Cost-Benefit Analysis of Yearly Mammograms: A Social Justice Approach to Individualized Medicine

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Objectives

- Develop a better scoring system for mammogram procedures.
- Reduce the costs of mammograms.
- Develop/propose new protocols.
- Discover which factors are more fatal and position them in a hierarchy.

Introduction

Breast cancer is the second most common cancer and the leading cause of death among women worldwide. To identify breast cancer, the United States Preventative Service Task Force (USPSTF) has suggested that women get biennial mammograms starting at age 40 until the age of 74 [1]. A mammogram is the procedure most commonly used to identify breast cancer, as it can detect the ailment before it causes signs and symptoms. This process, however, does not save everyone and is quite costly. An estimated 684,996 women lost their lives to the disease in 2020, and approximately 8 billion dollars are spent on mammographic procedures annually in the U.S. alone. Roughly half of the 8 billion dollars spent on mammograms are false positives [4]. These financial and psychological burdens plague women globally and add to the perceived cons of biennial mammograms. We have looked into developing a better scoring system. We found the Tyrer-Cuzick Screening Scoring System, which is similar to the scoring system that we have developed. In contrast to the current BI-RADS process, we take genetic and specific living style risk factors into consideration that contribute to breast cancer. To try to know whether a patient is likely to develop breast cancer, we created clustering algorithms that will predict that for us by using a point system that we developed.

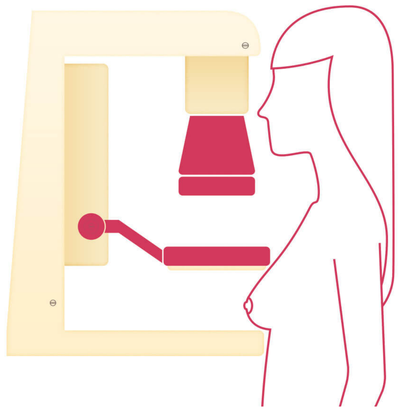


Figure 1:Mammographic Screening Procedure

Risk Factors

- Breast Density
- Body Mass Index (BMI)
- Age of first birth
- Previous history of a first-degree relative
- Age
- Menopausal status
- Race/ethnicity
- Hormone replacement therapy (CHRT)

Mammogram Scores

Breast Imaging Reporting and Data Systems (BI-RADS)

1. Breast density
2. Breast calcifications
3. Breast asymmetry
4. Breast lesions

Results

Predictive Model	# of Patients	Accuracy
KNN	7 million	97%
SVM	7 million	70%
Hierarchical	10,000	87%

Formulas

Total positive with risk factor/universal population with risk factor: $\frac{P}{U}$

$\vec{A}$ = Risk Factor $\quad$ $\vec{B}$ = Hierarchy Position

$$\vec{A} \cdot \vec{B} = (8)(BD) + (7)(BMI) + (6)(AG) + (5)(FD) + (4)(CHRT) + (3)(MP) + (2)(AFB) + (1)(R/E)$$

Clustering Algorithms

Uses training dataset to find K nearest points to predict the class/value of a new data point.

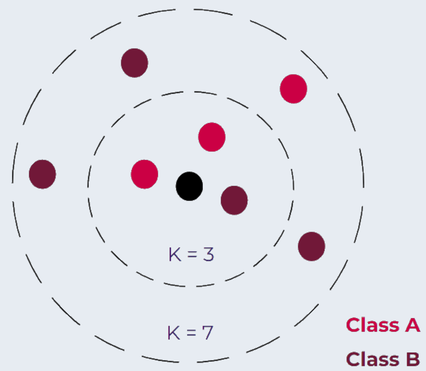


Figure 2:K-Nearest Neighbor

Maps data to a high-dimensional feature space.

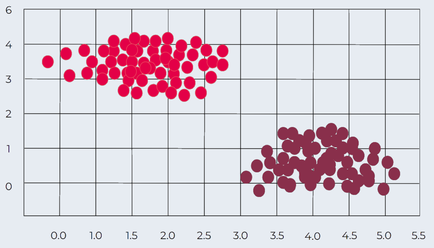


Figure 3:Support Vector Machine

Groups similar objects into groups called clusters.

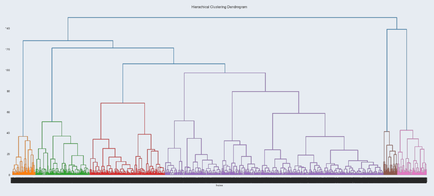
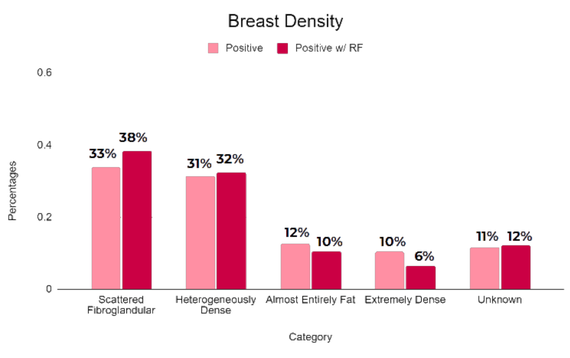
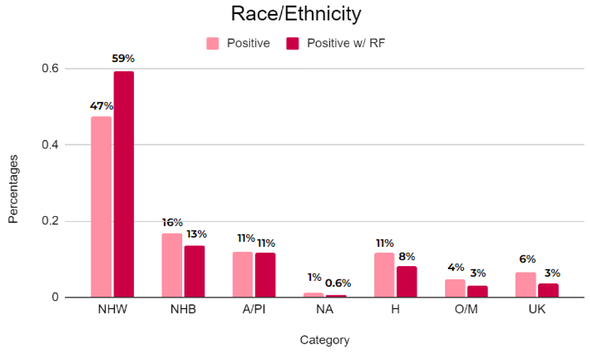


Figure 4:Hierarchical Clustering

Scoring System





Breast Density > BMI > Age Group > First Degree > HRT > Menopause > Age First Birth > Race/Eth

Tyrer-Cuzick Scoring System

The system calculates two risks; the likelihood that someone will develop breast cancer within the next 10 years, and estimates the risk over their lifetime [19]. The calculation is separated into four categories, personal history, number of children and medical history, family history, and results. The results show a personal and population 10-year risk and a personal and population lifetime risk. These results will show whether the patient is at an average, intermediate, or high risk of developing cancer. The average is less than 15%. The intermediate is between 15-19%. The high risk is over 20%.

Conclusion

Current mammogram protocols overlook genetic and specific lifestyle risk factors that enhance someone's likelihood of developing breast cancer. Our scoring system takes all those factors into consideration, but it is still in its initial stage. Once we finalize it, we can plug it right into our algorithms and start making realistic protocols that benefit as many people as possible. Tyrer-Cuzick's scoring system lets us know that we are on the right path. The majority of our risk factors may be the same, but our scoring system and hierarchy are different.

Future Work

Since our scoring system is similar to Tyrer's, when we finish our system, we will be able to compare them and see how efficient and effective ours is. For us to verify our research and asses its limitations, we will consult with medical professionals to evaluate our protocols based on our point system and algorithms. If it is proven to be beneficial, then we can proceed to conduct a cost-benefit analysis of the new protocols and be able to analyze how they affect women of color and people with low income.

References

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