                  6.0      9.0  1.115667e+06
1                 2019.0                  4.0    384.0  1.055291e+06
2                 2020.0                  7.0  24489.0  9.675951e+05
3                 2019.0                  5.0     59.0  1.455508e+06
4                 2019.0                  5.0      6.0  9.400000e+05
…                      …                    …        …             …
146047            2019.0                 11.0     65.0  1.264431e+06
146048            2019.0                 14.0     16.0  1.568312e+06
146049            2020.0                  5.0     97.0  1.275361e+06
146050            2021.0                  1.0    157.0  1.344255e+06
146051            2016.0                  8.0    472.0  1.844892e+06

                 std       min        25%        50%        75%        max  \
0       4.581119e+05  500000.0   800000.0  1070000.0  1500000.0  1771000.0
1       6.360957e+05   10000.0   600000.0   850000.0  1500000.0  3200000.0
2       7.616669e+05      15.0   390000.0   800000.0  1400000.0  3329999.0
3       6.554235e+05  200000.0  1075000.0  1300000.0  1850000.0  3160000.0
4       3.898718e+05  540000.0   625000.0   850000.0  1300000.0  1400000.0
…                  …         …          …          …          …          …
146047  5.743451e+05  500000.0   800000.0  1040000.0  1600000.0  3200000.0
146048  1.231984e+06   60000.0   216250.0  2275000.0  2550000.0  3000000.0
146049  5.880548e+05  200000.0   850000.0  1150000.0  1600000.0  3200000.0
146050  5.743742e+05  200000.0  1000000.0  1300000.0  1500000.0  3000000.0
146051  7.137398e+05    1000.0  1500000.0  1800000.0  2250000.0  3300000.0

        tier
0          2
```

```
1          3
2          1
3          3
4          1
…       …
146047     1
146048     3
146049     3
146050     3
146051     3

[146052 rows x 15 columns]
```

[112]:
```python
df_c.head()
```

[112]:
```
                company_hash  orgyear      ctc        job_position  \
0             atrgxnnt xzaxv   2016.0  1100000               other
1  qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                     Others   2015.0  2000000    backend engineer
3                  ngpgutaxv   2017.0   700000    backend engineer
4                 qxen sqghu   2017.0  1400000  fullstack engineer

   ctc_updated_year  years_of_experience    count          mean  \
0            2020.0                  6.0      9.0  1.115667e+06
1            2019.0                  4.0    384.0  1.055291e+06
2            2020.0                  7.0  24489.0  9.675951e+05
3            2019.0                  5.0     59.0  1.455508e+06
4            2019.0                  5.0      6.0  9.400000e+05

             std       min        25%        50%        75%        max  tier
0  458111.885897  500000.0   800000.0  1070000.0  1500000.0  1771000.0     2
1  636095.670307   10000.0   600000.0   850000.0  1500000.0  3200000.0     3
2  761666.853194      15.0   390000.0   800000.0  1400000.0  3329999.0     1
3  655423.458086  200000.0  1075000.0  1300000.0  1850000.0  3160000.0     3
4  389871.773792  540000.0   625000.0   850000.0  1300000.0  1400000.0     1
```

[113]:
```python
df_c.tier.value_counts(normalize=True)*100
```

[113]:
```
tier
3    47.952099
2    28.153671
1    23.894229
Name: proportion, dtype: float64
```

[114]:
```python
df_cjy_cj_c=df_cjy_cj.merge(df_c,␣
 ↪on=['company_hash','orgyear','ctc','job_position'\
```

```
↪,'ctc_updated_year','years_of_experience'], how = 'left')
```

[115]:
```
df_cjy_cj_c.head(10)
```

[115]:
```
                          company_hash  orgyear      ctc        job_position  \
0                      atrgxnnt xzaxv   2016.0  1100000               other
1            qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                               Others   2015.0  2000000    backend engineer
3                            ngpgutaxv   2017.0   700000    backend engineer
4                           qxen sqghu   2017.0  1400000  fullstack engineer
5  yvuuxrj hzbvqqxta bvqptnxzs ucn rna   2018.0   700000  fullstack engineer
6                  lubgqsvz wyvot   wg   2018.0  1500000  fullstack engineer
7                 vwwtznhqt ntwyzgrgsj   2019.0   400000    backend engineer
8                  utqoxontzn ojontbo   2020.0   450000              Others
9                               Others   2019.0   360000              Others

   ctc_updated_year  years_of_experience  classs  designation    count  \
0            2020.0                  6.0       1            2      9.0
1            2019.0                  4.0       3            3    384.0
2            2020.0                  7.0       1            1  24489.0
3            2019.0                  5.0       3            3     59.0
4            2019.0                  5.0       1            2      6.0
5            2020.0                  4.0       2            2      6.0
6            2019.0                  4.0       3            3    859.0
7            2019.0                  3.0       3            3     24.0
8            2020.0                  2.0       3            3    413.0
9            2019.0                  3.0       3            3  24489.0

           mean            std       min        25%        50%        75%  \
0  1.115667e+06  458111.885897  500000.0   800000.0  1070000.0  1500000.0
1  1.055291e+06  636095.670307   10000.0   600000.0   850000.0  1500000.0
2  9.675951e+05  761666.853194      15.0   390000.0   800000.0  1400000.0
3  1.455508e+06  655423.458086  200000.0  1075000.0  1300000.0  1850000.0
4  9.400000e+05  389871.773792  540000.0   625000.0   850000.0  1300000.0
5  9.066667e+05  539728.326722  620000.0   640000.0   700000.0   775000.0
6  1.706719e+06  676070.394042   11000.0  1300000.0  1675000.0  2110000.0
7  6.633333e+05  265782.956019  300000.0   422500.0   620000.0   892500.0
8  9.778668e+05  555184.830508   90000.0   550000.0   840000.0  1300000.0
9  9.675951e+05  761666.853194      15.0   390000.0   800000.0  1400000.0

         max  tier
0  1771000.0     2
1  3200000.0     3
2  3329999.0     1
3  3160000.0     3
4  1400000.0     1
```

