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Wednesday 2/10/2024

Report PS01 Cytoscape

Introduction to Network Science

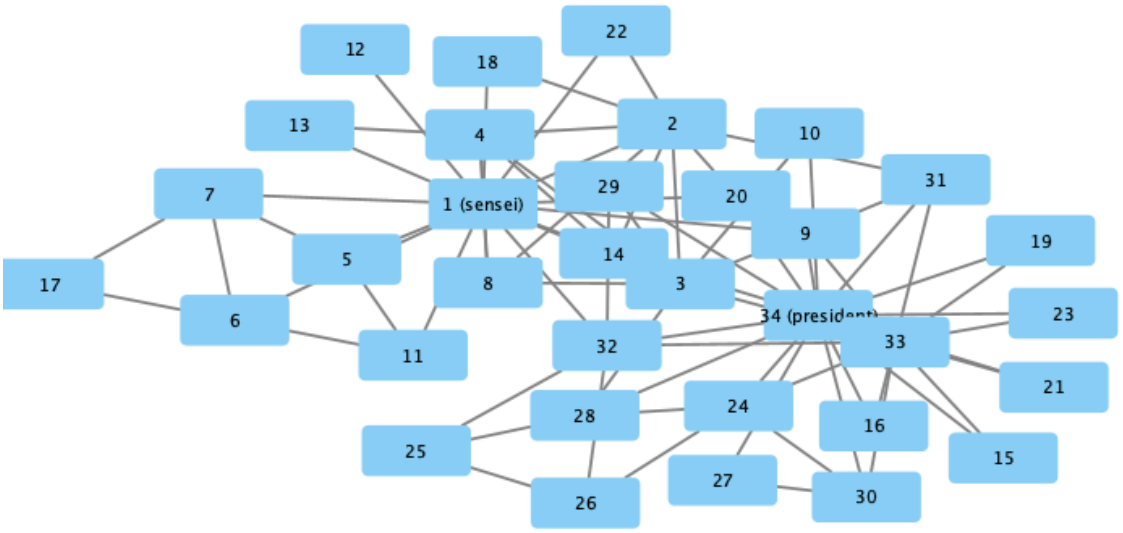
Section 1

Number of nodes and edges per graph

graph name	# of nodes	# of edges
karate	34	78
reptilia-tortoise-network-fi	787	1713
marvel-hero	6421	167112
game-of-thrones	84	216
got-relationships-uni	20	59

Section 2

1.1.1 Graph and top too nodes having the larger degree



The largest nodes are label 1 (sensei) and label 34 (president) with degree 16 and 17 respectively. Zachary's karate club is a popular example of community structure[1], therefore these two nodes are so connected because they represent central individuals in the structure of a club.

[1] Girvan, M.; Newman, M. E. J. (2002). *Community structure in social and biological networks*. Proceedings of the National Academy of Sciences. 99 (12): 7821–7826. doi:10.1073/pnas.122653799. PMC 122977. PMID 12060727.

