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CLASSIFICATION PROJECT

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# PREDICTING HEART DISEASE

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## INTRODUCTION

- ▶ **Motivation:** Kaiser Permanente, an HMO, wants to identify patients at high risk for heart disease who would benefit from a heart health program.<sup>[1]</sup>
- ▶ **Research Question:** How might we predict which patients are at high risk of heart disease?
- ▶ **Impact Hypothesis:** Reduce the number of patients who develop heart disease (arterial plaque or heart attack).

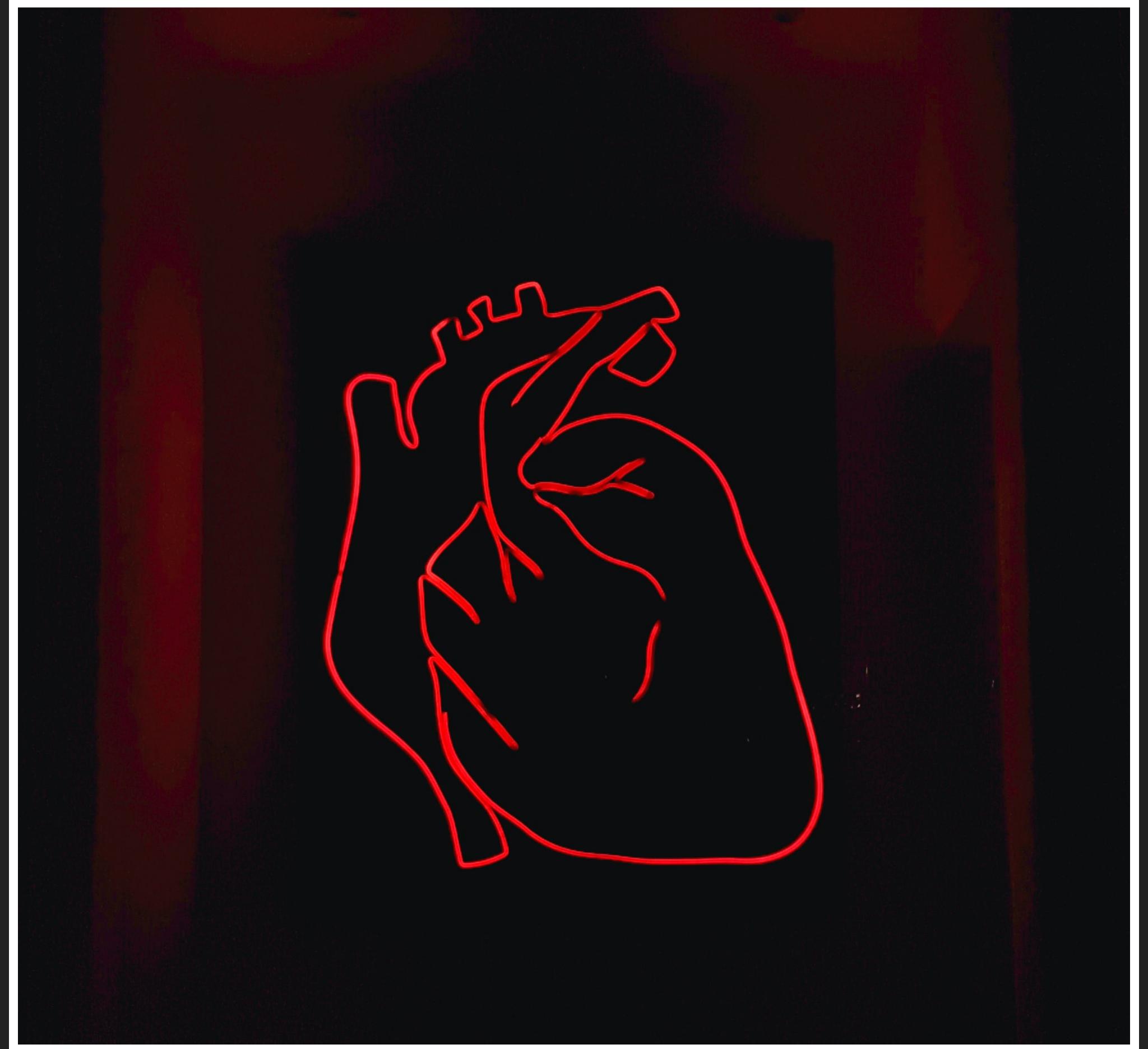


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# METHODOLOGY

- ▶ Dataset
  - ▶ Kaggle, Indicators of Heart Disease [2]
  - ▶ Excerpted from CDC BRFSS, 2020 [3]
  - ▶ Survey of American adults
  - ▶ n= 319,795
- ▶ Target
  - ▶ **Heart Disease**
    - ▶ coronary heart disease (plaque buildup)
    - ▶ myocardial infarction (heart attack)



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# RESULTS

## Workflow:

- ▶ Mapped values
- ▶ Recall, ROC AUC

## Feature engineering:

- ▶ Question groups [4]
