

CMS & Profitability Analysis

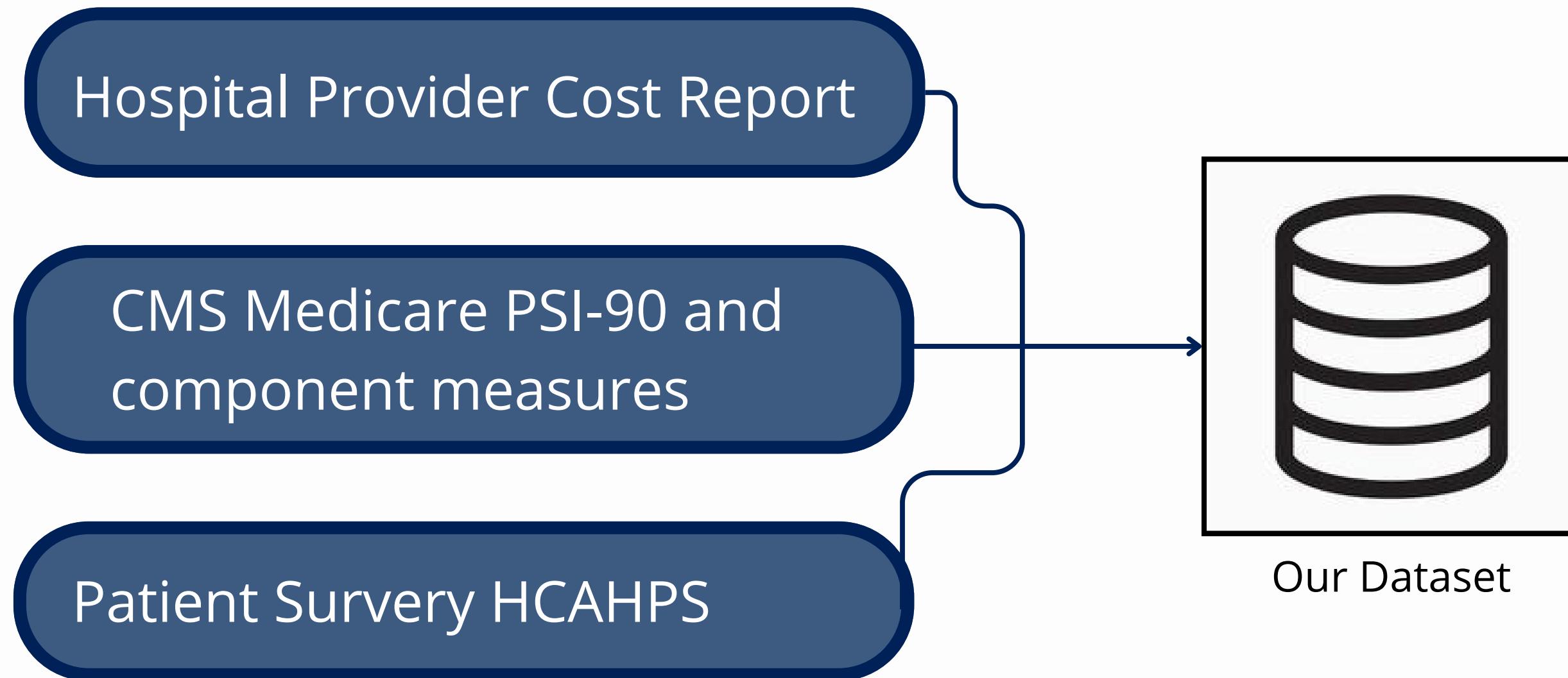
Agenda

- 1 EDA - Market Analysis
- 2 Hypothesis 1 - Correlation Between Star Rating & Profit
- 3 Unsupervised Learning - Uncovering Patterns
- 5 Hypothesis 2 - Factors Impacting Star Rating
- 4 Hypothesis 3 - Factors Impacting Profit
- 6 Observations

Financial Health of Market

Hypothesis 1: Correlation Star Rating and Profit

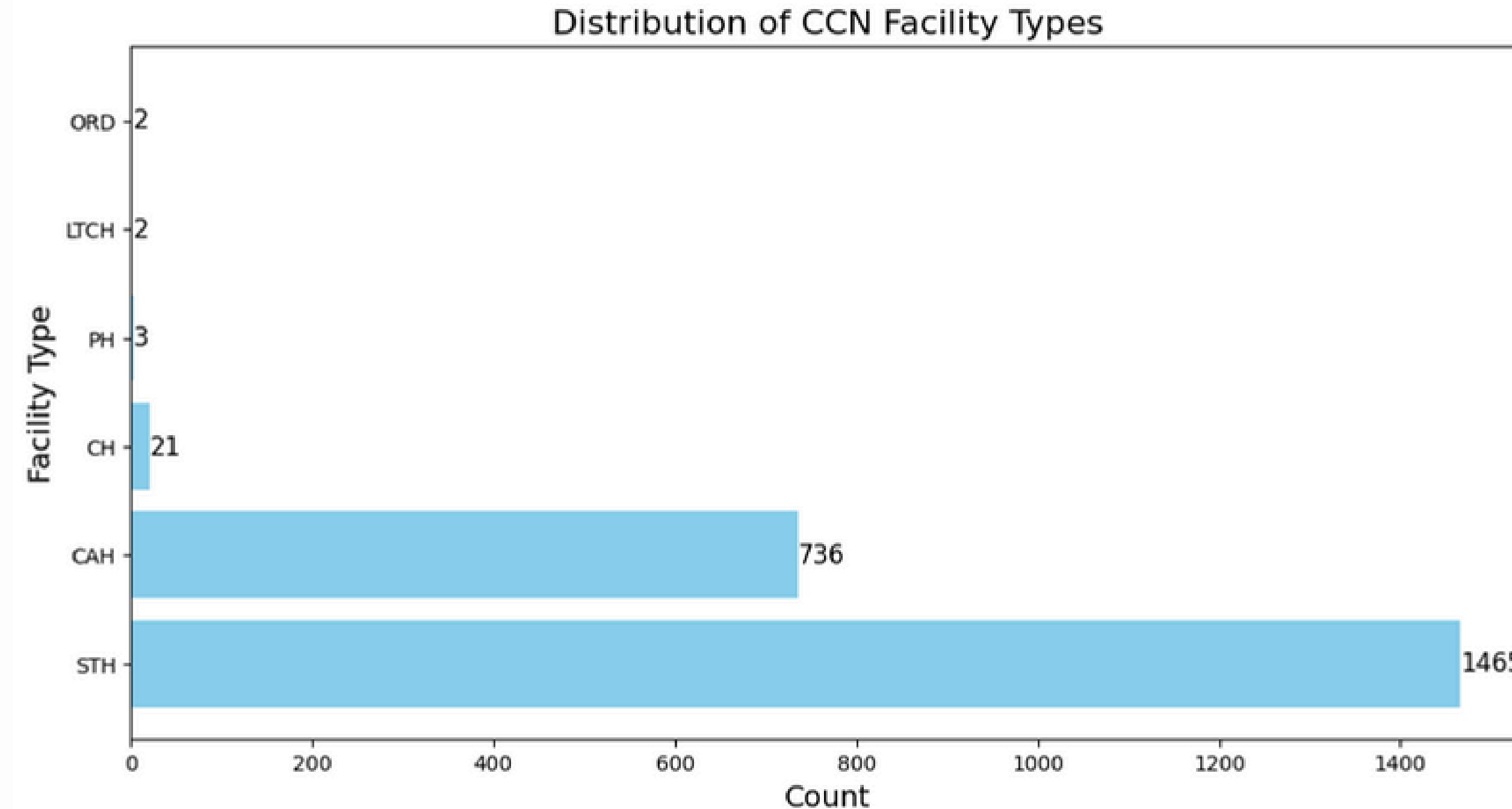
Dataset Creation



Dataset Details

- 2229 Rows 53 Columns
- National level Data
- Datasets were gathered from <https://data.cms.gov>

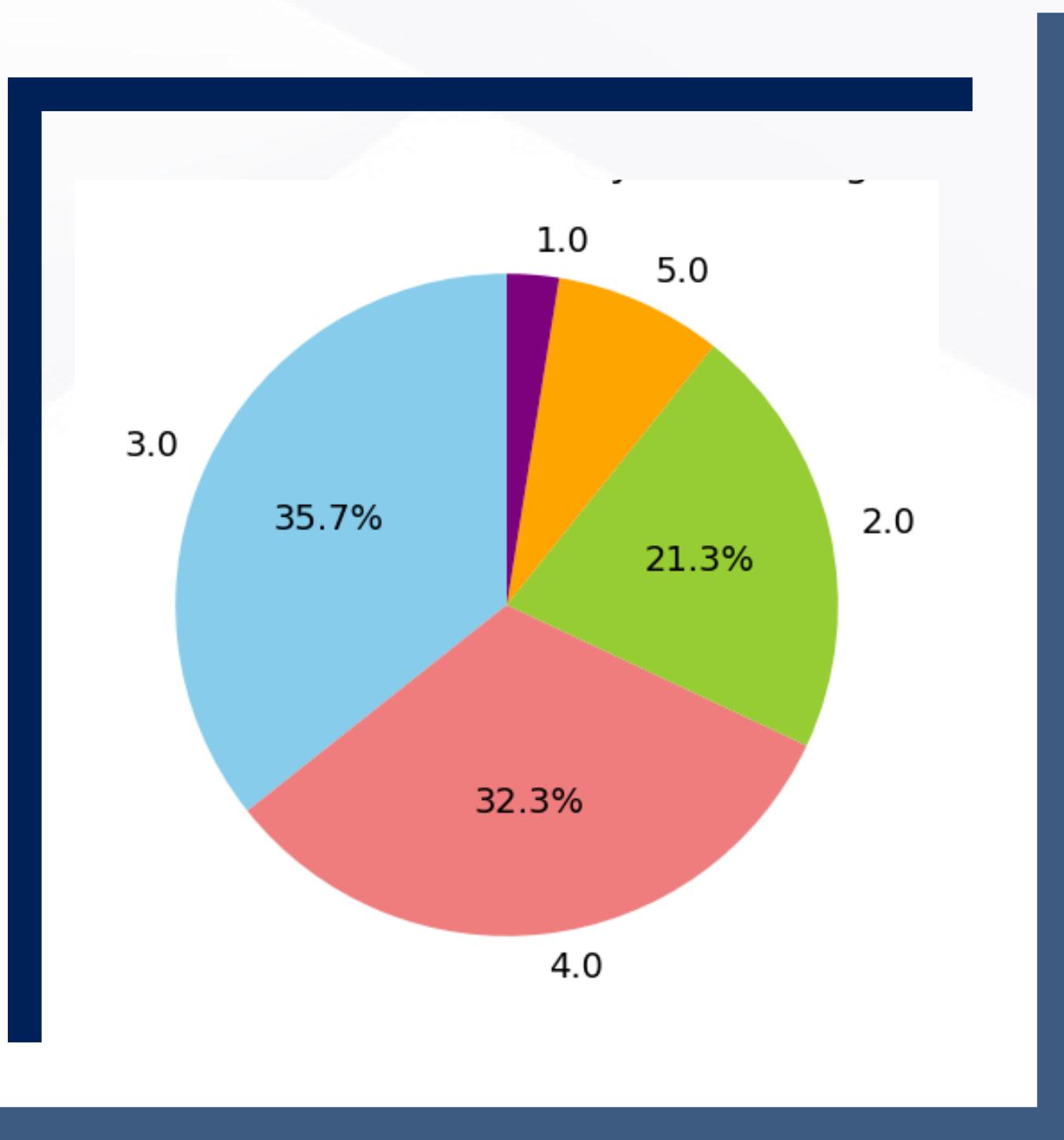
Dataset Overview: Types of hospitals



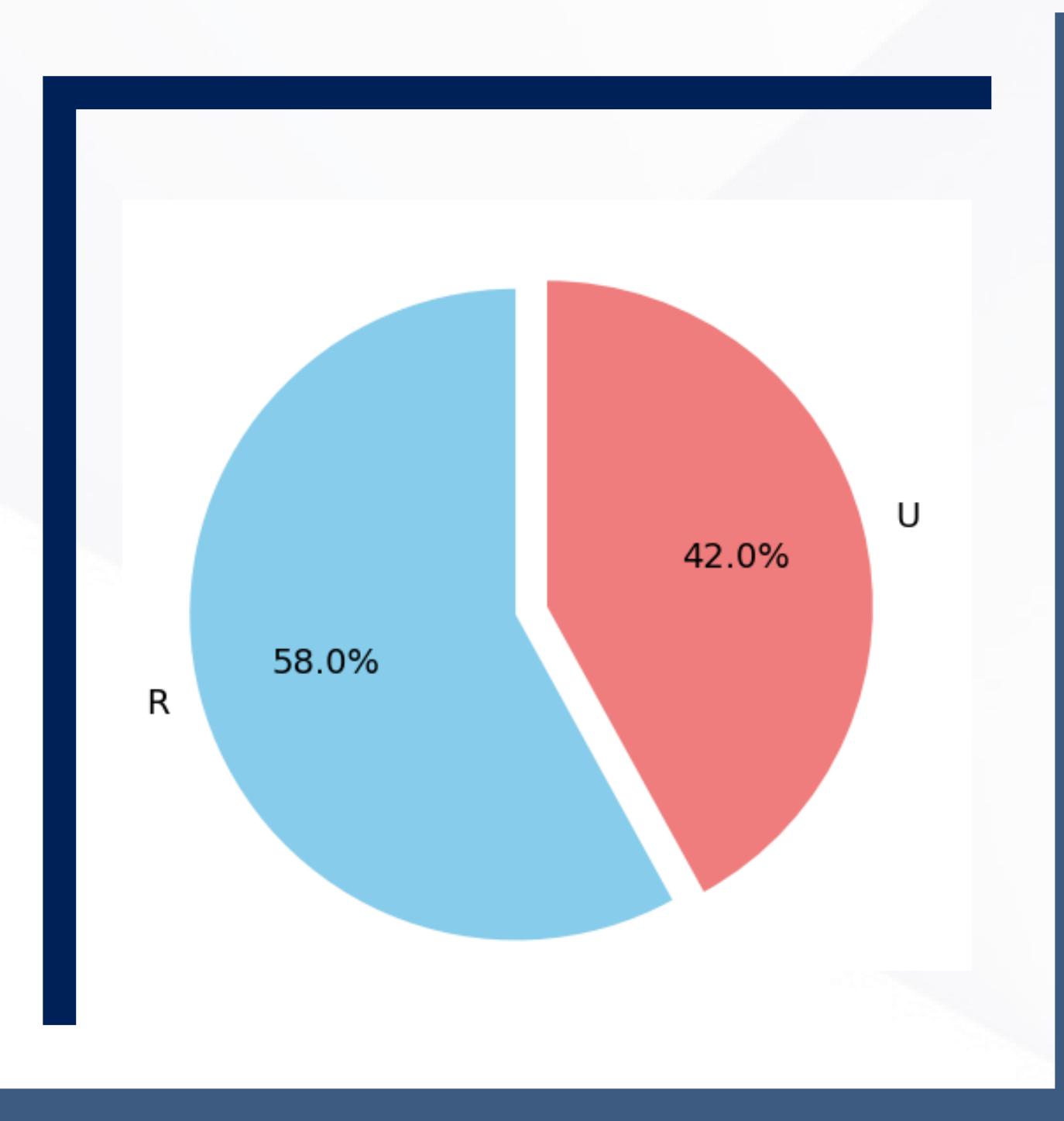
Facility Type

- **STH:** Short Term (General and Speciality) Hospitals
- **CAH:** Critical Access Hospitals
- **CH:** Children's Hospitals (Excluded from IPPS)

