Government Contracts in the Pandemic Era :A Comprehensive Impact Analysis Using Predictive Analytics

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informs BUSINESS ANALYTICS CONFERENCE

User Interface

ABSTRACT

In times of crisis such as the COVID-19 pandemic, effective allocation of resources becomes paramount for governments worldwide. Particularly, the procurement of goods and services through government contracts plays a pivotal role in disaster management efforts. This capstone project, conducted at the University of Illinois Chicago, focuses on exploring government spending trends and predicting winning business types for government contracts amidst the COVID-19 pandemic. Predictive analytical models like KNN, Random Forest, Decision Tree, XG Boost, Linear Regression & LSTM were used as well as a UI has been developed using Streamlit. By providing valuable insights into government spending patterns and forecasting successful contract duration and contract value, this research aims to significantly aid businesses' decision-making during crisis along with assisting them in gauging successful bids for government contracts, thereby facilitating informed decision-making and resource allocation strategies for effective disaster management.

BUSINESS PROBLEM

Fig 1. SAM.gov: US Government Contract Opportunities Database

The process of procuring government contracts typically involves several stages, including solicitation, proposal submission, evaluation, and award. However, during calamities such as pandemics or natural disasters, this process can be disrupted due to various factors such as budget reallocations, shifts in government priorities, and resource constraints. These disruptions may lead to delays in contract solicitations, cancellations of ongoing procurement processes, or changes in the types of goods and services needed by government agencies. The impact of such disruptions varies across different types of businesses and sectors.

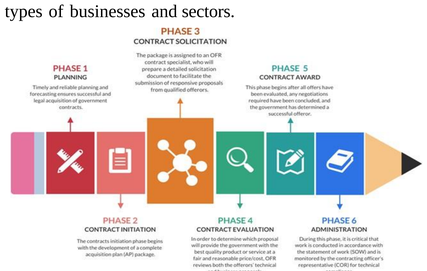

Fig 2. Government Contract Procurement LifeCycle

RESEARCH QUESTIONS

- What factors drive the success of diverse business types (e.g., Women Owned, Small Business) in securing government contracts?
- How effective are machine learning algorithms in predicting winning business type for government contracts, particularly in multiclass classification scenarios?
- How effective are machine learning algorithms in predicting the duration and value of the contract?

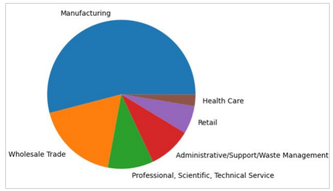

Fig 3. Proportion of Sectors by Contract Value

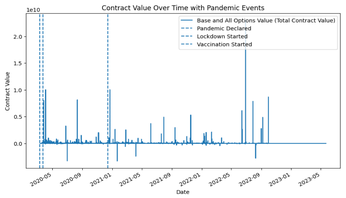

Fig 4. Contract Timeline - Government's reactive funding strategy

ANALYTICAL PROBLEM

Model 1: Predict Business Type Winning the Contract

Using different multiclass classification models like KNN, Random Forest, Decision Tree, we would predict the business type that can win the contract

Model 2: Predict Contract Duration

Using Regression & XG Boost, we would predict the contract duration

Model 3: Predict Contract Value

Using LSTM & Prophet, we would predict the contract value

DATA

The data for this study was sourced from sam.gov, comprising 150,000 government contracts with a total of 174 attributes. In the data cleaning phase, 110 relevant columns were selected, while contracts with negative or zero values were eliminated, along with any entries containing null values. To prepare the data for analysis, all text columns were label encoded, and 'Business Types' with less than 0.5% occurrence were dropped. Furthermore, highly correlated columns were removed to prevent multicollinearity. This rigorous data processing ensures that the dataset is suitably refined, optimized for subsequent analysis and model development, enhancing the accuracy and reliability of the research findings.