- ▶ Risk factors [5]

## Class imbalance handling:

- ▶ Precision/Recall Curve
- ▶ Decision threshold = 0.05

Figure 1. Correlation Matrix of Select Original Features

	y_heart_disease	dempg_age	behavior_tobacco	health_physical	health_mobility	disease_diabetes	disease_kidney	disease_stroke
y_heart_disease	1.000000	0.232325	0.107764	0.170721	0.201258	0.118281	0.145197	0.196835
dempg_age	0.232325	1.000000	0.130384	0.110789	0.242552	0.154070	0.122697	0.137280
behavior_tobacco	0.107764	0.130384	1.000000	0.115352	0.120074	0.038993	0.034920	0.061226
health_physical	0.170721	0.110789	0.115352	1.000000	0.428373	0.111644	0.142197	0.137014
health_mobility	0.201258	0.242552	0.120074	0.428373	1.000000	0.152876	0.153064	0.174143
disease_diabetes	0.118281	0.154070	0.038993	0.111644	0.152876	1.000000	0.095186	0.072476
disease_kidney	0.145197	0.122697	0.034920	0.142197	0.153064	0.095186	1.000000	0.091167
disease_stroke	0.196835	0.137280	0.061226	0.137014	0.174143	0.072476	0.091167	1.000000

# RESULTS

- ▶ **Logistic Regression + GridSearchCV:**
  - ▶ Recall = 0.522244
  - ▶ ROC AUC = 0.841228
- ▶ Scoring for each model:
  - ▶ X\_validate\_scaled
  - ▶ v\_validate

