Measuring Rural Economic Development through Categorical Data Analysis in Southern Etruria and Latium (400 BC–50 AD)

Stephen A. Collins-Elliott

Abstract

The comparison of the results of rural surveys and excavations has been a long-standing interest in the study of the ancient economy, seeking above all a way to measure changes in settlement patterns and site hierarchies over time. Nevertheless, cross-comparison has been inhibited by numerous factors, including differences in sample size, survey intensity, and classification. This paper presents practical techniques to address these issues, and focuses on the computational methodology employed to obtain estimates of the prevalence or degree of features in the landscape of southern Etruria and northern Latium that pertain to economic processes. As a proof-of-concept, it uses the published data from four survey projects around Caere, Fidenae, Crustumerium, and Cures Sabini (fig. 1). The method consists of a script, written in Python, that automates the process of translating across categories, which works as follows.

First, classification is addressed using a flexible semantic concordance to standardize site- and artifact-level features from published surveys and excavations as an ontology, by which I mean a formal set of definitions and their relationships to one another, taking the form of a network. Linking concepts together provides a map of the associations that artifact and feature labels have with one another, affording an expedient means to rework different taxonomic systems. Thus, not only can cross-project concordances be standardized, but their semantic connotations can be explored beyond the confines of their definitions, relating sites to variable economic tasks and domains of life. For example, villas, emblematic of aristocratic rural life, are also loci of production, and defining an ontology which links these categories together can serve to accommodate these overlapping associations. Second, the estimation of the prevalence of selected categorical factors can then proceed using random subsampling. This involves taking a random sample from the observed sample of sites, of a smaller size than the actual sample, to address the known factor of loss in the archaeological record and assess the quality of the data for how it varies in its size, which is reflective of the intensity of collection. Uncertainty is thereby accommodated within the estimation of different categorical features in the landscape of the Tiber River Valley.

Thus, it is possible to provide a more accurate assessment of quantified, long-term change in the rural economy, as the population of Rome increased over the last several centuries BC and first half of the first century AD. It is suggested that regional development in the *suburbium* is uneven, and certain phenomena might not be necessarily linked, such as the proliferation of large villas and the use of amphora-borne com-

Published in: Peter Attema – Günther Schörner (Eds.), The Rural Foundations of The Roman Economy. New Approaches to Rome's Ancient Countryside from the Archaic to the Early Imperial Period, Panel 11.1, Archaeology and Economy in the Ancient World 50 (Heidelberg, Propylaeum 2022) 19–33. DOI: *https://doi.org/10.11588/propylaeum.930.c12272*

modities (whether production or consumption). Further work to examine patterns of association, whether using methods like correspondence analysis, non-metric multidimensional scaling, and/or correlation, will be necessary. But, the practical tools developed here are aimed at moving toward a multi-faceted perspective of economic development and integration in the countryside beyond site counts and the intensity of agricultural productivity.

Introduction

The comparison of rural surveys has been a subject of continued interest in the study of the Roman *suburbium,* seeking above all a way to measure changes in settlement patterns and site hierarchies over time.[1] The issues have been long-discussed within the framework of project restudy, resurveying, and cross-project synthesis.[2] Where the aim of regional analysis has been the quantification of sites, finds, and the estimation of their surface density, the most ostensible culprits which impede straightforward comparison are differential visibility factors, methodology, and the intensity of fieldwork.[3] Different systems of classification also pose a significant problem, since different terms may be applied to identical finds or site-types, and vice-versa.[4] The representativeness of surface finds to those from subsurface strata is particular to the formation processes of each site. To be sure, this is ancillary to the larger (and unanswerable) question of the quantitative relationship of assemblages to the material culture in actual use in the past.[5] However, finding measures of rural economic development can profit from computational methods, not just in dealing with the uncertainty and doubt surrounding quantitative data, but also in interpretation and classification. This paper presents an approach as a proof-of-concept, to measure the prevalence of different categorical attributes or features within a landscape over time.

This paper proceeds in two sections. First, I outline a computational method to expedite the reclassification of archaeological finds, features, and site-types. Second, I implement a method of resampling to obtain statistical information on the estimations of the prevalence of different features.

Archaeological Classification and Semantic Networks

To start, it should be noted that the act of collecting finds and recording sites is not akin to an empirical trial, where a hypothesis is put forward, tested, and either proven or disproved. Rather, it comprises the accumulation of descriptive observations of conditions which are well beyond the control of the investigator. In synthesizing data from different projects, the lowest common denominator can be viewed as the factors of presence and "pseudo-absence" (since it is impossible to confirm absence) at a given location. The use of what might be called low-quality or low-resolution data can find some parallels in ecological studies of species detection, which employ presence and presence-absence data in conjunction with geographic data to produce predictive maps.[6] While predictive analysis is not the aim here, basic factors of presence and pseudo-absence provide a useful foundation toward the comparison of the regional distribution of features in the landscape. Each site can be considered in terms of its categorical attributes or features (such as its finds assemblages and other denotative qualities), whose presence can be indicated with either a yes (1) or a no (0).

Comparison mandates that the same definitions should be employed for every site. Nevertheless, archaeologists have yet to establish discipline-wide classificatory standards, and even if such standardization could be achieved, one would still have to deal with the task of reconciling past classificatory systems. The solution lies in creating an effective means of translating across projects. To that end, a semantic network provides a useful summary representation of the relationship between different concepts, as an ontology.[7] The ontology developed for this paper was drawn from the terminology employed in four well-known surveys in southern Etruria and northern Latium, listed in Table 1.

These explicit terms were supplemented with connotative associations that extended to larger behavioral domains (as broadly as "domestic" or "economic"), as well as translations from Italian into English. The sum of terms in the ontology came to 365, and

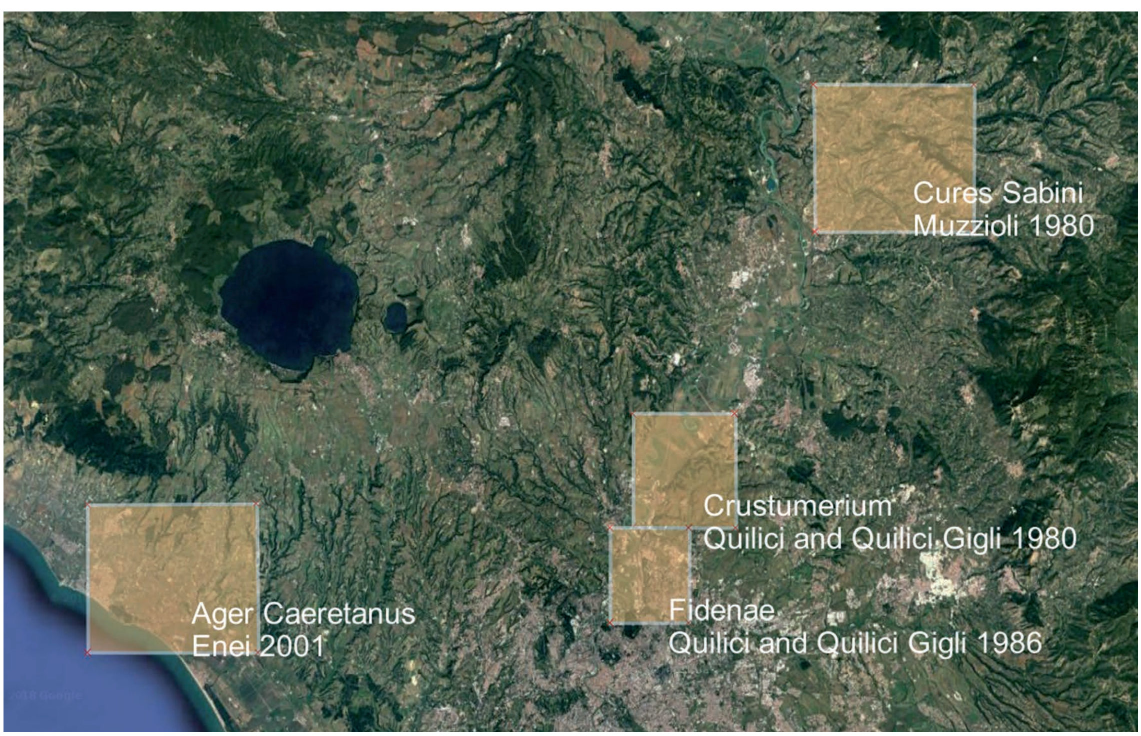

Fig. 1: Boundaries of the survey regions listed in Table 1.

Region	*N*	Publication
Ager Caeretanus	91	Enei 2001.
Crustumerium	128	Quilici – Quilici Gigli 1980.
Cures Sabini	139	Muzzioli 1980.
Fidenae	36	Quilici – Quilici Gigli 1986.

Table 1: Published surveys in south Etruria and northern Latium which provided data for this project, illustrated in Figure 1. *N* represents the number of sites in each sample set (not the total number of sites in the survey publication).

in the interest of keeping the ontology simple, relationships were kept at the level of "implies," through a directed line (fig. 2). For example, a string of relationships can be traced through the following links, with each feature in brackets:

[loomweight] ⟶ [textile production] ⟶ [craft production] ⟶ [economic]

The full network and all data are available online.[8] It should be noted that this network is under development, and, to be sure, alternative ontologies should be implemented to test for categorical stability or consistency.

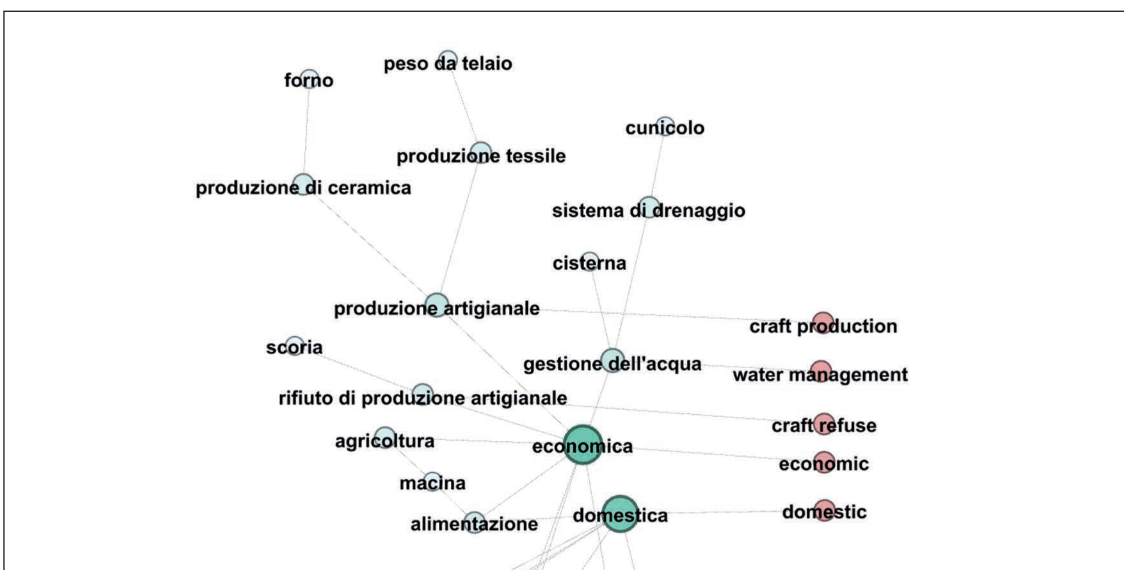

Fig. 2: Partial section of the semantic network showing links between associated concepts. Terms were left in Italian for the sake of convenience, with English translations added where necessary.

A partial set of site descriptions from each of these projects was then collected, breaking down each entry into its constituted set of features. For example, we can take the entry for site no. 268 from the *Ager Caeretanus* project:[9]

> 268. Area di frammenti
> Ampia circa 900 mq con densità 2, su terreno arpicato, di formazione alluvionale molto recente, coltivato a vignetto. Si rivengono: impasto rosso-bruno (*pithoi,* olle, bacini), sigillata italica (f. XXXVII), sigillata africana (prod. D), anfore (f. Will A/C, Dressel 2/4), comune imperiale da fuoco; tegole di I° fase, tegole romane, numerose scaglie calcaree e tufacee.
> Presenze di epoca etrusca (VII?–VI sec. a.C.) e romana (III sec. a.C.; I–IV sec. d.C.).
> Cerveteri, Casalone di Ceri, 10.8.88 (tav. 40).

The description can be recast into a set of features, with its phases listed as sets of intervals ("[–300,–200]" being the equivalent of the third century BC), coded in JSON:[10]

```
{
"id": "268",
"dates": ["[-300,-200]", "[1,400]"],
"features": ["area di frammenti", "sigillata italica",
    "Will A-C", "Dressel 2-4", "comune imperiale da fuoco",
    "tegola", "scaglie calcaree",
    "scaglie tufacee"]
}
```

Characteristics like scatter size could be added to the feature list. Features can also be coded with a dating phase, in order to avoid chronological contamination: E.g., [sigillata italica] can be assigned the date range [–30,75], or [comune imperiale da fuoco] the date range [–30,300]. Moreover, that attribute can be more precisely labeled as [comune imperiale da fuoco, Enei 2001], in order to avoid conflicting with an identical ceramic class from another project which might have a different periodization.[11] That said, superfluous attributes do not need to be added, for example, [amphora], since that vessel class is implicit in the finds of Greco-Italic (Will A-C) and Dressel 2-4 amphorae at the site. The script I wrote in Python returned a value of "1" if the feature was present at that site for a given year, and "0" if it was missing (pseudo-absent) from the site (Tab. 2).

The Python script then ran through the semantic network to see if any of the features present could be related to an attribute in question, translating that feature into all possible associated terms. Thus, specifying a feature like [amphora] would return the total sum of sites in the specific period which had attested any amphora class; specifying "craft production" yielded the total number of sites which had any features related to

	−250	50
area di frammenti	1	1
sigillata italica	0	1
Will A-C	1	0
Dressel 2-4	0	1
comune imp. da fuoco	0	1
tegola	1	1
scaglie calcaree	1	1
scaglie tufacee	1	1

Table 2: Presence/pseudo-absence table for the years ca. 250 BCE and 50 CE, using the example of *Ager Caeretanus* project, site no. 268, from Enei 2001, 201.

any type of craftwork (for example, loomweights, kilns). This represents the simplest form that such an ontology could take, given the variety of possible relationships. More elaborate and hierarchical networks would provide more nuanced ways of construing archaeological definitions and their associations. In sum, by transferring the interpretive process of archaeological artifacts to the formal ontology, a rapid means of reclassification is achieved, and any issues with the system of definitions and classes can be dealt with by reworking the ontology.

Subsampling Estimation

Proceeding to the second part of the paper, I estimate the prevalence of any one of these features using the total sum of sites as the population, rather than the surface area of the region in question. The object of estimation is therefore not counts of sites, but rather the proportion of sites that possessed a given feature in a region. It is also desirable to obtain information about the strength of certainty in the those estimates. Even as the population (the total number of sites) is unknown, we can nevertheless be sure that a portion of the total sites that were once occupied have been detected. Accordingly, a process of simulation that resamples from our sample would appear to be the most effective means to get information about variance, and hence a credible interval that would indicate the upper and lower boundaries of the measure according to a given level of certainty. While the bootstrap (resampling the same sample size with replacement) has been a popular technique, the premise of information loss would suggest that subsampling with a smaller sample size might be more germane to the situation of the archaeological data, and is worth exploring.[12]

This process of random subsampling simulates the effects of alternative results, where one has detected even fewer sites than what are in the sample. The script in Python accordingly selected a random subsample from the list of sites, and calculated the frequency of a given feature over a number of simulated runs (here, 1,000). The resulting set of simulated values could then be used to construct a probability density to locate the most probable value, argmax(x), as well as other descriptive statistics.[13] A histogram of subsampled values and the probability density derived from those subsamples are given in an example in Figure 3, which shows the probable estimation of the frequency of features of [amphora] and [water management] (the presence of a cistern or any system of channels), in the *Forma Italiae* survey around Cures Sabini.[14] With a certainty interval of 85%, the value of the subsampled frequency of amphorae lies between 0.18 and 0.50. According to the same degree of certainty, the subsampled frequency of features related to water management can be located within the range of 0.00 and 0.21. It can also be noted that a number of zero values will emerge in the course of subsampling, which could be taken as null values: one solution to this tendency is to construct the density on the open interval (0,1), which would exclude the values of 0 and 1. Similar spikes may be found at common fractional intervals, such as 0.5, 0.33, and 0.66: in the case of an overly small sample (such as only three or four sites), these

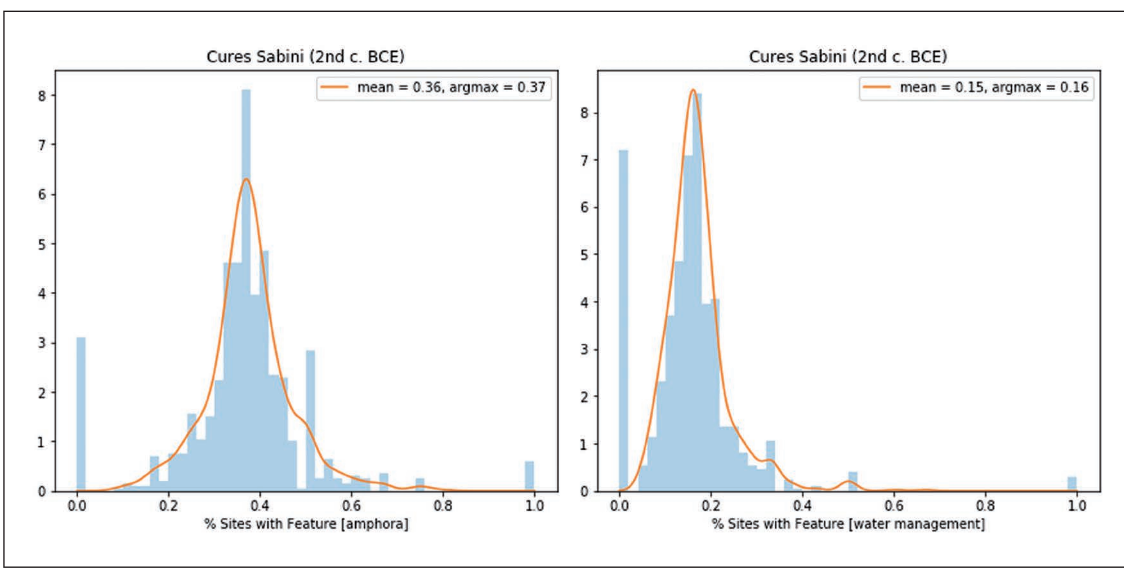

Fig. 3: Histograms and densities on the interval (0,1) of the subsampled values for the *Forma Italiae* survey around Cures Sabini for two different features, ca. 150 BC. Values of the mean and argmax (value which had the highest probability) in upper right-hand corner.

values may be the only ones which are generated by the subsampling routine, which would be clear in the histograms of the subsampling estimates.

This approach, which makes no assumptions about the shape of the data (i.e., that it would follow a normal distribution), is fruitful in that it allows for information on the effects of the sample size (the number of sites observed) to be carried over into a probability density. This can be used in constructing more complex models of the ancient economy. Rather than having a fixed or assumed *ad hoc* value, probability densities can provide a more nuanced picture about the degree to which we can be sure about our quantitative data.

To conclude with a few examples, it is important to highlight that the above procedure has its limits with the published data. It is not possible, for example, to ask questions about craft refuse or waste (as in the form of metal slag) from the survey around Fidenae, because that material class was not described in the survey catalogue. Other surveys might have been more thorough in the consistency with which they noted or labeled finds. That said, some classes of features or site-types remain valid. To take the features of [amphora], [villa], and [craft production] into consideration, the subsampled estimates of the prevalence of each feature can be plotted over time using a jitterplot, showing which values have a higher probability given the clustering of points (fig. 4).

To look at the case of one artifact class, amphorae, it might not be possible to compare frequencies across projects if they do not note their presence with the same regularity. However, assuming that the surveys are at least somewhat internally consistent, it should be possible to compare trends. In the case of the prevalence of amphorae, then, there would appear to be no clear pattern visible over time: both the *Ager Caeretanus* project and the *Forma Italiae* Cures Sabini survey show a peak, but at different moments of time. Around Caere the peak occurs in the first century BC, while around Cures Sabini it occurs around the second century BC. Crustumerium returns fairly consistently low frequencies of sites with amphorae, while the data from Fidenae appear to warrant little confidence for establishing a clear pattern before the second century BC, given the dispersion of the subsamples. There would at least seem to be a measure of micro-regional variation in the Roman *suburbium,* in either the production of amphorae or the transport and use of amphora-borne commodities.

There is, however, a more apparent trend in the prevalence of villas, a site-type which has been of long-standing use in the field, even as there is a movement away to the prescriptive archetype of the "Catonian" villa toward a recognition of the architectural variety which large rural estates had in the period of the Roman Republic.[15] Notwithstanding the assumed definition of villas, their prevalence in the landscape seems to undergo a steady increase into the last several centuries BC and first century AD in all but one of the survey regions, Cures Sabini. The exceedingly high frequency of villas (around 50% of the total number of sites) approaches that of the *Ager Cosanus,* a region recognized to have had one of the highest densities of villas in Etruria.[16] In light of this observation, it would be a fruitful exercise to revisit the construction of the concept of

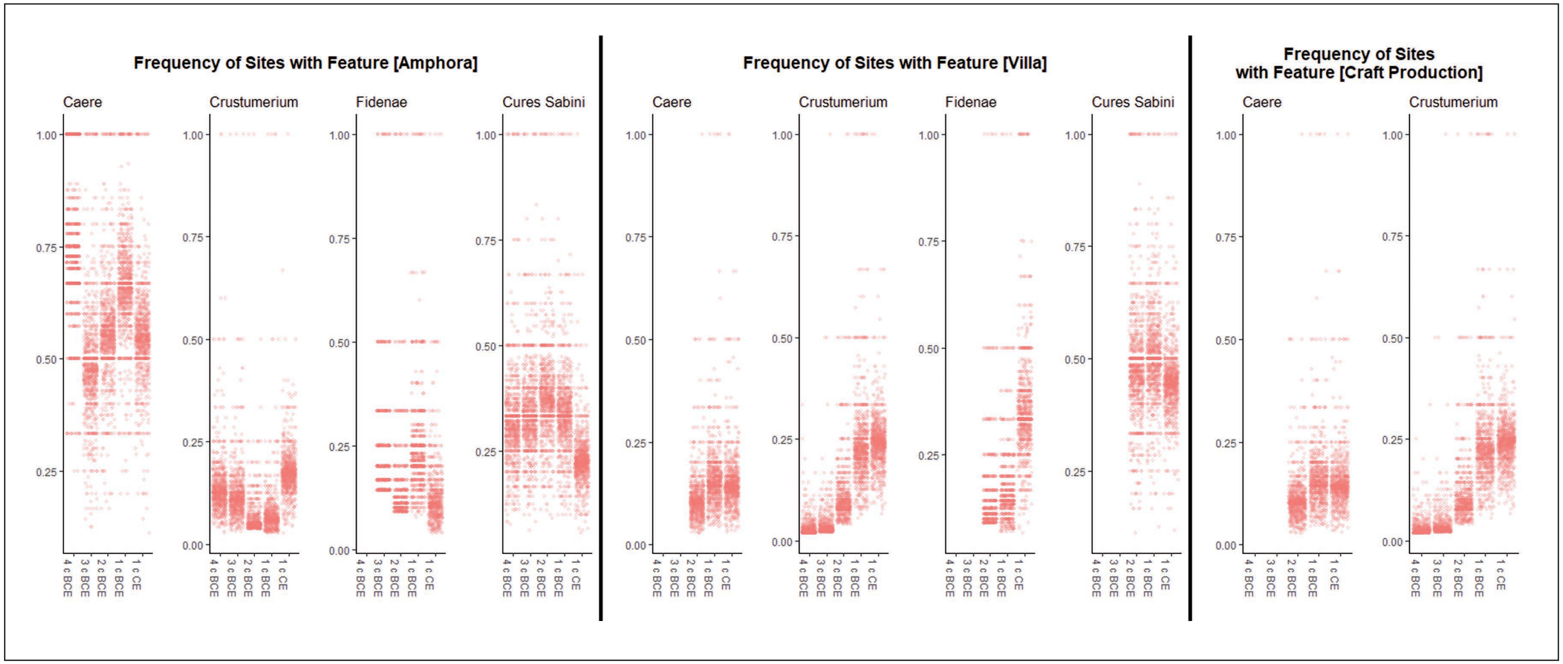

Fig. 4: Jitterplots of the subsampled frequency of select features in four south Etrurian/northern Latial landscapes, ca. 400 BC–50 AD: amphorae, villas, and craft production.

"villa" through the semantic network and to fully explore the range of connotations which the attendant material culture and architectural features has for its definition. Evaluating the correlation between the frequency of sites with amphorae (potentially as an indicator of maritime or riverine connectivity) and villas, and the relationship with other categories of evidence would also be useful, since these trends do not appear to be connected with one another.

Beyond either the artifact-type or the site-type, the use of a semantic network can expedite the process of measuring abstract indices, such as craft production, in the landscape. By linking material finds related to the production of textiles, ceramics, glass, and iron to a node in the network labeled [craft production], any finds which fell under that classification were automatically assigned that label. The results however can only be generated for two out of the four surveys, those around Caere and Crustumerium, while Fidenae and Cures Sabini lacked any evidence which pertained to those activities. They nevertheless would appear to show a gradual increase in the number of rural sites where craft activities were taking place, from the third-second century BC (around Caere) into the first century AD. However, comparing the prevalence of different features over time shows that not all categories of evidence work, due to the focus of interest in each survey (as in the case of craft refuse noted above).

Conclusions

Further data are necessary before proceeding with firm conclusions about the development of the rural economy in the hinterland of Rome over the last several centuries BC. Nevertheless, these preliminary results indicate that economic developments within the *suburbium* are not uniform or homogenous over the last four centuries BC and first century AD. The methods developed here also illustrate that inter-regional comparisons can be achieved computationally, both to expedite the translation of features across projects and to accommodate uncertainty in their quantification. There are a number of issues which impact site recovery rates and material culture in attendance, from visibility to the sampling strategies employed. Yet, the premise that there is a certain amount of information loss in the observation of archaeological data provides motivation for randomized subsampling as a means to simulate statistical information, which can serve to provide credibility in estimation. In turn, probability densities can be resampled and incorporated into more complex models of the ancient economy, allowing for a more accurate picture of the certainty or uncertainty of conclusions.

Looking ahead, the economic development of the *suburbium* (and beyond) can be measured not merely for increases or decreases in the numbers of sites occupied and the distribution of specific artifact-types, but for the prevalence of broader factors, like craft production, whose relationship to finds and site-types can be related through a semantic network. The use of random subsampling can be used to transfer the effects of sample size onto estimates, and further to establish probability densities for incorporation to more complex models of economic interaction. This approach enables the easy manipulation of classificatory schemes as well as a means to obtain summary statistics on estimates with an unknown population. It constitutes a basis for multivariate methods of categorical data analysis that can examine the relationships among multiple factors at work, involving correlation, multidimensional scaling, principal component analysis, and multiple correspondence analysis, to assess the dynamics of economic relationships at work in the countryside.

Notes

[1] Witcher 2005a; Witcher 2005b; Witcher 2006; Patterson et al. 2004. For the impact of the growth of the city of Rome on its hinterland, see Morley 1996.

[2] In general, see papers in Francovich – Patterson 2000; Alcock – Cherry 2004; Attema – Schörner 2012.

[3] Cherry 1983; Shennan 1985; Terrenato – Ammerman 1996; Banning 2002, 46–49. 60–68; Bintliff 2002; Terrenato 2004.

[4] Witcher 2012.

[5] Haselgrove 1985; Schörner 2012.

[6] Manel et al. 2001; Ferrier et al. 2002; Brotons et al. 2004; Phillips et al. 2006; Liu et al. 2011. On predictive analysis in the Tiber river valley see Kay – Witcher 2009.

[7] Quillian 1967; see Calvanese et al. 2016; Collins-Elliott 2018. Brughmans 2010; Brughmans 2013 discuss the development of formal network approaches in archaeology with previous bibliography.

[8] The project files are available from the repository at <http://www.github.com/scollinselliott/tyrrhenian/> (23.09.2018).

[9] Enei 2001, 201 no. 268.

[10] The original script in python relied on csv tables for both the datasets and the semantic network. These have been converted into json for downloading.

[11] For automated taxonomic concordances in dealing with ceramics, see Collins-Elliott 2016.

[12] Baxter 2003, 148–154; key works on the bootstrap and the related technique of the jackknife include Miller 1974; Efron 1979; Efron – Tibshirani 1994. Formal treatment of subsampling can be found in Politis – Romano 1994; Politis et al. 1999.

[13] On kernel density estimation see Baxter 2003, 30–33.

[14] Muzzioli 1980.

[15] See Terrenato 2001; Marzano 2007, 3–5; Terrenato 2007; and papers in Becker – Terrenato 2012.

[16] Carandini et al. 2002; Witcher 2006, 93 Tab. 1.

Image Credits

All images by the author.

References

Alcock – Cherry 2004
S. Alcock – J. Cherry (eds.), Side-by-Side Survey. Comparative Regional Studies in the Mediterranean World (Oxford 2004).

Attema – Schörner 2012
P. Attema – G. Schörner (eds.), Comparative Issues in the Archaeology of the Roman Rural Landscape. Site Classification Between Survey, Excavation and Historical Categories, JRA Suppl. 88 (Portsmouth 2012).

Banning 2002
E. Banning, Archaeological Survey (New York 2002).

Baxter 2003
M. Baxter, Statistics in Archaeology (London 2003).

Becker – Terrenato 2012
J. Becker – N. Terrenato (eds.), Roman Republican Villas: Architecture, Context, and Ideology (Ann Arbor 2012).

Bintliff 2002
J. Bintliff, Settlement Pattern Analysis and Demographic Modeling, in: P. Attema – G.-J. Burgers – E. van Joolen – M. van Leusen – B. Mater (eds.), New Developments in Italian Landscape Archaeology (Oxford 2002) 28–35.

Brotons et al. 2004
L. Brotons – W. Thuiller – M. Araújo – A. Hirtzel, Presence–absence versus Presence-only. Modelling Methods for Predicting Bird Habitat Suitability, Ecography 27, 2004, 437–448.

Brughmans 2010
T. Brughmans, Connecting the Dots: towards Archaeological Network Analysis, OxfJA 2010, 2010, 277–303.

Brughmans 2013
T. Brughmans, Thinking Through Networks: A Review of Formal Network Methods in Archaeology, AMethTh 20, 2013, 623–662.

Calvanese et al. 2016
D. Calvanese – P. Liuzzo – A. Mosca – J. Remesal – M. Rezk – G. Rull, Ontology-based Data Integration in EPNet: Production and Distribution of Food during the Roman Empire, Engineering Applications of Artificial Intelligence 51, 2016, 212–229.

Carandini et al. 2002
A. Carandini – M. Celuzza – E. Fentress – I. Attolini (ed.), Paesaggi d'Etruria. Valle dell'Albegna, Valle d'Oro, Valle del Chiarone, Valle del Tafone (Rome 2002).

Cherry 1983
J. Cherry, Frogs around the Pond: Perspectives on Current Archaeological Survey Projects in the Mediterranean Area, in: D. Keller – D. Rupp (ed.), Archaeological Survey in the Mediterranean Area, BARIntSer 155 (Oxford 1983) 375–416.

Collins-Elliott 2016

S. Collins-Elliott, Agglomerative Clustering Using Cosine and Jaccard Distances: A Computational Approach to Roman Vessel Taxonomy, ACalc 27, 2016, 7–25.

Collins-Elliott 2018

S. Collins-Elliott, A Behavioral Analysis of Monetary Exchange and Craft Production in Rural Tuscany via Small Finds from the Roman Peasant Project, JMedA 31, 2018, 155–179.

Efron 1979

B. Efron, Bootstrap Methods: Another Look at the Jackknife, The Annals of Statistics 7, 1979, 1–26.

Efron – Tibshirani 1994

B. Efron – R. Tibshirani, An Introduction to the Bootstrap (Boca Raton 1994).

Enei 2001

F. Enei, Progetto Ager Caeretanus. Il litorale di Alsium (Ladispoli 2001).

Ferrier et al. 2002

S. Ferrier – G. Watson – J. Pearce – M. Drielsma, Extended Statistical Approaches to Modelling Spatial Pattern in Biodiversity in Northeast New South Wales 1. Species-level modelling, Biodiversity and Conservation 11, 2002, 2275–2307.

Francovich – Patterson 2000

R. Francovich – H. Patterson (eds.), Extracting Meaning from Ploughsoil Assemblages, The Archaeology of Mediterranean Landscapes 5 (Oxford 2000).

Haselgrove 1985

C. Haselgrove, Inference from Ploughsoil Artefact Samples, in: C. Haselgrove – C. Millet – I. Smith (eds.), Archaeology from the Ploughsoil: Studies in the Collection and Interpretation of Field Survey Data (Sheffield 1985) 7–29.

Kay – Witcher 2009

S. Kay – R. Witcher, Predictive Modelling of Roman Settlement in the Middle Tiber Valley, ACalc 20, 2009, 277–290.

Liu et al. 2011

C. Liu – M. White – G. Newell, Measuring and Comparing the Accuracy of Species Distribution Models with Presence-absence Data, Ecography 34, 2011, 232–243.

Manel et al. 2001

S. Manel – H. Williams – S. Ormerod, Evaluating Presence–absence Models in Ecology: the Need to Account for Prevalence, Journal of Applied Ecology 38, 2001, 921–931.

Marzano 2007

A. Marzano, Roman Villas in Central Italy: A Social and Economic History (Leiden 2007).

Miller 1974

R. Miller, The Jackknife – A Review, Biometrika 61, 1974, 1–15.

Morley 1996

N. Morley, Metropolis and Hinterland: The City of Rome and the Italian Economy, 200 BC–AD 200 (Cambridge 1996).

Muzzioli 1980

M. Muzzioli, Cures Sabini, Forma Italiae Regio IV – Vol. II (Florence 1980).

Patterson et al. 2004
H. Patterson – H. Di Giuseppe – R. Witcher, Three South Etrurian 'Crises': First Results of the Tiber Valley Project, BSR 72, 2004, 1–36.

Phillips et al. 2006
S. Phillips – R. Anderson – R. Schapire, Maximum Entropy Modeling of Species Geographic Distributions, Ecological Modelling 190, 2006, 231–259.

Politis – Romano 1994
D. Politis – J. Romano, Large Sample Confidence Regions Based on Subsamples under Minimal Assumptions, The Annals of Statistics 22, 1994, 2031–2050.

Politis et al. 1999
D. Politis – J. Romano – M. Wolf, Subsampling (New York 1999).

Quilici – Quilici Gigli 1980
L. Quilici – S. Quilici Gigli, Crustumerium, Latium Vetus 3 (Rome 1980).

Quilici – Quilici Gigli 1986
L. Quilici – S. Quilici Gigli, Fidenae, Latium Vetus 5 (Rome 1986).

Quillian 1967
M. Quillian, Word Concepts: a Theory and Simulation of Some Basic Semantic Capabilities, Behavioral Science 12, 1967, 410–430.

Schörner 2012
G. Schörner, Comparing Surface, Topsoil and Subsurface Ceramic Assemblages: the Case of Il Monte, San Gimignano, in: P. Attema – G. Schörner (eds.), Comparative Issues in the Archaeology of the Roman Rural Landscape. Site Classification Between Survey, Excavation and Historical Categories, JRA Suppl. 88 (Portsmouth 2012) 31–41.

Shennan 1985
S. Shennan, Experiments in the Collection and Analysis of Archaeological Survey Data: The East Hampshire Survey (Sheffield 1985).

Terrenato 2001
N. Terrenato, The Auditorium Site in Rome and the Origins of the villa, JRA 14, 2001, 5–32.

Terrenato 2004
N. Terrenato, Sample Size Matters! The Paradox of Global Trends and Local Surveys, in: S. Alcock – J. Cherry (eds.), Side-by-Side Survey. Comparative Regional Studies in the Mediterranean World (Oxford 2004) 36–48.

Terrenato 2007
N. Terrenato, The Essential Countryside: The Roman World, in: S. Alcock – R. Osborne (eds.), Classical Archaeology (Malden 2007) 139–161.

Terrenato – Ammerman 1996
N. Terrenato – A. Ammerman, Visibility and Site Recovery in the Cecina Valley Survey, JFieldA 23, 1996, 91–109.

Witcher 2005a
R. Witcher, The Extended Metropolis: urbs, suburbium, and Population, JRA 19, 2005, 120–138.

Witcher 2005b
R. Witcher, The Hinterlands of Rome: Settlement Diversity in the Early Imperial Landscape of Regio VII Etruria., in: P. Attema – A. Nijboer – A. Zifferero (eds.), Papers in Italian Archaeology VI: Communities and Settlements from the Neolithic to the Early Medieval Period, BARIntSer 1452 (Oxford 2005) 1045–1055.
Witcher 2006
R. Witcher, Settlement and Society in Early Imperial Etruria, JRS 96, 2006, 88–123.
Witcher 2012
R. Witcher, 'That From A Long Way Off Look Like Farms': The Classification of Roman Rural Sites, in: P. Attema – G. Schörner (eds.), Comparative Issues in the Archaeology of the Roman Rural Landscape. Site Classification Between Survey, Excavation and Historical Categories, JRA Suppl. 88 (Portsmouth 2012) 11–30.