USER GUIDE

Revenue Management Forecasting Aggregation Analysis Tool (RMFAA Tool)

by Gary M. Thompson

CONTENTS

This guide is intended for use with the Revenue Management Forecasting Aggregation Analysis Tool (RMFAA) Tool, which is available for free download through the link on the accompanying page. The contents of this guide are: Overview, Getting Started, Data Requirements, Aggregation/Disaggregation Options, Forecasting Models, Error Measures, Results, and Tool Limitations.

Overview of the RMFAA Tool

The RMFAA tool is designed to help hoteliers identify the best level of aggregation to use in their revenue management forecasts of room demand. Hotel revenue managers (or revenue management systems) typically forecast the number of arriving guests (i.e., demand), for each day of arrival, for each length of stay, and each rate class. If, for example, a property tracks lengths of stay from one to seven nights, and five rate classes, that would require 35 forecasts for each day of arrival.

In making these forecasts, you have four options. First, you can forecast the total number of arrivals for a day and then break that number into length-of-stay and rate classes using historical proportions (i.e., full aggregation). Second, you can forecast the total number of arrivals for a particular day in each rate class and then break that number into lengths-of-stay using historical proportions (i.e., aggregation by rate class only). Third, you can forecast the total number of arrivals for a given day in each length of stay and then break that number into rate classes using historical proportions (i.e., aggregation by length of stay only). Finally, you can develop independent forecasts of the total number of arrivals for a day for each length-of-stay and rate class (i.e., no aggregation).

Based on the data you provide, the RMFAA tool determines which of these forecasting approaches works best for your property. To use the tool with something other than the sample data it contains, you'll need to provide the historical numbers of arrivals, by day, by length of stay, and rate class. Ideally, you should use unconstrained demand information (i.e., requests) and have two or more years of data.

Getting Started

Three steps are necessary to use the RMFAA tool:

- You must run the "Rev Mgt Forecasting Disaggregation Tool.exe" file. This file installs the portion of the tool that develops the forecasts (and is much faster than a comparable Excel macro).
- You must specify the data within the Excel spreadsheet.
- You must click one of the "Run" buttons you will find in the spreadsheet. This will open the interface that allows you to specify which forecasting models to evaluate.

Exhibit 1

Parameter worksheet

	A	B
	Parameter	**Value**
1	Number of Lengths of Stay (<= 7)	7
2	Number of Rate Classes (<= 5)	5
3	Number of Days of Historical Data (no limit)	156
4	Number of Days to Initialize Forecast Parameters	14
5	Number of Days to Forecast	14
6		
7		
8	**Rate Class**	**Description**
9	Rate Class 1	100
10	Rate Class 2	120
11	Rate Class 3	140
12	Rate Class 4	160
13	Rate Class 5	rack

Exhibit 2

Historical data specification (LOS worksheets, detail)

	RC 1	RC 2	RC 3	RC 4	RC 5
Day	100	120	140	160	rack
1	6	6	8	11	12
2	3	5	13	18	14
3	3	7	4	12	14
4	4	7	14	17	20
5	5	8	8	16	17
6	3	8	7	10	17
7	3	5	21	16	19
8	3	8	12	17	25
9	4	7	13	10	18
10	4	4	7	15	11
11	2	3	4	14	18
12	5	4	10	13	23
13	3	2	3	11	16
14	6	10	15	19	18

