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Sections and Chapters

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Contents

1 Introduction

The aim of my master's thesis is to (re)construct and study a network of the family ties inside the Swedish Council of the Realm (Riksrådet) from the early 16th century to the late 17th century. The study will be conducted by creating a data structure and a visual representation of a graph depicting the family links. The work will be focused on roughly two main sectors: first of which is the actual analysis of the family links between the councillors, the second one is the assessment of the method of historical network analysis.

In my thesis historical network analysis will be referred to as a computer-aided method, which links this work to the field of digital humanities. This study is also in the field of pre-modern history, because the timeframe of this study covers most of the 16th and 17th century. Methodologically, the study is quantitative study with an explorative approach.

Even though things like machine learning and artificial intelligence (AI) are particularly popular and to a certain degree hyped at the time of writing, it is important to assess and understand the fundamentals and basics of digital and computational methods. Obviously, it is easier to understand simpler models, and therefore ask important questions. Those questions are for instance: What are the premises for this model? What kind of data is suitable for this model? What kind of interpretations can be made from the results? What is the potential problem, how to fix or adjust the model if something goes wrong or unexpectedly?

The text will be divided in four sections. The introduction will present the premises of this work. As the method is a focal point of the study, it will be explained further in its own second section. The third section is about the practical implementation of the analysis and assesment of the results, and the last section collects everything together as a conclusion.

Furthermore, according to historians Miia Kuha and Petri Karonen, majority of historiography concerning Sweden (and Finland) in the early modern period is written in the national languages Swedish of Finnish.[1]

1.1 Research questions

The research questions are:

1. Can historical network analysis reveal new or unseen patterns in the affiliations between Swedish councillors of the Realm?
   - How dense is the network (how linked the council was in general)?

[1] Kuha and Karonen 2024, p. 6.

    - Are there any isolated nodes (councillors who have no relatives in the council)?
    - Can the graph be visually divided into clear subgraphs (is there a certain groups or 'houses' of related councillors)?

2. What are the potential difficulties and pitfalls in the implementation and interpretation of historical network analysis in this specific dataset, and further in the field of pre-modern history?

    - To what extent can pre-processing the dataset for the network analysis be automated with a script?

The source material for this study is the *Swedish Councillors of the Realm, 1523-1680* dataset, which also dictates the timespan of the study. The period is relatively long and momentous in Swedish history, including many important events, such as, adoption of hereditary kingship (1544), the conflicts between the sons of Gustav Vasa (from 1560's to early 1600's), thirty years war (from 1618 to 1648) and queen Christina abdicating the throne (1654).[2] These events and shifts obviously have had a significant impact on the ensemble and activities of the Swedish council of the realm. Yet, instead of event-history or lives of individual councillors, the focus of this study is on the macro level, in (re)constructing a visual and computational network model of the family relations between the councillors. A longer timespan is necessary in order to the generations of family links to accumulate enough to make a network meaningful to study.

This study is conducted with a quantitative dataset instead of more traditional way of qualitative text analysis. Therefore, the source criticism is done for the dataset as a whole. For example, by assessing the sources of the dataset, looking for possible human errors in the data and considering the original purpose and use of the dataset. The source criticism is discussed further in the subsection 1.4.

The basis and context of this study will lay on the pre-existing literature concerning the Swedish Council of the Realm. Previous historical research will form the base for deciding the parameters for the network model (graph), and direct the choices for the data processing. These decisions include, for instance, whether or not draw the link between brothers if they are already connected to same father present in the graph. These decisions need to be based on the prior knowledge on the social relations during the pre-modern era.

