Fruitful Synergies between Computer Science, Historical Studies and Archives: The Experience in the PRiSMHA Project

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Abstract: In this paper we present the mid-term results of the PRiSMHA project, aimed to contribute in building a digital "smart archivist", i.e., a web-based system providing an innovative access to historical archives. Such a system is endowed with a semantic layer over existing archival metadata, including computational ontologies and a knowledge base, containing a formal description of the content of the documents stored in the archives. The paper focuses on the fruitful synergies employed to reach its goal. In particular, it explains the steps of the "spiral" process implemented for creating a full-fledged formal semantic model, through the interaction between computer scientists, historians, and archivists. The paper also presents some "core side-effects" of this process: an analytical card for each document has been produced, all selected documents have been digitized, OCR-ized (when possible), and linked to a record on the archival platform. This experience enabled us to define a virtuous procedural model, from the paper documents up to the digital "smart archivist", based on a close collaboration between universities and cultural and historical institutions.

1 INTRODUCTION

In this paper we present the mid-term results of PRiSMHA (Providing Rich Semantic Metadata for Historical Archives), a three-year national project (2017-2020), funded by Compagnia di San Paolo and Università di Torino (Goy et al., 2017). PRiSMHA (di.unito.it/prismha) involves the Computer Science and the Historical Studies Departments of the University of Torino (Italy), and relies on a close collaboration with the Polo del '900 (www.polodel900.it), a cultural center in Torino, co-funded by Compagnia di San Paolo, Comune di Torino and Regione Piemonte. It involves nineteen institutions and hosts a very rich set of archives, a quarter of which is provided by the Fondazione Istituto Piemontese Antonio Gramsci (www.gramscitorino.it). The Polo del '900 archives can be accessed through the online platform *9centRo* (www.polodel900.it/9centro).

In the following, we start by presenting the overall framework in which PRiSMHA takes part (Section 2). Then we describe PRiSMHA's specific role and its main results at the mid-term milestone, by focusing on the fruitful synergies between different perspectives: historical studies and computer science, research institutions and cultural centers, automatic and user-driven data production (Section 3). We conclude the paper by indicating some future research directions (Section 4).

2 THE FRAMEWORK

The overall goal is to build a digital "smart archivist", i.e., a web-based system providing an intelligent access to historical archives.

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Let us consider the case of a young researcher looking for primary sources (leaflets, pictures, letters, etc.) that report or comment on violent actions performed by the police against students and workers during the social protest in 1968. A digital "smart archivist" would provide all documents somehow referring to such kind of actions, independently from the words actually used to report them in the primary sources.

In order to reach such a result, a simple keyword or tag-based search is not enough. As the long tradition of studies in Knowledge Representation and Reasoning – in the field of Artificial Intelligence – tells us, in order to be "intelligent", the system must "know" the documents and grasp their content. Therefore, the goal is providing the system with further machine readable knowledge than that actually represented by words occurring in the documents or in their textual metadata. Technically, this means building a *semantic layer* over existing archival metadata, including:

- Computational ontologies (Guarino et al., 2009) representing the semantic "vocabulary" (Goy et al., 2015);
- A knowledge base containing a detailed formal description of: the events narrated in the documents, the places where they happened, people, organizations, and collectives involved in them, together with the role they played.

In order to guarantee the needed computational interoperability, the standards of the Semantic Web must be employed: OWL 2 (Hitzler et al., 2012) for the computational ontologies and RDF (Hayes and Patel-Schneider, 2014) and the Linked Data principles (Heath and Bizer, 2011) for the knowledge base.

However, providing a system with a so deep and complex knowledge is a well-known bottleneck for knowledge-based systems (especially as regards as the knowledge acquisition step), that can threaten the sustainability of the approach. One main goal of PRiSMHA is to provide a solution to solve this problem.

