

# The integration of heterogeneous information from diverse disciplines regarding persons and goods

Bethany Aram 

Department of Geography, History and Philosophy, Universidad Pablo de Olavide de Sevilla, Spain

Aurelio López Fernández and Daniel Muñoz Amian

Department of Sports and Computer Science, Universidad Pablo de Olavide de Sevilla, Spain

## Abstract

This article presents a relational database capable of integrating data from a variety of types of written sources as well as material remains. In response to historical research questions, information from such diverse sources as documentary, bioanthropological, isotopic, and DNA analyses has been assessed, homogenized, and situated in time and space. Multidisciplinary ontologies offer complementary and integrated perspectives regarding persons and goods. While responding to specific research questions about the impact of globalization on the isthmus of Panama during the sixteenth and seventeenth centuries, the data model and user interface promote the ongoing interrogation of diverse information about complex, changing societies. To this end, the application designed makes it possible to search, consult, and download data that researchers have contributed from anywhere in the world.

### Correspondence:

Bethany Aram, Universidad Pablo de Olavide, Ctra. Utrera, km. 1, 41013 Sevilla, Spain.

### E-mail:

barawor@upo.es

## 1 Introduction

The need to integrate information from diverse disciplines, while often implicit in the digital humanities (Klein, 2015; Papadopoulos and Reilly, 2020), entails technical and epistemological challenges addressed less frequently. Interdisciplinarity, while often evoked, is more rarely developed. Over the last four years, the experts in stable isotope ratios, human genetics, historical archaeology, and early modern history involved in a project with interdisciplinary aspirations, ArtEmpire, have formulated and refined (and continue to add) requirements for the recording and analysis of diverse evidence unearthed. Our wide-ranging data converges on the isthmus of Panama,

1513–1671, derived from and focused on the persons and goods who traversed and settled the area. The concrete research questions driving the project concern the impact of early globalization on the populations involved, their changing and divergent conditions and opportunities for social mobility. Rather than elucidating these questions, however, this article presents the tool designed to address them: the 3C (Commerce, Culture, and Crisis)/Artery of Empire (ArtEmpire) database. The collection and analysis of the project's information have required interdisciplinary ontologies and data models, registered in 2017, as well as a graphic interface for the data's entry, retrieval, and consultation, visible online since 15 August 2019 at [artempire.cica.es](http://artempire.cica.es).

A brief discussion of the products examined, methods followed and choices made will precede the exposition of the solutions found to register and relate persons and goods with historical as well as archaeological attributes thanks to a particular concept, described as ‘belonging’, designed to register changing circumstances. Salient features of ArtEmpire’s multidisciplinary data entry/visualization as well as its inter-disciplinary search formula will be highlighted in relation to the ontologies developed, before providing specific examples of inter-disciplinary insights obtained regarding persons and goods. The data entry formula have been planned by specialists in each discipline in collaboration with information engineers in order to maintain the organic structure of the process of data extraction and, hence, to preserve as much primary, contextual information as possible. In this way, ArtEmpire’s database has been designed to facilitate the team’s interdisciplinary work and specific research objectives. At the same time, it reaches beyond them. The online database allows worldwide visualization and searches of its continually-updated contents as well as the exportation of the results obtained. Beyond the project’s specific hypotheses, the database aspires to inspire and to address new questions. To support this interest in openness and sustainability, Andalusia’s Centre for Information and Communications has agreed to host the database.

## 2 Process and Methods

Information systems engineers, historians, archaeologists, and geneticists working in five countries and four languages (in addition to PL/SQL and Angular2JS) have collaborated to develop this common database. As a starting point, the data structures and initial database management systems (or lack thereof) that the researchers habitually used were totally different. On the one hand, a great number of formats characterized the historians’ extremely varied and often fuzzy data. On the other hand, the data derived from archaeological excavations, isotopic analyses, and the extraction and sequencing of ancient DNA proved more structured and quantitative. At the same time, the projections of excavated material developed in the geographic information system (GIS) software ArcGIS in collaboration with

Patronato Panamá Viejo (Kottmann, 2006) used different geographic reference systems.

The difference in data structures, database management systems, and GIS coordinate systems used by the researchers, as well as the large volume, variety, and variability of the data, required homogenizing the data clusters into a defined and supported structure under a single database management system. In addition, this newly defined structure needed to facilitate the addition of future elements in the database, such as new historical document types or places, and to allow the incorporation of new characteristics of people and goods, as well as their specific, temporary relationships, during the period of research underway.

Previous databases for historical and humanities research, while inspiring in many ways, failed to meet our open-ended, interdisciplinary requirements. A crucial resource, SlaveVoyages Database, pioneered the storage and consultation of data from libraries and archives related to transatlantic slave traffic throughout the Atlantic world (Eltis, 2018). Subsequent historical projects, from DynCoopNet to *Mapping the Republic of Letters* (2019) (Palladio) to the China Historical GIS (incorporated in the Palagios network), use GISs in order to visualize different types of data over time as distinct levels and to superimpose data sets in order to detect relations among them (Owens, 2007; Berman, 2013; Crespo, 2014). Historian Jack Owens and information engineer Vitit Kantabutra have devoted years of study to the challenges that complex historical data entail for information systems. Facing some of the same general requirements as our engineers they designed a specific solution, termed ‘Intentionally-Linked Entities’, consisting in an improvement on the entity-relation scheme designed to eliminate redundancy and arity by incorporating a ‘system of pointers’ that accommodates varied and messy historical data (Kantabutra and Owens, 2013). However, the model designed lacked the user interface essential for our researchers to approach it. Finally, although not initially oriented towards GIS, the influential databases designed by Jean-Pierre Dedieu, Sylvia Marzagalli and others based on ‘fichoz’ in Filemaker Pro, have produced a number of open-source resources for historians, including Navigocorpus (Dedieu *et al.*, 2012), which further evidence the need for integrative approaches and tools.

