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Game of Networks: Family Ties Within the Swedish Council of the Realm (1520-1680)

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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 early modern history, because the timeframe of this study covers most of the 16th and 17th century. The work can also be categorized to political history due to the themes of authority and the Council of the Realm as a political institution. Methodologically, the study is macro-level 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 assesment of the results of the network analysis, and the last section collects everything together as a conclusion.

According to historians Miia Kuha and Petri Karonen, majority of historiography concerning Nordic countries in the early modern period is written in the national languages, in this case, Swedish or Finnish.[1] To make the subject, dataset and method more approachable for international–or at least Nordic–scientific community, I decided to write this work in English. This is a natural option also because English is language widely used in the field of programming and statistics.

1.1 Research Questions

The research questions are:

1. Can historical network analysis reveal new or unseen patterns in the affiliations

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

between Swedish councillors of the Realm?

- How dense is the network (how linked the council was in general)?
- 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.

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

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, 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 his-

[3] Elo and Kleemola 2015, pp. 415-417.
[4] Elo and Kleemola 2015, pp. 415-417.
[5] Keats-Rohan 2007, pp. 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).

torical 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 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 lower-ranking groups. Overall, in the latter half of 20th century more attention was paid towards lower social groups. 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 Ågren.[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

[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] Karonen 2014; 2009b, See e. g. Pentti Renvall "*Keskitetyn hallintolaitoksen kehitys*" in *Suomen kulttuurihistoria. II* (1934) or Kurt Ågren "*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.

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 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

> The position of the councillors of the realm was well recognized by the whole society. They were an elite group which enjoyed formal position in the power structure. Their job was to help the monarch reach decisions.[20]

In the early modern Sweden the Council of the Realm (Privy Council, swe. Riksrådet, fi. valtaneuvosto) was to give council to the Royal Majesty (monarch, king or queen) on decision making. The Council consisted of noblemen loyal to the monarch. The councillors held a signifficant power and authority on the realm, yet, the Council did not have the ability to make decisions bypassing or opposing the monarch. Ideally decisions would be made in concensus with the king or queen and the Council.[21]

The position of the Council as an institution was established in the early Middle Ages. With the elective kingship in the medieval period, the elections of Swedish kings were made with the consent of the Council. The authority and power possessed by the Council fluctuated from time to time, but it is said to been been on in its peak during the 15th century. However, in the early decades of the 16th century, the Council took part in the plot against the personal union of Sweden and Denmark *Kalmar Union* (1397-1523) and the Danish king. Consequently, ten councillors lost their lives in the dramatic events of

[17] Hakanen and Koskinen 2017b, pp. 47-48.
[18] Hakanen and Koskinen 2017b.
[19] Hakanen and Koskinen 2017b, p. 48, 67 (cite 4).
[20] Karonen and Hakanen 2017, p. 26.
[21] Karonen 2009a, pp. 13-14, Hakanen and Koskinen 2017b, pp. 47-50.

Stockholm Bloodpath or "the coronation of King Christian II of Denmark" in November 1520. These occurrences soon lead to the splitting of the Kalmar Union and Gustavus Vasa's (1495/1496-1560) rise to power.[22]

Following Gustavus Vasa's and his descendants accessement of the throne, the authority and power of the Council and upper aristocracy weakened. The Council was only called on by the king, further, the king was the one who chose the members of the Council, hence being able to favour the ones conforming him.[23] Gustavus Vasa and his sons percieved the upper aristocrats as rivals, therefore relying on the unoffical help and support of their ignoble[24] secretaries.[25]

Overall, the timeperiod between 1560 and 1611 was politically turbulent and unpredictable in the Swedish realm. The passing of Gustavus Vasa in 1560 lead to the bitter rivalry and struggle over the inheritance of the throne between his three sons. Each of his sons ruled Sweden for relatively short period of time, and the unforeseen changes of monarchs meant that the Council and nobility had to adapt and swear allegiance to the right sovereign at the right time. Loyalty to the wrong party lead to fall from favour at best or execution at worst. It can be considered essentially dangerous to be in a position of power during that timeperiod.[26]

The Council faced the the most severe crisis during the 1590's civil war. The warfare over Swedish throne was fought between Gustavus Vasa's youngest son Duke Charles (future king Charles IX 1550-1611) and Gustavus Vasa's grandson the king of Poland Sigismund. The war lead to the Duke Charles' rise to power, and the demise of the noblemen and councillors who had opposed him.[27] In fact, the Council was practically decimated in 1601, nonetheless, the kingdom needed the help of a legitime Council in order to take care of the administrative and diplomatic tasks. In 1602 Duke Charles appointed 15 new councillors.[28]

After the death of Charles IX in 1611, Charles' oldest son Gustavus Adolphus (Gustav II Adolf 1594-1632) became the king. At that time, the kingdom was at war with Denmark. To appease the nobility and settle the political situation within Sweden, Gustavus Adolphus gave a charter of guarantees, which, for example assured all of the high posts in civil administration to the nobility by privileges.[29] The authority and position of the aristocracy and the Council incremented significantly in the early 17th century. Due that, the Council was able to set the Regency (swe. Förmyndarregering, fi. holhoojahallitus) after the king's sudden death in 1632. Additionally, the Council started to gather

[22]Hakanen and Koskinen 2017b, pp. 49-50, Karonen, Hakanen, and Einonen 2017, pp. 8-9.

[23]Karonen 2014, p. 58.

[24]Nonaristocratic, common.

[25]Hakanen and Koskinen 2017b, p. 53.

[26]Karonen 2014, pp. 96-121, Hakanen and Koskinen 2017b, pp. 51-52.

[27]Hakanen and Koskinen 2017b, pp. 57-60, Karonen 2014, pp. 96-121.

[28]Hakanen and Koskinen 2017b, pp. 57-59.

[29]Karonen 2014, pp. 121-123, Karonen, Hakanen, and Einonen 2017, pp. 8-9.

Table 1: Parameters on the number of councillors between 1520-1680.(Hakanen and Koskinen 2017a) Calclutaed with R script: https://github.com/Heidi-Suurkaulio/mastersthesis/tree/main/RScripts

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
1.00	19.00	23.00	24.29	27.00	48.00

recurringly in Stocholm. The 1634 Instrument of Government (swe. regeringsform, fi. valtiomuoto) further warranted the position of the nobility and the Council.[30]

The position of the nobility and the Council started to decline drastically after the Charles XI's (1655-1697) succession of the throne in 1672. In the Diet of 1680 the monarch practically retracted the status of the Council. In 1681 the Council of the Realm was renamed the *Royal Council* (swe. Kungligt råd, fi. kuninkaallinen neuvos). Concurrently, the Great Reduction was being implemented, meaning that the fiefs[31] were reclaimed to the state. The reign of Charles XI is retroactively called the Age of Absolutims in Sweden.[32] Finally, in the 18th century the role of the Council steadily declined further, and it was disestablished during the reign of Gustavus III (1772-1792).[33]

The 1442 Law of Realm ordered the Council to be consisted of 12 noble men and varying number of bishops and other clerics.[34] As the religious reformation was implemented during the reign of Gustavus Vasa, the bishops and church men lost their position in the Council. Thereafter, the Council consisted primarily of noble men during the 1523-1680 time period.[35]

According to the *Swedish councillors of the Realm, 1523-1680* -dataset, between 1520 and 1680 the number of active councillors per year changed between 1 in 1601 to 48 in 1654, the mean being 24.29 and median 23. Most of the time the number was between 19 and 27 (Table 1).[36] The fluctuation of the councillors count is visible in the Figure 1.

Generally, it seems that the broader position of the Council and the enclosing aristocracy is proportional to the amount of the councillors. However, such an abstract and broad concept as 'position' should be understood as a *latent variable*. Latent variable meaning a factor that is mesurable and observable only indirectly through modeling and calculating other variables.[37]. As well as the definition of 'position' as a concept not being that simple and straight forward. It cannot be indubitably quantified in one diagram.

[30] Karonen 2014, pp. 195-197, Karonen and Hakanen 2017, pp. 16-17, Karonen, Hakanen, and Einonen 2017, pp. 8-9.

[31] Lands given to the aristocracy.

[32] Karonen 2014, pp. 289-295, Karonen, Hakanen, and Einonen 2017, pp. 8-9.

[33] Karonen 2009a, p. 14.

[34] Hakanen and Koskinen 2017b, p. 49.

[35] Karonen 2014, pp. 72-75, Karonen and Hakanen 2017, p. 15.

[36] Median is the middle observation on the data, it usually represents the middle point of the distribution.Box et al. 2005, p. 26, Moore, McCabe, and Craig 2017, pp. 30-31. 1/2 (50%) of the observations lay between the 1st and 3rd quartile.Moore, McCabe, and Craig 2017, pp. 32-33.

[37] "APA Dictionary of Psychology" 2018.

