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August 15, 2019

1 Klasterovanje teksta u skupu podataka zaposlenih u programerskim firmama

2 Uvod

Moj zadatak se sastojao iz toga da primenim algoritme klasterovanja koji su se radili na časovima kursa Istraživanje Podataka, i da na osnovu njih zaključim neke zaključke iz skupa podataka *employee_reviews*. U daljem tekstu ćemo proći kroz faze preprocesiranja, ukidanja *"nebitnih"* kolona, i primene algoritama za klasterovanje, kao što su *K-Sredina*, *DBSCAN* i *Hierarhijsko klasterovanje*. Dotaći ćemo se i ocena klasterovanja i zaključivanja optimalnog broja klastera za zadate algoritme(*koeficijent senke* i metoda *lakta*) Nakon toga, ćemo prikazati podatke i izneti bitne zaključke za zadati skup. Kao zadatu alatku za seminarski rad sam odabrao *Jupyter* svesku i jezik *Python*. Odabrao sam ovo okruženje jer mi se činilo jako zanimljivim za korišćenje i omogućavao je jednostavnije prebacivanje iz *.ipynb* formata u *pdf*, koji bi takođe imao i priložen korišćen kod. Sam jezik Python je takođe uticao na izbor ovog okruženja, zbog jednostavnosti pisanja koda i ogromnog broja modula za istraživanje skupa podataka.

[212]:
```
#osnovni moduli za korišćenje

from sklearn.cluster import KMeans

import pandas as pd
import numpy as np
import os
import re
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

2.1 Skup podataka *employee_reviews*

Naš skup podataka je preuzet sa linka. Skup podataka se sastoji od zaposlenih ljudi(bivših i sadašnjih) i njihovih recenzija i ocena radnog mesta.

[213]:
```
df = pd.read_csv('./employee_reviews.csv')
df.head(5) #razlog komentarisanja je jako los ispis
```

[213]:

	Unnamed: 0	company	location	dates	job-title	summary	pros	cons	advice-to-mgmt	overall-ratings	work-balance-stars	culture-values-stars	carrer-opportunities-stars
0	1	google	none	Dec 11, 2018	Current Employee - Anonymous Employee	Best Company to work for	People are smart and friendly	Bureaucracy is slowing things down	none	5.0	4.0	5.0	5.0
1	2	google	Mountain View, CA	Jun 21, 2013	Former Employee - Program Manager	Moving at the speed of light, burn out is inev...	1) Food, food, food. 15+ cafes on main campus ...	1) Work/life balance. What balance? All those ...	1) Don't dismiss emotional intelligence and ad...	4.0	2.0	3.0	3.0
2	3	google	New York, NY	May 10, 2014	Current Employee - Software Engineer III	Great balance between big-company security and...	* If you're a software engineer, you're among ...	* It *is* becoming larger, and with it comes g...	Keep the focus on the user. Everything else wi...	5.0	5.0	4.0	5.0
3	4	google	Mountain View, CA	Feb 8, 2015	Current Employee - Anonymous Employee	The best place I've worked and also the most d...	You can't find a more well-regarded company th...	I live in SF so the commute can take between 1...	Keep on NOT micromanaging - that is a huge ben...	5.0	2.0	5.0	5.0
4	5	google	Los Angeles, CA	Jul 19, 2018	Former Employee - Software Engineer	Unique, one of a kind dream job	Google is a world of its own. At every other c...	If you don't work in MTV (HQ), you will be giv...	Promote managers into management for their man...	5.0			

```
4                5.0                   5.0                         5.0

  comp-benefit-stars senior-mangemnet-stars  helpful-count  \
0                4.0                   5.0              0
1                5.0                   3.0           2094
2                5.0                   4.0            949
3                4.0                   5.0            498
4                5.0                   5.0             49

                                                link
0  https://www.glassdoor.com/Reviews/Google-Revie...
1  https://www.glassdoor.com/Reviews/Google-Revie...
2  https://www.glassdoor.com/Reviews/Google-Revie...
3  https://www.glassdoor.com/Reviews/Google-Revie...
4  https://www.glassdoor.com/Reviews/Google-Revie...
```

2.2 Osnovna svojstva

Kao što se može videti iz priliženog, radi se o poprilično velikom skupu podataka(67529 kolona i 17 atributa). Isto tako, iz priloženih podataka dole, možemo videti o kakvim tipovima je reč. Takođe, da određeni atributi imaju *null* vrednosti("summary" i "advice-to-mgmt"). Daljim pregledom našeg skupa podataka smo naišli na *"none"* vrednosti, koje samo pokazuju da korisnici kad su unosili recenzije o zadatoj firmi su izostavili neke stvari, koje su verovatno smatrali neobaveznim za unošenje. Na nama je da odlučimo kako ćemo ukloniti takve vrednosti, dva poznata načina su: uklanjanje svih redova u kojima se pojavljuju neke od tih *neželjenih* vrednosti ili postavljanje tih nepostojećih na neku podrazumevanu vrednost. Možda uklanjanje svih tih *neželjenih* vrednosti, za primer našeg skupa uzećemo tu vrednost *"none"*, možda i nije toliko dobar pristup(ranijim testiranjem se ispostavilo da ukloni više od 2/3 redova), jer možda gubimo bitne informacije u nekim drugim atributima koje su nam bitni za dalju analizu. Resenje koje bi možda bilo pametnije da je uklonimo samo za nama bitne kolone.

[214]:
```
#veličina našeg skupa
df.shape
```

[214]:
```
(67529, 17)
```

[215]:
```
#osnovna svojstva kao što su tipovi atributa i neke statističke ocene
print("Info: ", df.info())
print("Osnovna: ", df.describe())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 67529 entries, 0 to 67528
Data columns (total 17 columns):
Unnamed: 0                  67529 non-null int64
company                     67529 non-null object
location                    67529 non-null object
dates                       67529 non-null object
```

```
job-title                     67529 non-null object
summary                       67409 non-null object
pros                          67529 non-null object
cons                          67529 non-null object
advice-to-mgmt                67232 non-null object
overall-ratings               67529 non-null float64
work-balance-stars            67529 non-null object
culture-values-stars          67529 non-null object
carrer-opportunities-stars    67529 non-null object
comp-benefit-stars            67529 non-null object
senior-mangemnet-stars        67529 non-null object
helpful-count                 67529 non-null int64
link                          67529 non-null object
dtypes: float64(1), int64(2), object(14)
memory usage: 8.8+ MB
Info:  None
Osnovna:           Unnamed: 0  overall-ratings  helpful-count
count  67529.000000     67529.000000   67529.000000
mean   33765.000000         3.826075       1.268211
std    19494.087501         1.154989      16.085852
min        1.000000         1.000000       0.000000
25%    16883.000000         3.000000       0.000000
50%    33765.000000         4.000000       0.000000
75%    50647.000000         5.000000       1.000000
max    67529.000000         5.000000    2094.000000
```

[216]:
```
#brojimo null vrednosti da znamo da ih uklonimo
df.isnull().sum()
```

[216]:
```
Unnamed: 0                    0
company                       0
location                      0
dates                         0
job-title                     0
summary                     120
pros                          0
cons                          0
advice-to-mgmt              297
overall-ratings               0
work-balance-stars            0
culture-values-stars          0
carrer-opportunities-stars    0
comp-benefit-stars            0
senior-mangemnet-stars        0
helpful-count                 0
link                          0
dtype: int64
```

[217]:
```
#izvlacimo svojstva, koja ce nam verovatno biti potrebna
features = df.columns
features
```

[217]:
```
Index(['Unnamed: 0', 'company', 'location', 'dates', 'job-title', 'summary',
       'pros', 'cons', 'advice-to-mgmt', 'overall-ratings',
       'work-balance-stars', 'culture-values-stars',
       'carrer-opportunities-stars', 'comp-benefit-stars',
       'senior-mangemnet-stars', 'helpful-count', 'link'],
      dtype='object')
```

Kao što smo gore naveli, *"none"* vrednost je verovatno neka podrazumevana vrednost za prazno polje, tako da je možda bolje čak i ne uklanjati u svim atributima, sem u nekim bitnijim atributima.

[218]:
```
# iz ovog vidimo da ako uklonimo sve none vrednosti koje imamo,
# mozemo da izgubimo dosta podataka
for feature in features:
    print("feature name: %s | count `none` values: %d"
          %(feature, df[df[feature] == 'none'].shape[0]))
```

```
feature name: Unnamed: 0 | count `none` values: 0
feature name: company | count `none` values: 0
feature name: location | count `none` values: 25085
feature name: dates | count `none` values: 0
feature name: job-title | count `none` values: 0
feature name: summary | count `none` values: 9
feature name: pros | count `none` values: 0
feature name: cons | count `none` values: 1
feature name: advice-to-mgmt | count `none` values: 29164
feature name: overall-ratings | count `none` values: 0
feature name: work-balance-stars | count `none` values: 7160
feature name: culture-values-stars | count `none` values: 13546
feature name: carrer-opportunities-stars | count `none` values: 7108
feature name: comp-benefit-stars | count `none` values: 7161
feature name: senior-mangemnet-stars | count `none` values: 7775
feature name: helpful-count | count `none` values: 0
feature name: link | count `none` values: 0
```

```
/usr/lib/python3.7/site-packages/pandas/core/ops/__init__.py:1115:
FutureWarning: elementwise comparison failed; returning scalar instead, but in
the future will perform elementwise comparison
  result = method(y)
```

Ovde već vidimo da je jedan od kategoričkih atributa za koje sam mislio da će nam biti korisniji za dalju analizu, *advice-to-mgmt*, jako loš, budući da dosta zaposlenih nije htelo da napiše neki tekst u tom polju. Uklanjanjem none vrednosti na osnovu tog atributa bi dovelo do brisanja oko 30000 redova, što je već pola skupa. Pored toga, bez obzira što nisam razmatrao o njoj, kolona *location* ima isto 25085 *"none"* polja, i primena klasterovanja ovde se isto ne isplati(doduše ne bi se isplatila jer je početni zadatak bio klasterovanje teksta, a ne reči).

[219]:
```
#da iskopamo te srecnike koji nemaju konstruktivne kritike uopste :D
df[df["cons"] == 'none']
```

[219]:
```
       Unnamed: 0 company       location          dates  \
42755       42756   apple  Charlotte, NC   Jul 27, 2015

                                  job-title        summary  \
42755  Current Employee - Anonymous Employee  a great place

                          pros  cons advice-to-mgmt  overall-ratings  \
42755  everything is awesome!!  none           none              4.0

      work-balance-stars culture-values-stars carrer-opportunities-stars  \
42755                5.0                  5.0                         5.0

      comp-benefit-stars senior-mangemnet-stars  helpful-count  \
42755                5.0                    5.0              0

                                                      link
42755  https://www.glassdoor.com/Reviews/Apple-Review...
```

2.3 Preprocesiranje. Istraživačka analiza podataka - EDA.

Možda nas zanima koliko je recenzija za svaku firmu postavljeno, čisto da znamo kojih ima najviše, a kojih najmanje.

[220]:
```
#cisto radi vezbe i zabave, grupisacemo da vidimo koliko ima zaposlenih u kojoj␣
↪firmi
group_by_company = df.groupby('company').size()
group_by_company
```

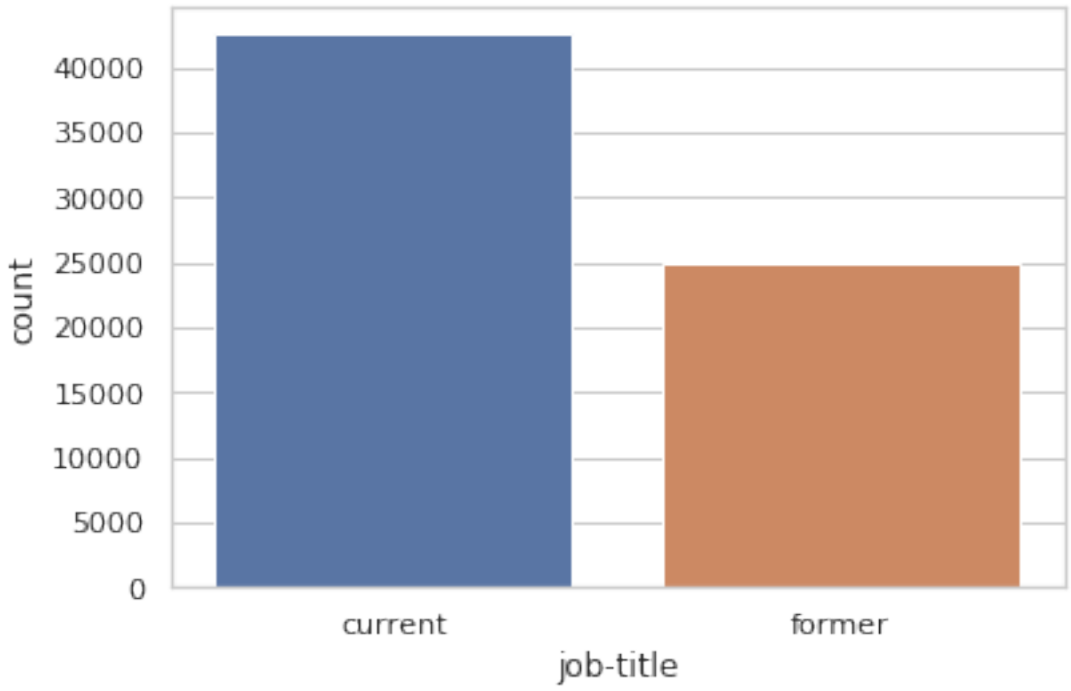
[220]:
```
company
amazon       26430
apple        12950
facebook      1590
google        7819
microsoft    17930
netflix        810
dtype: int64
```

Kao što vidimo, najviše recenzija ima za *Amazon* i *Microsoft*, dok najmanje za *Netflix* i *Facebook*. Takodje pošto smo prilikom gledanja našeg skupa zaposlenih uvideli da postoje sadašnji i bivši zaposleni, možda ne bi bilo loše da odnos bivših i sadašnjih radnika prikažemo.

[221]:
```
#isto tako smo mogli da grupisemo po poslu
group_by_job_title = df.groupby('job-title').size()
#odavde me zanima recimo koliko ima trenutnih, koliko ima bivsih zaposlenih
```

```
employee_ratio = df['job-title']
current_former = employee_ratio.map(lambda x : 'former' if 'Former' in x else␣
 ↪'current')
print(current_former.value_counts())
sns.countplot(current_former)
plt.show()
```

```
current    42539
former     24990
Name: job-title, dtype: int64
```



[222]:
```
#i po lokaciji
group_by_location = df.groupby('location').size()
```

[223]:
```
#a i po datumu
group_by_date = df.groupby('dates').size()
max_date = max(group_by_date.values)
maybe_important_date = list(filter(lambda x : x[1] == max_date,␣
 ↪list(group_by_date.items())))
maybe_important_date_name = maybe_important_date[0][0]
maybe_important_date_date = maybe_important_date[0][1]
print("dan kad je najvise komentara okaceno %s : %s\n"
      % (str(maybe_important_date_name), maybe_important_date_date))
#iz ovoga vidimo da je na taj dan najvise napisano izvestaja o amazonu
```

```
df[df['dates'] == maybe_important_date_name].groupby('company').size()
```

```
dan kad je najvise komentara okaceno  Sep 19, 2017 : 272
```

[223]:
```
company
amazon       251
apple          5
google         6
microsoft      9
netflix        1
dtype: int64
```

Procenat podataka na osnovu kompanije će nam reći zastupljenost recenzija za svaku datu kompaniju u našem skupu podataka. Ovaj podatak možemo iskoristiti da one manje zastupljene(kad smo ih gore prebrojavali, videli smo da se radi o *Facebooku* i *Netflixu*) izbacimo.

[224]:
```
#preprocesiranje podataka
#procenat podataka na osnovu kompanije
df["company"].value_counts()/len(df["company"])*100
```

[224]:
```
amazon       39.138740
microsoft    26.551556
apple        19.176946
google       11.578729
facebook      2.354544
netflix       1.199485
Name: company, dtype: float64
```

[225]:
```
df = df.drop(['Unnamed: 0', 'link'], axis=1)
df = df.loc[~df['company'].isin(['facebook', 'netflix']), :]
df = df.loc[df['dates'] != 'none', :]
df['year'] = pd.to_datetime(df['dates'], errors='coerce').dt.year
df.dropna(how='all', inplace=True)
df.dropna(subset=['company', 'summary', 'year', "overall-ratings", "job-title",␣
 ↪"advice-to-mgmt"], inplace=True)
df['year'] = df['year'].astype('int64')
df.head()
```

[225]:

	company	location	dates	\
0	google	none	Dec 11, 2018	
1	google	Mountain View, CA	Jun 21, 2013	
2	google	New York, NY	May 10, 2014	
3	google	Mountain View, CA	Feb 8, 2015	
4	google	Los Angeles, CA	Jul 19, 2018	

	job-title	\

```
0     Current Employee - Anonymous Employee
1         Former Employee - Program Manager
2  Current Employee - Software Engineer III
3     Current Employee - Anonymous Employee
4       Former Employee - Software Engineer

                                          summary  \
0                           Best Company to work for
1  Moving at the speed of light, burn out is inev...
2  Great balance between big-company security and...
3  The best place I've worked and also the most d...
4                    Unique, one of a kind dream job

                                            pros  \
0                     People are smart and friendly
1  1) Food, food, food. 15+ cafes on main campus ...
2  * If you're a software engineer, you're among ...
3  You can't find a more well-regarded company th...
4  Google is a world of its own. At every other c...

