

LARIISA: an Intelligent Platform to Help Decision Makers in the Brazilian Health Public System

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ABSTRACT

LARIISA is an intelligent framework for decision-making in public health systems. The project had its initial ideas conceived in 2009. Since then it has evolved in the academic and market perspective, becoming a product in 2018 called GISSA. This article presents the architectural evolution of LARIISA, the functionalities implemented, the scientific and commercial results achieved with GISSA. Ontology and Data Mining (DM) are technologies that support their inference mechanisms. A semantic portal is proposed for GISSA and a DM application is presented.

CCS CONCEPTS

• **Applied computing** → **Health care information systems**; *Enterprise data management*.

KEYWORDS

Intelligent Health System, Data Mining, Ontology

ACM Reference Format:

Luis Odorico M. Andrade, Raimundo Valter, Ronaldo Ramos, Vania Vidal, Daniel Andrade, and Mauro Oliveira. 2019. LARIISA: an Intelligent Platform to Help Decision Makers in the Brazilian Health Public System. In *Brazilian Symposium on Multimedia and the Web (WebMedia '19), October 29–November 1, 2019, Rio de Janeiro, Brazil*. ACM, New York, NY, USA, 4 pages. <https://doi.org/10.1145/3323503.3362122>

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WebMedia '19, October 29–November 1, 2019, Rio de Janeiro, Brazil

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ACM ISBN 978-1-4503-6763-9/19/10...\$15.00

<https://doi.org/10.1145/3323503.3362122>

1 INTRODUCTION

Among the challenges of information management in the health area, we highlight the difficulty faced by a significant part of managers to act efficiently on decision-making processes. To address some of these challenges, a framework called LARIISA [7][2] was originally conceived to support decision-making processes concerning public health governance.

LARIISA was specified in 2009 taking into account specific requirements of five governance fields: Knowledge Management, Systemic Normative, Clinical and Epidemiological, Administrative and Shared Management [7][2][5]. This framework is an intelligence solution that aims to specify and implement, from an analytical and experimental study of Context-Aware [3] Data Mining (DM) [6] technics, data warehouse, ontologies, and mashups [13]. The knowledge management framework is the platform component responsible for turning it in a basis for building smart systems. This segment considers three blocks namely inference engine, semantic search, and DM.

The intelligence management model comprises the adequacy of the mining block data to the knowledge management component (Intelligence). Comparative analysis of pattern recognition algorithms requires a deep study to define which is the best suited DM model. Moreover, it is also important to analyze how the system should (or not) learn after the inclusion of new information using ML techniques.

GISSA [8][4] is an instance of LARIISA, made for a Health Ministry program, named Stork Network, whose objective is to preserve the pregnant women's and fetus' health, especially in the first year of the newborns live. Infant mortality is a problem that affects all countries, with a higher incidence in those socially underdeveloped. According to the United Nations (UN), the death rate in Brazil fell 77% in 22 years [1]. Despite of this reduction, that rate is still considered very high. With the recent advances in information technology, much has been done to assist health systems managers in

decision-making processes, which are the use of intelligent solutions.

A GISSA prototype was implemented in 2014. It has the following functionalities: generation of risk alerts for live births with low weight alerts about delayed vaccination, prenatal cares, vaccination campaigns, among others. GISSA becomes a commercial product in 2018. It uses the SIM (data about infant mortality) and SINASC (live birth data) database systems, which belongs to DATASUS company (public data processing company), and provides a predictive model capable of detecting future cases of infant mortality, enabling decision makers to do something to mitigate the problem.

This paper is organized as follows. Section II presents the LARIISA platform, describing the importance of the ontology in their conception. Section III shows the GISSA Architecture and their intelligent aspects. Section IV describes the Data Mining application implemented in the GISSA product. In the Section V the GISSA Product is presented. Finally, it is discussed the importance of the LARIISA Project that brings real intelligence to the GISSA platform.

2 LARIISA GOVERNANCE SETTING

Knowledge Management

It comprises strategies/practices used by organizations for identifying, creating, and representing health care experiences. These strategies/practices are used for maintaining/transferring that experiences by using formal research and empirical processes, and other ways for generating new knowledge and improvements.

Systemic Normative

It refers to the participation of public officials and health managers for using and drafting laws in order to generate standards for consistency, concreteness, and certainty of health systems.

Clinical and Epidemiology

It ensures the knowledge of health-disease processes, from the concept that health is determined by biological, social, economic, genetic, and lifestyle factors, influencing the service of health care systems.

Administrative. It refers to the act of directing professionals for accomplishing a determined goal and the responsibility for maintaining/supervising the entities related that goal.

Shared Management

It refers to the ability of knowledgement sharing in health systems, providing global management visions of internal processes, government skills, society experiences, and their representative institutions, keeping a harmonic relationship with other federal states and international entities.

3 GISSA INTELLIGENT ARCHITECTURE

The GISSA Architecture (Figure 2) is a solution created from LARIISA to build a Decision Support System for the Brazilian Health Ministry in the context of the "Stork Network" project. A GISSA prototype was used as a proof of concept (PoC) in the municipality of Taua, CE, Brazil.

The framework GISSA consists of a set of components that allow to collect, integrate and visualize relevant information to the decision making process [11]. Currently, GISSA has alert systems to low weight newborns, delayed vaccination, prenatal care, and vaccine campaign, among others.

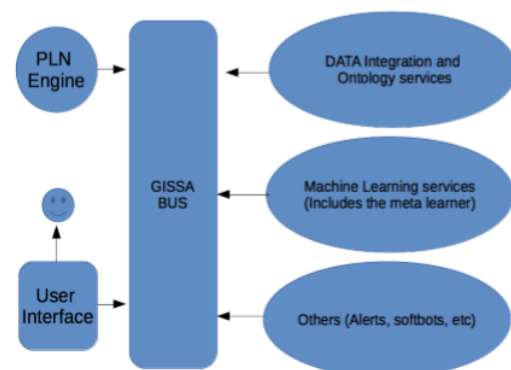


Figure 1: GISSASmart Model Components.

As shown in the Figure 1, the GISSA framework uses several smart computing tools in a service oriented approach. They vary from the ontologies mechanisms, which are used primarily for the databases integration, to the natural language processing engine, and the meta-learner.

The meta learner consists in the implementation of a strategy of selection of learning models that best fit the selected datasets. This system follows the work previously performed by [12] whose purpose is to select the best ML model to the context. Figure 2 presents the GISSA meta learner architecture. The steps of the meta learner work are described below. 1) Performance evaluation of Selected models; 2) Data preparation; 3) Iterative construction of models; 4) Selection of The best approach; 5) Setup the correct model for production.

4 DATA MINING APPLICATION

When considering GISSA context, collecting some data during each gestation stage period allows generating relevant information to identify death risk for mothers and babes using DM process.

Collecting data at every single moment in gestational period allows predict the death risk identification for maternal, neonatal and infant patients with different pattern recognition models. These predictive models could be applied at

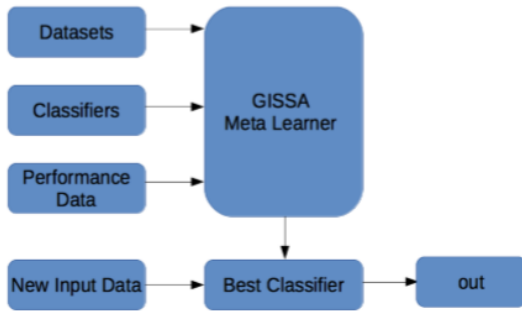


Figure 2: Gissa Meta Learn.

different stages of gestation and baby development. This individualized or joined information may be used to support public health strategies.

Results indicates that it is possible to identify risk of maternal death in more than 90% of the cases starting from scenarios with only three characteristics. For infant and neonatal mortality from 15 characteristics it is possible to identify the risk with 80% accuracy.

The selected predictive models for each addressed classification scenario (maternal, neonatal and infant) are serialized and available in a restful API. This software modularization allows simple integration with GISSA (mobile or web).

The intelligence module uses supervised machine learning classifiers to compute predictions and probabilities. A total of 27 predictive models is generated for neonatal mortality, 27 models for infant mortality and 18 models for maternal mortality. Figure 3 show the death risk estimated in a population of 86 mothers assisted by the public health agent in a given area of interest.



Figure 3: Aggregated Death Risk for a set of assisted Mothers.

5 GISSA PRODUCT

As previously mentioned, GISSA is a commercial product that resulted from the scientific and technological evolution

of the LARIISA Project. Currently, GISSA [1][11] is operated in Brazil in a dozen cities in Cear a and S o Paulo states.

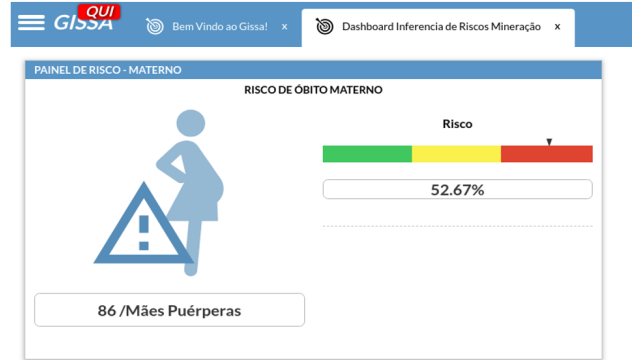


Figure 4: Desktop and mobile GISSA application.

GISSA is a cloud platform available to several stakeholders in the management of the municipal health system. It provides contextualized and responsive time information to qualify and facilitate the decision-making process. GISSA collects data that is already present in mandatory health databases for all cities. After data collection, these are processed and aggregated. Intelligent mechanisms are then applied, making dashboards, reports and alerts available to users via both the Web and Mobile Apps.

In addition, the GISSA platform allows new databases and the connection with mechanisms of prediction and context detection (Artificial Intelligence), for instance, a clinical and social risk inference for maternal and infant death. GISSA has an expanded view of management, taking into account management from epidemiological to financial and regulatory aspects.

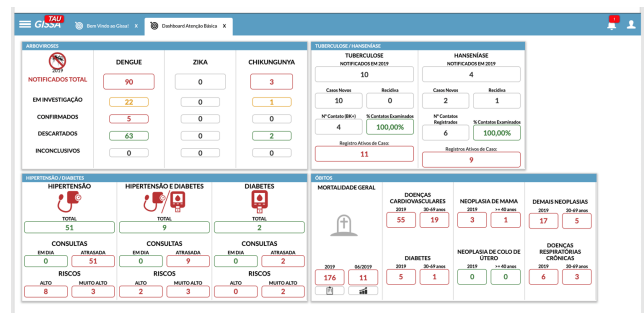


Figure 5: GISSA’s dashboard and alerts.

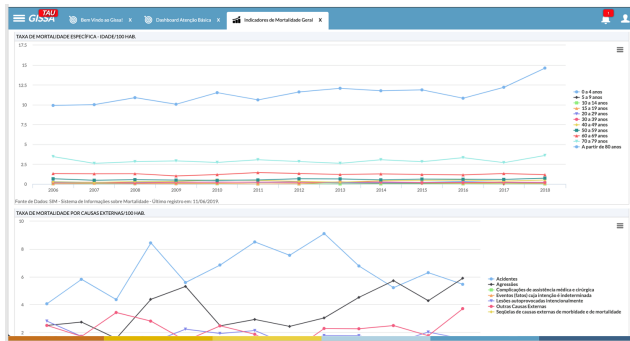


Figure 6: GISSA health indicators graphics.

6 CONCLUSION

According to the World Health Organization (WHO) [10], [9], many of the maternal and infant deaths are due to gestation or parturition complications and can be avoided. Health parameters monitoring is a key activity to reduce maternal, neonatal and infant mortality rates. GISSA is an intelligent system projected for this purpose.

As we can observe, this work does not present related works. Interestingly, we do not find relevant intelligent platforms similar to GISSA in preventing and reducing public maternal, neonatal and infant mortality rates, taking into account specific requirements of five governance fields: Knowledge Management, Systemic Normative, Clinical and Epidemiological, Administrative and Shared Management.

In ten years, from the creation of the LARISSA Project in 2009 to the GISSA product, already commercially available and in operation in several municipalities in Brazil, it is important to highlight a rich academic trajectory. They were two dozen theses and master's dissertations, more than forty scientific articles published in various international events, many prototypes and software records.

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