

Interactive Visualization for Real-time Public Transport Journey Planning

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Motivation - Schedules

3

Berchengebiet - Zähringerplatz - Laube - Bahnhof - Berchengebiet

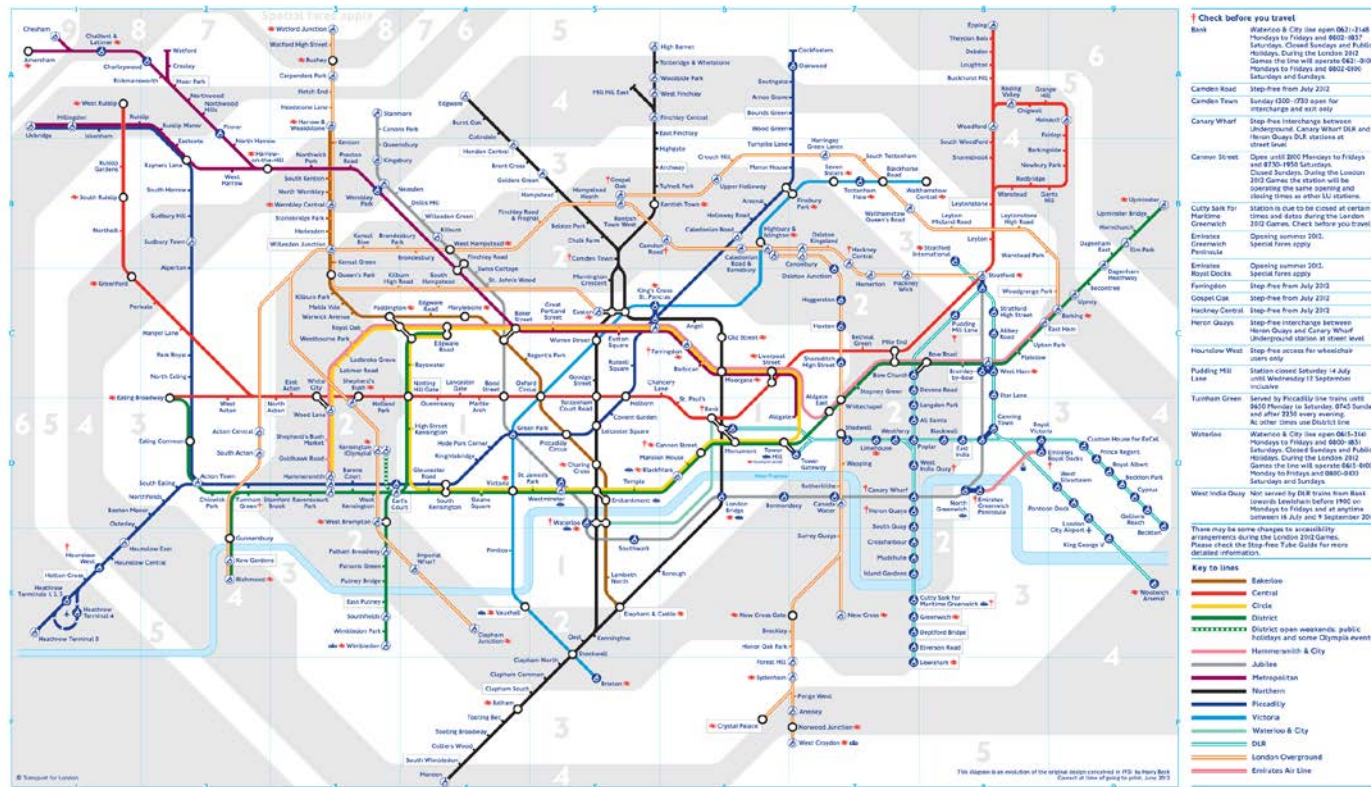
Montag - Freitag

	6:34	6:49	7:04	7:19	7:34	7:49	8:04	8:19	8:34	8:49	9:04	9:19	9:34	9:49	10:04	10:34	11:04	11:19	11:34	11:49	12:04	12:19
Brandenburgerstraße	6:34	6:49	7:04	7:19	7:34	7:49	8:04	8:19	8:34	8:49	9:04	9:19	9:34	9:49	10:04	10:34	11:04	11:19	11:34	11:49	12:04	12:19
Karlsruherstraße	6:35	6:50	7:05	7:20	7:35	7:50	8:05	8:20	8:35	8:50	9:05	9:20	9:35	9:50	10:05	10:35	11:05	11:20	11:35	11:50	12:05	12:20
Hardtstraße	6:36	6:51	7:06	7:21	7:36	7:51	8:06	8:21	8:36	8:51	9:06	9:21	9:36	9:51	10:06	10:36	11:06	11:21	11:36	11:51	12:06	12:21
Reute / Winkelstraße	6:38	6:53	7:08	7:23	7:38	7:53	8:08	8:23	8:38	8:53	9:08	9:23	9:38	9:53	10:08	10:38	11:08	11:23	11:38	11:53	12:08	12:23
Elberfeldstraße	6:39	6:54	7:09	7:24	7:39	7:54	8:09	8:24	8:39	8:54	9:09	9:24	9:39	9:54	10:09	10:39	11:09	11:24	11:39	11:54	12:09	12:24
Fürstenberg	6:40	6:55	7:10	7:25	7:40	7:55	8:10	8:25	8:40	8:55	9:10	9:25	9:40	9:55	10:10	10:40	11:10	11:25	11:40	11:55	12:10	12:25
Taborweg	6:41	6:56	7:11	7:26	7:41	7:56	8:11	8:26	8:41	8:56	9:11	9:26	9:41	9:56	10:11	10:41	11:11	11:26	11:41	11:56	12:11	12:26
Friedhof	6:43	6:58	7:13	7:28	7:43	7:58	8:13	8:28	8:43	8:58	9:13	9:28	9:43	9:58	10:13	10:43	11:13	11:28	11:43	11:58	12:13	12:28
Bismarcksteig	6:44	6:59	7:14	7:29	7:44	7:59	8:14	8:29	8:44	8:59	9:14	9:29	9:44	9:59	10:14	10:44	11:14	11:29	11:44	11:59	12:14	12:29
Zähringerplatz	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45	9:00	9:15	9:30	9:45	10:00	10:15	10:45	11:15	11:30	11:45	12:00	12:15	12:30
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Schnetztor	6:52	7:07	7:22	7:37	7:52	8:07	8:22	8:37	8:52	9:07	9:22	9:37	9:52	10:07	10:22	10:52	11:22	11:37	11:52	12:07	12:22	12:37
