

Data Set

Breast Cancer Wisconsin (Diagnostic) -- Predict whether the cancer is benign or malignant

Rationale and objectives of the study

1) Goal

The goal of this project is to predict whether the breast cancer is benign or malignant.

2) Public health concern for women worldwide

Breast cancer is the most common cancer among women and one of the major causes of death among women worldwide. One in eight women in the United States will be diagnosed with breast cancer in her lifetime. Worldwide, it is estimated that 124 out of 100,000 women are diagnosed with breast cancer, and approximately 23 out of the 124 women will die of this disease. On average, every 2 minutes a woman is diagnosed with breast cancer and 1 woman will die of breast cancer every 13 minutes. Public health data indicated that the global burden of breast cancer in women, measured by incidence, mortality, and economic costs, is substantial and on the increase.

3) Early detection helps recovery

When detected in its early stages, there is a 30% chance that the cancer can be treated effectively. Death rates from breast cancer have been declining since about 1990, in part due to better screening and early detection, increased awareness, and continually improving treatment options. A woman can get a better chance of complete regaining from the cancer if diagnosed at prior stage, thus firing the need of development of efficient diagnosis techniques like Information and Communication Technologies (ICT).

4) Detection dilemma

However, late detection of advanced-stage tumors makes the treatment more difficult. Currently, the most used techniques to detect breast cancer in early stages are: mammography (63% to 97% correctness), FNA (Fine Needle Aspiration) with visual interpretation (65% to 98% correctness) and surgical biopsy (approximately 100% correctness). Therefore, mammography and FNA with visual interpretation correctness varies widely, and the surgical biopsy, although reliable, is invasive and costly.

What is more, normally in traditional cases, double-reading (same mammograms are read by two radiologists individually) has been encouraged in decreasing the percentage of overlooked cancers and it is at present the supreme technique incorporated in most of the screening programs instead of the fact that it earns in surplus workload and costs.

Therefore, a platform for the computer-aided detection/diagnosis systems is established for backing up a single radiologist reading mammograms providing sustenance to her/his decisions.

5) Previous research work

Some papers were published during the last 30 years trying to achieve the best performance for the computational interpretation of FNA samples.

- Omar, et al ^[7] applied three machine-learning algorithms (Support Vector Machine, K-nearest neighbors, and Decision tree) to do classifier training. The outcomes of their study have revealed that quadratic support vector machine grants the largest accuracy of (98.1%) with lowest false discovery rates. Their experiments were carried out using Matlab.
- Vikas, et al ^[8] applied three popular data mining algorithms (Naïve Bayes, RBF Network, J48) to develop the prediction models. They used 10-fold cross-validation methods to measure the unbiased estimate of the three prediction models. The results indicated that the Naïve Bayes performed best which received 97.36% accuracy as a predictor on the holdout sample, RBF Network came out to be the second with 96.77% accuracy, J48 came out third with 93.41% accuracy.
- Ioannis, et al ^[11] used probabilistic and generalized regression neural classifiers to deal with the breast cancer diagnosis and prognosis using the Wisconsin Diagnostic Breast Cancer (WDBC) as well as the Wisconsin Prognostic Breast Cancer (WPBC) data sets. The accuracy of the neural classifiers reaches nearly 98% for the diagnosis and 92% for the prognosis problem.

- Borges, et al. ^[12] used two well-known machine learning techniques to test their training models: Bayesian Networks and J48. The best accuracy in their paper was achieved by the Bayesian Networks algorithm, 97.80% of accuracy in its best configuration, while J48 had 96.5% of accuracy.

More previous research work could be searched in Google Scholar or Springer, archived paper could be downloaded via Duke Library.

Data Description

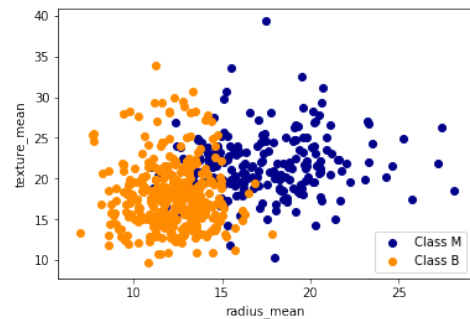
Wisconsin Diagnostic Breast Cancer (WDBC) dataset were utilized in this project. The dataset is publically available ^{[1][2]}, and was created by Dr. William H. Wolberg, physician at the University of Wisconsin Hospital at Madison, Wisconsin, USA. The dataset consists of **569** instances (357 benign – 212 malignant), where each one represents FNA test measurements for one diagnosis case. For this dataset each instance has **32** attributes, where the first two attributes correspond to a unique identification number and the diagnosis (benign / malignant). The rest 30 features are computations for ten real-valued features, along with their mean, standard error and the mean of the three largest values for each cell nucleus respectively.

