

Robust test

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Data

Data Importing and Cross-Validation

[1] 370

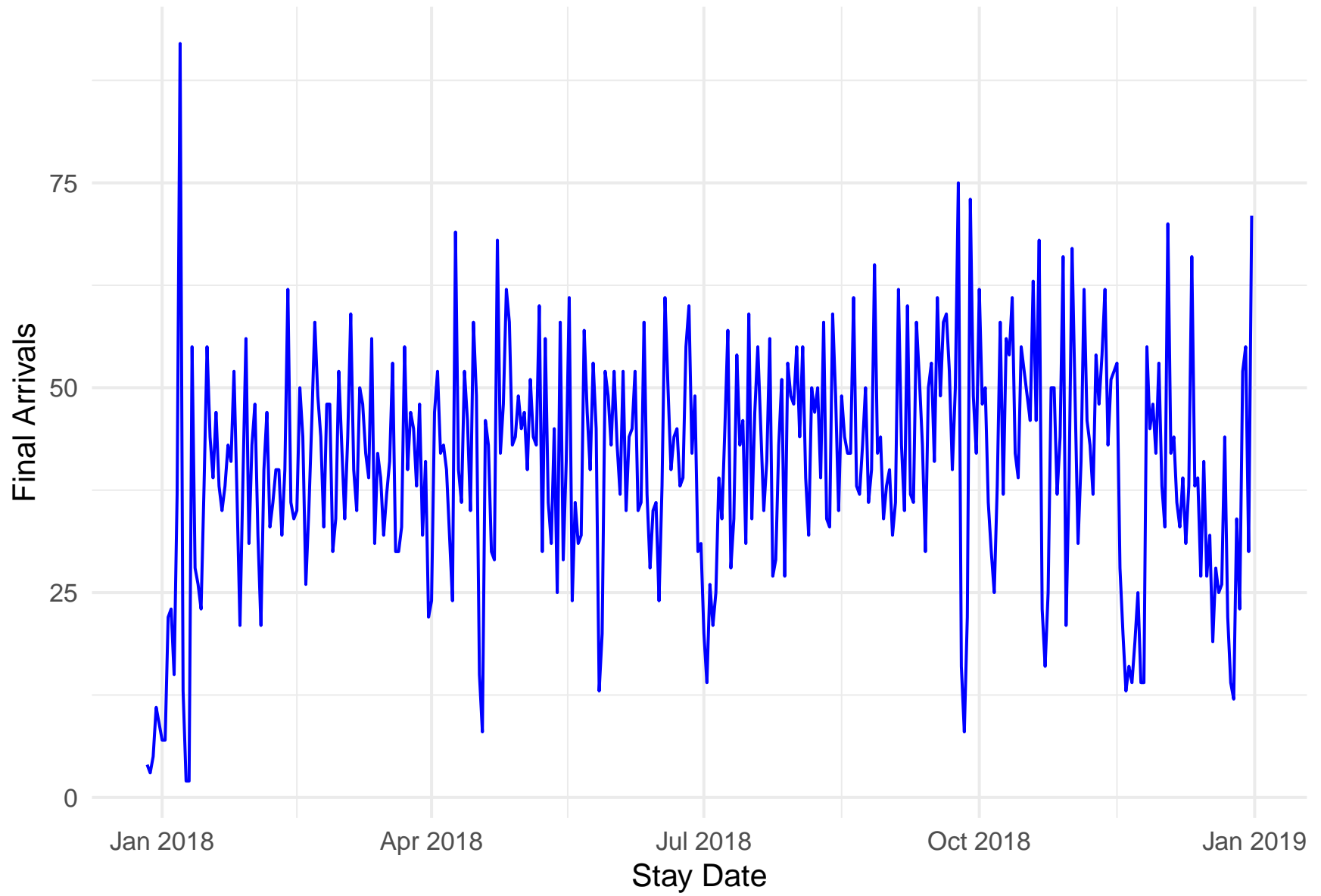


Table 1: Training Set Overview

	ROH0	DOW	ROH1	ROH2	ROH3	ROH4	ROH5	ROH6	ROH7	ROH14	ROH21	ROH30	ROH60	ROH90
2018-06-23	38	Saturday	38	38	33	32	31	29	29	19	14	14	10	8
2018-01-09	2	Tuesday	2	2	2	2	2	2	2	2	2	1	0	0
2018-07-09	57	Monday	54	51	51	46	44	41	39	31	8	5	5	4
2018-10-28	44	Sunday	42	40	37	33	31	26	24	22	18	13	5	0
2018-04-23	68	Monday	67	67	66	61	59	58	58	42	34	23	9	5
2018-10-21	68	Sunday	67	67	66	66	64	59	54	44	20	18	10	5
2018-08-12	33	Sunday	32	29	28	28	25	22	21	18	17	13	7	3
2018-08-27	65	Monday	60	60	58	55	53	51	47	44	38	26	16	10
2018-12-30	30	Sunday	24	22	20	19	19	19	18	16	13	8	7	4
2018-05-28	20	Monday	19	18	18	17	17	17	16	12	11	9	5	2

