Life-Saving Data Models

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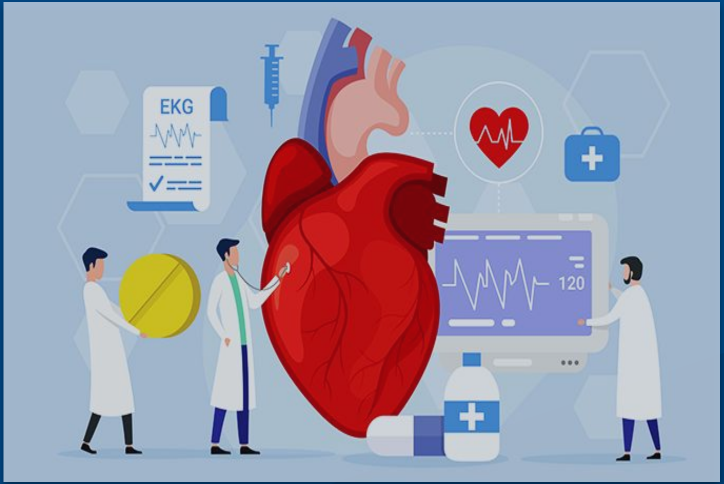

Who We Are

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Agenda

Project Background

❖ Goal of Study

❖ Data Intro

❖ Evaluation Metric

Exploratory Analysis

❖ Distributions

❖ Variable Relationships

Model Analysis

❖ Logistic Regression

❖ LASSO Regression

❖ Tree-Based Models

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Project Background

-- Tianxiao Zhang

Goal of Study

- Heart disease is the leading cause of death in the US
  - Accounts for more than 20% of deaths in most racial groups
- It requires timely diagnosis and treatment
- We want to identify potential heart disease in advance
  - Predict whether a person is likely to have heart disease (binary outcome) given other physical measures of the person that could be tracked earlier

Link: https://www.cdc.gov/heartdisease/facts.htm

Data Information

- Obtained from Kaggle.com
- 18 Variables and 320,000 observations
  - Physical measures & Other disease history
- Clean data & no missing values
- Imbalanced outcome distribution
  - Over 90% without heart disease, only 9% with heart disease
  - Could lead to biased predictions
  - Data resampling (downsample the majority group)
  - 55,000 observations after resampling

91% Accuracy

Data Source: https://www.kaggle.com/datasets/kamilpytlak/personal-key-indicators-of-heart-disease?resource=download

Evaluation Metric (for Model)

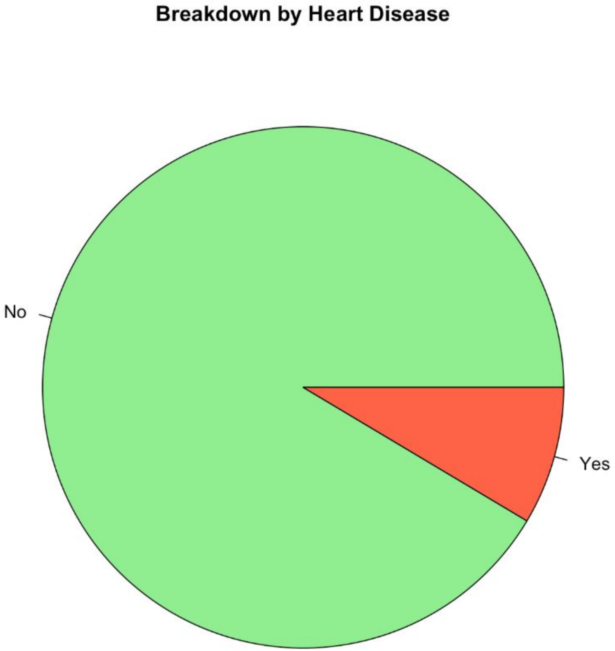
- Usually use Accuracy and F-1 score
- Recall is the most relevant metric for our data
  - Recall = TP / (TP + FN)
    - Recall is the largest when FN is minimized
  - The cost of FN is much higher than the cost of FP
    - FN means unable to identify the patient who will actually get heart disease
      - Miss the best treatment time
    - FP means false alarm when the patient will not actually get heart disease
      - Go to doctors for preventative measures

