Predicting Cognitive Decline

Group 8:
Brett Castro, Luke Napolitano, Sam Remmey, Lucy Shichman, Sanjana Srivastava

Introduction

- Alzheimer’s Disease: Progressive neurodegenerative disease that deteriorates memory and other important mental functions
  - Highly prevalent in patients 85+
  - Earlier detection allows for earlier treatment
  - Clinical diagnostic tools are expensive and invasive
- Research Questions
  - How can we use health indicators to predict cognitive decline?
    - Mini-Mental State Exam (MMSE) via MLR
    - Diagnosis via Logistic Regression
- Dataset summary:
  - Health information of 2149 patients
  - Symptoms, demographics, medical assessments, and medical history
    - 14 numerical, 22 categorical variables


Healthy Brain

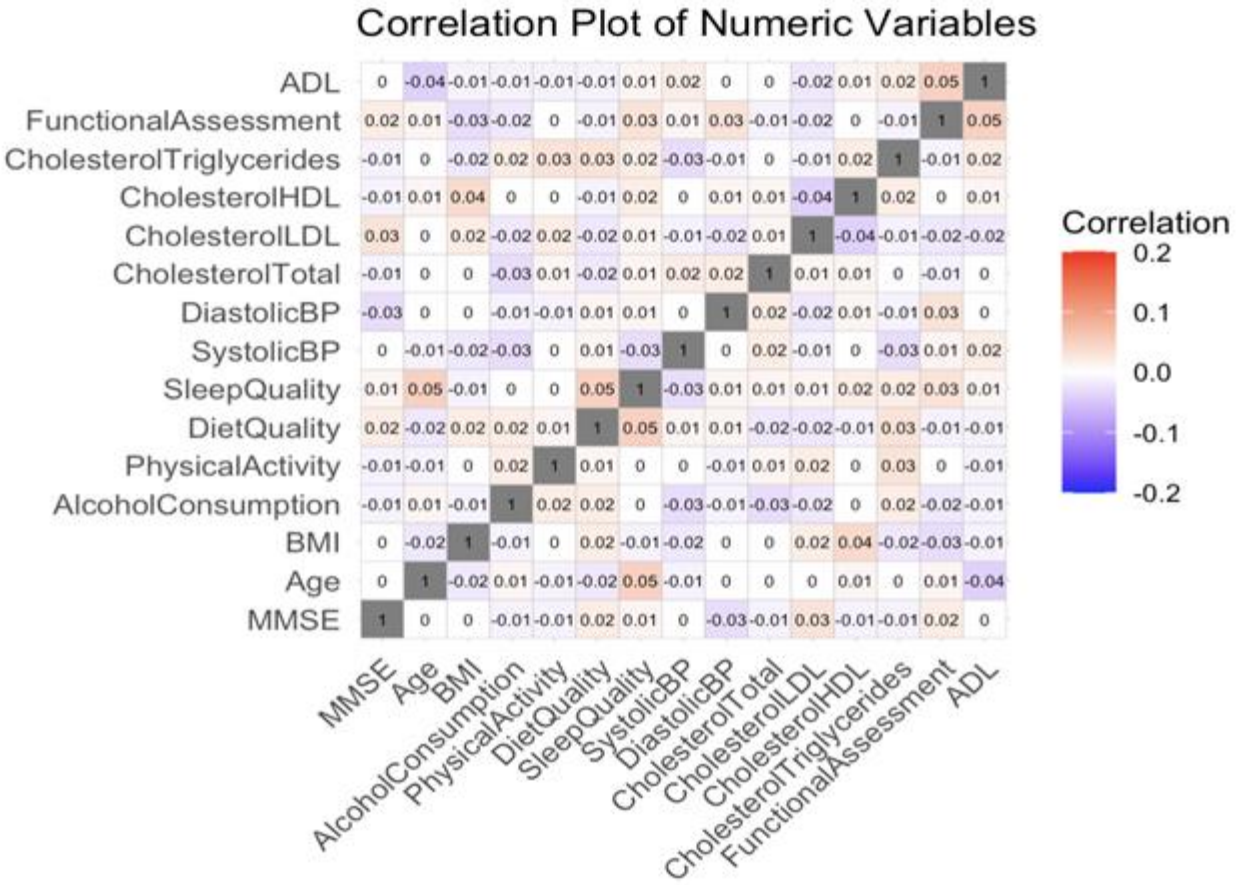

Mild Alzheimer’s Disease


Severe Alzheimer’s Disease

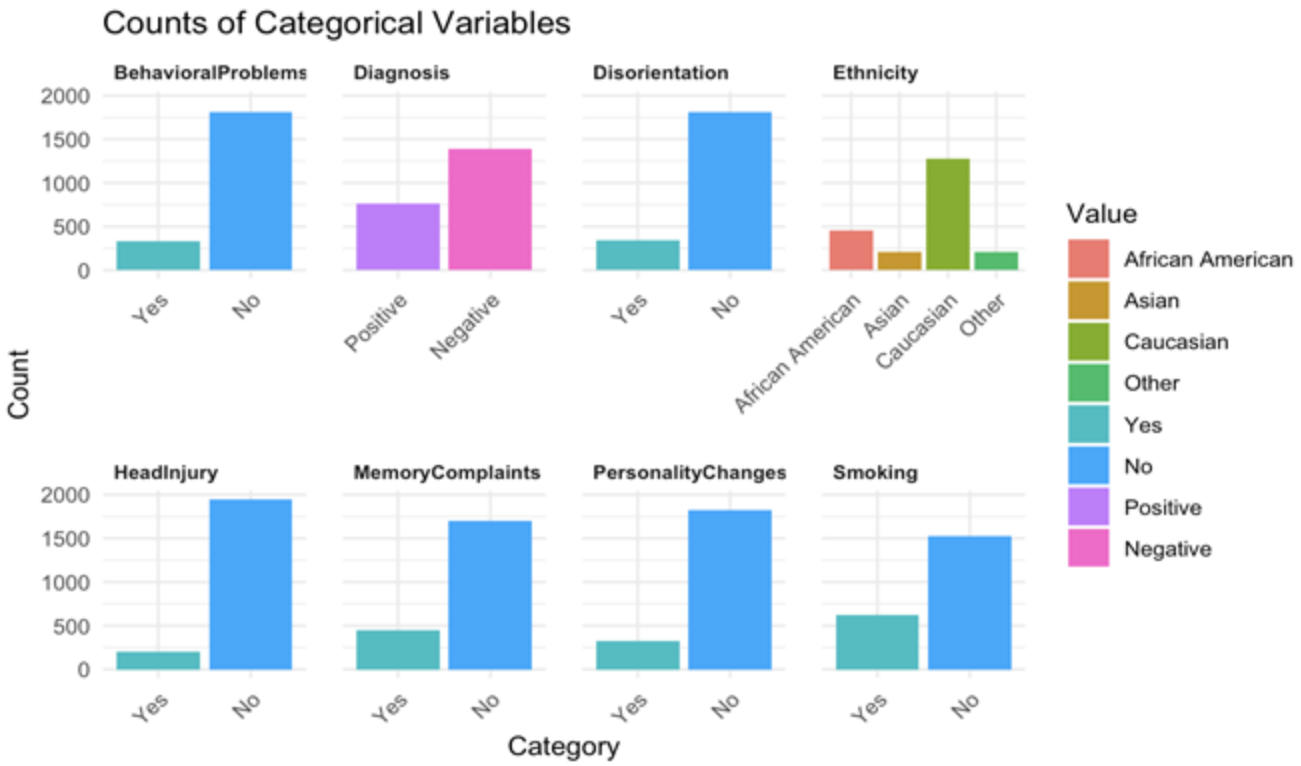
Dataset Citation: Abdul Samad, Enes Samet Aydı (2024), Rapid Alzheimer's Disease Diagnosis Using Advanced Artificial Intelligence Algorithms. International Journal of Innovative Science and Research Technology (IJISRT) IJISRT24JUN1915, 1760-1768. DOI: 10.38124/ijisrt/IJISRT24JUN1915.