Bodanplatz	6:53	7:08	7:23	7:38	7:53	8:08	8:23	8:38	8:53	9:08	9:23	9:38	9:53	10:08	10:23	10:53	11:23	11:38	11:53	12:08	12:23	12:38
Bahnhof	6:55	7:10	7:25	7:40	7:55	8:10	8:25	8:40	8:55	9:10	9:25	9:40	9:55	10:10	10:25	10:55	11:25	11:40	11:55	12:10	12:25	12:40
Konzilstraße	6:56	7:11	7:26	7:41	7:56	8:11	8:26	8:41	8:56	9:11	9:26	9:41	9:56	10:11	10:26	10:56	11:26	11:41	11:56	12:11	12:26	12:41
Sternenplatz	6:58	7:13	7:28	7:43	7:58	8:13	8:28	8:43	8:58	9:13	9:28	9:43	9:58	10:13	10:28	10:58	11:28	11:43	11:58	12:13	12:28	12:43
Zähringerplatz	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45	9:00	9:15	9:30	9:45	10:00	10:15	10:30	11:00	11:30	11:45	12:00	12:15	12:30	12:45
Bismarcksteig	7:02	7:17	7:32	7:47	8:02	8:17	8:32	8:47	9:02	9:17	9:32	9:47	10:02	10:17	10:32	11:02	11:32	11:47	12:02	12:17	12:32	12:47
Friedhof	7:03	7:18	7:33	7:48	8:03	8:18	8:33	8:48	9:03	9:18	9:33	9:48	10:03	10:18	10:33	11:03	11:33	11:48	12:03	12:18	12:33	12:48
Taborweg	7:04	7:19	7:34	7:49	8:04	8:19	8:34	8:49	9:04	9:19	9:34	9:49	10:04	10:19	10:34	11:04	11:34	11:49	12:04	12:19	12:34	12:49
Fürstenberg	7:05	7:20	7:35	7:50	8:05	8:20	8:35	8:50	9:05	9:20	9:35	9:50	10:05	10:20	10:35	11:05	11:35	11:50	12:05	12:20	12:35	12:50
Elberfeldstraße	7:06	7:21	7:36	7:51	8:06	8:21	8:36	8:51	9:06	9:21	9:36	9:51	10:06	10:21	10:36	11:06	11:36	11:51	12:06	12:21	12:36	12:51
Reute / Winkelstraße	7:07	7:22	7:37	7:52	8:07	8:22	8:37	8:52	9:07	9:22	9:37	9:52	10:07	10:22	10:37	11:07	11:37	11:52	12:07	12:22	12:37	12:52
Reute-/ Freibürgleweg	7:08	7:23	7:38	7:53	8:08	8:23	8:38	8:53	9:08	9:23	9:38	9:53	10:08	10:23	10:38	11:08	11:38	11:53	12:08	12:23	12:38	12:53
Breslauer Straße Ost	7:10	7:25	7:40	7:55	8:10	8:25	8:40	8:55	9:10	9:25	9:40	9:55	10:10	10:25	10:40	11:10	11:40	11:55	12:10	12:25	12:40	12:55
Breslauer Straße West	7:11	7:26	7:41	7:56	8:11	8:26	8:41	8:56	9:11	9:26	9:41	9:56	10:11	10:26	10:41	11:11	11:41	11:56	12:11	12:26	12:41	12:56
Brandenburgerstraße	7:12	7:27	7:42	7:57	8:12	8:27	8:42	8:57	9:12	9:27	9:42	9:57	10:12	10:27	10:42	11:12	11:42	11:57	12:12	12:27	12:42	12:57




