scaler-clustering-akash

January 28, 2024

[186]:
```
import pandas as pd
import numpy as np
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import StandardScaler
from matplotlib import pyplot as plt
plt.rcParams["figure.figsize"] = (18,10)
import re
import seaborn as sns
```

0.0.1 Problem Statement - To cluster or group CTC that company provides based on features of its employees like orgyear, CTC, job_position & ctc_updated_year

[187]:
```
pd.set_option('display.max_columns', None)
pd.set_option('display.max_colwidth', None)
```

[188]:
```
df = pd.read_csv('https://d2beiqkhq929f0.cloudfront.net/public_assets/assets/
↪000/002/856/original/scaler_clustering.csv')
```

[189]:
```
df
```

[189]:

	Unnamed: 0	company_hash	email_hash
0	0	atrgxnnt xzaxv	6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1	1	qtrxvzwt xzegwgbb rxbxnta	b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2	2	ojzwnvwnxw vx	4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
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	

```
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205838  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205839  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205840  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205841  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205842  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year
0        2016.0  1100000               Other            2020.0
1        2018.0   449999  FullStack Engineer            2019.0
2        2015.0  2000000    Backend Engineer            2020.0
3        2017.0   700000    Backend Engineer            2019.0
4        2017.0  1400000  FullStack Engineer            2019.0
…           …       …                   …                …
205838   2008.0   220000                 NaN            2019.0
205839   2017.0   500000                 NaN            2020.0
205840   2021.0   700000                 NaN            2021.0
205841   2019.0  5100000                 NaN            2019.0
205842   2014.0  1240000                 NaN            2016.0

[205843 rows x 7 columns]
```

0.1 EDA

[190]:
```
df.columns
```

[190]:
```
Index(['Unnamed: 0', 'company_hash', 'email_hash', 'orgyear', 'ctc',
       'job_position', 'ctc_updated_year'],
      dtype='object')
```

[191]:
```
df = df.rename(columns={'Unnamed: 0': 'id'})
```

[192]:
```
df.describe()
```

[192]:
```
                  id        orgyear           ctc  ctc_updated_year
count  205843.000000  205757.000000  2.058430e+05     205843.000000
mean   103273.941786    2014.882750  2.271685e+06       2019.628231
std     59741.306484      63.571115  1.180091e+07          1.325104
min         0.000000       0.000000  2.000000e+00       2015.000000
25%     51518.500000    2013.000000  5.300000e+05       2019.000000
50%    103151.000000    2016.000000  9.500000e+05       2020.000000
75%    154992.500000    2018.000000  1.700000e+06       2021.000000
max    206922.000000   20165.000000  1.000150e+09       2021.000000
```

[193]:
```
num_cols = df.select_dtypes(include=['float64', 'int64']).columns.tolist()
num_cols
```

[193]:
```
['id', 'orgyear', 'ctc', 'ctc_updated_year']
```

[194]:
```
# Create histograms for numeric feature columns
df['orgyear'].value_counts()
```

[194]:
```
2018.0    25256
2019.0    23427
2017.0    23239
2016.0    23043
2015.0    20610
          …
2107.0        1
1972.0        1
2101.0        1
208.0         1
200.0         1
Name: orgyear, Length: 77, dtype: int64
```

[195]:
```
# Data cleaning
# we see max orgyear 20165 which is wrong year so need to replace it to max year
maxYear = df['orgyear'].max()
print(maxYear)
maxYearCTC = df['ctc_updated_year'].max()
print(maxYearCTC)
```

```
20165.0
2021.0
```

[196]:
```
df.shape
```

[196]:
```
(205843, 7)
```

[197]:
```
# lets remove this filtered data as it pollutes Employment start date cannot be
  ↪<1980 and >2023
df_range = df[(df['orgyear']>=1980) & (df['orgyear']<=2023)]
df_range
```

[197]:
```
             id               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  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205838  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205839  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205840  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205841  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205842  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year
0        2016.0  1100000               Other            2020.0
1        2018.0   449999  FullStack Engineer            2019.0
2        2015.0  2000000    Backend Engineer            2020.0
3        2017.0   700000    Backend Engineer            2019.0
4        2017.0  1400000  FullStack Engineer            2019.0
…           …        …                   …               …
205838   2008.0   220000                 NaN            2019.0
205839   2017.0   500000                 NaN            2020.0
205840   2021.0   700000                 NaN            2021.0
205841   2019.0  5100000                 NaN            2019.0
205842   2014.0  1240000                 NaN            2016.0

[205619 rows x 7 columns]
```

[198]:
```
df = df_range.copy()
```

[199]:
```
# df.drop('Unnamed: 0', axis=1, inplace=True)
```

[200]:
```
df.isna().sum()
```

[200]:
```
id                    0
company_hash         44
email_hash            0
orgyear               0
ctc                   0
job_position      52497
ctc_updated_year      0
```

```
dtype: int64
```

[201]:
```
df[df['company_hash'].isna()]
```

[201]:

	id	company_hash
1115	1115	NaN
2400	2400	NaN
3277	3277	NaN
4205	4205	NaN
4596	4597	NaN
11753	11761	NaN
14739	14748	NaN
18853	18865	NaN
19466	19478	NaN
22846	22864	NaN
31489	31521	NaN
40272	40319	NaN
45630	45684	NaN
48583	48638	NaN
62974	63058	NaN
68706	68803	NaN
71138	71237	NaN
76614	76723	NaN
79347	79461	NaN
80516	80639	NaN
82680	82815	NaN
85037	85181	NaN
93712	93891	NaN
103107	103338	NaN
103299	103530	NaN
108479	108738	NaN
117021	117331	NaN
117915	118227	NaN
125509	125889	NaN
130031	130449	NaN
141214	141719	NaN
141355	141860	NaN
142613	143135	NaN
142955	143477	NaN
146191	146743	NaN
156511	157132	NaN
162073	162746	NaN
171527	172311	NaN
175270	176096	NaN
176727	177565	NaN
178114	178957	NaN
178330	179173	NaN

```
194796  195788          NaN
202282  203348          NaN

                                                                email_hash  \
1115    8fe09b732fe2e5b66c14904fd02ff89fb54f458465ac1e5b04468e11db641e01
2400    1074b55f02e6fc88596db85854e057c98cb53c038e0d7f3d5e353e0c1d1a977b
3277    66263f4942b046c67ae6e2570e7825c03792631a0b13f1b5fed1fe3eafc396db
4205    6eb55d779699a2ea94f340ab7a58c8ec505e38bbb41214278e72b5f03d2af064
4596    18813fe2a50a45cc02c5b3871c676bd147c80ff0327ee9e7bd8d9c121d9fa6d3
11753   ea4f735b9357e8086a42bacc1f64b18e98c3dd1ad81f60140c0f4e6be8616830
14739   b4a56d1199bc569aabd30cba8ea7a86fbddc85211453bac05e92b44a8e82e090
18853   07a60d6e853852471b0963b78a0a3074532572a258086431b4a14a2a1e2aaecc
19466   07a60d6e853852471b0963b78a0a3074532572a258086431b4a14a2a1e2aaecc
22846   bdce6736cc1d55a909a46aed9e0bfdcd7cd523bfcf9b63ffa17c618a9a6424e5
31489   8e70184e76f9a29078e8ddd928d24582e096f5b1a63197a6e3803966b40bff31
40272   4baf80fe2b9513f2f1d17d90f26071bd21f4a89d865fa1d16a18143c7b94e972
45630   b17c74b195c1fa8038bf82c674716ae81b41b995a3b4349fb7ae7d07e0873599
48583   d9d7be8e4e4e5b6eb1092772d366c6bb21c8502e0e8253871fd6605da409e721
62974   8420dc8fe52b5acaf629914b3917fbc37111924b9654042f659f342abb9ea48f
68706   8fe09b732fe2e5b66c14904fd02ff89fb54f458465ac1e5b04468e11db641e01
71138   8ce727669517d613c973b752e211e50f0bad3cab50d7cb1e03517b100bdb0473
76614   c83f98e2b2fb365515f48002f40db363a9de3319069f383a64f16d8b94d6bcc9
79347   1a5f329f97cdac513d7e33b5f8705e46053595ef6254c90ff68ba3d711588542
80516   cd6bc6ddf180c00306ad009a187cc5eb2a4b62af4ad58427f058a459a1ed8287
82680   5ef6071f5c390f317dfa60f7aadb9ee7a1abc92aaa02fc68c4b479578b52eca8
85037   a80b0711a63a65c0b70c3ed3f825043a8fc2b6871c3b0e53aad5dff78929c197
93712   50f183667fd8a115dda5aa345988b314e1d98a3d937ea047ad82db9148caddbc
103107  98177023d0d95876047a39ed525d4c7eb44af739502aca75a9b78373ef88eb29
103299  87f640fc89281c082d94d1ee7fd6ee7391a8e30ad6182ba292ddd14aa502ba59
108479  50f183667fd8a115dda5aa345988b314e1d98a3d937ea047ad82db9148caddbc
117021  1606fcb8a2b3e4b242df4ee71190194fc556cf0d54861633038209d41757b52a
117915  f4bb477609fc559301e37c73a5b17428afe18c53c0fa27f4993cba5efb3f425b
125509  9f9ba6d4e58f4f175f348d6d188be8ee8d5aa3537a0187ae5c6b7b067f01e051
130031  d7f39bfaa3be4957fa36a97fabb5ab7a39f6d55f377f334ece6bd1b3c8f6558a
141214  cd281f18ef3d9042fab48860b4a7f80ec1d559c3fc2f857c266fc367b05a4e4d
141355  a51106f9193e46db561f27b02db413396e651be5394ca5e008ce4bdc1fc9ae75
142613  ce803383ed3dda0838959afb466eb1cffff964c94cb1ea7cc5dec8e6293e61d4
142955  f47fbe35140825c07caf830b18058e737a3c6f18c50f503c535e5efdfbe5ac50
146191  f47fbe35140825c07caf830b18058e737a3c6f18c50f503c535e5efdfbe5ac50
156511  c9af26980cf32f393089c1b33d3e138450e506b2d044a359a23d117e36362ff5
162073  d000a77f0045504e2ee51a667ac0ad2671795b3f70ce33f16f9c06ba4ca20aa1
171527  824c00340acc623b57c75ca41535bf9d52fdee81d006bf7991990f47b1a62d99
175270  aae19078f349d6403856abf2c28ee731a32c0dbeb8de76587828b494a777454a
176727  a75da322109f201148da6b4a1ab785518e6229c1379a09a2501fa05a5ee19252
178114  3fd7b50dc84e8b2493f097c6fc33c8abed19107ed0b1d3f7330668f89f0bcfcd
178330  0e781c3797c031c6aad2fa3d97c82773624a5da9a35de93195eb67c77e0199e3
194796  c1ef4ed5eeb40dcacbb5f7d0fc345fb77c6176024eb2391f124989b73f76f4fc
```

202282 c9af26980cf32f393089c1b33d3e138450e506b2d044a359a23d117e36362ff5

	orgyear	ctc	job_position	ctc_updated_year
1115	2022.0	66600000	NaN	2020.0
2400	2018.0	250000	Other	2019.0
3277	2018.0	500000	Other	2019.0
4205	2018.0	600000	NaN	2020.0
4596	2020.0	300000	NaN	2021.0
11753	2018.0	300000	NaN	2021.0
14739	2013.0	1600000	NaN	2021.0
18853	2017.0	700000	FullStack Engineer	2021.0
19466	2017.0	700000	NaN	2021.0
22846	2010.0	2000000	NaN	2020.0
31489	2018.0	229999	NaN	2021.0
40272	2012.0	2000000	NaN	2021.0
45630	2020.0	600000	NaN	2020.0
48583	2011.0	910000	Data Scientist	2019.0
62974	2018.0	300000	NaN	2018.0
68706	2022.0	66600000	Database Administrator	2020.0
71138	2019.0	200000	NaN	2020.0
76614	2014.0	1000000	NaN	2021.0
79347	2015.0	2200000	NaN	2021.0
80516	2017.0	300000	NaN	2021.0
82680	2014.0	600000	NaN	2019.0
85037	2019.0	1200000	FullStack Engineer	2018.0
93712	2019.0	500000	Database Administrator	2019.0
103107	2011.0	1200000	NaN	2021.0
103299	2013.0	400000	NaN	2021.0
108479	2019.0	500000	NaN	2019.0
117021	2016.0	700000	NaN	2016.0
117915	2015.0	600000	NaN	2021.0
125509	2017.0	400000	NaN	2021.0
130031	2015.0	800000	Backend Engineer	2019.0
141214	2006.0	1000000	NaN	2019.0
141355	2015.0	110000	NaN	2016.0
142613	2018.0	2000000	Data Analyst	2018.0
142955	2019.0	2700000	FullStack Engineer	2019.0
146191	2019.0	2700000	NaN	2019.0
156511	2021.0	900000	NaN	2020.0
162073	2020.0	800000	NaN	2019.0
171527	2012.0	2100000	Other	2021.0
175270	2018.0	956000	NaN	2017.0
176727	2017.0	1200000	NaN	2018.0
178114	2007.0	132000	NaN	2017.0
178330	2018.0	1800000	NaN	2016.0
194796	2019.0	2000000	Data Scientist	2019.0
202282	2021.0	900000	Other	2020.0

[202]:
```
df.describe(include='object')
```

[202]:
```
                     company_hash  \
count                      205575
unique                      37238
top     nvnv wgzohrnvzwj otqcxwto
freq                         8335

                                                                email_hash  \
count                                                               205619
unique                                                              153253
top     bbace3cc586400bbc65765bc6a16b77d8913836cfc98b77c05488f02f5714a4b
freq                                                                    10

            job_position
count             153122
unique              1017
top     Backend Engineer
freq               43522
```

[203]:
```
company_group = df[df['company_hash']=='qtrxvzwt xzegwgbb rxbxnta']
company_group
```

[203]:
```
             id               company_hash  \
1             1  qtrxvzwt xzegwgbb rxbxnta
697         697  qtrxvzwt xzegwgbb rxbxnta
739         739  qtrxvzwt xzegwgbb rxbxnta
1389       1389  qtrxvzwt xzegwgbb rxbxnta
3118       3118  qtrxvzwt xzegwgbb rxbxnta
…           …                        …
198705   199734  qtrxvzwt xzegwgbb rxbxnta
200421   201469  qtrxvzwt xzegwgbb rxbxnta
201488   202539  qtrxvzwt xzegwgbb rxbxnta
202366   203432  qtrxvzwt xzegwgbb rxbxnta
204928   206006  qtrxvzwt xzegwgbb rxbxnta

                                                                email_hash  \
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
697     8dcec4009f7a5bdd8c6a2af379b5763816563e25d814d018daa334db7843efff
739     f4fa64972185ac2b73e99c0cc10d1bf50d6dbfbc9a2cbad8d14714cad5df925f
1389    97f1a965db57f2baacbbacf36b9572819e8a90007e3c86d090ddc96ab8fc7fd7
3118    fe8010b8aa29f7bd16d111ab332881cdfc819fbcc82b5d9b690ffe16310c2d44
…                                                                     …
198705  b67301f0a89fd75a87fb41e5eb7627735b7f75a06741e63faf62ce5c4fb358a3
200421  a9aa04db60d145b683c55499d8cdcfd5f1435a61e98d34659248bc8cbf491e08
201488  926f89662afe3e36f2577c8b5e313d47f433d363c1ca001caf10ee06b954145a
202366  0d9a272375d925015b9553d363a7d7c9984ce29fe755e4f73407ddf19983ac86
```

```
204928  534d61366054ec570b655666c6da30b7539ac99d9dd6fd5a619fbb6d2a28148d

        orgyear      ctc        job_position  ctc_updated_year
1        2018.0   449999  FullStack Engineer            2019.0
697      2018.0   700000    Backend Engineer            2020.0
739      2018.0   620000  FullStack Engineer            2020.0
1389     2020.0  1100000                 NaN            2021.0
3118     2019.0   630000    Backend Engineer            2021.0
…           …       …                   …               …
198705   2014.0  1300000    Backend Engineer            2019.0
200421   2018.0   457000        Data Analyst            2021.0
201488   2005.0  1750000        iOS Engineer            2019.0
202366   2018.0   450000    Backend Engineer            2020.0
204928   2017.0   450000     Devops Engineer            2019.0

[428 rows x 7 columns]
```

[204]:
```
# Checking unique emails and frequency of occurrence of the same email hash in␣
 ↪the data.
# Recording observation and inference, wherever necessary.
email_counts = df['email_hash'].value_counts()
email_counts
```

[204]:
```
bbace3cc586400bbc65765bc6a16b77d8913836cfc98b77c05488f02f5714a4b    10
6842660273f70e9aa239026ba33bfe82275d6ab0d20124021b952b5bc3d07e6c     9
298528ce3160cc761e4dc37a07337ee2e0589df251d73645aae209b010210eee     9
3e5e49daa5527a6d5a33599b238bf9bf31e85b9efa9a94f1c88c5e15a6f31378     9
b4d5afa09bec8689017d8b29701b80d664ca37b83cb883376b2e95191320da66     8
                                                                    ..
1bf133f4545f330347ce99d4ef23e10d08c72a6d2a71d1fff92426adebbafe7a     1
352332d97ee4a09346cd4b539c096843c97f6e88352adeaeb132e52c7fe15143     1
ce7b0b9c2d37b0df8fc9f9436961ece9086226b6450ace168bb475017bdd87c6     1
6ed7767a6ba36e8ab4f4d2397a4d32f26f34387720645906bf51a05c2152fd56     1
0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31     1
Name: email_hash, Length: 153253, dtype: int64
```

[205]:
```
email_group =␣
 ↪df[df['email_hash']=='b4d5afa09bec8689017d8b29701b80d664ca37b83cb883376b2e95191320da66']
email_group
```

[205]:
```
            id  company_hash  \
37734    37778  bvi ogenfvqt
45982    46036  bvi ogenfvqt
144760  145307  bvi ogenfvqt
151714  152309  bvi ogenfvqt
153866  154474  bvi ogenfvqt
154644  155256  bvi ogenfvqt
```

```
197145  198160  bvi ogenfvqt
203171  204242  bvi ogenfvqt

                                                                email_hash  \
37734   b4d5afa09bec8689017d8b29701b80d664ca37b83cb883376b2e95191320da66
45982   b4d5afa09bec8689017d8b29701b80d664ca37b83cb883376b2e95191320da66
144760  b4d5afa09bec8689017d8b29701b80d664ca37b83cb883376b2e95191320da66
151714  b4d5afa09bec8689017d8b29701b80d664ca37b83cb883376b2e95191320da66
153866  b4d5afa09bec8689017d8b29701b80d664ca37b83cb883376b2e95191320da66
154644  b4d5afa09bec8689017d8b29701b80d664ca37b83cb883376b2e95191320da66
197145  b4d5afa09bec8689017d8b29701b80d664ca37b83cb883376b2e95191320da66
203171  b4d5afa09bec8689017d8b29701b80d664ca37b83cb883376b2e95191320da66

        orgyear      ctc            job_position  ctc_updated_year
37734    2020.0   900000  Engineering Leadership            2021.0
45982    2020.0   900000      Engineering Intern            2021.0
144760   2020.0   900000            Data Analyst            2021.0
151714   2020.0   900000         Data Scientist             2021.0
153866   2020.0   900000                     NaN            2021.0
154644   2020.0   900000    Software Engineer 1             2021.0
197145   2020.0  2000000      Engineering Intern            2021.0
203171   2020.0  2000000            Data Analyst            2021.0
```

We notice that for every email hash repetition only 1 unique company_hash exists.