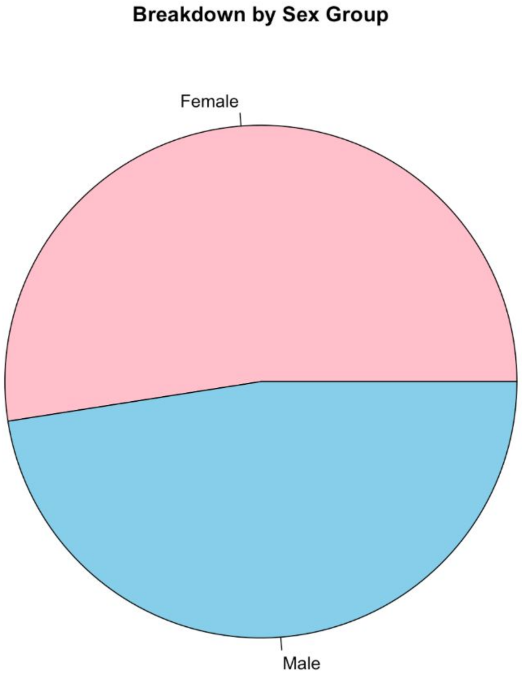
Exploratory Analysis

-- Yanqi Liu

A glimpse of the data

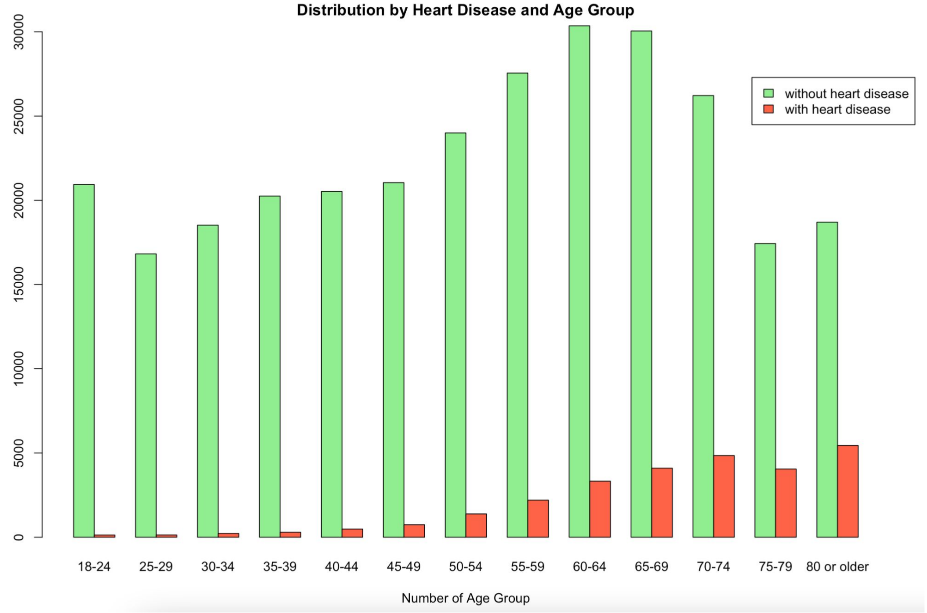
- The gender distribution is quite even with slightly more females than males.