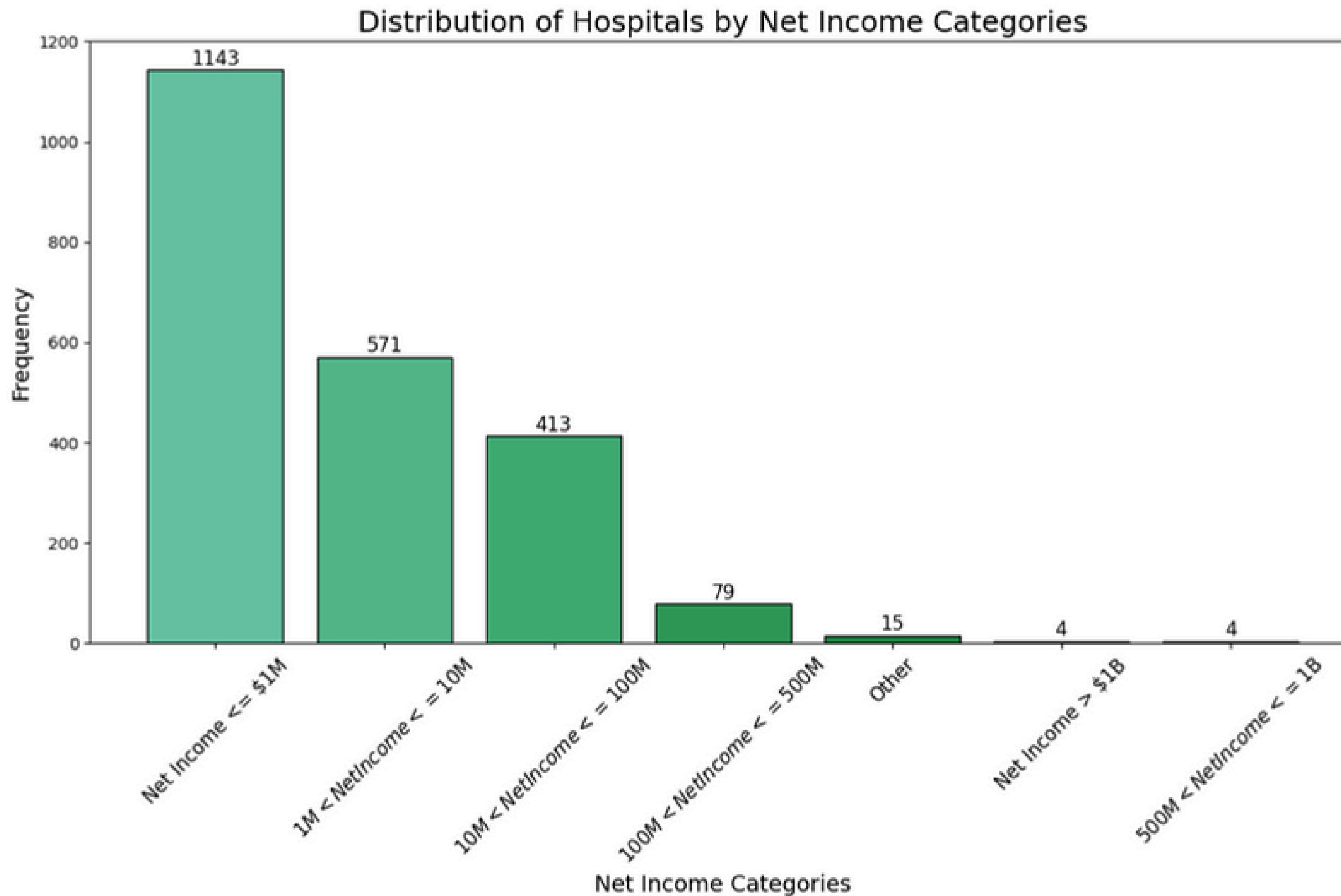
Summary Star Rating

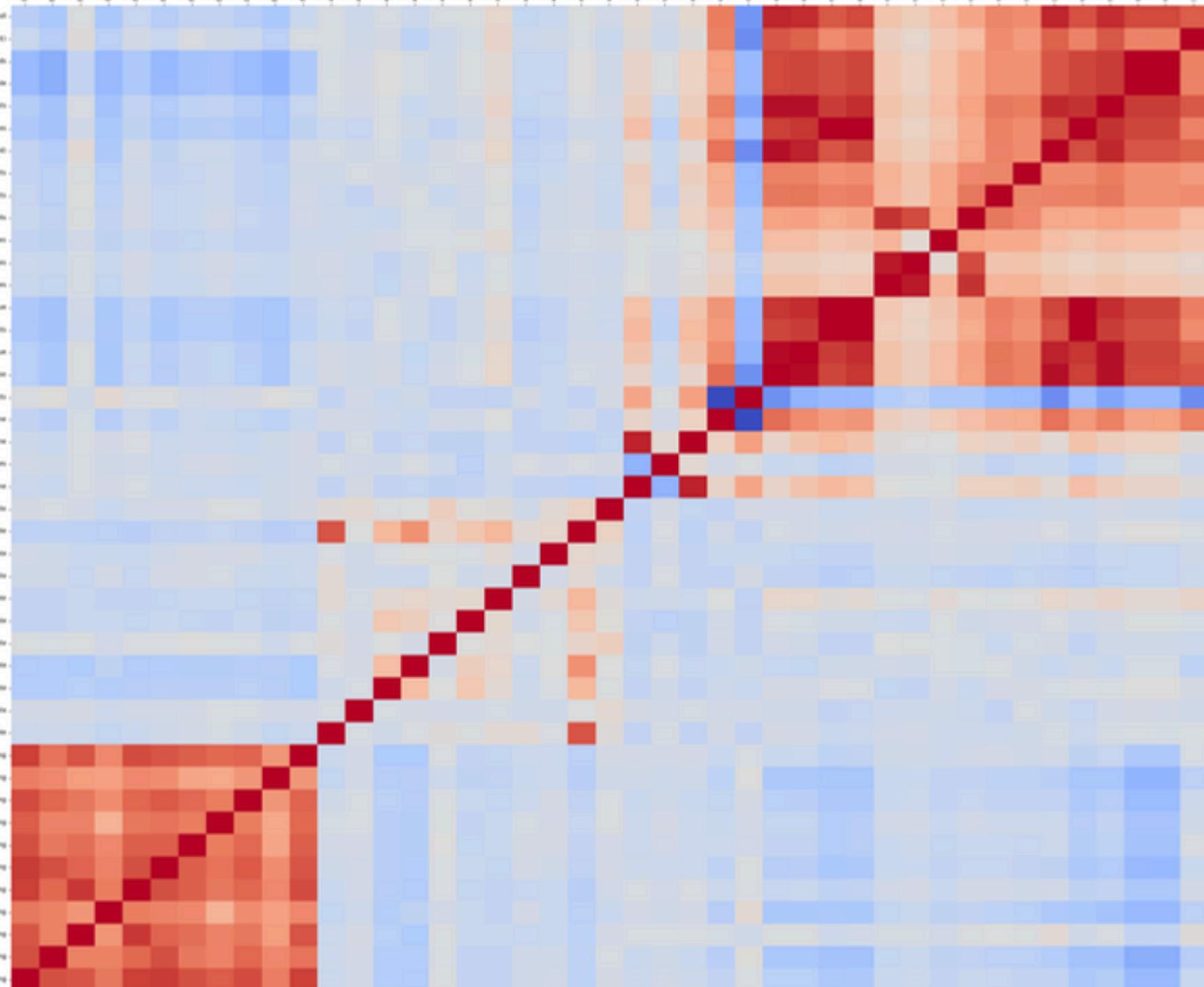


Rural vs Urban



Distribution of Net Income





Low



High

Subsets Analyzed



NUMBER OF BEDS



RURAL



URBAN



PSI



FACILITY ID



REGION

Insights: Rural vs Urban Hospitals

Rural Hospitals



Urban Hospitals



Total Salaries

	Low	Medium	High
Urban			
Total Salaries Net Patient Revenue	.77	.86	.91
Total Salaries Summary Star Rating	-.22	.16	.09
Rural			
Total Salaries Net Patient Revenue	.54	.90	.94
Total Salaries Summary Star Rating	-.06	-.09	-.06

Net Patient

Urban

	Low	Medium	High
Net Patient Revenue Summary Star Rating	-.14	.23	.12
Reccommended Hospital Rating Net Patient Revenue	.14	.28	.24

Rural

	Low	Medium	High
Net Patient Revenue Summary Star Rating	-.01	.06	.11
Reccommended Hospital Rating Net Patient Revenue	-.02	.26	.33

Urban

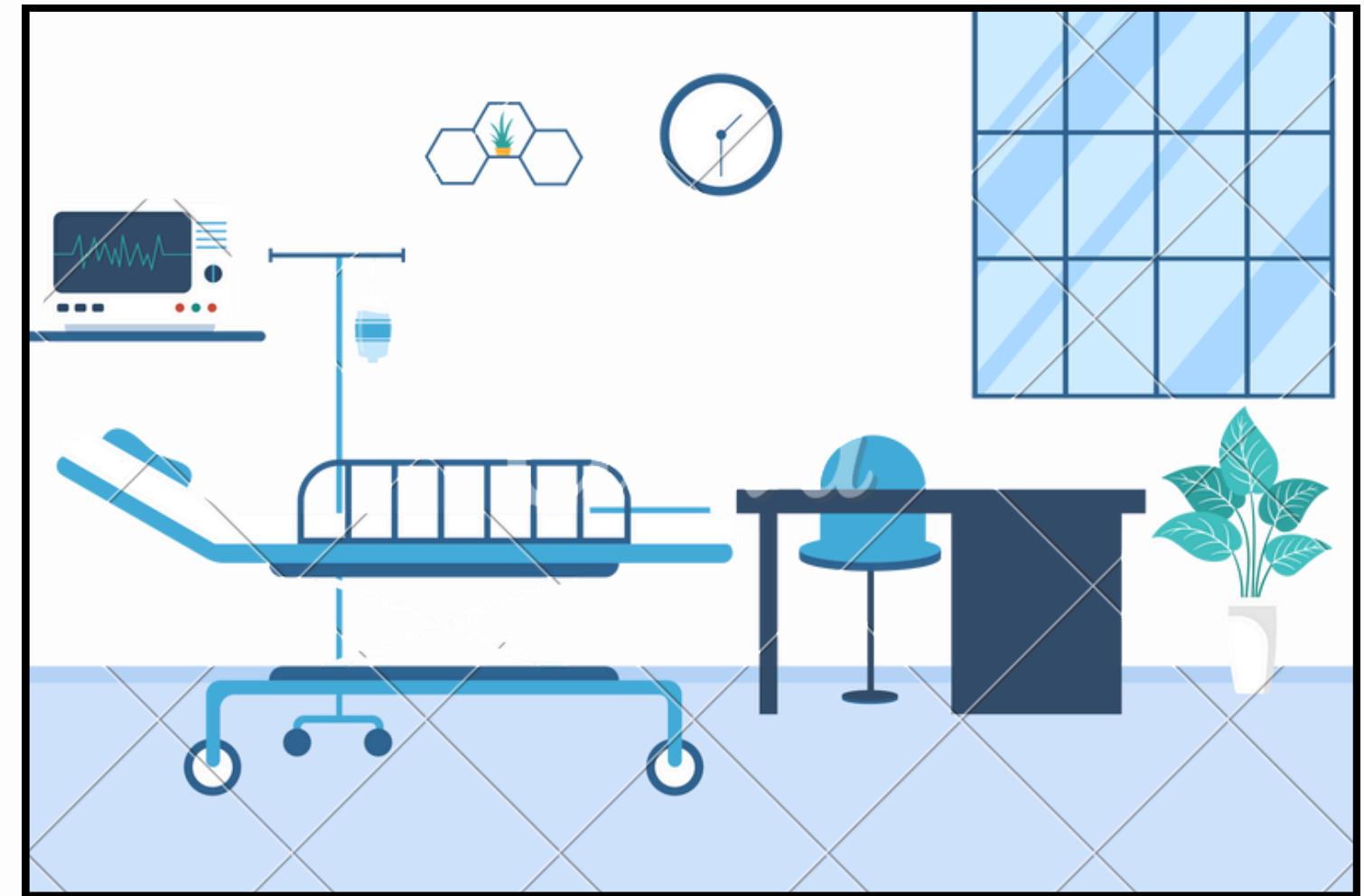
Rural

	Low	Medium	High
Total Beds Days Available Summary Star Rating	-.29	-.23	.01
Total Salaries Total Beds Days Available	.32	.32	.72
Total Beds Days Available Net Patient Revenue	.43	.34	.82
<hr/>			
Total Beds Days Available Summary Star Rating	-.35	-.25	-.05
Total Salaries Total Beds Days Available	.34	.34	.76
Total Beds Days Available Net Patient Revenue	.34	.45	.80

Hospital At the Atomic Level



**The Size Hospital Matters a lot
to the finances**



**But what happens when you
only look at a bed**

Hospital At the Atomic Level

	Before	After	Change
Total Salaries Per Bed Summary Star Rating	-.09	.42	566%
Fixed Assets Per Bed Summary Star Rating	-.05	.23	560%
Net Patient Revenue Per Bed Summary Star Rating	.05	.29	480%

What does this mean?

