

# Hotel Rooms and Revenue Forecaster

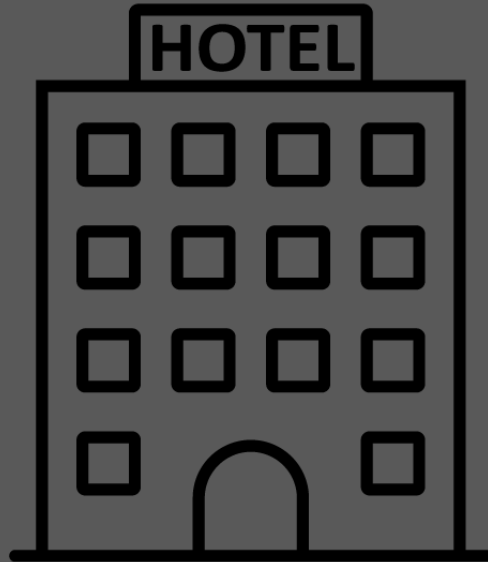
Author: Artem Lukinov



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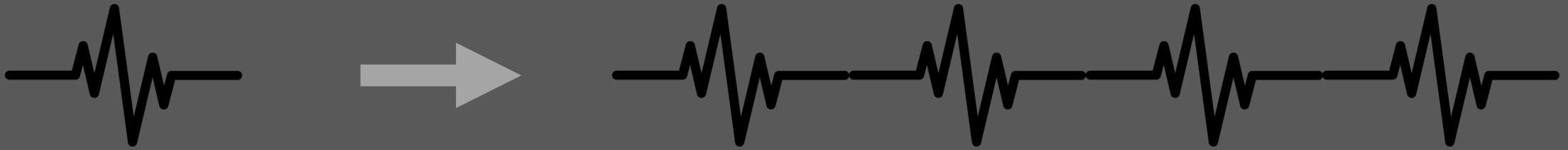
**Room Nights Sold forecast:** used for scheduling labor and controlling variable expenses to optimize business's bottom line daily

**Revenue forecast:** used for renovation schedules, large investments in operations, expansions.



# Forecast Process

Story as old as time: "The mean king and the manual labor"



60%

Accuracy



# How Can We Help?

What can be done to optimize this process?



# Machine Learning!

Reliance on data

Better analysis of historical data

Hidden insights

Computational power



# We want to

Determine whether it is possible to improve the accuracy of the baseline forecast

Use Machine Learning to forecast future data based on historical data

Stretch: wrap our model into software



# Data Source

Anonymous hotel

Easy cleaning

Mutual benefit

Domain knowledge

Popular format

\*Multiple levels

Large sample

Covid



# Covid data



Advertisement

Home > News > External Article > Press Release

## INDUSTRY UPDATE

EXTERNAL ARTICLE

24 December 2020

### 5 Predictions For 2021

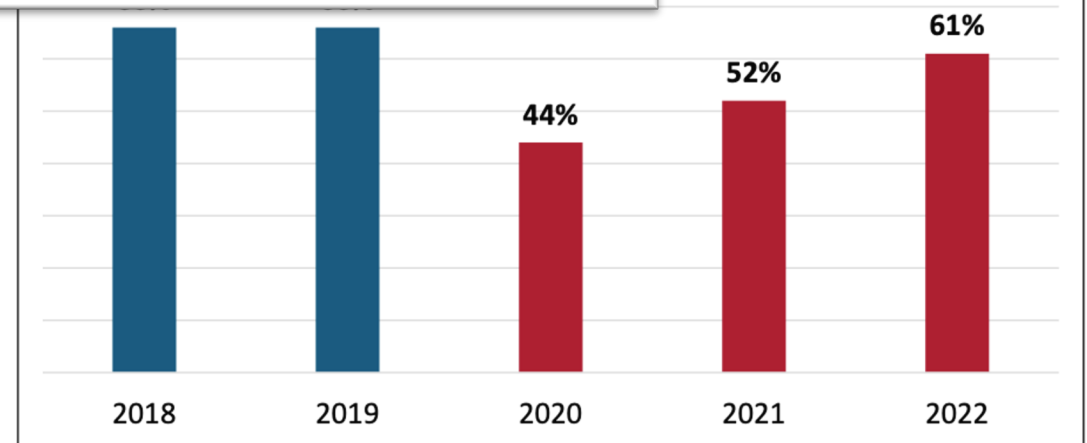
From the rebound of key hotel performance metrics to the potential return of group demand and international travel, the U.S. hotel industry could take its first steps on a