[206]:
```
# remove special characters from the dataset by using Regex for cleaning␣
 ↪company names
df['company_hash'] = df['company_hash'].str.replace('[^A-Za-z0-9 ]+', '',␣
 ↪regex=True)
df
```

[206]:
```
            id               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  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
```

```
2         4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3         effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4         6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                       …
205838    70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205839    7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205840    cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205841    fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205842    0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year
0        2016.0  1100000               Other            2020.0
1        2018.0   449999  FullStack Engineer            2019.0
2        2015.0  2000000    Backend Engineer            2020.0
3        2017.0   700000    Backend Engineer            2019.0
4        2017.0  1400000  FullStack Engineer            2019.0
…           …       …                   …                …
205838   2008.0   220000                 NaN            2019.0
205839   2017.0   500000                 NaN            2020.0
205840   2021.0   700000                 NaN            2021.0
205841   2019.0  5100000                 NaN            2019.0
205842   2014.0  1240000                 NaN            2016.0

[205619 rows x 7 columns]
```

Handling null values in dataset

[207]:
```
# replace NA in company_hash to first value of email_hash (just for uniqueness,␣
 ↪we will do label encoding later)
grouped = df.groupby('company_hash')

# Define a function to fill NA values with the first 'email_hash' value in the␣
 ↪group
def fill_na_with_first(group):
    first_email_hash = group['email_hash'].dropna().iloc[0]  # Get the first␣
 ↪non-NA value
    group['company_hash'].fillna(first_email_hash, inplace=True)
    return group

# Apply the function to each group within the DataFrame
df_filled = grouped.apply(fill_na_with_first).reset_index(drop=True)
df_filled
```

```
<ipython-input-207-599f3a77d0e6>:11: FutureWarning: Not prepending group keys to
the result index of transform-like apply. In the future, the group keys will be
included in the index, regardless of whether the applied function returns a
like-indexed object.
```

```
To preserve the previous behavior, use

        >>> .groupby(…, group_keys=False)

To adopt the future behavior and silence this warning, use

        >>> .groupby(…, group_keys=True)
  df_filled = grouped.apply(fill_na_with_first).reset_index(drop=True)
```

[207]:

	id	company_hash	email_hash	orgyear	ctc	job_position	ctc_updated_year
0	0	atrgxnnt xzaxv	6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af	2016.0	1100000	Other	2020.0
1	1	qtrxvzwt xzegwgbb rxbxnta	b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b	2018.0	449999	FullStack Engineer	2019.0
2	2	ojzwnvwnxw vx	4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059	2015.0	2000000	Backend Engineer	2020.0
3	3	ngpgutaxv	effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7	2017.0	700000	Backend Engineer	2019.0
4	4	qxen sqghu	6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095	2017.0	1400000	FullStack Engineer	2019.0
…	…	…	…	…	…	…	…
205570	206918	vuurt xzw	70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05	2008.0	220000	NaN	2019.0
205571	206919	husqvawgb	7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53	2017.0	500000	NaN	2020.0
205572	206920	vwwgrxnt	cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c	2021.0	700000	NaN	2021.0
205573	206921	zgn vuurxwvmrt	fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699	2019.0	5100000	NaN	2019.0
205574	206922	bgqsvz onvzrtj	0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31	2014.0	1240000	NaN	2016.0

```
[205575 rows x 7 columns]
```

[208]:
```
df_filled.isna().sum()
```

[208]:
```
id                     0
company_hash           0
email_hash             0
orgyear                0
ctc                    0
job_position       52466
ctc_updated_year       0
dtype: int64
```

[209]:
```
# replace NA in orgyear to ctc_updated_year
df_filled['orgyear'].fillna(df_filled['ctc_updated_year'], inplace=True)
df_filled
```

[209]:
```
            id               company_hash  \
0            0             atrgxnnt xzaxv
1            1  qtrxvzwt xzegwgbb rxbxnta
2            2              ojzwnvwnxw vx
3            3                  ngpgutaxv
4            4                 qxen sqghu
…          …                        …
205570  206918                  vuurt xzw
205571  206919                  husqvawgb
205572  206920                   vwwgrxnt
205573  206921             zgn vuurxwvmrt
205574  206922             bgqsvz onvzrtj

                                                email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205570  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205571  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205572  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205573  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205574  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year
0        2016.0  1100000               Other            2020.0
1        2018.0   449999  FullStack Engineer            2019.0
```

```
2        2015.0  2000000    Backend Engineer            2020.0
3        2017.0   700000    Backend Engineer            2019.0
4        2017.0  1400000  FullStack Engineer            2019.0
…           …       …                  …                 …
205570   2008.0   220000                NaN            2019.0
205571   2017.0   500000                NaN            2020.0
205572   2021.0   700000                NaN            2021.0
205573   2019.0  5100000                NaN            2019.0
205574   2014.0  1240000                NaN            2016.0

[205575 rows x 7 columns]
```

[210]:
```
df_filled.isna().sum()
```

[210]:
```
id                    0
company_hash          0
email_hash            0
orgyear               0
ctc                   0
job_position      52466
ctc_updated_year      0
dtype: int64
```

[211]:
```
df[df['job_position'].isna()]
```

[211]:
```
            id               company_hash  \
8            8          utqoxontzn ojontbo
9            9                      xrbhd
12          12  mvqwrvjo wgqugqvnt mvzpxzs
17          17                       puxn
18          18               mvlvl exzotqc
…          …                         …
205838  206918                   vuurt xzw
205839  206919                   husqvawgb
205840  206920                    vwwgrxnt
205841  206921              zgn vuurxwvmrt
205842  206922              bgqsvz onvzrtj

                                                email_hash  \
8       e245da546bf50eba09cb7c9976926bd56557d1ac9a17fb019e8de1fdb83fc0d6
9       b2dc928f4c22a9860b4a427efb8ab761e1ce0015fba1a5e804e1dc27e305b06b
12      7f24d2f5171ea469482a9966832237bc023678883ecd0c5142677b75a138b2fa
17      26b502eb6439ac80bd618a6f7c2b1c640b84c1e64c472cf0510b0b36c2d3c247
18      62d2e04b44c8bf2f6ec15d5b4c259c06199f598dc51816b1e32a84bc3ed980ea
…                                                                     …
205838  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205839  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
```

```
205840  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205841  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205842  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc job_position  ctc_updated_year
8        2020.0   450000          NaN            2019.0
9        2019.0   360000          NaN            2019.0
12       2020.0   800000          NaN            2020.0
17       2020.0  1400000          NaN            2019.0
18       2018.0   100000          NaN            2021.0
…           …       …           …                …
205838   2008.0   220000          NaN            2019.0
205839   2017.0   500000          NaN            2020.0
205840   2021.0   700000          NaN            2021.0
205841   2019.0  5100000          NaN            2019.0
205842   2014.0  1240000          NaN            2016.0

[52497 rows x 7 columns]
```

[212]:
```
# replace NA in job_position to Unknown
df_filled['job_position'].fillna("Unknown", inplace=True)
df_filled
```

[212]:
```
            id               company_hash  \
0            0             atrgxnnt xzaxv
1            1  qtrxvzwt xzegwgbb rxbxnta
2            2              ojzwnvwnxw vx
3            3                  ngpgutaxv
4            4                 qxen sqghu
…          …                        …
205570  206918                  vuurt xzw
205571  206919                  husqvawgb
205572  206920                   vwwgrxnt
205573  206921             zgn vuurxwvmrt
205574  206922             bgqsvz onvzrtj

                                                email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205570  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205571  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205572  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205573  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
```

```
205574  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31
```

	orgyear	ctc	job_position	ctc_updated_year
0	2016.0	1100000	Other	2020.0
1	2018.0	449999	FullStack Engineer	2019.0
2	2015.0	2000000	Backend Engineer	2020.0
3	2017.0	700000	Backend Engineer	2019.0
4	2017.0	1400000	FullStack Engineer	2019.0
…	…	…	…	…
205570	2008.0	220000	Unknown	2019.0
205571	2017.0	500000	Unknown	2020.0
205572	2021.0	700000	Unknown	2021.0
205573	2019.0	5100000	Unknown	2019.0
205574	2014.0	1240000	Unknown	2016.0

[205575 rows x 7 columns]

[213]:
```
df_filled.isna().sum()
```

[213]:
```
id                 0
company_hash       0
email_hash         0
orgyear            0
ctc                0
job_position       0
ctc_updated_year   0
dtype: int64
```

All missing values are handled in df_filled

[214]:
```
df_filled.shape
```

[214]:
```
(205575, 7)
```

[215]:
```
df = df_filled.copy()
```

[216]:
```
# Check for duplicates and drop them
df = df.drop_duplicates()
```

[217]:
```
df.shape
```

[217]:
```
(205575, 7)
```

Making some new features like adding 'Years of Experience' column by subtracting orgyear from current year

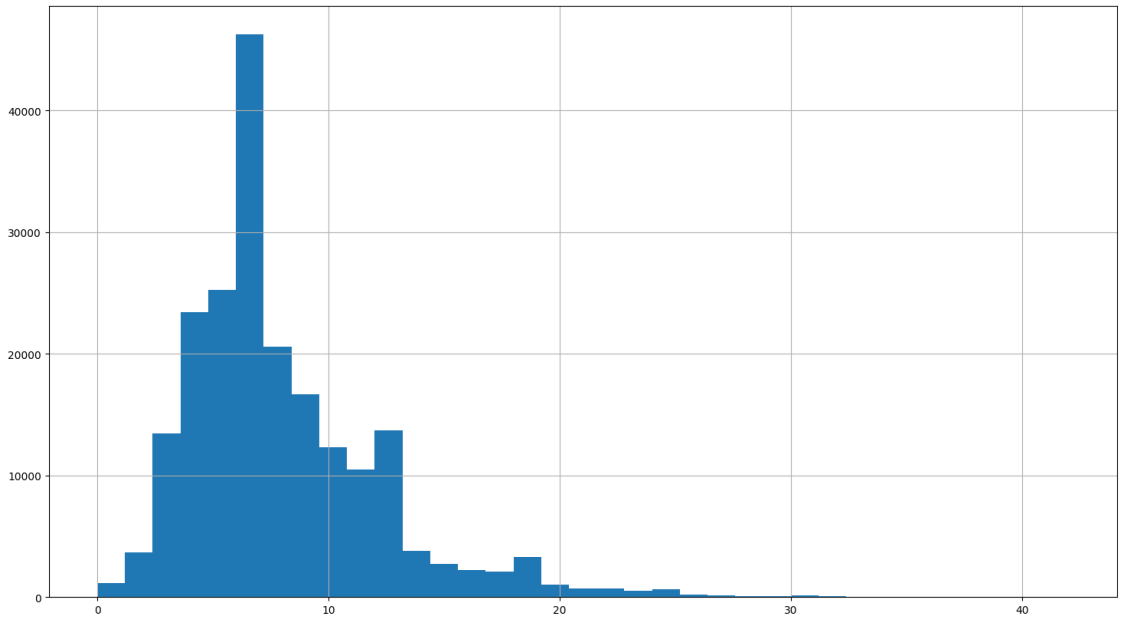
[218]:
```
df['YOE'] = 2023 - df['orgyear']
df
```

[218]:
```
            id               company_hash  \
0            0             atrgxnnt xzaxv
1            1  qtrxvzwt xzegwgbb rxbxnta
2            2              ojzwnvwnxw vx
3            3                  ngpgutaxv
4            4                 qxen sqghu
…          …                         …
205570  206918                  vuurt xzw
205571  206919                  husqvawgb
205572  206920                   vwwgrxnt
205573  206921             zgn vuurxwvmrt
205574  206922             bgqsvz onvzrtj

                                                     email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205570  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205571  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205572  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205573  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205574  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
3        2017.0   700000    Backend Engineer            2019.0   6.0
4        2017.0  1400000  FullStack Engineer            2019.0   6.0
…           …        …                   …               …     …
205570   2008.0   220000             Unknown            2019.0  15.0
205571   2017.0   500000             Unknown            2020.0   6.0
205572   2021.0   700000             Unknown            2021.0   2.0
205573   2019.0  5100000             Unknown            2019.0   4.0
205574   2014.0  1240000             Unknown            2016.0   9.0

[205575 rows x 8 columns]
```

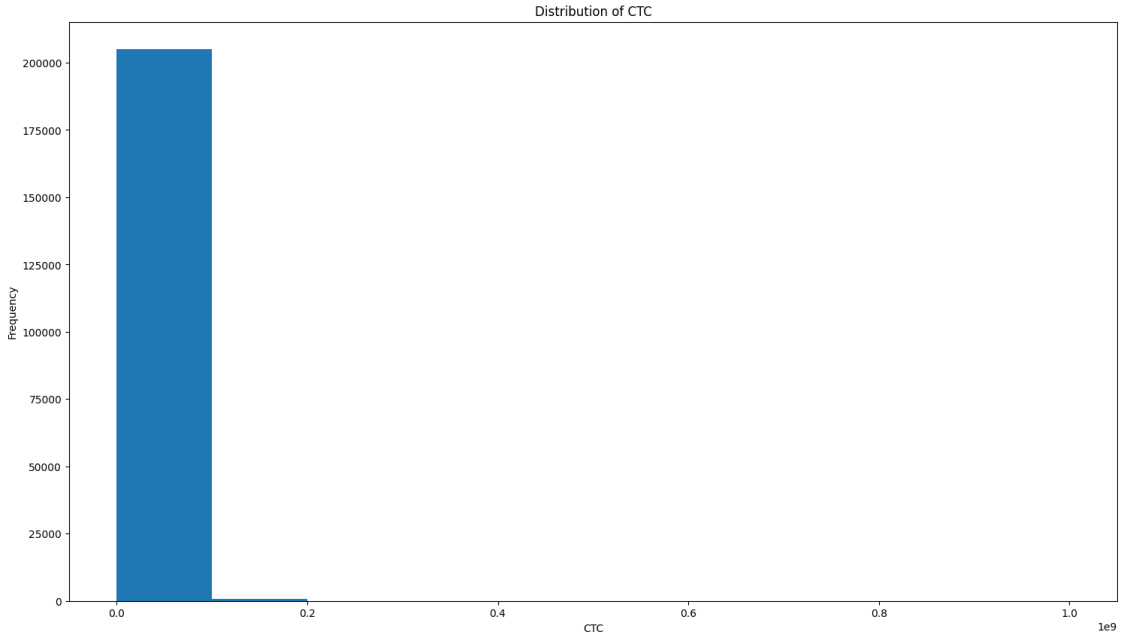
0.1.1 Univariate Analysis

[219]:
```
df['YOE'].hist(bins=35)
```

[219]:
```
<Axes: >
```

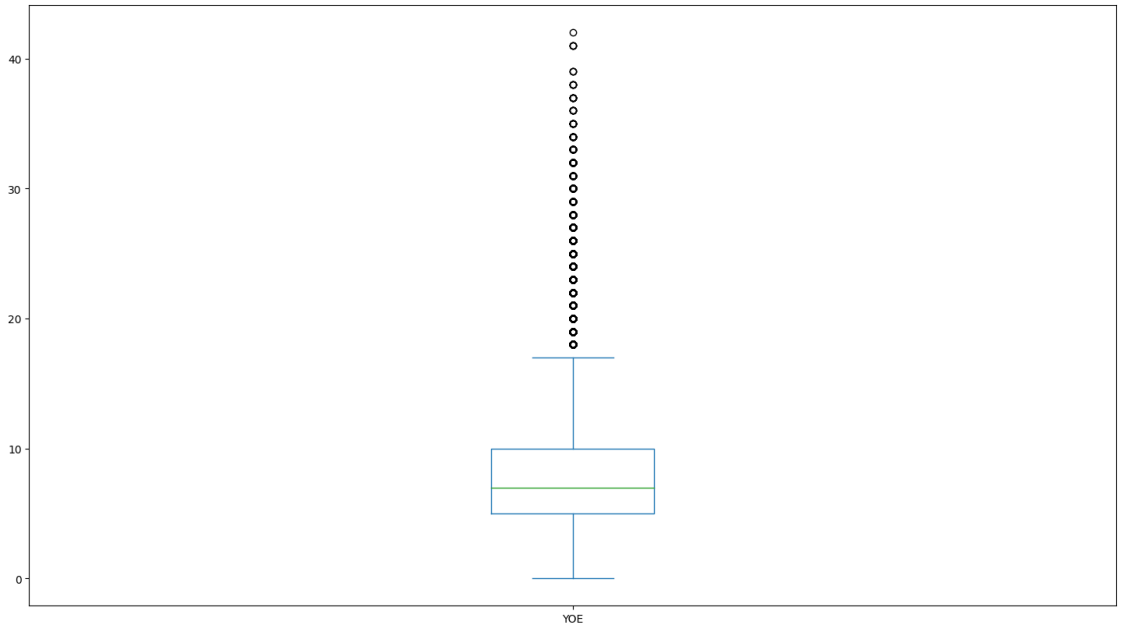


[220]:
```
import matplotlib.pyplot as plt
df['ctc'].plot.hist()
plt.title('Distribution of CTC')
plt.xlabel('CTC')
plt.ylabel('Frequency')
plt.show()
```



[221]:
```
df[['YOE']].plot(kind='box', subplots=True)
```

[221]:
```
YOE    Axes(0.125,0.11;0.775x0.77)
dtype: object
```

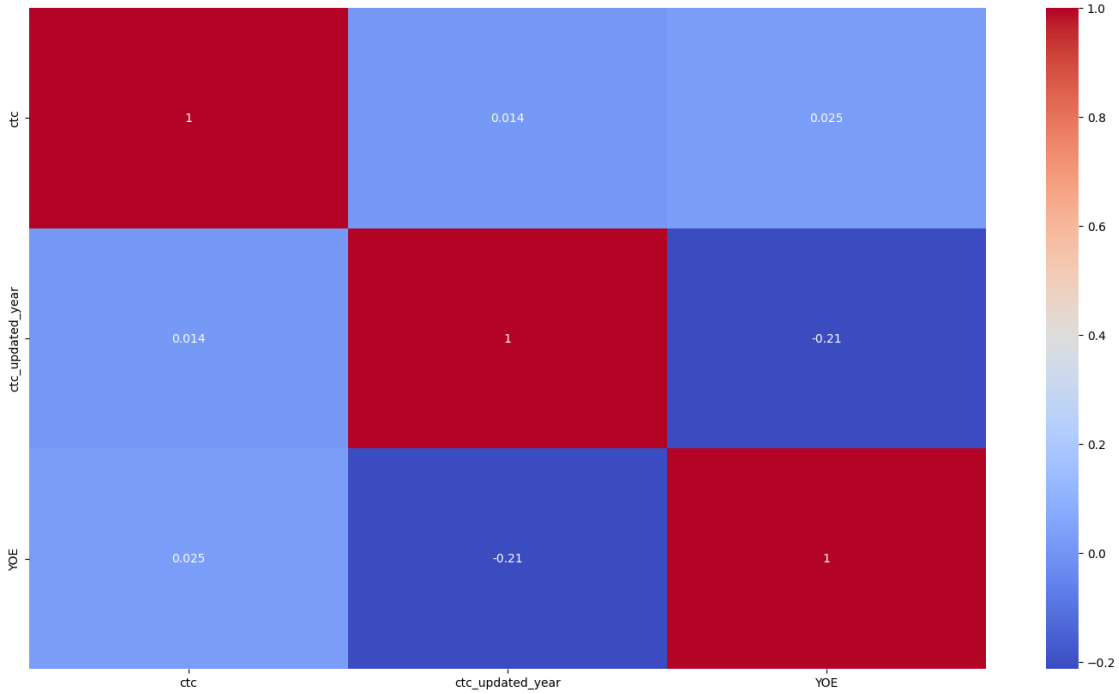


[221]:
```

```

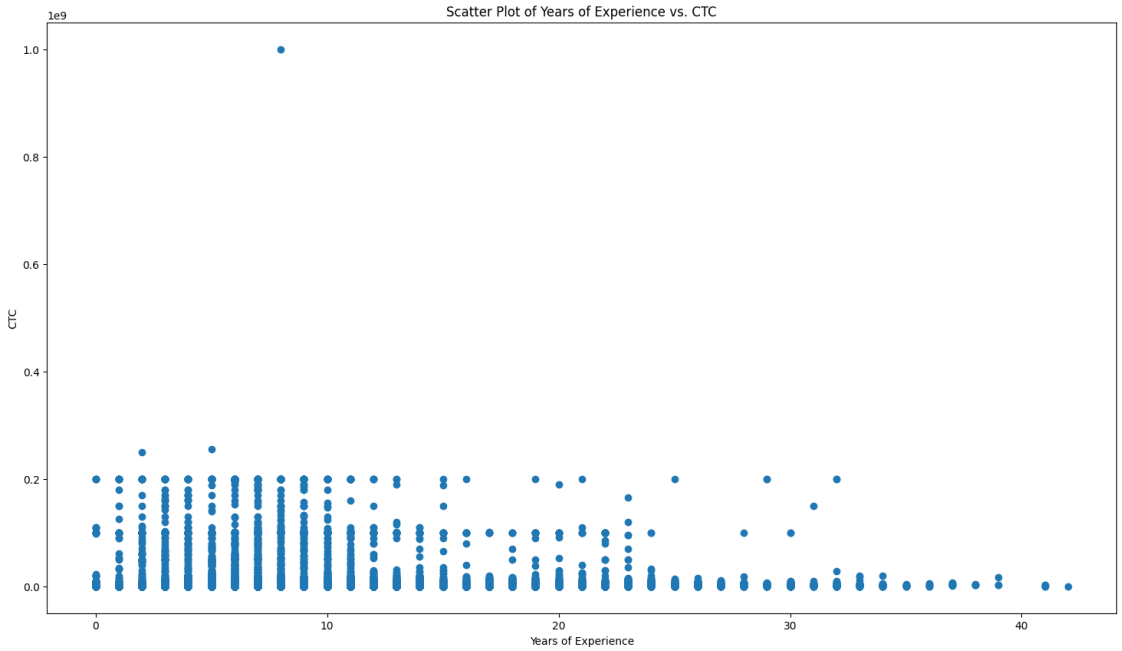
Bivariate Analysis

[222]:
```
import seaborn as sns
correlation_matrix = df[['ctc', 'ctc_updated_year', 'YOE']].corr()
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm')
```

