# Utilizing Various Machine-Learning techniques in Breast Cancer Detection

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***Abstract*— Worldwide, cancer is the most frequent cause of passing away for women. Any development in predicting and diagnosing cancer is crucial for a healthy life. As such, vital cancer accuracy in predicting patients' survival parameters and treatment aspects is necessary. Machine learning methods significantly impact breast cancer diagnosis and early diagnosis. This study aims to increase prediction accuracy using a novel statistical feature selection technique. This article examines the classification test accuracy, standard data precision, and the process performance of multiple machine learning (ML) algorithms, such as Random; using the Wisconsin Diagnostic Breast Cancer (WDBC) dataset, the following models were used: Support Vector Machine, Logistic Regression, Decision Tree (C4.5), Forest Naïve Bayes (NB), Linear Regression (LR), k-nearest-neighbors (KNN), and Multilayer Perceptron (MLP). The data set is partitioned to use the machine learning algorithm: 20% is used during the test phase, while 80% is used throughout training. Hyper-parameters that are manually assigned are utilized to modify the classifier. When applied to a subset of data, it showed that combining SVM and model in machine learning reached the maximum accuracy of up to 90%, which was noticeably superior to the other ML model.**

***Index Terms*— Breast cancer, Classification, K-nearest neighbors, Machine learning, Support vector machine**

## I. INTRODUCTION

Breast cancer is an infection where the breast's cells grow wholly and abnormally, culminating in the growth of a lump known as a tumor. If breast tumors are not treated, they may move to the liver, lungs, and bones, among other parts of the body(Murtaza et al., no date). Breast cancer affects both men and women, albeit men are at a lesser risk; hence, it is commonly understood that breast cancer is a malignancy that targets healthy cells. Breast cells that grow abnormally invade surrounding cells quicker and disperse to different body parts. When a cancerous growth (lump of tissue) develops in the breast, as well as the breast cancer results. There are two kinds of breast cancer: benign, non-cancerous, and cancerous (Dhahri et al., 2019). In the United States, it was anticipated that 62,930 new instances of non-invasive breast cancer and cancer will be 268,600 in 2019, saw the discovery of new invasive breast instances in women. Early identification is the best strategy to improve the likelihood of treatment and survival. Data mining has grown in popularity as a knowledge-finding method with promising applications in social science, business, finance, and medicine. Al-Jabbar and Associates, 2023(Sweilam et al., 2010). Recently, various classifier algorithms have been used to predict patient diagnoses and medical histories using datasets from the medical field. For instance, in breast cancer patients, they use machine-learning approaches to evaluate tumor behavior. Classification Preprocessing and feature extraction are the three primary phases of the breast cancer detection and classification processes created in the recent years. Utilizing a range of machine learning and data mining methods (Alaoui et al., 2021). Data mining algorithms applied in the healthcare sector are essential since they are good at forecasting. Moreover, they are diagnosing diseases, reducing the costs of medicine. They are making choices at the moment to save lives. Classification and prediction are the two most popular data mining modeling objectives. Several algorithms are utilized to diagnose breast cancer. In this review article the way, five classifiers performed are compared primarily: Logistic Regression, Random Forest, Support Vector Machine (SVM), and Decision tree (C4.5), K-Nearest Neighbors (KNN Network). These classifiers are considered to be among the top 10 and most beneficial algorithms of data mining, by the research community (Sweilam et al., 2010). We aim to apply machine learning methods to predict and diagnose breast cancer. We will identify the most effective classifier based on its performance regarding confusion matrix, precision, sensitivity, and accuracy. Our ability to diagnose is aided by data mining and machine learning technologies.