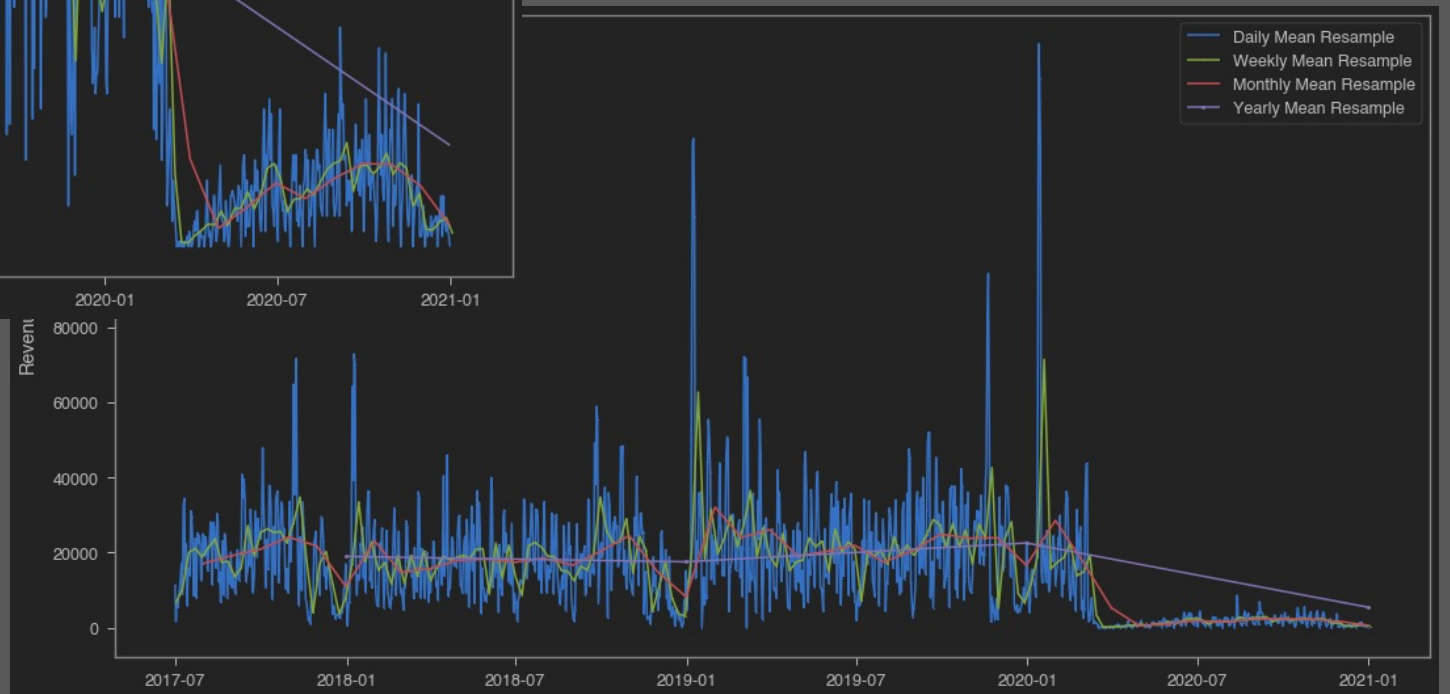
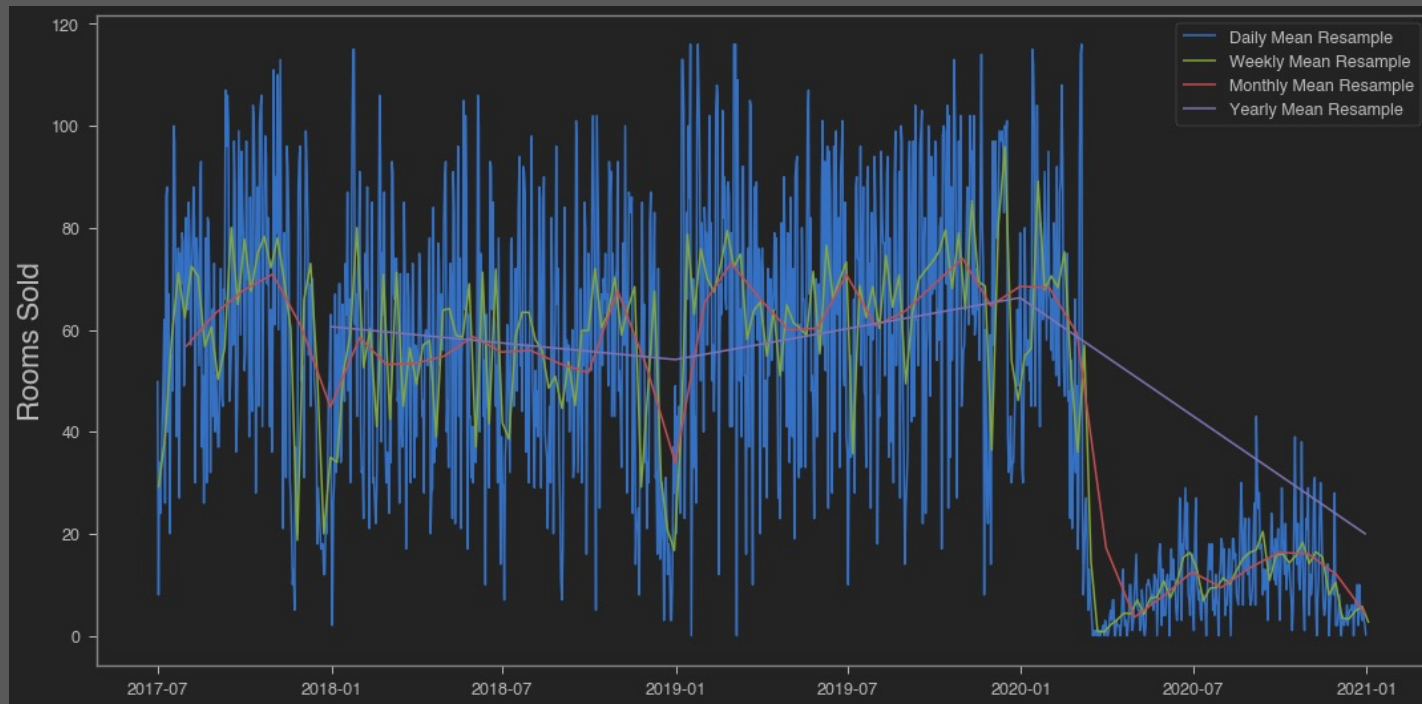
OWN OPERATE TECH DESIGN **PROCURE** HOTEL ROI

