Analiza društvene mreže Reddit

Univerzitet u Beogradu, Elektrotehnički fakultet, veb adresa ovde.
Predmet: Analiza socijalnih mreža, veb adresa ovde.
Tekst projektnog zadatka se može naći na veb sajtu predmeta ovde.

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Instalacija i učitavanje korišćenih biblioteka

Neophodne bilioteke se mogu instalirati korišćenjem Python package instalera `pip` .

In [1]:

```
import os
import matplotlib.pyplot as plt
import networkx as nx
import numpy as np
import pandas as pd
```

Format skupa podataka

Podaci su preuzeti sa sajta predmeta i otpakovani u odgovarajuće direktorijume. Kako postoji više datoteka sa istim tipom podataka, učitavamo ih sve zajedno i spajamo u jedinstvenu strukturu podataka.

In [2]:

```
reddit_data_path = "ASM_PZ2_podaci_2122/reddit2008"
submission_dataPath = f"{reddit_data_path}/submissions_2008_asm/"
comments_dataPath = f"{reddit_data_path}/comments_2008_asm_v1.1/comments_2008/"


def loadDataSet(folderPath):
    allFileData = pd.DataFrame([])
    for fileName in os.listdir(folderPath):
        singleFileData = pd.read_csv(folderPath + fileName, low_memory=False)
        allFileData = pd.concat([allFileData, singleFileData])

    return allFileData


def groupby_count(data_frame, groupby_list):
    return data_frame.groupby(groupby_list).size().reset_index(name="counts")


def groupby_count_sorted(data_frame, groupby_list):
    return groupby_count(data_frame, groupby_list).sort_values('counts', ascending=
```

Filtriranje skupa podataka

Na društvenoj mreži Reddit je moguće obrisati nalog - u tom slučaju se mogu dobiti podaci koji sadrže `[deleted]` kao korisničko ime. Ovakvi podaci nepovoljno utiču na analizu jer su ti nalozi mogli pripadati proizvoljnom broju korisnika i stoga ih filtriramo i ne koristimo u daljoj analizi.

In [3]:

```
submissionData = loadDataSet(submission_dataPath)
commentsData = loadDataSet(comments_dataPath)

# It is possible to have "[deleted]" as author name
submissionFilter = submissionData["author"] != "[deleted]"
commentsFilter = commentsData["author"] != "[deleted]"

filteredSubmissions = submissionData[submissionFilter]
filteredComments = commentsData[commentsFilter]

allData = pd.concat([filteredSubmissions, filteredComments])
```

Statistička obrada podataka

In [4]:

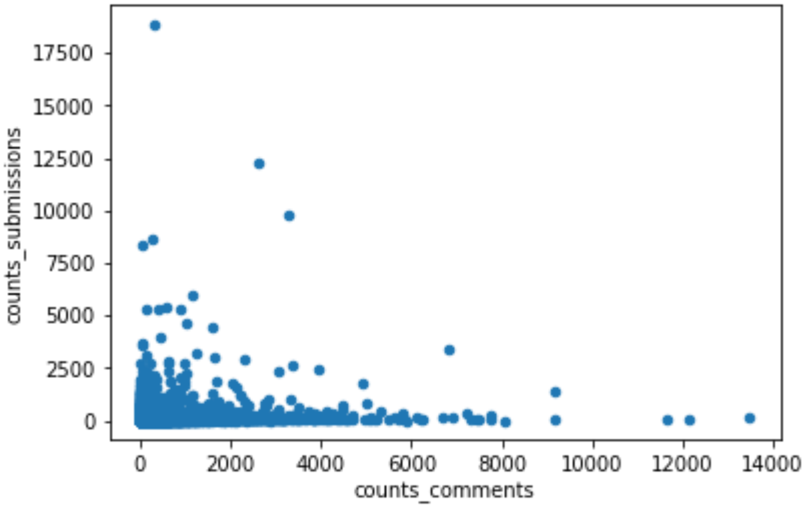
```
allSubredditIds = np.union1d(submissionData['subreddit_id'], commentsData['subreddi
print(f"Number of different subreddits: {len(allSubredditIds)}")

commentsPerSubreddit = groupby_count_sorted(commentsData, ["subreddit_id"])
print(f"Comments per subreddit:\n{commentsPerSubreddit[:1]}")

# subreddit - author - count interactions
interactionsPerAuthorPerSubreddit = groupby_count(allData, ["subreddit_id", "author
# subreddit - count authors
authorsPerSubreddit = groupby_count_sorted(interactionsPerAuthorPerSubreddit, ["sub
print(f"Authors per subreddit:\n{authorsPerSubreddit[:1]}")

print(f"AVG number users per subreddit:\n{authorsPerSubreddit['counts'].sum() / len

submissionsPerAuthor = groupby_count_sorted(filteredSubmissions, ['author'])
commentsPerAuthor = groupby_count_sorted(filteredComments, ['author'])
print(f"Max submissions per author:\n{submissionsPerAuthor[:1]}")
print(f"Max comments per author:\n{commentsPerAuthor[:1]}")

# author - subreddit - count interactions
interactionsPerSubredditPerAuthor = groupby_count(allData, ['author', 'subreddit_id
# author - count subreddits
subredditsPerAuthor = groupby_count_sorted(interactionsPerSubredditPerAuthor, ['aut
print(f"Subreddits per author:\n{subredditsPerAuthor[:1]}")
```

```
Number of different subreddits: 5032
Comments per subreddit:
     subreddit_id   counts
2689         t5_6  1884629
Authors per subreddit:
     subreddit_id  counts
4354         t5_6  163779
AVG number users per subreddit:
128.78398251192368
Max submissions per author:
      author  counts
84823    gst   18870
Max comments per author:
                author  counts
12603  NoMoreNicksLeft   13480
Subreddits per author:
         author  counts
26173  MrKlaatu     181
```

In [5]:

```
paersonCalculation = submissionsPerAuthor.copy().merge(commentsPerAuthor.copy(), on
paersonCalculation.plot.scatter(y="counts_submissions", x="counts_comments")
print(f"Pearson correlation matrix:\n{paersonCalculation.corr(method='pearson')}")
```

```
Pearson correlation matrix:
                    counts_submissions  counts_comments
counts_submissions            1.000000         0.150412
counts_comments               0.150412         1.000000
```



