05/01/2013

VINDOLANDA

PROCESS BOOK (FINAL VERSION)

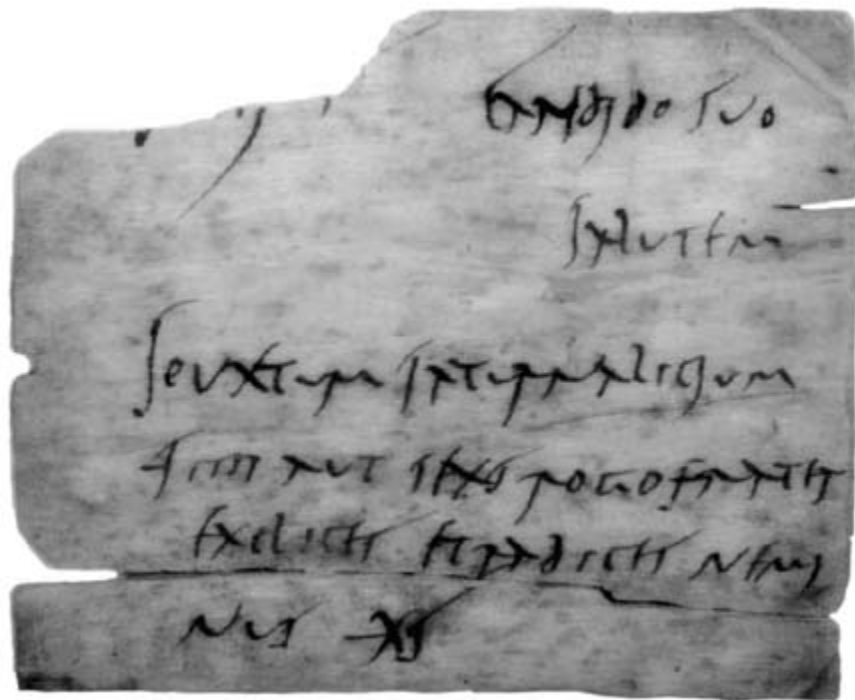### NIKHIL MULANI

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Overview and Motivation

My goal with this visualization project is to provide a "visual history" of Vindolanda (a Roman fort located near Hadrian's Wall) using source data from the hundreds of tablets recovered in the remains of the fort. I wrote my thesis on the evidence for social and economic diversity at the fort, and, in the process, collected a lot of data about people, places and transactions.

The nature of ancient evidence is to always be fragmented and available only in small, cryptic chunks. The written documentation found at Vindolanda is one of less than ten finds of such great magnitude throughout the Roman empire – this is truly big data by the standards of classical history. Therefore I saw this project as a unique opportunity to pull together the data I had collected while writing my thesis and use visualization techniques to give a holistic picture of the society and economics of this fort.

My main goal is to make a user of my visualization have a simultaneously educational and enjoyable experience. I want the user to feel the wonder of seeing and understanding this lost "small world" and its historical significance, through quantitative summary but also through a taste of the names, lives and activities found there.

The must-have features I would like to implement include interactive maps of the locations found in the tablets, an interactive network diagram of the community at the fort, and charts of the overall statistics of the transactions taking place at the fort. By my first milestone, these have been mostly implemented but with small bugs and nuisances that I plan on fixing soon (see Implementation section). I plan on adding significant enhancements, such as a "storybook" navigation scheme.

Related Work

I know that the elements that make up my "visual history" of people, places and transactions will primarily consist of geographies, networks and economic charts. Before I went about planning my visualization, I had a few models and background works in mind, including:
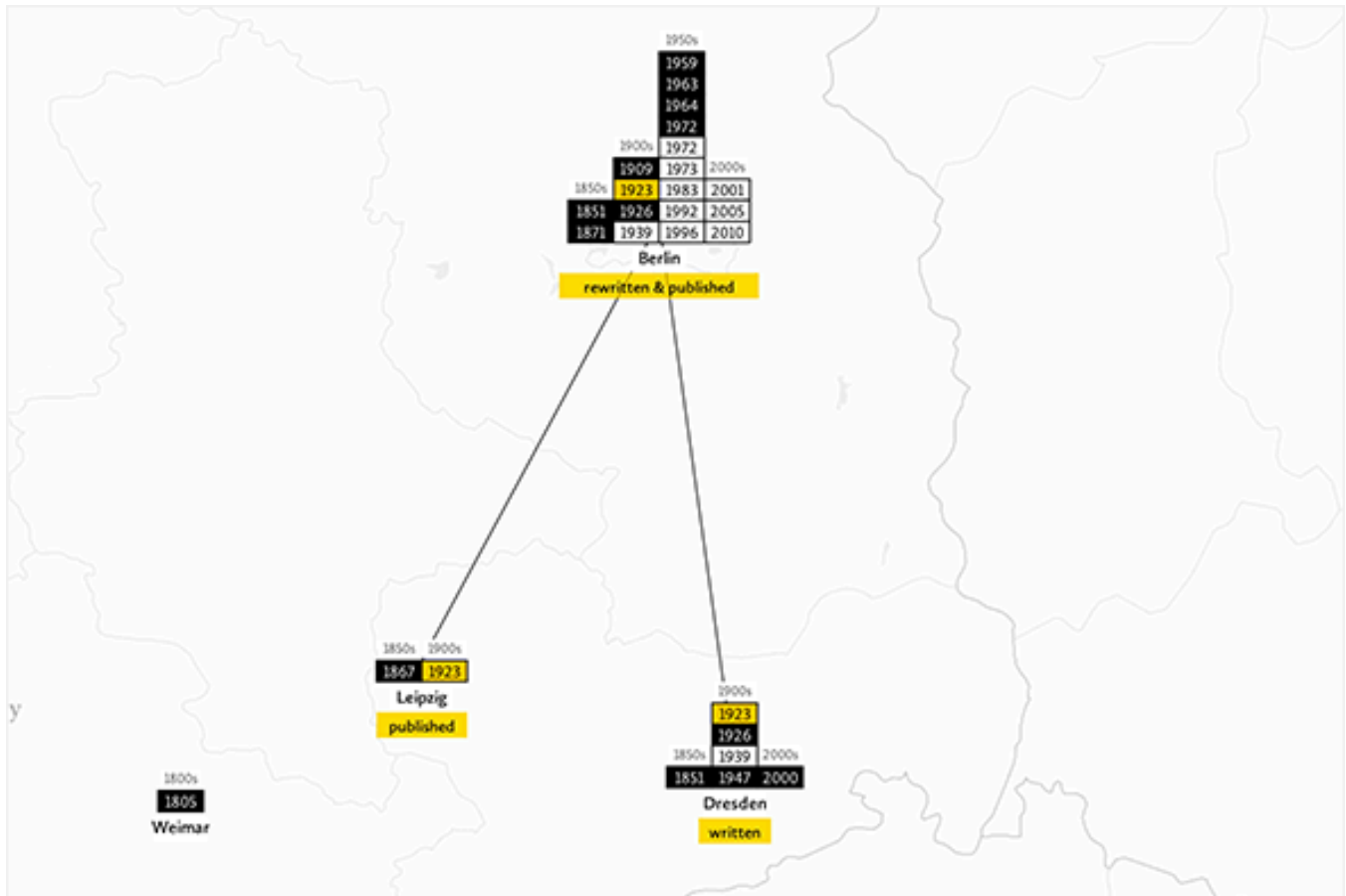
SUBJECT-MATTER BACKGROUND:

"Connectivity at Vindolanda" – Nikhil Mulani (My senior thesis).
"The Vindolanda Tablets and the Ancient Economy." – Kasper Gronlund Evers

VISUALIZATION GUIDELINES:

"Design for Information" - Isabel Meirelles

OTHELLO TIME MAP

This project by the NAND design studio (http://www.nand.io/visualisation/othello-time-map) used MapBox and D3 to track cultural, historical and social influences that link together translations and adaptations of Othello from different times and places. I found the clean black and white mapping and minimal – but informative - display inspiring.

THE INNER LIFE OF EMPIRES
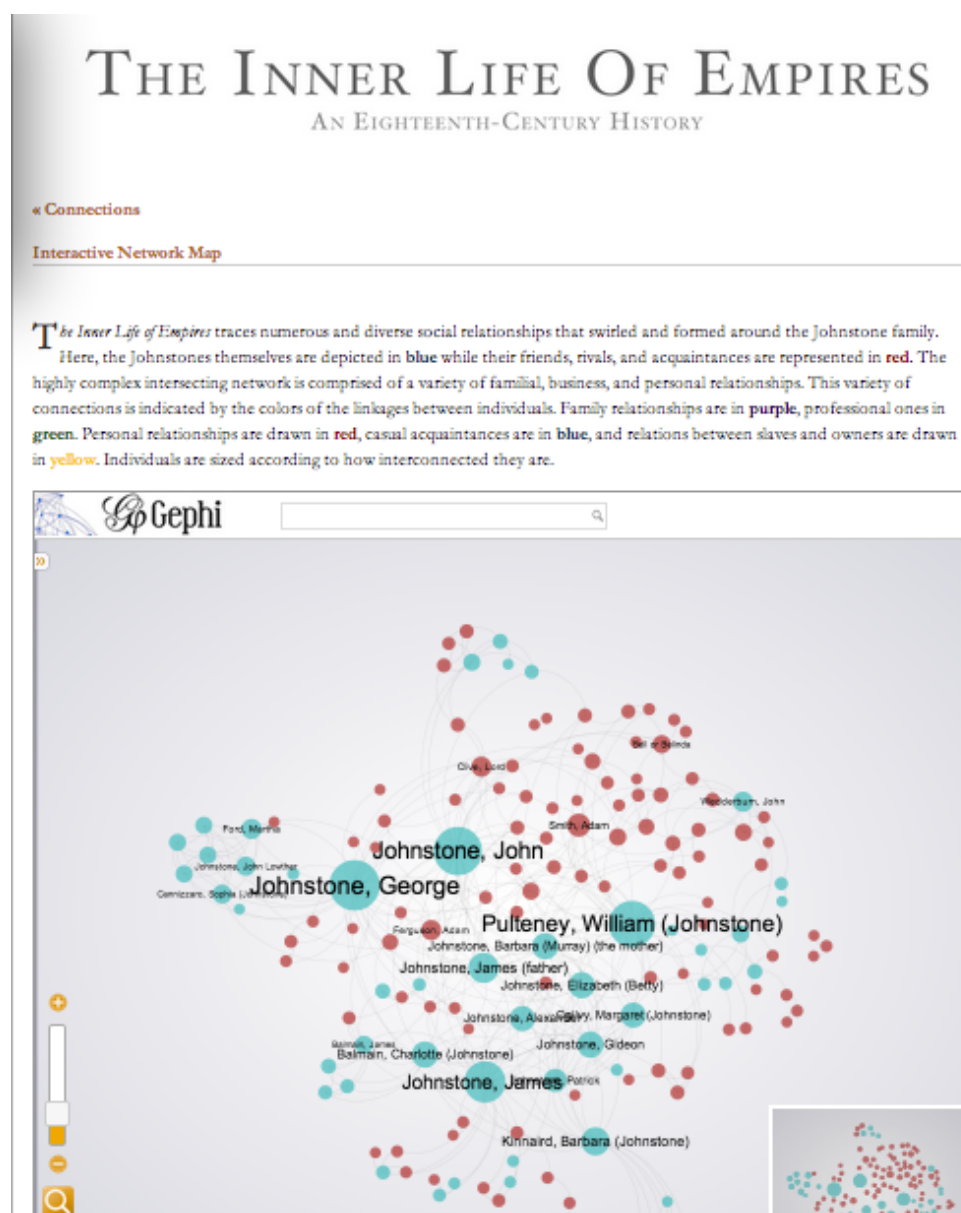
This project by Harvard's Center for History and Economics (http://www.fas.harvard.edu/~histecon/innerlife/) has very similar goals to my intended project. It used Gephi to visualize interpersonal networks found in a contained body of source documents (the letters of a Scottish family from the 19ᵗʰ century). There are a few tablets from the Vindolanda collection that show how diverse individuals were connected to each other, so I knew I would want to use similar visualization techniques.

ORBIS

This project by Stanford (http://orbis.stanford.edu/) shows a digital atlas of the Roman empire. Although not methodologically similar to what I'd like to, the subject matter is very similar. It has innovative methods of coping with the lack of information found in ancient sources, including generalizations made from what little information is available. I hope that since I will be keeping my scope focused with the Vindolanda collection of data, I will be able to show where data is unavailable rather than generalizing.