                                            cons  \
0                 Bureaucracy is slowing things down
1  1) Work/life balance. What balance? All those ...
2  * It *is* becoming larger, and with it comes g...
3  I live in SF so the commute can take between 1...
4  If you don't work in MTV (HQ), you will be giv...

                                    advice-to-mgmt  overall-ratings  \
0                                             none              5.0
1  1) Don't dismiss emotional intelligence and ad...              4.0
2  Keep the focus on the user. Everything else wi...              5.0
3  Keep on NOT micromanaging - that is a huge ben...              5.0
4  Promote managers into management for their man...              5.0

  work-balance-stars culture-values-stars carrer-opportunities-stars  \
0                4.0                   5.0                         5.0
1                2.0                   3.0                         3.0
2                5.0                   4.0                         5.0
3                2.0                   5.0                         5.0
4                5.0                   5.0                         5.0

  comp-benefit-stars senior-mangemnet-stars  helpful-count  year
0                4.0                    5.0              0  2018
1                5.0                    3.0           2094  2013
2                5.0                    4.0            949  2014
3                4.0                    5.0            498  2015
4                5.0                    5.0             49  2018
```

[226]:
```
df.shape
```

[226]:
```
(64743, 16)
```

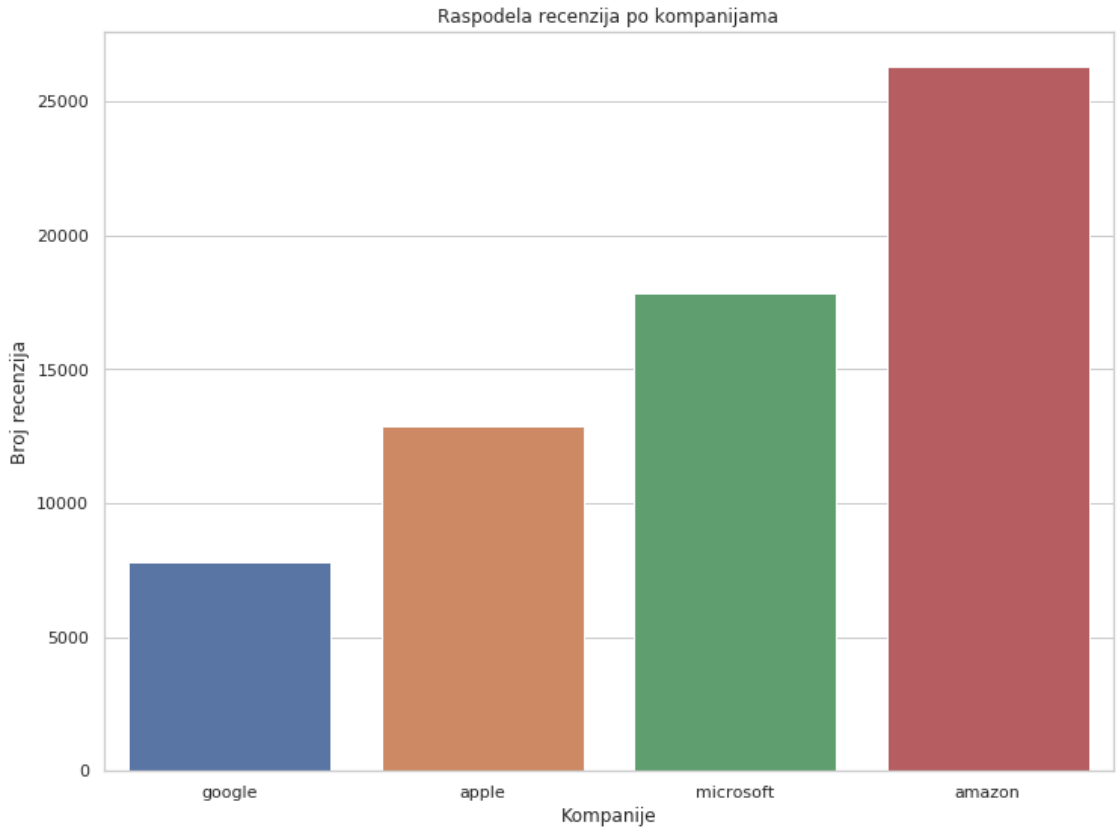
[227]:
```
df.groupby('company')['overall-ratings'].describe()
```

[227]:

company	count	mean	std	min	25%	50%	75%	max
amazon	26281.0	3.585100	1.257579	1.0	3.0	4.0	5.0	5.0
apple	12857.0	3.958000	1.063601	1.0	3.0	4.0	5.0	5.0
google	7775.0	4.338907	0.920843	1.0	4.0	5.0	5.0	5.0
microsoft	17830.0	3.815143	1.036999	1.0	3.0	4.0	5.0	5.0

Broj recenzija za svaku kompaniju

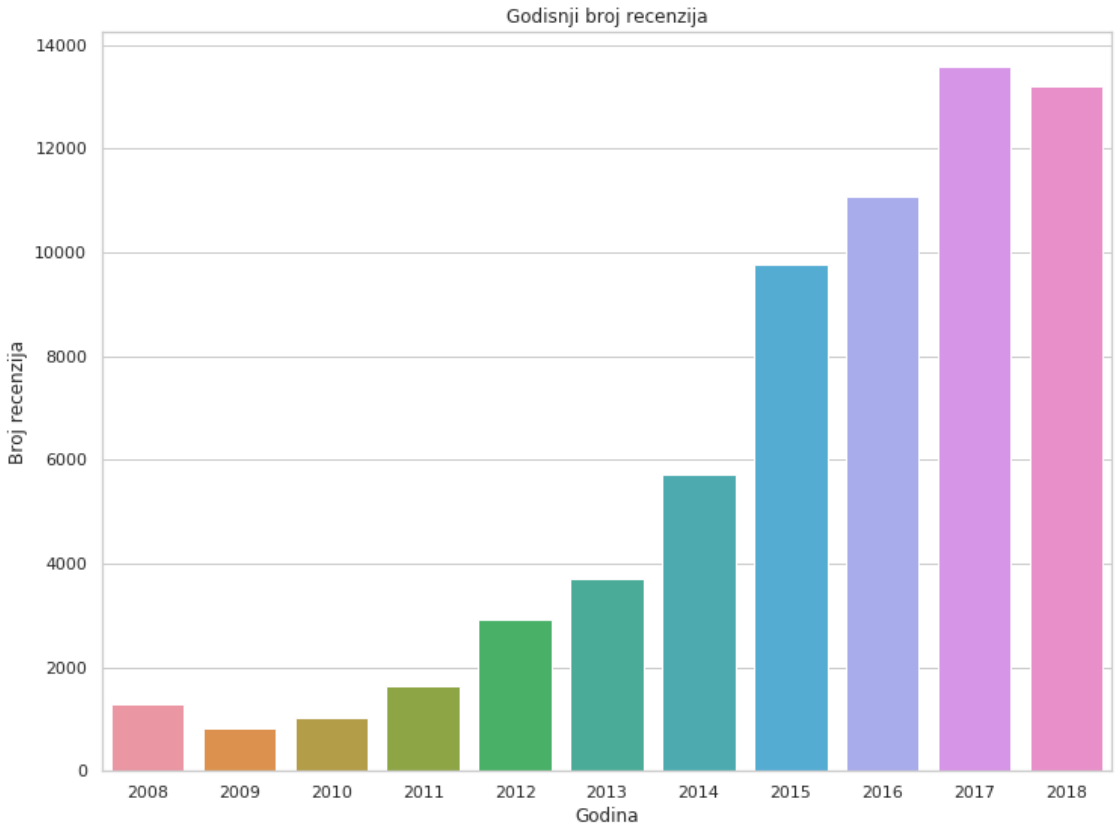
[228]:
```
rw_count = df['company'].value_counts().sort_values(ascending=True)
cmp_labels = rw_count.index.tolist()
cmp_index = np.arange(len(cmp_labels))
sns.set(style='whitegrid')
plt.figure(figsize=(12,9))
sns.barplot(cmp_index, rw_count)
plt.xticks(cmp_index, cmp_labels)
plt.xlabel('Kompanije')
plt.ylabel('Broj recenzija')
plt.title('Raspodela recenzija po kompanijama')
plt.show()
```



Zaključak koji izvlačimo iz ovoga je da Amazon ima najviše recenzija, dok Google najmanje.

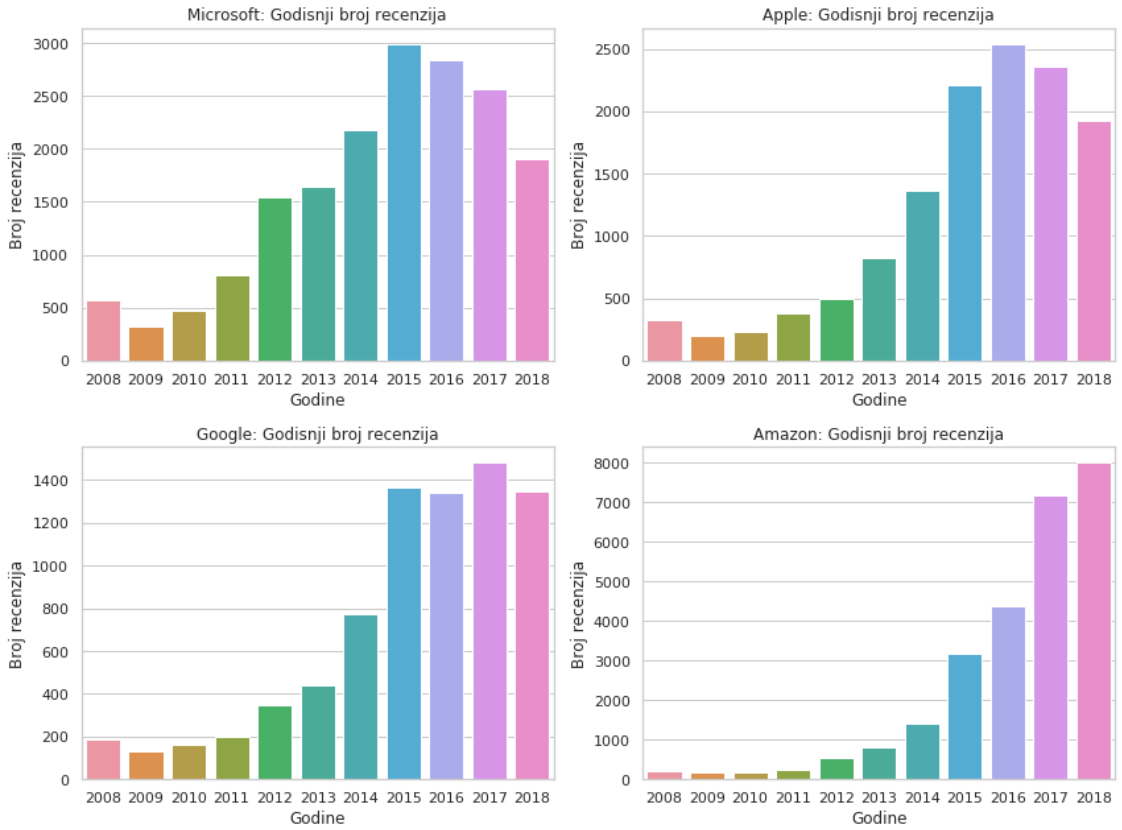
Broj recenzija po godinama

[229]:
```
yr_count = df['year'].value_counts().sort_index(ascending=True)
yr_labels = yr_count.index.tolist()
yr_index = np.arange(len(yr_labels))

#vecina recenzija je napisana u prethodnih 3-4 godine
plt.figure(figsize=(12,9))
sns.barplot(yr_index, yr_count)
plt.xticks(yr_index, yr_labels)
plt.xlabel('Godina')
plt.ylabel('Broj recenzija')
plt.title('Godisnji broj recenzija')
plt.show()
```



Zaključak koji izvlačimo ovde je da u poslednjih četiri ili pet godina najviše recenzija napisano(potencijalno možemo da eliminišemo recenzije iz godina 2008-2013, ali pre toga moramo da proverimo da li se iz godišnjeg broja recenzija po firmama može izvesti isti zaključak).

[230]:
```
fig, axs = plt.subplots(2,2,figsize=(12,9))
companies = [['microsoft', 'apple'], ['google', 'amazon']]

for i in range(2):
    for j in range(2):
        company = companies[i][j]
        yr_count = df[df['company'] == company]['year'].value_counts().
 ↪sort_index(ascending=True)
        yr_labels = yr_count.index.tolist()
        yr_index = np.arange(len(yr_labels))
        g = sns.barplot(yr_index, yr_count, tick_label = yr_labels, ax=axs[i][j])
        g.set(xticklabels=yr_labels)
        axs[i][j].set_xlabel('Godine')
        axs[i][j].set_ylabel('Broj recenzija')
        axs[i][j].set_title("%s: Godisnji broj recenzija" % (company.title()))
plt.tight_layout()
```

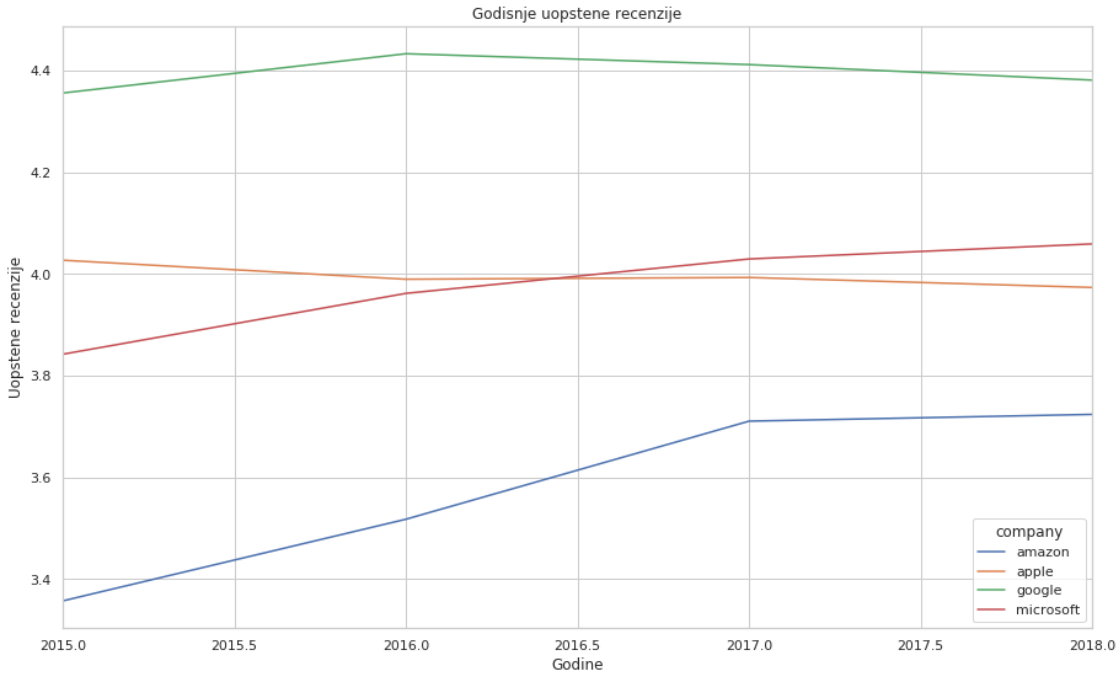


Zaključak koji izvlačimo ovde je da je najvise recenzija bilo u poslednjih četiri-pet godina.

[231]:
```
df = df[df['year'].isin(["2018", "2017", "2016", "2015"])]
```

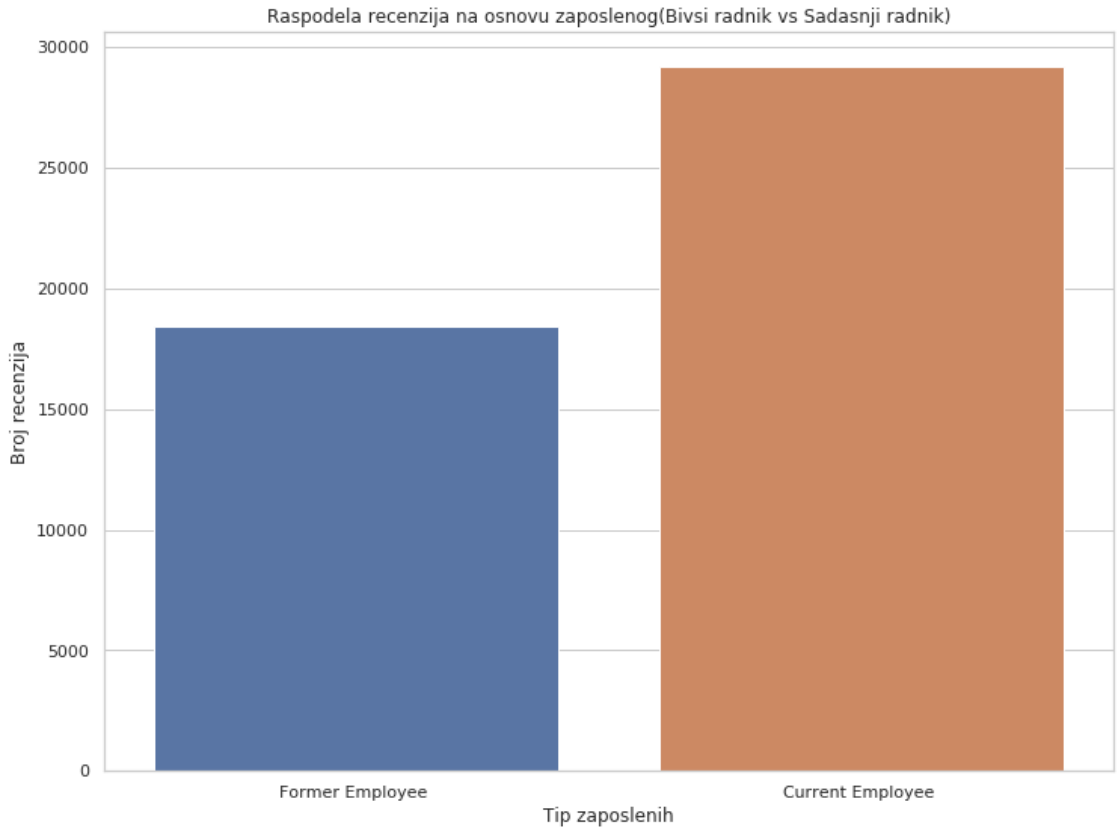
Prikaz promene prosečne ocene kompanije od 2015. do 2018. godine

[232]:
```
fig, ax = plt.subplots(figsize=(15,9))
df.groupby(['year', 'company'])['overall-ratings'].mean().unstack().plot(ax=ax)
plt.xlabel("Godine")
plt.ylabel("Uopstene recenzije")
plt.title("Godisnje uopstene recenzije")
plt.show()
```



Možemo primetiti da u svakoj kompaniji, sem u *Apple-u*, posle 2015. raste prosečna ocena

[233]:
```
current_employee_count = df['job-title'].str.split('-', expand=True)[0].
 ↪value_counts().sort_values(ascending=True)
employee_labels = current_employee_count.index.tolist()
employee_index = np.arange(len(employee_labels))