Montag - Freitag

Motivation – Beck's Map










Tube map



Motivation – Route Planners

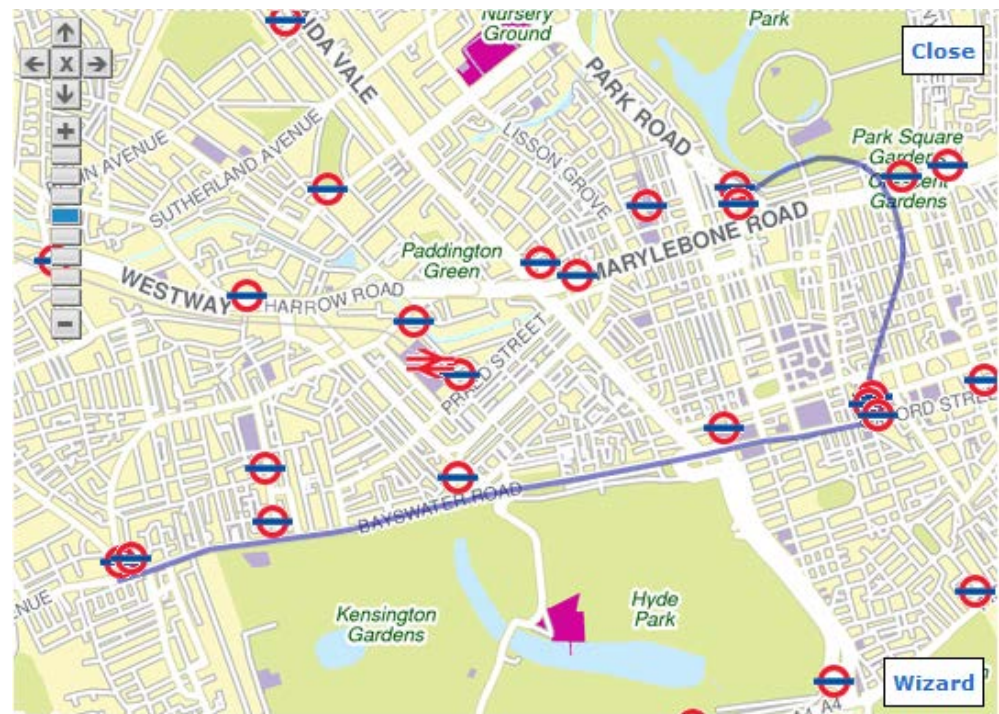
Journey details (Edit) **Travel preferences (Edit)**   

From Notting Hill Gate
To Baker Street
Leaving on Tue 20 Nov 2012 at 14:16

Time	Route details	Information	Maps
14:14	start Notting Hill Gate Underground Station	Av journey time: 7 mins Zone(s): 1	
14:21	Take the Central Line towards Hainault Underground Station or Central Line towards Epping Underground Station or Central Line towards Loughton Underground Station	  	
14:26	Bond Street Underground Station	Av journey time: 2 mins Zone(s): 1	
	Take the Jubilee Line towards Stanmore Underground Station or Jubilee Line towards Willesden Green Underground Station or Jubilee Line towards Wembley Park Underground Station		
14:28	end Baker Street Underground Station		
			