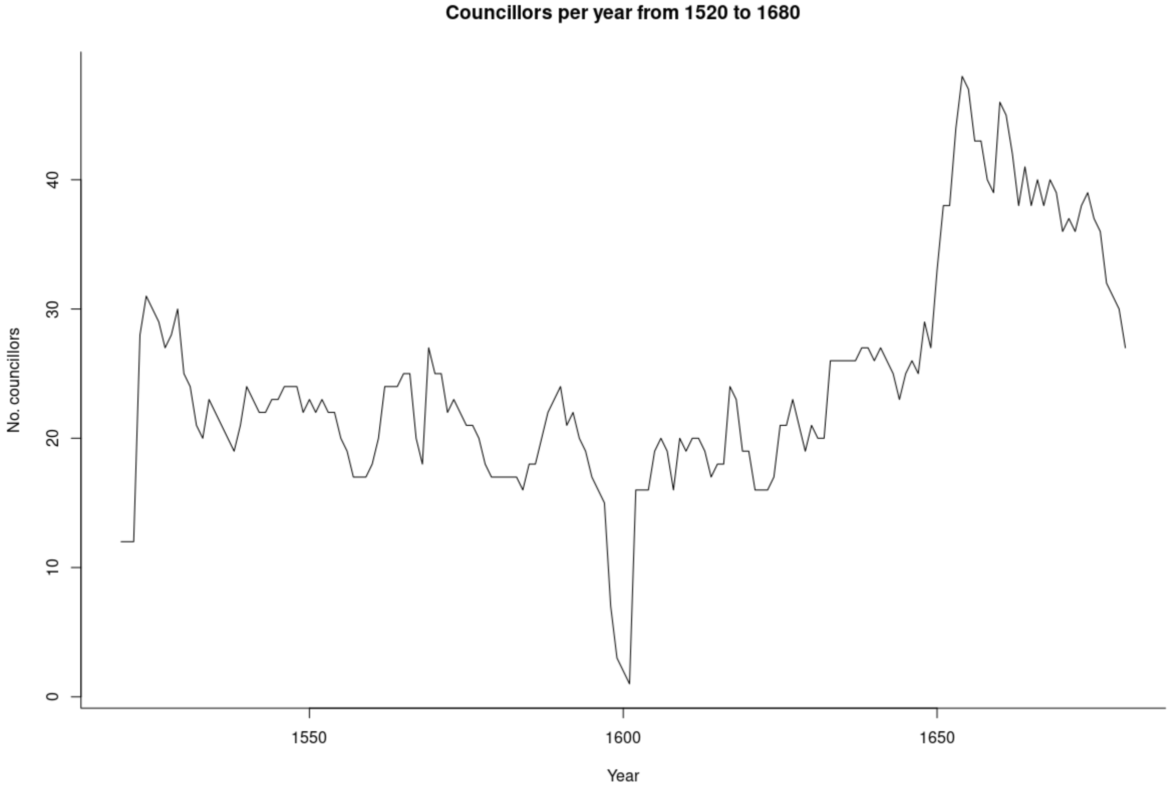

Figure 1: The changes of the number of councillors per each year.(Hakanen and Koskinen 2017a) Plotted with R script: https://github.com/Heidi-Suurkaulio/mastersthesis/tree/main/RScripts

In Figure 1, the amount of councillors declined during the religious reformation in the first half of the 16th century. Then the political instability is seen in the downward spikes after year 1560, most dramatic of those being in the turn of the 16th and 17th century. The amount started a rapid incline somewhere mid 17th century and hit its peak in 1654. It being the year queen Christina (1626-1689) relinquished the throne to her cousin Charles X Gustav (1622-1660).[38] According to Hakanen and Koskinen queen Christina could also have deliberately raised the number of councillors in order to dilute their power.[39] Yet, closing the year 1680 the number starts to drop exceedingly.

In early modern Sweden the monarch was the highest authority. Practically the deeds of the royal family members were on the second place, and the power of the Council came afther these two. Beneath these was the Diet of Sweden (swe. Riksdag, fi. valtiopäivät): the representatives of the four estates–the Nobles, the Clergy, the Burghers and the Peasants–that was to negotiate and legitimate the rules and laws given by the monarch.[40] All in all, the place in the Council of the Realm was highly sought after, and compared to the surrounding society or even encompassing nobility, the members enjoyed a significant

[38] Karonen, Hakanen, and Einonen 2017, pp. 8-9.
[39] Hakanen and Koskinen 2017b, pp. 63-64.
[40] Karonen 2014, pp. 57-61.

valuation, authority and most of the time prosperity and wealth.

1.4 Sources

Since this work is conducted with pre-collected dataset, this work can be vaguely categorized as secondary analysis. Secondary analysis meaning re-analyzing 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 (usually with quantitative methods) to create a synthesis on a certain question.[41]

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.[42] 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 original authors call it *database*. The difference between dataset and database is not clear-cut, but for example the U.S. Geological Survey (USGS) compactly 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.[43] 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.[44]

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

[41] Card and Little 2012, pp. 4-5.
[42] Elo and Kleemola 2015; Lintunen and Elo 2019.
[43] "What are the differences between data, a dataset, and a database?" 2022.
[44] Hakanen and Koskinen 2017b, p. 48. 2017a.

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.[45] As reported by Hakanen and Koskinen the dataset is collected using methodologies of collective biography, new prosopography and source criticism.[46]

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 2, 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 time span 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 from the 16th and 17th centuries, they are notably dispersed.[47] A case in point: according to the Dictionary of Swedish National Biography (Svenskt biografiskt lexikon) the birth year of king Gustav Vasa (1495 or 1496) is also an estimate.[48]

In practice, one of the registers the 1686 Church Law made mandatory to keep, were the books of births and christens (*födde och döpte / födelse- och dopböcker*). At first, it was necessitated to mark the name of the father, child's birthday and the day of the christen with the first name(s) of the nweborn to those records. The act of marking the mother's name and age and the godparents was adopted later, during the 18th century. After all, approximately 10 to 20 per cent of children are estimated to be systematically missing from these records prior to the mid-19th century.[49]

As the parish registers were kept primarily for the needs of local earthly and religious life, the first offical census (population tally) was conducted in the kingdom of Sweden in 1749. Yet, the census was based on the same records kept and collected by the parish vicars.[50] Therefore, we have generally quite limited knowledge on the population of early modern Sweden.

[45]Hakanen and Koskinen 2017b, p. 48, 76; 2017a.
[46]Hakanen and Koskinen 2017b, p. 48.
[47]Viikki 1994, pp. 169-176.
[48]Svalenius 1969.
[49]Eilola 2021a.
[50]Eilola 2021b.

For instance, historian Miikka Voutilainen with statisticians Jouni Helske and Harri Högmander have calculated the approximations of the population of Finland (eastern part of Sweden) between 1647 and 1850 with the parish registers and censuses. Due to the scatteredness and lack of the data they have utilized the *Bayesian statistics* along with computer simulations to calculate the estimated population. According to their model, the population of Finland was slightly less than 500 000 in the latter half of the 17th century, however, as the authors point out, estimating the population in the 17th century is relatively uncertain.[51] In his monograph *Pohjoinen Suurvalta* historian Petri Karonen refers to scholars who have previously estimated the population of Sweden being ≈ 1.15 million (Finland $\approx 300\ 000$) in 1570, and ≈ 1.5 million (Finland $\approx 330\ 000$) in 1620.[52]

Speaking of the scatteredness of the early modern source material, Bayesian statistics could be an applicable method on the study of the time period. Bayesian statistics is a separate paradigm in the field of statistics. In Bayesian approaches the concept of probability is thought as *inverse* or *subjective* meaning that the observed outcome is subjected to the previously known (*prior*) data. As an illustration, if we notice a street is wet, we most likely suspect a rain cloud or a Street sweeper instead of aliens crying large tears, based on our prior knowledge. Most of the times Bayesian models are based on computer simulations. Yet, instead of fixed values Bayesian models usually produces *posterior distributions* meaning distributions of the most likely outcomes of the model.[53]

Missing data directly affects the observation of the family affiliations. However, the focus of this work is not on the ages of the councillors but in their relations to each other, so, the more relevant question is whether or not there are missing family links.

Generally it can be assessed that family links found in the dataset represents the *lower limit* of the possible family ties. Bayesian methods could be used to further estimate the amount of family ties left unnoticed from the modern scholars.

Lastly, 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.

[51] Voutilainen, Helske, and Högmander 2020.
[52] Karonen 2014, pp. 33-34.
[53] Kruschke 2015, pp. TODO; For posterior distribution see e. g. Voutilainen, Helske, and Högmander 2020, Fig. 3.

