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A ontology for sharing open educational resources: the case of statistics teaching

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For statistics, as in many other fields, the amount of open or editorial educational resources available on the web is colossal. It is an essential aid for students, especially in distance education, who often complete their courses with search on the Internet. However, this opportunity requires, both for learners and teachers, to possess many skills in order to navigate in these resources, such as the ability to search and sort information, and then to extract and exploit useful elements (Terras, Ramsay, & Boyle, 2013). However, several studies show that beyond the individual factors, the complexity of the domain is a determining factor (Cravalho, 2010; Onwuegbuzie, 2003). It is possible to help the learner by working on the conceptual framework of the domain with concept maps, for example (Chei-Chang Chiou, 2009; Meunier, 2017; Roberts, 1999; Sander, Meunier, & Bosc-Miné, 2004), but the advances in web technologies and human learning computer environments encourage us to go much further.

The convergence of these two problematics, facilitating the organization of knowledge in the learner and structuring a set of educational resources in order to facilitate access and understanding, has oriented us towards semantic Web technologies. We propose an ontology of statistical concepts. This project, called ONTOSTATS (<http://gapai.univ-paris8.fr/ontostats/>) received the support of the French Ministry of Higher Education, Research and Innovation. The ontology in its current version contains 600 terms in 27 languages and indexes the corresponding Wikipedia pages and slightly less than 450 resources coming from the French thematic digital universities.

An ontology is a knowledge management system that makes it possible to explain relationships between concepts. Much more than a thesaurus organizing a set of terms, it allows us to describe in a machine-readable language a set of knowledge. For statistics teaching, as in many other fields, an ontology offers several advantages.

The first application is **knowledge sharing**. The ontology consists of a vocabulary used to label concepts and relationships between these concepts. The dissociation of labels and concepts allows for a multilingual description of the domain of knowledge. Relationships are class inclusion relations, but also properties or attributes that can take on multiple values. They allow us to infer what is usually implicit in the discourse.

These inferences are particularly useful in **decision support systems** such as those that have been developed in the medical field (Guefack Donfack, 2013; Raby & Ravaut, 2011). In statistical education, the equivalent of diagnosis is the identification of the appropriate procedure. Ontology is

not a simple decision tree. It offers a conceptual approach that allows the learner to see the prerequisites, limitations and justifications that lead to the choice of a procedure. Such a decision-making aid is useful not only to the learner but also to the practitioner, particularly non-statistician researchers, who can thus verify their methodological choices.

Ontologies also present numerous advantages for **pedagogical resources indexing** compared to using a norm (Bouzeghoub, Defude, Duitama, & Lecocq, 2005). If the author is not exhaustive, the system can deduce other relevant concepts for indexing the resource. The ontology description and query language is also designed to ensure interoperability between the computing devices using it.

However, it is mainly to **construct support-learning devices** that ontologies are promising. They provide a conceptual model for studying learning difficulties, but also errors of reasoning that students can make. An ontology can thus be used to design training paths by adapting the structuring of the pedagogical sequences (Guo & Chen, 2007), to design resource recommendation systems based on the relationships between the concepts (Shen & Shen, 2005), and also, when the ontology is associated with learning analytics, course personalization (Castro & Alonso, 2011) and learner assessment (Romero, North, Gutiérrez, & Caliusco, 2015).

With the Ontostats project, we aim to develop a collaborative and multidisciplinary approach for study learning difficulties, develop OER sharing and appropriate aids. Beyond the technical device, we believe the heuristic value of such approach.

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