Implementing Projected Contract Award Date Web App at Your Agency

2021-05-14

Introduction

This web app automates generating projected contract award timeframes. An interactive user interface displays projected award timeframes for pending shopping carts (procurement requests). Projected contract award dates are generated with a machine learning model that statistically predicts shopping cart award dates using key features from historical data on contract awards. The web app forecasts days to contract award for shopping carts in the PPS system. Predictions can also be expressed as a projected award date. The app works on shopping carts for new contracts.

The web app was developed at the Internal Revenue Service, but can be ported for use by other agencies. This supports the Office of Federal Procurement Policy goal of interagency and cross-functional teams partnering to scale of emerging acquisition technologies across the federal government.

Getting Started with Deploying Web App

Skills Needed	
Procurement SME	Machine Learning SME
- Understands procurement terminology and synonyms and antonyms (e.g. shopping cart/requisition and action dollar amount vs. total contract value). - Knows how to obtain reports from agency contract writing system(s) and understands data field definitions. - Communicates with agency acquisition workforce to promote usage of Projected Contract Award Date Web App.	- Understands principles of supervised machine learning algorithms (e.g. random forest, decision tree, logistic regression, or neural networks). - Able to use RStudio/RShiny or similar machine learning software (e.g. Python, SAS, Matlab). - Familiar with agency server infrastructure suitable for deployment of web apps and/or machine learning models.

Data Definitions

The machine learning model backend and web app user interface was developed using reports from the IRS Contracting Writing System. While column names vary between agencies these systems have the same core functions. For example, at the IRS, Shopping Cart Numbers, are a unique identifier for procurement requests. Other agencies may use alternative terminology such as Requisition Number.

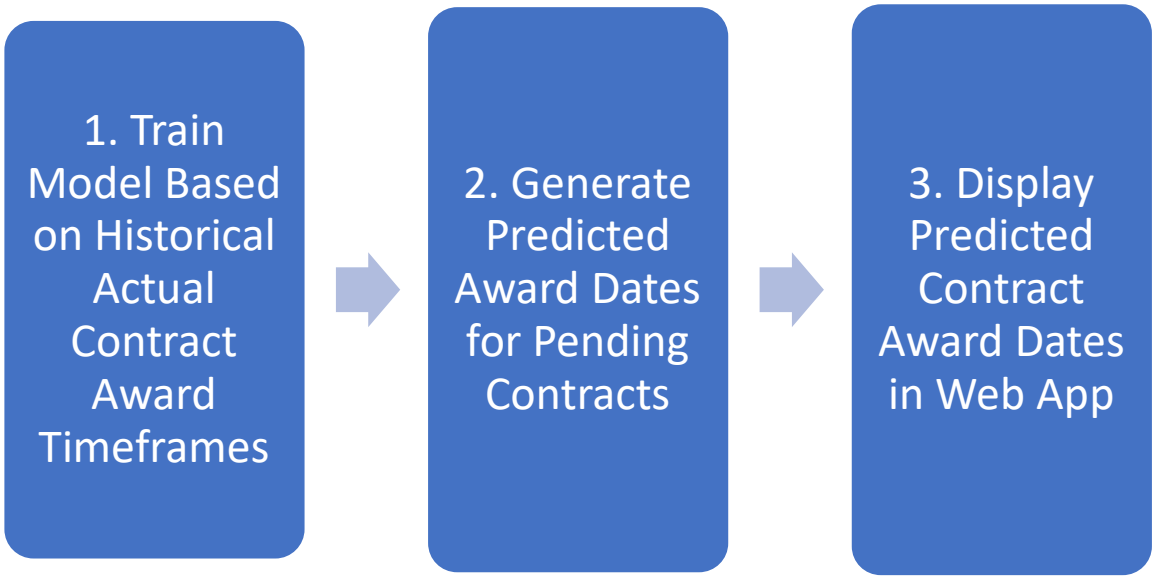
Data Definitions for Machine Learning Model and Web App		
Unique Identifier	SC Number (aka Requisition Number)	Numeric
Input to Model	Days Until Fiscal Year End (aka days from requisition approval until September 30th)	Numeric
	Contracting Office data elements: Contract Specialist (CS) Office, CS Division, CS Branch	Categorical
	Program Office data elements: Functional Area, Funding Business Unit (aka customer office / team)	Categorical
	SC PM Approval Date (aka data that program office submits requirement to procurement organization)	Date
	Planned Obligation (amount of funding)	Numeric
	Workload metrics (e.g. number of requisitions currently being worked by Contract Specialist)	Numeric
	Fund (appropriation)	Categorical
	Expiration of Fund / Appropriation and Fiscal Year	Numeric
Output from Model	Predicted Award Date (aka projected days to contract signature)	Date or Numeric