```
5  2000000.0     2
6  3300000.0     3
7  1150000.0     3
8  3000000.0     3
9  3329999.0     3
```

[116]:
```
df_cjy_cj_c.shape
```

[116]:
```
(146052, 17)
```

[117]:
```
data=df_cjy_cj_c.copy(deep=True)
```

[118]:
```
data.
 ↪drop(columns=['count','mean','std','min','25%','50%','75%','max'],inplace=True)
```

[119]:
```
data
```

[119]:
```
                     company_hash  orgyear      ctc        job_position  \
0                   atrgxnnt xzaxv   2016.0  1100000               other
1       qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                          Others   2015.0  2000000    backend engineer
3                       ngpgutaxv   2017.0   700000    backend engineer
4                      qxen sqghu   2017.0  1400000  fullstack engineer
…                               …        …        …                   …
146047                   mvqwrvjo   2011.0  2250000              Others
146048                  vuurt xzw   2008.0   220000              Others
146049                  husqvawgb   2017.0   500000              Others
146050                   vwwgrxnt   2021.0   700000              Others
146051             bgqsvz onvzrtj   2014.0  1240000              Others

        ctc_updated_year  years_of_experience  classs  designation  tier
0                 2020.0                  6.0       1            2     2
1                 2019.0                  4.0       3            3     3
2                 2020.0                  7.0       1            1     1
3                 2019.0                  5.0       3            3     3
4                 2019.0                  5.0       1            2     1
…                      …                    …       …            …     …
146047            2019.0                 11.0       1            1     1
146048            2019.0                 14.0       3            2     3
146049            2020.0                  5.0       3            3     3
146050            2021.0                  1.0       3            2     3
146051            2016.0                  8.0       3            3     3

[146052 rows x 9 columns]
```

[120]:
```
# org_data = pd.read_csv('data/scaler_clustering.csv')
# org_data
```

[121]:
```
# df_new=data.merge(org_data, on=['company_hash'], how = 'left')
# df_new
```

[122]:
```
pd.set_option('display.max_rows', 20)
```

[123]:
```
# Top 10 companies providing highest ctc's

data.groupby(['company_hash'])['ctc'].max().head(11).sort_values(ascending =␣
↪False)
```

[123]:
```
company_hash
Others                                     3329999
adw ntwyzgrgsj                             3200000
a ntwyzgrgsxto                             3150000
agnut                                      3000000
agdutq                                     2500000
aghmnzhn                                   2400000
adw ntwyzgrgsxto                           2350000
agotrtwn                                   1610000
agnoihvqto                                 1600000
aaqxctz avnv owxtzwto  vzvrjnxwo ucn rna   1400000
aggartmrht xzzgcvnxgzo                     1000000
Name: ctc, dtype: int64
```

4.0.5 Overview of what's next :

- Data processing for Unsupervised clustering - Label encoding/ One- hot encoding, Standardization of data
- Unsupervised Learning - Clustering
- Checking clustering tendency
- Elbow method
- K-means clustering
- Hierarchical clustering (you can do this on a sample of the dataset if your process is taking time)
- Insights from Unsupervised Clustering
- Provide actionable Insights & Recommendations for the Business.

- K-Means is a distance-based algorithm. Because of that, it's really important to perform feature scaling (normalize, standardize, or choose any other option in which the distance has some comparable meaning for all the columns).
- In this example, we use MinMaxScaler instead of StandardScaler, so as to transforming the feature values to fall within the bounded intervals (min and max), rather than making them to fall around mean as 0 with standard deviation as 1 (StandardScaler).

- MinMaxScaler is an excellent tool for this purpose. MinMaxScaler scales all the data features in the range [0, 1] or else in the range [-1, 1] if there are negative values in the dataset. This scaling compresses all the inliers in the narrow range [0, 0.005].

[124]:
```
data.shape
```

[124]:
```
(146052, 9)
```

[125]:
```
data['company_hash'].unique()
```

[125]:
```
array(['atrgxnnt xzaxv', 'qtrxvzwt xzegwgbb rxbxnta', 'Others', …,
       'srgxej', 'bh oxsbv', 'ohbngnvr ojontbo'], dtype=object)
```

[126]:
```
# Label Encoding

from sklearn import preprocessing
label_encoder = preprocessing.LabelEncoder()
data['company_hash']= label_encoder.fit_transform(data['company_hash'])
data['company_hash'].unique()
```

[126]:
```
array([  45, 1497,    0, …, 1667,  138, 1155])
```

[127]:
```
data['job_position']= label_encoder.fit_transform(data['job_position'])
len(data['job_position'].unique())
```

[127]:
```
762
```

[128]:
```
data
```

[128]:
```
        company_hash  orgyear      ctc  job_position  ctc_updated_year  \
0                 45   2016.0  1100000           377            2020.0
1               1497   2018.0   449999           235            2019.0
2                  0   2015.0  2000000           105            2020.0
3                936   2017.0   700000           105            2019.0
4               1535   2017.0  1400000           235            2019.0
…                …       …       …              …                …
146047           884   2011.0  2250000             0            2019.0
146048          2158   2008.0   220000             0            2019.0
146049           636   2017.0   500000             0            2020.0
146050          2186   2021.0   700000             0            2021.0
146051           127   2014.0  1240000             0            2016.0

        years_of_experience  classs  designation  tier
0                       6.0       1            2     2
1                       4.0       3            3     3
2                       7.0       1            1     1
3                       5.0       3            3     3
4                       5.0       1            2     1
```