Figure 2. Top 5 Best Performing Models

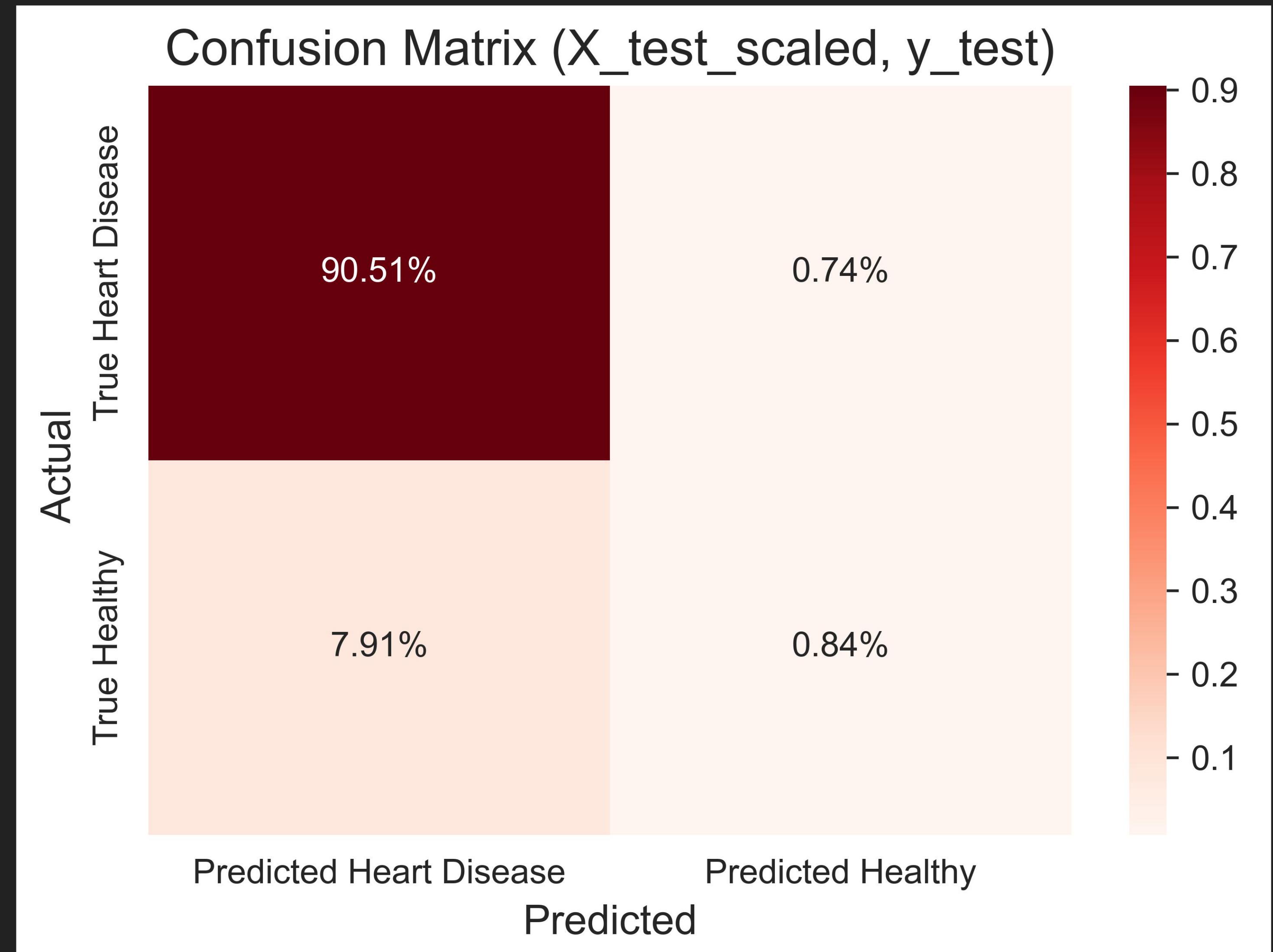
		Model	Variable	Recall	ROC AUC
16	Logistic regression GridSearchCV		log_reg_gridcv	0.522244	0.841228
2	Logistic regression		log_reg	0.519505	0.841142
14	Logistic regression question groups + risk fac...	log_reg_grp_risk	0.466844	0.799779	
12	Logistic regression group features	log_reg_grp	0.389535	0.797162	
7	Bernoulli NB	bern	0.365447	0.762406	

# RESULTS

## Test Model

- ▶ Model predicts heart disease
  - ▶ 90.51% correct
- ▶ Minimal false negatives
  - ▶ 0.74% missed

Figure 4.