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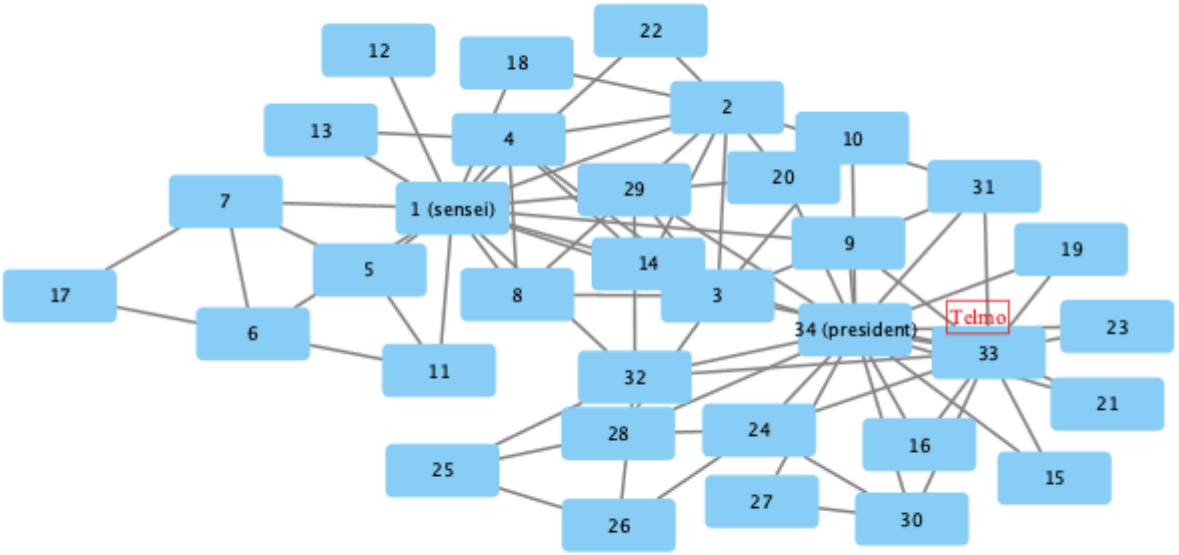
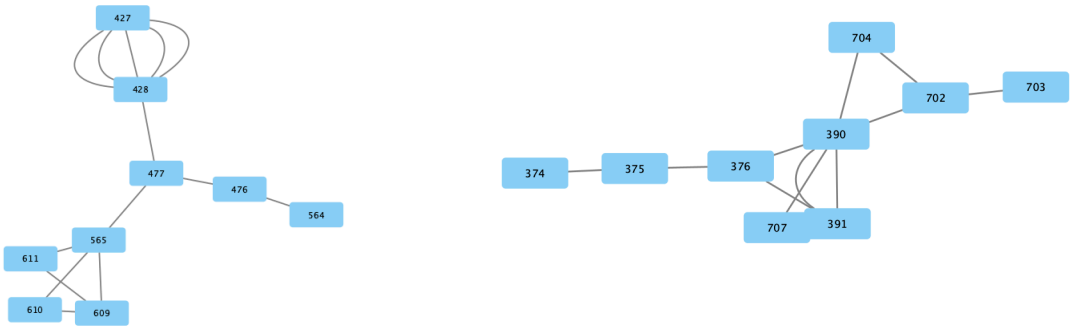
1.1.2 One person that has degree larger than 9



1.1.3 The Compound Spring Embedder

Force-directed graph drawing is a kind of algorithm to represent graphs in a cleaner way to understand them better by simulating interactions[2]. Particularly, the Compound Spring Embedder uses a simulation where nodes repel each other, and edges behave like springs, pulling connected nodes together[3].

1.2.1 Second and third largest connected sub-graphs



The first sub-graph with 9 nodes and 14 links and the second with 9 nodes and 11 links.

[2] Wikipedia contributors. (n.d.). *Force-directed graph drawing*. Wikipedia. Retrieved September 29, 2024, from https://en.wikipedia.org/wiki/Force-directed_graph_drawing
[3] Ceccarelli, S. (2020, July 2). *Network force-directed paradigm: Spring embedder*. Medium. https://medium.com/@ceccarellisimone1/network-force-directed-paradigm-spring-embedder-3f27dc723d3d

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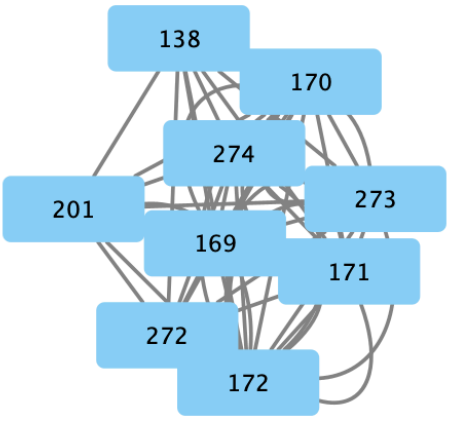
1.2.2 Clique

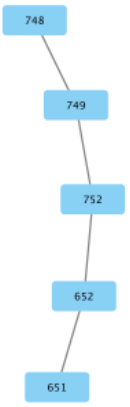
A clique is a subset of vertices of an undirected graph such that every two distinct vertices in the clique are adjacent[4]. To extract the cliques in cytoscape I used the Mclique plug-in[5].