1.2 Previous research

Historical network analysis can be understood as, to a certain degree established, but developing method. According to Finnish political historians Kimmo Elo and Olli Kleemola,

[2] Karonen, Hakanen, and Einonen 2017, p. 8-9.

the roots of historical network analysis are as far as in the late 19th century, yet, the modern appliance of the method is due the invention of computers, increase in the computing capacity and availability of user friendly network analysis software. They estimate that historical network analysis has gained its popularity from somewhere in the late 2000's.[3]

It appears that Elo and Kleemola approach historical network analysis as a predominantly digital or computational research method.[4] However, the definition is not that straightforward. Social network analysis, which is the basis for historical network analysis, involves theorising, model building and empirical research focusing on the patterns formed inside the networks.[5] (Social) network analysis has been employed in the field of history before the turn of the millenia, previous to the era of intuitive software.[6] So, the field of historical network analysis can be roughly divided in two approaches: one with more descriptive or theorising stance and the another that treats network analysis as a quantitative computer-aided method. In the context of this work, (historical) network analysis will be treated primarily as a computer-aided method, similarily to the article of Elo and Kleemola, therefore focusing mainly on the previous research with computational approach. The further theory and practice will be covered in the section 2.

The international *Historical Network Research Community* (HNR) was found in 2009. The community has grown over time, and nowadays HNR runs workshops, conferences, lectures and a Slack (chat) group, and publishes an open access journal, a newsletter and a research bibliography.[7] On the word of Kimmo Elo, historical network analysis has been the most popular computational method amongst historians.[8]

Scanning the HNR research bibliography, it appears that historical network analysis has been applied by researchers and research teams from around the globe in variety of research topics. The topics vary from the social networks of Chinese gods to the technical implementation of historical network analysis, and to the historical study of reconnaissance during the Cold War.[9] More relevant for this study, network analysis has been utilized in the study of ruling elite and power in the pre-modern period.[10]

In Finland, Kimmo Elo is one of the researchers highly profiled on the use of the historical network analysis. Among other things, he has co-authored two articles addressing the method in more explorative manner. The first article is "*Verkostoanalyysi historiallisten aineistojen eksploratiivisena analyysimenetelmänä : esimerkkinä sotavalokuvat*" written by Elo and Olli Kleemola. In the article they focus mainly on the applicability

[3] Elo and Kleemola 2015, p. 415-417.
[4] Elo and Kleemola 2015, p. 415-417.
[5] Keats-Rohan 2007, p. 22-24.
[6] Aronsson, Fagerlund, and Samuelson 1999, TODO check!
[7] "About HNR" 2021.
[8] Elo 2016, p. 22.
[9] Elo 2016, p. 22. "HNR Bibliography" 2024.
[10] Sigurðsson and Småberg 2013, See e. g. Ruth Ahnert's and Sebastian E. Ahnert's book *Tudor Networks of Power* (2023) or Paul D Mclean's article *Widening Access While Tightening Control: Office-Holding, Marriages, and Elite Consolidation in Early Modern Poland* (2004).

of historical network analysis. As their data, they use German war propaganda pictures taken from Finland during the second world war.[11]

The another article is "*Networks of Revolutionary Workers: Socialist Red Women in Finland in 1918*" written by Elo and political historian Tiina Lintunen. In this article the method of historical network analysis is applied on the connections between the women who participated to the Finnish civil war in 1918 on the side of the socialists also known as "reds".[12] Both of these articles share the exploratory perspective with this study, and therefore, offer a point of reference.

When it comes to the literature discussing early modern Sweden, historian Petteri Impola has made a quantitative analysis on the social groups studied by Swedish and Finnish historians. Generally the early modern royals and nobility was the the focal point within the Swedish scholars till the 1950's, whereas their Finnish colleques have been more focused on the peasants and other social groups. In the latter half of 20th century more attention was paid towards lower social classes. Yet, a resurgence of interest in the nobility has occured in the beginning of the 21st century. This new research examining nobility has been focusing on women, family connections and further social networks.[13] My work seems to be similar with the modern study of the nobility.

As a significant administration the members and activities of the Swedish Council of the Realm have been to some extent covered by previous research. For instance, the development and affairs of the council as an institution are addressed in the works of historians such as Petri Karonen, Pentti Renvall and Kurt Agren.[14] Additionally, short biographies of some members of the council can be found easily in the *Biografiskt lexikon för Finland* (Biographical Dictionary of Finland).[15] Those biographies include an assortment of notables found in the councillors dataset, such as, Herman (Claesson) Fleming, Gabriel Bengtsson Oxenstierna (af Korsholm och Wasa) or Lorentz (Ernstsson) Creutz d.ä.[16] Even so, the Council of the Realm has not been examined thoroughly down to the last man. And based on historians Marko Hakanen and Ulla Koskinen, the council as a focal point, does still hold some uncovered parts.[17]

Authors of the councillors dataset, Hakanen and Koskinen, have explained the dataset's background in their article *The Gentle Art of Counseling Monarchs (1560-1655).* In their

[11] Elo and Kleemola 2015.

