Complex Networks
Homework 3

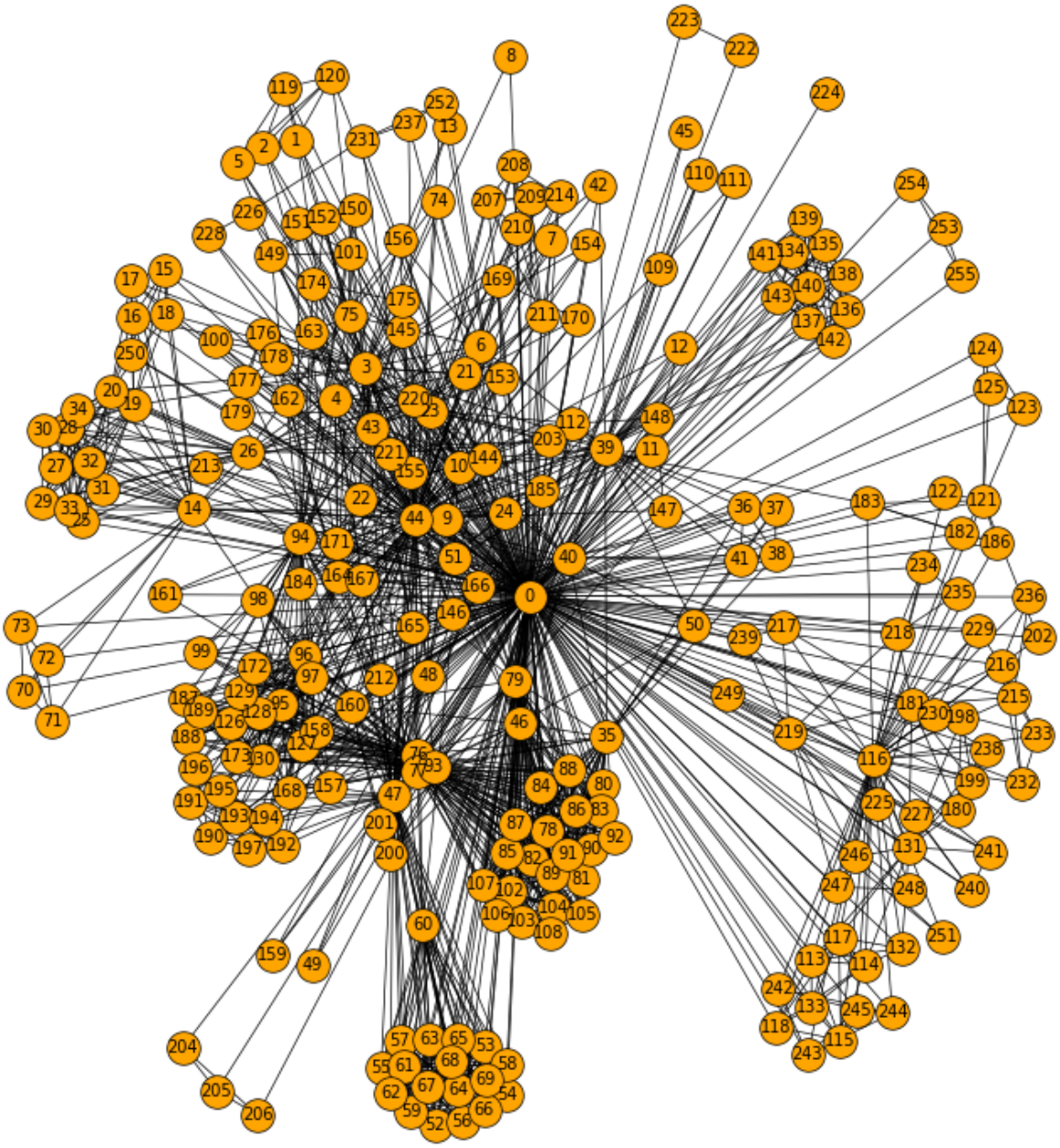
Koutsoukis Nikolaos

May 4, 2022

Contents

1 Graph

1.1 Authors and Co-authors Graph



1.2 Node index and author's name

0	Thanasis Korakis
1	Valentina Nejkovic
2	Filip Jelenkovic
3	Nikos Makris
4	Virgilios Passas
5	Milorad Tosic
6	Christos Zarafetas
7	Alexandros Valantasis
8	Theodoros Tsourdinis
9	Panagiotis Tzimotoudis
10	Giannis Kazdaridis
11	Nikos Sidiropoulos
12	Ioannis Zografopoulos
13	Christos Nanis
14	Panagiotis Skrimponis
15	Sheila Borges Rajguru
16	Karen Cheng
17	Jonatan Ostrometzky
18	Emily Ford
19	Zoran Kostic
20	Gil Zussman
21	Vasileios Miliotis
22	Kostas Chounos
23	Apostolos Apostolaras
24	Polychronis Symeonidis
25	Dipankar Raychaudhuri
26	Ivan Seskar
27	Dan Kilper
28	Tingjun Chen
29	Jakub Kolodziejski
30	Michael Sherman
31	Xiaoxiong Gu
32	Harish Krishnaswamy
33	Sumit Maheshwari
34	Craig Gutterman
35	Daniel Camps-Mur
36	Ferran Cañellas
37	Azahar Machwe
38	Jorge Paracuellos
39	Kostas Choumas
40	Dimitris Giatsios
41	Hadi Razzaghi Kouchaksarae
42	Panagiotis Karamichailidis
43	Donatos Stavropoulos
44	Leandros Tassiulas
45	Marios Karatisoglou
46	Paris Flegkas
47	Stratos Keranidis
48	Ilias Syrigos
49	Nikos Sakellariou
50	Joan Josep Aleixendri Cruel
51	Ioannis Zographopoulos
52	Luis Sánchez
53	Jorge Lanza
54	Juan Ramón Santana
55	Rachit Agarwal 0002
56	Pierre-Guillaume Raverdy
57	Tarek Elsaleh
58	Yasmin Fathy
59	SeungMyeong Jeong
60	Aris Dadoukis
61	Philip O'Brien
62	Jerry Horgan
63	Antonio Sacchetti
64	Giuseppe Mastandrea
65	Alexandros G. Fragkiadaki
66	Pavlos Charalampidis
67	Nicolas Seydoux
68	Christelle Ecrepont
69	Mengxuan Zhao
70	Emmanouil Pissadakis
71	Nikolaos Alachiotis
72	Dimitris Theodoropoulos
73	Dionisios N. Pnevmatikato
74	Pavlos Basaras
75	Navid Nikaein
