

FORECASTING HOTEL OCCUPANCY

for JHM Hotels, Inc.



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Background on JHM Hotels, Inc.

- National multi-brand hotel management company
- Founded in 1981
- 29 hotel properties with over 4,000 rooms and 1,000 associates in Southwest United States
- Operating under various franchise flags such as Hilton, Marriott, and Holiday Inn.

Hypothesis

- Different forecasting models will be needed to accurately forecasting daily hotel occupancy for each hotel due to its location and characteristics.

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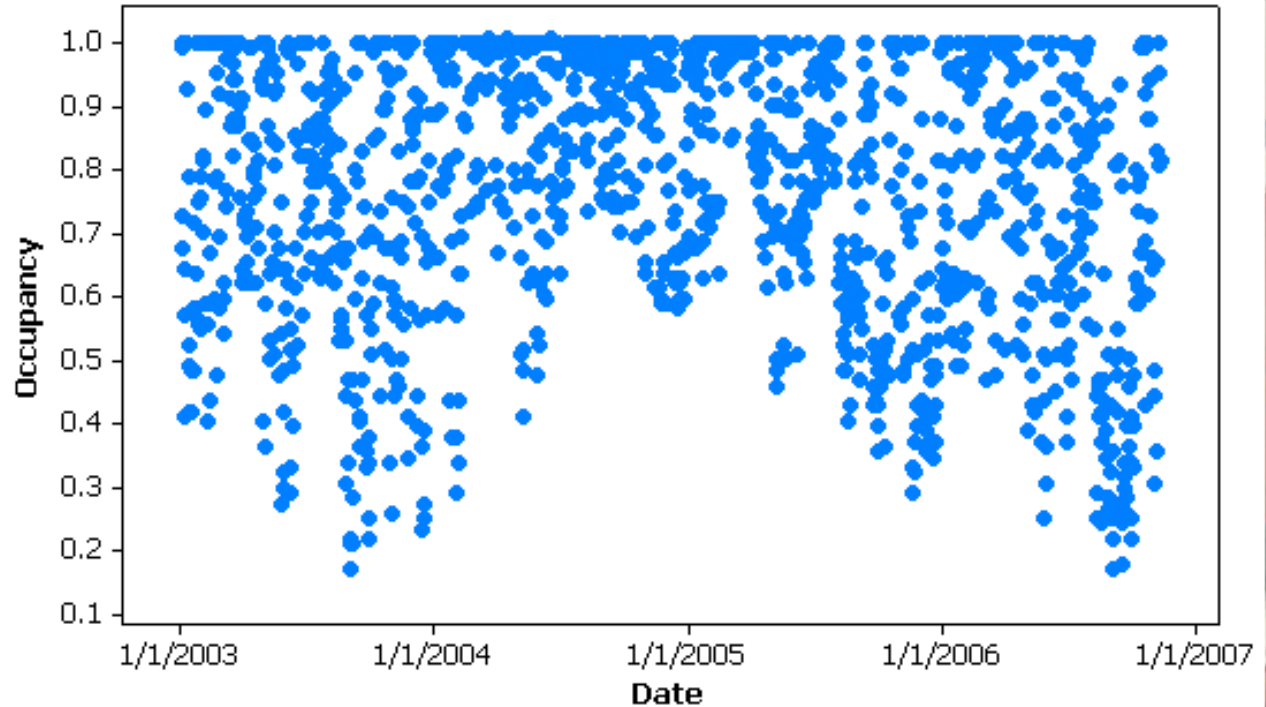


