

CMS Star Rating and Provider Analysis

Problem Statement

- CMS rates providers on a scale of 1 to 5. The objectives of the analysis are to:
Understand the star rating methodology and identify the important variables affecting star ratings
Recommend ways for Evanston Hospital to improve their current star rating of 3/5.
- The analysis is divided into four parts:
Data Understanding – Groups and Measures
Identifying important measures affecting star ratings
Predictive modelling of star ratings
Provider analysis: Recommending ways for Evanston Hospital to improve their rating

- **Data Understanding – Groups and Measures**
- Identifying important measures affecting star ratings
- Predictive modelling of star ratings

Data Understanding – 7 Groups, 62 Measures

CMS included 62 measures (or variables) classified under 7 groups having a certain weightage as follows:

Groups

- Mortality, Readmission, Safety of Care, Patient Experience (22% weightage groups)
- Timeliness of care, Effectiveness of care, Medical Imaging Efficiency (4% weightage groups)

Measures (some examples)

- Positive measures: Patients given appropriate vaccines, Patients given timely treatment etc.
- Negative measures: All mortality measures, readmission measures, timeliness measures (avg.time taken to provide emergency care etc.)

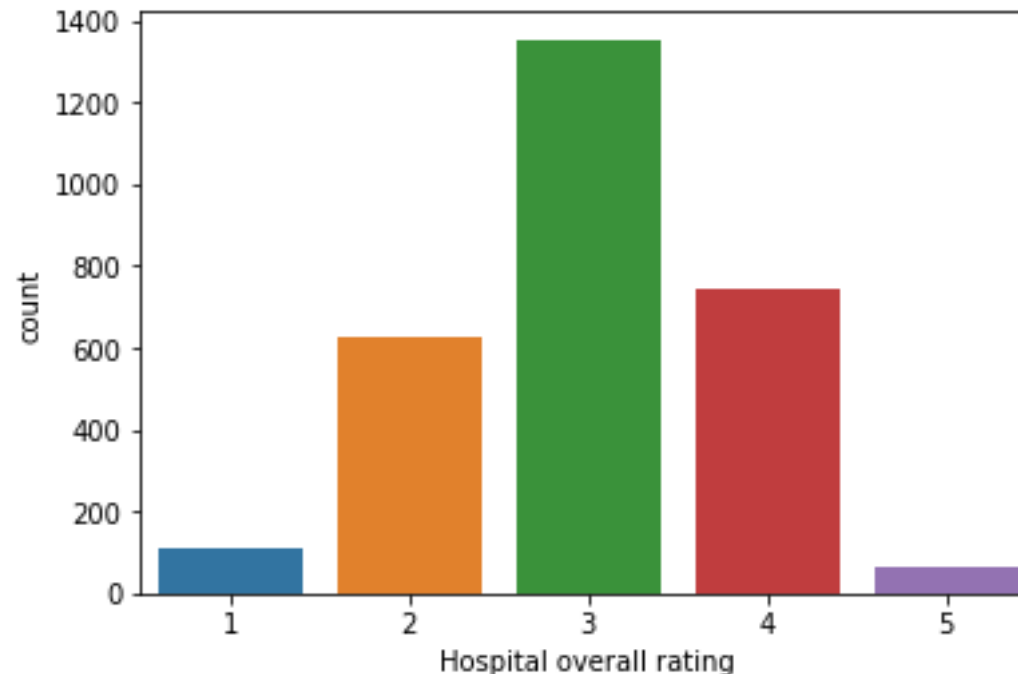
Data Understanding – Quality Issues: Format, Standardization and Missing Values

The three main data quality issues in the raw data provided by hospital compare are:

- **Data format**
 - The original data is in 'wide-format' in approx. 55 files which was converted into one 'long' master file such that each row represents a provider and each column a measure
 - Each cell is a numeric score of a measure
- **Standardisation of Measures**
 - Measures need to be standardised such that 'higher value indicates better performance'
- **Missing values**
 - About 50% measures have a large number of missing values – they have been imputed as per the guidelines provided by CMS