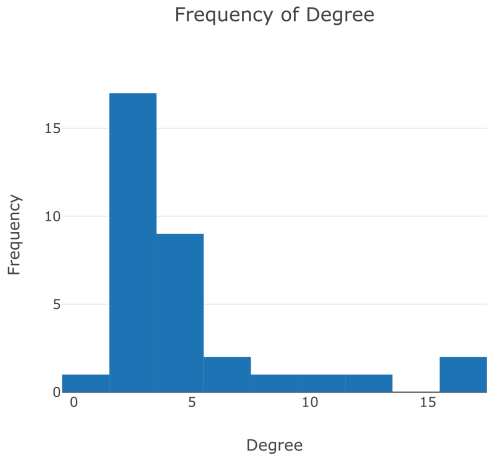
There are two cliques with 9 nodes and 49 edges. I arbitrarily chose this one.

1.2.3 Largest connected line graph

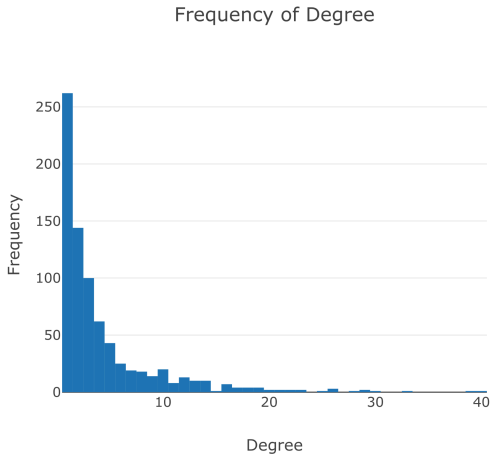
The largest connected component that is a line graph is composed of 5 nodes.



Section 3



Degree Distribution Karate Graph



Degree Distribution Tortoise Graph

[4] *Clique (graph theory)*. (n.d.). Wikipedia. Retrieved September 30, 2024, from https://en.wikipedia.org/wiki/Clique_(graph_theory)
[5] Bezawada, S. (2016). *MClique (Version 1.2)* [Software]. Cytoscape App Store. Retrieved from https://apps.cytoscape.org/apps/mclique

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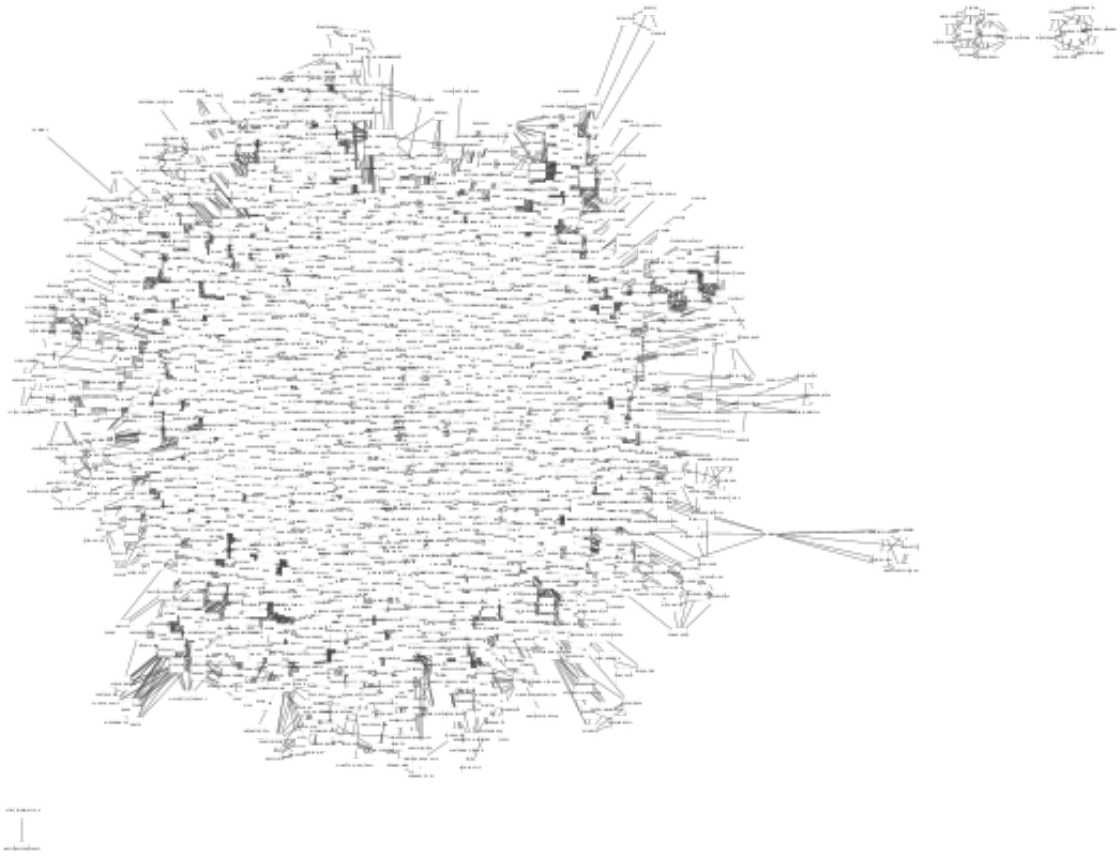
Section 4

