Improving Population Health:
Risk Stratification within CommUnityCare

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Business Background

Hospital Readmissions

Readmissions are one of the largest cost drivers in the U.S. health care system on both the macroeconomic and organizational levels.

Readmissions are oftentimes due to hospitals providing improper or inadequate treatment for inpatients and result in expensive penalties from the CMS.

Current intervention methods such as discharge re-engineering and transition care management have only made marginal improvements in overall readmission rates.

By identifying high-risk patients at the time of admission, hospitals can significantly reduce their readmission rates through proactive care management intervention.

CommUnityCare Health Centers

CommUnityCare provides services at 19 locations in Travis County and serves approximately 88,000 individual patients in the Greater Austin area each year.

Problems	Opportunities
Many patients are frequently re-admitted to inpatient and emergency clinics unnecessarily, which is very costly to hospitals.	Preventing these readmissions can translate to improved quality of care and significant cost savings.

Project Objectives

The main objective is to identify patients with high risk of readmission so that CommUnityCare can **reduce its readmission cost** and **better utilize its resources**.

Specifically, the project consists of three parts:

PART 1: Model Development

Create a classification model that identifies high-risk patients at the time of inpatient admission. Accurate predictions will lead to more targeted interventions and maximize cost savings.

PART 2: Readmission Risk Factors

Identify factors that contribute to readmission risk for each patient.
This information is helpful in constructing a more effective intervention plan.

PART 3: Dashboard Tool for CommUnityCare

Create a front-end dashboard that presents a risk score and the associated risk factors.
This will make the analysis interpretable and actionable for doctors and nurses.

Technical Methodologies

Pre-processing and Feature Engineering

Reshape dataset to encounter level → Create variables for past hospital visit information → ICD9 to ICD10 crosswalk → Integrate socioeconomic factors → Filter out one-time and transfer admits

Classification Models

Define target labels → Train-test splits → Tune hyper-parameters → Evaluate model performance

LIME

LIME is an algorithm that uses linear models to approximate how changes in the value of input variables affect the predicted probabilities. It explains the relative importance of each risk factor for a given prediction.
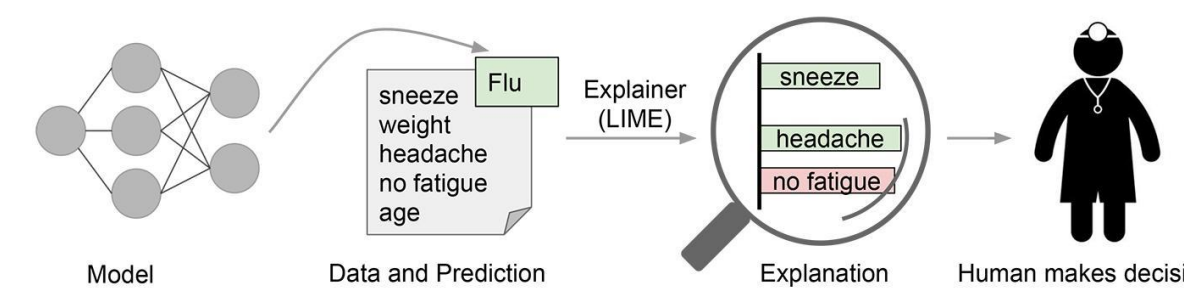