**We see some key moderate and weak
Correlations emerge**

There is **42% Association** between Total Salaries Per Bed and Summary Star Rating

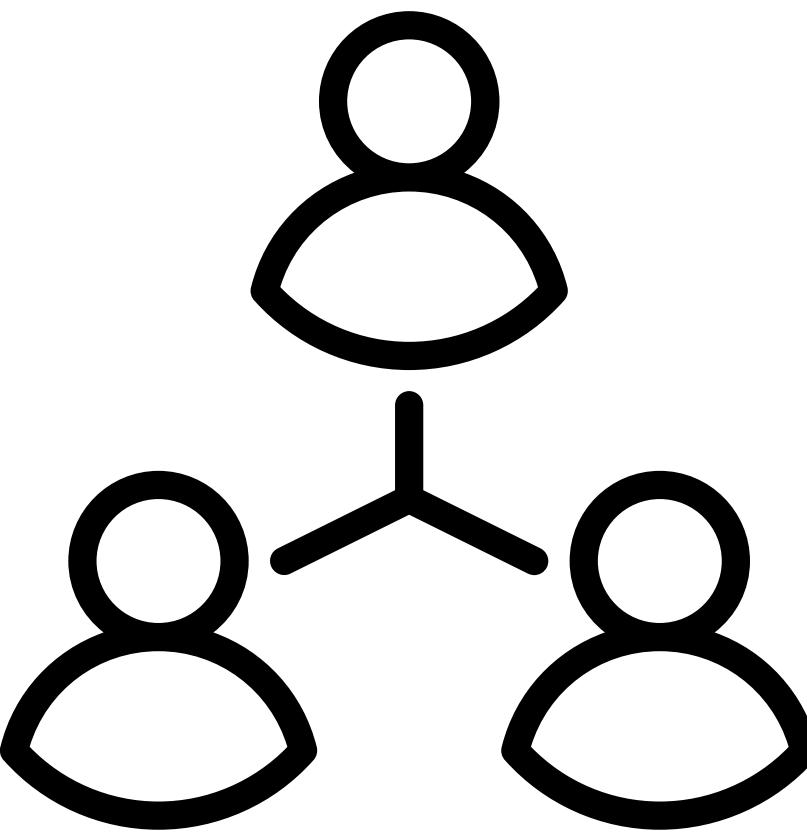
There is **29% Association between** Net Patient Revenue Per Bed and Summary Star Rating

There is **28% Association between** Fixed Assets Per Bed and Summary Star Rating

Key Take Aways



**No Clear Corelation
at first**



**Subsets and
Normalizing**



**What Does this
mean**

Questions?

Uncovering Patterns ML

Principle component analysis

Principle component analysis

Principal Component Analysis (PCA) simplifies complex data by identifying the most crucial patterns and trends

PC1

Financial Metrics

1. Total Costs
2. Less Total Operating Expense
3. Net Patient Revenue

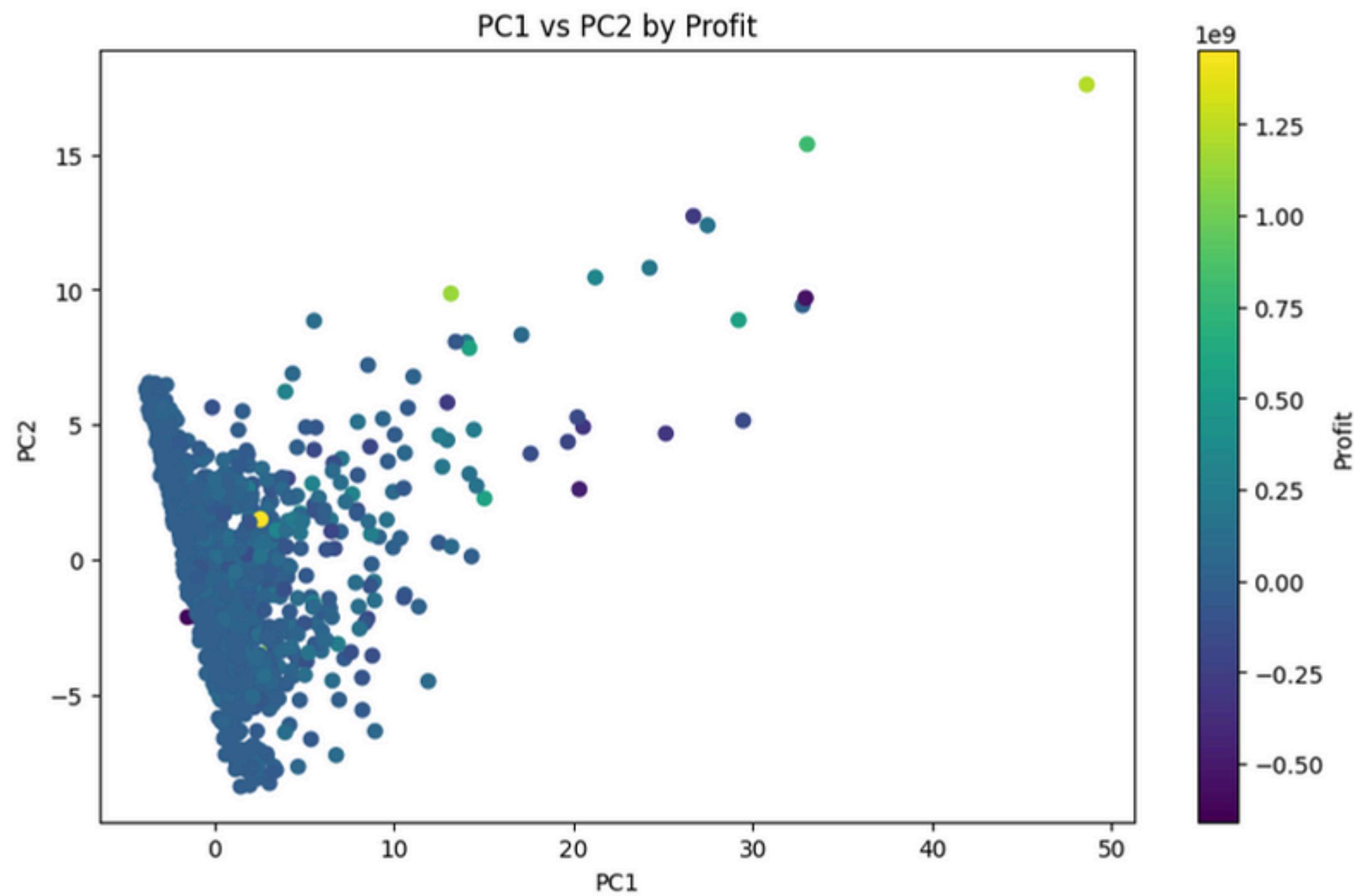
26.6%

PC2

Star rating Metrics

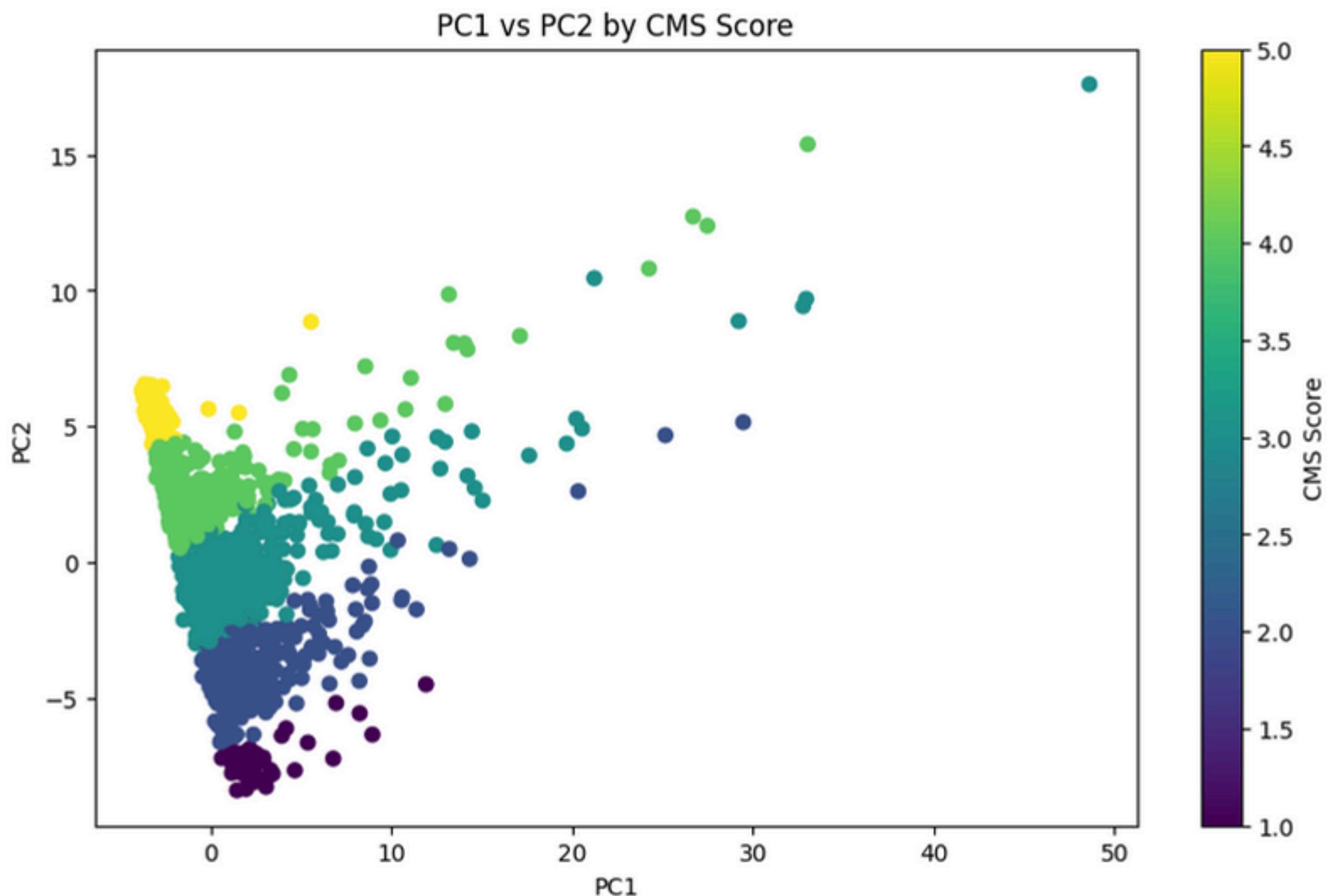
1. Summary star rating
2. Overall hospital rating - star rating
3. Care transition - star rating

