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Innovation in Information Technology for Biomedicine: Ontologies Applied to the Systems Interoperability

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Abstract

Biomedicine is a vibrant field identified with a continuous in innovation. To address the vast amounts of biomedical data, before innovating, one needs to interoperate data between information systems. Here we provide a brief account of the pioneer initiatives to foster systems integration.

Keywords: Innovation for Biomedicine; Top-level ontology; Systems interoperability; Information technology

Introduction

The ability to provide innovative, efficient, and quality digital services to society depends on the proper administration of financial, human, technological, and informational contributions that maintain the dynamic of its key sectors. Healthcare is an excellent example of these sectors. Within healthcare, innovations in information technology strive to promote and maintain healthcare services through "patient-centered" solutions, providing synchronous information to each citizen, regardless of the geographic location. Accordingly, actions to achieve "interoperability" between information systems are essential. Such a need poses significant challenges regarding innovation [1]. Interoperability is the capacity of information systems to communicate and exchange data without human intervention.

The Costs of the Lack of Interoperability

The economic impacts related to the interoperability gap between healthcare segments are striking.

In the year 2010, the US Institute of Medicine estimated high costs in dollars, in the range of billions to cover:

1. The unnecessary use of healthcare services (210 billion);
2. The inefficiency in the provision of healthcare services (130 billion);
3. High price of healthcare services (105 billion);
4. Administrative costs (190 billion);
5. Missed health prevention opportunities (55 billion) and
6. Fraud (75 billion) [2].

The American West Health Institute estimated, early in 2013, a potential of 30 billion dollars of annual waste related to healthcare. In Europe, the increase in life expectancy and the prevalence of chronic conditions consumed around 80% of national health budgets. On the other hand, there is an estimated savings of 99 billion euros in healthcare costs for the European Union GDP due to improvements in interoperability for digital healthcare [3]. Hence, the economic factor is crucial in interoperability.

Addressing Interoperability Issues

Interoperability issues must be addressed from multiple perspectives so that it is possible to articulate efficient outreach strategies. From an organizational perspective, it refers to the ongoing process of ensuring that systems, business processes, and corporate cultures are effectively managed, seeking to maximize opportunities for sharing information, knowledge, and services. It is recommended to enable devices and systems to connect securely and efficiently, with little or no inconvenience for users, also considering the adoption of intelligent agents as information sources and repositories. Architectural connections, access, exchange, integration, or combination in addition to the cooperative and coordinated use of data must be allowed, without borderlines between organizations, in seeking the maximum of continued data portability [4,5]. Reaching organizational interoperability demands attention to the issues that precede it in order of complexity: technical, syntactic, and semantic-after this reach, seeking it from an intercommunity, legal and international focus.

Ontologies Provide a Roadmap

Adopting interoperability architectures based on top-level ontologies favors the reach of the first four types of interoperability, with perspectives of saving time and computational processing resources in favor of a more precise semantic space. Top-Level Ontologies (TLO) are characterized by not being connected to knowledge domains. They share categories and cover various theories, supporting collections of mutually consistent and non-redundant ontologies [6]. They comprise formal theories that gather together philosophy and logic to promote investigations into reality in its structural aspects. The formal writing of definitions for each entity and the proposition of axioms that maintain the unique understanding of the structure allow inferences that reveal implicit knowledge [7].

Among the existing TLOs, the Basic Formal Ontology (BFO) presents a set of characteristics that make it preferable for the design of interoperability architectures in biomedicine:

A. Philosophical contributions combined in the ontological realism approach-a theory and methodology for the construction of interoperable ontologies;

B. A collaborative development community, composed of multidisciplinary experts organized in the Open Biomedical Ontologies (OBO) Foundry consortium with the support of the National Center for Biomedical Ontology (NCBO);

C. Governance principles over the ontology repository [7]. The reliability regarding the use of BFO as a resource for mitigating interoperability is sustained due to its reuse in more than 300 projects [8] its use in ISO/IEC PRF 21838-2.2-Information technology-Top-Level Ontologies (TLO)-Part 2: Basic Formal Ontology (BFO).

When used to support semantic interoperability architectures, TLOs offer benefits for articulating people, processes, and technologies in corporate environments, with positive impacts from several perspectives, namely, the human, the technological, the processual, and terminological [9,10].

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