Hotel 1

Residence Inn, Orlando, FL

- Located near Disney World
- Family and leisure clientele
- 124 Rooms

Scatterplot of Occupancy vs Date



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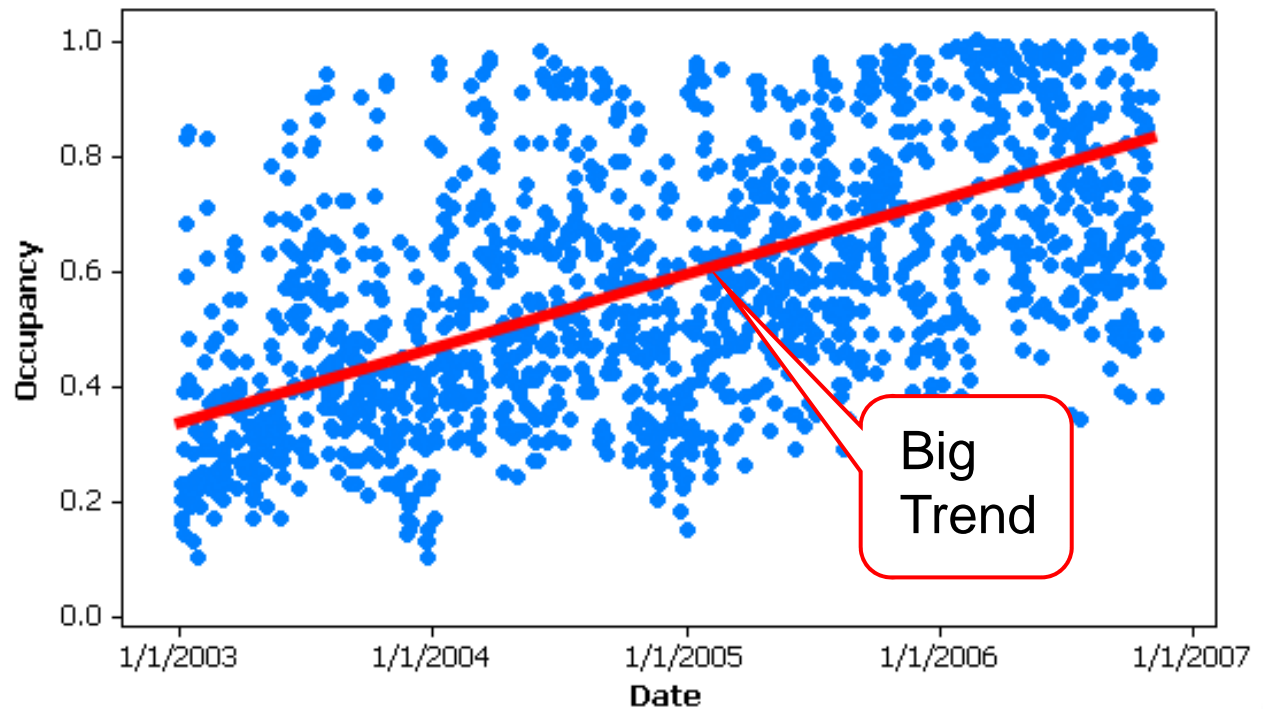
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Hotel 2 Holiday Inn, Atlanta, GA