4.1.1 Marvel-hero graph

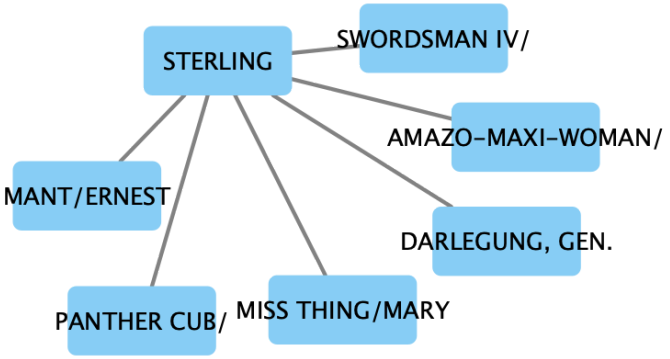


4.1.2 Top 20 nodes with the largest degree

The following list was obtained by applying a filter from the control panel:

Captain America, Human Torch/Johnny S, Angel/Warren Kenneth, Hawk, She-Hulk/Jennifer Wa, Wasp/Janet Van Dyne, Thor/Dr. Donald Blak, Ant-Man/Dr. Henry J., Spider-Man/Peter Parker, Beast/Henry &Hank& P, Invisible Woman/Sue, Mr. Fantastic/Reed Richards, Scarlet Witch/Wanda, Thing/Ben Grimm, Thing/Ben Grimm, Iron Man/Tony Stark, Vision, Cyclops/Scott Summer, Storm/Ororo Munroe S, Wolverine/Logan

4.2 Sub-graph for one character (Sterling)



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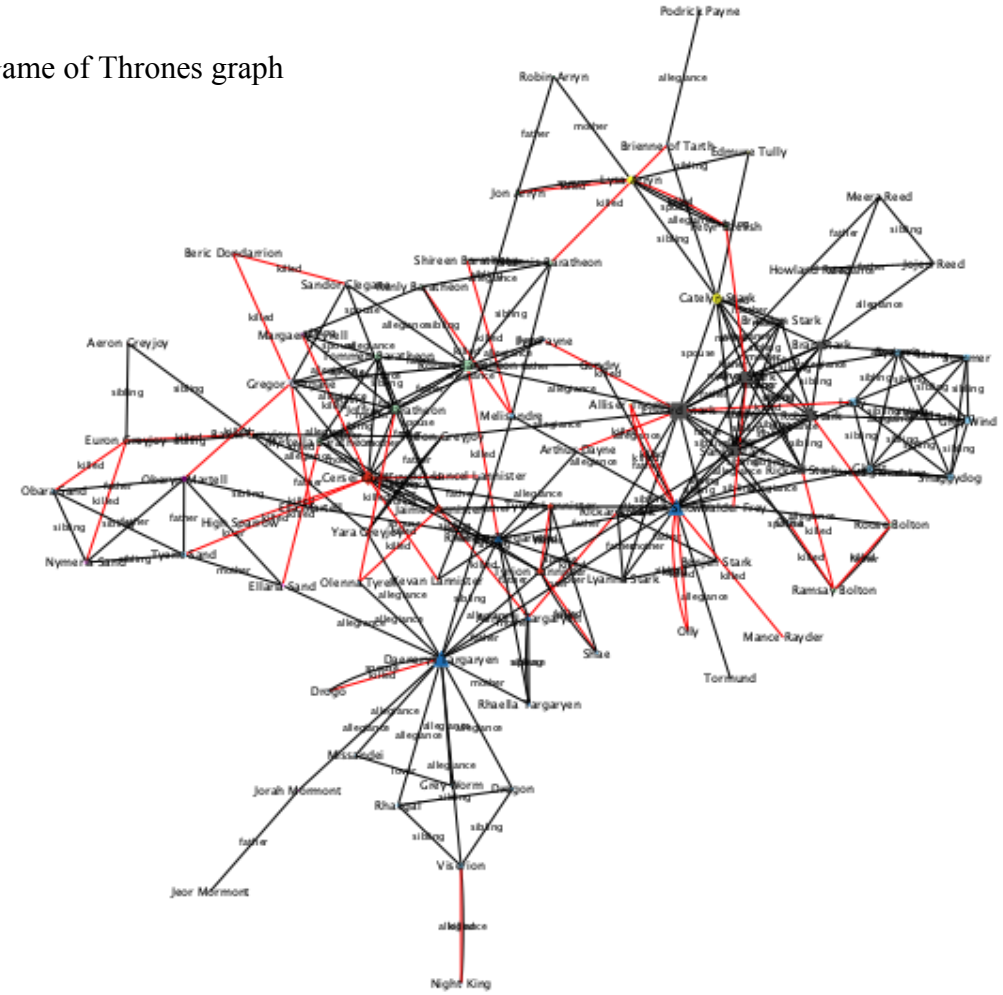
This sub-graph has a total of 7 nodes and 6 connections