Application Structure

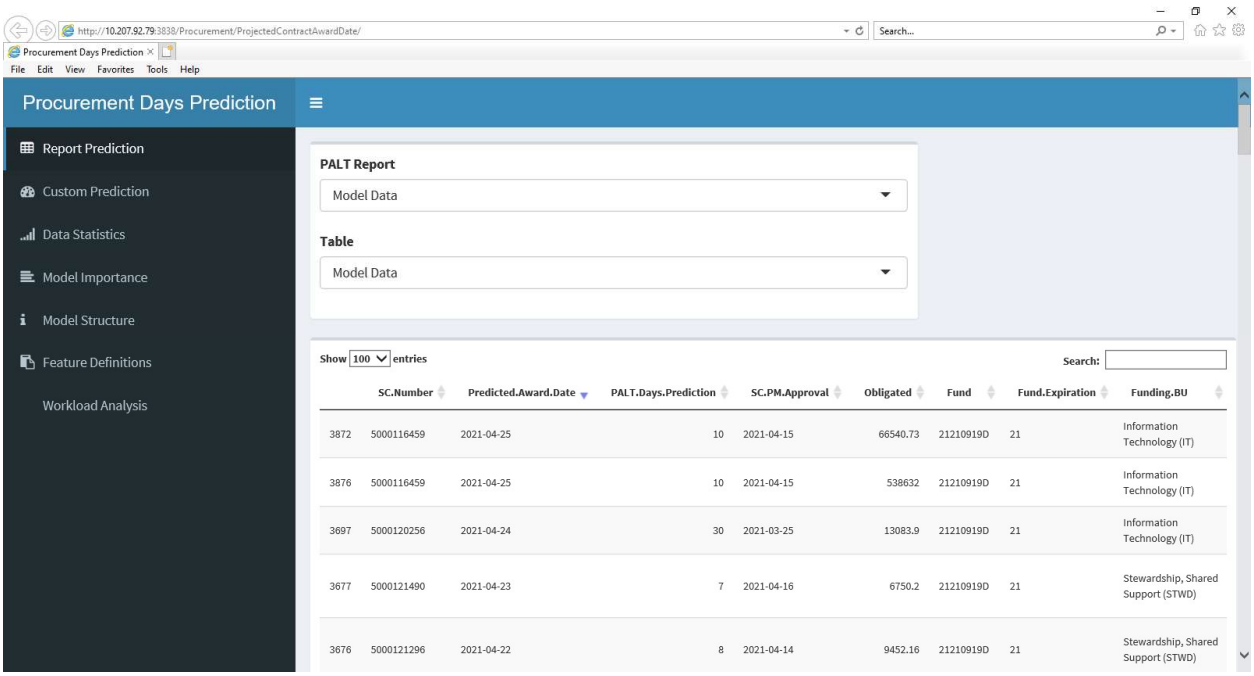
The application is based on RStudio / RShiny scripts for data preparation, generating machine learning predictions, and a front-end user interface. R scripts (.r file type) are plain text files that can be viewed with code editor or word processing (e.g. Notepad) software. RStudio software is available, at no cost, but use of this software must by approved by agency IT personnel. The R scripts for the Projected Contract Award Date Web App were first produced by federal employees and a commercial contractor under Contract Number 2032-H5-20-F-00908. Accordingly, the Government has unlimited rights to code and data produced under this contract. Unlimited rights is defined in 48 CFR 52.227-14 as “the rights of the Government to use, disclose, reproduce, prepare derivative works, distribute copies to the public,

and perform publicly and display publicly, in any manner and for any purpose, and to have or permit others to do so."

High Level Application Process Flow



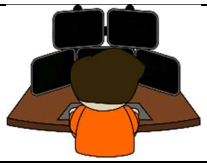
Screenshot of Projected Contract Award Date Web App



Predictions can be expressed as a projected award date or number of days. Predictions are not normally accurate down the exact day. However, expanding projections to a ballpark timeframe results in these accuracy thresholds.

Accuracy of Predictions	Value
Percent within +/- 30 days	86.75%
Percent within same month	61.62%
Percent within +/- 7 days	44.32%
Percent within same week	24.19%

User Personas

Contracting Officer's Representative (COR) or Contract Specialist	
Traditionally, milestone schedules have been developed manually and planned award dates are guestimates made by the acquisition team. In contrast, The web app automates generating projected contract award timeframes. Projections are made based on a statistical analysis of actual award timeframes for similar procurement. While normally exact date of award cannot be reliably forecasted – the machine learning approach aims to provide ballpark award timeframe projections that are as realistic and accurate as possible. with For small dollar purchases, acquisition plans are not required, and manual estimates of projected award days may be unavailable. With automated, computerized generation of projected award dates it is not too much trouble to generate projected timeframes for contract signature. Projected award dates will ideally be before or close to need dates for contractor support or products. Timely award of contracts is critical for agency mission objectives. Further, with continuous recurring needs it is importance to avoid a lapse in service (gap between expiring contract and replacement contract). If projected award dates cause a concern regarding whether contract award will be timely – this should be discussed by the acquisition team. It may be possible to expedite contract award and, in some cases, alternative acquisition strategies should be considered.	