[222]:
```
<Axes: >
```



[223]:
```
plt.scatter(df['YOE'], df['ctc'])
plt.title('Scatter Plot of Years of Experience vs. CTC')
plt.xlabel('Years of Experience')
plt.ylabel('CTC')
plt.show()
```

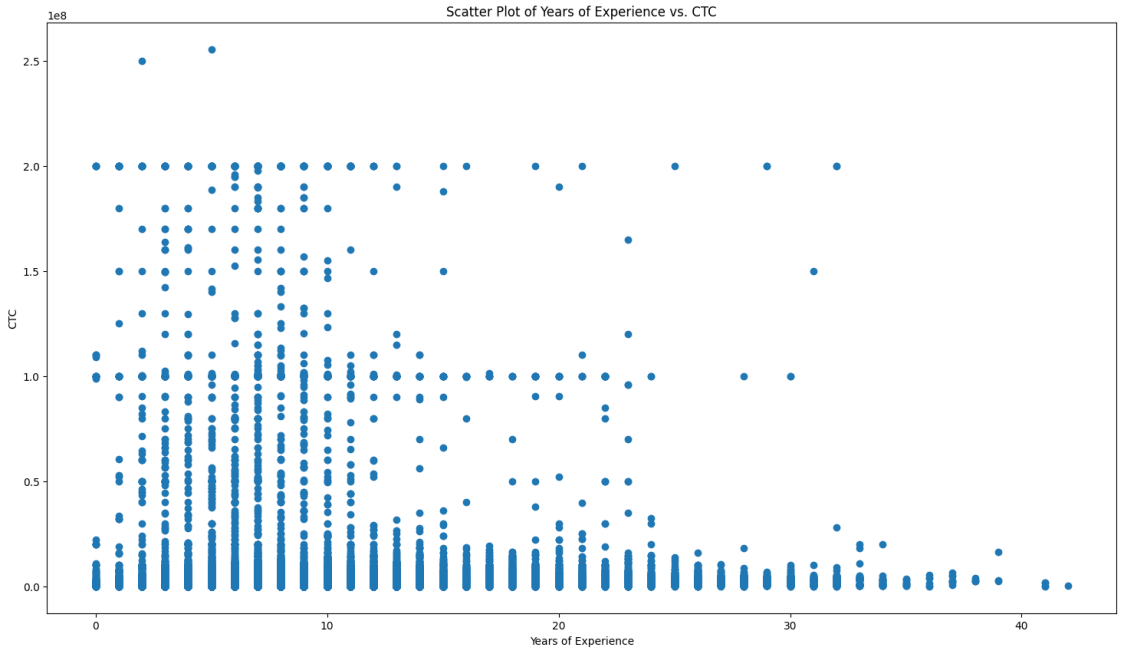


[224]:
```
# remove 1 outlier and see plot again
df = df[df['ctc']<0.8*1e9]
df
```

[224]:

```
            id               company_hash  \
0            0             atrgxnnt xzaxv
1            1  qtrxvzwt xzegwgbb rxbxnta
2            2              ojzwnvwnxw vx
3            3                  ngpgutaxv
4            4                 qxen sqghu
…          …                        …
205570  206918                  vuurt xzw
205571  206919                  husqvawgb
205572  206920                   vwwgrxnt
205573  206921             zgn vuurxwvmrt
205574  206922             bgqsvz onvzrtj

                                                        email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205570  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205571  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205572  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205573  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205574  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
3        2017.0   700000    Backend Engineer            2019.0   6.0
4        2017.0  1400000  FullStack Engineer            2019.0   6.0
…          …       …                  …              …    …
205570   2008.0   220000            Unknown            2019.0  15.0
205571   2017.0   500000            Unknown            2020.0   6.0
205572   2021.0   700000            Unknown            2021.0   2.0
205573   2019.0  5100000            Unknown            2019.0   4.0
205574   2014.0  1240000            Unknown            2016.0   9.0

[205574 rows x 8 columns]
```

[225]:
```
plt.scatter(df['YOE'], df['ctc'])
plt.title('Scatter Plot of Years of Experience vs. CTC')
plt.xlabel('Years of Experience')
plt.ylabel('CTC')
plt.show()
```



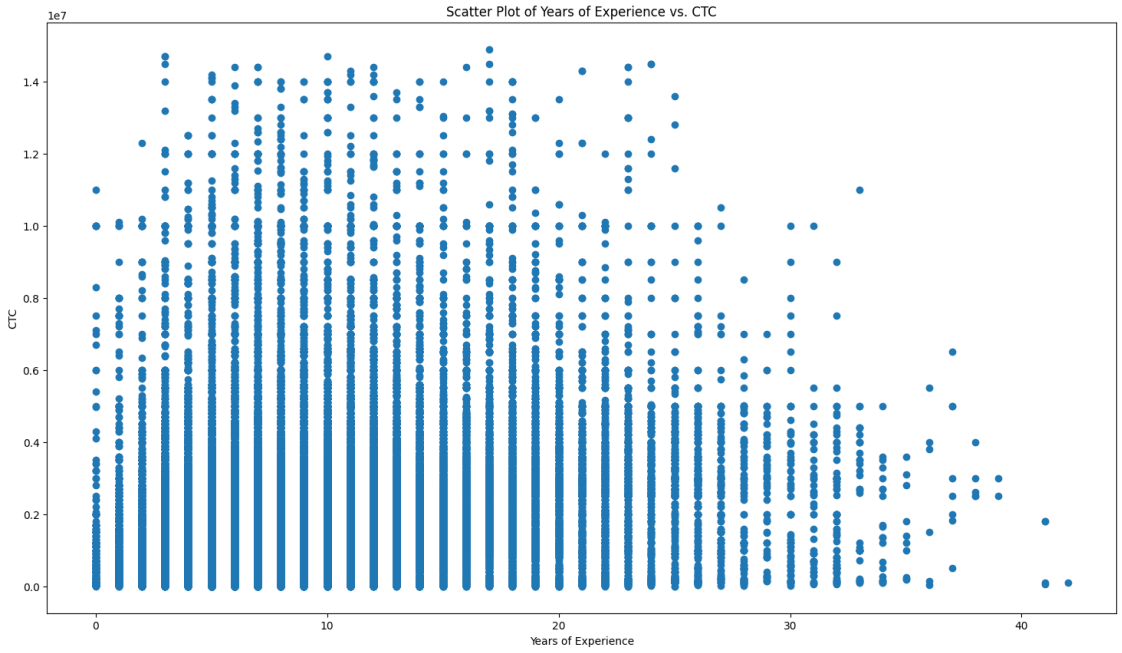
[226]:
```
# remove ctc more than 15 Lakhs and see plot again
dfless15lac_ctc = df[df['ctc']<0.15*1e8]
dfless15lac_ctc
```

[226]:

	id	company_hash	email_hash
0	0	atrgxnnt xzaxv	6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1	1	qtrxvzwt xzegwgbb rxbxnta	b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2	2	ojzwnvwnxw vx	
3	3	ngpgutaxv	
4	4	qxen sqghu	
…	…	…	
205570	206918	vuurt xzw	
205571	206919	husqvawgb	
205572	206920	vwwgrxnt	
205573	206921	zgn vuurxwvmrt	
205574	206922	bgqsvz onvzrtj	

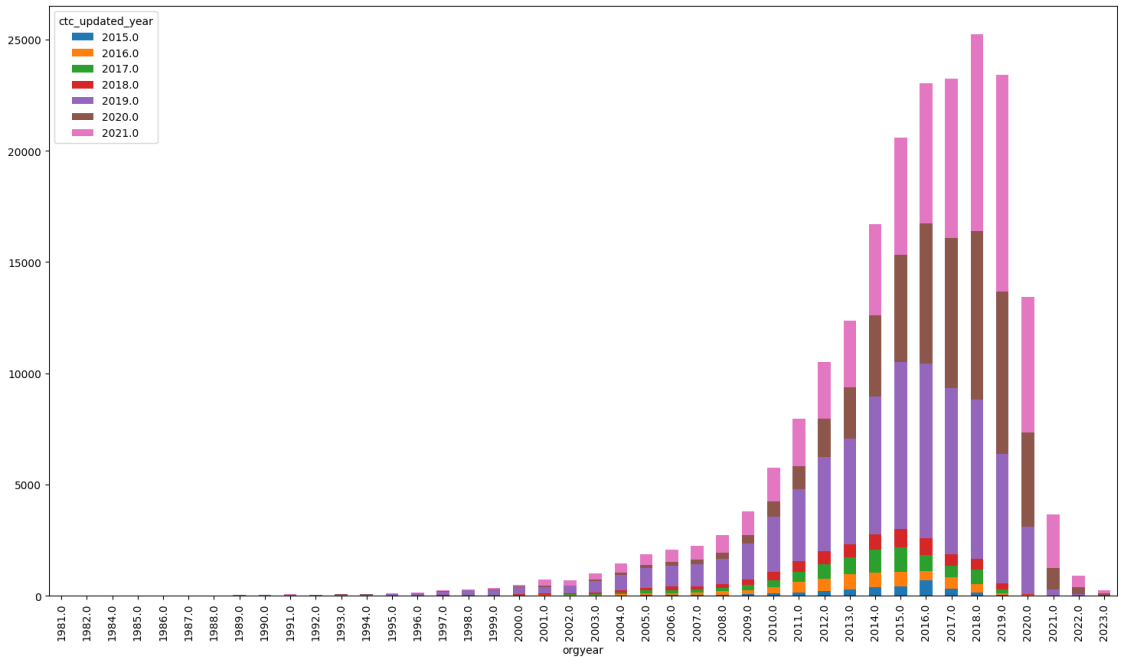
```
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205570  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205571  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205572  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205573  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205574  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
3        2017.0   700000    Backend Engineer            2019.0   6.0
4        2017.0  1400000  FullStack Engineer            2019.0   6.0
…           …       …                   …                …    …
205570   2008.0   220000             Unknown            2019.0  15.0
205571   2017.0   500000             Unknown            2020.0   6.0
205572   2021.0   700000             Unknown            2021.0   2.0
205573   2019.0  5100000             Unknown            2019.0   4.0
205574   2014.0  1240000             Unknown            2016.0   9.0

[203643 rows x 8 columns]
```

[227]:
```
plt.scatter(dfless15lac_ctc['YOE'], dfless15lac_ctc['ctc'])
plt.title('Scatter Plot of Years of Experience vs. CTC')
plt.xlabel('Years of Experience')
plt.ylabel('CTC')
plt.show()
```



[228]:
```
crosstab = pd.crosstab(df['orgyear'], df['ctc_updated_year'])
crosstab.plot(kind='bar', stacked=True)
```

[228]: <Axes: xlabel='orgyear'>



[228]:

0.2 Insights based on EDA:

1. The org year & ctc updated year were having few outliers that doesnot make sense like max year 20165 & min year so removed those values.
2. We handled null values in dataset, there were lot of null values in company_id & on analysis we saw for every email_id there exists unique company_id, so we can replace company_id to first email_id of that company.
3. Mostly dataset contains data with people having 3-12 years of experience.
4. Mostly people got increment (ctc updated) in years 2019 to 2021. Although, people have been working from 2009-2021 (orgyear).
5. With YOE 8-12 years, CTC has big range with 8 years work experience having most of it. According to data, it doesnot matter on YOE for CTC, CTC ranges depend on other things also. Data for 8-12 YOE is also more.
6. There is negative correlation between CTC updated year & YOE.

0.3 Manual Clustering

```
Manual Clustering on the basis of learner's company, job position and years of experience
Getting the 5 point summary of CTC (mean, median, max, min, count etc) on the basis of Company
Merging the same with original dataset carefully and creating some flags showing learners with
Doing above analysis at Company & Job Position level. Name that flag Class with values [1,2,3]
Repeating the same analysis at the Company level. Name that flag Tier with values [1,2,3]
```

[229]:
```
df
```

[229]:

	id	company_hash	email_hash
0	0	atrgxnnt xzaxv	6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1	1	qtrxvzwt xzegwgbb rxbxnta	b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2	2	ojzwnvwnxw vx	4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3	3	ngpgutaxv	effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4	4	qxen sqghu	6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…	…	…	…
205570	206918	vuurt xzw	70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205571	206919	husqvawgb	
205572	206920	vwwgrxnt	
205573	206921	zgn vuurxwvmrt	
205574	206922	bgqsvz onvzrtj	

```
205571  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205572  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205573  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205574  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31
```

	orgyear	ctc	job_position	ctc_updated_year	YOE
0	2016.0	1100000	Other	2020.0	7.0
1	2018.0	449999	FullStack Engineer	2019.0	5.0
2	2015.0	2000000	Backend Engineer	2020.0	8.0
3	2017.0	700000	Backend Engineer	2019.0	6.0
4	2017.0	1400000	FullStack Engineer	2019.0	6.0
…	…	…	…	…	…
205570	2008.0	220000	Unknown	2019.0	15.0
205571	2017.0	500000	Unknown	2020.0	6.0
205572	2021.0	700000	Unknown	2021.0	2.0
205573	2019.0	5100000	Unknown	2019.0	4.0
205574	2014.0	1240000	Unknown	2016.0	9.0

```
[205574 rows x 8 columns]
```

[230]:
```
agg_data = df.groupby(['company_hash', 'job_position','YOE']).agg({
    'ctc':['mean','median','max','min']
})
agg_data
```

[230]:

			ctc		
			mean	median	
company_hash	job_position	YOE			
0	Other	3.0	100000.0	100000.0	
	Unknown	3.0	100000.0	100000.0	
0000	Other	6.0	300000.0	300000.0	
01 ojztqsj	Android Engineer	7.0	270000.0	270000.0	
	Frontend Engineer	12.0	830000.0	830000.0	
…			…	…	
zz	Unknown	14.0	500000.0	500000.0	
zzb ztdnstz vacxogqj ucn rna	FullStack Engineer	6.0	600000.0	600000.0	
	Unknown	6.0	600000.0	600000.0	
zzgato	Unknown	9.0	130000.0	130000.0	
zzzbzb	Other	33.0	720000.0	720000.0	

			max	min
company_hash	job_position	YOE		
0	Other	3.0	100000	100000
	Unknown	3.0	100000	100000
0000	Other	6.0	300000	300000
01 ojztqsj	Android Engineer	7.0	270000	270000

```
                                Frontend Engineer  12.0  830000  830000
…                                                    …     …
zz                              Unknown            14.0  500000  500000
zzb ztdnstz vacxogqj ucn rna FullStack Engineer    6.0   600000  600000
                                Unknown            6.0   600000  600000
zzgato                          Unknown            9.0   130000  130000
zzzbzb                          Other              33.0  720000  720000

[113294 rows x 4 columns]
```

[231]:
```
agg_data = agg_data.reset_index()
agg_data
```

[231]:
```
                       company_hash        job_position   YOE       ctc  \
                                                                     mean
0                                 0               Other   3.0  100000.0
1                                 0             Unknown   3.0  100000.0
2                              0000               Other   6.0  300000.0
3                   01 ojztqsj    Android Engineer   7.0  270000.0
4                   01 ojztqsj   Frontend Engineer  12.0  830000.0
…                                …                 …   …       …
113289                         zz             Unknown  14.0  500000.0
113290  zzb ztdnstz vacxogqj ucn rna  FullStack Engineer   6.0  600000.0
113291  zzb ztdnstz vacxogqj ucn rna             Unknown   6.0  600000.0
113292                       zzgato             Unknown   9.0  130000.0
113293                       zzzbzb               Other  33.0  720000.0


          median     max     min
0       100000.0  100000  100000
1       100000.0  100000  100000
2       300000.0  300000  300000
3       270000.0  270000  270000
4       830000.0  830000  830000
…          …      …       …
113289  500000.0  500000  500000
113290  600000.0  600000  600000
113291  600000.0  600000  600000
113292  130000.0  130000  130000
113293  720000.0  720000  720000

[113294 rows x 7 columns]
```

[232]:
```
agg_data.columns = [' '.join(col).strip() for col in agg_data.columns.values]
agg_data
```

[232]:
```
                         company_hash        job_position   YOE  ctc mean  \
0                                   0               Other   3.0  100000.0
1                                   0             Unknown   3.0  100000.0
2                                0000               Other   6.0  300000.0
3                          01 ojztqsj     Android Engineer   7.0  270000.0
4                          01 ojztqsj    Frontend Engineer  12.0  830000.0
…                                  …                   …   …       …
113289                            zz             Unknown  14.0  500000.0
113290  zzb ztdnstz vacxogqj ucn rna   FullStack Engineer   6.0  600000.0
113291  zzb ztdnstz vacxogqj ucn rna             Unknown   6.0  600000.0
113292                        zzgato             Unknown   9.0  130000.0
113293                        zzzbzb               Other  33.0  720000.0

        ctc median  ctc max  ctc min
0         100000.0   100000   100000
1         100000.0   100000   100000
2         300000.0   300000   300000
3         270000.0   270000   270000
4         830000.0   830000   830000
…              …       …      …
113289    500000.0   500000   500000
113290    600000.0   600000   600000
113291    600000.0   600000   600000
113292    130000.0   130000   130000
113293    720000.0   720000   720000

[113294 rows x 7 columns]
```

[233]:
```
# data with varying mean median max min
agg_data[agg_data['ctc mean']!=agg_data['ctc median']]
```

[233]:
```
        company_hash        job_position  YOE      ctc mean  ctc median  \
50              1bs     Backend Engineer  4.0  1.116667e+06   1000000.0
51              1bs     Backend Engineer  5.0  9.333333e+05    900000.0
52              1bs     Backend Engineer  6.0  1.218333e+06   1250000.0
54              1bs     Backend Engineer  8.0  2.243333e+06   2000000.0
75              1bs               Unknown  4.0  1.030000e+06   1000000.0
…               …                     …  …           …          …
113260    zxztrtvuo    Frontend Engineer  4.0  5.100000e+05    500000.0
113262    zxztrtvuo    Frontend Engineer  7.0  8.324998e+05    849999.5
113269    zxztrtvuo   FullStack Engineer  7.0  8.993333e+05    923000.0
113274    zxztrtvuo               Unknown  3.0  5.888889e+05    450000.0
113275    zxztrtvuo               Unknown  4.0  1.142857e+06    500000.0

        ctc max  ctc min
50      1350000  1000000
51      1100000   800000
```

```
52      1610000   800000
54      2930000  1800000
75      1350000   600000
…           …       …
113260   550000   450000
113262   930000   700000
113269  1200000   575000
113274   900000   400000
113275  4500000   400000

[10126 rows x 7 columns]
```

[234]:
```
# merge these values with df
df_merged = df.merge(agg_data, on=['company_hash', 'job_position', 'YOE'],␣
 ↪how='left')
df_merged
```

[234]:
```
            id               company_hash  \
0            0             atrgxnnt xzaxv
1            1  qtrxvzwt xzegwgbb rxbxnta
2            2              ojzwnvwnxw vx
3            3                  ngpgutaxv
4            4                 qxen sqghu
…          …                         …
205569  206918                 vuurt xzw
205570  206919                 husqvawgb
205571  206920                  vwwgrxnt
205572  206921             zgn vuurxwvmrt
205573  206922             bgqsvz onvzrtj

                                                       email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205569  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205570  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205571  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205572  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205573  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE  \
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
```

```
3         2017.0   700000    Backend Engineer            2019.0   6.0
4         2017.0  1400000  FullStack Engineer            2019.0   6.0
…          …      …                   …                 …    …
205569    2008.0   220000             Unknown            2019.0  15.0
205570    2017.0   500000             Unknown            2020.0   6.0
205571    2021.0   700000             Unknown            2021.0   2.0
205572    2019.0  5100000             Unknown            2019.0   4.0
205573    2014.0  1240000             Unknown            2016.0   9.0

             ctc mean  ctc median    ctc max  ctc min
0       1.100000e+06   1100000.0    1100000  1100000
1       7.742856e+05    750000.0    1200000   449999
2       2.000000e+06   2000000.0    2000000  2000000
3       1.158571e+06   1200000.0    1750000   700000
4       1.400000e+06   1400000.0    1400000  1400000
…                …          …          …       …
205569  2.200000e+05    220000.0     220000   220000
205570  1.150000e+06   1450000.0    1500000   500000
205571  6.666667e+05    700000.0    1000000   300000
205572  5.920732e+06    710000.0  180000000     7300
205573  1.693333e+06   1700000.0    2200000  1200000

[205574 rows x 12 columns]
```

