Journal of Integrated Information Management

Vol 5, No 2 (2020)

Jul-Dec 2020

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To cite this article:

Dendrinos, M., Kyriaki-Manessi, D., & Tranta, A. (2024). Seeking for the evolutionary history of lands based on ontology organized spatiotemporal data and reasoning tools . *Journal of Integrated Information Management*, *5*(2), 7–14. Retrieved from https://ejournals.epublishing.ekt.gr/index.php/jiim/article/view/37882

Journal of Integrated Information Management electronic journal

Seeking for the evolutionary history of lands based on ontology organized spatiotemporal data and reasoning tools

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Article Info

Article history:
Received 07 December 2020
Received in revised form 16 December 2020
Accepted 29 December 2020

https://doi.org/10.26265/jiim.v5i2.4452

Abstract: *The present study focuses on spatiotemporal historical data organized in an OWL Protégé ontology environment. It aims at exploring the possibilities of using deduction logic tools in correlating alternate names of geographic regions related to time periods and presenting spatiotemporal interconnections. The application paradigm includes spatial data of local regions and sites of contemporary Greece and Turkey related to Hellenic historical archaeological sites temporally distributed in an extended period from Neolithic Age to the 19th century. The results are presented through advanced visualization tools embedded in the Protégé environment.*

Purpose: *The present study focuses on spatiotemporal historical data organized in an OWL Protégé ontology environment. It aims at exploring the possibilities of using deduction logic tools in correlating alternate names of geographic regions related to time periods and presenting spatiotemporal interconnections.*

Design/methodology/approach: *Methodology follows the systematic review paradigm and includes the development of a protocol for the following elements. Protocol for the inclusion of different types of entities. Protocol for the ways of standard use and expansion, in this case TNG and AAT vocabularies. Protocol for the description of entities within the ontological framework and finally a set of rules for the selection of vocabularies and authority tools. Literature search was conducted grouped in units to the corresponding protocols and likewise research results were tested per protocol.*

Findings*: The central idea of this study was the exploitation of embodied Deduction Logic tools in an ontology environment in order to reveal evolutionary history topics (as the relation of historical named entities based on their temporal features), as well as to connect historical monuments to places described by their real then used name apart from their contemporary identification.*

Originality/value: *The work could have a practical informational application as its ability to connect to google maps and Wikipedia and other linked data can turn it into a useful information tool.*

This work can also be used as a paradigm for cooperation between humanities and computational semantics, since there are a lot of available techniques that can enrich the information research and retrieval in digital humanities repositories, leading to the emergence of 'hidden' treasures in contexts not studied and exploited yet.

Index Terms: *ontologies, spatiotemporal data, metadata, controlled vocabularies*

I. Introduction

Spatiotemporal data **[1]** are data that are related to both space and time. Spatiotemporal data mining refers to the process of extracting knowledge from spatiotemporal data. Spatiotemporal data processes include seeking for the evolutionary history of cities and lands, disclosing complex weather data series, predicting physical events, and determining global warming trends in the case of the planet climate. Relational spatial and temporal data mining are of increasing importance in the frame of GPS devices and web-based maps including historical references. CIDOC CRM standard has also been used as a tool for configuring events as time instances in an ontology framework presenting plant decoration elements throughout history **[2]**.

Data mining techniques can be applied to various types of spatiotemporal data: multimedia and text data, local or web data, raw or organized (semi or fully organized) data. These techniques are borrowed from various domains, such as time-series theory **[3]**, data graphs and networks **[4]**, concept maps **[5]** and moving-object data **[6]**. Time-series statistical analysis includes generalized linear models, factor analysis, discriminant analysis and principal component analysis **[7]**.

II. Evolutionary History of Regions Based on Spatiotemporal Relations

The issue examined here is the disclosure of the historical chains of geographical named entities referring to the same land through the mediation of cities and historical sites/ monuments of various periods placed in the certain geographic region. The correlation of the recorded time periods of the heyday of the regions to the heyday time of the cities along with the building time of the monuments and the establishment of sites leads to the unveiling of the encrypted equivalence of the geographical named entities.

