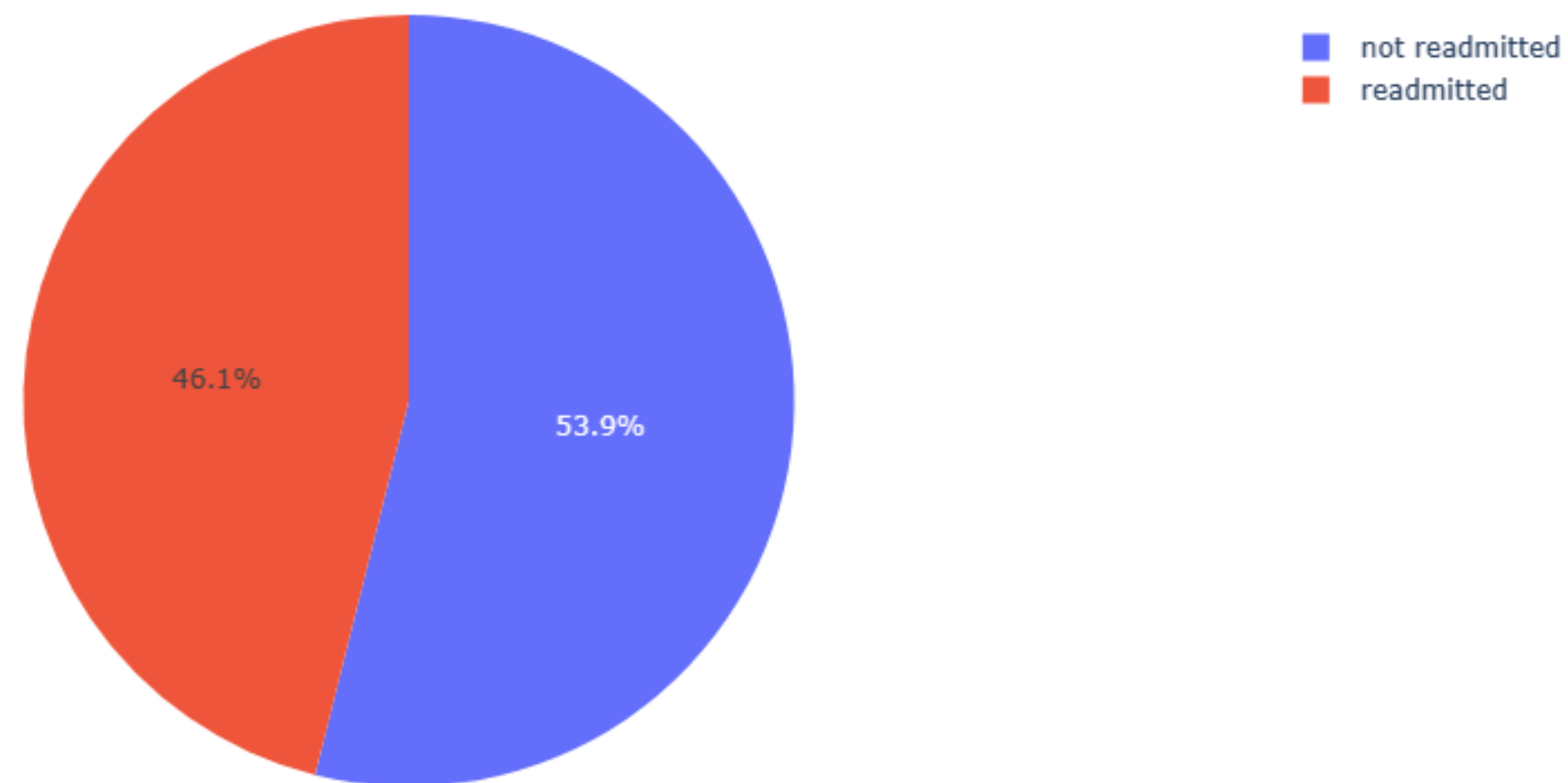


Healthcare Industry Case Study

Annually, approximately 3 million patients are readmitted to hospitals in the USA within 30 days. The overall direct cost of readmissions to hospitals/ Insurance companies ranges from US\$20 billion to \$40 billion. Hospitals, Insurance companies, doctors and patients are vexed with the unsolved problem of predicting the rate of hospital readmission for patients. The vision is to reduce 30hospital unplanned readmissions leading to lower healthcare costs and improved patient care.

The mission is to leverage Auto-ML & SXI based algorithms/data models to analyze real time and historical data from multiple sources to create a patient's risk/vulnerability profile, to certain conditions that could result in readmissions and offer personalized treatment recommendations to reduce the probability of the same.