[12] Lintunen and Elo 2019, Almost the same article is found in Finnish in the *Historiallinen Aikakauskirja* 116 (2/2018).

[13] Impola 2024.

[14] See e. g. Petri Karonen: *Pohjoinen Suurvalta* (2008) TODO check! or "*The council of the realm and the quest for peace in Sweden, 1718-1721*" in *Hopes and fears for the future in early modern Sweden, 1500-1850* (2009), Pentti Renvall "*Keskitetyn hallintolaitoksen kehitys*" in *Suomen kulttuurihistoria. II* (1934) or Kurt Agren "*Rise and decline of an aristocracy: The Swedish social and political elite in the 17th century*" in the *Scandinavian journal of history* (1976).

[15] "BLF – Biografiskt lexikon för Finland" 2014.

[16] "Artiklar A-Ö" 2014.

[17] Hakanen and Koskinen 2017b, p. 47-48.

study the council is approached through the concept of personal agency.[18] In the article, Hakanen and Koskinen also mention some prior collection and utilisation of datasets on the study of said councillors and their networks. Namely, Jan Samuleson has listed councillors and their affiliations from years 1523 – 1611, Kurt Ågren has collected councillors and their families from years 1602 – 1647, and Björn Asker made a similar collection from years 1640 – 1680. Unfortunately, some of the datasets remain unpublished.[19]

All in all, computer-aided historical network analysis is somewhat rare compared to the traditional methods of historiography. Nevertheless, it also seems that the pre-modern elite is collectively understood as a network amongst historians, and the ties between the members of nobility have been in the scope of interest for some time now. Which makes applying the computer-aided network analysis relevant. The aim of this work is to join the rather uncommon method of historical network analysis with the classic research topic, and to further explore and develop the method in the context of historical research.

1.3 The Council of the Realm

1.4 Sources

Since this work is conducted with pre-collected dataset, this work can be vaguely categorised as secondary analysis. Secondary analysis meaning re-analysing the data with new research questions or approaches, while primary analysis involves the collection of the data. Secondary analysis can also be discerned from meta analysis, which means comparing multiple previous studies (usally with quantitative methods) to create a synthesis on a certain question.[20]

On the contrary in their articles Kimmo Elo and Olli Kleemola or Elo and Tiina Lintunen apply a network analysis on their own primary datasets.[21] However, in the case of this work the benefit of doing secondary analysis is that the focus can be on the implementation and assessment of the method. Furthermore, the existing dataset will be automatically and manually re-examined for possible errors in the process, as will be discussed soon.

As mentioned earlier, this work is based on the *Swedish councillors of the Realm, 1523-1680* -dataset authored by Marko Hakanen and Ulla Koskinen. The dataset was published in 2017 and can be found in Digital repository of University of Jyväskylä under the license CC BY 4.0. The dataset was collected as a part of the research conducted for the anthology *Personal Agency at the Swedish Age of Greatness 1560–1720.*

To be precise, discussing the data I deliberately use the term *dataset*, whereas the

[18] Hakanen and Koskinen 2017b.
[19] Hakanen and Koskinen 2017b, p. 48, 67 (cite 4).
[20] Card and Little 2012, p. 4-5.
[21] Elo and Kleemola 2015; Lintunen and Elo 2019.

original authors call it *database*. The difference between dataset and database is not clear-cut, but for example the U.S. Geological Survey (USGS) briefly defines dataset as a structured collection of data and database as a collection of multiple datasets. USGS also mentions that the data in databases can (typically) be updated and manipulated easily in real time.[22] Hence, databases are generally more complicated interfaces for data management, and for this purpose the term dataset is more suitable.

