Increase Profitability by Predicting Customer Operating Ratios using Machine Learning

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ArcBest
More Than Logistics

Project Overview

The ArcBest pricing analysts determine the initial price, and potential profitability of a customer, using their expertise and evaluation of past accounts. This project involved data analysis of past shipments in order to provide a data-based tool for pricing analysts to use as a pricing aid. The Fully Allocated Operating Ratio (FAOR), represented by cost divided by revenue, was the key metric used to determine customer profitability.

ArcBest

ArcBest is a multi-billion dollar company founded in 1923 and currently has over 13,000 employees, providing services for customers ranging from individuals and private residential homes to Fortune 100 companies. The company is focused on four primary services; the one housing this project is ABF Freight, ArcBest's less-than-truckload (LTL) service provider.

| FleetNet America An *ArcBest* Company	Panther Premium Logistics	U-Pack We Drive. You Save.	ABF
Vehicle Maintenance & Repair	Panther Premium Logistics	Upack Moving Service	ABF Freight Less Than Truckload Service

Less-than-truckload occurs when a customer chooses to only utilize a portion of the entire space or weight available in a truck and often requires mixing of customer freights for full truck capacity.

According to the ArcBest 2017 Annual Report, ABF Freight provides service to more than 98% of U.S. cities having a population of 30,000 or more. The LTL services provided through ABF Freight accounted for 70% of the company's total revenue in 2017, or 1.96 billion in monetary value.

Current Process

- Pricing analysts receive information about the customer's freight from the sales representatives. The information involves factors like the ones in the process diagram below.
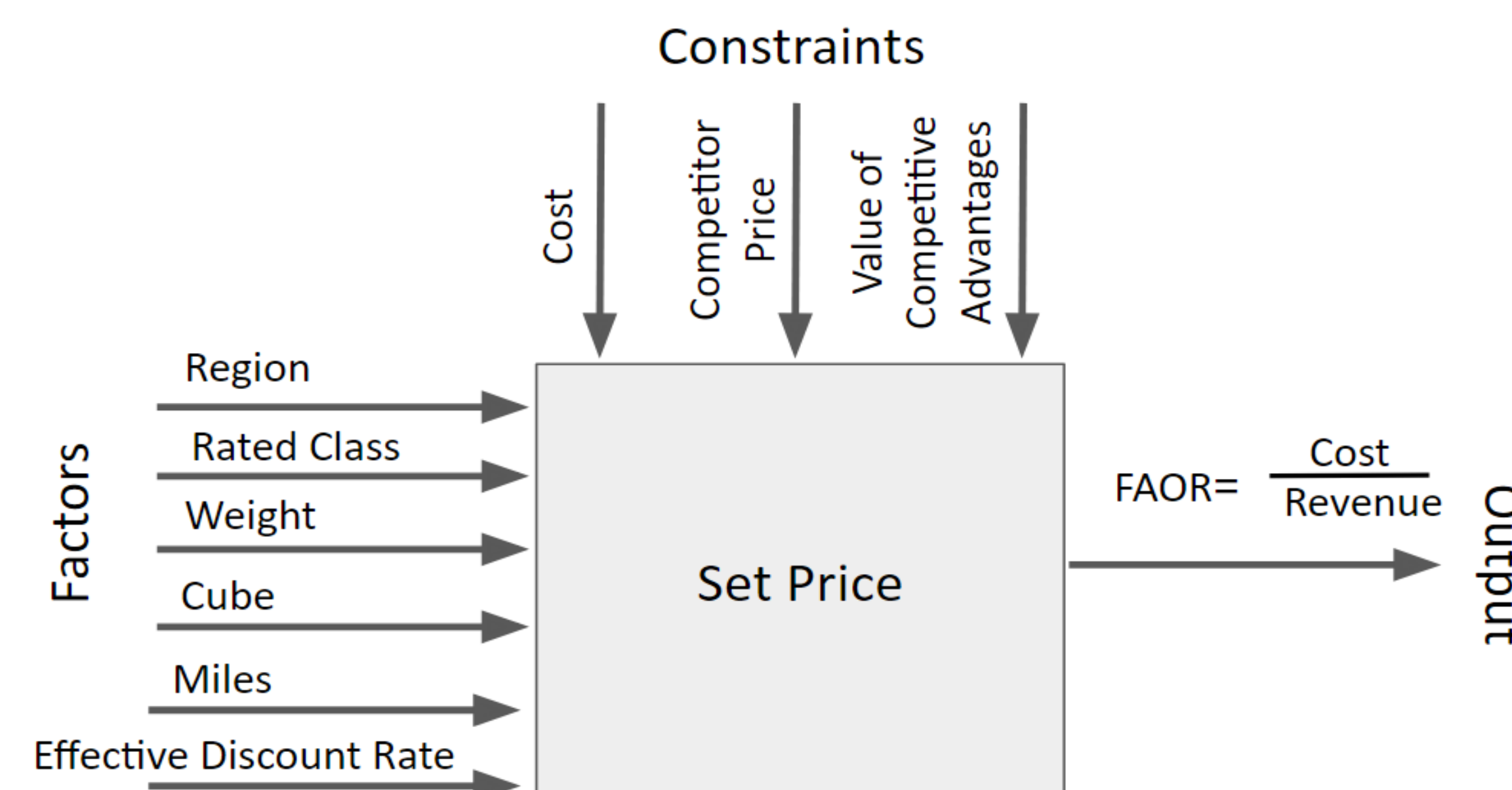