Key Findings

Demographics & Historical Admissions

Demographics and past admission records demonstrate strong discriminative power for high risk patients. As shown below, the distributions for the three classes are significantly different.
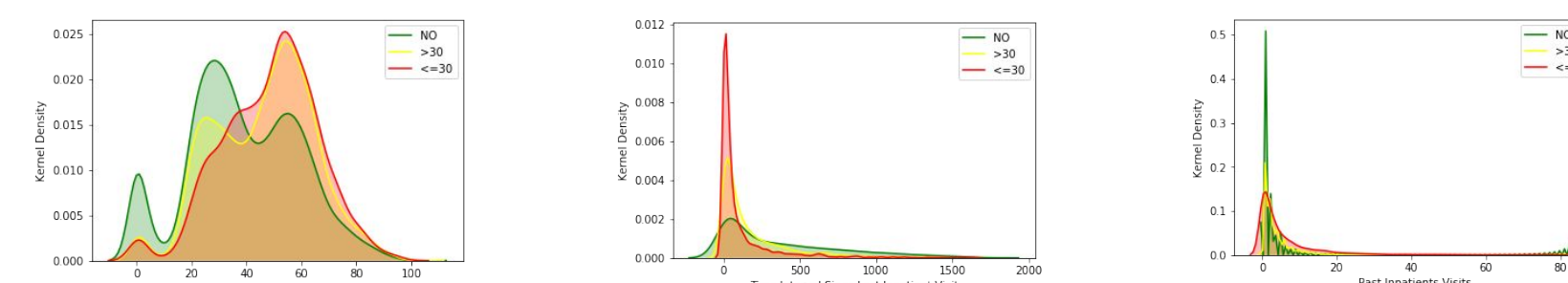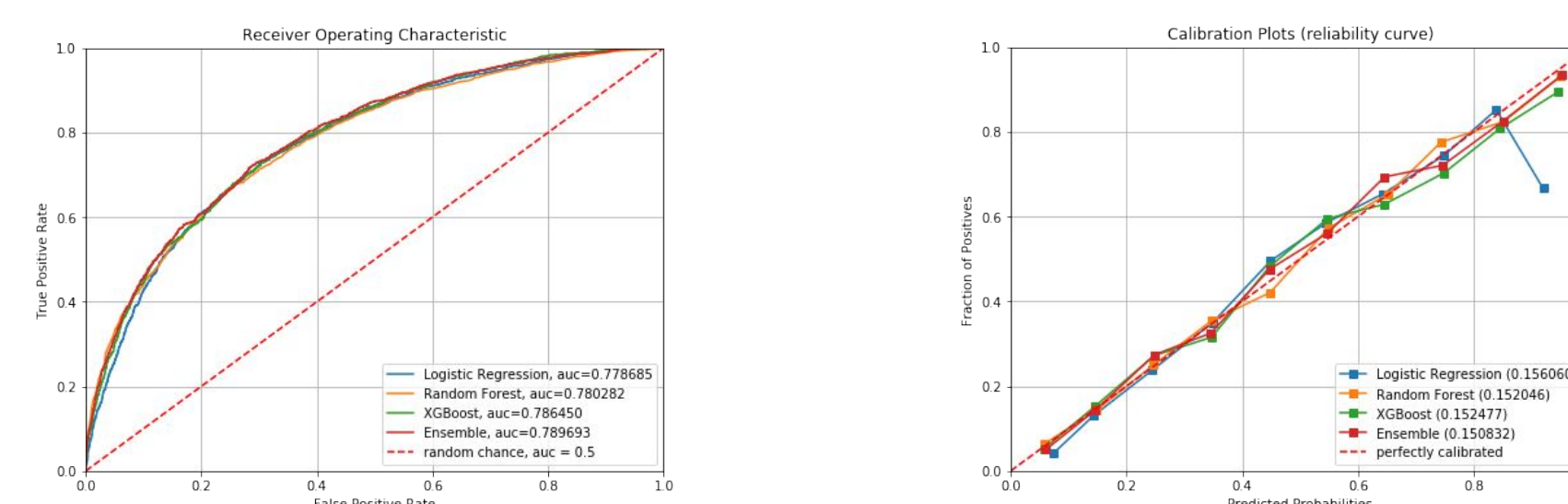

