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A COMPREHENSIVE ANALYSIS OF HEALTH CARE ANALYTICS: CANCER PREDICTION PERSPECTIVE

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ABSTRACT
Cancer, a complex array of diseases characterized by abnormal cell growth, poses significant challenges to global healthcare systems. Early detection is critical for improving patient outcomes, as timely intervention can lead to more effective treatment options and increased survival rates. The significance of early diagnosis is underscored by research indicating a marked difference in survival rates between early and late-stage cancer diagnoses. Data analytics play a pivotal role in healthcare, offering insights into risk prediction, treatment decisions, patient satisfaction, and service quality enhancement. Predictive analytics, powered by artificial intelligence, holds promise in revolutionizing cancer diagnosis and prognosis. By leveraging historical data, predictive analysis aids healthcare professionals in identifying high-risk patients and optimizing treatment strategies. Furthermore, machine learning techniques enable the development of advanced diagnostic tools, enhancing accuracy and efficiency in cancer detection. Collaborative efforts between researchers, healthcare practitioners, and data scientists are essential in harnessing the potential of data analytics to combat cancer effectively and improve patient care outcomes. As technology continues to advance, the integration of data analytics into cancer care holds immense potential for driving innovation and transforming healthcare delivery.

Keywords: Cancer prediction, classification, predictive analytics, accuracy, machine learning, and deep learning.

INTRODUCTION
Cancerous cell formation can occur in any part of the body and impact any organ. Oncology is not a single disease, but rather a collection of disorders that are all related to one another. Tumors that are malignant come in a range of shapes and sizes. Any internal organ, including the blood cells, can get contaminated and as a result of this, the disease can spread to other regions of the body. Despite the fact that malignant growths have some characteristics in common, the mechanisms in which they start and spread are vastly different [1]. Cells are like building blocks in our bodies, allowing us to function. Trillions of cells in the body provide the shape, nourishment, and energy. A cell's ability to replicate itself is further enhanced by its ability to retain hereditary traits and divide into two or more cells, each of which then divides into another cell. This process of cell division occurs as part of the broader cell cycle [2, 3].

Human cells will be isolated in a methodical manner. Each time a cell dies or wears out, a new one will be created. Cancer is caused by the proliferation of cells, both new and old. Constant cell proliferation alters the normal structure of cells, increasing their malignant potential. Human health is impacted, specifically in the organ or bodily portion where cancer first manifested itself. In the human body, cancer cells can easily spread to different organs and tissues [4]. As an example, cancerous cells in the lungs can easily spread to the skeletal system, where they can thrive and spread quickly. Metastasis is the process through which cancerous cells spread throughout the body. Treatments vary depending on the stage of the cancer and how well the patient responds to the treatment. Chemotherapy and surgery are used to treat only a few forms of cancer [5].

Significance of Early Diagnosis of Cancer
The goal of early cancer detection is to identify patients who are showing symptoms as soon as possible in order to provide them with the best treatment options [6]. There is a decreased chance of survival, greater treatment problems, and higher treatment costs when cancer therapy is delayed or unavailable. As a public health strategy, early detection improves cancer outcomes by allowing patients to undergo treatment at the earliest possible stage.

Office for National Statistics (ONS) has released the first accurate estimates of how long a person with cancer will live based on the stage of diagnosis [7]. For most cancers, early detection leads to a significantly better chance of survival at 1 to 5 years compared to later detection. There is a strong case to be made for early identification here. The survival rate for prostate cancer is approximately 100% when it is found in stages 1, 2, or 3, but lowers to 87.6% when it is found in stage 4 [8]. There is a similar but steeper fall in the percentage of people who survive for five years from stages 1, 2, and 3 to stage 4. Hodgkin lymphoma survival rates are generally high, regardless of stage.