[235]:
```
df_comparison=df_merged.copy()
```

[278]:
```
# Define a function to categorize the 'ctc' values
def categorize_ctc(row, comparison_column):
    if row['ctc'] < 0.5 * row[comparison_column]:
        return 3  # Less than 50% of mean_ctc -> Underpaid
    elif row['ctc'] > 1.5 * row[comparison_column]:
        return 1  # More than 150% of mean_ctc -> Cream employees
    else:
        return 2  # Within the range
```

Flag Designation calculation

[279]:
```
df_comparison['ctc_flag_mean'] = df_comparison.apply(categorize_ctc, args=('ctc␣
 ↪mean',), axis=1)
df_comparison['ctc_flag_median'] = df_comparison.apply(categorize_ctc,␣
 ↪args=('ctc median',), axis=1)
df_comparison
```

[279]:
```
           id               company_hash  \
0           0             atrgxnnt xzaxv
1           1  qtrxvzwt xzegwgbb rxbxnta
2           2              ojzwnvwnxw vx
```

```
3            3                  ngpgutaxv
4            4                 qxen sqghu
…          …                      …
205569  206918                  vuurt xzw
205570  206919                  husqvawgb
205571  206920                   vwwgrxnt
205572  206921             zgn vuurxwvmrt
205573  206922             bgqsvz onvzrtj

                                                                email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205569  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205570  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205571  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205572  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205573  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE  \
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
3        2017.0   700000    Backend Engineer            2019.0   6.0
4        2017.0  1400000  FullStack Engineer            2019.0   6.0
…          …       …                  …                …    …
205569   2008.0   220000            Unknown            2019.0  15.0
205570   2017.0   500000            Unknown            2020.0   6.0
205571   2021.0   700000            Unknown            2021.0   2.0
205572   2019.0  5100000            Unknown            2019.0   4.0
205573   2014.0  1240000            Unknown            2016.0   9.0

            ctc mean  ctc median    ctc max  ctc min  ctc_flag_mean  \
0       1.100000e+06   1100000.0    1100000  1100000              2
1       7.742856e+05    750000.0    1200000   449999              2
2       2.000000e+06   2000000.0    2000000  2000000              2
3       1.158571e+06   1200000.0    1750000   700000              2
4       1.400000e+06   1400000.0    1400000  1400000              2
…                …          …         …       …            …
205569  2.200000e+05    220000.0     220000   220000              2
205570  1.150000e+06   1450000.0    1500000   500000              3
205571  6.666667e+05    700000.0    1000000   300000              2
205572  5.920732e+06    710000.0  180000000     7300              2
205573  1.693333e+06   1700000.0    2200000  1200000              2
```

```
        ctc_flag_median
0                     2
1                     2
2                     2
3                     2
4                     2
…                   …
205569                2
205570                3
205571                2
205572                1
205573                2

[205574 rows x 14 columns]
```

[280]:
```
df_comparison[df_comparison['ctc_flag_mean']!=df_comparison['ctc_flag_median']]
# maybe many outliers
```

[280]:
```
            id                company_hash  \
81          81                   nv axsxnvr
83          83                    wgszxkvzn
116        116  mvqwrvjo wgqugqvnt mvzpxzs
185        185               ntwy bvyxzaqv
201        201               fxuqg rxbxnta
…           …                         …
205556  206905                     vbvkgz
205561  206910               zgn vuurxwvmrt
205564  206913                     vbvkgz
205568  206917               zgn vuurxwvmrt
205572  206921               zgn vuurxwvmrt

                                                                email_hash  \
81      d1829ec6261f538309e4496ff0c97a87ecd782067343d5a323f818ea0d7d46a1
83      985f3ffced0e16713147c7c36ec70c5414cc9d6c79fe9d940fa55672c4e3da07
116     3e2e7e6242f662ccd27dbd41ace1a029d19b9dedd7e4f7b49b507ddb1bdb01db
185     2ee09b45e4335aa9aeb6ac2b36ddd79dcbe5f7b954d2587f2a722800dd9d5ded
201     e4ad74a458078a292a1de28d2039c36b415e7e12682e94e98c3555be1858d865
…                                                                     …
205556  95023bca0172ad67bfc3453550c5cf056557bc2c8c7169c45d544526834d19a4
205561  586e06d65892218f96debd87457bc127de3cae87dd0edf32f1ec3b50bc2c1321
205564  f4415be48a1ef885e086dcd72181f667a289641e66f828159d7154228a9b9a95
205568  fe34477c3f64e6ed4301417c8fb9d5e2608722a10f1f4e5cf7872038bbb98b31
205572  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699

        orgyear      ctc        job_position  ctc_updated_year  YOE  \
81       2020.0   910000             Unknown            2019.0  3.0
```

```
83       2015.0   750000              Other            2019.0  8.0
116      2019.0   800000  Engineering Intern            2019.0  4.0
185      2017.0   250000    Support Engineer            2020.0  6.0
201      2016.0   720000             Unknown            2020.0  7.0
…         …       …                  …                  …   …
205556   2016.0  4800000             Unknown            2020.0  7.0
205561   2019.0   700000             Unknown            2019.0  4.0
205564   2014.0  3800000             Unknown            2019.0  9.0
205568   2021.0   800000             Unknown            2021.0  2.0
205572   2019.0  5100000             Unknown            2019.0  4.0

            ctc mean  ctc median    ctc max  ctc min  ctc_flag_mean  \
81      6.214284e+05    590000.0     970000   380000              2
83      4.405189e+06    600000.0  200000000   105000              3
116     3.380000e+06   1100000.0   12000000   800000              3
185     1.150556e+07    400000.0  100250000   250000              3
201     3.671746e+06    620000.0  190000000   100000              3
…                …          …         …       …            …
205556  3.910271e+06   1105000.0  200000000    28000              2
205561  5.920732e+06    710000.0  180000000     7300              3
205564  2.633232e+06   1890000.0   56700000    14000              2
205568  5.365137e+06   1000000.0  100000000    10000              3
205572  5.920732e+06    710000.0  180000000     7300              2

        ctc_flag_median
81                    1
83                    2
116                   2
185                   2
201                   2
…                   …
205556                1
205561                2
205564                1
205568                2
205572                1

[21136 rows x 14 columns]
```

[281]:
```
agg_data_company_job = df.groupby(['company_hash', 'job_position']).agg({
    'ctc':['mean','median','max','min']
})
agg_data_company_job = agg_data_company_job.reset_index()
agg_data_company_job.columns = [' '.join(col).strip() for col in␣
 ↪agg_data_company_job.columns.values]
agg_data_company_job
```

[281]:
```
                       company_hash        job_position  ctc mean  ctc median  \
0                                 0               Other  100000.0    100000.0
1                                 0             Unknown  100000.0    100000.0
2                              0000               Other  300000.0    300000.0
3                       01 ojztqsj     Android Engineer  270000.0    270000.0
4                       01 ojztqsj    Frontend Engineer  830000.0    830000.0
…                                …                   …         …           …
71201                           zz             Unknown  500000.0    500000.0
71202  zzb ztdnstz vacxogqj ucn rna  FullStack Engineer  600000.0    600000.0
71203  zzb ztdnstz vacxogqj ucn rna             Unknown  600000.0    600000.0
71204                        zzgato             Unknown  130000.0    130000.0
71205                        zzzbzb               Other  720000.0    720000.0

       ctc max  ctc min
0       100000   100000
1       100000   100000
2       300000   300000
3       270000   270000
4       830000   830000
…          …        …
71201   500000   500000
71202   600000   600000
71203   600000   600000
71204   130000   130000
71205   720000   720000

[71206 rows x 6 columns]
```

[281]:

[282]:
```
# merge these values with df_comparison
df_comparison2 = df_comparison.merge(agg_data_company_job,␣
 ↪on=['company_hash','job_position'], how='left')
df_comparison2
```

[282]:
```
            id               company_hash  \
0            0             atrgxnnt xzaxv
1            1  qtrxvzwt xzegwgbb rxbxnta
2            2              ojzwnvwnxw vx
3            3                  ngpgutaxv
4            4                 qxen sqghu
…          …                          …
205569  206918                 vuurt xzw
205570  206919                 husqvawgb
205571  206920                  vwwgrxnt
205572  206921             zgn vuurxwvmrt
205573  206922             bgqsvz onvzrtj
```

```
                                                                email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205569  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205570  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205571  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205572  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205573  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE  \
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
3        2017.0   700000    Backend Engineer            2019.0   6.0
4        2017.0  1400000  FullStack Engineer            2019.0   6.0
…           …       …                   …                 …    …
205569   2008.0   220000             Unknown            2019.0  15.0
205570   2017.0   500000             Unknown            2020.0   6.0
205571   2021.0   700000             Unknown            2021.0   2.0
205572   2019.0  5100000             Unknown            2019.0   4.0
205573   2014.0  1240000             Unknown            2016.0   9.0

          ctc mean_x  ctc median_x  ctc max_x  ctc min_x  ctc_flag_mean  \
0       1.100000e+06     1100000.0    1100000    1100000              2
1       7.742856e+05      750000.0    1200000     449999              2
2       2.000000e+06     2000000.0    2000000    2000000              2
3       1.158571e+06     1200000.0    1750000     700000              2
4       1.400000e+06     1400000.0    1400000    1400000              2
…              …            …         …          …                …
205569  2.200000e+05      220000.0     220000     220000              2
205570  1.150000e+06     1450000.0    1500000     500000              3
205571  6.666667e+05      700000.0    1000000     300000              2
205572  5.920732e+06      710000.0  180000000       7300              2
205573  1.693333e+06     1700000.0    2200000    1200000              2

        ctc_flag_median    ctc mean_y  ctc median_y  ctc max_y  ctc min_y
0                     2  1.085000e+06     1085000.0    1100000    1070000
1                     2  9.511363e+05      800000.0    2000000     300000
2                     2  2.000000e+06     2000000.0    2000000    2000000
3                     2  1.500000e+06     1540000.0    3500000     520000
4                     2  8.466667e+05      600000.0    1400000     540000
…                   …           …           …          …          …
```

```
205569                2  1.681941e+06     2300000.0    3500000       60000
205570                3  9.708333e+05      975000.0    1500000      500000
205571                2  1.341359e+06     1150000.0    4800000      300000
205572                1  5.520261e+06      800000.0  200000000        7300
205573                2  1.973902e+06     1850000.0    5250000      100000

[205574 rows x 18 columns]
```

Flag Class calculation

[283]:
```
df_comparison2['ctc_flag_mean_job'] = df_comparison2.apply(categorize_ctc,␣
 ↪args=('ctc mean_y',), axis=1)
df_comparison2['ctc_flag_median_company'] = df_comparison2.
 ↪apply(categorize_ctc, args=('ctc median_y',), axis=1)
df_comparison2
```

[283]:
```
             id               company_hash  \
0             0             atrgxnnt xzaxv
1             1  qtrxvzwt xzegwgbb rxbxnta
2             2              ojzwnvwnxw vx
3             3                  ngpgutaxv
4             4                 qxen sqghu
…           …                         …
205569   206918                 vuurt xzw
205570   206919                 husqvawgb
205571   206920                  vwwgrxnt
205572   206921             zgn vuurxwvmrt
205573   206922             bgqsvz onvzrtj

                                                                email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205569  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205570  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205571  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205572  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205573  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE  \
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
3        2017.0   700000    Backend Engineer            2019.0   6.0
```

```
4         2017.0  1400000  FullStack Engineer            2019.0   6.0
…          …      …                  …                 …   …
205569    2008.0   220000             Unknown            2019.0  15.0
205570    2017.0   500000             Unknown            2020.0   6.0
205571    2021.0   700000             Unknown            2021.0   2.0
205572    2019.0  5100000             Unknown            2019.0   4.0
205573    2014.0  1240000             Unknown            2016.0   9.0

           ctc mean_x  ctc median_x  ctc max_x  ctc min_x  ctc_flag_mean  \
0       1.100000e+06     1100000.0    1100000    1100000              2
1       7.742856e+05      750000.0    1200000     449999              2
2       2.000000e+06     2000000.0    2000000    2000000              2
3       1.158571e+06     1200000.0    1750000     700000              2
4       1.400000e+06     1400000.0    1400000    1400000              2
…              …           …         …          …            …
205569  2.200000e+05      220000.0     220000     220000              2
205570  1.150000e+06     1450000.0    1500000     500000              3
205571  6.666667e+05      700000.0    1000000     300000              2
205572  5.920732e+06      710000.0  180000000       7300              2
205573  1.693333e+06     1700000.0    2200000    1200000              2

        ctc_flag_median    ctc mean_y  ctc median_y  ctc max_y  ctc min_y  \
0                     2  1.085000e+06     1085000.0    1100000    1070000
1                     2  9.511363e+05      800000.0    2000000     300000
2                     2  2.000000e+06     2000000.0    2000000    2000000
3                     2  1.500000e+06     1540000.0    3500000     520000
4                     2  8.466667e+05      600000.0    1400000     540000
…                   …           …           …        …        …
205569                2  1.681941e+06     2300000.0    3500000      60000
205570                3  9.708333e+05      975000.0    1500000     500000
205571                2  1.341359e+06     1150000.0    4800000     300000
205572                1  5.520261e+06      800000.0  200000000       7300
205573                2  1.973902e+06     1850000.0    5250000     100000

        ctc_flag_mean_job  ctc_flag_median_company
0                       2                        2
1                       3                        2
2                       2                        2
3                       3                        3
4                       1                        1
…                     …                        …
205569                  3                        3
205570                  2                        2
205571                  2                        2
205572                  2                        1
205573                  2                        2
```

```
[205574 rows x 20 columns]
```

[284]:
```
# aggregating based on only company
agg_data_company = df.groupby(['company_hash']).agg({
    'ctc':['mean','median','max','min']
})
agg_data_company = agg_data_company.reset_index()
agg_data_company.columns = [' '.join(col).strip() for col in agg_data_company.
 ↪columns.values]
agg_data_company
```

[284]:

	company_hash	ctc mean	ctc median	ctc max	ctc min
0	0	100000.0	100000.0	100000	100000
1	0000	300000.0	300000.0	300000	300000
2	01 ojztqsj	550000.0	550000.0	830000	270000
3	05mz exzytvrny uqxcvnt rxbxnta	1100000.0	1100000.0	1100000	1100000
4	1	175000.0	175000.0	250000	100000
…	…	…	…	…	…
37232	zyvzwt wgzohrnxzs tzsxzttqo	940000.0	940000.0	940000	940000
37233	zz	935000.0	935000.0	1370000	500000
37234	zzb ztdnstz vacxogqj ucn rna	600000.0	600000.0	600000	600000
37235	zzgato	130000.0	130000.0	130000	130000
37236	zzzbzb	720000.0	720000.0	720000	720000

```
[37237 rows x 5 columns]
```

[285]:
```
# merge these values with df_comparison
df_manual_clustering = df_comparison2.merge(agg_data_company,␣
 ↪on=['company_hash'], how='left')
df_manual_clustering
```

[285]:

	id	company_hash	\
0	0	atrgxnnt xzaxv	
1	1	qtrxvzwt xzegwgbb rxbxnta	
2	2	ojzwnvwnxw vx	
3	3	ngpgutaxv	
4	4	qxen sqghu	
…	…	…	
205569	206918	vuurt xzw	
205570	206919	husqvawgb	
205571	206920	vwwgrxnt	
205572	206921	zgn vuurxwvmrt	
205573	206922	bgqsvz onvzrtj	

	email_hash	\
0	6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af	
1	b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b	

```
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205569  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205570  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205571  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205572  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205573  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE  \
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
3        2017.0   700000    Backend Engineer            2019.0   6.0
4        2017.0  1400000  FullStack Engineer            2019.0   6.0
…         …      …                  …                 …    …
205569   2008.0   220000            Unknown            2019.0  15.0
205570   2017.0   500000            Unknown            2020.0   6.0
205571   2021.0   700000            Unknown            2021.0   2.0
205572   2019.0  5100000            Unknown            2019.0   4.0
205573   2014.0  1240000            Unknown            2016.0   9.0

          ctc mean_x  ctc median_x  ctc max_x  ctc min_x  ctc_flag_mean  \
0       1.100000e+06     1100000.0    1100000    1100000              2
1       7.742856e+05      750000.0    1200000     449999              2
2       2.000000e+06     2000000.0    2000000    2000000              2
3       1.158571e+06     1200000.0    1750000     700000              2
4       1.400000e+06     1400000.0    1400000    1400000              2
…                …            …         …          …             …
205569  2.200000e+05      220000.0     220000     220000              2
205570  1.150000e+06     1450000.0    1500000     500000              3
205571  6.666667e+05      700000.0    1000000     300000              2
205572  5.920732e+06      710000.0  180000000       7300              2
205573  1.693333e+06     1700000.0    2200000    1200000              2

        ctc_flag_median    ctc mean_y  ctc median_y  ctc max_y  ctc min_y  \
0                     2  1.085000e+06     1085000.0    1100000    1070000
1                     2  9.511363e+05      800000.0    2000000     300000
2                     2  2.000000e+06     2000000.0    2000000    2000000
3                     2  1.500000e+06     1540000.0    3500000     520000
4                     2  8.466667e+05      600000.0    1400000     540000
…                   …          …            …          …          …
205569                2  1.681941e+06     2300000.0    3500000      60000
205570                3  9.708333e+05      975000.0    1500000     500000
205571                2  1.341359e+06     1150000.0    4800000     300000
205572                1  5.520261e+06      800000.0  200000000       7300
```

```
205573                2  1.973902e+06     1850000.0    5250000     100000

        ctc_flag_mean_job  ctc_flag_median_company      ctc mean  ctc median  \
0                       2                        2  1.115667e+06   1070000.0
1                       3                        2  2.197334e+06    900000.0
2                       2                        2  2.000000e+06   2000000.0
3                       3                        3  1.713929e+06   1400000.0
4                       1                        1  9.400000e+05    850000.0
…                     …                        …           …         …
205569                  3                        3  1.681941e+06   2300000.0
205570                  2                        2  2.119245e+06   1200000.0
205571                  2                        2  1.404485e+06   1300000.0
205572                  2                        1  5.477717e+06    800000.0
205573                  2                        2  2.413205e+06   1900000.0

          ctc max  ctc min
0         1771000   500000
1       200000000    10000
2         2000000  2000000
3         4700000   200000
4         1400000   540000
…             …      …
205569    3500000    60000
205570   74200000   200000
205571    4800000   200000
205572  200000000     7300
205573  100000000     1000

[205574 rows x 24 columns]
```

Flag Tier calculation

[286]:
```
df_manual_clustering['ctc_flag_mean_company'] = df_manual_clustering.
 ↪apply(categorize_ctc, args=('ctc mean',), axis=1)
df_manual_clustering['ctc_flag_median_company'] = df_manual_clustering.
 ↪apply(categorize_ctc, args=('ctc median',), axis=1)
df_manual_clustering['CTC_updated_in_years'] =␣
 ↪df_manual_clustering['ctc_updated_year'] - df_manual_clustering['orgyear']
df_manual_clustering
```

