

KPI Prediction and Machine Learning

September 19, 2018

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Your Presenters



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Principal



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- By the end of the session, attendees will be able to identify different opportunities for uses of machine learning around performance monitoring
- After the session, attendees will be able to distinguish different core model types and how they can contribute to more efficient predictions
- Following the session, you will be able to better prioritize opportunities for machine learning goals within your data

Learning Objectives

- The impact of AI in Healthcare
- Robust Multivariate Time Series Modeling
- Why KPI Prediction? Your Future Performance Now
- Results of Modeling

Agenda

The Impact of Prediction



AI's Impact on Healthcare

Robotic Process
Automation (RPA)

Business Office of the
Future

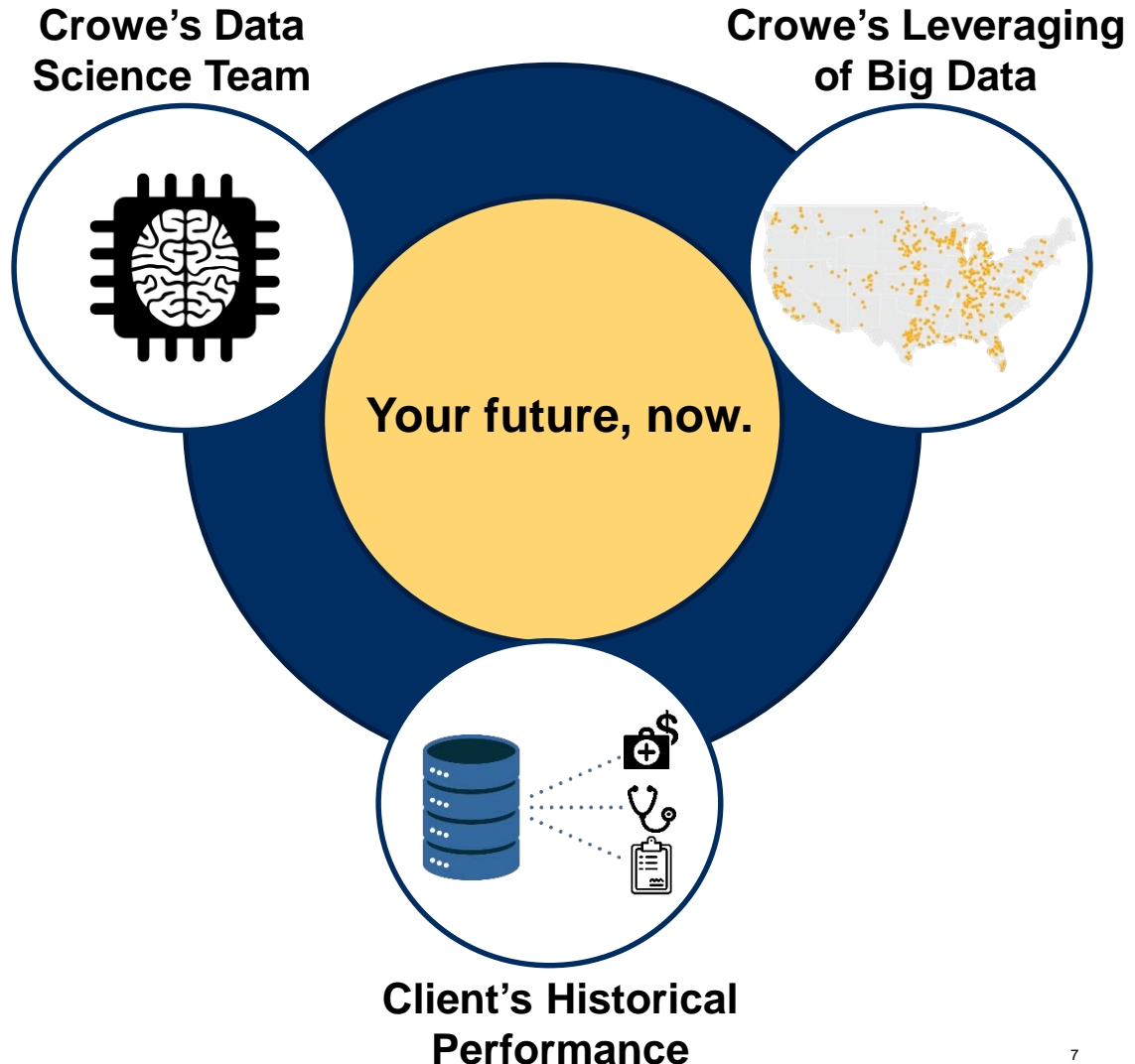
Biometrics

Medical Device Integration

Imaging & Machine
Learning

Machine Learning has Entered the Healthcare Industry

- Applying Crowe's approach to Deep Specialization to focused approach on machine learning application
- More data at client's fingertips than ever before doesn't always correlate to improved insights
- Focused on providing better insights and not just more data