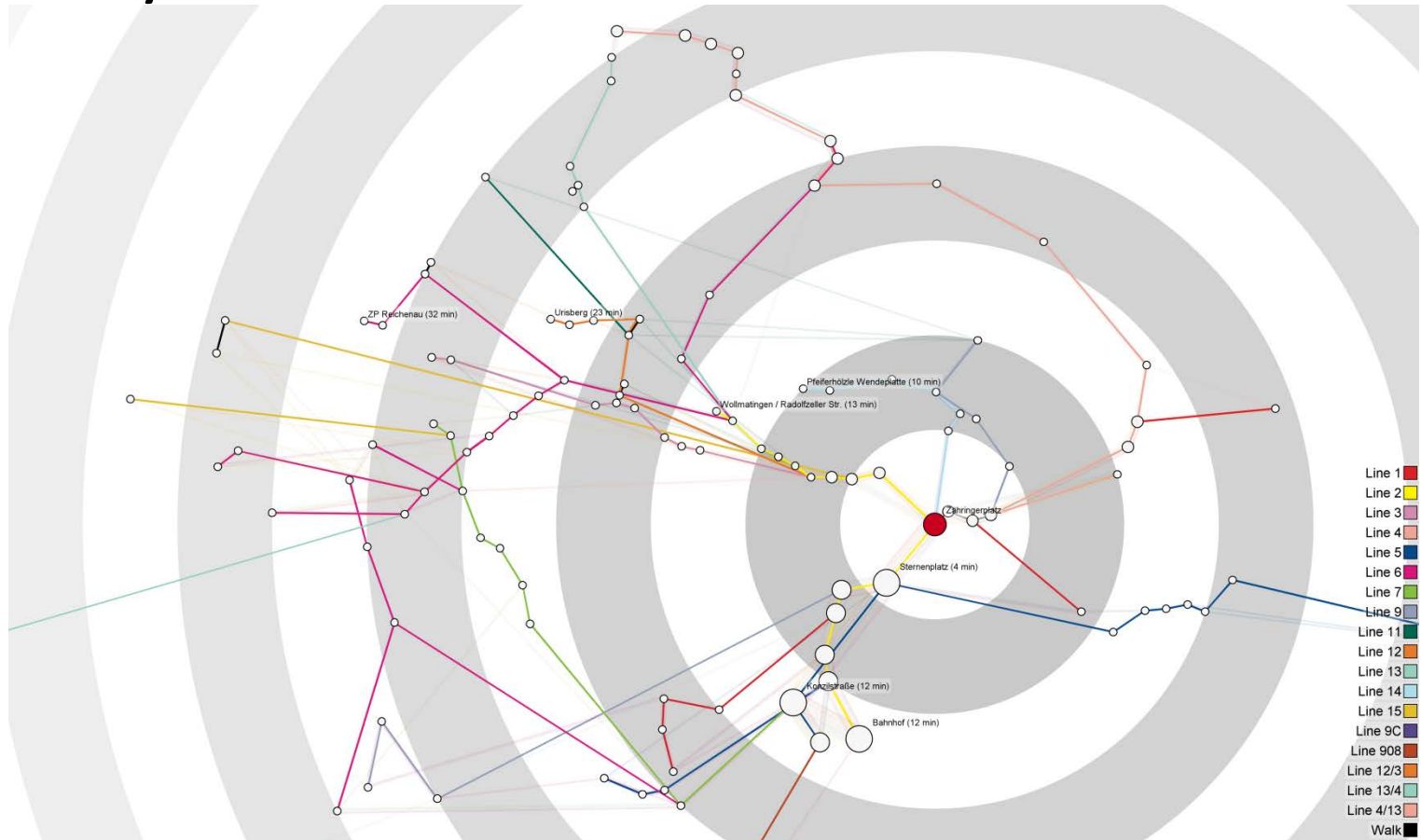
 Check fare prices and ticket options

Max. journey time: 00:14
Interchanges: 1



Goal

- Visualize optimal routes from one station to every other station

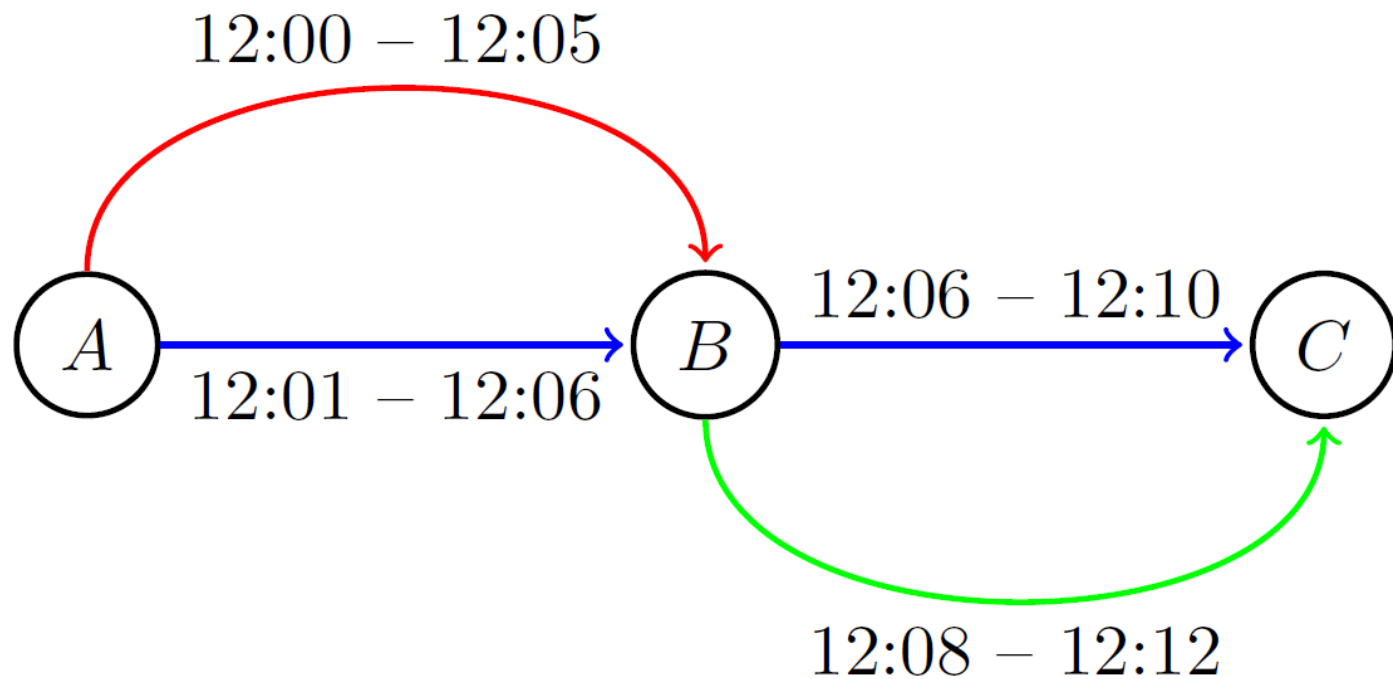




