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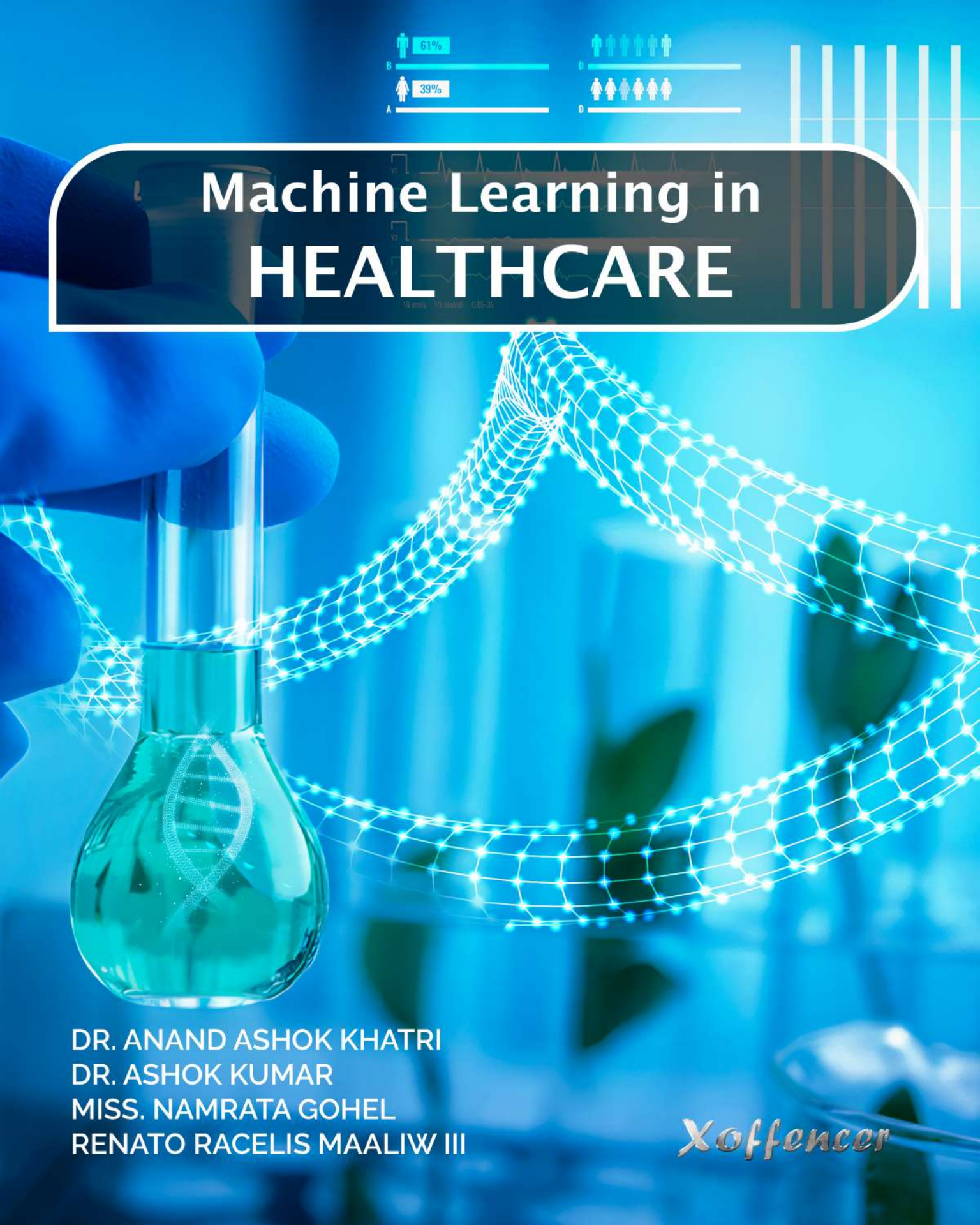

Machine Learning in HEALTHCARE

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Xoffencer

MACHINE LEARNING IN HEALTHCARE

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Xoffencer

www.xoffencerpublication.in

ISBN-13: 978-93-94707-99-3 (paperback)

Publication Date: 9 June 2023

Published by:

Xoffencer International Publication

Shyam Vihar Vatika, Laxmi Colony

Dabra, Gwalior, M.P. – 475110

Cover Page Designed by:

Satyam soni

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The study of how data pertaining to healthcare may be gathered, transferred, processed, stored, and retrieved is what is known as the field of healthcare informatics. Early illness prevention, early disease detection, early disease diagnosis, and early disease therapy are all essential components of this field of research. Within the realm of healthcare informatics, the only types of data that are considered reliable are those that pertain to illnesses, patient histories, and the computing procedures that are required to interpret this data. Conventional medical practices throughout the United States have made significant investments in state-of-the-art technological and computational infrastructure over the course of the last two decades in order to improve their ability to support academics, medical professionals, and patients.