- Located in metropolitan area
- Leisure and business clientele
- 205 Rooms

Scatterplot of Occupancy vs Date



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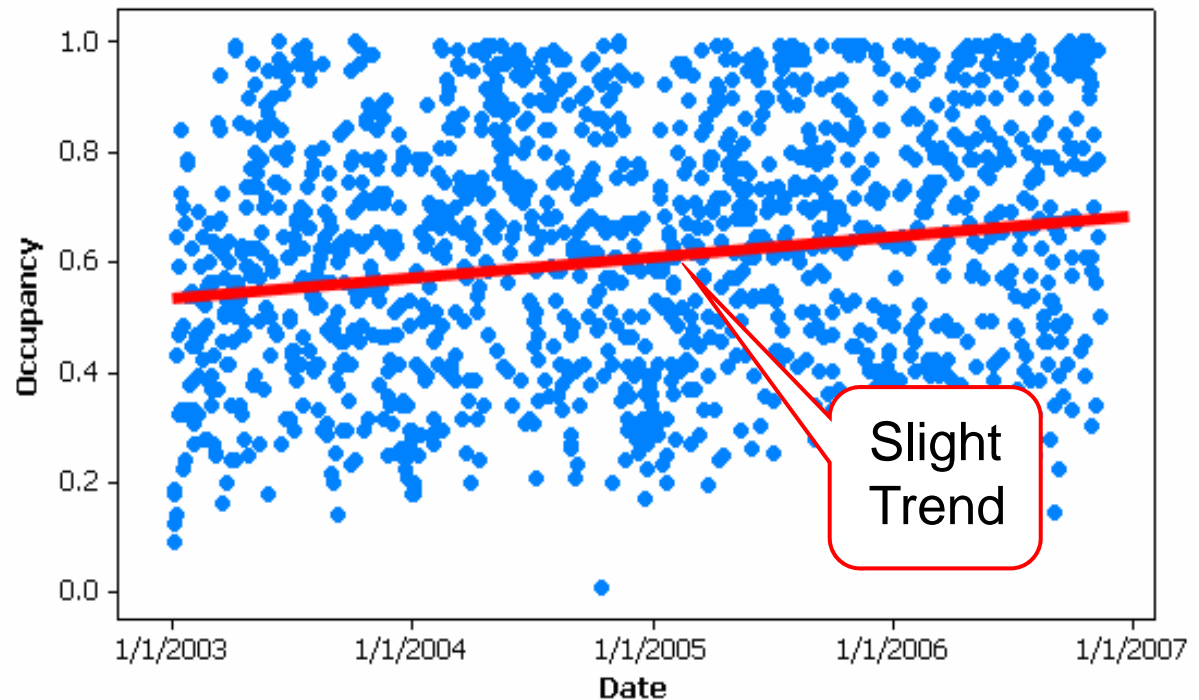
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Hotel 3 Courtyard, Gastonia, NC

