IE375 Spring 2020

A note on Initialization and Parameter Selection in Time-Series Analysis

- Always keep in mind the assumptions of using time-series analysis for forecasting.
- Searching for approaches other than available in the text-book will probably be needed in a real-life application – that is the reason why you have to learn the basics so that you can extend your knowledge to deal with specifics of the case you want to handle (basics of engineering).
- Hypothesize a demand structure before you follow the below procedures.

How to initialize time series forecasting?

Let current time be t=0. Let us presume that we have T_1 data points available.

1. Divide the data set into two parts: [$-T_1$, $-T$] and ($-T$, 0], where $|T| < |T_1|$.
   - No rule to select the size of the parts. Recommendations on sample size needed for estimation of parameters can be used to determine the number of periods that make up the first part.
2. Use standard statistical techniques or specifically designed approaches to estimate various components of the time series for time $-T$. (example: For demand structure with trend, estimate S_{-T}, G_{-T}).
   - Note that I haven't mentioned any of these methods in class. The text-book contains some methods of doing it (and of course there are many others) and you are responsible to actually do the initialization given a method. It is likely that exercise or homework questions require you to do the initialization. For homework and exercise problems, if it is not clear which method is asked for you can use any of the available methods in the text presented for the given demand structure. You do not need to memorize any of the methods for the exams as you will be given the description of such a method in case there is a question asking for it.
3. Apply smoothing formulas for time periods in ($-T$, 0] using one additional demand value at a time. Eventually, obtain estimates for various components of the time series for time t=0. These values can be used as initial values of your time-series formulas for forecasting future periods.
   - Note that the second part of the data, which is used for smoothing the values of various components of the time series is sometimes called "training" data – you train your smoothing functions using the available data, and the data used is independent of the data you used to initialize the smoothing process.
   - While applying the formulas, one would use any set of parameters needed for the formulas – in smoothing type time-series model, smoothing constants are the parameters in question. This is also the issue considered next in the next section.

How to select parameters of the forecasting method used?

Sometimes we call this step as "optimization" step to compute parameters of the forecasting model. Nevertheless, it is not a functional optimization, but simply selection of the best parameter value (given the discrete increments selected) using the available data and enumeration.

1. Select possible values for parameter values to be decided (as an example set the ranges of smoothing constants you need to determine for the forecasting model in question). Let $\mathbb{S}$ define the set of all possible parameter combinations. Also let **M** be defined as the measure to be used to evaluate forecast error. Note that **M** can be one of the mentioned measures in class, MSE, MAD, MAPE, or another compatible measure.
2. For each set of parameters element of $\mathbb{S}$ carry out the computations stated in Step 3 of "How to initialize time series forecasting?" with same *T*. Then compute the one-period ahead forecast error obtained for each period and eventually using all forecast errors compute **M**.
3. Select the set of parameters which yields the minimum value for **M**. This set of parameters is what you use in your forecasting formulas.
   - Note that in order to be able to differentiate among different sets; you need to have a reasonably-sized data for the second part.
   - Sanity check: If any of the parameters selected turns out to be very close to the extremes of the range you assigned in Step 1, check the correctness of the demand structure you hypothesized before you start implementation. If needed redo all the analyses again with a better-fitting demand structure.