Modeling

Additive Pick-up

Table 2: Additive Pick Ups

DOW	ROH1	ROH2	ROH3	ROH4	ROH5	ROH6	ROH7	ROH14	ROH21	ROH30	ROH60	ROH90
Sunday	2.16	3.09	4.43	5.68	6.57	8.21	9.25	13.8	18.4	22.1	29.4	32.9
Monday	2.95	4.41	5.33	7.67	9.33	10.97	12.56	20.6	26.4	33.1	42.6	46.0
Tuesday	2.24	4.00	4.42	4.78	5.95	6.98	8.88	15.7	20.6	25.8	32.1	35.0
Wednesday	2.10	3.90	5.55	6.08	6.60	7.92	9.30	16.1	21.7	26.2	33.1	36.1
Thursday	3.33	5.14	6.95	8.43	8.98	9.81	10.95	16.8	21.0	25.0	33.6	37.2
Friday	3.89	6.33	8.16	9.78	11.44	12.27	13.00	18.7	22.4	26.4	34.5	38.4
Saturday	3.76	5.64	7.67	9.44	10.73	11.91	12.53	16.6	19.6	22.9	29.6	32.3

Multiplicative Pick-up

Regression

Table 3: Multiplicative Pick Ups

DOW	ROH1	ROH2	ROH3	ROH4	ROH5	ROH6	ROH7	ROH14	ROH21	ROH30	ROH60	ROH90
Sunday	0.936	0.906	0.870	0.831	0.808	0.764	0.738	0.612	0.494	0.397	0.213	0.120
Monday	0.937	0.905	0.888	0.842	0.812	0.780	0.748	0.594	0.482	0.358	0.161	0.088
Tuesday	0.941	0.894	0.883	0.874	0.842	0.819	0.769	0.605	0.479	0.329	0.158	0.087
Wednesday	0.948	0.902	0.858	0.846	0.833	0.801	0.769	0.611	0.477	0.368	0.175	0.094
Thursday	0.913	0.870	0.828	0.795	0.781	0.758	0.731	0.583	0.484	0.387	0.184	0.102
Friday	0.905	0.849	0.807	0.770	0.731	0.713	0.695	0.566	0.482	0.390	0.204	0.119
Saturday	0.899	0.851	0.797	0.752	0.720	0.690	0.673	0.563	0.478	0.388	0.199	0.124

Neural Network

K-Nearest Neighbor

```
## [1] 5 5 5 5 5 5 5 5 5 5 7 11 11
```

```
weighted knn
```

```
## [[1]]
## [[1]]$kernel
## [1] "triangular"
##
## [[1]]$k
## [1] 3
##
##
## [[2]]
## [[2]]$kernel
## [1] "triangular"
##
## [[2]]$k
## [1] 3
##
##
## [[3]]
## [[3]]$kernel
```