Executives and Managers	

Traditionally, milestone schedules are one procurement at a time, and projected contract award dates are documented in individual acquisition plan documents. The web app provides a bird eye view enabling monitoring the status and likely contract award timeframes for multiple procurements. Results can be filtered to show pending procurements for a particular team, Business Unit, or program of interest.

Agency leaders need to monitor the status and progress on many different pending procurements. Executives and managers typically are not intimately familiar with progress on granular activities in the pre-award procurement process. Contract Specialists and CORs would know the exact status of quote/proposal evaluations and drafting contracts. At a leadership level, there is limited visibility exact status of granular pre-award activities. But the web app can provide a "30,000 foot" view of likely timeframes when contracts will be signed. These insights into, "how long will it take?", are important to ensuring that teams and programs can obtain timely contract support or product deliveries.

App Authors

The Procurement, Analytics, Research, and Technology (ART) Division and procurement research contractor Data and Analytic Solutions, Inc. (DAS) has developed this web app to provide an interface over the prediction modeling efforts they have conducted. Contact David Gill (David.Gill@irs.gov), Robert Carlson (Robert.J.Carlson2@irs.gov) or Trey Gilliland (Joseph.L.Gilliland@irs.gov) with any comments, questions, or concerns. Also ART's Technology Analysis (proc.dat.technology.analysis.branch@irs.gov) and Statistical Analysis (proc.dat.sab@irs.gov) branches can be contacted for assistance with the web app.

Appendix 1 – IRS Newsroom Article on Web App

IRS announces use of Projected Contract Award Date web app that predicts when contracts will be signed

WASHINGTON —The Internal Revenue Service's Office of the Chief Procurement Officer today announced the successful development of a web app called Projected Contract Award Date. The interactive forecast dashboard statistically predicts when contracts will be signed.

"This effort is a new trend in contract management that adjusts our business processes based on timing factors in the government contracting process, using cutting-edge data science technologies," said Shanna Webbers, IRS Chief Procurement Officer. "The web app will help us shorten the lead time in awards and save valuable time for our procurement staff as well as help contractors."

The IRS has $2.5 billion in contracts a year. 'When will a contract be signed?' is a key question for the IRS and generally for the federal government. This tool gives insight about when each request is likely to turn into a contract. The tool provides a technique other federal agencies can implement, potentially effecting $600 billion in government contracts.

The new web app provides information on requisitions for new contracts. Using historical data of contract awards, the intelligent web app forecasts the number of days to contract award for requisitions in the IRS's Integrated Financial System – Procurement for the Public Sector. Predictions can also be expressed as a projected contract award date.

The managerial implications of the new application are far-reaching. The web app with its predictive model will enable internal customers to accurately forecast needs and when they will be fulfilled, enable the IRS to adjust standards by redefining requirements – solicitation procedure, competition, dollar value and type of goods/services with commensurate realistic award lead time goals – and evenly distribute workload to contracting personnel and others.

This predictive web app is one of the results brought about by an IRS research partnership with Data and Analytic Solutions (DAS), a woman-owned, small business comprised of procurement practitioners as well as university professors and students with procurement and machine learning experience. Other research initiatives of the team include vendor risk analysis and natural language processing and clustering analysis.

Source: https://www.irs.gov/newsroom/irs-announces-use-of-projected-contract-award-date-web-app-that-predicts-when-contracts-will-be-signed