- Located near Charlotte Airport
- Business clientele
- 130 Rooms

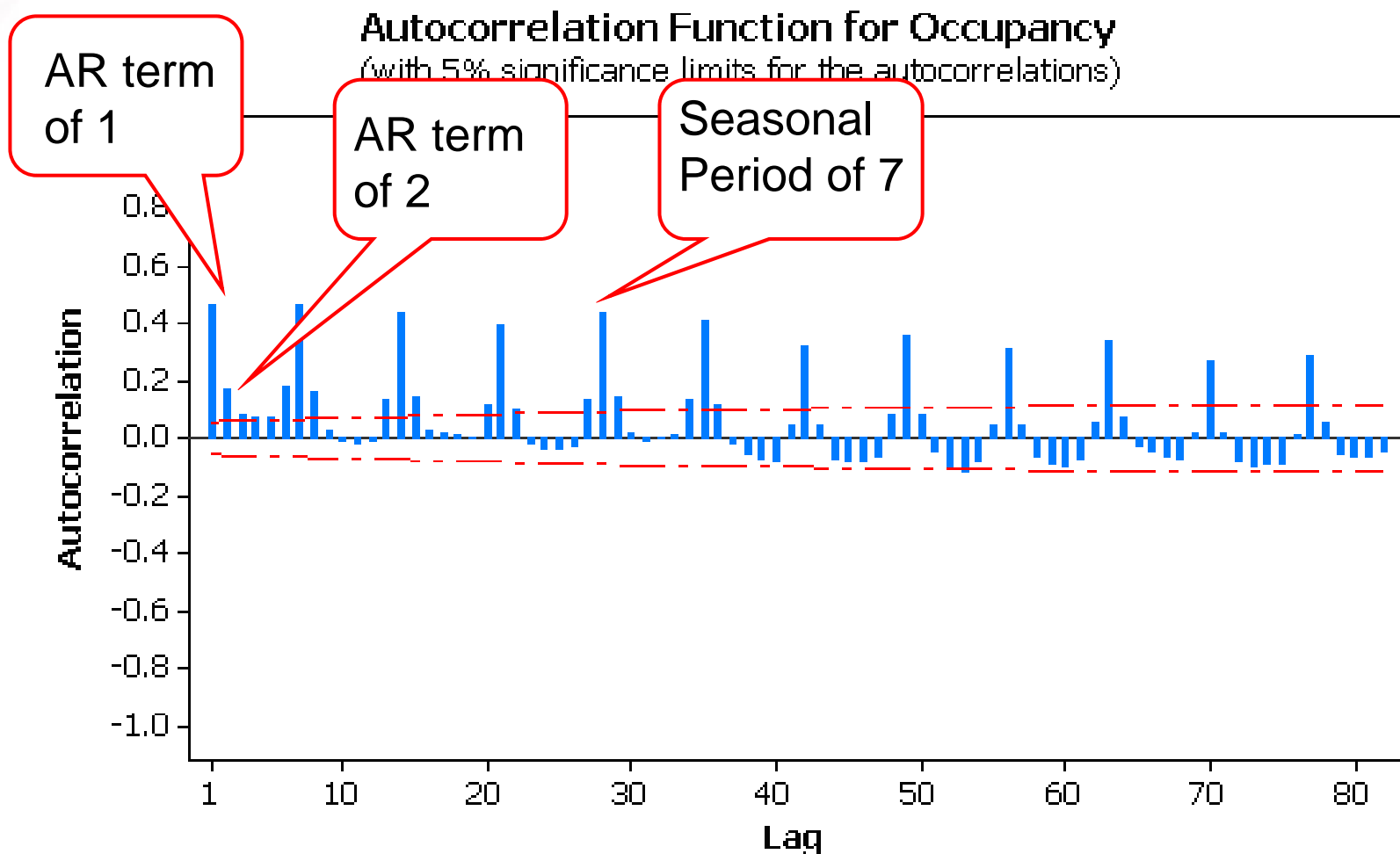
Scatterplot of Occupancy vs Date



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ACF for Courtyard

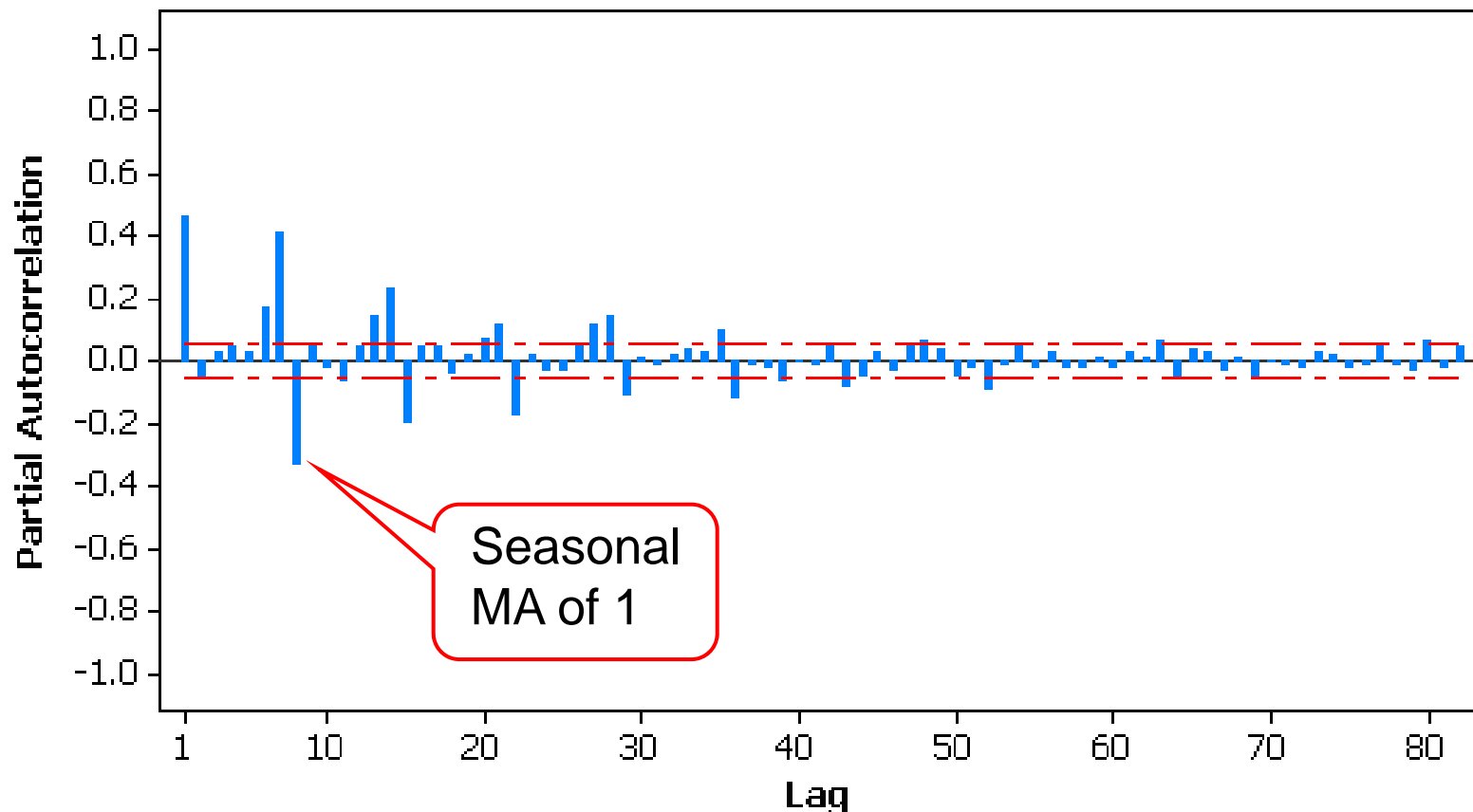


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PACF for Courtyard

Partial Autocorrelation Function for Occupancy
(with 5% significance limits for the partial autocorrelations)



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ARIMA (2,0,0)(1,1,1)₇ for Courtyard

Type		Coef	SE Coef	T	P
AR	1	0.6313	0.0267	23.67	0.000
AR	2	-0.0447	0.0267	-1.67	0.095
SAR	7	0.0893	0.0269	3.32	0.001