Socioeconomic Factors

Previous work has shown that social determinants of health play a significant role in hospital outcomes and readmission rates. We obtained the median income, higher education rate and poverty rate for each zip code from the US Census and American Community Survey, and our modeling results have confirmed that such factors do indeed offer predictive power.
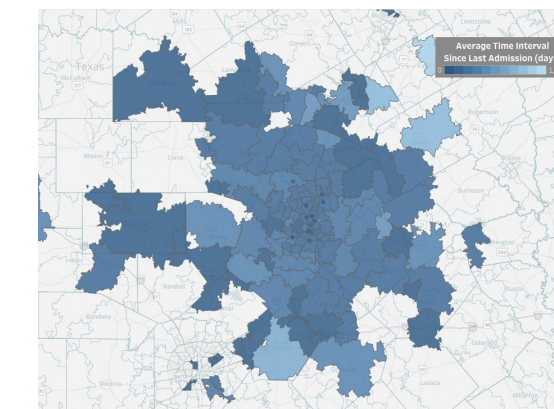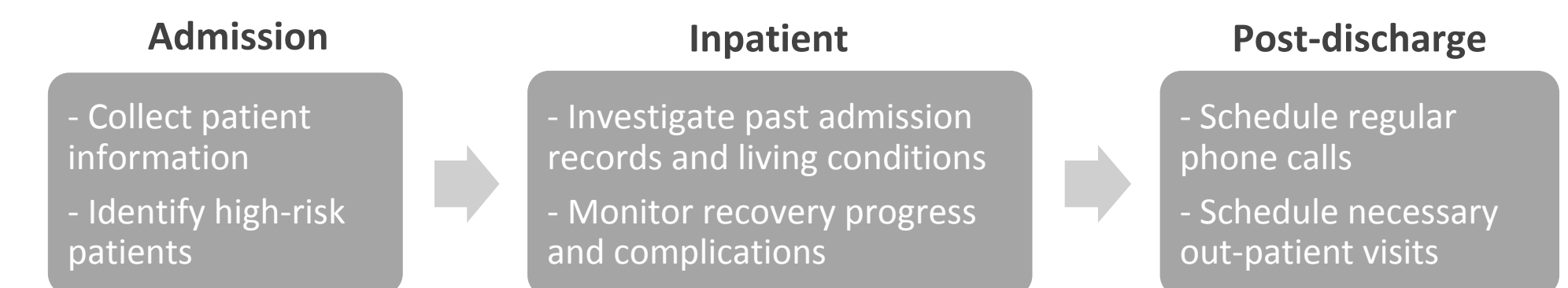

Model Performance

The metrics to evaluate model performance are *discrimination* and *calibration*. These two metrics are particularly important from a business standpoint because they both contribute to cost savings. The best model (XGBoost) achieves an AUC of 79% and an accuracy of 77%.


Recommendations

Proactive Interventions

| Admission	Inpatient	Post-discharge
- Collect patient information - Identify high-risk patients	- Investigate past admission records and living conditions - Monitor recovery progress and complications	- Schedule regular phone calls - Schedule necessary out-patient visits

Personalized Care Management Plans

We believe that stratifying patients into high-risk and low-risk groups alone is not informative enough for care management team to to take appropriate preventative steps post-discharge.

Based on the important risk factors obtained from LIME, personalized care management plans can be arranged accordingly for each high-risk patient to prevent the readmission from occurring.
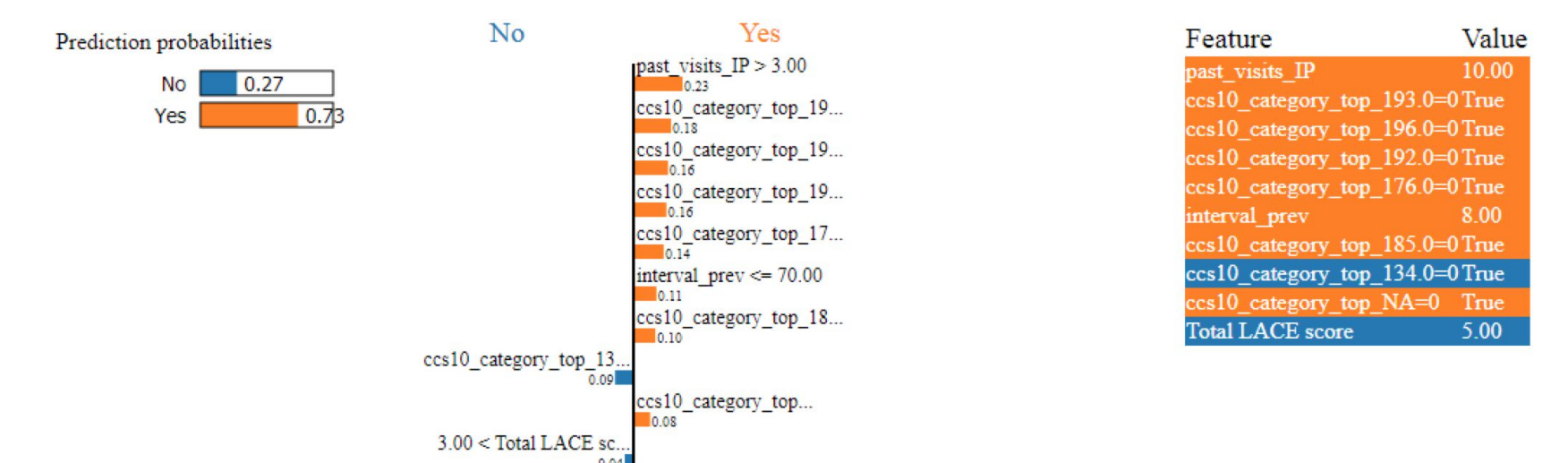
Business Value

Cost vs. Savings
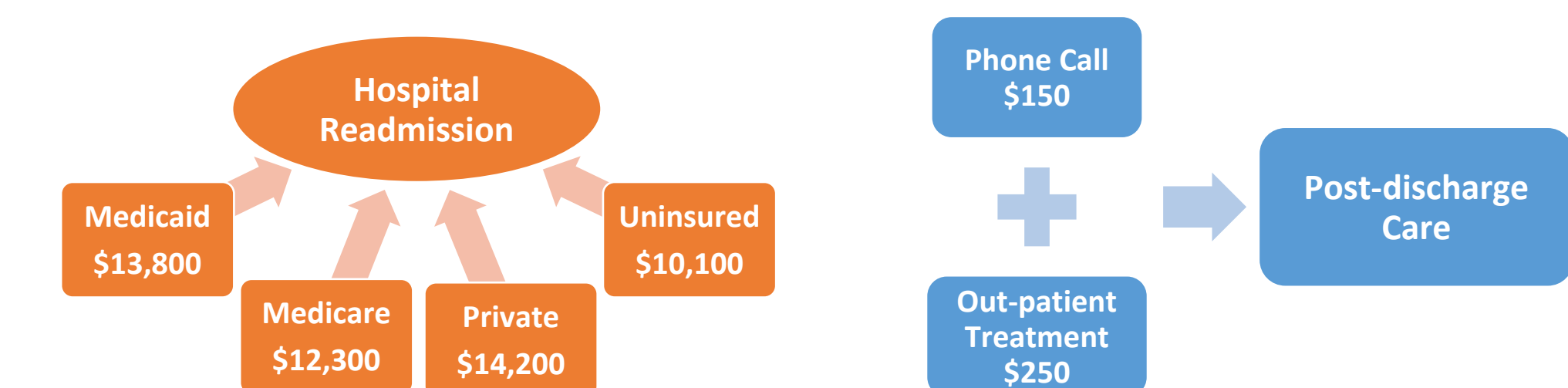
True Positives
For the correctly identified high risk patients, hospital care management interventions can effectively reduce readmission rates by approximately 20%.

False Positives
For the "False alarms", follow-up efforts will have been misallocated, leading to a wastage of resources.

Potential Savings

We estimate that the cost savings for CommUnityCare per 1000 patient is **$386,100**.