DySoC Critical Workshop: Modeling Complex Systems in Archaeology
Saturday-Sunday, 9-10 June 2018

Workshop Report

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This workshop focused on discussing models used in complex systems in archaeology, resulting from discussion at the 2018 Theoretical Roman Archaeology Conference (Edinburgh, UK) session, “Formal Approaches to Complexity in Roman Archaeology: Exploring Complex Systems and Understanding Change." The participants in this workshop came from US and European institutions, and presented a variety of computational approaches and techniques, including agent-based models, Approximate Bayesian computation, as well as simulation, resampling, and the bootstrap, which dealt with the situation of archaeological data. The aim of the workshop was to provide a critical but friendly atmosphere, to explore all aspects of the modelling process, but especially methodological comparison and model evaluation. Most of the discussion took place within the disciplinary context of Roman archaeology, the field of most of workshop members.

Agent-based models (ABM) have a demonstrated record over the past several decades for furthering the understanding of complex sociocultural and economic processes. Their application in Roman archaeology is, however, fairly recent compared to other disciplines. As a general introduction, participants discussed different theoretical issues underlying ABM implementation, whether models should be data-rich and all-encompassing, or whether they should be minimalizing, aiming at addressing as few variables as possible. Emphasis was placed on the clear statement of behavioral rules in the model, since optimality is not necessarily the driving factor in all situations: random copying and conformity serve as other rules which may be imposed on the agents. Taking care to ensure that behavioral rules did not serve both as the explanation behind and the premise within ABM was also highlighted. In particular, mobility and movement within ancient cities is an area where ABM offers potential for obtaining insights where little or no archaeological evidence exists, and options were suggested for the development of hierarchical or ranked crowd models to structure the path of specific events, such as religious processions in Ostia, in order to understand the presence of different religious institutions’ use of the cityscape. The participants proposed further comparison of ABM with other methods, such as gravitational models or state-transition systems like Markov chains, toward looking at human interaction and mobility in the ancient world.

Estimation was another subject of the workshop, which centered largely on the use of Monte Carlo and Bayesian methods in specific case studies. Participants discussed the evaluation of model parameters through simulation and the use of Approximate Bayesian computation (ABC) as a form of hypothesis testing. ABC was applied to data from the ICRATES database, which contains information on the presence of Roman ceramic fineware at archaeological sites in the eastern Mediterranean. The historical distribution of these wares is known, and ABC can be used to find the most probable

model parameters (such as frequency of exchange) in light of the observed historical data through a highest density estimate. Another case addressed the question of demography, which has been of long-standing interest in Roman studies. The estimation of changing rates of the urban and rural populations of the Empire has largely relied on lengthy, considered supposition of likely variables from a variety of historical and material sources. Computational methods serve to refine the logical and inferential process inherent in those debates, and in this vein the use of Monte Carlo simulation, fitting probability densities, and resampling from those densities was proposed as a way to overcome missing data or uncertain variables. The estimation of the frequency of artifact-types or other categorical variables over time was another area of discussion, and the motivations behind the bootstrap and random subsampling were explored as a way to address information loss in the archaeological record. The question of the level of acceptable certainty was also raised. A credible interval of 50% (or even lower) might be suitable within the context of archaeology, in light of the sparseness of inputs and the methodological difficulty in dealing with finds data, when sampling cannot be controlled (i.e., one finds what one finds).

Participants also shared and discussed their code (in NetLogo, Python, and R) which was used in their presentations, step-by-step, in the form of a technical roundtable. This roundtable was a crucial part of the workshop experience, since the study of complex systems is dependent on a knowledge of coding, which is often not a standard component of archaeological training. Looking ahead, fostering broader technical ability in computational work in the field will be an essential undertaking, with critical workshops for researchers to share their datasets and code representing a vital mechanism for success. In sum, this workshop demonstrated the way in which modeling complex systems provides an exciting, vibrant, and rich area of research in Roman archaeology, which can fruitfully avail itself of techniques which are commonplace in other disciplines.

Workshop Participants

Alex Bentley (University of Tennessee)
Simon Carrignon (Barcelona Supercomputing Center)
Stephen Collins-Elliott (University of Tennessee)
Katherine Crawford (University of Southampton)
Jack Hanson (University of Colorado)

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