Operate

### PwC report predicts rebound in H2 2021



# First Look



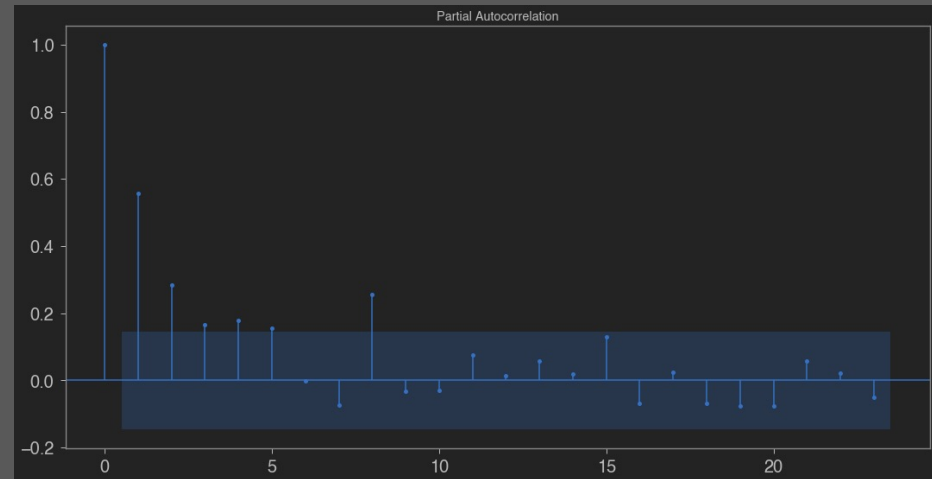
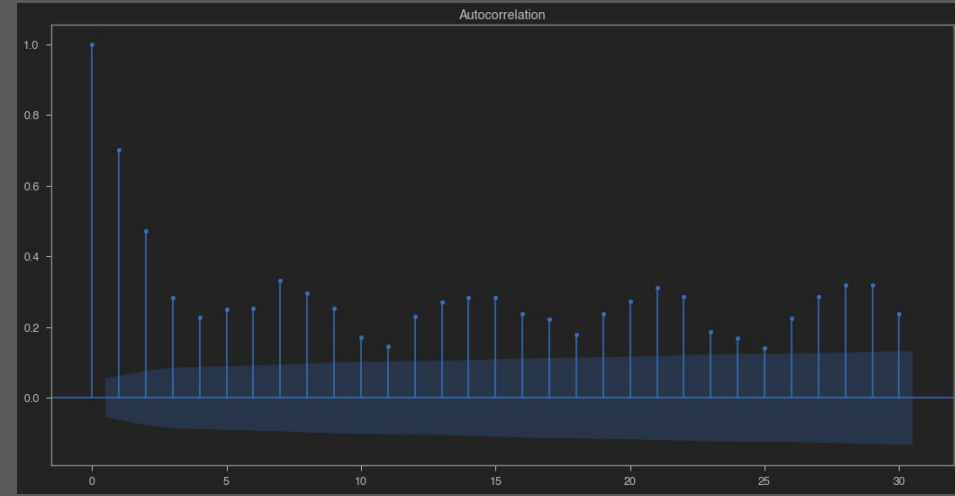
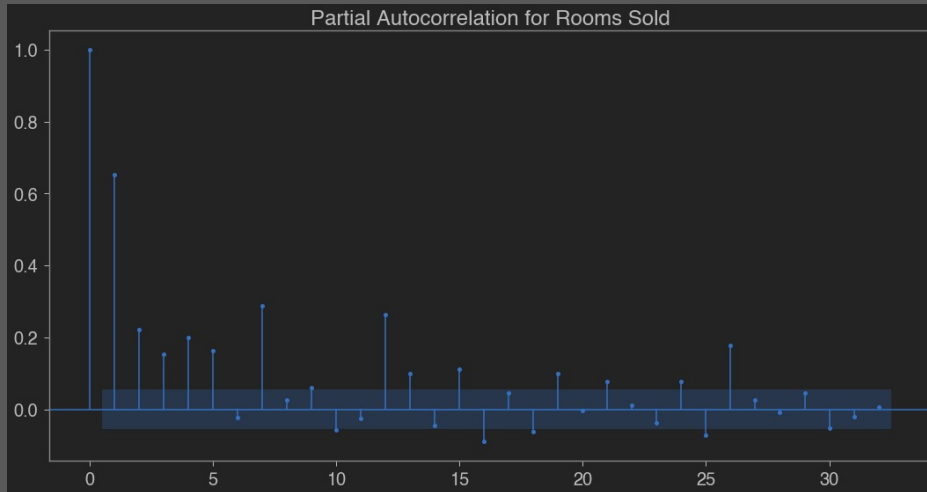
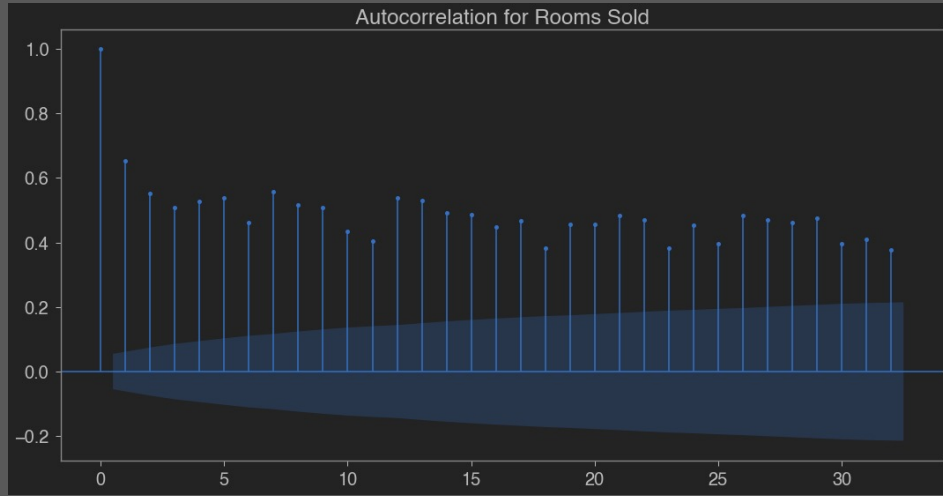
# Stationarity Check