	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)	1.89*** (0.51)	2.51*** (0.68)	3.39*** (0.76)	4.27*** (0.86)	4.75*** (0.93)	6.24*** (1.00)	7.30*** (1.12)	11.81*** (1.54)	17.79*** (1.73)	20.94*** (1.85)	26.22*** (1.97)	30.78*** (1.94)
DOWMonday	0.70 (0.52)	1.13 (0.69)	0.54 (0.79)	1.52 (0.90)	2.19* (0.96)	2.12* (1.05)	2.68* (1.19)	6.29*** (1.66)	7.80*** (1.98)	10.87*** (2.16)	13.46*** (2.42)	13.36*** (2.58)
DOWTuesday	0.08 (0.50)	0.92 (0.67)	-0.03 (0.75)	-0.96 (0.86)	-0.67 (0.93)	-1.33 (1.01)	-0.42 (1.14)	2.07 (1.62)	2.24 (1.94)	3.93 (2.14)	3.70 (2.41)	2.90 (2.56)
DOWWednesday	-0.07 (0.50)	0.79 (0.67)	1.09 (0.76)	0.32 (0.87)	-0.08 (0.94)	-0.43 (1.02)	-0.08 (1.15)	2.28 (1.63)	3.29 (1.95)	4.26* (2.14)	4.37 (2.42)	3.82 (2.57)
DOWThursday	1.16* (0.50)	2.03** (0.66)	2.49** (0.75)	2.71** (0.85)	2.34* (0.92)	1.47 (1.01)	1.57 (1.14)	2.91 (1.61)	2.48 (1.92)	2.88 (2.11)	4.42 (2.38)	4.59 (2.53)
DOWFriday	1.70*** (0.49)	3.19*** (0.65)	3.65*** (0.74)	4.00*** (0.84)	4.80*** (0.91)	3.92*** (0.99)	3.58** (1.12)	4.78** (1.58)	3.85* (1.89)	4.20* (2.08)	4.74* (2.34)	5.18* (2.49)
DOWSaturday	1.62** (0.49)	2.62*** (0.65)	3.37*** (0.74)	3.98*** (0.85)	4.47*** (0.91)	4.03*** (1.00)	3.58** (1.12)	3.15* (1.59)	1.29 (1.89)	0.94 (2.08)	0.71 (2.34)	-0.35 (2.48)
ROH1	1.01*** (0.01)											
ROH2		1.02*** (0.01)										
ROH3			1.03*** (0.02)									
ROH4				1.04*** (0.02)								
ROH5					1.06*** (0.02)							
ROH6						1.07*** (0.02)						
ROH7							1.07*** (0.03)					
ROH14								1.08*** (0.04)				
ROH21									1.03*** (0.06)			
ROH30										1.07*** (0.07)		
ROH60											1.38*** (0.13)	
ROH90												1.43*** (0.17)
R ²	0.97	0.95	0.94	0.92	0.90	0.89	0.85	0.71	0.58	0.50	0.37	0.28
Adj. R ²	0.97	0.95	0.94	0.92	0.90	0.88	0.85	0.70	0.57	0.49	0.35	0.27
Num. obs.	296	296	296	296	296	5 296	296	296	296	296	296	296
RMSE	2.29	3.07	3.47	3.96	4.28	4.67	5.27	7.47	8.91	9.79	11.02	11.71

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

```

## [1] "triangular"
##
## [[3]]$k
## [1] 3
##
##
## [[4]]
## [[4]]$kernel
## [1] "triangular"
##
## [[4]]$k
## [1] 4
##
##
## [[5]]
## [[5]]$kernel
## [1] "triangular"
##
## [[5]]$k
## [1] 3
##
##
## [[6]]
## [[6]]$kernel
## [1] "rank"
##
## [[6]]$k
## [1] 3
##
##
## [[7]]
## [[7]]$kernel
## [1] "rank"
##
## [[7]]$k
## [1] 3
##
##
## [[8]]

```

```
## [[8]]$kernel
## [1] "triangular"
##
## [[8]]$k
## [1] 5
##
##
## [[9]]
## [[9]]$kernel
## [1] "triangular"
##
## [[9]]$k
## [1] 6
##
##
## [[10]]
## [[10]]$kernel
## [1] "optimal"
##
## [[10]]$k
## [1] 9
##
##
## [[11]]
## [[11]]$kernel
## [1] "triangular"
##
## [[11]]$k
## [1] 5
##
##
## [[12]]
## [[12]]$kernel
## [1] "triangular"
##
## [[12]]$k
## [1] 8
```

Tree

this is the number of variables selected in building each tree.

```
## [[1]]
## [1] 7
##
## [[2]]
## [1] 7
##
## [[3]]
## [1] 7
##
## [[4]]
## [1] 7
##
## [[5]]
## [1] 7
##
## [[6]]
## [1] 7
##
## [[7]]
## [1] 7
##
## [[8]]
## [1] 4
##
## [[9]]
## [1] 4
##
## [[10]]
## [1] 4
##
## [[11]]
## [1] 4
##
## [[12]]
## [1] 2
```



```
##  
## [[13]]  
## [1] 0
```