The case study examined here for the unfolding of the proposed methodology is the wider area of the Mediterranean Sea, where indeed there are many instances

of geographical places, which had flourished under different names and different cultures and civilizations in an extended time span from Neolithic period until nearly our days. A great part of these regions belongs to the same linguistically ethnic community, even though they followed quite different religious cultures, such as the Greek or Cretan regions, which passed from polytheistic cults to Christianity. Another part concerns cultures of similar religious characteristics but different languages, such as the Roman conquest of Greece or the Venetian occupation of extended areas of the Greek peninsula, islands and mainly Crete. Lastly, a great part is related to the full occupation of lands by a quite different ethnic community with no linguistic or religious relation, such as the ancient and medieval lands of the East Roman Empire, which were inhabited by Slavic populations and/ or conquered by the Ottomans. Especially in the last case the place names have totally been altered.

An example of the first kind of change is passing from the territorial layout of the ancient Greek cities to the Byzantine themata as administrative districts. At a second stage one can observe the adoption of Venetian administrative divisions of sestieri and territoria in Crete. Accordingly, in other parts of the Mediterranean in areas under Turkish authority we observe the use of Ottoman Turkish names for the previously Greek names of districts of Asia Minor and other major cities.

Cases included, in this exploratory paradigm, are the districts of Minoan Crete, Roman Crete, Byzantine Crete and the Venetian Crete, geographic areas of ancient civilizations now in the dominion of other nations (such as Ephesus in former Lydia and currently in Turkey), provinces which slipped from classical Rome provinces to East Roman Empire themata (such as Nicopolis in Epirus), as well as milestone-cities passed from Late Byzantine to Ottoman Empire (such as Athens, Constantinople/ Istanbul, Smyrni/ Izmir, Adrianople/ Edirne).

III. THE TOOLS USED

In an effort to standardize the content elements of the ontology, several controlled vocabulary tools, authority files and public domain ontologies were used. Also, through this standardization process an effort was made to provide linked data and interconnect the ontology at hand with external authority sources such as LC Authority Files linking to existing bibliographic sources and Wikipedia content. Specifically:

Spatial data have been verified against the Getty Thesaurus of Geographic Names (TNG) **[8]** and the relevant geospatial tree was checked with the spatial class of the ontology. This process resulted in verification of names and provided source ids linking them to the aforementioned external source.

An example is given below, concerning the hierarchy trees of Iraklion (regional division) in TGN Thesaurus (Fig. 1).

Figure 1. Hierarchy tree of the term 'Iraklion (regional division)' in TGN Thesaurus, *Source: Getty Research Institute, TGN*

At the same time geospatial coordinates were incorporated and google maps became accessible from the ontology environment, thus expanding its usability and potential uses. This information was recorded in two relevant data properties -longitude and latitude- incorporated into the ontology at hand. By inserting the latitude and longitude of a place in decimal form divided by comma in the google maps search box, one can be transferred at the requested geographic area.

An example of geographical coordinates of Knossos in the form of data properties is given below (Fig. 2):

Figure 2. Latitude and longitude, given as datatype properties of *Knossos*

Temporal data were verified against the public domain ontology PeriodO **[9]**, mostly for providing temporal information that is referenced to relevant sources and offering proof for the validity of its recording and naming. As PeriodO provides also temporal data linked to geospatial data thus creating a particular reference for every region in relation to its historical stage within the world history, it proved to be an essential tool for the building of temporal class and the contents' validity. Connecting the ontology at hand with PeriodO's relevant historical period and its interconnection to spatial information served as a mean to relate the ontology to a valuable external source. In addition, PeriodO's active links provided the opportunity to utilize linked data. Links to PeriodO were created at the annotation part of the temporal classes.

An example is given below, concerning the PeriodO authority page about Minoan Period (3100-2050 BC) (Fig. 3) connected to the temporal class of the ontology: Minoan.Millenium2ndBC. The connection is accomplished through the annotation part of the relative class (Fig. 4).