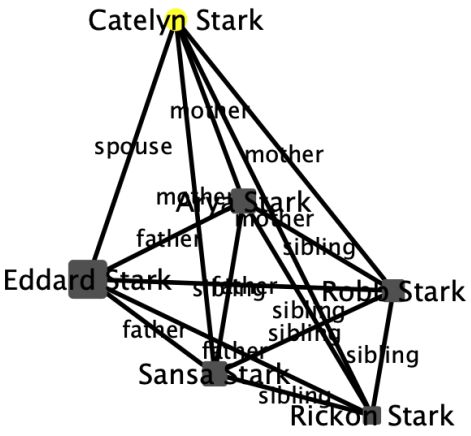
Section 5

5.1.1 Game of Thrones graph



5.1.2 Graph containing one clique of four or more characters

The following graph consists of 6 characters by the name of Catelyn Stark, Eddard Stark, Sansa Stark, Rickon Stark, Roba Stark and Arya Stark. In the edges we can see the relationships such as spouse, mother, father or sibling.



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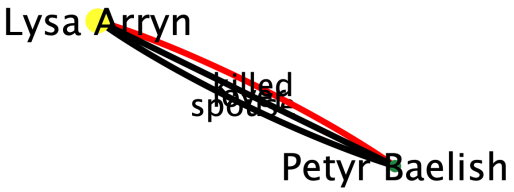
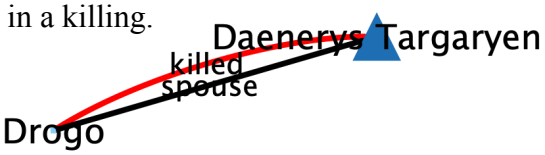
5.1.3 Multi-edge

The first case we have is between Lysa Arryn and Petyr Baelish, who are spouses, lovers, and involved in a killing.



The second case is between Drogo and Daenerys Targaryen, who share the relationships of being spouses and involved in a killing.



5.1.4 House of birth distribution

This observation can be made by modifying the style and setting the node label to the house of birth. By doing so, we notice a large concentration around major houses such as House Stark, House Lannister, and House Targaryen, while some houses are less represented and appear in more isolated parts of the graph. Lastly, characters from the same house tend to cluster together and seem to be grouped around key characters.

This is quite natural, as the series is based on the three main mentioned houses and therefore their characterster are more connected[6].

5.2.1 Graph description

The graph I created represents 20 individuals I know from Universitat Pompeu Fabra, including their full name, bachelor's degree, and year, connected through friendship, romantic relationships, or siblings.
The colors of the nodes represent the bachelor's degrees, red for Data Science, purple for Computer Science, yellow for Audiovisual Engineering, green for Telecommunications Engineering, and blue for Marketing.
The edges are colored black for friendship, red for romantic relationships, and blue for siblings.

