RESCHEDULING RAILWAY TIMETABLES IN PRESENCE OF PASSENGER TRANSFERS IN TRANSPORTATION NETWORKS

Juan A. Mesa (jmesa@us.es) , Francisco A. Ortega (riejos@us.es), Miguel A. Pozo (miguelpozo@us.es), Justo Puerto (puerto@us.es).

University of Seville, Spain

Abstract

This paper considers a transit line where a train fleet circulates and stops at the stations according to a predetermined schedule which is known by the users. At any instant, passengers arrive at different stations in order to board these vehicles according to a model of distribution of passenger arrivals that is assumed deterministic.
In this scenario, a service rescheduling forced by an incidence is determined in order to minimize the loss of passengers who require transfers between different line runs at the interchange stations. A case study consisting of a railway line with several equi-spaced stations, where it is possible a connection to other lines at intermediate stations is analyzed for different scenarios where the loss of transfers is penalized.

Graphical schedule representation based on points

The railway infrastructure manager usually establishes a sequence of temporal windows where the rail operator must locate the execution of different tasks. Assuming a canonical unit h, a uniform mesh of squares of length h can be used to represent the activity map of trains at section k (Figures 1 and 2).

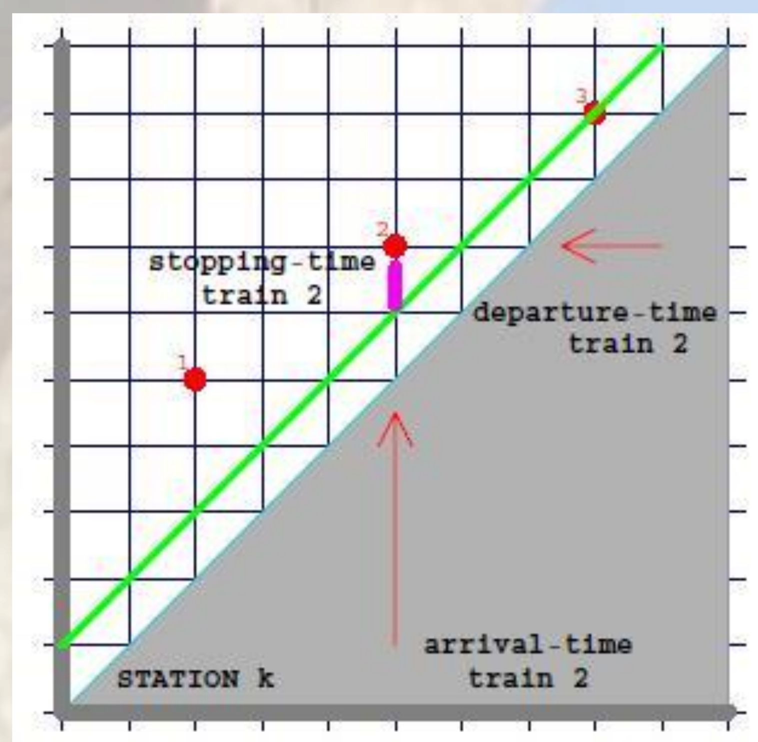


Figure 1: Three trains passing through station k

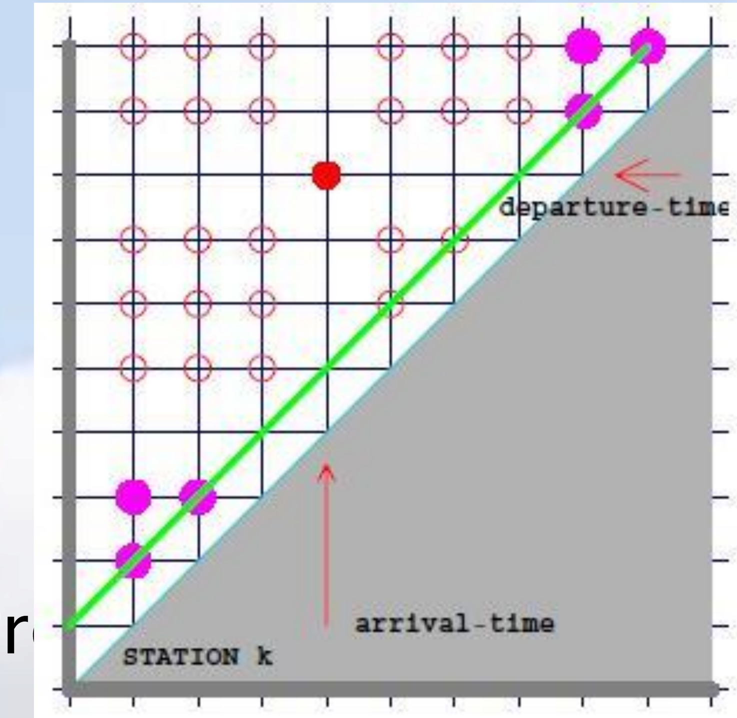


Figure 2: Candidate timetable-points to locate other trains at station k

Scenario for preserving transfers between lines

If transit corridor would intersect with others transit lines at specific stations, as is shown in Figure 3, the determination of new timetables should ensure the transfer of passengers between trains from different line runs at such interchange stations (Figure 4).