In [6]:

```
filterNonOver18 = submissionData["over_18"] == False
filteredSubmissionsNonOver18 = submissionData[filterNonOver18]
extractedCommentsData = pd.DataFrame(commentsData["link_id"].map(lambda element: el
commentsDataSubmissionId = groupby_count_sorted(extractedCommentsData, ["link_id"])
filteredSubmissionsNonOver18JoinedComments = filteredSubmissionsNonOver18.merge(com
topSubmissionsNonOver18JoinedComments = filteredSubmissionsNonOver18JoinedComments.
print(topSubmissionsNonOver18JoinedComments)
topSubmissionsNonOver18JoinedComments.to_csv("top_submission_non_over_18.csv")
```

```
        Unnamed: 0     id                                                url  \
290534      191390  7kpe5  https://www.reddit.com/r/AskReddit/comments/7k...   
574617      111467  6nz1k                             http://hundredpushups.com   
57505       135995  675oj  https://www.reddit.com/r/reddit.com/comments/6...   
942221      191265  78n1v  http://www.time.com/time/nation/article/0,8599...   
133696       36220  7beo2  https://www.reddit.com/r/politics/comments/7be...   
488720       73206  6jbc0  https://www.reddit.com/r/reddit.com/comments/6...   
764729      197408  6yn6t                      http://www.cnbc.com/id/26454655?   
721214       84267  6w7e6  https://www.reddit.com/r/reddit.com/comments/6...   
136018       41921  7bj3f  http://www.latimes.com/news/local/la-me-gaymar...   
772368        4466  6z2e2  http://www.nytimes.com/reuters/us/internationa...   

                                                permalink        author  \
290534  /r/AskReddit/comments/7kpe5/i_am_constantly_wo...     [deleted]   
574617  /r/science/comments/6nz1k/got_six_weeks_try_th...         zekel   
57505   /r/reddit.com/comments/675oj/post_the_funniest...   matiasklein   
942221  /r/WTF/comments/78n1v/a_black_community_in_oh_...      indorock   
133696  /r/politics/comments/7beo2/obama_wins_the_pres...  willjohnston   
488720  /r/reddit.com/comments/6jbc0/voice_a_true_yet_...     [deleted]   
764729  /r/politics/comments/6yn6t/its_official_sarah_...     [deleted]   
721214  /r/reddit.com/comments/6w7e6/just_out_of_curio...     [deleted]   
136018  /r/reddit.com/comments/7bj3f/who_else_disguste...     [deleted]   
772368  /r/reddit.com/comments/6z2e2/palin_says_her_da...   nucleophile   

        created_utc   subreddit subreddit_id  num_comments  score  over_18  \
290534   1229752197   AskReddit     t5_2qh1i          3467    515    False   
574617   1213826517     science      t5_mouw         33329   1621    False   
57505    1201730171  reddit.com         t5_6          2039   1098    False   
942221   1224677051         WTF     t5_2qh61          3657   1496    False   
133696   1225857637    politics     t5_2cneq          1934   8538    False   
488720   1210747619  reddit.com         t5_6          1808    274    False   
764729   1220020890    politics     t5_2cneq          1668   1073    False   
721214   1218660724  reddit.com         t5_6          1724    258    False   
136018   1225899136  reddit.com         t5_6          1605   5992    False   
772368   1220285161  reddit.com         t5_6          1425   1517    False   

       distinguished             domain  stickied  locked  hide_score  counts  
290534           NaN     self.AskReddit     False   False       False    3062  
574617           NaN  hundredpushups.com     False   False       False    2897  
57505            NaN    self.reddit.com     False   False       False    2076  
942221           NaN           time.com     False   False       False    2042  
133696           NaN      self.politics     False   False       False    2002  
488720           NaN    self.reddit.com     False   False       False    1939  
764729           NaN           cnbc.com     False   False       False    1837  
721214           NaN    self.reddit.com     False   False       False    1826  
136018           NaN        latimes.com     False   False       False    1731  
772368           NaN        nytimes.com     False   False       False    1558  
```

Modelovanje podataka grafovima

Skup podataka modelujemo pomoću 4 različita grafa:

1. SNet (Subreddit network) - sadrži kompletne podatke, sve sabredite i interakcje sa njima
2. SNetF (Subreddit network filtered) - filtrirani SNet na osnovu broja korisnika koji definišu interakciju izmedju više sabredita
3. SNetT (Subreddit network targeted) - filtrirani SNet na osnovu odabranih sabredita i grana kojima su povezani
4. UserNet - sadrži interakcije između korisnika - komentare na objave ili na komentare

Iz SNet eliminišemo sve čvorove koji nemaju nijednu granu kako bismo omogućili dalju analizu povezanosti čvorova grafa.

In [7]:

```
snet = nx.Graph()
snet.add_nodes_from(allSubredditIds)

authorSubredditIdGroups = allData.groupby(["author", "subreddit_id"]).groups
groups = dict()
for author, subredditId in authorSubredditIdGroups:
    if author not in groups:
        groups[author] = [subredditId]
    else:
        groups[author].append(subredditId)

for key in groups:
    subreddit_ids = groups[key]
    for i in range(0, len(subreddit_ids)):
        for j in range(i + 1, len(subreddit_ids)):
            if snet.has_edge(subreddit_ids[i], subreddit_ids[j]):
                snet.edges[subreddit_ids[i], subreddit_ids[j]]['weight'] += 1
            else:
                snet.add_edge(subreddit_ids[i], subreddit_ids[j], weight=1)

snet.remove_nodes_from(list(nx.isolates(snet)))
```

Odabir praga za filtriranje grana po težini

Prag za filtriranje je uzet kao prosečna vrednost svih težina grana u grafu SNet.

In [8]:

```
average_weight = sum([tags["weight"] for u, v, tags in snet.edges(data=True)]) / le
w_threshold = average_weight

# TODO: check if commented out works
# snetf = snet.edge_subgraph([(u, v) for u, v, tags in snet.edges(data=True) if tag

snetf = nx.Graph()
snetf.add_nodes_from(allSubredditIds)
snetf.add_edges_from([(u, v, tags) for u, v, tags in snet.edges(data=True) if tags[

snetf.remove_nodes_from(list(nx.isolates(snetf)))
```

Odabir sabredita od interesa

Sabrediti od interesa za analizu pomoću SNetT su uzeti iz teksta projektog zadatka.

In [9]:

```
targetSubreddits = {
    "reddit.com",
    "pics",
    "worldnews",
    "programming",
    "business",
    "politics",
    "obama",
    "science",
    "technology",
    "WTF",
    "AskReddit",
    "netsec",
    "philosophy",
    "videos",
    "offbeat",
    "funny",
    "entertainment",
    "linux",
    "geek",
    "gaming",
    "comics",
    "gadgets",
    "nsfw",
    "news",
    "environment",
    "atheism",
    "canada",
    "math",
    "Economics",
    "scifi",
    "bestof",
    "cogsci",
    "joel",
    "Health",
    "guns",
    "photography",
    "software",
    "history",
    "ideas",
}

targetSubredditIds = [allData[allData["subreddit"] == targetSubreddit]["subreddit_i
snett = snet.subgraph(targetSubredditIds)
```

UserNet

Modelujemo interakcije korisnika društvene mreže usmerenim grafom.

In [10]:

```
authorComments = pd.concat([filteredComments["author"], filteredComments["link_id"]
authorToAuthorInteractions = groupby_count(authorComments.merge(allData[["author",
edge_list = authorToAuthorInteractions.rename(columns={"author_from": "source", "au
usernet = nx.from_pandas_edgelist(edge_list, edge_attr=True, create_using=nx.DiGrap
```

Dobijene grafove čuvamo u standardnom `gml` formatu na disku kako bismo im mogli pristupati i iz eksternih alata.

In [101…

```
# nx.write_gml(snet, "snet.gml")
# nx.write_gml(snetf, "snetf.gml")
# nx.write_gml(snett, "snett.gml")
# nx.write_gml(usernet, "usernet.gml")
```

Generisanje Erdos-Renyi mreža

Erdos-Renyi mreže koristimo za poređenje sa mrežama reddit podataka.

Verovatnoća za stvaranje grana u grafu je odabrana kao gustina grafova koje ispitujemo.

In [102…

```
# erdos_renyi_snet = nx.erdos_renyi_graph(n=snet.number_of_nodes(), p=nx.density(sn
# erdos_renyi_snetf = nx.erdos_renyi_graph(n=snetf.number_of_nodes(), p=nx.density(
# erdos_renyi_usernet = nx.erdos_renyi_graph(n=usernet.number_of_nodes(), p=nx.dens
```

In [103…

```
# nx.write_gml(erdos_renyi_snet, "erdos_renyi_snet.gml")
# nx.write_gml(erdos_renyi_snetf, "erdos_renyi_snetf.gml")
# nx.write_gml(erdos_renyi_usernet, "erdos_renyi_usernet.gml")
```

Analiza modelovanih grafova

Klub bogatih

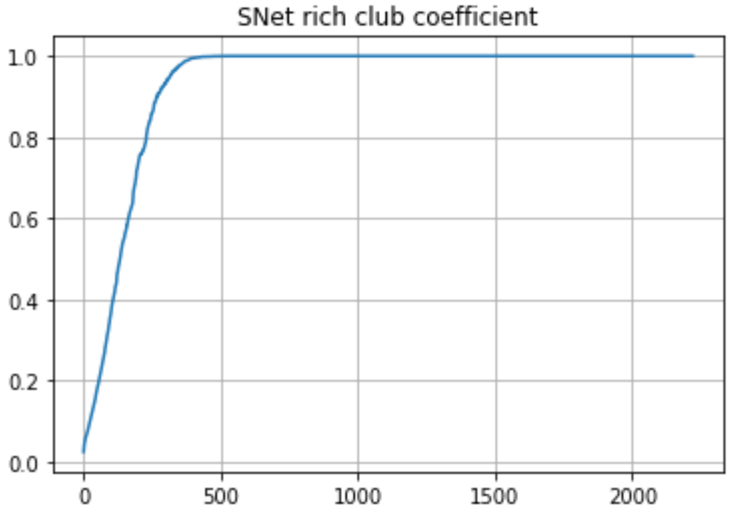
Kako bi izvrsavanje funkcija trajalo kratko, koristi se nenormalizovana varijanta. Kao sto se moze videti sa grafika dole, grafovi ispoljavaju klub bogatih (cvorovi su u klubu bogatih za vrednosti 1).

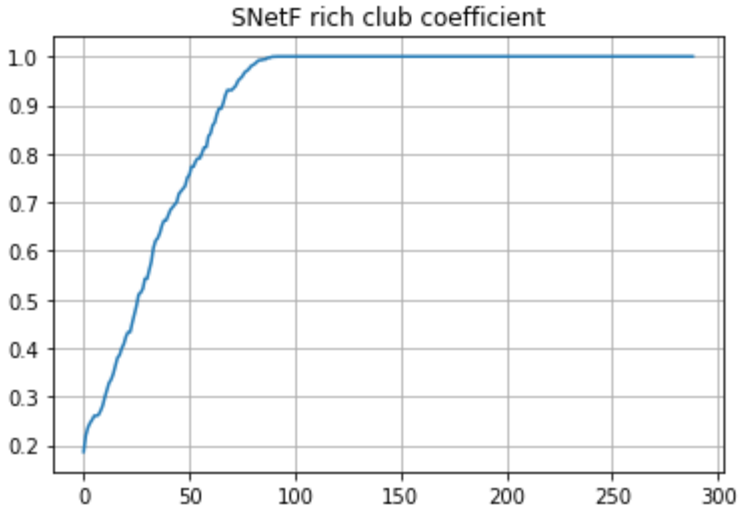
In [11]:

```
snet_rich_club_coefficient = nx.rich_club_coefficient(snet, normalized=False)
snetf_rich_club_coefficient = nx.rich_club_coefficient(snetf, normalized=False)

pd.DataFrame.from_dict(snet_rich_club_coefficient, orient="index").plot(title="SNet
pd.DataFrame.from_dict(snetf_rich_club_coefficient, orient="index").plot(title="SNe
```

Out[11]:

```
<AxesSubplot:title={'center':'SNetF rich club coefficient'}>
```





Asortativna analiza

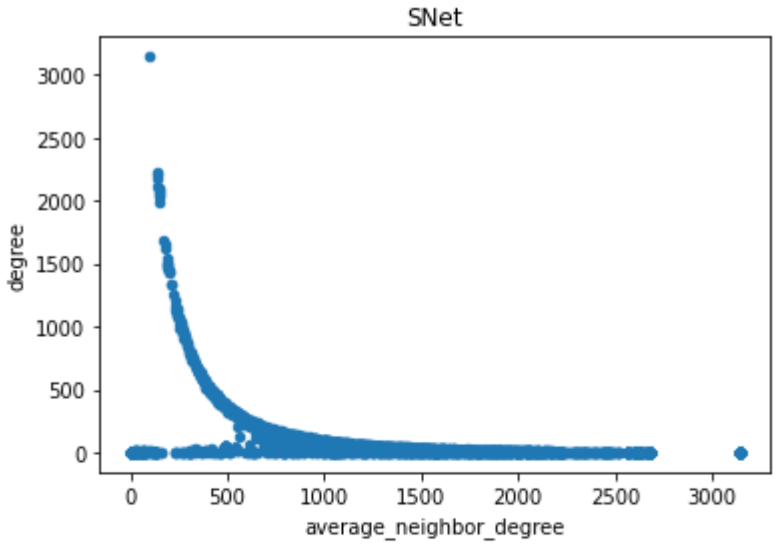
Kako su vrednosti koeficijenata asortativnosti manje od 0, ove mreže su disortitativna - čvorovi ne teže da se povežu sa sličnim čvorovima.

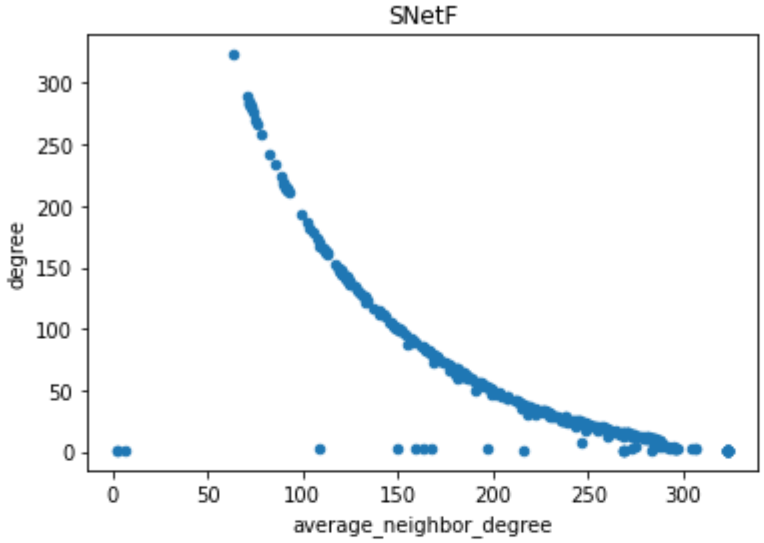
In [34]:

```
print(f"Degree assortativity (SNet) {nx.degree_assortativity_coefficient(snet)}")
print(f"Degree assortativity (SNetF) {nx.degree_assortativity_coefficient(snetf)}")

snet_node_degrees = {key: value for key, value in snet.degree}
snet_average_neighbor_degree = nx.average_neighbor_degree(snet)

snet_degree_average_neighbor_degree = pd.DataFrame.from_records([snet_node_degrees,
snet_degree_average_neighbor_degree.plot.scatter(x="average_neighbor_degree", y="de

snetf_node_degrees = {key: value for key, value in snetf.degree}
snetf_average_neighbor_degree = nx.average_neighbor_degree(snetf)

snetf_degree_average_neighbor_degree = pd.DataFrame.from_records([snetf_node_degree
snetf_degree_average_neighbor_degree.plot.scatter(x="average_neighbor_degree", y="d
```

```
Degree assortativity (SNet) -0.436456805812687
Degree assortativity (SNetF) -0.6177660601425986
```

```
Out[34]: <AxesSubplot:title={'center':'SNetF'}, xlabel='average_neighbor_degree', ylabel='de
gree'>
```



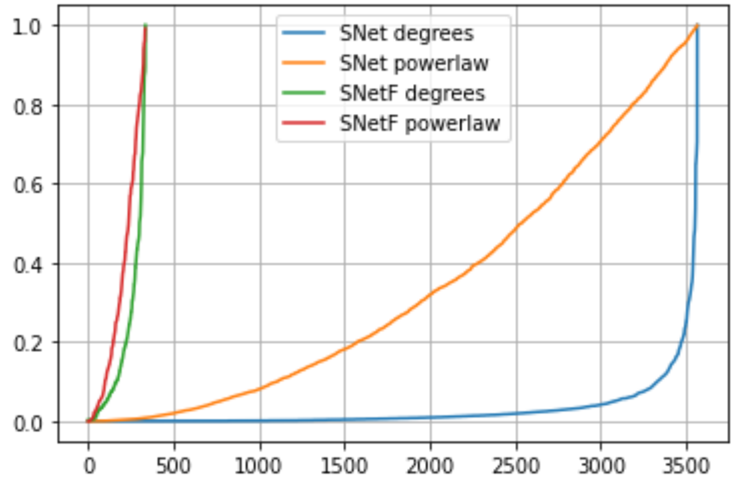


Stepen čvora i power law

Mreže ne prate power law raspodelu.

In [12]:

```
snet_sorted_degrees = np.array(sorted([degree for node_id, degree in snet.degree]))
snet_sorted_degrees_normalized = snet_sorted_degrees / snet_sorted_degrees[-1]
snet_x_axis = np.linspace(0, len(snet_sorted_degrees), len(snet_sorted_degrees))
snet_sorted_power_law = sorted(np.random.power(0.5, len(snet_sorted_degrees)))
plt.plot(snet_x_axis, snet_sorted_degrees_normalized, label="SNet degrees")
plt.plot(snet_x_axis, snet_sorted_power_law, label="SNet powerlaw")

snetf_sorted_degrees = np.array(sorted([degree for node_id, degree in snetf.degree]
snetf_sorted_degrees_normalized = snetf_sorted_degrees / snetf_sorted_degrees[-1]
snetf_x_axis = np.linspace(0, len(snetf_sorted_degrees), len(snetf_sorted_degrees))
snetf_sorted_power_law = sorted(np.random.power(0.5, len(snetf_sorted_degrees)))
plt.plot(snetf_x_axis, snetf_sorted_degrees_normalized, label="SNetF degrees")
plt.plot(snetf_x_axis, snetf_sorted_power_law, label="SNetF powerlaw")

plt.legend()
plt.grid()
```



Katz centrality

Isti čvorovi su centralni i po ovoj metrici, nezavisno od menjanja parametra beta.

```
t5_6 = reddit.com
t5_2qh16 = technology
t5_2cneq = politics
```

In [13]:

```
def calculate_katz_centrality(G, beta_scalar):
    beta_dict = dict()
    for node_id in G.nodes:
        beta_dict[node_id] = 1.0 if node_id != "t5_6" else beta_scalar

    return nx.katz_centrality(G, alpha=0.0005, beta=beta_dict, max_iter=1000)

count_of_most_important = 3

print("SNet Katz central nodes:")
snet_katz_dict_1 = calculate_katz_centrality(snet, 1.0)
print(sorted(snet_katz_dict_1, key=lambda node_id: -snet_katz_dict_1[node_id])[:cou
snet_katz_dict_5 = calculate_katz_centrality(snet, 50.0)
print(sorted(snet_katz_dict_5, key=lambda node_id: -snet_katz_dict_5[node_id])[:cou
snet_katz_dict_10 = calculate_katz_centrality(snet, 100.0)
print(sorted(snet_katz_dict_10, key=lambda node_id: -snet_katz_dict_10[node_id])[:c

print("SNetF Katz central nodes:")
snetf_katz_dict_1 = calculate_katz_centrality(snetf, 1.0)
print(sorted(snetf_katz_dict_1, key=lambda node_id: -snetf_katz_dict_1[node_id])[:c
snetf_katz_dict_5 = calculate_katz_centrality(snetf, 50.0)
print(sorted(snetf_katz_dict_5, key=lambda node_id: -snetf_katz_dict_5[node_id])[:c
snetf_katz_dict_10 = calculate_katz_centrality(snetf, 100.0)
print(sorted(snetf_katz_dict_10, key=lambda node_id: -snetf_katz_dict_10[node_id])[
```

```
SNet Katz central nodes:
['t5_6', 't5_2qh16', 't5_2cneq']
['t5_6', 't5_2qh16', 't5_2cneq']
['t5_6', 't5_2qh16', 't5_2cneq']
SNetF Katz central nodes:
['t5_6', 't5_2cneq', 't5_2qh16']
['t5_6', 't5_2cneq', 't5_2qh16']
['t5_6', 't5_2cneq', 't5_2qh16']
```