Questions

The questions I would like to answer in designing my visualization are concerned with social and economic history, and include the following:

- Where did the people living at Vindolanda come from?

- How did they interact with each other?

- What kind of goods did they exchange?

- What was the nature of business at this military fort?

- What were the lives of these people like?

Data

SOURCES:

- Data manually compiled and scraped when researching my thesis include:

    o The interpersonal network of soldiers, civilians, slaves and businessmen found in tablets 180, 181 and 344. (Visualized for my thesis using the network visualization program Gephi, exported as the VindolandaCommunity.gexf file.)

    o Place-names mentioned throughout the tablets. (VindolandaPlaces.xlsx)

    o A record of a journey traveled by a businessman living at the fort (Journey185.xlsx)

- Kasper Gronlund Evers compiled a spreadsheet with all of the transactions recorded in the Vindolanda tablets. (which I transcribed into TransactionData.xlsx)

CLEANUP:

- Evers had denoted prices as "xxxx denarii, xxxx asses" in the price column of his spreadsheet. I had to convert this to a decimal number so that I could eventually visualize the data using D3. To do this, I used the immensely useful Excel Formula tool and Find and Replace tool, and my knowledge that an "as" is $1/16^{th}$ of a "denarius," in Roman currency.

- I had to convert each of the xlsx files to a csv file so that I could call them from the D3 API.

- During my data exploration (see below for details), I discovered data subsets it would be useful to create, such as summaries of transactions by archaeological period (PeriodTransactions.xlsx) and transactions by type (transactiontypes.xlsx).

PROCESSING:

- When I am creating maps or charts that utilize data, I nest them inside a **d3.csv** call.

- The Sigma.js network visualization library includes a plugin that allows for processing GEXF data. I use the **sigma.parsers.gexf** call to access the GEXF parser.

FINAL DATA STRUCTURE:

For Processing:

Data/Journey185.csv

Data/Locations.csv

Data/PeriodTransactions.csv
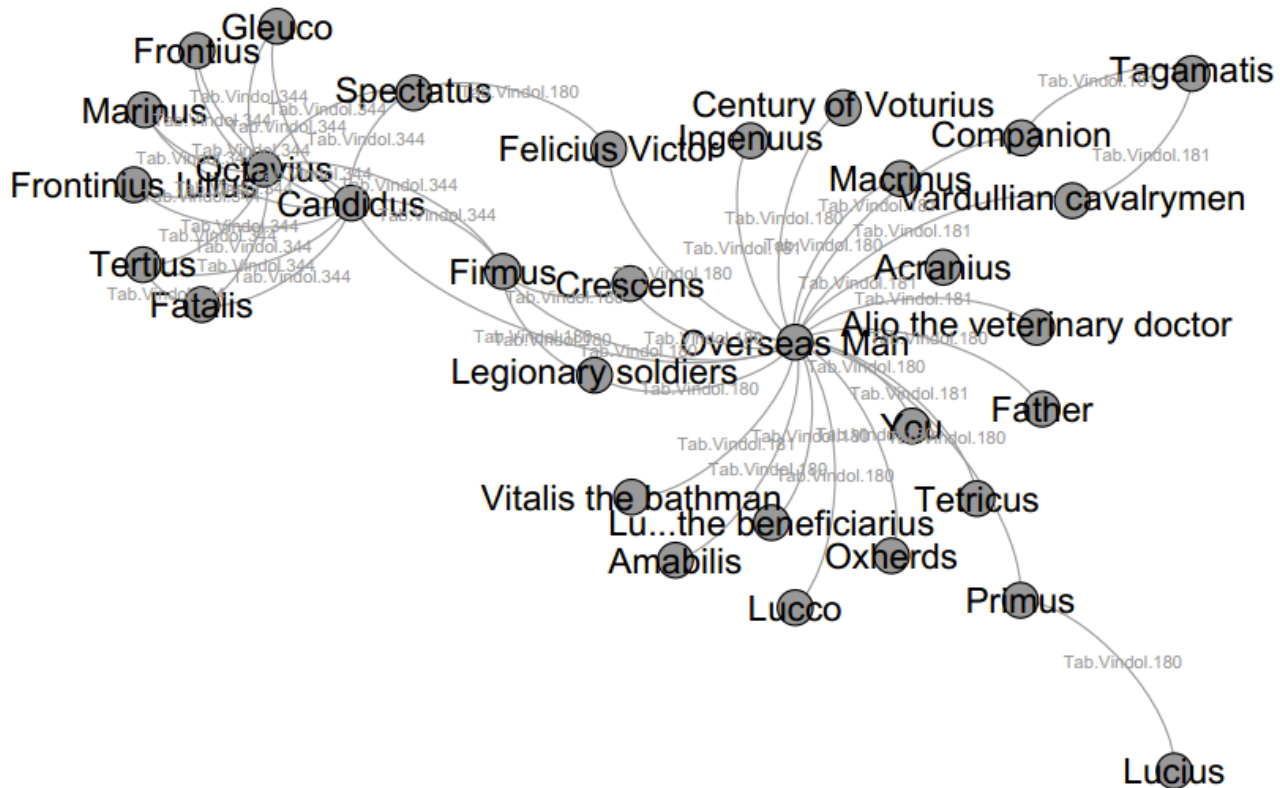
Data/TransactionData.csv

Data/TrasnactionTypes.csv

Data/VindolandaCommunity.gexf

Exploratory Data Analysis

NETWORK DATA:

I used the program Gephi to format and visualize my network data in a way that makes it easier to navigate, both for those familiar and unfamiliar with the tablets. I used the Yifan-Wu multilevel force algorithm to space out the network nodes to allow for ease of selecting individual nodes, and so that the viewer can clearly see how each node is connected to other nodes:

TRANSACTION DATA:

I used Microsoft Excel to traverse the data compiled by Evers and to generate quick graphs in order to find out where interesting and revealing patterns existed. I found out that grouping transactions by period and by type were both very informative, as they could reveal to the viewer which time periods saw more activity at the fort and what kind of economic activity was most commonplace at the fort. I used COUNTIF in two new spreadsheets to create sub-datasets that would save me time and effort in visualizing these groupings, and would create reusable datasets rather than traversing arrays of data.