Data Requirements

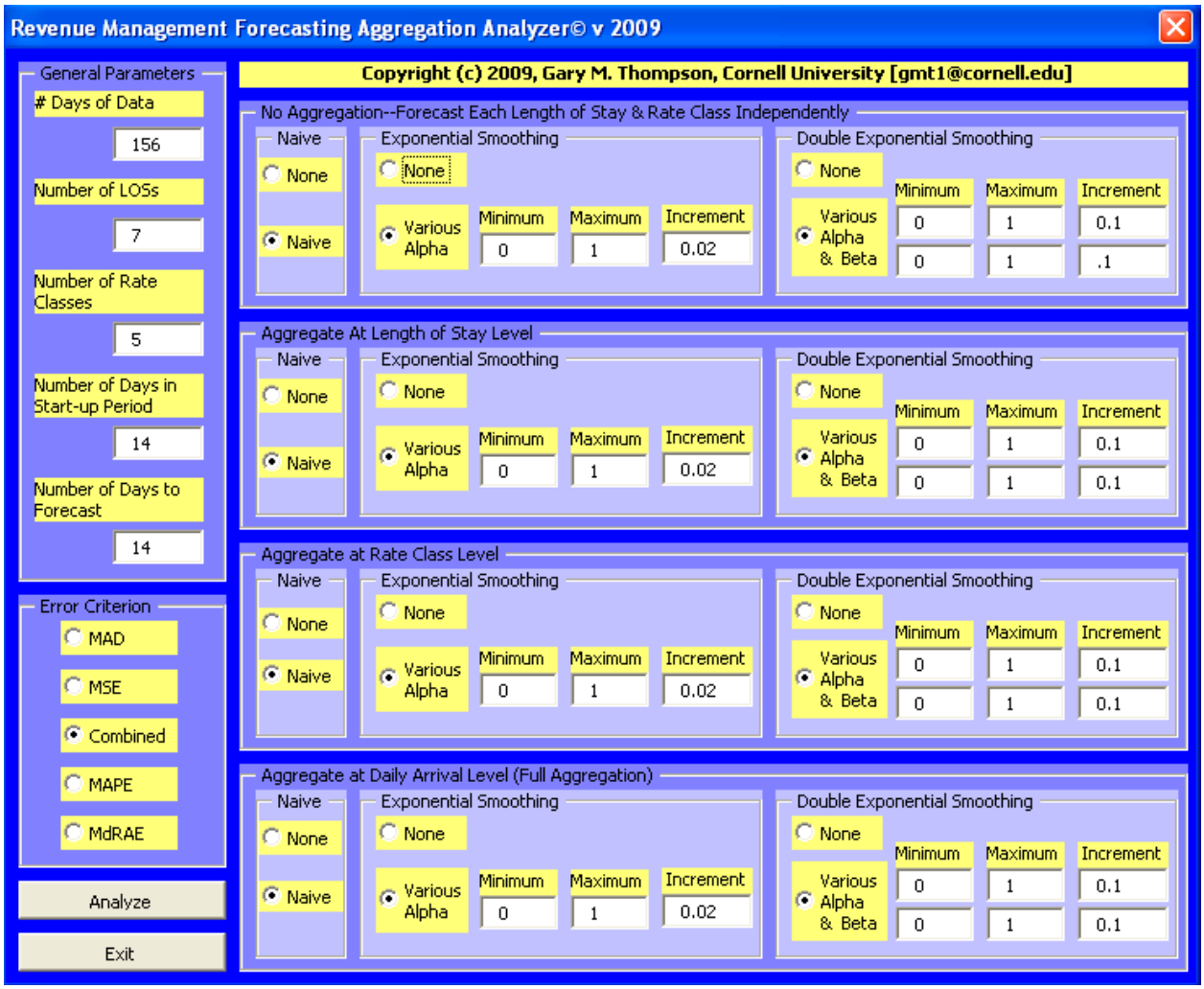
The RMFAA tool requires that you specify both parameters and the historical data that will be used to evaluate the forecasting methods:

Parameters. The required parameters can be found on the "Parameters" sheet, as illustrated in Exhibit 1. These parameters can also be changed in the forecasting interface, which you will see after clicking any of the "Run" buttons in the spreadsheet. The parameters you must specify are: the number of lengths of stay being evaluated, the number of rate classes, the number of days for which you have historical data, the number of days of data to be used to initialize the forecasting parameters, and the number of days ahead to forecast. In addition, you can provide identifying labels for each of the rate classes. All of these values can be entered directly in column B of the "Parameters" worksheet.

Historical Data. You must specify the historical data on the "LOS x" sheets, where x represents the particular length of stay (i.e., a number between 1 and 7). A specific example of one of the LOS worksheets is illustrated in Exhibit 2. Each entry in the LOS worksheet should represent an historical demand value. For example, the values of 3, 7, 4, 12, and 14 shown in row 5 in Exhibit 2 are the historical demand values on day 3 for rate classes 1 through 5, respectively.

Exhibit 3

The interface form for specifying the aggregation level, forecasting method, and error measure



Once the parameters have been set, and the historical data provided, it is time to open the Aggregation interface form, which you can do by clicking on any of the "Run" buttons found in the spreadsheet. The form itself is illustrated in Exhibit 3, while the information specified in this form is described in the next sections.

Aggregation/Disaggregation Options

The RMFAA tool evaluates the four aggregation-disaggregation options, as shown in the four boxes on the right side of the interface form shown in Exhibit 3:

1. **No aggregation**. With this option, forecasts are performed independently for each combination of rate class and length of stay for each arrival day.
2. **Aggregate by Length of Stay**. Here, forecasts are done for each length of stay for each arrival day. These forecasts are then broken into each combination of rate class and length of stay using the historical proportion for the rate class under the particular length of stay.
3. **Aggregate by Rate Class**. With this option, forecasts are done for each rate class for each arrival day. These forecasts are then broken into each combination of rate class and length of stay using the historical proportion for the length of stay under the particular rate class.
4. **Full Aggregation**. Here, forecasts are done for the day as a whole, and then broken into each combination of rate class and length of stay using the historical proportion for that combination.

Forecasting Models

The RMFAA tool will evaluate three different methods of forecasting for each level of aggregation. The forecasting methods are specified in the interface form within each aggregation option. Two of the forecasting methods can be implemented with a wide variety of specific parameter values:

1. **Naïve**. The naïve forecasting method simply uses the last demand value as the next forecast.

2. **Exponential Smoothing**. Exponential smoothing is a form of weighted moving average. It uses a single parameter, alpha, which ranges from 0 to 1. Higher values of alpha place more emphasis on recent data and so are better when the mean demand has recently changed. Low values of alpha put less emphasis on recent data, and so are appropriate for situations where there is random variation around a stable average.