```
...                        ...    ...          ...   ...
146047                    11.0     1                1     1
146048                    14.0     3                2     3
146049                     5.0     3                3     3
146050                     1.0     3                2     3
146051                     8.0     3                3     3

[146052 rows x 9 columns]
```

[129]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 146052 entries, 0 to 146051
Data columns (total 9 columns):
 #   Column               Non-Null Count   Dtype
---  ------               --------------   -----
 0   company_hash         146052 non-null  int64
 1   orgyear              146052 non-null  float64
 2   ctc                  146052 non-null  int64
 3   job_position         146052 non-null  int64
 4   ctc_updated_year     146052 non-null  float64
 5   years_of_experience  146052 non-null  float64
 6   classs               146052 non-null  int64
 7   designation          146052 non-null  int64
 8   tier                 146052 non-null  int64
dtypes: float64(3), int64(6)
memory usage: 10.0 MB
```

[130]:
```
# dropping org year and cts_updated year as we already have years of experience

data.drop(columns=['orgyear'],inplace=True)
data.drop(columns=['ctc_updated_year'],inplace=True)
```

[131]:
```
missingValue(data)
```

```
Total records in our data =  146052 where missing values are as follows:
```

[131]:

	Total Missing	In Percent
company_hash	0	0.0
ctc	0	0.0
job_position	0	0.0
years_of_experience	0	0.0
classs	0	0.0
designation	0	0.0

```
tier                              0         0.0
```

[132]:

```
data.head()
```

[132]:

```
   company_hash      ctc  job_position  years_of_experience  classs  \
0            45  1100000           377                  6.0       1
1          1497   449999           235                  4.0       3
2             0  2000000           105                  7.0       1
3           936   700000           105                  5.0       3
4          1535  1400000           235                  5.0       1

   designation  tier
0            2     2
1            3     3
2            1     1
3            3     3
4            2     1
```

[133]:

```
# Creating second copy after org_df

data_1 = data.copy()
```

[134]:

```
from sklearn.preprocessing import MinMaxScaler

# scaler = MinMaxScaler()
# scaler.fit(data)
# data=scaler.transform(data)

ms = MinMaxScaler()

data[['ctc']] = ms.fit_transform(data[['ctc']])
data.head()
```

[134]:

```
   company_hash       ctc  job_position  years_of_experience  classs  \
0            45  0.330330           377                  6.0       1
1          1497  0.135134           235                  4.0       3
2             0  0.600600           105                  7.0       1
3           936  0.210210           105                  5.0       3
4          1535  0.420420           235                  5.0       1

   designation  tier
0            2     2
1            3     3
2            1     1
3            3     3
4            2     1
```

5 Clustering using Sklearn's implementation of Kmeans

[135]:
```
# from sklearn.cluster import KMeans

# k = 3 ## arbitrary value
# kmeans = KMeans(n_clusters=k)
# y_pred = kmeans.fit_predict(data)
```

[136]:
```
# ## what are learned labels(cluster #)
# y_pred
```

[137]:
```
# ##coordinates of the cluster centers
# kmeans.cluster_centers_
```

[137]:
```
```

[138]:
```
X = data_1.copy()
scaler = MinMaxScaler()
scaler.fit(X)
X=scaler.transform(X)
```

[139]:
```
from sklearn.cluster import KMeans

k = 3 ## arbitrary value
kmeans = KMeans(n_clusters=k)
y_pred = kmeans.fit_predict(X)
```

[140]:
```
##coordinates of the cluster centers
kmeans.cluster_centers_
```

[140]:
```
array([[0.42106296, 0.58222686, 0.22694486, 0.4983092 , 0.07946338,
        0.22831217, 0.05954212],
       [0.41462362, 0.18998503, 0.23264329, 0.35999868, 0.98794806,
        0.86553632, 0.9793948 ],
       [0.45047391, 0.32970016, 0.2572445 , 0.39964184, 0.52520207,
        0.4544456 , 0.62352332]])
```

[141]:
```
y_pred is kmeans.labels_
```

[141]:
```
True
```

6 Visualizing Sklearn Clusters

[142]:
```
X
```

[142]:
```
array([[0.01529572, 0.33032993, 0.49540079, …, 0.        , 0.5       ,
        0.5       ],
       [0.50883753, 0.13513432, 0.3088042 , …, 1.        , 1.        ,
        1.        ],
       [0.        , 0.60060036, 0.13797635, …, 0.        , 0.        ,
        0.        ],
       …,
       [0.21617947, 0.15014964, 0.        , …, 1.        , 1.        ,
        1.        ],
       [0.74303195, 0.21020974, 0.        , …, 1.        , 0.5       ,
        1.        ],
       [0.04316791, 0.372372  , 0.        , …, 1.        , 1.        ,
        1.        ]])
```

[143]:
```
clusters = pd.DataFrame(X, columns=data_1.columns)
clusters['label'] = kmeans.labels_
clusters
```