Baseline Analysis

- Pricing analysts want to correctly identify the accounts as either profitable or unprofitable for ArcBest.

- The analysts determine an Expected FAOR based on expertise and similar freight, with the goal of being as close to the Actual FAOR as possible.

Percentage Breakdown of ArcBest Accounts based on Expected FAOR vs. Actual FAOR

		Analyst thought account would be (Expected FAOR)	
		Profitable	Not Profitable
Account turned out to be (Actual FAOR)	Not Profitable	16.6% Type II Error	28.6% Correct
	Profitable	36.9% Correct	17.9% Type I Error

Average Pricing Analyst Performance across All Regions based on Expected FAOR and Actual FAOR
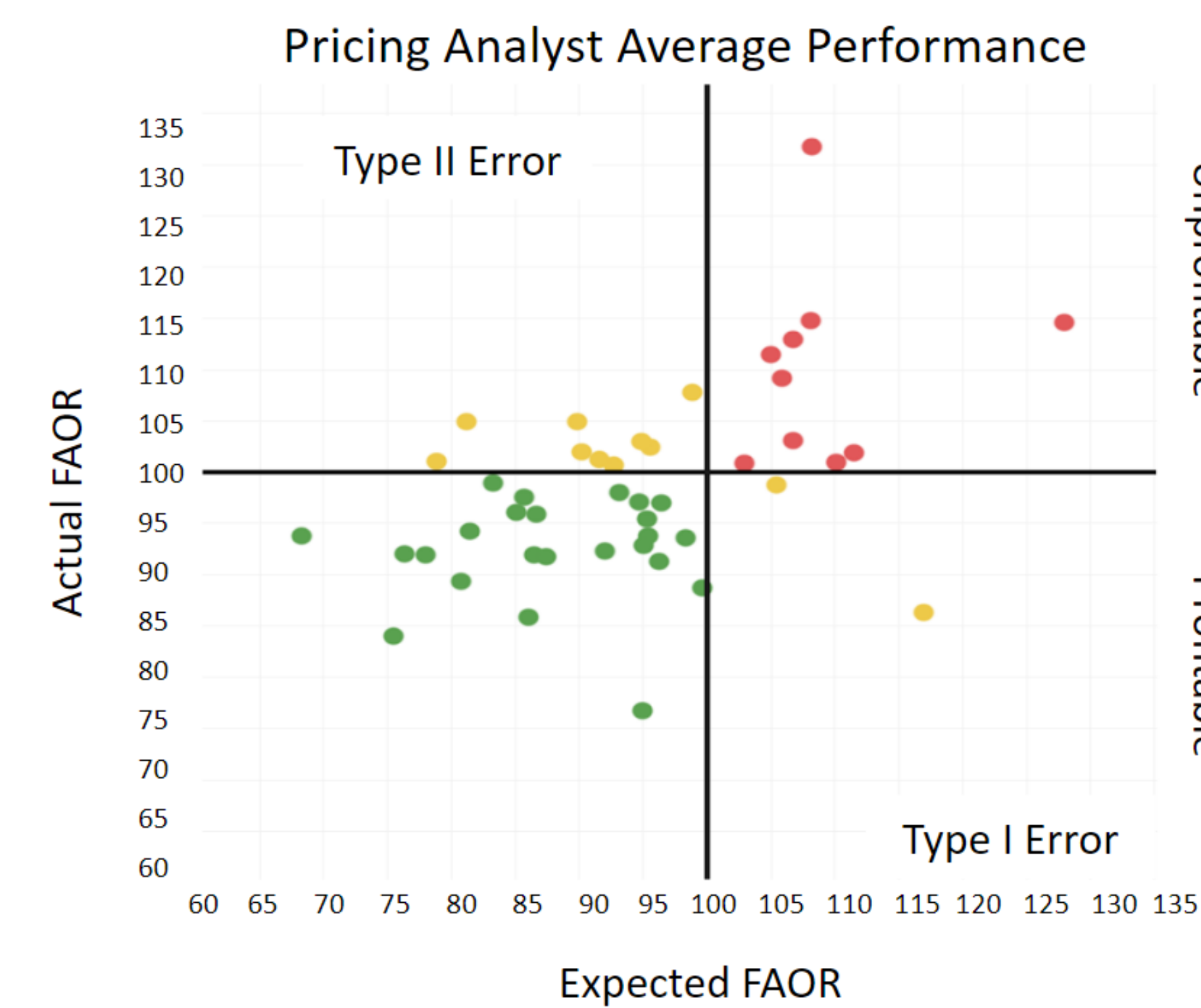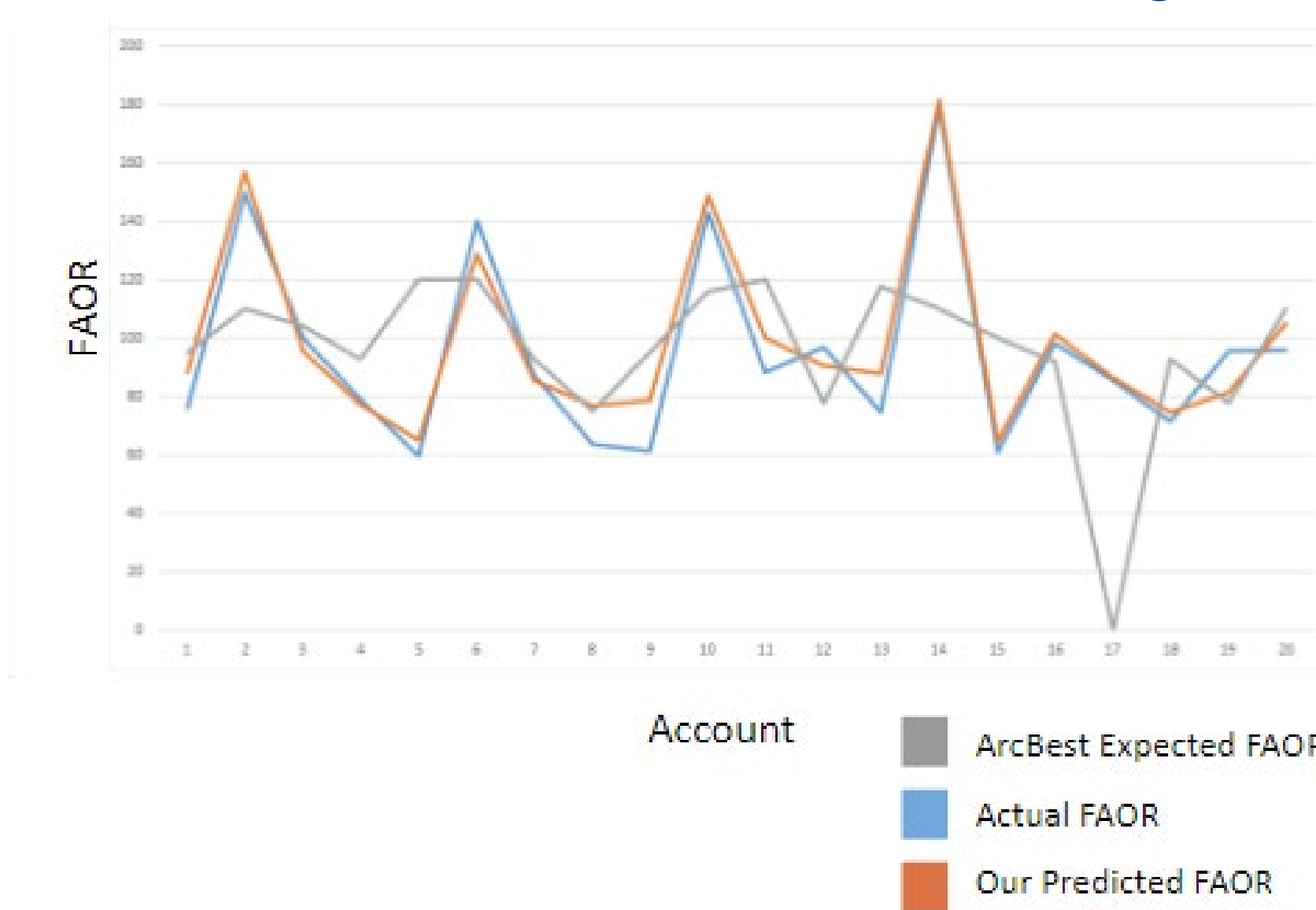