[286]:
```
            id               company_hash  \
0            0             atrgxnnt xzaxv
1            1  qtrxvzwt xzegwgbb rxbxnta
2            2              ojzwnvwnxw vx
3            3                  ngpgutaxv
4            4                 qxen sqghu
…          …                          …
```

```
205569  206918                  vuurt xzw
205570  206919                  husqvawgb
205571  206920                   vwwgrxnt
205572  206921             zgn vuurxwvmrt
205573  206922             bgqsvz onvzrtj

                                                                email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205569  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205570  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205571  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205572  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205573  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE  \
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
3        2017.0   700000    Backend Engineer            2019.0   6.0
4        2017.0  1400000  FullStack Engineer            2019.0   6.0
…         …      …                  …                 …    …
205569   2008.0   220000            Unknown            2019.0  15.0
205570   2017.0   500000            Unknown            2020.0   6.0
205571   2021.0   700000            Unknown            2021.0   2.0
205572   2019.0  5100000            Unknown            2019.0   4.0
205573   2014.0  1240000            Unknown            2016.0   9.0

          ctc mean_x  ctc median_x  ctc max_x  ctc min_x  ctc_flag_mean  \
0       1.100000e+06     1100000.0    1100000    1100000              2
1       7.742856e+05      750000.0    1200000     449999              2
2       2.000000e+06     2000000.0    2000000    2000000              2
3       1.158571e+06     1200000.0    1750000     700000              2
4       1.400000e+06     1400000.0    1400000    1400000              2
…                …           …         …          …              …
205569  2.200000e+05      220000.0     220000     220000              2
205570  1.150000e+06     1450000.0    1500000     500000              3
205571  6.666667e+05      700000.0    1000000     300000              2
205572  5.920732e+06      710000.0  180000000       7300              2
205573  1.693333e+06     1700000.0    2200000    1200000              2

        ctc_flag_median    ctc mean_y  ctc median_y  ctc max_y  ctc min_y  \
0                     2  1.085000e+06     1085000.0    1100000    1070000
```

```
1                    2  9.511363e+05      800000.0    2000000     300000
2                    2  2.000000e+06     2000000.0    2000000    2000000
3                    2  1.500000e+06     1540000.0    3500000     520000
4                    2  8.466667e+05      600000.0    1400000     540000
…                  …          …              …        …          …
205569               2  1.681941e+06     2300000.0    3500000      60000
205570               3  9.708333e+05      975000.0    1500000     500000
205571               2  1.341359e+06     1150000.0    4800000     300000
205572               1  5.520261e+06      800000.0  200000000       7300
205573               2  1.973902e+06     1850000.0    5250000     100000

        ctc_flag_mean_job  ctc_flag_median_company      ctc mean  ctc median  \
0                       2                        2  1.115667e+06   1070000.0
1                       3                        3  2.197334e+06    900000.0
2                       2                        2  2.000000e+06   2000000.0
3                       3                        2  1.713929e+06   1400000.0
4                       1                        1  9.400000e+05    850000.0
…                     …                        …          …          …
205569                  3                        3  1.681941e+06   2300000.0
205570                  2                        3  2.119245e+06   1200000.0
205571                  2                        2  1.404485e+06   1300000.0
205572                  2                        1  5.477717e+06    800000.0
205573                  2                        2  2.413205e+06   1900000.0

          ctc max  ctc min  ctc_flag_mean_company  CTC_updated_in_years
0         1771000   500000                      2                   4.0
1       200000000    10000                      3                   1.0
2         2000000  2000000                      2                   5.0
3         4700000   200000                      3                   2.0
4         1400000   540000                      2                   2.0
…           …      …                        …                  …
205569    3500000    60000                      3                  11.0
205570   74200000   200000                      3                   3.0
205571    4800000   200000                      3                   0.0
205572  200000000     7300                      2                   0.0
205573  100000000     1000                      2                   2.0

[205574 rows x 26 columns]
```

Based on the manual clustering done so far, answering few questions like:
Top 10 employees (earning more than most of the employees in the company) - Tier 1
Top 10 employees of data science in Amazon / TCS etc earning more than their peers - Class 1
Bottom 10 employees of data science in Amazon / TCS etc earning less than their peers - Class 3
Bottom 10 employees (earning less than most of the employees in the company)- Tier 3
Top 10 employees in Amazon- X department - having 5/6/7 years of experience earning more than t
Top 10 companies (based on their CTC)
Top 2 positions in every company (based on their CTC)

[287]:
```
df_manual_clustering
```

[287]:

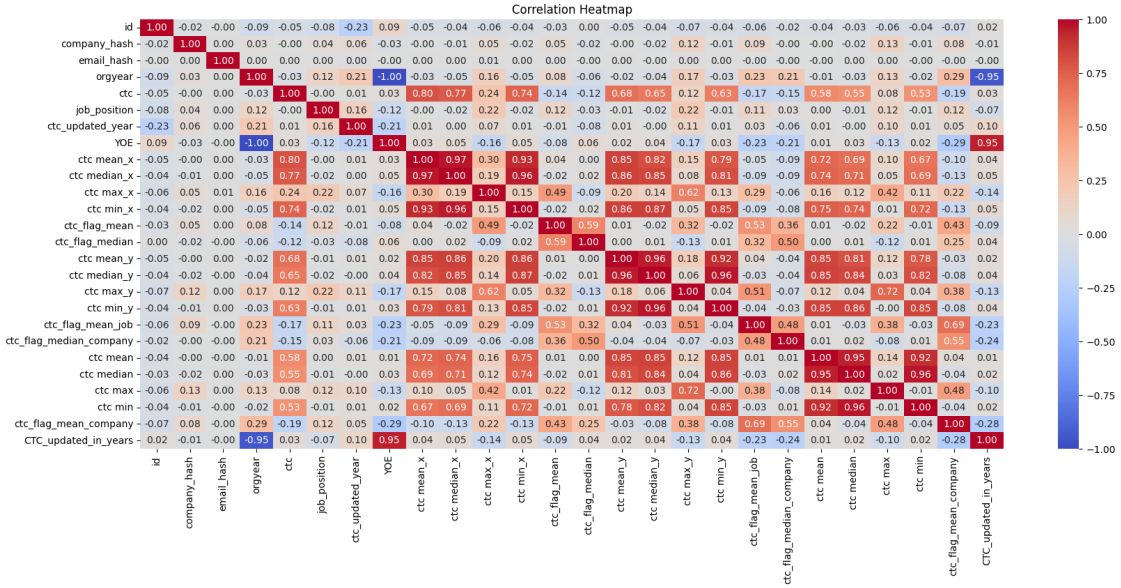
```
            id               company_hash  \
0            0             atrgxnnt xzaxv
1            1  qtrxvzwt xzegwgbb rxbxnta
2            2              ojzwnvwnxw vx
3            3                  ngpgutaxv
4            4                 qxen sqghu
…          …                         …
205569  206918                 vuurt xzw
205570  206919                 husqvawgb
205571  206920                  vwwgrxnt
205572  206921             zgn vuurxwvmrt
205573  206922             bgqsvz onvzrtj

                                                                email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205569  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205570  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205571  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205572  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205573  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE  \
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
3        2017.0   700000    Backend Engineer            2019.0   6.0
4        2017.0  1400000  FullStack Engineer            2019.0   6.0
…          …       …                  …                …    …
205569   2008.0   220000            Unknown            2019.0  15.0
205570   2017.0   500000            Unknown            2020.0   6.0
205571   2021.0   700000            Unknown            2021.0   2.0
205572   2019.0  5100000            Unknown            2019.0   4.0
205573   2014.0  1240000            Unknown            2016.0   9.0

          ctc mean_x  ctc median_x  ctc max_x  ctc min_x  ctc_flag_mean  \
0       1.100000e+06     1100000.0    1100000    1100000              2
1       7.742856e+05      750000.0    1200000     449999              2
2       2.000000e+06     2000000.0    2000000    2000000              2
3       1.158571e+06     1200000.0    1750000     700000              2
4       1.400000e+06     1400000.0    1400000    1400000              2
```

```
…              …            …         …         …              …
205569  2.200000e+05      220000.0     220000     220000              2
205570  1.150000e+06     1450000.0    1500000     500000              3
205571  6.666667e+05      700000.0    1000000     300000              2
205572  5.920732e+06      710000.0  180000000       7300              2
205573  1.693333e+06     1700000.0    2200000    1200000              2

        ctc_flag_median    ctc mean_y  ctc median_y  ctc max_y  ctc min_y  \
0                     2  1.085000e+06     1085000.0    1100000    1070000
1                     2  9.511363e+05      800000.0    2000000     300000
2                     2  2.000000e+06     2000000.0    2000000    2000000
3                     2  1.500000e+06     1540000.0    3500000     520000
4                     2  8.466667e+05      600000.0    1400000     540000
…                   …            …            …         …          …
205569                2  1.681941e+06     2300000.0    3500000      60000
205570                3  9.708333e+05      975000.0    1500000     500000
205571                2  1.341359e+06     1150000.0    4800000     300000
205572                1  5.520261e+06      800000.0  200000000       7300
205573                2  1.973902e+06     1850000.0    5250000     100000

        ctc_flag_mean_job  ctc_flag_median_company      ctc mean  ctc median  \
0                       2                        2  1.115667e+06   1070000.0
1                       3                        3  2.197334e+06    900000.0
2                       2                        2  2.000000e+06   2000000.0
3                       3                        2  1.713929e+06   1400000.0
4                       1                        1  9.400000e+05    850000.0
…                     …                        …           …          …
205569                  3                        3  1.681941e+06   2300000.0
205570                  2                        3  2.119245e+06   1200000.0
205571                  2                        2  1.404485e+06   1300000.0
205572                  2                        1  5.477717e+06    800000.0
205573                  2                        2  2.413205e+06   1900000.0

          ctc max  ctc min  ctc_flag_mean_company  CTC_updated_in_years
0         1771000   500000                      2                   4.0
1       200000000    10000                      3                   1.0
2         2000000  2000000                      2                   5.0
3         4700000   200000                      3                   2.0
4         1400000   540000                      2                   2.0
…           …      …                         …                   …
205569    3500000    60000                      3                  11.0
205570   74200000   200000                      3                   3.0
205571    4800000   200000                      3                   0.0
205572  200000000     7300                      2                   0.0
205573  100000000     1000                      2                   2.0

[205574 rows x 26 columns]
```

[288]:
```
# labeling

label_encoder = LabelEncoder()
df_manual_clustering_scaled = df_manual_clustering.copy()

# Fit the encoder on the categorical data and transform the data
df_manual_clustering_scaled['company_hash'] = label_encoder.
 ↪fit_transform(df_manual_clustering_scaled['company_hash'])
df_manual_clustering_scaled['email_hash'] = label_encoder.
 ↪fit_transform(df_manual_clustering_scaled['email_hash'])
df_manual_clustering_scaled['job_position'] = label_encoder.
 ↪fit_transform(df_manual_clustering_scaled['job_position'])
```

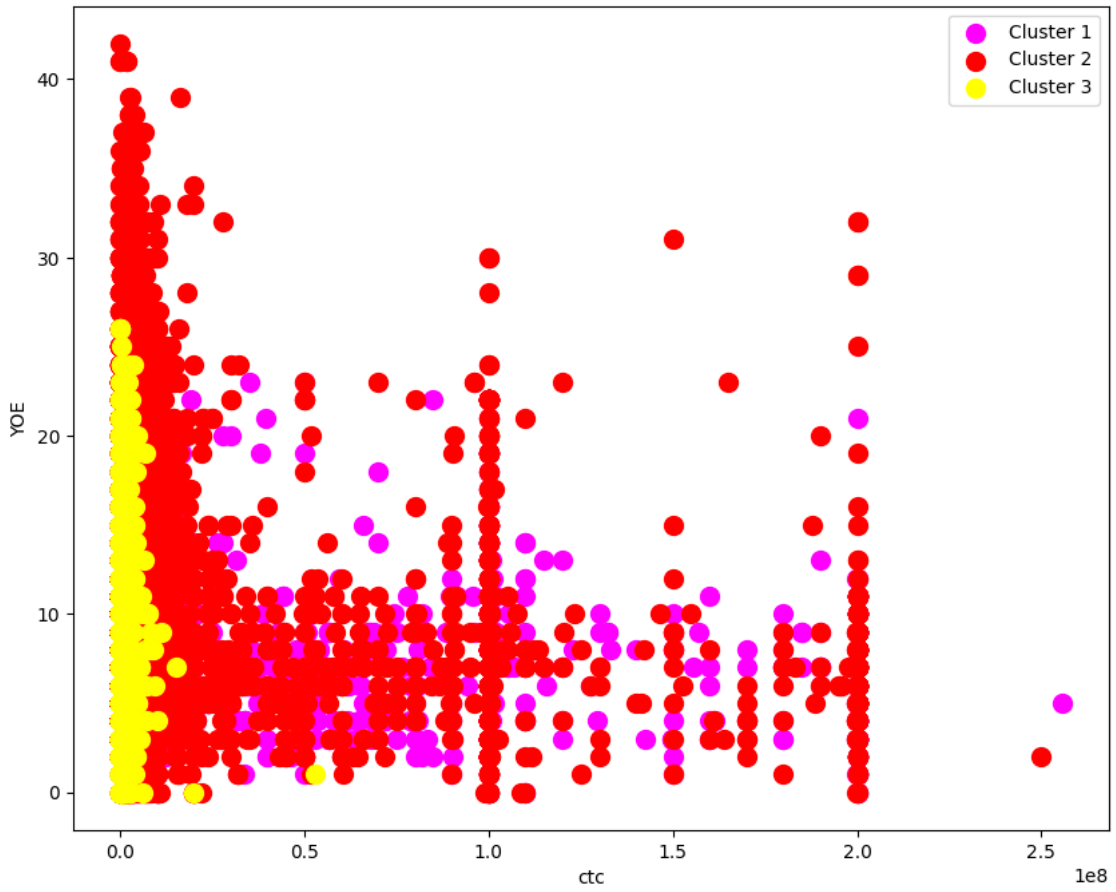
[289]:
```
correlation_matrix = df_manual_clustering_scaled.corr()
```

[290]:
```
plt.figure(figsize=(20, 8))
sns.heatmap(correlation_matrix, annot=True, cmap="coolwarm", fmt=".2f")
plt.title("Correlation Heatmap")
plt.show()
```



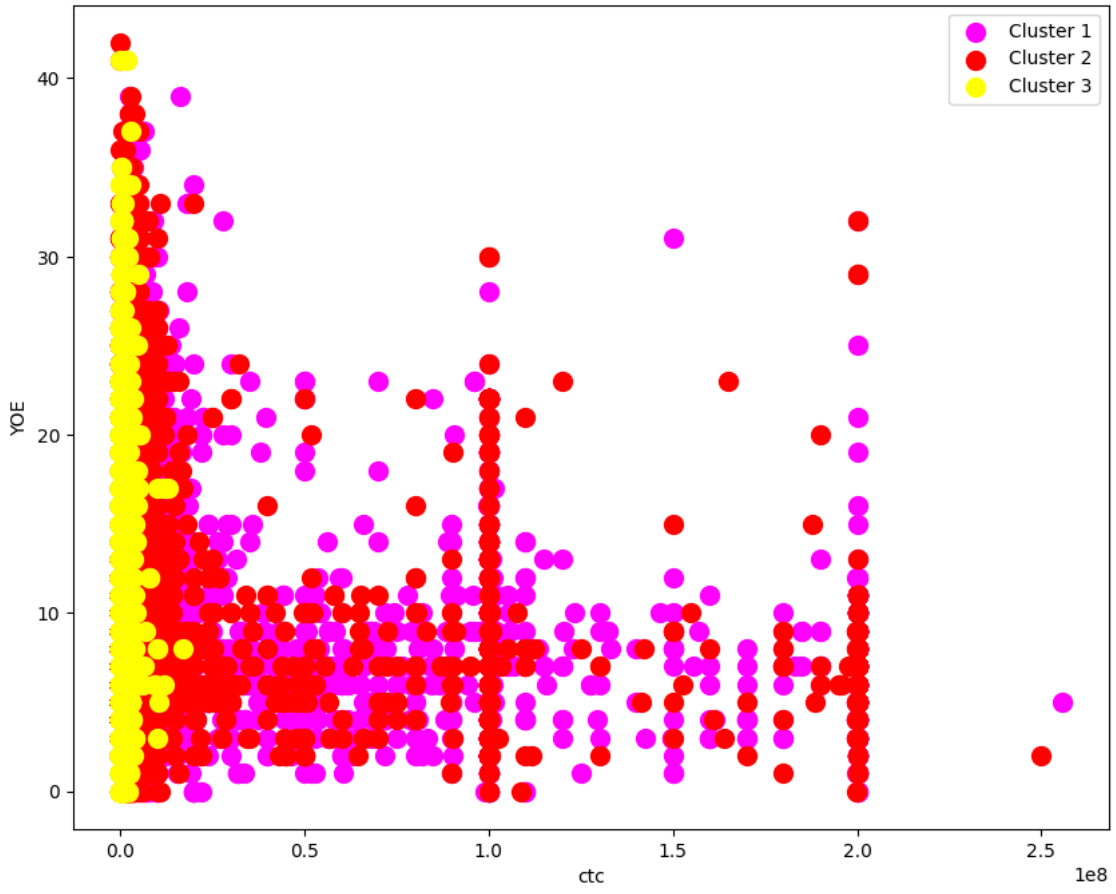
[305]:
```
fig, ax = plt.subplots(figsize=(10,8))
plt.
 ↪scatter(df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean']␣
 ↪== 1]['ctc'],␣
 ↪df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean'] ==␣
 ↪1]['YOE'], s=100, c='Magenta', label = 'Cluster 1')
```

```
plt.
  ↪scatter(df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean']␣
  ↪== 2]['ctc'],␣
  ↪df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean'] ==␣
  ↪2]['YOE'], s=100, c='Red', label = 'Cluster 2')
plt.
  ↪scatter(df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean']␣
  ↪== 3]['ctc'],␣
  ↪df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean'] ==␣
  ↪3]['YOE'], s=100, c='Yellow', label = 'Cluster 3')

plt.xlabel('ctc')
plt.ylabel('YOE')
plt.legend()
plt.show()
```

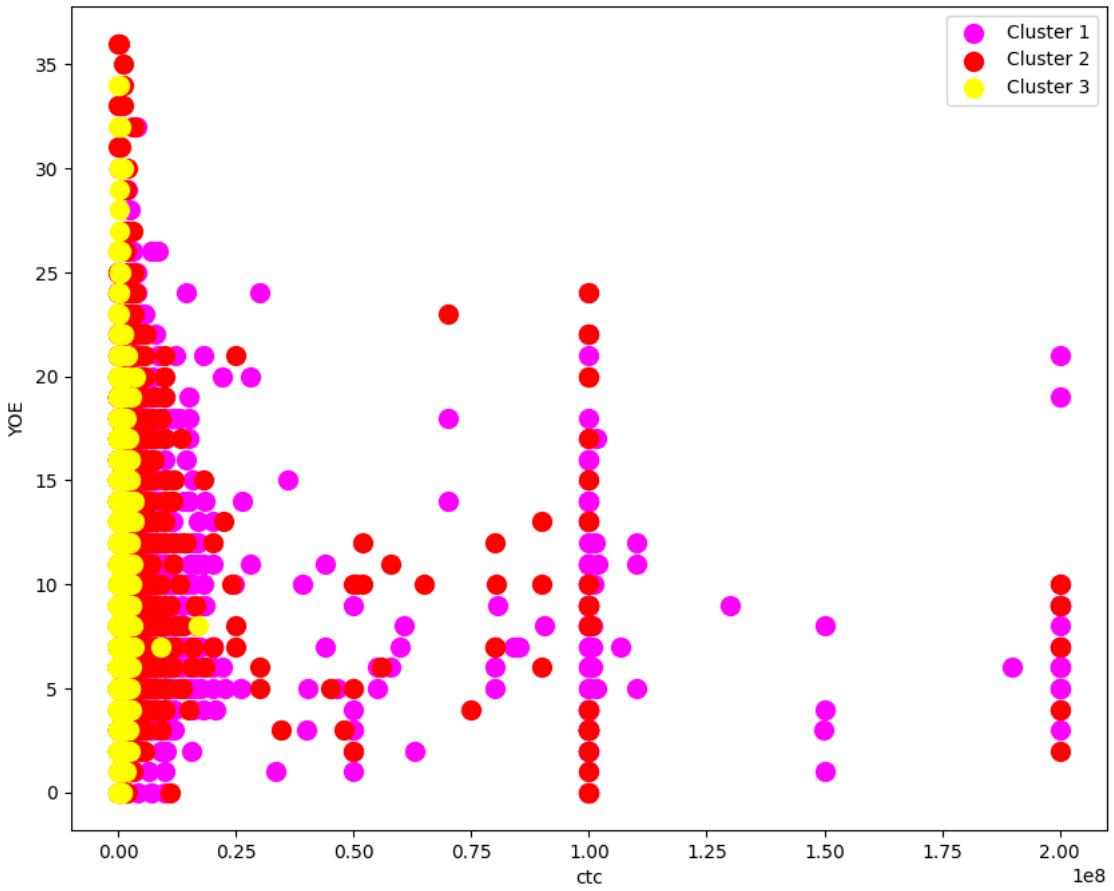


[304]:
```
fig, ax = plt.subplots(figsize=(10,8))
```

```
plt.
  ↪scatter(df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean_company']␣
  ↪== 1]['ctc'],␣
  ↪df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean_company']␣
  ↪== 1]['YOE'], s=100, c='Magenta', label = 'Cluster 1')
plt.
  ↪scatter(df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean_company']␣
  ↪== 2]['ctc'],␣
  ↪df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean_company']␣
  ↪== 2]['YOE'], s=100, c='Red', label = 'Cluster 2')
plt.
  ↪scatter(df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean_company']␣
  ↪== 3]['ctc'],␣
  ↪df_manual_clustering_scaled[df_manual_clustering_scaled['ctc_flag_mean_company']␣
  ↪== 3]['YOE'], s=100, c='Yellow', label = 'Cluster 3')

plt.xlabel('ctc')
plt.ylabel('YOE')
plt.legend()
plt.show()
```



[306]:
```
# also lets see for any particular job position
df_job =␣
 ↪df_manual_clustering_scaled[df_manual_clustering_scaled['job_position']==140]
fig, ax = plt.subplots(figsize=(10,8))
plt.scatter(df_job[df_job['ctc_flag_mean_job'] == 1]['ctc'],␣
 ↪df_job[df_job['ctc_flag_mean_job'] == 1]['YOE'], s=100, c='Magenta', label =␣
 ↪'Cluster 1')
plt.scatter(df_job[df_job['ctc_flag_mean_job'] == 2]['ctc'],␣
 ↪df_job[df_job['ctc_flag_mean_job'] == 2]['YOE'], s=100, c='Red', label =␣
 ↪'Cluster 2')
plt.scatter(df_job[df_job['ctc_flag_mean_job'] == 3]['ctc'],␣
 ↪df_job[df_job['ctc_flag_mean_job'] == 3]['YOE'], s=100, c='Yellow', label =␣
 ↪'Cluster 3')

plt.xlabel('ctc')
plt.ylabel('YOE')
plt.legend()
plt.show()
```



0.3.1 Manual clustering doesnot create clean clusters.

We had used mean/median of CTC in company / company & job role / company, job role & YOE to create 3 flags used as prediction label to cluster above. We also see strong correlation between CTC updation in years & Years of Experience. Also between CTC & CTC mean in company.

