Towards the Representation of Claims in Ontologies for the Digital Humanities

Salvatore Cristofaro[1], Emilio M. Sanfilippo[2]
Pietro Sichera[1], and Daria Spampinato[1]

[1] Institute of Cognitive Sciences and Technologies - CNR,
via Paolo Gaifami 18, 95126 Catania, Italy
{salvatore.cristofaro,pietro.sichera}@istc.cnr.it,
daria.spampinato@cnr.it
[2] Institute of Cognitive Sciences and Technologies - CNR
Laboratory for Applied Ontology,
via alla Cascata 56/C, 38123 Trento, Italy
emilio.sanfilippo@cnr.it

Abstract. Knowledge and data in the human sciences are sometimes expressed in hypothetical or even incompatible terms. One wonders therefore how to make sense of them in ontological modeling frameworks. Accordingly, we present in the paper some preliminary ideas to make ontologies for the Digital Humanities able to deal with hypothetical and incompatible scholarly statements, which we call *claims*. Our proposal builds on existing works in the state of the art. The results are still preliminary; the contribution is more on the definition of the problem and identification of the challenges rather than on the modeling itself, therefore future work to strengthen our proposal is necessary.

Keywords: Ontology · Uncertainty · Claims · Digital Humanities · Cultural Heritage · Vincenzo Bellini

1 Introduction

Research in the humanities, especially when focused on the study of past epochs, is often based on *partial* or *uncertain* data. Simple examples are persons' biographical elements such as birth or death dates. For instance, we know that Dante was born between May 21st and June 21st, 1265 although we do not currently know the exact birth date. In some other cases, we even have less precise information knowing, e.g., only the century in which something happened. There are plenty of similar examples including hypothetical knowledge about, e.g., artworks' authorship, cities' names or their archaeological provenance, just to mention some common examples [9]. In all these cases, data are the outcomes of research enterprises which are carried out on the basis of the available empirical evidence; still, the results remain hypothetical and they sometimes need to be expressed in probabilistic terms [10]. In addition, scholars may make *incompatible* hypotheses about the same phenomena. For instance, on the basis

of research, a scholar may infer that Dante was born on a certain day whereas another scholar may bring evidence but for a different date. Hence, to make sense of experts' knowledge, ontologies for the Digital Humanities (DH) need to find ways to accommodate the representation of hypothetical and incompatible scholarly statements, which we will call *claims* throughout the paper.

We address in the following some preliminary and ongoing research work related to these topics. In particular, by reviewing the state of the art, we rely on the work presented by Carriero et al. [3] to explicitly address the representation of hypothetical and contrasting data. We will also discuss some challenges which require further work to reach a higher modeling robustness.

The paper is organized as follows. In Sect. 2 we report on some examples of data collecting and organization, stressing the need for a framework addressing the representation of hypothetical/incompatible data. Relevant related works are reviewed in Sect. 3. We present in Sect. 4 an analysis of how to represent scholarly claims, which is further elaborated in Sect. 5. Sect. 6 concludes the paper.

2 Motivations and background

To exemplify the discussion about the modeling of hypothetical and incompatible knowledge and data in the Digital Humanities, we report here on some examples and data collected during a research project at the Belliniano Civic Museum of Catania (Italy) called *Museo Virtuale della musica BellinInRete* (BellinInRete hereafter) [6].

The Museum preserves different kinds of objects related to the composer Vincenzo Bellini (1801-1835). One of the main goals of BellinInRete is to digitalize data about the cultural heritage preserved in the Museum in order to, first, facilitate the management of the data; second, to make it available – through the Web – to both scholars and the general public. The use of Semantic Web (SW) technologies is a desiderata for these goals but also to make more explicit the intended meaning of the data. In addition, we think that BellinInRete would benefit from both the exploitation of the reasoning mechanisms of SW languages like the Web Ontology Language (OWL) and their use to make the data compliant with the FAIR principles [16].