Breakdown by Heart Disease


Breakdown by Sex Group

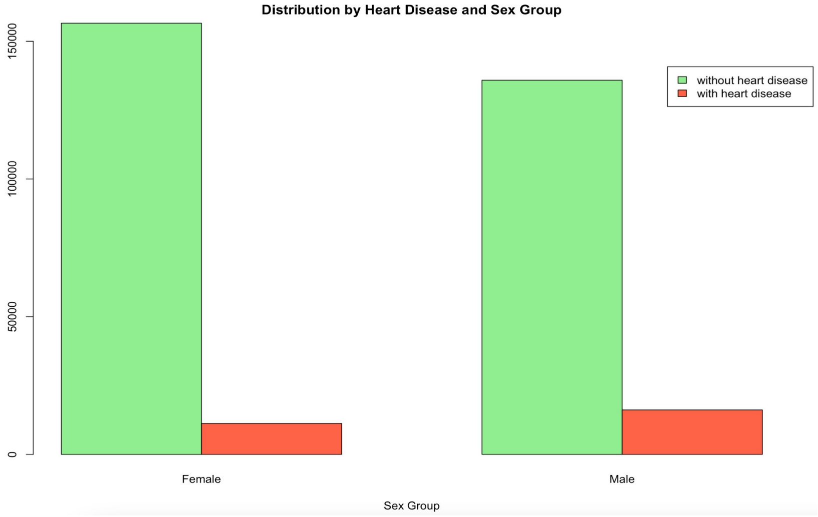
The relationship with age group

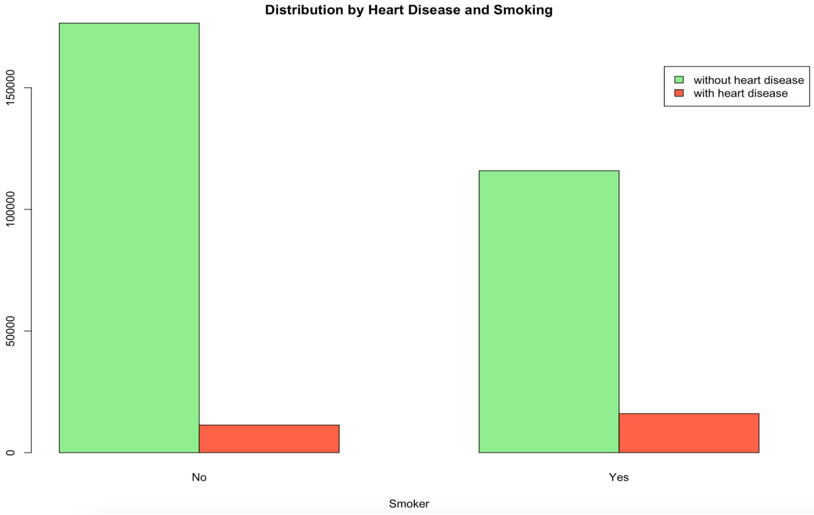
- Older people (> 60) have higher probability of getting heart disease