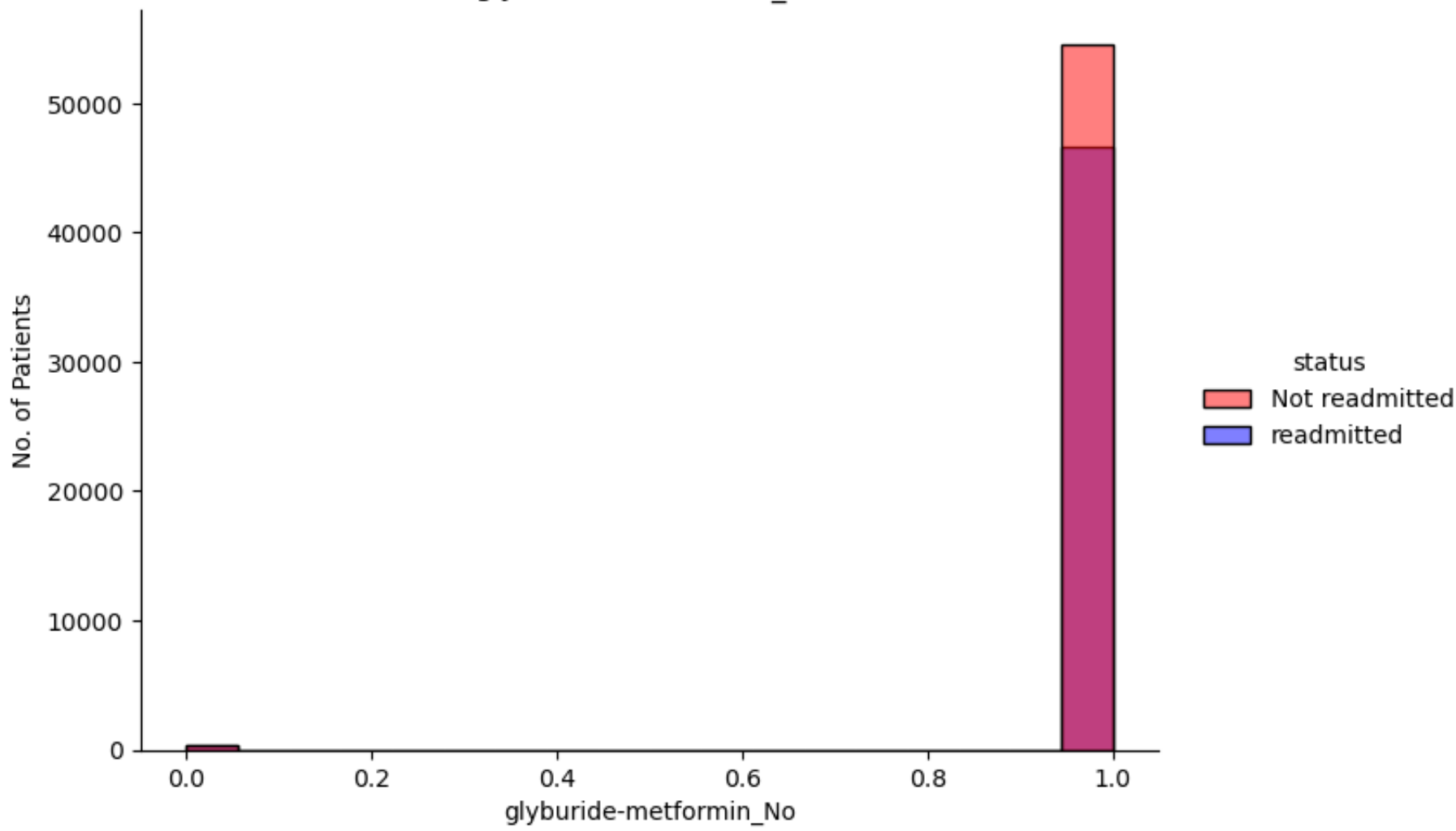
Class Distribution



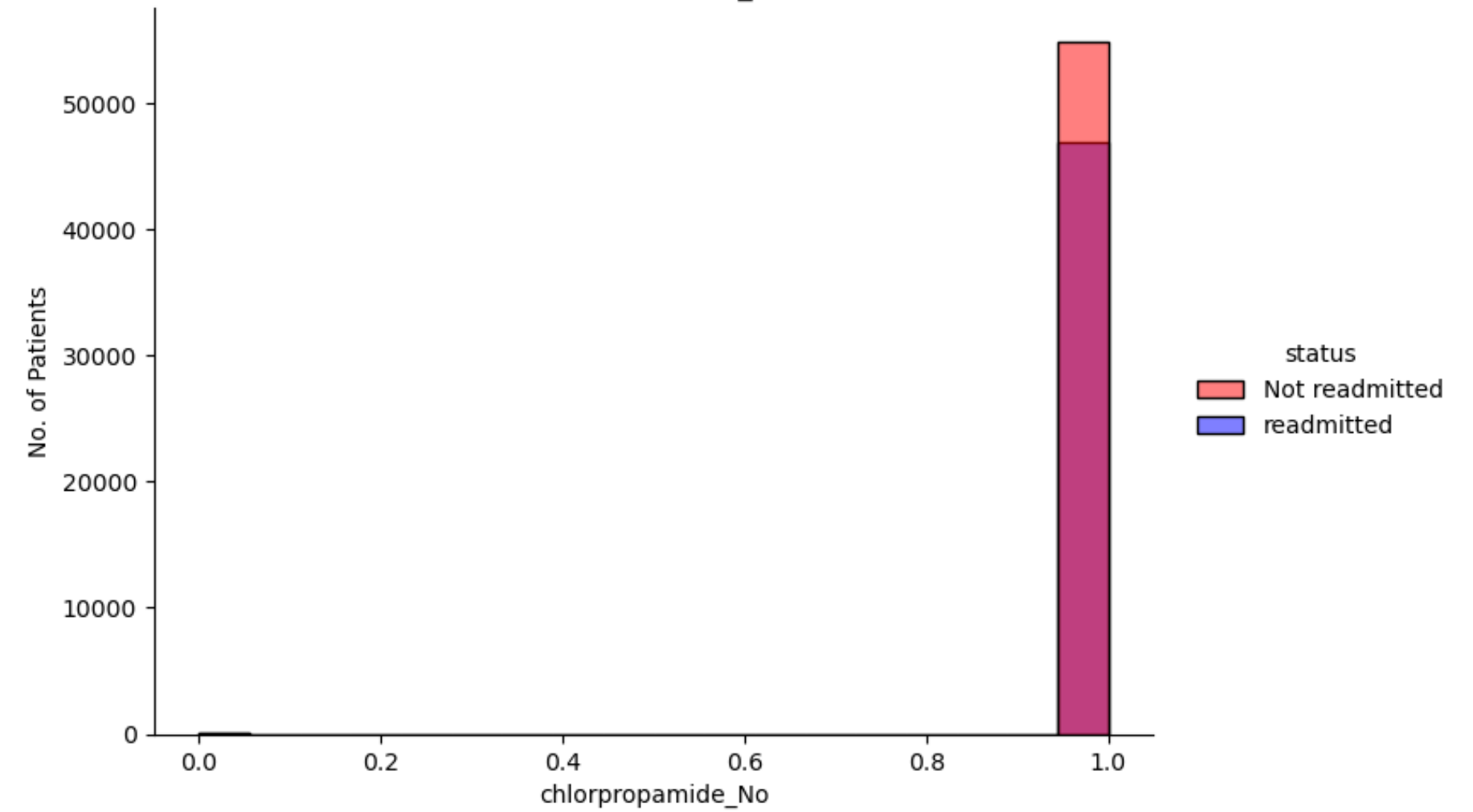
| Status | No. of Patients |
|------------------------------|-----------------|
| Not Readmitted (Good) | 54864 |
| Readmitted (Bad) | 46902 |
| Not Readmission Rate | 53.9% |