[143]:

	company_hash	ctc	job_position	years_of_experience	classs
0	0.015296	0.330330	0.495401	0.3750	0.0
1	0.508838	0.135134	0.308804	0.2500	1.0
2	0.000000	0.600600	0.137976	0.4375	0.0
3	0.318151	0.210210	0.137976	0.3125	1.0
4	0.521754	0.420420	0.308804	0.3125	0.0
…	…	…	…	…	…
146047	0.300476	0.675675	0.000000	0.6875	0.0
146048	0.733515	0.066066	0.000000	0.8750	1.0
146049	0.216179	0.150150	0.000000	0.3125	1.0
146050	0.743032	0.210210	0.000000	0.0625	1.0
146051	0.043168	0.372372	0.000000	0.5000	1.0

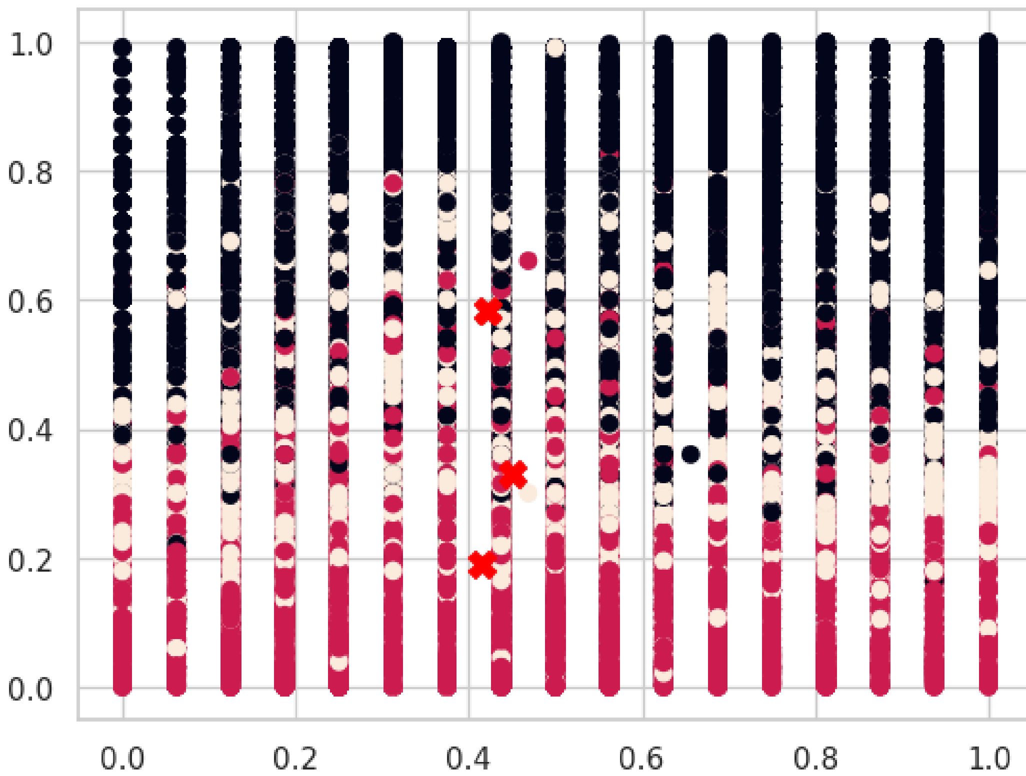
\

	designation	tier	label
0	0.5	0.5	2
1	1.0	1.0	1
2	0.0	0.0	0
3	1.0	1.0	1
4	0.5	0.0	0
…	…	…	…
146047	0.0	0.0	0
146048	0.5	1.0	1
146049	1.0	1.0	1
146050	0.5	1.0	1
146051	1.0	1.0	1

[146052 rows x 8 columns]

[144]:
```
def viz_clusters(kmeans):
    plt.scatter(clusters['years_of_experience'], clusters['ctc'],␣
 ↪c=clusters['label'])
    plt.scatter(kmeans.cluster_centers_[:, 0], kmeans.cluster_centers_[:, 1],
                color="red",
                marker="X",
                s=100)

viz_clusters(kmeans)
```



6.0.1 No clarity in visualization usinf scatter plot

Summary: - I have tried bunch of features to visualize but I am not able to get proper result and it's not clear. - Using polar plot for better visialization:

[145]:
```python
# Using polar plot for better visialization:
polar = clusters.groupby("label").mean().reset_index()
polar = pd.melt(polar, id_vars=["label"])
polar
```

[145]:
```
    label     variable     value
0       0 company_hash  0.421149
1       1 company_hash  0.414624
2       2 company_hash  0.450427
3       0          ctc  0.582043
4       1          ctc  0.189985
..    …            …         …
16      1  designation  0.865536
17      2  designation  0.454349
18      0         tier  0.059799
19      1         tier  0.979395
20      2         tier  0.623740

[21 rows x 3 columns]
```

[146]:
```python
# pip install plotly
```

[147]:
```python
import plotly.express as px

fig = px.line_polar(polar, r="value", theta="variable", color="label",␣
 ↪line_close=True,height=700,width=800)
fig.show()
```

6.0.2 Feature definitions:

- 1.
- 2.
- 3.

