FASTENAL®

Optimal Inventory Redistribution

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Outline

- Problem Statement
- Approach
  - Models:
    - Linear Regression
    - Time Series
    - Advanced Time Series
  - Redistribution
- Business Value
- Summary and Conclusions

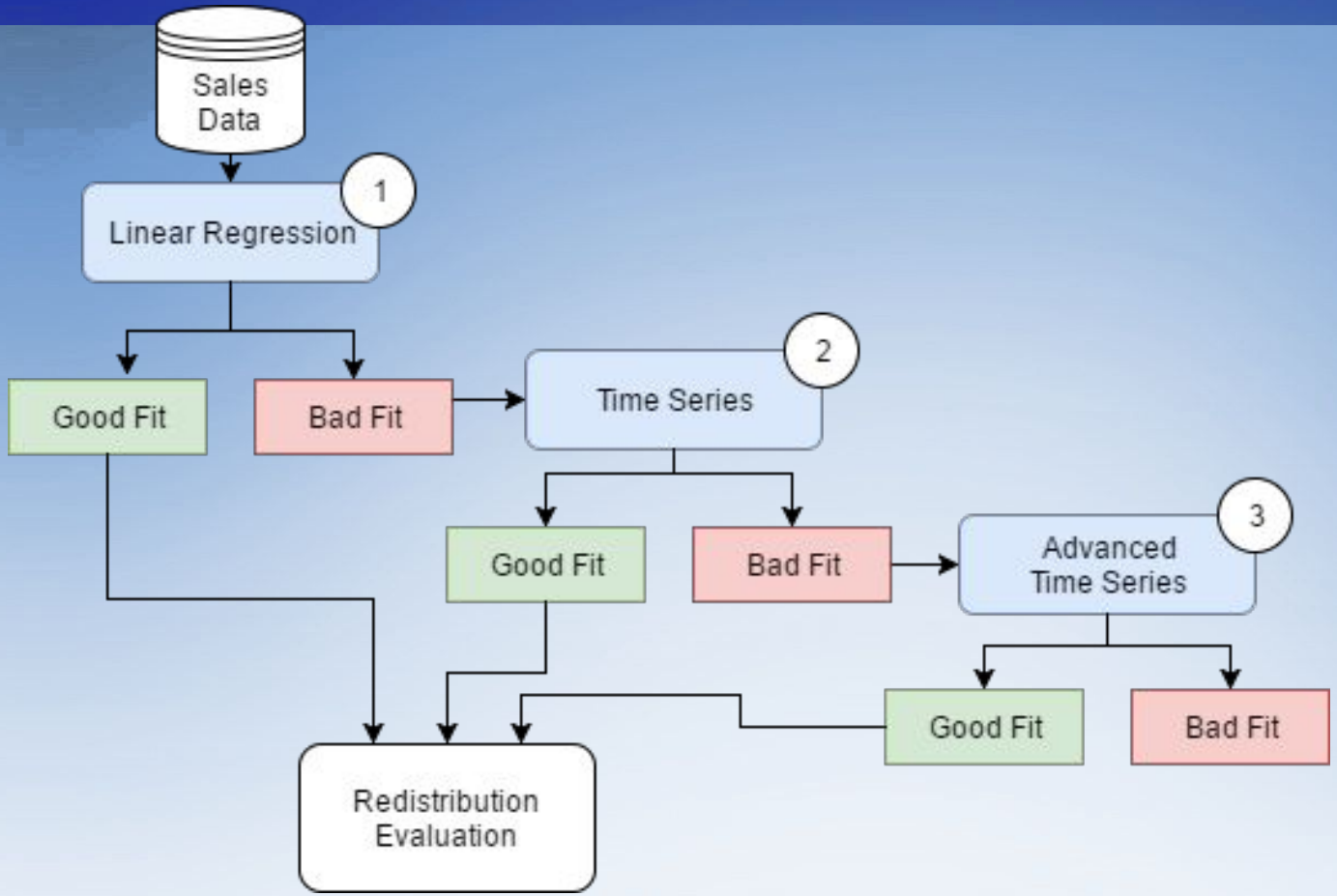
Problem Statement

- Be able to forecast future sales
- Use these forecasts to determine the optimum inventory for the various branch locations
- Look at current inventory and to see where improvements can be made in earns and turns performance
- Use product rationalization to remove redundant product from inventory