The dataset consists of information from 257 Swedish councillors of the realm. Each councillor has the following feature attributes: date of birth, year of death, year, date and age of appointment, noble rank, spouse(s) along with father's spouse and the individual's family links between other councillors. The councillors are identified with their full name and id number.[23]

Hakanen and Koskinen have compiled the data from secondary sources such as biographical registers and databases, biography collections, lineage databases and research literature. The dataset's sources are listed in the dataset and in the article written by Hakanen and Koskinen, those include for instance Nordic Family Book (Nordisk familjebok), National Biography of Finland (Finland's nationalbiografi, Kansallisbiografia), genealogies of old Swedish aristocratic families (Äldre svenska frälsesläkter) and further refereed literature.[24] As reported by Hakanen and Koskinen the dataset is collected using methodologies of collective biography, new prosopography and source criticism.[25]

Even though the dataset can be assessed as reliable and generally accurate, there is the general problem of some missing data. As seen in the example of Table 1, some of the councillors have missing attributes such as date of birth and therefore age of appointment. The missing attributes are most likely due the fact that during the timespan of the dataset there was no standard of civil registration.

The order of keeping parish registers (kyrkbok) was given in the Swedish Church Law 1686 (Kyrkio-Lag och Ordning), six years from the endpoint of the dataset. The Church Law made it mandatory for parish vicars to keep certain records and documents concerning the population and economy of the parish. Among other things these parish registers included the records of marriages, births, christens, deaths and funerals. Despite that the Swedish parish registers have been assessed exceptionally comprehensive by historians, there are some considerable deficiencies due to the differing circumstances and practices between parishes, furthermore some of the registers have been destroyed or lost. Even though some records do exist prior and post (TODO format) the Swedish Church Law 1686, they are notably dispersed.[26] A case in point: according to the Dictionary of Swedish National Biography (Svenskt biografiskt lexikon) the birth year of king Gustav

[22]"What are the differences between data, a dataset, and a database?" 2022.
[23]Hakanen and Koskinen 2017b, p. 48. 2017a.
[24]Hakanen and Koskinen 2017b, p. 48, 76; 2017a.
[25]Hakanen and Koskinen 2017b, p. 48.
[26]Viikki 1994, p. 169-176.

Vasa (1495 or 1496) is also an estimate.[27]

However, the focus of this work is not on the ages of the councillors but in their affiliations, so, the more relevant question is whether or not there are missing family links.

(TODO write script and do some checking)

As the relatively large dataset is compiled by humans, it leaves some room for typos and errors. While producing the first experimental graph of the dataset, some empty data points were found. These "ghosts" were nodes with only id number and one or two links to the other councillors. All in all there were four "ghosts" with the id numbers 147 (linked to 18 and 152), 215 (linked to 217), 249 (linked to 269) and 254 (linked to 94). With the help of Marko Hakanen it was resolved that those "ghost" nodes were data points removed from the dataset as the authors found out they have not been official councillors, however, some references to their id numbers had been left to the dataset by accident. The "ghost" nodes will be removed from the latter graphs.

[27] Svalenius 1969.

Table 1: Example rows of the dataset: Gyllenhorn, Joen Olsson and Natt och Dag, Måns Johansson (Hakanen and Koskinen 2017a)

Name	No.	D.O.B.	†	Appointed	Date	Age	Noble rank	Family members in the council	Spouse(s) / Father of Spouse / Date of Marriage
Gyllenhorn, Joen Olsson	82		1556	1529	00.6.		Uradel (Ancient Nobility)	Son-in-law 44	Karin Bese/Nils Nilsson Bese/1529
Natt och Dag, Måns Johansson	142	1498	1555	1529	00.6.	31	Uradel (Ancient Nobility)		Barbro Eriksdotter/Erik Turesson Bielke/ probably 27.6.1524