Augmented Dickey-Fuller Test

Metric	T-stat	Critical value at 1%	P-Value
Rooms	(-6.8264844063432655)	(-3.4310597571975685)	1.9419934100737604e-09
Revenue	(-9.727564233908703)	(-3.4310598342409824)	9.187072356670721e-17

# Stationarity Check

Rooms



Revenue

# Model choice

## Time Series:

- ARIMA
- SARIMA



## RNN:

- LSTM
- GRU



## Additional:

- Prophet
- NeuralProphet



# Prophet and NeuralProphet

Logistic  
regressions



Seasonality



Special  
events

Linear and  
non-linear  
regressions



AR-Net  
An Autoregressive  
Neural Network

# Time Series Models

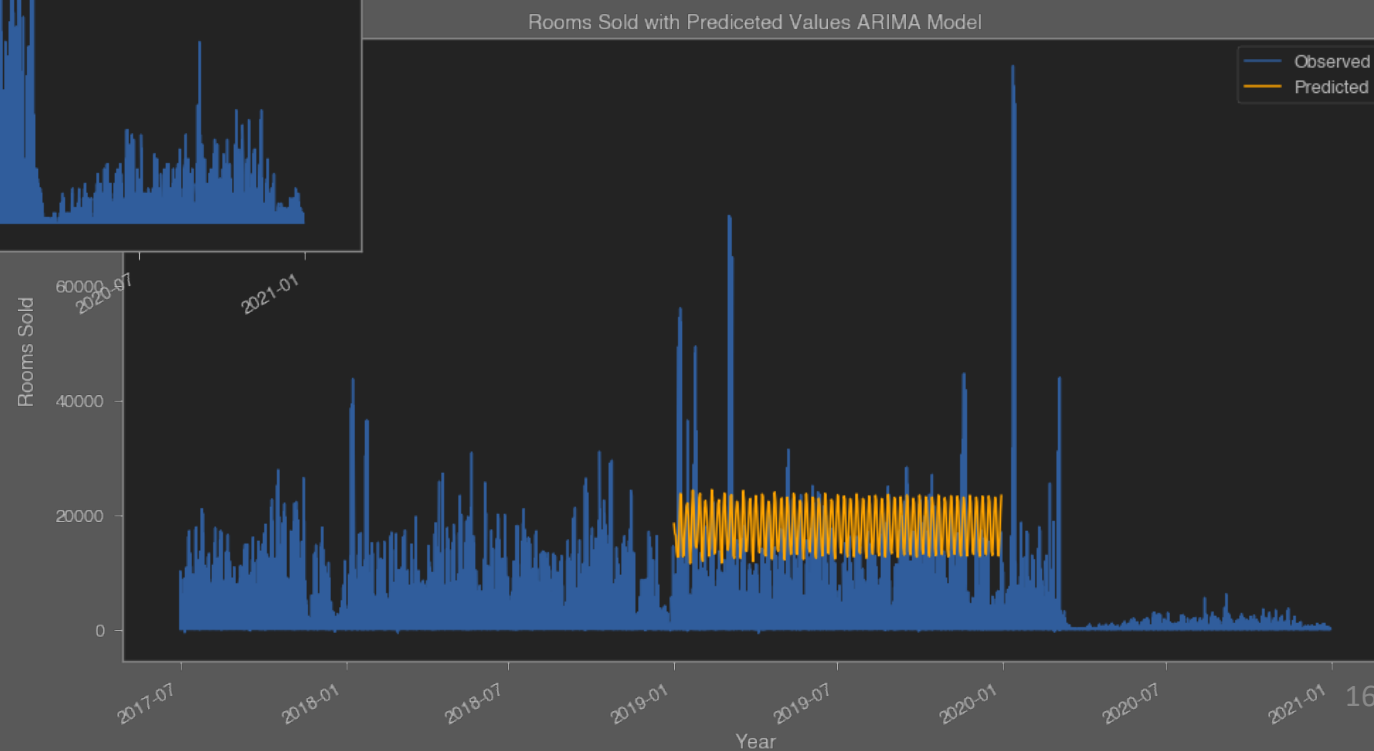
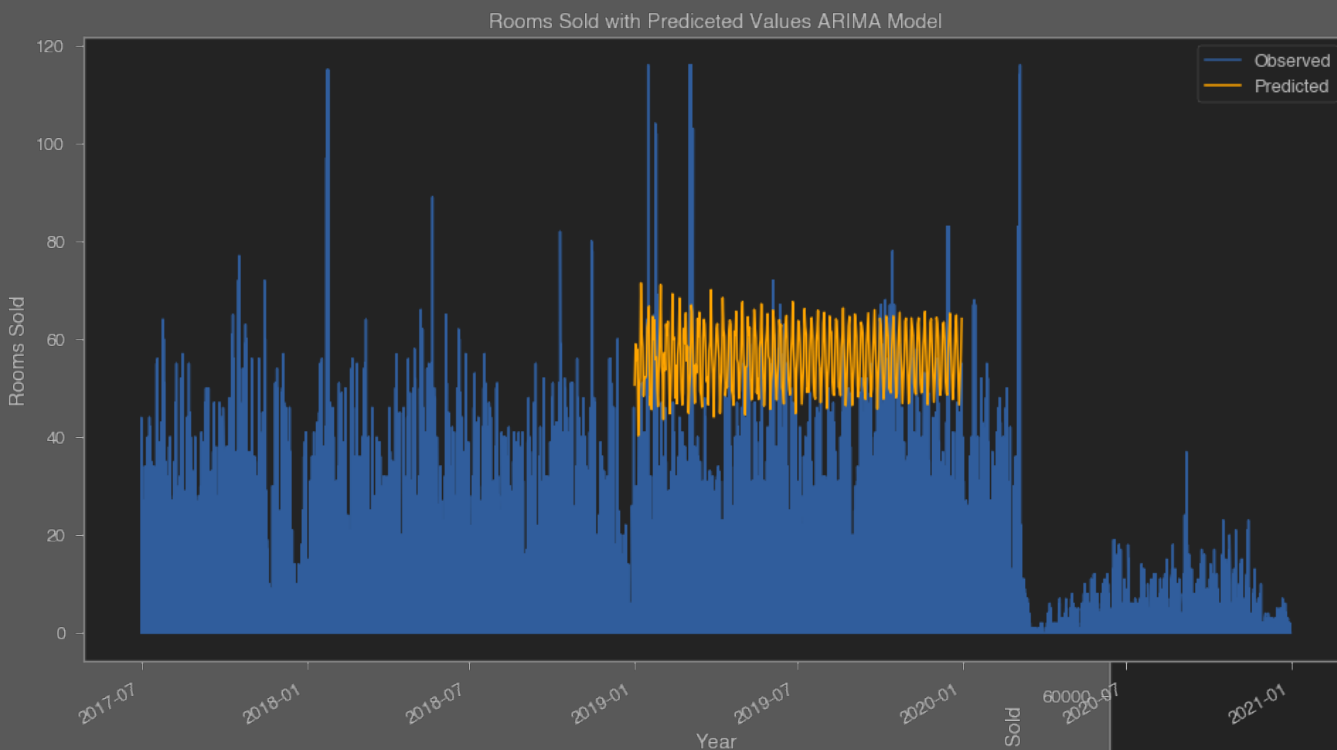
Model	AIC	RMSE	Improvement over Baseline
ARIMA (Baseline)	4995.92	27.83	-
<b>ARIMA Grid Search</b>	<b>4888.26</b>	<b>27.11</b>	<b>3%</b>
SARIMA	5039.08	48.36	-74%

## Revenue

Model	AIC	RMSE	Improvement over Baseline
ARIMA (Baseline)	11615.94	17412.2	-
<b>ARIMA Grid Search</b>	<b>11523.83</b>	<b>16481.31</b>	<b>5%</b>
SARIMA	11690.08	24786.68	-42%



# Best Time Series Model





# Recurring Neural Networks

Why LSTM and GRU? Memory!