[294]:
```
# get top 10 companies
top_10_companies = df_manual_clustering.nlargest(10, 'ctc␣
 ↪mean_y')['company_hash']
top_10_companies.values
```

[294]:
```
array(['aveegaxr xzntqzvnxgzvr hzxctqoxnj', 'oxburjyq ogrhnxgzo rru',
       'ihvrxnvo srgmvr rru', 'uvqp wgbuhntq ojontb xzw',
       'xfgqp ntwyzgrgsxto', 'outwnqt vzvrjnxwv', 'twgbtduqtoo',
       'ofvr xzegntwy ucn rna', 'nvrtzn ouvwt xzw', 'zxoyvzn wgbuhntqo'],
      dtype=object)
```

[295]:
```
filtered_df =␣
 ↪df_manual_clustering[df_manual_clustering['ctc_flag_mean_company'] == 1]
distinct_values = filtered_df['company_hash'].unique()
print(distinct_values)
```

```
['bgsrxd' 'nxbto xzntqztn' 'qxenxg' … 'ujut ntwyzgrgsxto' 'nvqvbo'
 'oyguwg']
```

[296]:
```
# get top 2 job positions
top_2_positions = df_manual_clustering.nlargest(3, 'ctc mean_y')['job_position']
distinct_positions = top_2_positions.unique()
distinct_positions
```

[296]:
```
array(['Unknown', 'Support Engineer', 'QA Engineer'], dtype=object)
```

[297]:
```
filtered_df = df_manual_clustering[df_manual_clustering['ctc_flag_mean_job'] ==␣
 ↪1]
distinct_values = filtered_df['job_position'].unique()
print(distinct_values)
```

```
['FullStack Engineer' 'Backend Engineer' 'Unknown' 'Frontend Engineer'
 'Android Engineer' 'QA Engineer' 'Other' 'Data Scientist'
 'Support Engineer' 'Data Analyst' 'SDET' 'Engineering Leadership'
 'Engineering Intern' 'Devops Engineer' 'Research Engineers'
 'iOS Engineer' 'Database Administrator' 'Product Manager' 'Co-founder'
 'Student' 'Program Manager' 'Backend Architect' 'Release Engineer'
 'Product Designer' 'Software Development Engineer - II' 'Non Coder']
```

```
'Engineer' 'Security Leadership' 'Associate' 'Project Engineer'
'System Engineer' 'project engineer' 'SDE II'
'Business Technology Analyst' 'Software Engineer (Backend)' 'SDE 1'
'SDE 2' 'Software Engineer 2' 'SDE-1' 'Fullstack Engineer' 'Na' 'None'
'Software Development Engineer - I'
'Application development senior analyst'
'Assistant System Engineer Trainee' 'SDE2' 'Associate Consultant'
'Software Development Engineer Intern' 'Senior  Software Engineer'
'MTS-2' 'Teaching Assistant' 'Sr Software Engineer']
```

[298]:
```
## Get the top 10 employees
sorted_df = df_manual_clustering.sort_values(by='ctc', ascending=False)
top_10_employees = sorted_df['id'].head(10)
top_10_employees.values
```

[298]:
```
array([117948,   3301,   9763, 103894,  16603,  20196,  90189,  10405,
        60429,    836])
```

[299]:
```
filtered_df = df_manual_clustering[df_manual_clustering['ctc_flag_mean'] == 1]
distinct_values = filtered_df['id'].unique()
print(distinct_values)
```

```
[    17     25     38 … 206887 206900 206916]
```

[300]:
```
## Get the bottom 10 employees
sorted_df = df_manual_clustering.sort_values(by='ctc', ascending=True)
bottom_10_employees = sorted_df['id'].head(10)
bottom_10_employees.values
```

[300]:
```
array([135886, 118549, 114452, 185851, 184706,  54885,  91723, 117256,
       167115,  82161])
```

[301]:
```
filtered_df = df_manual_clustering[df_manual_clustering['ctc_flag_mean'] == 3]
distinct_values = filtered_df['id'].unique()
print(distinct_values)
```

```
[    14     20     59 … 206910 206917 206919]
```

[302]:
```
## Get the top 10 employees by job position
sorted_df = df_manual_clustering.sort_values(by='ctc mean_x', ascending=False)
top_10_employees = sorted_df['id'].head(10)
top_10_employees.values
```

[302]:
```
array([ 3301, 23067, 12612,  2824, 20196, 29753,   361, 20184,  2793,
       22640])
```

[303]:
```
filtered_df = df_manual_clustering[df_manual_clustering['ctc_flag_mean_job'] ==␣
↪1]
```

```
distinct_values = filtered_df['id'].unique()
print(distinct_values)
```

```
[     4     15     17 … 206876 206887 206903]
```

[167]:
```
# Top 10 employees in Amazon- X department - having 5/6/7 years of experience␣
 ↪earning more than their peers - Tier X

df_filtered = df_manual_clustering[(df_manual_clustering['YOE'] >= 5) &␣
 ↪(df_manual_clustering['YOE'] <= 7) &␣
 ↪(df_manual_clustering['ctc_flag_mean_company']==1)]

df_sorted = df_filtered.sort_values(by=['ctc', 'job_position'],␣
 ↪ascending=[False, True])

top_10_employees = df_filtered.groupby(['company_hash'], group_keys=True).apply(
    lambda x: x.nlargest(10, 'ctc')
)

top_10_employees
```

[167]:
```
                          id company_hash  \
company_hash
01 ojztqsj   74315    74535   01 ojztqsj
1bs          128317  128911          1bs
             138145  138817          1bs
             167432  168383          1bs
             205082  206430          1bs
…                      …          …
zxzlvwvqn    33776    33885    zxzlvwvqn
             57419    57586    zxzlvwvqn
             56282    56447    zxzlvwvqn
zxztrtvuo    196545  197815    zxztrtvuo
             17377    17423    zxztrtvuo

email_hash  \
company_hash
01 ojztqsj   74315
819789ff4068fd5c8facf8a5074cdd2e1ff989c95ae02c02b81ac1447cbd6386
1bs          128317
9977fcf096a81795abeb0829760e399a0a7a727ebf8bbb2f975a66dbac3c5326
             138145
9977fcf096a81795abeb0829760e399a0a7a727ebf8bbb2f975a66dbac3c5326
             167432
d0d06e9bb510f55e1e26e25cc8e1f6dfbe31384d3864a5bbb5bf7e3c3a21ebc7
             205082
6eb6cb9918e8eceb347c37797a75e08f94c2050b857258f10609799502151a83
```

```
…
…
zxzlvwvqn    33776
4b083429e503553fb88ede06604aceccef192b2501226318f00d9eebdcde748b
             57419
4b083429e503553fb88ede06604aceccef192b2501226318f00d9eebdcde748b
             56282
d22eddf77b769126fdb8f25fe69489204d7f1b8fe18bb12b8ffbd0522c3e24c5
zxztrtvuo    196545
b5628c03989a151f60c89e726351817c3a62078e7c70deb9351e3b51c69c012f
             17377
41367fd92cd85ecfa2e2ce76f4ff94cde287b95df93871713fe4f52c7c61c000

                     orgyear     ctc             job_position  \
company_hash
01 ojztqsj   74315    2016.0  270000         Android Engineer
1bs          128317   2017.0  700000              QA Engineer
             138145   2017.0  700000                     SDET
             167432   2017.0  700000         Android Engineer
             205082   2018.0  700000                  Unknown
…                      …     …                          …
zxzlvwvqn    33776    2017.0  600000                  Unknown
             57419    2017.0  600000  Area Operations Manager
             56282    2017.0  500000          Backend Engineer
zxztrtvuo    196545   2016.0  575000        FullStack Engineer
             17377    2018.0  570000         Frontend Engineer

                     ctc_updated_year  YOE    ctc mean_x  ctc median_x  \
company_hash
01 ojztqsj   74315             2019.0  7.0  2.700000e+05      270000.0
1bs          128317            2019.0  6.0  7.000000e+05      700000.0
             138145            2019.0  6.0  7.000000e+05      700000.0
             167432            2019.0  6.0  7.000000e+05      700000.0
             205082            2021.0  5.0  9.200000e+05      800000.0
…                               …  …           …            …
zxzlvwvqn    33776             2021.0  6.0  1.800000e+06     1800000.0
             57419             2021.0  6.0  6.000000e+05      600000.0
             56282             2020.0  6.0  1.740000e+06     1730000.0
zxztrtvuo    196545            2019.0  7.0  8.993333e+05      923000.0
             17377             2019.0  5.0  5.850000e+05      585000.0

                     ctc max_x  ctc min_x  ctc_flag_mean  ctc_flag_median  \
company_hash
01 ojztqsj   74315      270000     270000              2                2
1bs          128317     700000     700000              2                2
             138145     700000     700000              2                2
             167432     700000     700000              2                2
```

```
             205082    1400000     700000              2                2
…                       …         …            …              …
zxzlvwvqn    33776     3000000     600000              1                1
             57419      600000     600000              2                2
             56282     3000000     500000              1                1
zxztrtvuo    196545    1200000     575000              2                2
             17377      600000     570000              2                2

                       ctc mean_y  ctc median_y  ctc max_y  ctc min_y  \
company_hash
01 ojztqsj   74315   5.500000e+05      550000.0     830000     270000
1bs          128317  1.452090e+06     1300000.0    3750000     600000
             138145  1.452090e+06     1300000.0    3750000     600000
             167432  1.452090e+06     1300000.0    3750000     600000
             205082  1.452090e+06     1300000.0    3750000     600000
…                          …            …         …         …
zxzlvwvqn    33776   1.739048e+06     1350000.0    5000000     180000
             57419   1.739048e+06     1350000.0    5000000     180000
             56282   1.739048e+06     1350000.0    5000000     180000
zxztrtvuo    196545  1.172701e+06      819999.0   11950000     400000
             17377   1.172701e+06      819999.0   11950000     400000

                       ctc_flag_mean_company  ctc_flag_median_company  \
company_hash
01 ojztqsj   74315                         1                        1
1bs          128317                        1                        2
             138145                        1                        2
             167432                        1                        2
             205082                        1                        2
…                                  …                        …
zxzlvwvqn    33776                         1                        1
             57419                         1                        1
             56282                         1                        1
zxztrtvuo    196545                        1                        2
             17377                         1                        2

                       CTC_updated_in_years
company_hash
01 ojztqsj   74315                      3.0
1bs          128317                     2.0
             138145                     2.0
             167432                     2.0
             205082                     3.0
…                                  …
zxzlvwvqn    33776                      4.0
             57419                      4.0
             56282                      3.0
```

```
zxztrtvuo    196545                  3.0
             17377                   1.0

[7771 rows x 21 columns]
```

[167]:

0.4 Clustering using KMeans, GMM & Hierarchical methods

[168]:
```
df = df_manual_clustering.copy()
df
```

[168]:
```
            id               company_hash  \
0            0             atrgxnnt xzaxv
1            1  qtrxvzwt xzegwgbb rxbxnta
2            2              ojzwnvwnxw vx
3            3                  ngpgutaxv
4            4                 qxen sqghu
…          …                        …
205569  206918                  vuurt xzw
205570  206919                  husqvawgb
205571  206920                   vwwgrxnt
205572  206921             zgn vuurxwvmrt
205573  206922             bgqsvz onvzrtj

                                                        email_hash  \
0       6de0a4417d18ab14334c3f43397fc13b30c35149d70c050c0618caea697c87af
1       b0aaf1ac138b53cb6e039ba2c3d6604a250d02d5145c100a9661a92bdcc0407b
2       4860c670bcd48fb96c02a4b0ae3608ae6fdd98176112e90fd66c9df6b37b9059
3       effdede7a2e7c2af664c8a31d9346385016128d66bbc58a44274d5d6876dfec7
4       6ff54e709262f55cb999a1c1db8436cb2055d8f79ab520214b31b95211adb095
…                                                                     …
205569  70027b728c8ee901fe979533ed94ffda97be08fc23f33b6e8d7cb06af04e0c05
205570  7f7292ffad724ebbe9ca860f515245368d714c84705b4264c8e881b4a61cdb53
205571  cb25cc7304e9a24facda7f5567c7922ffc48e3d5d6018c8852b58da2fde5e00c
205572  fb46a1a2752f5f652ce634f6178d0578ef6995ee59f6c819ec41f6af222a8699
205573  0bcfc1d05f2e8dc4147743a1313aa70a119b41b30d4a1f7e738a6a87d3712c31

        orgyear      ctc        job_position  ctc_updated_year   YOE  \
0        2016.0  1100000               Other            2020.0   7.0
1        2018.0   449999  FullStack Engineer            2019.0   5.0
2        2015.0  2000000    Backend Engineer            2020.0   8.0
3        2017.0   700000    Backend Engineer            2019.0   6.0
4        2017.0  1400000  FullStack Engineer            2019.0   6.0
…          …      …                  …               …    …
205569   2008.0   220000             Unknown            2019.0  15.0
205570   2017.0   500000             Unknown            2020.0   6.0
```

```
205571   2021.0   700000             Unknown            2021.0   2.0
205572   2019.0  5100000             Unknown            2019.0   4.0
205573   2014.0  1240000             Unknown            2016.0   9.0

          ctc mean_x  ctc median_x  ctc max_x  ctc min_x  ctc_flag_mean  \
0       1.100000e+06     1100000.0    1100000    1100000              2
1       7.742856e+05      750000.0    1200000     449999              2
2       2.000000e+06     2000000.0    2000000    2000000              2
3       1.158571e+06     1200000.0    1750000     700000              2
4       1.400000e+06     1400000.0    1400000    1400000              2
…                …             …          …          …              …
205569  2.200000e+05      220000.0     220000     220000              2
205570  1.150000e+06     1450000.0    1500000     500000              1
205571  6.666667e+05      700000.0    1000000     300000              2
205572  5.920732e+06      710000.0  180000000       7300              2
205573  1.693333e+06     1700000.0    2200000    1200000              2

        ctc_flag_median    ctc mean_y  ctc median_y  ctc max_y  ctc min_y  \
0                     2  1.115667e+06     1070000.0    1771000     500000
1                     2  2.197334e+06      900000.0  200000000      10000
2                     2  2.000000e+06     2000000.0    2000000    2000000
3                     2  1.713929e+06     1400000.0    4700000     200000
4                     2  9.400000e+05      850000.0    1400000     540000
…                   …             …             …          …          …
205569                2  1.681941e+06     2300000.0    3500000      60000
205570                1  2.119245e+06     1200000.0   74200000     200000
205571                2  1.404485e+06     1300000.0    4800000     200000
205572                3  5.477717e+06      800000.0  200000000       7300
205573                2  2.413205e+06     1900000.0  100000000       1000

        ctc_flag_mean_company  ctc_flag_median_company  CTC_updated_in_years
0                           2                        2                   4.0
1                           1                        1                   1.0
2                           2                        2                   5.0
3                           1                        2                   2.0
4                           2                        3                   2.0
…                         …                        …                   …
205569                      1                        1                  11.0
205570                      1                        1                   3.0
205571                      1                        2                   0.0
205572                      2                        3                   0.0
205573                      2                        2                   2.0

[205574 rows x 21 columns]
```

[169]:
```
# Create a LabelEncoder object
label_encoder = LabelEncoder()
```

```
# Fit the encoder on the categorical data and transform the data
df['company_hash'] = label_encoder.fit_transform(df['company_hash'])
df['email_hash'] = label_encoder.fit_transform(df['email_hash'])
df['job_position'] = label_encoder.fit_transform(df['job_position'])
df
```

[169]:

	id	company_hash	email_hash	orgyear	ctc	job_position	\
0	0	967	65689	2016.0	1100000	458	
1	1	19690	105755	2018.0	449999	292	
2	2	15482	43239	2015.0	2000000	140	
3	3	12085	143658	2017.0	700000	140	
4	4	20186	66892	2017.0	1400000	292	
…	…	…	…	…	…	…	
205569	206918	28705	66934	2008.0	220000	954	
205570	206919	8491	76135	2017.0	500000	954	
205571	206920	29038	121480	2021.0	700000	954	
205572	206921	35968	150460	2019.0	5100000	954	
205573	206922	2164	7274	2014.0	1240000	954	

	ctc_updated_year	YOE	ctc mean_x	ctc median_x	ctc max_x	\
0	2020.0	7.0	1.100000e+06	1100000.0	1100000	
1	2019.0	5.0	7.742856e+05	750000.0	1200000	
2	2020.0	8.0	2.000000e+06	2000000.0	2000000	
3	2019.0	6.0	1.158571e+06	1200000.0	1750000	
4	2019.0	6.0	1.400000e+06	1400000.0	1400000	
…	…	…	…	…	…	
205569	2019.0	15.0	2.200000e+05	220000.0	220000	
205570	2020.0	6.0	1.150000e+06	1450000.0	1500000	
205571	2021.0	2.0	6.666667e+05	700000.0	1000000	
205572	2019.0	4.0	5.920732e+06	710000.0	180000000	
205573	2016.0	9.0	1.693333e+06	1700000.0	2200000	

	ctc min_x	ctc_flag_mean	ctc_flag_median	ctc mean_y	ctc median_y	\
0	1100000	2	2	1.115667e+06	1070000.0	
1	449999	2	2	2.197334e+06	900000.0	
2	2000000	2	2	2.000000e+06	2000000.0	
3	700000	2	2	1.713929e+06	1400000.0	
4	1400000	2	2	9.400000e+05	850000.0	
…	…	…	…	…	…	
205569	220000	2	2	1.681941e+06	2300000.0	
205570	500000	1	1	2.119245e+06	1200000.0	
205571	300000	2	2	1.404485e+06	1300000.0	
205572	7300	2	3	5.477717e+06	800000.0	
205573	1200000	2	2	2.413205e+06	1900000.0	

	ctc max_y	ctc min_y	ctc_flag_mean_company	ctc_flag_median_company	\

```
0          1771000     500000                    2                    2
1        200000000      10000                    1                    1
2          2000000    2000000                    2                    2
3          4700000     200000                    1                    2
4          1400000     540000                    2                    3
…              …          …                     …                    …
205569     3500000      60000                    1                    1
205570    74200000     200000                    1                    1
205571     4800000     200000                    1                    2
205572   200000000       7300                    2                    3
205573   100000000       1000                    2                    2

        CTC_updated_in_years
0                        4.0
1                        1.0
2                        5.0
3                        2.0
4                        2.0
…                        …
205569                  11.0
205570                   3.0
205571                   0.0
205572                   0.0
205573                   2.0

[205574 rows x 21 columns]
```

[69]:
```
df.columns
```

[69]:
```
Index(['id', 'company_hash', 'email_hash', 'orgyear', 'ctc', 'job_position',
       'ctc_updated_year', 'YOE', 'ctc mean_x', 'ctc median_x', 'ctc max_x',
       'ctc min_x', 'ctc_flag_mean', 'ctc_flag_median', 'ctc mean_y',
       'ctc median_y', 'ctc max_y', 'ctc min_y', 'ctc_flag_mean_company',
       'ctc_flag_median_company', 'CTC_updated_in_years'],
      dtype='object')
```

0.5 PCA

[70]:
```
df_cluster_pca = df[['job_position', 'ctc', 'YOE', 'ctc mean_x', 'ctc mean_y',␣
↪'CTC_updated_in_years']] # we will cluster based on CTC & YOE
df_cluster_pca
```