plt.figure(figsize=(12, 9))
sns.barplot(employee_index, current_employee_count)
plt.xticks(employee_index, employee_labels)

plt.xlabel('Tip zaposlenih')
plt.ylabel('Broj recenzija')
plt.title('Raspodela recenzija na osnovu zaposlenog(Bivsi radnik vs Sadasnji␣
 ↪radnik)')
plt.show()
```



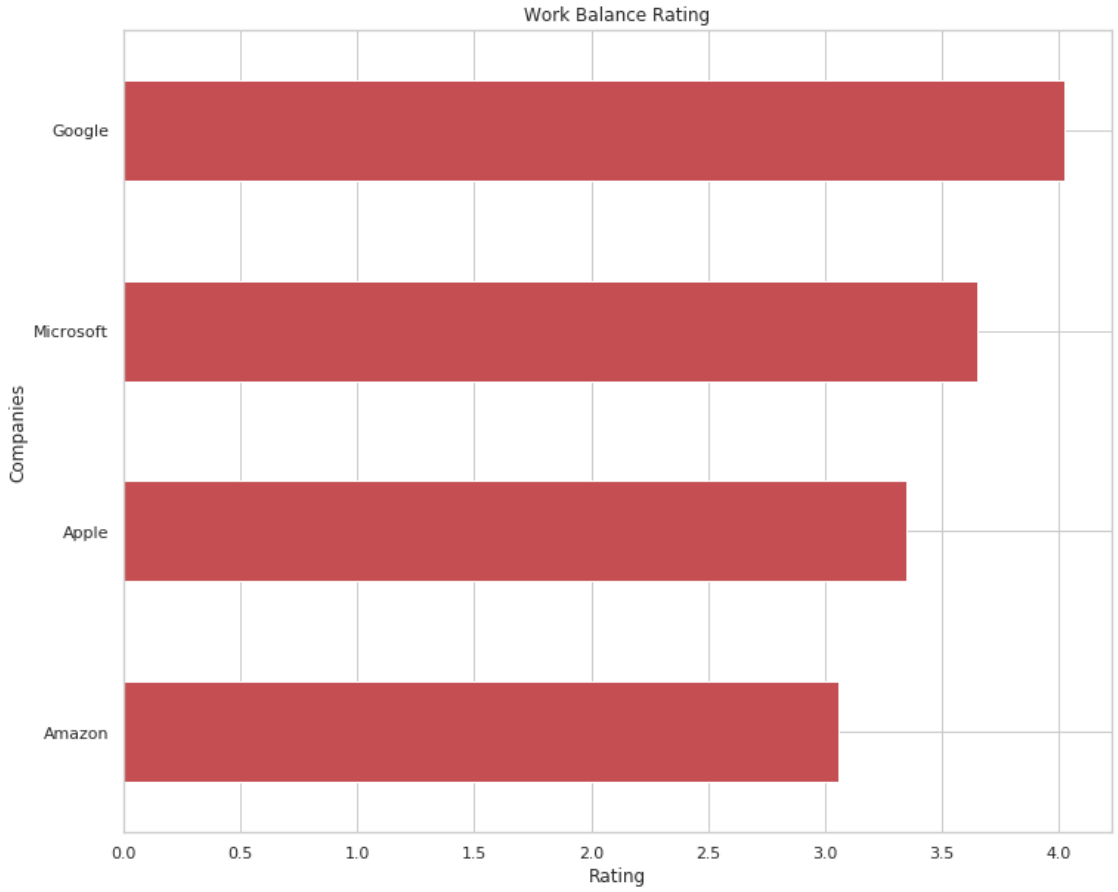
Prosečna ocena svih kompanija za svaki kriterijum

[234]:
```
ratings_comp = df[["company", "work-balance-stars", "culture-values-stars",␣
 ↪"carrer-opportunities-stars", "comp-benefit-stars", "senior-mangemnet-stars"]]
ratings_comp.set_index(["company"], inplace=True)
ratings_comp = ratings_comp[~(ratings_comp[["work-balance-stars",␣
 ↪"culture-values-stars", "carrer-opportunities-stars", "comp-benefit-stars",␣
 ↪"senior-mangemnet-stars"]] == "none").any(axis=1)]
ratings_comp[["work-balance-stars", "culture-values-stars",␣
 ↪"carrer-opportunities-stars", "comp-benefit-stars", "senior-mangemnet-stars"]]␣
 ↪= ratings_comp[["work-balance-stars", "culture-values-stars",␣
 ↪"carrer-opportunities-stars", "comp-benefit-stars", "senior-mangemnet-stars"]].
 ↪apply(pd.to_numeric)
group = ratings_comp.groupby("company")["work-balance-stars",␣
 ↪"culture-values-stars", "carrer-opportunities-stars", "comp-benefit-stars",␣
 ↪"senior-mangemnet-stars"].mean()
group.columns = ["Work Balance", "Culture Values", "Career Opportunities",␣
 ↪"Company Benefits", "Senior Management"]
group = group.transpose()
group
```

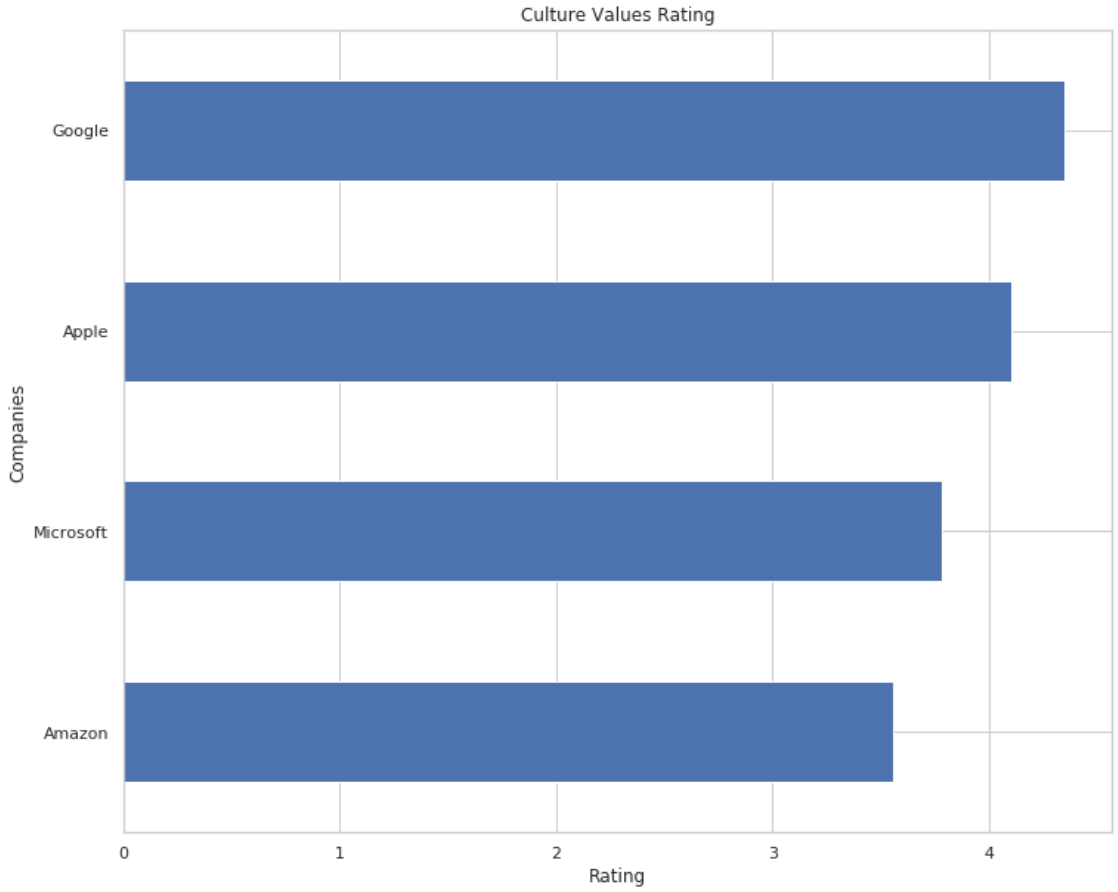
[234]:
company	amazon	apple	google	microsoft
Work Balance	3.058085	3.353150	4.026710	3.647677
Culture Values	3.555482	4.104449	4.352752	3.780830
Career Opportunities	3.642456	3.461402	4.081050	3.752911
Company Benefits	3.729022	4.112435	4.450610	4.053804
Senior Management	3.193497	3.465839	3.886254	3.345993

[235]:
```
def rating_per_company(rating_type, title, color):
    work_ratings = df[['company', rating_type]]
    work_ratings = work_ratings[~(work_ratings[[rating_type]] == "none").
 ↪any(axis=1)]
    work_ratings[rating_type] = work_ratings[rating_type].apply(pd.to_numeric)
    group = work_ratings.groupby(work_ratings["company"].str.
 ↪title())[rating_type].mean().reset_index()
    group.sort_values([rating_type],inplace=True)
    group.set_index('company').plot.barh(legend=False, figsize=(12, 10),␣
 ↪color=color)
    plt.title('{} Rating'.format(title))
    plt.xlabel('Rating')
    plt.ylabel('Companies')
```

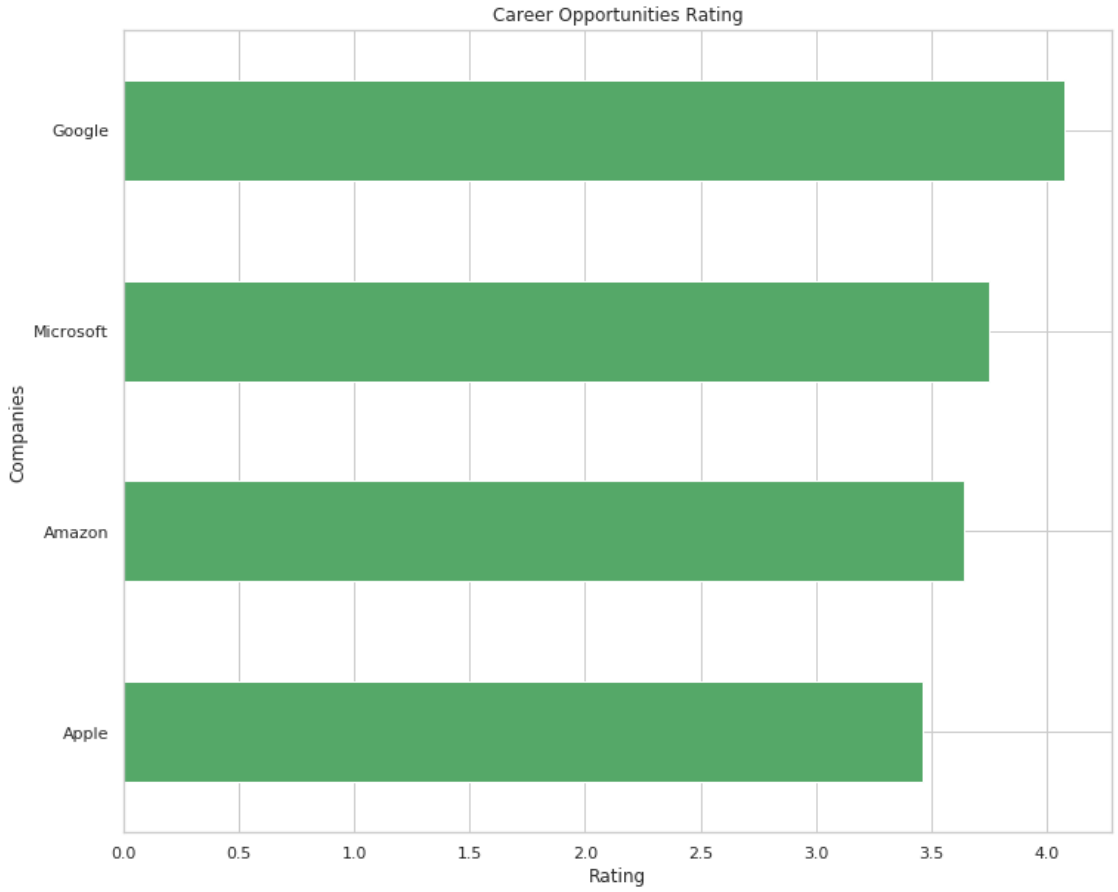
[236]:
```
rating_per_company('work-balance-stars', "Work Balance", "r")
```



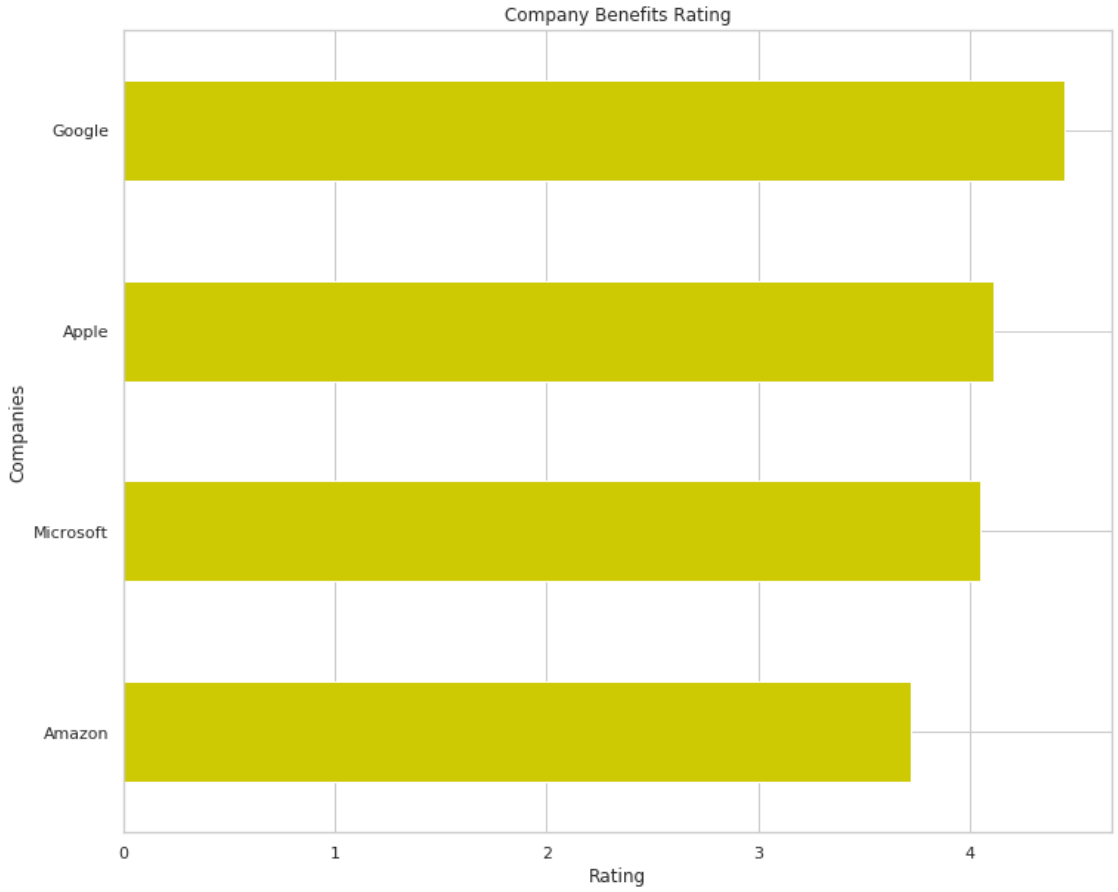
[237]:
```
rating_per_company("culture-values-stars", "Culture Values", "b")
```



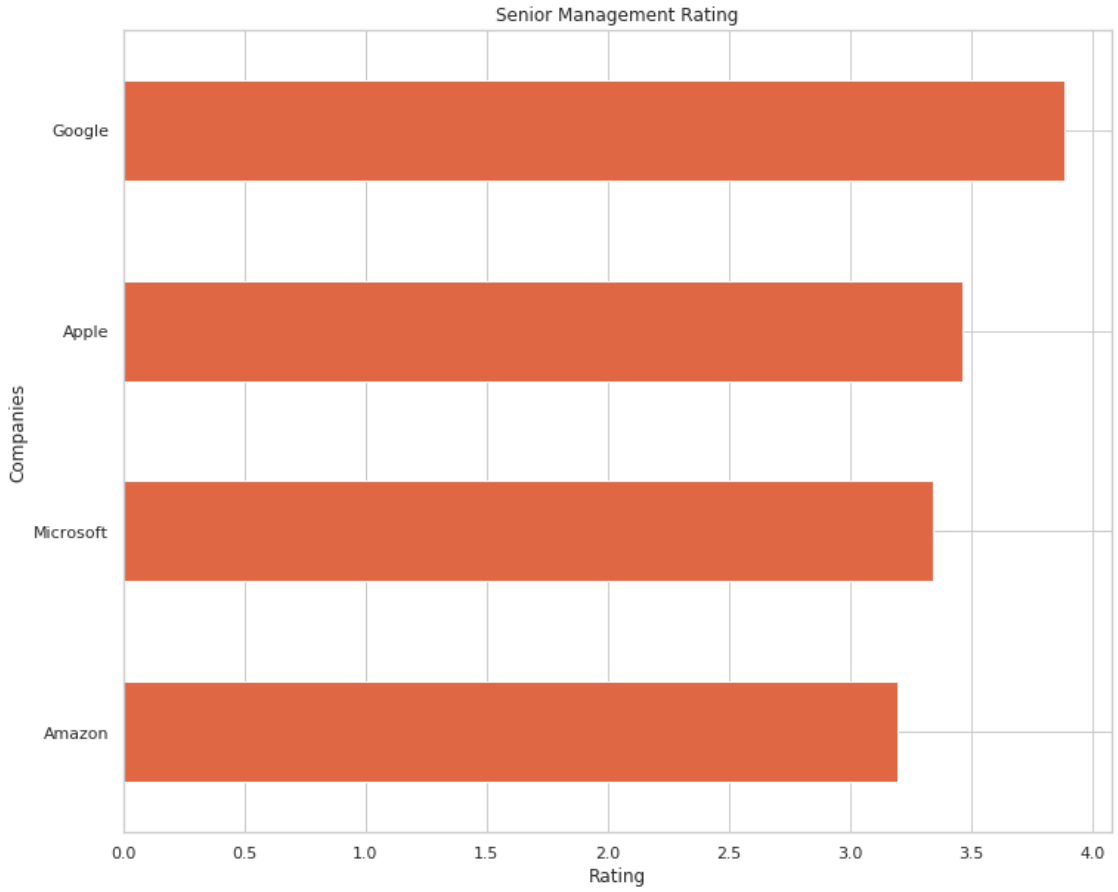
[238]:
```
rating_per_company("carrer-opportunities-stars", "Career Opportunities", "g")
```



[239]:
```
rating_per_company("comp-benefit-stars", "Company Benefits", "#cdca04")
```

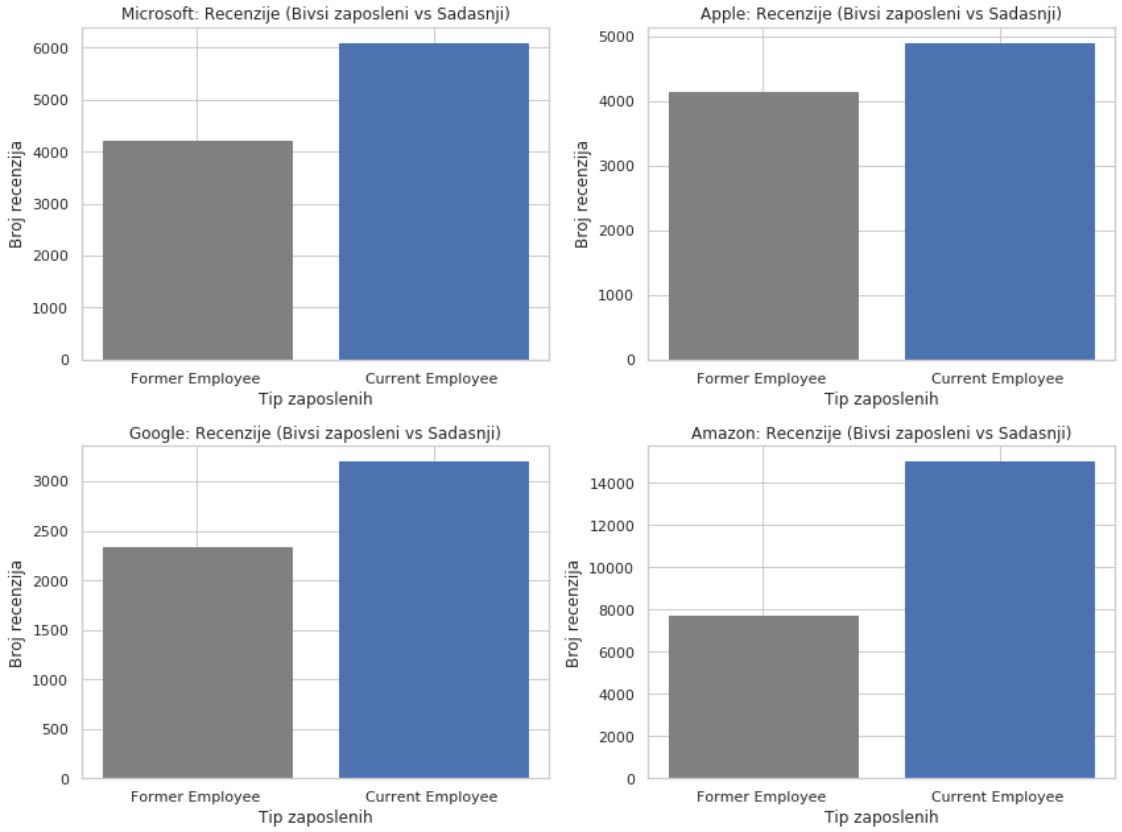


[240]:
```
rating_per_company("senior-mangemnet-stars", "Senior Management", "#e06743")
```



[241]:
```
fig, axs = plt.subplots(2,2, figsize=(12, 9), facecolor='w', edgecolor='k')
companies = ['microsoft', 'apple', 'google', 'amazon']
axs = axs.ravel()