Figure 1 Types of Breast Cancer (Dhahri et al., 2019)

DOI:http://doi.org/10.24086/cocos2024/paper.1531

## II. Machine Learning Algorithms

An algorithm for machine learning is a group of guidelines and directives that a computer uses—without explicit programming—to learn from data and anticipate future events or make judgments. It enables An ML classifier called a support vector machine (SVM) to generalize between two classes if provided with a training sample of labeled data. The main objective of SVM is to identify the place between elements in data types that are similar or different. This type of model is well organized and operates on a three-dimensional schema.(Zheng et al., 2014). An essential method in the field of machine learning is the SVM algorithm for detecting breast cancer, which remained an effective method in the number of algorithms that processed many samples. As well as supervised learning (SVM) introduces assessing data based on a hyperplane that splits data. While breast cancer happens, SVM can study the essential data, such as the shape of the tumor and the shape and types we collected from libraries like mammography images and X-rays (Zheng et al., 2014). Although each machine learning technique has pros and cons, Gradient Boosting, Neural Networks, and Random Forests have also been used to detect breast cancer. These algorithms serve as tools for regression and classification problems and are crucial for assisting medical professionals in treating breast cancer and accurately diagnosing it.

It determines which hyperplane best separates the data into distinct groups to optimize the margin between them.(Fatima et al., 2020). SVM can handle non-linear and linear data and performs well in high-dimensional environments. A classifier that determines the maximum minimum hyperplane (MMH) by utilizing the closest data points after classifying Wisconsin Diagnostic Breast Cancer datasets (Yadav et al., 2022).

### *A. k-Nearest Neighbors (K-NN)*

The algorithm for classification is supervised. It learns how to categorize other points using many labeled points as input. The designated locations near a new point or its closest neighbors are considered, and their votes are cast when a new point needs to be labeled(.. et al., 2023).

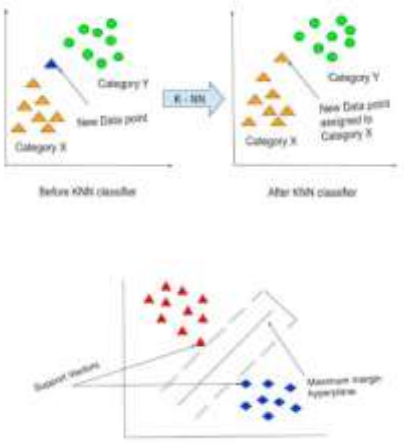


Figure 2 k-Nearest Neighbors (K-NN) (Jayandhi et al., 2021)

### *B. Random forests or random decision*

For classification, regression, and other problems, forests are an ensemble technique that builds many trees of decision in training, and the class receives the results. For every distinct tree, this is the mean prediction (regression) or mode of the classes (classification). Random decision forests address the issue of decision trees overfitting their training data. (Yadav, Singh, and Kashtriya, 2022).

### *C. Naïve Bayes Algorithm (NB)*

A sizable training dataset is assumed when using this model. The algorithm employs the Bayesian approach to identify the probability. It offers maximum accuracy when determining the likelihood of noisy data being used as input. This analogy classifier combines training tuples and training datasets. (Mohammed et al., 2020a). This Review is structured as below:

Section 2: introduces a Literature review

Section 3: provides a methods

Section 4: Discuss the issues and propose future directions. Lastly,

Section 5: concludes this present

## III. Literature review

Numerous research conducted in the last few years have used data mining algorithms to classify breast cancer using various medical datasets. These algorithms provide robust categorization capabilities, which inspire many scholars to use them in addressing intricate situations. Furthermore, data mining is frequently utilized in the medical industry to categorize and forecast anomalous occurrences to improve understanding of incurable illnesses like cancer (Mohammed et al., 2020). Applying data mining to classification shows promise in identifying breast cancer. Thus, the data mining methodology is applied in this work. This section of the Review article introduces prior studies on the identification of breast cancer(Dhahri et al., 2019).