Our Approach to the Problem

- Narrow the data to something we can study
- Forecasting Models
  - ***Linear Regression***
  - ***Time Series***
- Engineer our own Forecasting Model
  - ***ADVANCED TIME SERIES***
- Tackle Product Redistribution by applying Predictive Model

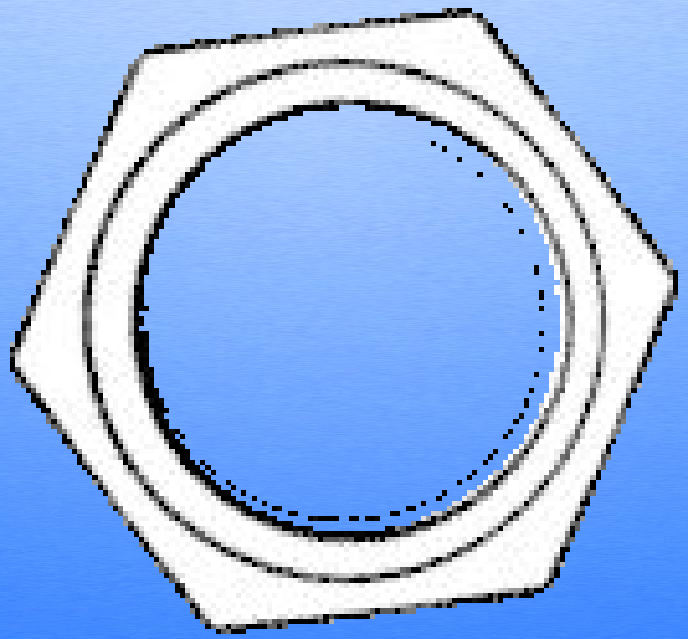
Summary of Our Process



How We Narrowed Our Scope

- Hub Cut
  - Computational constraints (too much for our 2.0/4.0 GHz processors)
  - Redistribution Costs remain reasonable (avoid transporting to a hub across the country)
- Traits of the Smallest Hub
  - Only 9 Branches (Fastenal's Hubs average at ~171 Branches)
  - 100,000 products
- Final Decision

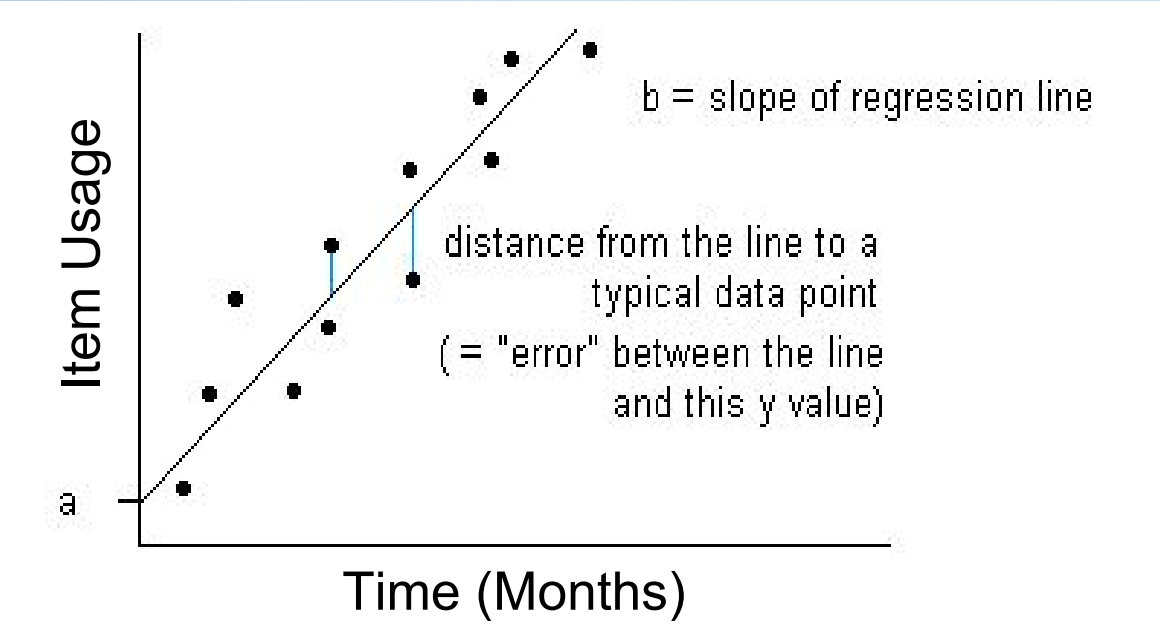
Of these 100,000 products we chose to analyze the top 4,000 products by volume



Linear Regression

What is Linear Regression?