The relationship with gender and smoking history

- Males & Smokers are more likely to have heart disease

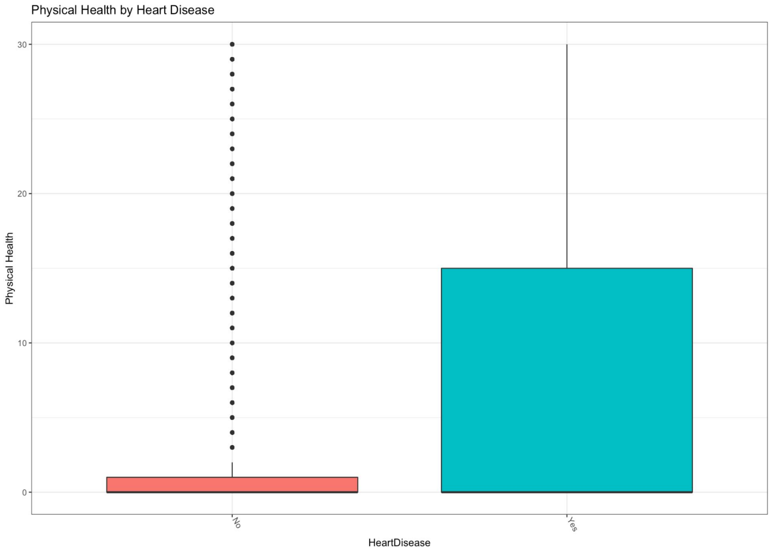


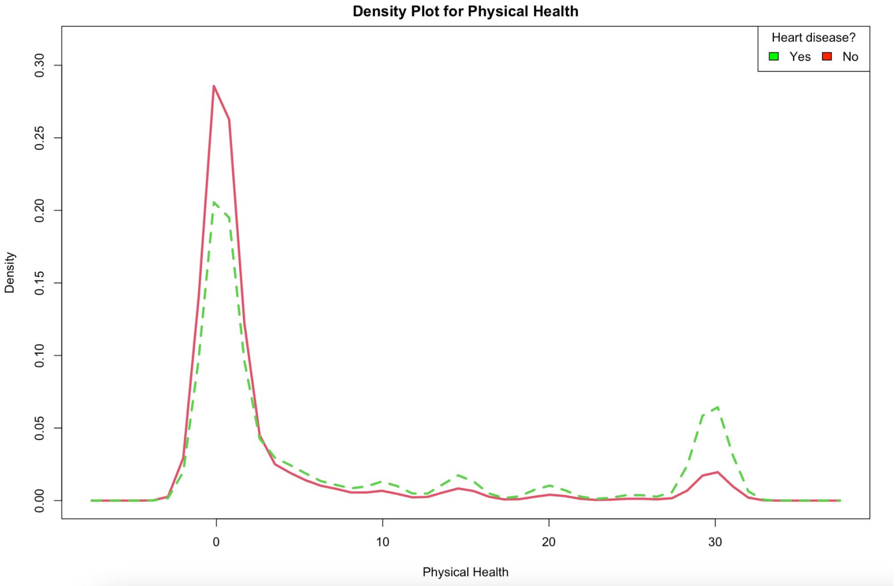


- No significant relationship between heart disease and other disease

The relationship with physical discomfort

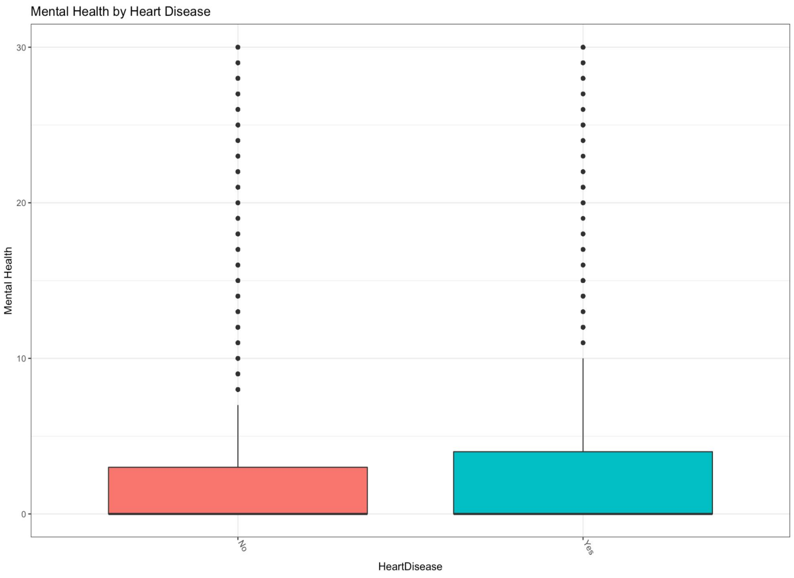
❖ Heart disease patients reported significantly more days of physical discomfort