16.7%

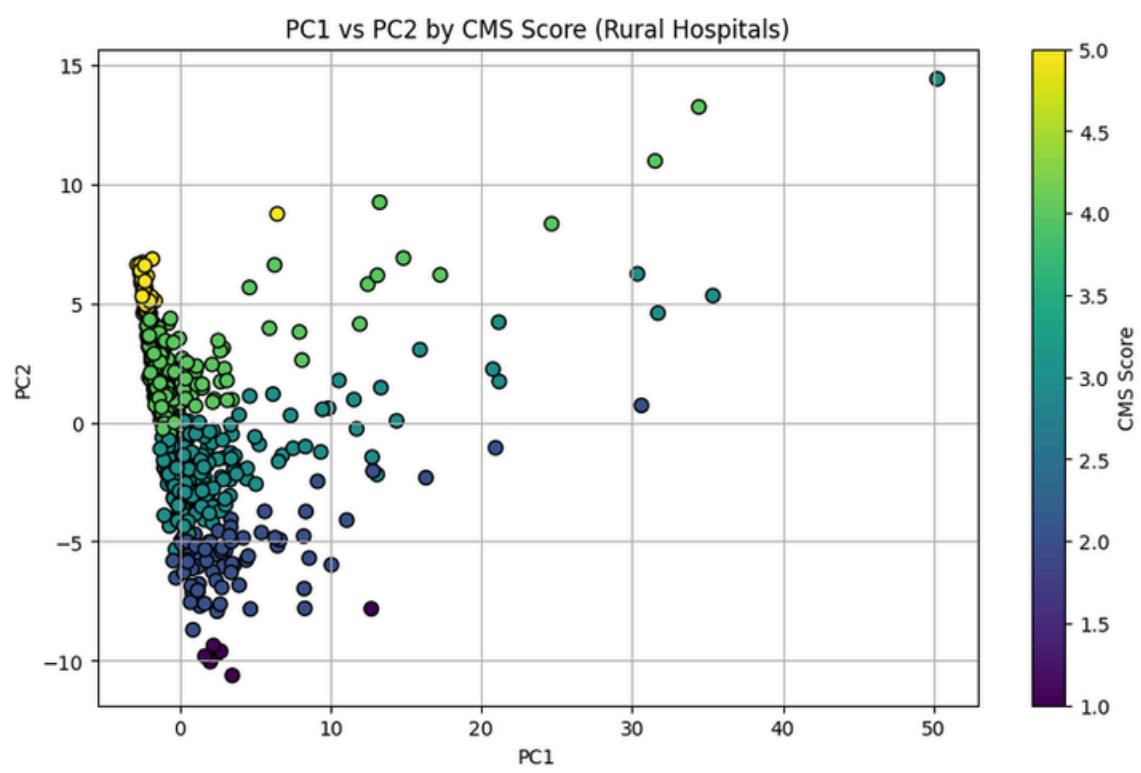
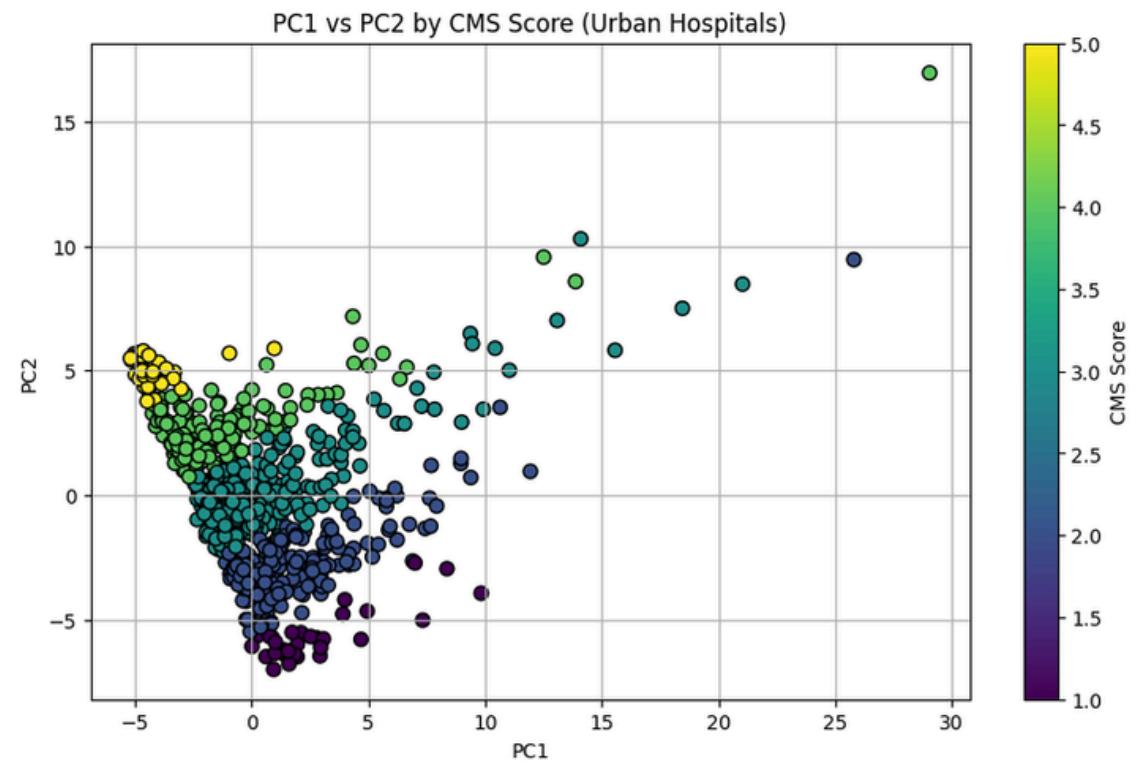


Profit(PC1) vs Star
rating (PC2)
Colored by profit

Profit(PC1) vs Star
rating (PC2)
Colored Star rating

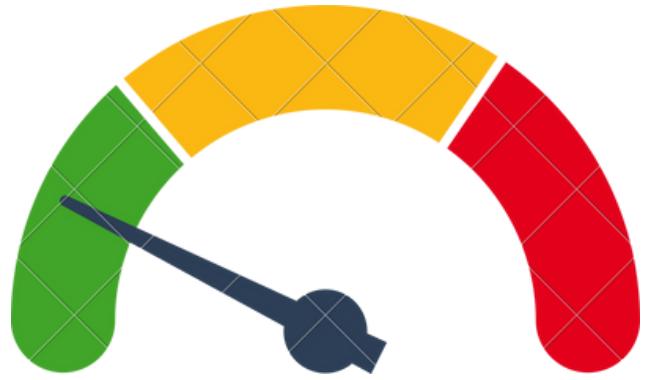


Urban and Rural subset

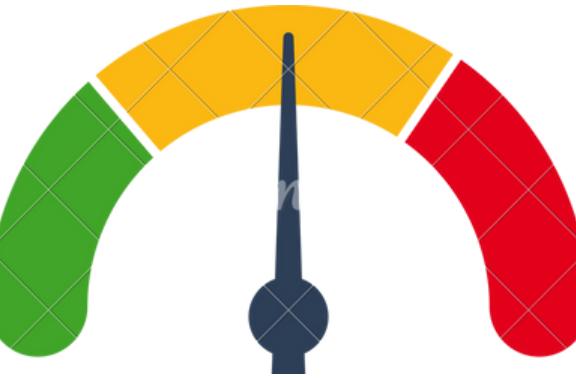


Variance	Urban	Rural
Color	Spread out	Narrower spread
Star Rating	Well distributed	Well distributed
	Even split	Even split

Beds subsets



Low Beds
> 50

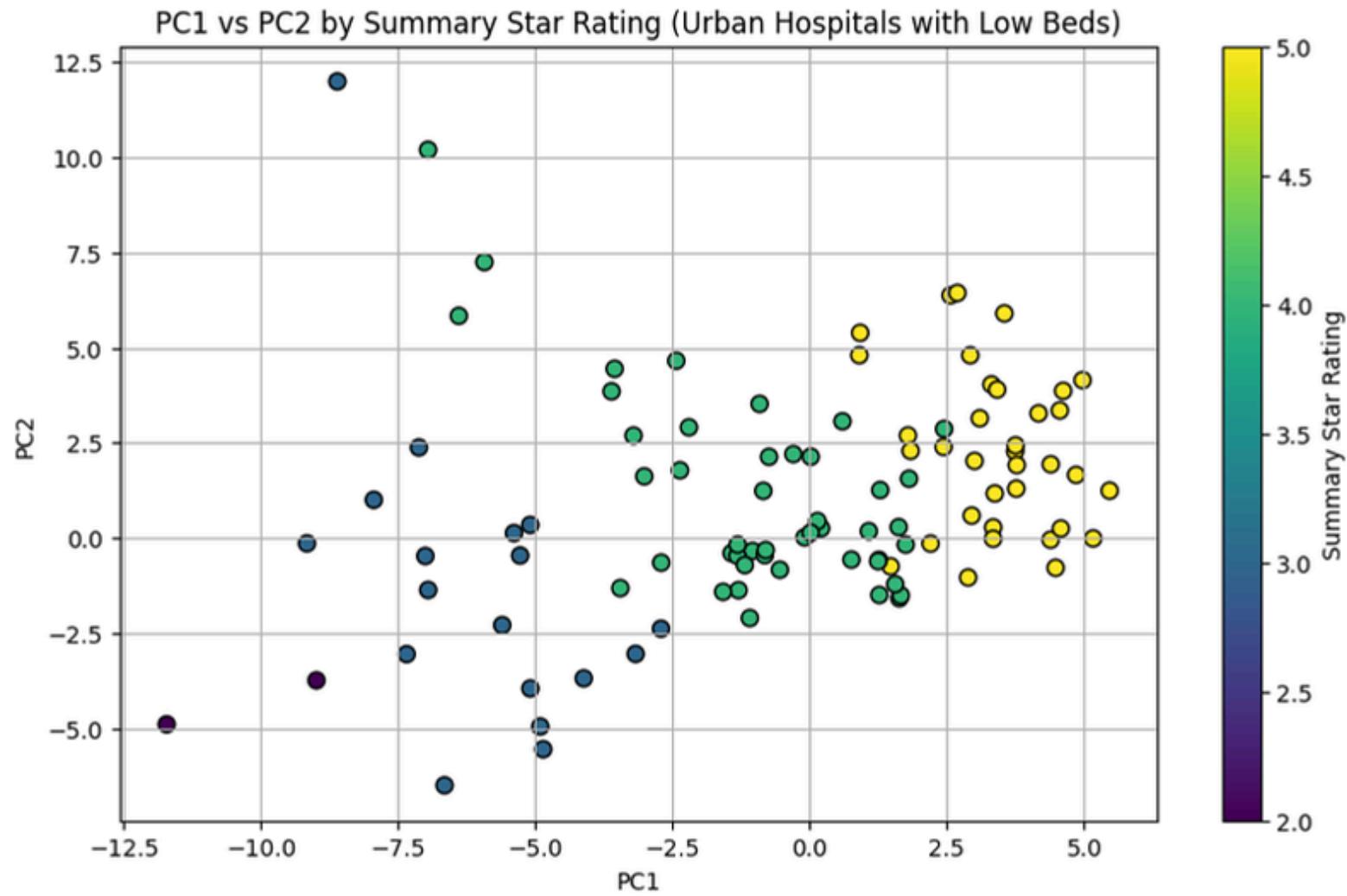


Medium Beds
50 - 200



High Beds
200 >

Urban

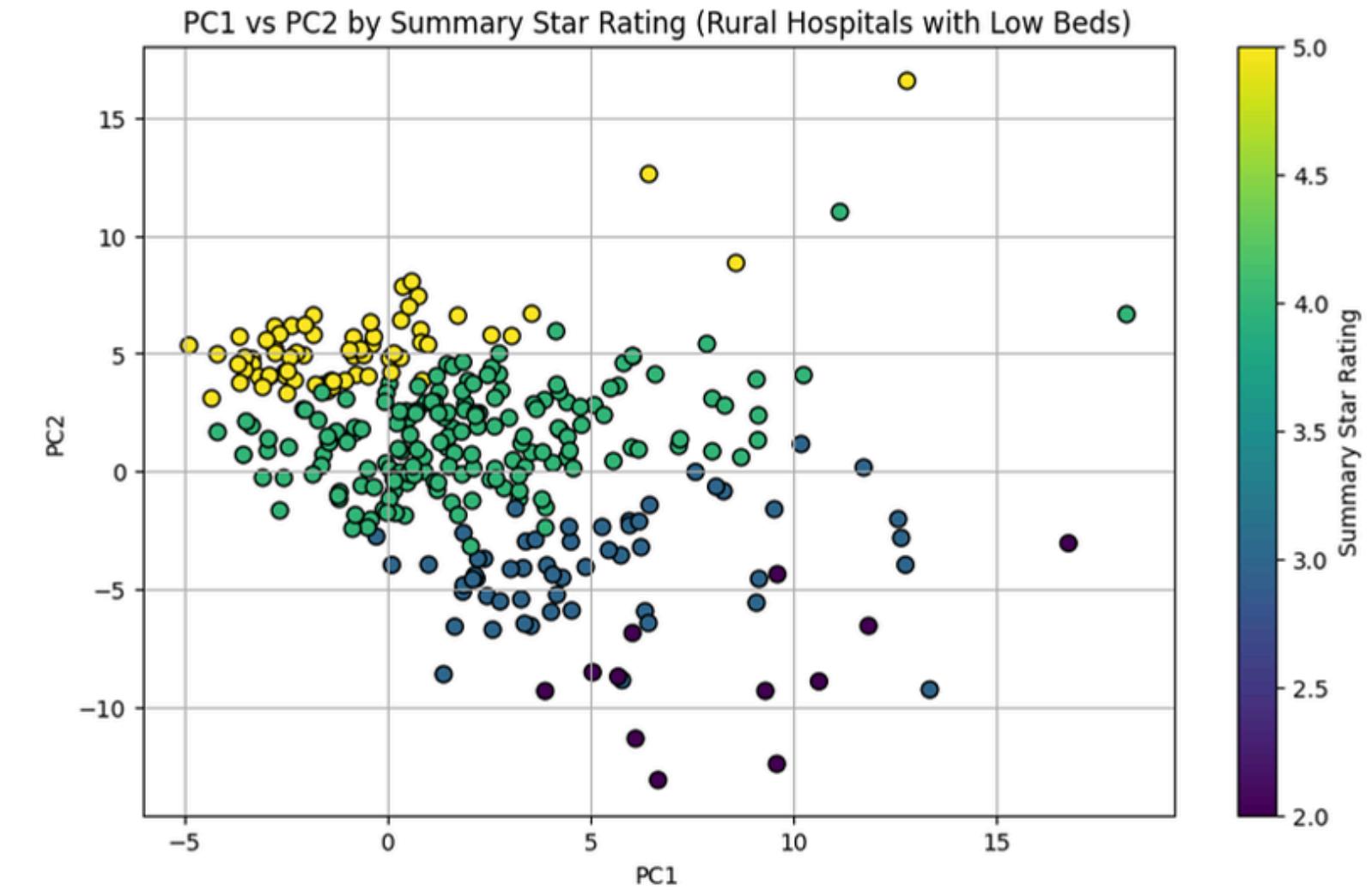


Star Rating Profit

Two large blue arrows pointing upwards, one above 'Star Rating' and one above 'Profit', indicating a positive relationship between these variables in the PCA space.