Today's KPI Reporting



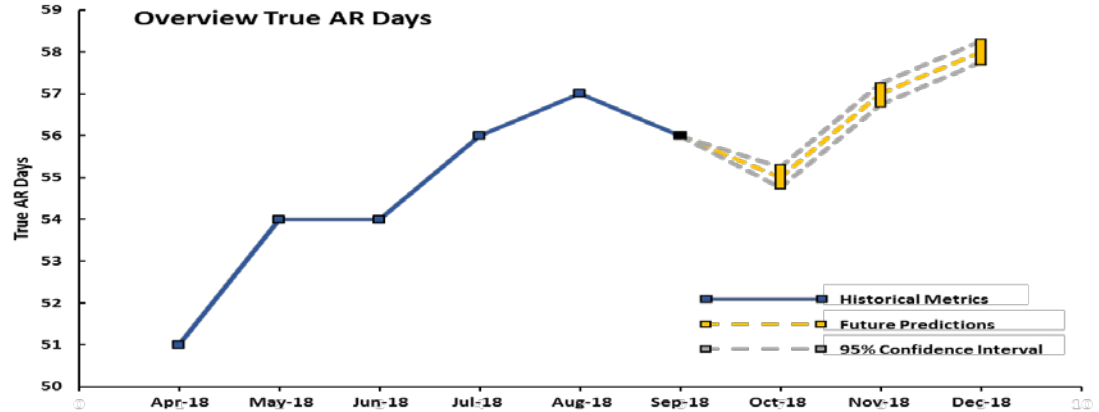
The KPI Reporting of Tomorrow



True AR Days – Healthcare System Name

Overview

- Most payor-specific AR turnover has improved over the past three months but days reduction impact has been offset by a rise in SP payor mix and related turnover.
- Commercial / Managed Care AR turnover remains above peer average due largely to Aetna & Cigna
- Reduction of AR turnover rates in Aetna, Cigna, & Medicare – Managed Care by 10% should result in top quartile AR days performance



Alerts

! Initial Denial Rate

Alert: Initial denial rate has risen above target range this month

⚠ TRUE AR Days

This KPI remains within acceptable bounds, but falls above goal

✓ DNFB

DNFB falls within range of stretch target

✓ Time to Payment

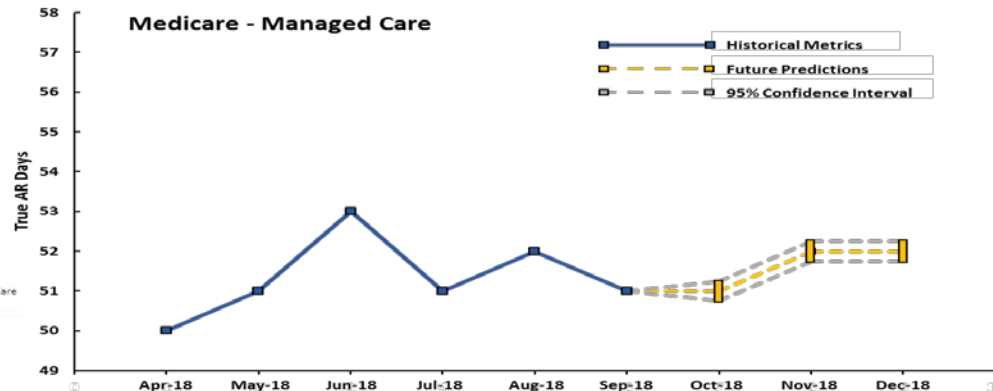
Time to Payment falls within range of stretch target

Payor Analysis

Facilities

- (All)
- City Medical Center
- Northwest Medical Center
- Physician Office
- Regional Health Hospital
- Rural North Clinic
- St. Joseph's Hospital

Crowe Payor



Robust Multivariate Time Series Modeling

What is Robust Multivariate Time-Series (RMTS)?

Robustness

- Handles outlier data
- Produces generalized forecasts
- Adjusts for level shifting

Multivariate

- Models external variables together
- Allows for the changing of variable impacts throughout time

Time-Series

- Data with added time component
- Allows for forecasting into the future
- Uses past errors for future corrections

Robustness, Multivariate, & Time-Series

Robustness Qualities

Identify Outliers

The **one-ahead forecasts** are used to label points which fall far outside the expected value

Cleaned Observations

The model will fit the data using more reasonable values in place of the outliers.

