Looking inside SAS® Forecast Studio

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Agenda

- SAS Forecast Server
- What is SAS Forecast Studio?
- SAS Forecast Studio most recent features
SAS Forecast Server – Issues Addressed

- The need for thousands (or even millions) of forecasts
  - Retailer with 4000 items x 8000 stores = 32 million forecasts
  - Electric utility “Smart Grid” – millions of time series

- The need to generate these forecasts automatically with limited personnel
  - Cannot hire hundreds of analysts to manually generate forecasts

- The need for quality forecasts (as accurate as can reasonably be expected given the nature of demand)
  - Based on good data and sound statistical practices
  - Forecasts that can be trusted to drive downstream processes such as Sales & Operations Planning and Replenishment
SAS Forecast Server - Issues Addressed

- Time-stamped data must be converted to time series data and managed automatically
  - Convert transactions from inventory / distribution systems, web sites, retail POS, call centers, etc. into time series

- Handling external factors that may or may not influence the time series
  - Housing starts, interest rates, temperature, etc.

- Handling calendar events that may or may not influence the time series
  - Disasters, price changes, promotional activity, etc.
Data Issues

- Continuous Time Series
  - Level, Trend, Seasonal, Cycle, etc.
  - Inputs (Causal) Effects, Calendar Effects
- Intermittent (or Interrupted) Time Series
  - Constant base value (typically zero)
  - Intermittent departures from the base value
- Life-Cycle/New Product Time Series
  - Finite beginning and/or ending time

Hierarchical Time Series

- All of the above properties in a hierarchical context
SAS Forecasting Overview: Business Requirements

- Three business requirements being addressed:
  - Scalable
    - A very large number of forecasts need to be produced quickly, but existing forecasting software could not scale
  - Manageable
    - There are too many forecasts to create and manage with limited personnel
  - Trustworthy
    - System generated forecasts were not trusted – requiring manual review and management override
SAS Forecasting Overview: User Personas

- SAS Forecasting products such as SAS/ETS and SAS High-Performance Forecasting addressed needs of the “traditional” SAS user:
  - **Statistical End User**
  - **High-End Data Analyst**

*But not every company has statisticians and SAS programmers on staff!*
SAS Forecasting Overview: User Personas

- SAS Forecast Server adds a GUI to address needs of another type of user:
  - Business Analyst

The power of SAS Forecasting can now be accessed by non-programmers!
SAS Forecast Studio users?

• Novice forecasters and business analysts
  – Automated model building
  – “Forecasting view” of output: graphs and data tables

• Experienced forecasters and analysts
  – Interactive model building
  – “Model Analysis” and “Series Analysis” in-depth views
  – “Scenario Analysis” View

• Consumers of forecasts
  – Predefined and customized reports and procedures
  – Export of forecast results to Excel, OLAP, other formats
  – Use SAS data set to feed other SAS Solutions and downstream planning systems
Today we’ll focus on SAS Forecast Studio
What is SAS Forecast Studio?

- **SAS Forecast Server** provides an enterprise environment for large-scale automated forecasting
- Users can work interactively using the **SAS Forecast Studio GUI** – or – create code to use in a batch environment
- Produces large volumes of forecasts quickly and automatically – letting analysts focus on exceptions
- Provides tools for analyst intervention in strategic and “high value” forecasts

The objective is to **generate a large number of forecasts** which are as **accurate** and **unbiased** as one can reasonably expect them to be, and **to do this as efficiently as possible.**
Large-scale forecasting using SAS Forecast Studio

- Forecast Studio is a large scale, automated forecasting system.
- Forecast analysts can quickly set up forecasting projects and run them.
- “80/20” rule: most forecasts are just fine, but the “problematic” or high-value ones can be easily identified, and time/energy focused on those.
- Full array of tools for advanced forecasters and statisticians to work with time series and with models, creating custom models for their forecasting problem.
- Scenario analyzer allows what-if modeling using the models fit by FS, which represent the underlying functional relationship between the dependent and independent variables, which has been identified and modeled by FS.
- Results are in a SAS data set, ready to be used – in SAS or exported to another application.
Main Functionalities

- Choice of automation level
  - Diagnosis
  - Model selection
  - Parameter setting
  - Forecast generation
- Scalability
- Events management
- Flexible hierarchies
- Extensible model selection list
  - Built in models or add your own customized models
- Extensible reporting through stored processes
- Scenario Analysis (what if?)
SAS Forecast Studio vs coding

- **Forecast Studio and High-Performance Forecasting:**
  - Combination Models
  - Custom Time Interval Support

- **Forecast Studio only:**
  - Rolling Simulations
  - Roles and capabilities
  - Start-up and shut-down code
  - Copy projects
  - Export model selection list
  - New override features
Combination Models

- Combining different forecasts (sometimes referred to as “Ensemble Models”) to produce another forecast
- Useful if individual models produced large errors
- Can significantly improve forecast accuracy
Combination Models

- Weighted combinations of different time series forecasting models are often found to produce more accurate forecasts than any of the individual models.

- SAS Forecast Server allows you to combine any number of time series forecasting models from the various model families (ARIMA, UCM, IDM, ESM)

- The combination techniques available include:
  - Simple Average, User Defined Weights, Ranked Weights, OLS Weights, RLS Weights, LAD Weights, AICC weights, etc.

- Additionally, it is possible to automatically generate the forecast model combinations:
  - Diagnostics that use Encompassing Tests to select candidate models to combine
Combination (Ensemble) Models - a closer look

Forecast Studio implementation

- In the “Modelling View” select “Combine models”
- Choose the models you want to combine, how to combine them etc.
Combination (Ensemble) Models

Forecast Studio implementation

Select combined model during project creation
Rolling Simulations

- Prior to implementing your forecast model it is important to get an idea of how stable the forecasting model will be over time.

- Rolling simulations enable you to iteratively simulate the forecasting process and:
  - allow you to analyze the ex-ante forecast performance of time series models at various forecast origins
  - allow you to analyze the ex-ante performance at various forecast leads (steps-ahead)
  - allow you to choose the best forecasting model based on simulated performance
Rolling Simulations

Forecast Studio implementation only*

- Iteratively simulates the process generating the forecasts at the selected level in the hierarchy (left hand side)

* Using a combination of Base SAS, High Performance Forecasting procedures and reporting you can perform the same task using code
After selecting the number of periods to include in the simulation and number of periods in the forecast horizon, Forecast Studio reestimates the selected model and produces forecasts.

In this example, 12 periods are used.

A line containing the out of sample forecasts is shown for each iteration and the forecasts are indicated in bold in the table below.
Rolling simulations

- The Simulation Statistics tab summarizes the results of the simulation.

- For each lead time a fit statistic is calculated and shown in the graph. In the example with 12 periods a lead time of 1 is encountered 12 times, a lead time of 2 encountered 11 times etc.