Support Vector Machine

Tuned (svm function) radial.

```
## [[1]]  
##      gamma  
## 1      0.1  
##  
## [[2]]  
##      gamma  
## 1      0.1  
##  
## [[3]]  
##      gamma  
## 1      0.1  
##  
## [[4]]  
##      gamma  
## 1      0.1  
##  
## [[5]]  
##      gamma  
## 1      0.1  
##  
## [[6]]  
##      gamma  
## 1      0.1  
##  
## [[7]]  
##      gamma  
## 1      0.1  
##  
## [[8]]  
##      gamma  
## 1      0.1
```

```
##
## [[9]]
##   gamma
## 1    0.1
##
## [[10]]
##   gamma
## 1    0.1
##
## [[11]]
##   gamma
## 1    0.1
##
## [[12]]
##   gamma
## 1    0.1
```

Results

Table 5: Mean Errors

	apk	mpk	reg	nn	knn	wknn	dtree	rf	svm
DBA1	0.142	0.093	0.119	-2.87	0.745	0.246	0.398	-0.086	0.098
DBA2	0.225	0.102	0.175	-4.51	1.108	0.444	0.518	0.043	0.071
DBA3	0.275	0.046	0.183	-5.80	1.205	1.170	0.825	0.285	0.068
DBA4	0.548	0.272	0.431	-6.97	1.591	1.155	1.174	0.701	0.189
DBA5	0.557	0.162	0.402	-8.15	1.582	0.685	0.883	0.522	-0.028
DBA6	0.954	0.517	0.804	-8.92	1.612	0.608	0.975	0.604	0.383
DBA7	1.182	0.671	1.043	-9.81	1.617	1.256	0.916	0.689	0.294
DBA14	0.657	-1.159	0.446	-16.53	1.350	1.207	0.437	0.877	-0.172
DBA21	1.233	-1.307	1.168	-20.36	2.263	2.092	1.211	1.733	1.371
DBA30	1.420	-2.278	1.291	-24.74	1.769	1.506	0.359	1.048	1.412
DBA60	2.542	-0.909	2.294	-31.64	2.908	2.454	2.114	2.550	2.804
DBA90	2.573	-3.569	2.304	-34.74	1.805	2.079	2.383	2.334	3.318
13	1.025	-0.613	0.888	-14.59	1.630	1.242	1.016	0.942	0.817

Table 6: Mean Absolute Errors

	apk	mpk	reg	nn	knn	wknn	dtree	rf	svm
DBA1	2.02	2.10	2.00	3.07	2.98	2.65	2.44	2.14	2.11
DBA2	2.57	2.73	2.56	4.59	3.48	3.35	3.60	2.88	2.50
DBA3	2.81	3.10	2.77	5.82	3.85	4.01	3.50	3.33	2.77
DBA4	3.03	3.42	2.97	7.02	4.07	4.26	3.27	3.67	2.92
DBA5	3.30	3.51	3.20	8.17	4.15	4.05	3.97	3.69	3.13
DBA6	3.73	3.69	3.45	8.92	4.22	3.87	3.98	3.67	3.24
DBA7	4.29	4.15	4.01	9.87	4.69	4.43	4.43	4.04	3.54
DBA14	6.38	6.33	6.19	16.53	6.19	6.37	5.74	5.86	5.54
DBA21	7.47	7.22	7.40	20.42	7.21	7.17	7.51	6.83	6.77
DBA30	8.89	9.64	8.82	24.77	8.15	8.44	8.69	8.06	8.15
DBA60	9.94	14.94	9.81	31.67	9.90	10.83	9.47	9.60	9.58
DBA90	10.46	22.18	10.55	34.75	10.41	10.79	10.67	10.55	10.63
13	5.41	6.92	5.31	14.63	5.78	5.85	5.61	5.36	5.07

Table 7: Standard Deviation Errors

	apk	mpk	reg	nn	knn	wknn	dtree	rf	svm
DBA1	2.52	2.63	2.51	2.56	4.28	3.52	3.02	2.67	2.64
DBA2	3.18	3.38	3.16	3.22	4.57	4.38	4.46	3.62	3.18
DBA3	3.66	3.95	3.62	3.65	5.20	5.44	4.44	4.36	3.70
DBA4	3.89	4.18	3.81	3.94	5.24	5.57	3.97	4.62	3.78
DBA5	4.09	4.31	3.95	4.17	5.35	5.08	4.89	4.65	3.90
DBA6	4.34	4.48	4.13	4.39	5.31	5.01	4.80	4.52	3.98
DBA7	4.88	4.95	4.64	5.11	5.71	5.53	5.25	5.01	4.38
DBA14	8.02	8.44	7.80	8.22	8.06	7.94	7.45	7.32	7.32
DBA21	9.39	9.70	9.30	10.13	9.45	9.37	9.51	8.88	8.58
DBA30	10.97	12.25	10.84	11.86	10.62	11.07	10.67	10.40	10.08
DBA60	12.75	19.42	12.53	13.57	12.97	13.87	11.85	12.09	12.31
DBA90	13.68	28.31	13.72	14.32	13.68	14.07	13.88	13.63	13.81
13	6.78	8.83	6.67	7.10	7.54	7.57	7.01	6.81	6.47