Appendix 2 – Resources for Predictive Modelers and Data Feature Definitions

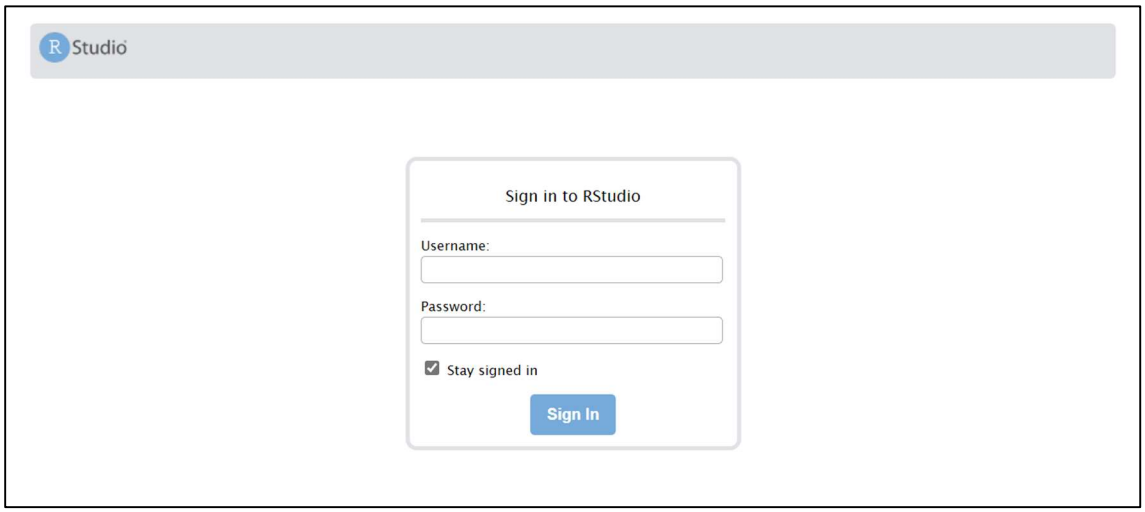
Prerequisites (* these steps are for technical users and are not necessary if you simply want to view projected contract award dates)

To run this access the development environment, you will need:

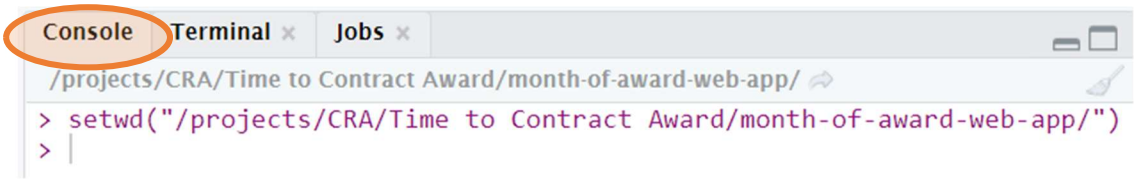
- CDW Mercury Server Access
- RStudio Service Access
- /projects/CRA/ Folder Permissions
- (*Optional*) - SecureCRT and SecureFX Software (to load new data)

Running the Web App

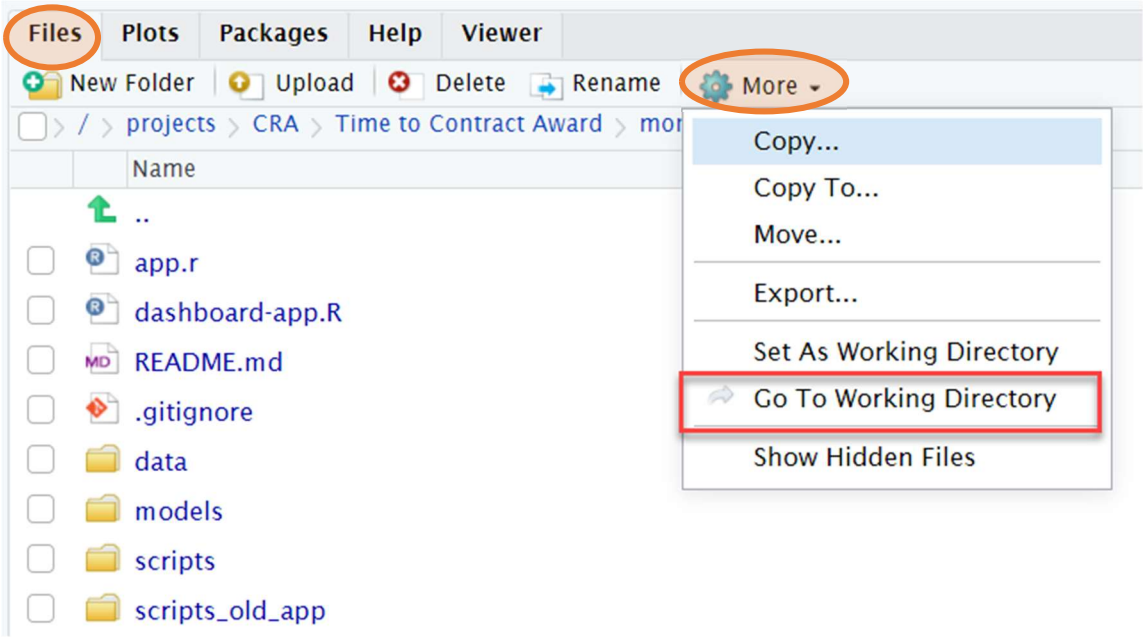
1. Login to RStudio on Mercury at RStudio Sign In