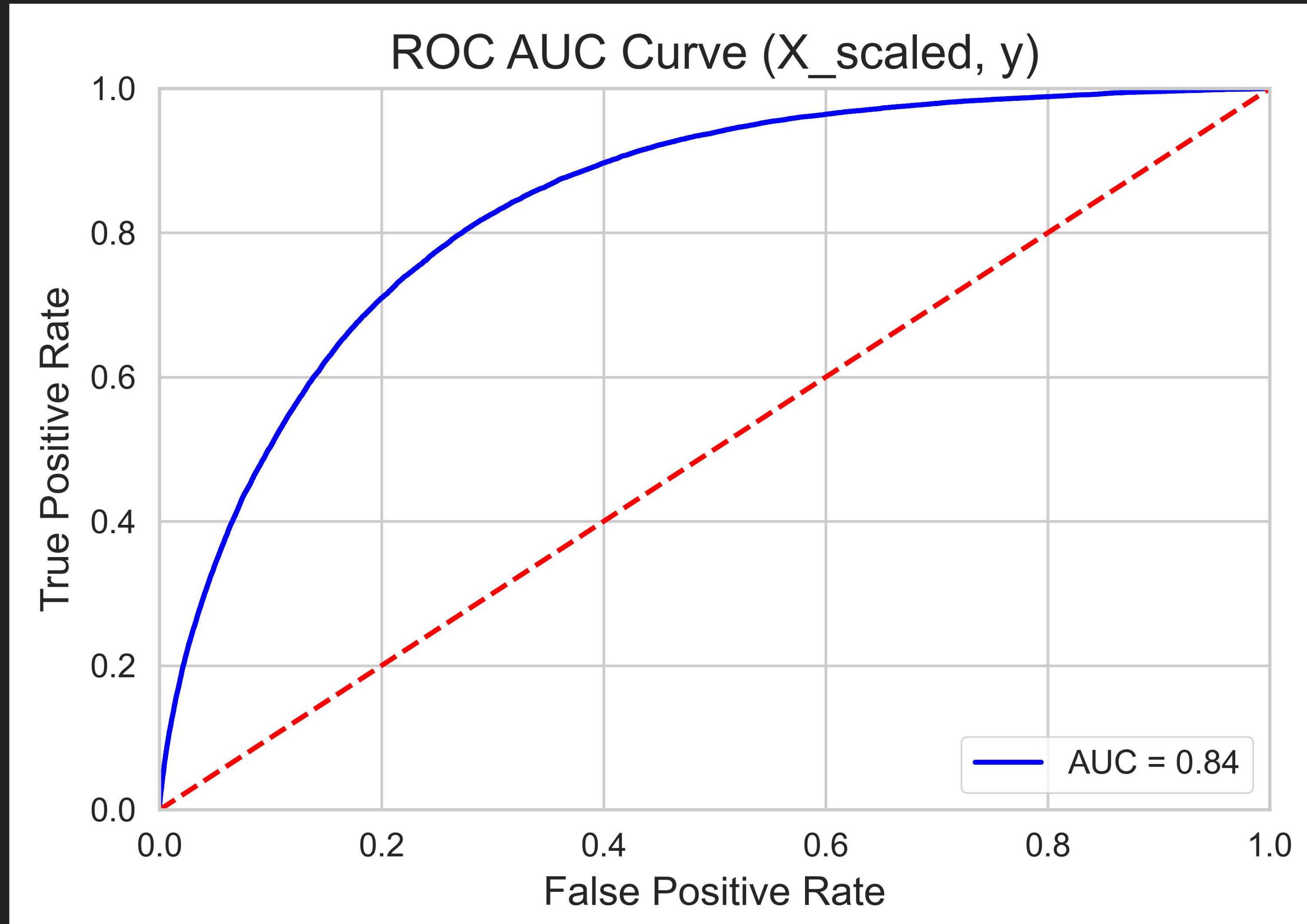


# RESULTS

## Model Performance

- ▶ Model performs well compared to chance
- ▶ AUC = 0.84

Figure 5.