Table 8: Mean Percentage Errors

	apk	mpk	reg	nn	knn	wknn	dtree	rf	svm
DBA1	0.028	-0.009	0.023	-0.099	0.197	0.089	0.089	0.015	0.055
DBA2	0.051	-0.014	0.041	-0.143	0.205	0.101	0.101	0.019	0.062
DBA3	0.071	-0.018	0.053	-0.197	0.228	0.124	0.111	0.027	0.080
DBA4	0.089	-0.016	0.064	-0.233	0.234	0.127	0.125	0.039	0.067
DBA5	0.103	-0.018	0.071	-0.261	0.238	0.106	0.123	0.035	0.050
DBA6	0.133	-0.007	0.099	-0.290	0.222	0.103	0.122	0.040	0.080
DBA7	0.161	0.002	0.127	-0.289	0.225	0.123	0.134	0.046	0.086
DBA14	0.249	-0.034	0.216	-0.441	0.261	0.189	0.132	0.152	0.155
DBA21	0.344	-0.022	0.333	-0.488	0.350	0.322	0.247	0.252	0.287
DBA30	0.421	-0.024	0.404	-0.598	0.379	0.379	0.253	0.281	0.355
DBA60	0.554	0.063	0.516	-0.795	0.592	0.585	0.401	0.496	0.544
DBA90	0.593	0.002	0.567	-0.869	0.566	0.524	0.575	0.578	0.631
13	0.233	-0.008	0.210	-0.392	0.308	0.231	0.201	0.165	0.204

Table 9: MAPE

	apk	mpk	reg	nn	knn	wknn	dtree	rf	svm
DBA1	0.071	0.066	0.068	0.115	0.249	0.148	0.147	0.077	0.106
DBA2	0.106	0.087	0.099	0.154	0.257	0.166	0.179	0.095	0.123
DBA3	0.127	0.098	0.115	0.200	0.286	0.191	0.180	0.113	0.144
DBA4	0.142	0.112	0.126	0.243	0.291	0.200	0.179	0.126	0.135
DBA5	0.160	0.117	0.137	0.264	0.296	0.189	0.196	0.123	0.133
DBA6	0.189	0.119	0.153	0.291	0.279	0.181	0.191	0.126	0.150
DBA7	0.224	0.129	0.188	0.299	0.293	0.199	0.213	0.137	0.156
DBA14	0.363	0.178	0.331	0.441	0.357	0.297	0.240	0.251	0.272
DBA21	0.464	0.203	0.454	0.522	0.443	0.418	0.368	0.348	0.393
DBA30	0.568	0.276	0.552	0.615	0.502	0.515	0.420	0.418	0.489
DBA60	0.696	0.462	0.661	0.800	0.725	0.749	0.537	0.631	0.674
DBA90	0.746	0.675	0.728	0.874	0.733	0.696	0.739	0.737	0.774
13	0.321	0.210	0.301	0.402	0.393	0.329	0.299	0.265	0.296

Table 10: Model Performances

	ME[^{note}]	MAE[^{note}]	SDE[^{note}]	MPE[^{note}]	MAPE[^{note}]	Time[^{note}]
Additive Pickup	1.025	5.41	6.78	0.233	0.321	0.139
Multiplicative Pickup	-0.613	6.92	8.83	-0.008	0.210	0.129
Regression	0.888	5.31	6.67	0.210	0.301	0.060
Neural Network	-14.586	14.63	7.10	-0.392	0.402	25.692
K-Nearest Neighbor	1.630	5.78	7.54	0.308	0.393	15.286
Weighted K-Nearest Neighbor	1.242	5.85	7.57	0.231	0.329	1.728
Decision Tree	1.016	5.61	7.01	0.201	0.299	0.082
Random Forest	0.942	5.36	6.81	0.165	0.265	92.122
Support Vector Machine	0.817	5.07	6.47	0.204	0.296	6.818

¹ Mean Error² Mean Absolute Error³ Standard Deviation Error⁴ Mean Percentage Error⁵ Mean Absolute Percentage Error⁶ time is calculated in seconds