One-year survival rate of 86.7% are still possible even if the cancer in stage 4. In contrast, the one-year survival rate for colorectal cancer is 97% if it is identified in stage 1, but just 43% if it is discovered in stage 4. Stage 1 lung cancer has a one-year survival rate of 87.3 percent, whereas stage 4 has a rate of 18.7 percent. Between stages 2 and 3, the one-year survival rate for patients with liver cancer drops significantly, following an unusual pattern. At the third and fourth stages of cancer, survival rates are drastically reduced compared to earlier two stages [9, 10].

Data Analytics in Healthcare

Data Analytics (DA) offers modalities for dealing with a wide range of data types, including volume, veracity, velocity, value, visualisation, and variability [11, 12]. The technology makes it possible to prune data that is structured, semi-structured, or unstructured. There is a lot of unstructured data in healthcare applications that may be analysed using data analytics methods. In the context of healthcare, the DA model and technology have found synergistic applications. They can be applied to the following situations:

- Risk Prediction: Large volumes of data can help hospitals identify the most prevalent symptoms and causes of illness and disease. Patients who may be at danger of developing a given health issue can be identified and treated as soon as possible.
- Decision based on data: It is easier for healthcare providers to make educated judgments regarding individual therapy when they have more information about a patient's medical history and the health of the general population.
- Improvement of patient’s satisfaction: Doctors can use data insights to better serve their patients by customizing treatment and enhancing the quality of care they provide. Even healthcare workers' performance can be evaluated and improved using software.
- Enhance service quality: Hospitals can use software to predict high demand periods and plan accordingly.
- Electronic Health Record (EHR): Electronic medical record storage improves efficiency by removing paper files. Additionally, it eliminates the need to move papers between multiple healthcare providers.
- Cost Reduction: Treatment expenditures and other hospital expenses can be reduced by utilising data to enhance patient care and make healthcare facilities more productive.

Predictive Analytics in Cancer Diagnosis and Prognosis

Predictive analysis, as the name implies, examines historical data in order to foretell future events. As a result, leveraging an AI system's power to fight cancer in the future could be promising. Predictive analysis can be a beneficial technique for healthcare professionals who are diagnosing and treating cancer patients. It enables such professionals to detect cancers and categorize them according to the level of risk they pose to patients, but also to adhere to worldwide healthcare privacy guidelines. The Artificial Intelligence (AI) was introduced into the healthcare profession to eliminate human error at every stage of disease diagnosis and treatment. As a result, incorporating cancer-related treatment procedures into an AI system allows clinicians to reduce the number of errors associated with utilizing wrong treatments for specific types of tumors.

Oncologists can utilize predictive analytics to identify high-risk cancer patients. Cancer relapses are common in these people, especially after high-intensity therapies like chemotherapy or various types of surgery. Even the most experienced health professionals may have difficulty identifying such patients at an early stage, but machine learning can identify particular patterns to predict the return of cancer cells in them. The expenditures of expensive treatments can be saved if such people are identified early, and health professionals can focus on adopting malignancy prevention strategies (medicines and lifestyle guidelines) to a larger extent. Secondly, AI-based predictive analysis could allow doctors to investigate cancer characteristics in specific patients in greater depth. This can help workers identify people whose bodies can handle chemotherapy without causing too much damage afterward. The bodies of certain patients may respond to some treatments more favorably than those of others. Finally, pathology and biopsy can benefit from predictive analysis [12].

One of the most serious issues with cancer treatment is the possibility of over- or under-treating people who do not require it. As a result, compared to cancer itself, such individuals have a larger risk of dying as a result of excessive therapy [13]. As a result, predictive analysis tools, such as Google's AI tool, improve cancer diagnosis accuracy, allowing clinicians to focus on measures other than potent medicines. In addition to these benefits, predictive analytics can help with other areas of cancer detection. Machine learning models, for example, might be used to develop sequencing panels in the future, allowing large healthcare organizations to avoid screening an entire population blindly for cancer. Predictive analytics is increasingly being used by health specialists in the field of oncology due to its numerous advantages [14, 15].

