Six Degrees of Cyrus: Applying Network Analysis to Herodotus

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Teaching Herodotus: a Digital Approach

Introduction

One of the foundational principles of Digital Humanities is the notion that new insights can be derived from the visualization of linear texts in non-linear forms. Some of these non-linear representations are themselves textual (for example, topic modeling), but many transform text into graphic visualizations. Although this idea is most often discussed in terms of scholarly research, there is a growing interest in the pedagogical implications of such visualizations. This poster investigates the effectiveness of visualization and network analysis for teaching ancient historiography. Its title itself reflects a network of ideas: it refers to the idea of "six degrees of separation" by way of the game "Six degrees of Kevin Bacon" (often used to explain network theory), via Diane Cline's influential study "Six degrees of Alexander". One result of our application of network analysis to Herodotus was a striking reinforcement of the centrality of the Persian king Cyrus in the first book of Herodotus' *Histories*.

Course Design

This course, an upper-division research seminar for Classics majors entitled "Watching the Barbarians: Herodotus, Ethnography, and Archaeology", was designed as part of a larger effort to assess the effectiveness of visualizations and network approaches for teaching ancient history and historiography. It is meant to function as a pedagogical test-bed for the visualizations of Herodotus created by the Hestia project (hestia.open.ac.uk). We have focused on the first four and a half books of the *Histories* (traditionally referred to as the "ethnographies"), since these cover vast distances in time and space and showcase the dense network of relationships between different cultures.
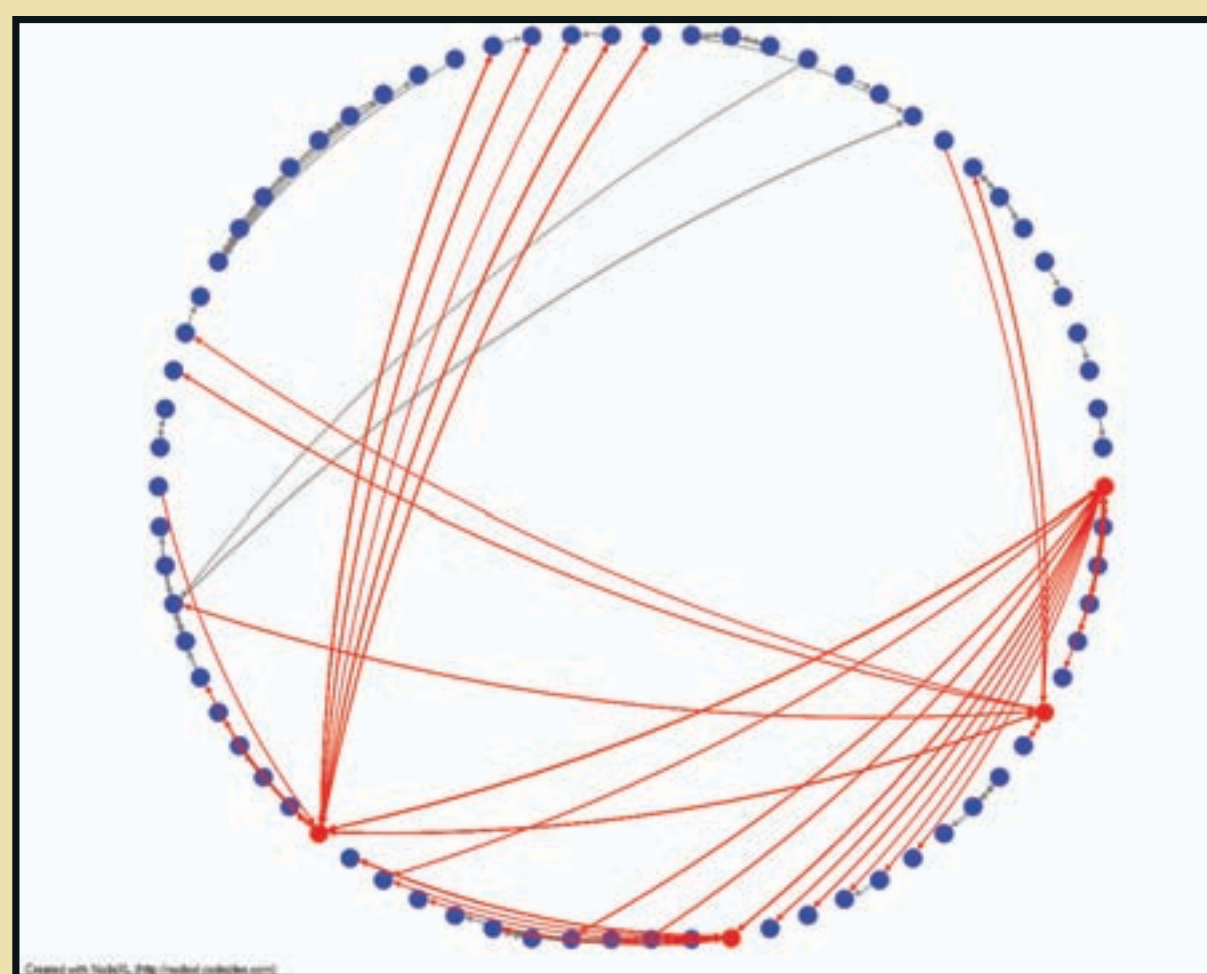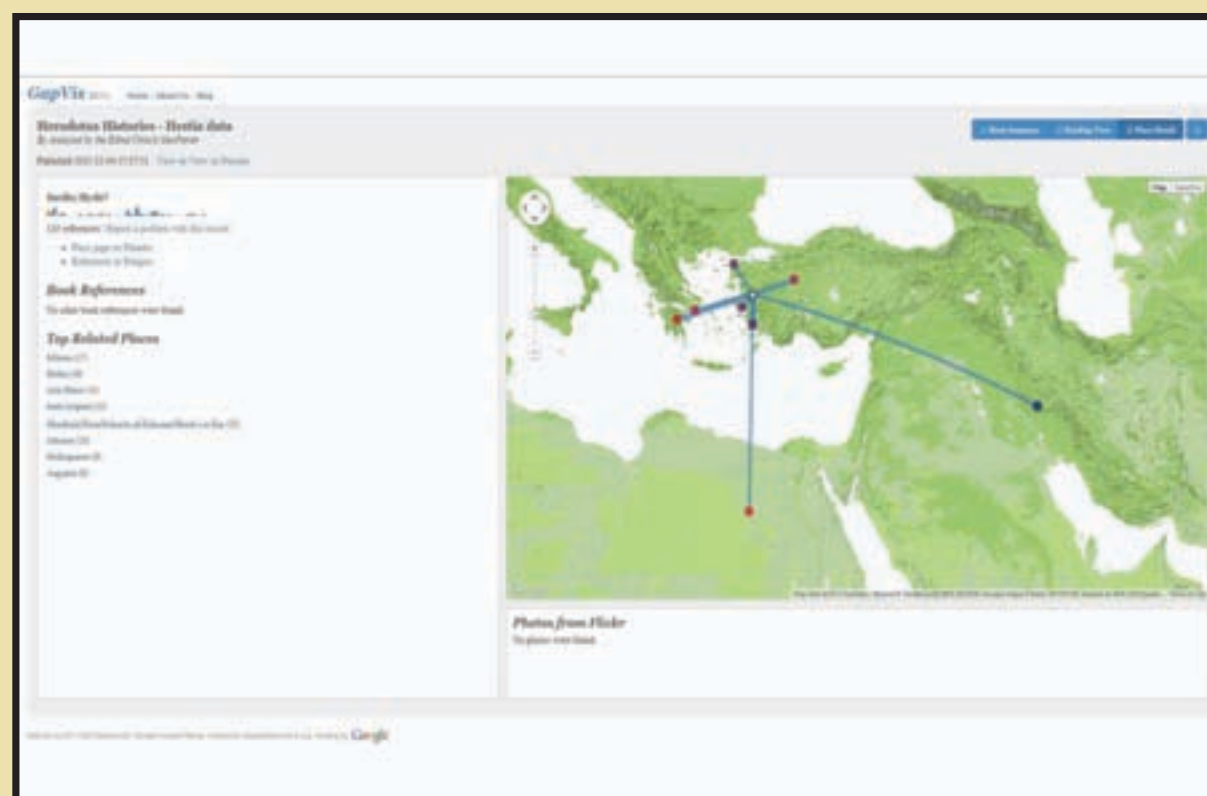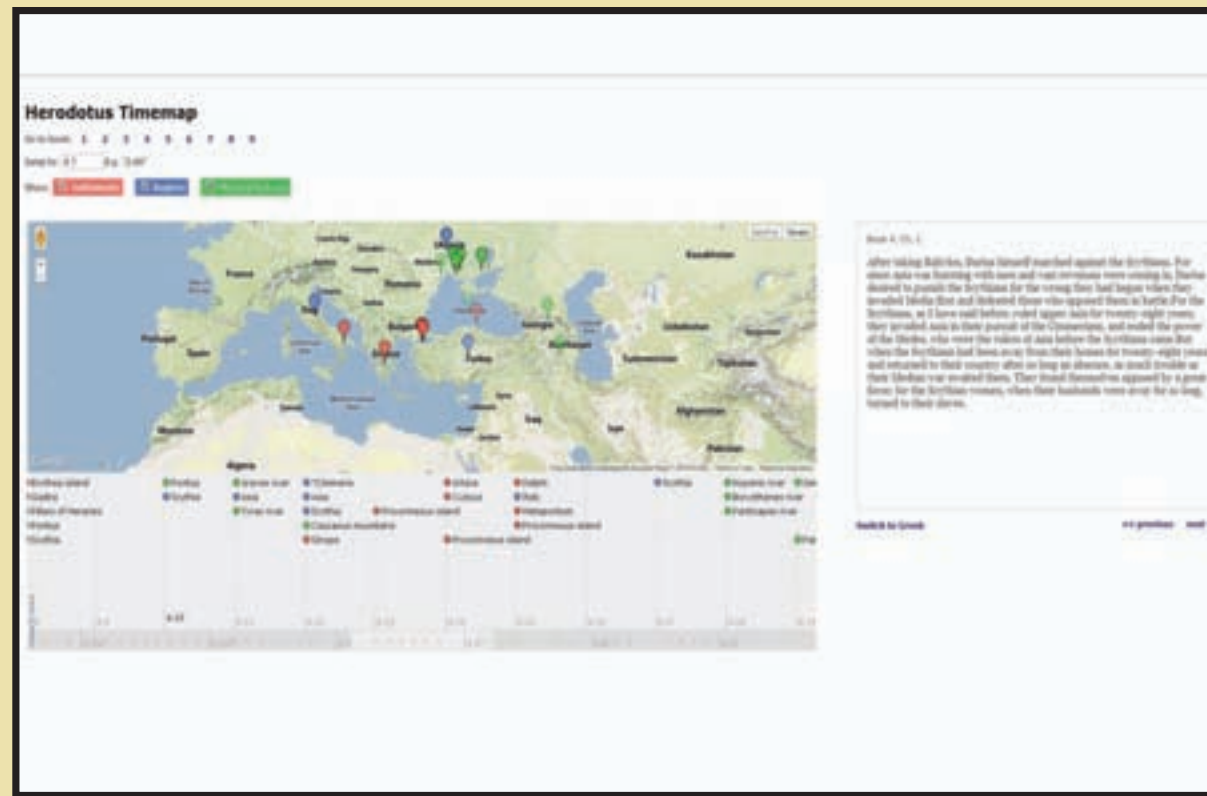
Students in the class were asked to carry out two new tasks, in addition to more standard reading and research assignments. First, they worked with the Hestia online text, on top of which they created web-based annotations using the Hypothes.is platform. The goal of this task was to determine whether the interactive interface makes it possible to see things in the text that might escape notice in a printed book.