Table 2: Example of the raw .csv file

1	Name;	Id;	D.O.B.;	died;	Appointed;	Date;	Age;	Noble rank;	Family;	Spouse(s) / Father of Spouse / Date of Marriage
2	Ingemar Petri;	162;	;	1530;	1495;	;	;	Estate unknown, Bishop;	;	;
3	Tre Rosor, Ture Jönsson;	231;	;	1532;	1497;	;	;	Uradel (Ancient Nobility);	Father CR, Father-in-law CR, Sons 228, 230, Son (illegitimate) 175;	Anna Johansdotter/ Johan Christiernsson Vasa (CR)

2 Method

My method is computer aided (social) network analysis. It is one of the most implemented methods in the field of digital humanities. Generally network analysis has other more everyday applications, such as, the analysis of the internet as a network in the field of technology. Quite a few textbooks have been written on network analysis.

2.1 Defining the network

Network analysis combines mathematics, statistics and social scineces. Primarily it is based on the mathematical graph theory. A graph is a representation of the network. Graph includes nodes (also colled vertice) and edges (also called links and connections).

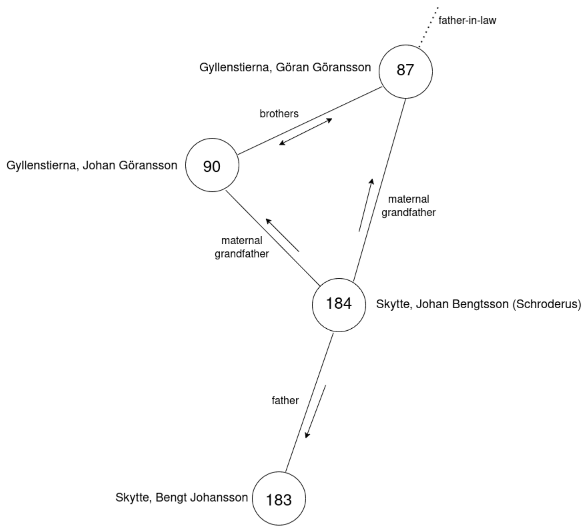

Figure 1: A sample from the graph

In this context the graph's nodes depict individual councillors with the input of name and id number. Correspondingly the edges represent the kinships between two nodes. For instance, in Figure 1 we can see that Johan Bengtsson (Schroderus) Skytte (id 184) is Bengt Johansson Skytte's (id 183) father and a maternal grandfather for Johan Göransson Gyllenstierna (id 90) and Göran Göransson Gyllenstierna (id 87). Johan Göransson and Göran Göransson are brothers, however, their father is not mentioned in the dataset. Göran Göransson also has further links in the network.[28]

Calculating different statistics is a crucial part of the network analysis. One of the most important measures is the **node degree**. In all its simplicity node degree means the amount of edges connected to a specific node. For example, the degree of Johan Bengtsson (Schroderus) Skytte (id 184) is three or the degree of Bengt Johansson Skytte (id 183) is one. The **average degree** is the mean [keskiarvo] of all the node degrees of

[28]Marko Hakanen and Ulla Koskinen. 2017a. *Swedish Councillors of the Realm, 1523-1680.* doi:`https://doi.org/10.17011/jyx/dataset/55523`.

the specific graph. The **density** of the network is based on the node degrees. In very dense network almost every node is connected to each other, but a sparse graph has just a few edges in it.

Another important factor is whether the graph is **directed** or **undirected**. In directed graph the edges have directions, like in the communication networks a message has a sender and a receiver. The directions are marked with an arrow. In undirected graphs the edges are bidirectional (two way), for example, a relationship between two brothers can be understood as undirected. Directed graphs have more features and a more complex structures, for instance, the degrees of inbound and outbound edges can be counted separately. For sipmlicity, the graphs presented in this work are undirected.

2.2 Implementation of the network analysis

The data processing and analysis is conducted with a combination of Python programming language and Gephi software. Python is used for extracting the data from the councillors-dataset and formulating it in the right format: readable for Gephi. The actual network analysis, visualization and calculating statistics, is performed with Gephi.

Python is a programming language popular amongst scientists. I selected Python due its simple syntax and ease in implementing small tasks like data processing. The language is understandable and widely used, which makes the work replicable. To be precise the script is written with Python 3.