2. Run the command **`setwd("/projects/CRA/Time to Contract Award/month-of-award-web-app/")`** in the RStudio console pane at the bottom-left of the screen

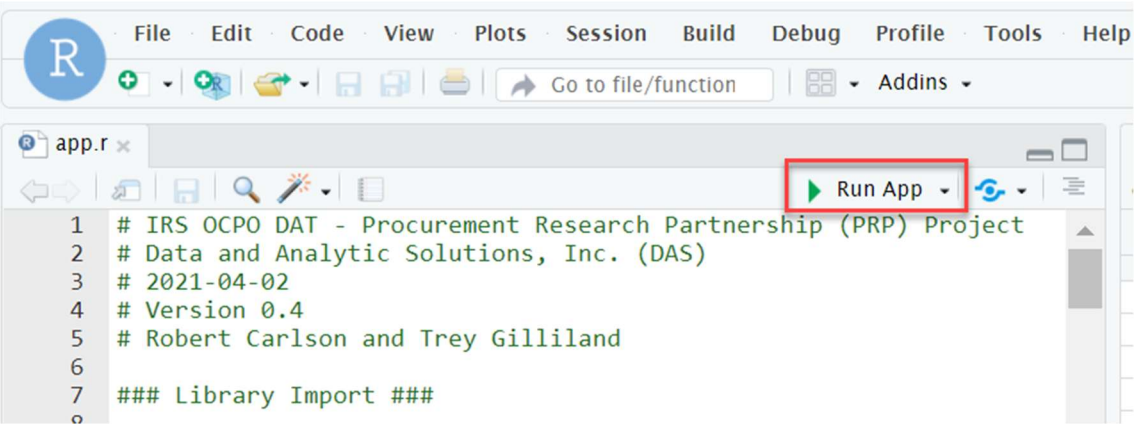


3. In the “Files” tab in the pane at the bottom-right of the screen, open the “More” dropdown menu and select “Go to Working Directory”



4. Double-click **`app.r`** from the file list in the Files tab from above to open in the Code pane at the top-left of the screen

5. In the Code pane, select Run App



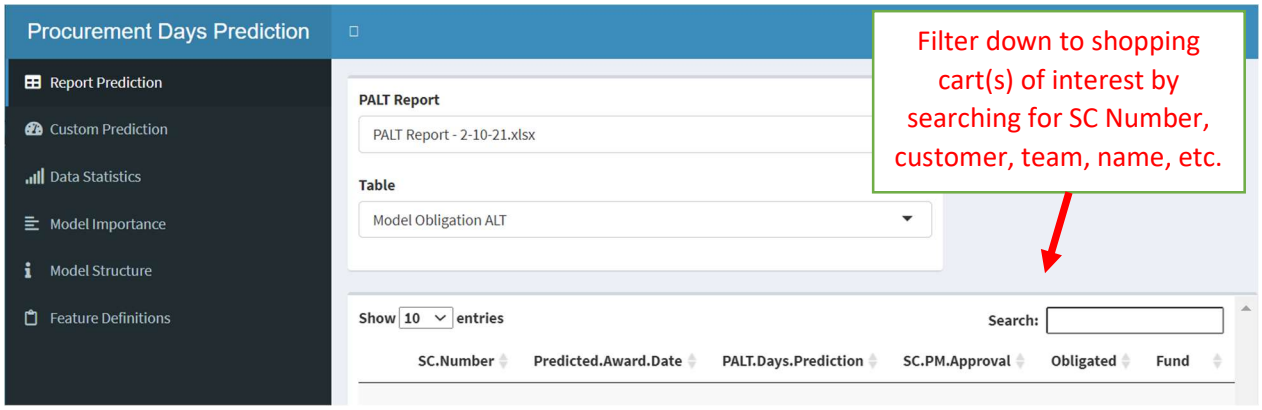
6. The web app should now be running in an external window.

Functionality

This web app currently consists of 6 tabs of functionality:

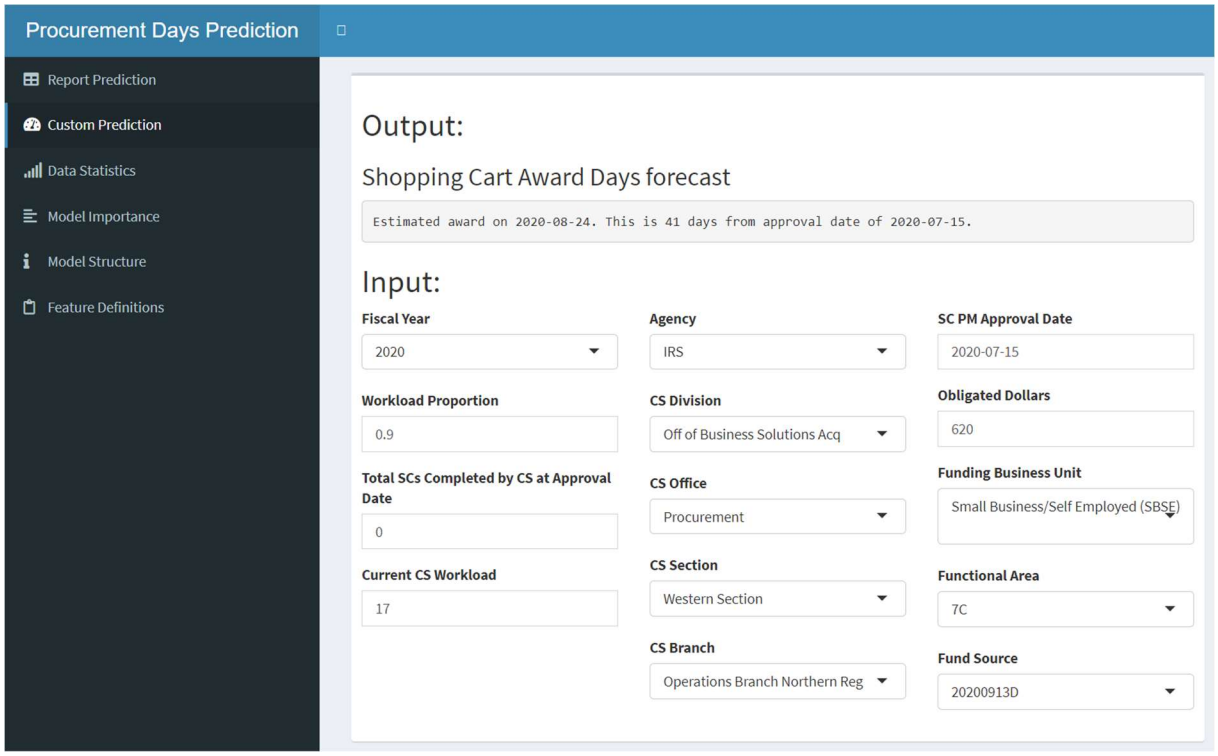
1. **Report Prediction**

Here users can explore records within PPS PALT reports available in the data/reports subfolder. The model can predict on the sheet of Open awards within the report giving users the ability to see the most likely date of award and total number of days in procurement for contracts that have not yet been awarded.



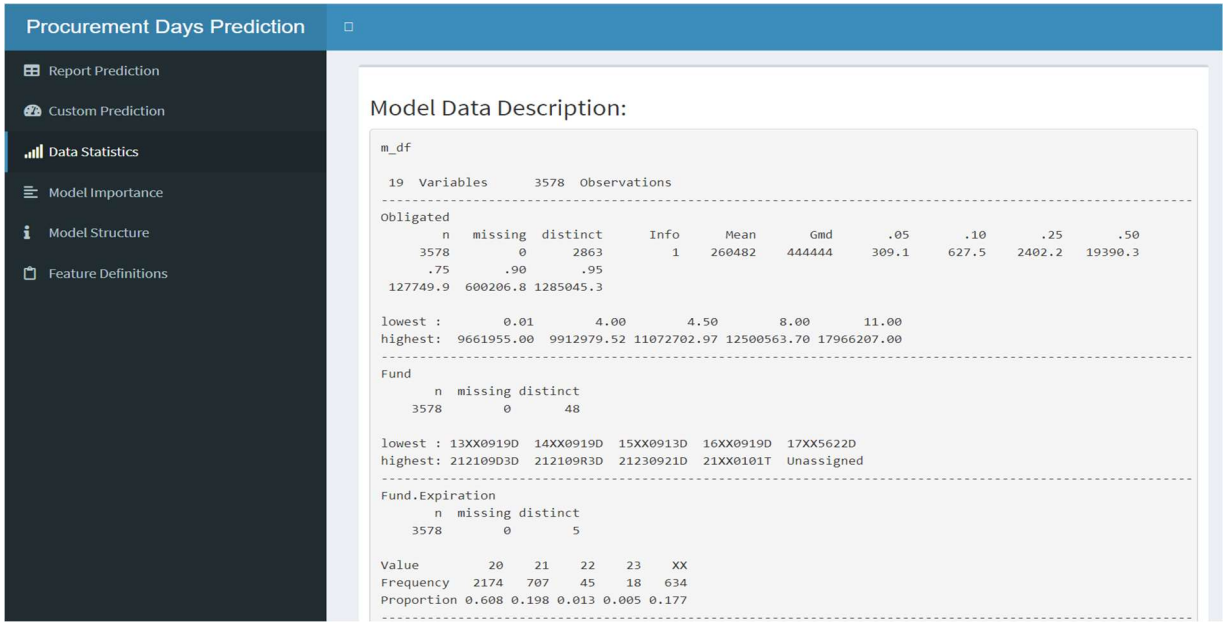
2. Custom Prediction

On the Custom Prediction tab, users can select their own custom inputs into the model to see how changing features of a potential contract influence the predicted date of award.



