Fujitsu HIKARI, a Healthcare Decision Support System based on Biomedical Knowledge

Boris Villazon-Terrazas, Fujitsu Laboratories of Europe, Madrid, Spain
Nuria Garcia-Santa, Fujitsu Laboratories of Europe, Madrid, Spain
Beatriz San Miguel, Fujitsu Laboratories of Europe, Madrid, Spain
Angel del Rey-Mejías, Innovation Unit, Instituto de Investigación Sanitaria, Hospital Clínico San Carlos, UCM, Madrid, Spain
Juan Carlos Muria, Fujitsu Technologies Solutions, Valencia, Spain
Germán Seara, Unidad de Innovación, Hospital Clínico San Carlos, Madrid, Spain
Blanca Reneses, Instituto de Psiquiatría. Instituto de Investigación Sanitaria. Hospital Clínico San Carlos, Madrid, Spain
Víctor de la Torre, Fujitsu Laboratories of Europe, Madrid, Spain

ABSTRACT

Fujitsu HIKARI is an artificial intelligence solution to assist clinicians in medical decision making, developed in the context of a joint collaboration project between Fujitsu Laboratories of Europe and Hospital Clínico San Carlos. This decision support system leverages on data analytics combined with healthcare semantic information to provide health estimations for patients, improving care quality and personalized treatment. Fujitsu HIKARI stands on the shoulders of biomedical knowledge, which includes (i) theoretical knowledge extracted from scientific literature, domain expert knowledge, and health standards; and (ii) empirical knowledge extracted from real patient electronic health records. The theoretical knowledge combines a theoretical knowledge graph (TKG) and a biomedical document repository (BDR). The empirical knowledge is encoded in an empirical knowledge graph (EKG). One of the main functionalities of Fujitsu HIKARI is the patient mental health risks assessment, which is based on the exploitation of its underlying Biomedical Knowledge.

KEYWORDS

Decision Support System, Healthcare, Knowledge Graph, Knowledge Representation, Medical Assistant, Ontology Integration, Personalized Medicine

INTRODUCTION

Biomedical knowledge bases (KBs) have become important assets in life sciences. Many of such biomedical knowledge bases are published as knowledge graphs (KGs) (Messina et al., 2017). In KGs, nodes are entities, which might include drugs, diseases, protein targets, substructures, side effects, pathways, etc. The edges represent the various relations among nodes. Such knowledge graphs can be deployed following linked data technologies, or any other graph related technology, e.g., property graphs (Bonnici et al., 2014).
Independently of the underlying technology, several studies have been focused on the construction of Knowledge Graphs for modelling and linking a wide variety of healthcare standards, and biomedical data sources (Hu et al., 2016). For example, the linked life data repository (2012) currently stores 10,192,505,364 statements. However, prior work on KB construction has three major limitations. First, most biomedical KBs are manually constructed and curated, and therefore cannot keep up to date with the rate at which new findings are published. Second, for automatic information extraction, the text genre of choice has been scientific publications, with less usage of resources like online communities and health portals. Third, large information extraction efforts have been mostly driven by the molecular biology/bioinformatics research communities, so the complexity of the medical domain is not yet fully covered (Williams et al., 2012).

The potential of modelling biomedical knowledge with knowledge graphs is huge, and some studies already demonstrate how useful this technology can be (Machado et al. 2015). In particular, one of the areas that is attracting the attention of the scientific community is the study of mental disorders (Taggart, 2016). Mental disorder is a leading disease burden (e.g. 4.4% of global population with depression in 2015 or 3.6% with anxiety disorders), estimated by World Health Organization (WHO) (2017). In UK, and major western European countries, mental illness is considered one of the biggest challenges of modern society. It is estimated that one in four residences in the UK is directly affected by mental illness, while 27% of the total adult European population experienced a certain type of mental disorders (Taggart, 2016).

In this context, depression is a common illness worldwide, with an estimated 350 million people affected. Especially, when long-lasting and with moderate or severe intensity, depression may become a serious health condition. It can cause the affected person to suffer greatly and function poorly at work, at school and in the family. At its worst, depression can lead to suicide. Over 800 thousand people die due to suicide every year, being suicide the second leading cause of death in the range of 15-29-year-olds (Taggart, 2016).

This paper presents Fujitsu HIKARI, a decision support system that relies on a KB called biomedical knowledge. HIKARI biomedical knowledge combines (1) theoretical knowledge extracted from scientific literature, domain experts, and health standards with (2) empirical knowledge extracted from the real patient Electronic health records (EHRs); and helps to assess potential patient health risks. Specifically, Fujitsu HIKARI estimates the risk of a patient of committing suicide and having an abuse of different substances such as alcohol, cocaine or cannabis. Fujitsu HIKARI is being developed in the context of a joint collaboration project between Fujitsu Laboratories of Europe and Hospital Clínico San Carlos.

The rest of the paper is organized as follows. First, the state of the art regarding decision support systems and biomedical knowledge graphs is presented. Second, the whole system of the Fujitsu HIKARI biomedical knowledge is described. Next, the exploitation of this knowledge and its initial evaluation are explained. Finally, conclusions are drawn in the last section.

BACKGROUND

Decision Support Systems

Decision support systems (DSSs) are interactive computer-based systems that aid users in judgment and choice activities. These systems do not only provide information, but also participate in even simple decision-making activities of any organization (Druzdzel et al., 1999; Shahsavaran et al., 2015). DSSs use data mining, KBs, statistics, data patterns, etc. to provide initial assessments and propose decisions to the domain experts. This nature of the DSSs makes them as useful tools in dynamic environments where it is needed anticipated quick decisions.

In the healthcare area, clinical decision support systems (CDSSs) are interactive DSSs that assist physicians and other health professionals with decision-making tasks. Three main types of CDSSs
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