Features Responsible – Auto ML/SXI

glyburide-metformin_No



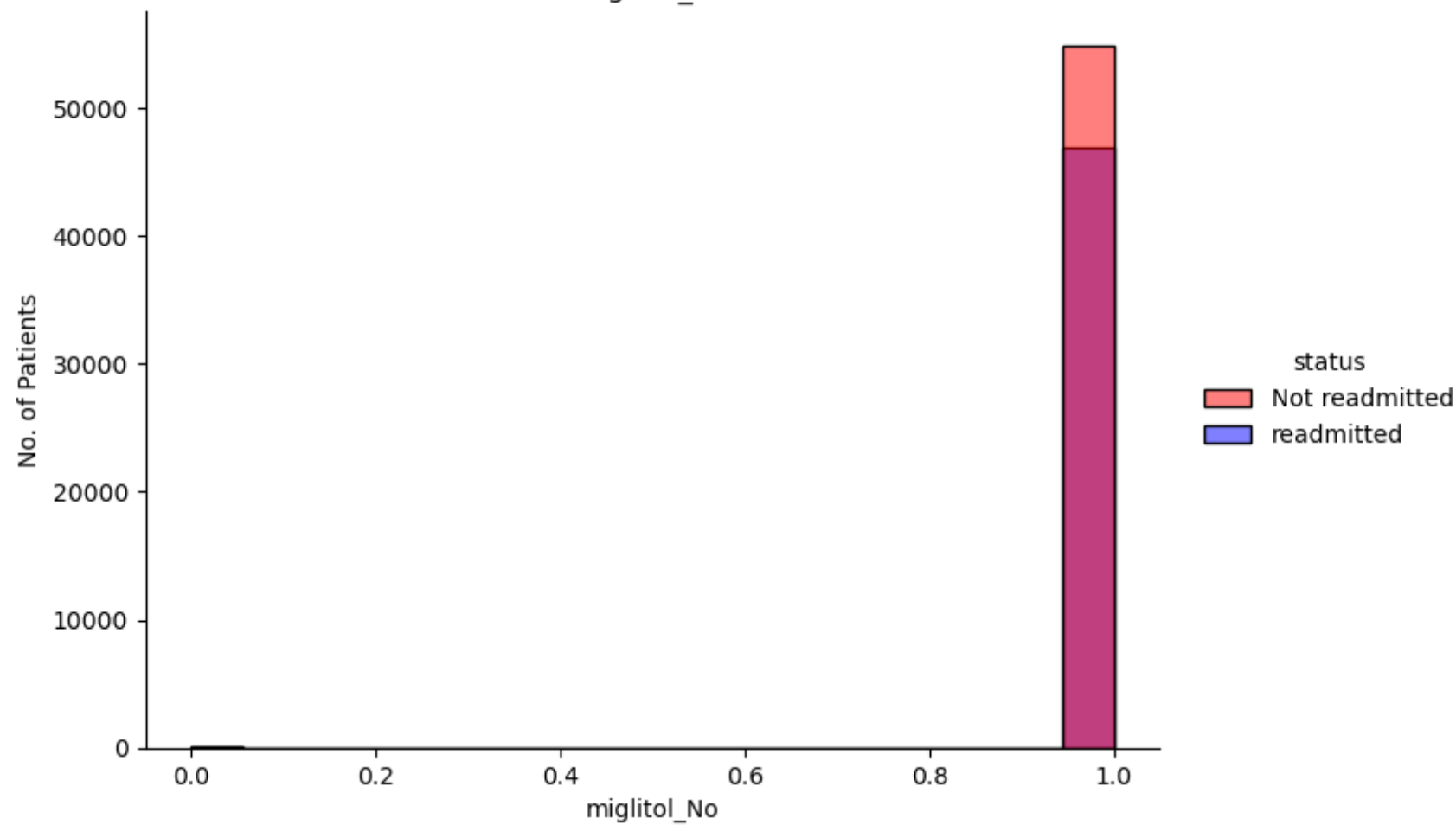
chlorpropamide_No



glyburide-metformin_No: whether the patient is prescribed this medication or not.