Low Beds

Rural

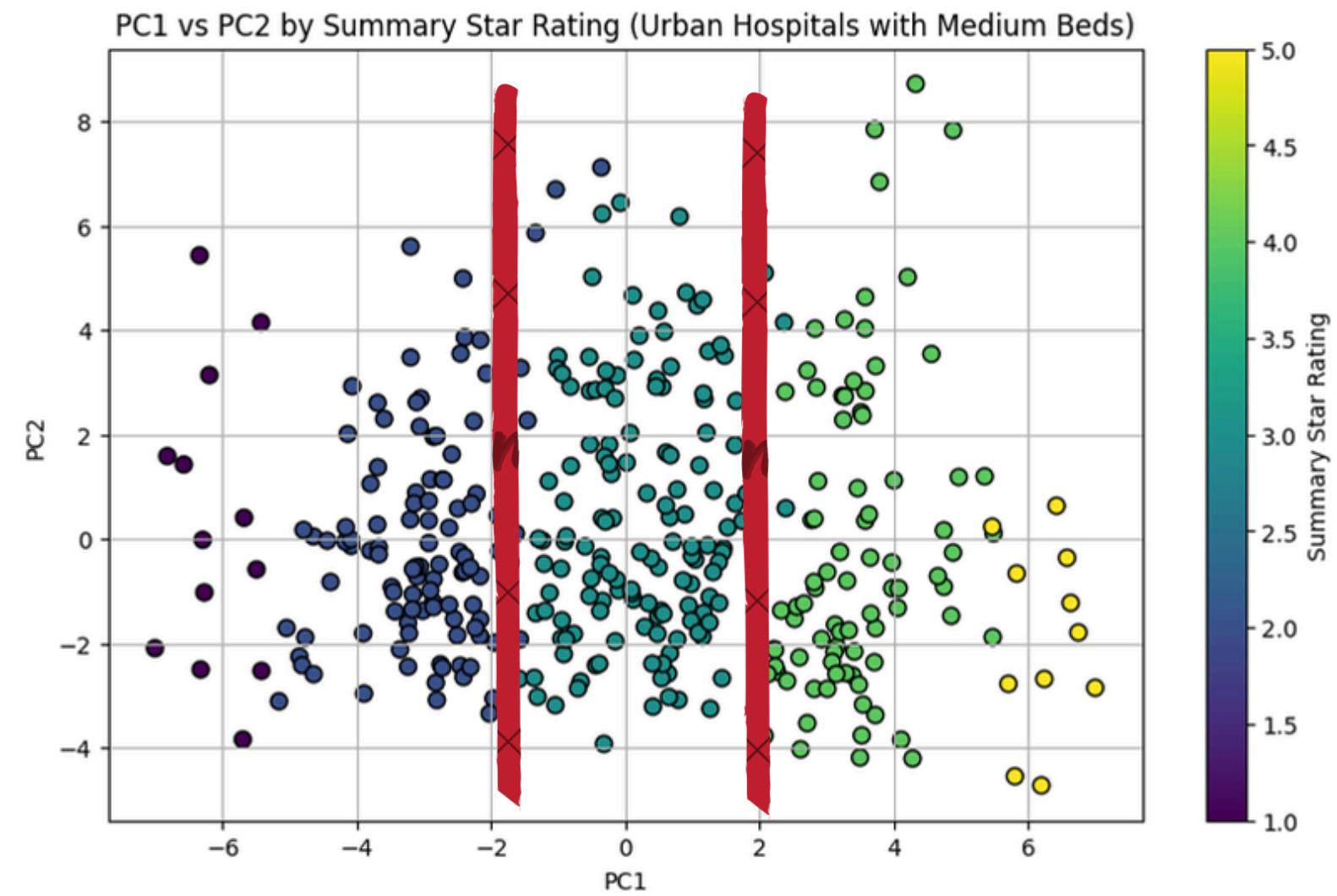


Star Rating Profit

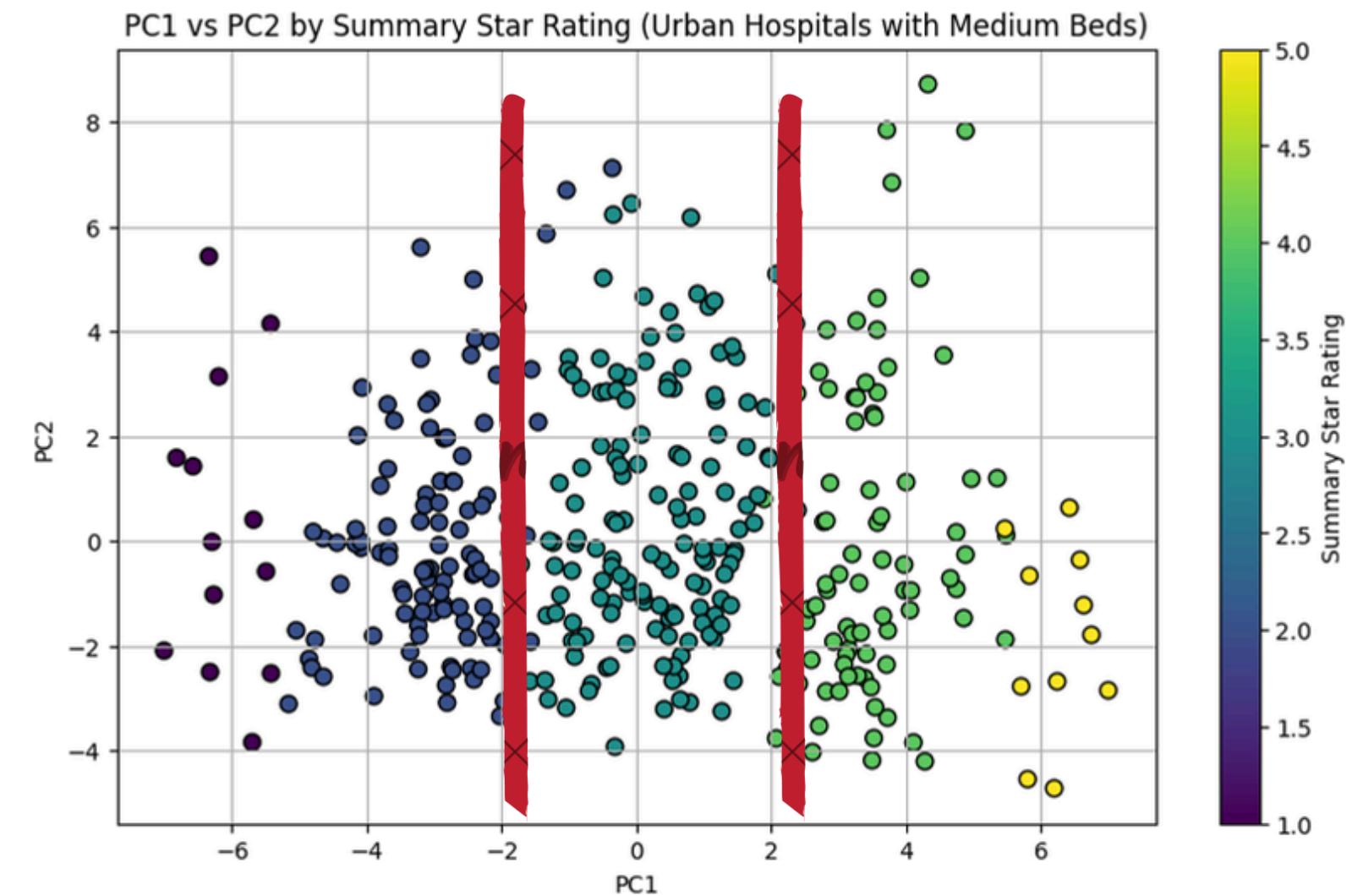
One large blue arrow pointing upwards above 'Star Rating' and one large blue arrow pointing downwards above 'Profit', indicating a mixed relationship between these variables in the PCA space.

Medium Beds

Urban



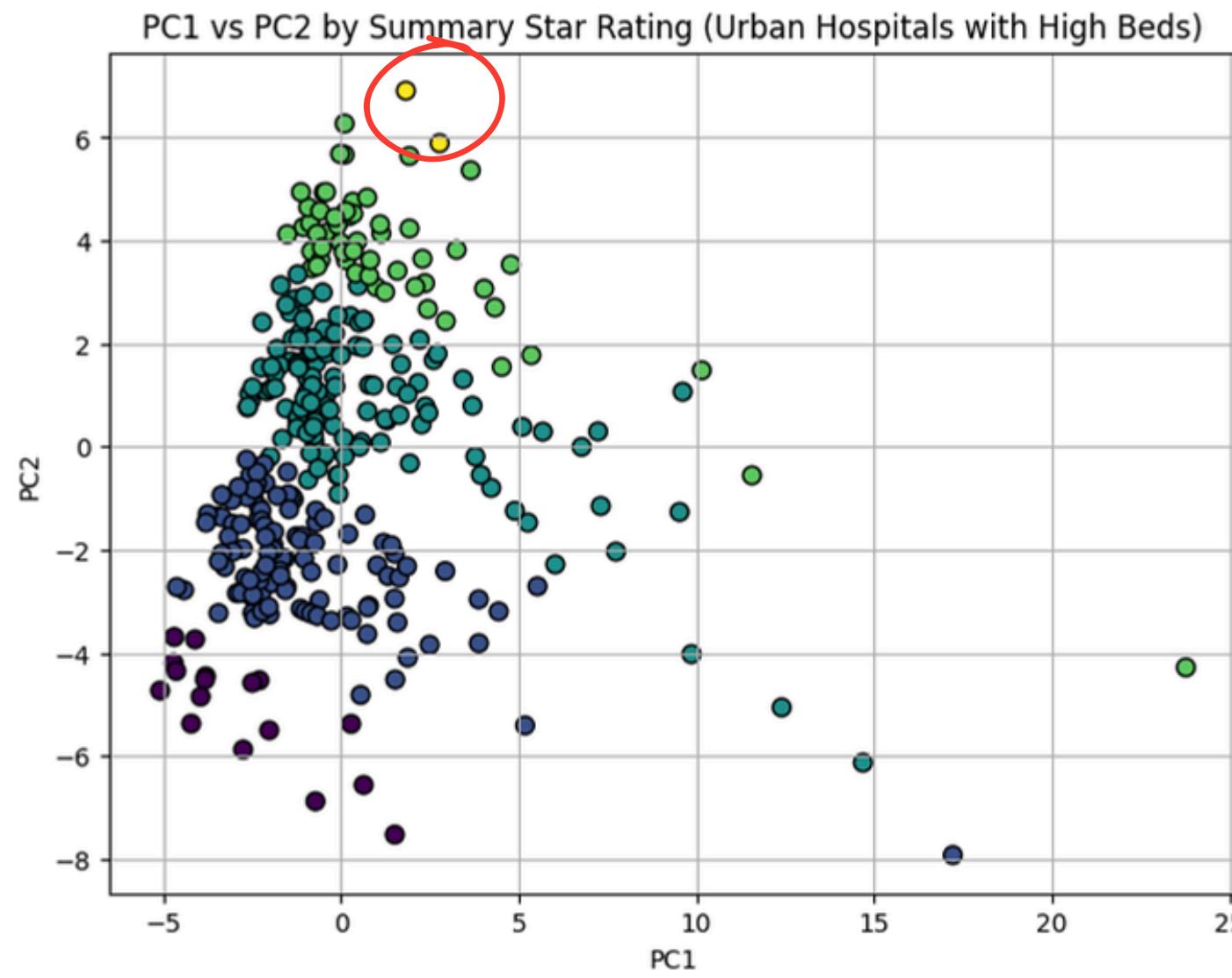
Rural



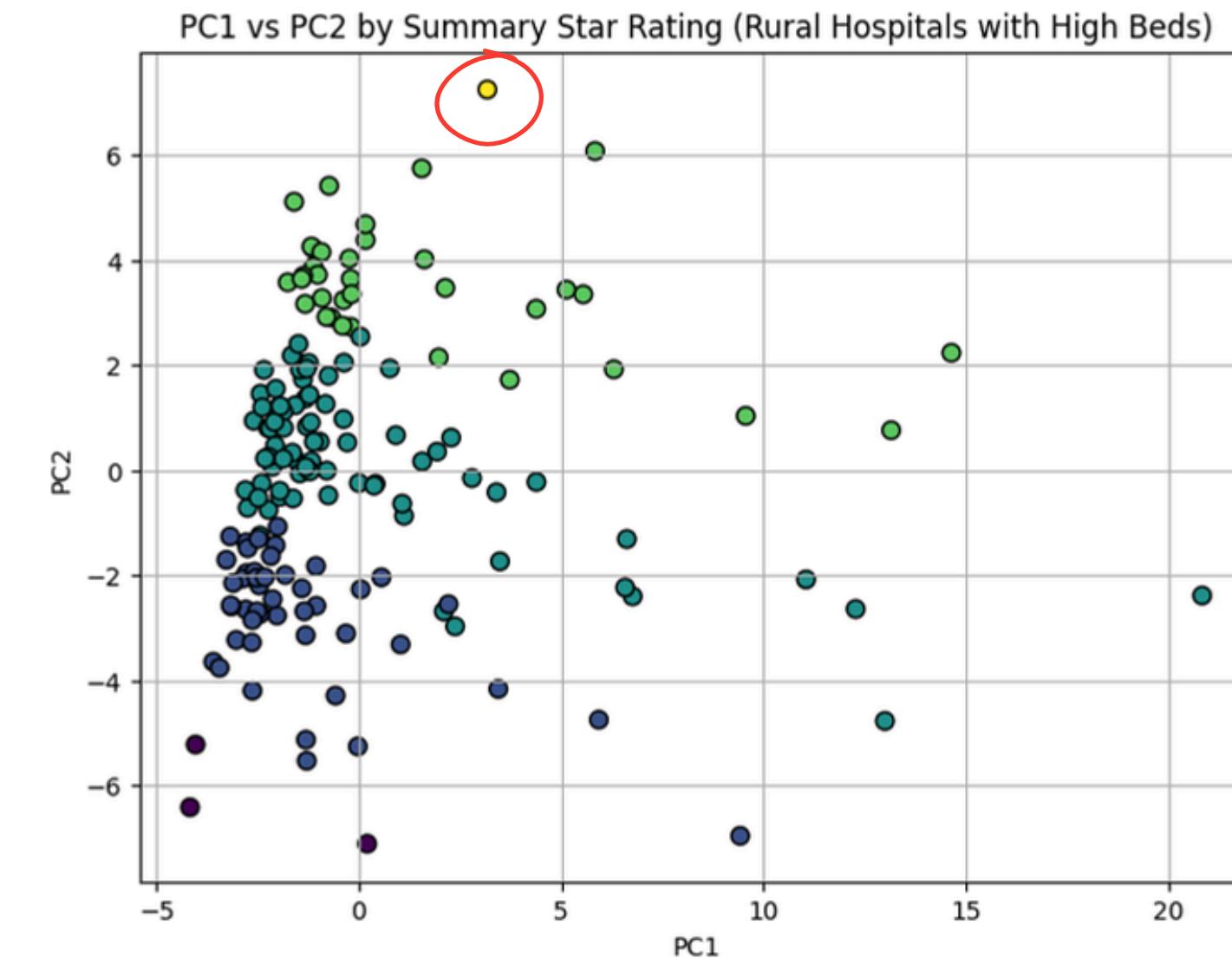
Urban

High Beds

Rural



Star Rating Profit



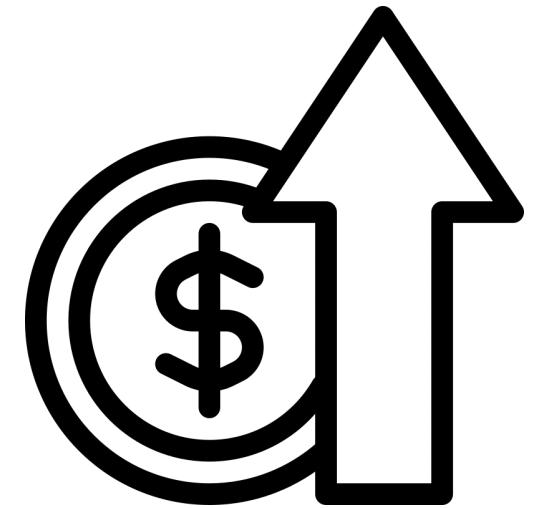
Star Rating Profit

Summary of beds analysis

	Urban	Rural
Low beds	  Star rating High profit	  Star Rating Profit
Medium beds	No Correlation	No Correlation
High beds	  Star Rating Profit	  Star Rating Profit

Key Take away

Star rating had a significant affect on the data



Urban hospitals had a bigger profit margins

Star rating decreased as the number of beds increased



Questions?

