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Comparative Analysis of Artificial Intelligence Algorithms for Breast Cancer Detection from Pathological Image in Burkina Faso

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Abstract. Artificial Intelligence (AI) has revolutionized many fields, including medical imaging. This revolution has enabled the digitization of medical images, the development of algorithms allowing the use of data captured in natural language, and deep learning, enabling the development of algorithms for automatic processing of medical images from massive medical data. In Burkina Faso, early and accurate detection of breast cancer is a significant challenge due to limited resources and lack of specialized expertise. In this article, we examine the effectiveness of different artificial intelligence algorithms for breast cancer detection from pathological image.

Keywords. Artificial Intelligence, Artificial Intelligence Algorithms, Breast Cancer Detection, Medical Imaging, Pathological Imaging, Burkina Faso.

1. Introduction

Breast cancer is one of the leading causes of death among women in Burkina Faso [1]. Although early detection is crucial for improving survival rates, the lack of experts in pathological anatomy often poses a major obstacle to this early detection. In this context, the use of Artificial Intelligence for the analysis of pathological imaging opens up new perspectives aimed at enhancing the accuracy and efficiency of breast cancer diagnosis [2]. We also highlight the diversity of approaches and AI algorithms proposed for breast cancer detection, thus underscoring the need for comprehensive comparative analysis. The aim of this study is to compare several artificial intelligence algorithms for detecting breast cancer from anatomopathological images, in order to determine the most effective one for cases in Burkina Faso.

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2. Literature review

The algorithms commonly used in breast cancer detection from pathological images include Convolutional Neural Networks (CNNs), Deep Neural Networks (DNNs), Support Vector Machines (SVMs), as well as other methods such as decision trees and clustering algorithms [3–5]. CNNs, which are at the core of many deep learning applications, consist of multiple layers, including convolutional, pooling, and fully connected layers [6,7].

The convolutional layer applies filters to extract visual features, followed by an activation function to introduce non-linearity [8]. The pooling layer reduces the spatial dimension of activation maps, while fully connected layers perform classification or prediction. These models are trained using an optimization algorithm such as stochastic gradient descent, often using pre-trained CNNs on large datasets like ImageNet, before being fine-tuned for specific tasks.

CNNs are widely used in various fields, including medical image classification, object detection, facial recognition, autonomous driving, and play a significant role in detecting and classifying anomalies from radiological and histopathological images in the medical domain.

3. Evaluation criteria

The various evaluation criteria, such as sensitivity, specificity, accuracy, and area under the ROC curve, play a crucial role in assessing the performance of breast cancer detection algorithms. Sensitivity measures the ability to correctly detect cases of breast cancer among all positive cases, thereby facilitating early and effective screening. Specificity assesses the ability to avoid false positives, thus minimizing diagnostic errors and unnecessary treatments. Accuracy quantifies the proportion of correct predictions among all positive predictions, ensuring the reliability of results for medical practitioners.

4. Comparison Methodology

The comparison methodology in our study comprises four key steps. Firstly, we perform data preprocessing to ensure their quality and consistency. Next, we select relevant performance criteria to assess the algorithms thoroughly. In parallel, we employ cross-validation techniques for robust evaluation of performance.

Finally, we utilize specific metrics such as precision, recall, and AUC to assess algorithm performance. These steps enable us to achieve a comprehensive and reliable comparison of artificial intelligence algorithms for breast cancer detection from histopathological images.

5. Data Collection and Preprocessing

First, we gather images from various medical sources, ensuring to include a variety of breast cancer cases. Next, these images are annotated by medical experts to identify areas of healthy breast tissue and cancerous tissue. Subsequently, the images undergo a preprocessing process, including steps such as resizing, color normalization, and noise removal, to ensure the quality and consistency of the data used for algorithm evaluation.

This data collection and preprocessing process is essential to ensure the reliability of the results obtained when comparing artificial intelligence algorithms for breast cancer detection.

6. Results

The source used for this comparison is a database comprising 1000 histopathological images of breast tissues taken from patients, sourced from various medical facilities. These images are accompanied by labels indicating the presence or absence of breast cancer.

Table 1. Algorithms Comparison Table.

Algorithmes	**Precision**	**Rappel**	**F1-score**	**Accuracy**
SVM	0.85	0.80	0.84	0.85
Decision Trees	0.85	0.83	0.86	0.85
K-Means	0.24	0.29	0.26	0.22
CNN	0.85	0.81	0.84	0.85

At the end of this study, the SVM (Support Vector Machine) model exhibits an accuracy of 85%, a recall of 80%, an F1-score of 84%, and an overall precision of 85%. Decision trees show similar results with an accuracy of 85%, a recall of 83%, an F1-score of 86%, and an overall precision of 85%. However, the K-Means clustering algorithm shows significantly lower performance, with only 24% accuracy, a recall of 29%, an F1-score of 26%, and an overall precision of 22%.

