

Breast Cancer Prediction

Machine Learning Project



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Motivation and Research Aim



Motivation

- 2.3 million women diagnosed with breast cancer; 685,000 deaths globally (2020)
- Use data to infer correlations between cancer diagnoses and chosen features

The Plan

<i>Input</i>	{Size, Texture, Compactness, etc}
<i>Methods</i>	{Classification, Clustering}
<i>Output</i>	{Malignant, Benign}



Related Work



- Logistic regression, KNN, SVM, naïve Bayes, decision tree, and random forest with a breast cancer dataset [1]
 - Removed non-numerical values and normalized numeric values [1]
 - Heat map and other plots created using R studio, Minitab, and Python [1]
- ML better for diagnoses compared to traditional methods (human interpretation) [2, 3, 4]
 - AI system had higher area under AUC-ROC curve than human detector by 11.5% [2]
 - Image analysis was used with ML to increase accuracy of breast cancer testing [3, 4]
- LDA and SVM resulted in increased accuracy [5]

Dataset & Features



Breast Cancer Dataset by M Yasser H from Kaggle

32 features, 569 examples (75%/25% train/test)

Features:

1	ID	9	symmetry mean	17	smoothness se	25	perimeter worst
2	diagnosis	10	concavity mean	18	compactness se	26	area worst
3	radius mean	11	concave points mean	19	concavity se	27	smoothness worst
4	texture mean	12	fractal dimension mean	20	concave points se	28	compactness worst
5	perimeter mean	13	radius se	21	symmetry se	29	concavity worst
6	area mean	14	texture se	22	fractal dimension se	30	concave points worst
7	smoothness mean	15	perimeter se	23	radius worst	31	symmetry worst
8	compactness mean	16	area se	24	texture worst	32	fractal dimension worst

Citation: Yasser H., M. (2022). Breast Cancer Dataset. Retrieved January 2024 from <https://www.kaggle.com/datasets/yasserh/breast-cancer-dataset>.

