Workshop: "Bridging the Gaps: (Ancient) History from the Perspective of Mathematical and Computational Modelling and Network Analysis"

13-14 November 2015 in Brno (Czech Republic)

Venue: Open Gardens, 33 Údolní street

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<u>**Keynote Lectures**</u>

The Complex Mediterranean: Networks, Diffusion and Social Dynamics in the Pre-Modern Period

Johannes Preiser-Kapeller (Austrian Academy of Sciences)

Abstract:

The "Mediterranean" has become one of the most prominent and most-discussed concepts in historical studies since Braudel's masterpiece of 1949, more recently followed by studies such as Horden and Purcell's "Corrupting Sea" (2000), Abulafia's "Great Sea" (2011) or Broodbanks "Making of the Middle Sea" (2013). Across this scholarship, we encounter various "Mediterraneans", sometime unified and centres of their own "world systems", sometimes fragmented into a multitude of "micro-regions" and "micro-ecologies". In this paper, I will demonstrate how concepts of network analysis and complexity theory can contribute to an integration of these various facets of the "Middle Sea" and a better understanding of the dynamics of its integration and dis-integration during time. Furthermore, phenomena of (cultural, religious, economic or epidemic) diffusion will be discussed against this changing framework and in their interplay with "global", regional and local networks. In general, the aim is to highlight aspects of social complexity of Mediterranean history beyond metaphors.

Lessons Learned from Simulating a Splinter Group of a Sect in Papua New Guinea and the Spanish Flu Pandemic

Ken Kahn (University of Oxford)

Abstract:

There is much to be learned from agent-based modelling in addition to what can be learned by running experiments on agent-based models. This talk will focus upon insights acquired while designing and building agent-based models. Two case studies will be presented. The first concerns Harvey Whitehouse's theory of the Modes of Religiosity. During a project aimed asimulating the cognition and behaviours of the followers and leaders of the Pomio Kivung sect, we discovered gaps in the both the data and theory that had gone unnoticed for many years. The process of making an explicit computational model of the theory led to a deeper understanding of the theory and various improvements. The second example involves an attempt to simulate the Spanish Flu Pandemic of 1918-19. Two versions of the model were built; each addressing different theories of where the pandemic originated. In the process we learned that one theory had a much wider range of parameter values that produced historically valid simulation runs than the other. The model also provided plausible answers to popular counter-factual questions regarding the influence World War I had on the

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dynamics of the pandemic.

Modeling Religions Past

István Czachesz (University of Heidelberg)

Abstract:

Can computers help us bring ancient history back to life? What are the possibilities and limitations of simulating past minds and past religious movements? In this talk I will consider the uses and benefits of computer modeling in the study of religions in the historical past. First, I will discuss what models are and what we can expect from them. Then I will address relevant problems of the scale, level, and complexity of human culture and history, considering how such factors influence the choice of modeling tools. In the final part of the talk, I will identify aspects of ancient religions that we can study using computer models and conclude by case studies that illustrate the opportunities of modeling religions past.

Individual papers

Religious Networks *in situ* and *in silico*

Justin Lane (University of Oxford & Boston University)

Abstract:

Current research concerning the nature of human sociality has largely concentrated on the psychological mechanisms humans utilize during communication and cooperation. This provides an empirical basis for studying humanities most unique social phenomena: religion. This paper presents the current status of an ongoing research collaboration between cognitive scientists, computer scientists, and archaeologists. It defends that using empirical lab studies of human cognition is not sufficient to speak to larger social phenomena such as religion. These empirical results must be re-incorporated into social systems. We argue that this is best done by multi-agent AI (MAAI) modelling. However, even with empirically backed MAAI models run on some of the world's fastest computers, these models are still largely hollow because they are not constrained by any historical reality. In this regard, our research team is utilizing archaeology to inform both the creation and behavioural constraints of a new agent-based model aimed at simulation large-scale religious shifts in the neo-lithic and medieval periods. As such, this research directly engages with both historical, archaeological, cognitive, and agent based approaches to social complexity. At its foundation is a mixture of social network and cognitive science on one hand and historical and archaeological data on the other. By using new computational approaches it seeks to seamlessly weave the two together in order to produce novel insights into the history and dynamics of religion.

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Exploration of Prehistoric Settlement Networks Using Graph Searching Algorithms in NetLogo: A Systematic Approach

Alžběta Danielisová[1] & Kamila Štekerová[2]

[1]Czech Academy of Sciences, [2]University of Hradec Králové

Abstract:

Our project "Social modelling as a tool for understanding Celtic society and cultural changes at the end of the Iron Age" was focused on development of social simulations of basic economic activities of the prehistoric populations. We aimed to verify hypotheses about the economic relations between aggregated settlements with special social and political functions and common rural settlements by means of the set of NetLogo models. Our current interest is in the network analysis and network models. We aim to study the process of foundation, diffusion and clustering of prehistoric settlement networks. The major problem lies in uncertain, fragmentary archaeological data. We propose an application of graph searching algorithms within NetLogo models in form an independent, reusable extending library (extension). The main idea behind the extension was to improve the performance of NetLogo which is frequently used by archaeological community. However, it is not suitable for large-scale and/or complex models such as the model of gradual spatial dispersion of settlement networks in large real-world areas (based on detailed GIS data), because manipulating a map made up of thousands of cells is extremely computationally intensive. The first version supports two graph models (agent-based graph and patch-based graph) and it provides two searching algorithms (Dijkstra, A*). It was implemented using a standard NetLogo API.

Religious Collective Memory as a Process: Agent-Based Model

František Kalvas (University of West Bohemia)

Abstract:

Author models religious collective memory as collective process without presence of material bearers of religious memory (constructions, books etc.). In this process (a) selected historical events are interpreted through (b) interpretation frames (c) by members of a group. Every individual forms in her/his mind the most consistent network of interpreted historical events. Interpreted religious attitude is in the center of such network. Inconsistencies in the network lead to cognitive dissonance. Individual diminishes cognitive dissonance by: (1) communication with neighbors in the social network, (2) densifying of network of her/his cognitive elements, (3) changing of interpretation frames, or (4) disconnecting of inconsistent cognitive elements.

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Author conducts simulation experiment with a group of 84 individuals who interpret same 40 events. Author analyzes impact of number of frames (2-4), frequency of commemorations (74x-468x), number of individuals with the right to commemorate selected event (2-8), cognitive dissonance threshold (1.1-2.0) and social network density (1.9-32.8 of ties per individual). Preliminary results of the output data will be presented.

The Archaeological Paradox: Problems of Interpreting Artefact Data from Cemetery Samples and a Way Out Using Agent-Based Modelling Software

Andreas Duering (University of Oxford)

Abstract:

Archaeology has failed to understand the mathematical complexity of artefact-based cemetery data. Published interpretations using grave goods in traditional archaeological research are highly problematic because of a well-known and little understood paradox – a discovery made in osteoarchaeology more than two decades ago. When Wood et al. presented the "Osteological Paradox" it became obvious that skeletal anthropology had to tackle the immense problem of the mathematical difference of static skeletal and dynamic living populations (Wood et al. 1992). Wood et al. showed that pathological, epidemiological and demographic results based on disease frequencies were no straightforward reflection of the living conditions of the studied populations. They behaved in a complex counterintuitive manner due to the effects of demographic nonstationarity, selective mortality and hidden heterogeneities of risks. To bridge the gaping chasm between skeletal data and the health conditions of past populations researchers in osteology have since addressed the paradox in a number of ways (Wright and Yoder 2003; Cohen, Wood, and Milner 1994; Jackes 1993; DeWitte and Stojanowski 2015). I argue that archaeologists who study artefacts from cemetery sites in all periods of time and regions must be aware that artefact data follows exactly the same complex principles as osteological data. I chose the title "Archaeological Paradox" in order to stress the universal character of the problem. Using the Population & Cemetery Simulator (PCS), an agent-based modelling tool for demographic archaeology, some simulations will show that artefact frequencies behave just as paradoxical as disease frequencies. Burial archaeology must come out of anaesthesia and rewrite its methodology. This paper presents case studies illustrating various effects of the paradox. My research also provides a basis for future models in archaeology which employ demographic processes based on data retrieved from human remains and the material culture of the grave.

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The Inner Worlds of Religious Literature: A social Network of the *Mahābhārata* and Its Semantics

Frederik Elwert (Ruhr-University Bochum)

Abstract:

In recent years, literary studies have been one of the most influential disciplines in the formation of the so-called digital humanities. The methods that were developed in this context cannot always be easily applied in historical research. The history of religions, however, presents an interesting case, as it is often concerned with both historical and literary data (if this distinction is meaningful in the first place). The study of religious literature can greatly benefit from digital methods, and in turn contribute to both digital humanities methodology and the history of religions. In the context of literary studies, network analysis is among the fruitfully applied methods. However, most applications focus on the reconstruction of the social structure of e.g. English plays (Moretti 2011) or Nordic sagas (Mac Carron and Kenna 2013). However, the semantic dimension, i.e. the meaning of social relations, has been studied less. I will argue that this is especially relevant for the study of religious literature. Using the Sanskrit epic "Mahābhārata" as an example, I will present results of the SeNeReKo project. In that project, we performed a joint analysis of the structure and content of relations between the Mahābhārata's most important gods and heroes. The resulting network includes information about the semantic fields related to both the actors and their relationships. These two types of information were collected automatically with the help of the "nubbi" topic modeling algorithm (Chang, Boyd-Graber, and Blei 2009), which assigns separate sets of topics to both persons and their relations. The visualization of such a network provides intuitive access to a high density of information like the topics associated with each actor and their relations. In contrast to the community detection algorithms usually used to find sub-groups in social networks, the topics allow to group actors based on semantic information, rather than structural information alone. The visually guided "distant reading" (Moretti 2013) of the complete text can be used as a powerful tool to complement and guide the "close reading" approach of hermeneutics that is usually applied to religious texts.

References:

Chang, Jonathan, Jordan Boyd-Graber, and David M. Blei. 2009. "Connections Between the Lines: augmenting Social Networks with Text." In Proceedings of the 15th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, 169–178. ACM. http://dl.acm.org/citation.cfm?id=1557044.

Mac Carron, P., and R. Kenna. 2013. "Network Analysis of the Íslendinga Sögur – the Sagas of Icelanders." ArXiv e-print 1309.6134. http://arxiv.org/abs/1309.6134.

Moretti, Franco. 2013. Distant Reading. London: Verso.

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From Sources to Data to Knowledge: A Knowledge Base for the Study of the German Society around 1200

Clemens Beck – Christian Knüpfer (University of Jena)

Abstract:

Precondition for a historical network-analytical research is a digital preparation of the relevant data. In the presented project there will be a new access to this problem. Together with the Regesta Imperii Online (a digital repository of regestas of German charters and other sources about German medieval rulers) and the Chair for artificial intelligence of the Friedrich-Schiller-University Jena we are planning to establish a medieval knowledge base. The knowledge base should represents the necessary knowledge about historical events, persons, geography and the many ties between them and the related sources. Besides a easy access to the represented data the knowledge base should 1) reproduce the historical state of knowledge and discussion in a clearly way, 2) be easily and flexibly expandable to new sorts of knowledge, 3) be usable to answer different historical questions, and 4) provide user-friendly options for the input and the presentation of the data.

Poster Session

Social Network of the Impoverished Nobility in Late Middle Ages

Jan Škvrňák (Masaryk University)

Abstract:

Beneš from Kvasice, the member of the high nobility in Moravia, published before his death in 1410 a list of his debts and creditors. This chart is a unique document to economical history of medieval domains, and gives us the opportunity to get a wider view of a medieval social network.

Mining in Dynamic Graphs

Karel Vaculík & Luboš Popelínský (Masaryk University)

Abstract:

Importance of data-mining and machine-learning techniques increases in large number of domains due to availability of data. Majority of standard data mining algorithms assumes data instances to be independent. However, there is a lot of real-world scenarios where

relationships between data instances exist. For example, there are relationships between people in social networks, between films, actors and directors or between chemical elements in chemical compounds. Such relationships can be easily, and without loss of information, expressed by a graph and then analysed with graph mining methods. Graphs do not have to represent only static or persistent relationships but also dynamic ones such as communication between people, or represent a general evolution of a network in time, i.e. addition and removal of individuals (a new piece of text, a new actor), change of linking between individuals, change of values associated with individuals (e.g. their roles), etc. Pattern mining in dynamic graphs - namely in social networks - has received a lot of attention in recent years. Here we briefly introduce the principal methods for mining in dynamic graphs. Then we focus not on graph mining in huge social networks like Facebook, but on the other research and application areas that may be more interesting for GEHIR project. It includes mining from text (the email correspondence in the Enron company), mining in educational data (constructive tasks in logic) or publication networks.

Digital materials for workshop

We have created a shared folder on our website, which is accessible on http://gehir.phil.muni.cz/workshop2015 . There will be available workshop digital materials (mainly posters and presentations) for free download. The content will change during the workshop.

At the beginning there are available digital versions of GEHIR member posters (see program before noon Saturday program).