Predictive Analysis

Profit

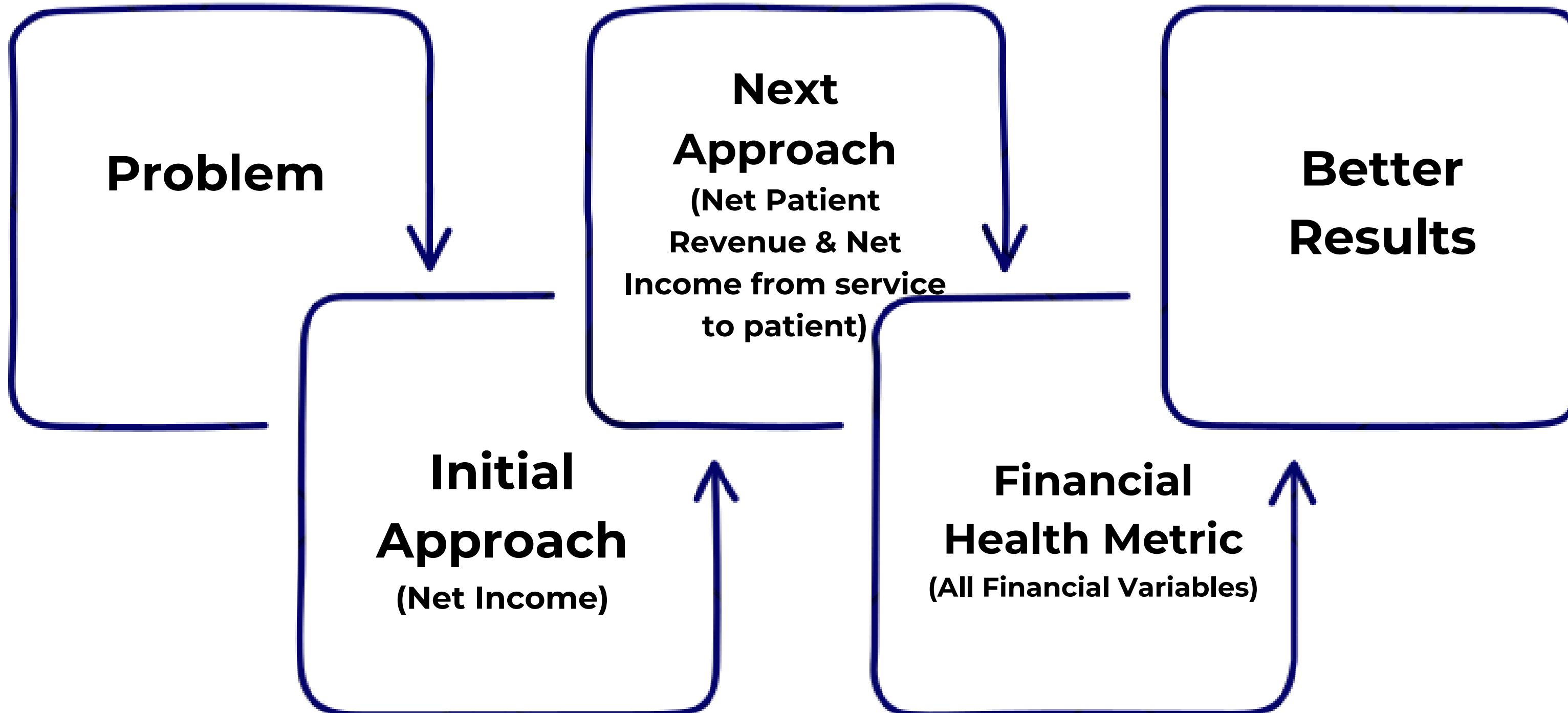
Does Star Rating Impact PROFIT?

Hypothesis: An Increase in star rating scores in Healthcare Institutions does not lead to increased profitability.

Alternative Hypothesis: An Increase in star rating scores in Healthcare Institutions leads to increased profitability.



Improving Predictive Analysis: Overcoming Multicollinearity



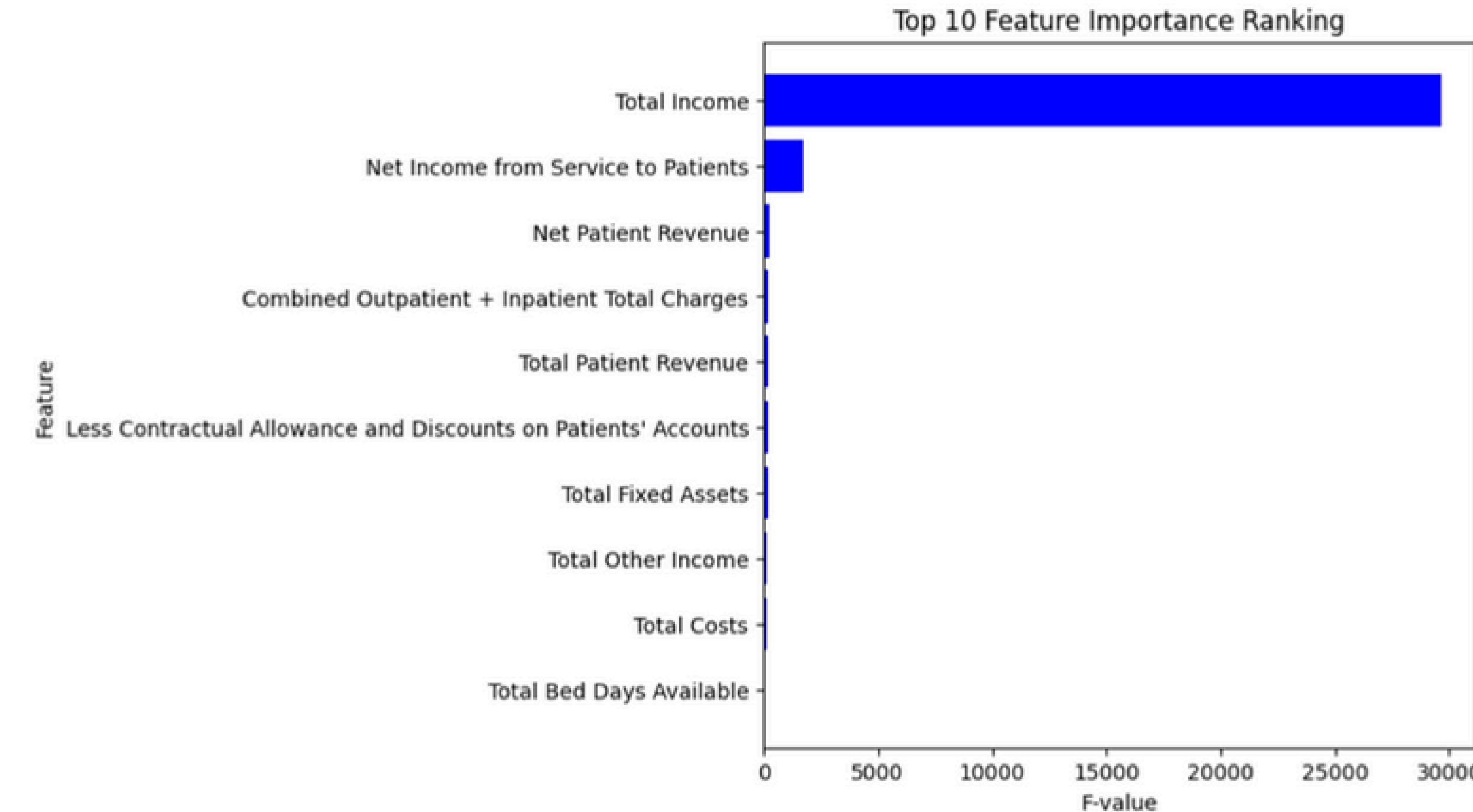
Best model is defined as a model with a high R² and a low Mean of Residuals.

Model 1 - Net Income

KBest

R2:
93.86%

MR:
-171,097



*Random Forest Model

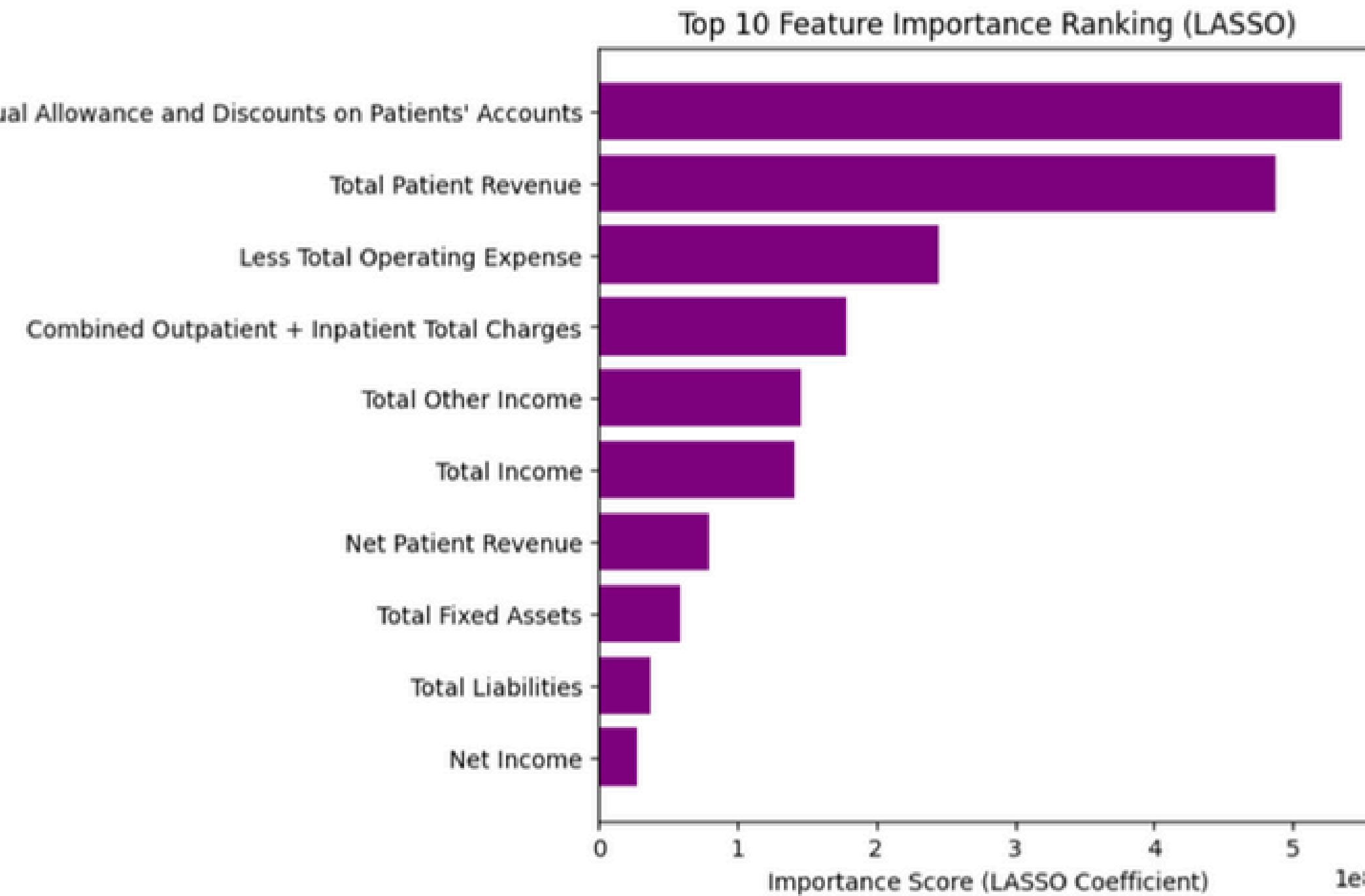
Model 2 - Net Income - Service to Patients