Level Shift Detection

Identifies smooth outliers found multiple times in a row and triggers a forced change in the level of the model to adjust.

Multivariate Modeling

Multiple Series

Evaluates multiple time series at the same time and combines their impacts into one uniform model.

Residual Analysis

Our multivariate model compares the residuals from each series to determine relationships among variables.

Changing Linear Relationship

The model allows the linear relationship (coefficient) to change over time. This incorporates the increasing and decreasing of a variable's impact throughout the time horizon.

Time-Series Benefits

Decomposition

Break the time series data into components

- Level (Expected Value)
- Trend
- Seasonality
- Variability

One-ahead Forecasts

Forecast each data point in the series using the decomposed values from the prior period

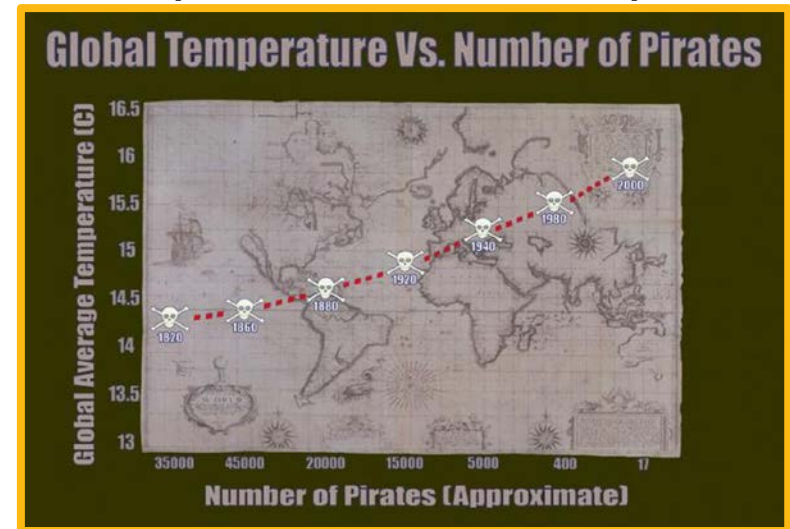
Update Decomposition Value

The new values for the level, trend, season and variability are calculated from the error between the actual value and the **one-ahead forecast**.

RMTS Advantages Over Traditional Time Series Modeling

- Automated model and variable selection process
- Trend, seasonality, variability and external variable relationships are allowed to change over time.
- The model has reduced impact from typical linear data and model assumptions
 - Stationarity
 - Normality
 - Homoscedasticity (Constant variance)
- Model and coefficient selection algorithms avoid issues common to traditional modeling
 - Spurious Correlation: Mistakenly identifying variables that appear related
 - Multicollinearity: Identifying too many variables which are interrelated
 - Autocorrelation of residuals: Patterns in the residuals

Spurious Correlation Example



Why KPI Prediction? Your Future Performance Now

What Metrics Matter to You?

Volumes

- IP Net Revenue Per Case
- OP Net Revenue Per Case
- IP Admissions (Volume)
- OP Visit (Volume)
- Medicare Net Revenue per IP Day

Accounts Receivable

- Cash/60 Day Lagged Net Revenue
- Six Months Cash Lag to Net Revenue
- TRUE AR days
- Net AR Days
- TRUE AR > 90 Days
- % AR > 90 Days Medicare
- % AR > 90 Days Medicaid
- % AR > 90 Days Commercial
- % AR > 90 Days Self-Pay
- % AR > 90 Days Other
- Late Charge % of GPSR
- Credit Days
- Credit Liability % of Credit AR

HIM

- DNFB Days

Payment Compliance

- Time to Insurance Payment - Overall
- Time to Insurance Payment - Medicare & Managed Medicare
- Time to Insurance Payment - Commercial Managed Care
- Time to Insurance Payment - Medicaid & Managed Medicaid
- Time to Insurance Payment - Other
- Time to Insurance Payment Gap - Denied vs. Non-Denied
- Insurance Payment Gap - Denied vs. Non-Denied
- Final Denial Write-Offs
- Initial Denial Rate
- Initial Denial Rate - Medicare & Managed Medicare