[70]:
```
        job_position      ctc   YOE    ctc mean_x    ctc mean_y  \
0                458  1100000   7.0  1.100000e+06  1.115667e+06
1                292   449999   5.0  7.742856e+05  2.197334e+06
2                140  2000000   8.0  2.000000e+06  2.000000e+06
3                140   700000   6.0  1.158571e+06  1.713929e+06
```

```
4                292  1400000   6.0  1.400000e+06  9.400000e+05
…              …      …    …           …            …
205569           954   220000  15.0  2.200000e+05  1.681941e+06
205570           954   500000   6.0  1.150000e+06  2.119245e+06
205571           954   700000   2.0  6.666667e+05  1.404485e+06
205572           954  5100000   4.0  5.920732e+06  5.477717e+06
205573           954  1240000   9.0  1.693333e+06  2.413205e+06

        CTC_updated_in_years
0                        4.0
1                        1.0
2                        5.0
3                        2.0
4                        2.0
…                        …
205569                  11.0
205570                   3.0
205571                   0.0
205572                   0.0
205573                   2.0

[205574 rows x 6 columns]
```

[71]:
```
scaler = StandardScaler()
X_cluster_pca = scaler.fit_transform(df_cluster_pca)
X_cluster_pca
```

[71]:
```
array([[-0.03633311, -0.10041986, -0.20925941, -0.12594359, -0.17140339,
        -0.12336313],
       [-0.54040269, -0.15657538, -0.68269025, -0.16123523, -0.00972009,
        -0.84614513],
       [-1.00196037, -0.02266618,  0.02745601, -0.02842725, -0.03921674,
         0.1175642 ],
       …,
       [ 1.46980251, -0.13497705, -1.39283651, -0.1728959 , -0.12823194,
        -1.08707246],
       [ 1.46980251,  0.24515205, -0.91940567,  0.39638993,  0.4806186 ,
        -1.08707246],
       [ 1.46980251, -0.08832484,  0.26417143, -0.06165504,  0.0225475 ,
        -0.60521779]])
```

[72]:
```
cov_X_st = np.matmul(X_cluster_pca.T, X_cluster_pca)/(len(X_cluster_pca)-1)
```

[73]:
```
eigenvalues, eigenvectors = np.linalg.eig(cov_X_st)
print(eigenvalues)
print(eigenvectors)
```

```
[2.41261484 1.96065299 0.98237182 0.42782339 0.048669   0.16789715]
[[-0.01453905  0.1379314   0.9896253  -0.00891342 -0.03631253  0.00269483]
 [ 0.56692195  0.07530792 -0.00638234 -0.62166935 -0.00199121 -0.53517357]
 [ 0.0955654  -0.69547896  0.07244463  0.0093261  -0.70838454 -0.0056926 ]
 [ 0.60361524  0.0773669  -0.00520254 -0.11587351 -0.00289174  0.78498465]
 [ 0.54332995  0.08680309  0.00375237  0.77453531  0.00116475 -0.31198942]
 [ 0.09847122 -0.69144215  0.12374029  0.00540191  0.7048823  -0.00335797]]
```

[74]:
```
(eigenvalues[0]+eigenvalues[1]+eigenvalues[2])  / eigenvalues.sum()
```

[74]:
```
0.8926022665385465
```

[75]:
```
eigenvectors = eigenvectors.T
X_prime = eigenvectors[0].dot(X_cluster_pca.T)
X_prime_reduced = X_prime
print(X_prime_reduced)
```

```
[-0.25769772 -0.33207685 -0.02254862 … -0.51207817  0.4231053
 -0.1307589 ]
```

[76]:
```
from sklearn import decomposition
pca = decomposition.PCA(n_components=3)
pcafit = pca.fit(X_cluster_pca)
percentExplained = pca.explained_variance_ratio_.sum()
print(percentExplained)
```

```
0.8926022665385476
```

[77]:
```
principal_components = pca.fit_transform(X_cluster_pca)
principal_components
```

[77]:
```
array([[-0.25769772, -0.19363789, -0.0657279 ],
       [-0.33207685, -0.96020924, -0.68715398],
       [-0.02254862,  0.24589612, -0.97488347],
       …,
       [-0.51207817, -1.88839593,  1.22041535],
       [ 0.4231053 , -1.68465546,  1.25160966],
       [-0.1307589 , -0.4280149 ,  1.39977081]])
```

0.6 Clustering using CTC & YOE for job position

[78]:
```
df = df[['job_position', 'ctc', 'YOE']] # we will cluster based on CTC & YOE
df
```

[78]:

	job_position	ctc	YOE
0	458	1100000	7.0
1	292	449999	5.0

```
2                140  2000000   8.0
3                140   700000   6.0
4                292  1400000   6.0
…                …       …    …
205569           954   220000  15.0
205570           954   500000   6.0
205571           954   700000   2.0
205572           954  5100000   4.0
205573           954  1240000   9.0

[205574 rows x 3 columns]
```

[79]:
```
df.isna().sum()
```

[79]:
```
job_position    0
ctc             0
YOE             0
dtype: int64
```

[80]:
```
X = df
```

[81]:
```
# Standardisation
# lets do standard scaling now
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
X_scaled
```

[81]:
```
array([[-0.03633311, -0.10041986, -0.20925941],
       [-0.54040269, -0.15657538, -0.68269025],
       [-1.00196037, -0.02266618,  0.02745601],
       …,
       [ 1.46980251, -0.13497705, -1.39283651],
       [ 1.46980251,  0.24515205, -0.91940567],
       [ 1.46980251, -0.08832484,  0.26417143]])
```

[81]:
```

```

Silhouette Score

[82]:
```
from sklearn.metrics import silhouette_score
from sklearn.decomposition import PCA
from sklearn.cluster import KMeans
```

[69]:
```
# Checking clustering tendency
silhouette_avg = silhouette_score(X, KMeans(n_clusters=4).fit_predict(X))
print(f'Silhouette Score for original data: {silhouette_avg:.2f}')
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
```

```
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
```

```
Silhouette Score for original data: 0.97
```

A high Silhouette Score indicates that the object is well matched to its own cluster and poorly matched to neighboring clusters. This suggests that the clustering is appropriate.

0.7 KMeans & Elbow method to find no of clusters to create

[90]:
```python
# Elbow method to find the optimal number of clusters
inertia = []
for k in range(1, 11):
    kmeans = KMeans(n_clusters=k, random_state=42)
    kmeans.fit(X)
    inertia.append(kmeans.inertia_)
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
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/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
```
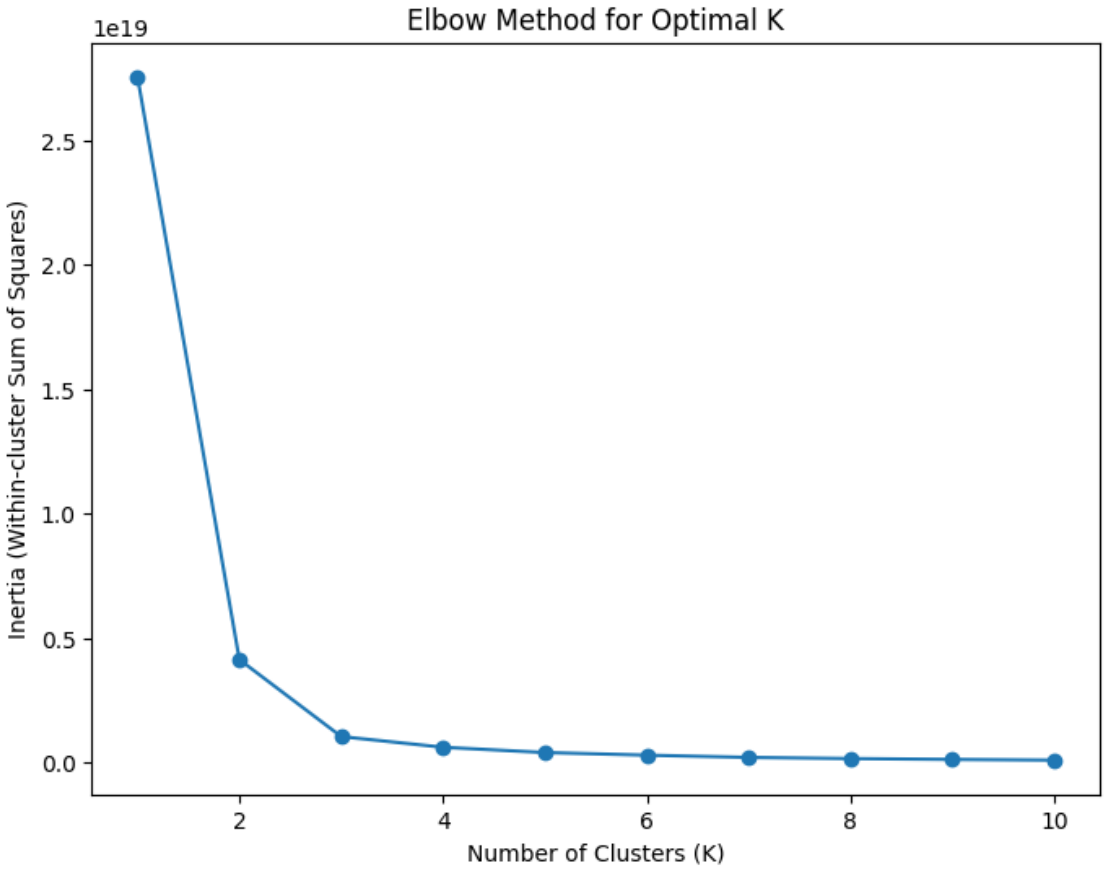

```
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
```

[91]:
```
# Plot the Elbow curve
plt.figure(figsize=(8, 6))
plt.plot(range(1, 11), inertia, marker='o')
plt.title('Elbow Method for Optimal K')
plt.xlabel('Number of Clusters (K)')
plt.ylabel('Inertia (Within-cluster Sum of Squares)')
plt.show()
```



Based on the Elbow method, let's choose K=4

[75]:

[117]:
```
from sklearn.cluster import KMeans

k = 4
kmeans = KMeans(n_clusters=k, init = 'k-means++')
y_pred = kmeans.fit_predict(X_scaled)
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870:
FutureWarning: The default value of `n_init` will change from 10 to 'auto' in
1.4. Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
```

[118]:
```
# from sklearn.cluster import KMeans

# k = 4
# kmeans = KMeans(n_clusters=k, init = 'k-means++')
# y_pred = kmeans.fit_predict(principal_components)
```

0.7.1 On testing with PCA components, the results were not very good!!

[119]:
```
df['predicted_label'] = y_pred
```

```
<ipython-input-119-60de8de49a36>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['predicted_label'] = y_pred
```

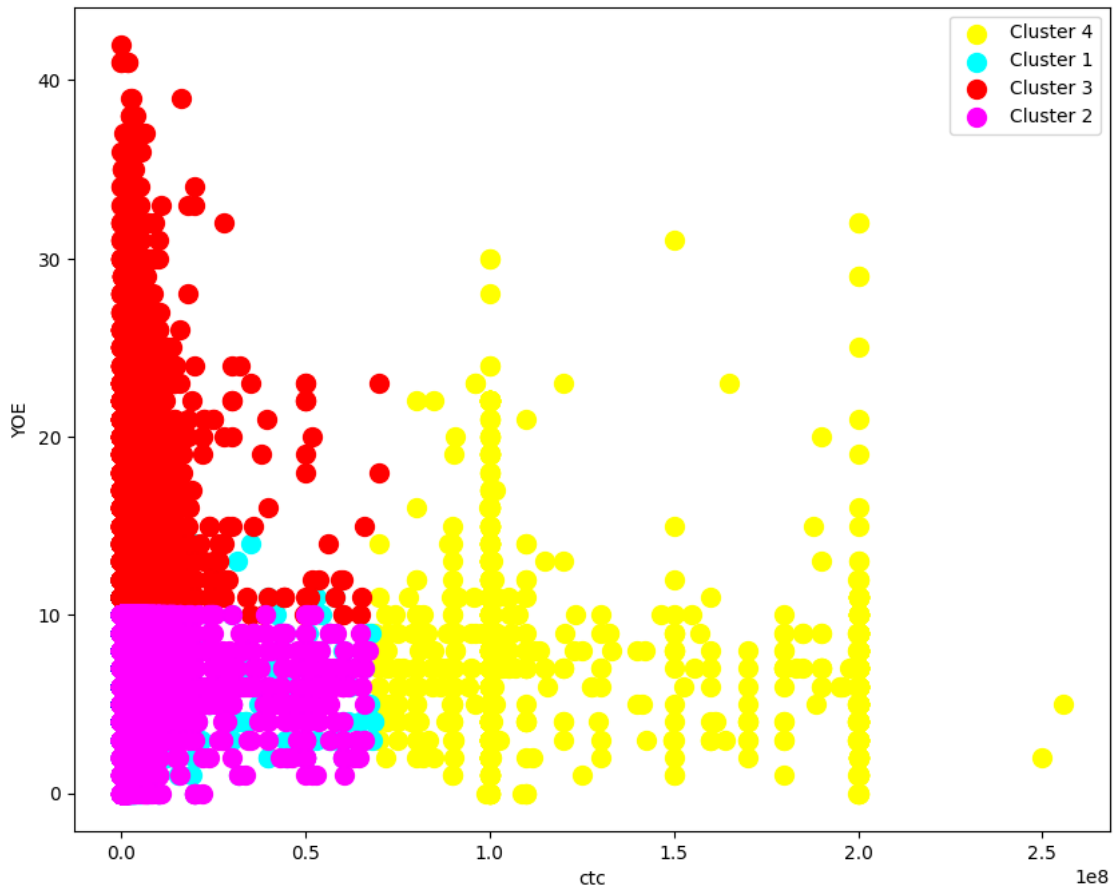
[120]:
```
df
```

[120]:

	job_position	ctc	YOE	predicted_label
0	458	1100000	7.0	1
1	292	449999	5.0	1
2	140	2000000	8.0	1
3	140	700000	6.0	1
4	292	1400000	6.0	1
…	…	…	…	…
205569	954	220000	15.0	2
205570	954	500000	6.0	0
205571	954	700000	2.0	0
205572	954	5100000	4.0	0
205573	954	1240000	9.0	0

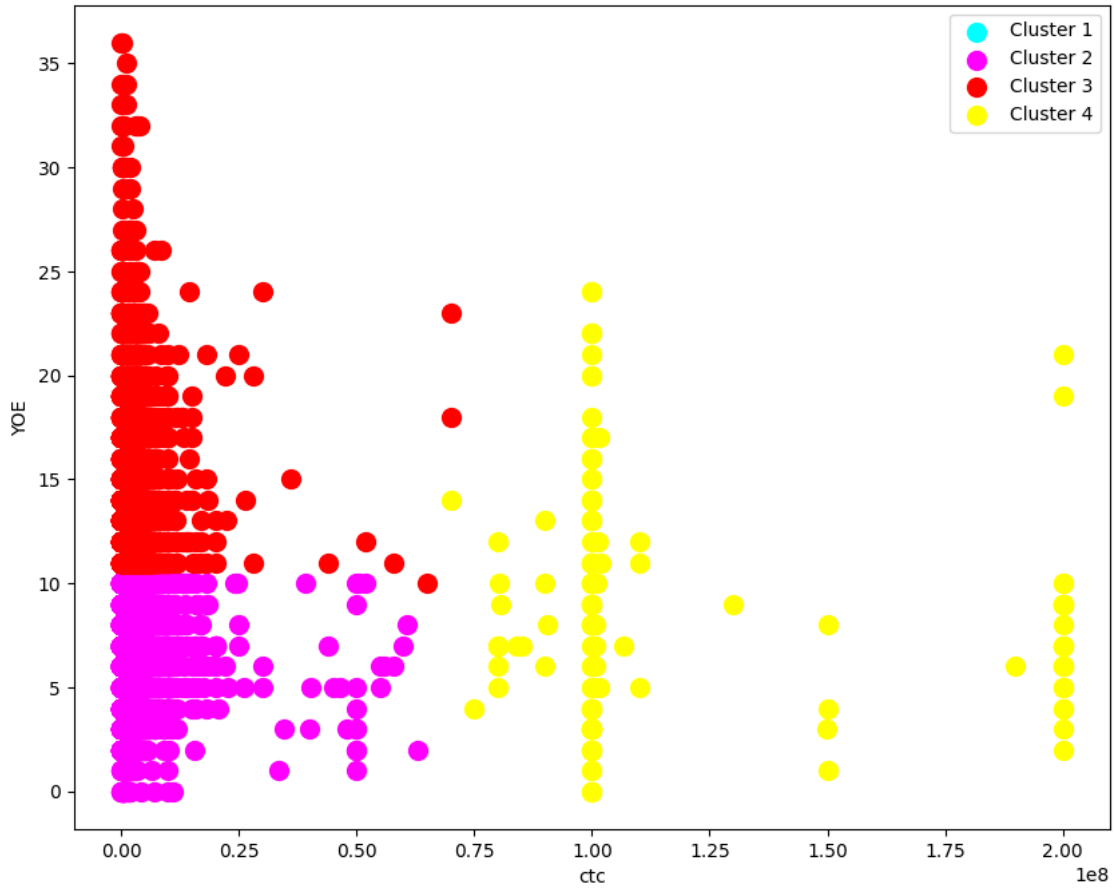
[205574 rows x 4 columns]

[123]:
```
fig, ax = plt.subplots(figsize=(10,8))
plt.scatter(df[df['predicted_label'] == 3]['ctc'], df[df['predicted_label'] ==␣
 ↪3]['YOE'], s=100, c='Yellow', label = 'Cluster 4')
plt.scatter(df[df['predicted_label'] == 0]['ctc'], df[df['predicted_label'] ==␣
 ↪0]['YOE'], s=100, c='Cyan', label = 'Cluster 1')
plt.scatter(df[df['predicted_label'] == 2]['ctc'], df[df['predicted_label'] ==␣
 ↪2]['YOE'], s=100, c='Red', label = 'Cluster 3')
plt.scatter(df[df['predicted_label'] == 1]['ctc'], df[df['predicted_label'] ==␣
 ↪1]['YOE'], s=100, c='Magenta', label = 'Cluster 2')

plt.xlabel('ctc')
plt.ylabel('YOE')
plt.legend()
plt.show()
```



[122]:
```
# also lets see for any particular job position
df_job = df[df['job_position']==140]
fig, ax = plt.subplots(figsize=(10,8))
```

```
plt.scatter(df_job[df_job['predicted_label'] == 0]['ctc'],␣
 ↪df_job[df_job['predicted_label'] == 0]['YOE'], s=100, c='Cyan', label =␣
 ↪'Cluster 1')
plt.scatter(df_job[df_job['predicted_label'] == 1]['ctc'],␣
 ↪df_job[df_job['predicted_label'] == 1]['YOE'], s=100, c='Magenta', label =␣
 ↪'Cluster 2')
plt.scatter(df_job[df_job['predicted_label'] == 2]['ctc'],␣
 ↪df_job[df_job['predicted_label'] == 2]['YOE'], s=100, c='Red', label =␣
 ↪'Cluster 3')
plt.scatter(df_job[df_job['predicted_label'] == 3]['ctc'],␣
 ↪df_job[df_job['predicted_label'] == 3]['YOE'], s=100, c='Yellow', label =␣
 ↪'Cluster 4')

plt.xlabel('ctc')
plt.ylabel('YOE')
plt.legend()
plt.show()
```



[98]:

We see clear boundary of cluster in case of particular job position (which we visualised) but a little overlap in Cluster 2 & Cluster 4

[99]:
```
X.shape
```

[99]:
```
(205574, 4)
```

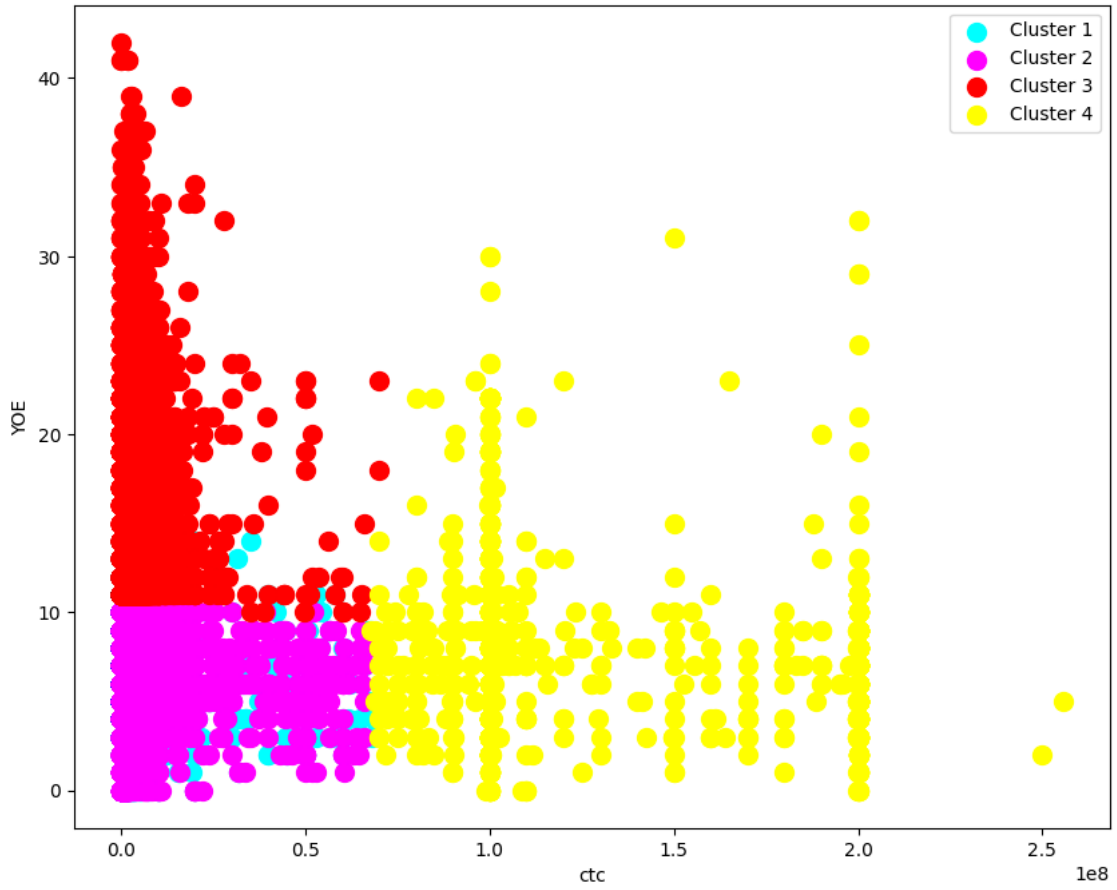
GMM

[113]:
```
from sklearn.mixture import GaussianMixture
gmm = GaussianMixture(n_components=3).fit(X_scaled)
y_pred = gmm.predict(X_scaled)
```