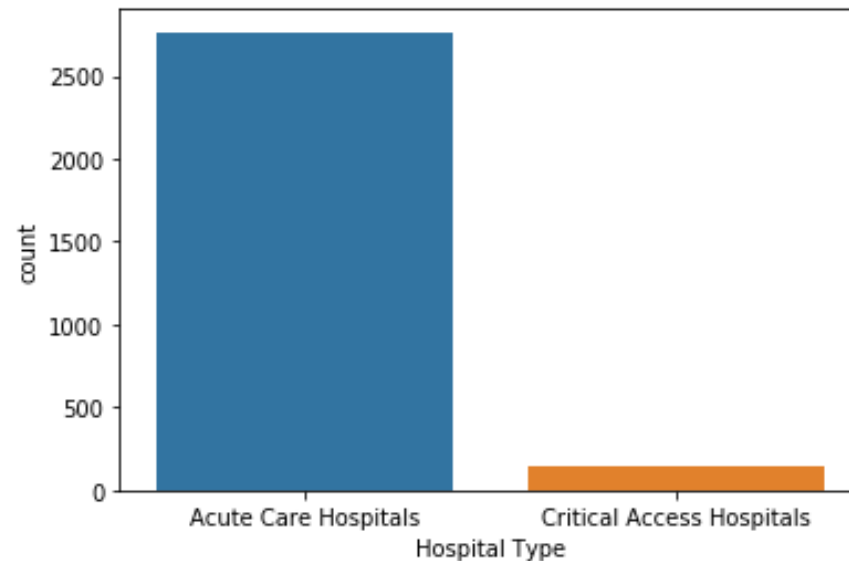
Data Understanding – Distribution of Star Ratings

- Approx. 42% providers have 3 star rating
- Approx. 20% have 2 and 4 each; 3.5% have 1 and 5 each



Data Understanding – Type of Hospital

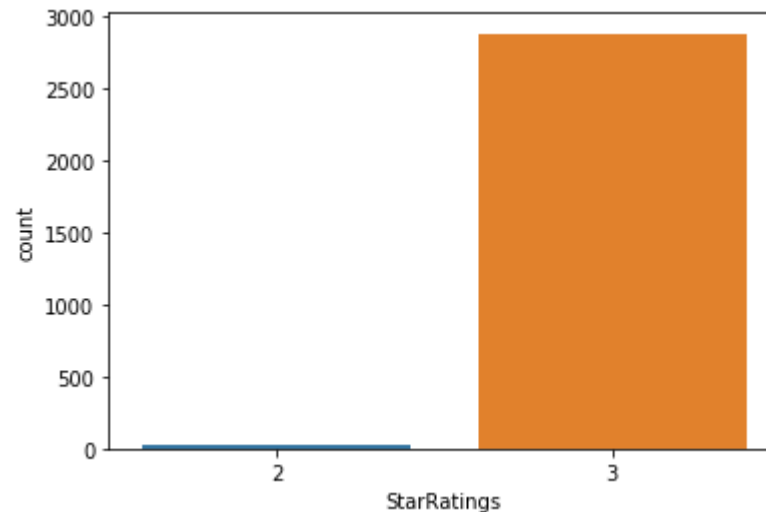
- Approx. 95 % providers are Acute Care
- Approx. 5% are Critical Access



- Data Understanding – Groups and Measures
- **Identifying important measures affecting star ratings**
- Predictive modelling of star ratings

Assigning Weights to Measures

- We have assigned average weighted score to each of the groups.
- We have then assigned the Star Rating Based on the Weighted Score of Each Group.
- Most of the Star Rating is 3 Star



- Data Understanding – Groups and Measures
- Identifying important measures affecting star ratings
- **Predictive modelling of star ratings**

Model Selection

- The types of supervised models we will choose for predicting the star ratings (1-5, five-class classification) :
 1. Decision tree (DT)
 2. K-nearest neighbour (KNN)
 3. Logistic regression (LR)

Model Selection - Decision tree (DT)

- A decision tree models the decision logics i.e., tests and corresponds outcomes for classifying data items into a tree-like structure.

Advantage :

- Resultant classification tree is easier to understand and interpret.
- Data preparation is easier.
- Multiple data types such as numeric, nominal, categorical are supported.
- Can generate robust classifiers and can be validated using statistical tests.

Disadvantage :

- Require classes to be mutually exclusive.
- Algorithm cannot branch if any attribute or variable value for a non-leaf node is missing.
- Algorithm depends on the order of the attributes or variables.
- Do not perform as well as some other classifier (e.g., Artificial Neural Network)

Model Selection - K-nearest neighbour (KNN)

- The K-nearest neighbour (KNN) algorithm is one of the simplest and earliest classification algorithms. It can be thought a simpler version of an NB classifier. Unlike the NB technique, the KNN algorithm does not require to consider probability values.