Routing

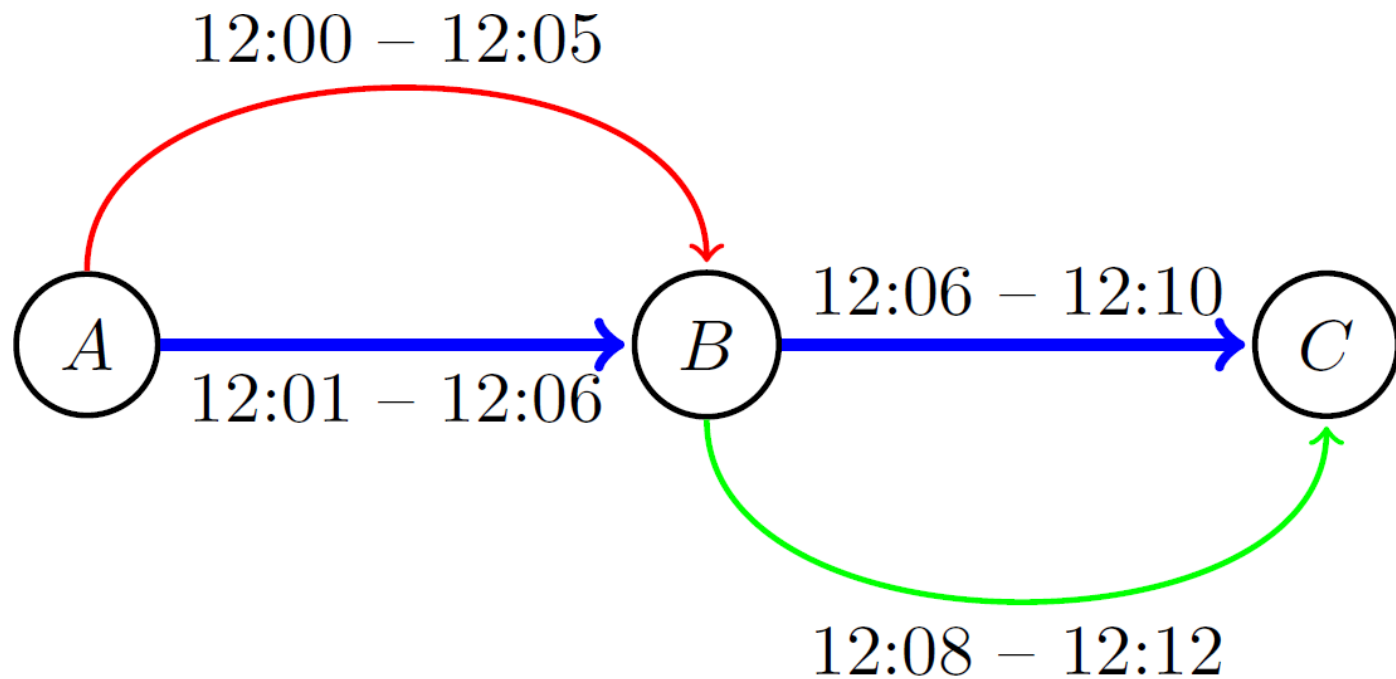
- Modification of Dijkstra's algorithm
- Time varying edge weights:
 - travel time + waiting time
- Walking is also considered
- Time is required to change lines