DOI:http://doi.org/10.24086/cocos2024/paper.1531

| Authors | Classifiers/Ensemble methods | Area of application/Disease | Accuracy achieved |
|---|---|---|---|
| (Das *et al.*, 2021; Al-Jabbar *et al.*, 2023) | Ensemble of Bayesian classifiers (multilayer perceptron neural network) | Severity of breast masses | 91.83% on training subset and 90.63% of the test |
| (Alaoui *et al.*, 2021) | classifier in Neural Network | Breast cancers classification | 98.83% |
| (Uddin *et al.*, 2023) | ANFIS (Adaptative et al.) | diagnosis in Breast cancer | 98.25% |
| (Chaurasia and Pal, 2020a) | Recursive partition tree: An approach to ensemble decision-making<br><br>(There are four molecular subtypes: triple-negative, HER2-amplified, Luminal-A, and Luminal-B.) | Breast cancer | 83.8%, 77.4%, 87.9% and 92.7% |
| (Murtaza *et al.*, no date) | Classification and regression trees (CART) and expectation maximization (EM) create fuzzy rules | In Breast cancer | 94.20% |
| (Dhahri *et al.*, 2019) | For instance, reduction, the adaptive modified binary firefly algorithm (AMBFA), and affinity propagation (AP) clustering<br><br>for prediction using the Vectors Machine (SVM) approach and selection-related predictor | Diagnosis of Breast cancer | 98.606% |
| (Yadav, Singh, and Rashtriya, 2022; et al., 2023) | Classifiers of Naïve Bayes and artificial neural networks are often used in machine learning. | Estimation of having breast cancer | 86.95% 83.54, respectively |
| (Jayanthi et al., 2021) | Naïve Bayes classifiers and artificial neural networks are frequently used in machine learning. | Diagnostic Breast Cancer | Ensemble learning using features based on Sparse Autoencoders |
| (Zheng, Yoon, and Lam, 2014) | Artificial neural networks and Naïve Bayes classifiers are often used in machine learning. | Breast Cancer (prediction benign & malignant) | 98.60% |
| (Fatima *et al.*, 2020; ... *et al.*, 2023) | Artificial neural networks and Naïve Bayes classifiers are two commonly used methods in machine learning. | Prediction model for colon cancer | 90.38%, 88.01%, and 85.13% |
| (Murtaza *et al.*, no date) | Support vector machines (K-SVM) and K-means | Tumor detection | Tumor detection |
| (Mohammed *et al.*, 2020) | Support Vector Machine-Radial Basis Function (SVM-RBF) kernel, Naïve Bayes, and Radial Basis<br><br>Decision trees and function neural nets | Breast cancer | SVM-RBF 96.84% |

Table 1.presents an overview of the review of the literature. (Researcher)

## IV. METHODOLOGY

A dataset utilized in research. The Wisconsin Breast Cancer dataset for the study was provided by the UCI Machine Learning Repository. Bennett (2023) uses the same dataset to distinguish between malignant and non-cancerous tumors. Nevertheless, characteristics that characterize the nucleus of the current image were taken from digital photographs of the new needle aspirate of a breast lump. After looking through the WDBC database for 569 individuals in Wisconsin hospitals, 212 instances were found to be malignant and 357 benign. FNA test measurements are represented by each observation (Olofintuyi, 2023). The first two attributes in this collection represent the diagnosis status and the identification number. The thirty genuine qualities, which include the worst-of-ten cell, standard error, and mean, are the remaining values (Yadav, Singh, and Rashtriya, 2022).

