

Visualizing Administrative Relationships of Umayyad Egypt from Arabic Papyri using R

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How I arrived to the topic and methodology of my project was a strange journey. I went back and forth between sources, programming languages, *dead* languages, and research questions. Nevertheless, I wanted to implement network analysis as the main feature of my project in some way since the beginning of this class. I originally got into network analysis through my mentor during my BA. He invited me to join a collaborative research project known as the Monastic Social and Spatial Networks Project (MSSNP), which investigates the monastic communities of northern Syria and 'Iraq from the fourth to eleventh centuries. My role in the project quickly gravitated towards the network and spatial analysis of the monasteries in question. There are other specialists on the project that focus on monasteries of the Late Roman period, archaeology of the Islamic world, and social history of Syriac-speaking communities.

In 2015, I started learning this methodology and made a small project that I presented as a poster during that year's ASOR annual meeting in Atlanta. I investigated the social network surrounding the monastery of Qenneshre during the seventh century. Specifically, I followed the lives of Theodotus of Amida (d. 698) Jacob of Edessa (d. 708). The main sources that I used to build my dataset were the *Life* of Theodotus of Amida and the *Chronicle* of Michael the Syrian (d. 1199). Michael the Syrian's work was extremely useful despite being 500 years after the period I was studying. Thankfully, his work preserves sections from Dionysius of Tell Mahre (d. 818), which are now lost. For this, I exclusively used social network analysis software, such

as Cytoscape and Gephi. I tried to play with the Python library NetworkX, but my programming skills in Python were not up to par at that time. My preliminary research the Syriac world through network analysis revealed a number of expected and unexpected outcomes. For one, I expected that the monastery of Qenneshre would be the central monastery connecting Theodotus and Jacob. Both of them studied there in their early careers. Many high status monks made their way to Qenneshre to study during the seventh century - especially to study under Severus Sabukht (d. 667). Many patriarchs of the Monophysite church also made their start at the Monastery of Qenneshre; one of the most famous being Athanasius of Balad. On the other hand, I did not expect to see the social personalities of these two actors manifest in the visualization. Theodotus of Amida, according to his biography, led the ascetic lifestyle. He journeyed throughout northern Mesopotamia, and even made a pilgrimage to Egypt to live the way of St. Anthony. He, however, made this journey mostly alone and was only accompanied by his disciple Joseph. Jacob of Edessa was more socially active. He took part in the translation community in northern Syria, and was Bishop of Edessa for some time. My visualization accurately revealed these opposite personalities.

I thought about continuing this research and further developing it as the final project for the Digital Humanities class. However, I saw this to be a sort of easy way out. For a few reasons, I technically already completed most of the data entry, and I was quite familiar with the sources available. Until recently, my Arabic skills were not where they ought to be. In tandem with my Classical Arabic tutorial with Robert Hoyland, I wanted to have my first graduate school projects to heavily rely on Arabic sources to help my training. Also, while I've had some training in computer science, my skills were not fully fleshed out, and in the past I've relied too heavily on

different software platforms. So, I saw a great opportunity to test myself, and better my skill set. I happened to come across G. Ruffini's *Social Networks in Byzantine Egypt*, and in it he has a chapter analyzing the Greek papyri from Aphrodito up to the 6th century.¹ Unsurprisingly, the 8th century Arabic papyri from that site is left out. While I am not entirely on board with the Ruffini's methodology and his use of network analysis, this sparked my attention to looking at papyri from Umayyad Egypt.

Our understanding of the early Islamic administration within the first 100 years after the death of the Prophet Muhammad is quite little and each provincial region had its own idiosyncrasies - especially between the administration of former Byzantine and Sasanid lands. Papyri give us a window into the intricacies of local Umayyad administration. These relationships can then be visualized through network analysis. I originally was going to focus on the Greek and Arabic papyri from Aphrodito that date to the early 8th century. These letters are an exchange between Basileos the Pagarch of Aphrodito and the Umayyad governor at Fustat - Qurra ibn Sharik.² The Qurra dossier is quite colorful and offers loads of social and administrative information, but I found them not so conducive for network analysis, as a majority of them are just from Qurra to Basileos. There were a few letters from the Qurra dossier sent to monasteries in Basileos' *nome*, which prompted my attention back to monastic networks, but for Early Islamic Egypt. I looked through a collection of Greek-Coptic papyri from the Monastery Apa Apollo, but, again, found that this collection was not suitable for what I wanted to accomplish. Most of these letters involved isolated interactions, and I could not follow a single person for any prosopographical work. I couldn't make those nice spaghetti

¹ G. Ruffini, *Social Networks in Byzantine Egypt* (Cambridge: Cambridge University Press, 2008), 147-197.