Customers Review 2,491



Thanos

September 2018

Verified Purchase

**Amazing! This box of cereal gave me a perfectly balanced breakfast, as all things should be. I only ate half of it but will definitely be buying again!**



**A Box of Cereal**  
**\$3.99**

# Recurring Neural Networks

## LSTM

### Rooms

neurons in a hidden layer	epochs trained	RMSE	improvement over baseline
8	100	30.26	-
32	100	29.98	1%
64	50	38.56	-27%

### Revenue

neurons in a hidden layer	epochs trained	RMSE	improvement over baseline
8	100	18918.36	-
32	100	20001.84	-6%
64	50	21398.04	-13%

## GRU

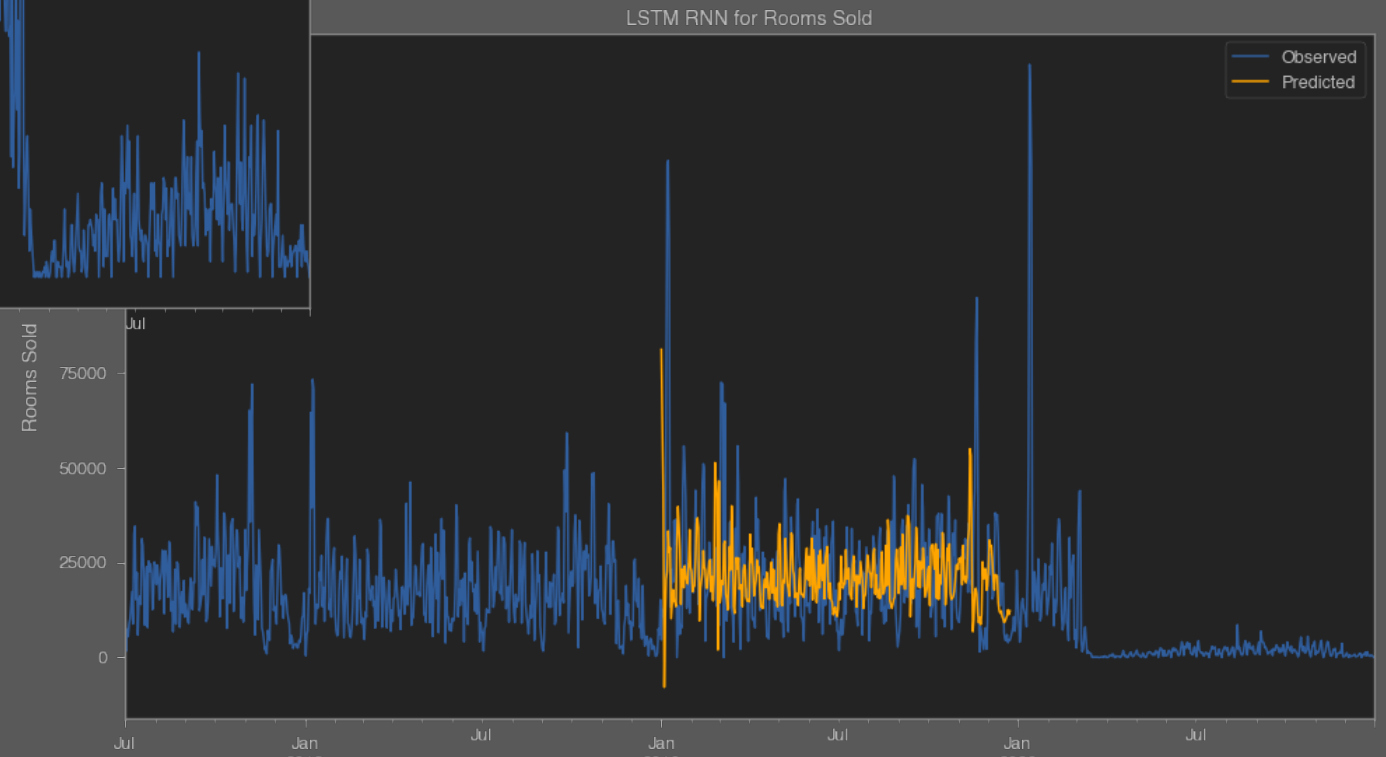
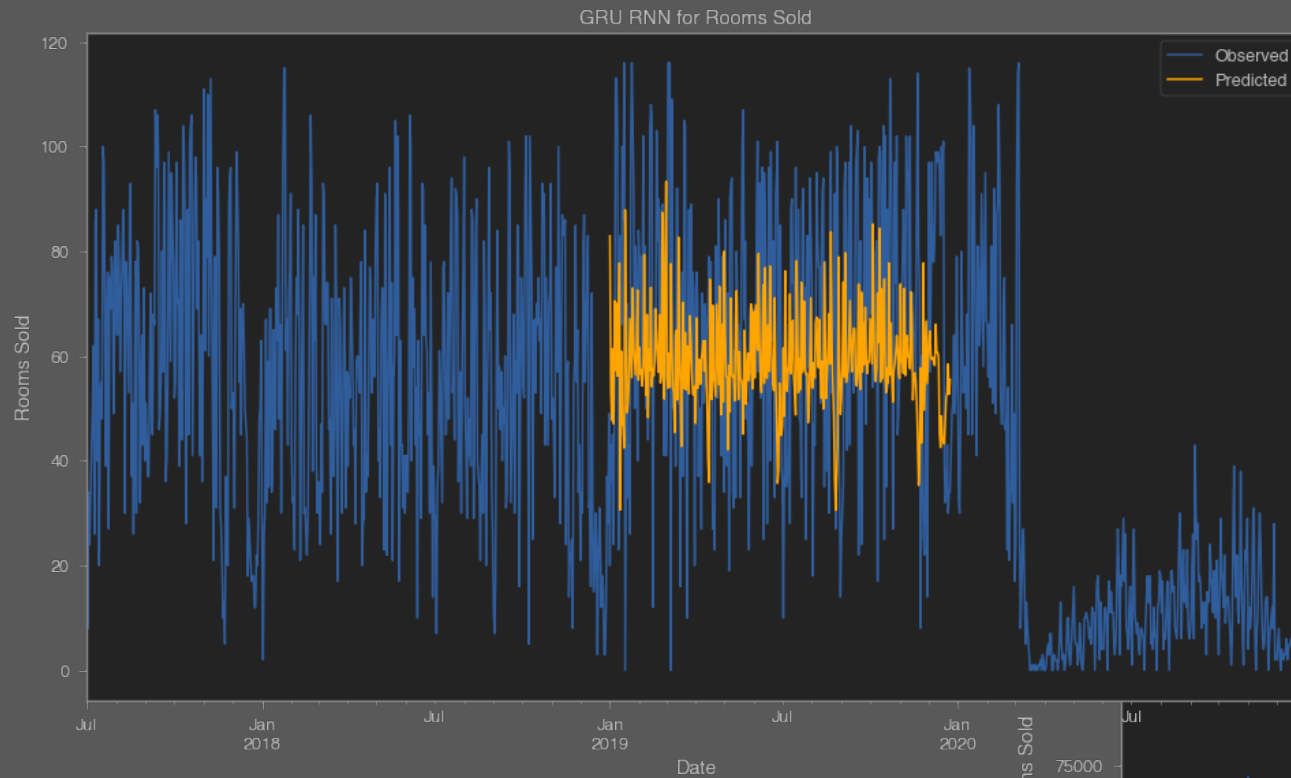
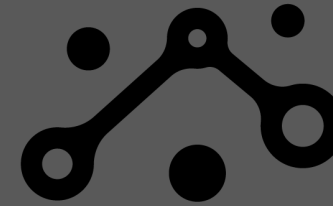
### Rooms