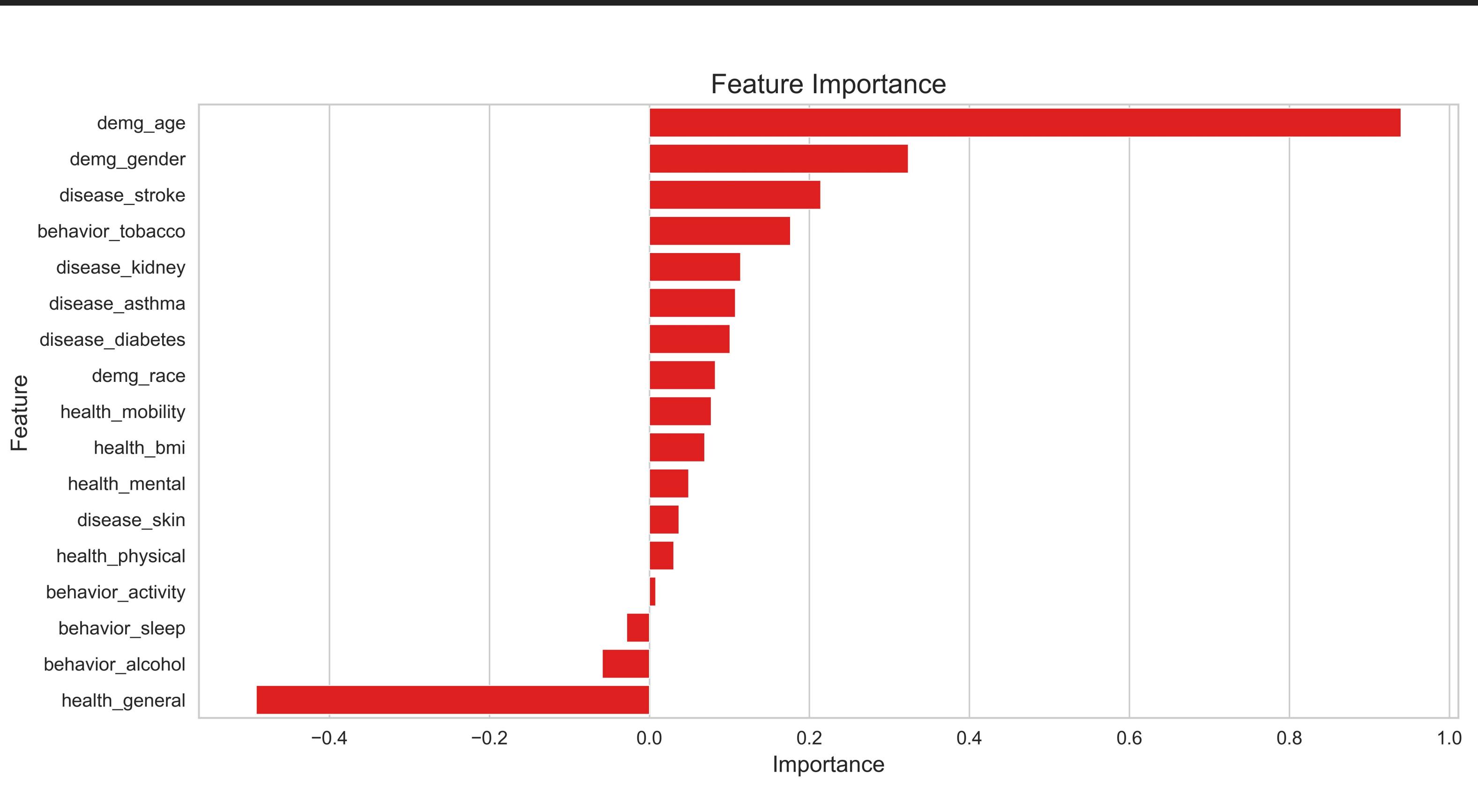


## RESULTS

Figure 6.