- Initial Denial Rate - Commercial Managed Care
- Initial Denial Rate - Medicaid & Managed Medicaid
- Initial Denial Rate - Other Payor
- Initial Denial Rate - Auth/Precert
- Initial Denial Rate - Billing/Claim Issue
- Initial Denial Rate - Coordination of Benefits
- Initial Denial Rate - Coverage/Eligibility
- Initial Denial Rate - Duplicate
- Initial Denial Rate - Medical Necessity
- Initial Denial Rate - Non-Covered Services
- Initial Denial Rate - Request for Information
- Initial Denial Rate - Timely Filing
- Initial Denial Rate - Other

Registration

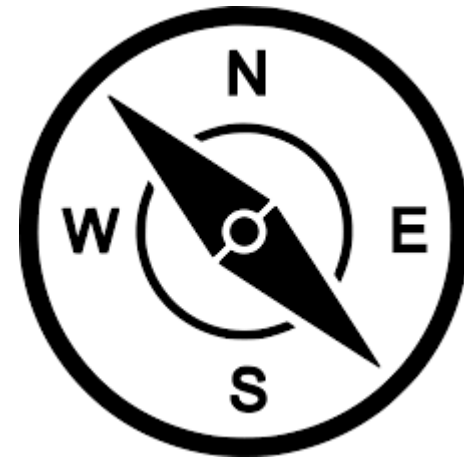
- Patient Responsibility % of GPSR
- Patient Collection Rate - Managed Care/Commercial
- Patient Responsibility - Managed Care/Commercial (% of allowed amount)
- POS Cash Collections % of Patient Cash
- Inpatient Self-Pay Conversion Rate

Uncompensated Care

- Uncompensated Care % of GPSR
- Bad Debt % of GPSR
- Charity % of GPSR
- Charity % of Uncompensated Care
- Self-Pay After Insurance Bad Debt % of Total Bad Debt
- Self-Pay After Insurance Uncompensated Care % of Total Uncompensated Care

How Could Forecasting Help You?

- What periods of time would be helpful to project out (3 months, 4 months, 6 months, etc.)?
- What types of items would you want to forecast (KPIs, stats, etc.)?
- How could you use this information (managing internal expectations, reducing risk, etc.)?



Real Data, Real Results



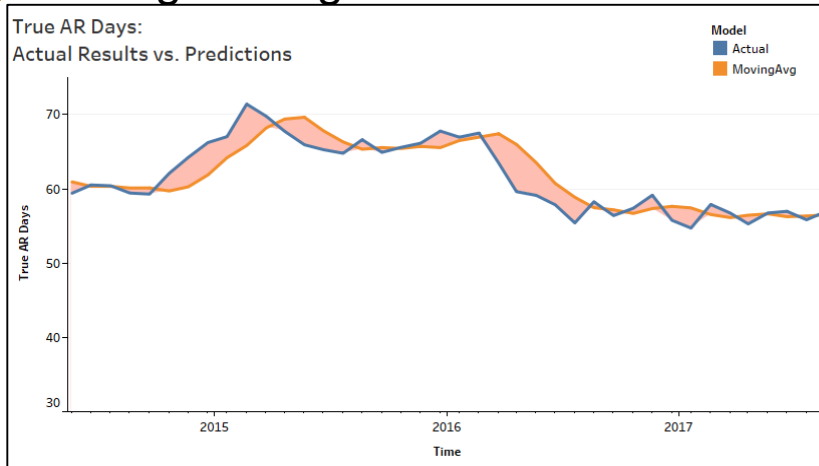
Works for Multiple Clients: With & Without 835/837 Data

Client	KPI	Moving Average Error	Univariate Error	Multivariate Error	Multivariate (Without 835/837) Error	Multivariate Crowe Payor Error
Healthcare System #1	TrueARDays	1.08%	0.77%	0.42%	---	0.32%
Healthcare System #1	TrueARGT90Days	0.94%	0.67%	0.29%	---	0.19%
Healthcare System #1	FinalDenialWriteOffs	12.34%	8.10%	5.65%	6.58%	---
Healthcare System #1	BadDebtOfGPSR	5.66%	4.67%	2.63%	2.65%	---
Healthcare System #1	CharityOfGPSR	3.78%	3.01%	1.76%	1.81%	---
Healthcare System #2						
Healthcare System #2	FinalDenialWriteOffs	17.44%	12.39%	6.04%	6.32%	---
Healthcare System #2	BadDebtOfGPSR	7.72%	6.45%	4.46%	4.46%	---
Healthcare System #2	CharityOfGPSR	4.42%	4.06%	1.64%	1.74%	---
Healthcare System #3						
Healthcare System #3	TrueARDays	1.47%	1.01%	0.49%	---	0.34%
Healthcare System #3	TrueARGT90Days	2.31%	1.28%	0.50%	---	0.53%
Healthcare System #3	FinalDenialWriteOffs	15.88%	13.91%	7.32%	10.45%	---
Healthcare System #3	BadDebtOfGPSR	23.21%	20.81%	9.13%	9.13%	---
Healthcare System #3	CharityOfGPSR	9.85%	9.42%	4.23%	4.23%	---