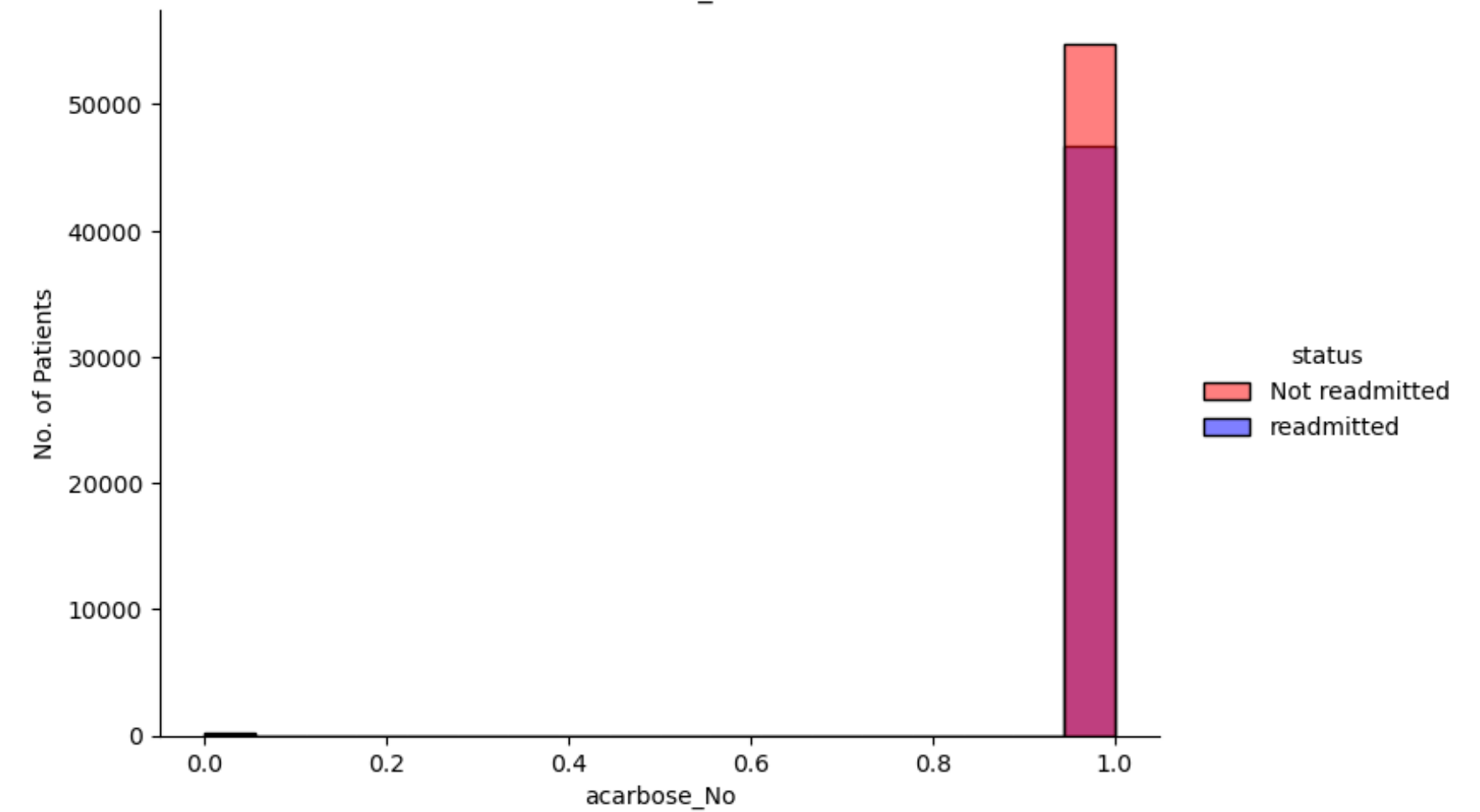
chlorpropamide_No: whether the patient is prescribed this medication or not

miglitol_No



miglitol_No: whether the patient is prescribed this medication or not

acarbose_No



acarbose_No: whether the patient is prescribed this medication or not

Auto-ML Methodology Results

| Algorithms | Test Accuracy (25 percentile) | Test Accuracy (50 percentile) | Test Accuracy (75 percentile) | Test Accuracy (90 percentile) |
|-----------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Random Forest | 88.1 | 89.0 | 88.5 | 88.61 |
| XGBoost | 88.4 | 88.4 | 88.6 | 88.58 |
| MLP | 88.5 | 88.5 | 88.5 | 89.0 |
| RNN | 88.5 | 88.5 | 88.56 | 88.56 |
| No. of Features | 45 | 87 | 130 | 156 |
| Avg. Accuracy | 88.37 | 88.60 | 88.54 | 88.68 |

- Based on our observation , MLP was the best performing algorithm with 89% accuracy in 90th percentile.
- 90th percentile is the best percentile with an average accuracy of 88.68%.

Auto-ML Methodology Conclusion

- In conclusion, predicting whether a patient will be readmitted or not is a crucial task for the healthcare industry. Auto-ML algorithms can be used to analyze large volumes of patient data and identify patterns that may be indicative of readmission risk. The dataset contains 101,766 records with 33 Categorical and 14 Numerical Features.
- The Auto-ML algorithms were able to predict whether the patient was readmitted or not have based on their features with an average accuracy between 85% – 90% and helped to identify features that determine the readmission rate and predict whether the patient is in high risk or not to be readmitted.
- The major factors which determines the patient's risk of being readmitted are prescribed medication such as glyburide-metformin, chlorpropamide, miglitol and acarbose.
- Overall, the application of Auto-ML in predicting patient being readmitted or not can help in saving the patients life by prescribing medicine quickly and more efficiently.