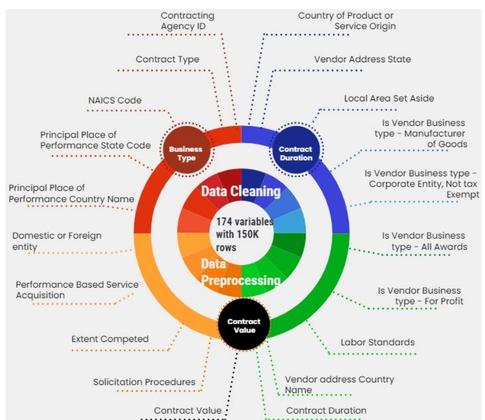

Fig 5. Input Variables

METHODOLOGY

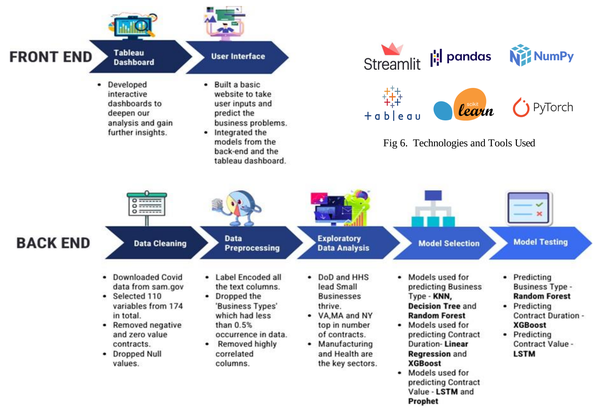

Fig 6. Technologies and Tools Used

*DoD: Department of Defense
*HHS: Health and Human Services

Fig 7. Methodology Diagram

MODEL BUILDING

- For predicting business type utilized: Decision Trees, Random Forest, KNN; with Random Forest leading at 92.5% accuracy, proving highly effective in forecasting the successful business type winning government contract.
- In predicting contract duration, XGBoost model demonstrated superior performance with R^2 value of 0.717, indicating a robust fit, while Linear Regression showing limited predictive power with R^2 of 0.207.
- Employed Long Short-Term Memory (LSTM) networks to accurately predict weekly contract counts and values, leveraging sequence-based analysis of 5 or 8-week periods. Categorizing contracts into three value ranges prior to the analysis was needed to enhance predictive efficacy.

RESULTS

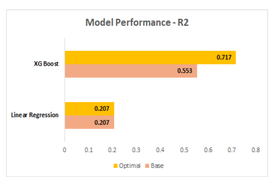

Fig 8. Model Comparison Based on R^2

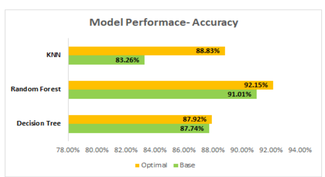

Fig 9. Model Performance Comparison Based on Accuracy

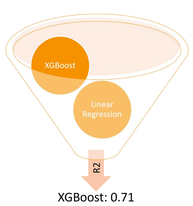

Fig 10. Model Selection

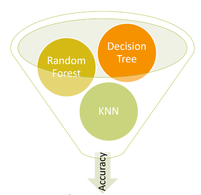

Fig 11. Model Selection

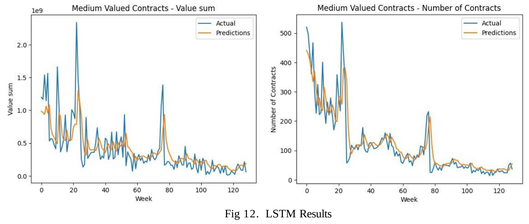

Fig 12. LSTM Results

DEPLOYMENT & LIFE CYCLE MANAGEMENT

- Documentation – Detailed documentation with the business problem and the solution used to solve it have been provided along with a paper highlighting the project life cycle.
- Source Code – GitHub repository has been provided with all the necessary code developed to solve the business problem.
- User Interface – Created a User Interface using *Streamlit* to take contract inputs for providing predictions. Tableau visualizations have been created and integrated with the UI.

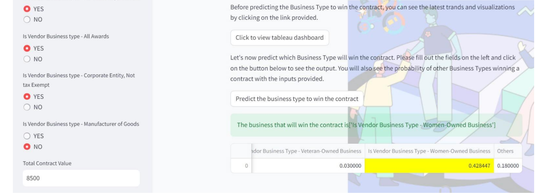

Fig 13. User Interface for Business Usecase

CONCLUSION

Our aim was to help vendors understand the nature of government contracts during a pandemic. To achieve this, we have created visualizations to help gain insights, like places which are giving out most contracts, vendor locations that are most successful in getting the contracts and so on. The models built, help predict the business type most likely to win the contract along with the most likely contract value and duration. This would help the vendors be better prepared for the upcoming contracts.

We would further like to work and make this a one stop shop for vendors by adding more features like predicting the number of contracts released in a particular sector and adding features like connecting multiple vendors to complete a contract.

ACKNOWLEDGEMENT

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