| Algorithms | Tool | Data set | Number of Attributes | Data Type | Data Processing Method | Accuracy | Reference |
|---|---|---|---|---|---|---|---|
| Support-Vector Machine ( SVM) K-Nearest Neighbor (KNN) Logistics Regression (LR) Naive Bayes (NB) | MATLAB | UCI depository WDBC WPBC | 32WDBC 34WPBC | Numeric | Feature selection | 93% 95% 90% 92% | (Murtaza *et al.*, no date) |
| Decision Tree (C4.5) Artificial Neural Network(ANN) Support-Vector Machine (SVM) | Weka I | Iranian Center ICBC | 22 Attributes | Numeric | Data Cleaning and Preparation | 93.6% 94.7% 95.7% | (Dhahri *et al.*, 2019) |
| Support-Vector Machine (SVM) K Nearest Neighbor (KNN) Logistics Regression(LR) | Spyder | UCI depository | 32 Attributes | Numeric | Feature selection Dimensionally Reduction | 92.78% 92.23% 92.10% | (Jayanthi, Jasmine, and Joans, 2021) |
| MLP K-Nearest Neighbor(KNN) CART Naive Bayes SVM | Mathematica | UCI depository WDBC | 32 Attributes | Images | Standardize rescaling method | 99.12% 95.61% 93.85% 94.73% 98.24% | (Alaoui *et al.*, 2021) |
| J48 Naive Bayes MLP Logistic Regression Support Vector Machine K-Nearest Neighbor (KNN) | Weka | Wisconsin Breast Cancer (WBC) Data Center | 9 Attributes | Numeric | Features Selection | 95.59% 96.79% 94.78% 96.79% 97.59% 95.19% | (Das *et al.*, 2021) |
| Support-Vector Machine(SVM) Algorithm Decision Tree | Weka Spark Weka Spark | University of California Irvine | 254 samples | Numeric | Features Selection | 98.03% 99.68% 95.09% 98.80% | (Yadav, Singh, and Rashtriya, 2022) |
| Random Forest Algorithm | Weka Spark | repository WDBC | | | | 96.07% 98.09% | |
| Artificial Neural Network Support Vector Machine | Weka | Wisconsin Hospital | 11 Attributes | Numeric | Common Featured Values Selection Method | 95.4% 96.9% | (Naji *et al.*, 2021) |
| Naive Bayes(NB) K-Nearest Neighbors (KNN) J48 | Weka | Collected from Doctors and cancer Experts | 61 Attributes | Numeric | Features Selection | 98% 98% 97% | (Olofintuyi, 2023) |
| SVM (Linear kernel) SVM (RBF-Kernel) SVM (Polynomial Kernel) SVM (Sigmoid Kernel) | Weka | Wisconsin Diagnostic Breast Cancer (WDBC) | 32 Attributes | Numeric | Data Selection Recursive Features Elimination | 99% 98% 87% 94% | (Chaurasia and Pal, 2020b) |

### *A. Accuracy*

Accuracy in machine learning refers to the extent to which the predictions made by a model match the actual results. It measures a model's classification or prediction accuracy for a given input. A high accuracy score means the model operates efficiently and produces accurate predictions(Mohammed et al., 2020). Low prediction accuracy suggests that the model needs to be refined or retrained. One of the most used evaluation measures, Accuracy, is critical to machine learning. Classification accuracy is the proportion of accurate predictions to the total number of predictions made. It is only helpful when all forecasts and prediction errors have equal weight, and each class has an equal amount of data, which is only sometimes the

DOI:http://doi.org/10.24086/cocos2024/paper.1531

case.

$$Accuraccy = \frac{TP+TN}{(TP+TN+FN+FP)} \quad \text{..... Eq ( 1)(Mohammed et al., 2020)}$$

### B. *Recall or sensitivity*

In machine learning, recall—also called sensitivity—is a performance statistic that assesses a model's accuracy in identifying every pertinent instance in a dataset. It measures the proportion of actual positive outcomes that the model accurately recognized. Stated differently, recall quantifies the model's capacity to identify every pertinent example in a dataset. It is especially crucial in situations like fraud detection or medical diagnostics where there is a significant financial risk of overlooking a positive occurrence (false negative)(Yadav et al., 2022). Low recall implies that the model might overlook significant cases, whereas high recall shows that the model is good at capturing pertinent occurrences. The total amount of positive samples divided by the overall number of samples yields the recall.