for i, company in enumerate(companies):
    current_employee_count = df.loc[df['company'] == company]['job-title'].str.
 ↪split('-', expand=True)[0].value_counts().sort_values(ascending=True)
    employee_labels = current_employee_count.index.tolist()
    employee_index = np.arange(len(employee_labels))

    bars = axs[i].bar(employee_index, current_employee_count,␣
 ↪tick_label=employee_labels)
    bars[0].set_color('gray')
    bars[1].set_color('b')
    axs[i].set_xlabel('Tip zaposlenih')
    axs[i].set_ylabel('Broj recenzija')
    axs[i].set_title('%s: Recenzije (Bivsi zaposleni vs Sadasnji)' %(company.
 ↪title()))
```

```
fig.tight_layout()
```



Zaključak je da najviše napisanih recenzija za svaku kompaniju dolazi od trenutno zaposlenih ljudi.

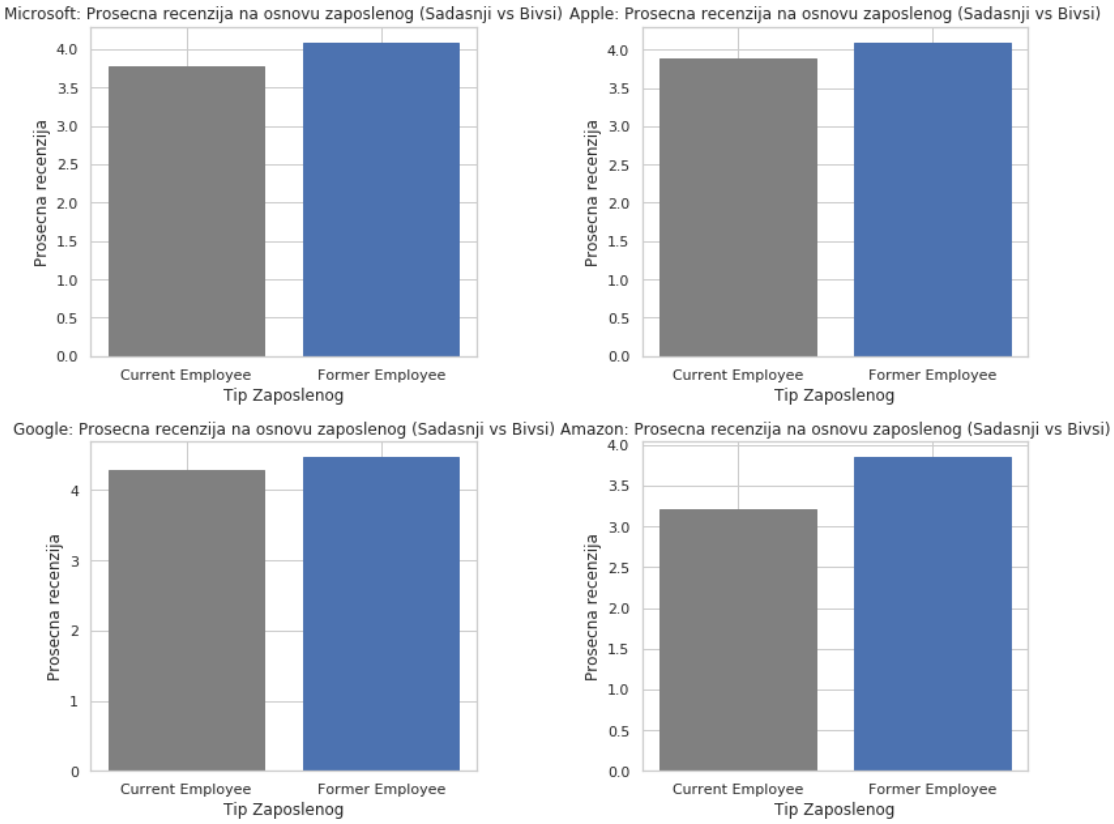
[242]:
```
df['job-title'].str.split(' - ', expand=True)[1].value_counts().head(5)
```

[242]:
```
Anonymous Employee              21779
Software Engineer                 928
Specialist                        647
Software Development Engineer     613
Warehouse Associate               583
Name: 1, dtype: int64
```

Prosečna ocena za kompaniju na osnovu bivšeg i sadašnjeg zaposlenog

[243]:
```
fig, axs = plt.subplots(2,2, figsize=(12, 9), facecolor='w', edgecolor='k')
companies = ['microsoft', 'apple', 'google', 'amazon']
axs = axs.ravel()
```

```
for i, company in enumerate(companies):

        job_rating = df[df['company'] == company][['job-title',␣
↪'overall-ratings']]
        job_rating['job-title'] = job_rating['job-title'].str.split(' - ',␣
↪expand=True)[0]
        job_rating_count = job_rating.groupby('job-title')['overall-ratings'].
↪mean().sort_values(ascending=True)

        bars = axs[i].bar([0,1], job_rating_count, tick_label = ['Current␣
↪Employee', 'Former Employee'])
        bars[0].set_color('gray')
        bars[1].set_color('b')
        axs[i].set_title('{}: Prosecna recenzija na osnovu zaposlenog (Sadasnji␣
↪vs Bivsi)'.format(company.title()))
        axs[i].set_xlabel("Tip Zaposlenog")
        axs[i].set_ylabel("Prosecna recenzija")

fig.tight_layout()
```



Zaključak je da *Amazon* ima najveću razliku u prosečnoj oceni koje su dali bivši i sadašnji za-

posleni.

2.4 Izbor korisnijih kolona za dalju analizu

Od svih kolona, deluje mi da su nam samo *summary*, *pros*, *cons*, *overall-ratings* korisnije, jer iz njih možemo tekst da izvučemo da bi sproveli dalju analizu, dok prosečnu ocenu možemo da pretvorimo u kategorički atribut. Daljom analizom *summary* kolone, može se videti da je većina tih sažetaka jako kratka i da sadrži ili par reči ili poziciju zaposlenog.

[244]:
```
new_df = df.iloc[:,[0,4,5,6,8]]
new_df.head()
```

[244]:

	company	summary	pros	cons	overall-ratings
0	google	Best Company to work for	People are smart and friendly	Bureaucracy is slowing things down	5.0
3	google	The best place I've worked and also the most d...	You can't find a more well-regarded company th...	I live in SF so the commute can take between 1...	5.0
4	google	Unique, one of a kind dream job	Google is a world of its own. At every other c...	If you don't work in MTV (HQ), you will be giv...	5.0
5	google	NICE working in GOOGLE as an INTERN	People are not that busy, so they are nice to ...	Food is not good as I expected. People said it...	5.0
6	google	Software engineer	Great working environment. Good work life balance	Usual big company problems. Hierarchy.	5.0

[245]:
```
review = new_df['overall-ratings']
ctgr = review.map(lambda x : 'positive' if x > 3 else 'negative')
new_df['overall-ratings'] = ctgr
new_df.head()
```

```
/usr/lib/python3.7/site-packages/ipykernel_launcher.py:3:
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: http://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  This is separate from the ipykernel package so we can avoid doing imports
until
```

[245]:
```
  company                                                summary  \
0  google                              Best Company to work for
3  google  The best place I've worked and also the most d...
4  google                      Unique, one of a kind dream job
5  google                  NICE working in GOOGLE as an INTERN
6  google                                   Software engineer

                                                      pros  \
0                       People are smart and friendly
3  You can't find a more well-regarded company th...
4  Google is a world of its own. At every other c...
5  People are not that busy, so they are nice to ...
6  Great working environment. Good work life balance

                                                      cons overall-ratings
0                  Bureaucracy is slowing things down        positive
3  I live in SF so the commute can take between 1...        positive
4  If you don't work in MTV (HQ), you will be giv...        positive
5  Food is not good as I expected. People said it...        positive
6              Usual big company problems. Hierarchy.       positive
```

[246]:
```
new_df['overall-ratings'].value_counts()
```

[246]:
```
positive    32850
negative    14749
Name: overall-ratings, dtype: int64
```

3 Klasterovanje

Klasterovanje ili klaster analiza je pronalaženje grupa objekata takvih da su objekti u grupi međusobno slični, odnosno da su objekti u različitim grupama međusobno različiti.

3.1 Klasterovanje teksta

Pošto računari razumeju samo brojeve, tekst je potrebno pretvoriti u brojeve. Klasterovanje teksta ima primenu u automatskoj organizaciji dokumenata(tekstova), izvlačenju tema ili brzih informacija. Svodi se na korišćenje *deskriptora*, koji su skupovi reči koji opisuju sadržaj klastera. Cilj klasterovanja teksta je da grupiše tekstove u razdvojene skupove klastera.

Postupak prilikom klasterovanja teksta * tokenizacija * okrnjavanje(*eng. stemming*) * uklanjanje zaustavnih reči i znakova interpukcije * računanje učestalosti termova svih tokena(*CountVectorizer, TF-IDF, Word2Vec*) * klasterovanje * ocenjivanje i grafički prikaz

Da bi mogli da sprovedemo klasterovanje teksta, koristimo NLTK. On je skup alatki za obradu prirodnih jezika(NLP), koji u svojem sastavu ima i zaustavne reči(*eng. - stopwords*) i alat koji svodi na koren reči(ne nužno morfološki koren). Takođe nije samo razvijen da obrađuje engleski jezik, već može i ostale. Pored ovih, omogućava i druge obrade, vezane za semantičko značenje, označavanje, parsiranje.

[247]:
```
import nltk
nltk.download('stopwords')
from nltk.corpus import stopwords
sno = nltk.stem.SnowballStemmer('english')
stop = set(stopwords.words('english'))

def cleanpunc(sentence):
    cleaned = re.sub(r'[?|!|\'|"|#|<|>]',r'',sentence)
    cleaned = re.sub(r'[.|,|)|(|\|/]',r' ',cleaned)
    return  cleaned

#print(stop)
#print(sno.stem("tasting"))
```

```
[nltk_data] Downloading package stopwords to /home/vumpus/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
```

[248]:
```
i=0
stringic=' '
final_string=[]
all_positive_words=[]
all_negative_words=[]
s=''
for sent in new_df['pros'].values:
    filtered_sentence=[]
    for w in sent.split():
        for cleaned_words in cleanpunc(w).split():
            if((cleaned_words.isalpha()) & (len(cleaned_words)>2)):
                if(cleaned_words.lower() not in stop):
                    s=(sno.stem(cleaned_words.lower())).encode('utf8')
                    filtered_sentence.append(s)
                    if (new_df['overall-ratings'].values)[i] == 'positive':
                        all_positive_words.append(s)
                    if(new_df['overall-ratings'].values)[i] == 'negative':
                        all_negative_words.append(s)
                else:
                    continue
            else:
                continue
    stringic = b" ".join(filtered_sentence)

    final_string.append(stringic)
    i+=1
```

[249]:
```
new_df['CleanedText'] = final_string
new_df['CleanedText'] = new_df['CleanedText'].str.decode('utf-8')
```

```
/usr/lib/python3.7/site-packages/ipykernel_launcher.py: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: http://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  """Entry point for launching an IPython kernel.
/usr/lib/python3.7/site-packages/ipykernel_launcher.py:2:
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: http://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

3.2 Brojači reči

3.2.1 *CountVectorizer*

CountVectorizer koristi princip *"džak reči"*, što znači da se svaka reč u svakom tekstu broji i predstavlja kao matrica.