neurons in a hidden layer	epochs trained	RMSE	improvement over baseline
8	100	29.87	-
32	100	31.82	-7%
64	50	30.27	-1%

### Revenue

neurons in a hidden layer	epochs trained	RMSE	improvement over baseline
8	100	19246.39	-
32	100	22128.54	-7%
64	50	20892.71	-1%

# Best RNNs



# Prophet vs. NeuralProphet vs. the rest

## Rooms

Model	RMSE	Improvement over base
Prophet (baseline)	24.43	-
Prophet Grid Search	25.61	-5%
<b>NeuralProphet</b>	<b>22.59</b>	<b>8%</b>

## Revenue

Model	RMSE	Improvement over base
Prophet (baseline)	41479.04	-
Prophet Grid Search	11015.68	73%
<b>NeuralProphet</b>	<b>9554.99</b>	<b>77%</b>

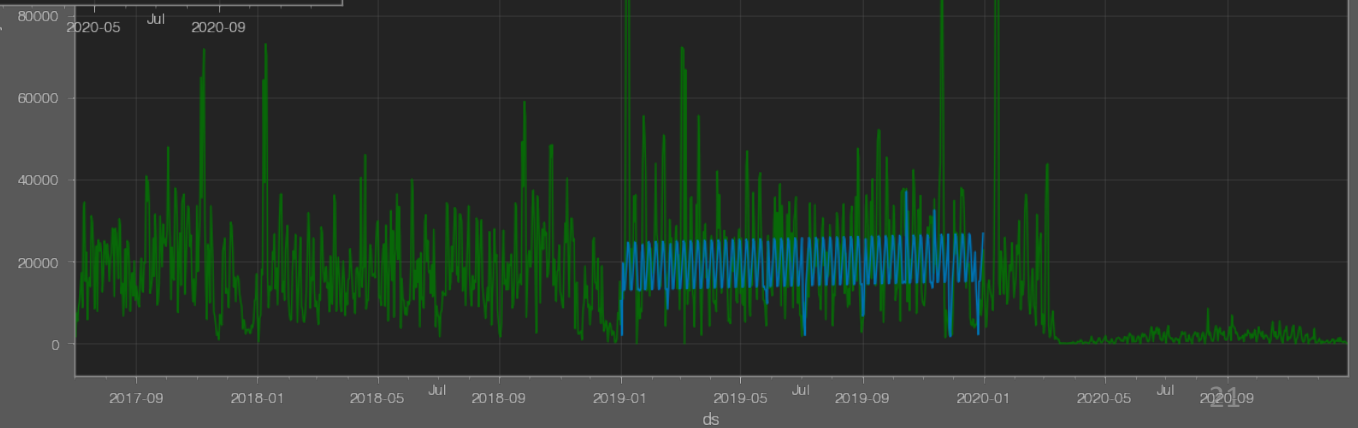
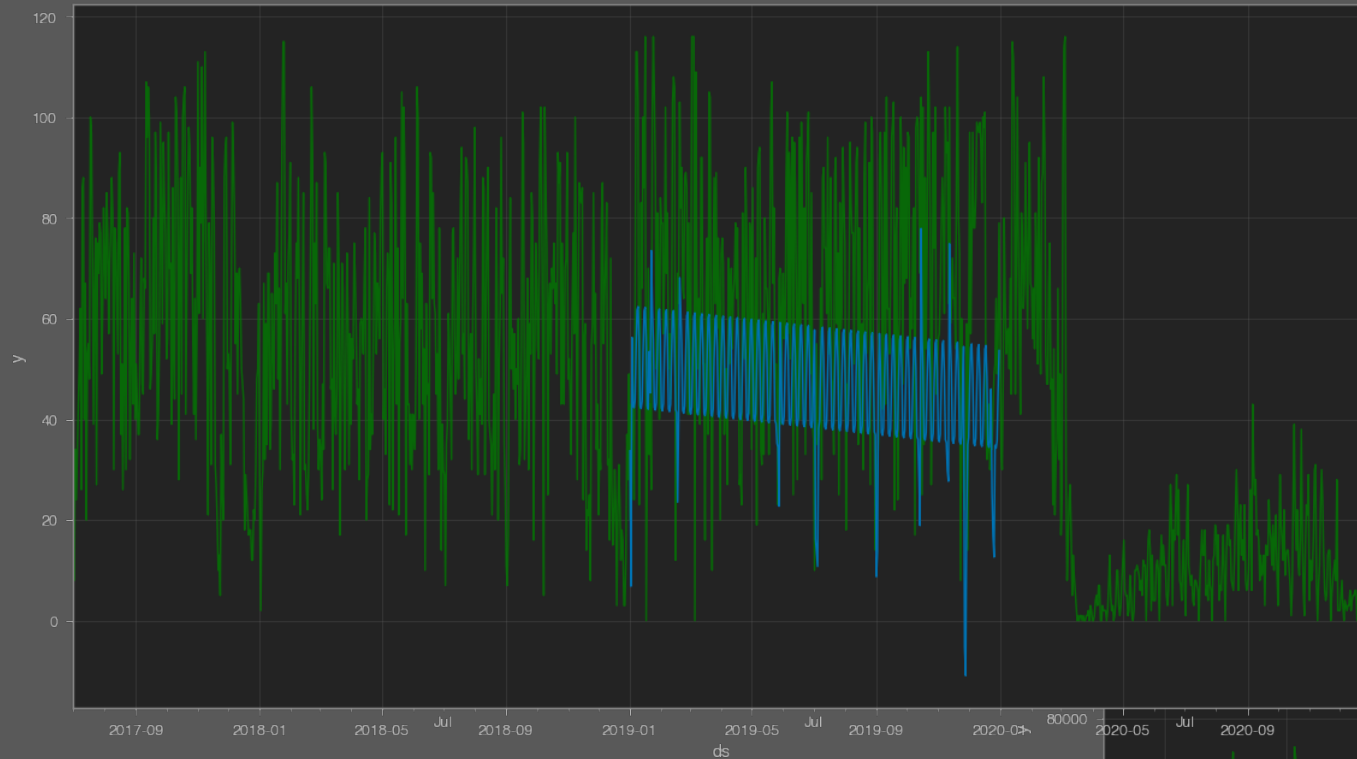
## Rooms

Rank	Model	RMSE
1	NeuralProphet	22.59
2	Prophet (baseline)	24.43
3	ARIMA Grid Search	27.11

## Revenue

Rank	Model	RMSE
1	NeuralProphet	9554.99
2	Prophet Grid Search	11015.68
3	ARIMA Grid Search	16481

# NeuralProphet



# Key Takeaways

NeuralProphet was the best performer

RNNs have potential

Machine Learning can help in yet another industry

Exploration leads to efficiency

# How can we use this?

Explore NeuralProphet and others

Include all market segments

Use as core algorithm for a product

Thank you

Q&A