Second, each student was assigned a state-level "actor" in the text – that is, a political collective like "the Athenians", "the Samians", or "the Achaemenid dynasty" of the Persians. The students were responsible for creating network graphs of the interactions between this state-level actor and other actors, both collective and individual, in the text. The goal of this task was twofold: first, to allow the students to learn the basics of network analysis approaches and tools in a practical environment; and second, to see whether these tools could actually lead to useful research insights in a class focused on particular content, rather than on network-analysis methodology.

Finally, students are writing a traditional research paper -- but one informed, where possible, by network approaches. Classroom time has thus been split between more standard historiographical discussion and hands-on, workshop-format engagement with network tools and methods. Students and instructor have learned together: the instructor also created a network of directed interactions between individuals or small groups in the first book of the *Histories*, carrying out this work in spreadsheets shared with the class.

This effort highlighted a limit of network visualizations: without the axis of time, the graph of relationships in Herodotus includes a vast number of second-degree connections between people who did not live at the same time. To account for this phenomenon, we assigned "pseudo-dates" to each interaction, using a date format that reflected the book and chapter in the *Histories*. These pseudo-dates could then be used to active the dynamic timeline functions of some of our network graphing programs. Not surprisingly, the issue of the representation of events and changes over time became one of the most important issues in our use of network approaches.

Research and Study: Student Perspectives

Mapping Networks for Research

One of the students applied network methods in her research project for the course. She created graphs of the relationships described by Herodotus between Athens and other states between 561 and 479 B.C.E in order to compare them with Athenian economic interactions in the mid-5th c., as reflected by the Athenian tribute lists.

Network analysis is not the driving force for this research. In the end, however, it came to serve as a useful illustration and visualization tool to inform and aid the study of Athenian interactions with her allies and later, with her empire. At the same time, collecting and formatting the data was an immensely time-consuming process, and the learning curve for the network tools was steep.

Above, a map of directed Athenian interactions in Herodotus depicted using Palladio. Left, a map of Athenian interactions in Herodotus depicted using Gephi. The Gephi network does not show the directed edges, but serves to illustrate each state actor with whom the Athenians were interacting. Below, data spreadsheets.

