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Archaeology in the Digital Age: From Paper to Databases

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Research units in archaeology often manage large and precious archives containing various documents, including reports on fieldwork, scholarly studies and reference books. These archives are of course invaluable, recording decades of work, but are generally hard to consult and access. In this context, digitizing full text documents is not enough: information must be formalized, structured and easy to access thanks to friendly user interfaces.

The situation at AOROC, a research unit of Ecole normale supérieure specialized in archaeology, is precisely the one described hereabove: several decades of research are contained in documents, which are hardly accessible, even for people working in the lab. The situation is such that researchers may produce studies largely overlapping with previous work, which remained unknown because of its poor accessibility.

A partnership has thus been established between AOROC and LATTICE, another research unit specialized in Digital humanities and natural language processing, to digitize and structure a part of these documents. A pilot study concerned a collection of texts covering excavations related to the Gaul period (*Cartes Archéologiques de la Gaule*, [Provost, 1988-]), over an area encompassing a large part of modern France from the Iron Age to the Medieval period (800BC to 800AD). 128 volumes have been published so far: each volume corresponds to one French department (some departments are covered by several volumes). The pilot study concerned three of these volumes, along with other types of documents so as to ensure the genericity of the developed solution. The idea is of course not just to digitize and transfer documents online but also to extract key information so as to feed structured databases (Poibeau et al., 2013). The result should be accessible using a standard but powerful query language.

A first step consists in recognizing the structure of the documents, which mainly consist in notices, each notice corresponding to a specific “municipality” (the structure is not formally encoded in the source documents and may vary from one document to the other). Specific zones inside the notices have to be recognized (see **figure 1**): this can be done by specific scripts but also needs some manual cleaning. In our opinion, the most interesting part concerns the natural language processing techniques used for information extraction. These include:

- Named entity recognition (i.e. the recognition of proper names, location, dates, etc.)
- Technical term extraction (i.e. all archaeological terms)
- Entity linking (i.e. the recognition of the different variants of a same term or entity and its connection to the same type of object in the database).

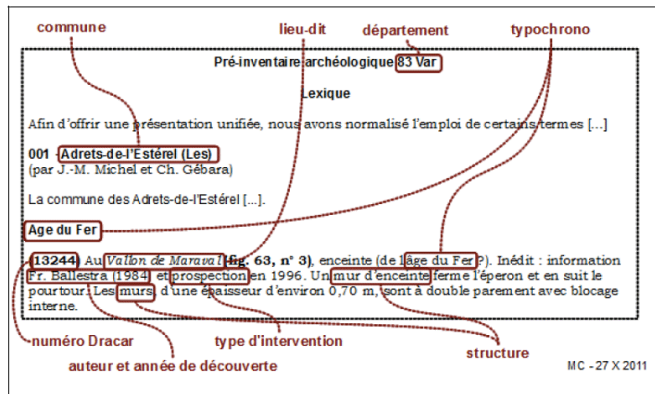


Figure 1: a typical notice with key information to be recognized

Different tools have been used, like TreeTagger (<http://www.cis.uni-muenchen.de/~schmid/tools/TreeTagger/>) for part-of-speech tagging, Yatea (<https://metacpan.org/release/Lingua-YaTeA>) for technical term extraction and TyDI for terminology structuration (<http://ciam.inra.fr/logiciels/node/195>). In-house solutions have been developed for document structure, named entity recognition and entity linking. All the modules are parameterized so that they can be easily adapted to new sources of data. These tools are based on up-to-date natural language processing techniques and have obtained excellent results in recent benchmarks like Semeval (Ruiz and Poibeau, 2015).

The result of the project made it possible to automatically feed a structured database based on the textual content analysis. Documents are now accessible online with full text facilities, structured indexes and ontologies (see figure 2). It is thus possible to interrogate the database with queries dealing with a specific location, a specific series of objects or a given period of time.

<p>GERARD COLLON JEAN DELMORI</p> <p>008 - Saint-Céols (I.N.S.E.E. n° 202)</p> <p>009 - Saint-Germain-du-Puy (I.N.S.E.E. n° 213)</p> <p><?xml version="1.0" encoding="UTF-8" ?> <?cracine <?departement profondeur="0" non="departement" pere="father" ...</dep <?chronologie profondeur="0" non="chronologie" pere="father" <?epoque protohistorique profondeur="1" non="epoque protohistorique" <?age du bronze profondeur="2" non="Age du Bronze" pere="epoque pr <?age du bronze final profondeur="3" non="Age du Bronze final" p <?fin de l. age du bronze profondeur="3" non="fin de l' Age du B </age du bronze" <?age du fer profondeur="2" non="Age du Fer" pere="epoque protobri <?debut du premier age du fer profondeur="3" non="debut du premi <?fin du premier age du fer profondeur="3" non="fin du premier A <?milieu de l. age du fer profondeur="3" non="milieu de l' Age d <?debut du premier siecle av profondeur="3" non="debut du premie <?debut du premier siecle av profondeur="3" non="debut du premie </age du fer" <?epoque du hallstatt profondeur="2" non="epoque du Hallstatt" per <?debut du hallstatt ancien profondeur="3" non="debut du Hallsta <?hallstatt ancien profondeur="3" non="Hallstatt ancien" pere="4 </epoque du hallstatt" <?la tene profondeur="2" non="La Tene" pere="epoque protohistorique <?tene ancienne profondeur="3" non="Tene ancienne" pere="La Tene <?tene moyenne profondeur="3" non="Tene moyenne" pere="La Tene" <?tene finale profondeur="3" non="Tene finale" pere="La Tene" <?epoque de la guerre des galles profondeur="4" non="epoque de </tene finale" </la tene" </epoque protohistorique" <?epoque medievale profondeur="1" non="epoque medievale" pere="chronologie" <?moyen age profondeur="2" non="Moyen Age" pere="epoque medievale" <?debut du moyen age profondeur="3" non="debut du Moyen Age" pere="debut du moyen age" <?haut_moyen_age profondeur="3" non="haut Moyen Age" pere="Moyen Age"/></haut_moyen_age" </moyen age" <?epoque merovingienne profondeur="2" non="epoque merovingienne" pere="epoque medievale"/></epoque merovingienne" <?epoque carolingienne profondeur="2" non="epoque carolingienne" pere="epoque medievale"/></epoque carolingienne" </epoque medievale" <?epoque chasséenne profondeur="1" non="epoque chasséenne" pere="chronologie"/></epoque chasséenne" <?epoque moderne profondeur="1" non="epoque moderne" pere="chronologie"/></epoque moderne" <?epoque gallo-romaine profondeur="1" non="epoque gallo-romaine" pere="chronologie" <?debut de l. epoque romaine profondeur="2" non="debut de l' epoque romaine" pere="epoque gallo-romaine" <?epoque tibereclaude profondeur="3" non="epoque Tibereclaude" pere="debut de l' epoque romaine" <?debut de l. epoque augusteene profondeur="4" non="debut de l' epoque augusteene" pere="epoque tibereclaude"/></debut de l. epoque augusteene" <?epoque augusteene profondeur="3" non="epoque augusteene" pere="debut de l' epoque romaine" <?epoque augusteene profondeur="4" non="epoque augusteene" pere="epoque augusteene" <?debut de l. epoque augusteene profondeur="5" non="debut de l' epoque augusteene" pere="epoque augusteene"/></debut de l. epoque augusteene" <?quart du premier siecle profondeur="5" non="quart du premier siecle" pere="epoque augusteene"/></quart du premier siecle" </epoque augusteene" </epoque augusteene" <?epoque augusteene" <?epoque augusteene profondeur="3" non="epoque augusteene" pere="debut de l' epoque romaine"/></epoque augusteene" <?epoque augusteene profondeur="3" non="epoque augusteene" pere="debut de l' epoque romaine"/></epoque augusteene" <?debut de l. epoque romaine" </debut de l. epoque romaine"</p>	<p>008 - Saint-Céols (I.N.S.E.E. n° 202)</p> <p>009 - Saint-Germain-du-Puy (I.N.S.E.E. n° 213)</p> <p>structure -- construction -- Evacuation des eaux -- aqueduc</p> <p>/moblier -- art</p> <p>/structure -- dépôt -- bâtiment</p> <p>/moblier -- récipient -- céramique</p> <p>/departement -- Cher</p> <p>/moblier -- objet domestique -- couteau</p> <p>/structure -- dépôt</p> <p>/moblier -- récipient -- dépotoir -- dépôt monétaire</p> <p>/structure -- funéraire -- enclos</p> <p>structure -- dépôt -- enclos quadrangulaire</p> <p>/moblier -- récipient -- céramique -- vase -- pot</p> <p>/moblier -- récipient -- seau</p> <p>/Ecofact -- silex</p> <p>/structure -- construction -- sol</p> <p>/structure -- non</p> <p>/structure -- habitat -- ville gallo-romaine -- villa romaine</p> <p>/structure -- ville</p> <p>/structure -- voie romaine -- voie</p>	<p>008 - Saint-Céols (I.N.S.E.E. n° 202) Aucun site archéologique n'est mentionné dans la bibliographie.</p> <p>009 - Saint-Germain-du-Puy (I.N.S.E.E. n° 213) Cette commune est traversée d'ouest en est par la voie Bourges-Sancerre : A. Buhot de Kersers, Statistique monumentale, I, 1875, p. 48 ; - M.-E. Fomvielle, J. Deguérêt, dans Cahiers du Berry, 60, 1980, p. 21-26, Aux Bourbards (fig. 15), sur la terrasse alluvionnaire, dans la vallée du Langis, J. Holmgren a découvert, en 1976, "une vaste villa gallo-romaine, avec cour centrale (d'au moins 180 m de long) et bâtiment principal à l'est ; le matériel céramique (sigillée, commune et Argonne) date des IIe au IVe s. ; A. Leday, La campagne, 1980, (I), p. 55, 64, 69, 80, 88, 101, 108, 110 et (II), pl. XII ; - J. Holmgren, A. Leday, dans Cahiers du Berry, 60, 1980, p. 9, pl. II-3 ; - Y. de Kisch, dans Gallia, 38, 2, 1980, p. 317 (prospection aérienne et au sol J. Holmgren et A. Leday) ; - O. Ruffier, dans Cahiers du Berry, 103, 1990, p. 63-64 ; - J. Holmgren, site 122. À Tierceville, J. Holmgren a photographié un enclos quadrangulaire : J. Holmgren, site 330. Au lieu-dit le Champ des Pierres ou le Domaine Neuf, près de Turly, on a trouvé, en 1867, des débris de tuiles à rebords, et quelques monnaies romaines du Haut-Empire (Domitien, Hadrien, Antonin, Marc-Aurèle, Gallien) ; A. Buhot de Kersers, Statistique monumentale, I, 1875, p. 47 ; - L. Martinet, Le Berry préhistorique, 1878, p. 101 ; - O. Ruffier, dans Cahiers du Berry, 103, 1990, p. 63-64. Au Domaine des Augustins, un antoninien de Claude II :</p>
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Figure 2: the original published text, along with some structured outputs after analysis

This work can be compared to other initiatives with a similar goal. In archaeology, one can cite archaeological archiving bodies such as the ADS (<http://archaeologydataservice.ac.uk/>), tDAR

(<http://www.tdar.org/about/>), or OpenContext (<http://opencontext.org/>), among others. Research on interoperability between archaeological databases includes, among many others (Binding et al., 2008; Doerr, 2003; Jordal et al., 2004; Vlachidis and Tudhope, 2012). Our project is different since it is from the beginning designed to deal with texts in different languages, especially French, German and English, with a cross-linguistic perspective. One of the major research issues is the maintenance of an international terminology referring to complex notions that can vary from one country to the other. The system should be flexible enough to be able to match related concepts (even if they vary slightly from one source to the other), but relevant enough so as to provide only relevant information. This goal involves a permanent dialogue between experts of the domain and the maintenance of an up-to-date terminology. The tools and interfaces developed within the project should help to keep this goal a reality as much as possible.

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