6.1 Super clarity in visualizing the clusters using polar line plots:

6.1.1 Observations and Recommendations:

- We have three cluster mainly (label - 0, 1, 2)
- `job_position` , `years of experience`, `comapny_hash` for all the people in the three cluster is nearly same. So we can compare the other features keeping this useful info in mind.
- The students **whose salaries are already high (Label 2)**, and who comes from a descent job role in a descent company, having slightly more amount experience, hardly care about designation , class or tier as they all are **best of all** !!
  - (Recomm.) Scaler should completely **ignore these students for advertising/marketing their product** as they don't need to upskill as they already are **super skilled.**
  - (Recomm.) Instead, Scaler team should identify and talk to these folks **if they are interested in teaching/mentoring**. This way, Scaler would be having **best of the best instructors/mentors** in the business.
- The students **who have median salary (not too high, not too low) (Label 0)**, and who comes from a descent job role in a descent company, having descent amount experience, requires little upscalling.
  - (Recomm.) Scaler should advertise these set of students with **some advanced courses** so that they can compete with top tier students.
- The students **who have least salary (Label 1)**, and who comes from a descent job role in a descent company, having descent amount experience, **requires lots of upscalling**. As these students belongs to **designation - 3, class- 3, tier- 3**
  - (Recomm.) These are the target audience. Scaler team **should heavily focus on advertising / marketing all their tech products/ couses, free master clases**, to these set of learners

[148]:
```
!pip install pyclustertend==1.4.9
```

```
Requirement already satisfied: pyclustertend==1.4.9 in
/usr/local/lib/python3.10/dist-packages (1.4.9)
```

[149]:
```
import matplotlib.pyplot as plt
import seaborn as sns
import sklearn
from sklearn.cluster import KMeans
from pyclustertend import hopkins
from sklearn.preprocessing import scale
```

[150]:
```
data_new = data.copy()
```

[151]:
```
# data_new.drop('label', axis = 1,inplace = True)
```

[152]:
```
data_new.dropna(inplace=True)
```

[153]:
```
data_new
```

[153]:
```
        company_hash       ctc  job_position  years_of_experience  classs  \
0                 45  0.330330           377                  6.0       1
1               1497  0.135134           235                  4.0       3
2                  0  0.600600           105                  7.0       1
3                936  0.210210           105                  5.0       3
4               1535  0.420420           235                  5.0       1
…                  …         …             …                    …       …
146047           884  0.675675             0                 11.0       1
146048          2158  0.066066             0                 14.0       3
146049           636  0.150150             0                  5.0       3
146050          2186  0.210210             0                  1.0       3
146051           127  0.372372             0                  8.0       3

        designation  tier
0                 2     2
1                 3     3
2                 1     1
3                 3     3
4                 2     1
…                 …     …
146047            1     1
146048            2     3
146049            3     3
146050            2     3
146051            3     3

[146052 rows x 7 columns]
```

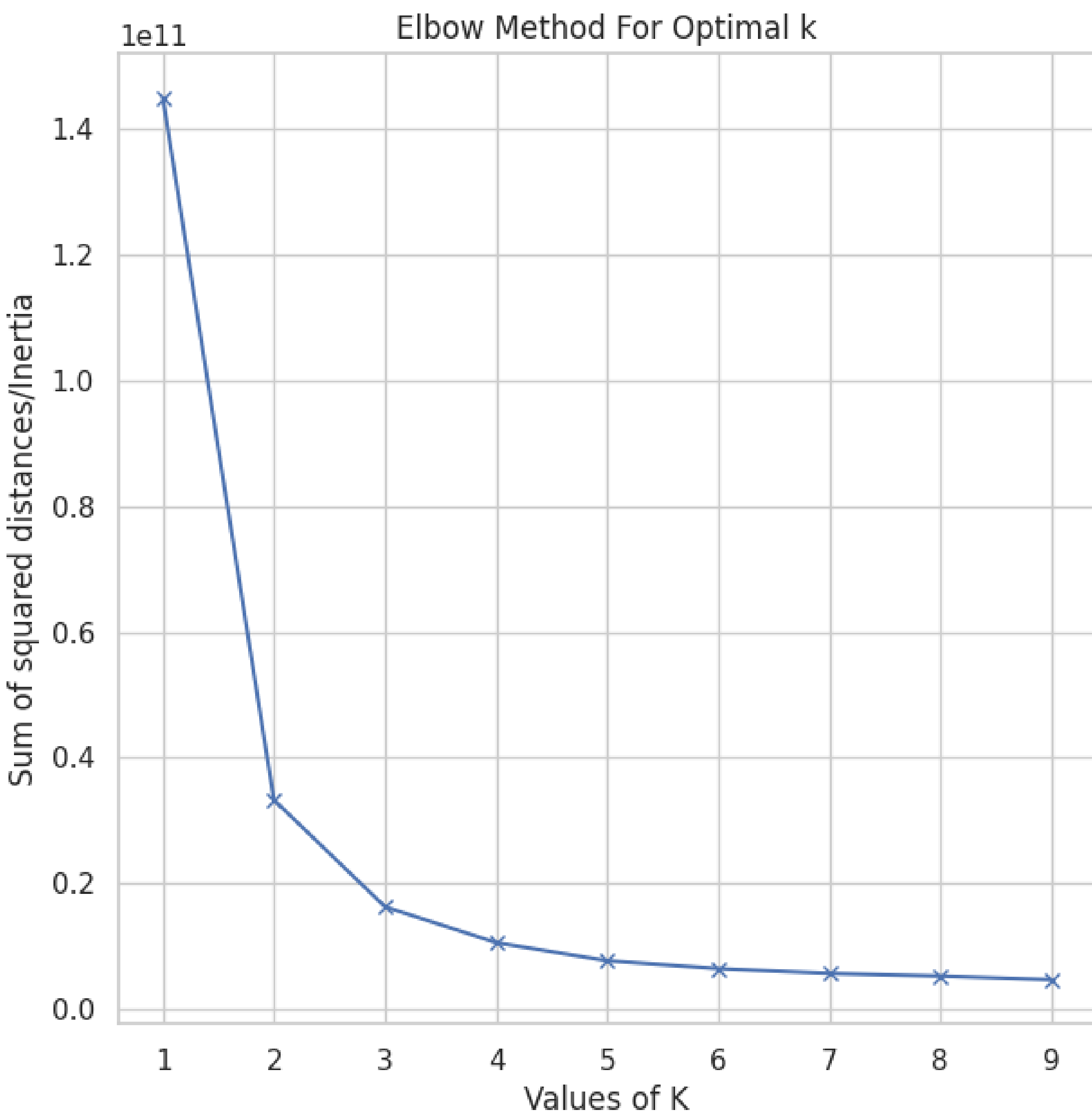
[154]:
```
hop=hopkins(data_new,150)
```

