A Comprehensive Analysis of Big Data Analytics and its Application in the Health Sector

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ABSTRACT

Health organisations gather more data faster from a more extensive range of sources daily. Examining this enormous volume of data opens up new avenues for providing cutting-edge, individualised social and health services.

The utilisation of Big Data Analytics and its supporting technologies can facilitate the processing and analysis of data to derive significant insights that can enhance the quality, sustainability, and efficiency of health and social care systems. As a result, health organisations face a new situation where analytical tools must support both Big Data and traditional business intelligence methodologies. This presents significant methodological and technological problems. We provide a methodological approach in this study to address the integration of Big Data Analytics technologies into an integrated care provider.

INTRODUCTION

Health and social care service providers now have more opportunities to improve patient outcomes, lower costs, and provide higher-quality treatment because of the digitalization of medical records [1]. Organizations can create a rich, holistic view of each patient by combining electronic health records (EHRs) with other data sources like medical images, physician notes, enterprise resource planning (ERP), and information gathered from monitoring devices. This leads to more individualized health and social care services. Furthermore, by combining data from the social, demographic, environmental, and behavioural domains, new patterns that could have remained undetected could be found. Therefore, analysing these data will be the primary force behind changing how health and social care services are provided, enabling patients to take charge of their health and promoting the health and social care systems' effectiveness, quality, and sustainability [2].

However, organisations need to implement innovative strategies and solutions that can aid in processing the multitude of sources to produce relevant insights, given the variety, volume, and velocity of health data. Big Data analytics, which uses technologies that provide hitherto unheard-of possibilities to store, analyse, and visualise datasets in ways that would not have been conceivable previously, can be crucial to accomplishing this goal [3]. Analytical platforms must adapt to support both approaches because health organisations still require "classical" tools and techniques for data processing, structure, and analysis (such as Data Warehouses, OLAP analysis, etc.). This suggests significant technological obstacles and scientific, managerial, and legal difficulties. In this work, we outline the main components of our methodological strategy to deal with these issues and provide an analytical framework that is scalable, adaptable, and easily matched to a broad range of needs.

PUTTING BIG DATA ANALYTICS ANDHEALTCARE IN PRACTICE

Healthcare analytics offers procedures and techniques for taking unprocessed medical data and turning it into new, insightful information that helps make cost-effective healthcare decisions. As seen in Figure 1, the primary goal of integrating Big Data and health data analytics with other academic fields like the social and behavioural sciences is to create a novel analytical framework that enhances the entire health continuum (promotion, prevention, diagnosis, treatment, recovery, and care/chronic). In this vein, new avenues for identifying population health trends, enhancing disease prevention, and developing more advanced diagnostic tools become possible by integrating health records with social and demographic data. Additionally, the integration of behavioural science and medical records offers a

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more comprehensive view of human health, opening up new avenues for the promotion of good behaviour as well as new tools for developing individualised, data-driven health recommendations and medical interventions.

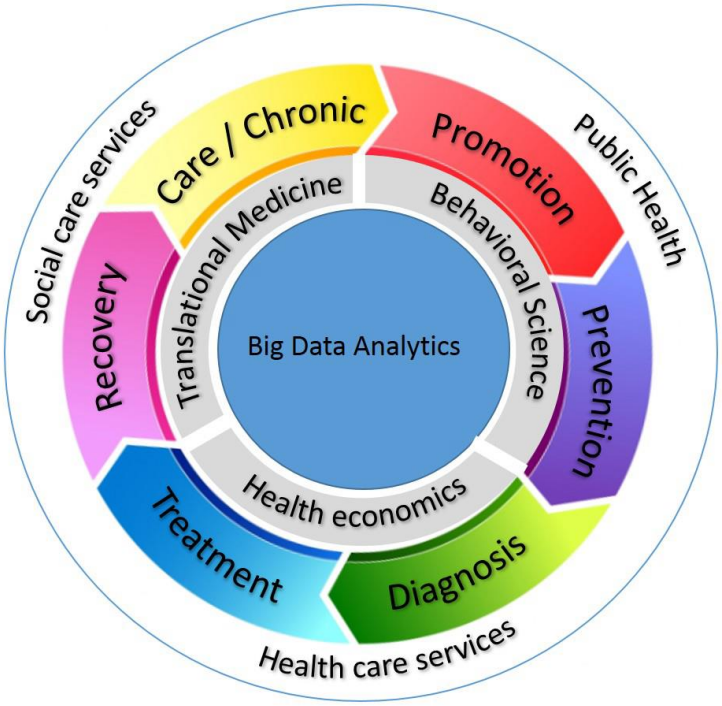

Figure 1. Health Big Data Analytics approach

Thus, this strategy promotes better patient outcomes and higher care quality, better patient population health, and longer-term viability of the health and social care systems.

A. Challenges, methodology and design guidelines

The speed of advancements in the Big Data technological dimensions is vertiginous, which represents important challenges when deciding to implement this type of projects and technologies in a health organization. Some examples of the challenges to deal with are, for example, the creation of technological silos within the organization, the speed of technology evolution, shortage of suitable computing skills, stability of solutions, and the lack of well-defined requirements.

The implementation of Big Data Analytics as a business support is therefore not easy, fast or cheap. Consequently, to tackle these challenges we propose a methodology and strategy for the implementation of the analytical framework closer to real needs by deploying the technology platform through concrete analytical projects avoiding the creation of technological silos. This approach allows to tailor the development and configuration of the platform to specific functional and analytical requirements, which facilitates its deployment and validation and reduces the degree of freedom in decisions about technologies and solutions to use.

In view of the different analytical requirements of each specific analytical project, the technological platform to be implemented should be easily adaptable to different scenarios, covering both a more traditional analytical approach and more innovative environments where technologies associated with Big Data Analytics are needed.

In this context, several decisions should be made with respect to the data storage approach, distributed design, tool selection and analytics models. To this end, we consider the following design guidelines:

- Heterogeneous data.
- Distributed computing.

Big Data is not only about the size of data but about the ‘size’ (i.e. the complexity) of the analytics. Indeed, ‘Big Analytics’ over ‘Not too BigData’ can become a Big Data problem. Therefore, the framework must include distributed storage and computing capabilities.

- Use of metadata

Metadata is a key tool in Data Governance processes as they facilitate their interpretation and use by both individuals and automated processes. Data Governance means managing the data to adopt an integrated and transversal vision of the data across the whole organization.

- Flexibility and agility

The analytic pipeline must be agile and flexible enough to adapt to evolving analytical requirements.

- Open Software, and documentation and community resources, solutions stability and use of standards.

B. Challenges, methodology and design guidelines

Taking into account the methodology and the design guidelines explained previously, we present an analytical framework that capitalizes on the recent advancements on various technologies such as big data processing and storing and virtualization to build a flexible, scalable data management and analytics platform that supports various categories of analytics functions for heterogeneous healthcare data sources. Figure 2 provides the conceptual view of the proposed architecture with the different levels and the main components considered.

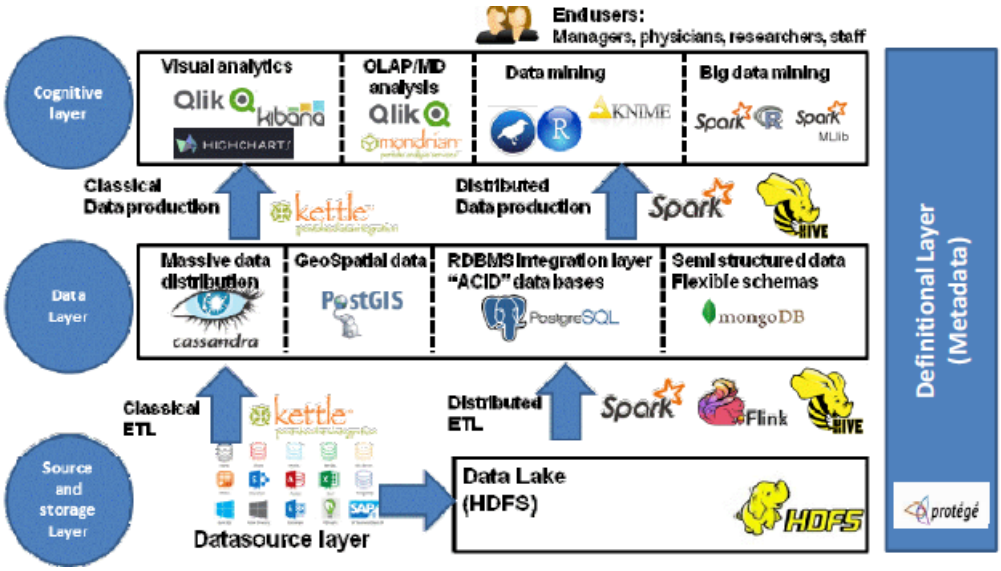

Figure 2. Conceptual architecture of the proposed analytical framework

CONCLUSION

Big data analytics has emerged as a nascent field in the health domain raising many promises and challenges. To tackle both, there is a need to implement specific solutions in real scenarios to materialize the potential benefits overcoming the barriers. Our methodological approach comprises a flexible, scalable analytical framework that is easily adaptable to a wide array of requirements. This approach allows us to deploy big data analytics to a wide range of scenarios addressing the specific needs of an integrated care organization. Additionally, the proposed approach and framework allows us the introduction of new analytic practices and technologies in a gradual manner, coexisting with classic technologies but avoid the creation of technological silos which is often an undesired side effect of pilot-driven implementation approaches.

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