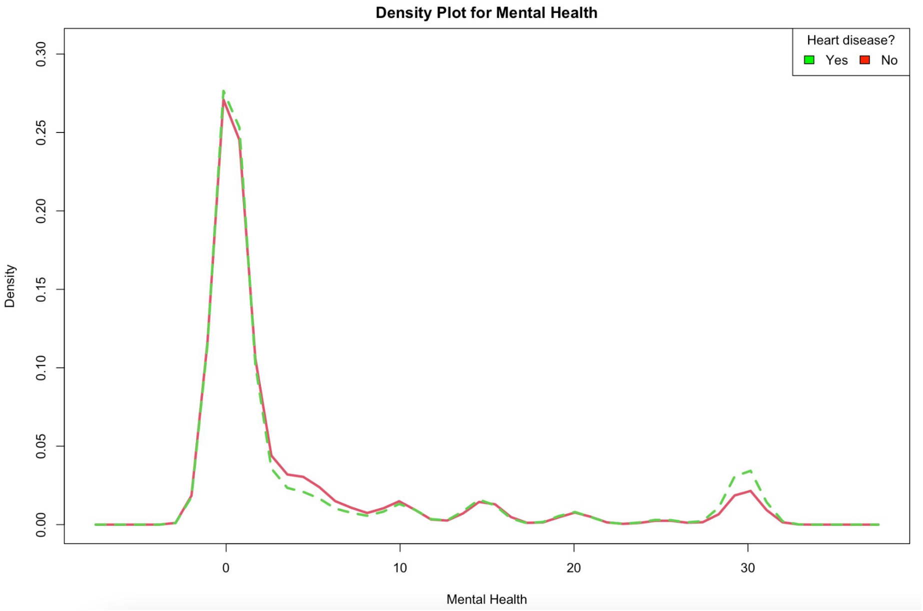

Physical Health by Heart Disease


Density Plot for Physical Health

The relationship with mental discomfort

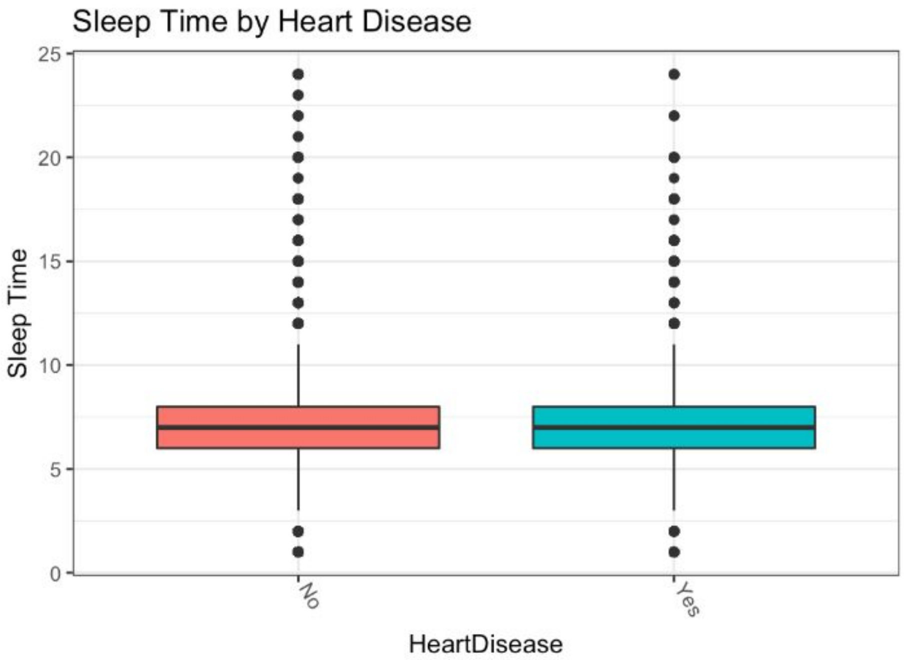
- Heart disease patients reported slightly more days of mental discomfort