Sensitivity Analysis

Actual Data Values

| NUM_PROCEDURES | CHANGE | INSULIN_NO | GLIPZIDE_NO | PIOGLITAZONE_NO | STATUS |
|----------------|--------|------------|-------------|-----------------|--------|
| 0 | 0 | 0 | 1 | 1 | 0 |
| 50 % | 100 % | 100 % | -100 % | -100 % | |

Status -0 :
readmitted

Adjusted Data Values

| NUM_PROCEDURES | CHANGE | INSULIN_NO | GLIPZIDE_NO | PIOGLITAZONE_NO | STATUS |
|----------------|---------|------------|-------------|-----------------|--------|
| 1.5 | 1.0 | 1.0 | 0.0 | 0.0 | 1 |
| ↑ (1.5) | ↑ (1.0) | ↑ (1.0) | ↓ (-1.0) | ↓ (-1.0) | |

Status -1 : not
readmitted

- The top 5 features :

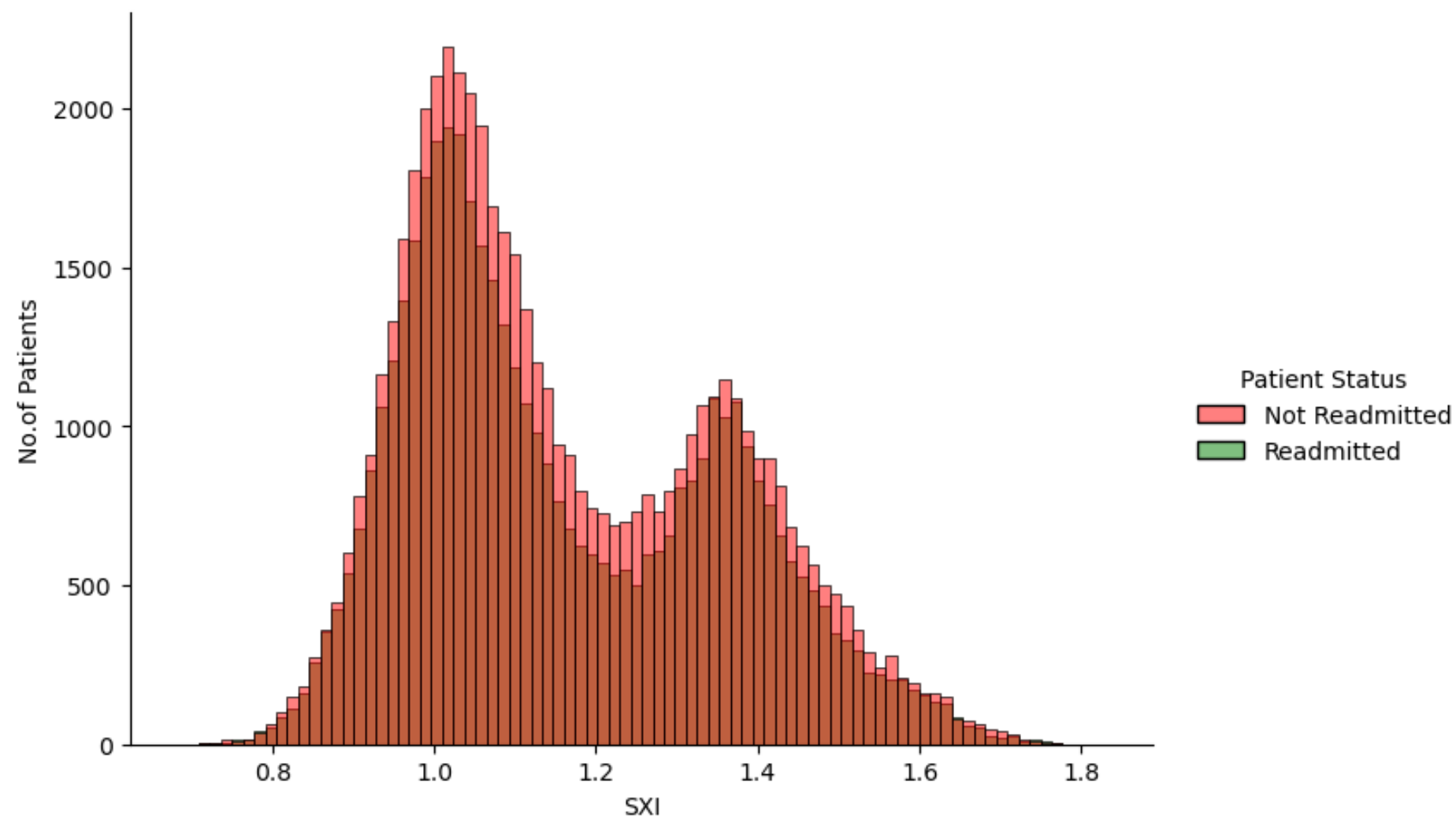
- NUM_PROCEDURES = No:of lab procedures performed during the encounter
- CHANGE = Indicates if there was a change in diabetic medications (either dosage or generic name).
- INSULIN_NO = whether the patient is prescribed insulin medication or not.
- GLIPZIDE_NO = whether the patient is prescribed GLIPZIDE medication or not.
- PIOGLITAZONE_NO = whether the patient is prescribed for PIOGLITAZONE medication or not.

For this patient we can see:

- num_procedures with 51% increase
- CHANGE with 100% increase (medication has changed (1))
- INSULIN_NO with 100% increase(insulin not prescribed)
- GLIPZIDE_NO with -100% decrease (medication prescribed)
- PIOGLITAZONE_NO with -100 decrease (medication prescribed)