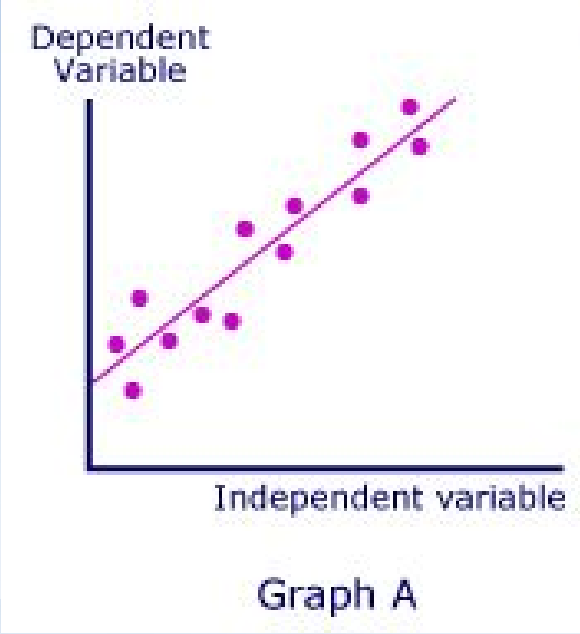
Line of Best Fit: Relationship Between Variables



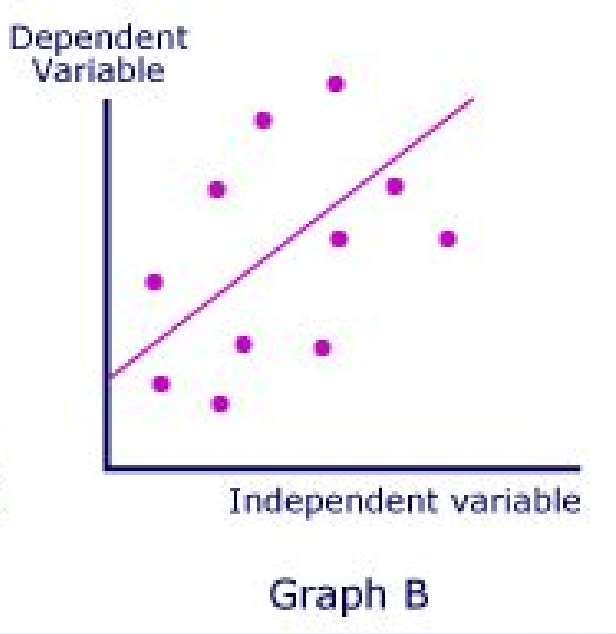
How Do We Measure Usefulness?

Measured Error (using R^2)

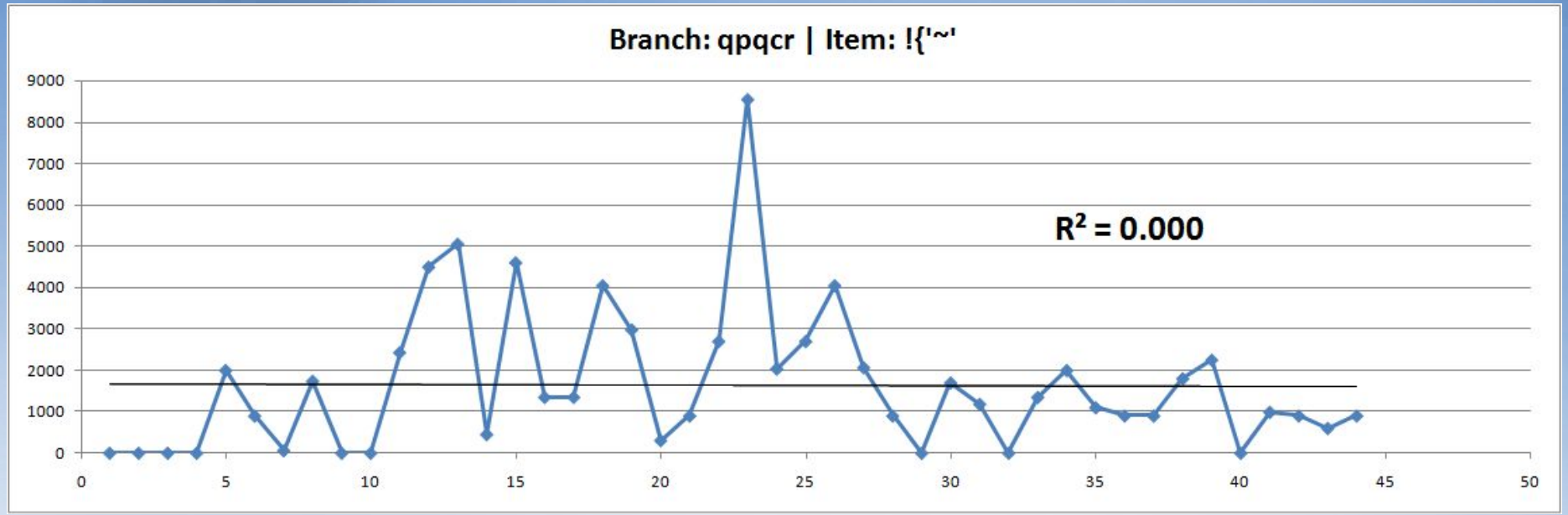
Good Fit ($R^2 = 0.9$)