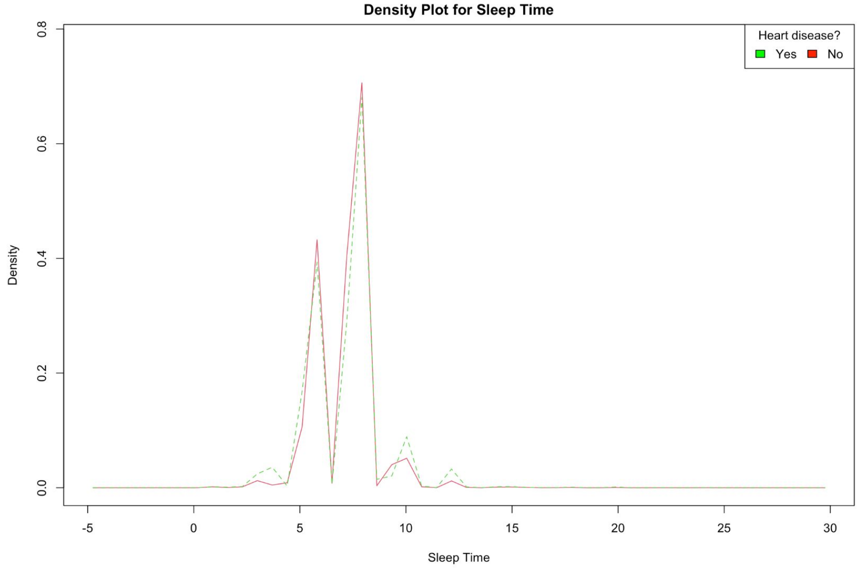




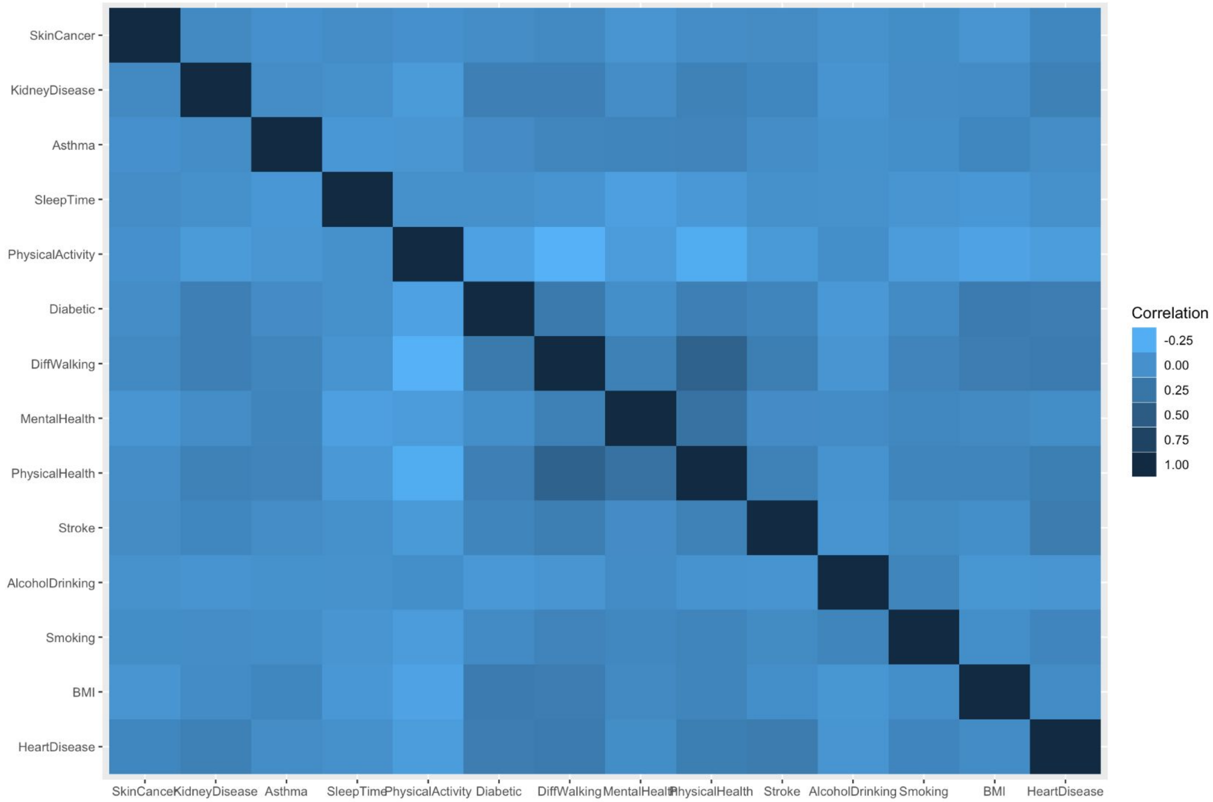
The relationship with sleep time

- Having good sleeping routine/habit does not keep someone away from heart disease.





Correlation between variables

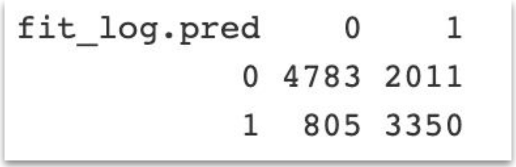


Model Analysis

-- Muhua Chen

Logistic Regression

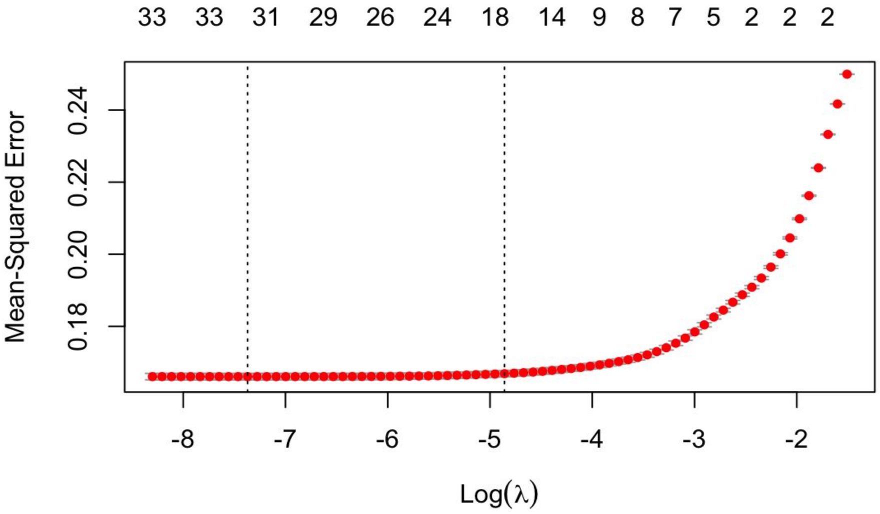
- Backward Elimination
  - Remove the most insignificant variable each time (largest P-value)
  - Final models contains variables significant at 0.05 level
- Important Features
  - **Physical features** such as age and sex
  - **Existing health conditions** such as stroke, generic health, asthma and kidney disease
  - **Lifestyle Habits** such as smoking
- Model Performance
  - **Accuracy**: 0.74; **Recall**: 0.86, **F1-score**: 0.77