A first attempt to model the heritage items preserved in the Belliniano Civic Museum via SW ontologies has been undertaken within BellinInRete by relying on the standard RDA cataloging framework, see [4]. More recently, an initial ontology inspired by CIDOC-CRM [1], namely OntoBelliniLetters [5], has been proposed (and is currently under refinement) concerning the organization of a corpus of letters of Vincenzo Bellini (and held by the Museum as well).[3]

[3] Within the project BellinInRete, a digital edition of Bellini's letters is carefully realized using the XML-based Text Encoding Initiative (TEI) for text markup and digitization (`http://licodemo.ilc.cnr.it/bellini-in-rete/`). This effort represents a relevant part of the project.

Some of the data provided by the domain experts involved in the project are expressed by including different confidence degrees. In particular, this is the case of information about the dating of paper documents such as letters or musical scores but also paintings and posters, among other objects. As mentioned in the introduction, dates attributed to these items (e.g., when a letter was written by Bellini) are sometimes just approximated and hypothetical. For instance, to mention a simple case, one may not know the exact date when a poster advertising a performance was printed. However, if the poster reports the performance's date, one can at least infer that the poster was printed at some time before that date.[4] To mention another example, although a letter may not specify the date when (or the place where) it was written, the postmark may provide information about when it was sent, a piece of data from which scholars can make hypotheses about when the letter was approximately written.[5]

From a knowledge representation perspective, what is required in our understanding is a modeling framework allowing domain experts to specify explicitly their claims and the degrees of confidence of such claims about the investigated phenomena. In our view, therefore, the framework should satisfy – at least – the following requirements:

R1: It needs to allow for the explicit representation of both certain and uncertain data, as well as the representation of conflicting data;
R2: It needs to allow for the representation of meta-data about claims, e.g., who made the claim, when, and which confidence degree it bears (probable, improbable, etc.), among others.

In addition, as technological requirement, considering the wide use of the SW in nowadays applications, the framework should be manageable through SW languages and technologies (R3).

We explore in the next sections the development of such a framework by commenting on the state of the art and identifying some challenges for future work.

3 State of the art analysis

We have seen above that knowledge and data in the human sciences are often expressed in uncertain terms. It is not therefore surprising that existing works in the DH have already explored various manners to express uncertainty.

In application contexts dealing with the digital representation of text documents, the XML-based Text Encoding Initiative (TEI) allows modeling uncertainty by means of (combinations of) dedicated markup tags as reported in the

[4] This is the case of the poster with inventory number CT0031_S_19 advertising a commemorative performance celebrating the centenary of Bellini's death.

[5] For instance, the date reported on the letter with inventory number CT0031_LL1.9 (a letter written in Naples by Bellini and addressed to Giovanni Battista Perucchini) does not include any month information. However, from the postmark, we know that it was sent in January.

TEI guidelines.[6] This approach is useful to annotate digital texts although it is less relevant for our purposes.

In scenarios explicitly addressing the definition of knowledge or data models, it is worth mentioning the extension of CIDOC-CRM [1] called CRMinf [15]. The purpose of this latter ontology is to represent meta-data of argumentation processes such as *inference making* resulting in *beliefs* with *belief values*. Examples of belief values are *true* and *false*, although the space of values can be enlarged. For instance, mimicking the value of a fuzzy logic, one may express any real number within the interval $[0, 1]$ (see [13]). The contents of beliefs, i.e., what beliefs say, called *proposition set*, as well as the premises which one assumes to infer a belief are all intended as CIDOC-CRM's *information objects*, i.e., descriptions which exist independently from specific supports. For example, one may represent a particular inference making process reaching the belief with (i) proposition set 'Dante was born between May 21st, 1265 and June 21st, 1265' and (ii) belief value *probable*. In addition, the ontology covers the class *Inference Logic* for "the rules used as inputs to [...] Inference Making" [15, p.10]. It should be clear that CRMinf is meant to *document* reasoning procedures for logical derivations but, since it is only informally specified, it cannot formally express them.

In the work of Carriero et al. [3] relative to the development of a SW ontology for cultural heritage, the authors rely on the ontology called *Descriptions and Situations* (D&S) [8] for representing scholarly attributions; e.g., the attribution of authorship to a document. A *situation* is a portion of reality whose constituting entities stand in some relations and satisfy a *description* (i.e., an information object, see [14]). Some situations, called *interpretations*, bear an epistemological nature because they do not represent domain entities as they are but as they are conceived and characterized by domain experts. For instance, the situation in which a person is attributed to a book in the role of author is an interpretation, an "epistemological fact", based on some (possibly partial) scholarly evidence.

A different approach is proposed by Martin-Rodilla et al. [10] based on fuzzy logic. The authors have also proposed a manner to represent fuzzy values in conceptual models [9]. By relying on fuzzy logic, this proposal allows to express the degree of truth of data in a precise manner (which can be also approximated in qualitative terms, as the authors show). Differently from both CRMinf and Carriero et al. [3], however, the authors do not characterize the attribution of uncertainty values, e.g., in terms of who made it, when, etc.

We will see in the next sections how the approaches of CRMinf and Carriero et al.[3] could be exploited to represent uncertain but also conflicting claims. Also, although the use of non-classic logics seems better suited to deal with partial or probable knowledge, differently from Martin-Rodilla et al. [10], we stick on classical logic to facilitate the use of SW technologies in future works.

[6] `https://tei-c.org/release/doc/tei-p5-doc/en/html/CE.html`, last accessed in June 2021.

4 A modeling proposal based on claims

We can consider an ontology as a representation about which things exist in an application domain, how they are related and characterized. Alternatively, an ontology stands for a representation of a domain as this is understood by some agents (domain experts, typically) within a certain context. Let us call *realism* and *descriptivism* these two approaches, respectively (see [11]). As common practice in ontology engineering, the assumptions behind the two approaches do not necessarily find an explicit place in ontologies.

To make an example, consider a relation like *bornAt* holding between a person and the time when she was born. From an ontology modeling perspective, it can be represented in different ways. An approach, inspired by ontologies like DOLCE [11] or CIDOC-CRM [1], could be provided by formulas like (1-2) (we do not mean to provide an exhaustive formal representation but to introduce some examples to exemplify the discussion). Formula (1) introduces the primitive predicate $broughtIntoLife(e, x, t)$ saying that the event e brought person x into life at time t.

$$broughtIntoLife(e, x, t) \rightarrow Event(e) \wedge Person(x) \wedge Time(t) \tag{1}$$

This predicate is used in (2) by which $bornAt(x, t)$ means that there was an event, namely, a birth event, bringing x into life at t.[7]

$$bornAt(x, t) \leftrightarrow \exists e(broughtIntoLife(e, x, t)) \tag{2}$$

Further restrictions can be used to characterize the event's time, e.g., to specify that it cannot span across days, months or years.[8] From a realist perspective, the formulas are meant to describe how reality is. In the descriptivism view, they tell how experts conceive reality. In both cases, however, reference to either plain reality or experts' conceptualization remains at the meta-modeling level, and these assumptions are not reflected in the formulas.

Assume now that we do not know the exact date when someone was born. To mention an example from BellinInRete, it is not certain that Francesco Ferlito, Vincenzo Bellini's uncle, was born in 1770. In this case, we are not only interested in saying that there was an event which brought Ferlito into life (either in the realist or descriptivism sense). We need to make explicit reference to what domain experts think and, in particular, we need to represent the association between Ferlito and his birth time as an *hypothetical assessment*, i.e., a (sound) belief about when he was born. As said in the previous sections, the representation of hypotheses plays a relevant role in the human sciences (and not only of course), e.g., because scholars have only partial data about domain entities.

A way to handle similar scenarios may be via the explicit introduction of *claims*. The idea is to represent some of the properties characterizing domain

[7] Recall that ontologies like DOLCE [11] or CIDOC-CRM [1] allow representing data values, including dates, according to value spaces (called *quality spaces* in DOLCE).

[8] A degree of approximation is commonly employed when representing dates. As a matter of fact, one seldom represents the exact moment when someone was born.

entities from an explicit descriptivist and epistemological perspective. For instance, recalling the example above, this view may lead to a formula like (3), where $bornAt(x, t, c)$ is now a ternary predicate read as 'person x was born at time t *according to* claim c'.

$$bornAt(x, t, c) \leftrightarrow Claim(c) \wedge \exists e(broughtIntoLife(e, x) \wedge assigns(c, t, e)) \quad (3)$$

Intuitively, $bornAt(x, t)$ in formula (2) expresses a direct link between a person and her birth event's time, whereas $bornAt(x, t, c)$ in (3) bears an "epistemological flavor" saying that the relation $bornAt$ between x and t holds only because of claim c. In a sense, the predicate $bornAt$ is "relativized" to the claim, hence it expresses an hypothesis about the phenomena. Note that the formula employs the (primitive) relation $assigns(c, t, e)$ saying that 'claim c assigns time t to the event e.' Also, $broughtIntoLife$, differently from formula (1), is now a binary relation between an event and a person (for simplicity, we do not formally introduce this new predicate), because the link between the event and the time when the event is supposed to have occurred is asserted only via the claim.

In our understanding, a modeling approach on these lines could turn useful to make explicit the dependency of some data on intentional attributions, recalling the requirements mentioned in Sect. 2. In the next section, we dig into the notion of claim addressing some modeling challenges for its representation in ontologies, including the relation between, say, "claimed-" and "regular-" predicates (e.g., $bornAt$ in (3), and $bornAt$ in (2), respectively).

5 Discussion on claims

In order to put forward the introduction of claims, we shall say more about how they could be conceived, also with respect to existing ontological frameworks. Since our research is still preliminary, we address some proposals and challenges which need to be further investigated to reach a higher robustness.

Claims wrt the state of the art. We understand claims as entities that (i) result from scholarly investigations, (ii) bear epistemological values (see below), (iii) are accessible in an inter-subjective manner, (iv) can be collaboratively formulated by multiple scholars, and (v) depend on their creators. Thus, different scholars can express – independently from each other – similar but not identical claims. In addition, (vi) there can be conflicting claims about the same phenomena; e.g., the impresario Alessandro Lanari was born in 1790 according to Seminara (see [2, p. 201]), and in 1787 according to the data reported in VIAF.[9] Finally, it seems reasonable to consider claims as (vii) static entities which can persist through time but cannot change. For example, if scholar s formulates claim c at time t about document d attributing it to author a, then, if at a later time t' s attributes the authorship of d to a different author a', s creates a new claim c' which entertains various relations with c (e.g., being about the same document d, being produced by the same scholar s, being a revision of c, etc.).

[9] `http://viaf.org/viaf/30590930`, last accessed in June 2021.

There are some analogies but also relevant differences between our ideas and what done by CRMinf [15]. First, CRMinf's *beliefs* are temporal entities. To quote from [15, p.11], "[t]his can be understood as the period of time that an individual [agent] or group [of agents] holds a particular set of propositions to be true, false or somewhere in between". Claims stand on a more abstract level, since we do not mean to represent a temporal entity in which an agent holds an hypothesis, e.g., the state in which agent a thinks that Alessandro Lanari was born in 1790; rather, we focus on the hypothesis itself. In this sense, claims are more similar to CRMinf's *proposition sets*. Clearly, one can introduce the time in which a claim is created, as well as its creation event or the state in which someone holds the claim. Second, we agree with CRMinf in that claims depend on their creators, which can be single agents (*actors* in CIDOC-CRM's terminology) or groups.

Carriero et al. [3] express scholarly attributions via the representation of *interpretations* (i.e., facts with an epistemological status). As a working hypothesis, claims could be understood as specific types of descriptions (in the sense of [3]) satisfying the conditions mentioned at the beginning of this section. In particular, when a claim assigns a property to an entity, e.g., a birth date to a person or authorship to a document, there is a corresponding interpretation representing the epistemological fact in which the entity satisfies that property (see below for discussion and examples).

The conceptual model. Following Carriero et al.'s [3], the diagram in Fig. 1 illustrates (in a preliminary manner) how our approach may work (classes in yellow are taken from [3]). More precisely, the conceptual model is based on the ontology called ArCo context description and its modeling pattern for representing situations.[10]

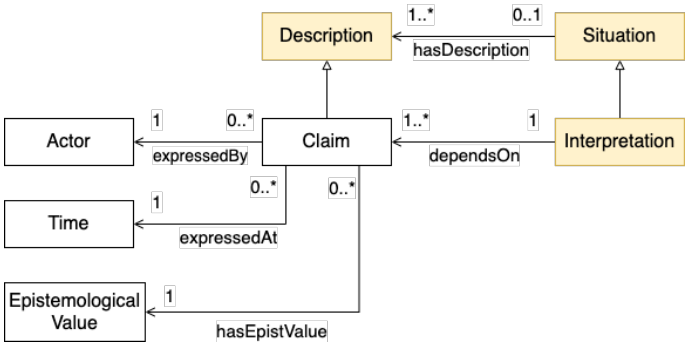

Fig. 1. Preliminary modeling of claims based on Carriero et al. [3].

[10] The ontology is available at `https://w3id.org/arco/ontology/context-description/1.2`; the situation-pattern can be found at `http://www.ontologydesignpatterns.org/cp/owl/situation.owl` (both resources last accessed in June 2021).

Considering the diagram in the figure, the relation *hasDescription*, here used between *Situation* and *Description*,[11] tells that a situation is the state of affairs corresponding to (*satisfying*) what the description describes. For instance, for the description d telling that Lanari was born in 1790, the situation satisfying d is constituted by Lanari exemplifying the property of *being born in 1790*. The relation *is situation of* (and its inverse *has situation*; not shown in the diagram) is used to link a situation to its constituting elements. Recall that situations in [3] are the ontological counterparts for *reified relations* in languages like OWL which do not support the representation of predicates with arity higher than two (see [3, p.20]). In the context of [3], therefore, the relation *is situation of* can be seen as the link between a reified relation and its arguments. As said, the *Interpretation* class models situations with an epistemological grounding, hence, they exist because of interpretation criteria (represented in [3] by the class *Interpretation Criterion*) identifying them. These criteria share some similarity with our notion of claim. The authors do not however specify, e.g., whether the identity of interpretation criteria is bound to their creators or whether they can change in time while maintaining their identity. This is the reason why we subsume *Claim* under *Description* rather than extending *Interpretation Criterion* (which indeed does not appear in Fig. 1). We use the relation *dependsOn* to stress that interpretations require claims to exist. Its cardinality is *one-to-many* on the side of *Claim*; this is because a situation may correspond to multiple claims which state the same fact but differ with respect to their creators. Claims attributing different or even incompatible properties to the same entities pose some challenges which we will address later in this section.

Concerning *epistemological values*, intuitively, one may need to say that a claim bears a certain level of uncertainty. Recall that classical logic is *bivalent*, i.e., (logical) propositions are either true or false (and nothing more). This could pose some limits for representing claims, and an approach based on the use of non-classical logics would be likely more suited, e.g., along the lines of what done by Martin-Rodilla et al. [10]. On the other hand, as said, the use of classical logic allows using SW technologies for knowledge representation and reasoning, which is a desiderata in nowadays DH application scenarios and in our project(s) as well (requirement R3, Sect. 2)

A way to handle epistemological values in a modeling framework based on classical logic could be done on the lines of CRMinf (see Sect. 3). For instance, one may introduce a class for (sorts of) epistemological characteristics, i.e., *Epistemological Value* in Fig. 1, expressing either qualitative values only (similarly to [7,9]) or more precise quantitative metrics.[12] The manner in which these values are established is meta-information remaining out of the scope of the ontology; that is, we assume that a scholar decides which epistemological value a claim bears with respect to the adopted research methodology. We are aware that

[11] Domain and range for *hasDescription* are not specified in ArCo context description. At first glance, this relation generalizes the relation *satisfies* used in D&S [8].

[12] The representation of epistemological values can be refined by adopting an approach similar to DOLCE [11] to model values in terms of *quality spaces*.

this is only a simple way to "mimic" non-classical truth-values. In a sense, our proposal is a trade-off between modeling needs and technological requirements.

Finally, as the terminology suggests, relations between *Claim*, *Actor*, and *Time* are simple links to relate claims to the actor (single person or group) who made the claim and the time at which the claim is expressed, respectively.

Figure 2 represents an exemplification of the diagram above to a specific claim by which Alessandro Lanari was born in 1790 according to Seminara such that the claim has epistemological value *probable* and was expressed at a certain time. Since we represent the attribution of a birth date, both the claim and the resulting interpretation are called – following [3] – *dating* claim and interpretation. Also, the relation *is dating of* is used in [3] to explicitly link a dating interpretation to the person to which it is about.[13]

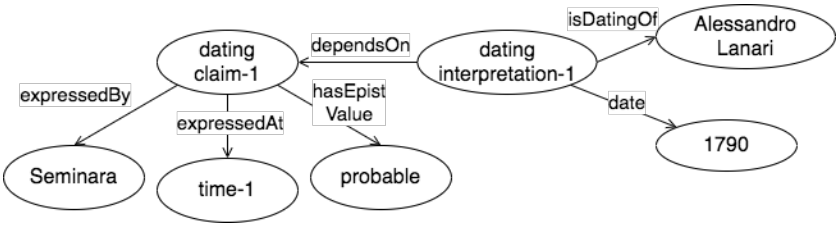

Fig. 2. Seminara's claim about Alessandro Lanari's birth date

Challenges. Moving to some open challenges requiring further research, first, the structure of claims and situations need to be better characterized and linked. For instance, a formula like (4) could be adopted to tell that if claim c assigns birth date t to person p, there exists an interpretation i standing for the epistemological fact in which the dating of (the birth event of) p is t, and i satisfies/depends on c (see Fig. 2). A similar approach could be used to characterize other types of assignment relations and the corresponding claims.

$$assignsBirthDate(c,t,p) \rightarrow \exists i(hasDescription(i,c) \wedge dependsOn(i,c) \wedge isDatingOf(i,p) \wedge date(i,t)) \quad (4)$$

A second and important challenge concerns the relation between hypothetical and non-hypothetical (i.e., certain) knowledge, therefore, the use of claimed-predicates (e.g., $bornAt(x,t,c)$) in tandem with regular predicates ($bornAt(x,t)$). For example, considering again the case represented in Fig. 2, the dating interpretation tells that Alessandro Lanari was born in 1790 according to a dating claim. Consequently, we cannot infer that Lanari was born in 1790 independently

[13] The representation of claims could be done at different levels of granularity. For instance, in the case of dates, one may explicitly tell that the claim is about both the month and the day, in which case two different dating claims (about the same person) would be needed.

from the claim. Thus, a formula like (5) cannot be assumed in general.

$$bornAt(x, t, c) \rightarrow bornAt(x, t) \tag{5}$$

In our understanding, an ontology for the DH needs to represent claims along with an approach for domain entities which do not require the attribution of hypothetical properties. There are at least two scenarios where the use of claims seems appropriate: the first one, to express a level of uncertainty about the data; the second one, to document the *provenance* of the data, e.g., as seen above, that it is *according to* Seminara that Lanari died in 1790. This however requires a deeper analysis of provenance knowledge and modeling requirements to better understand how our approach can deal with provenance scenarios in applications.

Also, it could be argued that data increase in reliability and becomes more certain if there is increasing evidence about them, or the scholarly community has put in place verification strategies. The verification of data in the human sciences can be challenging, especially when one has only partial sources about past phenomena. From this perspective, one might dig into the link between certainty and uncertainty via theories for judgement aggregation, exploring therefore the manner in which multiple claims could be consistently aggregated (see [12]). Aggregation mechanisms are also needed to combine data which are expressed at different granularities; e.g., claims ascribing the birth date of a person with a time interval *vs.* claims ascribing specific time points within the interval.

A third challenge, mentioned throughout the paper, concerns the representation and management of incompatible claims, which can lead into inconsistencies with respect to the assumed background knowledge; e.g., with axioms establishing that a person cannot be born on different dates. One may explore in this case, too, the application of judgment aggregation methods to discard conflicting data. If this is not possible, e.g., because there is no definitive reliability measure in favor of a piece of data, another strategy could consist in "relaxing" the knowledge constraints.

Just to mention an example, a formula like (6) could be (reasonably) used to tell that when two different claims c and c' attribute birth dates t and t', respectively, to the same person x, t and t' need to be the same date.

$$bornAt(x, t, c) \wedge bornAt(x, t', c') \rightarrow t = t' \tag{6}$$

However, since there can be conflicting claims about the same phenomena, an approach on the lines of (6) could be too restrictive. For this reason, (6) could be discarded from the background knowledge to make it possible for two equally reliable claims to attribute incompatible properties to the same entity, leading to incompatible but co-existent situations.

Figure 3 shows VIAF's claim about Alessandro Lanari's birth date. This claim and the corresponding situation coexist with what represented in Fig. 2 (at least, up to the point in which some grounded evidence emerges from one of the two claims).[14]

[14] For archival purposes, one may be interested in keeping claims that have been discarded because they are not anymore accepted by the scholarly community. In this

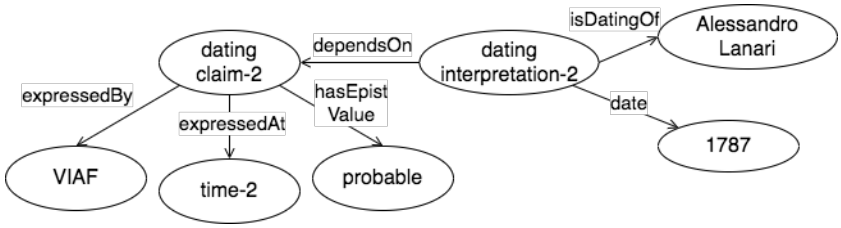

Fig. 3. VIAF's claim about Alessandro Lanari's birth date

6 Conclusions and future work

We discussed in the paper the representation of hypothetical knowledge in the field of the Digital Humanities from an ontological modeling perspective. We proposed to tackle this topic in terms of properties *claimed* by scholars on research evidence. Claims can be formulated collaboratively by multiple scholars, are accessible in an inter-subjective manner, and bear epistemological values describing their level of uncertainty/reliability.

The research work described in the paper is still in its infancy, and some identified research challenges remain still open; examples include the representation of claims about incompatible properties and the relationships between hypothetical and certain knowledge. We plan to address these challenges more carefully as future work. In particular, this will be done by taking into account theories for judgment aggregation and modeling approaches for the representation of beliefs. This analysis will hopefully contribute to reach a more mature level of understanding of the raised issues and to put forward our ideas in a robust formal setting exploitable in SW applications.

Acknowledgements: We are grateful to colleagues at the CNR Institute of Cognitive Sciences and Technologies (ISTC), as well as to SWODCH's reviewers for their valuable comments on previous versions of the paper. No one but us is responsible for any remaining mistake.

References

1. Bekiari, C., Bruseker, G., Doerr, M., Ore, C.E., Stead, S., Velios, A.: Definition of the CIDOC Conceptual Reference Model. version 7.1. ICOM/CIDOC Documentation Standards Group. CIDOC CRM SIG (2021)
2. Bellini, V.: Carteggi (ed. Seminara, G.). No. CXXXI in Historiae Musicae Cultores, Leo S. Olschki Editore (2017)
3. Carriero, V.A., Gangemi, A., Mancinelli, M.L., Nuzzolese, A.G., Presutti, V., Veninata, C.: Pattern-based design applied to cultural heritage knowledge graphs. Semantic Web (Preprint), 1–45 (2019)

case, in order to avoid conflicts with the background knowledge, the discarded data could be decoupled from the knowledge base (see [12] for a proposal on these lines).

4. Cristofaro, S., Spampinato, D.: OntoBellini: Towards an RDA Based Ontology for Vincenzo Bellini's Cultural Heritage. In: Proceedings of the Joint Ontology Workshops 2019. CEUR Workshop Proceedings, vol. 2518 (2019)
5. Cristofaro, S., Spampinato, D.: OntoBelliniLetters: A formal ontology for a corpus of letters of Vincenzo Bellini. In: Metadata and Semantic Research. pp. 192–203. Springer International Publishing, Cham (2021)
6. Del Grosso, A.M., Capizzi, E., Cristofaro, S., De Luca, M.R., Giovannetti, E., Marchi, S., Seminara, G., Spampinato, D.: Bellini's correspondence: a digital scholarly edition for a multimedia museum. Umanistica Digitale **3**(7), 23–47 (Dec 2019)
7. Figuera, M.: A fuzzy approach to evaluate the attributions reliability in the archaeological sources. International Journal on Digital Libraries pp. 1–8 (2020)
8. Gangemi, A., Mika, P.: Understanding the semantic web through descriptions and situations. In: OTM Confederated International Conferences" On the Move to Meaningful Internet Systems". pp. 689–706. Springer (2003)
9. Martin-Rodilla, P., Gonzalez-Perez, C.: Conceptualization and non-relational implementation of ontological and epistemic vagueness of information in digital humanities. In: Informatics. vol. 6, p. 20. Multidisciplinary Digital Publishing Institute (2019)
10. Martin-Rodilla, P., Pereira-Fariña, M., Gonzalez-Perez, C.: Qualifying and quantifying uncertainty in digital humanities: a fuzzy-logic approach. In: Proceedings of the Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality. pp. 788–794 (2019)
11. Masolo, C., Borgo, S., Gangemi, A., Guarino, N., Oltramari, A.: WonderWeb deliverable D18. Tech. rep., Laboratory for Applied Ontology ISTC-CNR (2003)
12. Masolo, C., Botti Benevides, A., Porello, D.: The interplay between models and observations. Applied Ontology **13**(1), 41–71 (2018)
13. Niccolucci, F., Hermon, S.: Expressing reliability with CIDOC-CRM. International Journal on Digital Libraries **18**(4), 281–287 (2017)
14. Sanfilippo, E.M.: Ontologies for information entities: State of the art and open challenges. Applied ontology **16**(2), 111–135 (2021)
15. Stead, S., Doerr, M., Ore, C.E., Kritsotaki, A.: CRMinf: The argumentation model. an extension of CIDOC-CRM to support argumentation (0.10.1). ICOM/CIDOC Documentation Standards Group. CIDOC-CRM SIG (2019), `http://www.cidoc-crm.org/crminf/sites/default/files/CRMinfver10.1.pdf`
16. Wilkinson, M.D., Dumontier, M., Aalbersberg, I.J., Appleton, G., Axton, M., Baak, A., Blomberg, N., Boiten, J.W., da Silva Santos, L.B., Bourne, P.E., et al.: The fair guiding principles for scientific data management and stewardship. Scientific data **3** (2016)