Table 2: 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 3: 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)

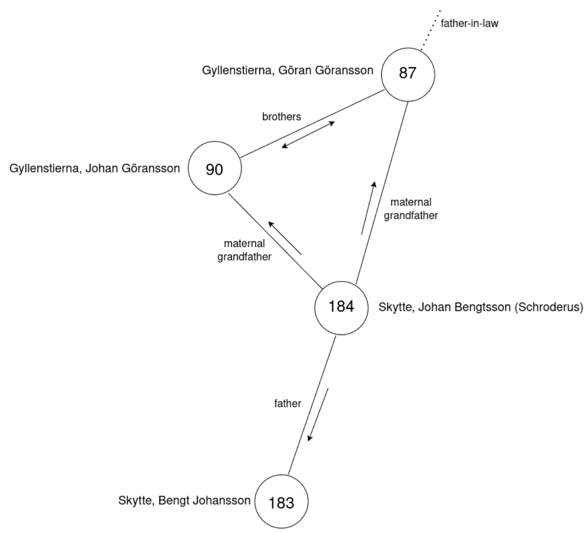

Figure 2: A sample from the graph

2 Method

(TODO the history of network analysis) 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).

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 2 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 and Göran Göransson are brothers, however, their father is not mentioned in the dataset. Göran Göransson also has further links in the network.[54]

Calculating different statistics is a crucial part of the network analysis. One of the most important measures is the **node degree**. The node degree simply means the number of edges adjoined to a specific node.[55] For example, the degree of the node depicting Johan Bengtsson (Schroderus) Skytte (id 184) is three, and the degree of the node depicting

[54] Hakanen and Koskinen 2017a.
[55] Raj P. M., Mohan, and Srinivasa 2018, pp. 2-3.

Bengt Johansson Skytte (id 183) is one.

The **average degree** is the mean of all the node degrees of the specific graph. It is calculated by adding all the node degrees and dividing the sum with the number of nodes.[56] In the case of this study, the average degree describes the average number of direct family links councillors had within the Council. The average degree of Figure 2 is $\frac{1+3+2+3}{4} = 2.25$.

The **density** of the network is also based on the node degrees. In a dense network almost every node is connected to each other, but a sparse graph has just a few edges between the nodes. The density is calculated by dividing the number of actual edges with the mamximum number of edges. The scale of density is from 0 to 1, 1 implying a **complete graph**. In a complete graph each node is adjoined to each other node.[57] In pratice, density is probably not the most depicting parameter of social networks because it is heavily dependant on the size of the network.

The maximum edges–meaning the amount of all possible edges–increases rapidly with the number of nodes. Formally, the maximum edges follows the *binomial coefficient*. The formula being:[58]

$$\binom{n}{k} = \frac{n!}{k!(n-k)!} = \frac{n(n-1)...(n-k+1)}{k!}$$

In this case $k = 2$, because two nodes share one edge. The variable n is the amount of nodes in the graph. In R environment this can be calculated easily using the function `choose(n,k)`. For example in a graph consisting of 257 nodes (the amount of the councillors in the dataset) the amount of possible edges is 32 896:

$$\binom{257}{2} = \frac{257!}{2!(257-2)!}$$

or `choose(257,2)` with R.

In practice the rapidly growing amount of possible edges makes it inefficient to compare two graphs of different size. The number of possible edges in a graph with 100 nodes is 4 950 and in a graph with 101 nodes it is 5 050 a difference of 100 possible edges. In the context of social networks the difference is signifficant.

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.

[56] Raj P. M., Mohan, and Srinivasa 2018, pp. 3-4.
[57] Raj P. M., Mohan, and Srinivasa 2018, pp. 5-6.
[58] Laininen 2002, p. 16. Raj P. M., Mohan, and Srinivasa 2018, pp. 5-6.

2.2 Implementation of the Network Analysis

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

Python is a high level[59] programming language. Python can be used in variety of tasks including data processing, machine learning (AI models) or web development. Python is intended to be of object oriented programming style, however, it is not determined to be used only on that paradigm.[60] For instance, my personal programming style is more in the imperative style.

I selected Python due its simple syntax and ease in implementing relatively small tasks in data processing. The language is understandable and widely used amongst scientists, which makes the work replicable. To be precise the scripts are written with Python 3, exact version being Python 3.11.7.

As graphs are structures commonly used in programming, it would have been possible to conduct the actual network analysis using tools provided by Python or R[61], yet, Gephi software provides a graphical user interface (GUI) and more intuitive tools for the manipulation and visualization 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.[62] 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.[63]

Lastly, I use R programming language and environment for calculations and statistical analysis. R is a language and platform particularily designed for statistical analysis. It

[59] Meaning code intended to be read and undersood by humans if compared for example with binary code written only with 0s and 1s.

[60] Mastrodomenico 2022, p. 1.

[61] See e. g. Raj P.M., Krishna, Ankith Mohan and K.G Srinivasa *Practical Social Network Analysis with Python* or Dehmer, Matthias; Shi, Frank Emmert-Streib and Yongtang Shi *Computational Network Analysis with R.*

[62] "About Gephi".

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

contains tools and ready-made functions for efficiently calculating and plotting statistical data.[64] The language is widely used amongst scientists.

All of these tools are open source and free to download. In the name of replicability and transparency, all scripts written for this work available on my GitHub page.[65]

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[66]

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

[64] R 2020.
[65] `https://github.com/Heidi-Suurkaulio/mastersthesis`
[66] `https://github.com/Heidi-Suurkaulio/mastersthesis/tree/main/TestRun`

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 "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 4: 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 5: 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 1.4. 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

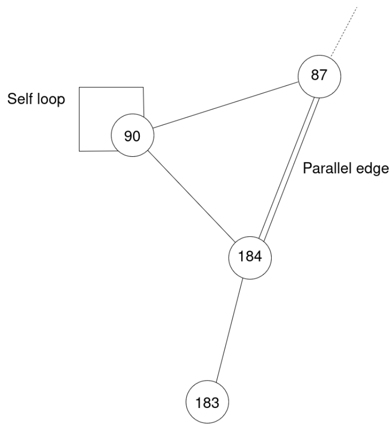

Figure 3: Visualisation of the parallel edge and self loop

is widely recognized in the field of network analysis, and therefore Gephi does have some builtin features for handling it.

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 a Historical Time Period

> Every model is an approximation.
> All models are wrong; some models are useful.
> (Box et al. 2005, prefix)

A graph is elementally a generalizing and simplifying model of complex social networks within the Swedish Council of the Realm. Yet, when bulding any kinds of (computational) models, decisions between the complexity and abstraction must be made. In fact besides too simplifying models, too complex or overfitted ones are a problem on their own.[67] Due that, one of the most important question is what factors to include and and what to exclude. Yet, a more existential question is what we can even know about historical social networks.

As I am working with pre-collected data, many of the significant choices have been made by the authors of the dataset, Hakanen and Koskinen, and by the scholars their work is leaning on. Thus, it is important to understand the limitations of the data and model. The data–and consequently the graph–is able to give an abstraction of the offically recorded family links inside the Council of the Realm. However, with the data in question, it is not possible to know about the messy every day relationships, friendships, informal discussions, intentions, emotions or disputes these 257 men have had.

The general historical data also has its limitations. What comes to the study of early modern period, the scholars are working with a finite body of source material. As mentioned in the section 1.4 the national order of keeping records of the parish population was given in 1686. And, source material concerning lower social estates and groups like peasants, women or marginalized groups are even harder to find.[68] Still, at least noble women are included in the contemporary lineage diagrams as seen later in Figure 4, which in itself means that women had meaning and status in the social realm. So maybe building a network including noblewomen or the noblemen and their clients would be an achievable task in the future.

As discussed in the beginning of this section (2) networks were not explicitly part of the early modern social or political theory. However, did the contemporaries understand their social relations–families and friendships–as networks is a more complex question. And it probably cannot ever be answered undisputedly. Still, when applying a modern model to historical context, it is important to remember that we are operating on modern time with modern understanding, and be aware of the possible anachronims.

[67] TODO
[68] TODO

Figure 4: Lineage of the house of Vasa from the *Hortus Regius* or "Queen Christina's Genealogical Tree with Political Emblems".(Rosenhane and Holsteyn (artist) 1645)

Early modern Sweden was a hierarchical and inegual society. The social order was divided into four estates: the Nobles, the Clergy, the Burghers and the Peasants, which all had their own privileges and duties. Most of the privileges belonged to the Nobles while the Peasants had parctically none. Even though the ideal of the society was static–everything and everyone had its owen place–social mobility amongst the estates did happen.[69]

The social structure was justified by the Lutheran theology and religion. According to Lutheran doctrine, God had chosen the monarch to hold the divine power and justise on Earth, as God did in the Kingdom of Heaven. The disrespect of the monarch became a taboo, and an unexpiated sin would doom the whole community to face the God's wrath. Still a consensus and harmony were seen as ideals in the political sphere.[70]

For instance, a widely known manuscript from early modern period *Hortus Regius* ("the Royal Guarden") can be used to illustrate the worldview of the early modern nobility. *Hortus Regius* is digitized and freely available on the internet making it easy to

[69]Karonen 2009a, pp. 21-23, Karonen and Hakanen 2017, pp. 21-22.
[70]Karonen 2009a, pp. 24-28, 2014, pp. 161-163.

approach.[71] The book was given to queen Christina by a diplomat Shering Rosenhane (1609-1663) in circa 1645. It consists of delicately illustrated political emblems[72] and noble family trees leading to queen Christina.[73] The manuscript has been widely used by scholars of early modern Norden.