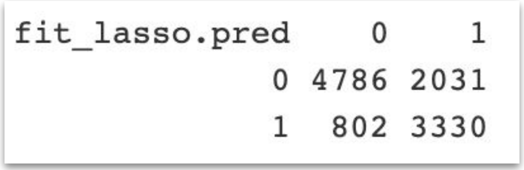


```
fit_log.pred    0    1
           0 4783 2011
           1  805 3350
```

LASSO Regression

- Choosing Lambda
  - Lambda.min and Lambda.1se are similar in terms of error
    - Chose lambda.1se for a more parsimonious model
  - All variables are significant, no need for further backward elimination
- Difference from first model
  - Removes AlcoholDrinking, MentalHealth, and SleepTime
- Model Performance
  - **Accuracy**: 0.74; **Recall**: 0.86, **F1-score**: 0.77

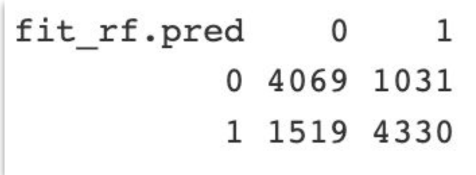




```
fit_lasso.pred    0    1
             0 4786 2031
             1  802 3330
```

Tree-Based Models

- Decision Tree
  - Worse general health, stroke, males and older people are more likely to have heart disease
  - **Accuracy**: 0.71; **Recall**: 0.77, **F1-score**: 0.73
- Random Forest
  - Settled for 100 trees and 3 features sampled at each split.
  - **Accuracy**: 0.77; **Recall**: 0.73, **F1-score**: 0.76



```
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          0 4069 1031
          1 1519 4330
```

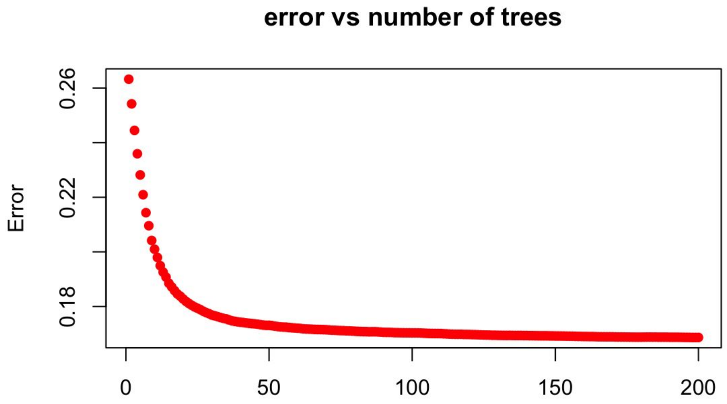

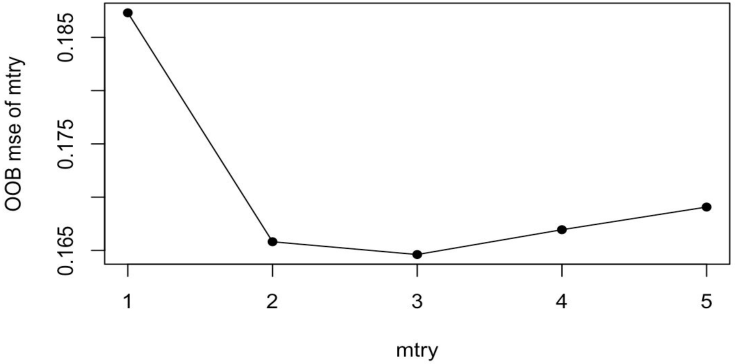

Final Recommendation

- Logistic Regression (LASSO)
  - Best performance for recall and F1 score
    - Accuracy is slightly lower than tree-based models, but recall is higher
  - Easier to interpret and more computationally efficient
- Potential Improvements
  - Try other models such as SVM and boosting
  - Collect more data variables
    - This dataset is focused on physical measures and other disease indicators of the patient
    - Conditions of patient's relatives could also be helpful

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Thank you for listening!

Questions?

Please enjoy the summer break!