

ANALYSIS OF SCIENTIFIC QUESTIONS IN ARCHAEOLOGY

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Contents

1. Introduction.....	4
2. Goals and Selection of Sources.....	5
3. Method applied	6
4. Description of Work.....	7
4.1 Creating the Questions	7
4.2 Classifying by Human Activity	7
4.3 Ranking by Generalization of Knowledge	8
4.4 Parametric Generalization of Questions.....	10
4.5 Seeking the Target Type of the Questions.....	10
4.6 Classification by Epistemological Types.....	11
5. Interpretations.....	13
5.1 Analysis by Human Activity	13
5.2 Analysis by Generalization of knowledge	14
5.3 Analysis by parametric generalization of questions	15
5.4 Analysis by Target Type of Questions	18
5.5 Analysis by Epistemological Types	19
6. Conclusions.....	22
Appendix A - Definitions for Categories of Human Activities.....	23
Appendix B - Levels of generalization of knowledge	25
Appendix C - Definitions for Parameter Types of Questions.....	25
Appendix D - Definitions for Target Type of Questions.....	28
Appendix E - Definitions of Epistemological Types.....	29

1. Introduction

The widespread use of computers and information systems in all fields of research recently makes it possible to aggregate large bodies of digital information for a whole discipline and to enable homogeneous access for researchers world-wide by using shared ontologies. So-called digital research infrastructures are planned and implemented, with the ambition that a large number of research questions can be solved just by collecting the relevant data from the infrastructure and process it using private or public IT tools.

This trend has also reached archaeology, which employs IT methods from the late 1950ties on. The European Community has been funding since 2013 ARIADNE¹, the first European research infrastructure project in archaeology, and its continuation project ARIADNE-PLUS. Recently, detailed digital excavation recordings produce even a "Big Data" problem².

The great open question is which overarching common data model is adequate to represent the extreme diversity of archaeological data, which uses results from all kinds of sciences, in a way that enables effective, automated collection of data relevant to a research problem. ARIADNE, as many other research projects in archaeology world-wide has started with the CIDOC CRM³ (ISO 21127:2006⁴) and its extensions as common model. Yet, the final proof of adequacy of its details and extensions and the development of effective access methods to archaeological data in the form of semantic models can only be done through the analysis of real research questions.

However, real research questions do not exist as a resource. Some museums and archives register real questions from users, but typically fear to disclose them in order not to expose clients. Applications for funding contain research questions, but there is no central collection, and these questions are at a high, speculative level, and not as specific as those questions that correspond to inquiries to information systems. The scientists themselves, as any human being, do not remember easily their more specific questions because the human brain seems to make us forget questions more or less immediately after getting the answers.

¹ ARIADNE is funded by the European Commission under the Community's Seventh Framework Programme, contract no. FP7-INFRASTRUCTURES-2012-1-313193. The project started on 1st February 2013 and runs for 48 months. (<http://www.ariadne-infrastructure.eu/About>)

² Gattiglia, G. (2015). "Think big about data: Archaeology and the Big Data challenge." *Archäologische Informationen - Fokus: Open Access & Open Data.*, Vol 38. ISSN-Print: 0341-2873, ISSN-Internet: 2197-7429, (<https://journals.ub.uni-heidelberg.de/index.php/arch-inf/article/view/26155>)

³ The CIDOC CRM is the culmination of over 10 years work by the CIDOC Documentation Standards Working Group and CIDOC CRM SIG which are working groups of CIDOC (<http://www.cidoc-crm.org/>)

⁴ Since 9/12/2006 CIDOC-CRM is official standard ISO 21127:2006 (<https://www.iso.org/standard/34424.html>)

Finally, in order to compare research questions to a conceptual model and query mechanism, one has to abstract from the actual, particular question to a categorical form corresponding to a conceptual model. This requires linguistic and knowledge engineering skills, as well as an understanding of the domain. This methodological “meta-analysis” is typically not within the skills or research interests of an archaeologist.

The present study aims at generalizing over a variety of research questions related to archaeology, so that we can improve information systems, and ultimately, help forward research.

Since sources concerning questions in archaeology are scarce, and even interviews with archaeologists about current questions have not contributed much to get a representative collection of concrete archaeological questions, we try to reconstruct linguistically and semantically questions from reports of research findings, which are abundant.

We are completely aware of the biases and limitations of this method, but in the absence of any other systematic approach to the problem, we regard that this will provide, despite all shortcomings, a much better and justified guess of what is needed than anything we knew before.

The publication of the results of the research described below, as on-line⁵ and down-loadable resource, is intended to constitute a corpus of reference that archaeologists and other researchers can study, review and reuse and that IT specialists can use for further generalizations in order to design and implement more effective and adequate information systems.

2. Goals and Selection of Sources

Our goal is the classification of scientific questions in archaeology by multiple criteria, as well as evidence of their frequency of occurrence, in order to build more efficient information systems which may potentially help answer such kinds of questions with respect to existing archaeological data, in contrast to, in addition to or in support of setting up excavation campaigns and direct observation of finds.

Because of the lack of real questions, we used as sources the abstracts presented at the 19th annual meeting of the European Society of Archaeologists⁶,

⁵ https://isl.ics.forth.gr/archaeological_questions/

⁶ Turek, J. (Ed). (2013) *Abstracts: 19th Annual Meeting of the European Association of Archaeologists 2013 Pilsen. Czech Republic*. Pilsen: University of West Bohemia. (https://www.e-a-a.org/EAA/Conferences/Past_EAA_Conferences/EAA/Navigation_conferences/Past_conferences.aspx ,https://www.academia.edu/5878122/Jan_Turek_ed._Abstracts_19th_Annual_Meeting_of_the_European_Association_of_Archaeologists_2013_Pilsen_Czech_Republic_)

held in Pilsen in the Czech Republic from 4 to 8 September 2013. Since that was a general conference without a specific theme, we hope that we get a broad spectrum of topics. For that reason, we sought specific archaeological questions in the abstract of each paper or we reconstructed the questions behind the presentation of some research results, in order to realize what issues the researchers were concerned about. The latter was based on descriptions of scientific results in each text, which we transformed into questions, based on our interpretation of the context of each abstract, but also by our general understanding of each text. We then used several abstraction and classification methods to assess the frequency of occurrence of certain types of questions.

The selected texts are from section “A: Interpreting the Archaeological Record (Sessions A01 – A08)”. This section is ideal, because it represents research using existing documentation of excavations – the same situation we envisage when using data kept in a research infrastructure as a starting point of research. Beyond that, this section of presentations was not limited to a specific subject. Because of the big number of the texts, we considered choosing certain texts at random. As a result, the occurrences that are derived from the various sorts of classifications, apply only to the specific texts which were selected. Nonetheless they constitute some kind of real evidence and a certain statistical relevance.

3. Method applied

To reach our goal, we chose the following processing steps:

- Find or create questions from the texts,
- Generalization of questions into forms of questions by introducing parameters that replace particular items by kinds of referred entities, such as “Hungary” by “Place”,
- Classifying the subject of questions by related categories of human activity,
- Ranking questions by levels of generalization of knowledge (i.e., particular things and events / collective behaviour /universal or categorical phenomena),
- Classifying questions by the target type (“head”) of the question, such as “who was the creator of...” by “Actor”,
- Categorization of questions by more specific terms (Basic theme) for further clarification (see section 4.5)
- A final classification of forms of questions by a series of ad-hoc epistemological types in the archaeological reasoning process.

The definitions about the above classifications are listed in Appendix A through Appendix E of this analysis.

4. Description of Work

4.1 Creating the Questions

After having studied each text, we collected already pre-formulated archaeological questions which we explicitly found in the texts, such as question A01.03 (3) below, or we reconstructed the underlying questions from specific results we found in the text, such as A01.03 (1a), based on our interpretation of the context of each abstract, but also by our general understanding of each text. For each question, we used all related terms that were explicitly-mentioned in the texts (such as place or period in which an event happened), but often it was necessary to complement this information with things and concepts implicitly present in the texts in order to make their meaning complete. For example:

- In the abstract A01.03 we found an explicit question: «*However, it remains an open question how significant was amber to Bronze Age societies.*» We extracted this part of the phrase to a query: “*How significant was amber to Bronze Age societies?*” [A01.03 (3)].
- In the abstract A01.03 we found an underlying question: «*Bronze Age in the eastern Baltic region began when the first imported goods appeared. The first wave of imported objects in the graves appeared only in the middle Bronze Age in so called Sambian Barrow Culture graves. This phenomenon is traditionally explained by the intense amber trade, “the Sambian sphere of exchange”.*» We transformed the descriptions of these scientific results into the question: «*Why appeared the first wave of imported objects in the Sambian Barrow Culture graves in the east Baltic region?*» [A01.03 (1a)]

4.2 Classifying by Human Activity

The successful ontological analysis of archaeological data using the CIDOC CRM, which has been supported by enough authors, shows the central importance of relating finds to various kinds of events, in particular human actions. Since the development of the CRM is driven by evidence from actually used documentation formats that are so far more taken from museum objects and excavation practice, there is always a question if the subject coverage is adequate. Therefore we classified in the following the questions we found by “*related categories of human activity*”, based on the archaeological subject implied by each question. This analysis constitutes a quantitative overview of the archaeological subject, which can be regarded as the product of the current research interest of archaeologists using excavation records and the availability of evidence for these subject areas, with all reservations about how representative and statistically relevant the material from this conference may be considered.

We tried to find a suitable existing classification system detailed enough in order to understand if current classes of activities modelled in the CRM or other

ontologies constitute a sufficient high-level coverage for documenting the respective relevant facts. Some sociological theories may provide such categorizations, but may not be free from ideologies and considerations limited to recent societies, and not detailed enough for our purposes. We considered in detail the “Social Historical and Industrial Classification System (SHIC)”, or the AAT hierarchy of “Activities”, otherwise excellent resources, but found them to be only of limited use, because the archaeological material has its own specific focus, based on the kind of surviving evidence, such as burial systems and “built contexts”.

Therefore we invented these categories ad-hoc, even though having the AAT and SHIC in mind. Our categories are not an attempt to make another sociological theory, but a pragmatic approach under the impression of the actual material. The categories we chose are:

- Social organization,
- Material base, tools, technology, expertise (know-how)
- Trade/Commercial relations
- Economy,
- Religious system,
- Burial system,
- Cosmological system, belief system
- Psychological context of values,
- Art (in space, on tools, on objects)
- Intercultural relations (interactions and exchange of ideas between people of different cultures)
- Aesthetic needs
- Wars (competition for resources and domination between societies)
- Political relations (interactions between societies).

Some questions cannot easily be classified into related categories of human activity, since they do not refer to concrete evidence of that type. For example the question «*Which is the distribution of distinctive artefacts in the surrounding areas of the English Peak District during the Early Bronze Age?*» [A05.03 (3)], seems not belong even to some of the above general categories of human activity. Rather, the distribution can be a result of any human activity and the chance of deposition. The detailed definitions of the categories of human activity⁷ are listed in Appendix A of this analysis.

4.3 Ranking by Generalization of Knowledge

In addition, we classified each question by “levels of generalization of knowledge”. They characterize the degree of abstraction of a question from the

⁷ https://isl.ics.forth.gr/archaeological_questions/human_activity

material facts constituting the observable reality. They are important distinctions for the design of information systems and for the epistemological process of evidence-based reasoning because of the differences in management and methods of argumentation. The levels are:

- particular
- collective behaviour
- universal

More specifically, if a question reveals an isolated incident or thing, it is categorized by the category: **particular**. For example the question: A01.13 (1): «*What do we learn from the most ancient amber processing workshop which has been recovered south of the Alps and in the whole Mediterranean Region?*»: this question is about a single thing and activity, i.e., it relates to a specific workshop and therefore is classified at this level of generalization of knowledge. In a strict sense, only particulars can be observed. Formal ontologies, such as the CIDOC CRM and others using knowledge representation languages, are normally instantiated by particulars and classifications of particulars. Query languages, such as SQL or SPARQL are geared to retrieve sets of particulars.

If a certain question is about collective and repetitive behaviour, it is classified by the category: **collective behaviour**. For example the question: A01.02 (2): «*From which region began the amber batches to reach the Vologda region?*»: this question pertains to a multitude of repeated individual actions of similar kinds with similar effects taken collectively as a coherent phenomenon. For this reason we categorized it at this level of generalization knowledge. Knowledge about collective behaviour is either an induction from the observation of a multitude of particulars or based on evidence of a collective effect, such as the abrasion of stairs in a building. Ontologies for describing collective behaviour are still poorly developed. Typically, tools for quantitative statistical analysis are employed for inferring knowledge about collective behaviour. There are enough unsolved challenges for IT support at this level of reasoning.

Finally, if a question is about categories of globally distinct things or phenomena, typically types of an ensemble, it is classified under: **universal**. For example the question: A01.15 (1): «*What are the types of amber products in Italy?*»: this question refers to types of amber products under some contextual constraints and therefore is classified under this category of generalization of knowledge. Typically, universals are treated by terminological or classification systems. There is ample IT support for inferring typologies of entities from frequencies of combinations of features, and for documenting and exchanging typologies. Universal laws describing the dynamics of behaviour, as they appear in physics, are rarely a subject of serious archaeological research.

The definitions of the levels of generalization of knowledge⁸ are listed in Appendix B of this analysis.

4.4 Parametric Generalization of Questions

The major goal of this study is to help finding an adequate query language or system for supporting the kinds of questions identified in this study. The first, most direct step to do so is to parametrize all specific or particulars by a general category, which does not alter the sense of the relationships and expected results other than pertaining to any example of this kind.

For instance, from a query language point of view, the question A01.01-P-3(1): “What are the exotica which were found in the protohistoric settlement of Roca?” does not change by replacing the place “Roca” by another one, the “settlement of Roca” by another site at this place (if there is any), the term “protohistoric” by another period or the term “exotica” by another object category. Consequently, the question generalizes to “What are the [object type y] which were found in the [built context f] of [period x] of [place z]?”. With this method, we empirically approach the envisaged query language.

This kind of parametrization does not solve the formalization of relationships implicit in the natural language phrases, such as “which were found in” above. This should be subject to a subsequent study. In some cases, as in this one (A01.01-P-3(1)), they can be directly mapped to a CRM compatible ontology (actually the “S19 Encounter Event” of CRMsci), but in many cases the relationships are of a much more complex nature, such as in A07.15 (1): “Which are the ways in which space is delineated and used within the [built context x]?”.

The kind of parametrization actually helps revealing the relevant parts of the questions that cannot be easily formalized with current IT means and ontological analysis, which is another important goal of this study. The complete list of parameters⁹ employed and their definitions are listed in Appendix C of this analysis.

4.5 Seeking the Target Type of the Questions

Further, the above parametrization does not formalize the kind of information expected as an answer to the question, linguistically loosely corresponding to the “head” of the question, or in SQL to the “FROM” clause. In the above simple case A01.01-P-3(1) the archaeologist seeks a set of object types, a more detailed classification of things of category “exotica”. Consequently, we classified this question under the target type “What (thing)”. Current query languages are well designed to answer such questions that are asking for a set of a specific category or

⁸ https://isl.ics.forth.gr/archaeological_questions/levels

⁹ https://isl.ics.forth.gr/archaeological_questions/parameters

kind, time and place, i.e., the classical “Who When Where What” questions, which dominated the design of museum information systems around the year 2000. However, this study revealed enough more complex and different kinds of questions. For those we could not find a clear category, we assigned the term “complex”. We did not distinguish if a singular or plural answer had been sought. The ad hoc categorization we applied used the following types:

- Who (actor),
- What (thing),
- Which (activity/event),
- Which (time-span),
- Where/Which (place),
- How/Why,
- Use,
- Distribution,
- What show us/What do we learn,
- Relationships,
- Temporal evolution,
- Structure,
- Social Function,
- Epistemological,
- Complex

The complete list of types¹⁰ employed and their definitions are listed in Appendix D of this analysis. In addition, we have commented the target types by more specific terms (basic theme) for further clarification, which are listed in each question separately, either inside the downloadable folder in the spreadsheets of “Classification per question of sessions A01-A08 chapters” in the column “basic theme”, or on the web publication on the menu “Questions” in the column “Basic theme” of each question.

4.6 Classification by Epistemological Types

In order to develop a better understanding of all those questions that do not have an obvious correspondence to current query languages, we have tried, as a first step, to classify the epistemological process or role that appear standing behind the question or is even explicitly mentioned in the abstract.

For instance, the answer to the question A03.14 (4): “From what kind of [material type x] were made the [object type y] in society of [people z] in [place y] during [period]?” was actually used in the source to falsify a hypothesis that human

¹⁰ https://isl.ics.forth.gr/archaeological_questions/form_types

bones were employed, which of course becomes then input for another interpretative process. Therefore, we have classified questions as the above by “Discrimination of material artefact types constrained by super type/place/period/context type”. The respective research referred to in abstract A03.14 not only used documented data, but carried out primary analytical observation on finds from excavations, which is not a task of IT. The information part of these kinds of questions, i.e., once observation data have digitally been encoded, is easily implemented with current query languages.

Questions, such as A01.03 (1): “Which time-span appeared the first wave of imported [object type x] in the [built context y] of [culture z] in the [place f]?” need a more complex processing: Firstly, the respective objects have to be selected, then the chronology of their depositions be found, and finally a reliable beginning of the temporal distribution of these chronologies be determined. We have classified such questions as making an inference “From object type to time”. To be answered by IT means, a suitable query to a database and the use of a statistical evaluation tool, possibly graphical, can be employed.

We finally encountered that many higher-level questions pertain to inferring some cause, driving force or consequences from some sort of evidence, such as inferring the function of types of objects from their form and/or context of finding or traces found on them. These inferences can, in general, not be automated by an information system, but it is important to understand how some support to do them may be developed in an information system. Therefore, we created ad-hoc categories for classifying questions by these epistemological aspects under various types, such as “From object type to significant functional properties”. They are particularly interesting, because their treatment in current information systems is neither simple nor always obvious. We present a more detailed discussion in the conclusions.

For a better overview, we generalized the epistemological types by four major categories, which differ in their interpretative immediacy to the source material and the way an information system may or may not at all support such questions. These more abstract categories are the following:

- Descriptive questions
- Comparison of specific types or phenomena
- Phenomenological correlations between different categories of types
- Interpretative conclusions

The definitions about the categories and the subcategories of the higher level questions¹¹ are listed in Appendix E of this analysis.

¹¹ https://isl.ics.forth.gr/archaeological_questions/categories

5. Interpretations

In this section we present and interpret the quantitative analysis of the classifications described above. The on-line version of this work allows users to carry out quantitative analysis specifying even more parameters than presented here. Since the material is very limited in number, a quantitative interpretation can only represent some indications, a sort of hints that future research may deepen. Nevertheless, it constitutes valid evidence, and we have tried to be as explicit as possible about our assumption, so that the reader may develop his own opinion about any bias we may have introduced.

After the analysis of 121 abstracts from the chapter A: «Interpreting the Archaeological Record» (sessions A01-A08) which were presented at “19th Annual Meeting of European Association of Archaeologists, 2013 Pilsen, Czech Republic”, we ended up with the following results:

Creating the Questions: We extracted or reconstructed **388 questions**, which we generalized into a form using parameters closer to the way they could be implemented and answered by information systems.

5.1 Analysis by Human Activity

Classifying by human activity resulted in the following distribution independent from all other parameters (note that some questions appear under more than one category):

Category:	Number of questions:	per cent %
Social organization	148	38%
Religious system	86	22%
Art	82	21%
Aesthetic needs	48	12%
Commercial relations	43	11%
Material base	35	9%
Intercultural relations	31	2.40%
Burial system	29	7.50%
Technology	21	5.40%
War	16	4.20%
Belief system	12	3.10%
Economy	9	2.40%
Tools	7	1.80%
Trade	7	1.80%
Psychological self-understanding	5	1%
Cosmological system	4	1.05%
Political relations	4	1.05%
Expertise (know how)	3	0.80%

Ecosystem	1	0.30%
Archaeological process	1	0.30%

Table 1: Distribution of questions by categories of human activities

Categories that stand out are:

- Social Organization with 38%
- Belief System, Cosmological System, Burial System, Religious System, summing up to 34%
- Art and Aesthetic Needs, summing up to 33%.
- Material Base, Technology, Expertise, Tools, summing up to 17%
- Economy, Commercial Relations, Trade, summing up to 16,3%

From a point of view of evidence found in excavations, one can expect burial systems to offer themselves for investigation more than their role in society may justify. However, following this argument, one may expect tools and material base to be stronger represented than they are here in this study.

The strong focus on social organization, followed by religious systems and art may indeed reflect an increased archaeological interest in the subject matter per se.

On the other side, the buildings of an elite, temples, art and religious objects often constitute quite conspicuous evidence and attract public interest, and hence may more easily have generated a general interest than the less obvious forms of evidence, at least in the past. Modern studies, as those presented in this conference, use of course much more subtle forms of evidence for investigating such topics.

Commercial Relations, Trade, Political Relations and Intercultural Relations, summing up to 16,35%, are of particular interest for IT support, because such studies can benefit very much from global data integration in order to detect and compare evidence from the partners or provenance of such relations across the globe. Trading routes, in particular, are even more complex to be revealed.

However, we would rather leave it to the reader of this study to form his/her own opinion.

5.2 Analysis by Generalization of knowledge

Ranking by Generalization of Knowledge resulted in the following distribution: most questions, 339, belong to **collective behaviour**, whereas questions for **universals** are 30 and for **particulars** are 19.

We regard that the dominance of questions about **collective behaviour** is not surprising. Evidence-based reasoning always starts with particulars, but this level of description is typically found within the archaeological records, at the excavation

and observation level, and apparently not a dominant question when evaluating archaeological records afterwards. The questions about collective behaviour are typically answered by evaluating the data about sets of particulars in the archaeological records.

Particulars may appear as target in this kind of secondary research when several facts about a particular can be integrated from different sources, for instance a specific building or a particular battle. Individual persons and their doings are not easily evident in archaeology finds, some inscriptions on tombstones or inscriptions commissioned by some VIP notwithstanding. Equally difficult is revealing the history of individual mobile objects before their final deposition or discovery from archaeological evidence.

We were more surprised about the relatively few questions about **universals**, i.e., in particular typologies, which was a major topic in IT-supported archaeology in the past. There may be a shift in research interest to more complex forms of analysis.

From an IT perspective, we have the impression that current database and knowledge representation systems are rather well geared to describe the facts produced at the excavation or observation level, but are rather underdeveloped for systematically answering archaeological questions about collective behaviour directly from the facts base. In particular, the mostly implemented SQL querying paradigm does only answer first order questions in most of its variants, including SPARQL. For instance, the characteristic questions for the first appearance of some phenomenon we encountered in this study are not possible. The challenge is to normalize and integrate many possibly related facts under a common schema or better, ontology, and then to provide flexible tools for extracting deductions that then can quantitatively be evaluated. Incomplete knowledge and indirectly inferred facts, in particular the necessity of using plausibility arguments, make the normalization and integration of evidence-based facts an extremely complex task, often underestimated by IT experts.

Once homogeneous, complete and normalized data sets are available, there are enough IT tools in the archaeological practice for supporting the generation of typologies and for quantitative analysis of collective behaviour by standard means of statistical processing, as, e.g., reported in the CAA Conference series in the past years.

5.3 Analysis by parametric generalization of questions

Parametric Generalization of Questions yields a complex distribution presented in the table below. Note that percentages do add up to more than 100%. The parameters we have selected are still ad-hoc and can further be generalized. For

instance, “Culture” and “Period” and nearly synonymous, and can be treated the same in an IT system. Nevertheless, there are parameters that very apparently dominate.

Parameters can be roughly separated in **particulars** and **types**. Types are all parameters that contain the word “type”, as well as “kind of animal” and “decorative motive”. Since the kinds of studies represented here focus on collective behaviour, and typologies in general play an important epistemological role in archaeology, we expect types to be strongly represented as parameters as well. Nevertheless, particulars appear even more than types as parameters, but the categories these particulars pertain to differ strongly in frequency from those the types pertain to, as analysed below.

As to be expected, **place** and **period** are the most important constraints to archaeological questions, even though there are enough questions in which such context is given indirectly by more specific things. Periods determine both time and space, therefore, given a period, an additional constraint to a particular place is rather a refinement of the latter. If we add **culture** to period, this covers close to 60% of the questions. But also **built context** and **site** are an alternative to constraining research to a geographic place, and usually imply a time-span as well. In that case, specifying a period may be used to further constrain the phase of use of a context the research refers to. In some rarer cases, place, culture, built context and site may refer to **provenance** of things appearing at other sites and cultural **relationships** rather than to the phenomena occurring within such limits.

Surprisingly, archaeologists very rarely specify **time-spans**. This appears to be because absolute chronologies are usually debated and refined with new finds, whereas periods, cultures or phases of use of built structures have a much clearer empirical temporal identity of reference.

A less dominant particular parameter is **people**, i.e. populations of some area or social groups, with 5.2 %. All other particulars, such as **activity** (a specific battle) are below 1%. An interesting particular, among others, is **trail** (amber trail), an interesting challenge for conceptual modelling, in contrast to the mostly well-confined archaeological sites. Some of these rarer ones may stand further generalization. We have no question specifying a particular mobile object or person as parameter. This does however not mean that such questions do not appear in the course of the studies presented here internally.

Category	Number of questions	Per cent %
Place	196	50.50%
Period	187	48.20%
Object type	145	37.40%
Built context	76	19.60%
Site	60	15.50%
Built context type	50	12.90%
Culture	42	10.80%
Activity type	38	9.80%
People type	23	6.00%
People	20	5.20%
Context type	15	3.90%
Kind of animal	13	3.40%
Feature type	8	2.10%
Material type	7	1.80%
Type	7	1.80%
Time span	5	1.30%
Activity	4	1.00%
Entity type	3	0.80%
Built context feature type	2	0.50%
Conceptual object	2	0.50%
Context	2	0.50%
Cosmographic domains	2	0.50%
Motive type	2	0.50%
Spirits	2	0.50%
Actor	1	0.30%
Decorative motive	1	0.30%
Fact	1	0.30%
Function	1	0.30%
Representation type	1	0.30%
Style	1	0.30%
Terms	1	0.30%
Trade network	1	0.30%
Trail	1	0.30%
Type of transfer of custody	1	0.30%

Table 2: Distribution of questions by query parameters

We are looking now at parameters of **types**:

The parameter next in frequency to time (period, culture) and place (geographic or built context) is **object type** with 37%, pertaining to all kinds of

mobile objects, followed by **built context type** with 13%, pertaining to immobile structures. Object type very frequently appears as constraint for asking about distributions of subtypes of the specified one. Built context type is slightly rarer than the particular built context, whereas **activity type** with 10% is much more frequent than a particular activity, whereas **people type** with 6% is only slightly more frequent than particular people. Non-built contexts appear only as types. A lot of studies happened to deal with kinds of animal as sources of food, veneration and materials, whereas questions specifying material types were surprisingly rare with 2%.

Future work needs to be done to refine this picture more and in particular to analyse the specified relationships connecting these parameters.

5.4 Analysis by Target Type of Questions

Seeking the Target Type of Questions: The target type of the questions were for a large part obvious, but the most interesting questions do not easily fall into a simple category. The classical “who, when, where, what” questions cover in our classification about half of the questions. Whereas “**what thing**” is absolutely the most frequent question with 21.7%, that about persons or groups of persons (“**who (actor)**”) is among the rarest ones with 2.6%. The “when” question is more rarely asked directly (“**which time-span**”) with 3.9%, but the questions for **activities or events** amount to 10.9% and may imply a “when” something has happened.

Asking for an activity or event could also be interpreted as asking for “**how**” or “**why**”, but we have reserved the latter category for the questions pertaining to complex and composite processes. Despite that it still is the second most kind of question. Whereas questions for events or activities are easy to program, it needs further research to find out if or how IT could support answering “how” or “why” questions. May they can adequately be answered by series of more individual activities and processes. How and why are often synonymous and therefore we take it as one category. Overall, it demonstrates the importance of events and activities in the archaeological discourse, which are still poorly represented in many museum documentation systems. For instance, the popular Dublin Core format ignores events completely.

The category “**what show us/ what do we learn from**” have more the character of discovery, than asking for a specific result. They are also quite frequent, with nearly 10%. Together with “how/why”, they are an indication of the higher level of questions and answers given in research abstracts, and do not give us clues how to find out which auxiliary questions actually may lead to respective answers.

Our category of complex questions amounts to 9%. Further analysis may be able to split them into multiple questions and some other, rarer types.

Interesting is a series of questions that ask not only for a set of items, but for their distribution, in frequency, over space, but often also over time as temporal evolution. Here, these questions are not further broken down by the kind of things they pertain to, i.e., object types, context types or activity types. The reader may find these details in the description of the parametrized questions themselves. We may regard them as interest in the quantitative relations between comparable phenomena occurring at different places or times. Together with questions for other kinds of relationships they sum up to nearly 14%. They constitute a feasible challenge for IT system design. Spatiotemporal distributions can be produced by many advanced system already, but querying for other kinds of relationships cannot yet be regarded as a standard feature.

Finally, there is a small (1.80%) but distinct category of questions asking for the structure of things.

Category	Number of questions	Per cent %
What (thing)	84	21.70%
How/Why	47	12.10%
Which (activity/event)	42	10.90%
What show us/What do we learn	38	9.80%
Complex	35	9.00%
Where/Which (place)	31	8.00%
Relationships	25	6.40%
Distribution	20	5.20%
Which (time-span)	15	3.90%
Use	14	3.60%
Social Function	11	2.90%
Who (actor)	10	2.60%
Temporal Evolution	9	2.30%
Structure	7	1.80%

Table 3: Distribution of questions by target type

5.5 Analysis by Epistemological Types

Classification by Epistemological Types: As described above, we have groups the epistemological types under four major categories. The respective distribution is the following:

Category:	Number of questions:	per cent %
Descriptive questions:	120	31%
Comparison of specific types or phenomena:	22	6%

Phenomenological correlations between different categories of types:	161	42%
Interpretative conclusions:	85	22%

Table 4: Distribution of questions by query parameters

In the following paragraphs we discuss these major categories in more detail. Appendix D contains the list of all definitions of our Epistemological Types.

For the above categorization we observed that:

- **Descriptive questions** are the most simple in their structure. They refer directly to listing facts from the source records. Even though these kinds of questions are the most immediate to be answered by an information system, they constitute only 31% of the questions that characterize an archaeological research result. Characteristically, they refer to distributions of facts with respect to some parameters, but also to spatial relations. There were a few questions that cannot directly be related to objective properties of individuals, such as six questions about the lifestyle or social status of a particular group of individuals. These questions are listed in “Description of social status” subcategory. The definitions of the kinds of descriptive questions¹² are listed in Appendix E of this analysis.
- **Comparison of specific types or phenomena** is more indirect. Questions of this category refer to the similarity, difference or co-occurrence of material artefact types, object types or activity types. They refer to a multitude of parameters that may be used, depending on the underlying research hypotheses, in order to compare quantitatively or qualitatively the respective phenomena. The actual parameters do not appear in the abstracts. They imply descriptive questions about those parameters as basis. Given the parameters, information systems may effectively support these questions: Retrieved parameter lists can be fed into typical quantitative evaluation tools. This category comprises just 6% of the questions. The definitions of the kinds of comparison of specific types or phenomena questions¹³ are listed in Appendix E of this analysis.
- Most of the questions belong to the category **Phenomenological correlations between different categories of types**. This fact shows us which the issues that concerned the archaeologists were. This category comprises 42% of the questions. In this category we observed that some reverse question types belong. For example, the subcategory “From representation type to object type” and its reverse one “From object type to representation type”. Also start, ending or maximum of an activity and also appearance or

¹² https://isl.ics.forth.gr/archaeological_questions/descriptive_questions

¹³ https://isl.ics.forth.gr/archaeological_questions/comparison

disappearance of kinds of things are sought, questions that are not answered by the usual SQL-like first-order query systems. We have grouped together the above categories to a further classification (in the spreadsheet “Spatiotemporal distribution (Appearance, Disappearance, Majority) of questions of sessions A01-A08” inside the downloadable publication) in order to see the diversity of them because query systems do not give us this possibility. The definitions of the kinds of phenomenological questions¹⁴ are listed in Appendix E of this analysis.

- **Interpretative conclusions** are questions to be answered by characteristic archaeological inferences from existing evidence to non-evident phenomena, or seeking existing evidence for non-evident phenomena, and, similarly, seeking non-evident relations between evident phenomena. Interesting enough, inverted directions of inference appear systematically, even though with quite different frequency. For example “From evidence to cause” and its inverted category “From cause to evidence”, or “From product to raw material” and “From raw material to product” appears, but the inverted direction is rarer. We found only four questions (which belong to the subcategory “From activity to participants/actor”) seeking a particular actor responsible for something. These four questions are listed in the spreadsheet “Classification of questions to Epistemological categories” in the subcategory “From activity to participants/actor” inside the downloadable publication, also on the web publication on the menu “Interpretative questions” under the same subcategory. Also start, ending or maximum of an activity and also appearance or disappearance of kinds of things are sought again in this category, these questions are not answered by the usual SQL-like first-order query systems. Furthermore interpretative conclusions built on complex hypotheses and verifications of which observable phenomena in the archaeological record should be regarded as conclusive for a cause or other, not-evident phenomena. These may include intermediate studies of all the previously described categories, which can effectively supported by information systems. For finding the final interpretations of this kind, we regard current information systems as not adequate. However, all steps and reasons leading to such conclusions could and should be documented in information systems for future reuse and scrutiny. This category comprises 22% of the questions. The definitions of the kinds of interpretative questions¹⁵ are listed in Appendix E of this analysis.

¹⁴ https://isl.ics.forth.gr/archaeological_questions/phenomenological_questions

¹⁵ https://isl.ics.forth.gr/archaeological_questions/interpretative_conclusions

6. Conclusions

In this study, we have provided an empirical collection of scientific questions of archaeologists, as a corpus for further studies on the matter itself and for improving the adequacy of IT systems for archaeology.

Some of the questions are genuine as documented by the archaeologists themselves and some are inferred from research results taken as answers. As such, they do not constitute the so-called “original questions” which appear before possible answers are encountered. The latter may only be found in communication protocols or interviews during on-going studies. Nevertheless, these “a posteriori questions” reflect genuinely the topics of scientific interest.

Deliberately, we have taken the empirical material from the process of “evaluating the archaeological record”, i.e., working of the documented results of excavations and other field studies. This is most adequate to understand how IT systems should provide access to primary archaeological documentation, in particular *facts integrated from many sources*. As such, it does not represent the questions an archaeologist has during the field work, such as the alignment of stratigraphy, finding wholes of parts etc. Such questions may be inferred from the rich sets of highly dedicated tools that have been developed for these purposes.

We have taken these questions from research abstracts, i.e., finished research results. As such, they do not reflect all the wealth of auxiliary questions that appear in the course of research, which we expect to concentrate more on the particular and detail of things and contexts. Interpreters of this material need to be aware of that. However, the presented material itself reveals in some way different stages of the interpretative reasoning chain, which we have tried to represent by our “epistemological types” and their order of presentation.

We have engaged in and presented an initial epistemological analysis already, in particular with respect to the kind of IT support that may be apparent or not. We have analysed questions of subject coverage, entities of interest, interpretative processes and query structures. Further studies may refine and deepen quite substantially this analysis. In the sequence it seems to us of very high interest to use this material for conceptual modelling of an ontology that represents the relationships appearing directly or indirectly in these questions and the abstracts themselves as a core requisite for further IT system design. Most adequate would be to use the CIDOC CRM as a starting point.

Appendix A - Definitions for Categories of Human Activities

These classification terms pertain to kinds of human activities and needs directly or indirectly-causally related to the phenomena the question is about. They are not result of a mature philosophical theory but a humble attempt of creating an intuitive order for future discussions.

- **Aesthetic needs:** This term pertains to activities that satisfy subjective and sensory-emotional values of beauty and taste with the creation or appreciation of beauty, be it by the design or formation of the material environment beyond the purely utilitarian, the creation of objects or decorations, by performances or access to natural things and environments of aesthetic value.
- **Archaeological process:** This term pertains to the characteristics and methods of the archaeological process itself rather than its findings.
- **Art:** This term pertains to activities regarded as producing or being art, regardless if of primary or secondary religious or social function. **broader term:** Aesthetic needs.
- **Belief system:** This term pertains to manifestations of beliefs about laws of nature and other, intellectual or spiritual principles governing the world and afterlife, about spiritual and religious beings and phenomena, ethical demands, cosmogony and eschatology.
- **Burial system:** This term pertains to methods and ceremonies of burial. Beyond practical needs. It is a manifestation of the **broader term:** Belief System.
- **Commercial relations:** This term pertains to activities dealing with the acquisition, storage and transport of goods for distribution to third parties against economic compensation. Includes logistics, trade routes, and the respective human communications and agreements, in particular between independent communities.
- **Cosmological System:** This term pertains to beliefs about the structure and governing principles or agents of the universe. **Broader term:** Belief system
- **Economy:** This term pertains to interactions and methods regulating obligations from service provisions and taxation either based on a monetary system or another accounting system of equivalence of value of goods and services. **Broader term:** Social Organisation
- **Ecosystem:** This term pertains to the interactions of people with the non-human-made animate and inanimate physical world around them and its

influence on populations, including cultivated areas and modified water resources.

- **Expertise (Know how):** This term pertains to methods and skills in treating or producing material things for whatever purpose, as well as agricultural methods and ways to control or change the environment. **Broader term:** Material base.
- **Intercultural relations:** This term pertains to exchanges and influences between independent communities on a cultural level, i.e. know-how, styles, political ideas, beliefs etc.
- **Material base:** This term pertains to activities and know-how dealing with material needs of food and eating, shelter, health, including production of food, tools, vehicles, buildings. It includes whatever technology to shape or produce material items. It includes modifying or protecting environment and nature.
- **Political relations:** This term pertains to diplomatic interactions between independent or semi-independent communities regulating common interests and competition for resources. It includes relations with tributaries.
- **Psychological self-understanding:** This term pertains to manifestations of the self-understanding of people as part of their environment.
- **Religious system:** This term pertains to the institutions, agents and ceremonies of an established religion. **Broader term:** Social Organisation
- **Social organization:** This term pertains to institutionalized social relationships and organisation, regulating social interactions between people and their interests, systems of power, their agents and activities, division of labour, military service etc.
- **Technology:** This term pertains to explicit methods in treating or producing material things for whatever purpose. **Broader term:** Expertise (know-how)
- **Tools:** This term pertains to the use and production of devices, especially ones held in the hand, for carrying out a particular function in mechanical processes.
- **Trade:** This term pertains to activities dealing with the acquisition, storage and transport of goods for distribution to third parties against economic compensation. **Broader term:** Commercial relations
- **War:** This term pertains to violent interactions between communities in competition for resources and domination.

The above categorization is also available in the [Glossary](#)¹⁶ on the web publication.

¹⁶ https://isl.ics.forth.gr/archaeological_questions/human_activity

Appendix B - Levels of generalization of knowledge

These are the three terms characterizing the relation of abstraction of a question from the material facts constituting the observable reality.

- **Particular:** This term classifies questions about properties, identity or existence of particular items, be it a person, a social group, an activity, an object or a building.
- **Collective behaviour:** This term classifies questions about dedicated kinds of activities of specific social groups or communities in some area and for some time, either directly about the activities or by considering their effects and products or remaining evidence.
- **Universal:** This term classifies questions about general human behaviour or kinds of processes and their kinds of effects, even if they became evident only in specific times and contexts.

The above categorization is also available in the [Glossary](#)¹⁷ on the web publication.

Appendix C - Definitions for Parameter Types of Questions

This is a list of kinds of elements in the questions analysed in this study that been generalized from the specific.

- **Activity:** This stands for some particular intentional action or interaction, such as producing one thing, but also extended ones, such as a complex ceremony, a battle or building a house.
- **Activity type:** This stands for a kind of activity, such as producing a kind of tool, cultivating a kind of crops, trading goods, holding specific kinds of ceremonies, typically by multiple, unknown actors.
- **Actor:** This stands for an identifiable person, individual social group or community, such as the inhabitants of a settlement.
- **Built context:** This stands for a coherent built structure, be it a room, a building, a mound, a built complex or complete settlements, such as houses, graves, cities.

¹⁷ https://isl.ics.forth.gr/archaeological_questions/levels

- **Built context feature type:** This stands for a kind of feature being part of a built context, such as doors, columns, rooms, streets, boundaries and thresholds.
- **Built context type:** This stands for kinds of built contexts, such as workshops, castles, villages.
- **Conceptual object:** This stands for an identifiable immaterial item, such as a text, an idea, a belief.
- **Context type:** This stands kinds of physical environment in which processes and activities of interest have happened, such as caves.
- **Cosmographic domains:** This stands for cosmographic domains such as earth, sky or underworld.
- **Culture:** This stands for a specific population extended over some area and time, exhibiting cultural unity in their activities, habits and kinds of products, such as Trojan or Paleo-Eskimo Dorset.
- **Decorative motive:** This stands for a pattern repeatedly used for decorative purposes. It might be abstract, such as a cross, or represent something material, such as a wine rank.
- **Entity type:** This stands for any kind of individual entity, being material or immaterial, animate or inanimate, such as animals.
- **Fact:** This stands for a particular fact, such as the fact that women were members of ancient cults.
- **Feature type:** This stands for a kind of feature found on some material things, such as faces or body ornamenting items.
- **Function:** This stands for a function, which may either be a repeated activity specified in terms relative to the expected utility in a technical or social environment, such as “eating”, an affordance such as “for sitting”, or a kind of event to be protected from, such as “shelter from rain”.
- **Kind of animal:** This stands for a kind of animal, be it a particular species, genus, or a category determined by human use, such as food or helping transport.
- **Material type:** This stands for a kind of physical material something was made from, used in a process, found, produced or traded, such as iron or ivory or kinds of bones.
- **Motive type:** This stands for a kind of depicted, figural or decorative motive such as linear patterns.
- **Object type:** This stands for a kind of material object, be it with respect to form, function or kind of structure, material or construction.
- **People:** This stands for a particular person, population or social group, such as prehistoric people.

- **People type:** This stands for collectives of people in some time and area defined by some common characteristics of its individuals, such as Nomadic people.
- **Period:** This stands for a particular period limited in time and space, often characterized by an established archaeological term, such as the thirty year's war in Czech Republic.
- **Place:** This stand for a particular geographic area of any size, even as small as parts of a building, such as Northeast Canada.
- **Representation type:** This stand for a way of visually representing some theme or kind of thing, such as a human body, a plant species or an animal species.
- **Site:** This stands for a particular archaeological site, such as the Igloolik sites in Nunavut at Canada.
- **Spirits:** This stands for a particular spiritual being, such as a deity.
- **Style:** This stands for a particular style, such as the European classicism style.
- **Terms:** This stands for terms, such as names for ceramic vessels based on human body parts.
- **Time span:** This stands for a particular time-span, such as the year i.e. 1631.
- **Trade network:** This stands for a particular trade network, such as the amber's trade network.
- **Trail:** This stands for a path connecting canters of social or commercial interest of or spaces of natural resources.
- **Type:** This stands for a term defining some category such as a type of an object.
- **Type of transfer of custody:** This stands for ways in which the physical control of things has gone into other hands, such as looted things from the wars.

The above categorization is also available in the [Glossary](#)¹⁸ on the web publication.

¹⁸ https://isl.ics.forth.gr/archaeological_questions/parameters

Appendix D - Definitions for Target Type of Questions

In each spreadsheet of “Classifications per question of sessions A01-A08” exists a column which refers to “Target type of question form”. Here we mention all the categories.

Namely:

- **What (thing):** this term characterizes questions which expect as answer a list of one or more material things or kinds of things, as specified by the parameters of the question.
- **Who (actor):** this term characterizes questions which expect as answer an actor or kind of actor, as specified by the parameters of the question.
- **Which (activity/event):** this term characterizes questions which expect as answer an activity or an event, as specified by the parameters of the question.
- **Which (time-span):** this term characterizes questions which expect as answer a time span, as specified by the parameters of the question.
- **Where/which (place):** this term characterizes questions which expect as answer a place or a site, as specified by the parameters of the question.
- **How/Why:** this term characterizes questions which ask for the reason why or how something has happened or has evolved.
- **Use:** this term characterizes questions which ask for the kind of use of kinds of things.
- **Distribution:** this term characterizes questions which ask for the distribution of types of a certain category depending on parameters, such as object types or activity types over time or certain places.
- **What show us / what do we learn:** this term characterizes questions which expect as answer an extended interpretation of archaeological finds.
- **Temporal evolution:** this term characterizes questions which ask for the temporal evolution or changes of the appearance of object types or other kinds of phenomena.
- **Structure:** this term characterizes questions which ask for the volume, the structure or the constructions of built works.
- **Relationships:** this term characterizes questions which ask for relationships or connections between things or kinds of things or other phenomena.
- **Social function:** this term characterizes questions which ask for the social function or the role of some things or kinds of kinds or activities.
- **Epistemological:** this term characterizes just one question which asks for the scientific method used for the research, rather than the subject matter of the research itself.

- **Complex:** this term characterizes questions which ask for complex interpretations.

The above categorization is also available in the [Glossary](#)¹⁹ on the web publication.

Appendix E - Definitions of Epistemological Types

This text presents the definitions of the Epistemological Types we have used to classify the parametrized questions and to organize a comprehensive overview in the spreadsheet “Classification of questions to epistemological Types”, which presents all the extracted and parametrized questions from chapters A01 to A08 of [session A01: «4000 years of world career – amber from the Neolithic to Iron Age» of the 19th EAA Annual Meeting](#)²⁰. As described in section 5.5 above, the categorization we apply is based on a first approximation of the epistemological process behind the relationships that appear in the questions.

We have generalized the epistemological types by four major categories:

- **Descriptive questions**, which are more simple in their structure and they refer to listing facts in the source material. Specifically they refer to the distribution of facts with respect to some parameters. These questions describe material artefact types or other types of things restricted by some constraints. They just refer to the phenomenological distribution of types and do not describe causes nor do they lead to any conclusion.
- **Comparison of specific types or phenomena.** In this category we made a distinction of material artefacts types and activity types. Also in this category questions refer to the co-occurrence of object types, to similarity or difference of belief systems or to the similarity of cultures and social status.
- **Phenomenological correlations between different categories of types.** In this category questions refer to correlations between specific object types, activity types or representation types with other types without explaining causes. Also here belong many questions which reveal start or ending or the maximum of concentration of object types, also appearance or disappearance of kinds of things are sought.

¹⁹ https://isl.ics.forth.gr/archaeological_questions/form_types

²⁰ <http://proposal.eaa2013.cz/programme/theme.php?theme=Interpreting%20the%20Archaeological%20Record>

- **Interpretative conclusions.** In this category we end up with some conclusions which come from observations of evidence. The questions which belong in this category show us causality.

The following are the definitions of the Epistemological Types themselves:

Descriptive questions:

- **Discrimination of material artefact types constrained by super type/place/period/context type:** This category contains questions which refer to material artefact types, object types and built context types constrained by place, period, context type and supertype.
- **Discrimination of material artifact types, constrained by activity type/super type/place/period/context type (note: activity types are inferred and not evidential):** This category contains questions which refer to material artefact types constrained by place, period, supertype, context type and activity types which are inferred and not evidential.
- **Discrimination of other types, constrained by place/period/context type:** This category contains questions which refer to other types (such as feature types or activity types) constrained by of place, period or context type.
- **Distribution patterns of object/context type:** This category contains questions which refer to distribution patterns of object types or context types.
- **Distribution patterns of activity type:** This category contains questions which refer to distribution patterns of activity types.
- **Spatial distribution of activity type:** This category contains questions which refer to the spatial distribution of activity types such as battles of war.
- **Spatial distribution of object/context type:** This category contains questions which refer to the spatial distribution of object types or built context types.
- **Temporal distribution of object/context type:** This category comprises of questions which refer to temporal distribution of object types or built context types.
- **Temporal distribution of activity type in time:** This category contains questions which refer to the temporal evolution of activity types in time.
- **Spatial relations:** This category contains questions which refer to spatial relations of built context types.
- **Description of social status:** This category contains questions which refer to the lifestyle, social status and the social role of people in specific places and period.

- **Structure of built context type (analysis):** This category contains questions which refer to the construction, the volume, the morphology or the structure of built context types.
- **Place of activity:** This category contains questions which refer to the place of activity and specifically to the place of battles.

Comparison of specific types or phenomena:

- **Distinction of material artefact types by comparing provenance:** This category contains questions which refer to the distinction between material artefact types by comparing their provenance.
- **Distinction of activity types:** This category contains questions which refer to the distinction of activity types and specifically to similarities and differences between them.
- **Co-occurrence of object types:** This category contains questions seeking object types which existed together in some activities or inside built contexts.
- **Similarity of object types (at different places):** This category contains questions seeking the similarity of object types at different places.
- **Similarity/difference of belief systems:** This category contains questions seeking similarities and differences of belief systems which were shared by people.
- **Similarity of culture (activity types):** This category contains questions which refer to similarity of cultures.
- **Similarity of social status:** This category contains just one question which refers to the differences in the social status of owners of houses.

Phenomenological correlations between different categories of types:

- **From activity type to place:** This category contains questions which seek places in which activity types took place.
- **Trade routes: (From activity to place):** This category contains questions which seek the trade routes which object types followed to reach a place.
- **From representation type to object type:** This category contains questions which seek the relationships of given object types to types of representation depicted on such objects.
- **From object type to representation type (motives or symbolic values):** This category contains questions which seek representation types which were depicted on object types. This category is the inverted of the above category.
- **From object type to context type:** This category contains questions which seek the context type in which discovered or appeared object types.

- **From object type/context type to activity type:** This category contains questions which seek object types or context types which were used for activity types.
- **From object type to the type of the whole object:** This category contains just one question which seeks the parts of a context type which existed in a place during a specific period.
- **From object type to undefined:** This category contains questions which seek more general information about object types, context types or built context types.
- **From object type to significant functional properties:** This category contains questions which seek the significant functional properties which some object types or built context types had.
- **From object type to place (find, creation, use, origin):** This category contains questions which seek the place of find, of creation, of use or the place of origin of object types or built context types.
- **From object type to object property:** This category contains just one question which seeks the materials by which the majority of built context types were constructed.
- **From object type to time:** This category contains questions which seek the time span in which object types appeared, disappeared, produced or developed in places.
- **From activity type to time:** This category contains questions which seek the time span in which activity types appeared or began in places.

Interpretative conclusions of causes:

- **From evidence to cause:** This category contains questions which seek the cause by which an event happened.
- **From cause to evidence:** This category contains questions which seek the evidence which inform us about the cause of their existence.
- **From change to cause:** This category contains questions which seek the cause by which a change happened.
- **From product to raw material:** This category contains just one question which seeks the information which we get about the raw materials from the presence of object types in a specific place.
- **From raw material to product:** This category contains questions which seek the raw materials by which products were made of.
- **From activity (type) to cause (as cause we regard purpose and motivations):** This category contains questions which seek the cause by which activity or activity types happened.

- **From activity type to object type:** This category contains questions which seek object types which were necessary for some activity types.
- **From activity type to actor type:** This category contains questions which seek societies which used or did not use context types for their activities.
- **From activity to participants/actor:** This category contains questions which seek actors by whom activities were done.
- **From actor type to activity type:** This category contains questions which seek the activity types which were made by actor types.
- **From object type to actor type (including spiritual beings regarded to be present among the living):** This category contains questions which seek the object types or built context types which belong to actor types or have a relation with them.
- **From actor type to object type:** This category contains questions which seek the object types which related to actor types.
- **From symbols to actor type:** This category contains just one question which seeks the actor types by whom symbols were intended to be read and understood.
- **From space to social relevance:** This category contains questions which seek the relation between space and people.
- **From goal to activity type:** This category contains just one question which seeks the activity types which people made in order to succeed their goals.
- **From people to social status:** This category contains just one question which seeks the social status of a specific group of people.

The above categorization is also available in the Glossary²¹ of the web publication.

²¹ https://isl.ics.forth.gr/archaeological_questions/categories