SMA	7	0.9723	0.0023	418.74	0.000

P-Values are Significant.
Note: AR(2) adds explanatory power

Differencing: 0 regular, 1 seasonal of order 7
 Number of observations: Original series 1418
 Residuals: SS = 30.5588 (backforecasts excluded)
 MS = 0.0217 DF = 1407

Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	21.8	43.1	71.4	82.3
DF	8	20	32	44
P-Value	0.005	0.002	0.000	0.000

Lag 12, 24, etc. are significant (bad), but due to large # of observations.

Historical MAPE 31.41%
7 Day Forecast MAPE 22.07%
5 Day Forecast MAPE 11.00%
Thiel's U 0.2426
AIC 643.52

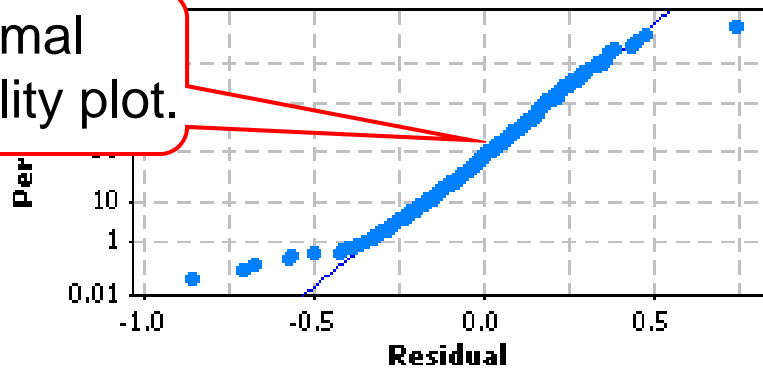
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ARIMA (2,0,0)(1,1,1)₇