Comprehensive Analysis

Murthy et al. (2023) emphasize the critical need for early detection and prognosis in cancer treatment, categorizing patients into high and low-risk groups. They advocate for the application of deep learning and machine learning models in understanding cancer development and treatment. Various techniques including Support Vector Machines, Bayesian Networks, Decision Trees, and Neural Networks have been employed, achieving a detection rate of 99.89%. However, the authors stress the necessity for careful estimation and consideration of these approaches in daily medical practice. Their survey analyzes the contributions of predictive models, categorizing algorithms, datasets, and performance measures. They highlight challenges in cancer prediction, including the ongoing testing and experimentation phase of machine learning models, their need for larger, higher quality datasets, and the persistent issue of bias [16].

Shaikh et al. (2022) echo the importance of timely screening and treatment in cancer research, advocating for the use of ML and Deep Learning methods in classifying cancer subtypes. They highlight the significance of these techniques in understanding cancer progression and emphasize the need for validation before integrating them into clinical practice. Various methods such as Artificial Neural Networks, Support Vector Machines, and Decision Trees are discussed for predictive modeling. While acknowledging the potential of ML methods, the authors caution about the necessity of rigorous validation for their practical implementation in healthcare settings [17].

In Urszula et al. (2021), they examined network capacity and tuned topologies for network models and presented a study on a variety of networks. They claim that in order to make models more efficient and faster, it is necessary to retain all application data in memory. For this goal, Extreme Learning Machines(ELM) were examined. When comparing ELM to Imagenet and other back-propagation networks, this paper looked at what ELM doesn't do well [18].

Alzubaidi et al. (2021) conducted research on the application of deep learning and its advantages over machine learning models, as well as the challenges they face. Several approaches were discussed, including supervised, unsupervised, semi-supervised, and reinforcement learning, as well as the recursion perspective. There were several advantages to employing CNN, as well as the use of pre-trained models rather than assessing new data with transfer learning. Several datasets for deep learning were discussed, as well as comparisons between different programming languages [19].

Ending Indramaya et al. (2021) used a total of nine benchmark functions, the Dragonfly Algorithm (DA), Grey Wolf Algorithm (GWO), and Rao Algorithms are all subjected to meticulous analysis. The findings suggest that Rao had a higher level of overall performance compared to GWO and DA. Although GWO and Rao outperform DA when it comes to obtaining the convergence score, DA has the advantage when it comes to scanning a vast search space, and in theory, if there is enough population, DA is capable of doing better than either GWO or Rao [20].

Devvi Sarwinda et al. (2021) studied a deep learning strategy in image classification using ResNet architecture to look for signs of colorectal cancer. Deep learning classification systems have impressed researchers to the point where they are being considered for use in the medical imaging field. Within the scope of this investigation, they trained ResNet-18 and ResNet-50 on pictures of colon glands. These models were trained to differentiate between benign and malignant forms of colorectal cancer [21].

According to Deepthi et al. (2020), one of the most promising areas for research at the present time is the medical industry because of the exponential increase of both data and technologies such as machine learning. Big Data Analytics and Machine Learning are relatively new fields of study that are helping with the prediction and diagnosis of diseases, and they make it much simpler to manage the massive amounts of patient data that are being collected. They were able to make an accurate prediction about the disease by employing Machine Learning techniques such as Naive Bayes, Decision Tree, and Random Forest on the dataset that was provided to them. They put their findings into practise by using the programming language Python. In addition, they evaluate the outcomes using a variety of algorithms, and the findings of their investigation demonstrate which algorithm is the most effective in terms of accuracy, as well as in terms of how well it performs on the dataset that is provided [22].

Maniruzzaman et al. (2020) introduced a diabetes prediction system based on machine learning. To forecast diabetes, the scientists use a variety of models. They employed a dataset of 6561 patients, 657 of whom were cases, and the rest were controls. To make their inferences, they employed performance indicators like accuracy and area under the curve. Ensemble classifiers, according to the authors, can provide greater accuracy. Most of the time, when you put together a group of classifiers, you get the best features from a lot of different classifiers, which is always good for improving accuracy [23].