Lasso

R2: 86%

MR:
1,407,004

Feature



*Linear Regression Model

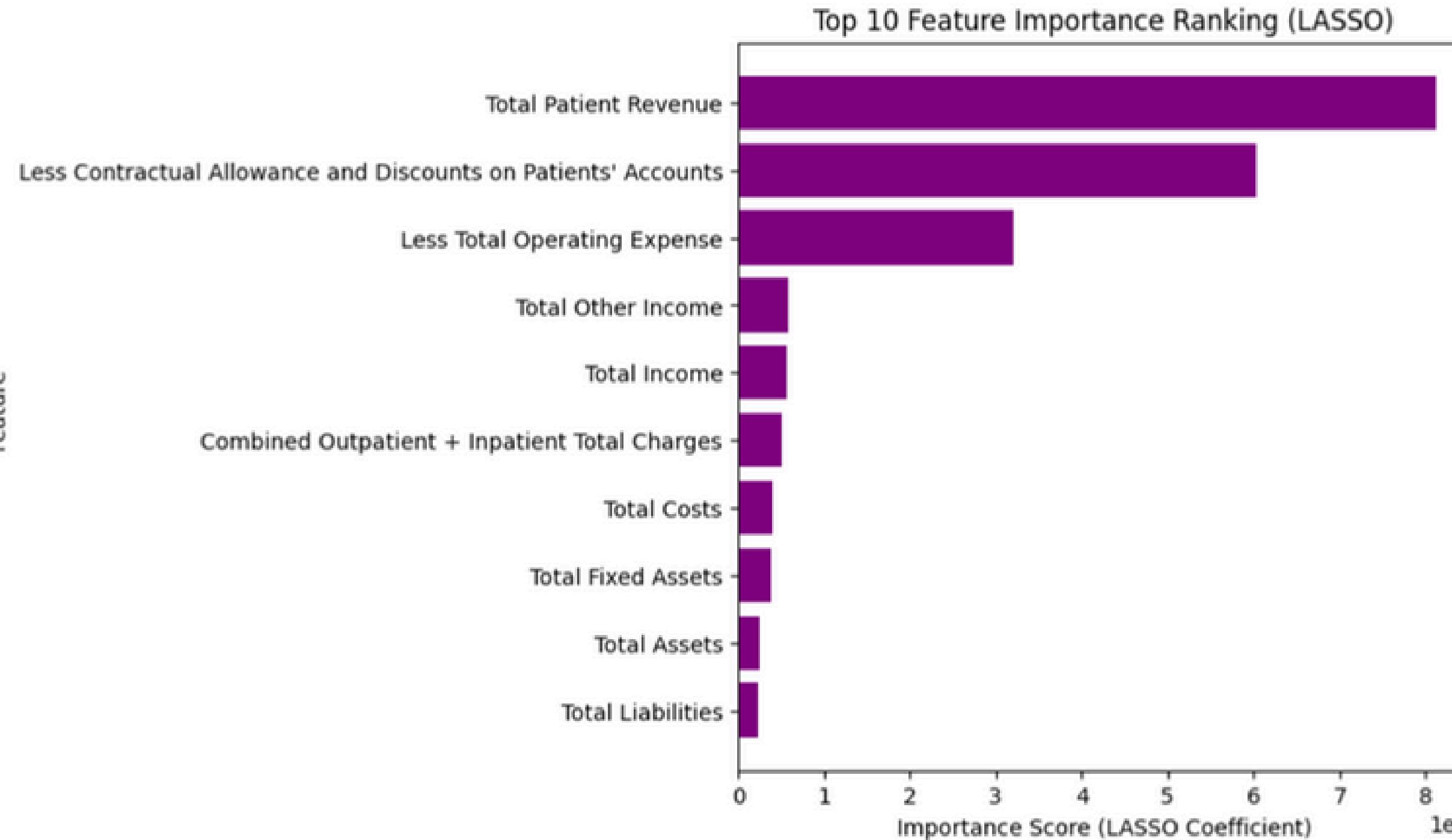
Model 3 – Net Patient Revenue

Lasso

R2:
99.73%

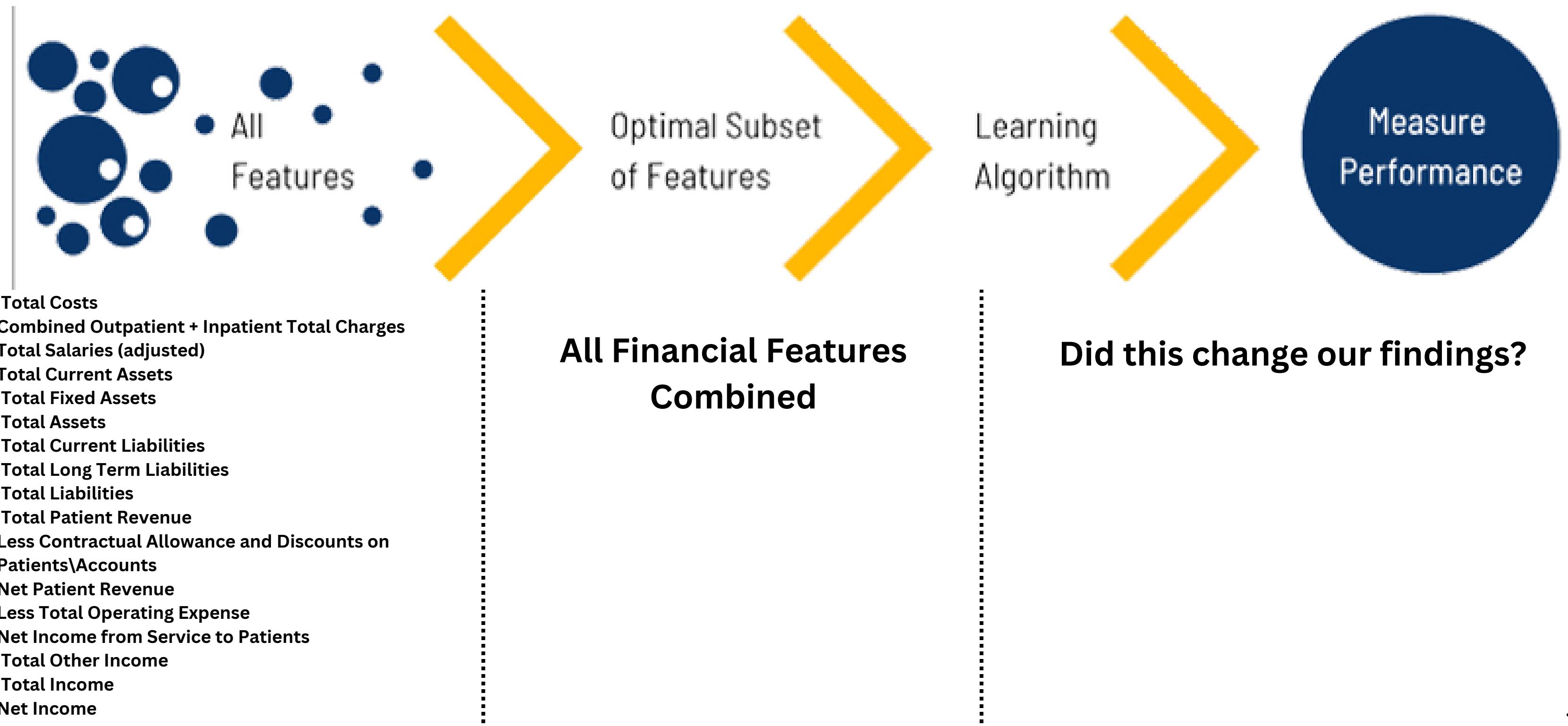
MR:
-555,390

Feature



*Linear Regression Model

Creating the Holistic Financial Health

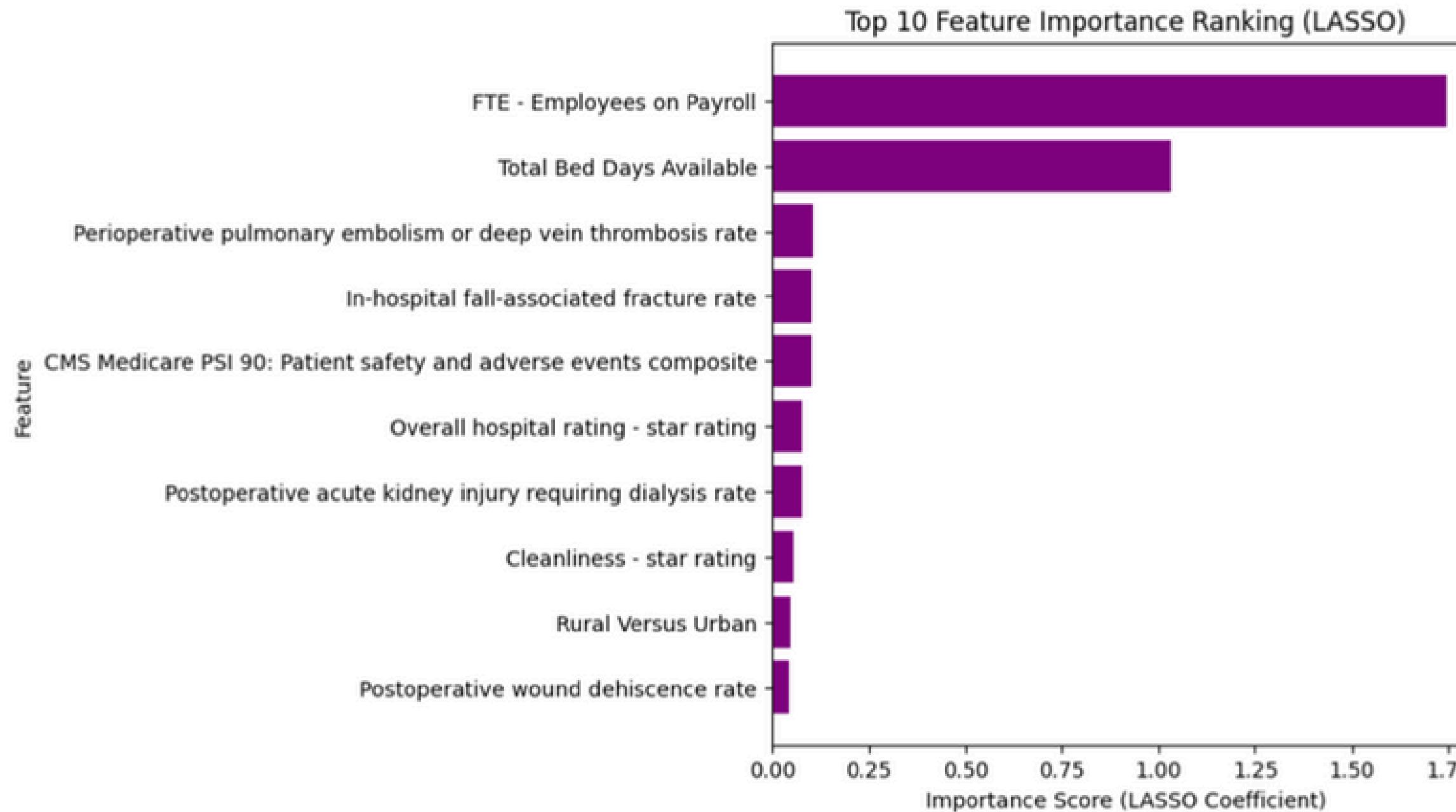


Model 4 – Overall Financial Health

Lasso

R2:
82.33%

MR: 0.13



*Gradient Boosting Regression Model

Features that Impact Financial Health

'Postoperative wound dehiscence rate'

'Quietness - star rating'

Overall hospital rating - star rating'

'Postoperative acute kidney injury requiring dialysis rate'

'Cleanliness - star rating'

'Preoperative pulmonary embolism or deep vein thrombosis rate'

'In-hospital fall-associated fracture rate'

'FTE - Employees on Payroll'

'Total Bed Days Available'

'CMS Medicare PSI 90: Patient safety and adverse events composite'

'Rural Versus Urban'