Methods - Algorithms



Classification

Logistic Regression

K-Nearest Neighbors

Naive Bayes

Decision Tree

Random Forest

Boosting

Support Vector Machines

Clustering

K-Means

Hierarchical

Mean-Shift

Methods - Metrics



Classification

Accuracy

Recall

Precision

F1-Score

Clustering

Internal Metrics

Silhouette Score

Davies-Bouldin index

Calinski-Harabasz Index

External Metrics

Adjusted Rand Index

Normalized Mutual Information

Results - Data Process & Feature Selection

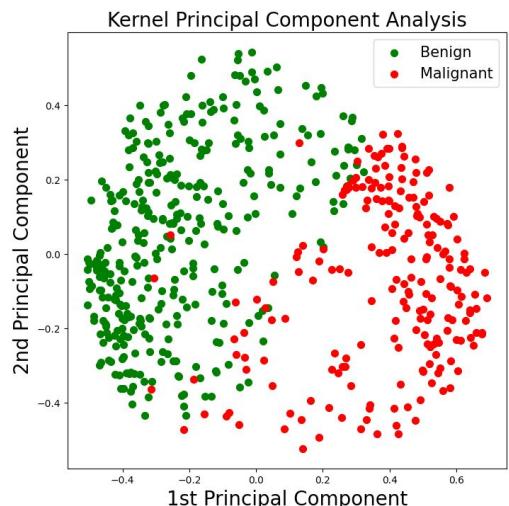
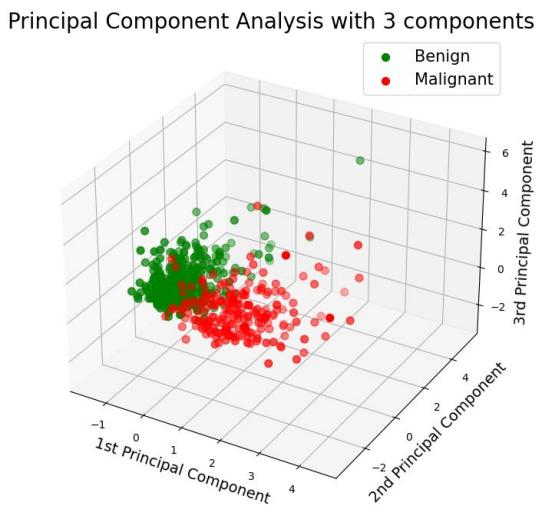
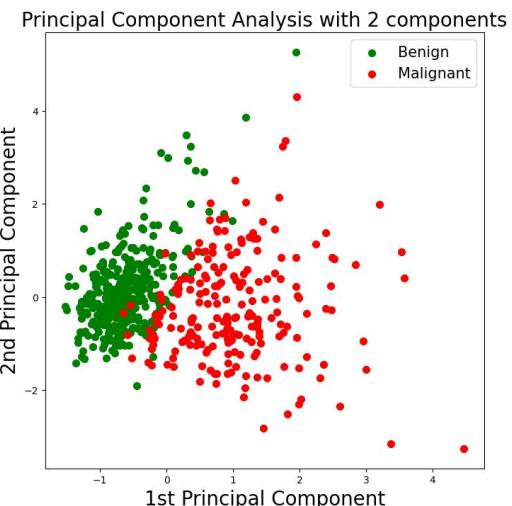
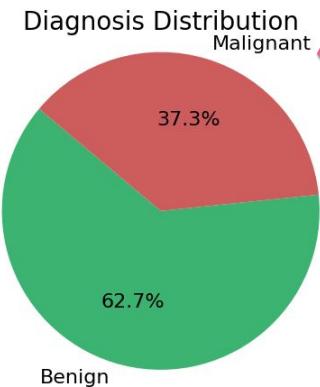
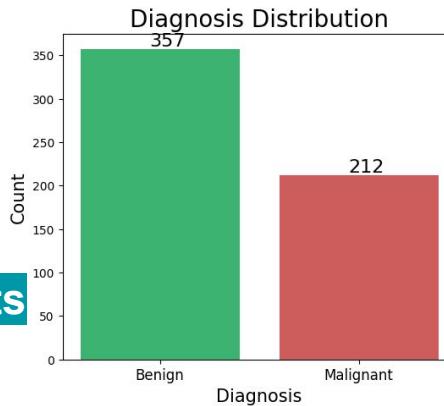


Remove empty value

Encode diagnosis (B->0, M->1)

Standard Scaler

Split data into train(75%) and test(25%) sets



Results - Model Training



Find hyperparameters before training model

- Grid Search to find hyperparameters for a model
- Find the best score
- Classification use Recall; Clustering use ARI

Get Evaluation Metrics with hyperparameters

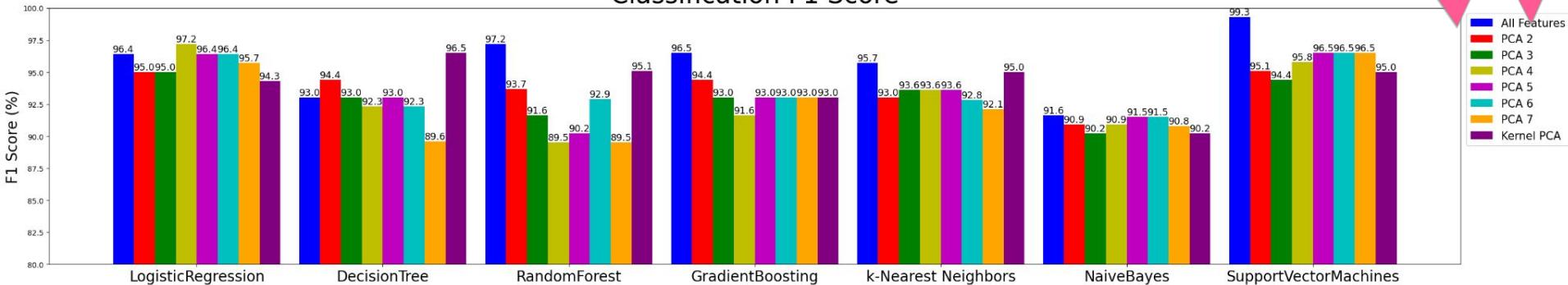
- Fit the model for original dataset and 7 kinds of transformed dataset
- Classification get Train/Test Accuracy, Recall, Precision, F1 Score
- Clustering get Silhouette Score, DBI, CHI, ARI, NMI