### Feature Importance

- ▶ Age
- ▶ Gender
- ▶ Stroke
- ▶ Tobacco use
- ▶ Kidney disease
- ▶ [Correlation matrix](#)
- ▶ Identified 4 out 5
- ▶ Missed gender



## RESULTS

### Predictions

- 1: 60, man, smoker, no chronic disease
  - No
  - Probability: 0.341
- 2: 80, female, stroke, smoker, kidney disease
  - Yes
  - Probability: 0.613
- 3: 85 year old, man, not smoker, kidney disease
  - Yes
  - Probability: 0.585



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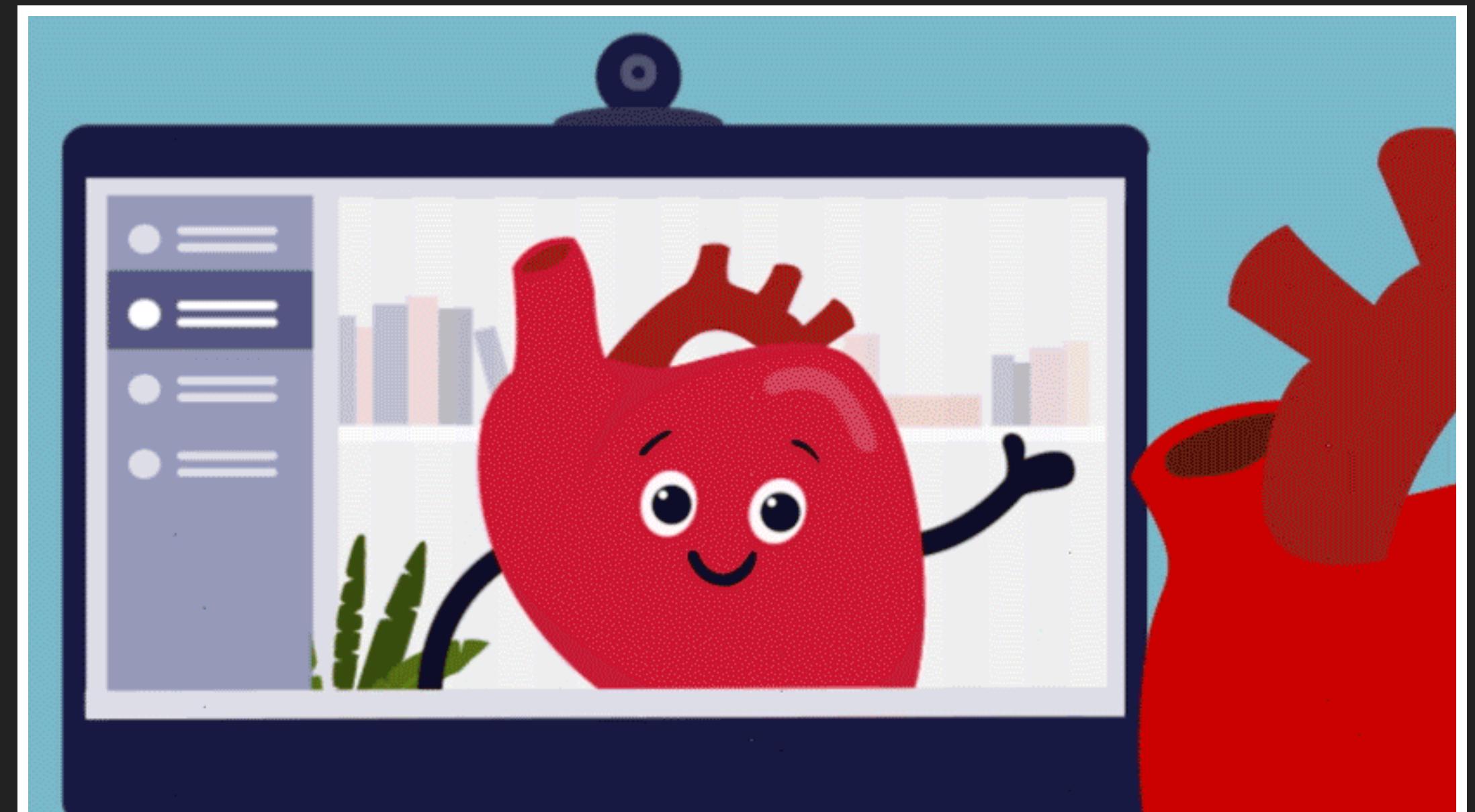
## CONCLUSIONS