As graphs are structures commonly used in programming, it would have been possible to conduct the actual network analysis using tools provided by Python, yet, Gephi software provides a visual user interface and more intuitive tools for the manipulation of the graph. Furthermore, the Gephi format makes the data and graph accessible also for non programmers.

Gephi is a software for network visualization and analysis. It contains tools for manipulating, filtering, clustering and visualizing the graph. It has built in appliances for fixing errors in data and calculating necessary statistics.[29] Gephi reads data from text format (comma separated values .csv) or Microsoft Excel tables (XLSX), and Gephi projects are saved as .gephi files. The processed graphs and data can be exported as images or tables.

Nonetheless, Gephi does have some weaknesses. It is not always the most intuitive to use, and especially the visual configurations of the graph causes some issues. I have encountered difficulties with the node labels (the councilor's name next to the node). Sometimes the problems lies in the Gephi settings, but if the whole software crashes when trying to make the node labels visible, the problem lies within the software itself and should be solved when starting the program.[30]

[29]"About Gephi".
[30]For Linux environments opening Gephi from command line with command "LIBGL_ALWAYS_SOFTWARE=1 ./gephi" can sometimes help.

Both of these tools are also open source and free to download. All scripts written for this work available on GitHub.[31]

Basically the steps of network analysis are :

1. Choosing the subject and data
2. Pre processing the data for the network analysis
3. Constructing the graph and finding possible issues and errors
4. Counting the statistics
5. Deciding the layout (algorithm)
6. Doing the interpretations

However, the analysis is not that straightforward, sometimes the steps 2 and 3 must be repeated and re-repeated. Yet, on some circumstances the graph is not visualized or the statistics are not deemed important. These steps will be discussed in practice below.

2.2.1 Test run

To draft the structure of the graph and understand the nuances of the given data, a test run was carried out. The test run was done with a simple Python script, and no attention was paid to the temporal aspects of the network or the potential directions within the graph. The script and Gephi project used, and the visualization of the graph of the test run is available in GitHub in the TestRun folder[32]

The data processing was started by manually cleaning the data in LibreOffice Calc (equivalent to Microsoft Excel). The columns and rows containing information of the source material of the dataset and councillor's years active were removed. That made the structure of the data coherent and easier to manipulate with the Python script. The manually cleaned data is exported as .csv (comma separated values) file. The .csv file's header (the first line of the file) should be modified so that the column name "No." is changed to "Id" and "Family members in the council of the realm" is changed to "Family", the first one can cause an error if referenced in the Python code, the latter is inconveniently long.

The script itself reads the data from the .csv file. The connections between the councillors are separated from the "Family" column, based on the knowledge that each connection is marked with the id number of another councillor. The connections are then formatted and printed to .csv file. The connections .csv file containing values for "Source" id of the source concillor, "Target" id of target councillor, "Type" standard

[31] `https://github.com/Heidi-Suurkaulio/mastersthesis` TODO right link later
[32] `https://github.com/Heidi-Suurkaulio/mastersthesis/tree/main/TestRun`

"Undirected", "Id" id number for the connection, "Weight" standard 1.0. Another .csv file is formatted and printed with the information of councillors' names and id numbers.

Table 3: Example of the connections .csv file

1	Source,	Target,	Type,	Id,	Weight
2	231,	228,	Undirected,	0,	1.0
3	231,	230,	Undirected,	1,	1.0

Table 4: Example of the councillors .csv file

1	Id;	Label
2	162;	Ingemar Petri
3	231;	Tre Rosor, Ture Jönsson

These .csv files are readable for Gephi. The outcome was an undirected graph of the councillors' affiliation network that had accumulated during the 160 years. The graph consisted of 261 nodes (257 real + 4 "ghosts") and 372 edges (including self loops and "ghost" nodes). The test run revealed three problems within the graph: the emergence of the empty "ghost" nodes, parallel edges and thirdly self loops.

The "ghost" nodes were excess nodes with no name and only an id number and one or two connections in the graph. They were due to the references to the data points removed from the original dataset, and therefore can be ignored. The ghosts are discussed further in the subsection sources. However, the more essential problem were parallel edges and self loops.