3. **Double Exponential Smoothing**. Double exponential smoothing is a form of averaging that incorporates a trend component. It uses two parameters, alpha and beta, which each range from 0 to 1. Alpha works the same way it does in exponential smoothing. Higher values of beta place more emphasis on recent data and so are better when the trend has recently changed. Low values of beta put less emphasis on recent data, and so are appropriate for situations where there is random variation around a stable trend.

Error Measures

The RMFAA tool allows you to select one of five error measures, which is done in the bottom left portion of the interface form shown in Exhibit 3. The forecasting method that yields the lowest error, for the selected error measure, is the one used to generate the future demand forecasts. The error measures are:

1. **MAD, or Mean Absolute Deviation**. This the average value of the absolute errors.

2. **MSE, or Mean Squared Error**. This is the average of each of the squared error values.

3. **Combined**. This measure equals MAD+MSE+the absolute value of the bias (which measures whether the forecast is consistently too high or too low).

4. **MAPE, or Mean Absolute Percentage Error**. This averages the absolute values of errors, expressed as a percentage of the actual demand.

5. **MdRAE, or Median Relative Absolute Error**. This measures the error as a proportion of the error for a naïve forecast (where a naïve forecast is simply the last actual demand).

Exhibit 4

Results worksheet (detail)

	A	B	C	D	E	F
		Error Measures				
	Aggregation Method	MAD	MSE	Combined	MAPE	MdRAE
1	Disaggregate, ExpSm Alpha=0.040	2.734809	13.21489	18.68451	27.45875	2.25
2	Disaggregate, ExpSm Alpha=0.060	2.737626	13.2664	18.74165	27.48108	2
3	Disaggregate, ExpSm Alpha=0.020	2.748491	13.33561	18.8326	27.51971	2.5
4	Disaggregate, ExpSm Alpha=0.080	2.743058	13.36922	18.85533	27.48956	2
5	Disaggregate, ExpSm Alpha=0.100	2.754728	13.47062	18.98008	27.5787	2
6	Disaggregate, ExpSm Alpha=0.120	2.770221	13.61288	19.15332	27.70147	2
7	Length of Stay, ExpSm Alpha=0.040	2.777062	13.71066	19.26479	27.80359	2
8	Rate Class, ExpSm Alpha=0.080	2.780081	13.71529	19.27545	27.79638	2
9	Length of Stay, ExpSm Alpha=0.060	2.778873	13.71932	19.27706	27.82593	2
10	Rate Class, ExpSm Alpha=0.040	2.778471	13.73662	19.29356	27.74917	2
11	Length of Stay, ExpSm Alpha=0.020	2.783903	13.72676	19.29457	27.81414	2
12	Rate Class, ExpSm Alpha=0.060	2.781891	13.73159	19.29537	27.79584	2
13	Rate Class, ExpSm Alpha=0.100	2.783702	13.75312	19.32052	27.82417	2
14	Disaggregate, ExpSm Alpha=0.140	2.783099	13.75453	19.32072	27.79184	2
15	Length of Stay, ExpSm Alpha=0.080	2.783099	13.76217	19.32837	27.86225	2
16	Length of Stay, ExpSm Alpha=0.120	2.790141	13.75755	19.33783	27.96473	2
17	Rate Class, ExpSm Alpha=0.120	2.784708	13.77746	19.34688	27.80969	2

Results

Running the analysis yields the following results, which are found on the "Results" sheet, and illustrated in Exhibit 4:

1. **Forecasting methods**, ordered from best to worst, based on the error measure you specified, which are listed in column A.
2. **Error measures**, for each of the combinations of forecasting models and aggregation/disaggregation options you had selected, which are listed in columns B-F.
3. **Highlighting the best value** of the error measure you had specified, for the best performing forecasting model (row 2, in one of columns B-F, corresponding to the error criterion you had selected).
4. **Forecasts** for the number of future days you specified (in columns H through J+ and rows 3+). These forecasts are made using the best-performing forecasting method.

RMFAA Tool Limitations

As with any analysis tool, the RMFAA tool has limitations:

- It is limited to 7 lengths-of-stay.
- It is limited to 5 rate classes.
- It does not implement any forecasting methods that use booking curve data (e.g., pickup methods). It develops the forecasts using only the full set of historical data.

Errors, Questions or Suggestions

If you experience any errors while using the tool, if you have any questions about its use, or have suggestions for enhancements, please contact Professor Gary M. Thompson, at gmt1[at]cornell.edu. ■

ABOUT THE AUTHOR

Gary M. Thompson, Ph.D., is professor of operations management at the Cornell University School of Hotel Administration (gmt1@cornell.edu), where he teaches undergraduate and graduate courses in service operations management. His research, which focuses on wine cellars, restaurant operations, scheduling conferences, and on workforce staffing and scheduling, has appeared in a number of outlets. He has consulted for several prominent hospitality companies and is the founder and president of Thoughtimus, Inc., a small software development firm focusing on scheduling products.