Understanding Narrative Structure through Animated Maps

Another student found it impossible to apply network analysis in the context of her research paper, but found the Hestia visualization of the text very helpful for understanding the "hodological" structure of Herodotus' text, as described by Alex Purves (2010).

Herodotus's hodological approach allows the author to discuss geography and climate while simultaneously orienting readers within the landscape without the use of maps or visual aids. For example, when Herodotus introduces the peoples living around the Black Sea in Book 4, his narrative moves around the coast following a set path, introducing groups as they appear on this clockwise route.

The spatial visualization of the places Herodotus mentions and their co-referenced locations makes it easier to recognize the hodological structure of the text, which is not apparent to students in printed versions. But this requires not only that the nodes in the network be georeferenced, but also that the resulting map can change dynamically to reflect narrative sequence.

Visualizing Herodotus: Interactive Text, Maps, and Graphs

The original Hestia project (interface to the upper left), led by Elton Barker of the Open University and Leif Isaksen of the University of Southampton in the UK, produced a cartographic visualization of the *Histories* of the ancient Greek historian Herodotus. This online interface combined the text of the 5th-century B.C.E work with a map of the places it mentioned, synchronized with a scrolling narrative timeline, so that locations appeared and disappeared on the map as they were mentioned and then left behind in the text. Locations were manually tagged in a TEI text of the work and categorized as settlements, regions, and physical features.
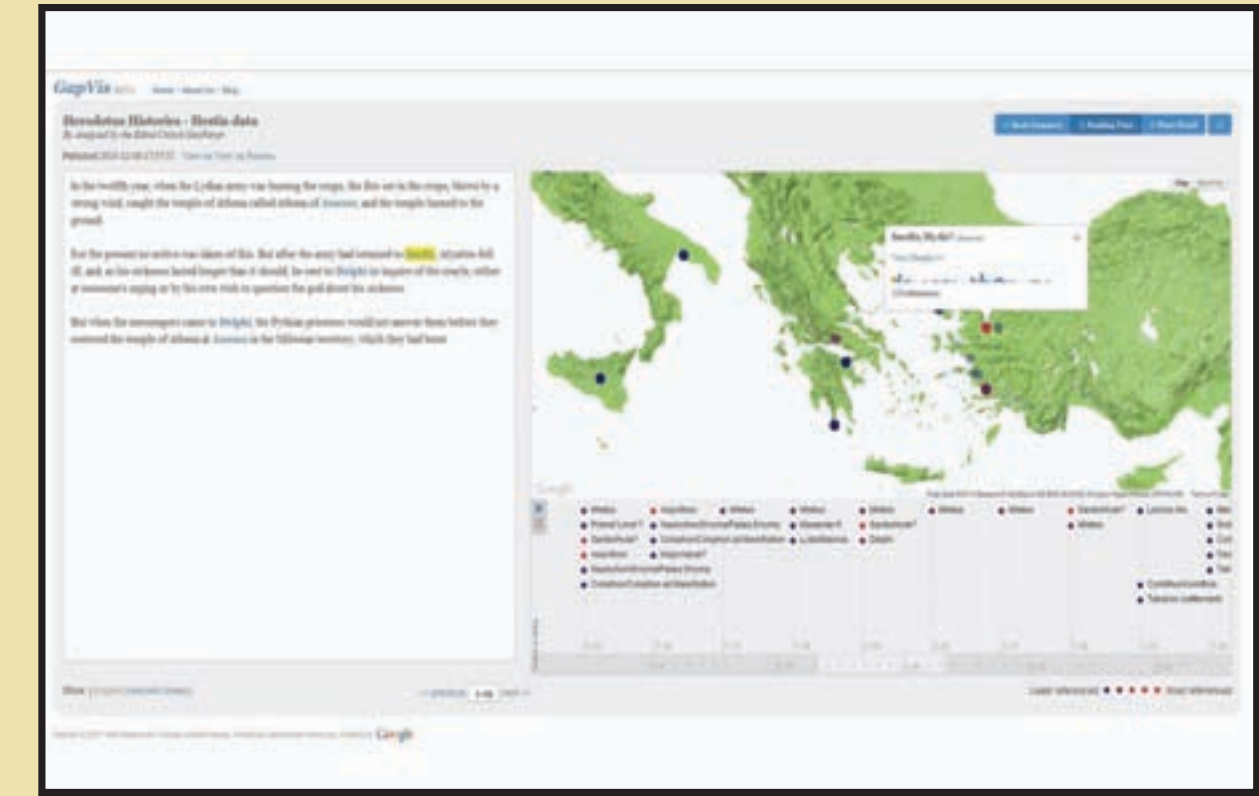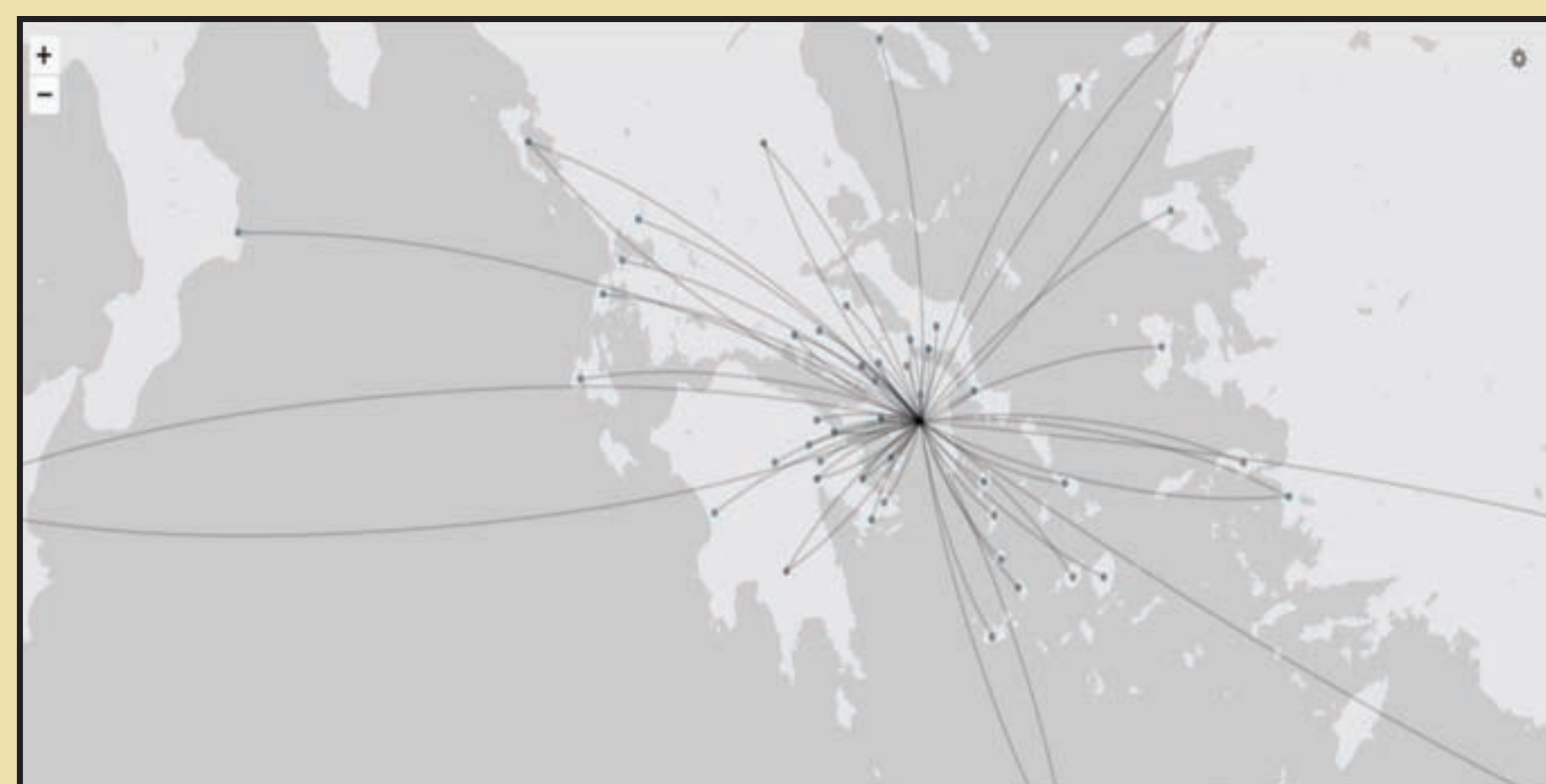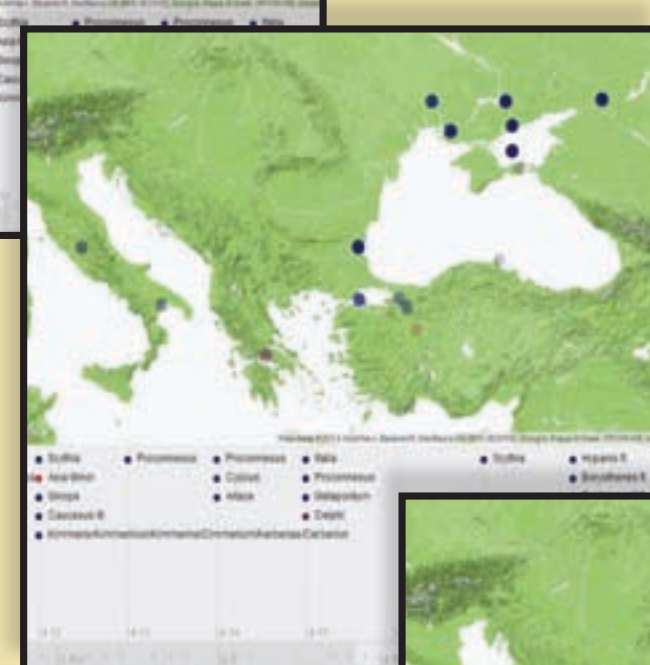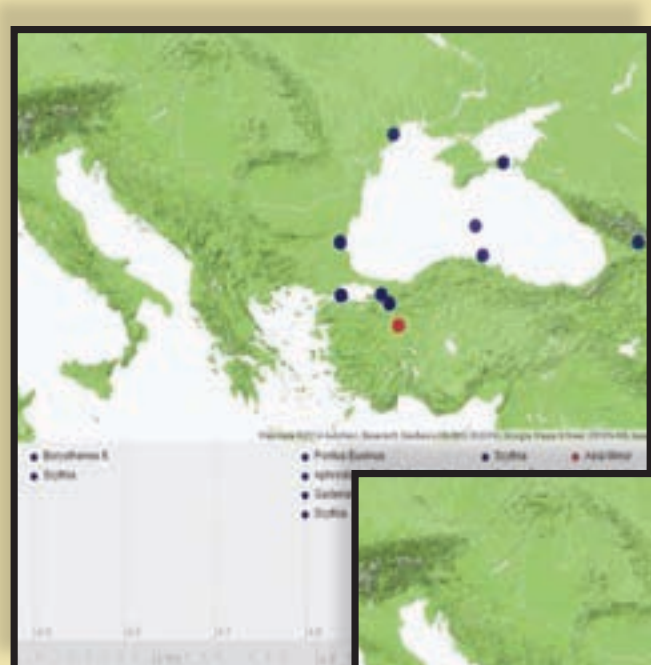
A second grant-funded phase introduced a new interface, using the GapVis platform developed for the Google Ancient Places project. In this interface, in addition to the narrative timeline and map, all places have individual pages on which the user can see the frequency with which they appear in the text as a histogram and as a list of passages; a link to a corresponding URI in the Pleiades spatial gazetteer and to the Pelagios data-integration platform; and a simple co-occurrence network that shows the sites that appear most frequently in the same passage as the place in question. This is the interface we used in this class (above and left).

