Predicting Recurrence and Risk Factors of Differentiated Thyroid Cancer using Explainable AI

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Table of contents

Introduction

- Thyroid cancer has almost tripled since 1975 (Davies & Welch, 2014)
  - Absolute increase around 4x greater for women than men
- Recurrence rates between 6.6% and 28% (Ywata de Carvalho et al., 2021)
- Multiple studies investigating machine learning applications for thyroid cancer
  - Creation of three rules using machine learning to help prediction of thyroid cancer recurrence (Kim et al., 2021)
  - Recurrence of differentiated thyroid cancer using a deep neural network (Ahmad & Haddad, 2024)
  - Recurrence of thyroid cancer using SVM, KNN, Decision Tree, Random Forest, and ANN (Borzooei et al., 2023)

Problem Statement

- Machine learning is increasingly used to predict thyroid cancer recurrence
- Existing studies vary in methods, patient groups, and model interpretability
- More exploration is needed to understand which models are most effective
- This project investigates multiple ML models using a public thyroid cancer dataset

Goal: Evaluate model performance and interpretability to support early risk identification

Purpose of Code

- Dataset: Cohort of 383 patients for a minimum of 10 years within a 15-year timeframe; 16 features and 383 observations
- Preprocessing:
  - No missing values
  - 75/25 data split
  - One-hot encoding and label encoding
- Models (classification):
  - Logistic Regression
  - Support Vector Machine
  - Random Forests

Purpose of Code

- Hyperparameter tuning:
  - GridSearch
  - Stratified cross-validation, k=10
- Metrics:
  - Accuracy
  - Precision
  - Sensitivity (Recall)
  - F1 score
  - Specificity
  - ROC curve
  - AUC
- Feature importance plots, LIME

Code Demo

Conclusion

Model	Metrics	Current	Benchmark
Logistic Regression	Sensitivity	92.59%	N/A
	Specificity	100%	N/A
	AUC	99.09%	N/A
Support Vector Machine	Sensitivity	96.30%	99.33%
	Specificity	100%	97.14%
	AUC	98.87%	99.71%
Random Forests	Sensitivity	96.30%	99.66%
	Specificity	100%	94.28%
	AUC	97.29%	99.38%

Conclusion

- Response is the most important variables for each model
- Logistic Regression = Best AUC, Support Vector Machine = most balanced metrics
- Models performed worse than other models trained on the same dataset; but still decent overall
- Models had balanced training and testing metrics, indicating no underfitting or overfitting
- Could benefit from a larger dataset
- Strong application for machine learning in this area

References

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Thank you!