Today's efforts to gather multidisciplinary and worldwide data unfailingly draw upon GIS. One prominent example, 'Seshat: Global History Databank', brings together historical and archaeological information based on the published literature and according to the system's coding manual (Turchin *et al.*, 2020). Other initiatives, such as 'Open Context' (2019), facilitate research by privileging conservation of the primary material in archaeological collections organized geographically by provenance and curated online. Discipline-specific collections of online data also include Nucleotide (2019) and Genbank (2019) for geneticists, who drawn upon and are ethically required to contribute data to them. Yet such resources prove inhospitable and often incomprehensible to non-specialists. Along similar lines, ArtEmpire's partners at CEZA have worked to develop 'IsoMemo: A Big Isotopic Data Initiative' (2019), which competes with 'Isoarch' (Salesse *et al.*, 2018). None of these resources, however, permit multidisciplinary data entry, searches, and consultation.

The limitations of current humanities and historical databases and their inability to accommodate interdisciplinary research led us to prioritize the need to define, homogenize, and integrate historical, archaeological, isotopic, and genetic data in a space-time framework with different scales and precision levels. The preparation of temporal and spatial information for projection in GIS appeared crucial not only to situate disparate data in a common frame of reference, but also as a potential gauge of the Early Modern process of globalization and the impact of early contact on the populations and goods involved. After examining the resources available, an informed choice of database system required systematic exploration of the organization of the data and relevant ontologies in each discipline before considering the possible correspondences and synergies among them and, finally, choosing the best technology.

### 3 Preliminary Studies

#### 3.1 Multidisciplinary input

In the framework of each discipline—archaeology, isotopes, DNA, and history—it became crucial to organize the data produced while preserving its original context as much as possible.

The archaeologists, whose data initially appeared more precise and regular than the historians', sought to bring together the results of excavation campaigns undertaken employing different systems of spatial registration by establishing equivalencies among them. They identified specific contexts (funerary, domestic, military, submarine, etc.) and stressed that the database should give the possibility of adding new contexts in the future. To accommodate these needs, the structure of the data model included open dictionaries that allow researchers to add contexts in the future, as can be seen in Fig. 1. In order to accommodate the methodology applied in funerary excavations in 2017 and 2018, the 'Harris Matrix', without losing previous data, the archaeologists identified 'Stratigraphic Units' (UE) of two main types: burials (with potential grave goods) and others (structures, contextual elements, or landfill), all including associated objects.

The archaeological excavations recovered human remains that, once cleaned and analysed, enabled specialists in ancient DNA and isotopes to extract and to share samples from them. Like the team's archaeologists, its experts in isotopes and ancient DNA worked to homogenize their data by incorporating emerging standards in their respective fields in order to define and to build a robust structure. As can be seen in Fig. 2, these researchers shared sets of common data, including attributes relevant for both disciplines, such as the sample's surface and overall preservation. Each discipline also carried out its own set of analyses to produce results: from bioapatite and collagen in the case of isotopes and regarding mitochondrial, Y-chromosome and whole-genome DNA.

As with the archaeological evidence and samples extracted from it, we explored and recorded the original, organic structure of the historical material consulted in archives and libraries in order to preserve the form and content of the data produced to the greatest extent possible. In an attempt to systematize a variety of historical sources, our team defined different 'types' of documents habitually encountered, with particular attention to the attributes of the persons and goods documented. A refusal to relinquish messy, imprecise data led the definition of twenty document types, including 'letter' (carta, cédula, consulta), 'last will and testament' (testamento), 'auction' (almoneda), 'inventory of goods' (inventario de bienes),