Problem of Changing Lines



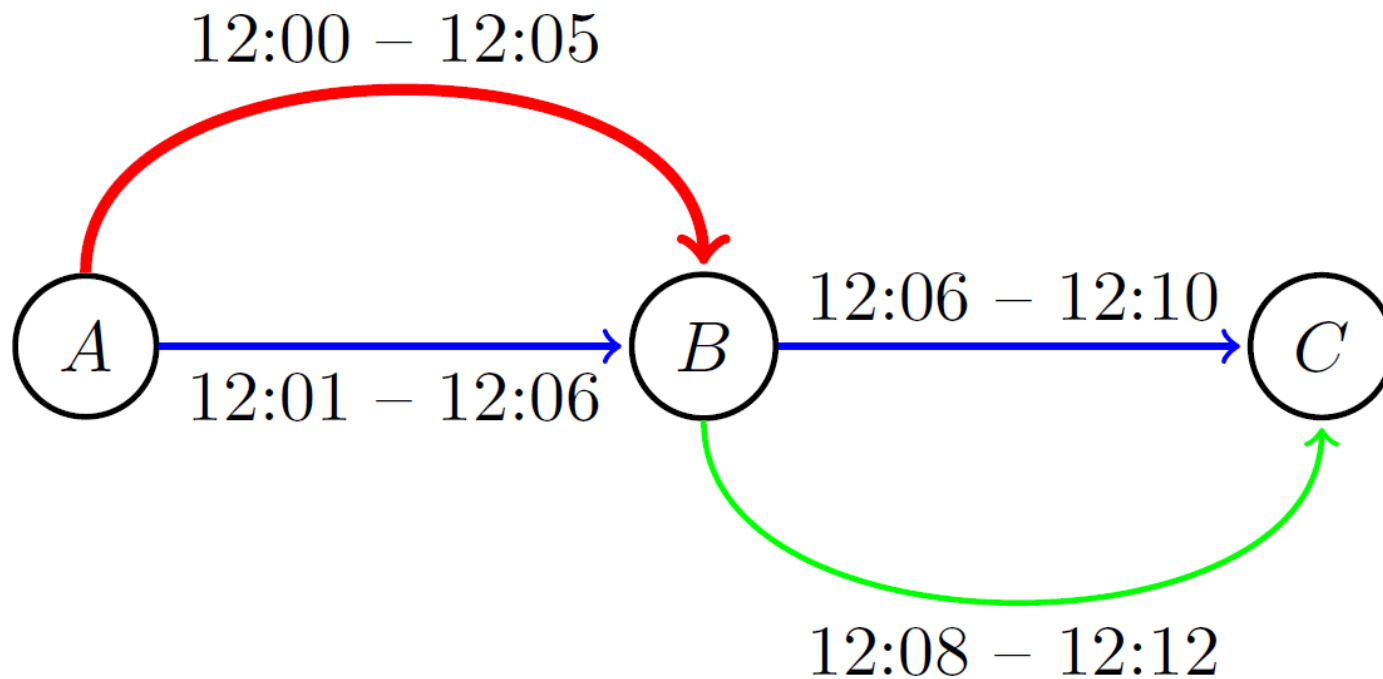
Change time: 2 min.

Problem of Changing Lines



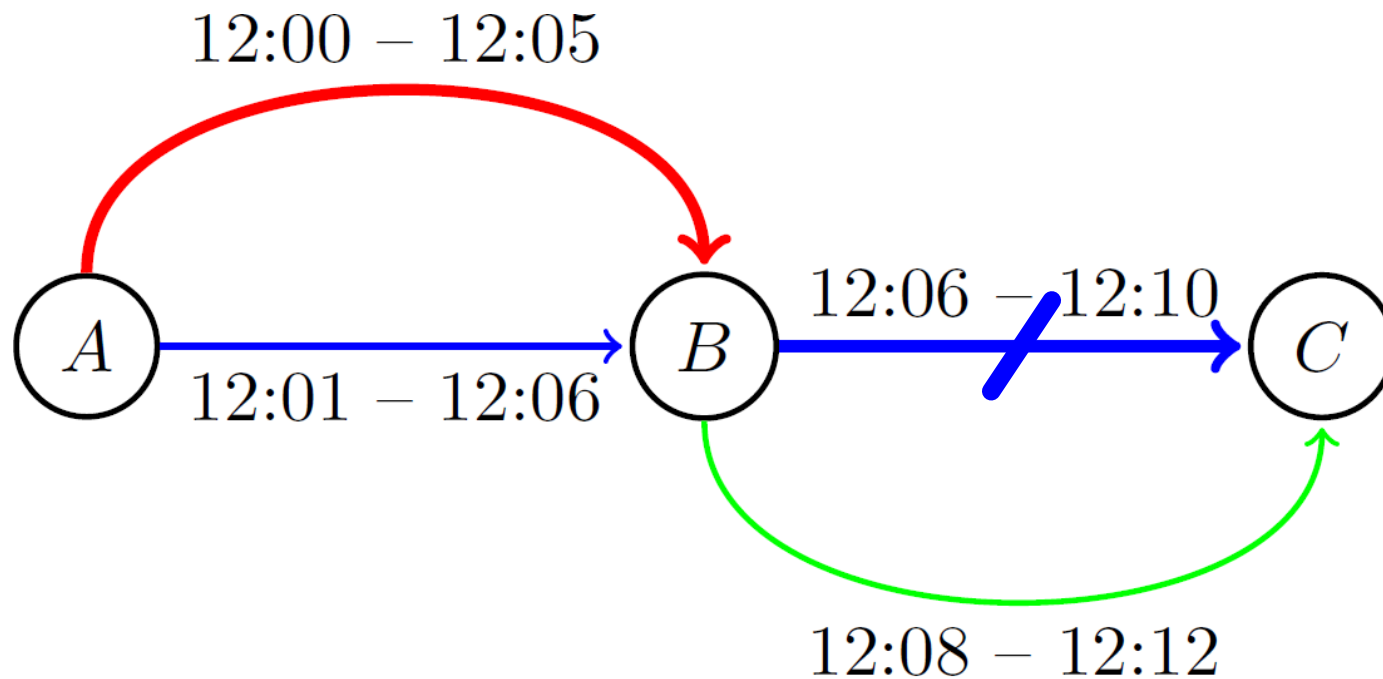
Change time: 2 min.

Problem of Changing Lines



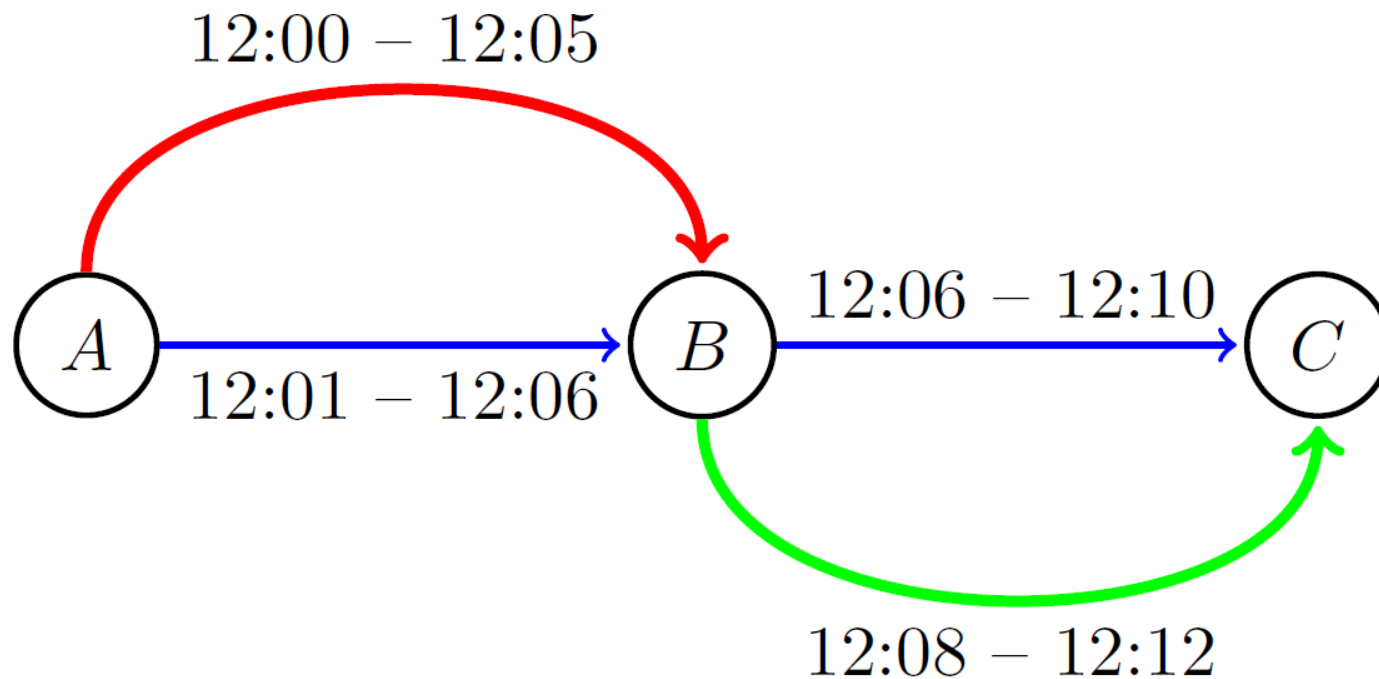
Change time: 2 min.

