

Healthcare Financial Modeling

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According to HFMA

(Healthcare Financial Management Association)

In 2016, roughly 68% of patients with medical bills of \$500 or less did **NOT** pay their full balance off. Hospital bills greater than or equal to \$3,000, **99% percent** were **NOT** paid in full.

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Can we predict the percentage of an overdue bill that a patient will pay, based on household income?

Our Data

- Zip code and Median household income (SimpleMaps)
 - Conducted in 2017
 - Includes zip codes, median
 - 18k+ records with 20+ columns
- Hospital Patient data (Undisclosed company)
 - Data from 2012-2015
 - 500k+ records with 20+ columns
- 3000 records and 8 features used for modeling
- Not available for public use (private data)

Data Preprocessing

Feature Engineering:

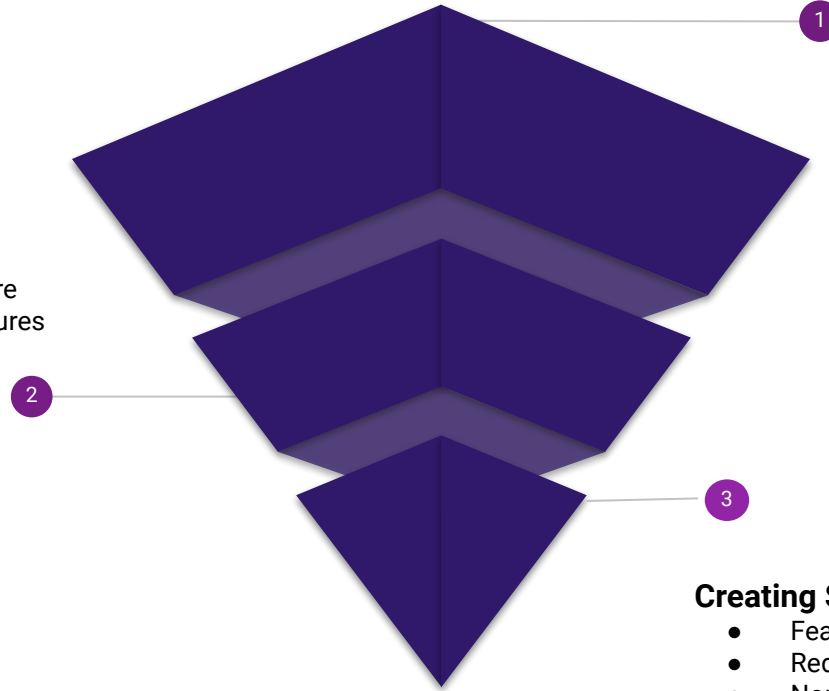
- Grouped our target variables
- Created income level groups
- Created age to income feature
- Created a total of 6 new features

Data Cleaning:

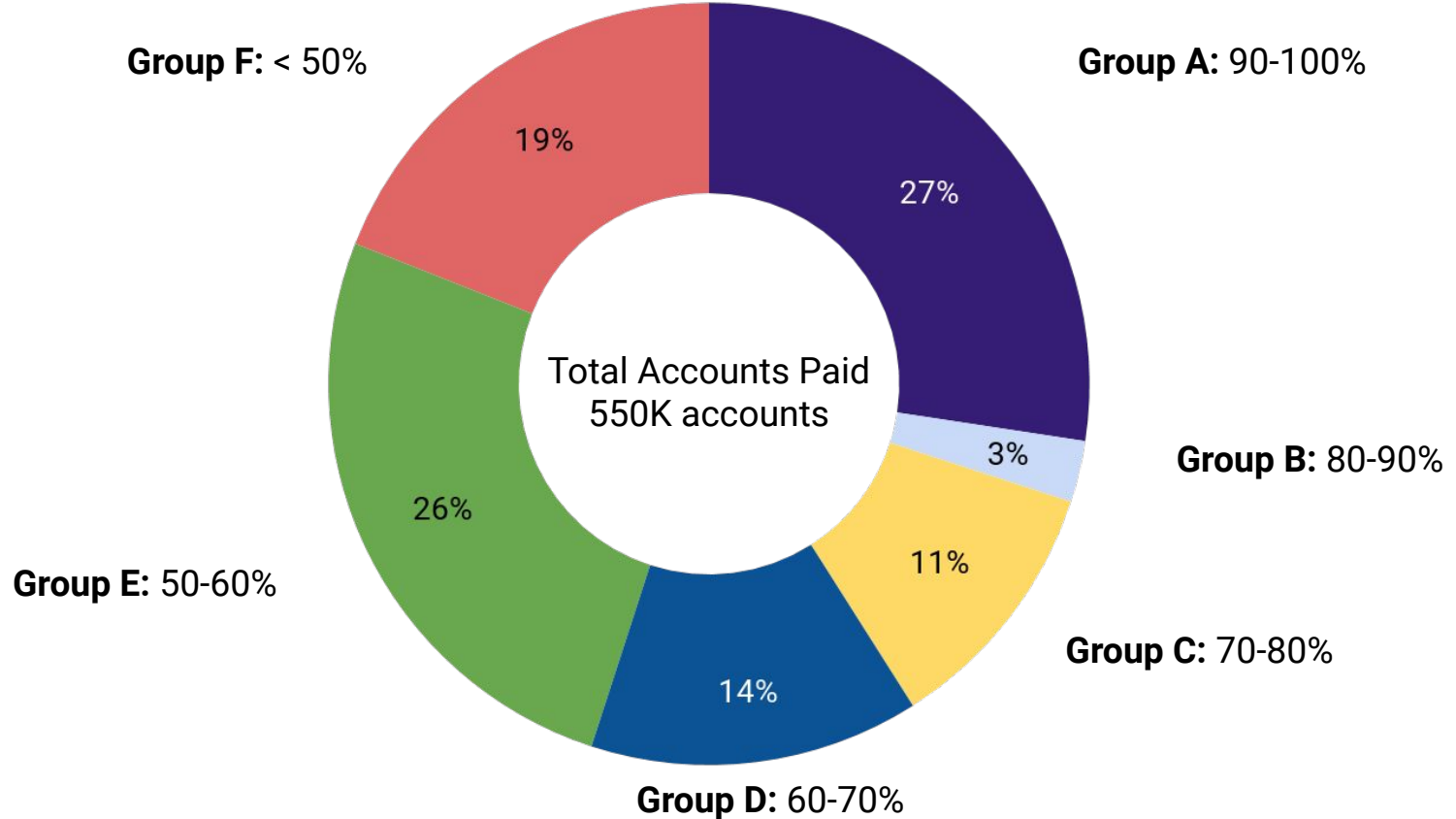
- Deal with missing values and unused features and initial data exploration

Creating Subset of Data

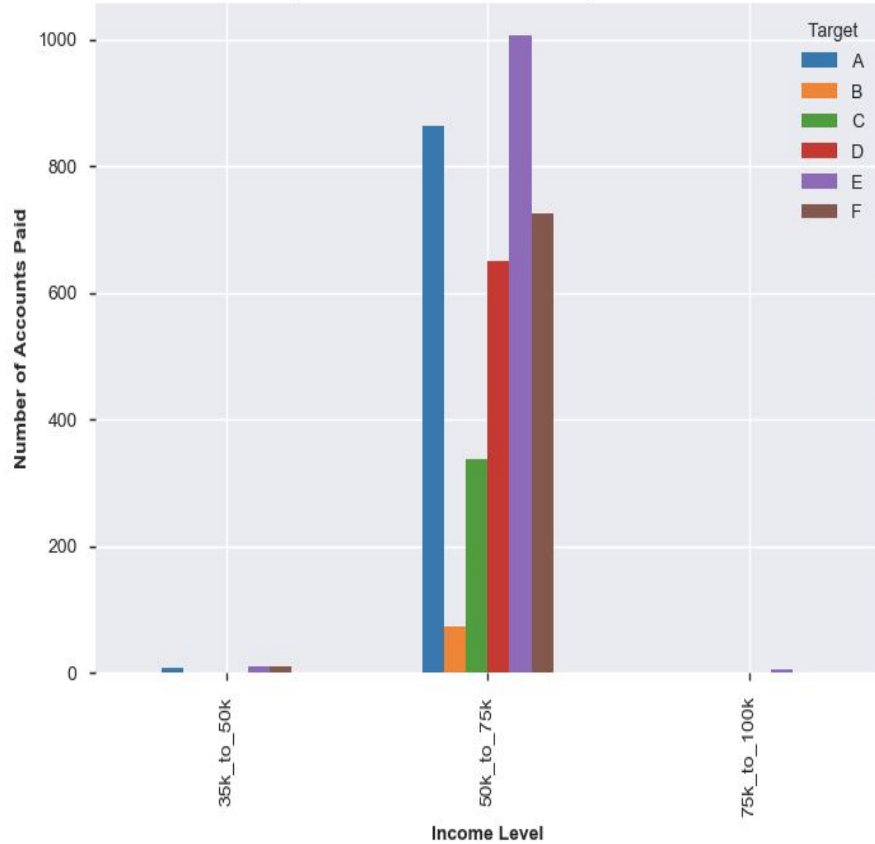
- Feature selection, 8 total
- Reduced data to 3k records
- Normalize our data