- Advantage :

- Simple algorithm and can classify instances quickly.
- Can handle noisy instances or instances with missing attribute values.
- Can be used for classification and regression.

- Disadvantage :

- Computationally expensive as the number of attributes increases.
- Attributes are given equal importance, which can lead to poor classification performance.
- Provide no information on which attributes are most effective in making a good classification.

Model Selection - Logistic regression (LR)

- Logistic regression (LR) is a powerful and well-established method for supervised classification. It can be considered as an extension of ordinary regression and can model only a dichotomous variable which usually represents the occurrence or non-occurrence of an event.

- Advantage :

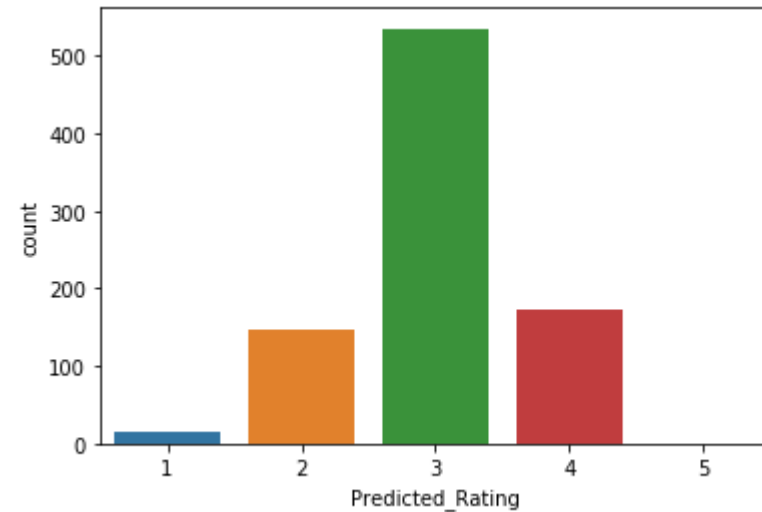
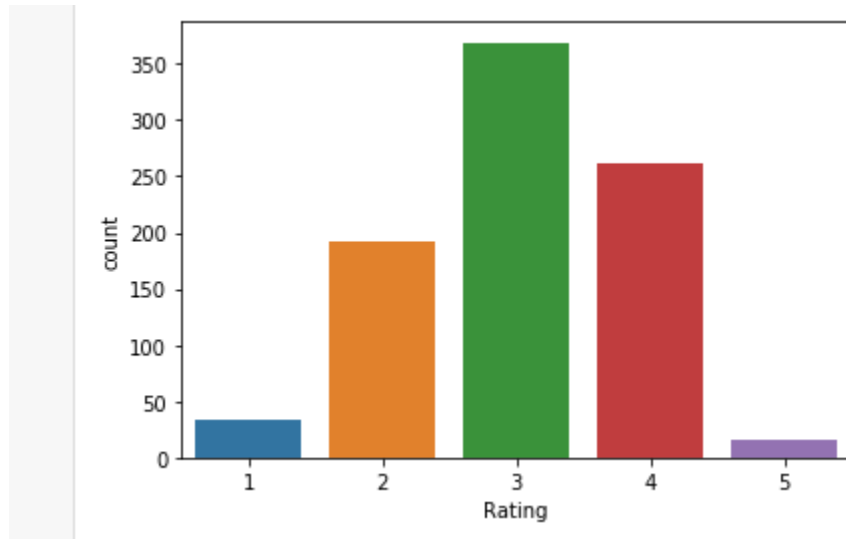
- Easy to implement and straightforward.
- LR-based models can be updated easily.
- Does not make any assumptions regarding the distribution of independent variable (s).
- It has a nice probabilistic interpretation of model parameters.

- Disadvantage :

- Does not have good accuracy when input variables have complex relationships.
- Does not consider the linear relationship between variables.
- Key components of LR - logic models, are vulnerable to overconfidence.
- May overstate the prediction accuracy due to sampling bias.

Predicting Star Ratings – Overall Accuracy of approx. 64% with Random Forest

- Random Forest predicts star ratings with an overall accuracy of approx. 64 %.



Recommendations for EVANSTON HOSPITAL

The key measures of improvement are:

- **Readmission (~20%):** Hospital-wide readmissions, readmission due to heart failure, pneumonia, heart attack, COPD, and hip-knee surgery
- **Patient Experience (~6%):** Hospitality (recommendations, patient-friendliness) and cleanliness
- **Safety (~4%) :** SSI and MRSA