5.2.2. CSV tables

got-characters.csv

id	character-name	year	bachelors
0	Alex Comas	4	Audiovisual Engineering
1	Alèxia Rosell	4	Telecommunications Engineering
2	Telmo Linacisoro	4	Computer Science

[6] Quora User. (n.d.). What are the houses in Game of Thrones in order of significance? In Quora. https://www.quora.com/What-are-the-houses-in-Game-of-Thrones-in-order-of-significance

3	Berta Noguera	4	Data Science
4	Bruno Manzano	4	Computer Science
5	Paula Mateos	4	Data Science
6	Jan Aguiló	3	Data Science
7	Pau Chaves	3	Data Science
8	Aniol Chaves	3	Data Science
9	Pol Bonet	3	Data Science
10	Queralt Zamora	4	Data Science
11	Raul Hategan	4	Computer Science
12	Sergi Puig	4	Computer Science
13	Jose Perez	4	Data Science
14	Viktoria Olmedo	4	Audiovisual Engineering
15	Marcel Martin	4	Computer Science
16	Maria Sannino	4	Data Science
17	Pol Arbiol	2	Data Science
18	Arnau Arevalo	2	Data Science
19	Anna Abetlló	2	Marketing

got-relationships.csv

src	dest	relation
2	3	In Relationship
2	1	Friends
2	2	Friends
2	4	Friends
2	5	Friends
2	6	Friends
2	7	Friends
2	8	Friends
2	9	Friends
2	10	Friends
2	11	Friends
2	12	Friends
2	13	Friends
2	14	Friends
2	15	Friends
2	16	Friends
2	17	Friends
2	18	Friends
2	19	Friends
2	0	Friends
0	1	Friends
0	3	Friends
0	5	Friends
0	11	Friends
0	12	Friends
1	0	Friends
1	3	Friends

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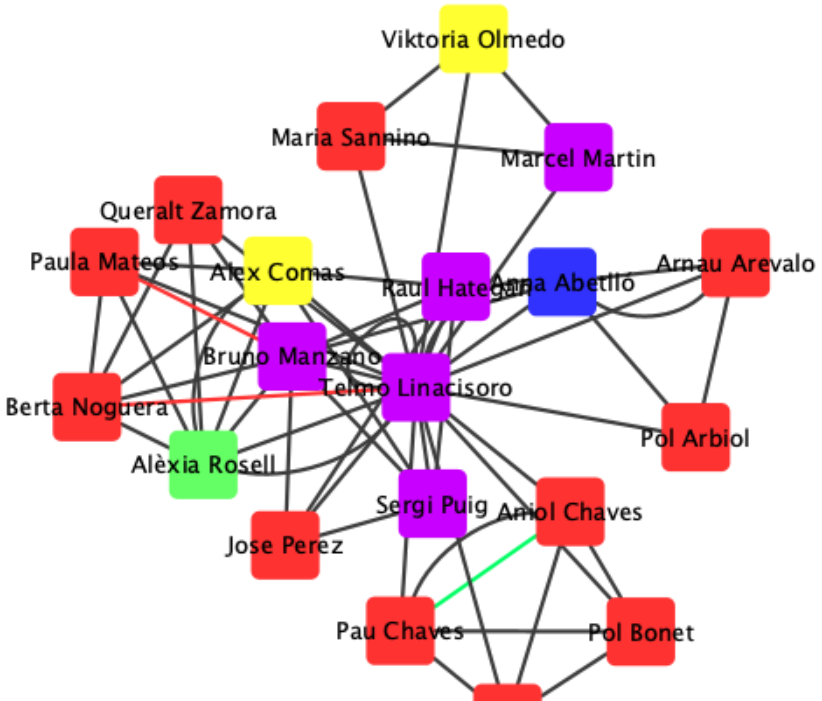
1	4	Friends
1	5	Friends
1	10	Friends
1	2	Friends
3	4	Friends
3	5	Friends
3	10	Friends
4	5	In Relationship
4	10	Friends
4	11	Friends
4	12	Friends
4	13	Friends
6	7	Friends
6	8	Friends
6	9	Friends
7	8	Friends
7	9	Friends
8	9	Friends
11	12	Friends
11	13	Friends
12	13	Friends
14	15	Friends
14	16	Friends
15	16	Friends
17	18	Friends
17	19	Friends
18	19	Friends
18	19	In relationship
7	8	Siblings
4	19	Friends
2	19	Friends

5.2.3 Graph drawing



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You can see that I’m the central character in this case and that there are some clusters representing different years. Some people I know from the first, second, third or fourth year are mostly related between them.

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I hereby declare that, except for the code provided by the course instructors, all of my code, report, and figures were produced by myself.