Bad Fit ($R^2 = 0.2$)

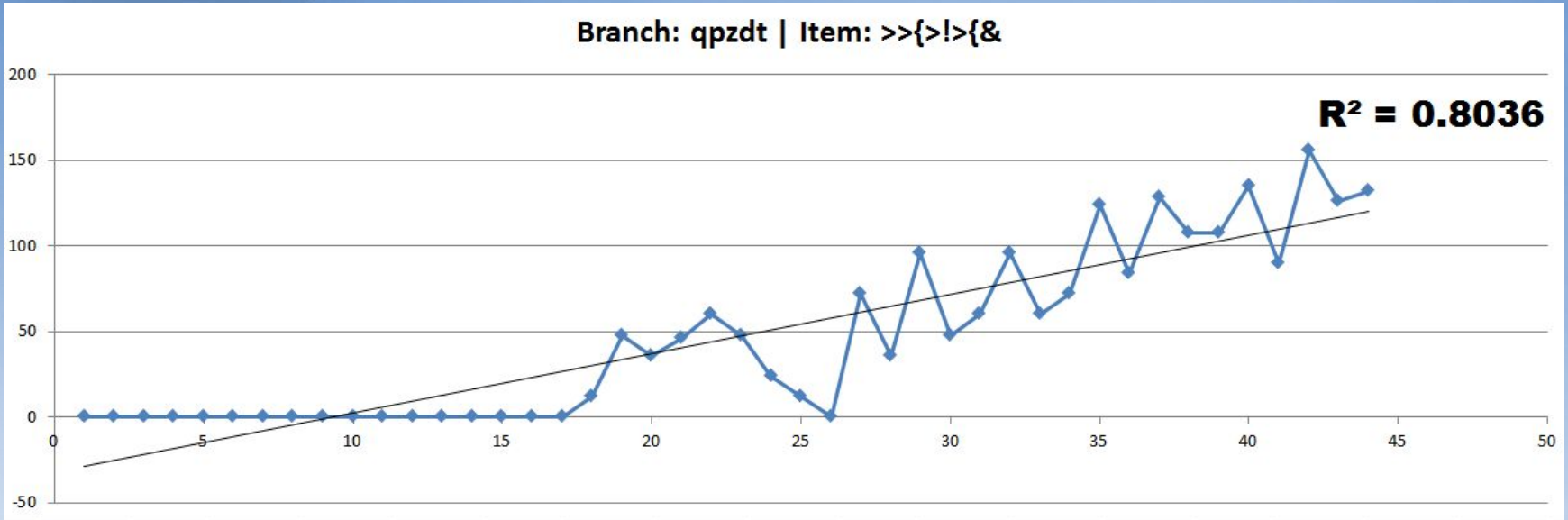


Simulated Accuracy



BAD FIT

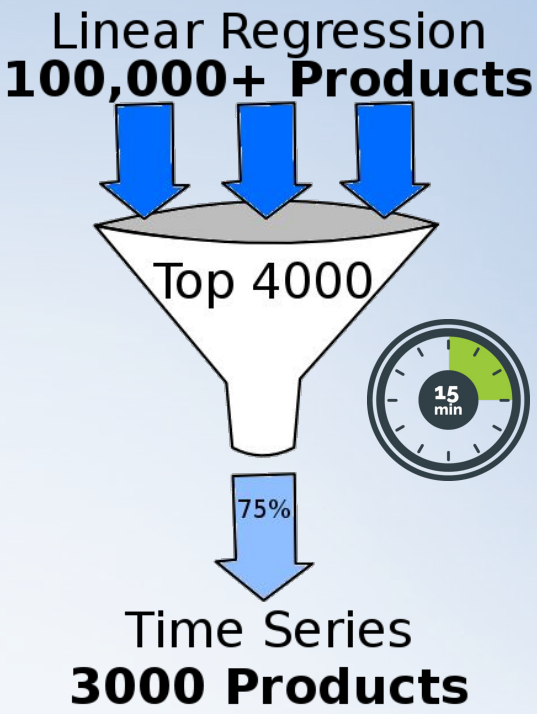
Simulated Accuracy

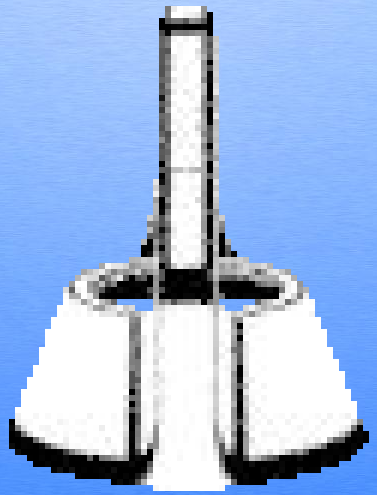


GOOD FIT

Usefulness of Linear Regression