The parallel edges occur because one relationship, such as father and son, is sometimes marked parallel in the dataset. For example, in the case of Göran Göransson Gyllenstierna (id 87) the relatives are "Maternal Grandfather 184, Brother 90, Father-in-law 3, ...", and the same relationship is found in his grandfather's Johan Bengtsson (Schroderus) Skytte's (id 184) links: "Son 183, Grandson through daughter 87". Yet, the connection to Göran Göransson's brother Johan Göransson Gyllenstierna (id 90) is not marked in the grandfathers links. This means that the node of Göran Göransson Gyllenstierna (id 87) has one excess link compared to his brother's node. The case is visualized in the Figure 2.

These duplicate edges would cause bias to the calculation of the node degrees and any statistics based on them. A node degree is a sum of all the edges connected to one node, and if the relationships are inconsistently marked with one or two edges, the factually similar nodes would get different degrees. These inconsistent node degrees would accumulate when counting the average degrees an so forth. The problem of parallel edges is widely recognized in the field of network analysis, and therefore Gephi does have some builtin features for handling it.

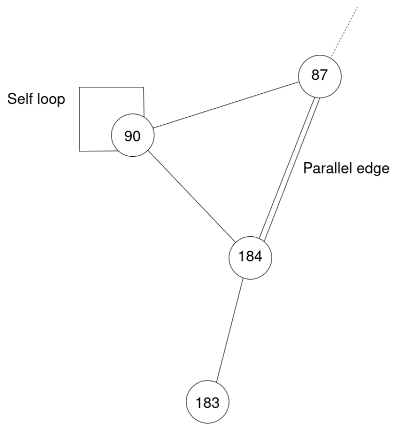

Figure 2: Visualisation of the parallel edge and self loop

While importing data to Gephi (on Import Spreadsheet) the strategy for merging the parallel edges can be chosen. One option is, for example, placing the sum or average of the parallel edges in the edge's degree, yet using only one connection to to represent the edge in the graph. In this context a more simple solution was chosen, with the option "Firs" Gephi will use only the first connection between two nodes ignoring any latter ones. This will reduce the amount of connections from 698 found in the connections.csv to only 372.

Self loops occur when one node has – for some reason or another – a connection to itself. Similarly to the parallel edges, they cause bias to the node degrees. In this graph a self loop can be found at least on the node with id 5 and id 90. In the case of id 5: Gustaf Axelsson Baner, his relatives are "Father 4, Father-in-law 217, Brother 9, Sons 5, 7, 8, 10, Sons-in-law 152 and 197", and similarly with id 90: Johan Göransson Gyllenstierna his family reads "Maternal Grandfather 184, Brother 90". These self loops are most likely caused by a typo in the dataset, because it is reasonable to assume that none is a son or brother to themselves.

Gephi does have a switch whether or not self loops are allowed in the graph, and it can automatically remove them based on the preference. The self loops are present in the test run graph alongside with the ghost nodes, yet those will be removed from the subsequent analysis. To highlight the ghosts they are colored cray, and the four nodes referred as an example here are colored red in the test run graph.

The last step in the preparation of the network analysis is the selection of the layout algorithm. For the test run an algorithm called Yifan Hu was used with default configurations except parameter theta set to 2.0. Then layout option "noOverlap" was chosen to separate possibly overlapping nodes, and some further manual placement of the nodes was done to make the graph more readable. The outcome was visually somewhat dense network in the middle and mostly unconnected isolated nodes around it.

2.3 Fitting modern model on historical timeperiod

Figure 3: Lineage of the house of Vasa from the *Hortus Regius* or "Queen Christina's Genealogical Tree with Political Emblems".(Rosenhane and Holsteyn (artist) 1645)

3 Conclusion

Collecting and creating network data from scratch is hard and time consuming. What comes to early modern studies, we should also try to reconstruct the networks between women.

Primary sources

Hakanen, Marko, and Ulla Koskinen. 2017a. *Swedish Councillors of the Realm, 1523-1680.* doi:https://doi.org/10.17011/jyx/dataset/55523.

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