3. Data Statistics

On the Data Statistics tab users can review distributions and summary statistics of fields and features the model is trained on to understand the underlying data.

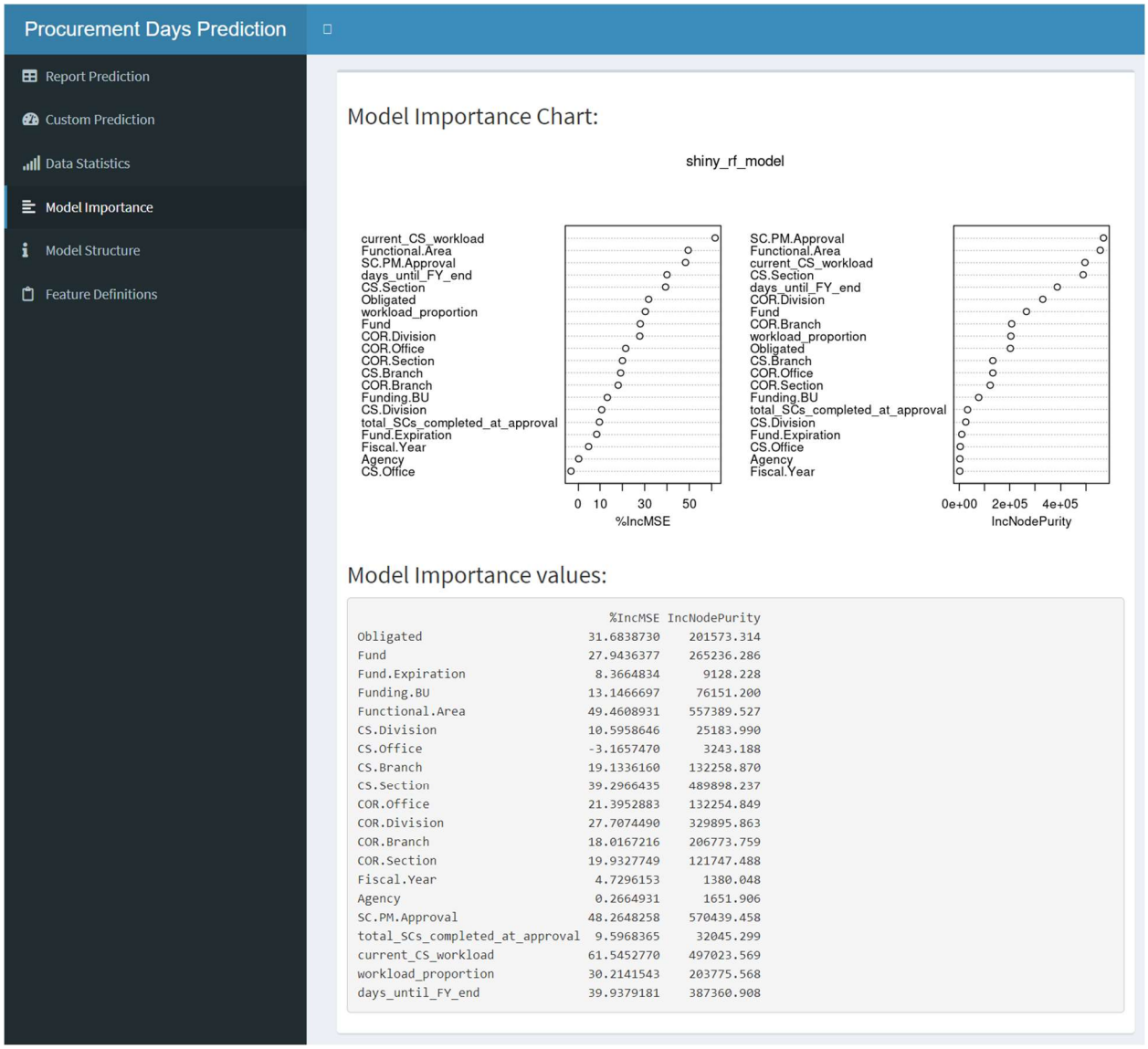


4. Model Importance

The Model Importance tab presents two charts of the importance of the underlying features of the model.