Decision Tree Hyperparameters				
Parameter Data	max_depth	min_samples_split	min_samples_leaf	
All Features	None	2	10	
PCA 2	None	1	10	
PCA 3	None	1	10	
PCA 4	20	4	5	
PCA 5	10	4	2	
PCA 6	None	4	10	
PCA 7	10	2	2	
Kernel PCA	10	2	10	

Results - Classification

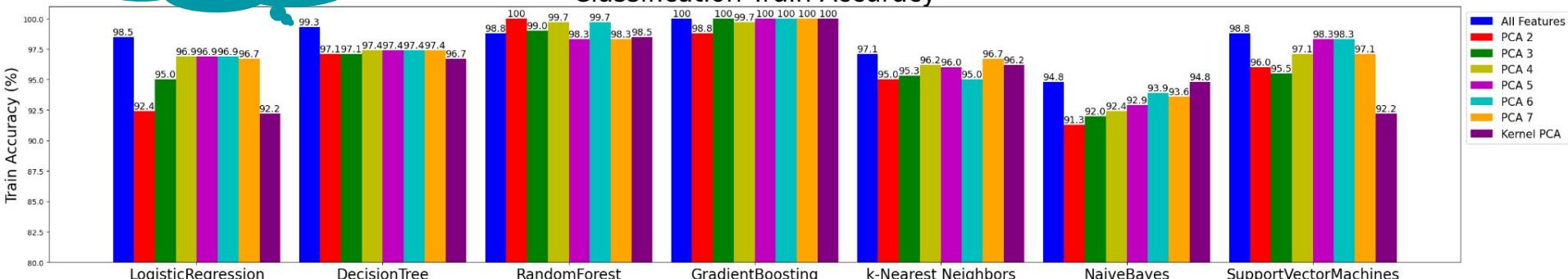


Classification F1 Score



Tree-Based
Methods overfitting

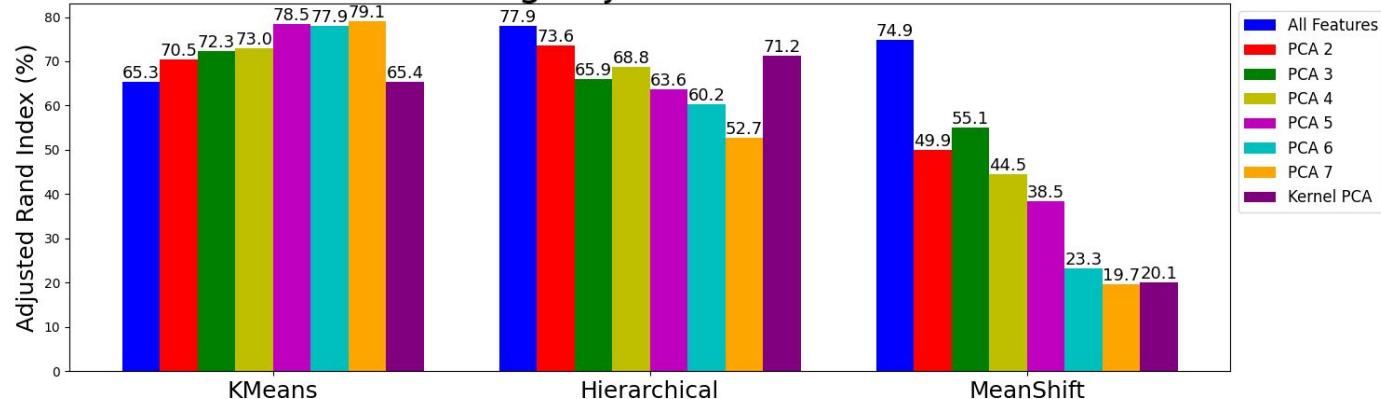
Classification Train Accuracy



Results - Clustering

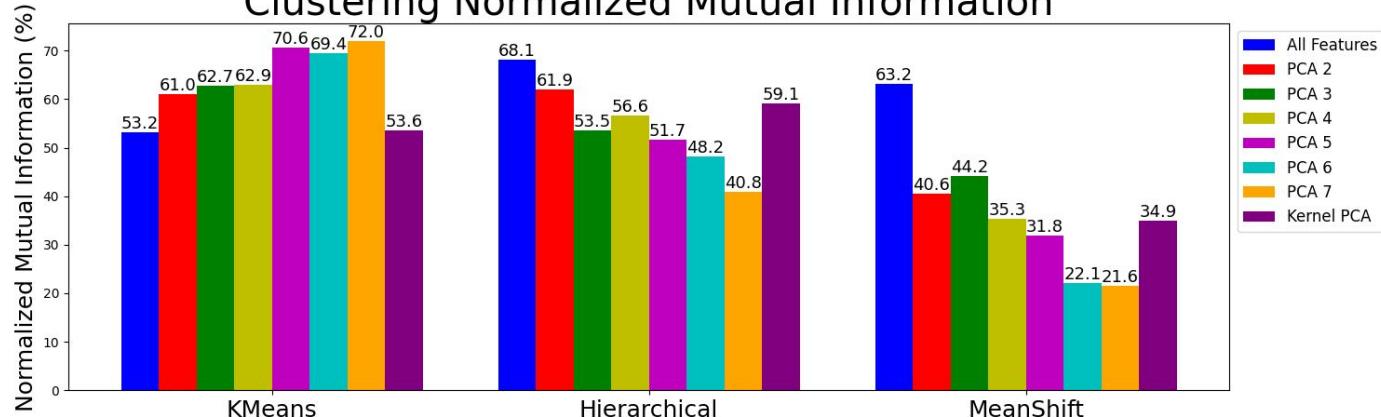


Clustering Adjusted Rand Index



62.7%

Clustering Normalized Mutual Information



Conclusion



Overall, Classification performance is better than Clustering

Classification:

- ❖ Original dataset performance is better than other transformed data for most of classification methods.
- ❖ SVM in original dataset is the best(99.3%);

Clustering:

- ❖ Hierarchical and MeanShift in original dataset performance is better than transformed data.
- ❖ K-Means PCA performance is better than original dataset and kernel PCA, and the performance is getting better when PCA components increase from 2 to 7.
- ❖ K-Means in PCA with 7 components is the best(79.1%) in clustering.

Discussion



Classification:

- ❖ Any feature selection can help to improve classification performance?
- ❖ How to prevent Tree-Based methods' overfitting?