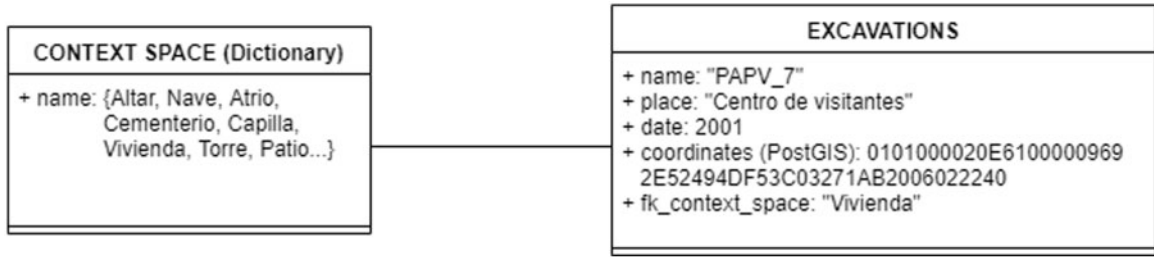


Fig. 1 Incorporation of dictionaries to basic excavation fields

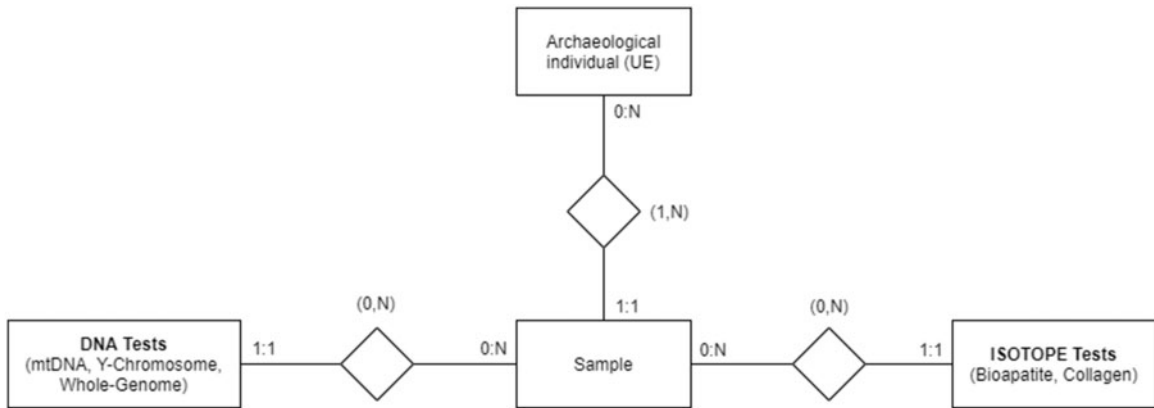


Fig. 2 A sample, extracted from an archaeological individual (UE), contains common attributes relevant to DNA and isotopes analyses

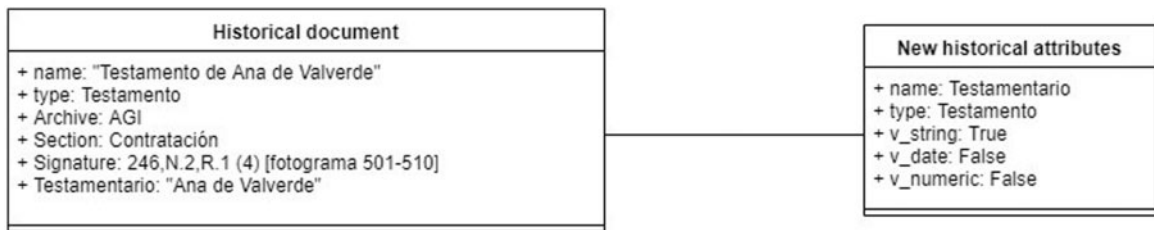


Fig. 3 Incorporation of new attributes in a specific type of historical document

‘questionnaire’ (interrogatorio), ‘act’ (acta, acta sentencia, acta repartimiento), ‘authorization’ (poder), ‘relation of merits and services’ (relación de méritos y servicios), ‘judicial review’ (juicio de residencia), ‘visit’ (visita), ‘legal dispute’ (pleito entre partes), ‘seizure of goods’ (incautación), ‘accounts – income’ (contabilidad—data), ‘accounts – expenses’ (contabilidad—cargo), ‘contract’ (contrato/asiento), and ‘sale/purchase’ (compra-venta), with the possibility of adding additional types of documents (much like

archaeological ‘contexts’) in the future. As can be seen in Fig. 3, this requirement led to the construction of an open hierarchy compatible with the project’s needs.

The use of open dictionaries also enabled the historians to store data regarding persons (their names, origins, roles, positions, occupations, etc.) and goods (names, materials, weights, prices, etc.). Finally, our work to define the data contained in each type of document led to the realization that the ontology of the data

model should accommodate attributes that are common for all types of historical documents (collection, section, signature, title, date, summary, partial or complete transcription, etc.) as well as others that are specific for each documental type (such as ‘witnesses’ for certain legal proceedings). Thus, the historical section applied the same solution adopted for DNA and isotopes (Fig. 2) to differentiate common and specific data.

Entry and revision of the information regarding historical as well as archaeological persons and goods required a two-step process. In both sections, Step 1 facilitated the rapid entry of data regarding persons and goods reflected in Step 2, where it could be edited and detailed further. In the historical section, Step 2 featured lists of persons, goods, and places registered in a single document, which permitted the designation of explicit relations among persons or persons, goods, and places mentioned. For archaeological material, Step 2 allowed the registration of anomalies, cultural modifications, or paleo-botanic particles on specific remains, as well as images of them, in emerging windows. The data migrated into the historical and archaeological sections required attention from individual researchers in Step 2 to identify and code geographical references as well as salient features attributed to persons and goods. Some of these features, such as the association of ethnonyms with possible places of origin, subsequently have been programmed. In any case, both manual and automatic processes require periodic clean-up operations executed to homogenize dictionaries and to prevent redundancy due to orthographic variations and diverse criteria. Upon detection such criteria are discussed and standardized as much as possible.

### 3.2 Cross-disciplinary synergies

After considering the various datasets and their homogenization, the team members sought to detect and maximize points of interest and comparison among the disciplines. The varied data, situated in common temporal and spatial reference systems, could then be organized in terms of the subjects approached from all of the fields involved: individuals or persons and objects or goods, as well as the relations among them. However, the different disciplines produced temporal and spatial information on different scales and with different levels or types of accuracy.

Initially, the greatest precision emerged in the spatial attributes of the archaeological material excavated

and the dating derived from historical sources, since a wide range exists in the calibration of radiocarbon dates for much of the period of interest, due to a plateau in the calibration curves from approximately 1450–1650. Information related to individuals and goods from diverse sources required different scales for locating them in space (from the micro to the global) as well as in time (with a focus on the years 1519–1671 not excluding comparisons with pre-Hispanic populations). Depending on the tooth or bone sampled, isotopic ratios reflect geology and diet at different stages of an individual’s lifetime, whereas ancient DNA records the individual’s inheritance over tens of thousands of years. Thus, different scales of time became crucial in the analysis of the variable and heterogeneous information recorded.

A degree of cross-disciplinary exchange arose in efforts to define comparable attributes within the different disciplinary ontologies. Some of the archaeologists’ mechanisms for recording uncertainty (or ‘indeterminate’ evidence regarding, for example, an individual’s sex or possible ethnic affiliations), have proven helpful for the historical team which, in turn, has been able to offer the archaeologists information useful for challenging standard assumptions within the field. Finally, a multi- and interdisciplinary search engine draws upon data entered into the sections designed by specialists in each field in order to facilitate comparisons among data sets or to display them in a single frame of reference.

### 3.3 Technological choice

Studies of the data produced within each field as well as between them showed the need for a database management system capable of supporting a complex data model and storing a large amount of data, including thousands of images. The database system, while compatible with GIS, also needed to support an intuitive and simple web application that hides the system’s complexity and can be accessed from anywhere in the world.

The work of homogenization and classification of the data as well as the search for synergies among the disciplines pointed to clear points of intersection. These points of union confirmed the need for a relational database, which associates each object with a specific identifier. This requirement, as well as the need to process large amounts of data efficiently and to integrate geographic coordinates in the database

itself, led to the selection of PostgreSQL, an object-oriented and open source relational database management system.

## 4 Results and Discussion

The consultative, cyclical methodology followed has led to an interdisciplinary and relational data model. Its most innovative entities, developed to accommodate historical data, have subsequently been refined to facilitate interaction (through comparison, contrast and combination) with the results of archaeological excavations, as well as the bioanthropological, isotopic, and genetic analyses of the human remains excavated. Prior to its availability for public online consultation, the database underwent ‘securizing’, with nginx applied so that researchers could still log-in to the specific formula for data input and consult material labelled ‘confidential’ pending further study. An unexpected setback—the failure of searches following the addition of more and more images—was remedied by moving the images to an area of the server uninvolved in online processing. The interdisciplinary model’s concretion in a tangible user interface has enabled the team to test its capabilities, detect problems, and explore initial results, as detailed below with respect to persons and goods situated in time and space.

### 4.1 Time and place

At the core of the data model, a polyvalent entity, ‘Belonging’ (Fig. 4), enables ArtEmpire to situate persons, institutions, and goods in time and space. In the first instance, it permits registration of all of the dates and places that appear in any archival document and thereby offers a more precise temporal frame of reference for related archaeological material. For this reason, the entity includes attributes related to time (start date and end date) together with indications of their level of precision or scale (from that of an exact date to a century or even a historical period), as illustrated in Fig. 4.

In order to inform ‘Belonging’, another entity, ‘Place’, includes a system of geolocalization based on geographical coordinates in the WGS84 and NAD27 systems. This entity enables us to locate points on a map referenced by a pair of coordinates, lines, or even shapes and polygons, composed by an array of pairs of coordinates. Hence, the geolocalization of

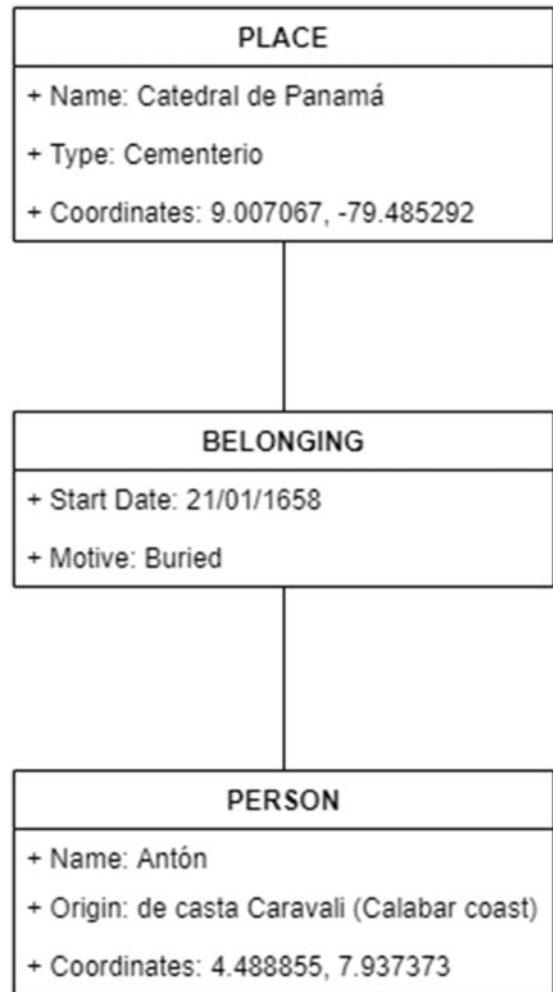


Fig. 4 The entities ‘Belonging’, ‘Person’, and ‘Place’ in ArtEmpire’s relational data model

persons and goods mentioned in the historical documentation, while often vague and unreliable, is complemented by more precise geographical information from the archaeological excavations. For example, in Fig. 4, the burial of a historical individual, Antón de casta Carabali, who died upon reaching Panamá in 1658, in the Cathedral cemetery or atrium, provides the first historical reference to this archaeological space.

As a recently-enslaved ‘negro bozal’ from the Calabar coast, Antón, although baptised, may have appeared insufficiently evangelized for interment within the Cathedral. These data inform and complement archaeologists’ interpretation of the Cathedral



atrium, where ten individuals were excavated in 2017, as a seventeenth-century burial ground for men and women of African, European, indigenous American, and mixed ethnic filiation who either did not fully belong to the Catholic community or had contravened its norms.

## 4.2 Persons

The entity ‘Belonging’ also enables researchers to relate one or more individuals to temporal and spatial events registered in historical documents. This solution makes it possible to register persons in space and time based on specific archival documentation. Technically, the challenge entails the association of ‘Belonging’ with another entity, called ‘Person\_Role\_Belonging’. This entity facilitates the identification of individuals not only by their names or id numbers, as in the great majority of databases, but also according to other relevant (observed or alleged) characteristics. In this sense, a ‘Person’ can be registered in the database with a full name recorded in an archival document, which situates, in turn, the individual in a specific time and place, and may also indicate the person’s role, occupation, position, ascribed origin, age, or gender. This person, moreover, may be associated with one or more individuals recorded (or to be recorded) in the database, along with the nature of their relationship (biological or other), and any institutions (another entity, registered according to its name and location/s) to which they belonged. In this way, genealogies can be constructed and groups defined through the consultation of relations among individuals in the system. Likewise, individuals can be associated with any category and sub-category of goods, as would be the case with determined objects. All of these characteristics allow researchers to identify an individual or individuals according to name, date, place, and other characteristics such as roles, positions or occupations, origins, or ethnic affiliations, in order to accommodate different people with the same name or names or cases of individuals with different names or other characteristics recorded at different times and places.

Although the names of archaeological individuals are unknown in this data set, their physical remains provide information often unrecorded in historical documents. The remains of each individual recovered are assigned a number or Stratigraphic Unit within the excavation and examined for evidence of age, disease,

fractures, nutritional, or articular stress, as well as possible sex and ethnic affiliation. The assessment of such indicators, compared with the results of isotopic as well as ancient DNA analyses, tests the reliability of each discipline’s standard assumptions and provides comprehensive biographical data, which is unusually global from a disciplinary as well as a geographical standpoint.

To illustrate such a process, the database facilitates comparisons and contrasts between archaeological and ancient DNA evidence. In this respect, one of our first queries concerned the bioanthropological and molecular identifications of specific archaeological individuals’ sex. The results of our search point to inconsistencies in some 20% of the individuals sampled to date (Rivera Sandoval, 2018; Aram, Achilli and Capodiferro, 2019), with results that appear divergent in three out of twenty individuals sampled and inconclusive results regarding another of the twenty individuals sampled, as illustrated in Tables 1 and 2.

Significantly, the bioanthropological and ancient DNA assessments coincided in the pre-hispanic individuals sampled and diverged only with respect to the post-contact population, whose ancient DNA requires more extensive analyses. The results to date, however, suggest that global migrations may increase the complexity of sex identification. This type of finding provides an example of the unexpected results that can be obtained from crossing different data sets.

## 4.3 Goods

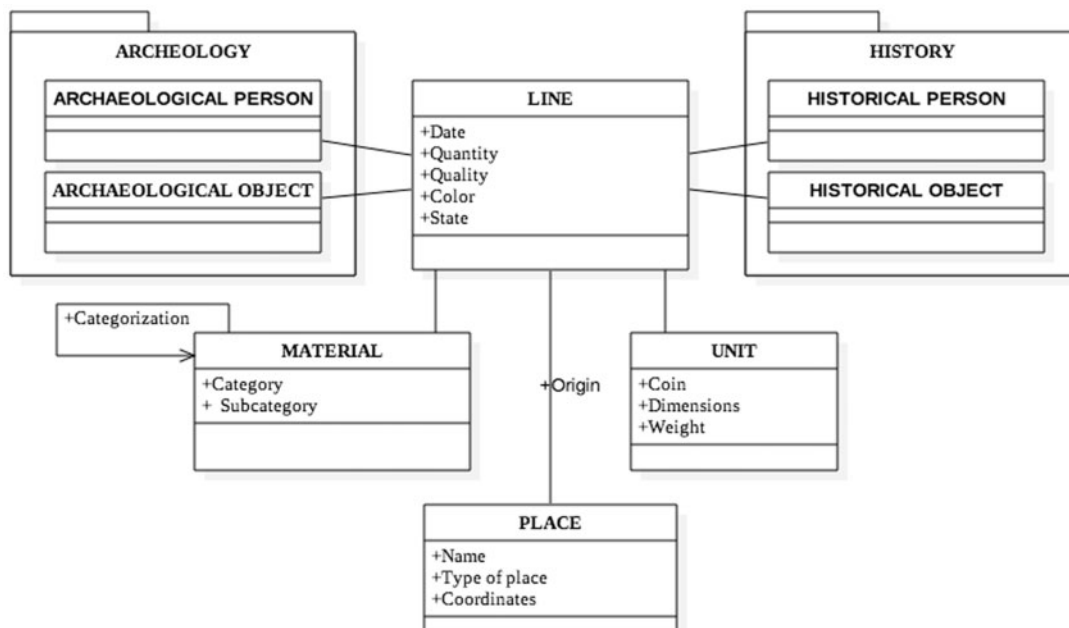
As with individuals, globalization increases the diversity and complicates the identification of goods. Hence the entity ‘Belonging’ used to situate individuals also offers the possibility of locating a good or object excavated and analysed or described in a historical source in time and space. Thanks to this entity, historical goods or objects can be related to each other, to different places and to multiple persons, and followed

**Table 1** Sex determination by bioanthropological estimation and the ancient nuclear genome

Sex	Archaeology	DNA
Unknown	17	0
Male	118	13
Female	80	8
Probably female	6	3
Probably male	42	0

**Table 2** Cases of inconsistent results of bioanthropological sex determination versus the ancient nuclear genome

Excavation	UE/individual	Sample name	Archaeology sex	DNA sex
PAPV_3( <i>Sur de la Plaza 2004 – Nave</i> )	27	PAPV_27_LTP	Female	Male
PAPV_5( <i>Catedral 2000 – Nave-Oeste</i> )	61	PAPV_61_FE	Female	Male
PAPV_3( <i>Sur de la Plaza 2004 – Nave</i> )	26	PAPV_26_M3SD	Probably male	Female
PAPV_3( <i>Catedral 2000 – Nave-Este</i> )	52	PAPV_52_FE	Male	Female



**Fig. 5** Entities common and related to archaeological and historical objects

over time around the globe. In this way, the ‘Object’ entity enables researchers to track the movement and evolution of goods and products. It also facilitates the registration and analysis of the relationships among different persons and objects and the different persons related to specific goods (as owners, sellers, buyers, etc.) at specific places and dates.

In order to attain such objectives, a variety of entities is required (Fig. 5). The fundamental entity, ‘Object’, records basic information, such as the article’s type or name, as well as attributes including colour, state, quality, quantity, origin, or description. Basic entities designed to register the object’s features include ‘Material’ and ‘Unit’. These entities register the main substance or substances used to make a given object and other characteristics, such as its economic value, weight, and dimensions. The need to record an

article’s monetary value is met through dictionaries of coins and currencies with different values. At the same time, just as different monies can be used to value goods; multiple units can be employed for weights and measures, to facilitate their accurate registration, avoiding errors in conversion. In order to associate this information with the historical and archaeological data, the entities ‘Object’, ‘Material’, and ‘Unit’ converge in another, denominated ‘Line’, which confers the required meaning upon a given good in terms of the aforementioned characteristics. The ‘Archaeological Object’ is also connected to the ‘Line’ entity, which enables it to have the same characteristics as the historical objects.

At this point, one of the ‘Object’ entity’s most important characteristics is its ability to relate a given object and all of its characteristics with a specific



individual. Thus, a person can be registered as purchasing an object or objects or even another person at a given place and time. All of the archaeological objects associated with an individual's burial (grave goods such as crosses, rings, medals, or pins) or funerary context (such as nails, shells, or tiles) can be analysed and compared to the articles listed in historical records, including ship registers and post-mortem inventories.

A 'group of goods' table has been designed for situations involving quantities of goods or groups of objects in order to incorporate multiple 'lines' in a 'group of goods', with new characteristics such as the name or date of the group, method of payment, taxes applied to the transaction, or the state of the object at the time. Common use of the entities 'Line' and 'Group of Goods' for historical and archaeological data maximizes the possibilities for multidisciplinary analysis, since objects excavated can be compared to or considered to complement others registered in

historical documents. These associations, notwithstanding a degree of uncertainty or error, can be obtained thanks to the common functions and properties of the tables mentioned.

Although the data model and formula for data entry initially distinguish between historical and archaeological information, as well as the results of isotopic and DNA analyses, its goal is the cross-referencing of all sets of data available regarding persons and goods—whether obtained from the archive, the field, or the laboratory—in time and space. The entities and attributes of each section have been designed to facilitate these comparisons. Returning to the entity 'Belonging', it becomes possible to see how archival documents are related to specific persons and goods with observed or alleged attributes and temporal-spatial locations. The database facilitates the association of 'Belonging', which can be assigned a motive (circumstance or action),

(a)

▼ Búsqueda Avanzada / Advanced Search

ELEMENTO DE BÚSQUEDA / SEARCH ITEM  
Bien - Objeto - Elemento Arquitectónico / Good - Object - Architectonic Element

SECCIONES / SECTIONS  
 Historia / History  Arqueología / Archaeology

VISUALIZACIÓN / VISUALIZATION

Historia / History	Añadir todo / Add all	Eliminar todo / Remove all	Arqueología / Archaeology	Añadir todo / Add all	Eliminar todo / Remove all
Seleccionar campos para mostrar / Select display fields	+	-	Seleccionar campos para mostrar / Select display fields	+	-
Lugar / Place	X	X	Lugar / Place	X	X
Fecha inicio / Start date	X	X	Fecha inicio / Start date	X	X
Bien / Good	X	X	Fecha fin / End date	X	X
Persona asociada / Person associated	X	X	UE / Individual	X	X
Cantidad / Number	X	X	Excavación / Excavation (place)	X	X
Material / Material	X	X	Objeto / Good	X	X
Origen / Origin	X	X	Descripción / Description	X	X
Color / Color	X	X	Cantidad / Quantity	X	X
Calidad / Quality	X	X	Material / Material	X	X
Peso / Weight	X	X	Origen / Origin	X	X
Medida / Measure	X	X	Color / Color	X	X
Precio / Price	X	X	Peso / Weight	X	X
Descripción / Description	X	X	Medida / Measure	X	X
Imágenes o PDFs / Images or PDFs	X	X	Imágenes / Images	X	X

Muestras isotópicas y ADN / Isotopes and DNA samples  
 Añadir general / Add general:  Añadir isotopía / Add isotopes:  Añadir ADN / Add DNA:  Eliminar todo / Remove all:

Seleccionar campos para mostrar / Select display fields

FILTRADO / FILTERING

Lugar / Place:

Fecha / Date:  /

Filter Union:  Value Union:

Historia / History:  AND (fewer results)  OR (more results)

Seleccionar campos para filtrar / Select filter fields

Objeto / Good:  X

Objeto / Good:  X

Fig. 6 Information regarding historical and archaeological objects: button covers (pasamanos). (a) Search; (b) Results.

(b)

**Historia / History**  
Mostrando 0 - 5 de 5

Lugar / Place	Fecha inicio / Start date	Fecha fin / End date	El/en / Good	Persona asociada / Person associated	Cantidad / Number	Material / Material	O
Panamá	30/11/1592	30/11/1592	pasamanos	Bartolomé Cuadrado	16	textil-algodón-hilado	N
Panamá	12/8/1595	12/8/1595	pasamanos	Cristóbal de Vargas	3	textil	N
Panamá	11/30/1608	14/10/1608	pasamanos	Martín de Palacios Alvarado	N/A	N/A	N
Panamá	11/30/1608	14/10/1608	pasamanos	N/A	N/A	metal-plata	N
Panamá	24/11/1625	24/11/1625	pasamanos	Pedro del Castillo	1	N/A	N

**Arqueología / Archeology**  
Mostrando 0 - 8 de 8

Lugar / Place	Fecha inicio / Start date	Fecha fin / End date	UE / Individual	Excavación / Excavation (place)	Objeto / Good	Tipo de objeto / Type of good	Des
Panamá Viejo, Catedral	1/1/1626	1/1/1671	54	RPV_5 [Catedral 2000 - Nave-Oriente]	Pasamanos	ajuar	N/A
Panamá Viejo, Catedral	1/1/1600	1/1/1671	1049	RPV_5 [Catedral 2017 - Nave PV(CA-1)]	Pasamanos	ajuar	Tipo: tejido met forr estil bus
Panamá Viejo, Catedral	1/1/1600	1/1/1671	1051	RPV_5 [Catedral 2017 - Nave PV(CA-1)]	Pasamanos	ajuar	N/A
Panamá Viejo, Catedral	1/1/1600	1/1/1671	1103	RPV_5 [Catedral 2017 - Nave PV(CA-1)]	Pasamanos	ajuar	N/A

Fig. 6 (b) Results for Historical and Archaeological Objects: Button covers

with persons, roles, and goods. In this way, temporal and spatial coordinates can be related to an expanding number of persons, goods, and groups of goods contained in the database.

Having established the mechanism to register the temporal and spatial situations pertaining to persons and goods, our data model has focused on the registration of their specific attributes. The evidence available regarding ‘archaeological individuals’ who did not intend to have their remains scrutinized might be considered more reliable than that recorded by ‘historical individuals’, whose representations often belie their intentions. Yet neither set of data appears complete or fully representative, and both require interpretation. There arises the possibility of comparing the allegations of historical actors with data obtained from their

physical remains. A similar complementarity emerges from the possibility of comparing archaeological and historical registers of goods. The existence (and, by all estimations, increase) of contraband or unofficial, normally unrecorded, commerce during the Early Modern period accords particular importance to the comparison of goods in the archaeological and archival registers. Moreover, the goods contemplated in the ‘Objects’ entity include plants and animals and their derivatives, whose role in early globalization and impact on previously separate continents is difficult to overestimate (Melville, 1996; Crosby, 2003, 1986).

In order to illustrate the system’s potential to display cross-disciplinary results regarding goods, the archaeological and historical data can be searched for specific objects. To illustrate such a search in

Fig. 6a, among other articles, button covers or ‘pasa-manos’, long associated with Northern European fashion, are of interest to both disciplines:

Based on the results obtained and shown in Fig. 6b, to date the database registers button covers as merchandise in five historical documents and as grave goods associated with eight individual burials excavated in 2017.

Archaeologists have only recorded button covers made of metal threads, particularly silver and gold (Martín and Figueroa, 2001). The historical references to button covers from 1592–1625, while slightly predating their chronology as funerary goods, indicate that such luxury items were frequently made of silk or cotton fibres, although those composed of metal survive best in the archaeological register. Hence the historical register broadens the information about objects excavated and classified in different styles, without the variety of fibres or colours registered 400 years ago. Interestingly, the silver and gold button covers listed in inventories and sold at auctions registered in the database also appeared in the graves of the archaeological individuals buried in Old Panama’s Cathedral. These individuals’ probable African, European, mixed and undetermined ethnic filiations, following the bioanthropological analyses applied, support the project’s hypotheses about their social insertion and mobility on an artery of empire.

## 5 Conclusions

A complex system has been forged to register and relate information produced in diverse disciplines. This model, developed in PostgreSQL, facilitates advanced multidisciplinary searches capable of generating knowledge unavailable to any single expert or specialty without the solutions developed. Transversal entities including ‘Person’, ‘Object’, and ‘Belonging’ make it possible to situate individuals and products in time and space and beyond disciplinary boundaries.

The massive data model’s entities and attributes have been detailed in the documentation originally compiled to guide development of the user interface. Once revised and completed according to the real design and experience to date, this documentation will

be deposited in the Pablo de Olavide University’s online repository. For more frequent online consultation, a user’s manual has been prepared in Spanish and English. Finally, technical instructions for troubleshooting, programming additions, and making adjustments to the interface, including a series of videos, have also been compiled. Andalusia’s Scientific Computing Centre (CICA) has agreed to host the database during and after the research project.

The user interface developed allows researchers to precede in three stages: first, the specialists input evidence (from a document, an excavation, or a genetic/isotopic analysis) into the system according to the formula designed. For the historical and archaeological material, the process of data input and annotation requires particular attention to persons, goods, space, and time. Finally, multiple annotations make it possible to compare data sets from different fields. To date, the system contains 3,178 historical documents (letters, testaments, lawsuits, etc.) and 23 excavations, with 598 Stratigraphic Units (burials, architectonic elements, etc.), and 4,172 images. It also includes the results of 200 isotopic and 83 genetic analyses. The contextualized preservation, sharing, display, and availability of these data have proven an immediate benefit. Meanwhile, the results obtained from multidisciplinary searches improve with the entry and more rigorous coding of new data, as well as expansion of the system’s dictionaries.

Cross-disciplinary comparison of the results obtained to date sometimes suggests that new knowledge may entail (and, indeed, require) recognition of unsuspected benefits and limitations of understandings previously generated within each discipline. The interface designed for a diverse team, moreover, has demanded a level of cross-disciplinary intelligibility and comprehensibility essential for wider use. The database, available for open online consultation since 15 August 2019, remains a work in progress. Researchers continue to detect and solve technical issues while integrating new results. A limited amount of the data, including sensitive results from the genetics and stable isotopes labs that still require careful interpretation, will remain confidential through 31 December 2020. Most of the data, however, already are openly accessible, alongside the insights promised from an interdisciplinary approach to them.

## Acknowledgement

The authors acknowledge the help of all project participants and contributors to the database design and input, especially Alessandro Achilli, Marco Capodiferro, Alejandro García Montón, Iosvany Hernández, Corina Knipper, Juan G. Martín, Tomás Mendizábal and Javier Rivera Sandoval, who have contributed data as well as expertise. We are also grateful to the anonymous reviewers and to Guillaume Gaudin for helpful advice on earlier versions of this work.

## Funding

This research has received funding from the European Research Council (ERC) under the Europe Union's Horizon 2020 innovation programme, grant agreement ERC CoG 648535, and taken place in collaboration with the Patronato Panamá Viejo as well as the General Archive of the Indies/Spanish Ministry of Culture and Sports.

## References

- Berman, M. L.** (2013). Modeling and visualizing historical GIS data. *Tiempos Modernos: Revista Electrónica de Historia Moderna*, 7(26): 8–19.
- Aram B., Achilli A., and Capodiferro, M.** (2019). Sex differentiated mobility and mixture. The genetic and historical impact of European expansion. In *Paper delivered at the Universidad Pablo de Olavide in ArtEmpire's II International Scientific Encounter, Persons and Goods in Interdisciplinary Perspective*, Seville, 28 November.
- Crespo, A.** (ed.) (2014). *Spatio-Temporal Narratives: Historical GIS and the Study of Global Trading Networks*. Newcastle upon Tyne: Cambridge Scholars Publishing.
- Crosby, A. W.** (1986). *Ecological Imperialism: The Biological Expansion of Europe 900–1900*. Cambridge: Cambridge University Press.
- Crosby, A. W.** (2003). *The Columbian Exchange: Biological and Cultural Consequences of 1492*. Westport, CT: Greenwood Press.
- Dieudé J., Silvia M., Pierrick P. and Werner S.** (2012). Navigocorpus at work: a brief overview of the potential of a database. *International Journal of Maritime History*, 24: 331–60, <http://navigocorpus.org>.
- Eltis, D.** (2018). Trans-Atlantic Slave Trade. Understanding the database, <https://www.slavevoyages.org/voyage/about#> (accessed 15 November 2019).
- Genbank.** (2019). <https://www.ncbi.nlm.nih.gov/genbank/> (accessed 1 November).
- Isomemo: A Big Isotopic Data initiative.** <https://isomemo.com/> (accessed 1 November 2019).
- Kantabutra, V. and Owens J.B.** (2013). Intentionally-linked entities: a better database system for representing dynamic social networks. Narrative geographic information, and general abstractions of reality. *academia.edu* (accessed 1 November 2019), doi: 10.1111/j.1478-0542.2007.00476.x.
- Klein, J. T.** (2015). *Interdisciplining Digital Humanities: Boundary Work in an Emerging Field*. Ann Arbor, MI: University of Michigan.
- Kottmann, A.** (2006). *Informe SIG*. Unedited report. Vía Cincuentenario, Panama: Patronato Panamá Viejo.
- Mapping the Republic of Letters.** (2019). <http://republicofletters.stanford.edu/> (accessed 1 November 2019).
- Martín, J. G. and Figueroa, P.** (2001). *Pasamanería Colonial*. Vía Cincuentenario, Panama: Arqueol. Panamá la Vieja, pp. 215–24.
- Melville, E.** (1996). Conquest landscapes: ecological consequences of pastoralism in the new world. In Gruzinski, S. and Wachtel, N. (eds), *Le Nouveau Monde, Mondes Nouveaux. L'expérience Américaine*. Paris: EHESS/CNRS, pp. 99–113.
- Nucleotide (NCBI)** (2019). <https://www.ncbi.nlm.nih.gov/nucleotide/> (accessed 1 November 2019).
- Open Context.** <https://opencontext.org/> (accessed 1 November 2019).
- Owens, J.** (2007). Toward a geographically-integrated, connected world history: employing geographic information systems (GIS) | J. B. (Jack) owens - academia.edu. *History Compass*, 5(6): 2014–40, <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1478-0542.2007.00476.x> (accessed 8 April 2020).
- Papadopoulos, C. and Reilly, P.** (2020). The digital humanist: contested status within contesting futures. *Digital Scholarship in the Humanities*, 35 (1): 127–45.
- Rivera Sandoval, J.** (2018) *Análisis Bioantropológico de la Serie Osteológica Excavada en la Catedral de Panamá Viejo, temporada 2017*. Proyecto ERC CoG 648535, An Artery of Empire. Conquest, Commerce, Crisis, Culture and the Panamanian Junction (1513–1671), Ciudad de Panamá.

- Salesse, K., Fernandes R., de Rochefort X., Brůžek J., Castex D. and Dufour É.** (2018). IsoArch.eu: an open-access and collaborative isotope database for bioarchaeological samples from the Graeco-Roman World and its margins. *Journal of Archaeological Science: Reports*, **19**: 1050–5.
- Seshat: Global History Databank.** (2019). <http://seshatdatabank.info/> (accessed 1 November 2019).
- Turchin, P., Whitehouse, H., Francois, P.** et al. (2020) An introduction to seshat: global history databank. *Journal of Cognitive Historiography*, 1–6, in press, doi: 10.1558/jch.39395.