Exploratory Data Analysis - Numerical

- Low correlations
- Strongest correlation: 0.05



Exploratory Data Analysis - Categorical



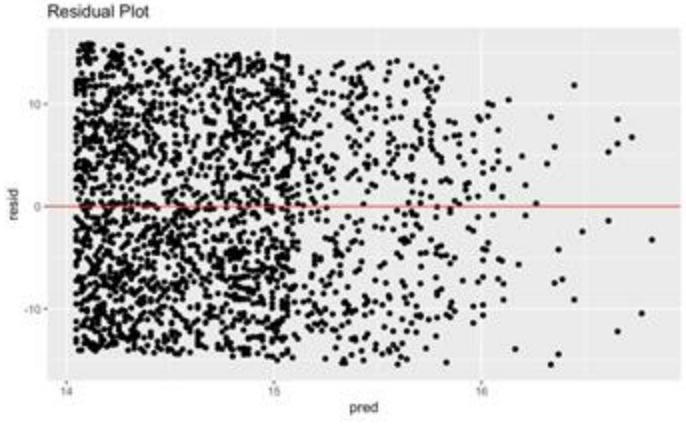
- Key categorical variables
- More negative diagnoses
- Majority white patients

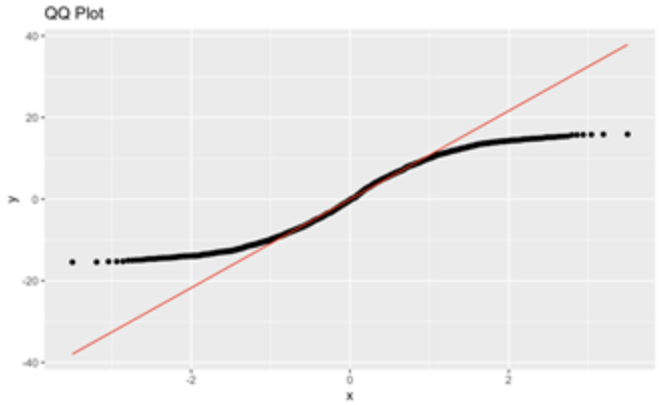
MLR: How can we use health indicators to predict MMSE score?

- Building the model:
  - checking assumptions
  - log transformations
  - trimming influential/leverage points
  - stepAIC
  - lasso

MMSE = 21.3271 - 1.5233(log_DiastolicBP) + 0.7412(I_PersonalityChangesYes) + 1.0159 (I_DisorientationYes)

  - P-value = 0.03919, Adjusted R^2 = 0.002528, Residual SE = 8.533
- Cross-validation
  - 5 folds, 10 repetitions
  - RMSE = 8.539161, R^2 = 0.004267931
- Prediction Interval
  - Given a diastolic BP of 72, no personality changes, and no disorientation, we are 95% confident that MMSE score is between -211.6598 and 34.95187
  - actual: 21.46353





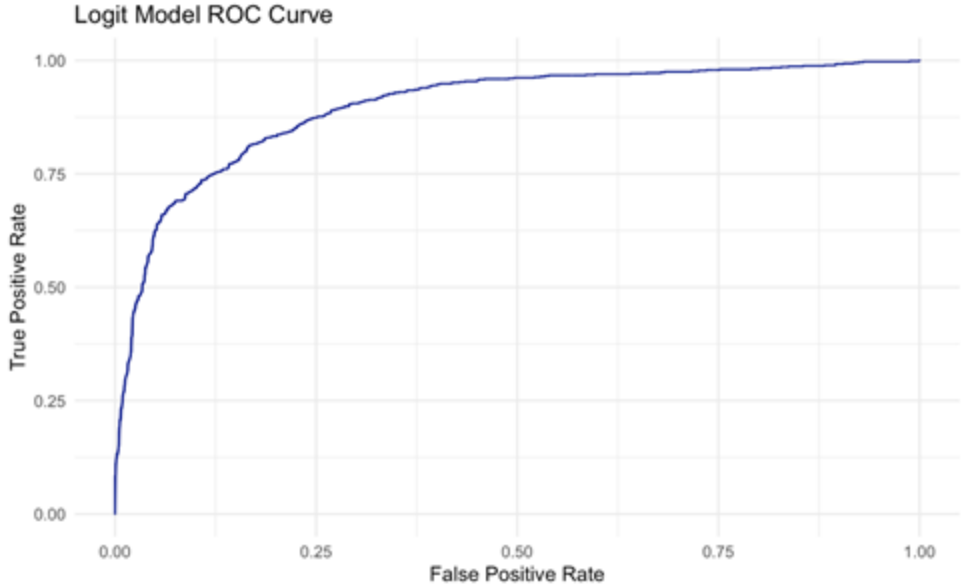
Logistic Regression: How can we use health indicators to predict Alzheimer's diagnosis?