- Efficiency
  - 15 minutes to run with 100,000+ items
- Effective
  - 25% of the top 4000 items **Accurately Modeled**
- The rest funneled to **Time Series**





Time Series

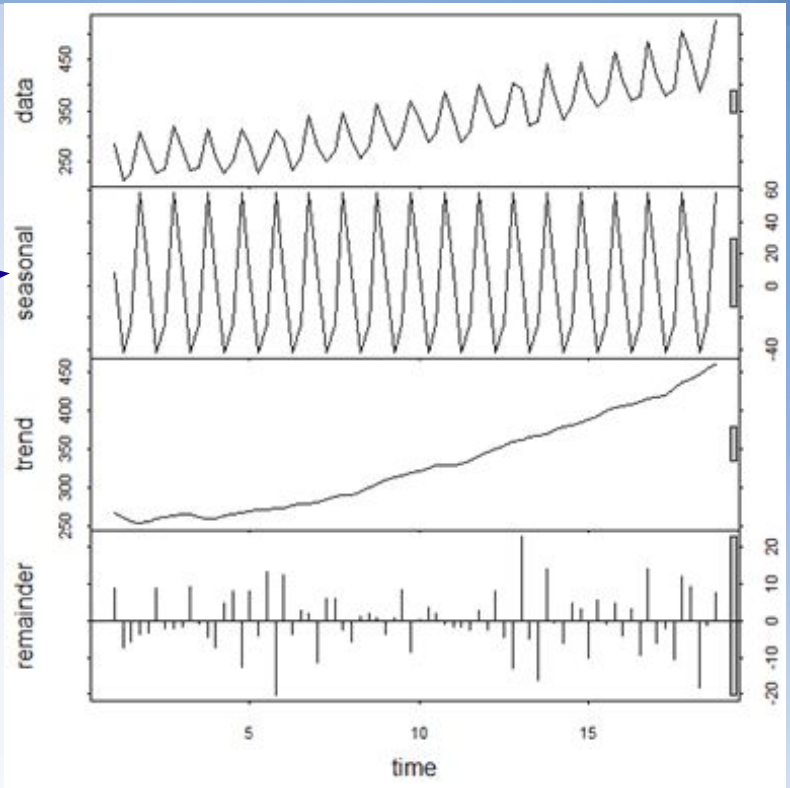
What is Time Series? Why Use It?