Significant resources have been invested in order to raise the quality of medical treatment that can be provided by using these approaches. The aim to offer patients with healthcare that is not only reasonably priced and of good quality, but also completely free of any and all anxiety served as the impetus for these many projects. As a direct result of these efforts, the advantages and significance of utilizing computational tools to help with referrals and prescriptions, to set up and manage electronic health records (EHR), and to make technological advancements in digital medical imaging have become more obvious. These tools can also assist with setting up and managing electronic health records (EHR).

It has been shown that computerized physician order entry, commonly known as CPOE, may improve the quality of care that is provided to patients while simultaneously lowering the number of prescription mistakes and adverse drug reactions. When a doctor uses CPOE, they are able to swiftly get pertinent patient data without having to leave the screen where they are entering prescriptions. The history of the patient provides the treating physician with advance notice of any possibly dangerous responses. Moreover, the CPOE offers the physician the ability to monitor the order's development as it moves through the system. This gives doctors access to an extra resource for evaluating problems with prescriptions and reworking them to

CHAPTER 2

WAVELET-BASED MACHINE LEARNING TECHNIQUES FOR ECG SIGNA

Diseases of the cardiovascular system, abbreviated as CVD, are a significant factor in modern mortality rates. In high-income, industrialized nations, it's responsible for close to 40% of fatalities, making it the leading cause of death overall. Globally, it's responsible for over 30% of all deaths. In spite of the fact that the prevalence of cardiovascular sickness is falling in nations with high per capita incomes, it is rising in all other countries. In the great majority of cases, the sino-atrial (SA) node serves as the pacemaker as well as the primary electrical impulse generator in the heart. Cardiac arrhythmia, which is also sometimes referred to as dysrhythmia, is an all-encompassing word that refers to a variety of irregularities in the heart's rhythm. A number of illnesses are characterized by abnormal electrical activity inside the heart.

When arrhythmia is present, it is possible that many impulse sources may compete with one another to be the dominant source of impulses for the sinus node. One kind of sickness that may affect the cardiovascular system is called arrhythmia. This sickness, if left untreated, involves the danger of catastrophic medical consequences, some of which include cardiac arrest, hemodynamic collapse, and unexpected death. Arrhythmias are conditions that may be caused by abnormalities in the production as well as the transmission of cardiac impulses. Although the heart rate might be normal, abnormally rapid, or abnormally slow, the interbeat interval can be normal, excessively short, or abnormally lengthy.

Because of the potential for some arrhythmias to progress into more severe problems if they are not treated, early intervention with the proper medicine is essential in many cases. The danger of passing away is quite significant for those who have arrhythmias such as ventricular fibrillation and flutter. The international focus that has been brought to the study and development of technologies for mass screening in order to offer predictive healthcare is a direct result of the rising prevalence of cardiovascular disease and mortality. The provision of high-quality cardiac care to all of a country's population is one of the most difficult difficulties faced by nations of both developed and under-developed states. Yet, since there are not enough cardiac specialists with necessary qualifications, individual attention for patients may be limited, and healthcare providers

CHAPTER 3

THE APPLICATION OF GENETIC ALGORITHM FOR UNSUPERVISED OF ECG

The term "cardiovascular diseases" refers to a collection of conditions that affect both the heart and the blood arteries. On a global scale, cardiovascular disease is responsible for 16.7 million fatalities, or 29.2% of all deaths. Ischemic heart disease and coronary artery disease (CAD) are responsible for around 7.2 million fatalities per year (IHD). Over 80 percent of all fatalities caused by cardiovascular diseases occur in developing, low- and middle-income nations globally. The fact that individuals of younger generations and those from rural communities are more afflicted, as a result of changes in demographics and sedentary lifestyles, is a key cause for worry in a lot of different nations. It is anticipated that the number of fatalities caused by cardiovascular diseases would rise by 111% between the years 1990 and 2020 in India alone.