[250]:
```
from sklearn.feature_extraction.text import CountVectorizer
c_vect = CountVectorizer()
bow = c_vect.fit_transform(new_df['CleanedText'].values)
bow.shape
```

[250]:
```
(47599, 10180)
```

[251]:
```
terms = c_vect.get_feature_names()
terms[:20]
```

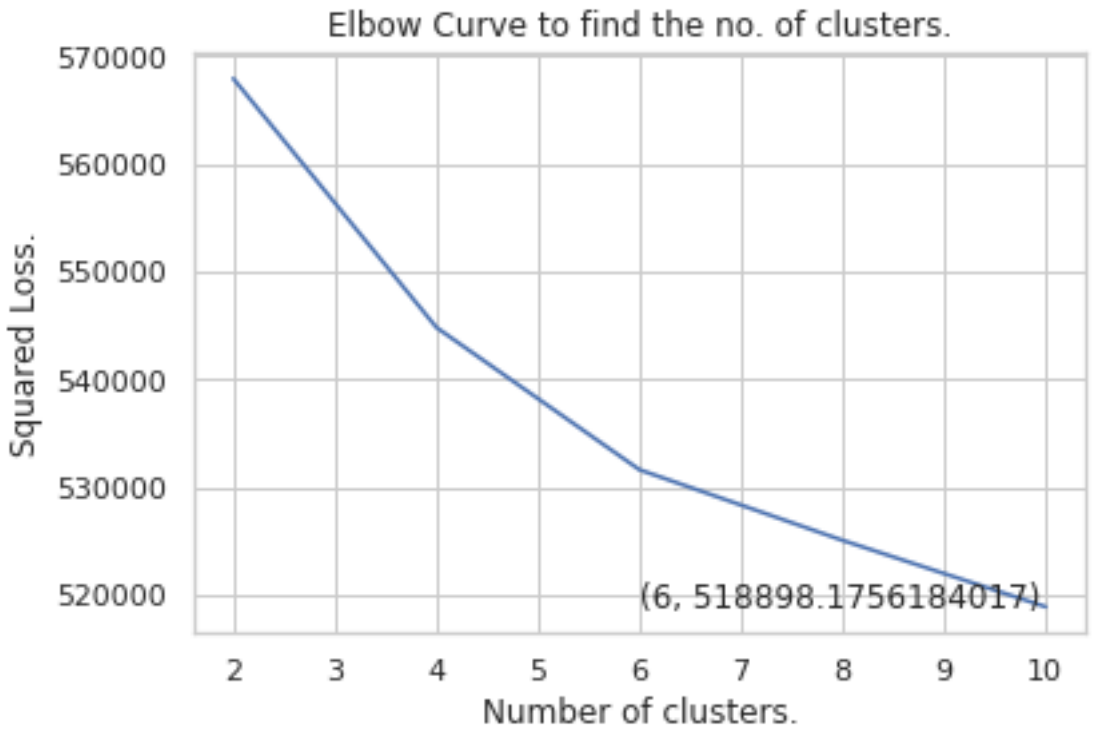
[251]:
```
['aa',
 'aaa',
 'aaaaaamaz',
 'aan',
 'aand',
 'aandacht',
 'aandelen',
 'aapl',
 'aar',
 'ab',
 'aba',
 'abandon',
 'abd',
 'aber',
 'abgefeiert',
```

```
 'abid',
 'abidjan',
 'abil',
 'abiliy',
 'abl']
```

"Lakat" metoda "Lakat" metoda se koristi u klaster analizi za otkrivanje optimalnog broja klastera za zadati skup podataka. Nekad nije dobro osloniti(jer je višeznačna i ona će odrediti optimalan broj klastera za naš raspon, ali je pitanje da li je raspon broja klastera koji smo uzeli u obzir dobar) se na nju i da je bolje koristiti koeficijent Senke(*eng. Silhouette coefficient*). Za svako k računamo unutrašnju sumu kvadrata klastera(WSS), i iscrtavamo krivu za to zadato k. Mesto gde se nalazi "lakat" se uzima kao optimalan broj klastera za zadat skup podataka.

[252]:
```
def elbow_method(text, num_clus):
    squared_errors = []
    for cluster in num_clus:
        print("Fit %d clusters." %(cluster))
        kmeans = KMeans(n_clusters = cluster).fit(bow)
        squared_errors.append(kmeans.inertia_)

    optimal_clusters = np.argmin(squared_errors) + 2
    plt.plot(num_clus, squared_errors)
    plt.title("Elbow Curve to find the no. of clusters.")
    plt.xlabel("Number of clusters.")
    plt.ylabel("Squared Loss.")
    xy = (optimal_clusters, min(squared_errors))
    plt.annotate('(%s, %s)' % xy, xy = xy, textcoords='data')
    plt.show()

    print ("The optimal number of clusters obtained is - ", optimal_clusters)
    print ("The loss for optimal cluster is - ", min(squared_errors))

    return optimal_clusters
num_clusters = elbow_method(bow, range(2,12,2))
```

```
Fit 2 clusters.
Fit 4 clusters.
Fit 6 clusters.
Fit 8 clusters.
Fit 10 clusters.
```




```
The optimal number of clusters obtained is -  6
The loss for optimal cluster is -  518898.1756184017
```

[253]:
```
model = KMeans(n_clusters = num_clusters,init='k-means++', n_jobs =␣
 ↪-1,random_state=99)
model.fit(bow)
```

[253]:
```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
       n_clusters=6, n_init=10, n_jobs=-1, precompute_distances='auto',
       random_state=99, tol=0.0001, verbose=0)
```

[254]:
```
bow_labels = model.labels_
bow_cluster_center=model.cluster_centers_
```

Koeficijent senke je unutrašnji kriterijum provere našeg klasterovanja. Uzima vrednosti između -1 i 1. Što je bliži koeficijent jedinici, govorimo o jako dobro razdvojenim klasterima i da su naši parametri za klasterovanje prikladni. Negativna vrednost nam govori o mešavini podataka u klasterima.

[255]:
```
from sklearn import metrics as met
bow_silhouette_score = met.silhouette_score(bow, bow_labels, metric='euclidean')
```

[256]:
```
bow_silhouette_score
```

[256]:
```
0.0244953197458108
```

[257]:
```
new_df['Bow Cluster Label'] = model.labels_
new_df.head(2)
```

```
/usr/lib/python3.7/site-packages/ipykernel_launcher.py: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: http://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  """Entry point for launching an IPython kernel.
```

[257]:

	company	summary	\
0	google	Best Company to work for	
3	google	The best place I've worked and also the most d...	

	pros	\
0	People are smart and friendly	
3	You can't find a more well-regarded company th...	

	cons	overall-ratings	\
0	Bureaucracy is slowing things down	positive	
3	I live in SF so the commute can take between 1...	positive	

	CleanedText	Bow Cluster Label
0	peopl smart friend	4
3	cant find compani actual deserv hype get youll...	3

[258]:
```
#da vidimo kako su grupisani podaci
new_df.groupby(['Bow Cluster Label'])['pros'].count()
```

[258]:
```
Bow Cluster Label
0     9526
1    12000
2    10084
3     1870
4    14094
5       25
Name: pros, dtype: int64
```

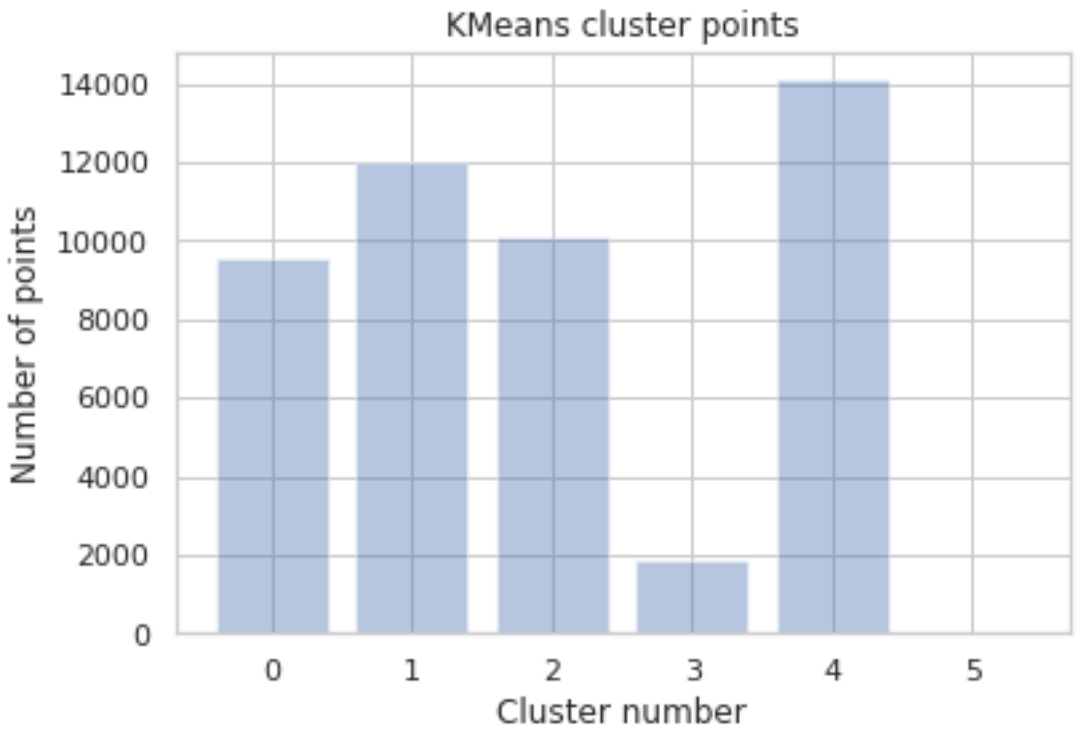
[259]:
```
def top_terms_per_cluster(centers, num_of_clusters, terms, num_of_terms):
    print("Top terms per cluster:")
    order_centroids = centers.argsort()[:, ::-1]
    for i in range(num_of_clusters):
        print("Cluster %d:" % i, end='')
```

```
        for ind in order_centroids[i, :num_of_terms]:
            print(' %s' % terms[ind], end='')
            print()
top_terms_per_cluster(bow_cluster_center, num_clusters, terms, 10)
```

```
Top terms per cluster:
Cluster 0: great
 benefit
 peopl
 work
 compani
 pay
 opportun
 good
 lot
 environ
Cluster 1: work
 great
 peopl
 environ
 compani
 place
 lot
 opportun
 cultur
 benefit
Cluster 2: good
 work
 benefit
 pay
 peopl
 compani
 environ
 great
 lot
 salari
Cluster 3: work
 peopl
 compani
 great
 amazon
 get
 team
 lot
 good
 time
Cluster 4: benefit
```

```
 peopl
 compani
 lot
 opportun
 learn
 pay
 time
 environ
 get
Cluster 5: amazon
 work
 time
 compani
 manag
 hour
 peopl
 get
 year
 like
```

[260]:
```
import matplotlib.pyplot as plt
def plot_cluster_points(cluster_label_str, feature, num_clusters):
    plt.bar([x for x in range(num_clusters)], new_df.
 ↪groupby([cluster_label_str])[feature].count(), alpha = 0.4)
    plt.title('KMeans cluster points')
    plt.xlabel("Cluster number")
    plt.ylabel("Number of points")
    plt.show()

plot_cluster_points('Bow Cluster Label', 'pros', num_clusters)
```



[306]:
```
def print_review_asigned_to_cluster(cluster_label_str, feature, num_clusters):
    for i in range(num_clusters):
        print("review of assigned to cluster ", i)
        print("-" * 70)
        print(new_df.iloc[new_df.groupby([cluster_label_str]).
 ↪groups[i][0]][feature])
        print('\n')
        print(new_df.iloc[new_df.groupby([cluster_label_str]).
 ↪groups[i][5]][feature])
        print('\n')
        print(new_df.iloc[new_df.groupby([cluster_label_str]).
 ↪groups[i][10]][feature])
        print('\n')
        print(new_df.iloc[new_df.groupby([cluster_label_str]).
 ↪groups[i][20]][feature])
        print("_" * 70)

print_review_asigned_to_cluster('Bow Cluster Label', 'pros', num_clusters)
```

```
review of assigned to cluster  0
----------------------------------------------------------------------
* Smart people * World class infrastructure * Diverse selection of projects and
teams
```

Employees, food, benefits, perks, shuttle, basically an all-expenses-paid college.

- Great Food - Mentor and Feedback

very good experience, colleagues are smart

---

review of assigned to cluster 1

Great products. Vision you can feel good about. Fair compensation. Automonomy in your role. Wide array of industries / roles employees are able to explore. Feedback loops give employees that ability to provide feedback to management regularly on their performance. Expectation that you will go above and beyond the minimum scope of your role - those that do, are typically rewarded. What more do you want from an employer.

Very inspiring engineers to work with.

Never have to skip a paycheck.

Fantastic Work Environment. Great opportunities to advance.

---

review of assigned to cluster 2

Really fun work environment with startup

food, shuttle, technology, perks, health, 401K, brand

Brilliant colleagues, excellent engineering standards, a clear career progression, ample mentorship, challenging and interesting projects, exposure to the bleeding edge of technologies, excellent work-life balance, top-notch code standards, great benefits, delicious food, beautiful work environment. Internal mobility is amazing. If you ever feel like you need a new team or a new challenge, you can transfer at will. Joining Google doesn't mean you join a particular team, it means you're entering a huge community of brilliant people doing exciting things who are eager to have you join them. You'll learn what it looks like when engineering is done right. Stay for more than a few years and recruiters won't be able to get enough of you. "Ex-Googler" carries a lot of weight, and I've seen lots of people leave Google to take on shockingly

influential roles at startups and other companies.

the place was nice and th people were too

---

review of assigned to cluster 3

People are not that busy, so they are nice to help our. They did make a suitable intern project that you can finish it in time and learn something.

Continually impressed by the opportunities and value

Really like the people and culture. The location is great and I am challenged.

The people really are the best part of Google

---

review of assigned to cluster 4

People are smart and friendly

Perks, autonomy, cool products, smart people

Great place to work, learn new things, grow and innovate. Able to maintain a respectful and healthy workplace culture despite the recent press.

Great benefits, work life balance, and pay for the position.

---

review of assigned to cluster 5

Great working environment. Good work life balance

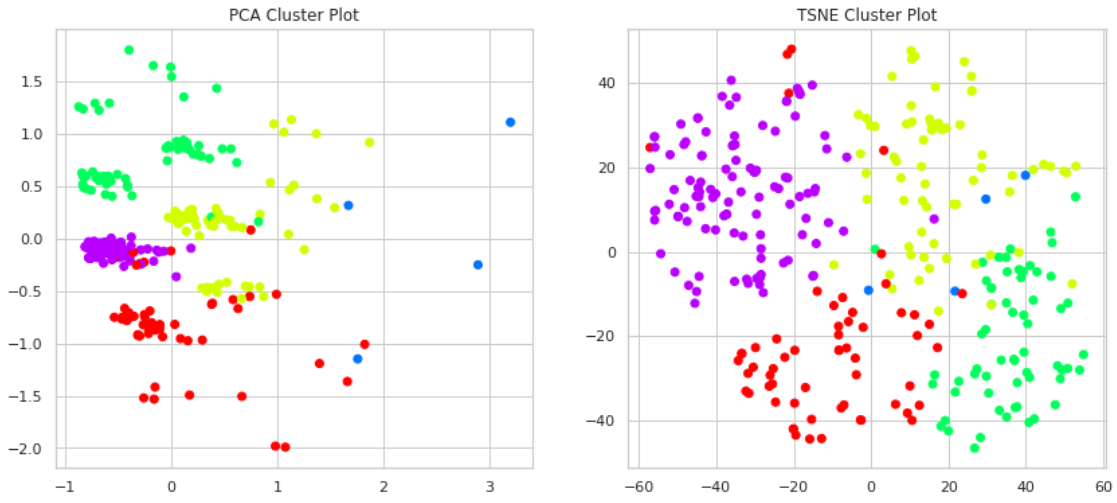
-Dynamic Environment -Team Oriented. -Great Training. -Incredible managers and peers.

pick your own schedule, Virtual

Customer obsessed Frugality is not the priority Quality of service

---

[262]:
```
import matplotlib.cm as cm
from sklearn.decomposition import PCA
from sklearn.manifold import TSNE

def plot_tsne_pca(data, labels):
    max_label = max(labels)
    max_items = np.random.choice(range(data.shape[0]), size=3000, replace=False)

    pca = PCA(n_components=2).fit_transform(data[max_items,:].todense())
    tsne = TSNE().fit_transform(PCA(n_components=50).
 ↪fit_transform(data[max_items,:].todense()))


    idx = np.random.choice(range(pca.shape[0]), size=300, replace=False)
    label_subset = labels[max_items]
    label_subset = [cm.hsv(i/max_label) for i in label_subset[idx]]

    f, ax = plt.subplots(1, 2, figsize=(14, 6))

    ax[0].scatter(pca[idx, 0], pca[idx, 1], c=label_subset)
    ax[0].set_title('PCA Cluster Plot')

    ax[1].scatter(tsne[idx, 0], tsne[idx, 1], c=label_subset)
    ax[1].set_title('TSNE Cluster Plot')

plot_tsne_pca(bow, bow_labels)
```