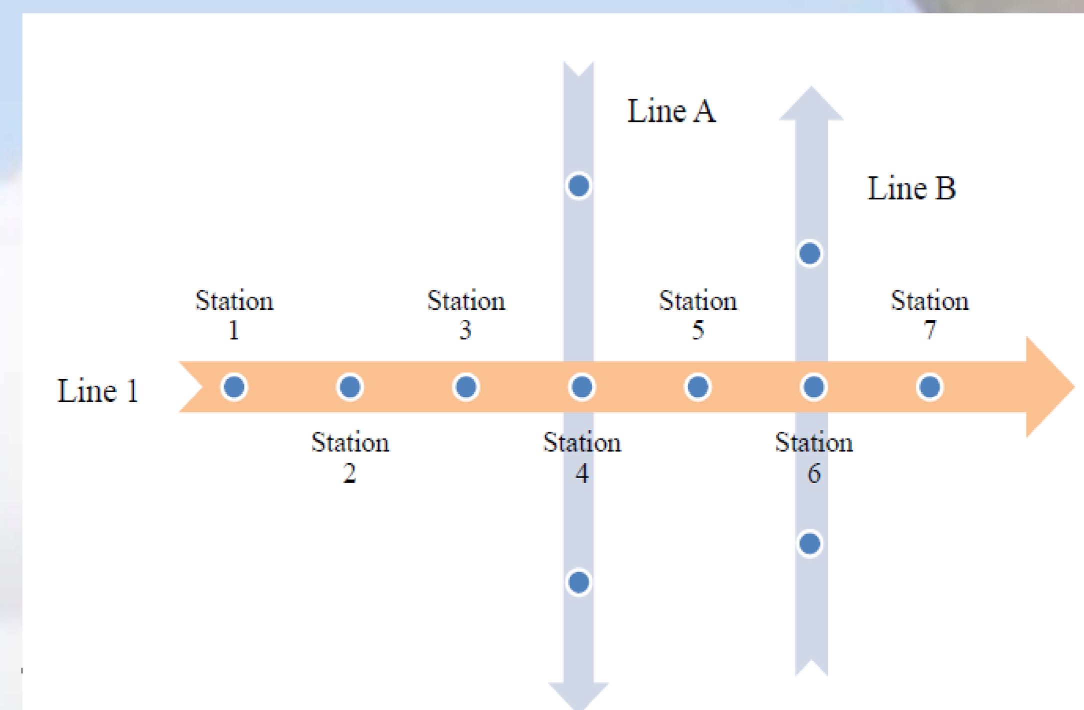


Figure 3: Corridor intersecting other external lines