The CNN (Convolutional Neural Network) model demonstrates performance comparable to SVMs and decision trees, with an accuracy of 85%, a recall of 81%, an F1-score of 84%, and an overall precision of 85%. The following diagram illustrates the comparative graphical modeling between the SVM, decision trees, CNN, and K-Means algorithms on three performance measures: precision, accuracy, recall, and F1 score.

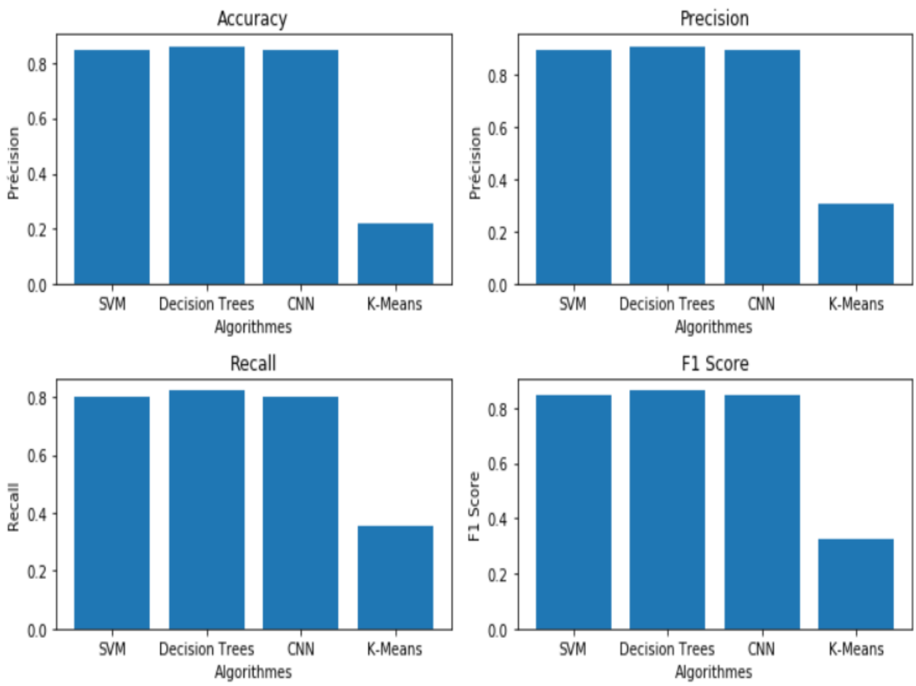

Figure 1. Presentation of Comparisons Results

7. Discussion

Regarding the performance of different algorithms, SVM and decision trees demonstrate similar performance in terms of precision, recall, F1 score, and accuracy. The CNN model also exhibits comparable performance to SVM and decision trees across all metrics, indicating its ability to be competitive in breast cancer detection from histopathological images. However, K-Means shows relatively low precision, suggesting it generates a large number of false positives, and its recall is also low, indicating it misses many positive cases. This suggests that K-Means may not be suitable for this specific task, likely due to its use of unsupervised classification. The CNN model emerges as a promising option for breast cancer detection from histopathological images.

Its performance compares favorably to traditional classification algorithms such as SVM and decision trees, suggesting that CNN could offer an effective solution for this specific task, accurately capturing the complex spatial features of the images. Algorithms can help identify early signs of breast cancer in anatomopathological images, promoting earlier and more effective treatments. By monitoring image changes over time, they allow for evaluating disease progression and adapting treatments accordingly. Physicians can use algorithm results as tools to decide on treatments and surgical interventions. These algorithms provide fast and accurate analysis of images, facilitating early detection and intervention.

By improving detection accuracy, they reduce diagnostic errors, minimizing false positives and negatives. More accurate detection helps direct medical resources to patients needing the most attention, avoiding treatment delays. With early and accurate detection, treatments are more effective, potentially improving clinical outcomes and reducing breast cancer-related morbidity and mortality. By analyzing large amounts of imaging data, algorithms provide valuable information for epidemiological research, leading to a better understanding of breast cancer risk factors and trends in the population.

8. Conclusions

We examined the effectiveness of various artificial intelligence algorithms in breast cancer detection from histopathology images, within the specific context of Burkina Faso. The results highlighted the crucial importance of AI in combating breast cancer, especially in regions with limited medical resources.

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