Chapter 1
Integrating Knowledge-Driven and Data-Driven Methodologies for an Efficient Clinical Decision Support System

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ABSTRACT

Clinical decision support systems (CDSSs) symbolize a significant transformation in healthcare delivery. CDSS enhances healthcare delivery by enabling personnel in medical institutions to handle complex decision-making processes with great speed and high accuracy. Decision support systems are developed using a knowledge-driven or data-driven approach, although both approaches seem to complement each other. For instance, while data-driven is an objective approach, the knowledge-driven approach is subjective. The objective of the chapter is to elaborate on the integration of data-driven and knowledge-driven methodologies for clinical decision support systems. An overview of data-driven and knowledge-driven approaches is presented with a review of both current and dated literature on the subject with numerous viewpoints to support the discussion. Based on the findings, a promising methodology is proposed that integrates data-driven and knowledge-driven approaches and is believed to overcome the challenges of the individual approaches.

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INTRODUCTION

Decisions are made based on rules, data, business models and documents. In an attempt to solve problems that will help an organization in making an informed decision, some constraints and limitations are encountered which need a tool to assist in overcoming them. A Decision Support System (DSS) is a tool that assists a decision-maker to overcome the limitations and constraints that are capable of hindering an informed decision making for an organization. Decisions are made based on rules and beliefs to guide the existence of all beings and structures and the system under them. Rules must however be represented logically to become a source of knowledge. An expert needs rules to guide the operations of his function and spends time studying the rules and the principles. Aside from the rules, an expert needs to observe samples (data) of what he and some of his colleagues have done using the rules and principles of their profession. Sometimes the expert discovers that these observations (data) are not necessarily mutually consistent in a logical sense since gathered data can be easily dissonant (Dubois et al., 2000, Obot et al, 2019).

At a certain stage of his practice, an expert depends so much on these observations (data) than on the application of rules. Decisions are taken based on the experience and the knowledge acquired from the observation and training. Such experiences and knowledge are stored as cases in the computer memory and could be retrieved, reused, revised and retained in a reasoning methodology known as Case Based Reasoning (CBR). Adaptation of an old case as a new case poses a difficult task in CBR, especially in some domains that are time-bound. However, the fact that one can learn from failure (failed case) makes CBR an approach of choice in DSS. CBR improves over time as the number of cases grows and with increased chances of getting data readily or with little stress, though these datasets have to be organized and indexed into cases. CBR and Rule Base Reasoning (RBR) are complementary approaches to building knowledge-based intelligent decision support systems (Berka, 2011).

Artificial Neural Networks (ANN) is a knowledge representation approach that mimics the behavior of the human neural system like the brain with the interconnections of billions of human neurons. In ANN, the nodes hold information that is transmitted to every other neuron connected to it via the weight that depicts the knowledge of the system. Classification patterns are made based on the data provided to the networks, and the results of computations are improved with the growth of data. The methodology of ANN is driven by data to store knowledge on the weights of the network.

Big data analytics also play a vital role in a data-driven DSS. Big data is the measured amount of unstructured data, including the technology for extracting and analyzing useful information from it. It is concerned with employing the veracity, volume, velocity, variety and value of digital data to make informed decisions that impact positively the growth of an organization. Big data enables the extraction of better knowledge needed to drive an organization. These datasets are easily obtained due to the high penetration of internet and mobile devices in the communities which has increased usability amongst the populace. The processed data could help reveal hidden patterns, market trends, customers' preferences and other useful information in order to make useful decisions (Riahi & Riahi, 2018). This approach, which is often referred to as data mining, helps to ask and answer questions such as: Who are the most regular patients in the hospital? What medication is most or least needed on weekends? What trend is the most successful in the rainy/dry season? Due to the complexity of big data, it is reasonable to apply artificial intelligence tools in extracting hidden information through the process of learning and adaptation.

The chapter is organized into seven main sections. The first section is the introduction, which provides an overview of the chapter. The second section, which constitutes the background, presents the different

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