Since the expense of treatment may have a significant impact on a nation's economy, it is imperative that effective strategies for the early identification and prevention of coronary artery disease (CAD) be developed in order to lessen the burden of heart disease. The irregular beating of a patient's heart is the root cause of arrhythmia. In most cases, arrhythmias are brought on by irregularities in the heart's impulse production, its conduction, or both of these processes. Arrhythmias are most often caused by cardiovascular disorders, making them the most prevalent kind of etiology.

There are a number of arrhythmias that might pose a danger to a patient's life and need prompt diagnosis and treatment. Life-threatening medical situations include conditions known as arrhythmias, such as ventricular fibrillation and ventricular flutter. The electrocardiogram, often known as an ECG, is a diagnostic tool that does not need any kind of invasive procedure. These anomalies are explained in terms of their anatomical (that is, structural) and physiological (that is, functional) sources, respectively. In typical conditions, the attending physician will study the progression of the ECG pattern, get an understanding of the illness process, and ultimately arrive at a diagnosis of the underlying condition.

As a result, the ECG plays a significant part in the screening process for cardiac problems. The early identification and treatment of cardiac disorders is essential; yet,

CHAPTER 4

UNDERSTANDING FOOT FUNCTION DURING STANCE PHASE BY BAYESIAN NETWORK BASED CAUSAL INFERENCE

If a person's natural gait is significantly different from their average gait, then that person may have a foot anomaly. It's possible that problems with the nervous system and the musculoskeletal system both had a role in causing this aberration. These days, the majority of foot disorders may be identified and scientifically predicted based on subjective assessment. Due to the fact that this is the case, it is hard to guarantee that people who have problems with their feet will get the treatment and rehabilitation that is suitable for their condition. Since an in-depth understanding of the foot's mechanics would make it possible to conduct an impartial evaluation, research in the fields of treatment and rehabilitation, in addition to motor control, is very necessary.

This is due to the fact that an unbiased evaluation can become possible with increased awareness of the function of the foot. The relevance of this particular subject cannot be overstated for this precise reason. The major objective of this study is to create innovative tools with the potential to help in determining the type and source of foot function impairment, as well as offering assistance in the treatment and rehabilitation of foot function. For the purposes of this project, the study will be carried out at a school located in the United Kingdom. How effectively our feet function is mostly dependent on the connection that exists between our muscular, neurological, and skeletal systems, in addition to the environment in which we walk.

By measuring and recording the levels of activity produced by the muscles in the lower body, we were able to identify and quantify the principal movers in that region. It was also possible to capture the effect of the motion by measuring and recording the trajectories of the toe and ankle joints. In the end, we gathered evidence by measuring the plantar pressure distributions and documenting the results (which represented the interaction between the human and the environment). After this, the causal construction for foot function was determined with the use of the Bayesian network (BN), which served as the theoretical explanation of probabilistic illation. This was done so that we might have a deeper comprehension of the mechanical workings of the foot. To validate the BN's ability to reflect and identify the primary causal links that are dependent on

CHAPTER 5

USING MACHINE LEARNING TO PLAN REHABILITATION FOR HOME CARE CLIENTS

There has been a substantial amount of use of machine learning techniques in biological applications, such as in the process of anticipating the function that genes and proteins perform. One example of this type of application is in the field of gene therapy. Despite the fact that several applications have been found for them, they have not been implemented very widely in the therapeutic decision-making process. These applications include, but are not limited to, the prediction of cardiovascular illnesses, the evaluation of the severity of pancreatitis, the detection of breast cancer or melanoma, and the diagnosis of melanoma itself. Other uses include the assessment of the severity of pancreatitis. It's possible that some of the reluctance to adopt machine learning algorithms in clinical practice stems from the belief that these methods are 'black-box' techniques that are incompatible with decision-making that is based on explicit evidence-based care pathways combined with the clinician's own experience and insights.