$$Recall = \frac{TP}{(TP+FN)} \quad \text{…….. Eq 1}$$

### D. *Specificity*

This can be used to define how many negatives the ML model returned. In machine learning, specificity refers to a model's ability to detect negative instances accurately. It is the proportion of actual negative occurrences to accurate pessimistic predictions(.. et al., 2023). A model with a high specificity is good at detecting real negatives; when it has a low specificity, it is not good at telling positive cases from negative ones. To find this, utilize a confusion matrix and the formula below:

$$\text{Specifity} = \frac{TN}{(TP+FN)} \quad \text{……Eq 2}$$

### E. *Precision.*

Precision is the ratio of accurately anticipated positive samples to the overall positive samples. It is assessed how well the model classified a sample as positive.

In machine learning, the accuracy of an algorithm's optimistic predictions is called precision (Jayandhi et al., 2021). The calculation involves dividing the number of optimistic forecasts the model correctly predicted by the number of optimistic predictions the model made. Stated differently, accuracy measures the fraction of correctly identified positive cases.

$$Precison = \frac{TP}{(TP+FP)} \quad \text{……Eq 3}$$

### F. *Pre-processing WDBC Dataset*

Among the most deadly and diverse diseases of our day, breast cancer claims the lives of a great deal of women worldwide. In WDBC, datasets process data to detect cancer, so another systematic technique is utilized to guarantee the accuracy and structure of the study.(Dhahri et al., 2019). Identifying the data includes jobs like extracting some data feature, converting some analysis to incorrect data, or duplicating data to assess it. (Jayandhi et al., 2021) In machine learning, the data will be divided into training sets and test sets to extract features for training and testing data to predict output data for analysis. Fundamentally, constructing accurate models is reliable to detect breast cancer depending on the WDBC dataset. Some techniques will modify and recognize cancers. This model proposed information from the data in WDBC and cause coding that provided for dataset that sugested the technique used in Map Reduce skills. This technique extracts features to build the model and how it displays the attributes. The suggested method eliminates redundant values that could skew the classification (.. et al., 2023).


Figure 3.Primary Steps of the recommended Map-Reduce method to Generation Coding for Every Value in the WDBC Dataset (Murtaza et al., no date)

## V. Results and Discussion

The most frequent malignancy in women is breast cancer. Globally, it is even more common than lung cancer. Over 2.3 million new cases were about 11.7% of all cancer cases in 2020. In 2020, breast cancer will account for approximately 685,000 deaths among females due to cancer-related causes. After utilizing the Wisconsin Diagnostic dataset for Breast Cancer to test machine learning algorithms, AUC, Accuracy, F1 Score, Sensitivity, Precision, and confusion Matrix were employed as metrics of performance to assess and contrast the models and determine which algorithm was most effective for the most accurate cancer prediction. The Confusion Matrix is a tool for quantifying the Execution of a classification task when the result may belong to two or more different class types. A table with the dimensions "Predicted" and "Actual" along with the columns "True Positives (TP), True Negatives (TN), False Positives, and False Negatives (FN) (FP)" makes up a confusion matrix. The most famous performance indicator for classification algorithms is accuracy. It is referred to as the proportion of all predictions made to the number of accurate predictions. The proposed models found to perform experiments will be displayed. This section will contrast the classification algorithms utilized in this review. According to the findings of measures of recall and accuracy to determine which algorithm was more successful in breast cancer`s the timely identification and diagnosis. Remember that the

DOI:http://doi.org/10.24086/cocos2024/paper.1531

Wisconsin Diagnostic Breast Cancer (WDBC) dataset was employed to test the suggested model. The recommended model utilizes the most popular and efficient machine-learning methods to detect and diagnose breast cancer. The classification process has two steps: a learning or training step in which data is evaluated by a testing step and a classification algorithm in which data is used to classify the data and determine the classification's correctness.