² H.I. Bell, "The Aphrodito Papyri," *The Journal of Hellenic Studies* 28 (1908): 97-120.

monster visualization. That's when I realized my problem: I was trying to make the papyri fit the visualization I wanted, and not have the visualization represent the actual papyri.

So, I finally decided on using the 'Abd Allah ibn As'ad dossier from Medinat al-Fayyum as my dataset for this project. The 39 papyri in this dossier are scattered throughout many collections, but are all translated and analyzed by Petra Sijpesteijn in her book *Shaping a Muslim State*.³ I decided to make a set of visualizations that would show how the social actors in the papyri are connected by the actual documents, and the transmission of these surviving letters to the actors in the network. I began with two different csv files - one contained the nodes with their qualitative attributes, and the other recorded the edges and their attributes. I went through each papyrus recording the following if at all possible: the author and recipient of the papyrus (this included letters mentioned in the papyrus, but did not survive today)⁴, the administrative rank of individuals mentioned, location of the origin and destination of the letter, year/period it was written, the citation, languages used in the letter, the name of the scribe who wrote the letter, and any buzzwords relating to the Umayyad administration. For my interests, I recorded any tax jargon, such as any mention of the *jizya* and *kharaj* taxes.

I went into this project intending to not use any software program to create my visualization for me, but use Python and the NetworkX library in a Jupyter Notebook. This became evidently difficult to accomplish. I began building an environment that used the NetworkX, Pandas, Sqlite, Matplotlib, and NumPy libraries. Ideally, this would give me a numerous amount of options for data visualization, manipulation, and organization all confined

³ P. Sijpesteijn, *Shaping a Muslim State: World of a Mid-Eighth-Century Egyptian Official*, Oxford: Oxford University Press, 2013.

⁴ An Example: "Further, the am[ir, may God] preserve him, wrote to me that the sc[ribe] of your district did not pay him anything." (*P.Mich.inv.* 5558(1)); Sijpesteijn, *Shaping a Muslim State*, 273-74.

into one platform. This was the main benefit, than using multiple software programs and risking data loss between them. However, it became clear that the NetworkX library had a number of problems. While I was able to sync my Pandas-based database with NetworkX, I had trouble moving past a basic network visualization, and it would not easily recognize my node and edge attributes. It is clear that NetworkX was more suited for discrete mathematics and visualization of graph theory. Thus, I made the last minute risky decision to drop Python all together and switch to the programming language R.

R's package libraries are made for network visualization. I am still ecstatic over how more intuitive, and well-documented R is over the NetworkX library. With R, I used the igraph and visNetwork libraries. The igraph library allowed me to make basic network visualization and statistical analysis of the network itself. The visNetwork library, on the other hand, allowed me to make interactive networks that can be exported as an html file. I was able to make dialog boxes where you can essential conduct queries based on the node and edge attributes that will highlight the related relationships. For example, if you wanted to know which papyri in this dossier involved the Pagarch, the visualization will highlight that node and its direct neighbors. As well, I added a pop-up box that appears if you hover your mouse over an edge in question and will display the citation information. The capabilities are almost endless. I have yet to figure out how to have more than one attribute appear in the pop-up box, and I am still trying to figure out how to add more dialog boxes in order to enhance the querying capabilities. There are geospatial possibilities with R through the map and geosphere libraries, but the documentation is quite poor for maps outside the USA. It is nonetheless possible, and would benefit this project if more time was available.

It would also be beneficial to add hyperlinks or in some way associate this model to online papyri databases like the Arabic Papyrology Data base and Trismegistos connecting my model to their URIs. While networks are a hot trend these days, researchers who use this methodology to understand the ancient world take a huge risk. The notion that one could recreate a community's social network is a stretch with our limited primary sources. Nevertheless, network analysis is quite useful to understand and visualize the relationships of what survives today. With that, the visualizations I've made with R are a platform to better understand the administrative relationships of Umayyad Egypt, how social actors of the 'Abd Allah ibn As'ad dossier are physically related in the papyri.

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