76	Anna Tzanakaki
77	Markos P. Anastasopoulos
78	Ignacio Berberana
79	Dimitris Syrivelis
80	Ilker Demirkol
81	Jesús Gutiérrez Terán
82	Eckhard Grass
83	Qing Wei 0001
84	Emmanouil Pateromichela
85	Nikola Vucic
86	Albrecht J. Fehske
87	Michael Grieger
88	Michael Eiselt
89	Jens Bartelt
90	Gerhard P. Fettweis
91	George L. Lyberopoulos
92	Eleni Theodoropoulou
93	Dimitra Simeonidou
94	Kostas Katsalis
95	Bijan Rahimzadeh Rofoee
96	Giada Landi
97	Jordi Ferrer Riera
98	Kostas Kousias
99	L. Kiraly
100	Agorastos Dimitrios Sama
101	Romain Favraud
102	Nebojsa Maletic
103	Eduard Garcia Villegas
104	Vaia Kalokidou
105	Peter Legg
106	Dusan Markovic
107	Jay Kant Chaudhary
108	Jim Zou
109	Georgios S. Paschos
110	Chih-Ping Li
111	Eytan H. Modiano
112	George Iosifidis
113	C. Nicolas Barati
114	S. Amir Hosseini
115	Marco Mezzavilla
116	Shivendra S. Panwar
117	Sundeep Rangan
118	Michele Zorzi
119	Nenad Milosevic 0001
120	Zorica B. Nikolic
121	Fraida Fund
122	Regina Lin
123	Vicraj Thomas
124	Niky Riga
125	Sarah Edwards
126	Shuping Peng
127	Yan Yan 0019
128	Giacomo Bernini
129	Nicola Ciulli
130	Eduard Escalona
131	Pei Liu 0001
132	Theodore S. Rappaport
133	Parisa Amiri-Eliasi
134	Hyunwoo Lee 0001
135	Donghyun Kim
136	Junho Suh
137	Ted Taekyoung Kwon
138	Pedro Martinez-Julia
139	Antonio F. Skarmeta
140	Taewan You
141	Loic Baron
142	Serge Fdida
143	JongWon Kim
144	Harris Niavis
145	Ioannis Igoumenos
146	Max Ott
147	Dimosthenis Delimpasis
148	Konstantinos Chounos
149	Eryk Schiller
150	Islam Alyafawi
151	Zhongliang Zhao
152	Torsten Braun
153	Vasilis Maglogiannis
154	Dries Naudts
155	Ingrid Moerman
156	Spyros Kechagias
157	Yi Shu
158	Georgios Zervas
159	Constantine Dovrolis
160	Vasilis Sourlas
161	Thanasis Papapioannou
162	Raymond Knopp
163	Antonio Maria Cipriano
164	Iordanis Koutsopoulos