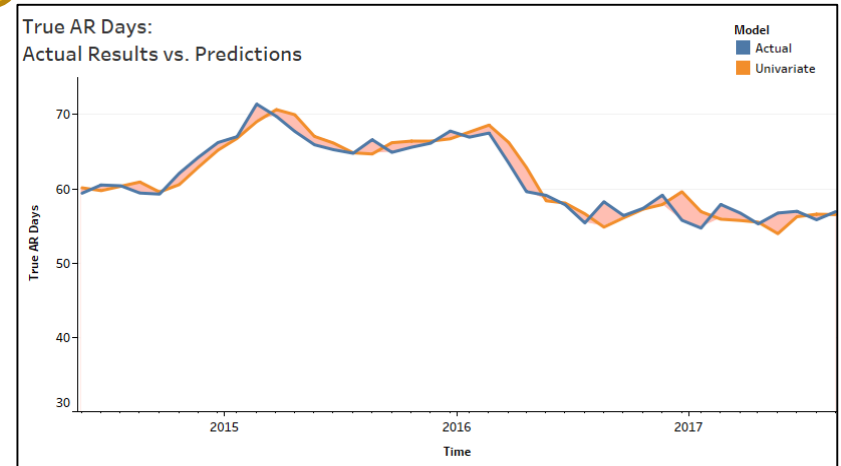
Error rates are relative percentages. For example, a 10% prediction with a 5% error will fall between 9.5%-10.5%.

Model Improvement for 3 Month True AR Days Prediction

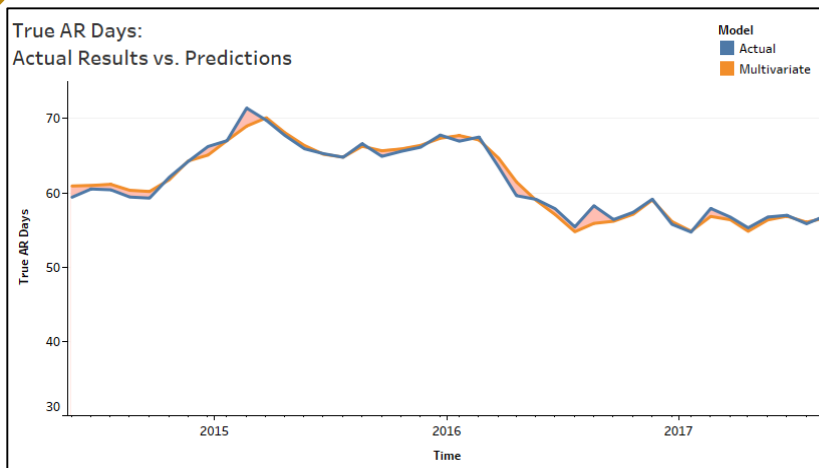
1 Moving Average



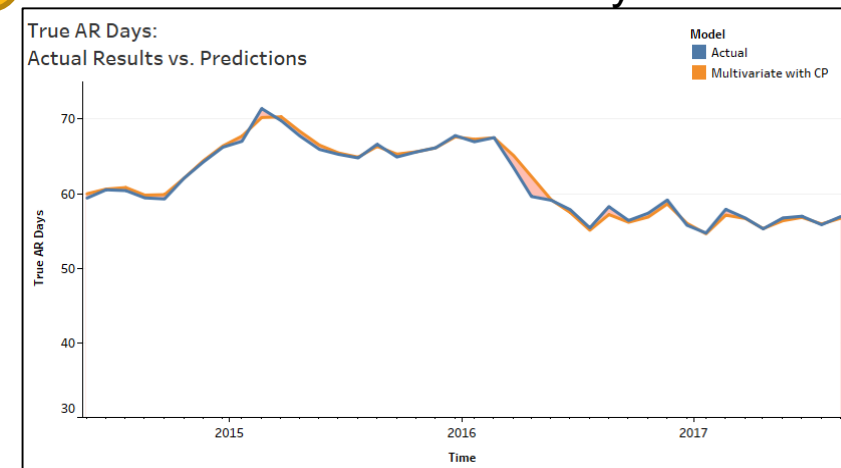
2 Univariate



3 Multivariate

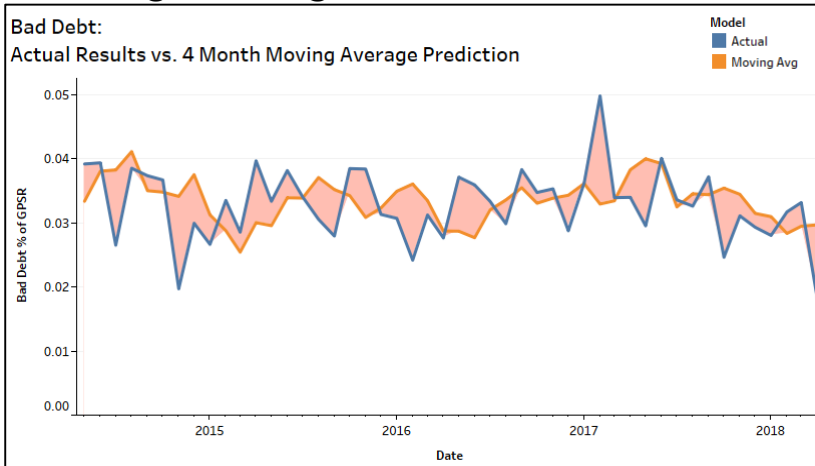


4 Multivariate with Crowe Payor

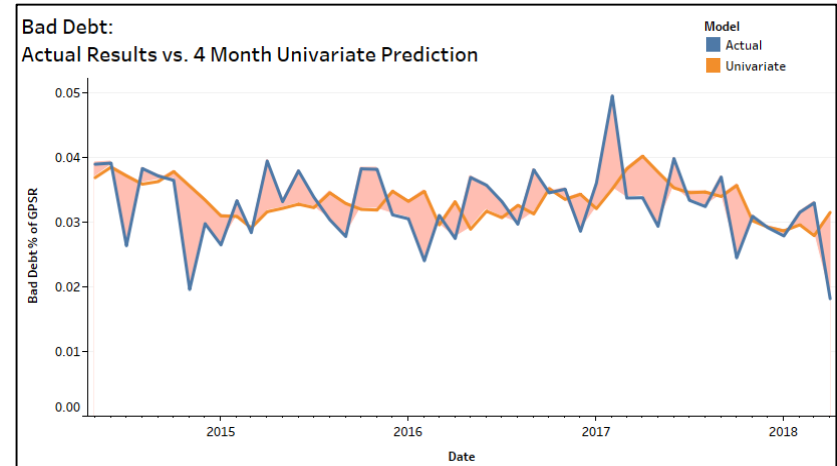


Model Improvement for 4 Month Bad Debt