In his monography *Pohjoinen suurvalta* Petri Karonen interprets the drawing of a building and scale found in *Hortus Regius* as a metaphor to the structure of the kingdom. The building consists of four floors on top of each other. Each floor represents each estate. Next to the building is a scale with a crown on one side and the symbols of the four estates on the other. When the crown and the symbols are present, the scale is in equilibrium. The hierarcical structure of the building with the scale were symbols of the ideal static, harmonious and immutable world order.[74]

When it comes to the subject of this work, the more relevant parts of the manuscrip are the family trees. In *Hortus Regius* there are nine genealogy charts depicting royal families in Europe at the time. The charts are drawn as trees with filigree leaves, and beautiful backgrounds and animals such as lions, horses and deer beside them. The ornaments probably holding meaningful symbolism.[75] Figure 4 is a portrayal of the patrilineal tree of queen Christina and also the Vasa dynasty.

Gustavus Vasa "Gustavus I Rex" is found on the trunk of the tree. His children–including the female descendants–and their families are depicted as the branches. Gustavus Vasa's son and Christina's grandfather king Charles IX "Carolus IX Rex" and Christina's father Gustavus Adolphus "Gustavus Adolphus Rex" can be found near the treetop. Christina herself "Christina Regina" is on the top of the tree with a crown.

Interestingly, some political picks are easy to spot on the genealogy chart of Vasa dynasty. The branch of Gustavus Vasa's son king Eric XIV (1533-1577) "Ericus 14 Rex(TODO check)" is broken violently leaving behind just a sharp cutting. In fact Eric was dethroned by his brother duke John (1537-1592, future king John III) and later poisoned.[76] Yet, no mention of Eric's two children with his wife of ignoble birth Karin Månsdotter can be found either. These political choises are understandable when thinkig the family tree in its context.

As a matter of fact, genealogy charts were of a high value to the aristocracy on the early modern timeperiod. Family trees were to prove the noble birth and therefore to legitimate the high status and rank (the position signed by God). The charts have been

[71] In 2025: Internet Archive: `https://archive.org/details/urn-nbn-se-kb-digark-4937173/mode/1up` Library of Congress: `https://www.loc.gov/resource/gdcwdl.wdl_17187/?st=gallery`.

[72] Instructions, virtues, metaphors

[73] “"Hortus Regius" or Queen Christina's Genealogical Tree with Political Emblems.”; Blennow 2023, p. 271.

[74] Karonen 2014, pp. 162-165.

[75] Rosenhane and Holsteyn (artist) 1645.

[76] Melin, Johansson, and Hedenborg 2006, pp. 118-124.

so valuable that in some cases they have been enhanced or even forged.[77]

One compelling question is wheither or not family trees can be understood as networks.[78] Technically they do fit the criteria of a network with nodes (persons) and directed edges (inheritance). Furthermore, some text books have depicted family trees as an examples of simple networks.[79] Obviously, family trees still have not been used in the sense of network analysis or as analytical tools as we know them today. But the contemporaries may have still been more familiar with the idea of networks than we may think.

2.4 the Script

For the conclusive analysis, I did some improvements to the Python cript. The script is available in GitHub[80] and can be found in Appendix A. The viable version of the script is largely based on the test run script, however I added the functionality and did some refactoring; adjustments to make the code more slick.

The scirpt reads and prints data in exaclty same format as the previous one. The input data must be formatted similarily to the example of Table 2 in the .csv format. However, the name of the input file is given as a command line parameter. The new functionality is that also the timerange of the network can be delimited with command line parameters. As a side-effect of the timerange functionality, the "ghost" nodes discussed in Chapter 1.4 are removed automatically.

The format of the command is as follows:

```
python data_sifter.py Councillors_of_the_Realm1523-1680.csv
```

This produces the network from the original timeperiod given in the dataset. And, for example, command "`python data_sifter.py <dataset.csv> prior 1650`" and "`python data_sifter.py <dataset.csv> post 1590`" limits the networks to councillors and their relatives appointed before 1650 or after 1590. Lastly the command "`python data_sifter.py <dataset.csv> 1540 1620`" delimits the network to councillors and their relatives appointed between 1540 and 1620.

When it comes to the script and the graph, I made some simplifications. The types of the relationships, such as brother, grandfather or , are not taken into account. Each relationship is taken from the dataset by the Id number and marked as an undirected edge with weight standard 1.0. This means that the graph does not separate blood relations from the relationships formed through marriages. As family ties per se have

[77]TODO

[78]I have had unoffical discussions with my friends an colleques about the subject matter and most of them have counted family trees as networks.

[79]See e.g. TODO

[80]`https://github.com/Heidi-Suurkaulio/mastersthesis/tree/main/PythonScript`

Table 6: Example of the test dataset

Name;	Id;	Appointed;	Family
A;	1;	1000;	example 11
B;	2;	1000;	3, 4

been mentioned to be important in the previous research, this graph depicts family ties as an abstraction.[81]

The second simplification is that only the years of appointments are taken into account, but the years of death are not. Most of the time the position of the councillor was a lifelong.[82] So, the graph can not give a defined picture of the amount of the councillors active during a certain timeperiod. Basically the graph represents the family network of councillors appointed during certain timeperiod, and answers the question: *Who were appointed to the Council and to which degree they were related to each other?* The script could be further develop into regognizing the type of the relationship and taking the years of death–the obvious end to the position–into account.

2.4.1 Testing the Script

Before anything else the script had to be tested. Testing is one of the most important–yet daunting–task in programming. Due the size and complexity of the Councillors dataset, the Python script is hard and ambiguous to test with the original data. To test the logic and behavior of the script I crated a small test dataset with simple dummy data. The test dataset is intentionally so small that it is readable by human. With the script the test dataset is available in GitHub.[83]

The test dataset consist of 12 entries with values for name, Id number, (year of) appointment and family links. The names are represented by capital alphabets from A to L, and Ids are sequential numbers from 1 to 12. The values in appointment-column are numbers between 1000 and 1299, and there are intentionally four entries within every range of 100. The family links are represented by numbers found in the Ids except one which should be excluded by the script if everything works as planned.

When run with default setting the test dataset should produce 13 connections excluding the connection to the non-existent Id 30, as it does. Giving the range 1000-1999, 1100-1199 and 1200-1299 as arguments divides the dataset in the groups of four as intended. Lastly giving the "prior 1150" and "post 1138" as arguments reduces the amount of entries and connections as expected. With the small test dataset the algorithm should work as intended. Inconveniently, the accuracy of the connections still has to be checked manually.

[81] TODO
[82] Hakanen and Koskinen 2017b, TODO.
[83] `https://github.com/Heidi-Suurkaulio/mastersthesis/tree/main/PythonScript`

To review the results the script gives with the original dataset I used some simple R script to do dublicate checking.

Table 7: Absolute amount in different ranks

Commoner	Ennobled	Estate unknown	Unknown	Ancient nobility	
5	8	7	1	236	= 257

Table 8: Proportional amount in different ranks

Commoner	Ennobled	Estate unknown	Unknown	Ancient nobility	
1.9	3.1	2.7	0.3	91.8	≈ %

3 Family Ties Between 1520 and 1680

During the time period between 1520 and 1680 there were 257 men active in the Council of the Realm. As discussed earlier in subsection 1.3 the council consisted mostly of men with noble background. To quantify this: according to the dataset 236 of the 257 councillors (91.8%) were part of the ancient nobility "uradel", and only approximately 5% were of unknown or ignoble background, most of the time bishops or other clerics.

The kingdom of Sweden was ruled by nine monarchs: Gustavus Vasa (1523-1560), Eric XIV (1560-1568), John III (1568-1592), Sigismund (1592-1599), Charles IX (1599-1611), Gustavus Adolphus (1611-1632), Christina (1644-1654), Carl X Gustav (1654-1660) and Carles XI (1672-1697), and two regnants from 1632 to 1654 and from 1660 to 1672 during the time period. The amount of councillors appointed by each monarch[84] or regnant varied from none to 56. Yet, 13 councillors were present before the reign of Gustavus Vasa.

The monarchs who appointed the most councillors were Gustavus Vasa (56) and queen Christina (45). The large number of councillors appointed by Gustavus Vasa may be explained by the sheer length of his reign. He ruled Sweden for 37 years, whereas all of the other monachs ruled less than 20 years. Also the religious Reformation was performed during his reign. The bishops and clerics that lost their position in the Council were replaced by noblement chosen by the king.[85] As queen Christina ruled only for ten years, the exceptionally high number on her reign is interesting. Therefore, her reign will be discussed in greater detail in subsection 3.3.

However, the king who appointed no new councillors was the son of John III: Sigismund (1566-1632). He was both the king of Poland and Sweden forming a personal union between the two countries. Why king Sigismud did not appoint any new councillors?

All of the councillors active between 1520 and 1680 are represented in a graph of 257 nodes and 362 edges, with self loops and parallel edges removed. The number of edges exceeds the number of nodes which means that theoretically all of the nodes could be linked to one another. Although, the edges are not distributed that way. Some of the

[84] Calculated with a R script. To avoid the script dublicating the years that the monach changed, the beginning of each reign is adjusted, the actual year + 1. E. g. Eric XIV's reign is calculated 1561-1568, the actual being 1560-1668. This may cause slight inaccuracy.

[85] Karonen 2014, TODO.

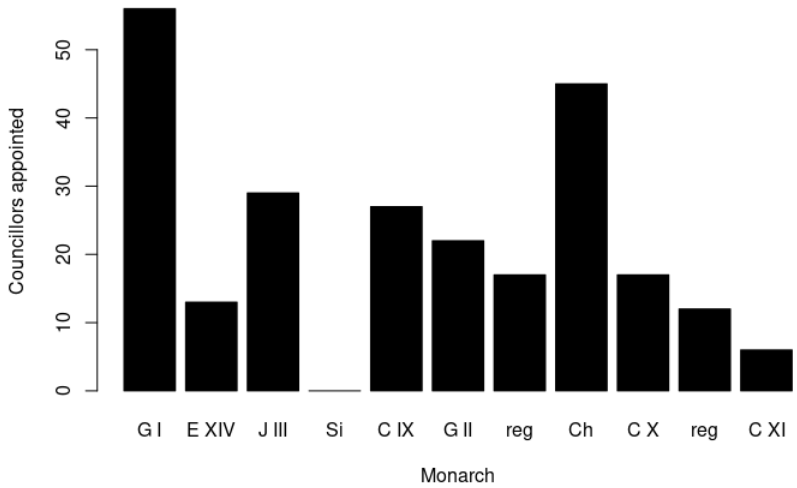

Figure 5: Number of councillors appointed by each monarch or regnant from 1523 to 1680. (Hakanen and Koskinen 2017a) From left to right G I: Gustavus I Vasa (1523-1560), E XIV: Eric XIV (1560-1568), J III: John III (1568-1592), Si: Sigismund (1592-1599), C IX: Charles IX (1599-1611), G II: Gustavus Adolphus (1611-1632), reg: regnant (1632-1654), Ch: Christina (1644-1654), C X: Carl X Gustav (1654-1660), reg: regnant (1660-1672) and C XI: Carles XI (1672-1697).

nodes are linked to more than one other node, but some isolated nodes are indeed present. The average degree of the graph is $2.817 \approx 2.8$ meaning that councillors typically had 2 or 3 direct relations to another members of the Council.

The graph density is 0.011. In the mathematical definition the graph is sparse (scale from 0 to 1). However, interpretation in practical sense is not that straightforward. Having a completely dense social network, meaning that every node is directly linked to each other, is almost impossible. In this context it would mean, that each councillor is a direct relative through blood or marriage to each other, which would be weird to say at least. Further, taking the dimension of time into account, the mathematical interpretation would be even more nonsensical: how a nobleman appointed to the council in the 1670's could be directly linked to a bishop died in 1530's.

The question wheither or not the councillors were higly linked to each other is more of a qualitative one. In the context of early modern institution, how we define a higly linked or even nepotistical institution? Probably the graph density has more explanatory value as a parameter to be compared between graphs collected from other contemporary communities.

Even so, the proportion of the nodes with at least one connection in the graph is $224/257 \approx 0.8715$ Which means that between 1520 and 1680 the probability of a councillor being related to someone else in the Council is $\approx 87\%$. In that sense the councillors can be considered highly networked.

Another interesting finding are the nodes with the highest and lowest degree. Maybe the most eclectic and fascinating group is the isolated nodes. There are 33 isolated nodes meaning that 33 councillors did not have any family ties within the Council. Some of them are members of the nobility with family ties to councillors active prior the beginning year of the dataset, so the connections are excluded from this graph. These are for example: Ture Bengtsson Lilliesparre (127) or Nils Olofsson Vinge (242). Yet, some of the isolated nodes represent bishops and clerics like Magnus Sommar (186) or Ingemar Petri (162) present in the Council before the religious Reformation.

Besides that, the isolated nodes also reveal something about the international relationships during the time period. For example a teacher from France Dionysius Beurraeus (12) or a Scottish baron Robert Douglas (58) can be found. Also the famous German born chancellor Conrad von Pyhy (168) is represented as an isolated node. During his stay in Sweden von Pyhy had a significant impact on the politics of Gustavus Vasa.[86] This means that as a merited foreigner one could make their way up to the Swedish Council of the Realm.

On the contrary, the nodes with the highest degree (≥ 5) are of councillors who are part of the old well established aristocratic families like De la Gardie, Oxentierna, Gyllenstierna, Bielke, Stenbock, Sparre and Ribbing. Also Finnish families of Horn and Kurck can be found.[87] That in itself ties to the previously known fact that the aristocratic families had a remarkable stance in the negotiations and politics of the Swedish kingdom.

To focus more on the temporal dimension of the graph, I decided to divide the dataset in half. As seen in Figure 1 the most intuitive point to do the division is between years 1600 and 1601. In year 1601 duke Charles had won the civil war against king Sigismund and he practically decimated the Council of the Realm while eliminating the noblemen loyal to the former king. However, by 1602 he had to appoint 15 new councillors in order to manage the growing number of tasks in diplomacy and administration.[88] By coinsidence, year 1601 also divides the time range of the dataset in half. The first graph depicts the network prior to year 1600 and the latter one post year 1601, so both of these represent the family ties accumulated approximately for 80 years.

3.1 Prior to Year 1600

The graph depicts the family links within the Council during most of the 16th century. It consist of 111 nodes and 92 edges. In this case the number of edges subceeds the number of nodes meaning that at least some isolated nodes must be present.

The average degree in this graph is $1.658 \approx 1.7$, meaning that typically councillors were directly related to one or two other members. The number is smaller than in the

[86] Karonen 2014, pp. 81-83.
[87] TODO
[88] Karonen 2014, TODO.

larger graph. However, it can be partly explained by the shorter time range, simply the family networks had not have enough time to accumulate. Thereafter, the closest comparison is the graph of councillors family ties post 1601, which will be discussed later.

The graph density is 0.015, allthough, comparing that to the larger graph is not that straightforward. The amount of nodes having at least one connection is $85/111 \approx 0.765$ meaning that the probability of councillors to be linked at least one other member is $\approx 77\%$. That is 10 percentage points smaller than in the larger graph. Even though this prior to year 1600 graph is not directly comparable with the larger graph, it indicates that the family links in the 16th century were more sparse.

The amount of isolated nodes is significant: 26–whereas in the larger graph it was 33. The fact that all of the bishops and clerics must be present in this graph partly explains this. Limiting the time range also breaks some of the existing links, so for example, Pontus De la Gardie seems to be without any connections in that graph, even though his descendands were remarkably woven into the networks of Swedish aristocracy. Taking these factors into account, still the relatively high number of isolated nodes may suggest the relatively high number of incomers and larger social mobility in general.

The nodes with highest degree (≥ 4) were of the remarkable noble families such as Bielke and Stenbock, however the Bååt family is more apparent in this graph than in the larger one or any of the later ones (TODO check). Did the house lose its standing somehow, or did they blend with the other noble families?

3.1.1 The Last Man Standing: Nils Gyllenstierna

The latter half of the 16th century and espcially the turn of the 17th century was politically turbulent time in the kingdom of Sweden. The latter half of the 16th century being affected by the rivalry between the sons of Gustavus Vasa which culminated in the civil war during the 1590's. The battle between king Sigismund and duke Charles was won by duke Charles, who later directed his spite upon the Council of the Realm. Many of the councillors were executed or fled Sweden. Despite that the Council was almost fully devastated in 1601, one councillor was left behind: Nils Göransson Gyllenstierna (91).

Due to these circumstances, Nils Gyllenstierna had an exceptional political career. He was a nobleman born in 1526, and appointed to the Council (most likely) by John III in autumn 1560 at the age of 35. When he died of natural causes in 1601 at the age of 75, he had served a total of 41 years in the Council. Furthermore, he had been able to keep his position throughout all of the Gustavus Vasa's sons reigns.[89]

What led him to keep his position?

In fact, the last councillor to be executed in Sweden was Hogenskild Nilsson Bielke

[89]Hakanen and Koskinen 2017a.

Table 9: Number of edges needed for different densities of network. The observed numbers are bolded

	Amount of possible edges		
Density	32 896 (all)	6 105 (prior to 1600)	10 585 (post 1601)
0.011	**361.9**	67.2	116.4
0.015	493.5	**91.6**	158.8
0.0174	572.4	106.2	**184.2**

(16). He was born in 1538, and appointed to the Council by king Eric XIV in 1562 at the age of 24. He was inprisoned in Linköping in 1600 due to his incautious letters regarding duke Charles. He was executed in 1605 at the age of 67. All in all, he had served in the Council of the Realm for 36 years (being inactive for two years between 1590-1591).[90]

3.2 Post Duke Charles' Revenge

Practically, this graph begins from the year 1602 when duke Charles had to appoint 15 new councillors and the Council of the Realm was re-established. The graph consists of 146 nodes and 184 edges, now the number of edges exceeds the number of nodes. After 1601 (or 1602) the average degree of node is $2.251 \approx 2.3$, larger than the 1.7 prior to 1600. Also, visually the graph seems more dense.

The number of isolated nodes is significantly lower: 16, compared to the 26 prior to 1600 or the 33 in the whole time period. Again it still must be remembered that limiting the time range cuts some family ties present in the dataset. Subsequently, the proportion of nodes with at least one edge is $130/146 = 0.890...$,thereby, the probability of councillor having at least one direct relation in the Council was now $\approx 89\%$. That is 12 precentage points greater than the 77% in the 16th century, and two presentage points greater then the 87% from the whole time period.

Also the density of this graph is the largest: 0.017. In prior to 1600 it was 0.015 and from the whole time period 0.011. To make the densities comparable to some degree, the amount of edges needed for different densities is counted in Table 9. Still, the scale of the larger graph makes it hard to compare with the other graphs, so, I will focus on the two smaller ones. The graph prior to 1600 would need ≈ 14 more edges to have the density of 0.017, whereas in the graph post 1601 the difference between the density of 0.015 and 0.017 is ≈ 26. This behaviour is explained in the subsection 2.1. So, even though the time scale is similar (80 years), the density and the absolute amount of edges is different. This means that it can be argumented that the post 1601 graph is more dense than the one prior to 1600.

What the isolated nodes can tell us?

All in all, 17th century has been called in the previous literature "the century of

[90] Hakanen and Koskinen 2017b, p. 58. 2017a.

the nobility", and the presented data seems to confirm the trend.[91] It seems that the family affiliations became more prominent in the Council of the Realm, and important in general, during the 17th century. Similarily, the amount of incomers decreased, which implies the slackening of social mobility.

3.3 In the Court of Queen Christina

Queen Christina was the daughter of the king Gustavus Adolphus and queen consort Maria Eleonora of Brandenburg (1599-1655). She inherited the throne at the age of 6, after her fathers sudden death in the battlefield in November 1632. Before she was declared an adult at the age of 18 in 1644, the kingdom was ruled by a regnant.[92] The reign and personal life of queen Christina are fascinating chapters in the Swedish history.[93]

Due that Christina's father was frequently away from Sweden and the long period of the interregnum, the authority of the Council of the Realm had grown remarkably when Christina was enthroned. Contrary to the previous monarchs, she was forced to go for the Council to get councel, yet, the situation did not stay that way for long. In the words of Hakanen and Koskinen:

> Christina played the high nobility at their own social network game rather than enter into open warfare with them. That is, she quickly created a large group of loyal supporters around her ...

Furthermore, she appointed many new councillors to dilute the power of the original Council. By the year 1654 she had appointed 45 new councillors.[94]

The network of councillors appointed by queen Christina is displayed in Figure 6. As queen Christina's reign lasted for only ten years the graph is not comparable to the other larger graphs, despite that, it is interesting in its own right. The graph consist of 45 councillors, all of them which must have been close to queen Christina in one way or another.

Overall, the network seems sparse, but, an interestingly clustered pattern can be found in the middle of the network. Eight councillors: Karl Mauritz Johansson Lewenhaupt (125), Gustaf Adolf Johansson Lewenhaupt (126), Gustaf Otto Gustafsson Stenbock (207), Fredrik Gustafssonare Stenbock (204), Erik Gustafssonall Stenbock (202), Bengt Gabrielsson Oxenstierna af Korsholm och Wasa (148), Gabriel Gabrielsson Oxenstierna af Korsholm och Wasa (154) and Hans Claesson Wachtmeister (240) are all related to each other direclty or indirectly.

[91] TODO

[92] TODO source

[93] For more information see e.g. Peter Englund *Silvermasken: en kort biografi över drottning Kristina* finnish version *Kuningatar Kristiina*, or Marie-Louise Rodén *Drottning Christina: en biografi.*

[94] Hakanen and Koskinen 2017b, p. 64.

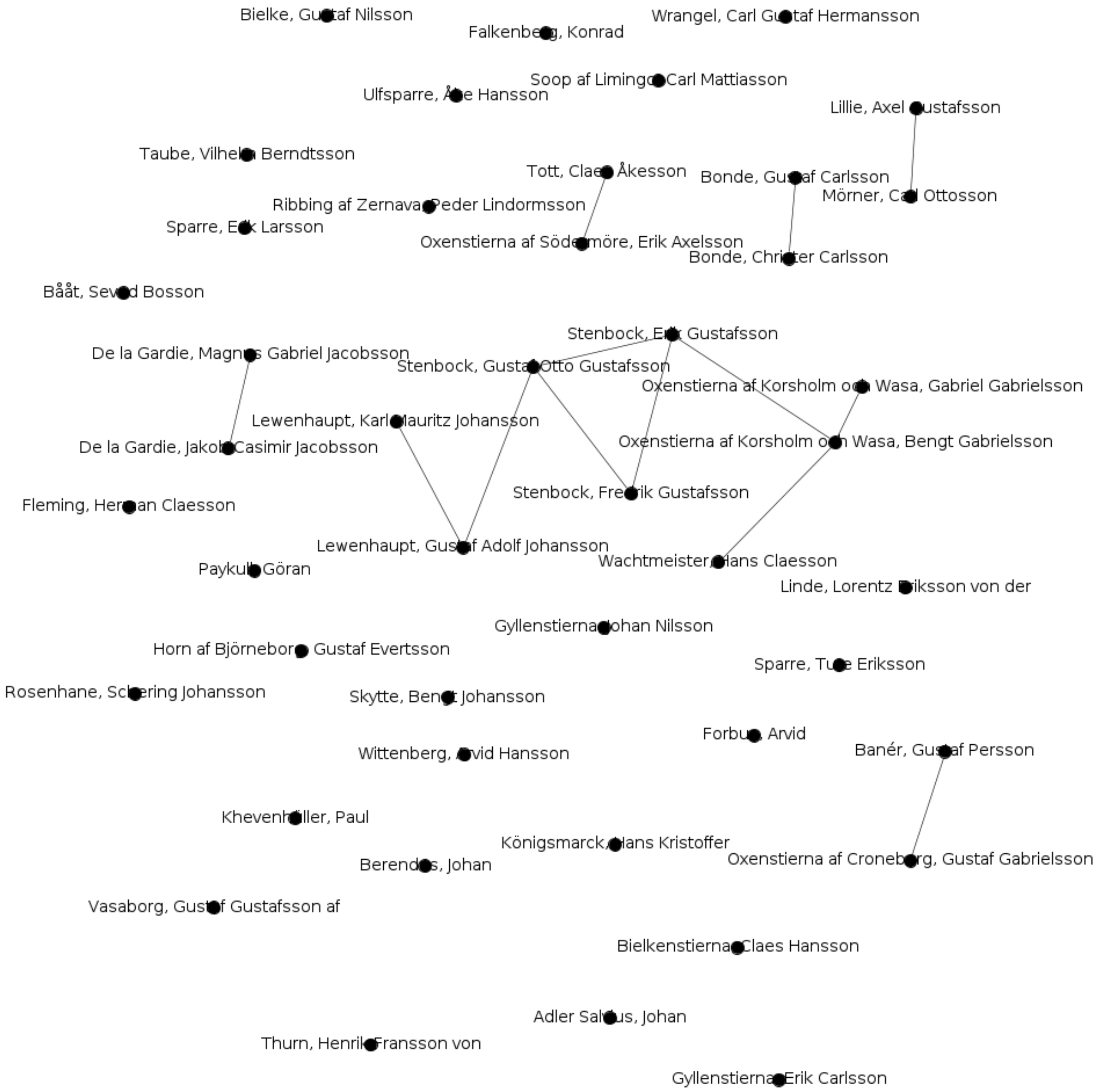

Figure 6: A graph of councillors appointed by queen Christina between 1644 and 1654.(Hakanen and Koskinen 2017a)

This tightly woven network seems to concentrate around the two brothers Gustaf Otto Gustafsson Stenbock and Erik Gustafssonall Stenbock. Due that they presumably had a significant position in the political life. What led them having this position?

Some other interesting individuals can be also found in the graph. Christina appointed his paternal half brother Gustaf Gustafsson af Vasaborg (241)–Gustavus Adolphus' illegitimate son–to the Council on 5th of September 1646. Also the diplomat and nobleman Schering Johansson Rosenhane (177) who gave queen Christina the *Hortus Regius* -manuscript was appointed to the Council by Christina on 30th of September 1650.[95] This may mean that family ties–even illegitimate–were of high value, but also mutual relationships had their place in the political sphere of early modern Sweden.

[95] Hakanen and Koskinen 2017a.

4 Conclusion

Network analysis can reveal new patterns on the family networks of the Swedish councillors of the Realm, but in this case, it mostly seems to support the already known. The graphs depicting the councillors' family ties in the early modern period are highly linked for the most part. This, in accordance with the previous research, indicates that an individual's place in the society was determined by the family background. Yet, the density of the networks–depicting the importance of the family relations–changes with time. The graph of the 16th century is more sparse than the graph of the 17th century.

Probably one of the most telling part of the graphs were the isolated nodes or lack of thereof. In the graph depicting the 16th century, the isolated nodes were somewhat common, but the amount decreased in the 17th century graph. In some cases the nodes were of incomers to the Swedish political life, and therefore indicating social mobility. The councillors represented by these nodes usually led interesting life stories.

When it comes to the question of noble houses, the graphs did not form visually separate subgraphs or components, which would indicate individual families or houses. Instead the well established and famous noble lines such as Gyllenstierna, De la Gardie and Sparre were present in the nodes with the most connections. In that case it seems that the family networks were connected to each other, and most prominent houses were integrally intervowen into the network of the councillors of the Realm.

Collecting and creating network data manually from scratch is a daunting and time consuming task. To make process of building the graphs from already existing data easier, I coded a small Python script to do the manual, error prone and dull work for me. Altogether, automatizing the process of extracting historical data is not that straightforward.

> Here is a truth: nobody wants to run your program. What they want is to get their work done, or play their game, or send their email... The truth is that good code is invisible. It simply allows things to flow smoothly. Bad code is memorable. It interferes, makes people frustrated and angry.(Parker 2021, prefix p. XVI)

Automatically processing data that is not designed and collected to be automatically processed is hard. Scripts do not have an understanding of context. If the dataset or file names contain minor characters, such as dots or spaces, the script may crash. These detrimental small characters have to be manually replaced from the dataset or to be excluded from the processed data. Also the slighest changes in the spelling is able to corrupt the whole model.

For instance, working on a similar task for the *Shared Past, Different Interpretations* -project, I came across two different spellings of the same name in the dataset. This caused the script to create two nodes, of the one and same person to the graph. To make matters worse, the person was a highly central figure on the network, and the conflicting nodes discretely broke the whole model. With the help of alert colleaque, and by a lucky coinsidence, the error was spotted in time. Had that not happened, the graph would have remained inherently inaccurate. Usually it helps, if the programmer–or the working group–has at least conceptual understanding of the data.

An important observation concerning the actual network analysis is which statistics are usable in the context of historical social networks. For example, the graph density should tell us how interwoven the network was. Instead, as the number of possible nodes increases so rapidly with the size of the network, the density of two networks, with even a little difference in size, is almost impossible to compare. Furthermore, the mathematical definition of dense network would be odd in the context of larger social networks. On the other hand, the far simpler parameters, such as node degree or the ratio of isolated nodes from all nodes, are way more depicting.

While doing this work I made some simplifications on the data processing and model building. For instance, the calculated and reported numbers of edges are in fact the lower limit of the probable numbers. While limiting the time range of the graphs, some existing family links are excluded from the calculation, and, furthermore, some links were already excluded from the original dataset. This means that the actual networks were most likely slightly more linked. This deviation or uncertainty could be further quantified with the methods of Bayesian statistics.

As computational network analysis seems to be a working method in the study of early modern history, it could be implemented in the study of wider social groups. Reconstructing social networks with noble women or the clients of the noblemen could be a doable task in the future.

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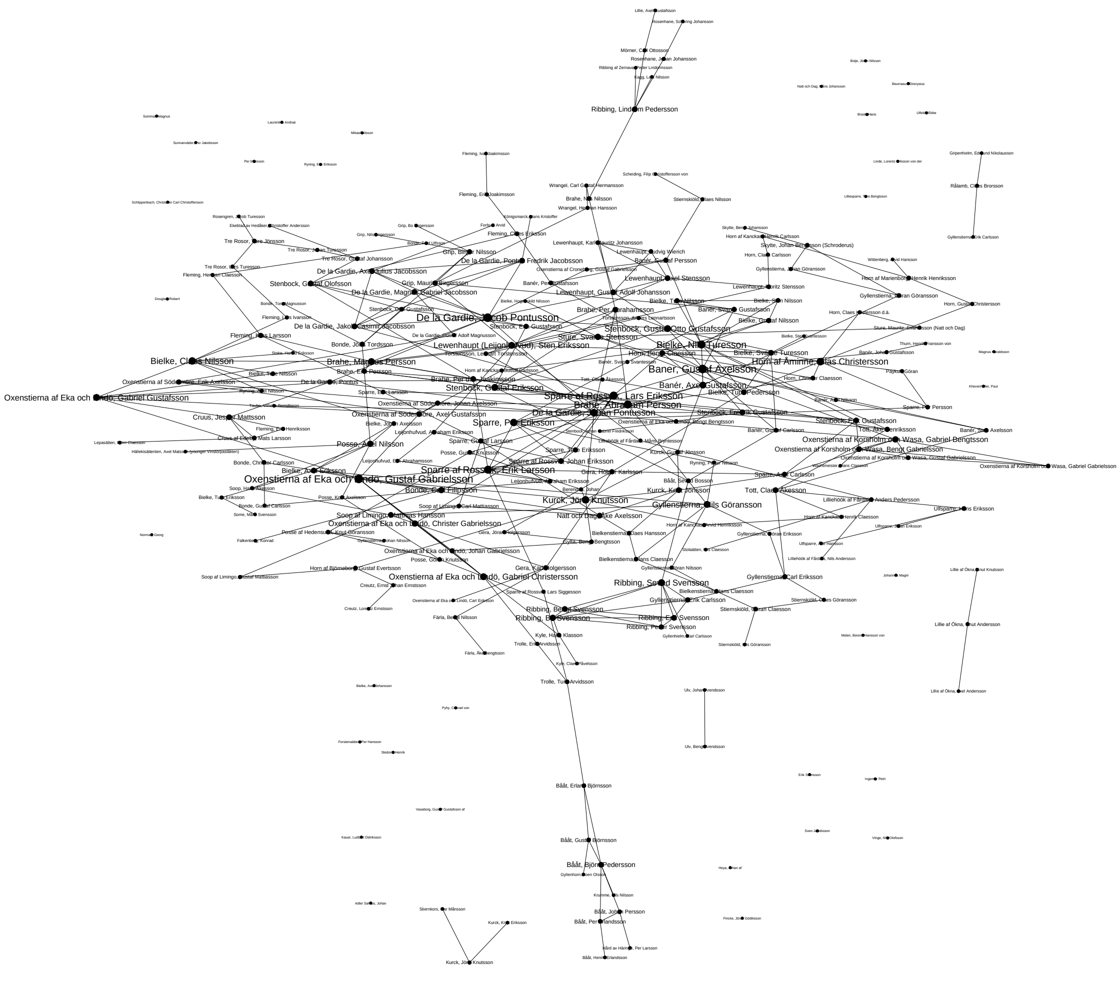
A Python Script Used in Data Extraction

```
__author__ = "Heidi Suurkaulio"
__dependencies__ = ["sys", "pandas", "csv", "re"]
__version__ = "1.0"
__date__ = "01-05-2025"
__project__ = "https://github.com/Heidi-Suurkaulio/mastersthesis"
__maintainer__ = "Heidi Suurkaulio"
__email__ = "heidisuur@gmail.com"

import sys
import pandas as pd
from csv import writer
import re

# testing that the filename is present
if len(sys.argv) < 2:
    print("Error: file name must be given in format .csv")
    sys.exit()

# reading the data
dataset_name = sys.argv[1]
dataset = pd.read_csv(dataset_name ,sep=";", index_col="Id")
dataset["Connections"] = None

# make sure the years of appointment are numeric type
dataset.update(pd.to_numeric(dataset['Appointed']))

# if start and end year or interval is given, limits the dataset on given parameters
if len(sys.argv) == 4:
    match sys.argv[2]:
        case "prior":
            # the year of appointment is the same or smaller than given
            end_year = int(sys.argv[3])
            dataset = dataset.loc[dataset['Appointed'] <= end_year]
        case "post":
            # the year of appointment is the same or greater than given
            start_year = int(sys.argv[3])
            dataset = dataset.loc[dataset['Appointed'] >= start_year]
        case default:
            # the year of appointment is greater than the first year given
            # the year of appointment is smaller than the last year given
            start_year = int(sys.argv[2])
            dataset = dataset.loc[dataset['Appointed'] >= start_year]
            end_year = int(sys.argv[3])
            dataset = dataset.loc[dataset['Appointed'] <= end_year]
```

```
# save the connections to the dataset
for index, ent in dataset.iterrows():
    st = ent.Family
    if isinstance(st, str):
        cons = re.findall(r'\b\d+\b', st)
        cons = list(map(int, cons)) # convert to integer
        dataset.at[index, "Connections"] = cons

# find current indexes
current_ids = dataset.index

# make a list of connections
printable = []
printable.append(['Source', 'Target', 'Type', 'Id', 'Weight'])
i = 0
for index, entr in dataset.iterrows():
    if isinstance(entr.Connections, list) and len(entr.Connections) > 0:
    for o in entr.Connections:
        if o in current_ids: # check if the id mentioned in connection is in dataset
            printable.append([index, o, "Undirected", i ,"1.0"])
            i = i + 1

# print all
dataset.to_csv("councillors.csv", columns=["Name"], sep=";", header=["Label"])

with open("connections.csv", "w", newline='') as csvfile:
    wr = writer(csvfile)
    wr.writerows(printable)
```