165	Thierry Rakotoarivelo
166	Thierry Parmentelat
167	Giannis Igoumenos
168	Joan Antoni García Espín
169	Spyros Lalis
170	Stavros Ioannidis 0002
171	Wei Liu 0019
172	Y. Yan
173	Joan A. Garcia-Espin
174	Katerina Pechlivanidou
175	Dimitrios Katsaros 0001
176	Mahmoud Hadef
177	Jim O'Reilly
178	Alain Mourad
179	Belkacem Mouhouche
180	Chun Nie
181	Elza Erkip
182	Cong Wang 0014
183	Michael Zink
184	Lieven Hollevoet
185	Antonios Argyriou
186	Yong Liu 0013
187	Dora Christofi
188	Michael Georgiades
189	Renaud Larsen
190	Konstantinos Choumas
191	Felix Juraschek
192	Mesut Günes
193	Emmanuel Baccelli
194	Pawel Misiorek
195	Andrzej Szwabe
196	Theodoros Salonidis
197	Henrik Lundgren
198	Francesco Verde
199	Anna Scaglione
200	George Parisis
201	Dirk Trossen
202	Chen Dong
203	Maximilian Ott
204	Hongbin Li
205	Phuoc Tran-Gia
206	Hong-Shik Park
207	Giovanni Di Stasi
208	Roberto Bifulco
209	Stefano Avallone
210	Roberto Canonico
211	Nikolaos Giallelis
212	Adamantios Fiamegkos
213	Georgios Kyriakou
214	Francesco Paolo D'Elia
215	Özgü Alay
216	Yao Wang 0001
217	Feilu Liu
218	Jian Lin
219	Zhifeng Tao
220	Angelos-Christos G. Anad
221	Luis Rodriguez
222	Giovanni Pau 0001
223	Ryuji Wakikawa
224	Sung-Ju Lee
225	Michael E. Knox
226	George Athanasiou
227	Shashi Raj Singh
228	Özgür Erçetin
229	Ozgu Alay
230	Yao Wang
231	Ioannis Broustis
232	Caleb Li
233	Anurag Rai
234	Xiao Wang
235	Shunyuan Ye
236	Zhe Xu
237	Gentian Jakllari
238	Yuanpeng Liu
239	Jinyun Zhang
240	Ankit Sharma
241	Vikas Gelara
242	Kaustubh Sinkar
243	Amit Jagirdar
244	Hang Liu
245	Saurabh Mathur
246	Sathya Narayanan
247	Salik Makda
248	Boris Gitelman
249	Yevgeniy B. Slutskiy
250	Andreas Pitsillides
251	Abhijit Bagri
252	Srikanth V. Krishnar
253	Nikos I. Passas
254	Evangelos Zervas
255	Lazaros F. Merakos

2 Exercise 1

Calculating all (overlapping and non-overlapping) communities with the algorithm Clique Percolation Method (**CPM**). Using the CFinder software I got the following results:

- **k = 3**: 4 communities
- **k = 4**: 10 communities
- **k = 5**: 16 communities
- **k = 6**: 26 communities
- **k = 7**: 20 communities
- **k = 8**: 16 communities
- **k = 9**: 13 communities
- **k = 10**: 6 communities
- **k = 11**: 6 communities
- **k = 12**: 6 communities
- **k = 13**: 5 communities
- **k = 14**: 6 communities
- **k = 15**: 3 communities
- **k = 16**: 3 communities
- **k = 17**: 3 communities
- **k = 18**: 3 communities
- **k = 19**: 3 communities
- **k = 20**: 3 communities
- **k = 21**: 1 community

(For more information you can see the 1_exercise/output_cfinder folder)

3 Exercise 2

The tree of the communities was calculated based on the algorithm Girvan-Newman in two ways:

- With the recalculating the edge betweenness centrality in every node of the tree
- Without recalculating the edge betweenness centrality in every node of the tree

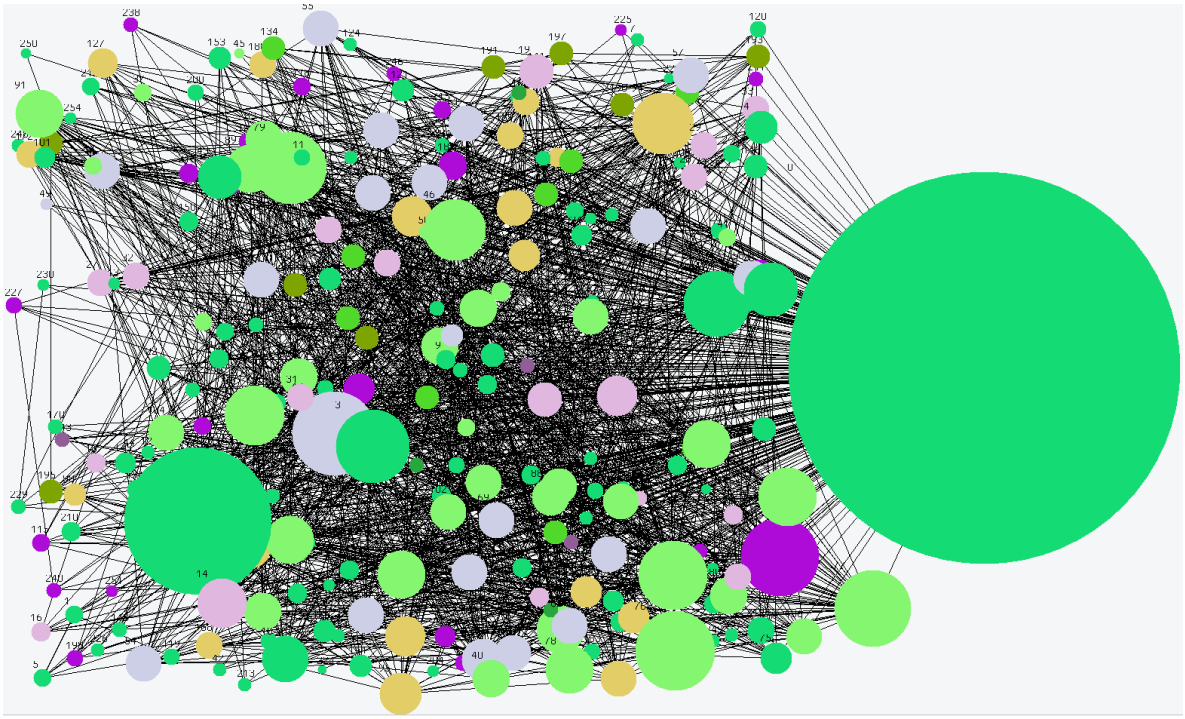
But, because the output files are too large, you can see that on 2_exercise/with_ebc.txt, and 2_exercise/without_ebc.txt for more information.

There is a difference between the trees, which is logical because calculating the edge betwenness centrality each time, changes the structure of the tree. Having different height at the end.

4 Exercise 3

Calculating all the communities with the CiBC algorithm, using the AviNet software. And take the following results:

4.1 Output graph of AviNet

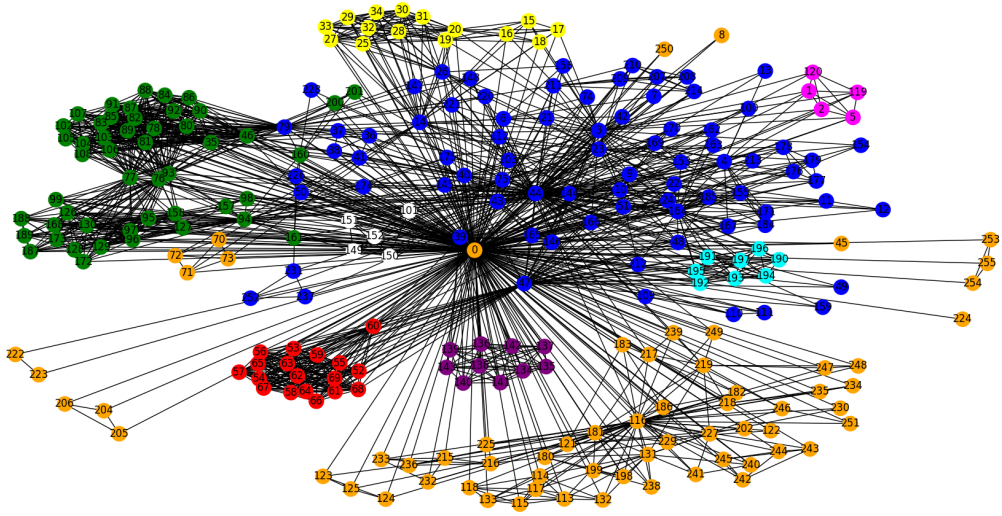


4.2 Communities of AviNet

Community	Nodes
1	15, 14, 16, 17, 18, 19, 20, 156, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34
2	70, 71, 72, 73
3	134, 135, 136, 137, 138, 139, 140, 141, 142, 143
4	157, 127, 158, 168, 126, 128, 129, 130, 187, 188, 189, 172, 173, 99, 94, 95, 96, 97, 98
5	185, 45, 36, 35, 37, 38, 39, 40, 41, 102, 103, 104, 105, 106, 107, 108, 50, 46, 21, 80, 76, 77, 78, 79, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93
6	190, 191, 192, 193, 194, 195, 196, 197
7	212, 49, 47, 48, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69
8	232, 215, 216, 233, 225, 180, 181, 198, 199, 240, 227, 241, 251, 246, 238, 132, 131, 236, 202, 115, 113, 114, 116, 117, 118, 133
9	242, 243, 244, 245
10	253, 254, 255, 204, 205, 206, 122, 121, 123, 124, 125, 207, 208, 209, 210, 211, 214, 119, 1, 2, 5, 120, 182, 183, 186, 110, 109, 111, 234, 218, 235, 213, 149,...

5 Exercise 4

Calculating all the communities, using the modularity optimization algorithm.



6 Exercise 5

Used the Louvain algorithm, which is located at link louvain.

```
Begin: Sat Apr 30 23:07:45 2022

Computation of communities with the Newman-Girvan Modularity quality function

level 0:
  start computation: Sat Apr 30 23:07:45 2022
  network size: 255 nodes, 3368 links, 3368 weight
  quality increased from -0.0115686 to 0.555425
  end computation: Sat Apr 30 23:07:45 2022
level 1:
  start computation: Sat Apr 30 23:07:45 2022
  network size: 28 nodes, 154 links, 3368 weight
  quality increased from 0.555425 to 0.599066
  end computation: Sat Apr 30 23:07:45 2022
level 2:
  start computation: Sat Apr 30 23:07:45 2022
  network size: 8 nodes, 42 links, 3368 weight
  quality increased from 0.599066 to 0.599066
  end computation: Sat Apr 30 23:07:45 2022
End: Sat Apr 30 23:07:45 2022
Total duration: 0 sec
0.599066
```

```
Number of levels: 3
level 0: 255 nodes
level 1: 28 nodes
level 2: 8 nodes
```