TIME SERIES

- Data with respect to Time

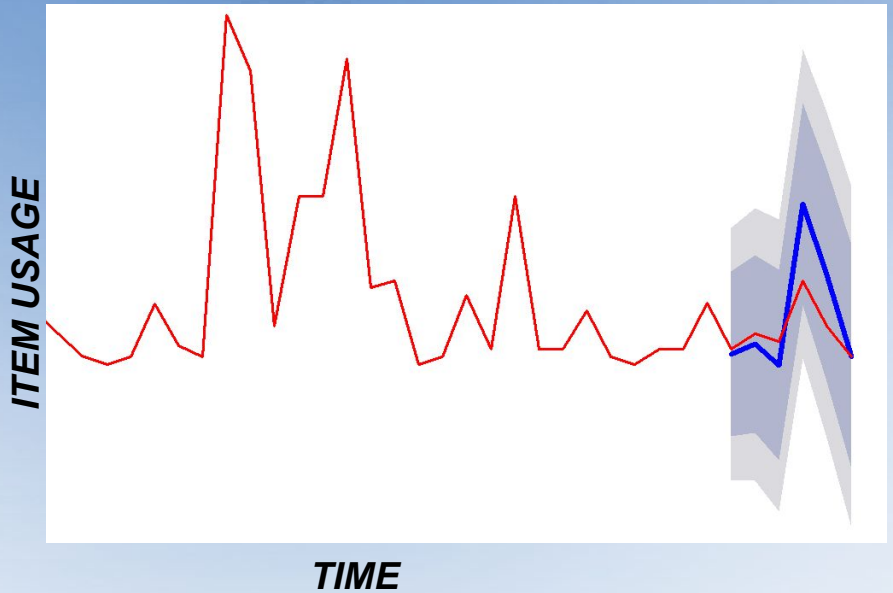
  X *= Time* ***Y*** *= Data*

- Accounts for **SEASONALITY**

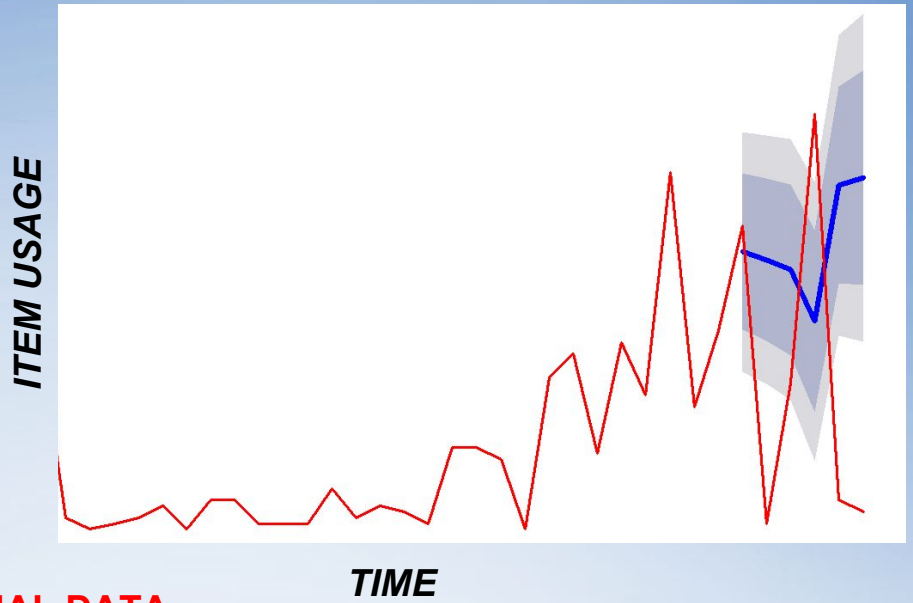


What Is A Good Time Series?

Good



Bad



RED = ACTUAL DATA
BLUE = PREDICTION

Something More Than *Basic*… *Something* *Advanced*

- We created an **Advanced** Time Series model
- How it is better than Basic Time Series:
  - Previous-20-month Training Sets
  - Predicts Sales AND get ***ERROR***
  - Smaller Confidence Intervals