Several techniques of data mining, deep learning, and machine learning for breast cancer prediction are compiled in this review article. A comparative overview of machine learning methods for accurately predicting breast cancer based on a tool (classifier/ensemble methods) and an area of application (disease) is given in Table 1. A comparative overview of machine learning methods for predicting breast cancer is given in Table 2, which considers the data processing method, data type, data sources, tools, and accuracy level of each algorithm in various scenarios. Every technique has its own set of applications and datasets. However, upon comparing these algorithms, we discovered that SVM, a machine learning algorithm, is the most appropriate for predicting breast cancer. Through my research, I noticed that SVM, with other algorithms of machine learning, achieved a high rate of detecting breast cancer, as I drew and illustrated in Figure 4.

Table 2. The proportion of accuracy for the diagnostic dataset of breast cancer (Researcher)

| Algorithms | Accuracy in Training Set (%) | Accuracy in Training Set |
|---|---|---|
| SVM | 99.8% | 97.2% |
| Logistic | 95.5% | 96.4% |
| Regression Decision Tree | 95.4% | 95.5% |
| Random Forest | 98.8% | 95.1% |
| K-NN | 94.6% | 93.7% |

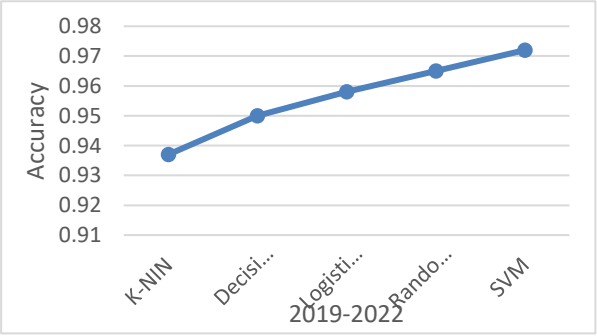


Figure 3. The dataset's accuracy percentage for breast cancer diagnosis (Researcher)

## VI. Conclusion

The second most common cause of mortality for women worldwide is breast cancer. The study begins with a review of the various forms of breast cancer to gain an understanding of the main varieties, signs, and causes of the disease. Following that, an overview of significant ensemble, deep learning, and machine learning methods has been given. These methods involve highly complex algorithms that are employed to predict breast cancer. Thus, methods of data mining and machine learning are utilized to forecast breast cancer. One of the key objectives of this review is to determine which algorithm is best suited to predict breast cancer. The study evaluated the dataset of Wisconsin Diagnostic Breast Cancer (WDBC), various machine learning techniques, methods for data mining and deep learning, K-Nearest Neighbors (KNN), Decision Tree (C4.5), Logistic Regression, Forest Naïve Bayes (NB) Random, Support Vector Machine (SVM), Multilayer Perceptron (MLP) and Linear Regression (LR). Our main goal was to identify the optimal algorithm that could predict the occurrence of breast cancer with greater accuracy. Individuals wishing to understand and evaluate machine learning algorithms may want to approach the topic more technically and analytically to establish a foundational understanding of deep learning. This research aimed to provide an overview of all previous research on machine learning algorithms used in breast cancer prediction. The support vector machine with additional machine learning models has been discovered to have surpassed all other classifiers and attained the best accuracy (97%) in machine learning at different classification stages. This study recommended utilizing (SVM) algorithm with other algorithms in Machine Learning to detect various types of cancer detection.

## VII. References

.. A.T. et al. (2023) 'A Comparative Analysis of Methods for Detecting and Diagnosing Breast Cancer Based on Data Mining,' Journal of Artificial Intelligence and Metaheuristics, 4(2), pp. 08–17. Available at: https://doi.org/10.54216/JAIM.040201.

Alaoui, E.A.A., et al. (2021) 'Improvement in automated diagnosis of soft tissue tumors using machine learning,' Big Data Mining and Analytics, 4(1), pp. 33–46. Available at: https://doi.org/10.26599/BDMA.2020.9020023.

