Pick-up method + machine learning: a proved efficient approach to forecast hotel demand

*Rachel Zhang*

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# Data

**Importe Dataset and Cross-Validation**

0

25

50

75

Jan 2018

Apr 2018

Jul 2018

Oct 2018

Jan 2019

Stay Date

Final Arrivals

This analysis is conducted under R version 3.6.0 with set.seed(0). The robust test in Section X is conducted under set.seed(123).

We randomly selected 80% of the records as the training dataset to tune models, and the rest 20% records are used for model performance test. Here is a peek of the training set:

Table 1: Training Set Overview

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ROH0 | | DOW | | ROH1 | ROH2 | ROH3 | ROH4 | | ROH5 | | ROH6 | ROH7 | ROH14 | ROH21 | ROH30 | | | ROH60 | | | ROH90 | |
| 2018-11-15 | 52 | Thursday | | 49 | 46 | 42 | 41 | | 41 | | 41 | 38 | 29 | 25 | | | 22 | | 7 | | | 1 |
| 2018-06-11 | 58 | Monday | | 58 | 56 | 53 | 51 | | 47 | | 47 | 47 | 40 | 37 | | | 30 | | 9 | | | 4 |
| 2018-05-04 | 51 | Friday | | 48 | 47 | 46 | 44 | | 41 | | 38 | 38 | 30 | 28 | | | 21 | | 4 | | | 1 |
| 2018-10-21 | 68 | Sunday | | 67 | 67 | 66 | 66 | | 64 | | 59 | 54 | 44 | 20 | | | 18 | | 10 | | | 5 |
| 2018-09-22 | 40 | Saturday | | 38 | 36 | 36 | 35 | | 33 | | 32 | 31 | 27 | 20 | | | 8 | | 5 | | | 5 |
| 2018-07-01 | 20 | Sunday | | 17 | 16 | 16 | 14 | | 13 | | 13 | 13 | 10 | 10 | | | 6 | | 2 | | | 2 |
| 2018-10-29 | 66 | Monday | | 61 | 56 | 55 | 53 | | 51 | | 49 | 43 | 32 | 26 | | | 25 | | 7 | | | 2 |
| 2018-03-21 | 30 | Wednesday | | 28 | 25 | 21 | 21 | | 21 | | 20 | 20 | 9 | 5 | | | 5 | | 3 | | | 0 |
| 2018-09-29 | 49 | Saturday | | 45 | 45 | 42 | 39 | | 37 | | 36 | 36 | 31 | 26 | | | 23 | | 17 | | | 12 |
| 2018-11-21 | 14 | Wednesday | | 14 | 13 | 12 | 12 | | 12 | | 12 | 11 | 10 | 10 | | | 9 | | 6 | | | 2 |
| **Modeling**  **Additive Pick-up** |  |  | |  |  | Tab | le 2: Ad | | ditive Pic | | k Ups |  |  |  | | |  | |  | | |  |
| DOW | ROH1 | | ROH2 | ROH3 | ROH4 | ROH5 | | ROH6 | | ROH7 | | ROH14 | ROH21 | ROH30 | | ROH60 | | | | ROH90 | | |
|  |  | |  |  |  |  | |  | |  | |  |  |  | |  | | | |  | | |
| Sunday | 2.11 | | 3.04 | 4.40 | 5.58 | 6.51 | | 8.18 | | 9.22 | | 13.9 | 18.8 | 22.8 | | 30.1 | | | | 33.9 | | |
| Monday | 2.84 | | 4.34 | 5.16 | 7.59 | 9.57 | | 11.14 | | 12.89 | | 21.8 | 27.4 | 33.2 | | 42.6 | | | | 45.9 | | |
| Tuesday | 2.42 | | 4.28 | 4.58 | 4.97 | 6.17 | | 7.25 | | 8.92 | | 16.6 | 21.7 | 27.3 | | 33.5 | | | | 36.7 | | |
| Wednesday | 1.95 | | 3.58 | 5.37 | 5.77 | 6.16 | | 7.30 | | 8.51 | | 15.5 | 20.5 | 25.3 | | 32.6 | | | | 35.8 | | |
| Thursday | 3.40 | | 5.11 | 6.84 | 8.31 | 8.84 | | 9.67 | | 10.84 | | 17.0 | 21.4 | 25.8 | | 34.1 | | | | 37.3 | | |
| Friday | 3.32 | | 5.76 | 7.61 | 9.27 | 10.83 | | 11.54 | | 12.24 | | 17.9 | 21.6 | 25.5 | | 33.6 | | | | 37.5 | | |
| Saturday | 3.71 | | 5.69 | 7.74 | 9.55 | 10.98 | | 12.14 | | 12.88 | | 17.3 | 20.3 | 23.7 | | 30.3 | | | | 33.3 | | |

*Note:*

The pick-ups are calculated by taking the average of additive increments between current day and a future date by day of week.