If this is the case, then some of the reluctance to adopt machine learning algorithms could be explained by this belief. It's possible that this is due to the perception that decision-making that is based on explicit evidence-based care pathways is incompatible with such methodologies. Although we can understand their concerns, we believe that it is a missed opportunity for them not to take advantage of the growing number of databases that contain assessment data that could be improved with the assistance of machine learning and data mining methods, thereby providing a new and vital basis for evidence-based clinical decision making. This hesitation is understandable given the increasing availability of enormous databases that include evaluative information; yet, we find it quite disappointing. This is disappointing in view of the increasing availability of assessment databases, despite the fact that we can see why some people may take a position against assessment databases.

In this chapter, we explain how these algorithms may be employed in creative ways beyond basic "black box" projections to deliver useful therapeutic and scientific insights. These creative uses go beyond what would be considered "black box" forecasts. Because there haven't been many studies conducted on this subject, we've decided to focus our investigation on the ways in which machine-learning strategies

CHAPTER 6

RULE-BASED COMPUTER AIDED DECISION MAKING FOR TRAUMATIC BRAIN INJURIES

There were approximately 1.7 million freshly documented cases of traumatic brain injury in 2010, according to a report that was published by the Center for Disease Control and Prevention (CDC) (TBI). There are approximately 52,000 people who lose their lives as a direct result of these incidents, and of the people who are fortunate enough to survive, many are left with disabilities that cannot be cured. A catastrophic brain injury is a contributing factor in 30.5% of all casualties that are the outcome of accidents that occurred in the United States. Children aged 0 to 14 years old make annual appointments to emergency departments for cases of traumatic brain injury reaching almost half a million (473,947), with a significant percentage of these children suffering from neurological problems.

An estimated total of $60 billion was spent in the United States in 2014 on the direct hospital expenses and secondary costs associated with catastrophic brain injuries. Because traumatic brain injuries are generally the outcome of particular causes, and because the methods of treatment for these injuries are already well established, the occurrence of long-term disabilities and deadly complications can be decreased through the utilization of computer-aided systems. The utilization of these systems can significantly improve both decision-making and the distribution of resources for emergency treatment. This is possible due to the fact that these systems are less subjective and more accurate.

In addition, research indicates that the cost of providing care for trauma patients can be reduced significantly by employing a comprehensive trauma care system that places an emphasis on the utilization of computer-assisted resources. This can help reduce the overall cost of providing care for trauma patients. It is important to reach decisions regarding the treatment of patients who have experienced catastrophic brain injuries as swiftly and accurately as is humanly feasible. This, in turn, can increase the possibilities of patient survival.

Because of the extreme urgency associated with these injuries, being able to make an estimate of the length of time a patient might need to be treated in the intensive care

CHAPTER 7

FEATURE EXTRACTION BY QUICK REDUCTION ALGORITHM

In this, we will walk you through the most current iteration of our process for the selection of features. This approach is based on the quick reduction algorithm as its primary building block (QRA). We contrasted the outputs of our automated technique with those obtained from a more traditional ANOVA (analysis of variance across groups) research to see which was more accurate. In order to classify the individuals who took part in the study, we made use of an artificial neural network (ANN), feeding it the extracted features to use as input parameters for the ANN. Even though it used just nine of the dataset's twenty-six variables, our QRA-based algorithm correctly classified 97.5% of the patients. Although though the ANOVA analysis was only effective in properly identifying 75% of the patients, it was still able to derive three distinguishing features from the data. The effectiveness of our QRA-based approach was proven via testing with genuine clinical data, and our procedure is fully automated. The collected features will be employed in real clinical applications for the cerebrovascular assessment of migraine patients who have difficulties with aura as well as those who do not have these problems.

Migraines are a kind of neurological condition that have been shown to have a connection with an increased risk of subclinical cerebral vascular lesions. This connection was discovered via research. As a result of the findings of epidemiological studies which demonstrated that people who suffer from migraines are at a higher risk of having vascular accidents, a number of specialists have come to the conclusion that migraines are a form of systemic vasculopathy. This line of thinking stems from the fact that migraine sufferers have a higher risk of having vascular accidents. Many investigations and evaluations have been carried out in order to investigate and assess the connection that exists between migraines and abnormalities in cerebral autoregulation or vasomotor tone.