[155]:
```
hop
```

[155]:
```
0.057361554817738185
```

[156]:
```
plt.figure(figsize = (7,7))
Sum_of_squared_distances = []
K = range(1,10)
for num_clusters in K :
    kmeans = KMeans(n_clusters=num_clusters)
    kmeans.fit(data_new)
    Sum_of_squared_distances.append(kmeans.inertia_)
plt.plot(K,Sum_of_squared_distances,'bx-')
plt.xlabel('Values of K')
plt.ylabel('Sum of squared distances/Inertia')
plt.title('Elbow Method For Optimal k')
```

```
plt.show()
```



From above plot, it's clear that we require 3 clusters and our earlier assumption is correct.

[157]:
```
kmeans = KMeans(n_clusters=3)
kmeans.fit(data_new)
print(kmeans.cluster_centers_)
print(kmeans.cluster_centers_.shape)
```

```
[[2.20004364e+02 3.38710849e-01 1.89451912e+02 6.82628404e+00
  2.20934977e+00 2.16183802e+00 2.24353766e+00]
 [2.41601544e+03 3.28778754e-01 1.78887926e+02 6.30840606e+00
  2.19061878e+00 2.11384724e+00 2.24195741e+00]
 [1.25708218e+03 3.53266177e-01 1.75597005e+02 6.46729692e+00
  2.17258388e+00 2.08546987e+00 2.23449622e+00]]
(3, 7)
```

[158]:

```
data_new['k-m label']=kmeans.fit_predict(data_new)
```

[159]:

```
data_new
```

[159]:

```
        company_hash       ctc  job_position  years_of_experience  classs  \
0                 45  0.330330           377                  6.0       1
1               1497  0.135134           235                  4.0       3
2                  0  0.600600           105                  7.0       1
3                936  0.210210           105                  5.0       3
4               1535  0.420420           235                  5.0       1
…                …       …           …                   …     …
146047           884  0.675675             0                 11.0       1
146048          2158  0.066066             0                 14.0       3
146049           636  0.150150             0                  5.0       3
146050          2186  0.210210             0                  1.0       3
146051           127  0.372372             0                  8.0       3

        designation  tier  k-m label
0                 2     2          0
1                 3     3          2
2                 1     1          0
3                 3     3          2
4                 2     1          2
…               …   …        …
146047            1     1          2
146048            2     3          1
146049            3     3          0
146050            2     3          1
146051            3     3          0

[146052 rows x 8 columns]
```

[160]:

```
data_new.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 146052 entries, 0 to 146051
Data columns (total 8 columns):
 #   Column               Non-Null Count   Dtype
---  ------               --------------   -----
 0   company_hash         146052 non-null  int64
```

```
 1   ctc                 146052 non-null  float64
 2   job_position        146052 non-null  int64
 3   years_of_experience 146052 non-null  float64
 4   classs              146052 non-null  int64
 5   designation         146052 non-null  int64
 6   tier                146052 non-null  int64
 7   k-m label           146052 non-null  int32
dtypes: float64(2), int32(1), int64(5)
memory usage: 8.4 MB
```

[161]:

```
df_cjy_cj_c
```

[161]:

```
                      company_hash  orgyear      ctc       job_position  \
0                  atrgxnnt xzaxv   2016.0  1100000              other
1     qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                          Others   2015.0  2000000    backend engineer
3                       ngpgutaxv   2017.0   700000    backend engineer
4                     qxen sqghu   2017.0  1400000  fullstack engineer
…                              …       …       …                  …
146047                  mvqwrvjo   2011.0  2250000             Others
146048                 vuurt xzw   2008.0   220000             Others
146049                 husqvawgb   2017.0   500000             Others
146050                  vwwgrxnt   2021.0   700000             Others
146051           bgqsvz onvzrtj   2014.0  1240000             Others

        ctc_updated_year  years_of_experience  classs  designation    count  \
0                 2020.0                  6.0       1            2      9.0
1                 2019.0                  4.0       3            3    384.0
2                 2020.0                  7.0       1            1  24489.0
3                 2019.0                  5.0       3            3     59.0
4                 2019.0                  5.0       1            2      6.0
…                      …                    …       …            …        …
146047            2019.0                 11.0       1            1     65.0
146048            2019.0                 14.0       3            2     16.0
146049            2020.0                  5.0       3            3     97.0
146050            2021.0                  1.0       3            2    157.0
146051            2016.0                  8.0       3            3    472.0

                mean           std       min        25%        50%        75%  \
0       1.115667e+06  4.581119e+05  500000.0   800000.0  1070000.0  1500000.0
1       1.055291e+06  6.360957e+05   10000.0   600000.0   850000.0  1500000.0
2       9.675951e+05  7.616669e+05      15.0   390000.0   800000.0  1400000.0
3       1.455508e+06  6.554235e+05  200000.0  1075000.0  1300000.0  1850000.0
4       9.400000e+05  3.898718e+05  540000.0   625000.0   850000.0  1300000.0
…                  …             …         …          …          …          …
146047  1.264431e+06  5.743451e+05  500000.0   800000.0  1040000.0  1600000.0
146048  1.568312e+06  1.231984e+06   60000.0   216250.0  2275000.0  2550000.0
```

```
146049  1.275361e+06  5.880548e+05  200000.0   850000.0  1150000.0  1600000.0
146050  1.344255e+06  5.743742e+05  200000.0  1000000.0  1300000.0  1500000.0
146051  1.844892e+06  7.137398e+05    1000.0  1500000.0  1800000.0  2250000.0

              max  tier
0       1771000.0     2
1       3200000.0     3
2       3329999.0     1
3       3160000.0     3
4       1400000.0     1
…             …     …
146047  3200000.0     1
146048  3000000.0     3
146049  3200000.0     3
146050  3000000.0     3
146051  3300000.0     3

[146052 rows x 17 columns]
```