- We had the data for 45 pricing analysts within ArcBest and what we found was that almost half (twenty one analysts) predicted incorrectly about whether an account would be profitable or not, or accepted accounts that they knew might be unprofitable for the majority of their shipments.
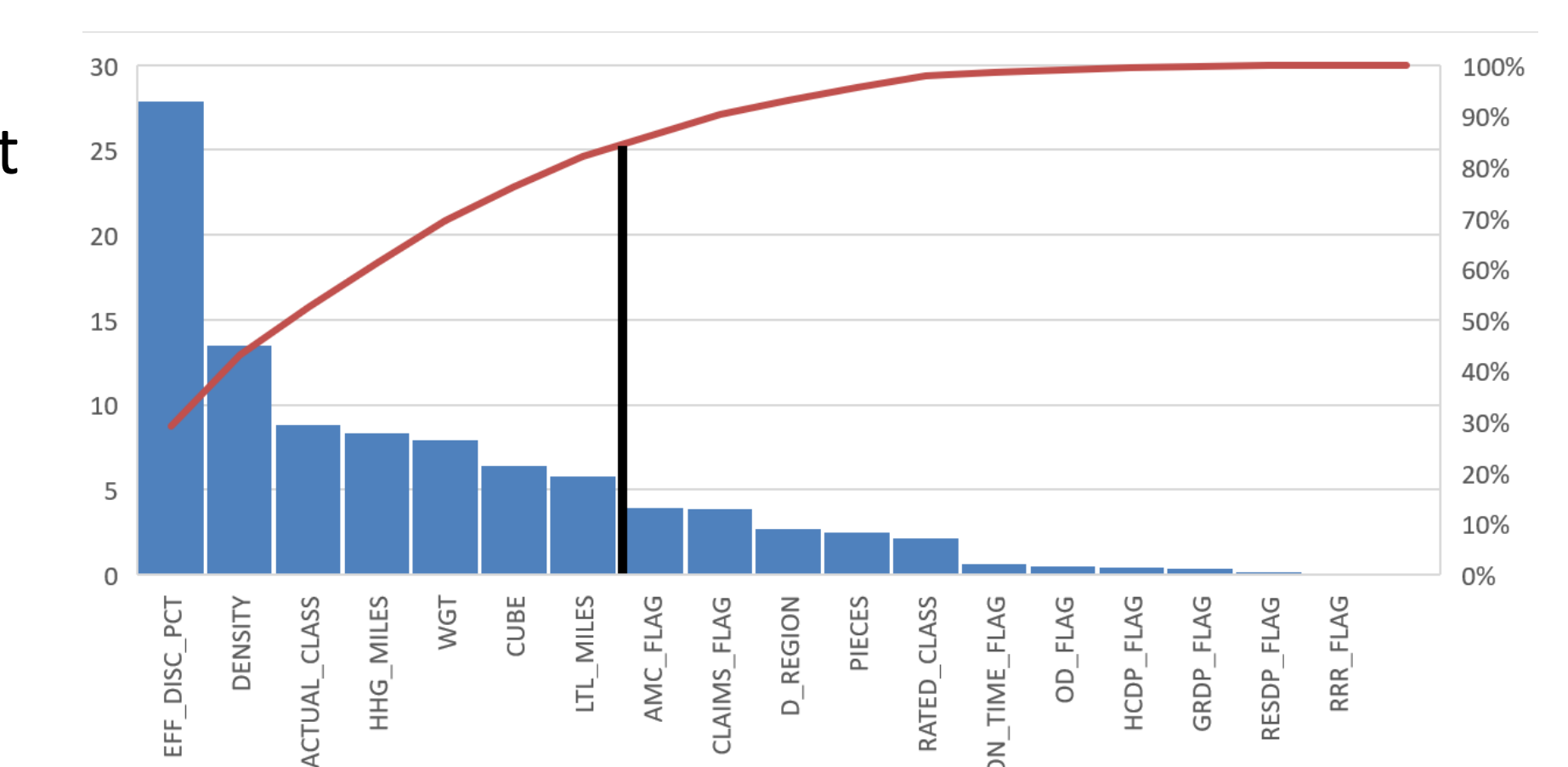
Solution Design