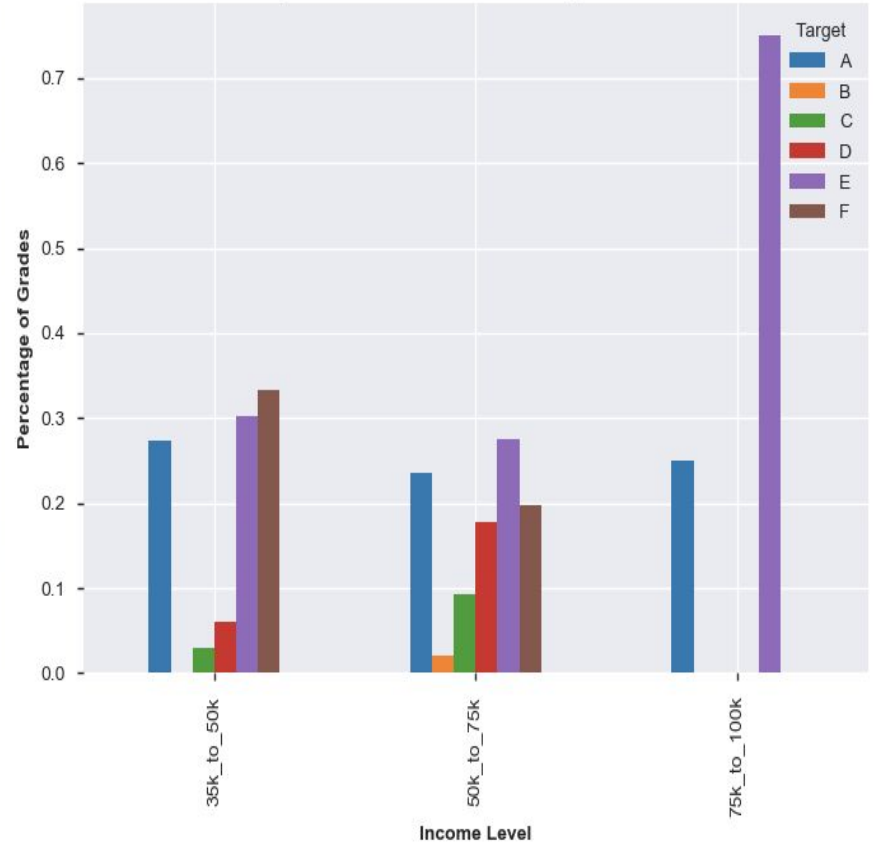
Percentage of Payment per Group



Group vs. Income Level for Zip code 44107



Group vs. Income Level for Zip code 44107



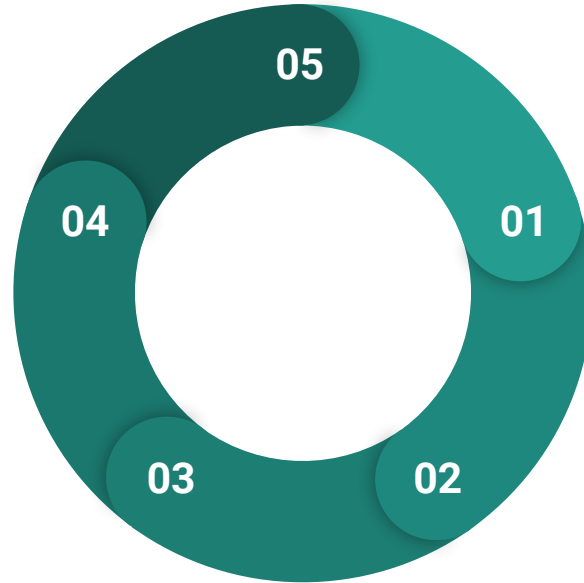
Machine Learning

Compare results

Select algorithm(s) that is best suited for future work

Tune our algorithm

Use best hyperparameters, deal with imbalanced data if necessary



Build our machine learning pipeline

- Logistic regression - Lasso
- Logistic regression - Ridge
- Random Forest Classifier
- SVM
- Gradient Boosting Classifier