We experimented with a number of different network visualization and analysis tools. NodeXL (nodexl.codeplex.com) offered an intuitive interface in Excel and a variety of network statistics (above, nodes in Book 1 of the *Histories* with high betweenness centrality scores in personal interactions, in this case Cyrus, Croesus, Astyages and the Pythia). The learning curve for Cytoscape (www.cytoscape.org) was higher, but it also offered a robust set of tools for the quantitative analysis and visualization of networks (below left).

In the end, however, we found that quantitative analytical tools were less important than the ability to place actors and interactions in space and time. Gephi, despite its continuous frustrations, offered plug-ins that made it possible to represent geographic space and change over time (above right). Mid-semester, the CESTA lab at Stanford released a tool that proved even more popular: Palladio (palladio.designhumanities.org), an online interface for refining and visualizing simple tabular data. This site made it even easier to display data on a map and to filter by time (right). These two platforms have become our tools of choice for uses focused more on visualization than quantitative analysis.

Map of Achemenid interactions throughout Herodotus' book 1 created via Gephi using Map of Countries and GeoLayout plugins. This directed network assumes that the Achemedis used Sardis as their base and includes actions performed by individuals acting on behalf of the rulers.

Samian interactions throughout the first five books of Herodotus, visually rendered via Cytoscape. This egocentric graph shows the different actors with whom the Samians were interacting, according to Herodotus.
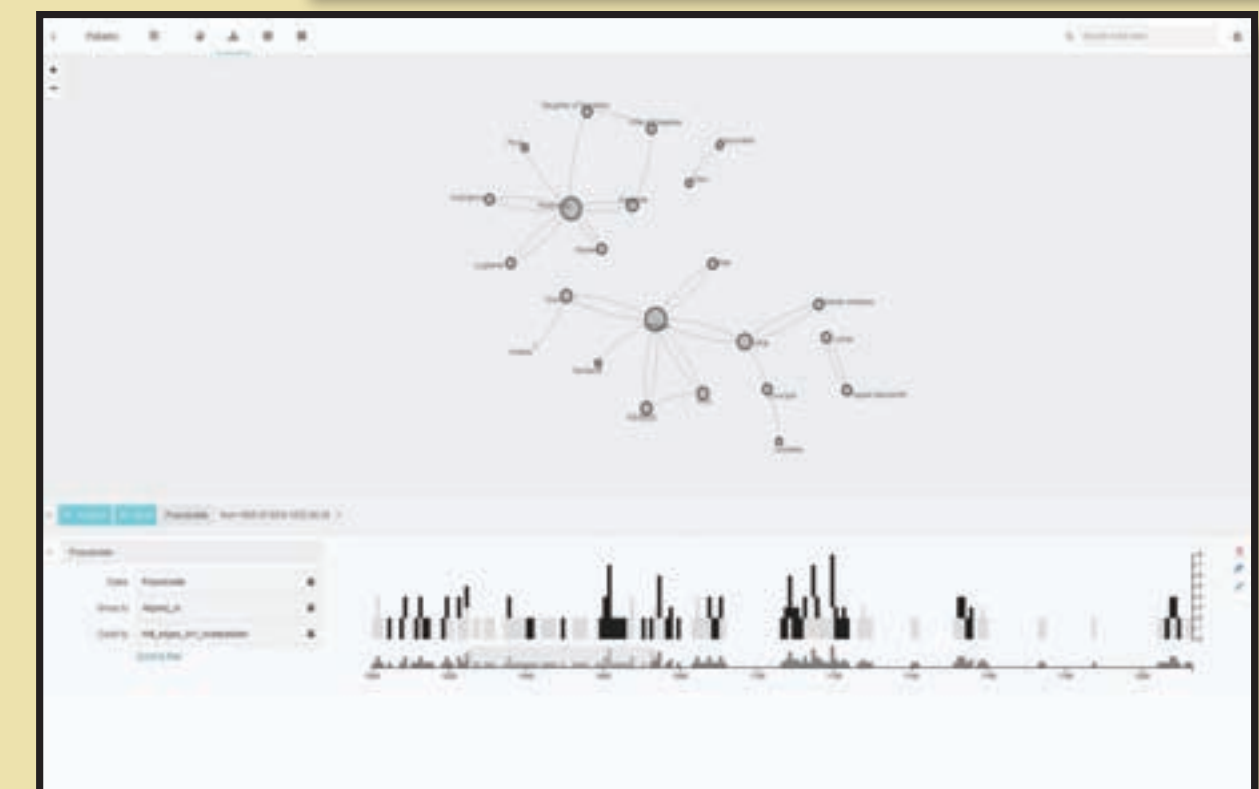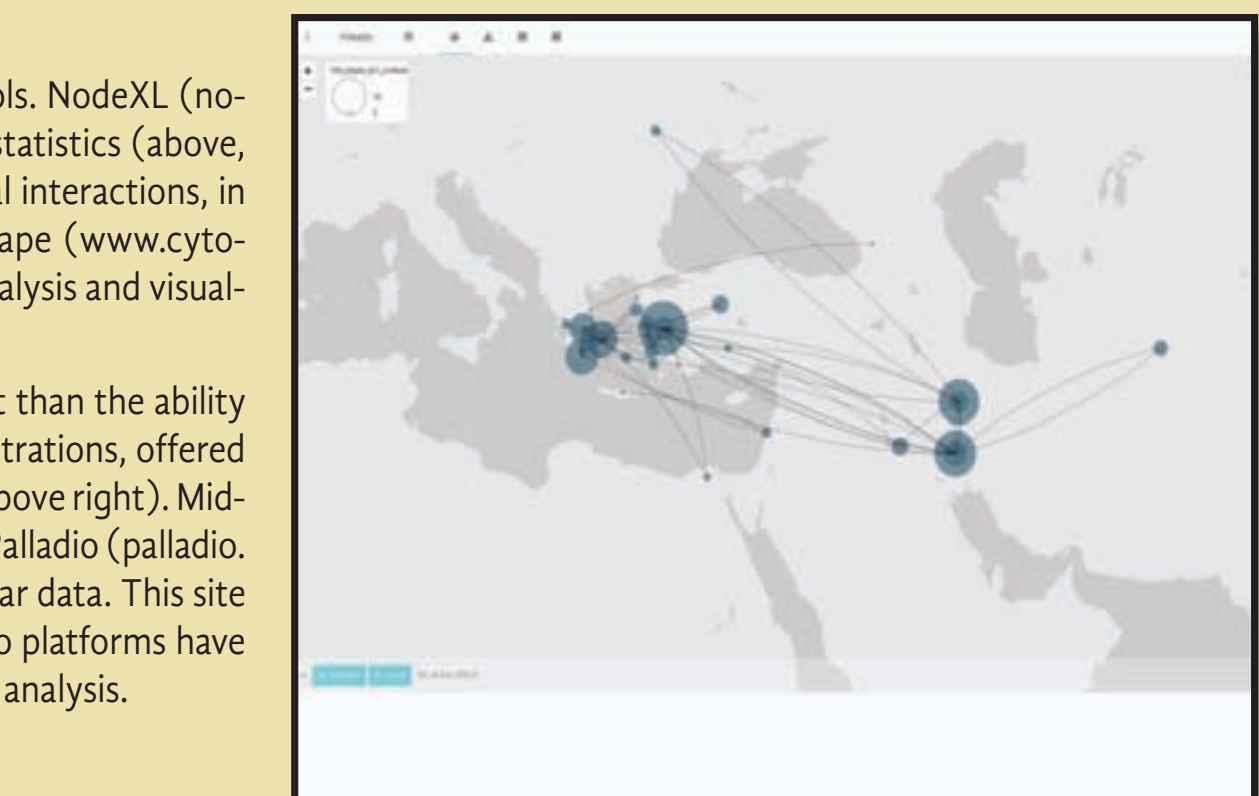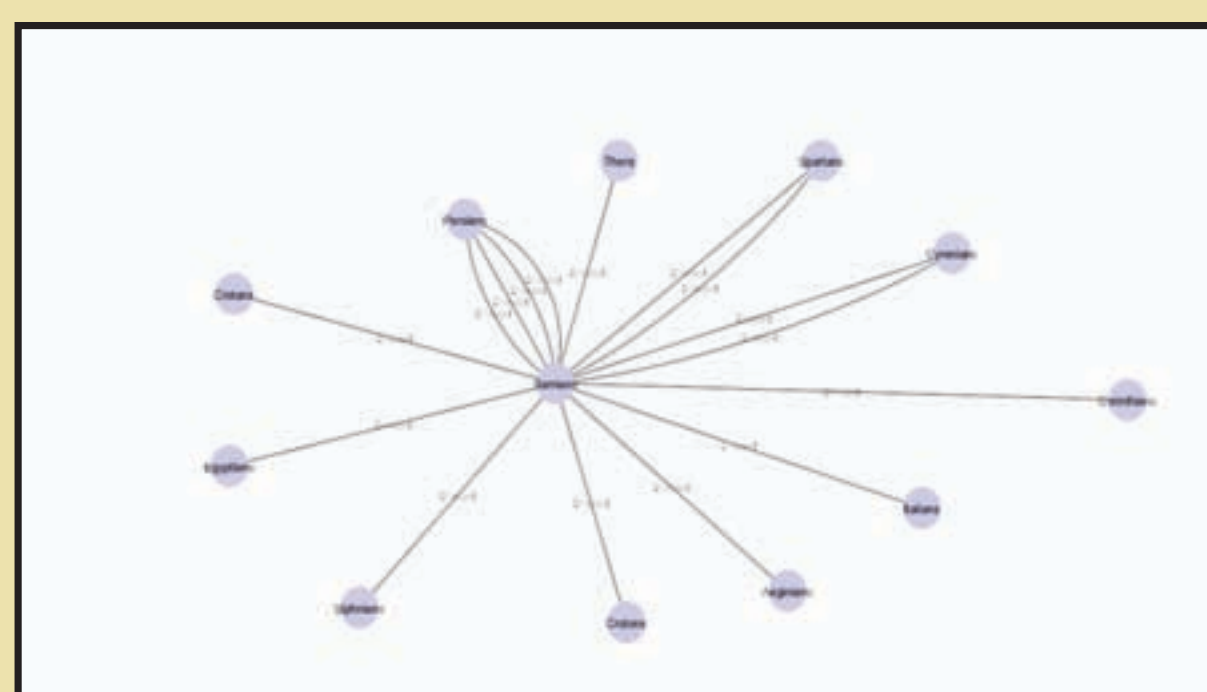
Student Conclusions: Challenges and Advantages

- Reading Herodotus, dealing with historiography and archaeology, and learning how to use and apply network tools all at the same time in the span of a single semester was time consuming, frustrating, and sometimes overwhelming.
- The use of a digital text and tools for studying Herodotus ran counter to the traditional methods taught in Classics departments, which made adapting to these new methods difficult.
- Not only was there a steep learning curve for the tools, but it was hard to figure out research questions for which network approaches are appropriate (much time was spent making graphs that did not produce new insights).
- On the other hand, the graphs we produced served as a good visual aid for representing and exploring relationships and narrative structure in Herodotus, and the act of creating the graphs led to deeper engagement with the text.
- In some cases, network analysis graphs did serve to inform and aid the exploration of new research topics and questions -- but contextual understanding of the material is a prerequisite.
- Time and space are critical elements in network approaches to the study of ancient historians.