Fire Department Response Time Predictive Analysis

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Abstract

In emergency response, every second counts. This project aims to create a robust model able to predict the response times of fire departments in the Louisville Metro and surrounding areas using a dataset from Louisville Metro Open Data. The analysis uses decision tree regression to obtain a model with a relatively low root mean squared error. The results can be used to assess potential patterns and allow decision makers to re-evaluate how to approach emergency management. To combat potential overfitting or statistical issues, other models will be used in further analysis.

Introduction

In emergency response, each second carries significance. This project aims to better predict the response times of fire departments in the Louisville Metro and surrounding areas. Using predictive analysis, the model forecasts the estimated response times of agencies based on given variables. By better understanding what and how variables affect the response time we can make emergency management more efficient and in turn, increase safety and welfare in our community.

Objective

Develop a Robust Model:

Create a model that accurately predicts response time of agencies

Analyze Agency-Specific Response Dynamics:

Compare response times between agencies to assess potential variations and patterns. This allows us to understand how organizational factors influence response times.

Establish Benchmark Standards and Improvement Targets:

Utilizing insights from the model to set benchmarks time standards for various incidents. This highlights areas where improvement and intervention need to be established.

Enhance Emergency Management Decision-Making:

By better accessing response times we can make decisions to improve resource allocation, zoning, and operational planning, overall improving the safety and effectiveness of the community and its emergency response teams.

Materials and Methods

- Gathered Data using Louisville Metro Open Data.
- Cleaned data using Python to use in the model including the reorder of the priority column.
- Used Decision Tree Regression to formulate initial model for Response Time (seconds).

Results

The results show a mean squared error (mean difference between predicted and actual times) of around 8 seconds. Initially, there were issues with the way the priority column was ordered however, after fixing the problem has been resolved. There is a potential for overfitting in the model with such a low rmse.

```
XPR = Priority_re.loc[:, ~Priority_re.columns.isin
                  (['Response_time', 'ARRIVE', 'DISPATCH', 'DATE'])]
yPR = Priority_re['Response_Time']
XPR_train,XPR_test,yPR_train,yPR_test=train_test_split(XPR,yPR,test_size=.2, random_state=0)
```

```
regressor=DecisionTreeRegressor(random_state=0)
regressor.fit(XPR_train,yPR_train)
yPR_pred=regressor.predict(XPR_test)
rms=sqrt(msc(yPR_test,yPR_pred))
print('The mean squared error of the Priority_re is',rms)
```

```
The mean squared error of the Priority_re is 7.789996718252472
```

Conclusions/Future Works

The decision tree regressor fits the model extremely well. In the future, I plan on using random forest and XGBoost models to try and enhance the reliability of the model. I also plan on including zip codes and regions to the variable list to better predict the response time. This way of predicting response times can be expanded and modified to create similar metrics for other emergency responders including police and ambulances. With this newfound knowledge would give emergency telecommunicators a way to give those in need an accurate estimation of wait times before responders are on site.

References

- Louisville Metro Open Data
- Python and Libraries
- Microsoft Excel
- Github
- ChatGPT/stackoverflow

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