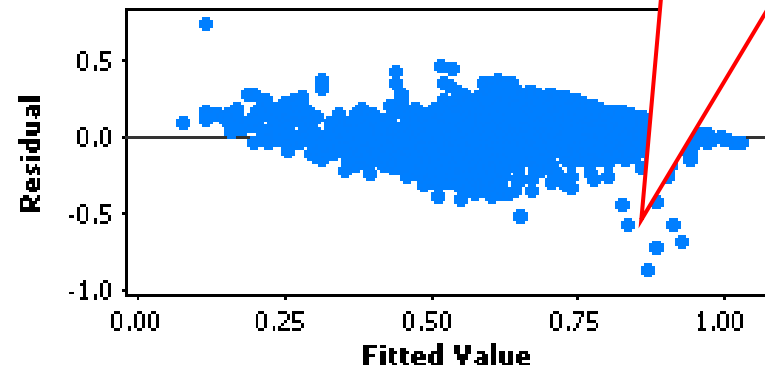
Residual Plots for Occupancy

Normal Probability Plot of the Residuals



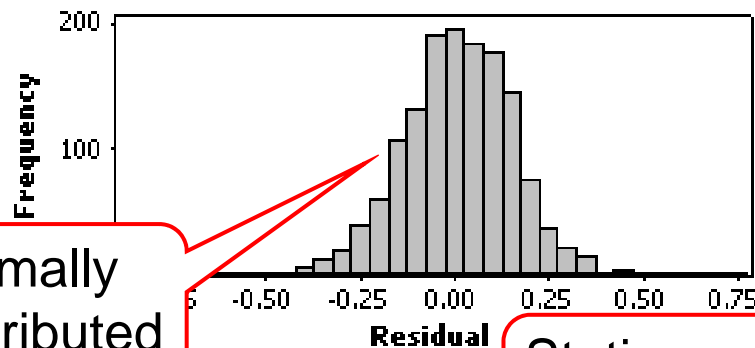
Fits normal probability plot.

Residuals Versus the Fitted Value



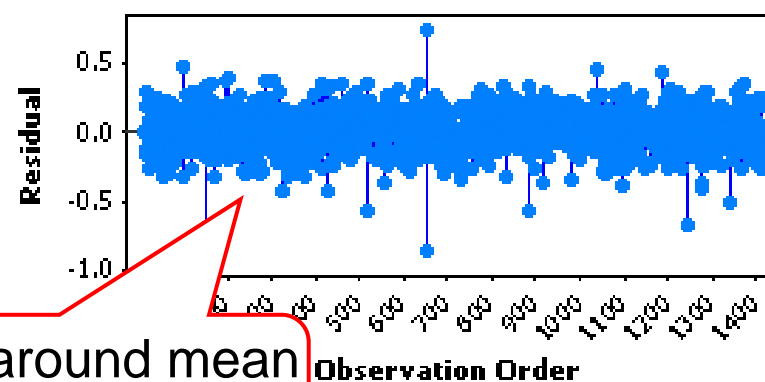
Unusual observations that cannot be explained.

Histogram of the Residuals



Normally Distributed

Residuals Versus the Order of the Data



Stationary around mean and stationary variance.

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Results for Courtyard, Gastonia, NC

Model	Historical		7 Day Forecast*		5 Day Forecast	
	MAPE	Theils U	MAPE	MAPE	AIC	R-sqr. adj.
Moving Average (7)	40.94%	1.561	28.09%	15.12%		
Single Exp Smoothing	41.77%	1.541	28.10%	15.09%		
Decomp w/o Trend (7)	37.24%	1.671	24.65%	14.71%		
Decomp w/ Trend (7)	35.98%	1.662	14.84%	11.51%		
Holt Winters	34.36%	1.565	20.51%	12.24%		
ARIMA (2,0,0)(2,0,0)7	31.85%	0.299	27.82%	16.79%	759.00	
ARIMA (4,0,0)(5,0,0)7	20.28%	0.252	23.33%	12.13%	686.50	
ARIMA (4,1,0)(5,0,0)7	27.45%	0.338	25.89%	18.33%	686.50	
ARIMA (2,0,0)(1,1,1)7	31.41%	0.243	22.07%	11.00%	643.52	
Multiple Regression 1	30.34%	0.268	19.70%	15.74%		46.10%
Multiple Regression 2	52.43%	2.676	24.87%	19.52%		40.50%

BEST
MODEL

Multiple Regression 1: Occupancy = 0.0116 + 0.361 LagOcc1 + 0.197 LagOcc7 + 0.169 LagOcc14 + 0.113 LagOcc21 + 0.206 LagOcc28 - 0.00602 Month

*5 Day Forecast MAPE only takes into account Monday through Friday since all of the models have trouble forecasting the low occupancy on the weekends of this business-centric hotel.