### Insights

- ▶ Age strongest predictor of heart disease.
- ▶ Chronic disease raises risk.
- ▶ Tobacco use is also a high risk behavior.

### Recommendations

- ▶ Pilot program with patients 75 and over for pilot heart health program.
- ▶ Develop program for patients of all ages with multiple chronic diseases.
- ▶ Promote smoking cessation programs.



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## FUTURE WORK

- ▶ Logistic regression model with top 5 features of importance
- ▶ Explore 75+ to identify nuance differences in risk for heart disease.
- ▶ Include more survey responses from BRFSS related to lifestyle and behavior.

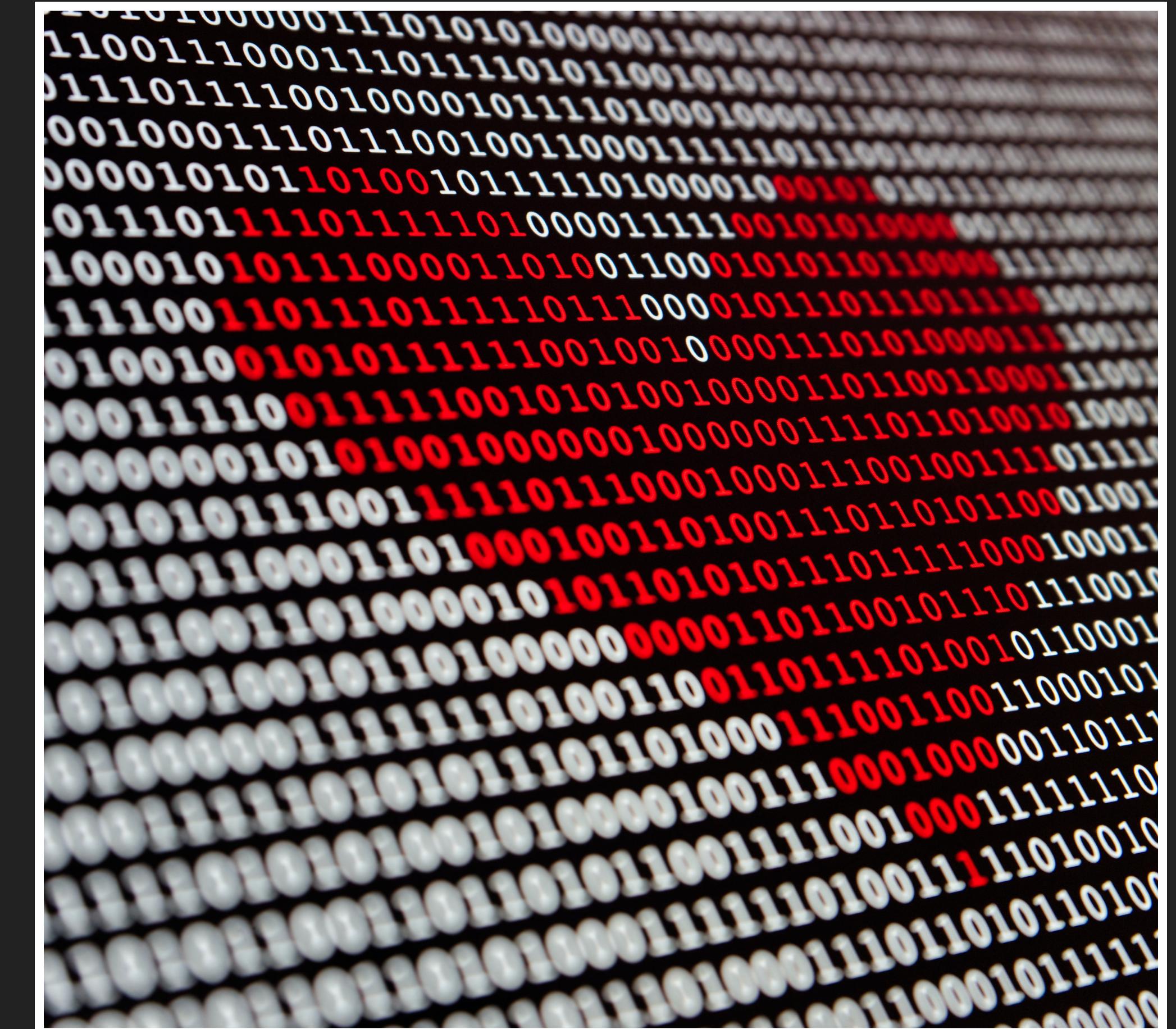


Photo by Alexander Sinn on Unsplash

## APPENDIX

- ▶ Summary, data, and slides are available at [github.com/slp22/classification-project](https://github.com/slp22/classification-project)



[Photo by Kelly Sikkema on Unsplash](#)

## APPENDIX: SOURCES

1. National Heart, Lung, and Blood Institute, Coronary Heart Disease: <https://www.nhlbi.nih.gov/health/coronary-heart-disease/causes>
2. Kaggle Personal Key Indicators of Heart Disease: <https://www.kaggle.com/datasets/kamilpytlak/personal-key-indicators-of-heart-disease>
3. CDC Behavioral Risk Factor Surveillance System: <https://www.cdc.gov/brfss/index.html>
4. Data Dictionary: [https://www.cdc.gov/brfss/annual\\_data/2020/pdf/codebook20\\_llcp-v2-508.pdf](https://www.cdc.gov/brfss/annual_data/2020/pdf/codebook20_llcp-v2-508.pdf)
5. CDC Heart Disease Facts: <https://www.cdc.gov/heartdisease/facts.htm>