Yet, there is a difference between the two types of migraines in terms of the risks associated with the cardiovascular and cerebrovascular systems. Both types of migraines may be debilitating. Patients who suffered from migraines with aura (MwA) were seen to have a greater number of functional impairments as compared to

CHAPTER 8

A SELECTION AND REDUCTION APPROACH

Atherosclerosis is a potentially deadly ailment that may lead to the loss of flexibility in the artery wall as well as the deposition of lipids and other blood-borne molecules inside the arterial wall itself. This can lead to a heart attack or stroke, which are both potentially fatal events. This may put a person at risk for having a heart attack or a stroke, both of which have the potential to be deadly. This lack of flexibility results in likely impairments to the blood circulation within a range of roughly 5–10 years, which has the potential to cause injury to the key organs (i.e., liver, kidneys, heart and brain). In the field of atherosclerosis prevention and monitoring, the clinical test that is applied most often is the ultrasonic inspection of the arterial bed.

Acoustic waves are used in the process of photographing big arteries such as the aorta, the carotid artery, the femoral artery, and the brachial artery in order to have a better understanding of the composition of the inner wall of these arteries. This imaging is performed because the intima-media thickness (IMT) of the major arteries is a crucial marker of the health of the patient's cardiovascular system. The atherosclerosis indicator that is used the most often is the intima-media thickness (IMT) of the carotid artery (CA), and it has been used in a number of multi-center studies all over the world. Assessing the thickness of the carotid intima-media in a clinical setting is not a straightforward task (IMT).

The majority of the time, a skilled sonographer will acquire a longitudinal projection of the CA and manually measure the IMT by putting two markers in correspondence to the two most visible interfaces of the image ions. This will be done in order to determine the IMT. These approaches, despite their precision, call for a large amount of time and are not particularly adaptable to the new quality level that is expected by modern clinical recommendations. Because of this, work that followed the groundbreaking research has employed computer algorithms to help medical professionals in evaluating the thickness of the carotid intima-media (IMT).

For the purpose of carotid wall segmentation and IMT measurement using ultrasound images, Molinari et al. have carried out research on the numerous IMT measuring techniques that are presently in use in the medical community. The majority of IMT measurement techniques are semi-automated, which means that a human operator must

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Specific Suggestions per Chapter:

Introduction to Machine Learning in Healthcare

1. The chapter provides a good introduction to machine learning in healthcare. However, it would benefit from a clearer explanation of the unique challenges and considerations specific to healthcare data, such as privacy, data quality, and interpretability.

2. Consider including real-world examples or case studies that highlight successful applications of machine learning in healthcare, showcasing the impact and potential of the field.

3. The chapter could provide a brief overview of different machine learning algorithms commonly used in healthcare, including their strengths and limitations.

Application of Genetic Algorithm for Unsupervised ECG Analysis

1. The chapter presents an interesting application of genetic algorithms for unsupervised ECG analysis. However, it would be beneficial to include more details on the specific steps and algorithms involved in the genetic algorithm approach.

2. Reflect on providing a comparison with other unsupervised ECG analysis methods, such as clustering algorithms or anomaly detection techniques, to highlight the advantages of the genetic algorithm approach.

3. Include visual representations or examples of the ECG analysis process using genetic algorithms to enhance understanding for readers.

Machine Learning to Plan Rehabilitation for Home Care Clients

1. The chapter addresses an important topic of using machine learning to plan rehabilitation for home care clients. However, it would be valuable to include information on the types of machine learning algorithms commonly used in this context, such as reinforcement learning or predictive modelling.

2. Consider discussing the challenges and limitations of implementing machine learning-based rehabilitation planning, including factors like data availability, patient variability, and interpretability of the decision-making process.

3. The chapter could benefit from providing practical guidelines or best practices for integrating machine learning algorithms into existing home care systems.

4. Discuss its implications on enhancing patients' recovery time.

Decision Making for Traumatic Brain Injuries

1. The chapter focuses on decision-making for traumatic brain injuries. However, it would be beneficial to provide a broader discussion on the role of machine learning in diagnosing and predicting outcomes for different types of brain injuries.

2. Provide a section on explainability and interpretability of machine learning models in the context of decision-making for traumatic brain injuries, as these aspects are crucial for gaining trust and acceptance from healthcare professionals.

Quick Reduction Algorithm

1. It would be helpful to provide a more comprehensive explanation of the algorithm's working principles, underlying mathematical concepts, and its applications in healthcare.

2. Insert paragraphs for feature selection or dimensionality reduction algorithms commonly used in healthcare, showcasing the advantages and limitations of the Quick Reduction algorithm.