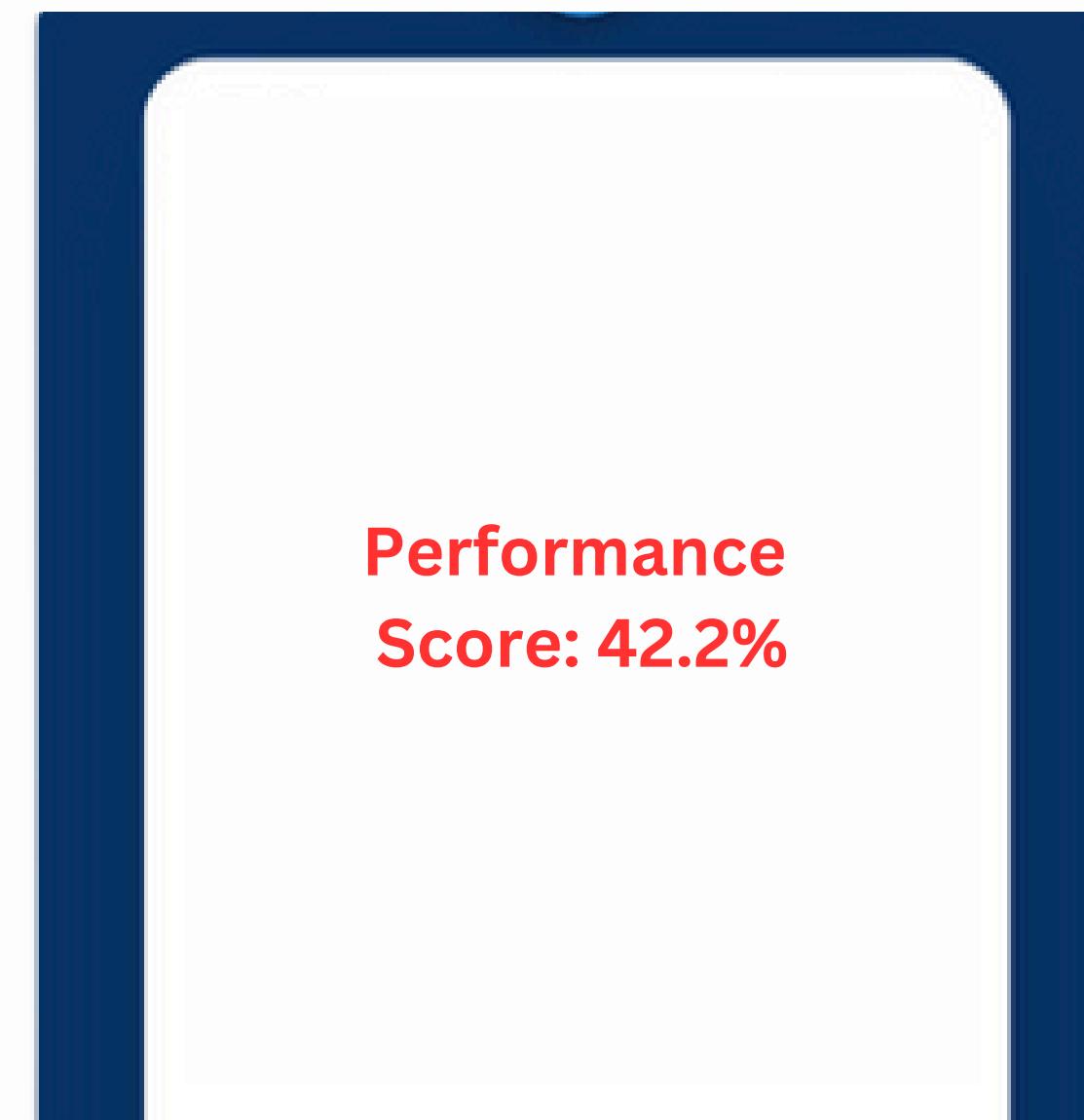
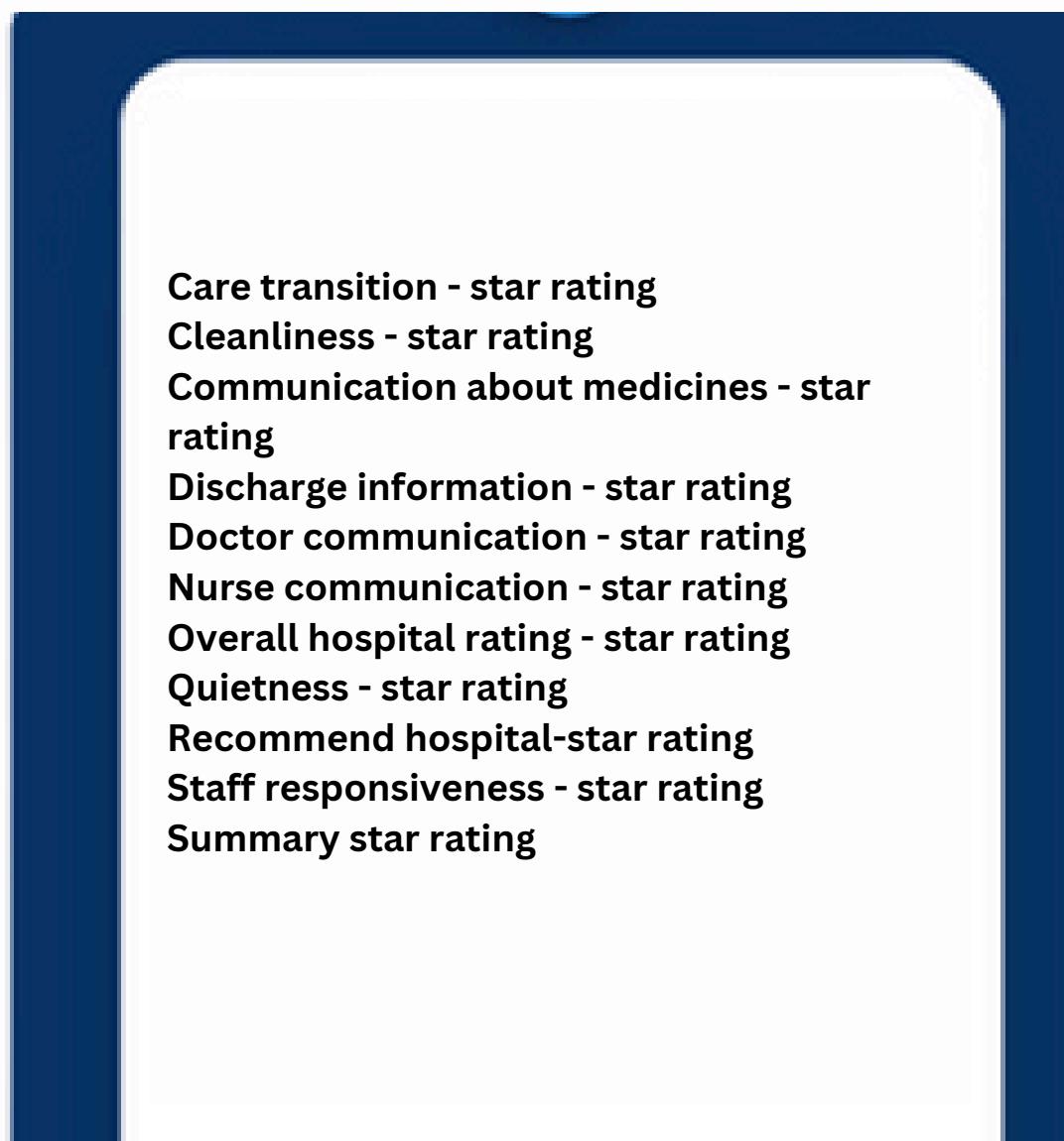
**Impact on
Financial Health**

Questions?

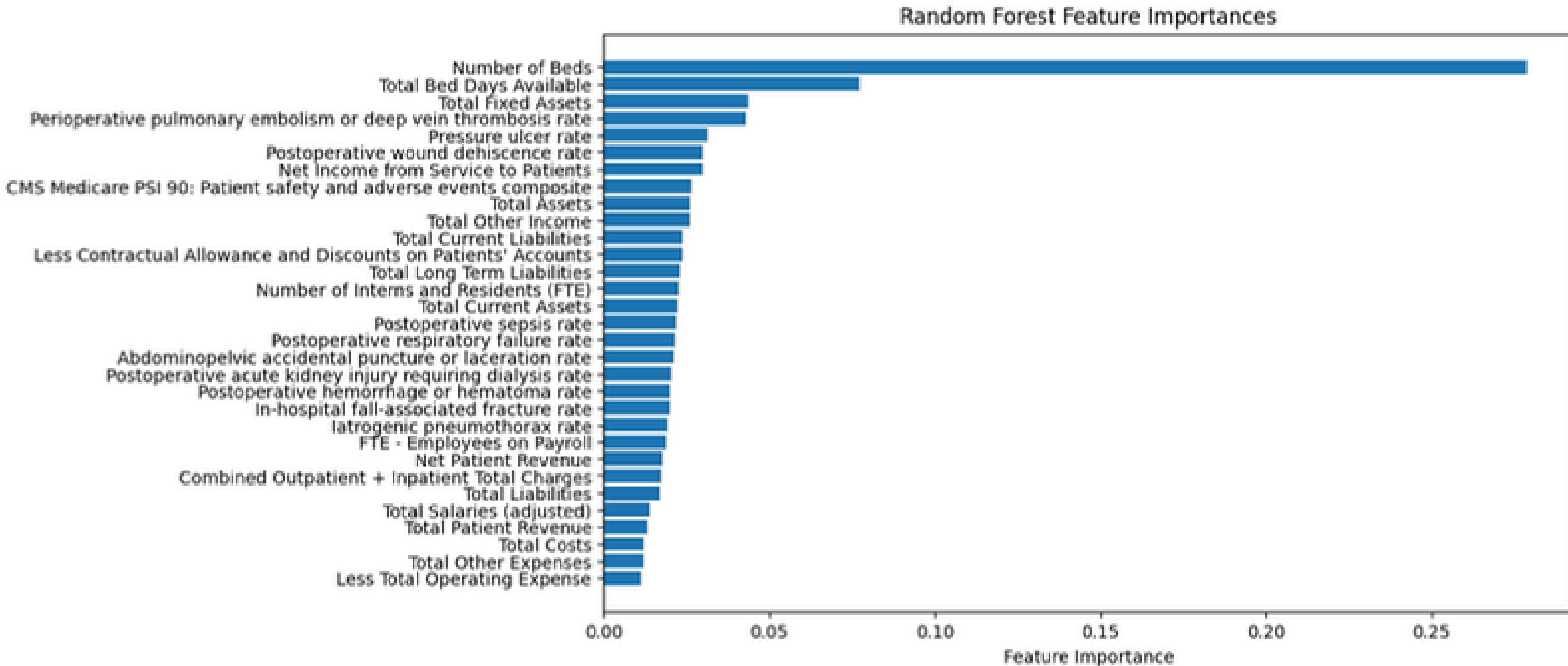
Predictive Analysis

Star Ratings

Creating the Holistic Star Rating



Features Impacting Star Rating



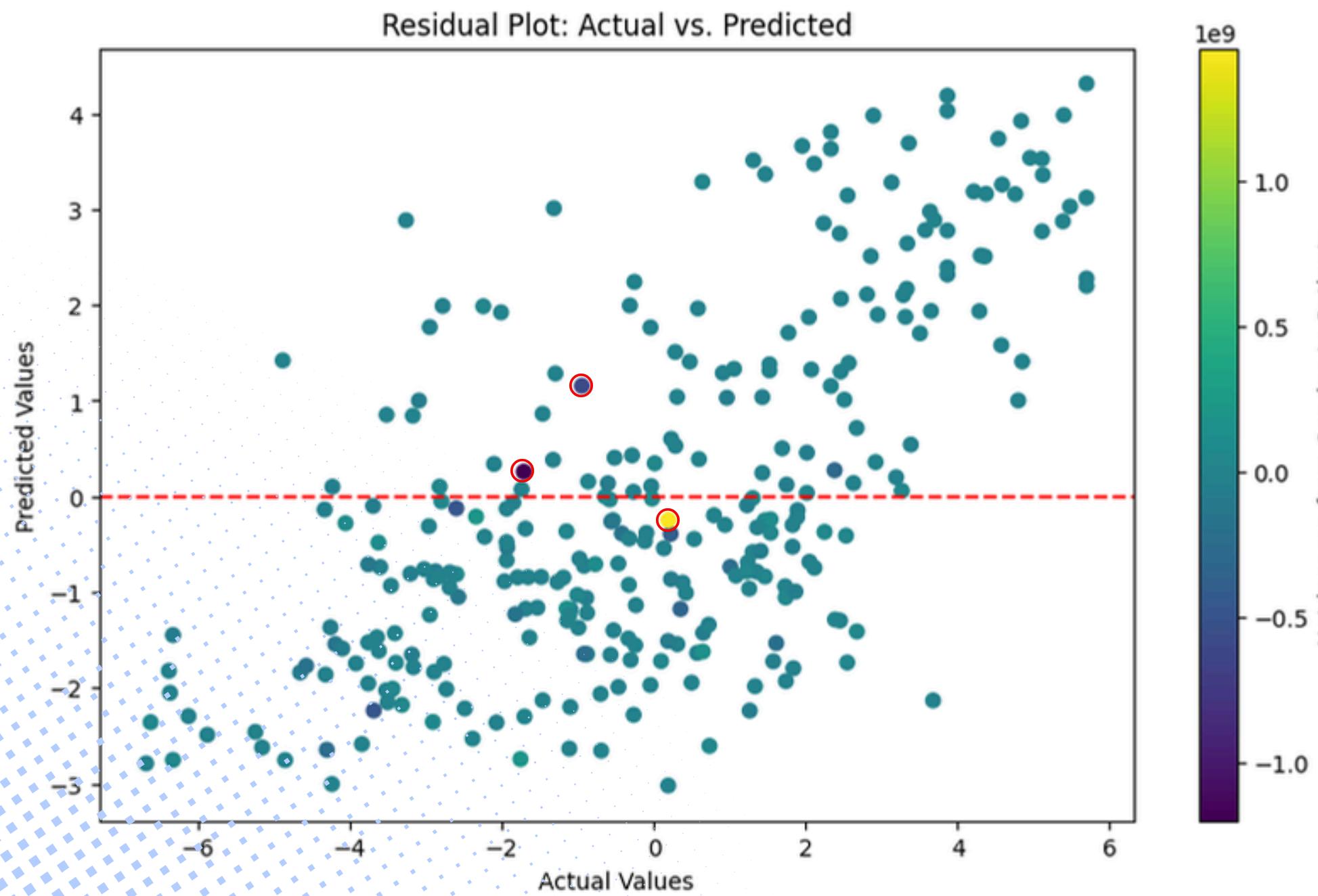
Features that impact Star Rating

- Number of Beds
- Bed Days available
- Total Fixed Assets
- Net Income from Service to Patients
- Pressure ulcer rate
- Perioperative pulmonary embolism or deep vein thrombosis rate
- CMS Medicare PSI 90: Patient safety and adverse events
- Postoperative wound dehiscence rate



Impact on Star Ratings

Ratings broken down by Net Income



The scatter plot shows a linear relationship between the number of beds and Star Ratings.

This proves that there is no causation between Star Ratings and Income metrics.

Other Model Performance

Decision Tree

Performance: -0.04
MSE: 8.3 pts

Gradient Boosting

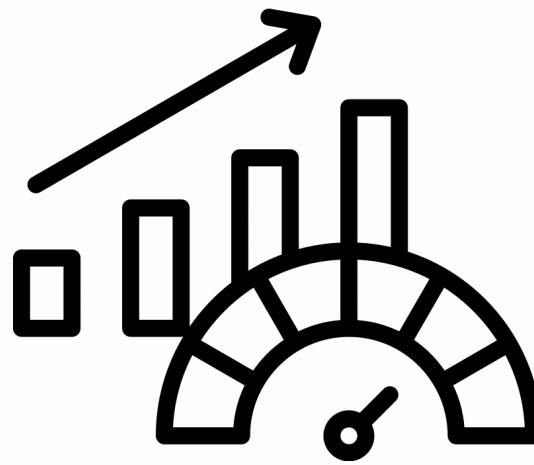
Performance: 41%
MSE: 4.8 pts

Questions?

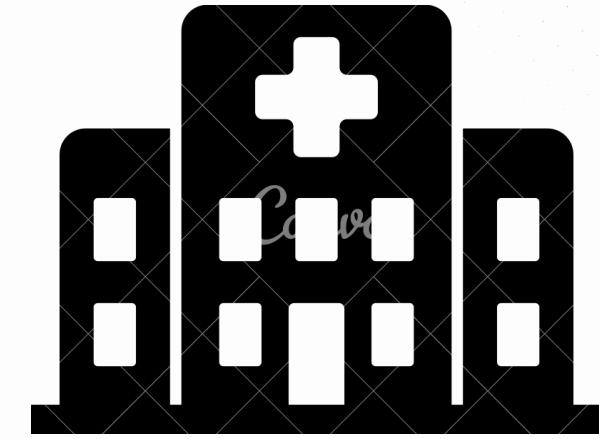
Key Takeaways



Models favor capacity-based metrics (beds, available days) over income metrics.



The model shows a lot of performance overlap with Star Ratings



Size of Hospitals and some Post-Op facilities impact Star Ratings