Supplemental Online Materials to (Data-Driven Dynamic Optimization for Real-Time Parking Reservation Considering Parking Unpunctuality) by (Pengyu Yan, Mingyan Bai, Xiaoqiang Cai, Zhibin Chen, and Hongke Xie)

The real parking demands are collected from a parking garage of a shopping mall for 81 days from August 3 to November 1 in 2019 in Chengdu, China, consisting of 68,795 parking records. We set the operation horizon of the reservation system (parking garage) is from 9:00 to 21:00 for each day. The horizon from 9:00 to 21:00 (12 hours) is equally divided into T=24 decision periods with a length of 30 minutes. The operation time is denoted as 9:00-9:30, 9:30-10:00, ⋯, 20:30-21:00. Correspondingly, the decision period t is denoted as 1, 2, ⋯, 24, and the real parking demands $d_{t,k}$ with type k in period t can be defined as $1 \leq k \leq K_t \equiv 24 - t + 1$.Table 1 and Table 2 show the values of mean and standard variance of the real demands $d_{t,k}$ with type k in period t for 81 days over the operation time from 9:00 to 21:00.

Table 1: Values of mean of the real demands $d_{t,k}$ with type k in period t over the operation time from 9:00 to 21:00.

Type / Operation time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
9:00-9:30	5.37	3.63	2.22	1.70	1.48	1.15	0.48	0.32	0.38	0.20	0.25	0.25	0.08	0.23	0.22	0.25	0.15	0.30	0.13	0.13	0.12	0.10	0.07	0.07
9:30-10:00	6.93	5.95	3.73	2.55	1.45	0.75	0.62	0.32	0.45	0.37	0.25	0.15	0.13	0.13	0.18	0.17	0.25	0.22	0.12	0.08	0.10	0.07	0.30	
10:00-10:30	6.47	5.92	3.23	1.95	1.45	0.83	1.10	0.50	0.38	0.32	0.38	0.17	0.17	0.17	0.13	0.22	0.17	0.08	0.12	0.12	0.13	0.15		
10:30-11:00	5.80	5.07	2.45	1.77	1.23	0.82	0.63	0.52	0.42	0.35	0.25	0.25	0.32	0.22	0.22	0.20	0.08	0.15	0.07	0.12	0.28			

11:00-11:30	5.92	3.73	3.28	2.28	1.65	1.03	0.70	0.90	0.48	0.33	0.25	0.20	0.22	0.25	0.13	0.17	0.15	0.13	0.08	0.10				
11:30-12:00	5.20	4.45	6.10	3.92	2.30	1.60	0.98	1.00	0.48	0.23	0.25	0.32	0.17	0.15	0.17	0.27	0.05	0.08	0.17					
12:00-12:30	4.75	5.42	6.45	3.88	2.12	1.60	0.80	0.53	0.57	0.27	0.32	0.18	0.28	0.20	0.15	0.07	0.23	0.07						
12:30-13:00	4.42	3.73	3.55	3.03	2.13	1.10	0.83	0.65	0.52	0.48	0.43	0.27	0.27	0.48	0.23	0.33	0.18							
13:00-13:30	4.62	3.37	2.67	2.08	1.75	1.52	0.90	0.78	0.80	0.68	0.38	0.28	0.23	0.18	0.27	0.23								
13:30-14:00	4.47	3.33	3.18	2.23	2.18	1.37	1.20	1.27	0.75	0.65	0.30	0.15	0.22	0.15	0.27									
14:00-14:30	5.20	4.17	3.05	3.13	2.17	2.23	1.32	1.07	0.47	0.37	0.15	0.20	0.25	0.13										
14:30-15:00	5.00	3.82	3.22	2.68	2.97	1.95	1.22	0.48	0.53	0.22	0.23	0.17	0.12											
15:00-15:30	5.88	5.27	3.15	3.17	2.85	1.48	0.78	0.43	0.30	0.30	0.28	0.23												
15:30-16:00	6.13	5.92	4.17	2.95	2.53	1.27	0.55	0.52	0.38	0.22	0.23													
16:00-16:30	7.35	6.25	4.75	3.33	2.12	1.20	0.53	0.50	0.45	0.27														
16:30-17:00	6.40	6.83	4.72	2.73	1.90	1.55	0.75	0.77	0.52															
17:00-17:30	7.15	6.80	4.48	4.22	2.92	2.18	2.13	0.95																
17:30-18:00	8.53	6.07	6.88	6.20	5.10	3.43	1.70																	
18:00-18:30	6.22	7.42	9.38	8.67	6.95	3.85																		
18:30-19:00	6.32	9.57	13.03	10.98	6.70																			
19:00-19:30	6.45	13.53	14.20	9.92																				
19:30-20:00	7.13	12.70	10.90																					
20:00-20:30	7.43	10.12																						
20:30-21:00	6.55																							