Clustering:

- ❖ Any feature selection can help to improve performance for Hierarchical and MeanShift?
- ❖ K-Means can meet best performance with what PCA components?

References



- [1] Ak, M.F. A Comparative Analysis of Breast Cancer Detection and Diagnosis Using Data Visualization and Machine Learning Applications. *Healthcare* 2020, 8, 111. <https://doi.org/10.3390/healthcare8020111>
- [2] McKinney, S.M., Sieniek, M., Godbole, V. et al. International evaluation of an AI system for breast cancer screening. *Nature* 577, 89–94 (2020). <https://doi.org/10.1038/s41586-019-1799-6>
- [3] W. Nick Street, W. H. Wolberg, and O. L. Mangasarian "Nuclear feature extraction for breast tumor diagnosis", Proc. SPIE 1905, Biomedical Image Processing and Biomedical Visualization, (29 July 1993); <https://doi.org/10.1117/12.148698>
- [4] Wolberg WH, Street WN, Mangasarian OL. Image analysis and machine learning applied to breast cancer diagnosis and prognosis. *Anal Quant Cytol Histol.* 1995 Apr;17(2):77-87. PMID: 7612134.
- [5] David A. Omondiagbe et al 2019 IOP Conf. Ser.: Mater. Sci. Eng. 495 012033
- [6] Yasser H., M. (2022). Breast Cancer Dataset. Retrieved January 2024 from <https://www.kaggle.com/datasets/yassersh/breast-cancer-dataset>.

Thank You

Breast cancer  Stronger Together