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Results for Holiday Inn, Atlanta, GA

	Historical		7 Day Forecast		
Model	MAPE	Theils U	MAPE	AIC	R-sqr. adj.
Moving Average (7)	29.26%	1.308	31.66%		
Moving Average (10)	30.33%	1.420	32.16%		
Single Exp Smoothing	23.87%	2.640	37.56%		
Decomp w/ Trend (7)	14.49%	3.214	30.05%		
Holt Winters	27.86%	3.564	39.02%		
ARIMA (4,0,0)(5,0,0)7	15.96%	0.309	31.67%	703.61	
ARIMA (4,1,0)(5,0,0)7	13.69%	0.396	25.57%	758.72	
→ ARIMA (2,0,0)(1,1,1)7	15.56%	0.312	21.51%	623.85	
Multiple Regression 1	20.76%	0.725	33.27%		64.40%
Multiple Regression 2	15.12%	3.508	26.75%		72.74%

BEST
MODEL

Multiple Regression 2: Occupancy = $(7.83 + 0.806 \text{ lag } 1 - 0.133 \text{ lag } 2 + 0.0318 \text{ lag } 7 + 0.0423 \text{ lag } 28 + 2.93 \text{ FedFunds} + 0.290 \text{ AvgRoomCost} - 43.3 \text{ SU}) / \text{Rooms Available}$

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Results for Residence Inn, Orlando, FL

	Historical		7 Day Forecast		
	MAPE	Theils U	MAPE	AIC	R-sq (adj)
Moving Average (7)	22.80%	0.756	17.80%		
Single Exp Smoothing	14.88%	1.650	21.63%		
Decomp w/ Trend (7)	29.50%	1.890	19.00%		
Holt Winters	23.70%	1.430	20.40%		
ARIMA (4,1,0)(5,0,0)7	14.10%	0.382	19.63%	418.09	
ARIMA (2,0,0)(1,1,0)7	10.22%	0.690	18.10%	345.58	
ARIMA (2,0,0)(1,1,1)7	13.69%	0.156	16.07%	317.62	
ARIMA (2,0,1)(1,1,0)28	10.28%	0.719	23.94%	346.22	
Multiple Regression 1	8.60%	0.860	16.90%		70.00%
Multiple Regression 2	8.46%	0.680	14.70%		71.10%

BEST
MODEL

Multiple Regression 2: Occupancy = (-4.04 + 0.989 Lag1 + 0.0631 Lag7 + 0.0661 Lag3 – 1.96 FedFunds + 0.0310 Lag28 – 0.360 Lag 2 + 18.7 Monday + 11.9 Tuesday + 10.8 Wednesday + 7.69 Thursday + 14.5 Friday + 12.3 Saturday + 5.35 Valentines + 0.169 AvgRoomCost) / Rooms Available

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Differences in ARIMA (2,0,0)(1,1,1)₇ Models

The ARIMA (2,0,0)(1,1,1)₇ model for each hotel has vastly different coefficients for each of the terms in the models.

Two autoregressive terms and weekly seasonality terms can be used to accurately forecast hotel occupancy for each hotel!

Courtyard

Type		Coef	SE Coef	T	P
AR	1	0.6313	0.0267	23.67	0.000
AR	2	-0.0447	0.0267	-1.67	0.095
SAR	7	0.0893	0.0269	3.32	0.001
SMA	7	0.9723	0.0023	418.74	0.000

Holiday Inn

Type		Coef	SE Coef	T	P
AR	1	0.9260	0.0263	35.18	0.000
AR	2	-0.1931	0.0264	-7.33	0.000
SAR	7	-0.0274	0.0273	-1.00	0.315
SMA	7	0.9577	0.0032	294.86	0.000

Residence Inn

Type		Coef	SE Coef	T	P
AR	1	1.0286	0.0255	40.27	0.000
AR	2	-0.3060	0.0255	-12.00	0.000
SAR	7	0.0550	0.0279	1.98	0.048
SMA	7	0.9473	0.0080	117.77	0.000

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Conclusion

- Courtyard by Marriott in Gastonia, NC caters toward business clientele – located near Charlotte Airport.
- Holiday Inn in Atlanta caters towards business/leisure clientele located in a large metropolitan area.
- Residence Inn in Orlando, FL caters towards families and vacationers with close proximity to Disney World.

Hypothesis is Right! Forecasting daily hotel occupancy does differ due to different locations and hotel characteristics as seen in the varying coefficients in the last $ARIMA(2,0,0)(1,1,1)_7$ models. However, the $ARIMA(2,0,0)(1,1,1)_7$ model can be used to accurately generate future daily hotel occupancy rates for all three hotels even though the three hotels have vastly different datasets!

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Sources

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