Table 3: Multiplicative Pick Ups

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DOW | ROH1 | ROH2 | ROH3 | ROH4 | ROH5 | ROH6 | ROH7 | ROH14 | ROH21 | ROH30 | ROH60 | ROH90 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Sunday | 0.939 | 0.910 | 0.874 | 0.841 | 0.817 | 0.772 | 0.746 | 0.623 | 0.500 | 0.395 | 0.215 | 0.113 |
| Monday | 0.940 | 0.907 | 0.890 | 0.841 | 0.801 | 0.773 | 0.739 | 0.571 | 0.459 | 0.343 | 0.149 | 0.082 |
| Tuesday | 0.942 | 0.892 | 0.884 | 0.874 | 0.844 | 0.821 | 0.787 | 0.599 | 0.477 | 0.320 | 0.158 | 0.081 |
| Wednesday | 0.942 | 0.901 | 0.855 | 0.846 | 0.837 | 0.810 | 0.782 | 0.622 | 0.506 | 0.390 | 0.191 | 0.097 |
| Thursday | 0.914 | 0.873 | 0.835 | 0.802 | 0.789 | 0.766 | 0.738 | 0.585 | 0.482 | 0.380 | 0.181 | 0.106 |
| Friday | 0.921 | 0.864 | 0.822 | 0.785 | 0.748 | 0.733 | 0.717 | 0.590 | 0.507 | 0.419 | 0.236 | 0.145 |
| Saturday | 0.902 | 0.852 | 0.798 | 0.753 | 0.717 | 0.687 | 0.668 | 0.552 | 0.473 | 0.382 | 0.197 | 0.120 |

*Note:*

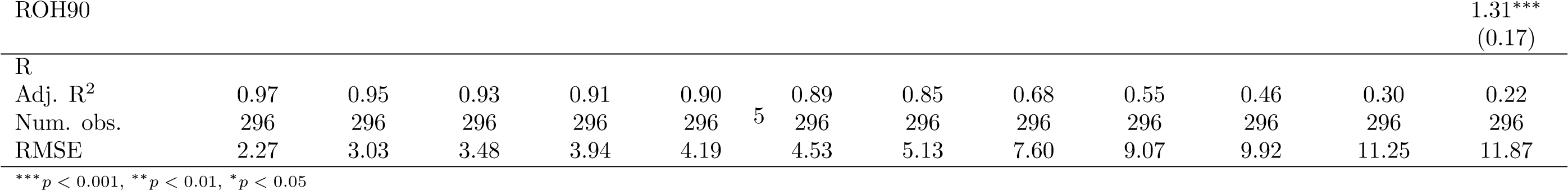
The pick-ups are calculated by taking the average of ratio increments between current day and a future date by day of week.