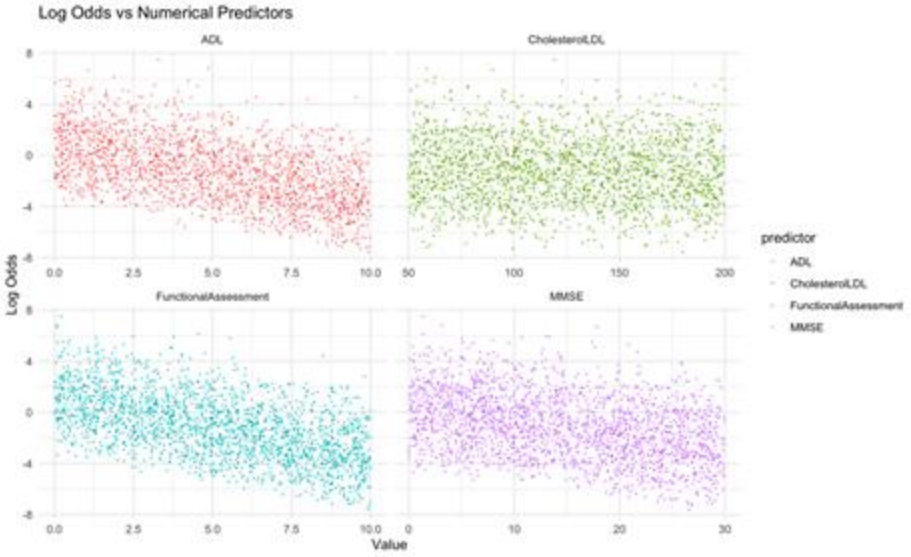
- Building the model
  - Including MMSE, trying to predict diagnosis
  - No transformations
  - Reducing model to only include predictors significant at α=0.05
  - stepAIC (AIC:1835.6 -> AIC:1615), reducing information loss
  - Lasso: kept same variables as stepAIC model

Log odds = 4.268 - 0.003(CholesterolLDL) - 0.107(MMSE) - 0.445(FunctionalAssessment) + 2.595(I_MemoryComplaintsYes) + 2.487(I_BehavioralProblemsYes) - 0.416(ADL)

  - AUC = 0.903, Accuracy = 0.841, F-1 score = 0.798
- Cross-validation
  - 10 folds
  - AIC = 1617.2
- Prediction
  - Based on this model, the predicted probabilities of a positive diagnosis are **0.396** and **0.929** for two different patients who have an actual diagnosis of negative and positive, respectively.

Logistic Regression: How can we use health indicators to predict Alzheimer's diagnosis?





AUC = 0.903, Accuracy = 0.841, F-1 score = 0.798

Conclusion & Future Work

- We found that the logistic model predicting diagnosis was far more useful than the multi-linear regression model predicting MMSE score
- Other explorations:
  - predicting MMSE:
    - Random Forest: 8.207 RMSR, 9.17% variance explained
  - predicting diagnosis:
    - Support Vector Machine: Overall accuracy (94%)
- Developing non-invasive alzheimer's diagnostic modeling:
  - Machine Learning with clinical data
  - NLP with speech testing data

Research Citation: Moradi, E., Prakash, M., Hall, A., Solomon, A., Strange, B., Tohka, J., & Alzheimer's Disease Neuroimaging Initiative (2024). Machine learning prediction of future amyloid beta positivity in amyloid-negative individuals. Alzheimer's research & therapy, 16(1), 46. https://doi.org/10.1186/s13195-024-01415-w

Research Citation: Amini S, Hao B, Yang J, et al. Prediction of Alzheimer's disease progression within 6 years using speech: A novel approach leveraging language models. *Alzheimer's Dement*. 2024; 1-9. https://doi.org/10.1002/alz.13886

Thank You! Questions?