Evidence of Improvement

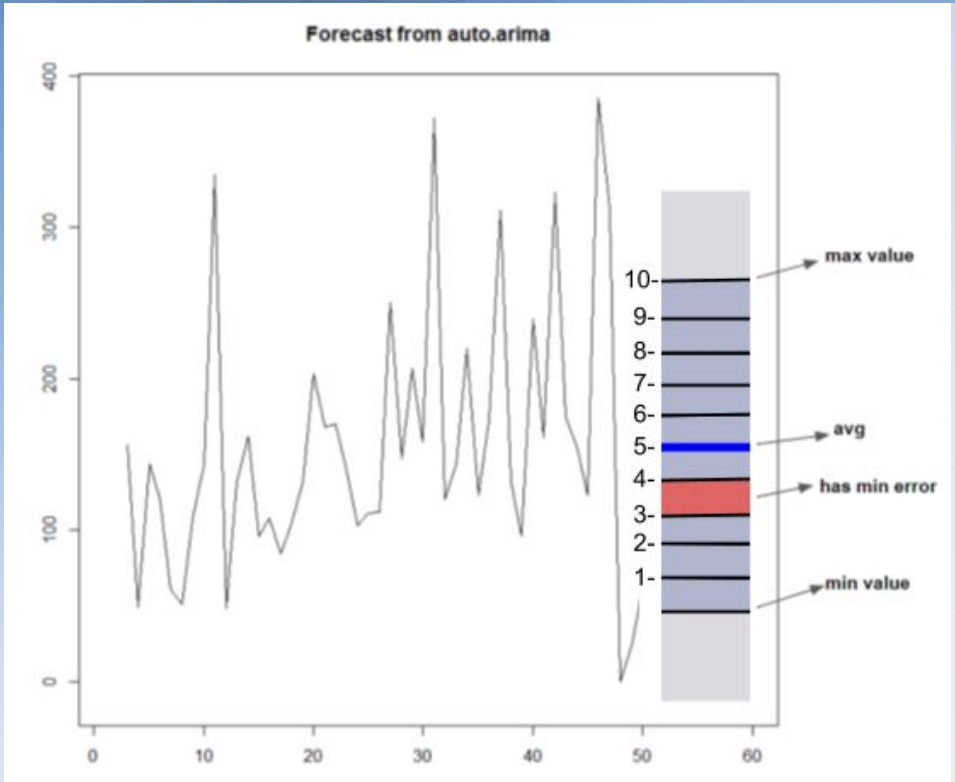
- Tested Models Against Real Data
- Simulated Predictions for Months 30 to 48
  - Training sets: previous-20-month steps

Training (months)	Test (month)
10 - 29	**30**
11 - 30	**31**
12 - 31	**32**
...	...
17 - 46	**47**

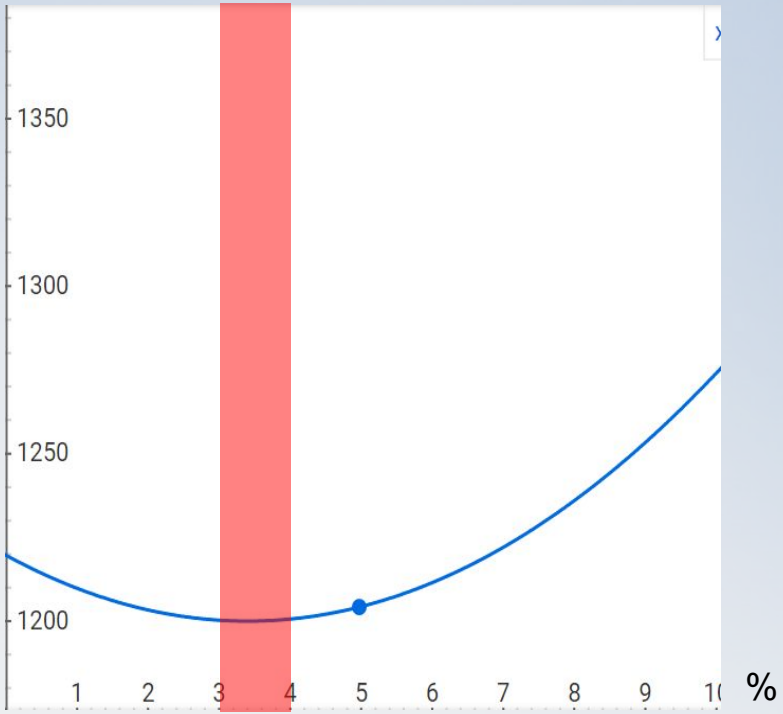
Confidence Level

	Advanced Time Series	*Basic Time Series*
Accuracy:	***80.5%***	***78.1%***
Interval:	***Smaller***	***Bigger***