- We ran Random Forests Algorithms for every region to find the variable importance of each freight factor and then narrowed the scope by eliminating the variables from analysis that did not help account for 80% of the importance.

Pareto Chart of Variable Importance affecting FAOR in Region 1 for 2016

Comparison of Analyst Expected FAOR and Tool Predicted FAOR vs. Actual FAOR for Region 1

Difference between Expected and Predicted FAOR values with Actual FAOR for Region 1
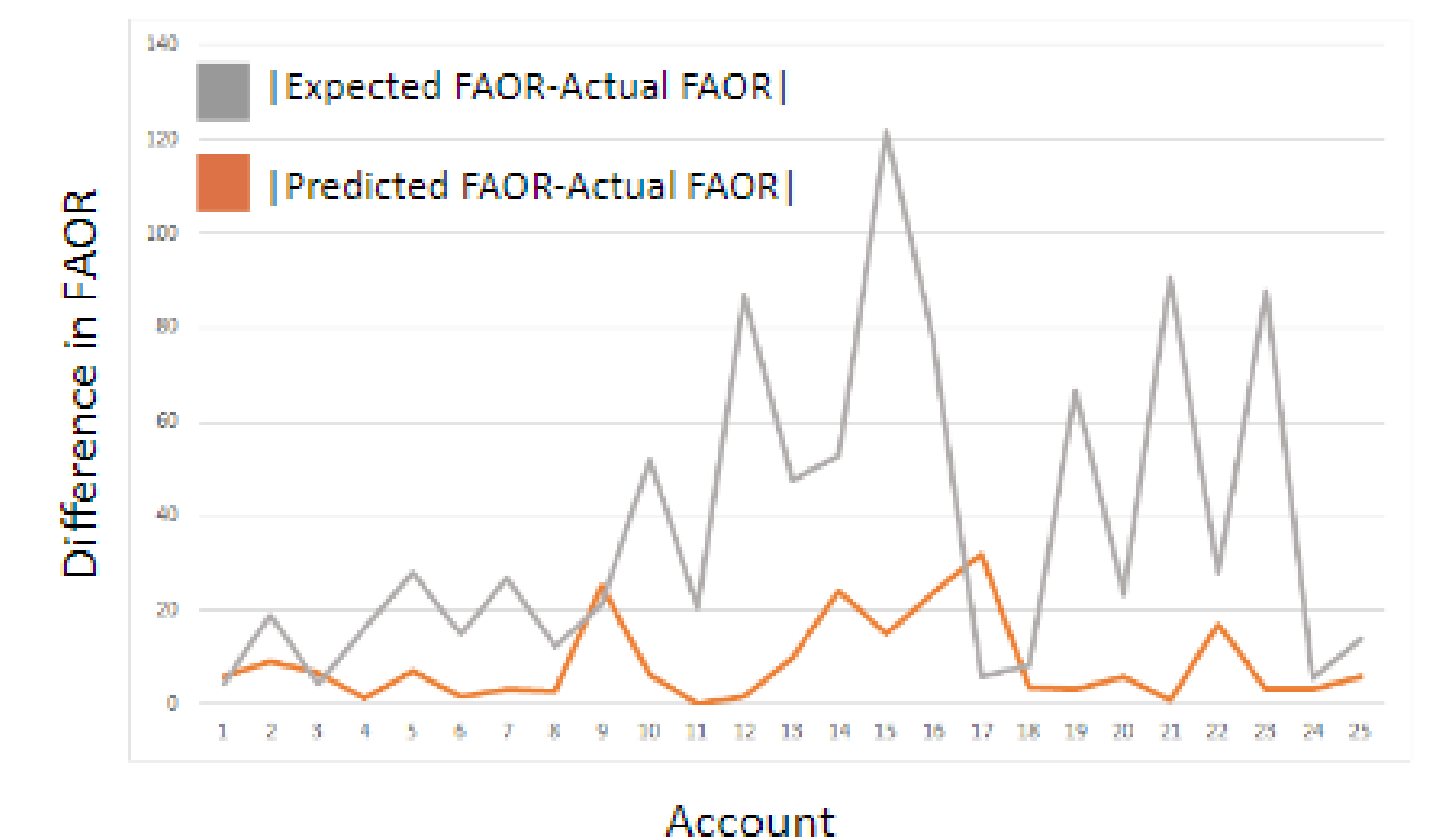

- The algorithm provides an FAOR value that is significantly more accurate to the Actual FAOR value than the previous Expected FAOR values used to value the profitability of a shipment.
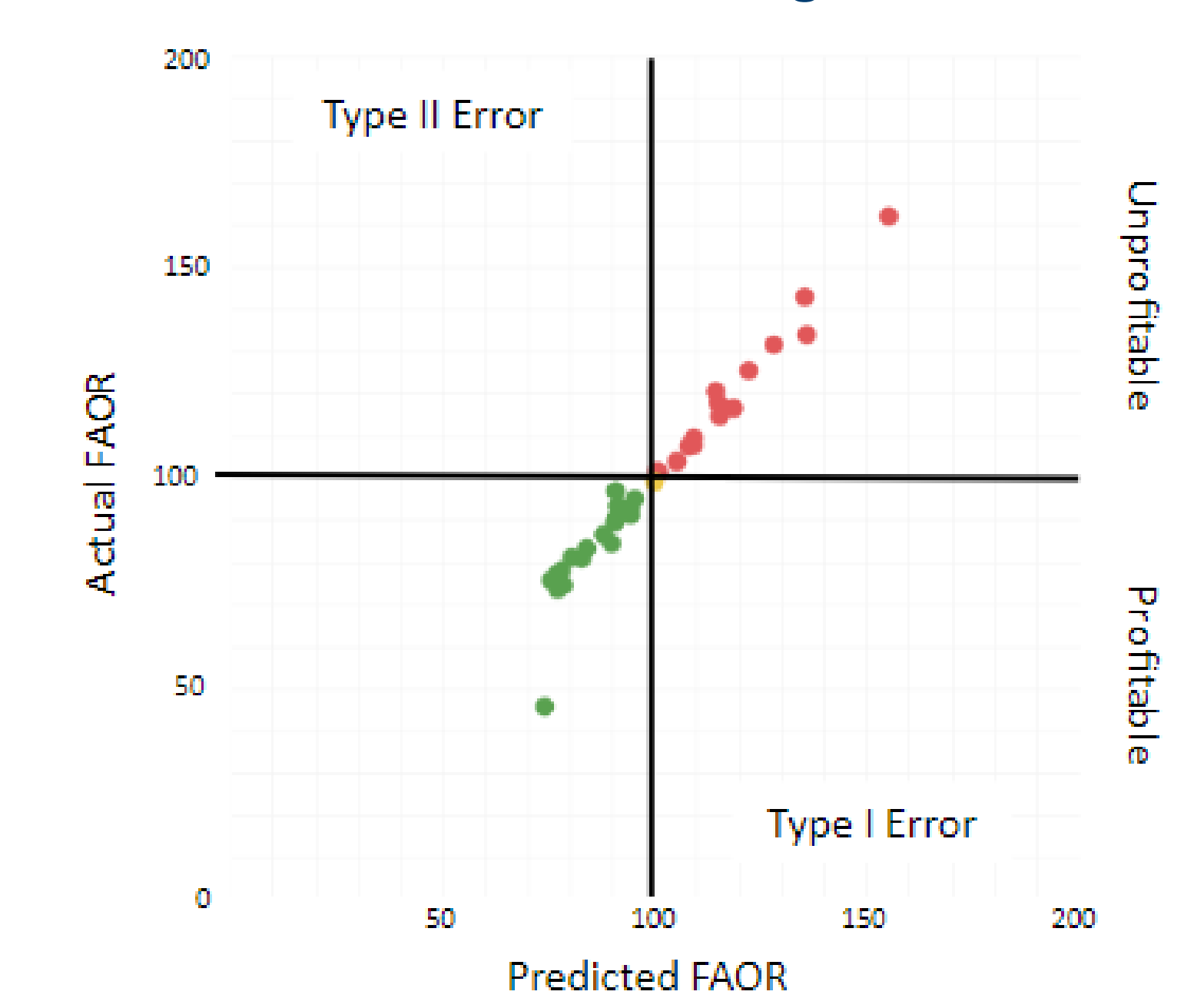
Solution Implementation

Pricing Analyst Average Performance Before Tool for Region 1
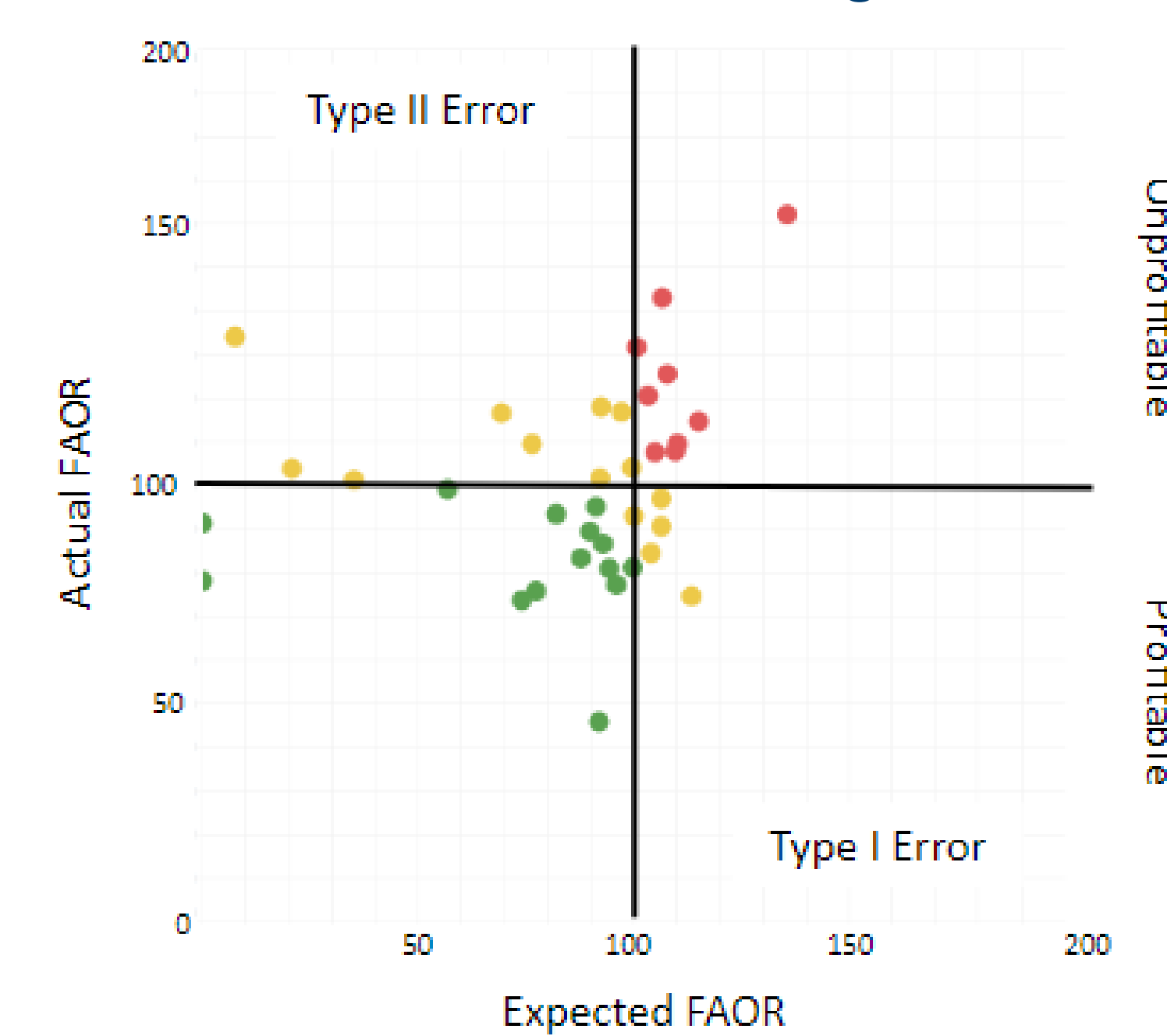
Pricing Analyst Average Performance After Tool for Region 1

- Using the tool, all percentages of error occurring have been reduced and all percentages of a correct prediction have increased. This will lead to the deliverable asked for at the beginning of the project of at least a 1% increase in probability.

Error Type

Regions	Correct: Expected	Correct: Predicted	Type I: Expected	Type I: Predicted	Type II: Expected	Type II: Predicted	Correct: Expected	Correct: Predicted
1	27.7%	45.4%	23.3%	5.5%	16.6%	3.0%	32.5%	46.1%
2	21.5%	30.9%	16.1%	6.6%	35.4%	2.0%	27.1%	60.4%
3	26.5%	41.3%	20.7%	5.9%	24.5%	2.5%	28.3%	50.3%
4	19.9%	33.3%	19.8%	6.4%	18.5%	2.1%	41.8%	58.1%
5	25.6%	34.0%	15.5%	7.1%	33.0%	2.1%	26.0%	56.8%
6	23.2%	34.4%	17.5%	6.3%	22.4%	2.4%	36.9%	56.8%
7	23.9%	39.0%	21.6%	6.1%	24.5%	2.6%	30.0%	51.9%
8	23.9%	34.7%	21.6%	7.2%	24.5%	2.4%	30.0%	55.9%
9	31.7%	38.7%	13.4%	6.4%	37.8%	2.3%	17.1%	52.6%
10	18.8%	35.9%	23.7%	6.7%	21.2%	2.5%	36.2%	54.9%