Figure 3. PeriodO authority page about Minoan 3100 BC – ca 1050 BC | Crete

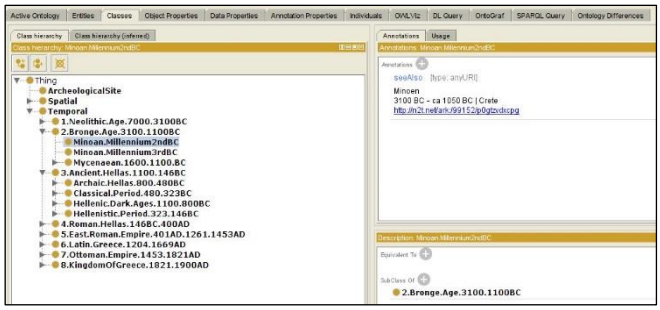

Figure 4. Annotation of temporal class: Minoan.Millenium2ndBC with the PeriodO authority page about Minoan period

Furthermore, as we were dealing with monuments and cultural manifestations the Getty Art and Architecture Thesaurus (AAT) was consulted in order to depict style periods as part of temporal data (such as Neolithic, Minoan, Mycenaean periods). Links to AAT Getty **[10]** were inserted at the annotation part of either spatial classes with temporal characteristics or temporal classes with spatial characteristics.

Topical elements were also incorporated as it became evident that subjects related to geospatial and temporal data can offer a holistic approach to the intellectual content and provide a more complete information package. Topical elements were verified against both AAT and the LC Subject Authorities (https://authorities.loc.gov/) thus expanding the possibility of creating linked data on this end as well. Topical terms were given along with their AAT id and provided link to the aforementioned external source. In addition, links to Wikipedia data were provided expanding the ontology's informational capabilities. All these links were created at the annotation part of certain monuments (individuals), like in the paradigms of the Temple of Artemis and Knossos Palace (see also Table 2).

An example is given below, concerning the hierarchy tree of *Early Minoan* term on ATT Getty Thesaurus (Fig. 5).

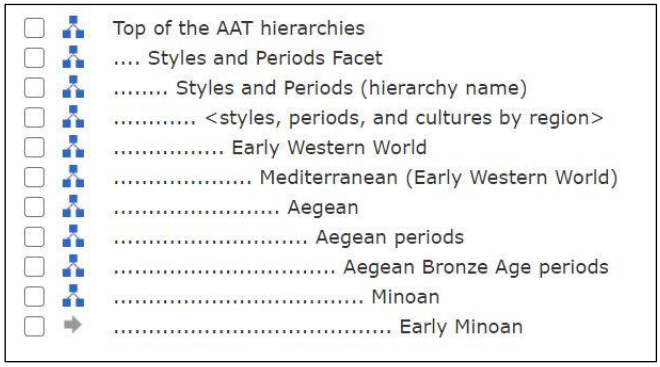

Figure 5. Hierarchy tree of the term 'Early Minoan' in ATT Getty Thesaurus.

As it has already been mentioned, an effort was made to connect the embedded spatial and temporal classes with the nearest to them terms of Getty Thesaurus of Geographical Names (TGN), as well as to the terms of Getty Art & Architecture Thesaurus (AAT). This is accomplished by putting the relevant permanent link in the annotation part of the relevant class: Class Heraklion.Region has been interconnected to the term Iraklion (regional division) of TGN Thesaurus. Class Minoan.Knossos has been interconnected to the term Early Minoan of ATT Getty Thesaurus.

IV. The Structure of a Spatiotemporal Ontology of Mediterranean Regions

Ontology is a sophisticated data structure organized in the form of a hierarchy of classes (collections of similar objects/ individuals) enriched with customized relations between individuals of the same or different classes (object properties with domain and range certain classes) and defined features of individuals of a certain class (datatype properties with domain a certain class and range a certain data type as text, number, date, etc.).

The open-source environment OWL Protégé 4.3 (https://protege.stanford.edu/) was used.

An exceptional feature of the OWL Protégé ontologies is the capability of application of *inference* mechanisms, in case of a previous characterization of some classes with some certain properties, such as the connection of flourishing of the places of a region to specific historical periods. Reasoning engines can be activated and give additional hierarchical relationships, apart from those initially defined. As we will see later in detail (Case 2 – Fig. 6) the connection of Ionia to 6th cent. BC period is used by the reasoning engine, which concludes that Ionia belongs hierarchically to the current Izmir.Province including Ephesus, while Ephesus has been explicitly defined as a place of Izmir.Province.

The developed spatio-temporal ontology has the following structure:

Classes: *Archaeological Site* (the class which includes certain archaeological sites and archaeological monuments in general). *Spatial* (the class of all the spatial elements: wider or narrower, current or past regions and cities). *Temporal* (the class of all the temporal elements: wider or narrower periods in various cultural contexts).

Spatial contains the following subclasses: Past_region, Current_region. Past_region contains: Ancient_Crete, Minor.Asia, Ancient_Aegean, East_Roman_Thema, Venetian_Crete. Ancient_Crete contains: Cydonia, Minoan.Knossos, Minoan.Phaestos, Minoan.Malia, Roman.Gortyna. Ancient_Aegean contains Rhodes. Minor.Asia contains Ionia, Lydia etc. Venetian Crete contains: Venetian_sestieri (administrative divisions of Venetian Crete in 13th cent), Venetian_territoria (administrative divisions of Venetian Crete in 14th cent and then). Venetian_sestieri contains: Candie, Castello, Dorsoduro, San.Marco, San.Polo, Santa.Croce, Santi.Apostoli. Venetian_territoria contains: Candia, Canea, Rettimo, Siteia. Current_region contains: Greece, Turkey. Greece contains: Central.Macedonia.Region, Crete.Region, Epirus.Region, South.Aegean.Region. Crete.Region contains: Apokoronas.Region, Chania.Region, Faistos.Region, Gortyna.Region, Heraklion.Region, Hersonissos.Region, Kissamos.Region, Sfakia.Region, Sitia.Region. South.Aegean.Region contains: Rhodes.Region etc. Turkey

contains: Edirne.Province, Istanbul.Province, Izmir.Province.

Temporal contains the following subclasses: Neolithic.Age.6800.3100BC, Bronge.Age.3200.1100BC, Ancient.Hellas.1100.146BC, Roman.Hellas.146BC.330AD, East.Roman.Empire.330AD.1261.1453AD, Latin.Greece.1204.1669AD, Ottoman.Empire.1453.1821AD, KingdomOfGreece.1821.1900AD. Neolithic.Age contains 7th to 3rd millennia BC. Bronge.Age contains: 3rd and 2nd Minoan millennia BC and Mycenaean.1600.1100BC. Ancient.Hellas contains: Hellenic.Dark.Ages.1100.685 BC, Archaic.Hellas.700.480BC, Classical.Period.480.323BC Hellenistic.Period.323.146BC. All of these temporal subclasses contain the corresponding centuries as subclasses. Temporal subclasses were formed based on PeriodO references.

Object properties: Flourishes_in (any spatial element as geographical region or city flourished in a certain temporal element as millennium, century or year). Built_in (any archaeological site or monument erected in a certain temporal element). Is positioned_in (any archaeological site or monument lies now in a certain current spatial element as a contemporary city).

Datatype properties: Latitude and longitude coordinates are defined using as Domain: Spatial and Range: Decimal.

The spatiotemporal properties presented above could be alternatively implemented as datatype properties with range date. Every effort was made to make the structure of the ontology perspicuous enough, so as to provide references to all historical periods used. PeriodO was a great source and whenever there was a gap in information, the LC authorities were used. AAT's *styles and periods* section were used as an auxiliary tool offering the interconnection of time period and subject element.

In the limitations of this effort, one should take into account that when using datatype properties, these could not be displayed in the diagrams produced by the incorporated visualization tools. Therefore, we decided to use only object properties for the implementation of the spatiotemporal relations. This was definitely a drawback for the visualization aspect, although the ontology structure itself was complete.

Visualizations of the ontology structure focusing on a certain class were produced by Ontograf, a visualization software incorporated into Protégé 4.3. Protégé 4.3 version was used as it provides better visualization capabilities than the latter version 5.5 or webprotege.

IV. EXTRACTION OF HISTORICAL REGIONS' RELATIONS THROUGH DEDUCTION LOGIC RULES

First-order or predicate logic is the logic used for the proof of predicates (or compounds of logically connected predicates, called well-formed formulas). Predicate calculus is one step further than simple propositional calculus which does not use quantifiers; therefore, propositional logic is the foundation of first-order logic.

First-order logic is the simplest logic, differentiated from higher-order logics, where predicates can also have predicates as their arguments and function quantifiers are also allowed.

A deductive classifier is an inference engine applied to hierarchical structures of classes and subclasses mutually connected through certain relations. The classifier both determines the overall validity of the defined relations and extracts new relations, not explicitly declared in the initial scheme.

First-order deductive classifiers are incorporated in OWL Protégé environment, giving us the capacity to extract encrypted spatiotemporal relations, as connections of historical regions to assigned historical temporal entities and inclusion (membership in terms of ontology) of nowadays cities to past regions. The supposition for the activation of the reasoner is the previous equivalent definition of the class under question through an object property restriction on the range classes connected through logical operators. Furthermore, examples of the equivalent definition of a class and the concluded uncovered additional classifications of that class along with additional memberships are given below.

All cases included in the ontology are tabularized as depicted in Table 1.

Table 1. Spatio-temporal elements of the archeological sites (monuments) included in the ontology

Monument/ Archaeological site	year/ century	ancient city name of the period	modern city name	region name of the period	modern region name
Temple of Artemis	440 BC	Ephesus	Kuşadasi	Ionia	Izmir.Province
Agia Photini	17th c AD	Izmir	Smyrni	Izmir.Province	Izmir.Province
Temple of Athena Lindia	300 BC	Lindos	Lindos	Rhodes	Rhodes.Region
Knossos.Palace	2nd m. BC	Knossos		Minoan.Knossos	Heraklion.Region
Phaestos.Palace	2nd m. BC	Phaestos		Minoan.Phaistos	Faistos.Region
Malia.Palace	2nd m. BC	Malia	Malia	Minoan.Malia	Hersonissos.Region
Zakro.Palace	2nd m. BC	Zakros	Zakros	Minoan.Zakros	Sitia.Region
Lissos.site	3rd BC	Lissos	Sougia	Cydonia	Sfakia.Region
Lissos. Asclepieion	3rd BC	Lissos	Sougia	Cydonia	Sfakia.Region
Agios Kirikos	1436 AD	Lissos	Sougia	South. Canea	Sfakia.Region
Gortyna. Praetorium	1st c AD	Gortyna	Gortyna	Roman .Gortyna	Gortyna.Region
Rotonda	6th c AD	Kissamos	Kissamos	Krētēs. thema.Kissamos	Kissamos.Region
St.George	1243 AD	Alikianos	Alikianos	North. Dorsoduro	Chania.Region
Basilica.St.Mark	1239 1303	Chandax	Heraklion	Candie	Heraklion.Region
St.Nicolas	11th AD	Vamos	Vamos	Krētēs. thema. Apokoronas	Apokoronas.Region
St.Minas	1862 AD	Heraklion	Heraklion	Heraklion	Heraklion.Region
Agia.Sophia	537 AD	Constantinople	Istanbul	Thrace. thema	Istanbul.Province
St.Dimitrius	5th c AD	Thessalonica	Thessaloniki	Thessalonike. thema	Central.Macedonia. Region
Macedonian Tower	10th c AD	Edirne	Adrianople	Makedonia. thema	Edirne.Province
Byzantine.Walls	555 AD	Nicopolis	Preveza	Nicopolis.thema	Epirus.Region
Parthenon	430 AD	Athenae	Athenae	Classical.Athens	Attica.Region
Monastery of Daphni	[Byzantine] 11th c. AD	Athenae	Athens, Haidari (Prefecture of Attiki)	Hellas. thema	Attica.Region
Monastery of Osios Loukas	[Byzantine] 11th AD	Thebes	Steiri, Boeotia	Hellas.thema	Boeotia.Region

Table 2. Tabularized data and their matching verifications to external sources/paths to linked data

Monument	Temple of Athena Lindia	Temple of Artemis	Knossos Palace
Matching linked data	Wikipedia https://en.wikipedia.org/wiki/Temple_of_Athena_Lindia	LC https://lccn.loc.gov/sh91004849 Wikipedia https://en.wikipedia.org/wiki/Temple_of_Artemis	LC https://lccn.loc.gov/sh85096911 Wikipedia https://en.wikipedia.org/wiki/Knossos
Year/Century	3rd cent.BC	440 BC	2nd m. BC
Verification			PeriodO https://client.perio.do/?page=period-view&backendID=web-https%3A%2F%2Fdata.perio.do%2F&authorityID=p0qv6m8&periodID=p0qv6m85m6c
Ancient city name of the period	Rhodes	Ephesus	Knossos
Verification	TGN http://vocab.getty.edu/tgn/7011266	LC https://lccn.loc.gov/sh85044266	LC http://vocab.getty.edu/tgn/7228703
Modern city name	Lindos	Kuşadasi	
Region name of the period	Rhodes	Ionia	Minoan Knossos
Verification by style period	http://vocab.getty.edu/aat/300020111	AAT http://vocab.getty.edu/aat/300386027	AAT http://vocab.getty.edu/aat/300020224
Modern region name	Rhodes.Region	Izmir.Province	Herakleion.Region
GEO verification	TGN http://vocab.getty.edu/tgn/7011265	TGN http://vocab.getty.edu/tgn/1001053 Google maps	TGN http://vocab.getty.edu/tgn/7002690 Google maps

All elements of Table 2 were verified against the tools described above giving us a table with links to external resources.

A sample of this work relevant to paradigms presented here is presented in Table 2.

Paradigm 1. The class *Rhodes* (ancient Rhodes) belongs by definition to *Past Region* spatial category, specifically to *Ancient Aegean*. Defining *Rhodes* equivalently as an AND conjunction of the contemporary *Rhodes.Region* and the *anonymous* class of the spatial elements flourished in 3rd cent. BC, the reasoner infers the following additional classifications and memberships: *Rhodes* becomes also subclass of the contemporary *Rhodes.Region* and it gets as member *Lindos* (Fig. 6), since *Lindos* has also flourished in 3rd cent. BC, and belonged by definition to contemporary *Rhodes.Region* (Fig. 6). In this way, *Temple of Athena Lindia*, an instance of *ArchaelogicalSite*, built in 3rd cent. BC and being situated in *Lindos* (Fig. 7), is indirectly connected to ancient *Rhodes*.

The defined and implied relations focusing on class *Rhodes* are shown in detail in Fig. 8.

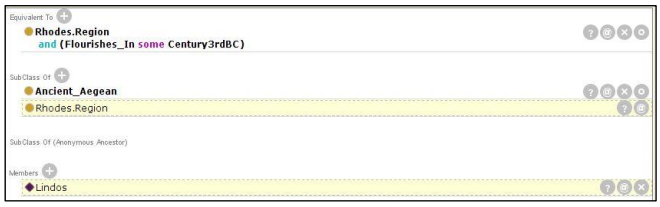

Figure 6. The class *Rhodes*.

Figure 7. The individual *Lindos.*

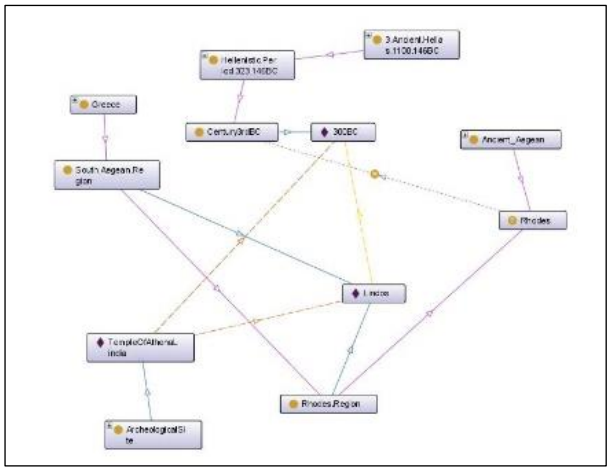

Figure 8. Classes, individuals and relations of *Rhodes*, produced by Ontograf

Paradigm 2. The class *Ionia* belongs by definition to *Past Region* spatial category, specifically to *Asia Minor*. Defining *Ionia* equivalently as an AND conjunction of the contemporary *Izmir.Province* and the *anonymous* class of the spatial elements flourishing in 6th cent. BC, the reasoner infers the following additional classifications and memberships: *Ionia* becomes also subclass of the contemporary *Izmir.Province* and it gets as member *Ephesus* (Fig. 9), since *Ephesus* had also flourished in 6th cent. BC, and belongs by definition to contemporary *Izmir.Province* (Fig. 10). In this way, *Temple of Artemis*, an instance of *Archeological Site*, built in 6th cent. BC and being situated in *Ephesus* (Fig. 11), is indirectly connected to ancient *Ionia*. The historical network is extended here with *Izmir.Smyrni* city, another defined instance of *Izmir.Province*, where *Saint Photini* (another instance of *Archeological Site*) was built in 17th cent AD.

The defined and implied relations focusing on *Ionia* class are shown in detail in Fig. 12.

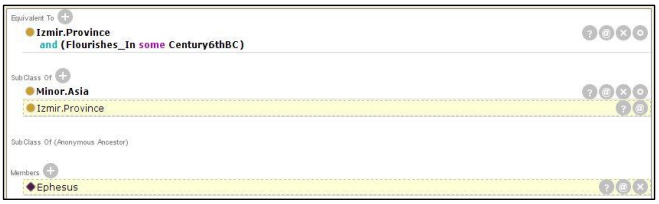

Figure 9. The class *Ionia*.

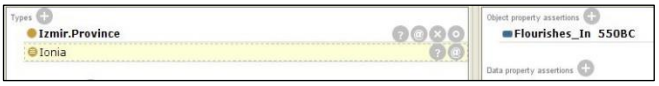

Figure 10. The individual *Izmir.Smyrni.*

Figure 11. The individual *Temple of Artemis*

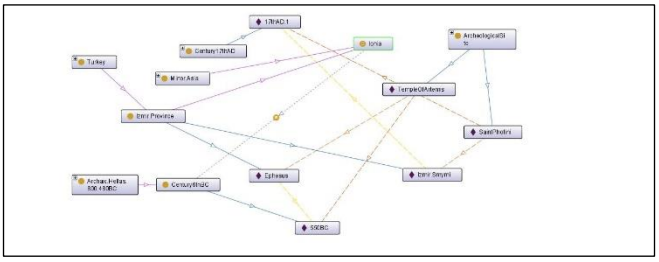

Figure 12. Classes, individuals and relations around ancient *Ionia*, produced by Ontograf

Paradigm 3. The class *Minoan.Knossos* belongs by definition to *Past Region* spatial category, specifically to *Ancient.Crete*. Defining *Minoan.Knossos* equivalently as an AND conjunction of the contemporary *Heraklion.Region* and the *anonymous* class of the spatial elements flourishing in 2nd Mill. BC, the reasoner infers the following additional classifications and memberships: *Minoan.Knossos* becomes also subclass of the contemporary *Heraklion.Region* and it gets as member *Knossos*, since *Knossos* had also flourished in 2nd Mill. BC, and belongs by definition to contemporary *Heraklion.Region.* In this way, *Knossos Palace*, an instance of *ArchaelogicalSite*, built in 2nd Mill. BC and being situated in *Knossos*, is indirectly connected to ancient *Minoan.Knossos*. The historical network is extended in the case of

Heraklion.Region to two other periods: The Venetian Crete and the 19th Cent. Crete being just liberated from Ottoman occupation. Venetian sestiere *Candie* identified with Heraklion.Region is connected to Chandax.Heraklion where sits the Basilica of St.Mark, being built between 1239 AD and 1303 AD. In Liberated Crete Heraklion, an instance of Heraklion.Region is related through Heraklion.Region class to Minoan and Venetian Crete, along with St.Minas church, being built in 1862 AD in Heraklion, rendering it an instance of the class *Archeological Site.*

The defined and implied relations focusing on ancient *Minoan.Knossos* and *Candie*, connected to contemporary *Heraklion.Region* are presented in detail in Fig. 13.

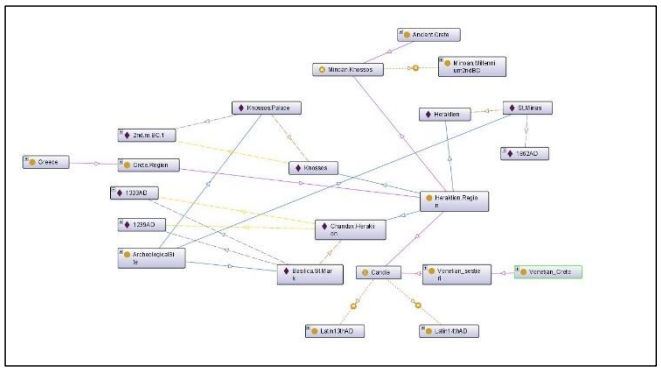

Figure 13. Classes, individuals and relations around *Minoan Knossos* and *Candie* (a Venetian Crete territory, produced by Ontograf).

V. A TIME TRAVEL / TRANSTEMPORAL VIEW OF GEOGRAPHICAL REGIONS

After completing the structure of certain geographical regions through the ages, one can benefit from the rich information stored along with the graphical capabilities of the Protégé environment so that he has a condensed history of any selected region. Various places of a wider area, such as Heraklion and Knossos, often mentioned with different names (Chandax and Heraklion), belonging to Heraklion region are connected with their historical names (Candie and Minoan Knossos). The graphical representation of this spatio-temporal structure can be accompanied by multimedia content (photos or videos), which have been inserted in the annotation part of the relative individuals. Such a diachronic view of Heraklion region is depicted below (Fig. 14), through Knossos, Chandax and Heraklion from the Minoan, Venetian and modern periods of the area, accompanied by illustrative monuments of those periods, Knossos palace, San Marco basilica and Saint Minas church respectively.

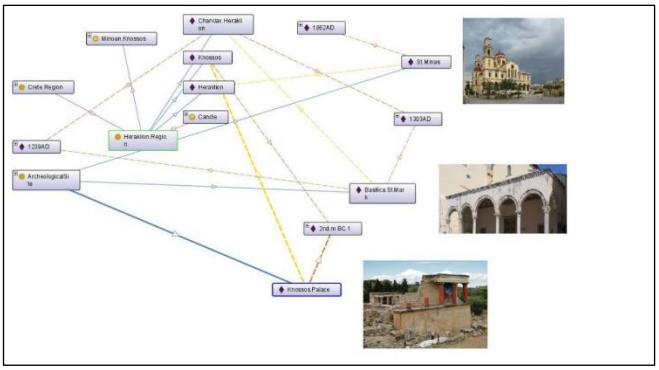

Figure 14. A time travel view of the Heraklion region.

VI. CONCLUSIONS AND FURTHER RESEARCH

The central idea of this study was the exploitation of embodied Deduction Logic tools in an ontology environment in order to reveal evolutionary history topics (as the relation of historical named entities based on their temporal features), as well as to connect historical monuments to places described by their initial then changed name apart from their contemporary identification.

This approach can be also followed in other spatiotemporal frames, such as evolutionary history of philosophical or scientific terminology, where the 'spatial' part is the concept world of philosophical or scientific notions. An interesting research could be the automatic extraction of chains of alchemical/ chemical terms from the ancient times until the scientific revolution in chemistry in the 18th century.

The work could have a practical informational application as its ability to connect to google maps and Wikipedia and other linked data can turn it into a useful information tool.

This work can be also used as a paradigm for cooperation between humanities and computational semantics, since there are a lot of available techniques that can enrich the information research and retrieval in digital humanities repositories, leading to the emergence of 'hidden' treasures in contexts not studied and exploited yet.

Furthermore, in building and assessing the ontology an interdisciplinary collaboration took place which was very important: not only the cooperation across disciplines was of importance, but also the communication mechanisms that lead to the implementation of a tool that can be used for facilitating digital humanities' projects.

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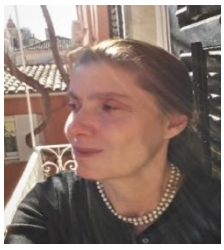
VIII. AUTHORS

Dr. Markos Dendrinos received his Diploma in Computer Engineering and Informatics and his Ph.D. in Digital Signal Processing from National Technical University of Athens (NTUA) in 1984 and 1989 respectively and his M.Sc. in History & Philosophy of Science in 2000. He is currently professor in the Dept. of Archival, Libraries and Information Studies of the University of West Attica, offering the courses of Cognitive Science, Databases and History & Philosophy of Science and also in the Post-Graduate Programme Information Management in Libraries, Archives and Museums offering a course in semantics organized by the same department. He was also professor in the Post-Graduate Programme Computer Science – Management and Organisation of Libraries focused on the New Technologies of Information organized by Dept. of Library Studies of Ionion University and Dept. of Librarianship and Information Systems of TEI of Athens and in in the Post-Graduate Programme Technoglossia, organized by University of Athens and NTUA. He was a researcher in the Institute for Language and Speech Processing, Athena Research Centre, from 1992 until 2010, participating in various national and European projects in the frame of speech processing. He also participated in various research and development national and European projects as professor of the department in various disciplines, such as the library and archival organization, as well as digital humanities through conceptual maps and ontologies. He has published or presented his research in the fields of signal processing, speech recognition, speech enhancement from noise, databases and ontologies in more than 30 papers in widely recognized journals and conferences with more than 300 citations.



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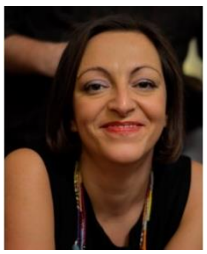

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