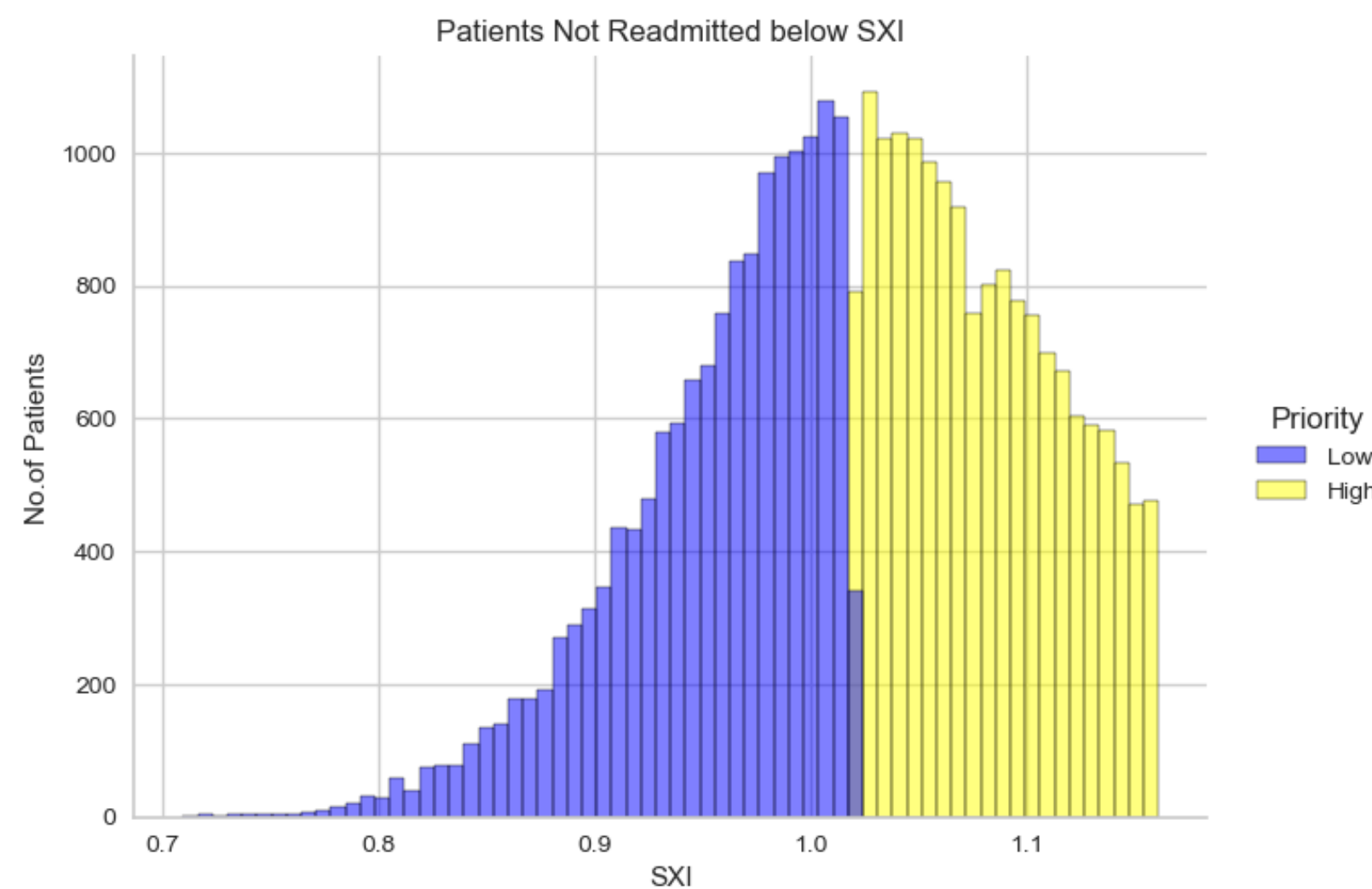
Which will lead the patient to be not readmitted.

SXI Method



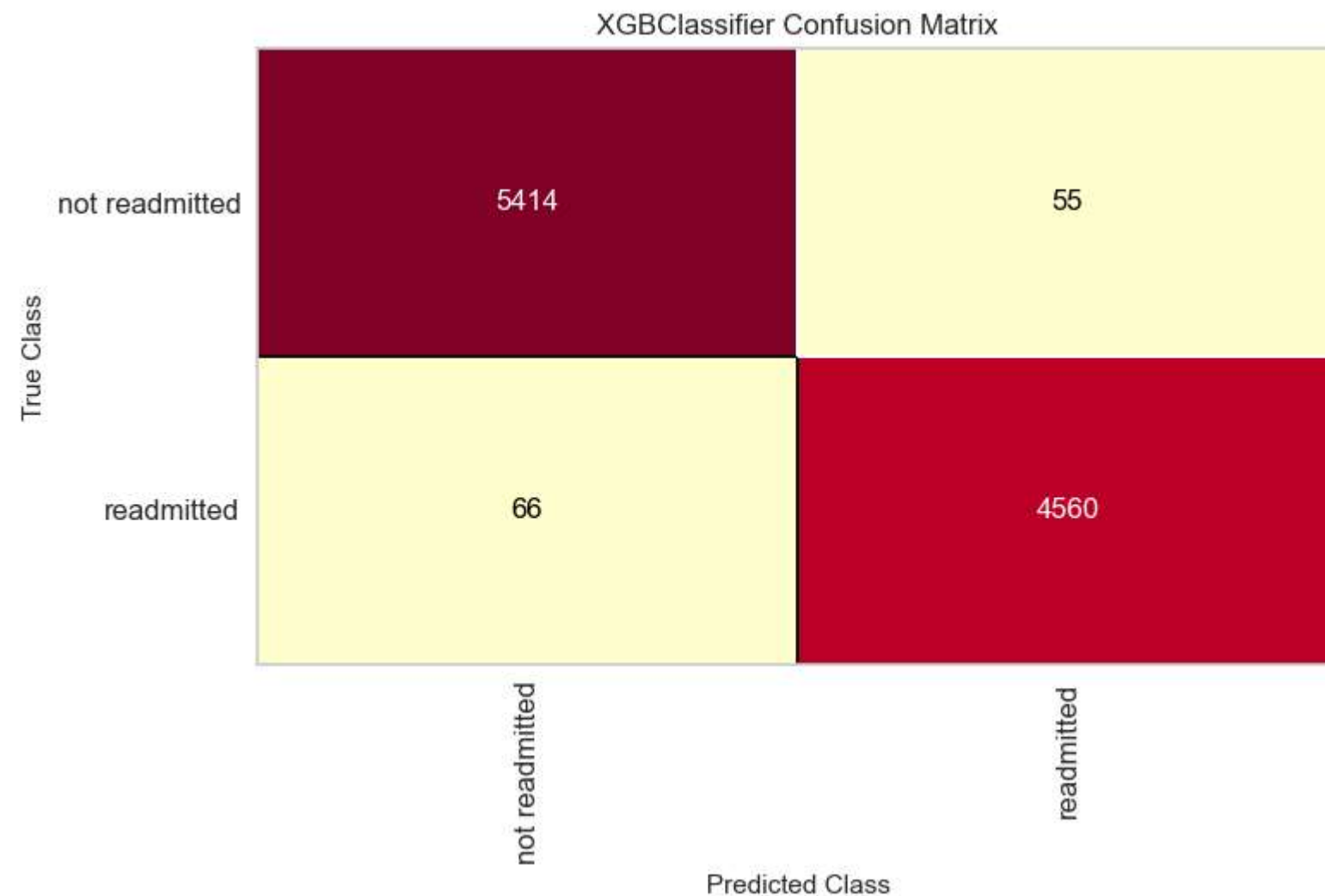
| | |
|--|------------|
| SXI | 1.2 |
| Top SXI | 1.83 |
| Minimum SXI | 0.68 |
| No. of patients not readmitted above SXI | 23112 |
| No. of patients readmitted above SXI | 19539 |
| No. of patients not readmitted below SXI | 31752 |
| No. of patients readmitted below SXI | 27363 |
| SXI Model Accuracy | 98.8 |