The first view provides a plot of the importance values of the features used within the model. These plots are sorted in order of importance from top to bottom.

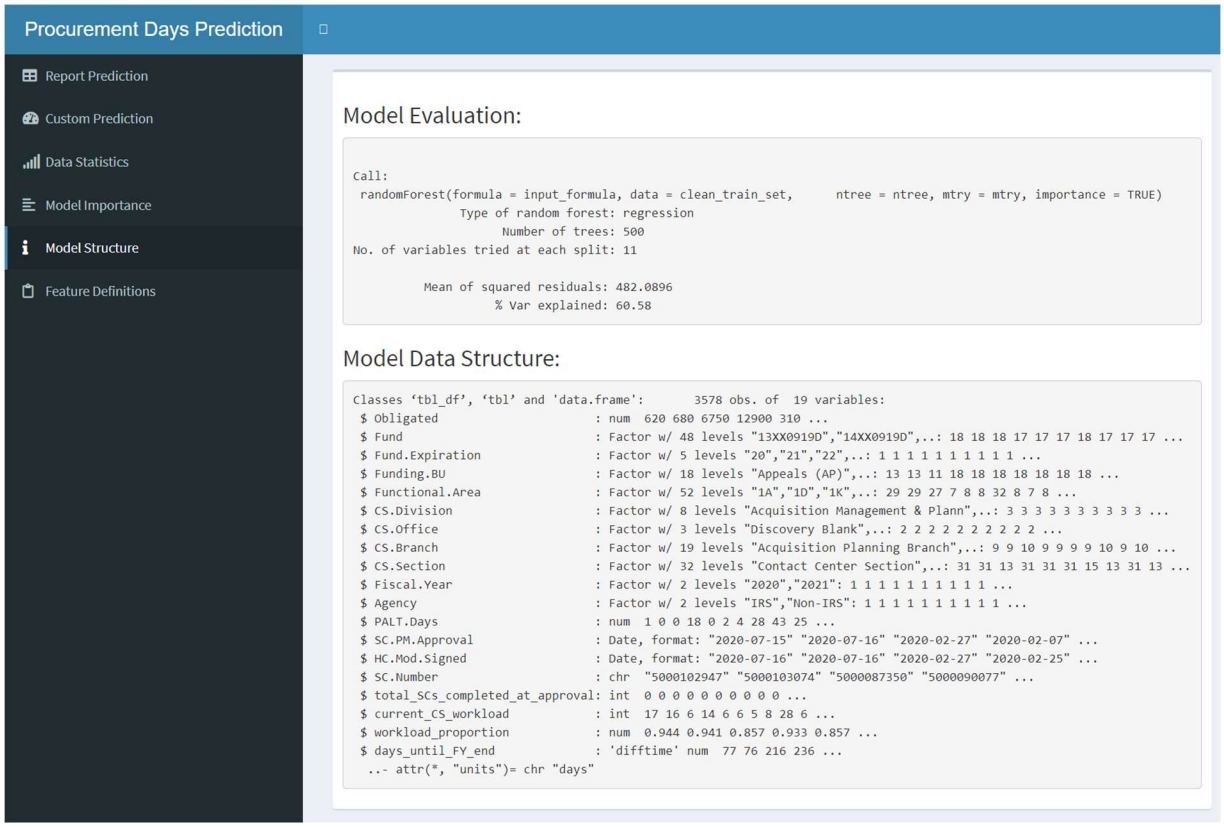
The second view provides the specific importance values of each feature that are used in the plots in the first view.



	%IncMSE	IncNodePurity
Obligated	31.6838730	201573.314
Fund	27.9436377	265236.286
Fund.Expiration	8.3664834	9128.228
Funding.BU	13.1466697	76151.200
Functional.Area	49.4608931	557389.527
CS.Division	10.5958646	25183.990
CS.Office	-3.1657470	3243.188
CS.Branch	19.1336160	132258.870
CS.Section	39.2966435	489898.237
COR.Office	21.3952883	132254.849
COR.Division	27.7074490	329895.863
COR.Branch	18.0167216	206773.759
COR.Section	19.9327749	121747.488
Fiscal.Year	4.7296153	1380.048
Agency	0.2664931	1651.906
SC.PM.Approval	48.2648258	570439.458
total_SCs_completed_at_approval	9.5968365	32045.299
current_CS_workload	61.5452770	497023.569
workload_proportion	30.2141543	203775.568
days_until_FY_end	39.9379181	387360.908

5. Model Structure

The Model Structure views provide insight into how the Random Forest model is trained and how the underlying model data structure of the training data is shaped.



6. Feature Definitions

This static view defines the data-derived features and calculations used in the model.