Klasteri 1, 2 i 4 imaju najviše grupisanih recenzija. Da vidimo šta je najčešće:

[315]:
```
print("Cluster 1: ")
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[1][2]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[1][12]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[1][22]]['pros'])
print("\nCluster 2: ")
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[2][2]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[2][12]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[2][22]]['pros'])
print("\nCluster 4: ")
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[4][2]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[4][12]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[4][22]]['pros'])
```

```
Cluster 1:
The people are great to work with
----------------------------------------------------------------------
comfortable environment, free food, nice people
----------------------------------------------------------------------
Great perks such as gym bikes and food

Cluster 2:
Nice perks. Good work life balance
----------------------------------------------------------------------
Have been at Google almost 2 years. Google is like heaven for a software
engineer. I love contributing to the amazing products and learning from the best
in the business. My coworkers are very supportive and positive, and manager
really cares about me and my goals.
----------------------------------------------------------------------
Scale, values, ambitions. The company continues to be a strong innovator and
technical leader.

Cluster 4:
* There is endless opportunity * You'll never stop learning * I haven't thought
about money since I joined.
----------------------------------------------------------------------
Easy place and people are nice
----------------------------------------------------------------------
free food and good pay
```

Klaster 5 ima najmanje recenzija. Da ispišemo sve, kad ih je toliko malo:

[322]:
```
print("Cluster 5: ")
print("_" * 70)
for i in range(0, 25, 1):
    print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).
 ↪groups[5][i]]['pros'])
    print("_" * 70)
```

```
Cluster 5:
----------------------------------------------------------------------
Great working environment. Good work life balance
----------------------------------------------------------------------
casual, high standards, good co workers
----------------------------------------------------------------------
The 10hr shifts go by fast if you stay positive and don't watch the clock, if
your a picker.
----------------------------------------------------------------------
Amazon is always inventing, always looking for new ways to remove waste from a
service, or industry. You can change entire careers without finding a new
employer.
----------------------------------------------------------------------
Pay is good and cost of living is lower than the bay area
----------------------------------------------------------------------
-Dynamic Environment -Team Oriented. -Great Training. -Incredible managers and
peers.
----------------------------------------------------------------------
There is an entrepreneurial spirit here that is not felt in any other work
environment. We are free to come up with new ideas and implement them to better
our team/dept. Leadership is brilliant and supportive.
----------------------------------------------------------------------
benefits from day 1, Career Choice Program, Set schedules, opportunity for
overtime, many various schedules to chose from
----------------------------------------------------------------------
Lot's of benefits and room for growth
----------------------------------------------------------------------
Good management Good work life balance Mobility
----------------------------------------------------------------------
pick your own schedule, Virtual
----------------------------------------------------------------------
Plenty of great opportunities and challenges, if you have management that will
resource you properly. Some teams (orgs) appear to be properly resourced, while
other teams and orgs are drastically under resourced (strategically lean they
like to call it).
----------------------------------------------------------------------
When you venture into a job with Amazon, you are likely not going to be prepared
for what you experience. Amazon is a place where you will have very challenging
work for a very good cause, customer experience. I have a career of working in
the customer service business and I've learned more and achieved more in my time
```

with Amazon than with any other organization. People are passionate about the work which does result in sometimes heated conversations, but those conversations are all grounded on one thing, "What is the best experience for customers?" It is refreshing to go into discussions with this same grounding as it enables you to walk out of the room and know the debate was not personal towards an individual, but focused on doing the right thing for our customers. I also appreciate the focus on excellence in written communication. I have learned even more about the power of the written word than I knew coming into the company. By applying your focus to writing a document, you enable a clarity of thought that isn't seen through power point. Writing in a narrative format forces you to think critically about your proposal or update and forces you to think about the questions that others will have on your document. While it may be a painful adjustment in the beginning, you will quickly realize the value and will never want to go back! The last big Pro to working at Amazon is that you never know what's going to happen next. In my time with the company I've seen us grow from a retailer to disruptor in the reading industry to disruptor in the tablet industry to a disruptor in the creation of digital content to who knows what is next to disrupt. It is very exciting to work for a company that is constantly evolving and becoming a bigger part of the digital ecosystem while also challenging conventional thoughts about any industry.

Great learning experience. I learned a lot while working there.

Unlimited opportunity Great salaries and compensation package Super-smart co-workers Mobility within the company and subsidiaries encouraged for both tech and non-tech positions

---

Amazon has a very nice starting hourly wage ($12.50/hr). You wont find many places with similar or higher starting wages.

Awesome place to work with lot of growth and respect to the employees irrespective of their level. Its been the worlds most customers centric.

Fun to work at, open environment

Bring A Part of Innovation Recognized Worldwide

Good work atmosphere and great opportunity to grow

Customer obsessed Frugality is not the priority Quality of service

---

Good Brand, Employability, AWS, Descent Salary

Pay is above industry average. Benefits are fantastic and include top tier medical, dental, and vision. Stock purchase plan is great. Many talented people work there.

Discounts, great team, always a great working culture at apple.

```
----------------------------------------------------------------------
Exceptionally accommodating for different employee needs. Great job security.
Able to grow and move up. Close connections with peers. Team support daily.
----------------------------------------------------------------------
```

3.2.2 TF-IDF

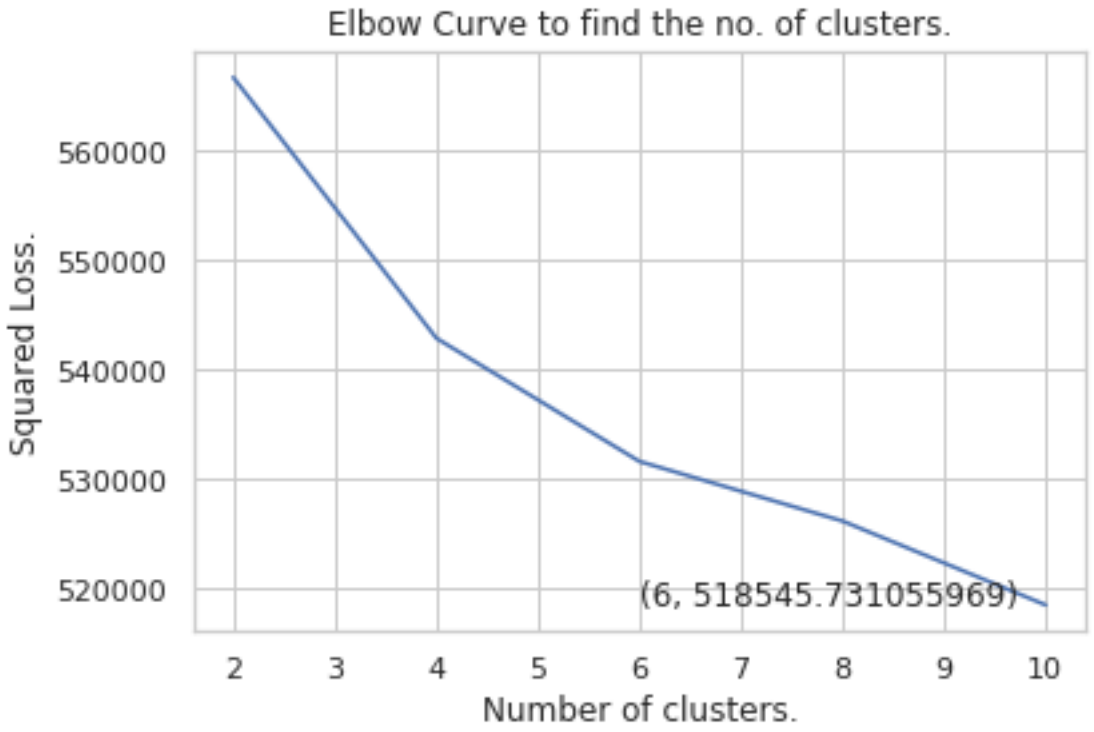
TF-IDF (*eng. Term frequency-inverse document frequency*) je još jedan od načina za prevođenje niski u brojeve. Ocena reči se izračunava proizvodom učestalosti zadate reči i inverznom ferkvencijom(*"što je učestalija u ostalim tekstovima, ocena će biti manja"*).

[263]:
```
from sklearn.feature_extraction.text import TfidfVectorizer

tfidf_vect = TfidfVectorizer()
tfidf = tfidf_vect.fit_transform(new_df['CleanedText'].values)
tfidf.shape
```

[263]:
```
(47599, 10180)
```

[264]:
```
num_clusters = elbow_method(tfidf, range(2,12,2))
```

```
Fit 2 clusters.
Fit 4 clusters.
Fit 6 clusters.
Fit 8 clusters.
Fit 10 clusters.
```



```
The optimal number of clusters obtained is -  6
The loss for optimal cluster is -  518545.731055969
```

[265]:
```
model_tf = KMeans(n_clusters = num_clusters)
model_tf.fit(tfidf)
```

[265]:
```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
       n_clusters=6, n_init=10, n_jobs=None, precompute_distances='auto',
       random_state=None, tol=0.0001, verbose=0)
```

[266]:
```
labels_tf = model_tf.labels_
cluster_center_tf=model_tf.cluster_centers_
```

[267]:
```
terms1 = tfidf_vect.get_feature_names()
terms1[:10]
```

[267]:
```
['aa',
 'aaa',
 'aaaaaamaz',
 'aan',
 'aand',
 'aandacht',
 'aandelen',
 'aapl',
 'aar',
 'ab']
```

[268]:
```
silhouette_score_tf = met.silhouette_score(tfidf, labels_tf, metric='euclidean')
silhouette_score_tf
```

[268]:
```
0.009020989957536007
```

[269]:
```
# Giving Labels/assigning a cluster to each point/text
tfidf_df = new_df
tfidf_df['Tfidf Cluster Label'] = model_tf.labels_
tfidf_df.head(5)
```

```
/usr/lib/python3.7/site-packages/ipykernel_launcher.py:3:
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: http://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  This is separate from the ipykernel package so we can avoid doing imports
```

```
      until
```

[269]:
```
  company                                                summary  \
0  google                                Best Company to work for
3  google  The best place I've worked and also the most d...
4  google                      Unique, one of a kind dream job
5  google                  NICE working in GOOGLE as an INTERN
6  google                                   Software engineer

                                                    pros  \
0                         People are smart and friendly
3  You can't find a more well-regarded company th...
4  Google is a world of its own. At every other c...
5  People are not that busy, so they are nice to ...
6  Great working environment. Good work life balance

                                                    cons overall-ratings  \
0                  Bureaucracy is slowing things down        positive
3  I live in SF so the commute can take between 1...        positive
4  If you don't work in MTV (HQ), you will be giv...        positive
5  Food is not good as I expected. People said it...        positive
6              Usual big company problems. Hierarchy.        positive

                                        CleanedText  Bow Cluster Label  \
0                                peopl smart friend                  4
3  cant find compani actual deserv hype get youll...                  3
4  googl world everi compani lot peopl serious ga...                  5
5  peopl busi nice help make suitabl intern proje...                  4
6           great work environ good work life balanc                  1

   Tfidf Cluster Label
0                    4
3                    4
4                    4
5                    4
6                    0
```

[270]:
```
tfidf_df.groupby(['Tfidf Cluster Label'])['pros'].count()
```

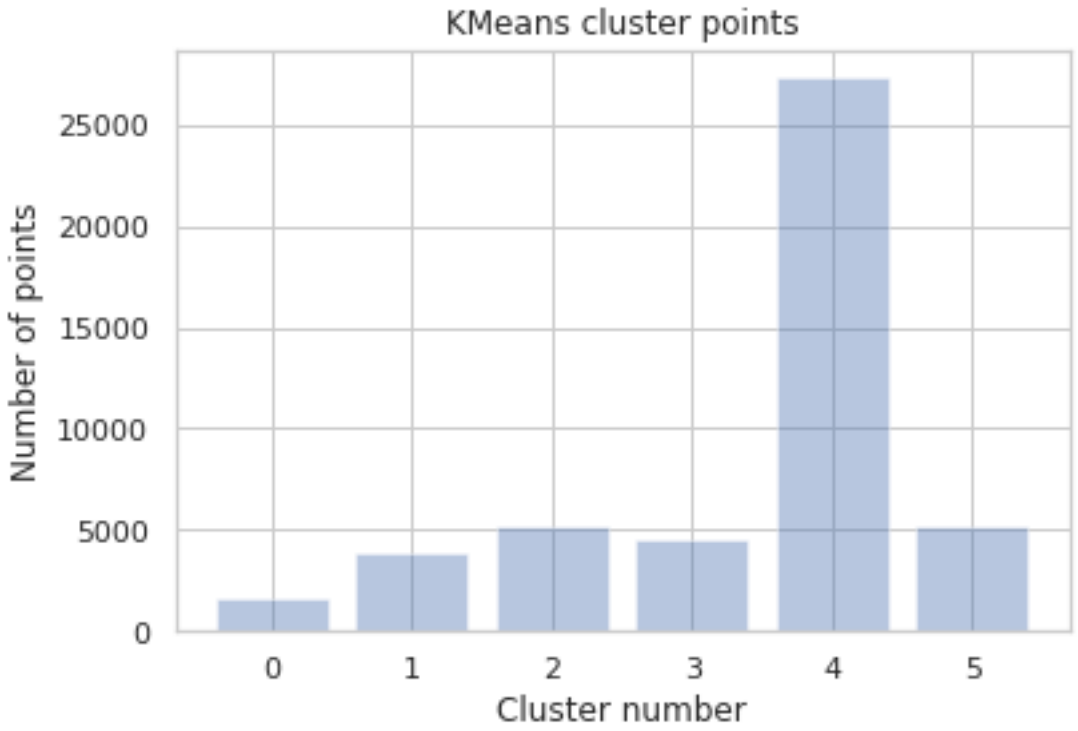
[270]:
```
Tfidf Cluster Label
0     1659
1     3801
2     5152
3     4530
4    27309
5     5148
Name: pros, dtype: int64
```

[271]:
```
top_terms_per_cluster(cluster_center_tf, num_clusters, terms1, 10)
```

```
Top terms per cluster:
Cluster 0: balanc
 life
 work
 good
 great
 benefit
 cultur
 peopl
 environ
 flexibl
Cluster 1: pay
 benefit
 good
 great
 decent
 work
 hour
 time
 peopl
 job
Cluster 2: good
 work
 benefit
 environ
 salari
 compani
 peopl
 cultur
 place
 great
Cluster 3: lot
 learn
 opportun
 work
 great
 peopl
 good
 new
 smart
 compani
Cluster 4: work
 peopl
 compani
 benefit
```

```
 great
 environ
 best
 cultur
 opportun
 get
Cluster 5: great
 work
 benefit
 peopl
 compani
 environ
 place
 cultur
 opportun
 team
```

[272]:
```
plot_cluster_points('Tfidf Cluster Label', 'pros', num_clusters)
```



[273]:
```
print_review_asigned_to_cluster('Tfidf Cluster Label', 'pros', num_clusters)
```

```
A review of assigned to cluster  0
------------------------------------------------------------------------
Great products. Vision you can feel good about. Fair compensation. Automonomy in
```

your role. Wide array of industries / roles employees are able to explore. Feedback loops give employees that ability to provide feedback to management regularly on their performance. Expectation that you will go above and beyond the minimum scope of your role - those that do, are typically rewarded. What more do you want from an employer.

Google’s perks are great: free food, shuttle to work, stock options, fun offices and amenities. The company is also full of really smart people that I’m constantly learning from.

The best company I've worked for. Culture, perks, the way people are treated. Very thankful for this experience.

Great company with creative ideas.

A review of assigned to cluster 1

---

perks are pretty good, as is culture

Amazing and talented co workers best place to work at $$$

Have been at Google almost 2 years. Google is like heaven for a software engineer. I love contributing to the amazing products and learning from the best in the business. My coworkers are very supportive and positive, and manager really cares about me and my goals.

High impact projects, open engineering-based culture, free food

---

A review of assigned to cluster 2

Great benefits, growth and people to work with and challenge you.