Using deep learning, Mea et al. (2020) proposed a method for analysing causes of death from death certificates using deep learning. The World Health Organization's ICD-10 classification was employed in the system. Deep learning and supervised categorization were used by the system to achieve 99.03 percent accuracy [24].

Novel feature selection method using deep learning to group classifier outputs is suggested by Khamparia et al. (2020). Feature selection was done based on integrated Bhattacharya coefficient and genetic algorithm (GA), where fitness was estimated based on ensemble outputs of deep learning classifiers. The Bhattacharya coefficient determines the most effective gene subset; GA determines the most discriminative. The multi-model ensemble based DL method was applied to two neuromuscular disease datasets. The results showed that the proposed integrated strategy improves neuromuscular disorder prediction accuracy over previous datasets and classifier algorithms [25].

A comparison of several distinct machine learning methods for the diagnosis of breast cancer has been presented by Bayrak et al. (2019). The UCI Machine Learning repository serves as a source for the Wisconsin Breast Cancer dataset collection, which is then evaluated. Both the Support Vector Machine (SVM) and the Artificial Neural Network (ANN) have been put to use in the prediction of the classification of breast cancer in order to determine which one is superior by comparing the respective values of accuracy, precision, recall, and ROC Area. The SVM technique, which boasts the maximum degree of accuracy, has proved successful in achieving the best results [26].

Uddin et al. (2019) compared supervised machine learning disease prediction systems. Their study aims to predict disease risk and uncover critical trends in supervised machine learning methods. In 48 articles comparing supervised machine learning algorithms for disease prediction, the support vector machine was utilised in 29 and the Nave Bayes algorithm in 23. They also discovered that the Random Forest method outperformed the others in precision [27].

An effective Deep learning technique to the classification of pneumonia in healthcare was proposed by Okeke Stephen et al. (2019). They suggested a convolutional neural network model that could be trained from the ground up to identify chest X-ray image samples and detect the presence of pneumonia. They used a number of different data augmentation strategies in to increase the validation and accuracy of classification of the CNN model, and they were successful in doing so, achieving a notable validation accuracy. Rescale, the rotation range, the width and height shift, the horizontal flip, the shear range, and the zoom range are the augmentation procedures that are utilised. They were able to get a performance of the classification model on a variety of data sets with a accuracy of 95% for training and accuracy of 93% for validation [28].

Esteva et al. (2019) discussed deep learning in healthcare using computer vision, NLP, and reinforcement learning. They focused on analytical approaches that affect essential fields in medicine, such as computer vision in medical imaging, CNNs for data analysis, and EHR data for natural language processing and deep learning algorithms. RNNs process sequential inputs like language, speech, and time-series data. Generalized deep learning algorithms review robotic-assisted surgery and genomics applications [29].

Researchers Sara Hosseinzadeh Kassani et al. (2019) conducted an investigation into the effects of several deep learning architectures on the detection of melanoma. They analysed dermoscopic pictures of skin lesions to determine how well CNN performed. To increase the overall quality of the images, they utilised a variety of pre-processing techniques, such as lighting correction, contrast enhancement, and artefact removal. In addition to this, they used a data augmentation process to address the class skewness issue. This methodology included techniques such as horizontal and vertical flipping. The steps of preprocessing and data augmentation were utilised since they helped increase the accuracy of the results. They examined several different DCNN classification models, including AlexNet, ResNet50, VGGNet16, VGGNet19, and Xception. ResNet50 was found to have the greatest accuracy of all of the models, coming in at 92% [30].