3 PRiSMHA: FRUITFUL SYNERGIES

The solution can be found by looking in two directions:

- Crowdsourcing collaborative approaches, if a digital version of the archival resources is available (Ashenfelder, 2015) (Beaudoin, 2015) (MicroPasts, 2018).
- Automatic Information Extraction techniques, when full texts are available (Boschetti et al., 2014). Note that automatic extraction techniques from documents other than texts (images, videos, audio recordings) are currently out of the scope of the project.

Thus, the specific goal of PRiSMHA is to verify/demonstrate the feasibility of a solution based on the integration of these two approaches.

3.1 Building the Ontology

PRiSMHA relies on two modular ontologies: a *top/core ontology* called HERO (Historical Event Representation Ontology), and a *domain ontology*, called HERO-900. Overall, the OWL2 version of HERO+HERO-900 counts more than 400 classes and more than 350 properties; moreover, it is a strongly axiomatized ontology (more than 4.000 logical axioms).

We started from the definition of HERO, representing the semantically rich common vocabulary. "Common" means shared between:

- The system, the users of the crowdsourcing platform, and final users querying the digital "smart archivist";
- Computer scientists and ontologists actually designing and implementing the system, and historians providing a historical, analytical perspective on the documents.

This top-level semantic model contains concepts such as place, time, event, organization, collective entity, participant, different roles played in events, etc. Table 1 shows the basic structure of HERO.

HERO is the result of the integration of an analysis of existing models – (Agora, 2018) (CIDOC-CRM, 2018) (Raimond and Abdallah, 2007) (Doerr et al., 2010) (van Hage et al., 2009) (Nanni et al., 2017) (Sprugnoli and Tonelli, 2017) – and the outcomes of the dialog between computer scientists and historians about the notion of *event*, its properties (e.g., participation in events, roles played by participants) and the relations between events (e.g., cause, influence).

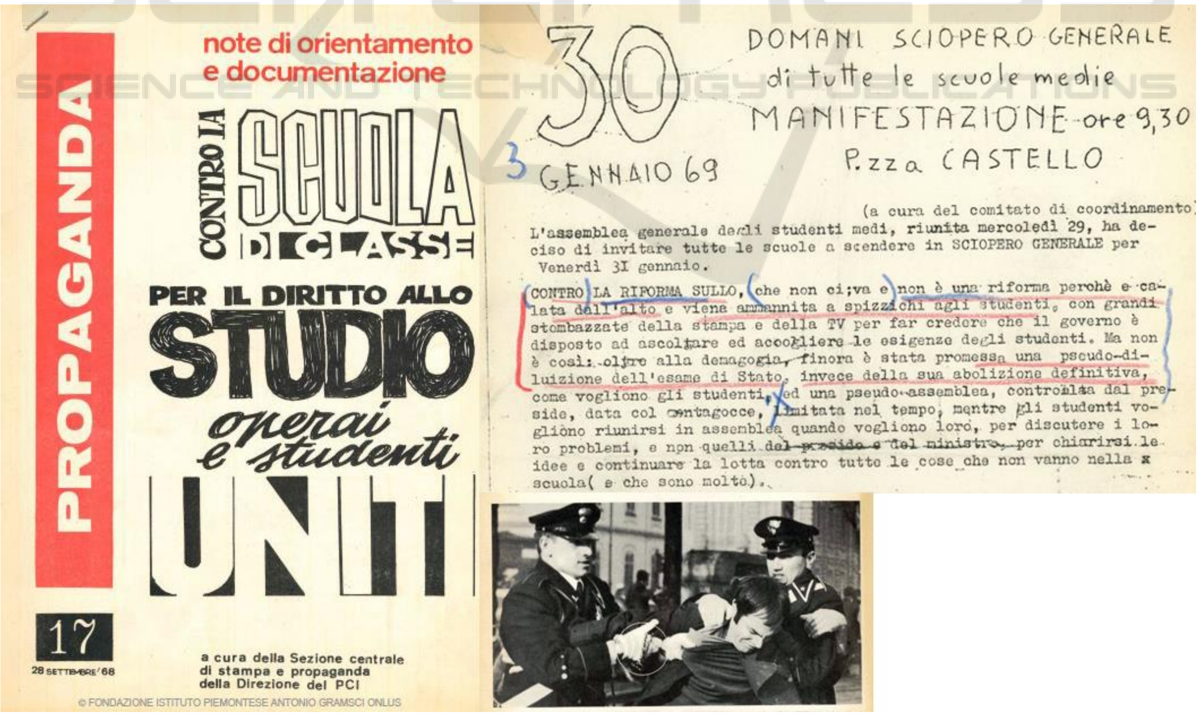
Most of the existing models – the most famous of which is probably CIDOC-CRM – are mainly designed for representing production, preservation and curation activities and has been employed in several projects for describing documents types, creators, geographical/temporal anchoring. Although most of these models support the representation of events and their participants, their level of detail and granularity does not make any of them the first choice, when the focus is the fine-grained representation of historical events and the relations over them outside documents. By the way, for interoperability reasons, PRiSMHA includes mappings between HERO top level classes/properties and the corresponding elements in the most used existing ontologies.

We identified the students and workers protest during the years 1968-1969 in Italy as the specific domain to focus on in developing our proof-of-concept. The available documents concerning this period are mainly non-digitized typewritten leaflet (often containing manual annotations or drawing), newspaper or magazine articles, and some pictures (see Figure 1).

The historians analyzed the documents, from the Ist. Gramsci's archives, referring to this period, in order to select the most relevant ones with respect to our goal. The top-level semantic model defined in HERO has guided the analysis and subsequent selection of documents: For each document, an analytical card has been built, structured on the basis of the classes and properties defined in the top-level semantic model.

Table 1: The basic structure of HERO.

HERO-TOP	Very general classes and properties, e.g., concepts such as *abstract entity*, *(non)physical object*, *occurrence*, and properties such as *being part of*, *being a sub-concept of*
HERO-EVENT	General classes and properties useful for characterizing events, e.g., *event*, *state*, *action*, *coming into existence*, *participating in an event*, *playing the role of agent in an event*, *occurring at a certain time or in a certain place*, *causing*
HERO-ROCS (Roles, Organizations, Collections, Sets)	General classes and properties useful for representing roles, organizations, collections, and sets, e.g., *role*, *organization*, *being affiliated to an organization*, *playing a (social) role*, *being a member of a collective/set*
HERO-PLACE	General classes, properties (and individuals) useful for characterizing places, e.g., *place*, *building*, *inside/outside*, *close to*, *...*
HERO-TIME	General classes and properties useful for representing time intervals, e.g., *time interval*, *day*, *date*, Allen's relations between time intervals (*preceding*, *following*, *overlapping*, ...), *Monday*, *February*, *UTC+1:00*



30
3 GENNAIO 69

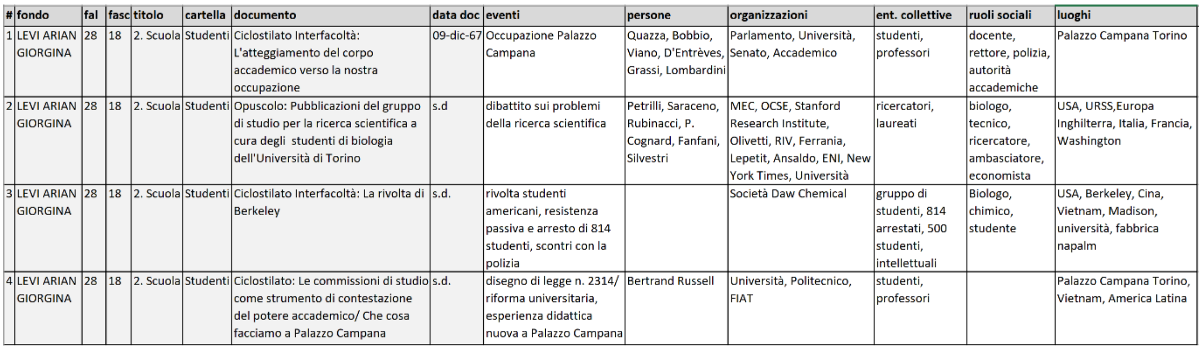
DOMANI SCIOPERO GENERALE
di tutte le scuole medie
MANIFESTAZIONE ore 9,30
P.zza CASTELLO

(a cura del comitato di coordinamento)

L'assemblea generale degli studenti medi, riunita mercoledì 29, ha deciso di invitare tutte le scuole a scendere in SCIOPERO GENERALE per Venerdì 31 gennaio.

CONTRO LA RIFORMA SULLO, (che non ci;va e) non è una riforma perchè e calata dall'alto e viene ammannita a spizzichi agli studenti, con grandi stombazzate della stampa e della TV per far credere che il governo è disposto ad ascoltare ed accogliere le esigenze degli studenti. Ma non è così: oltre alla demagogia, finora è stata promessa una pseudo-diluizione dell'esame di Stato, invece della sua abolizione definitiva, come vogliono gli studenti, ed una pseudo-assemblea, controllata dal preside, data col contagocce, limitata nel tempo, mentre gli studenti vogliono riunirsi in assemblea quando vogliono loro, per discutere i loro problemi, e non quelli ~~del preside e del ministro,~~ per chiarirsi le idee e continuare la lotta contro tutte le cose che non vanno nella ~~x~~ scuola(e che sono molte).

Figure 1: Examples of documents concerning the students and workers protest during the years 1968-1969 [copyright: Fondazione Istituto Piemontese Antonio Gramsci].



#	fondo	fal	fasc	titolo	cartella	documento	data doc	eventi	persone	organizzazioni	ent. collettive	ruoli sociali	luoghi
1	LEVI ARIAN GIORGINA	28	18	2. Scuola	Studenti	Ciclostilato Interfacoltà: L'atteggiamento del corpo accademico verso la nostra occupazione	09-dic-67	Occupazione Palazzo Campana	Quazza, Bobbio, Viano, D'Entrèves, Grassi, Lombardini	Parlamento, Università, Senato, Accademico	studenti, professori	docente, rettore, polizia, autorità accademiche	Palazzo Campana Torino
2	LEVI ARIAN GIORGINA	28	18	2. Scuola	Studenti	Opuscolo: Pubblicazioni del gruppo di studio per la ricerca scientifica a cura degli studenti di biologia dell'Università di Torino	s.d	dibattito sui problemi della ricerca scientifica	Petrilli, Saraceno, Rubinacci, P. Cognard, Fanfani, Silvestri	MEC, OCSE, Stanford Research Institute, Olivetti, RIV, Ferrania, Lepetit, Ansaldo, ENI, New York Times, Università	ricercatori, laureati	biologo, tecnico, ricercatore, ambasciatore, economista	USA, URSS,Europa Inghilterra, Italia, Francia, Washington
3	LEVI ARIAN GIORGINA	28	18	2. Scuola	Studenti	Ciclostilato Interfacoltà: La rivolta di Berkeley	s.d.	rivolta studenti americani, resistenza passiva e arresto di 814 studenti, scontri con la polizia		Società Daw Chemical	gruppo di studenti, 814 arrestati, 500 studenti, intellettuali	Biologo, chimico, studente	USA, Berkeley, Cina, Vietnam, Madison, università, fabbrica napalm
4	LEVI ARIAN GIORGINA	28	18	2. Scuola	Studenti	Ciclostilato: Le commissioni di studio come strumento di contestazione del potere accademico/ Che cosa facciamo a Palazzo Campana	s.d.	disegno di legge n. 2314/ riforma universitaria, esperienza didattica nuova a Palazzo Campana	Bertrand Russell	Università, Politecnico, FIAT	studenti, professori		Palazzo Campana Torino, Vietnam, America Latina

Figure 2: A fragment showing the analytical cards corresponding to four documents from the archive of the Fondazione Istituto Piemontese Antonio Gramsci (*fondo Giorgina Arian Levi*).

The cards, besides some fields related to archival and practical aspects (e.g., classification data; see the first eight columns, in grey, in Figure 2), contain fields describing the content of the document in terms of *events*, *people*, *organizations*, *collectives*, *social roles*, and *places*, referred to by the document itself (see the last six columns, with white background, in Figure 2).

The selected documents have been digitized, OCR-ized (when possible), and linked to the archival record on the *9centRo* platform.

Moreover, the content of the cards, built by historians analyzing documents, has been used, in turn, to build the *domain ontology* (HERO-900), i.e., the specific semantic model that refines HERO and contains concepts, properties, and relations characterizing the chosen domain (e.g., *Strike*, *PoliceCharge*, *TradeUnion*, …). In building HERO-900, this source of domain-specific information has been coupled with domain expertise directly provided by historians.

This "spiral" process is a concrete demonstration of one of the most important synergies the PRiSMHA project is based on, i.e., the synergy between the historical perspective, the computer science requirements, and the archivists support: We started from the dialog between computer scientists and historians; we built the top-level ontology; we used it as a lens to select and analyze archival documents; we exploited the document analysis – together with domain expertise – to build the domain ontology.

Moreover, this process provided us with the needed experience on the field that enabled us to define a virtuous procedural model, from the paper documents up to the digital "smart archivist", based on a close collaboration between universities and cultural and historical institutions.

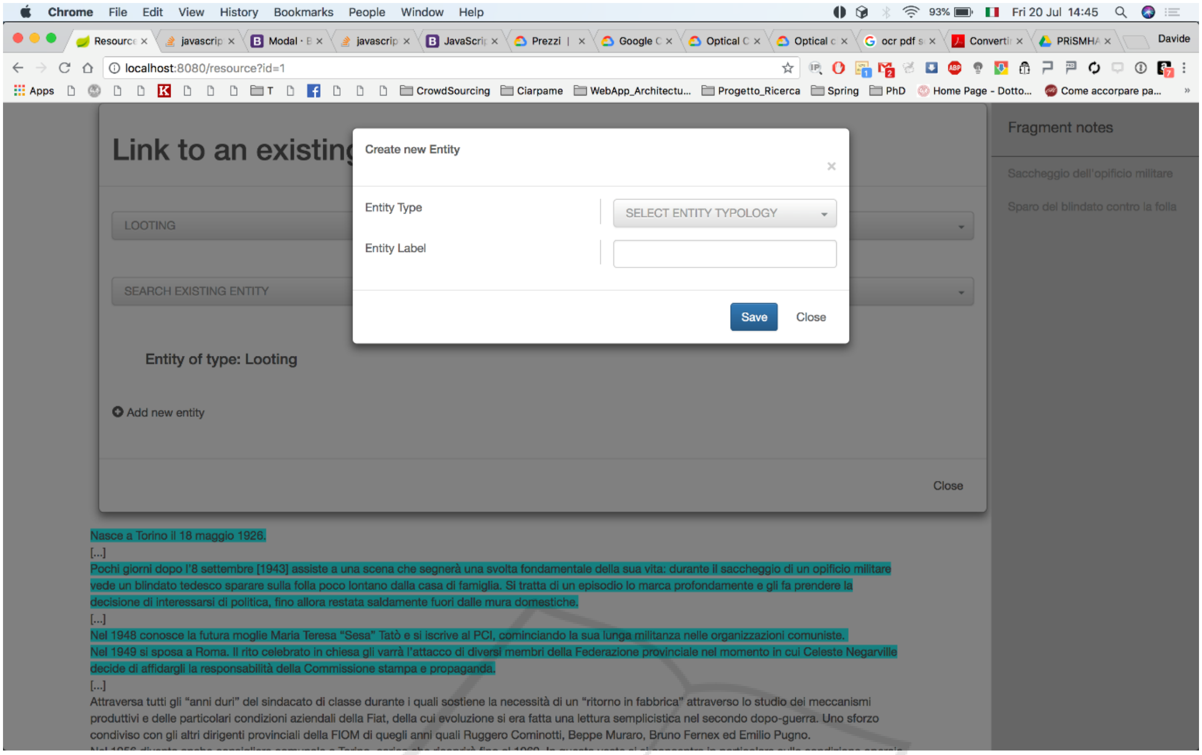
3.2 Building the Knowledge Base

Following an iterative methodology based on rapid prototyping, we designed and built a first prototype of the crowdsourcing platform, implementing a limited number of the functionalities that had emerged from the elicitation of user requirements and the definition of the use cases.

The current prototype offers a form-based User Interface that enables users to "annotate" archival documents with formal semantic descriptions of their content. Figure 3 shows a screenshot of the prototype, i.e., the page enabling the user to create a new entity to be added to the semantic knowledge base. The document lays in the background (relevant fragments are highlighted); a modal window enables the user to look for existing entities in the knowledge base or to add a new entity by clicking on the corresponding button: in this last case, a new modal window overlays the previous one, thus enabling the user to select the entity type (represented by a class in the ontology) and provide a label for the new entity.

The process of associating formal semantic representations to the documents is driven by the underlying ontology HERO-900, and aims at collaboratively building the knowledge base (encoded as a RDF triplestore) used by the system.

Meanwhile, we are investigating the exploitation of automatic Information Extraction on OCR-ized archival documents. This is a very challenging issue, due to the specific nature of texts in these documents (Rovera et al., 2017), (Moretti et al., 2016). We aim at studying how the output of such activity can provide an effective support to the annotation process on the crowdsourcing platform.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Link to an existing
LOOTING
SEARCH EXISTING ENTITY
Save
Close
Add new entity
Close
Fragment notes

Create new Entity

Entity Type: SELECT ENTITY TYPOLOGY

Entity Label:

Entity of type: Looting

Saccheggio dell'opificio militare

Sparo del blindato contro la folla

Nasce a Torino il 18 maggio 1926.
[...]
Pochi giorni dopo l'8 settembre [1943] assiste a una scena che segnerà una svolta fondamentale della sua vita: durante il saccheggio di un opificio militare vede un blindato tedesco sparare sulla folla poco lontano dalla casa di famiglia. Si tratta di un episodio lo marca profondamente e gli fa prendere la decisione di interessarsi di politica, fino allora restata saldamente fuori dalle mura domestiche.
[...]
Nel 1948 conosce la futura moglie Maria Teresa "Sesa" Tatò e si iscrive al PCI, cominciando la sua lunga militanza nelle organizzazioni comuniste.
Nel 1949 si sposa a Roma. Il rito celebrato in chiesa gli varrà l'attacco di diversi membri della Federazione provinciale nel momento in cui Celeste Negarville decide di affidargli la responsabilità della Commissione stampa e propaganda.
[...]
Attraversa tutti gli "anni duri" del sindacato di classe durante i quali sostiene la necessità di un "ritorno in fabbrica" attraverso lo studio dei meccanismi produttivi e delle particolari condizioni aziendali della Fiat, della cui evoluzione si era fatta una lettura semplicistica nel secondo dopo-guerra. Uno sforzo condiviso con gli altri dirigenti provinciali della FIOM di quegli anni quali Ruggero Cominotti, Beppe Muraro, Bruno Fernex ed Emilio Pugno.

Figure 3: A screenshot of the UI enabling the user to create a new entity to be added to the triplestore.

4 CONCLUSIONS AND FUTURE WORK

In this paper we have presented the mid-term results of the PRiSMHA project, that aims at contributing to the design and implementation of a web-based system providing an intelligent access to historical archives. In particular, we showed the products of the fruitful synergies between historical studies and computer science, as well as the results of the collaboration between research institutions and cultural centers. Such results include a *top/core ontology* (HERO) and a *domain ontology* (HERO-900), which together drive the User Interface of the prototype platform devoted to the user-generated semantic KB.

Plans for the next activities within the PRiSMHA project encompass:

- The evaluation of the mentioned prototype with users, in order to get a feedback for implementing the second version;
- The design of an enhanced interaction model for the crowdsourcing platform aimed at integrating suggestions coming from the Information Extraction tools.

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