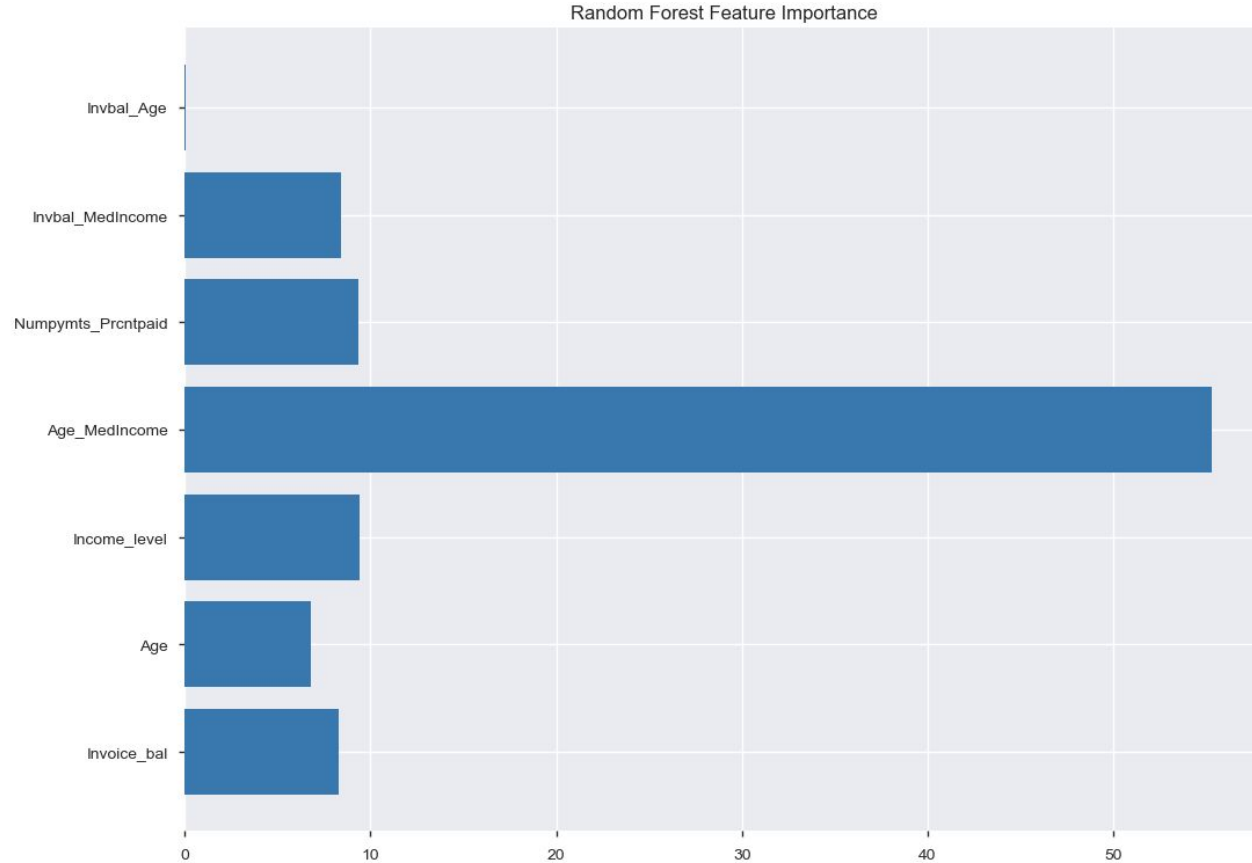
Run models within pipeline

Initial results from models within pipeline

Run a gridsearch

Discover best hyperparameters using cross-validation

Feature Importance



Summary

Can we predict the percentage of an overdue bill that a patient will pay, based on household income?

... **Yes, with a certainty of 77%**

Further findings:

- Patients with Income level between 50k to 75k are more likely to make payments on their overdue hospital bill.
- 56% of total (550k+) patients that have made payments, fall within the income level of 50k to 75k.
- Within that income level, 29% of patients pay between 90-100% of their hospital bill, and 26% of patients pay between 50-60% of their hospital bill.

Further Analysis - Suggestions

1. Time series analysis:

- a. What's the average time it takes for patients to pay?

2. Number of payments:

- a. Is there a relationship between number of payments with other features? If so, which ones?

3. Explore different algorithms

- a. Run multiple linear regression models to see if we can get better results

Thank you for you time!