3. Emphasize the trade-offs and considerations when choosing between feature selection and dimensionality reduction techniques in healthcare, considering factors like data size, model complexity, and interpretability.

General Suggestions:

1. Ensure that each chapter starts with a brief overview and learning objectives to guide readers and provide a clear roadmap of the content covered.

2. Include more visual aids, such as diagrams, charts, or figures, to illustrate complex concepts, algorithms, or healthcare-related data.

3. Provide references to relevant datasets or publicly available healthcare datasets that readers can use to practice and implement the discussed machine learning techniques.

4. Include detailed explanations and step-by-step tutorials on implementing the machine learning algorithms discussed in each chapter using popular programming languages and frameworks commonly used in healthcare, such as Python and TensorFlow.

5. Consider including discussions on the ethical considerations and challenges associated with implementing machine learning in healthcare, including issues of bias, fairness, privacy, and security.

6. Provide a glossary of key terms and concepts specific to machine learning in healthcare to assist readers in understanding the technical terminology used throughout the book.

7. Include summaries or recaps at the end of each chapter to reinforce key takeaways and facilitate understanding.

8. Incorporate discussions on current research trends and emerging topics in machine learning in healthcare, such as deep learning, federated learning, or interpretability techniques, to keep the content up-to-date and relevant.

9. Ensure that the book caters to a wide range of readers, from beginners to intermediate-level practitioners, by gradually introducing concepts and providing both intuitive explanations and technical details.

10. Consider including interviews or perspectives from healthcare professionals, researchers, or industry experts who have first-hand experience in applying machine learning in healthcare, providing real-world insights and practical tips.

11. Conduct thorough proofreading and editing to ensure consistency in terminology, formatting, and grammar throughout the book. Please make these majore changes before book publication.

Rishabh Rathore, Ph.D
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ISBN: 978-93-94707-99-3

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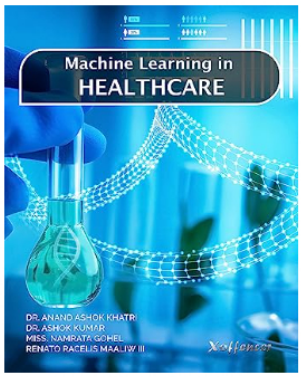

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Hence, the purpose of healthcare informatics is to detect patterns in data and then learn from the patterns that have been found. EHR systems have made it possible for hospitals to more easily access and share the medical data of their patients, which has resulted in significant cost savings in the healthcare industry. This cost reduction may be attributable to the removal of unnecessary health testing as well as a decrease in operating expenses. Nevertheless, the present state of administration of EHR systems makes it challenging to gather and mine clinical information for patterns and trends across a variety of populations. This is due to the fact that the management of EHR systems is now in a state of flux. As a result of initiatives like the American Recovery and Reinvestment Act (ARRA) of 20091, significant progress is being made toward the digitization of medical records into a common format. This will make it possible to compile medical data into massive repositories. Machine learning may then be used to the data obtained from these massive archives in order to forecast and get an understanding of patterns across geographical places. The computational obstacles that are preventing the proliferation, sharing, and standardization of EHRs are the primary focus of research in this field. As these databases include personal information about patients, the goal is to establish open-access databases that are both safe and able to withstand a wide variety of cyber-threats. The following is a listing of some of the most notable medical databases in the region: Significant resources need to be invested in research and computing in order to overcome the several obstacles that must be overcome in order to create these massive data repositories of medical information, which will be covered in following sections.

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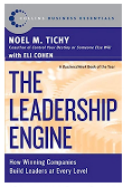

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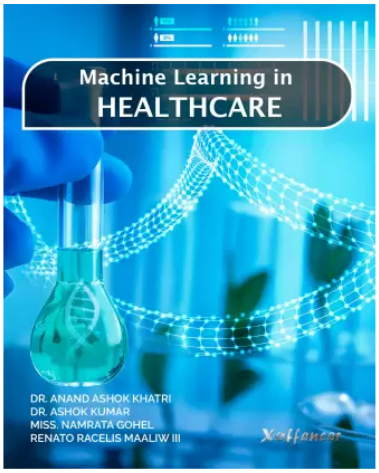

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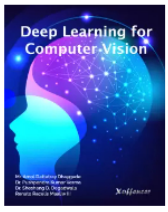

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