General data visualization are shown [\[here\]](#).

Note: You might need to download to view.

	id	diagnosis	radius_mean	texture_mean	perimeter_mean
0	842302	M	17.99	10.38	122.80
1	842517	M	20.57	17.77	132.90
2	84300903	M	19.69	21.25	130.00
3	84348301	M	11.42	20.38	77.58
4	84358402	M	20.29	14.34	135.10

(a)



(b)

Here (a) shows first five columns and five rows of dataset; (b) shows first two features plot classified by diagnosis value (M / B).

These are all real-valued features computed for each cell nucleus, from the graph and data visualization, we could observe that diagnosis value (M / B) are closed related to the shape or value of cell nucleus. Thus, we could apply machine learning algorithm to train an optimized model for the dataset, and test our trained model within the dataset.

Anticipated Technical Approach/Methods

Original dataset before being publically available, there are missing points. However, this dataset has been revised, so it could be considered 'noise-free' and has none missing feature values.

1) First step of the dataset analysis would be pre-processing the data. Though it was claimed there were no missing values, we need to be meticulous when we are dealing with data. The pre-processing will focus on managing the missing attributes, the unbalanced data (outlier values) and the number of attributes used to train the classifier.

2) Second step would be data visualization. As we have 32 features, it would be complex and time-costing to train such multi-features model. We could use PCA for Data Visualization. One of the most important applications of PCA is for speeding up machine learning algorithms.

3) Third step would be using different data mining algorithms to develop prediction models. We could apply the algorithm we learn in class like KNN, or other applicable algorithms like (Naïve Bayes, RBF Network, J48, Support Vector Machine, and Decision tree) to solve the diagnosis problem. As the dataset is publically available and the same, previous work is replicable. The main reason for the project is to learn, thus I think reproduce previous work should be meaningful.

4) Fourth step would be model performance measuring. We have many influencing factors to define how good a training model is. However, for simplicity, here we use accuracy to be the metric for machine learning algorithms (precision, recall, F1 Score, ROC Curve, etc would be fine). Furthermore, we could apply classification accuracy, sensitivity, specificity, positive and negative predictor values and confusion matrix to evaluate different models performance.

Reference:

- [1] <https://www.kaggle.com/uciml/breast-cancer-wisconsin-data/discussion/62297>
- [2] <http://archive.ics.uci.edu/ml/datasets/Breast+Cancer+Wisconsin+%28Diagnostic%29>
- [3] <https://www.nationalbreastcancer.org/>
- [4] Shaikh, Tawseef Ayoub, and Rashid Ali. "Applying Machine Learning Algorithms for Early Diagnosis and Prediction of Breast Cancer Risk." *Proceedings of 2nd International Conference on Communication, Computing and Networking*. Springer, Singapore, 2019.
- [5] Henriksen, Emilie L., et al. "The efficacy of using computer-aided detection (CAD) for detection of breast cancer in mammography screening: a systematic review." *Acta Radiologica* 60.1 (2019): 13-18.
- [6] Sri, M. Navya, et al. "A Comparative Analysis of Breast Cancer Data Set Using Different Classification Methods." *Smart Intelligent Computing and Applications*. Springer, Singapore, 2019. 175-181.
- [7] Obaid, Omar Ibrahim, et al. "Evaluating the Performance of Machine Learning Techniques in the Classification of Wisconsin Breast Cancer." *International Journal of Engineering & Technology* 7.4.36 (2018): 160-166.
- [8] Chaurasia, Vikas, Saurabh Pal, and B. B. Tiwari. "Prediction of benign and malignant breast cancer using data mining techniques." *Journal of Algorithms & Computational Technology* 12.2 (2018): 119-126.
- [9] Bhattacharjee, Aindrila, et al. "Classification approach for breast cancer detection using back propagation neural network: a study." *Biomedical image analysis and mining techniques for improved health outcomes*. IGI Global, 2016. 210-221.
- [10] Coughlin, Steven S., and Donatus U. Ekwueme. "Breast cancer as a global health concern." *Cancer epidemiology* 33.5 (2009): 315-318.
- [11] Anagnostopoulos, Ioannis, et al. "The Wisconsin Breast Cancer Problem: Diagnosis and DFS time prognosis using probabilistic and generalised regression neural classifiers." *Oncology Reports, Special Issue Computational Analysis and Decision Support Systems in Oncology* (2005).
- [12] Borges, Lucas Rodrigues. "Analysis of the Wisconsin Breast Cancer Dataset and Machine Learning for Breast Cancer Detection." *Group* 1.369 (1989).