Not Readmitted below SXI



- Users who have below SXI values and who are not readmitted are more prone to be readmitted.
- In order to decrease the readmission rate, these patients are one to focus on, because in future they have more chance to be readmitted.
- The average SXI on “not readmitted below SXI” is 1.02. Here we further categorize, so patient’s SXI below 1.02 are to be mostly taken care in future.

SXI Method Accuracy is 98.8%



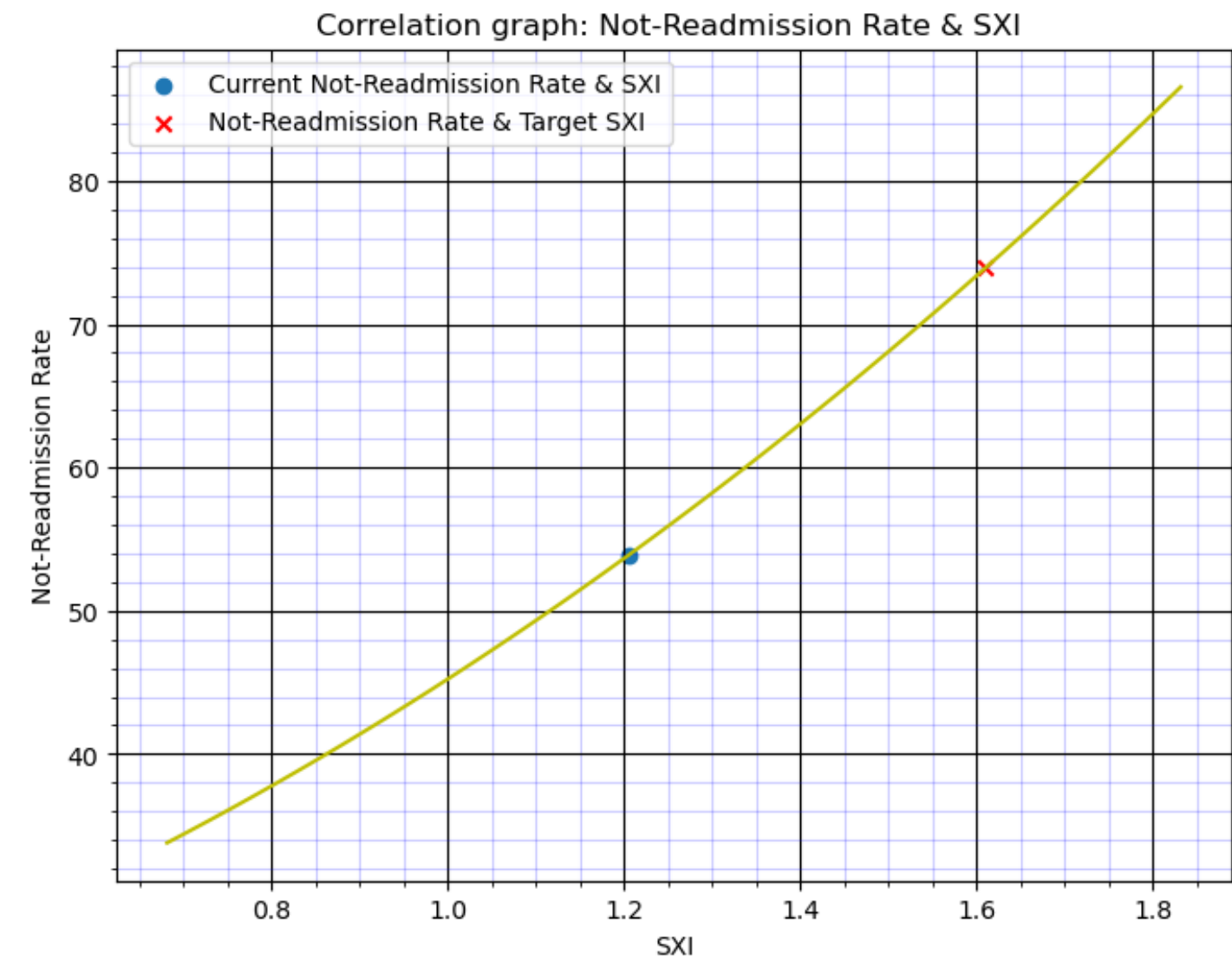
- Actual and Predicted was Not Readmitted Patients (TP) : 5843
- Actual and Predicted was Readmitted Patients (TN) : 4942
- Actual Not Readmitted Patients and Predicted Readmitted Patients (FN): 20
- Actual Readmitted Patients Predicted Not Readmitted Patients (FP) : 18