**Multiplicative Pick-up**

**Regression**

The regression model uses the nearest ROH and the DOW of the target day.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 | Model 10 | Model 11 | Model 12 |
| (Intercept) | 1*.*88*∗∗∗* | 2*.*54*∗∗∗* | 3*.*51*∗∗∗* | 4*.*17*∗∗∗* | 4*.*58*∗∗∗* | 5*.*92*∗∗∗* | 6*.*69*∗∗∗* | 11*.*59*∗∗∗* | 17*.*74*∗∗∗* | 21*.*88*∗∗∗* | 27*.*68*∗∗∗* | 32*.*50*∗∗∗* |
|  | (0*.*51) | (0*.*68) | (0*.*77) | (0*.*87) | (0*.*92) | (0*.*98) | (1*.*11) | (1*.*61) | (1*.*80) | (1*.*87) | (2*.*00) | (1*.*93) |
| DOWMonday | 0*.*66 | 1*.*16 | 0*.*49 | 1*.*62 | 2*.*57*∗∗* | 2*.*35*∗* | 3*.*01*∗∗* | 7*.*60*∗∗∗* | 8*.*52*∗∗∗* | 10*.*36*∗∗∗* | 12*.*89*∗∗∗* | 12*.*19*∗∗∗* |
|  | (0*.*49) | (0*.*66) | (0*.*76) | (0*.*85) | (0*.*90) | (0*.*98) | (1*.*11) | (1*.*62) | (1*.*93) | (2*.*10) | (2*.*39) | (2*.*52) |
| DOWTuesday | 0*.*30 | 1*.*23 | 0*.*15 | *−*0*.*69 | *−*0*.*44 | *−*1*.*09 | *−*0*.*44 | 2*.*91 | 3*.*02 | 4*.*68*∗* | 3*.*96 | 3*.*24 |
|  | (0*.*51) | (0*.*68) | (0*.*78) | (0*.*88) | (0*.*94) | (1*.*01) | (1*.*15) | (1*.*70) | (2*.*03) | (2*.*23) | (2*.*53) | (2*.*67) |
| DOWWednesday | *−*0*.*17 | 0*.*53 | 0*.*97 | 0*.*15 | *−*0*.*43 | *−*1*.*02 | *−*0*.*86 | 1*.*65 | 1*.*77 | 2*.*61 | 2*.*90 | 2*.*19 |
|  | (0*.*48) | (0*.*65) | (0*.*74) | (0*.*84) | (0*.*89) | (0*.*97) | (1*.*10) | (1*.*62) | (1*.*93) | (2*.*12) | (2*.*41) | (2*.*53) |
| DOWThursday | 1*.*28*∗∗* | 2*.*05*∗∗* | 2*.*42*∗∗* | 2*.*71*∗∗* | 2*.*28*∗* | 1*.*36 | 1*.*48 | 3*.*09 | 2*.*66 | 2*.*91 | 4*.*18 | 3*.*46 |
|  | (0*.*48) | (0*.*64) | (0*.*73) | (0*.*83) | (0*.*88) | (0*.*96) | (1*.*08) | (1*.*60) | (1*.*91) | (2*.*09) | (2*.*37) | (2*.*50) |
| DOWFriday | 1*.*18*∗* | 2*.*68*∗∗∗* | 3*.*16*∗∗∗* | 3*.*62*∗∗∗* | 4*.*26*∗∗∗* | 3*.*22*∗∗* | 2*.*83*∗* | 3*.*87*∗* | 2*.*70 | 2*.*53 | 2*.*99 | 3*.*09 |
|  | (0*.*49) | (0*.*65) | (0*.*75) | (0*.*85) | (0*.*90) | (0*.*98) | (1*.*11) | (1*.*64) | (1*.*96) | (2*.*15) | (2*.*44) | (2*.*58) |
| DOWSaturday | 1*.*62*∗∗* | 2*.*69*∗∗∗* | 3*.*45*∗∗∗* | 4*.*17*∗∗∗* | 4*.*78*∗∗∗* | 4*.*32*∗∗∗* | 4*.*04*∗∗∗* | 3*.*83*∗* | 1*.*63 | 0*.*94 | 0*.*49 | *−*0*.*60 |
|  | (0*.*49) | (0*.*65) | (0*.*75) | (0*.*85) | (0*.*91) | (0*.*98) | (1*.*11) | (1*.*64) | (1*.*95) | (2*.*13) | (2*.*42) | (2*.*55) |
| ROH1 | 1*.*01*∗∗∗*  (0*.*01) |  |  |  |  |  |  |  |  |  |  |  |
| ROH2 |  | 1*.*01*∗∗∗*  (0*.*01) |  |  |  |  |  |  |  |  |  |  |
| ROH3 |  |  | 1*.*03*∗∗∗*  (0*.*02) |  |  |  |  |  |  |  |  |  |
| ROH4 |  |  |  | 1*.*04*∗∗∗*  (0*.*02) |  |  |  |  |  |  |  |  |
| ROH5 |  |  |  |  | 1*.*06*∗∗∗*  (0*.*02) |  |  |  |  |  |  |  |
| ROH6 |  |  |  |  |  | 1*.*07*∗∗∗*  (0*.*02) |  |  |  |  |  |  |
| ROH7 |  |  |  |  |  |  | 1*.*09*∗∗∗*  (0*.*03) |  |  |  |  |  |
| ROH14 |  |  |  |  |  |  |  | 1*.*09*∗∗∗*  (0*.*05) |  |  |  |  |
| ROH21 |  |  |  |  |  |  |  |  | 1*.*05*∗∗∗*  (0*.*06) |  |  |  |
| ROH30 |  |  |  |  |  |  |  |  |  | 1*.*06*∗∗∗*  (0*.*07) |  |  |
| ROH60 |  |  |  |  |  |  |  |  |  |  | 1*.*29*∗∗∗*  (0*.*13) |  |

2 0.97 0.95 0.93 0.92 0.91 0.89 0.86 0.69 0.56 0.47 0.32 0.24