How Advanced Time Series Collects Error



collectError



Result of Advanced Time Series

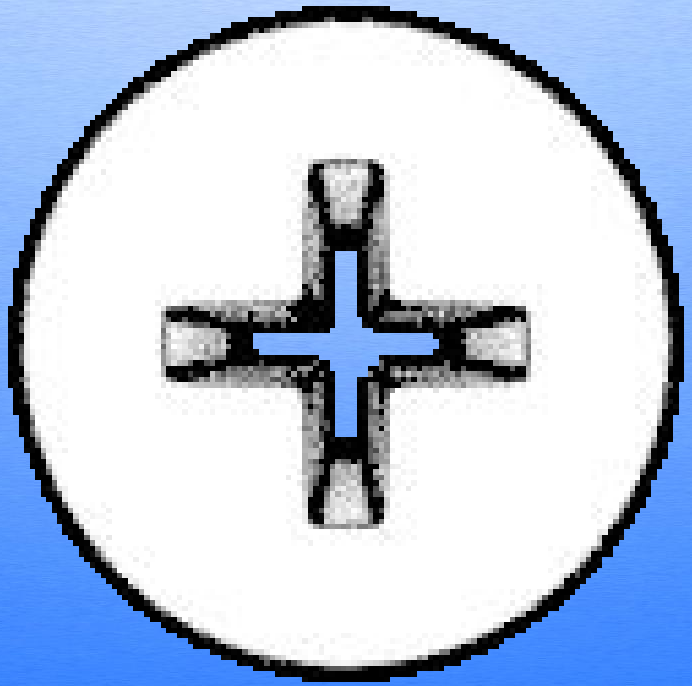
Example Simulation

Smallest Hub:

Branches: 9; Products: Top *69*; Item usage: 39,468; Month: *48*

----------MATCHED AGAINST ACTUAL DATA FOR MONTH 48----------

Predicted Item Usage with Minimum Error = ***16,412 items***

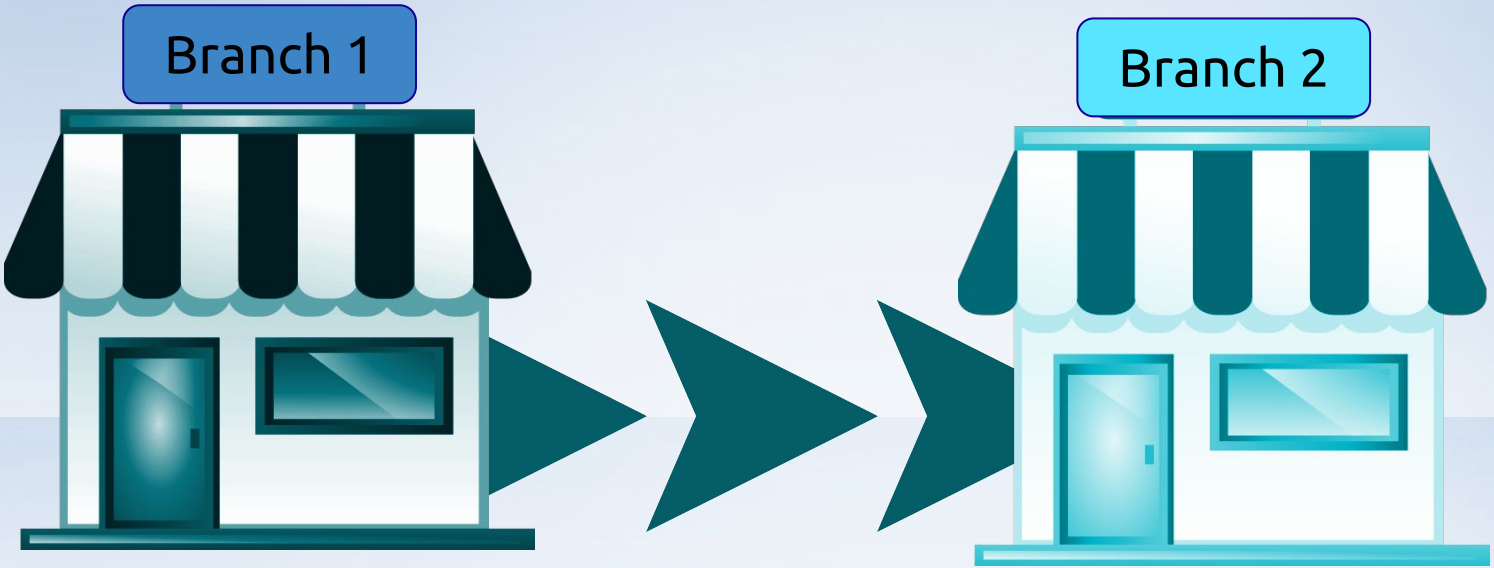


Redistribution

Redistribution

Move Products to Satisfy the Local Branches' Needs

- Move overstock to a location where they are more likely sell



Business Value

- Reduce chance of running out of stock
- Maximize sales while simultaneously reducing overhead
- Reduce risk when investing capital
  - Our Advanced Time Series is more accurate than Time Series used by other companies by **2.4%**

Conclusions

- We developed a process to forecast future sales
- Our Advanced Time Series model gives a **competitive edge**
- Our process can be used on any hub

Acknowledgements

- PIC Math
- Faculty Advisors: Dr. Chen and Dr. Vidden
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