## APPENDIX: DATA DICTIONARY

### Target

- `y_heart_disease`: Y/N | coronary heart disease (CHD) or myocardial infarction (MI)

### Health Behaviors

- `behavior_activity`: Num (0-30) | # days did physical activity/exercise other than regular job
- `behavior_alcohol`: Y/N | heavy drinker, defined as men: 14+/wk, women: 7+/wk (includes beer, wine, malt beverage, liquor)
- `behavior_sleep`: Num (0-24) | # hours of sleep in a 24-hour period, on average
- `behavior_tobacco`: Y/N | smoked at least 100 cigarettes in your life

### Demographics

- `demg_age`: 18-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80+
- `demg_gender`: male/female
- `demg_race`: White, Black, Asian, American Indian/Alaskan Native, Hispanic, Other race

### Health Measures

- `health_bmi`: Num | Body Mass Index (BMI)
- `health_physical`: Num (0-30) | # days physical health not good, includes physical illness and injury
- `health_mental`: Num (0-30 ) | # days mental health not good, includes stress, depression, and problems with emotions
- `health_general`: Excellent, Very Good, Fair, Poor | Would you say that in general your health is...
- `health_mobility`: Y/N | serious difficulty walking or climbing stairs

### Chronic Disease

- `disease_asthma`: Y/N
- `disease_diabetes`: Y/N/Y pregnancy/N borderline
- `disease_kidney`: Y/N | kidney disease, excludes kidney stones, bladder infection or incontinence
- `disease_skin`: Y/N | skin cancer
- `disease_stroke`: Y/N

## APPENDIX: HIGH RISK FACTORS

Figure 1. Correlation Matrix of Select Original Features

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Figure 6. Feature Importance