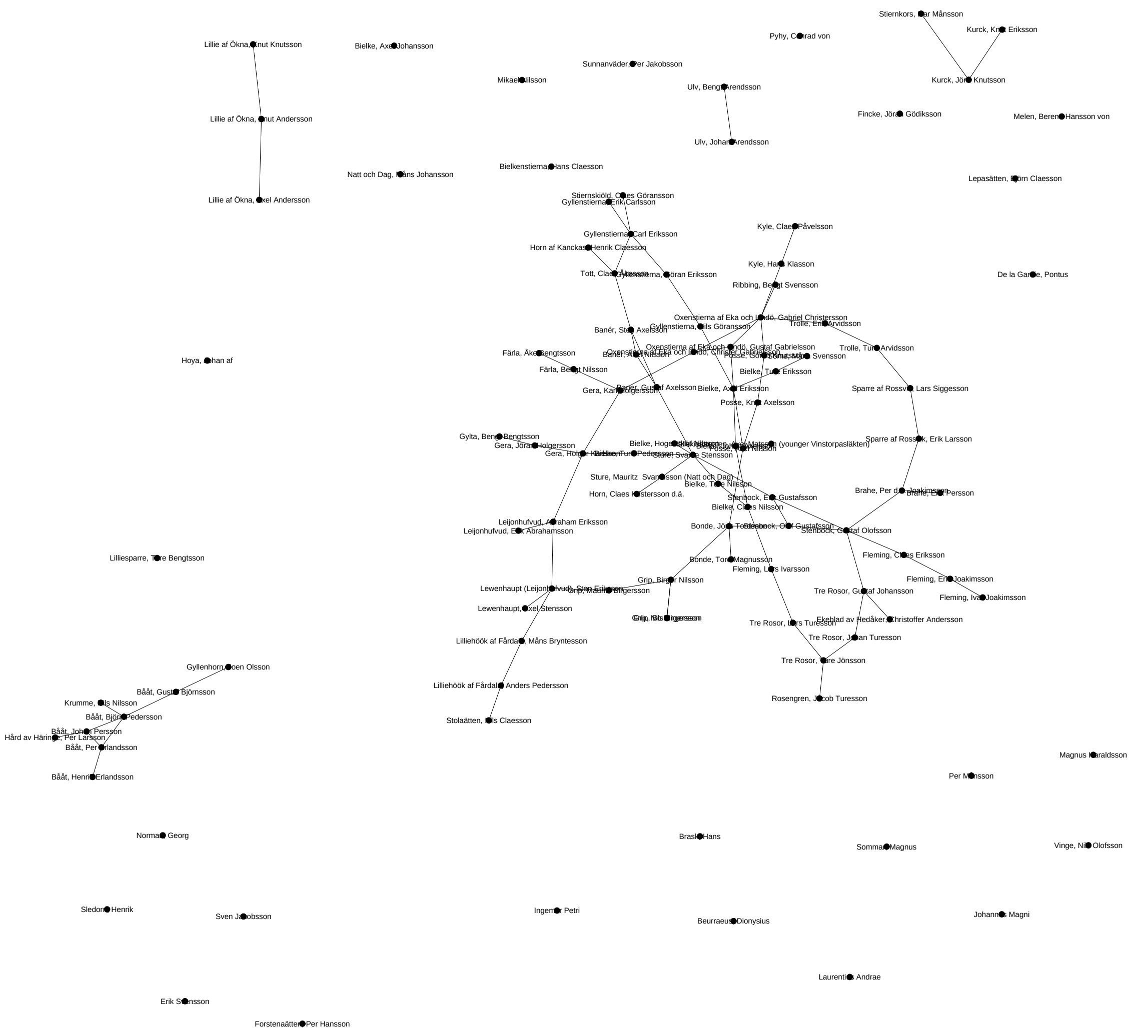
Downloadable version with instructions available in `https://github.com/Heidi-Suurkaulio/mastersthesis/tree/main/PythonScript`

B Graph 1520-1680



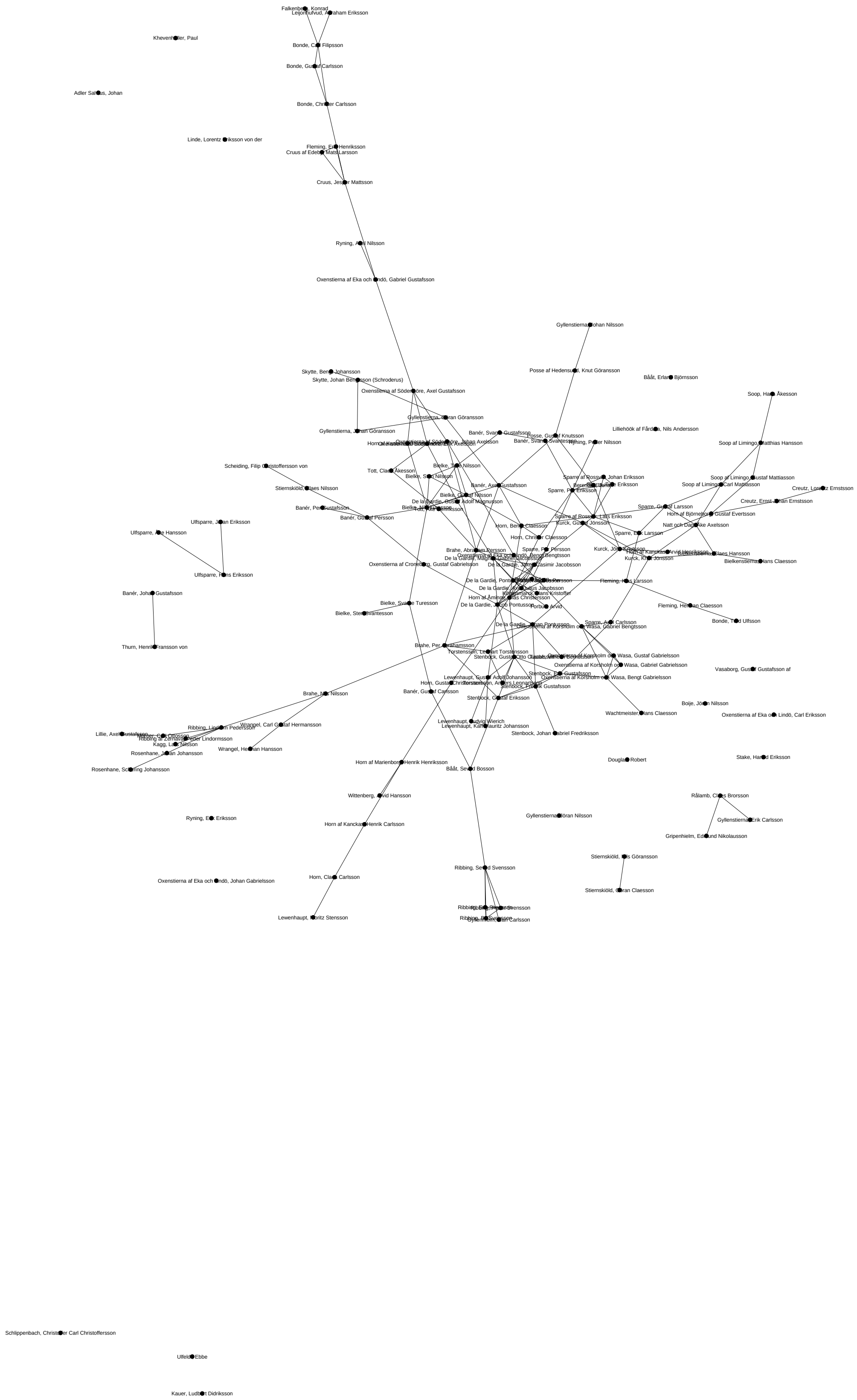
Higher resolution available in: `https://github.com/Heidi-Suurkaulio/mastersthesis/tree/main/GephiProjects`

C Graph Prior 1600



Higher resolution available in: `https://github.com/Heidi-Suurkaulio/mastersthesis/tree/main/GephiProjects`

D Graph Post 1601



Higher resolution available in: `https://github.com/Heidi-Suurkaulio/mastersthesis/tree/main/GephiProjects`