R in Supply Chain: Mallinckrodt Pharmaceuticals' Experience with Demand Forecasting in R

Laura D. Rose

1/18/2022

My background

- I work in the Demand area of the Supply Chain Department of Mallinckrodt Pharmaceuticals Specialty Generics division.
- Job responsibilities include statistical forecasting and measuring forecast accuracy.
- I had only about 5 months of experience regularly programming in R when I started the project.

How it began...

- My pandemic project was creating a Shiny app for time series forecasting.
- I got inspiration for the app from an R Ladies STL meetup.
- My manager was impressed by the app and wondered if we could save money by replacing the SaaS we currently used for statistical forecasting.
- The SaaS cost around $200K per year, and generated negative-number forecasts that the IT support for this company could not root-cause.

First Steps

- ▶ I collected some demand data and did a rolling forecast accuracy analysis to get an idea of the accuracy we could expect if we switched to the R `forecast` package automatic forecasting functions, such as `ets()`, etc.
- ▶ The `ets()` function was comparable to the models used in the SaaS.
- ▶ The accuracy of the automatic `ets()` function was comparable with what we were currently getting from the SaaS, which required manual intervention from the Demand Analyst/Manager.
- ▶ Thus the decision was made to move forward with the project, contingent on the support of the IT group.

Initial Stages of the Project

- ▶ The money for the SaaS came out of the IT Department's budget, so we had to get buy-in from them to move ahead with the project.
- ▶ This wasn't difficult, as they were interested in saving money as well and were frustrated with the lack of support from the SaaS company and the time required for IT analysts to figure out what was going wrong.
- ▶ The decision was made to explore enterprise-capable options for R Studio, instead of just having me run scripts/schedule jobs on my laptop with R Studio Desktop, as I had been doing up till then.
- ▶ This led us to look into R Studio Server Pro (the more recent version is R Studio Workbench), and we contracted with Lander Analytics to help with the server setup and maintenance and application installation.

Project Process

- The IT analyst who was responsible for maintaining the data used for statistical forecasting collaborated with me to replace data management previously done by the SaaS with in-house solutions .
- This included creation of demand history tables (both cleansed and non-cleansed history), since I would need to access demand history by SKU/customer group/location via ODBC connection and some basic SQL in order to estimate the models and calculate the forecast.
- The outlier cleansing process changed as well, since we had previously cleansed history directly in the SaaS application.
- We also needed a table to store the statistical forecast generated from the R script, as well as a table for historical forecasts used for measuring forecast accuracy.

Other Benefits of the Project

- ▶ We were able to use R Studio Server Pro for other uses besides statistical forecasting.
- ▶ I had previously written R scripts to do many data analysis and wrangling tasks (measuring WMAPE, checking Commercial forecast upload vs. download from our ERP system, analyzing customer orders vs. forecast, etc.), and we set these up as jobs to run on the server using `cronR`, an R package which interfaces with cron.
- ▶ These scripts saved a lot of time, since we were able to measure MAPE and compile data/reports with little-to-no intervention from Demand Managers.
- ▶ When I was out on short-term disability this summer, the jobs ran well and saved my coworker a lot of time.
- ▶ My coworker left the company in November, and being able to schedule and run scripts has made it possible for me to effectively do his previous job duties as well as my own and to hopefully improve processes.

Summary of the Project

- ▶ From the time I completed the original rolling forecast accuracy analysis to the time we went live with R Studio Server Pro was about 11 months (June 2020-May 2021).

- ▶ There are still more improvements to be made to our forecasting processes, but the project completed the initial goal of replacing the SaaS with a solution at least as effective.

- ▶ Forecast accuracy (lag 3) has been about the same, maybe slightly worse (a few percentage points), than what we achieved with our expensive SaaS, but we met our goal for statistical forecast accuracy in 2021.

- ▶ Still, the slight trade off in accuracy, which will probably be improved over time as we introduce new models, etc., was definitely worth the cost savings.

- ▶ Instead of the `forecast` package I originally started with, I switched to the `tidyverts` suite of packages. I have found these to be very useful for automatic forecasting and produce stable models for supply chain forecasting which require little user intervention.

Future State of R Forecasting & Analysis at Specialty Generics

- Even though the impetus for the project started with a simple time series app, we made the decision to forecast with a script scheduled as a monthly job, instead of an app.
- However, I've since developed a Shiny app that allows the Demand Manager to interactively play with changing parameters and cleansing history for the exponential smoothing and other univariate models, to choose a specification they believe to be optimal.
- This mimics a lot of the functionality we had in our previous SaaS.

Future State of R Forecasting & Analysis, continued

- ▶ I'm also working on another Shiny app to visualize our Generics data with a pivot table and monthly/weekly bottles/doses, per user specification.
- ▶ This will hopefully replace a slow tool that we use to create visualizations for our Demand Review slide deck.
- ▶ I recently started collaborating with the Commercial team with the goal of automating some of their forecasting processes by comparing end-purchaser demand as it rolls up under our distributor customers with pricing contracts.
- ▶ Finally, there are other forecasting options within the `tidyverts` packages (such as hierarchical forecasting) and other packages with machine learning methods (e.g., `modeltime`) that we may explore in the future as time allows.

What We Learned from the Project

- If you are interested in replacing a SaaS at your company by a certain date, start the project sooner versus later.
- The SaaS often performs other functions besides forecasting, so you will need to come up with solutions for data storage and management.
- Make sure you have an estimate of the time involved on your part as well as time from any collaborator(s), and that the estimated time is consistent with the time they have available.
- Learning project management skills ahead of time will be helpful.
- Map out your current process at the start of the project. You don't want to realize you haven't accounted for something you previously relied on the SaaS to do when you've almost completed the project.
- Murphy's Law: If something can go wrong, it will.

Questions?