Nice perks. Good work life balance

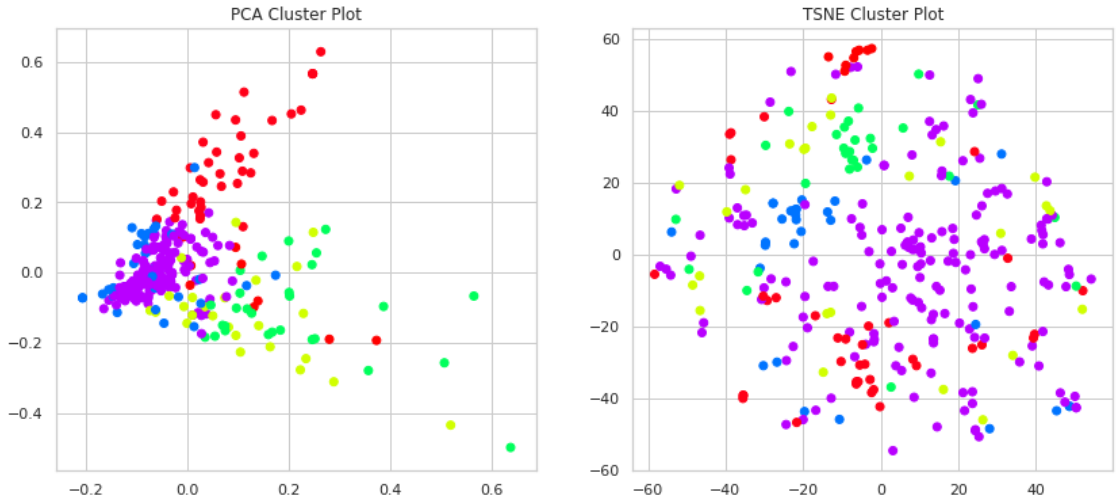
food, shuttle, technology, perks, health, 401K, brand

great work culture , good for starters

A review of assigned to cluster 3

```
--------------------------------------------------------------------
I like and learned from the beginning accounting


- A company culture that encourages dissent, discourse, transparency, and
fairness - Strong compensation, from benefits, to perks, to base pay - Decent
internal mobility opportunities - Employees are proud to work on globally
impactful products, leading to a great sense of pride - Lots of opportunities to
get involved in extracurriculars: sports teams, affinity groups, plan events,
lead debate on internal company/cultural issues


The food is pretty good


Too many to list here - all the standard google magic
--------------------------------------------------------------------
A review of assigned to cluster  4
--------------------------------------------------------------------
People are smart and friendly


People are not that busy, so they are nice to help our. They did make a suitable
intern project that you can finish it in time and learn something.


Great working environment. Good work life balance


work culture, benefits, growth, people,
--------------------------------------------------------------------
A review of assigned to cluster  5
--------------------------------------------------------------------
Impact driven. Best tech in the world.


Good managers, benefits , some support, nice atmosphere


Really fun work environment with startup


I love Google a lot
--------------------------------------------------------------------
```

[274]:
```
plot_tsne_pca(tfidf, labels_tf)
```



Klasteri 2, 4 i 5 imaju najviše recenzija. Vidimo da se u 5 pojavljuju i o malo "negativnijim" stranama posla, kao što su smene od 10 sati.

[324]:
```
print("Cluster 2: ")
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[2][2]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[2][12]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[2][22]]['pros'])
print("\nCluster 4: ")
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[4][2]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[4][12]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[4][22]]['pros'])
print("\nCluster 5: ")
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[5][2]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[5][12]]['pros'])
print("_" * 70)
print(new_df.iloc[new_df.groupby(['Bow Cluster Label']).groups[5][22]]['pros'])
```

```
Cluster 2:
Nice perks. Good work life balance

----------------------------------------------------------------------
Have been at Google almost 2 years. Google is like heaven for a software
engineer. I love contributing to the amazing products and learning from the best
in the business. My coworkers are very supportive and positive, and manager
really cares about me and my goals.

----------------------------------------------------------------------
Scale, values, ambitions. The company continues to be a strong innovator and
```

```
technical leader.

Cluster 4:
* There is endless opportunity * You'll never stop learning * I haven't thought
about money since I joined.
--------------------------------------------------------------------------
Easy place and people are nice
--------------------------------------------------------------------------
free food and good pay

Cluster 5:
The 10hr shifts go by fast if you stay positive and don’t watch the clock, if
your a picker.
--------------------------------------------------------------------------
When you venture into a job with Amazon, you are likely not going to be prepared
for what you experience. Amazon is a place where you will have very challenging
work for a very good cause, customer experience. I have a career of working in
the customer service business and I've learned more and achieved more in my time
with Amazon than with any other organization.  People are passionate about the
work which does result in sometimes heated conversations, but those
conversations are all grounded on one thing, "What is the best experience for
customers?" It is refreshing to go into discussions with this same grounding as
it enables you to walk out of the room and know the debate was not personal
towards an individual, but focused on doing the right thing for our customers.
I also appreciate the focus on excellence in written communication. I have
learned even more about the power of the written word than I knew coming into
the company. By applying your focus to writing a document, you enable a clarity
of thought that isn't seen through power point. Writing in a narrative format
forces you to think critically about your proposal or update and forces you to
think about the questions that others will have on your document. While it may
be a painful adjustment in the beginning, you will quickly realize the value and
will never want to go back!  The last big Pro to working at Amazon is that you
never know what's going to happen next. In my time with the company I've seen us
grow from a retailer to disruptor in the reading industry to disruptor in the
tablet industry to a disruptor in the creation of digital content to who knows
what is next to disrupt. It is very exciting to work for a company that is
constantly evolving and becoming a bigger part of the digital ecosystem while
also challenging conventional thoughts about any industry.
--------------------------------------------------------------------------
Pay is above industry average. Benefits are fantastic and include top tier
medical, dental, and vision. Stock purchase plan is great. Many talented people
work there.
```

3.2.3 *Word2Vec*

Reč u vektor (*eng. Word2Vec*) je još jedan poznat algoritam da pretvorimo reči u brojeve(*eng. - word embedings*). Svaka reč dobije određen niz brojeva(rezultat pretvaranja je ogromna “matrica”), i pošto imamo nizove brojeva, moći ćemo rastojanjem izmedju vektora da utvrdimo sličnost između

reči.

[304]:
```
i=0
list_of_sent=[]
for sent in new_df['CleanedText'].values:
    list_of_sent.append(sent.split())

#list_of_sent[:10]
```

[303]:
```
i=0
list_of_sent_train=[]
for sent in new_df['CleanedText'].values:
    filtered_sentence=[]
    for w in sent.split():
        for cleaned_words in cleanpunc(w).split():
            if(cleaned_words.isalpha()):
                filtered_sentence.append(cleaned_words.lower())
            else:
                continue
    list_of_sent_train.append(filtered_sentence)
#list_of_sent_train[:10]
```

[277]:
```
import gensim
w2v_model=gensim.models.Word2Vec(list_of_sent_train,size=100, workers=4)
```

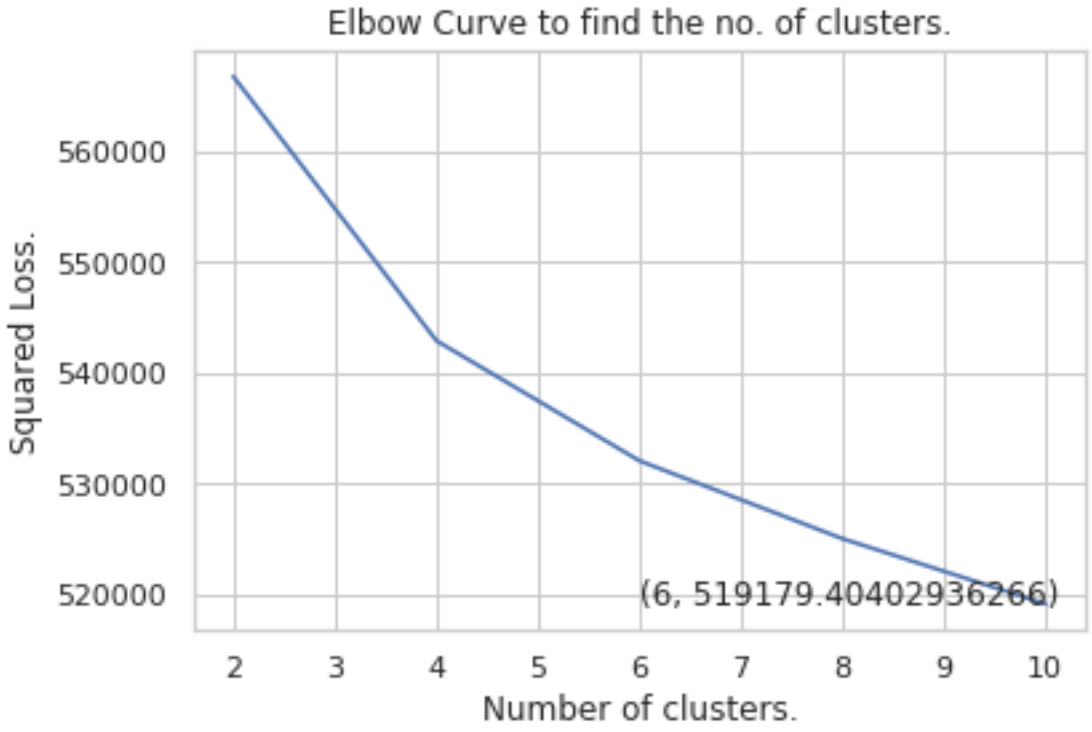
[278]:
```
sent_vectors = [];
for sent in list_of_sent_train:
    sent_vec = np.zeros(100)
    cnt_words =0;
    for word in sent:
        try:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
        except:
            pass
    sent_vec /= cnt_words
    sent_vectors.append(sent_vec)
sent_vectors = np.array(sent_vectors)
sent_vectors = np.nan_to_num(sent_vectors)
sent_vectors.shape
```

```
/usr/lib/python3.7/site-packages/ipykernel_launcher.py:12: RuntimeWarning:
invalid value encountered in true_divide
  if sys.path[0] == '':
```

[278]:
```
(47599, 100)
```

[279]:
```
num_clusters = elbow_method(sent_vectors, range(2,12,2))
```

```
Fit 2 clusters.
Fit 4 clusters.
Fit 6 clusters.
Fit 8 clusters.
Fit 10 clusters.
```




```
The optimal number of clusters obtained is -  6
The loss for optimal cluster is -  519179.40402936266
```

[280]:
```
model_w2v = KMeans(n_clusters = num_clusters)
model_w2v.fit(sent_vectors)
```

[280]:
```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
       n_clusters=6, n_init=10, n_jobs=None, precompute_distances='auto',
       random_state=None, tol=0.0001, verbose=0)
```

[281]:
```
word_cluster_pred=model_w2v.predict(sent_vectors)
word_cluster_pred_2=model_w2v.labels_
word_cluster_center=model_w2v.cluster_centers_
```

[282]:
```
silhouette_score_tf = met.silhouette_score(sent_vectors, word_cluster_pred_2,␣
↪metric='euclidean')
silhouette_score_tf
```

[282]:
```
0.10463852943277908
```

[283]:
```
df_w2v = tfidf_df
df_w2v['AVG-W2V Cluster Label'] = model_w2v.labels_
df_w2v.head()
```

```
/usr/lib/python3.7/site-packages/ipykernel_launcher.py:2:
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: http://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

[283]:

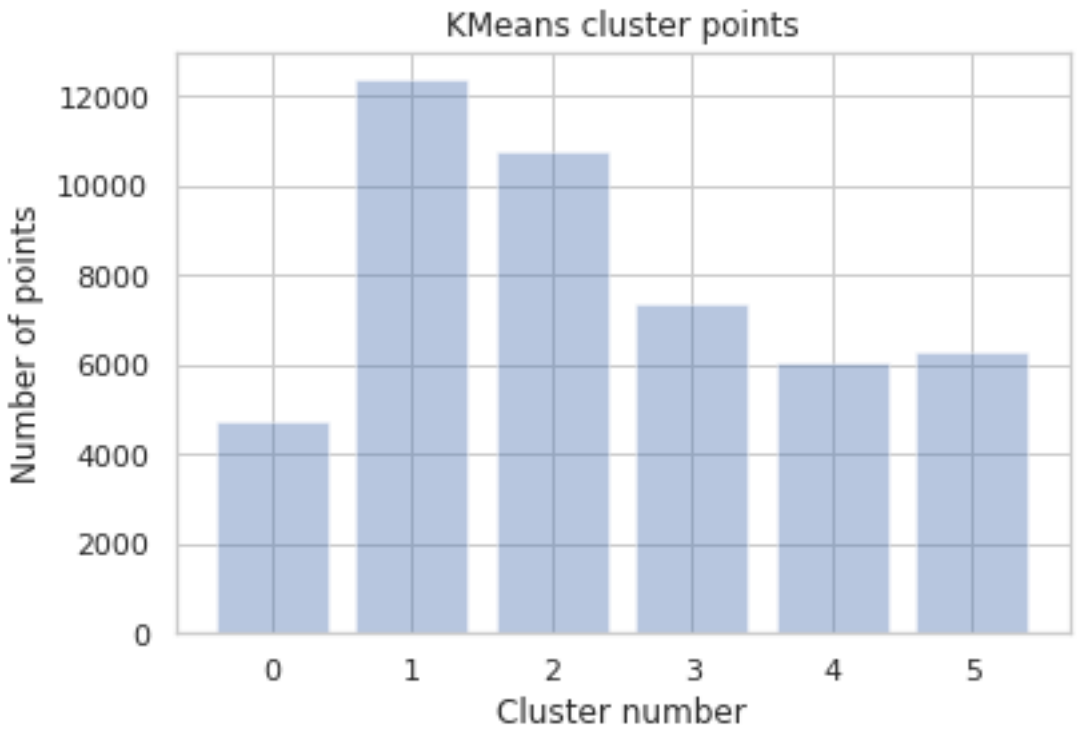
	company	summary	pros	cons	overall-ratings	CleanedText	Bow Cluster Label	AVG-W2V Cluster Label
0	google	Best Company to work for	People are smart and friendly	Bureaucracy is slowing things down	positive	peopl smart friend	4	4
3	google	The best place I've worked and also the most d...	You can't find a more well-regarded company th...	I live in SF so the commute can take between 1...	positive	cant find compani actual deserv hype get youll...	3	3
4	google	Unique, one of a kind dream job	Google is a world of its own. At every other c...	If you don't work in MTV (HQ), you will be giv...	positive	googl world everi compani lot peopl serious ga...	5	5
5	google	NICE working in GOOGLE as an INTERN	People are not that busy, so they are nice to ...	Food is not good as I expected. People said it...	positive	peopl busi nice help make suitabl intern proje...	4	4
6	google	Software engineer	Great working environment. Good work life balance	Usual big company problems. Hierarchy.	positive	great work environ good work life balanc	1	1

```
   Tfidf Cluster Label  AVG-W2V Cluster Label
0                    4                      2
3                    4                      1
4                    4                      1
5                    4                      3
6                    0                      2
```

[284]:
```
# How many points belong to each cluster ->
df_w2v.groupby(['AVG-W2V Cluster Label'])['pros'].count()
```

[284]:
```
AVG-W2V Cluster Label
0     4756
1    12372
2    10791
3     7358
4     6043
5     6279
Name: pros, dtype: int64
```

[285]:
```
plot_cluster_points('AVG-W2V Cluster Label', 'pros', num_clusters)
```

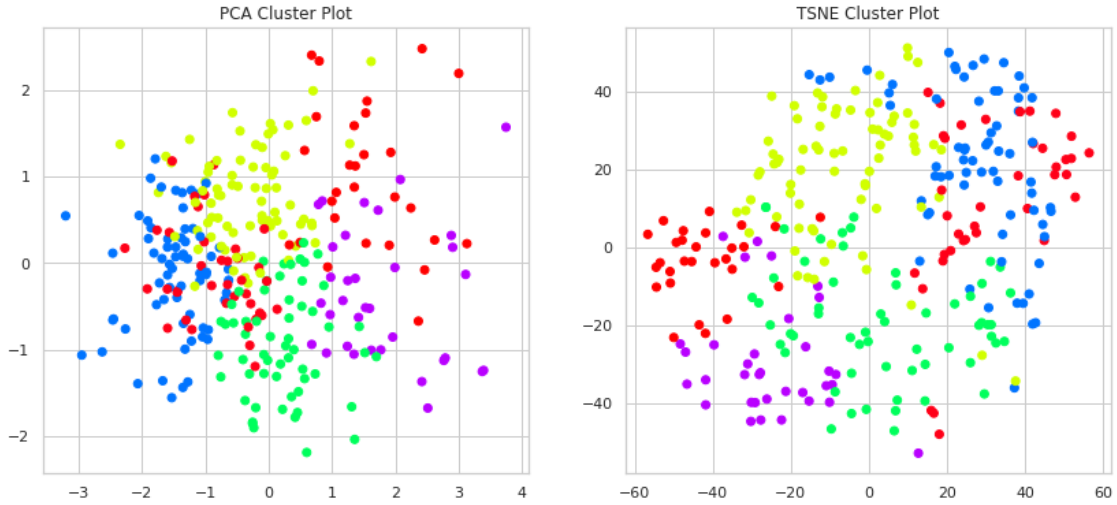


[307]:
```
print_review_asigned_to_cluster('AVG-W2V Cluster Label', 'pros', num_clusters)
```

```
review of assigned to cluster  0
------------------------------------------------------------------------
The food is pretty good


Very friendly work environment. I was certainly treated well by all other
employees.


Lots of Good food, some good perks


Great company with amazing perks
------------------------------------------------------------------------
review of assigned to cluster  1
------------------------------------------------------------------------
People are not that busy, so they are nice to help our. They did make a suitable
intern project that you can finish it in time and learn something.


The people are great to work with


Good opportunities for different technical experiences, good work-life balance,
good compensation, great coworkers


Smart people, great environment
------------------------------------------------------------------------
review of assigned to cluster  2
------------------------------------------------------------------------
People are smart and friendly


Great benefits, growth and people to work with and challenge you.


is very good. is very very good


Great company with creative ideas.
------------------------------------------------------------------------
review of assigned to cluster  3
------------------------------------------------------------------------
work culture, benefits, growth, people,


Great place to work, learn new things, grow and innovate. Able to maintain a
```

```
respectful and healthy workplace culture despite the recent press.


All good, excellent benefits, okay salary


Pay was excellent. Perks were great. Office was awesome. Lunch was usually
delicious.
--------------------------------------------------------------------------
review of assigned to cluster  4
--------------------------------------------------------------------------
The people are awesome. Lots of perks. Reduce administrative burdens. The food
is great. There's a wide variety of tasks.