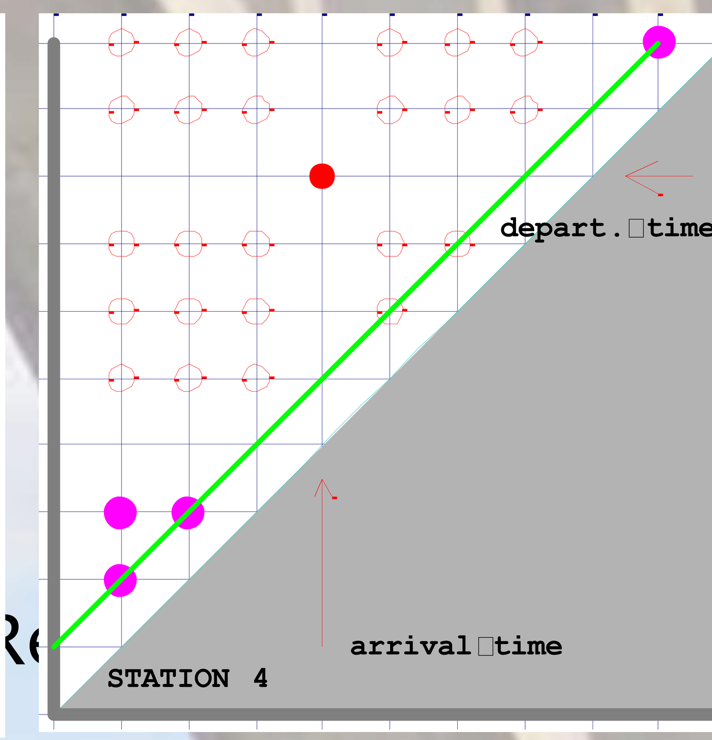
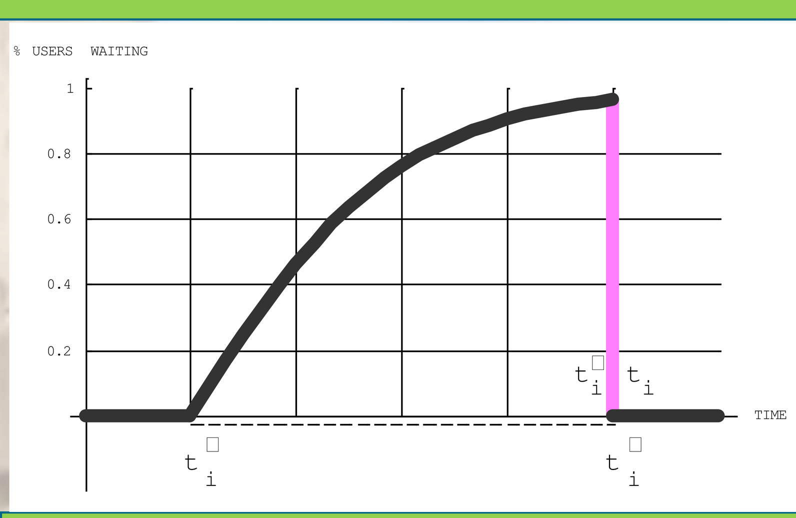
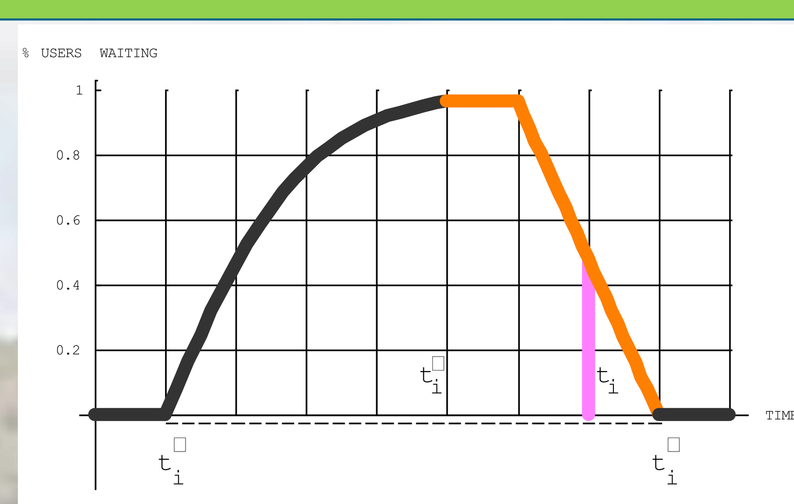


Figure 4: Timetable-points where transfers are possible

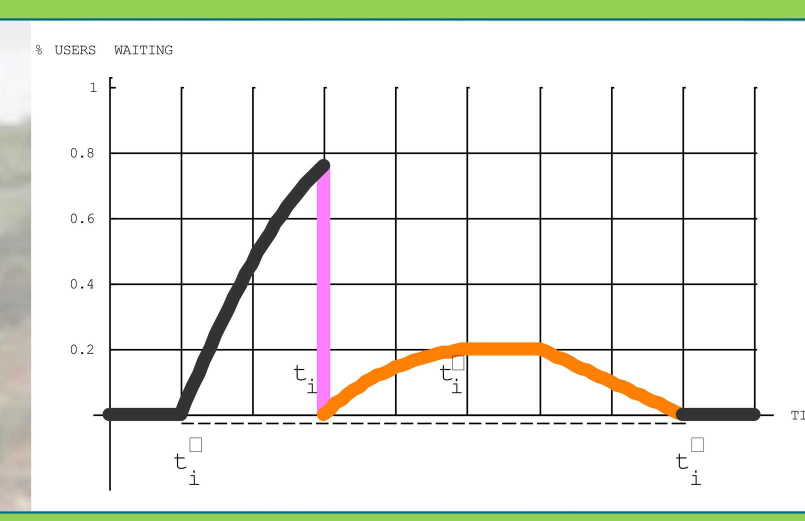
Assuming a pattern for the demand behavior



Normal demand behavior in terms of percentage of user´s presence at platform



Demand behavior when train is delayed



Demand behavior if train departed in advance

Model Formulation. Computational experience. Application to a real case. Conclusions

Select the best 9 train schedules in the commuter train systems of Madrid (25 trains along Line C4 Parla-Atocha).

	Stations													
	$k=1$		$k=2$		$k=3$		$k=4$		$k=5$		$k=6$		$k=7$	
#j	t	$A_k^{(j)}$	t	$A_k^{(j)}$	t	$A_k^{(j)}$	t	$A_k^{(j)}$	t	$A_k^{(j)}$	t	$A_k^{(j)}$	t	$A_k^{(j)}$
12	6:04	335	6:10	1	6:13	44	6:15	7	6:18	44	6:21	46	6:31	147
13	6:12	177	6:18	5	6:21	113	6:24	48	6:26	124	6:29	81	6:38	302
14	6:16	307	6:22	1	6:25	35	6:28	29	6:30	64	6:34	58	6:42	123
15	6:22	55	6:28	8	6:31	138	6:33	54	6:36	163	6:39	86	6:48	234
16	6:28	429	6:34	10	6:36	145	6:39	62	6:42	173	6:44	119	6:54	349
17	6:34	511	6:40	4	6:42	102	6:44	26	6:46	153	6:50	115	7:00	571
18	6:40	484	6:46	12	6:48	151	6:50	54	6:52	119	6:57	107	7:07	129
19	6:46	491	6:52	10	6:54	166	6:56	70	7:00	157	7:04	160	7:12	184
20	6:54	414	7:00	24	7:03	254	7:05	119	7:08	158	7:12	185	7:20	490
21	7:01	476	7:07	17	7:10	195	7:12	88	7:15	106	7:18	145	7:26	514
23	7:09	421	7:15	33	7:18	260	7:20	111	7:24	146	7:27	209	7:35	491
24	7:16	550	7:22	38	7:25	218	7:27	158	7:30	123	7:34	298	7:43	574
25	7:22	414	7:28	36	7:31	247	7:34	119	7:38	136	7:41	243	7:48	451
26	7:28	421	7:34	26	7:37	127	7:41	104	7:44	97	7:47	154	7:54	276
27	7:34	386	7:40	31	7:42	145	7:45	113	7:48	103	7:53	144	8:00	424
28	7:40	384	7:46	47	7:48	171	7:50	108	7:54	99	7:58	180	8:06	284
29	7:46	323	7:52	31	7:54	202	7:57	134	8:00	128	8:04	231	8:12	647
30	7:52	408	7:58	19	8:01	190	8:02	77	8:05	84	8:09	192	8:18	446
31	7:58	441	8:03	49	8:06	210	8:09	91	8:13	119	8:15	223	8:24	335
32	8:04	165	8:10	47	8:13	229	8:15	110	8:19	126	8:23	259	8:30	338
33	8:11	347	8:15	44	8:18	225	8:21	134	8:25	98	8:28	165	8:36	302
34	8:16	336	8:22	38	8:25	294	8:28	112	8:30	79	8:33	158	8:42	271
35	8:22	317	8:28	33	8:31	230	8:34	119	8:36	119	8:40	156	8:48	410
36	8:28	335	8:34	36	8:37	119	8:39	91	8:41	61	8:45	144	8:54	364
37	8:34	265	8:40	13	8:43	117	8:45	66	8:47	43	8:52	153	9:00	381

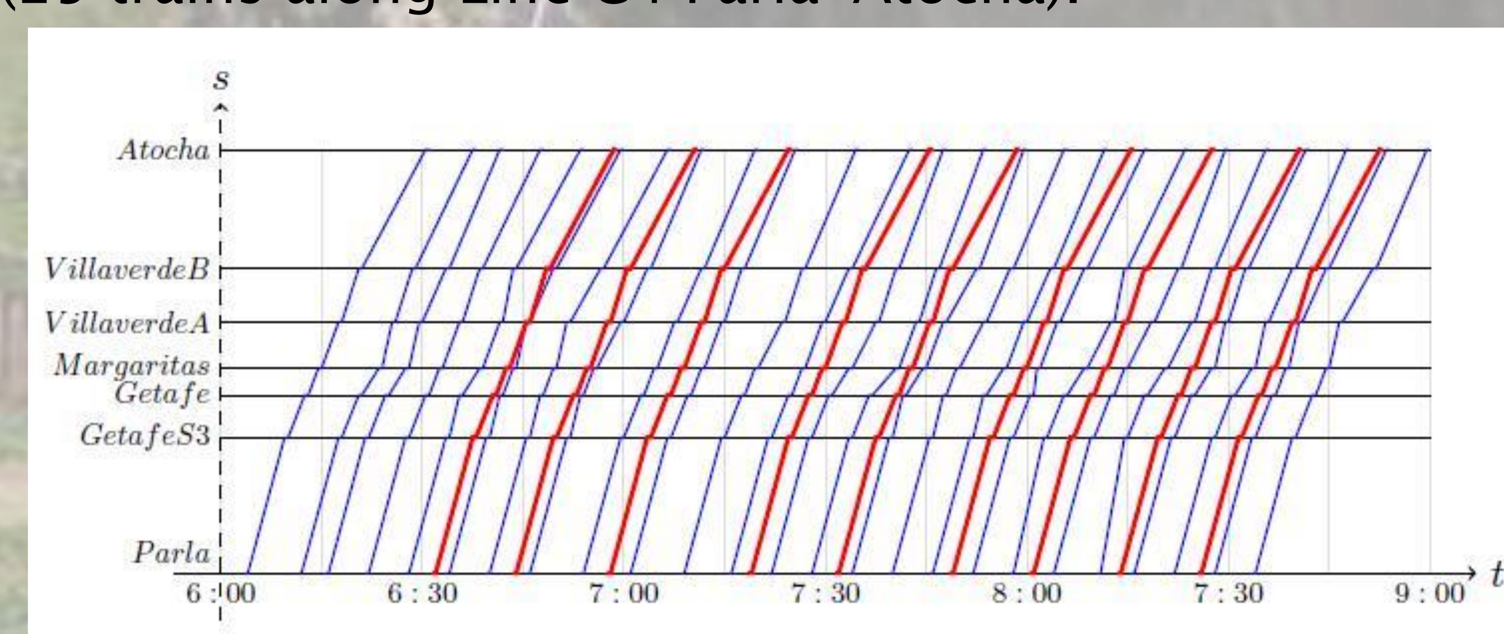


Diagram shows in blue lines the initial timetables provided by the company, and in bold red a reschedule of 9 trains provided using the proposed methodology. Computational results show an improvement of a 20.9% in the number of passengers with respect to a myopic decision.

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