[162]:
```
df_cjy_cj_c.
↪drop(columns=['count','mean','std','min','25%','50%','75%','max'],inplace=True)
```

[163]:
```
data_org = df_cjy_cj_c.copy()
```

[164]:
```
final_data = pd.concat([data_org,data_new['k-m label']], axis=1)
final_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 146052 entries, 0 to 146051
Data columns (total 10 columns):
 #   Column               Non-Null Count   Dtype
---  ------               --------------   -----
 0   company_hash         146052 non-null  object
 1   orgyear              146052 non-null  float64
 2   ctc                  146052 non-null  int64
 3   job_position         146052 non-null  object
 4   ctc_updated_year     146052 non-null  float64
 5   years_of_experience  146052 non-null  float64
 6   classs               146052 non-null  int64
 7   designation          146052 non-null  int64
 8   tier                 146052 non-null  int64
 9   k-m label            146052 non-null  int32
dtypes: float64(3), int32(1), int64(4), object(2)
memory usage: 10.6+ MB
```

[165]:
```
final_data
```

[165]:

```
                    company_hash  orgyear      ctc        job_position  \
0              atrgxnnt xzaxv   2016.0  1100000               other
1     qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                        Others   2015.0  2000000    backend engineer
3                     ngpgutaxv   2017.0   700000    backend engineer
4                     qxen sqghu   2017.0  1400000  fullstack engineer
…                            …      …        …                 …
146047                 mvqwrvjo   2011.0  2250000              Others
146048                vuurt xzw   2008.0   220000              Others
146049                husqvawgb   2017.0   500000              Others
146050                 vwwgrxnt   2021.0   700000              Others
146051           bgqsvz onvzrtj   2014.0  1240000              Others

        ctc_updated_year  years_of_experience  classs  designation  tier  \
0                 2020.0                  6.0       1            2     2
1                 2019.0                  4.0       3            3     3
2                 2020.0                  7.0       1            1     1
3                 2019.0                  5.0       3            3     3
4                 2019.0                  5.0       1            2     1
…                    …                    …      …          …    …
146047            2019.0                 11.0       1            1     1
146048            2019.0                 14.0       3            2     3
146049            2020.0                  5.0       3            3     3
146050            2021.0                  1.0       3            2     3
146051            2016.0                  8.0       3            3     3

        k-m label
0               0
1               2
2               0
3               2
4               2
…           …
146047          2
146048          1
146049          0
146050          1
146051          0

[146052 rows x 10 columns]
```

[166]:

```
data_frac=data_new.sample(frac=0.0025)
#the most we could do without crashing
```

[167]:

```
data_frac
```

[167]:
```
        company_hash       ctc  job_position  years_of_experience  classs  \
131463          1926  0.390390             0                  6.0       3
5771             569  0.750751             0                  4.0       1
86562           2309  0.162162             0                  2.0       2
28327           2191  0.135135           679                  5.0       2
142745          2918  0.630630             0                  4.0       1
…                  …       …             …                    …     …
71366           2176  0.255255           686                  9.0       3
78411            252  0.270270           230                  5.0       2
64197            519  0.450450           235                  7.0       3
17649           2191  0.270270             0                  3.0       2
132246          1926  0.360360             0                  4.0       3

        designation  tier  k-m label
131463            3     3          1
5771              1     1          0
86562             2     2          1
28327             2     3          1
142745            1     1          1
…               …     …        …
71366             3     3          1
78411             1     2          0
64197             3     3          0
17649             1     2          1
132246            1     3          1

[365 rows x 8 columns]
```