Munir et al. (2019) reviewed cancer diagnosis with Deep Learning. Deep neural networks can analyse images intelligently. In this analysis, preprocessing techniques such as contrast adjustment employing smoothing, normalisation, and noise reduction, image segmentation such as thresholdbased, region-based, pixel-based, model-based segmentation, and postprocessing such as PCA can be done. Convolutional Neural Networks (CNNs), Generative Adversarial Network (GANs), Deep Autoencoders (DAEs), Restricted Boltzmann's Machine (RBM), Stacked Autoencoders (SAE), Convolutional Autoencoders (CAE), Recurrent Neural Networks (RNNs), Long Short-Term Memory (LTSM), Multi-Scale Convolutional Neural Network (M-CNN), Multi- They also summarise deep learning health care applications and suggest CNN outperforms all models [31].

Using collaborative variation deep learning, Deng et al. (2019) investigated a Healthcare Recommendation System (HRS). Their research on HRSs utilised a novel Collaborative Variational Deep Learning model (CVDL) to make use of information from multiple sources in order to make suitable healthcare recommendations for primary care services. In order to learn deep latent representations for item contents in latent space, it uses an extra Variational Autoencoder (VAE). To generate the maximum posterior that predicts the learning model parameters, they suggested using a Stochastic Gradient Variational Bayes (SGVB) technique. Their method has been shown to perform better than hybrid collaborative filtering methods, according to the experiments that were carried out on three different datasets [32].

Nour Eldeen Khalifa1 et al. (2019) proposed deep transfer learning for diabetic retinal disease detection. Deep Learning models were trained and tested using the APTOS 2019 dataset. AlexNet, Res-Net18, SqueezeNet, GoogleNet, VGG16, and VGG19 were used. Compared to DenseNet and Inception ResNet. Data augmentation

was utilised to prevent overfitting. Precision, recall, and F1 score were calculated to illustrate the models' robustness. Using AlexNet, they achieved 97.9% research accuracy [33].

For the purpose of breast cancer categorization, Farhadi et al. (2019) recommended using deep learning techniques with structured healthcare data. They presented an effective way for using deep transfer learning in huge image databases, based on structured data, in order to address the problem of excessive data in breast cancer data. They were able to predict the high-grade malignant tumours in patients who had been diagnosed with breast cancer by using concepts from transfer learning [34].

Need for the Research

Nowadays, among worldwide researchers, Health informatics has become trendy as a rising domain of interest and it has helped in the introduction of various initiatives related to public health. The healthcare system is making use of clinical information that has been developed and further, it can be used for early prediction of disease outbreaks and to monitor diseases. Precision and accuracy are always preferred in analytical systems. The increasingly growing number of machine learning and deep learning applications in healthcare enables one to envision a world in which evidence, study, and creativity work together to support countless patients. The development of Machine Learning and Deep Learning techniques which can be researched in different healthcare domain applications such as Image classification, predictive analytics and visual analytics are entrenched with patient data, thereby increasing the efficiency of new treatment options for physicians and helpful for the patients. Predictive and visual analytics aid in the identification of new cost effective solution regimes. Data Analytics can analyse large amounts of data found in cancer-related applications. It can handle a wide range of data types for analysis. These applications can be used to make useful inferences.

CONCLUSION

Cancer remains a formidable challenge in healthcare, but advancements in data analytics and predictive technologies offer hope for improved outcomes. Early diagnosis is paramount, as evidenced by the significant disparity in survival rates between early and late-stage diagnoses. Data analytics, powered by artificial intelligence, enables risk prediction, personalized treatment decisions, and enhanced patient care. Machine learning techniques facilitate the development of advanced diagnostic tools, augmenting accuracy and efficiency in cancer detection. Collaboration between researchers, healthcare professionals, and data scientists is essential to harness the full potential of these technologies. As technology continues to evolve, the integration of data analytics holds promise for revolutionizing cancer care, driving innovation, and ultimately improving patient outcomes. Embracing these advancements and fostering interdisciplinary collaboration will be key to realizing the transformative potential of data analytics in combating cancer.

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