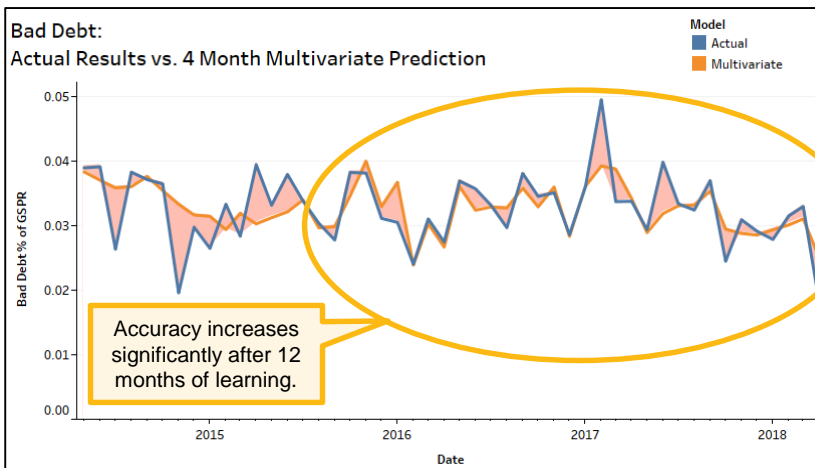
1 Moving Average



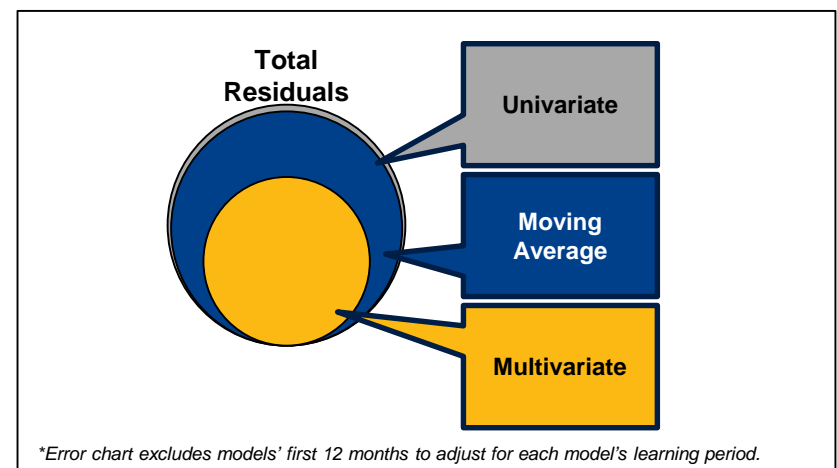
2 Univariate



3 Multivariate

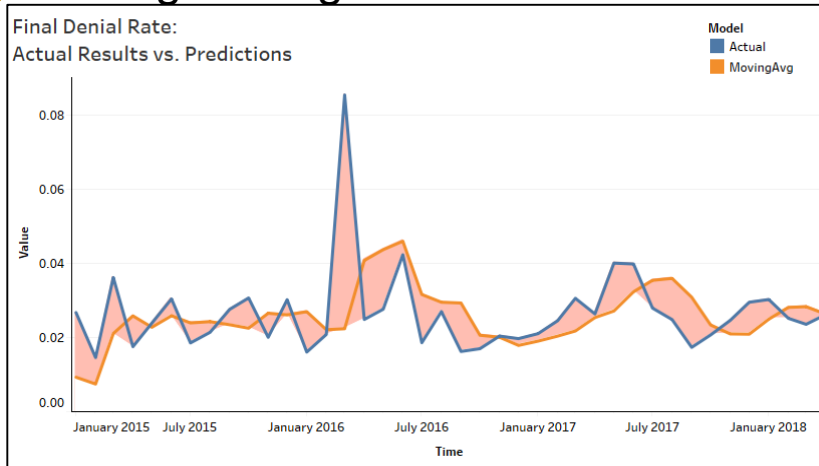


Error Area*

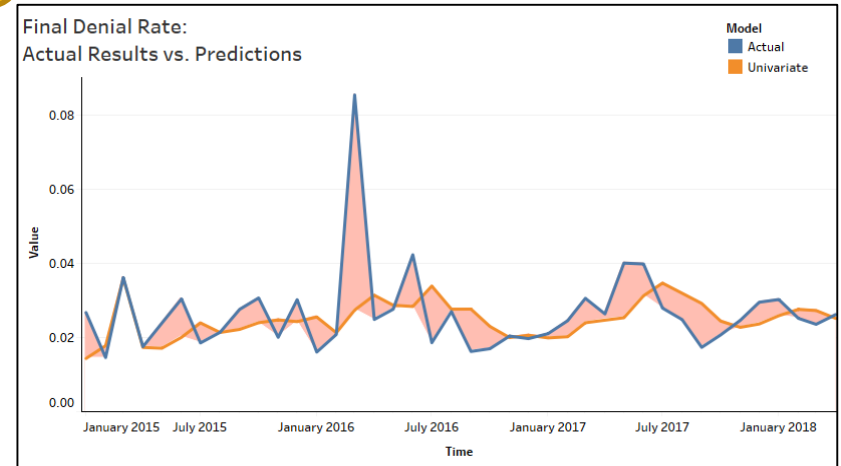


Model Improvement for Final Denials

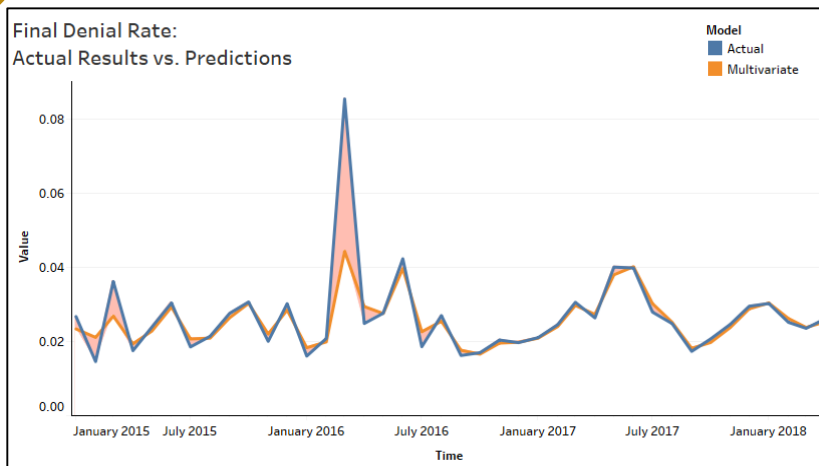
1 Moving Average



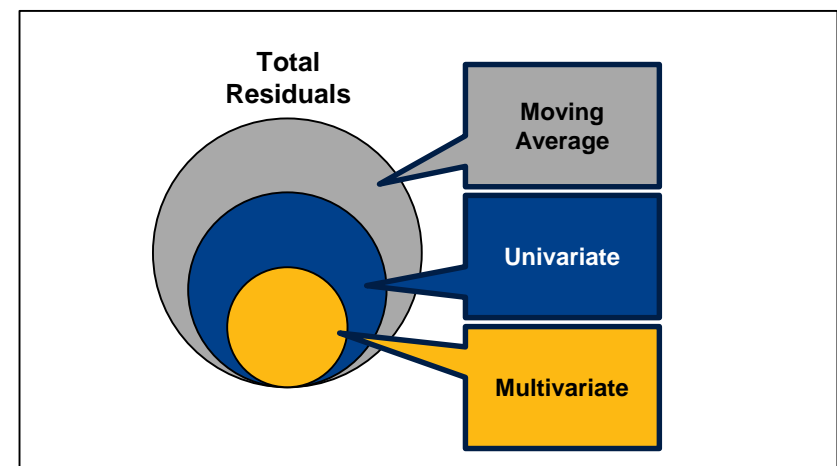
2 Univariate



3 Multivariate



Error Area



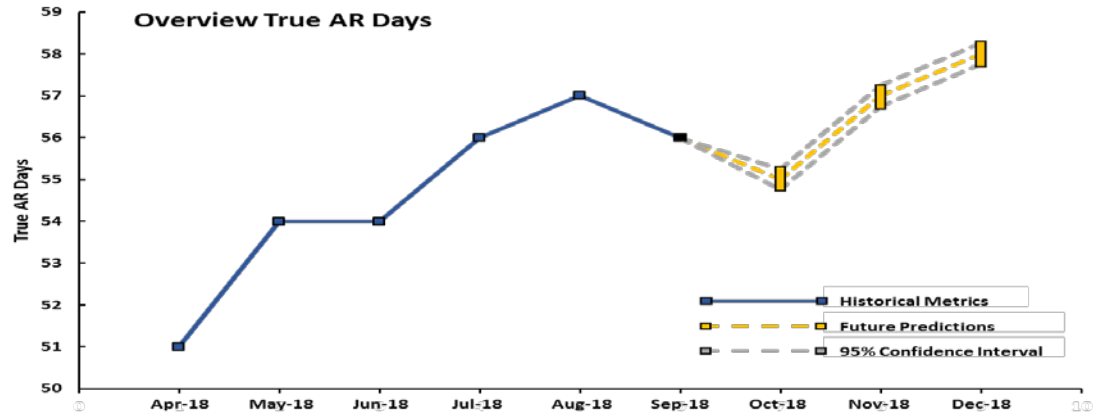
The Future of Dashboarding



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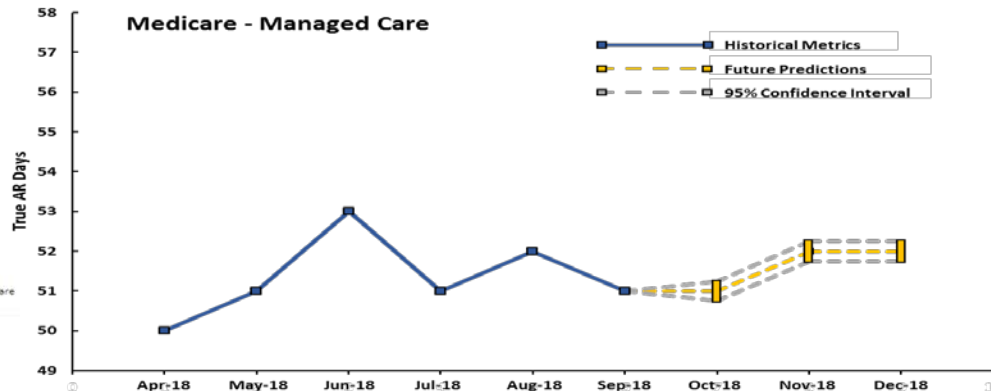
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