MAPPING DATA:

To get a sense of the map views I would need to create, I pinned the latitude and longitude coordinates to Google Maps and zoomed in and out to find comfortable rectangles. I noted down the central coordinates of good-looking rectangles, so that I could try them out in my map visualizations.

## Design Evolution

Initial Sketch:

My initial inclination was to attempt to show all the information about Vindolanda in a single display, by utilizing pop-up tool-tips on a map display:

Once I started to try and implement this, I realized that it would be difficult to give a holistic picture of Vindolanda the way I was intending to. Using a map as the primary means of having the user access information meant that there would be much information (such as charts and network diagrams) that would only be accessible if the user clicked on Vindolanda (which there was no reason that the user would know about in the first place).

**Revised Sketches (I apologize for my inept drawing) :**

I decided that it would make more sense to create an "interactive storybook" type visualization, where I guided the user through each part of the relevant information about Vindolanda. I drew these sketches intending to create a storyboard of a virtual, interactive history book that the user could flip through. The thrust of the "story" would be "zooming in" from a broad view of the entire Roman empire, to just Roman Britain, to the network diagram of the community at Vindolanda, and finally to the one-to-one transactions occurring at the fort.
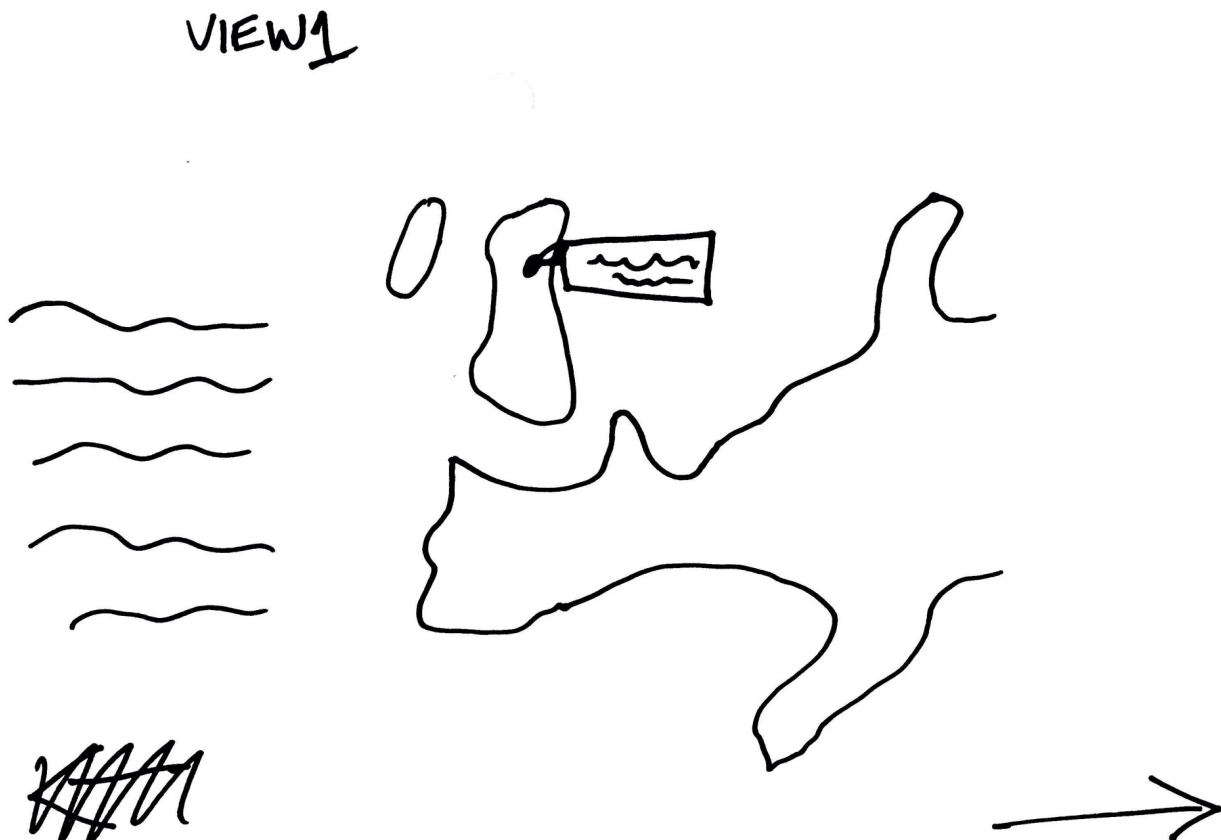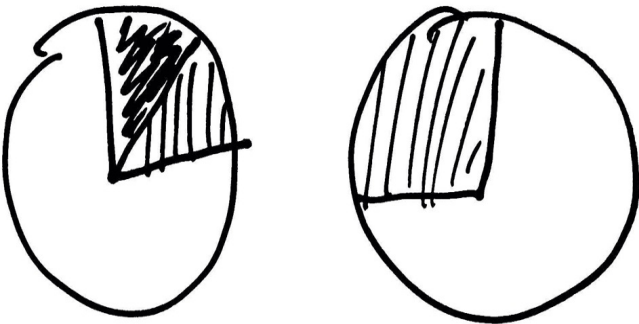
VIEW 2
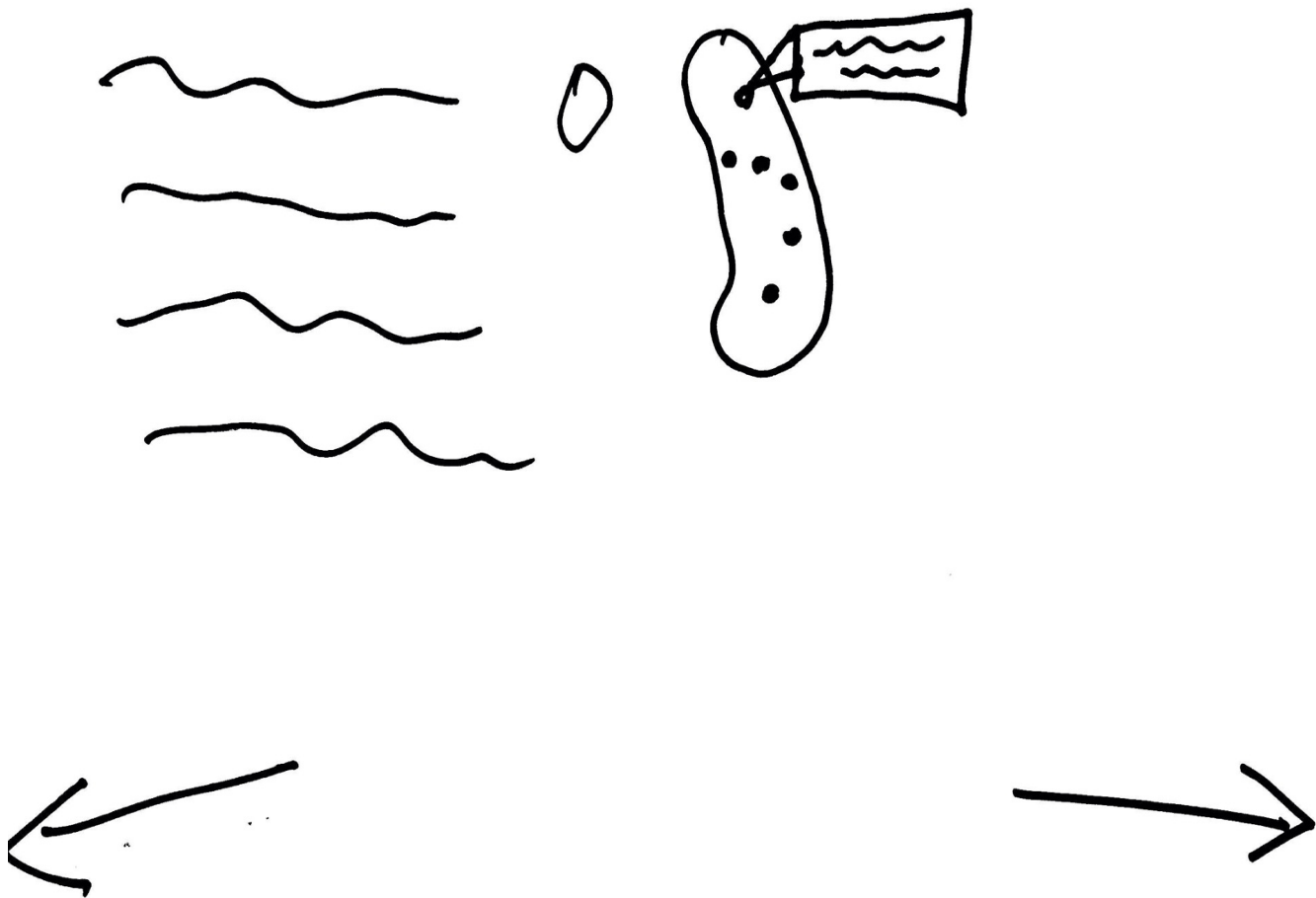
VIEW 3
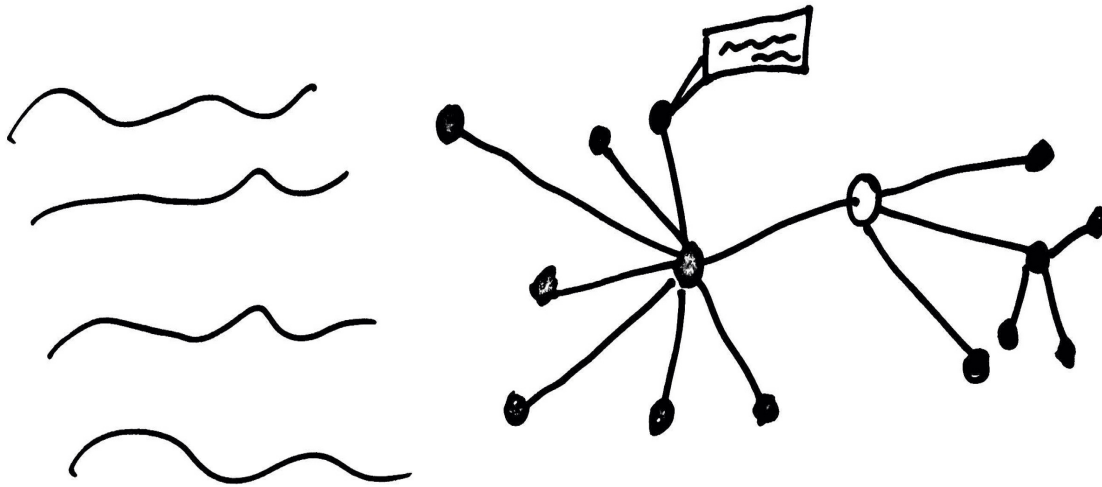
VIEW 4