Al-Jabbar, M. et al. (2023) 'Multi-Method Diagnosis of Histopathological Images for Early Detection of Breast Cancer Based on Hybrid and Deep Learning,' Mathematics, 11(6). Available at: https://doi.org/10.3390/math11061429.

Chaurasia, V. and Pal, S. (2020a). 'Applications of Machine Learning Techniques to Predict Diagnostic Breast Cancer,' SN Computer Science, 1(5). Available at: https://doi.org/10.1007/s42979-020-00296-8.

Chaurasia, V. and Pal, S. (2020b) 'Applications of Machine Learning Techniques to Predict Diagnostic Breast Cancer,' SN Computer Science, 1(5). Available at: https://doi.org/10.1007/s42979-020-00296-8.

Das, A. et al. (2021). 'Breast cancer detection using an ensemble deep learning method,' Biomedical Signal Processing and Control, 70. Available at: https://doi.org/10.1016/j.bspc.2021.103009.

Dhahri, H. et al. (2019). 'Automated Breast Cancer Diagnosis Based on Machine Learning Algorithms,' Journal of Healthcare Engineering, 2019. Available at: https://doi.org/10.1155/2019/4253641.

Fatima, N. et al. (2020). 'Prediction of Breast Cancer, Comparative Review of Machine Learning Techniques, and Their Analysis,' IEEE Access. Institute of Electrical and Electronics Engineers Inc., pp. 150360–150376. Available at: https://doi.org/10.1109/ACCESS.2020.3016715.

Jayanthi, G., Jasmine, J.S.L. and Joans, S.M. (2021) 'Mammogram learning system for breast cancer diagnosis using deep learning SVM,' Computer

Systems Science and Engineering, 40(2), pp. 491–503. Available at: https://doi.org/10.32604/CSSE.2022.016376.

Mohammed, S.A. et al. (2020) 'Analysis of breast cancer detection using different machine learning techniques', in Communications in Computer and Information Science. Springer, pp. 108–117. Available at: https://doi.org/10.1007/978-981-15-7205-0_10.

Murtaza, G. et al. (no date) Breast Cancer Multi-classification through Deep Neural Network and Hierarchical Classification Approach.

Naji, M.A. et al. (2021) 'Machine Learning Algorithms for Breast Cancer Prediction and Diagnosis', in Procedia Computer Science. Elsevier B.V., pp. 487–492. Available at: https://doi.org/10.1016/j.procs.2021.07.062.

Olofintuyi, S.S. (2023) 'BREAST CANCER DETECTION WITH MACHINE LEARNING APPROACH', FUDMA JOURNAL OF SCIENCES, 7(2), pp. 216–222. Available at: https://doi.org/10.33003/fjs-2023-0702-1392.

Sweilam, N.H., Tharwat, A.A. and Abdel Moniem, N.K. (2010) 'Support vector machine for diagnosis cancer disease: A comparative study', Egyptian Informatics Journal, 11(2), pp. 81–92. Available at: https://doi.org/10.1016/j.eij.2010.10.005.

Uddin, K.M.M. et al. (2023) 'Machine learning-based diagnosis of breast cancer utilizing feature optimization technique', Computer Methods and Programs in Biomedicine Update, 3. Available at: https://doi.org/10.1016/j.cmpbup.2023.100098.

Yadav, R.K., Singh, P. and Kashtriya, P. (2022) 'Diagnosis of Breast Cancer using Machine Learning Techniques -A Survey', in Procedia Computer Science. Elsevier B.V., pp. 1434–1443. Available at: https://doi.org/10.1016/j.procs.2023.01.122.

Zheng, B., Yoon, S.W. and Lam, S.S. (2014) 'Breast cancer diagnosis based on feature extraction using a hybrid of K-means and support vector machine algorithms', Expert Systems with Applications, 41(4 PART 1), pp. 1476–1482. Available at: https://doi.org/10.1016/j.eswa.2013.08.044.

DOI:http://doi.org/10.24086/cocos2024/paper.1531