[168]:
```python
data_frac.drop('k-m label', axis = 1, inplace = True)
```

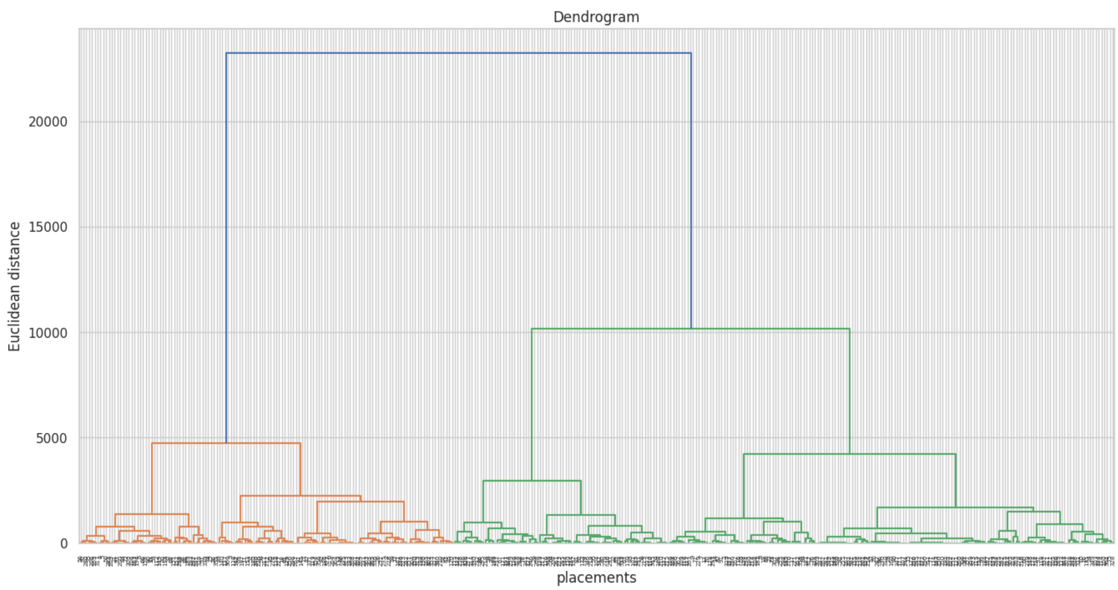
[169]:
```python
data_frac.info(verbose=True)
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 365 entries, 131463 to 132246
Data columns (total 7 columns):
 #   Column               Non-Null Count  Dtype
---  ------               --------------  -----
 0   company_hash         365 non-null    int64
 1   ctc                  365 non-null    float64
 2   job_position         365 non-null    int64
 3   years_of_experience  365 non-null    float64
 4   classs               365 non-null    int64
 5   designation          365 non-null    int64
 6   tier                 365 non-null    int64
dtypes: float64(2), int64(5)
memory usage: 22.8 KB
```

[170]:
```python
import sys
sys.setrecursionlimit(100000)
```

[171]:
```python
# Visual representation of clusters using dendrogram

plt.figure(figsize = (16,8))
import scipy.cluster.hierarchy as sch
dendrogrm = sch.dendrogram(sch.linkage(data_frac, method = 'ward'))
plt.title('Dendrogram')
plt.xlabel('placements')
plt.ylabel('Euclidean distance')
plt.show()
```



[171]:
```python

```

[172]:
```python
from sklearn.cluster import AgglomerativeClustering
model = AgglomerativeClustering(n_clusters=3, affinity='euclidean',␣
↪linkage='ward')
model.fit(data_frac)
```

[172]: AgglomerativeClustering(affinity='euclidean', n_clusters=3)

[173]:
```python
data_frac['Aglo-label'] = model.fit_predict(data_frac)
```

[174]:
```python
data_frac
```

[174]:
```
        company_hash       ctc  job_position  years_of_experience  classs  \
131463          1926  0.390390             0                  6.0       3
5771             569  0.750751             0                  4.0       1
86562           2309  0.162162             0                  2.0       2
28327           2191  0.135135           679                  5.0       2
142745          2918  0.630630             0                  4.0       1
…                …       …            …                   …      …
71366           2176  0.255255           686                  9.0       3
78411            252  0.270270           230                  5.0       2
64197            519  0.450450           235                  7.0       3
17649           2191  0.270270             0                  3.0       2
132246          1926  0.360360             0                  4.0       3

        designation  tier  Aglo-label
131463            3     3           0
5771              1     1           1
86562             2     2           0
28327             2     3           0
142745            1     1           0
…              …     …         …
71366             3     3           0
78411             1     2           1
64197             3     3           1
17649             1     2           0
132246            1     3           0

[365 rows x 8 columns]
```

[175]:
```
final_data
```

[175]:
```
                     company_hash  orgyear      ctc        job_position  \
0                  atrgxnnt xzaxv   2016.0  1100000               other
1       qtrxvzwt xzegwgbb rxbxnta   2018.0   449999  fullstack engineer
2                          Others   2015.0  2000000    backend engineer
3                       ngpgutaxv   2017.0   700000    backend engineer
4                      qxen sqghu   2017.0  1400000  fullstack engineer
…                            …      …      …                 …
146047                   mvqwrvjo   2011.0  2250000              Others
146048                  vuurt xzw   2008.0   220000              Others
146049                  husqvawgb   2017.0   500000              Others
146050                   vwwgrxnt   2021.0   700000              Others
146051             bgqsvz onvzrtj   2014.0  1240000              Others

        ctc_updated_year  years_of_experience  classs  designation  tier  \
0                 2020.0                  6.0       1            2     2
1                 2019.0                  4.0       3            3     3
2                 2020.0                  7.0       1            1     1
```

```
3                 2019.0                    5.0       3            3     3
4                 2019.0                    5.0       1            2     1
…                  …                  …     …           …   …
146047            2019.0                   11.0       1            1     1
146048            2019.0                   14.0       3            2     3
146049            2020.0                    5.0       3            3     3
146050            2021.0                    1.0       3            2     3
146051            2016.0                    8.0       3            3     3

        k-m label
0               0
1               2
2               0
3               2
4               2
…           …
146047          2
146048          1
146049          0
146050          1
146051          0

[146052 rows x 10 columns]
```

6.1.2 To conclude, above is the final_data with all required features.

- We can submit this data to marketing team so that they can focus on those clusters of students who are in dire need and are willing to move forward in life.