STATS:

TRANSACTIONS: apples

Implementation (as of Milestone 1)

Overall:

All of the views currently appear on the same page (at the recommendation I received my design critique – see attached comments) rather than on individual pages. Once I implement the story-esque functionality that will allow the user to swap views, this will no longer be necessary.

Mapping:
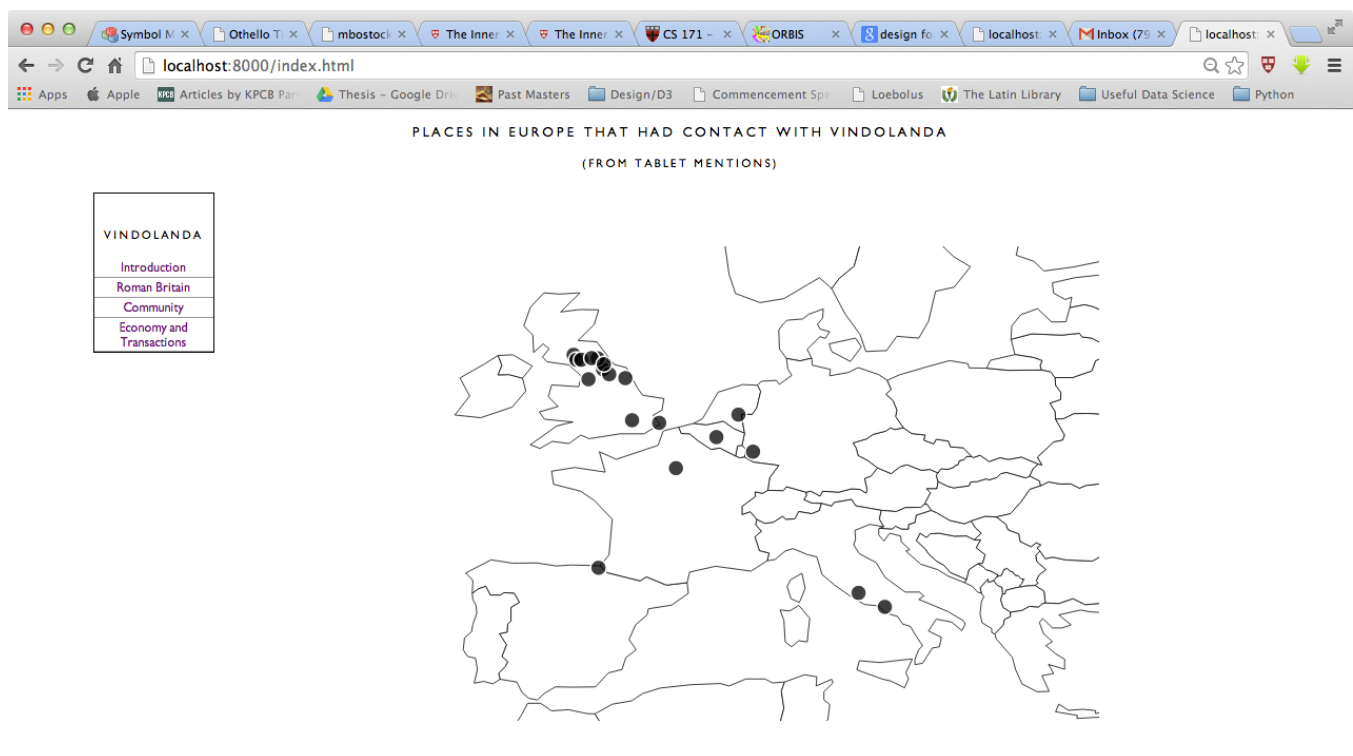
Mapping currently utilizes the D3 and Datamaps libraries to parse a locations list and display them on an interactive map. Technically, the tooltips should appear and show the name of the ancient location – but although this is implemented in the Datamaps library, it is showing so far off the screen that it is not visible to the viewer. I plan on fixing this.

I also plan on including the Datamaps capability of arcs to show the journey data that has not yet been mapped, and to show how each of these places would have linked to Vindolanda by way of water/road transportation.

Network:
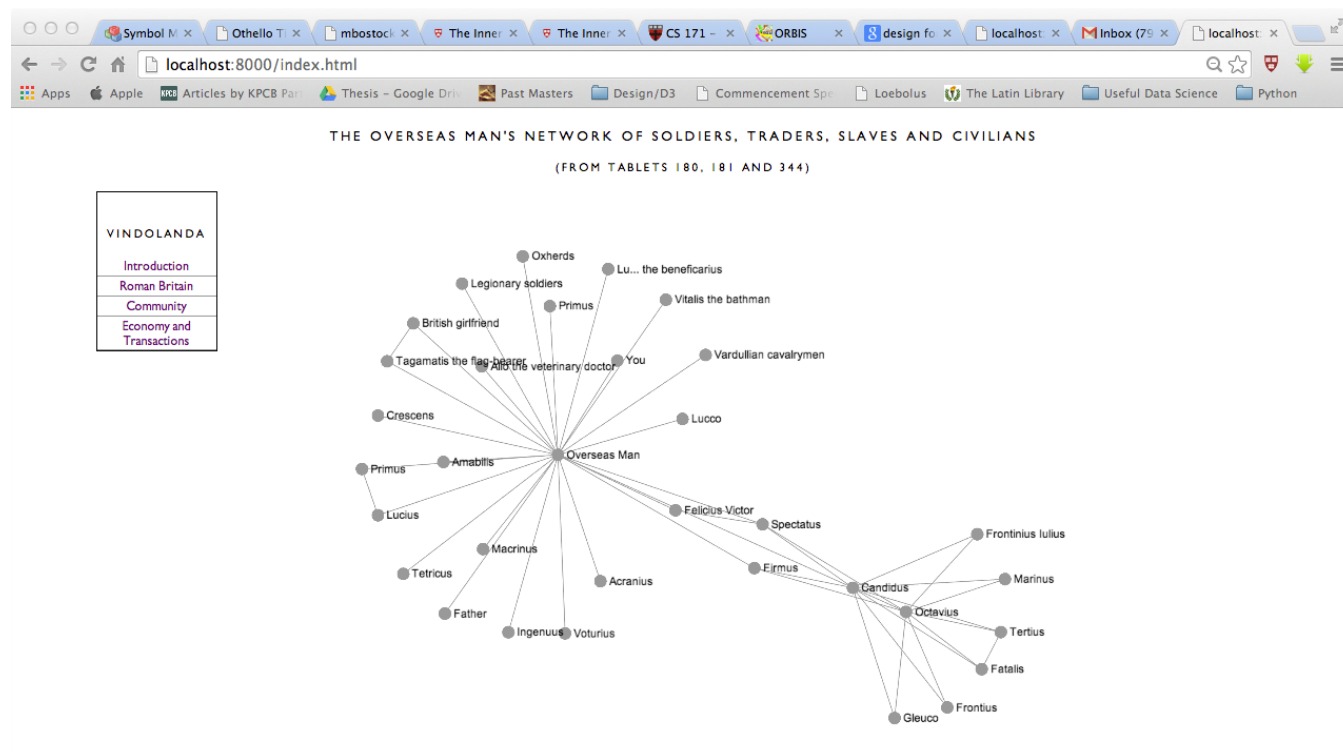
Network visualization currently utilizes the Sigma.js library, which allows for easy parsing of GEXF files and – crucially – retaining the formatting created while doing data exploration in the Gephi program. I hope to allow the user to manipulate and change the structure of this network with more functionality than is currently available.

Transactions:
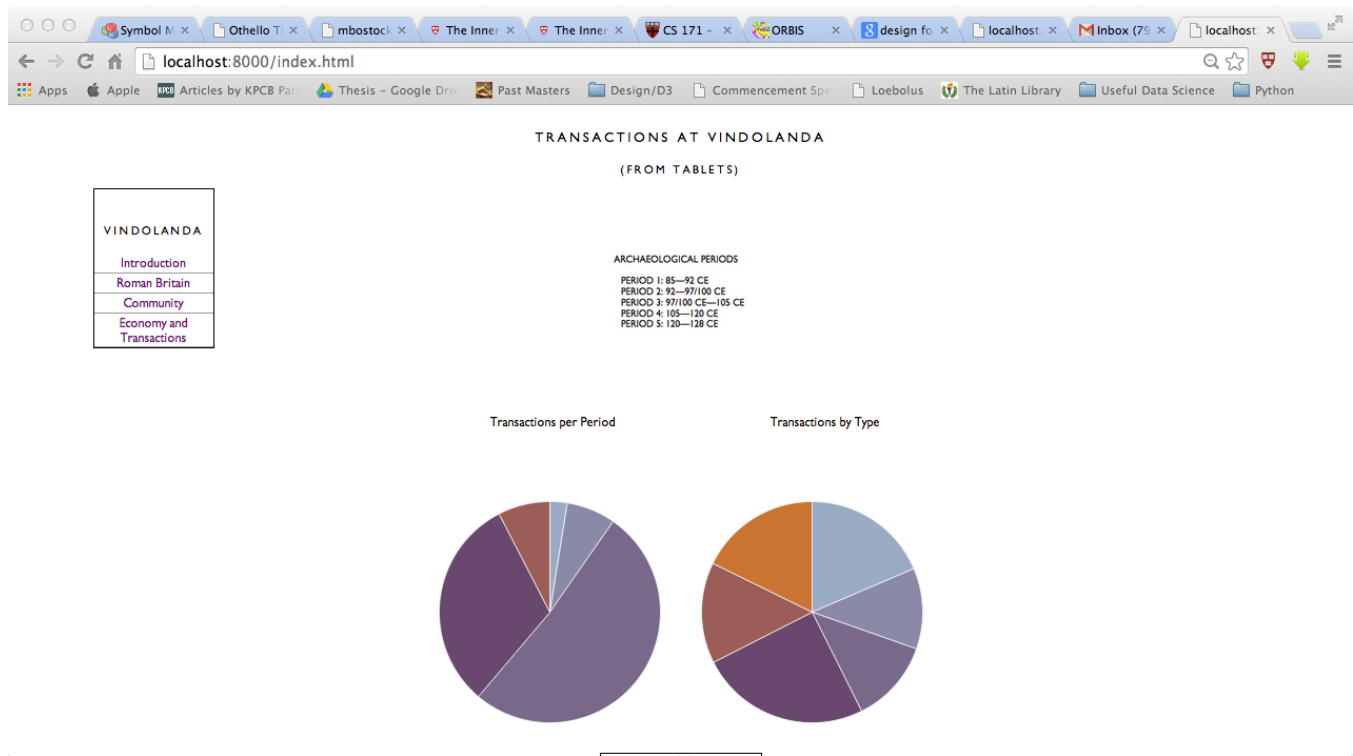
I currently use D3 to create pie charts of the two sub-datasets I created while exploring the transaction data. Instead of keys, I use tooltips to show what each pie segment symbolizes. I do plan on adding more pie charts and do not want to clutter the screen with keys, but I might change the way I encode this information if I can devise a more efficient way to do it.

The transactions are the richest part of the data structure, and I am far from done visualizing them. I would like to include further charts showing price ranges and quantities of transactions by kind of good. I would also like to include something akin to a treemap, which would allow the user to navigate through all of the transactions at Vindolanda by object being purchased/traded/gifted.

Implementation (as of Final Version)

Overall:

All of the views now appear on individual pages, and have had substantial enhancements added for visual pleasure and increased detail. I have successfully implemented the storybook format I set out to create, with the floating menu in the left-hand corner serving as a table of contents. I have moved the text for each page to the left of the accompanying visualizations, to allow the user to see pictures and read analysis simultaneously.

Mapping:

After making custom modifications to the Datamaps library, tooltips now function on the mapping displays. Additionally, arcs have been added to show travel/trade routes.

Network:
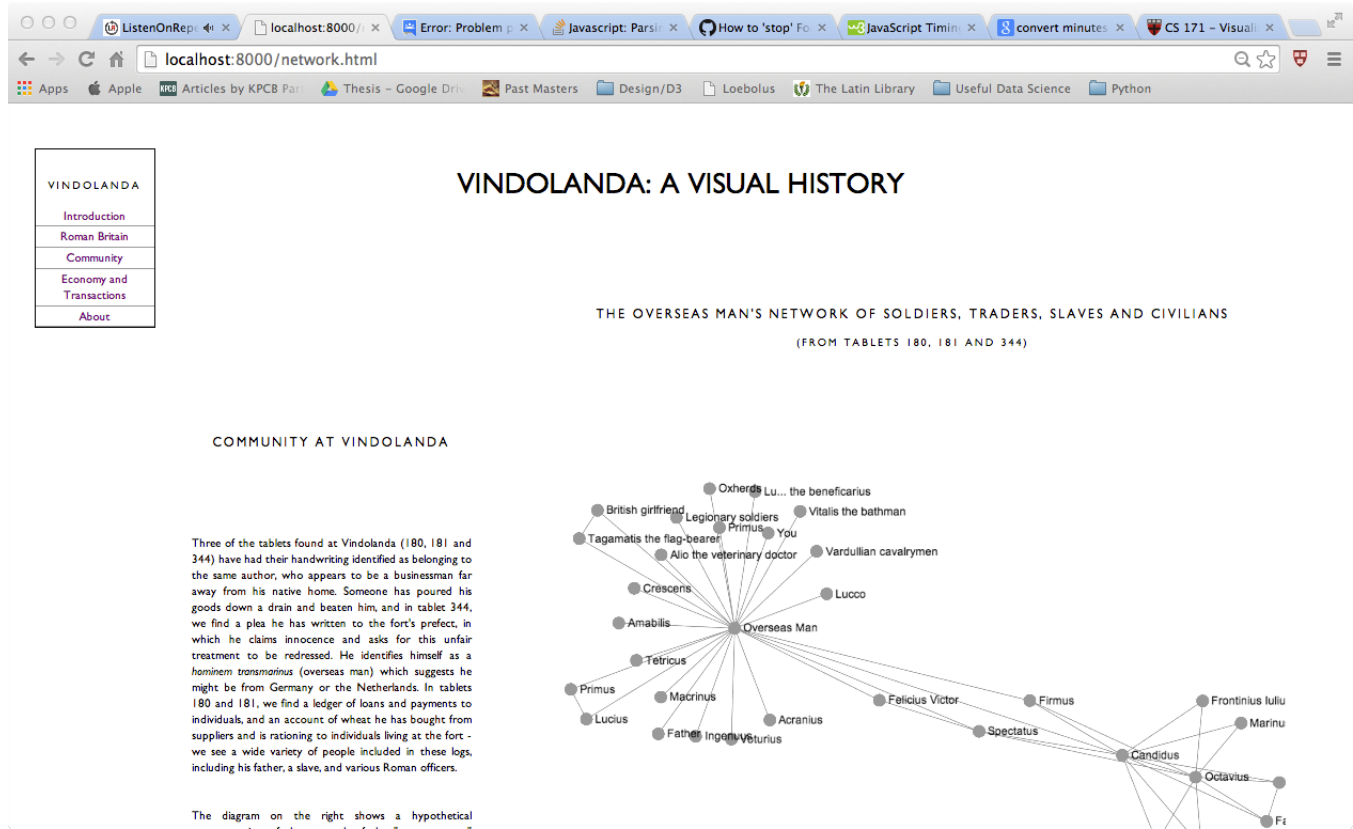
The network display now includes an animated network – both for visual pleasure and for encouraging the user to play around with the network by dragging it and zooming in or out.

Transactions:
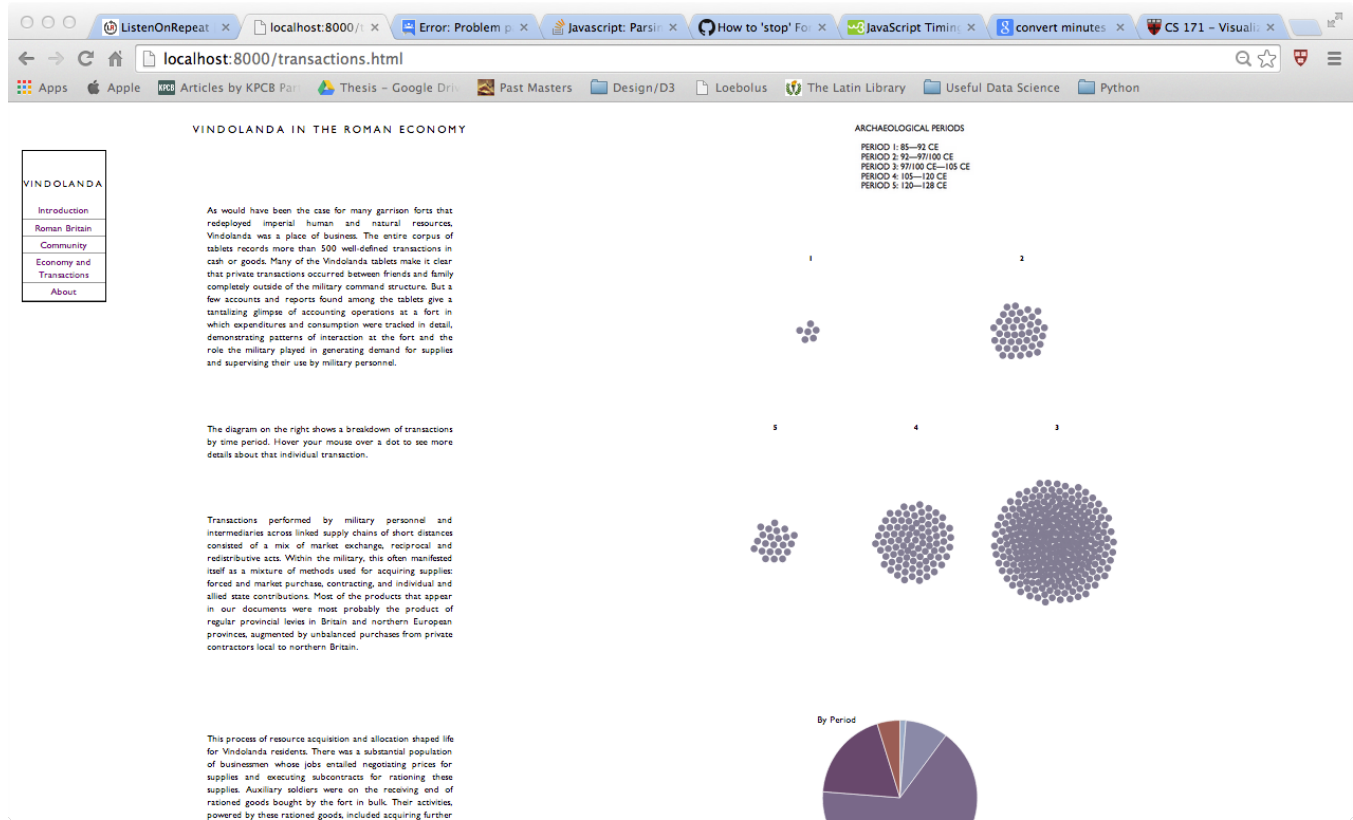
The transactions are the richest data set, so the page now includes a set of force clustered diagrams of individual transactions for the user to explore and see details from using tooltips. This is a much more pleasant experience than perusing a spreadsheet, and I wish I had been able to use it when writing my thesis! Additional background text has been added, and the pie charts have had their titles added using SVG rather than HTML text, so that adjusting browser size does not mess up the webpage display.

Evaluation

The project largely turned out the way I hoped it would. As I wrote my thesis, I had a series of images in my head. These images involved a "zooming in" process - from the Roman empire at large, to Roman Britain, to the community at the fort, and finally, to one-to-one relationships. I was able to duplicate this journey from the macroscopic to the microscopic, by way of using Javascript visualization frameworks, and moving from maps, to a network diagram, and then finally to the dots for individual transactions.

My visualizations were successful in making me excited all over again, about a dataset I was already very familiar with. Although I had asked and answered many questions about this data in my thesis, the visualization I made has created an entirely new set of questions for me – for instance, while using the transaction visualization, I asked myself: Why do only transactions involving food remain from Period 1? These kinds of questions usually lead to fruitful inquiry, if pursued with in-depth research.

My hope is that users of my website will learn about Vindolanda, but most importantly, leave the website being excited to learn more about the Roman empire and the fort Vindolanda.

There are a few things I would do, if I had more time: create a custom map layout that showed Roman provinces instead of modern countries and find a way to add tooltips to a Sigma.js network diagram to allow for viewing more detail.