Table 2: Values of standard variance of the real demands $d_{t,k}$ with type k in period t over the operation time from 9:00 to 21:00.

Type / Operation time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

9:00-9:30	6.87	12.10	3.10	2.98	2.08	1.46	0.48	0.35	0.40	0.19	0.29	0.22	0.08	0.18	0.17	0.22	0.13	0.28	0.12	0.18	0.20	0.12	0.06	0.06
9:30-10:00	8.66	10.88	9.13	4.11	1.71	0.65	1.00	0.42	0.41	0.37	0.22	0.16	0.18	0.12	0.18	0.17	0.25	0.24	0.10	0.18	0.12	0.06	0.31	
10:00-10:30	7.02	13.34	4.05	3.31	1.88	1.01	0.89	0.55	0.40	0.35	0.44	0.14	0.17	0.17	0.12	0.20	0.14	0.11	0.14	0.14	0.12	0.13		
10:30-11:00	9.13	8.63	3.31	1.85	1.25	0.82	0.70	0.58	0.41	0.36	0.19	0.25	0.28	0.24	0.20	0.16	0.08	0.46	0.06	0.10	0.27			
11:00-11:30	7.21	4.00	5.40	3.50	1.33	1.37	0.81	0.79	0.52	0.39	0.25	0.19	0.24	0.22	0.15	0.17	0.33	0.12	0.11	0.09				
11:30-12:00	6.46	5.18	7.22	5.71	3.51	2.37	1.35	1.43	0.55	0.21	0.35	0.22	0.14	0.13	0.34	0.53	0.05	0.14	0.14					
12:00-12:30	9.09	6.61	8.48	4.64	2.54	2.24	1.03	0.55	0.65	0.26	0.28	0.22	0.27	0.49	0.33	0.06	0.21	0.06						
12:30-13:00	4.31	4.10	4.41	3.77	3.75	0.89	0.84	0.69	0.58	0.65	0.51	0.26	0.43	7.25	0.28	0.79	0.22							
13:00-13:30	5.77	3.33	2.79	2.11	2.12	1.75	1.06	0.80	1.19	0.85	0.40	0.30	1.38	0.18	0.23	0.38								
13:30-14:00	4.92	3.89	5.18	2.35	1.95	2.27	1.59	1.60	1.02	0.96	0.41	0.19	0.20	0.16	0.20									
14:00-14:30	7.93	3.97	3.45	4.05	2.37	3.05	1.42	1.46	0.52	0.40	0.13	0.23	0.29	0.12										
14:30-15:00	4.97	3.98	4.10	3.82	4.27	2.98	1.07	0.68	0.68	0.20	0.25	0.14	0.10											
15:00-15:30	8.77	6.33	3.76	4.71	4.86	1.35	0.90	0.58	0.24	0.34	0.37	0.21												
15:30-16:00	8.15	10.44	7.04	4.45	4.28	1.93	0.65	0.45	0.44	0.20	0.21													
16:00-16:30	8.63	12.19	8.12	3.06	2.90	1.63	0.68	0.35	0.58	0.30														
16:30-17:00	8.34	11.91	9.00	3.53	1.79	1.88	0.65	0.98	0.35															
17:00-17:30	8.03	9.39	6.72	5.17	3.84	2.15	2.15	0.75																
17:30-18:00	13.72	7.53	9.84	13.06	5.96	3.45	2.71																	
18:00-18:30	8.47	7.04	11.94	13.89	9.91	7.16																		
18:30-19:00	6.45	18.68	26.17	22.05	10.68																			
19:00-19:30	7.91	23.12	30.63	19.44																				
19:30-20:00	9.05	18.31	17.39																					
20:00-20:30	12.58	15.24																						
20:30-21:00	9.55																							