[114]:
```
df['predicted_label'] = y_pred
```

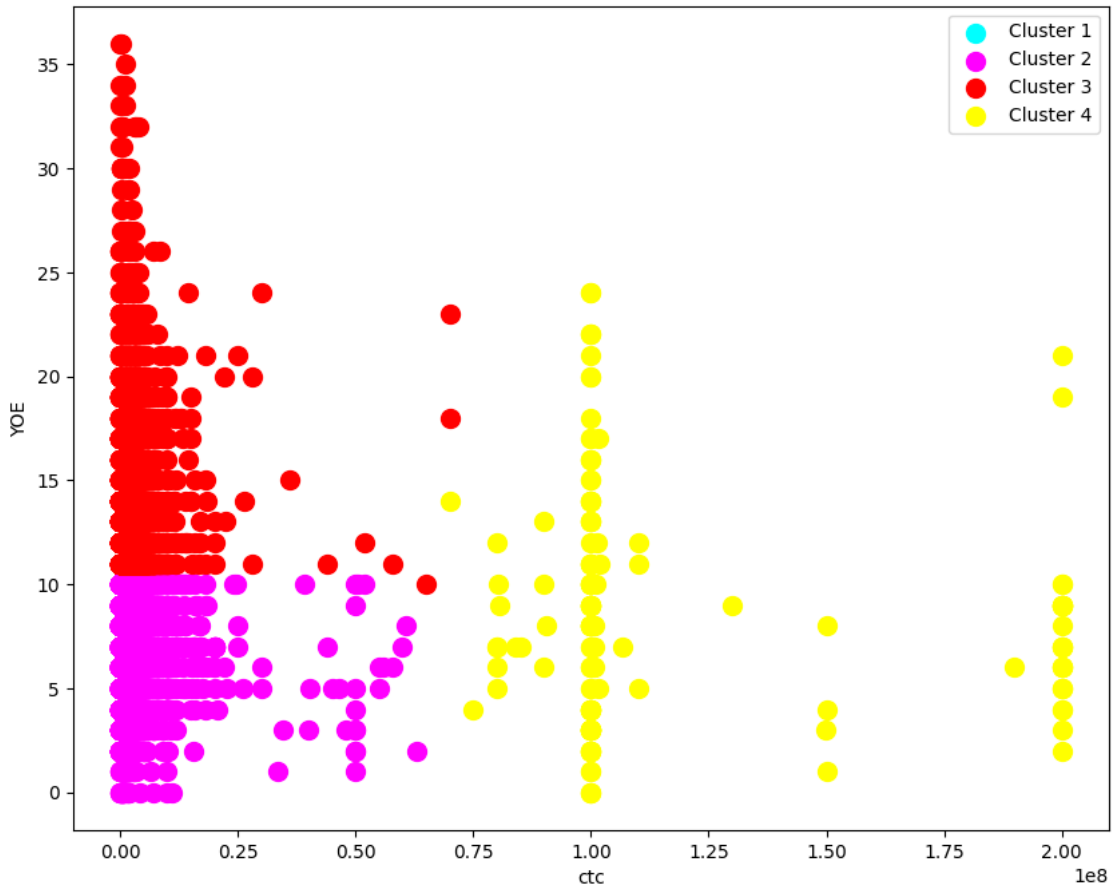
```
<ipython-input-114-60de8de49a36>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['predicted_label'] = y_pred
```

[124]:
```
fig, ax = plt.subplots(figsize=(10,8))
plt.scatter(df[df['predicted_label'] == 0]['ctc'], df[df['predicted_label'] ==␣
 ↪0]['YOE'], s=100, c='Cyan', label = 'Cluster 1')
plt.scatter(df[df['predicted_label'] == 1]['ctc'], df[df['predicted_label'] ==␣
 ↪1]['YOE'], s=100, c='Magenta', label = 'Cluster 2')
plt.scatter(df[df['predicted_label'] == 2]['ctc'], df[df['predicted_label'] ==␣
 ↪2]['YOE'], s=100, c='Red', label = 'Cluster 3')
plt.scatter(df[df['predicted_label'] == 3]['ctc'], df[df['predicted_label'] ==␣
 ↪3]['YOE'], s=100, c='Yellow', label = 'Cluster 4')

plt.xlabel('ctc')
plt.ylabel('YOE')
plt.legend()
plt.show()
```



[125]:
```
# also lets see for any particular job position
df_job = df[df['job_position']==140]
fig, ax = plt.subplots(figsize=(10,8))
plt.scatter(df_job[df_job['predicted_label'] == 0]['ctc'],␣
 ↪df_job[df_job['predicted_label'] == 0]['YOE'], s=100, c='Cyan', label =␣
 ↪'Cluster 1')
plt.scatter(df_job[df_job['predicted_label'] == 1]['ctc'],␣
 ↪df_job[df_job['predicted_label'] == 1]['YOE'], s=100, c='Magenta', label =␣
 ↪'Cluster 2')
plt.scatter(df_job[df_job['predicted_label'] == 2]['ctc'],␣
 ↪df_job[df_job['predicted_label'] == 2]['YOE'], s=100, c='Red', label =␣
 ↪'Cluster 3')
plt.scatter(df_job[df_job['predicted_label'] == 3]['ctc'],␣
 ↪df_job[df_job['predicted_label'] == 3]['YOE'], s=100, c='Yellow', label =␣
 ↪'Cluster 4')

plt.xlabel('ctc')
plt.ylabel('YOE')
```

```
plt.legend()
plt.show()
```



Using GMM, we see more than 10 Lakhs CTC seems to be clustered as Cluster 3 with no variation due to YOE. For other clusters we see 0-15, 15-25 & 25+ YOE cluster within 10 Lakhs CTC.

[126]:
```
df_job.shape
```

[126]: (43521, 4)

[83]:
```
sampled_X = df.sample(n=5000) # using 5000 columns to do Hierarchial Clustering
sampled_X
```

[83]:

	job_position	ctc	YOE
50879	140	145000	6.0
92967	140	700000	6.0
85651	140	2400000	10.0
65467	287	930000	10.0
63279	140	1650000	7.0

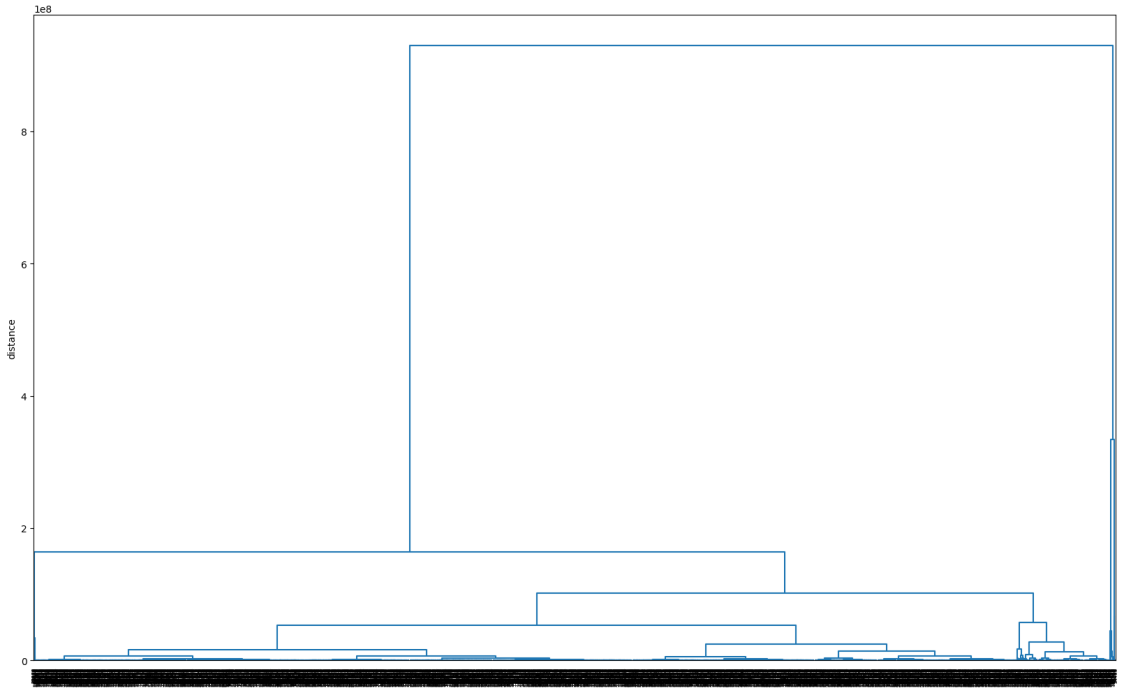
```
…                …       …    …
85268            954  1500000   3.0
26380            954   630000   3.0
188433           292  1050000   4.0
89863            292  1350000   8.0
47638            954   850000   8.0

[5000 rows x 3 columns]
```

Hierarchical clustering

[129]:
```
import scipy.cluster.hierarchy as sch
Z = sch.linkage(sampled_X, method='ward') #linkage = ward
```

[130]:
```
fig, ax = plt.subplots(figsize=(20, 12))
sch.dendrogram(Z, labels=sampled_X.index, ax=ax, color_threshold=2)
plt.xticks(rotation=90)
ax.set_ylabel('distance')
```

[130]:
```
Text(0, 0.5, 'distance')
```



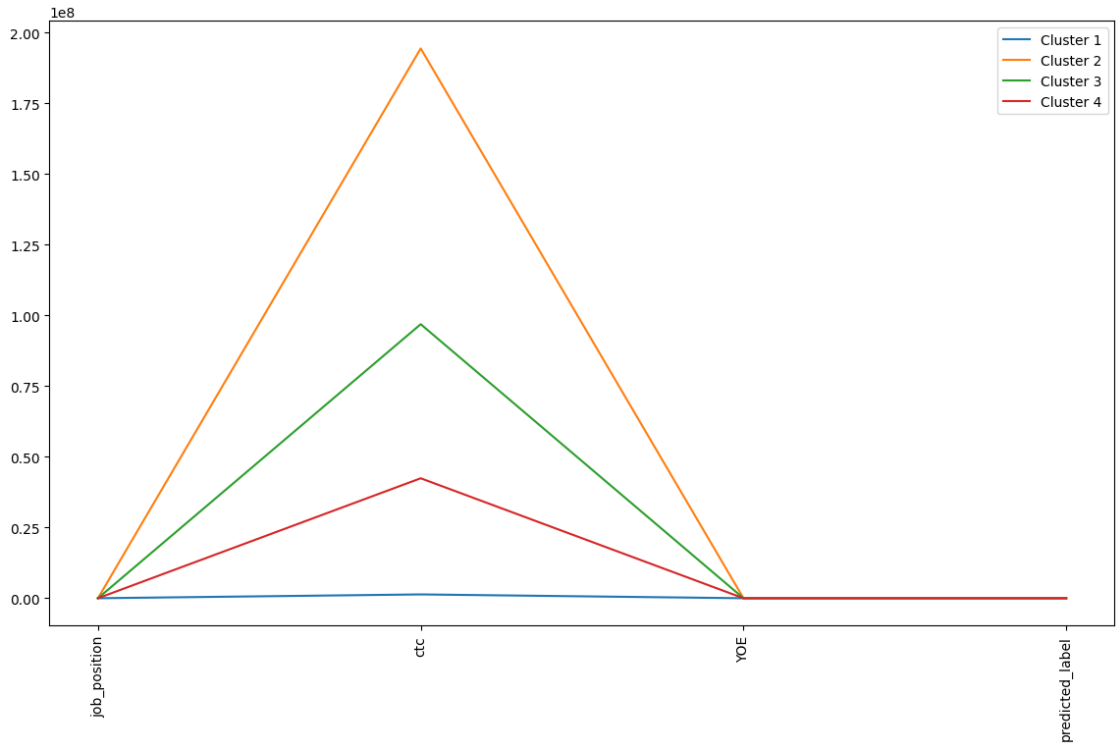
[84]:
```
# import hierarchical clustering libraries
from sklearn.cluster import AgglomerativeClustering

# create clusters
```

```
agglo = AgglomerativeClustering(n_clusters=4, linkage = 'ward')
y_pred = agglo.fit_predict(sampled_X)
y_pred
```

[85]:
```
viz_df = sampled_X
viz_df['predicted_label'] = y_pred
```

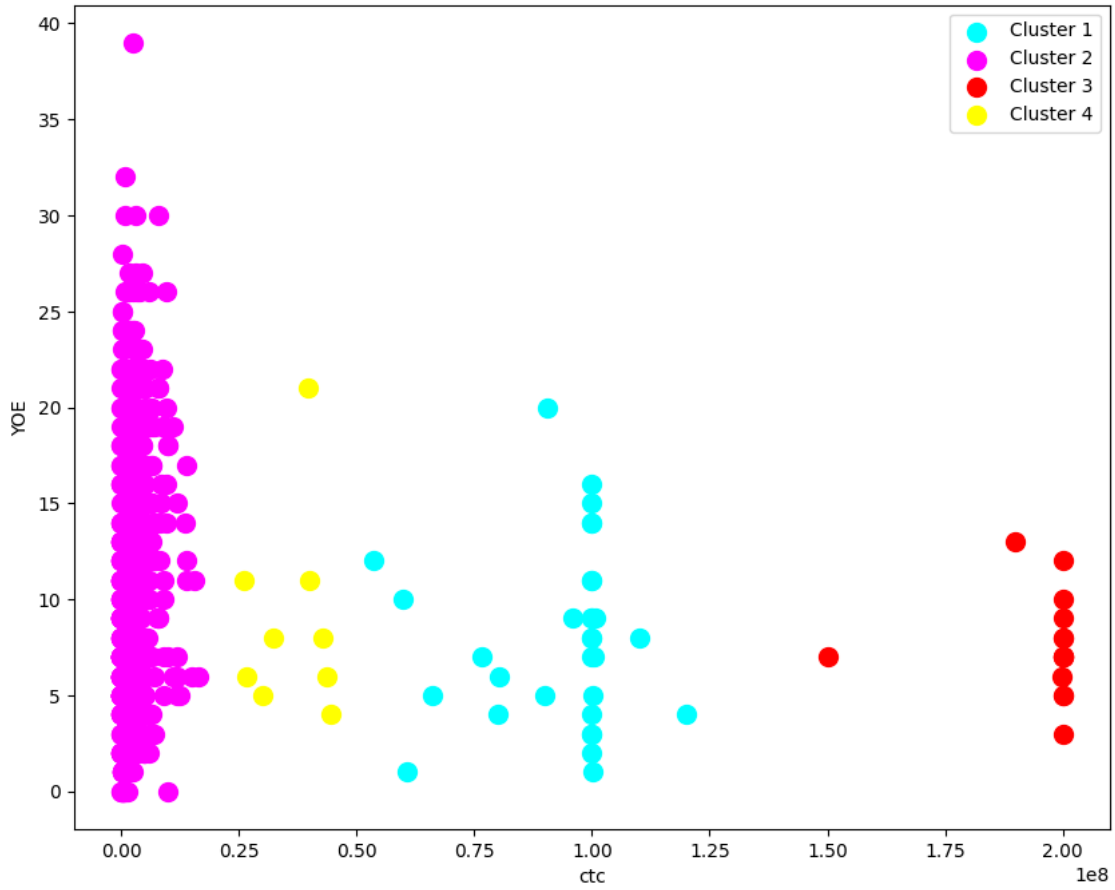
[133]:
```
#Plot a line graph to see the characteristics of the clusters
viz_df['label'] = pd.Series(y_pred, index=viz_df.index)

clustered_df = viz_df.groupby('label').mean()

labels = ['Cluster 1', 'Cluster 2', 'Cluster 3', 'Cluster 4']

plt.figure(figsize=(14,8))
plt.plot(clustered_df.T, label=labels)
plt.xticks(rotation=90)
plt.legend(labels)
```

[133]: <matplotlib.legend.Legend at 0x7cae69d6d2a0>



[86]:
```
fig, ax = plt.subplots(figsize=(10,8))
```

```
plt.scatter(viz_df[viz_df['predicted_label'] == 0]['ctc'],␣
 ↪viz_df[viz_df['predicted_label'] == 0]['YOE'], s=100, c='Cyan', label =␣
 ↪'Cluster 1')
plt.scatter(viz_df[viz_df['predicted_label'] == 1]['ctc'],␣
 ↪viz_df[viz_df['predicted_label'] == 1]['YOE'], s=100, c='Magenta', label =␣
 ↪'Cluster 2')
plt.scatter(viz_df[viz_df['predicted_label'] == 2]['ctc'],␣
 ↪viz_df[viz_df['predicted_label'] == 2]['YOE'], s=100, c='Red', label =␣
 ↪'Cluster 3')
plt.scatter(viz_df[viz_df['predicted_label'] == 3]['ctc'],␣
 ↪viz_df[viz_df['predicted_label'] == 3]['YOE'], s=100, c='Yellow', label =␣
 ↪'Cluster 4')

plt.xlabel('ctc')
plt.ylabel('YOE')
plt.legend()
plt.show()
```



[ ]:

0.8 Insights & Recommendations

1. While doing Manual clustering, we could not see any clear distinction in clusters created using mean/median of CTC. We created Designation Flag, Class Flag & Tier Flag. We were trying to cluster YOE to CTC for clusters created. Although we can use the CTC flag values for top & bottom employees based on job position, company_id and YOE to categorise & finding employees of each cluster. Flag value 1 being top & 3 being bottom.
2. With YOE 8-12 years, CTC has big range with 8 years work experience having most of it. According to data, it doesnot matter on YOE for CTC, CTC ranges depend on other things also. Data for 8-12 YOE is also more.
3. There is negative correlation between CTC updated year & YOE. It makes sense that CTC updation decreases as YOE increases. Promotion to Manager/Sr Manager takes more years.
4. Mostly people got increment (ctc updated) in years 2019 to 2021. Although, people have been working from 2009-2021 (orgyear). This may be inferred that these 3 years market was very good.
5. Mostly dataset contains data with people having 3-12 years of experience. We can try to collect data for other experience years. Also, density of data is not consistent, we can use SMOTE to tackle it but prefer to have original data as it is unssupervised learning.
6. While we did Clustering using KMeans, we found that ideal clusters value of 4 using Elbow method. We see quite good clustering and clean distinctions when K=4. We can infer:

- Cluster 1 - Employees with less experience and fairly good CTC –> Fairly CTC receiving employees
- Cluster 2 - Employees having Years of Experience (YOE) as less than 10 years and CTC less than 7.5 Lakhs. —> Regular employees
- Cluster 3 - Underpaid employees (less than 7.5 Lakhs CTC) having Years of Experience (YOE) as more than 10 years. –> Underpaid employees
- Cluster 4 - Employees having CTC more than 7.5 Lakhs CTC. –> High CTC receiving employees

7. We saw similar cluster results while clustering using GMM. When using AgglomerativeClustering, we couldnot train on whole data so trained on 5000 samples only (due to limited RAM & session crash issue), but we see good clusters although on limited data.

8. Looking at clusters and all data, we can recommend company to hire employees based on skills and not YOE as for all clusters we see trend that CTC for each clusters varies more or less across wide range of YOE. Good companies tend to give good CTC irrespective of job position.

[ ]: