

A CONTEXT AWARE DECISION-MAKING ALGORITHM FOR HUMAN- CENTRIC ANALYTICS: ALGORITHM DEVELOPMENT AND USE CASES FOR HEALTH INFORMATICS SYSTEM



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A Context Aware Decision-Making Algorithm for Human-Centric Analytics: Algorithm Development and Use Cases for Health Informatics System

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FOREWORD

In the dynamic and ever-progressing realm of healthcare informatics, the confluence of data-driven decision-making and human-centric analytics emerges as a crucial field with immense potential to transform patient care and propel healthcare systems toward unprecedented heights of excellence. "A Context-Aware Decision-Making Algorithm for Human-Centric Analytics: Algorithm Development and Use Cases for Health Informatics Systems" is not just a book; it is a comprehensive expedition into the cutting-edge world of algorithmic innovation, meticulously crafted for the complexities of health informatics.

At its essence, health informatics is the art and science of utilizing data to inform decisions that enhance patient outcomes, optimize healthcare procedures, and catalyze breakthroughs in medical research. In this book, the authors undertake an enlightening exploration into the world of context-aware decision-making algorithms. Their journey is one that not only challenges conventional approaches but also deeply engages with the subtle interplay of human-centric analytics. What sets this book apart is its holistic approach to algorithm development, effectively addressing the myriad dimensions of health informatics. It delves into the nuances of context awareness and extends to the tangible implementation of decision-making algorithms in real-world settings. Each chapter weaves a rich narrative of insights, methodologies, and practical applications, collectively highlighting the transformative role of human-centric analytics in reshaping healthcare.

The interdisciplinary content of the book, drawing expertise from computer science, data analytics, healthcare management, and artificial intelligence, epitomizes the collaborative ethos essential for navigating the complexities of health informatics. In an era where innovative healthcare solutions are more critical than ever, the algorithms showcased here stand as harbingers of advancement, charting a course towards a healthcare future that is both efficient and empathetically patient-focused. The authors, esteemed authorities in their fields, introduce groundbreaking algorithmic innovations and present compelling, real-world use cases. These applications range from clinical decision support to individualized patient care, exemplifying the algorithms' versatility and capacity for adaptation in diverse healthcare scenarios.

This book is invaluable for healthcare practitioners, researchers, and decision-makers. It offers a beacon of knowledge and innovation, guiding the way to a future where health informatics is leveraged to its fullest potential for improving patient care and the evolution of healthcare systems worldwide.

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PREFACE

A new era in healthcare has been brought about by technological advancements; this period is characterized by the intelligent use of data to support decision-making and improve the human-centered aspects of patient care. To explore the complex field of health informatics, our book, "A Context-Aware Decision-Making Algorithm for Human-Centric Analytics: Algorithm Development and Use Cases for Health Informatics System," provides a detailed examination of algorithms and how they can revolutionize decision-making processes.

The awareness that algorithm development and human-centric analytics are increasingly intertwined and have become crucial to the development of healthcare systems catalyzed this book. The creation of algorithms suited to the details of health informatics has become essential as we manage the elaborated patient data, clinical workflows, and the varied demands of healthcare stakeholders.

This book chapter offers an overview of studies, perspectives, and applications that together add to the conversation on context-aware decision-making in health informatics. These sections encompass a range of multidisciplinary viewpoints from computer science, artificial intelligence, data analytics, and healthcare administration. This reflects the teamwork needed to address the complicated problems in health informatics.

The creation of algorithms has significant ramifications for the provision of healthcare services in the real world and is not only an academic undertaking. Beyond theoretical concepts, the proposed algorithms provide workable answers to the challenges of contemporary healthcare delivery. The use cases showcased the exciting potential of algorithms, ranging from individualized patient care to clinical decision support systems. The focus of this book is on the aspects below.

Smart health trackers - Fitbit wearables are popular fitness tracking devices that offer a range of features designed to help individuals monitor and improve their health and well-being. The Fitbit data is extracted using the Fitbit APIs to perform a deeper analysis of the data and understand the correlation and anomalies present in the data and the implications on the user using suitable ML models.

Gallstone Detection - Detecting gallstones using object detection involves the application of computer vision techniques to identify and locate gallstones within medical images, typically ultrasound or CT scans. Object detection algorithms such as SSD - EfficientDet, Faster R-CNN, and Mask R-CNN are employed to automate this process, providing faster and more accurate analysis.

Diabetic Retinopathy - Diabetic retinopathy is a diabetes complication that affects the eyes and can lead to blindness if not detected and treated early. This model uses improved LSTM based on a hybrid Harris Hawk and Mayfly model to identify and categorize hemorrhages.

We invite readers to embark on a journey of "A Context-Aware Decision-Making Algorithm for Human-Centric Analytics," exploring the intricate interplay between algorithms, human-centric analytics, and the future of healthcare.

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CHAPTER 1**INTRODUCTION**

Abstract: Healthcare analytics indeed plays a crucial role in leveraging data from various sources to identify trends, patterns, and insights that can lead to improvements in healthcare delivery and decision-making. Feature selection is particularly important in healthcare analytics because it helps identify the most relevant data attributes or features that contribute to predictive models or analysis. By selecting the most informative features, healthcare professionals can build more accurate models and gain better insights into patient outcomes, treatment effectiveness, disease prediction, and more. Challenges in healthcare data include issues related to data quality, privacy concerns, data integration from disparate sources, and the complexity of healthcare systems. Overcoming these challenges requires robust analytics techniques and methodologies tailored to the healthcare domain. Machine learning algorithms play a significant role in healthcare analytics by enabling predictive modeling, clustering, classification, and other tasks. Choosing the right algorithm depends on the specific healthcare application and the nature of the data being analyzed. This chapter outlines Feature Selection algorithms and discusses the challenges associated with healthcare data. It also introduces an abstract architecture for data analytics in the healthcare domain. Furthermore, it compares and categorizes various machine learning algorithms and techniques according to their applications in healthcare analytics.

Keywords: Big data, Data analytics, Electronic Health Record (EHR), Healthcare analytics, Machine learning algorithms.

1. INTRODUCTION

In the context of human beings, healthcare refers to the diagnosis, treatment, and prevention of diseases, illnesses, injuries, and other impairments in order to maintain and enhance overall health. The healthcare industry is comprised of organizations that provide clinical sorts of help, manufacture medical equipment or pharmaceuticals, provide clinical protection, or coordinate the delivery of medical services to patients. The snowballing of healthcare data has created the potential to use data-driven methodologies, such as machine learning technologies, to aid diagnosis. Healthcare organizations create and collect huge volumes of information that contain useful signals and information that go beyond conventional analytical approaches [1]. As human beings, we are hardwired to take in information and process it in context. Whether we are aware of it or not,

the situation in which we find ourselves often determines how and why we behave. This environment is diverse, subjective, and ever-changing [2]. But for machines, deriving this contextual information is difficult.

The term “context” [3, 4] refers to any piece of data that helps paint a picture of how something functions within the healthcare system [5]. A context is characterized by information derived from the environment [6]. In the field of healthcare, researchers often overlook contextual features. Any information that may be used to describe the conditions of distinct entities and their interactions is referred to as context. Context, according to Almazan, “comprises one or more relationships that an information item has with other information items”. Any entity, real or virtual (such as a person, a computer, or an object), as well as a concept (such as place, time, and so on), may be an information item [7].

All things that can influence how a system operates or how a user interacts with it are considered entities [7]. When seen from a phenomenological point of view, the setting is regarded as an interactional dilemma in which the relationship quality that exists between two things or between two actions is referred to as contextuality, the contextual characteristics are defined on the fly, the attribute of context is the one that is caused, and context is generated by the action [8]. A predicate connecting two or more information items is referred to as a relationship, and this connection is subject to alter at any moment and for any cause [9].

A programme or workflow is said to be context-aware [10] if it considers the environment in which it operates. The definition of context awareness states, “A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the task being performed by the user”. Better matching of healthcare services to the medical conditions and needs of patients under health monitoring; increased ICU space outcome *via* advanced ML models; and the integration of a cloud-based medical appointment scheduling application are just some of the ways in which “context-aware workflows” can enhance the quality of healthcare delivery, use limited healthcare and human resources more efficiently, and improve the health of patients. It is possible to employ context information in a transitional setting. Replicated internal context data in a workflow variable or current external context data in the context management system might be used [11].

The term “context awareness” refers to the concept that an application is able to comprehend the surroundings in which it is operating and modify its behavior automatically depending on the data it has gleaned from its surroundings rather than requiring direct input from the user. Therefore, applications of this type

would make use of context information to determine the current state of the environment, store user preferences in order to gain a better understanding of the situation that currently exists in the environment, invoke some context actions in order to adapt their behavior, and optionally notify the user or update a user interface [12].

KD Anind [13] defines a context-aware system as one that takes the user's current activity into account when determining what data and services are most useful to them. Byun *et al.* make a similar argument, emphasizing that context awareness allows for the extraction, interpretation, and application of contextual information, as well as the adaptation of functionality based on the context in which it is being used [14].

Both the field of computers and the field of social sciences have come to acknowledge the significance of contextual information as a crucial modelling factor [15]. It is hard to design and build applications that can understand their surroundings. The process of acquiring context is not an easy one. Context information is multi-dimensional; it may be received from diverse and dispersed sources (*e.g.*, electronic health records, patient files, apps); it can be either dynamic or static; and it can need an extra interpretation in order for an application to find it useful. The process of adaptation may be connected to the semantics of the programme and may be based on a variety of different techniques, depending on the level of dynamism that is necessary. Applications that are aware of their context require certain methods of development [16].

Context-aware computing aims to collect and make use of data about the current setting in order to show pertinent data or deliver services that are suitable for the current environment [17]. The term “context” refers to both the conceptual setting in which an application is utilized (the user's profile, preferences, and social circumstances) and the physical setting in which the programme is executed (which is typically heterogeneous and resource-constrained). To deliver results from an application that meets the requirements of its users, it is necessary to collect and make sense of data from several context sources [18].

Context has many different dimensions; to name a few, it can include perceptual information, environmental information (such as the amount of pollution), physical information (such as one's current location), social information (such as one's family and co-workers), and temporal information (such as the time of day). One's context also includes non-perceptual information like recollections of prior encounters or their emotional state [2]. There are different context parameters considered for our research work. Some of them includes age, gender, data from