| Train Count | Test Count | Actual Train count for not readmitted | Actual train count for readmitted again | Actual test count for not readmitted again | Actual test count for readmitted again | Predicted test count not readmitted again | Predicted test count readmitted again | Precision rate | Recall rate | Model Accuracy |
|-------------|------------|---------------------------------------|---|--|--|---|---------------------------------------|----------------|-------------|----------------|
| 40380 | 10095 | 18486 | 21894 | 4626 | 5469 | 4615 | 5480 | 0.988 | 0.985 | 0.988 |

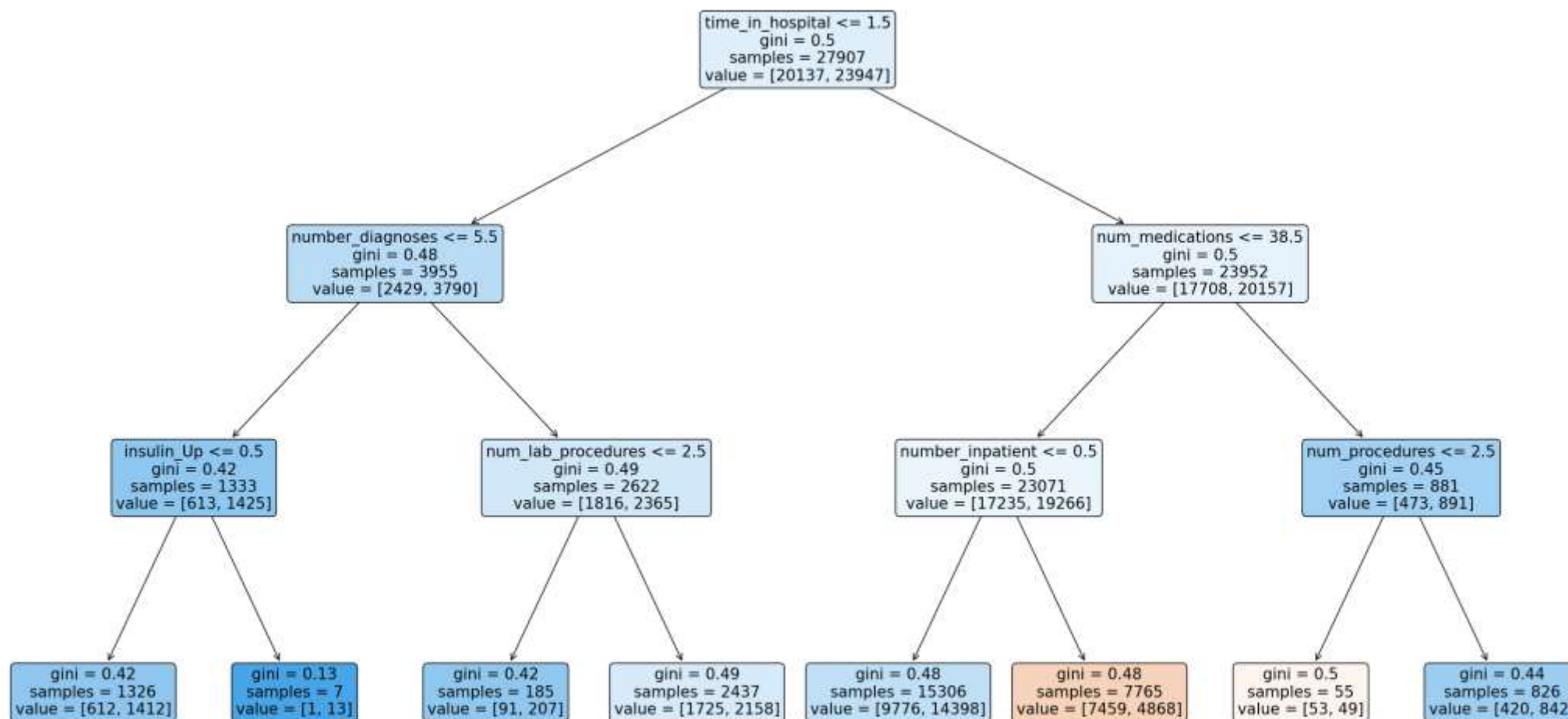
- **Precision rate:** Precision is defined as the ratio of actual not readmitted patients(True Positive) to a total number of predicted not readmitted patients. $TP / (TP + FP)$
- **Recall rate:** The recall is calculated as the ratio between the Actual numbers of not readmitted patients to the total number of wrongly predicted not readmitted patients as readmitted patients plus actual number of not readmitted patients. $TP / (TP + FN)$
- **Model Accuracy:** It is the fraction of predictions where the model got right. $(TP + TN) / (TP + FP + TN + FN)$

SXI Method - Conclusion

| | |
|------------------------------------|--------|
| SXI | 1.2 |
| Target SXI | 1.61 |
| Not Readmission rate | 53.91% |
| Target Not Readmission rate | 73.91% |



The correlation between SXI and Not Readmission rate is 0.99



Tree - Interpretation

- **Total Time in Hospital < 1.5 days**
- **Number of Diagnoses <= 5**
- **Insulin High dosage <= 50% probability**
- **Leads to the patients not being readmitted**