Pretty good benifits and bank.


salary was fine but in line with other companies


Best culture Great values Friendly people Great perks
--------------------------------------------------------------------------
review of assigned to cluster  5
--------------------------------------------------------------------------
Awesome job environment to work in


Great perks such as gym bikes and food


Overall, an unarguably fantastic place to work.


Smart coworkers good benefits lots of respect
--------------------------------------------------------------------------
```

[287]:
```
#ne znam koliko je ispravno ovo
import scipy
csr_sent_vectors = scipy.sparse.csr_matrix(sent_vectors)
plot_tsne_pca(csr_sent_vectors, word_cluster_pred_2)
```



3.3 Klasterovanje putem DBSCAN

[288]:
```
dbscan_df = df_w2v.head(10000)
dbscan_df.head()
```

[288]:

	company	summary	pros	cons	overall-ratings	CleanedText	Bow Cluster Label
0	google	Best Company to work for	People are smart and friendly	Bureaucracy is slowing things down	positive	peopl smart friend	4
3	google	The best place I've worked and also the most d...	You can't find a more well-regarded company th...	I live in SF so the commute can take between 1...	positive	cant find compani actual deserv hype get youll...	3
4	google	Unique, one of a kind dream job	Google is a world of its own. At every other c...	If you don't work in MTV (HQ), you will be giv...	positive		
5	google	NICE working in GOOGLE as an INTERN	People are not that busy, so they are nice to ...	Food is not good as I expected. People said it...	positive		
6	google	Software engineer	Great working environment. Good work life balance	Usual big company problems. Hierarchy.	positive		

```
4  googl world everi compani lot peopl serious ga...                5
5  peopl busi nice help make suitabl intern proje...                4
6           great work environ good work life balanc                1

   Tfidf Cluster Label  AVG-W2V Cluster Label
0                    4                      2
3                    4                      1
4                    4                      1
5                    4                      3
6                    0                      2
```

[289]:
```
#print(dbscan_df.shape)
i=0
list_of_sent=[]
for sent in dbscan_df['CleanedText'].values:
    list_of_sent.append(sent.split())


#list_of_sent[:10]
```

[290]:
```
i=0
list_of_sent_train=[]
for sent in dbscan_df['CleanedText'].values:
    filtered_sentence=[]
    for w in sent.split():
        for cleaned_words in cleanpunc(w).split():
            if(cleaned_words.isalpha()):
                filtered_sentence.append(cleaned_words.lower())
            else:
                continue
    list_of_sent_train.append(filtered_sentence)
#list_of_sent_train[:10]
```

[291]:
```
w2v_model=gensim.models.Word2Vec(list_of_sent_train,size=100, workers=4)
```

[292]:
```
db_sent_vectors = [];
for sent in list_of_sent_train:
    sent_vec = np.zeros(100)
    cnt_words =0;
    for word in sent:
        try:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
        except:
            pass
    sent_vec /= cnt_words
```

```
    db_sent_vectors.append(sent_vec)
db_sent_vectors = np.array(db_sent_vectors)
db_sent_vectors = np.nan_to_num(db_sent_vectors)
db_sent_vectors.shape
```

```
/usr/lib/python3.7/site-packages/ipykernel_launcher.py:12: RuntimeWarning:
invalid value encountered in true_divide
  if sys.path[0] == '':
```

[292]:
```
(10000, 100)
```

[293]:
```
from sklearn.cluster import DBSCAN


dbscan_model = DBSCAN(eps = 0.8, min_samples = 2, n_jobs=-1, metric='euclidean')
dbscan_model.fit(db_sent_vectors)
```

[293]:
```
DBSCAN(algorithm='auto', eps=0.8, leaf_size=30, metric='euclidean',
       metric_params=None, min_samples=2, n_jobs=-1, p=None)
```

[294]:
```
dbscan_df['AVG-W2V DBSCAN Cluster Label'] = dbscan_model.labels_
dbscan_df.head(2)
```

```
/usr/lib/python3.7/site-packages/ipykernel_launcher.py: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: http://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  """Entry point for launching an IPython kernel.
```

[294]:
```
   company                                            summary  \
0  google                           Best Company to work for
3  google  The best place I've worked and also the most d...

                                              pros  \
0                    People are smart and friendly
3  You can't find a more well-regarded company th...

                                              cons overall-ratings  \
0                Bureaucracy is slowing things down        positive
3  I live in SF so the commute can take between 1...        positive

                                        CleanedText  Bow Cluster Label  \
0                              peopl smart friend                   4
3  cant find compani actual deserv hype get youll...                   3
```

```
   Tfidf Cluster Label  AVG-W2V Cluster Label  AVG-W2V DBSCAN Cluster Label
0                    4                      2                             0
3                    4                      1                             0
```

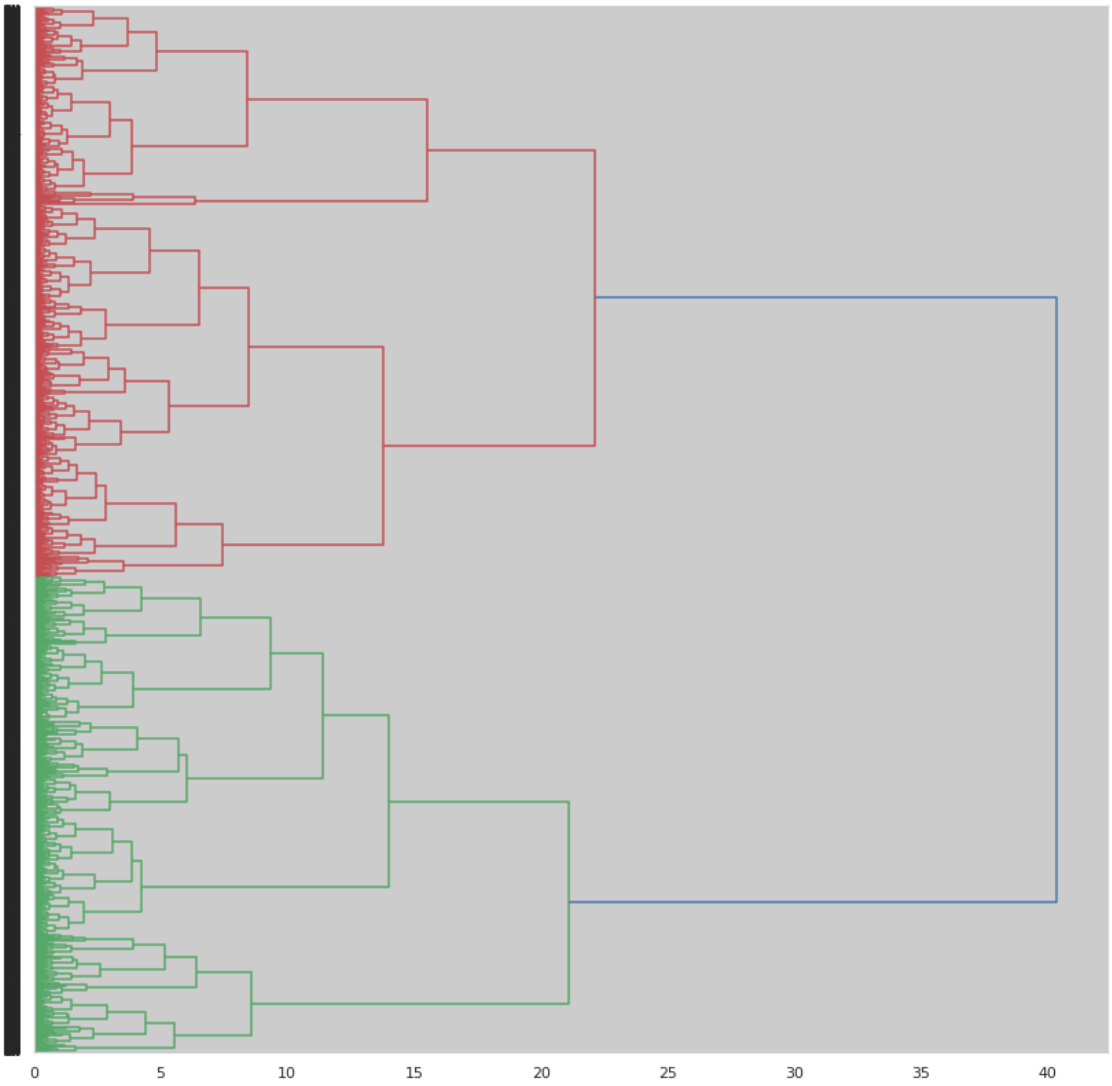
[295]:
```
db_word_cluster_pred_2=dbscan_model.labels_

dbscan_df.groupby(['AVG-W2V DBSCAN Cluster Label'])['pros'].count()
```

[295]:
```
AVG-W2V DBSCAN Cluster Label
0    10000
Name: pros, dtype: int64
```

Već za $eps = 0.8$, DBSCAN algoritam sve tačke grupiše u jedan klaster. Tako da ovde ne možemo izvući nikakve interesnatne teme vezane za naše recenzije.

3.4 Hiearhijsko klasterovanje

[296]:
```
from scipy.cluster import hierarchy
plt.figure(figsize=(14,14))
dendro=hierarchy.dendrogram(hierarchy.linkage(db_sent_vectors,method='ward'),␣
 ↪orientation="right")
plt.show()
```



[297]:
```
from sklearn.cluster import AgglomerativeClustering

cluster = AgglomerativeClustering(n_clusters=2, affinity='euclidean',␣
 ↪linkage='ward')
agg=cluster.fit_predict(db_sent_vectors)
```

[298]:
```
agg_df = dbscan_df
agg_df['AVG-W2V AGG Cluster Label'] = cluster.labels_
agg_df.head()
```

```
/usr/lib/python3.7/site-packages/ipykernel_launcher.py:2:
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: http://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

[298]:

	company	summary	pros	cons	overall-ratings	CleanedText	Bow Cluster Label	Tfidf Cluster Label	AVG-W2V Cluster Label	AVG-W2V DBSCAN Cluster Label	AVG-W2V AGG Cluster Label
0	google	Best Company to work for	People are smart and friendly	Bureaucracy is slowing things down	positive	peopl smart friend	4	4	2	0	0
3	google	The best place I've worked and also the most d...	You can't find a more well-regarded company th...	I live in SF so the commute can take between 1...	positive	cant find compani actual deserv hype get youll...	3	4	1	0	0
4	google	Unique, one of a kind dream job	Google is a world of its own. At every other c...	If you don't work in MTV (HQ), you will be giv...	positive	googl world everi compani lot peopl serious ga...	5	4	1	0	0
5	google	NICE working in GOOGLE as an INTERN	People are not that busy, so they are nice to ...	Food is not good as I expected. People said it...	positive	peopl busi nice help make suitabl intern proje...	4	4	3	0	0
6	google	Software engineer	Great working environment. Good work life balance	Usual big company problems. Hierarchy.	positive	great work environ good work life balanc	1	0	2	0	1

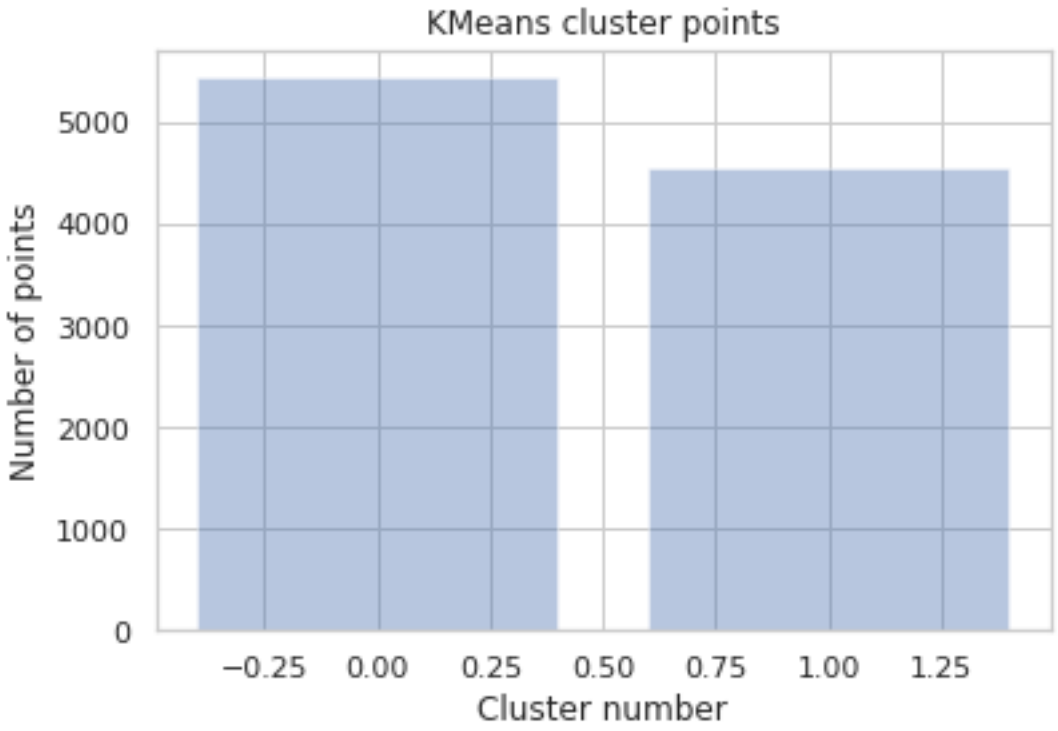
[299]:
```
silhouette_score_agg = met.silhouette_score(db_sent_vectors, cluster.labels_,␣
 ↪metric='euclidean')
silhouette_score_agg
```

[299]:
```
0.2879121768664256
```

[300]:
```
agg_df.groupby(['AVG-W2V AGG Cluster Label'])['pros'].count()
```

[300]:
```
AVG-W2V AGG Cluster Label
0    5444
1    4556
Name: pros, dtype: int64
```

[301]:
```
plt.bar([x for x in range(2)], agg_df.groupby(['AVG-W2V AGG Cluster␣
 ↪Label'])['pros'].count(), alpha = 0.4)
plt.title('KMeans cluster points')
plt.xlabel("Cluster number")
plt.ylabel("Number of points")
plt.show()
```



[308]:
```
for i in range(2):
    print("reviews of assigned to cluster ", i)
    print("-" * 70)
```

```
    print(agg_df.iloc[agg_df.groupby(['AVG-W2V AGG Cluster Label']).
↪groups[i][0]]['pros'])
    print('\n')
    print(agg_df.iloc[agg_df.groupby(['AVG-W2V AGG Cluster Label']).
↪groups[i][5]]['pros'])
    print('\n')
    print(agg_df.iloc[agg_df.groupby(['AVG-W2V AGG Cluster Label']).
↪groups[i][10]]['pros'])
    print('\n')
    print(agg_df.iloc[agg_df.groupby(['AVG-W2V AGG Cluster Label']).
↪groups[i][20]]['pros'])

    print("_" * 70)
```

```
reviews of assigned to cluster  0
----------------------------------------------------------------------
People are smart and friendly


* There is endless opportunity * You'll never stop learning * I haven't thought
about money since I joined.


The people are great to work with, good perks.


Better than average engineers. Competitive compensation.
----------------------------------------------------------------------
reviews of assigned to cluster  1
----------------------------------------------------------------------
Great products. Vision you can feel good about. Fair compensation. Automonomy in
your role. Wide array of industries / roles employees are able to explore.
Feedback loops give employees that ability to provide feedback to management
regularly on their performance. Expectation that you will go above and beyond
the minimum scope of your role - those that do, are typically rewarded. What
more do you want from an employer.


I love Google a lot


Nice perks. Good work life balance


Amazing and talented co workers best place to work at $$$
----------------------------------------------------------------------
```

4 Finalni zaključak

"Lakat" metoda je za K-sredina algoritam pokazala da je optimalan broj klastera 6, dok koeficijent senke za sva tri slučaja korišćenja algoritma ne prelazi *0.1*. U slučaju *tf-idf-a*, najveći broj recenzija je grupisao za jedan klaster(*Cluster 4: 27304*), verovatno zbog toga što su reči postale jako učestale u skupu tekstova(pošto smo radili sa kolonom *'pros'*, verovatno su se reči kao što su 'posao', 'benefit', 'zabava', 'hrana' dosta pojavljivale) U slučaju *bow-a*, zabeležen je najmanji broj recenzija(*Cluster 5: 25*), dok su ostale recenzije raspodeljene jednako. U slučaju *word2vec-a*, se trudi da raspodeli recenzije ravnomerno po klasterima, i za zadate parametre klasterovanja daje najbolji koeficijent senke za K-sredina klasterovanje.

Zbog bržeg izvršavanja, za *DBSCAN* i Hierarhijsko smo uzeli samo 10000 podataka iz čitavog skupa. DBSCAN je jako loše odradio svoj posao na skupu od 10000 podataka, grupisajući sve recenzije u jedan klaster(verovatno bi mogla bolja raspodela da se postigne smanjivanjem eps, jer je za 0.2 delio recenzije na dva klastera(doduše Klaster 1 je imao 12 recenzija samo.)). Za hierarhijsko klasterovanje smo koristili *avg word2vec* metodu, zato što raspodeljuje klastere jednako, i imala je najveću ocenu senke(približno 0.3).

5 Literatura

Literatura i kodovi koji su mi pomogli za projekat se mogu naći na ovim linkovima: - eda i preprocesiranje skupa podataka - klasterovanje - countvectorizer - tfidf - word2vec - word2vec - slajdovi i kodovi sa predavanja i vežbi

[ ]: