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Systematic bias in humanities datasets: ancient and medieval coin finds in the FLAME project

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Abstract

FLAME is an online digital humanities project providing economic data for investigations of the transition from Late Antiquity to the Early Middle Ages (CE 325-750) in Western Eurasia and North Africa. While accumulating, entering, and displaying the data, the project's leadership has become increasingly aware of the inherent distortions in these data. These deviations operate on various levels, from the disparate events that provide the coin finds that serve as the basis of its data to previously unexamined scholarly biases that underpin such a quantitative approach to historical analysis. By systematically examining these phenomena, we hope to frame a discussion of such inherent biases in other digital humanities undertakings.

Introduction

When did antiquity end and when did Western Eurasia become medieval? FLAME (Framing the Late Antique and Medieval Economy), a collaborative digital humanities project based at Princeton University, aims to provide answers to this question through the examination of coin data from the period of this transition — roughly 325–750 CE. FLAME gathers as much coin-find evidence as possible, digitizes it, and visualizes the results. In a series of conferences, we have examined this period and reflected upon the possibilities that FLAME raises for framing (or re-framing) the discussion of the ancient economy. 1

In this paper, we outline the shape of FLAME, starting with its questions and motivations and describing its methodology and presentation. We highlight several issues that demonstrate more general challenges to digital humanities projects, particularly those that synthesize large and disparate bodies of evidence. We explore the issue of systematic bias across our project layers. Beginning with the ancient evidence itself, we suggest a typology of the bias that we have dealt with in the course of the project, including biases that result from the project design itself. We conclude that this bias creates insuperable obstacles for certain kinds of goals, such as comprehensiveness, or even acceptable levels of representation for certain regions, in pursuing big-data analysis in ancient history. The data is significant, but there are also important lessons to be learned from its defects: among them how to present systematic bias to users, as well as how to use data in ways that account for identified biases. 2

1. Introduction to the FLAME project

The question of the late antique - early medieval transition

The nature of the transformation of Western Eurasia from the "ancient world" to the beginning of the medieval one has long been debated. With the development of scholarship, the types of the evidence used to attempt to answer this 3

question have continuously expanded. The classic studies on this subject, from [Gibbon 1776] to [Dopsch 1923] and [Pirenne 1922], based their arguments to a great extent on the sparse literary and legal sources that survive from the fourth through the eighth centuries CE. At the beginning of the twenty-first century, two major works brought material culture into the conversation: [McCormick 2001] *Origins of the European Economy: Communications and Commerce, A.D. 300-900* and [Wickham 2005] *Framing the Early Middle Ages: Europe and the Mediterranean, 400-800*. McCormick cited the importation of Arabic and Byzantine coinage into Europe c. 750-900 as one of the catalysts of the development of a distinctive European economy, but otherwise ignored earlier monetary developments and was more anecdotal than systematic in his use of the evidence of coin finds to illustrate commercial relations.[1] Wickham avoided McCormick's Eurocentric approach and used a meticulous study of ceramic manufacture and distribution to establish patterns of continuity and rupture of exchange around the Mediterranean. He was explicit in his intention to eschew numismatic analysis, explaining his decision in a footnote that expressed hope that future studies would examine coinage more carefully.[2]

4 The outlines of the changes in minting from antiquity to the Middle Ages have long been clear. In the fourth century CE, the Roman Empire, which controlled the Mediterranean and beyond in antiquity, had been using a trimetallic system of gold, silver, and bronze in the Mediterranean world, while its Sasanian (Persian) rival to the East used a currency that consisted almost entirely of silver. By the eighth century, monetary economies in the region morphed into new forms and standards. A silver-based monetary economy developed in Europe, a bimetallic one of gold and bronze in Byzantium in the northeast Mediterranean, and a trimetallic system in the extensive lands of the Umayyads in the greater MENA (Middle East and North Africa) region. The extent and volume of the circulation of the coins that these economies used can be determined only from a careful compilation and study of modern coin finds. Although digital tools facilitate the analysis and visualization of the resulting patterns in the literature, an understanding of the underlying forces shaping this data is necessary. Only a critical reflection on the processes that led to the deposition, excavation, study, and compilation of late antique coins can help overcome the biases inherent in these processes and contribute to the historical narrative of the period.

5 FLAME was formed in 2013, in the context of the annual Stone Lectures at Princeton which Chris Wickham delivered. It began as an explicit attempt to take Wickham's aforementioned footnote to illuminate the economic history of western Eurasia from the fourth to eighth century by assembling and presenting numismatic data. From the beginning, its creators conceived it as a resource database, that is, making the data available to others online but also meeting and managing the expectation of a broader audience than its creators.[3] In retrospect, the project's inception influenced several subsequent biases.[4] Although FLAME began with the necessary academic expertise in numismatics, represented by Princeton's numismatist, Alan Stahl, who came up with the idea for the project, the early stages of the project did not include any digital technical expertise and included rudimentary and unstandardized Excel files. Then-graduate student Lee Mordechai "grew" into the role of technical director over time. As a result, FLAME developed organically and benefitted from formal expertise in the digital humanities only after a couple of years. Most initial members were postdocs and graduate students affiliated with Princeton at the time. Project development was inconsistent until the hiring of Mark Pyzyk as full-time project manager in 2020. The subsequent regular discussions in the project's weekly meetings were crucial in thinking about and fleshing out the biases underlying FLAME, as well as attempts to resolve them and how to communicate them to FLAME's audience. FLAME's leadership defined the temporal delimitation of the project to c. 325-750 CE and divided the project into two consecutive stages that would examine the simpler question of coin minting and the far more complex problem of coin circulation.

6 As FLAME operated for several years without funding, its leadership prioritized rapid data collection which would both serve as a proof-of-concept for subsequent funding, as well as producing results that its many non-tenured members could use in their research. In retrospect, this decision introduced and amplified existing (but then unrecognized) biases. For example, each member of FLAME was given responsibility for a defined region of western Eurasia. They worked independently of each other, coordinating with the leadership. This accelerated data gathering but probably also sharpened differences between regions, compounding the problems in regional biases (see below). Although many additional contributors have joined FLAME over the years, the rationale underlying the project's spatial division remains an organizing principle and the project's temporal limits have not moved. From an early stage, the project decided to

focus on a few key variables relevant to its driving questions and ignore others. For example, FLAME records a coin's metal but ignores its weight, as well as descriptions of text or images it might bear. This was another decision that expedited data gathering, but it also resulted in fewer variables for cross-checking and made it more difficult to address some of the project's subsequent biases. A key subsequent decision, taken a few years later, was to import data from other digital sources - again greatly increasing the amount of data in FLAME but introducing its own biases (discussed below).

Today, FLAME's application provides comprehensive data to its users while also highlighting the many gaps in current scholarly knowledge. It encourages historians and other users to be more cognizant of these unknowns and their implications, fostering a more methodological and transparent approach to the study of the economic aspects of the transition between Late Antiquity and the Middle Ages. This paper focuses on the methodological and theoretical contribution of FLAME to the broader discourse in the digital humanities. 7

Technical Approach

FLAME experimented with several different data structures before settling on its current format. FLAME's core is a relational database (SQL Server). Project members add to and edit the database through an Admin Panel website, developed in JavaScript. The public version of this website includes a list of possible values for FLAME's key variables such as metal, denomination and mint.[5] Automatic tests within the Admin Panel highlight potential issues with existing entries — for example, coins with dates outside the project's range — which require additional attention from project contributors and administrators. 8

FLAME's users interact with a graphic user interface (GUI). The GUI is based on a map, developed in ArcGIS and JavaScript, on which the project's data is displayed. A side panel allows users to run advanced searches and place filters on the data, with most results displayed on the map. Additional results may appear in tabular or graph formats. FLAME's design encourages exploration of the results through customization. For example, when visualizing the coinage output of a mint over time in a histogram, users can color-code different elements based on the metallic content of coins minted in that location; the data behind the histogram can then be exported in several formats (e.g. CSV, XLS). 9

FLAME has imported data from other projects and datasets. Some of these projects are openly accessible online. Others consist of data collected by individuals, who then decided to donate it to FLAME. The decision to import data resulted in an increase in the size of FLAME's database by an order of magnitude but also led to multiple challenges in using and maintaining these data (see below for biases). Each of these datasets is idiosyncratic in its coverage and data structure, so FLAME converts the data to its own format using custom-built scripts. Since these other projects and datasets are continuously updated but have no API (Application Programming Interface), the process is undertaken on an ad hoc basis, using custom-written scrapers and data transformations, leaving the resultant data unlinked except for a reference URL on FLAME's side for users wishing to follow entries back to their source. For this reason, FLAME keeps a record of the dataset, from which the information is derived. Since the data is not linked according to a wider linked open data standard, the same data points could appear in two different datasets with different names. As digital numismatic projects operate autonomously, two or more databases could and often do end up containing the same coin finds but digitized and classified them according to different criteria, depending on the idiosyncratic goals or structure of these projects. To evaluate potential duplicate data, FLAME developed an additional program that suggests possible duplicates, which are then checked by project staff.[6] 10

Beginning in parallel to FLAME's public launch in 2021, the project has begun to place more emphasis on User Experience (UX) to make the site and web applications more user-friendly. FLAME's leadership has periodically observed and interviewed potential users — specialist and non-specialist academics, as well as some students. These interviews have resulted in changes to the public-facing user interface (UI), as well as the development of new features. The emphasis on UX developed further through collaboration with the University of Houston's SYRIOS project, a National Endowment for the Humanities-funded project that illustrates the history of ancient Syria through coinage.[7] 11

Within the typology of digital humanities projects, FLAME shares some of its characteristics with other projects that work 12

with material culture, and more specifically projects that focus on numismatics.[8] As such, FLAME's development coincides with that of several other digital projects concerned with ancient numismatics. These projects were generally developed organically as digital versions of traditional reference publications that include as much data as possible that conform to certain criteria. Thus, for example, the Online Coins of the Roman Empire (OCRE) represents a catalog of all coin types minted in the Roman Empire until 491 CE and was based on the Roman Imperial Coinage (RIC) series of reference works. Other projects include the Coin Hoards of the Roman Empire (CHRE) project, which aims to collect all the information about coin hoards in the Roman Empire and beyond between c. 30 BCE and 400 CE, and the Portable Antiquities Scheme (PAS), which includes archaeological objects found in England and Wales — mostly finds made and reported by the public, including coins. Both these projects collected new material and had no published precedent, but were nonetheless perceived as digital versions of printed catalogs.

13 FLAME shares some of its core features with these projects. For example, like FLAME, both the CHRE and PAS projects include a GUI, but unlike FLAME, both CHRE and PAS place more emphasis on their data than their visual representation. Both are also similar to FLAME in their data structure, separating data at the level of individual coins and finds of coins found within a common archaeological context. These approaches emerged organically in different projects, resulting in different architectures. A subsequent collaborative ontology, nomisma.org, was later established in an attempt to provide stable digital representations of numismatic concepts between these and other numismatic projects. Projects such as OCRE and PAS have organized at least some of their data in a Nomisma-compliant manner, although the many technical challenges have slowed collaboration, including with FLAME.[9]

14 Other digital numismatic projects focus almost always on a single political entity (e.g., the Roman Empire) and/or a limited region (e.g., France). FLAME, however, attempts to push the discussion forward by aggregating and harmonizing data from different sources during a time of major change in its database. Other numismatic projects facilitate answering numismatic research questions, such as classifying coins into types, attempting to provide digital catalogs of coins that share some variable, or finding patterns across coin finds.[10] FLAME, on the other hand, has as its core a historical question — the nature of the Late Roman to Medieval transition — that is primarily concerned with change over time whether through coin production (i.e. how many coins were produced) or coin circulation (i.e. which coins circulated where). This has heightened our sensitivity to data biases — regional, temporal, and compositional with respect to coin find contents — at the level of project design. While our digital numismatic colleagues are all well aware of these topics (we are under no illusions here), FLAME has been incentivized by the nature of its starting questions to dig deeper into these factors: how, otherwise, could we claim to accurately pursue our main question?

2. Issues of bias

15 Over several years of working on FLAME's development, reflecting on its features, and receiving feedback from colleagues, we have concluded that FLAME's data contains serious gaps, reflecting biases that affect all stages in the process of discovering, preserving and publishing coins. In theory, numismatics seems like an ideal candidate for digitization because some of its variables–such as the number of coins found or the year in which a coin was minted–are easily quantifiable and thus facilitate further analyses. Although some earlier publications treated biases in digital numismatics anecdotally, providing little empirical data or theoretical reflection on them, there has been little systematic analysis on issues addressing entire assemblages of numismatic materials.[11] However, a closer look at the numismatic evidence collected in the field — FLAME's basic data — reveals several types of biases, which we originally assumed could be minimized through the accumulation of data. Once we had about a million coins in our database, we believed, our database would be a more or less acceptable proxy for the coins that were produced and circulated in Late Antiquity. In retrospect, this view was naive. At present we believe that many of the biases we describe are intractable in the near future and that tackling them would require significant targeted research. As a result, despite the amount of data it contains, FLAME is not a representative sample of the ancient monetary circulation.

16 We treat bias below on a spectrum of proximity to the ancient past. That is, the closer the bias is to the historical material we propose to examine–e.g., individual transactions of coins, the burial of hoards, and so on–the more primary we consider it. Critically, we insist on counting FLAME itself as a source of bias that stands between researchers and

the ancient past, sitting at the furthest remove from the historical processes we provide insight into.[12] Figure 1 below summarizes some of the biases that shaped the patterns of the survival of coins of which scholarship is aware. It utilizes “corpora” of coins - with a corpus consisting of a group of coins that share some key characteristic (e.g. all coins found in southern France or all coins produced in Constantinople). The figure demonstrates that only a tiny fraction of coins survives and enters scholarly awareness.

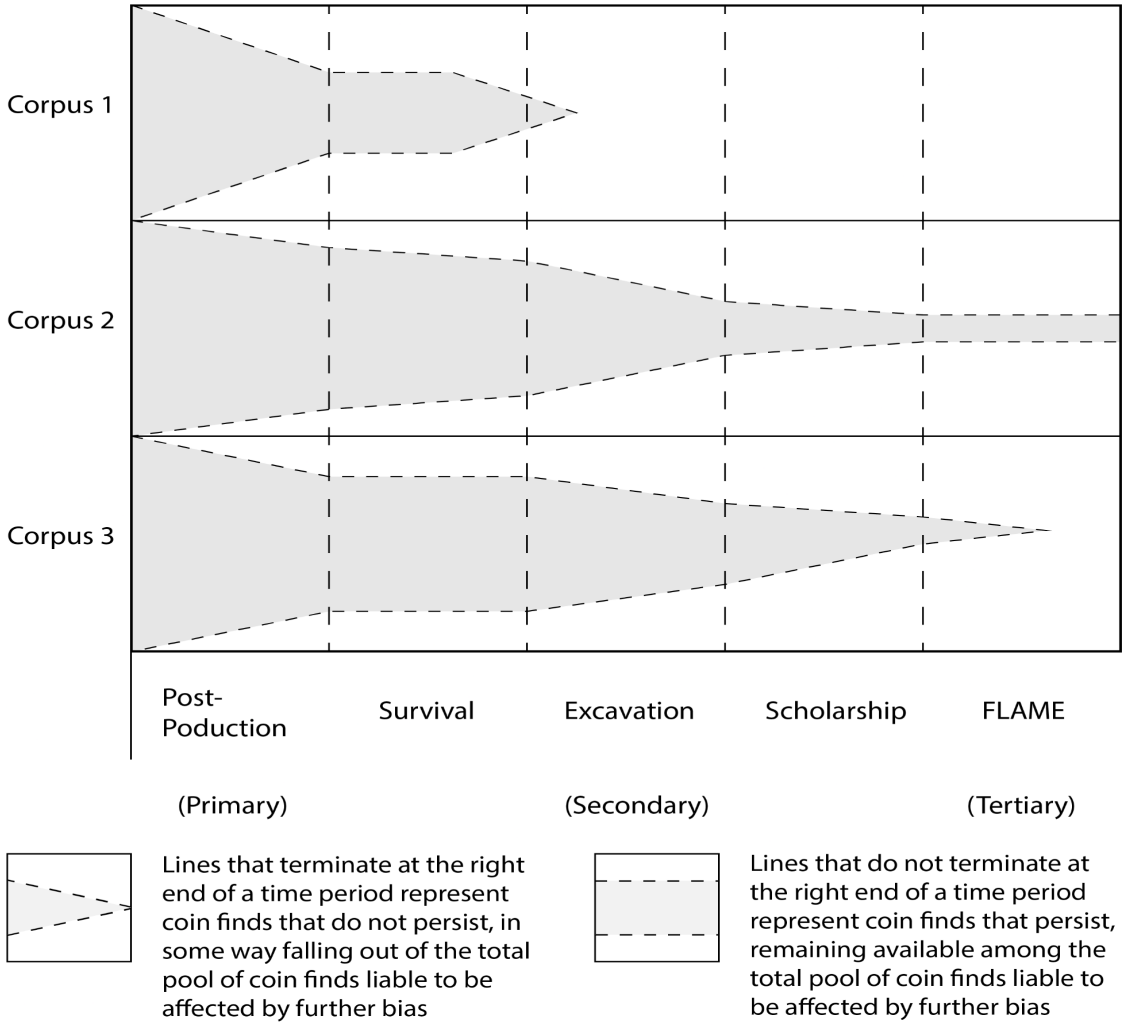

Figure 1. The figure proceeds from left to right.

The shaded area highlights the decrease from the total number of coins minted in Late Antiquity on the left to the number represented in the FLAME database on the right. In each of the three corpora (e.g., regions) the number of coins is reduced over time for various reasons — some do not enter or survive in the soil and others are not excavated or published. Within the figure, Corpus 1 is partially excavated but never published; Some of the coins from Corpus 2 survive to appear in FLAME; and Corpus 3 is partially published but FLAME utilizes it only in a limited manner. The figure is not drawn to scale; while the amount of coins produced at any point in Late Antiquity or the Early Middle Ages is unknown, comparative evidence suggests that only an extremely small fraction of coins (i.e. far less than 1%) produced would be reported in scholarship. 17

In the following section, we introduce four classes of bias: primary, secondary, tertiary, and FLAME project bias. We begin, however, with Regional Bias (see next section), as we believe that this methodological “layer” best illustrates the complexities of the problem. While it is useful to think about proximity to the past as a factor in data bias, Regional Bias shows that we must not fool ourselves into isolating these categories from one another. 18

Regional Bias

Much of the bias in FLAME's data emerges from regional differences rooted in modern national or institutional factors, such as law, cultural organization, national historical memory, or political circumstance — to say nothing of economic reality. These national differences strongly influence the discovery, preservation, and publication of archaeological objects. The absence of a substantive rule of law can be ruinous to the cultural heritage of a region. The most common form that this takes is the looting and selling of artifacts. Such trade in looted goods has been regulated internationally since 1970 but with unequal implementation.[13] Those artifacts that are not effectively controlled make their way through various channels to an enormous market of collectors. In a global context, the vast majority of countries are significantly affected by artifact looting. Even countries like France, the United Kingdom, or the United States, which more effectively regulate objects found within their borders, serve as an endpoint for artifacts illicitly exported from other nations.[14] Ongoing warfare can also degrade or destroy a country's cultural heritage. Thus, regions such as Syria, Libya, and more recently Ukraine have suffered serious loss of heritage objects and structures.[15] 19

The circumstances particular to each region can be easily observed on FLAME's map of coin finds. Thus, FLAME's users might be surprised to see that Italy and Turkey at present contain considerably fewer coin finds in FLAME than England and France. Italy and Turkey were far more central components in the late antique monetized macro-economy and therefore we would expect them to be better represented. That this is not the case is probably the result of modern regional biases, rather than any ancient pattern of circulation and deposition. FLAME has attempted to lessen such disparities, for example, through the establishment of coordinated teams in such under-reported areas. 20

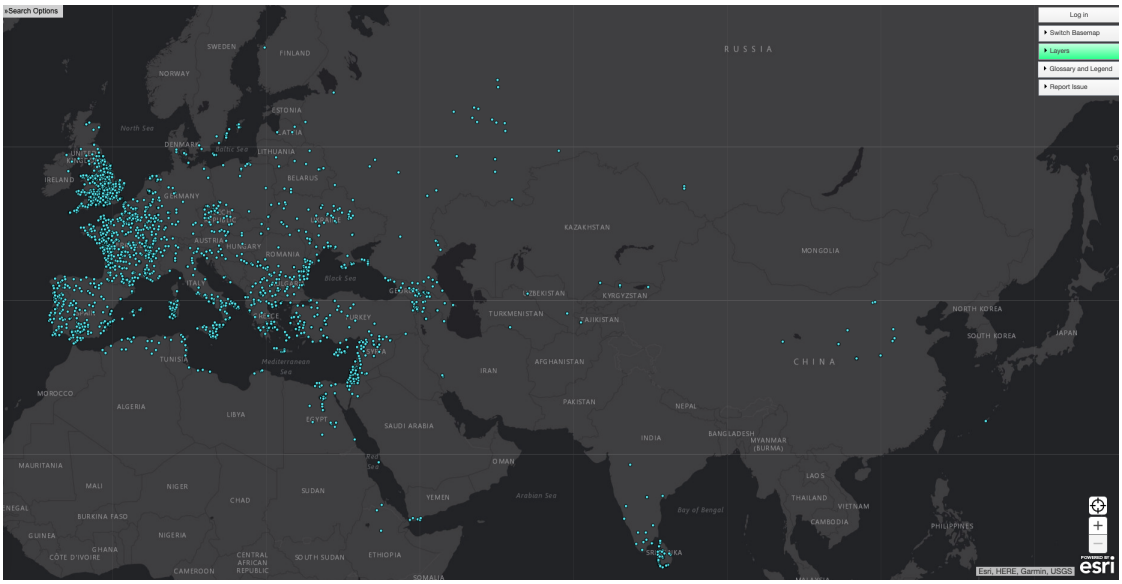

Figure 2. Global distribution of coin finds in FLAME.

Numismatists with knowledge of these regions will be mostly unsurprised by this. Most are aware that archaeological and scholarly circumstances are more favorable in some places than in others. The question is why. Though a tempting guess, it is not always a matter of wealth. Italy, for example, is a wealthy country with a dynamic academic culture and a strong interest in excavating and publishing archaeological materials on its territory. And yet we find comparatively little published material there compared to some other countries. On the other hand, Romania–significantly poorer today than Italy, but even more so under communism–is among the best-excavated and published numismatic contexts in Europe for late Roman coins. This was because its communist government was strongly invested in establishing Romania's "Roman" roots and devoted enormous resources to supporting archaeological work, including coin evidence, that furthered this ideological objective. 21

FLAME has approached this problem by investigating why a given region looks the way that it does in FLAME. Answers are rarely simple and often require considering the legal, political, and historical contexts that have shaped the disciplinary histories and coin publication records of the region. These factors have remained largely invisible to non-experts and seldom discussed in publication, even among specialists. 22

Case Study: The United Kingdom

One of the best examples of such regional bias can be found in the United Kingdom, which shows the influence of politics and law on the shape of modern scholarship not only externally, in relation to other countries, but internally as well. This bias explains the stark differences in coin finds reported in England and Wales versus Scotland and Northern Ireland (discussed further below). 23

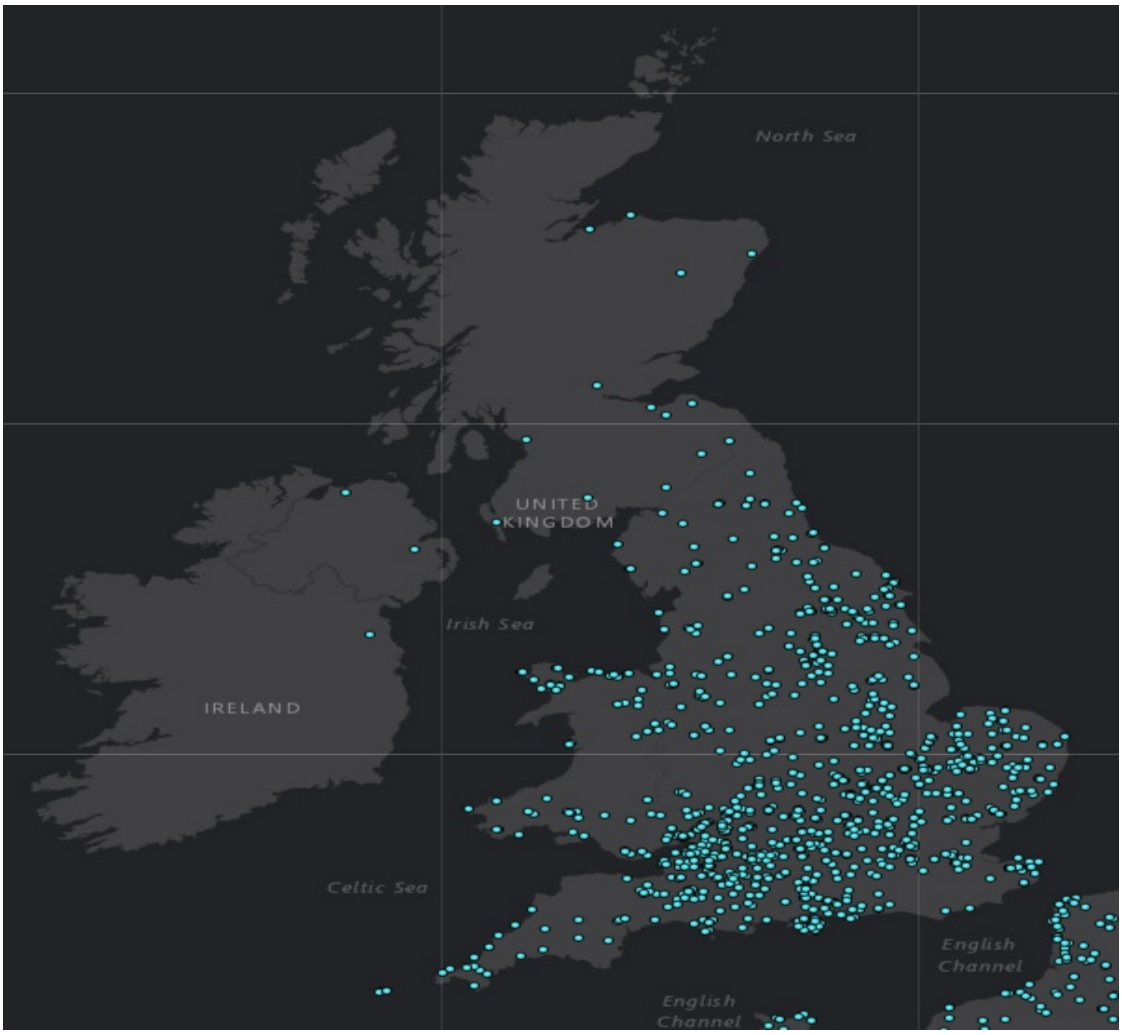

Figure 3. Coin find distribution in the British Isles and Northwestern France.

The main force behind this distortion has been the Portable Antiquities Scheme, a government program operating since 1997 within the parameters of several national heritage laws but in particular the Treasure Act — which deals with archaeological finds of precious metal objects.[16] The PAS regulates and (sometimes controversially) incentivizes the discovery and reporting of archaeological objects found by private individuals. While individuals are required by law to report significant discoveries of more than a single coin if gold or silver, or more than ten base metal (i.e. bronze) coins, the PAS framework facilitates the process, preventing some of the more important archaeological objects from being funneled into gray and black markets. The objects are first inspected by local authorities — Field Liaison Officers (FLOs) — who analyze, categorize, photograph, and record the objects in an online database .[17] Under most circumstances, the reporters will receive the objects back, at which point they are free to do with them what they want - and many do sell their finds to museums or on the market. This process is arguably a great incentive for them to report their finds or at least removes significant disincentives to doing so. The PAS is therefore a point of contrast to the many countries where found artifacts are considered the property of the state, with no (or limited) compensation offered to finders. The data gleaned from the process is published by PAS online, freely and openly. This has meant huge gains in coin find data for England and Wales in the years since its adoption. 24

This bias is obvious when comparing England, a peripheral and minor part of the Atlantic-Mediterranean macro-economy for much of the period FLAME covers, with Mediterranean countries. Thus, England and Wales's 1355 coin finds far outnumber those of core economic regions in antiquity like Italy (467), Turkey (265), and Egypt (74). This has much to do with the structure of reporting in the UK, as well as the resources — and the legal enforcement efforts — devoted to making the system work. As we mentioned earlier, because Scotland and Northern Ireland do not participate in the PAS, the publication of coin finds discovered on their territory lags significantly behind England and Wales. This leads to a significant distortion in the British data encoded in FLAME; at the moment, FLAME records almost nothing about coin circulation in the United Kingdom outside of England and Wales. The British case study therefore demonstrates the extent of some of the biases underlying intra- and international variations within FLAME's data, biases that would remain unknown by most of the project's users. 25

Primary biases (ancient)

The regional biases discussed above are a modern phenomenon. But other biases lie much closer to the materials themselves and to the ancient economic activity of which they were a part. What we define as primary biases derive from lived experience in Late Antiquity and the early medieval period. Since we cannot fully reconstruct lived experience in the past, many of these biases are theoretical. Therefore, we must use proxies to answer questions about, e.g., the differential loss of coins. The few scholarly attempts made to understand the effects of primary biases on the modern numismatic landscape (i.e., the coins that scholars are left to work with in the present) have generally based their studies on theoretical models derived from modern economic phenomena.[18] The vast differences between societies over time, however, obstruct such an analogy. For example, there are obvious issues inherent in comparing a monetary economy, where transactions and taxes were paid in precious metal coins, to one where payments are primarily in credit and most cash denominations are bills. 26

In the pre-modern world, coins served as means of exchange and holders of wealth; they were issued in three metals (alloys based on gold, silver, and copper, respectively) and in various denominations (standards of fineness and weight holding a fixed value in the monetary system, e.g., in the contemporary United States, coins of 1, 5, 10, 25, or 50 cents). At various times and places in antiquity, certain metals and denominations were available, corresponding to different sectors and levels of economic activity. In general, gold-based coinages were used for extraordinary, costly transactions (e.g., purchases of land) and constituted the principal medium for storing wealth. Copper-based coins were used for everyday transactions. Silver-based coinages, between gold and copper in value, were used for salaries and middle-range purchases, and could also facilitate day-to-day exchanges and larger purchases. 27

Virtually all ancient and medieval coins available for collecting and study have spent most of the time since their minting underground. They may have been buried intentionally or accidentally. The chief reason for intentionally burying coins in antiquity was that there were few alternatives to save wealth securely. Pre-modern societies rarely had any form of deposit banking, and so individuals or institutions usually put saved coins along with other precious objects into a vessel, burying them somewhere they could be dug up when needed. Such "hoards" frequently comprised the highest-value coins available to whoever hid them. Hoarding was relatively common in the pre-modern world, though perhaps more so in times of perceived insecurity (e.g., war). If the burier failed to retrieve the coins, they might come down to us as a hoard. Other intentional contexts for coin deposits would be the burial of individuals or other ritual offerings. Such cultural practices lead to biases in the coins that survive up to our times — for example, the clear bias towards high-value gold and silver coins in most hoard finds. 28

Other coins ended up in the ground through a different mode — accidental loss. The vast majority of coins found in excavations and single finds — which represent random accidental losses — are copper. The simple act of accidentally dropping a coin during a transaction or travel would have been the first step in this process, but the likelihood that the person would have recognized the loss and retrieved the coin is far more likely in the case of high-value coins, especially in antiquity where a single gold coin could be worth hundreds of bronze coins. Also important is the fact that copper is often less bright in color than gold or silver. As artificial lighting was rare, many transactions took place outdoors in dusty or muddy locations that were close to the color of copper. Such coins were less likely than gold or silver to attract the attention of passersby. Another factor in the predominance of copper coins in archaeological 29

contexts is their generally fiduciary nature; that is, their value was dependent on the state's commitment to convertibility into precious metal coinage. In cases of demonetization, for example as part of a coinage reform, such coins would be worthless and might be casually discarded. Within this context, silver coins issued within a tri-metallic system might be significantly under-represented in modern samples since they were noticeable enough to be observed and retrieved when lost (as opposed to copper), but not valuable enough to be well-represented in hoards (as opposed to gold).

Secondary bias (archaeology)

The second class of bias focuses on the archaeological context in which coins are found, as well as the various natural and technical processes at play in a coin's survival over time and its subsequent discovery. Excavations are the most common legal context from which buried coins are intentionally retrieved. Within excavations, coins are valued as chronological indicators for a particular archaeological layer. Most excavation coins are presumed to be the result of unintentional loss and so, as sketched out above, are usually copper-based and small. They are often in bad physical shape owing to wear (since they were used daily), direct contact with corrosive environments (e.g., soil), and the greater susceptibility of copper to corrosion compared to silver or gold. These factors tend to coincide with each other, often corroding coins to the point that they are unreadable. A case in point is the *minimi* of the fifth and sixth centuries CE, a designation for coins of about 10 mm in diameter, often poorly struck in the first place. The categorization of such coins as unattributed or unidentified, — if they are recognized at all in the course of excavation — is a source of bias on sites, especially when dealing with strata associated with Late Antiquity. On the other hand, prominent features on certain denominations might allow for partial identification. For example, the sixth- and seventh-century Byzantine 40-nummi bronze piece is quite large and heavy and carries a large M which is easily identifiable even if other features are illegible. 30

Figure 4. The two left images are of a 5 nummi of Justin I (518-527) excavated in Antioch on June 12, 1937; it is 12 mm in diameter - Coin: 4308 - https://catalog.princeton.edu/numismatics . The two images on the right are of a 40 nummi piece of Justin I (518-527), purchased from Peter J. Donald; it is 33 mm in diameter: Coin: 17215 - https://catalog.princeton.edu/numismatics.

A further source of bias among coins from excavations is the process of site selection by archaeologists. Some of these are limited by definition - for example, built-over areas in modern cities generally allow for only limited archaeological excavations. Moreover, Late Antiquity, the period FLAME investigates, has traditionally attracted less scholarly and public interest than e.g. Greco-Roman antiquity, a period that remains the focus of many excavated sites, or sectors within larger excavations. In FLAME's case, this probably contributes to the sharp reduction in coin finds between the beginning and end of the period, with which the project is concerned. This imbalance in the results of excavations often stems from ideological interests (for example, demonstrating the level of civilization or identity of certain site inhabitants). This might operate at the level of the archaeologists, those granting funding or permits for excavations, or both. For instance, it is common for excavations in Greece or Turkey for much of the 20th century to bulldoze (often literally) through levels associated with medieval or late antique remains, usually to reach Hellenistic and Classical layers, which scholars, funders, and governments considered more prestigious. This affected not only what came out of the ground, but where it went (into a bucket or a museum showcase), as well as how it was preserved, cataloged, studied, and published. 31

Besides excavation contexts, coins are often discovered in hoard contexts. Hoards are typically defined as two or more

coins thought to have been buried together, often in a vessel or other container, which exhibit a radically different pattern of coin preservation. As hoards were usually buried in secret, they are often found outside of habitation areas excavated by archaeologists. In the nineteenth century, hoards were frequently discovered by farmers as the result of adopting deeper plows or through exploitation of areas that had been abandoned since the Middle Ages. The expansion of urban areas – with their deeper digging for infrastructure (e.g. building foundations, sewers, utilities, etc.) – as well as transportation routes (e.g. roads and railways) resulted in more hoard finds as well. In more recent times, the use of metal detectors has greatly increased the rate at which such finds are made (hence the phenomenon of "detectorists" in the United Kingdom, who are a major constituent of the aforementioned Treasure Act and PAS policies). Whether such coins are brought to the attention of government authorities or local numismatists varies greatly depending on legislation and policy, and is a major source of bias affecting FLAME's database and circulation map, as discussed above. 32

Tertiary (scholarship)

A third class of bias derives from the scholarship upon which FLAME draws, in particular its unevenness in key variables such as the number of publications (e.g. articles, archaeological reports) or the ratio of excavated-to-published coin finds. These biases are also largely intractable as they stem from broader trends in scholarship and publication practices (e.g., who studies what? Who publishes, where and for what reasons?). 33

In light of modern academia's pressures on scholars' time, researchers must decide how to allocate limited time and attention. This touches upon, but is not the same as, the archaeological biases discussed above. Scholarly bias may take the form of prioritizing certain academic activities over others. Archaeologists, for example, often prioritize excavating sites over publishing the results. Because of this, many sites that are excavated are not — and likely will not be — published. A 2001 survey of archaeological excavations in Israel revealed that fewer than 20 percent of excavations carried out in the seasons between 1970–1989 had published their results.[19] Similarly, the major salvage excavations in Beirut's city center over the 1990s and 2000s had at least 15 different teams excavating over 200 sites. Only a handful of these have been published to date.[20] 34

Similar decisions are made within excavations themselves. For example, as discussed above, researchers decide to excavate certain strata and features and not others based on *ad hoc* criteria. In the case of Beirut, the published excavation sites bulldozed the layers above the destruction layer of 551, making it extremely difficult to understand post-551 Beirut. Even after the excavation of a site, the numismatic material is often challenging for the average archaeologist to deal with. Although the ideal solution is to bring in a numismatic specialist, in reality many coins remain unpublished because such a specialist is unavailable. 35

Relatively few hoard finds of coins are published after their discovery and many of the publications lack key details like the mint of origin and denomination of the coins. Coins are often deposited with regional archaeological services or local museums; their contents can be reconstructed only by an inspection of such an institution's accession records or its physical storage facilities. Many, perhaps a majority in some countries, of discovered hoards are immediately dispersed on the collectors market, with no record made of their contents. 36

A further bias derives from the notorious decentralization of numismatic publications, an existing problem exacerbated by FLAME's scope. Reports of finds can appear in local and relatively inaccessible journals, excavation reports, edited volumes, festschrifts, and journal articles, among others. Many of these are not systematically used for disseminating numismatic research. This phenomenon already makes it difficult to locate all these reports, so that FLAME's information is more representative of the most accessible publications rather than the whole of numismatic scholarship. It also favors English or other standard research languages (e.g., German over Armenian), often published by Western-oriented presses. 37

There is, in general, no comprehensive centralized resource to track coin finds, even at the national level. Such attempts have been attempted in the past with various levels of success — for example Kropotkin's survey of Roman and Byzantine coin finds in the Soviet Union or Militky's equivalent inventory in the Czech Republic.[21] The latter example indicates that additional biases intrude at the sub-national level, with certain counties or regions being better 38

covered than others (Prague, for instance, is hugely overrepresented among Czech coin finds).[22] Even the PAS reports of British finds include only material discovered since its inception in 1997; earlier finds have to be added from traditional sources. While there are a few aggregated numismatic publications that aim to report on all recent numismatic papers,[23] they are rarely comprehensive and tend to briefly survey an enormous number of diverse publications, leading to relatively low resolution.

Finally, the unequal products of scholarship resulting from the biases above contribute to biases in reference works – the catalogs and other methodological apparatus most scholars use to identify a coin or better understand a numismatic process. As a general rule of thumb, the more coins are available for study (through publication, ideally), the better the resulting product. There are other factors as well — for example, the popularity of certain topics over others. While good catalogs for Roman imperial coins (e.g. aforementioned Roman Imperial Coinage series) have appeared from the 1920s, their Byzantine equivalents date only to the 1970s. Comprehensive catalogs of Sasanid Persian coins date to the 2000s and are still incomplete today.[24] Other types of coinage — for example that of central Asia — are barely covered by any scholarship. 39

The biases listed above mean that FLAME better represents — in both quality and quantity of information — areas and periods with good reference works such as the Roman Mediterranean compared to areas that are less well covered such as central Asia. 40

FLAME project biases

Previous sections have described biases in FLAME's data at the level of coinage itself, as well as regional contexts affecting the discovery, preservation, and publication of coin finds. These are, in essence, exogenous to FLAME. There are, however, biases inherent to FLAME itself that involve how the project is structured, institutionally and operationally. 41

Most FLAME researchers are volunteers who provide the numismatic data for regions about which they have some expertise. In general, they work alone, coordinating their activity through project representatives. The participation of such individuals does not, generally, arise in a vacuum, and is structured by pre-existing individual and disciplinary contexts. Many early participants, for example, were Princeton University graduate alumni. Subsequently, volunteers might have seen a conference presentation on the project given by a FLAME representative, or they might have been put in touch by someone with knowledge of the project. Such weak ties follow familiar paths, generally through North American and Western European universities.[25] Many contributors were first visiting scholars at Princeton or had passed through programs such as Dumbarton Oaks' numismatic summer seminar (co-taught by Stahl) or that of the American Numismatic Society. Disciplinary and institutional networks play a critical role in the shaping of such work, which favors some regions over others. For example, the authors of this article, who have constituted the leadership of FLAME, all specialize in aspects of northern Mediterranean and European scholarship. When FLAME has attempted research on coin finds in regions where its leadership has fewer ties such as North Africa, the Indian subcontinent, or East Asia, it has run into problems recruiting individuals who might help. These are limitations we have sought to address, with varying degrees of success. 42

In certain cases, enough researchers studied a particular region that it made sense to organize them into clusters working under a regional coordinator. Up to this point, five regional clusters have come together to work on FLAME. This has included groups focused on the Anatolian peninsula, the Iberian peninsula, Southern Italy, Ukraine, as well as a group working at the University of Hamburg focusing on early Islamic coinage. That the last group departs from the typical regional focus is a result of scholarly specialization — most FLAME scholars focus their research on pre-Islamic (e.g., Roman, Byzantine, etc.) or Islamic coins but not both categories. 43

At both the individual and cluster levels, biases affect the data structurally and, occasionally, more or less at random. Structurally, FLAME’s biases intersect with the modern secondary biases that we identified above. Thus, some countries are better able to support individuals and groups of scholars or have particular national priorities that favor the publication and reporting of coins, such as the Romanian example cited above. These factors affect the potential for collaboration with scholars from these countries. 44

There are likewise biases that FLAME imported from other projects (with biases of their own) through their datasets. Examples include the Coin Hoards of the Roman Empire (CHRE), the Portable Antiquities Schema (PAS), Antike Fundmünzen in Europa (AFE), the Early Islamic dataset (EI), and the Thessaloniki dataset (THS). [26] It is safe to assume that all these projects suffer from many of the same biases we have described above. The extent to which they identify or publish information on these biases varies but is often minimal, and so their specific project biases are largely outside of our capacity to address. 45

3. Lessons for Digital Humanities

FLAME demonstrates that while powerful digital tools may help to address archaeological and historical topics, they cannot overcome problems in source materials. Biases that have plagued different research questions generally persist and we are unable to even gauge their severity, except in outline, because we cannot say how many materials have *not* been discovered, reported, or published in various regions. This makes the exercise of gauging robustness in late antique and medieval coin data more epistemological than technical. In our opinion, there is no technical solution to this problem. FLAME itself has introduced its own biases to its digital representation of the research question — biases that derive from its implementation, visual design, and varied experience of its contributors. All in all, many of these issues are intractable and will not be resolved in the foreseeable future — a feature we feel FLAME shares with other digital humanities projects, which have acknowledged similar biases to varying degrees. The ORBIS Project, for instance — a digital itinerary planner and travel-time calculator for the Roman world — was significantly affected by project-level biases that led to the inclusion of the Black Sea in the project's data but not the Red Sea.[27] The Mapping the Republic of Letters project — a mapping application that visualizes connections between intellectuals and scholars of Early Modern Europe — has noted Primary and Secondary Biases that it considers to be insuperable.[28] The recognition of such blind spots is important in establishing the limits at which projects in the digital humanities can operate effectively and the extent to which scholars might draw conclusions from accumulated digital data. 46

The biases involved in the collection, analysis, and presentation of data do not mean that FLAME's efforts, or those of any other digital humanities project, are useless. On the contrary, FLAME has forced us, its creators, to reflect more systematically on biases underlying scholarship on the late antique economy, many of which have not been formally discussed in scholarship. The result is a more critical approach to the broader research question, and one that translates across the digital humanities. 47

FLAME's mapping application is invaluable to scholars, moreover, not only because it makes explicit the totality of information available to scholars of this period (it is a reflection of scholarship, after all, and not the ancient world itself), but because it makes imaginable the information that is missing. Thus, while numismatists will not, presumably, cease their research because of the sudden revelation of how much they do not know (something they already suspect), they can and should be more self-conscious about it, and about where and how this is so. Moreover, scholars whose interests are methodological or historiographical now have a tool to examine not only the late antique and medieval economy, but also the basis on which knowledge of it is built. In this context, much of FLAME's work over the past few years has moved towards making its biases and other issues more transparent to project users. These were not questions we considered during the first years of the project, when we were more concerned about providing data to historians studying the ancient economy. 48

We have pursued two separate strategies to address systematic bias in FLAME's data. The first marks certain kinds of bias directly in FLAME's user interface, associating coin finds directly with particular biases that afflict them. These are communicated through pop-up tabs that appear when users click on coin finds. These bias labels, each of which expands to provide a detailed definition of the bias, as well as a link to the entry on our website, are dynamically generated, based on an automated set of criteria that assign bias on a case-by-case basis. These biases are most often at the primary level, where certain coin features help to identify them. For example, in Figure 8, the status of High Use Bias is based almost entirely upon the metal of the coin — bronze coins tend to be used more than gold or silver coins, and so finds that are characterized primarily by bronze or other base metallic coinages are assigned this bias. 49

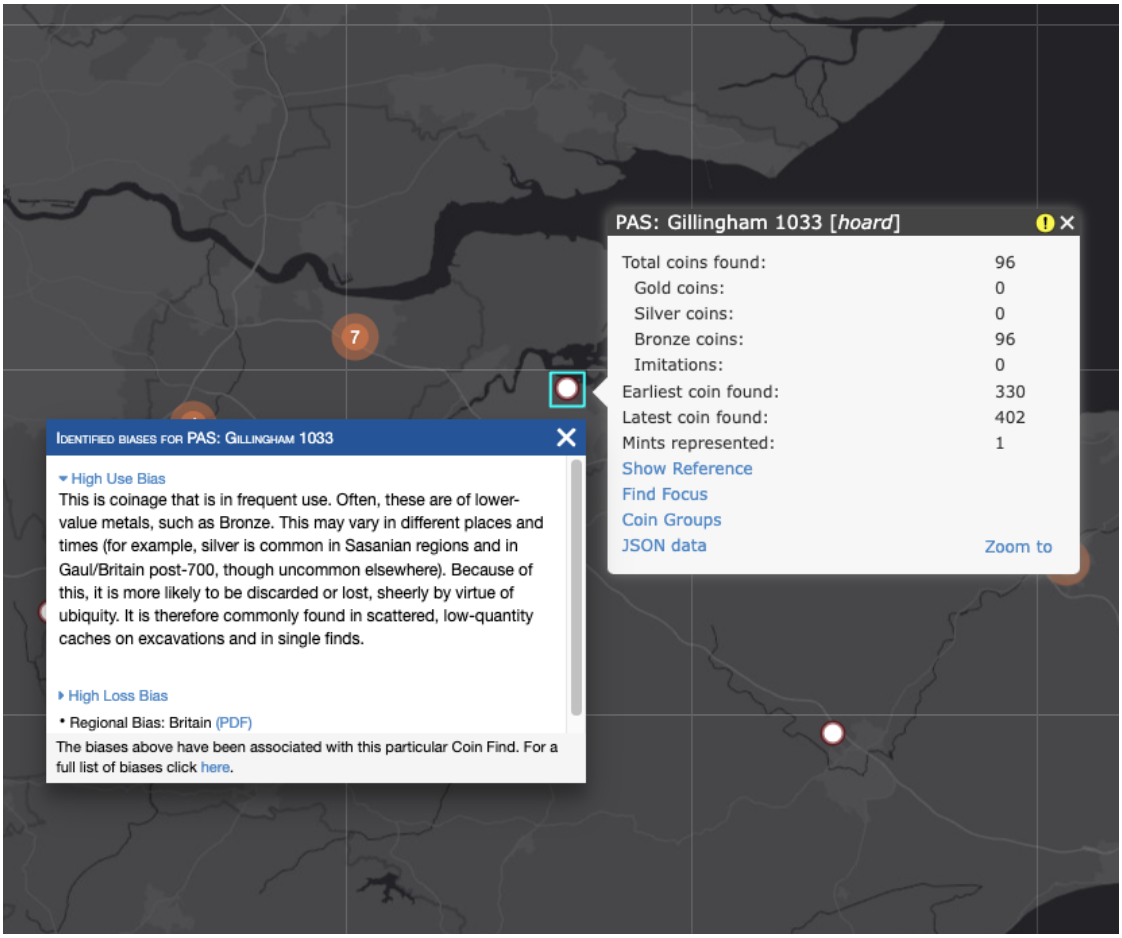

Figure 5. A coin-find just east of London, England, with main panel (upper right) and secondary bias panel (lower left).

In other cases, we have been unable to assign biases based on coinage alone. Regional biases have required considerable case-specific descriptions, and we have therefore adopted a unique format to communicate these. This is the second of our two-pronged approach to addressing bias. For regions like Britain, we have asked area experts to write short essays explaining the particulars of the region in somewhat more detail than what we saw above. These essays are posted as PDFs on a resources page on the FLAME website, but they are also integrated directly into our UI and can be accessed through the same bias tab described above (see Fig. 8, where the bullet “Regional Bias: Britain” provides direct access to a PDF of the bias essay). Such links to discussions of possible regional biases are assigned automatically to any find on the territory of the region in question. A list of biases we have identified appears on a dedicated page on our website, a link to which appears in all bias tabs.[29] This list is not comprehensive for FLAME or any other historical numismatic project. In both the application and this paper, we have attempted to compromise responsibly, settling for a level of explicitness and systematicity. 50

In this context, we believe that the best strategy for addressing these issues is to use the powerful digital platforms we have built to highlight them. We encourage users to engage with substantial critical approaches to the underlying data through a few mouse clicks, for example through the regional bias essays, and by constantly reminding users that these biases exist. This coupling of data and bias warning would have been extremely difficult, if not impossible, to do using traditional publication practices. Transparently highlighting biases in our data and presentation and making that information available to project users are key steps towards the production of more robust research. 51

4. Conclusion

All scholars who work in historical and archaeological disciplines are aware that the evidence upon which they draw is incomplete and not fully representative of past conditions. Source analysis is a basic component of the training of 52

historians and modern archaeological inquiry is accompanied by an understanding of the selective nature of the evidence that comes from excavations. Within this scholarly context, FLAME introduces an unprecedented concentration of relevant data - and tools to analyze and visualize it - for questions regarding the late antique and medieval economy. Yet this presentation also introduces profound challenges. Historians trained in the traditional humanities are rarely prepared to contend with problems inherent in large-scale quantitative datasets such as those underlying FLAME. On the other hand, although digital humanities scholarship has produced impressive tools for viewing, accessing and using data, it often does so without integrating traditional humanistic insights that might realistically temper expectations for such data, at least not to a level that satisfies more traditional colleagues. A large database with sophisticated graphical representations, based on finds of over a million coins, might appear to some scholars as a robust proxy for past conditions, but, as we have seen, such an assumption is naive, since the data carries multiple layers of biases. In this regard, FLAME's emphasis on revealing the biases and their impact on the shape of our data is a major contribution. Once scholars are thoroughly acquainted with the biases inherent in its data and their presentation, the FLAME database can serve as the basis for discussions of one of the key transitions in global history, using more data — and more precise data — than has ever been possible before.

FLAME's case suggests that other digital humanities projects should reflect on the biases they replicate, introduce, or inherit from other projects as early as possible. These reflections should be made public and be considered part of a more robust presentation of the project, whether in formal settings such as conferences or in project materials such as publications. The online presence of the project and its documentation should include discussions of these biases that are accessible to users, including the project's attempts to acknowledge and ideally resolve them. If possible, the project should also incorporate this more critical discourse into its user interface. A shared discussion following such norms would benefit a broad range of digital humanities projects and make their results more robust. 53

The future of digital projects such as FLAME is inherently interdisciplinary. Their continued improvement requires the engagement and support of the broader community — with scholars to explore its data, critique its design, suggest improvements to its interface and functionalities, and contribute additional material. We hope that designers of and contributors to these future projects find the results of our introspective processes outlined above useful. 54

Notes

[1] Cf. [Smith 2003]. For a critical view of the use of numismatic evidence, [Stahl 2003].

[2] [Wickham 2005, 702] n. 17: "Coinage is … the other artisanal product which has been used as an economic guide … I have relied on it less than on ceramics, in part to avoid an over-complex exposition; in part because it is often unclear how much coin distributions tell us about economics as opposed to the structures of public administration and of diplomatic gift exchange … All the same, coinage is a crucial indicator, and I would hope that future comparative studies give it proper weight".

[3] For "resource database", see also [Lockyear 2016, 160].

[4] For a comparative account of how the beginning of a digital numismatics project influences its later development, see [Gruber and Lockyear 2015].

[5] http://csla100w.princeton.edu:83/.

[6] This program was developed by Mary Alice Jouve in 2022 at Princeton University.

[7] FLAME provided UX testers to Houston's students in a user experience course. Testing was conducted on FLAME's Circulation Module as part of the development of a future mapping tool for the SYRIOS project. For more information on SYRIOS, see: https://syrios.uh.edu/.

[8] See also Breier 2010 for the connections between archaeology (i.e. broader material culture) and numismatics with regards to specifically GIS databases.

[9] http://nomisma.org/datasets. Challenges include the high technical skill needed to meet the entry-level for fitting data to the nomisma.org structure and the difficulties (and cost) of revising existing projects to conform to this structure. This will be discussed in depth in a future publication.

[10] See for example [Lockyear 2016, 165].

[11] An overview of the use of data from finds and their use in the reconstruction of circulation as a basis for historical inference can be found in [Howgego 1995, 88–95]. More focused on the period covered by FLAME are the chapters in [Naismith 2018b], especially [Naismith 2018a] and [Rovelli 2018]. See also [Naismith 2011, 199–251]. Such discussions consider the different types of evidence supplied by hoards and excavations, but do not explore the issues involved with comparing records of coin finds from different modern countries or such issues as the differential motivations of archaeologists in what they choose to excavate and to publish. Nor do they deal with the questions introduced by the assembly of large amounts of data from multiple sources.

[12] There is a long methodological literature on the practice of history and the historian's standing in relation to the past. Post-war historiography — for instance, [Collingwood 1946]; [Carr 1961]; [Oakeshott 1983]; [White 1986] — focuses intensely on the problem of historical objectivity. Much of this tradition is helpfully synthesized in [Novick 1988]. We do not engage directly with this literature in the present article, but the notion of a fundamental disconnect between historians and historical material, and the alienation of the past from investigators in the present, stems from this 20th-century scholarship.

[13] Specifically through the *UNESCO Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property*. Of course, implementation of the convention is left up to individual states that are signatories to the treaty. In the United States, the issue is governed primarily through the *Convention on Cultural Property Implementation Act* of 1982.

[14] [Davis-Marks 2020]; [Mead 2020].

[15] For Libya: [Brodie 2019], [Kane 2015] and [Mugnai et al. 2017]. For Syria: [Almohamad 2021] and [Casana 2015]. Ukraine's loss of cultural heritage due to war is more recent — scholarship will no doubt emerge over the coming years regarding its extent.

[16] A recent (2023) amendment to the Treasure Act would allow any metal object of exceptional historical/value to be defined as treasure. This would close the loophole that allowed exceptional items such as the Crosby Garrett Helmet (an extremely rare example of a Roman bronze cavalry helmet) to be sold on the market, in this case for the equivalent of $3.6 million in 2010.

[17] https://finds.org.uk/database.

[18] Many of these questions focus less on numismatic materials themselves and more on problems inherent in theoretical models meant to fill in large-scale historical gaps — for instance, statistical formulae designed to infer the size of the ancient coin supply from the meager evidence left to us today. For scholarship critiquing efforts at reconstructing Roman Republican monetary production by [Crawford 1974]and [Hopkins 1980], see: [Buttrey 1993]; [De Callataÿ 1995]; [Howgego 1992]; [Katsari 2003]; [Lockyear 1999]. While other articles appear on topics such as randomness in coin survival (e.g. [Robertson 1989]), no methodological topic other than ancient monetary production has received the widespread and sustained attention of numismatists.

[19] [Kletter and De-Groot 2001].

[20] [Mordechai 2019, 208–210ff]. For a comparison between published and unpublished coins see p. 227 and #abou_2018.

[21] [Kropotkin 1961]; [Kropotkin 1962]; [Militkỳ 2010].

[22] Drapelova, Pavla, "Working on the FLAME database: the Czech Perspective", Talk given at the FLAME conference *Networks in Transition: Monetary Exchange from Antiquity to the Middle Ages*, March 18, 2022.

[23] E.g. *Byzantinische Zeitschrift*, whose annual bibliography goes well beyond the geographic and chronological limits of the Byzantine Empire. *Numismatic Literature*, which used to contain an annotated bibliography and index of important publications of coin finds of all eras, was discontinued in 2013. *Coin Hoards*, which at first was an independent periodical covering finds of coins of all periods, now focuses only on hoards of ancient Greek coinage.

[24] https://www.oeaw.ac.at/oeai/forschung/altertumswissenschaften/numismatik/sylloge-nummorum-sasanidarum.

[25] On weak ties, see [Granovetter 1973], 1973). The point is that such "acquaintance" ties, found in low-density social networks, are important binding agents between different organizations and therefore play a large role in mobility between networks. Conferences, visiting scholarships, and summer seminars are good mechanisms to establish such weak ties.

[26] A full list of external data sources, including descriptions of the organization, project, and principal investigators, can be found at:

https://coinage.princeton.edu/flames-datasets/.

[27] So, while the Black Sea is modeled in ORBIS and mentioned at multiple points in [Scheidel 2013], [Scheidel 2014], the Red Sea is not. That is in spite of a comparably good guide — that is, comparable to Arrian's *Periplus of the Euxine Sea*, which was the basis for the Black Sea data — being available in the Hellenistic *Periplus of the Erythrean Sea*. The difference lay in the composition of project staff. While the Black Sea inclusion was supported by one of the ORBIS participants — Mark Pyzyk — the Red Sea had no comparable advocate and was presumably excluded for this reason.

[28] [Edelstein and Kassabova 2020]. One example was the dearth of English letters addressed to or from the philosopher Voltaire. The authors conclude that this dearth did not result from data errors or lack of evidence but from a systematic lack of interest in England on the part of Voltaire himself. They too concluded that such lacunae were insuperable and were interesting in themselves.

[29] https://coinage.princeton.edu/biases-in-flames-data/.

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