Problem of Changing Lines



Change time: 2 min.

Problem of Changing Lines



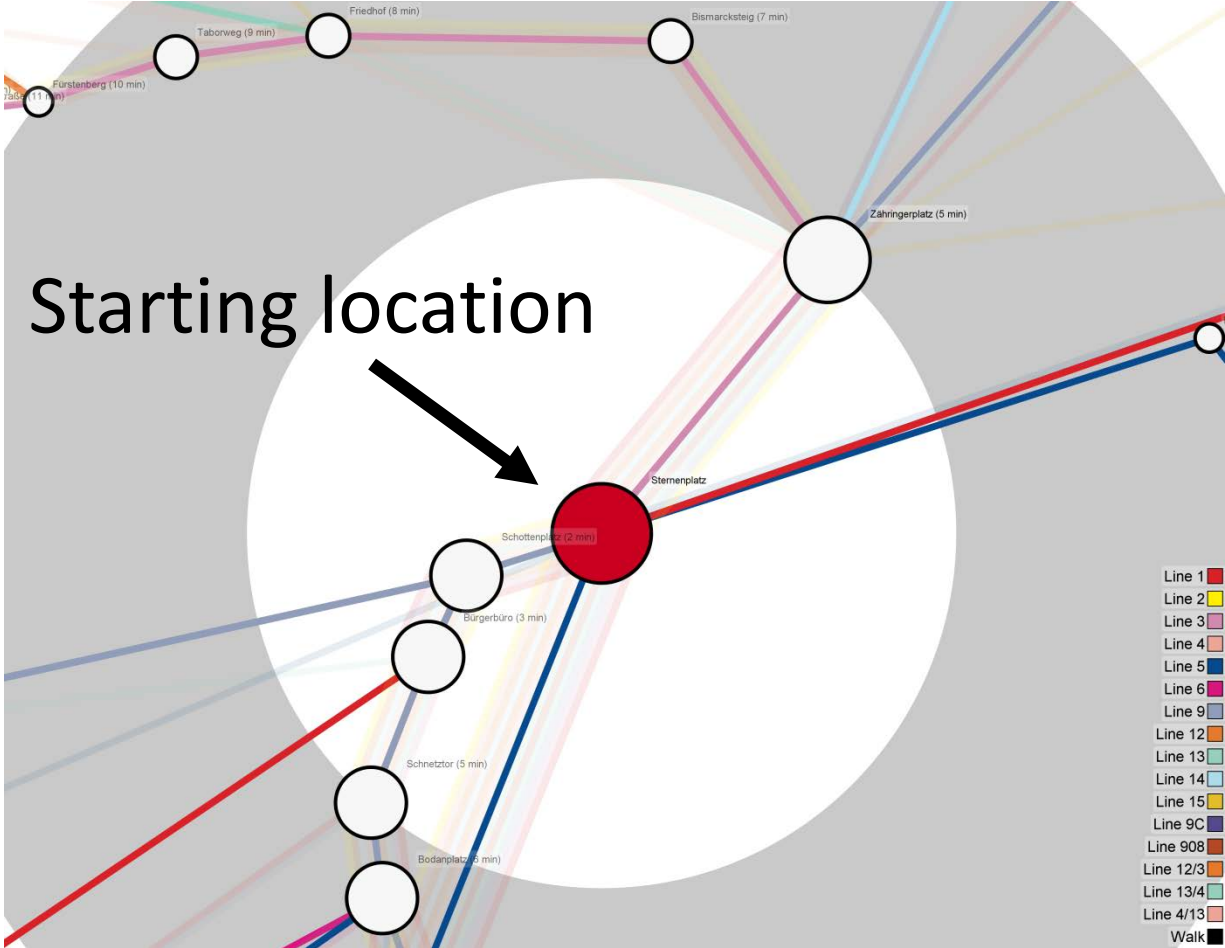
Change time: 2 min.



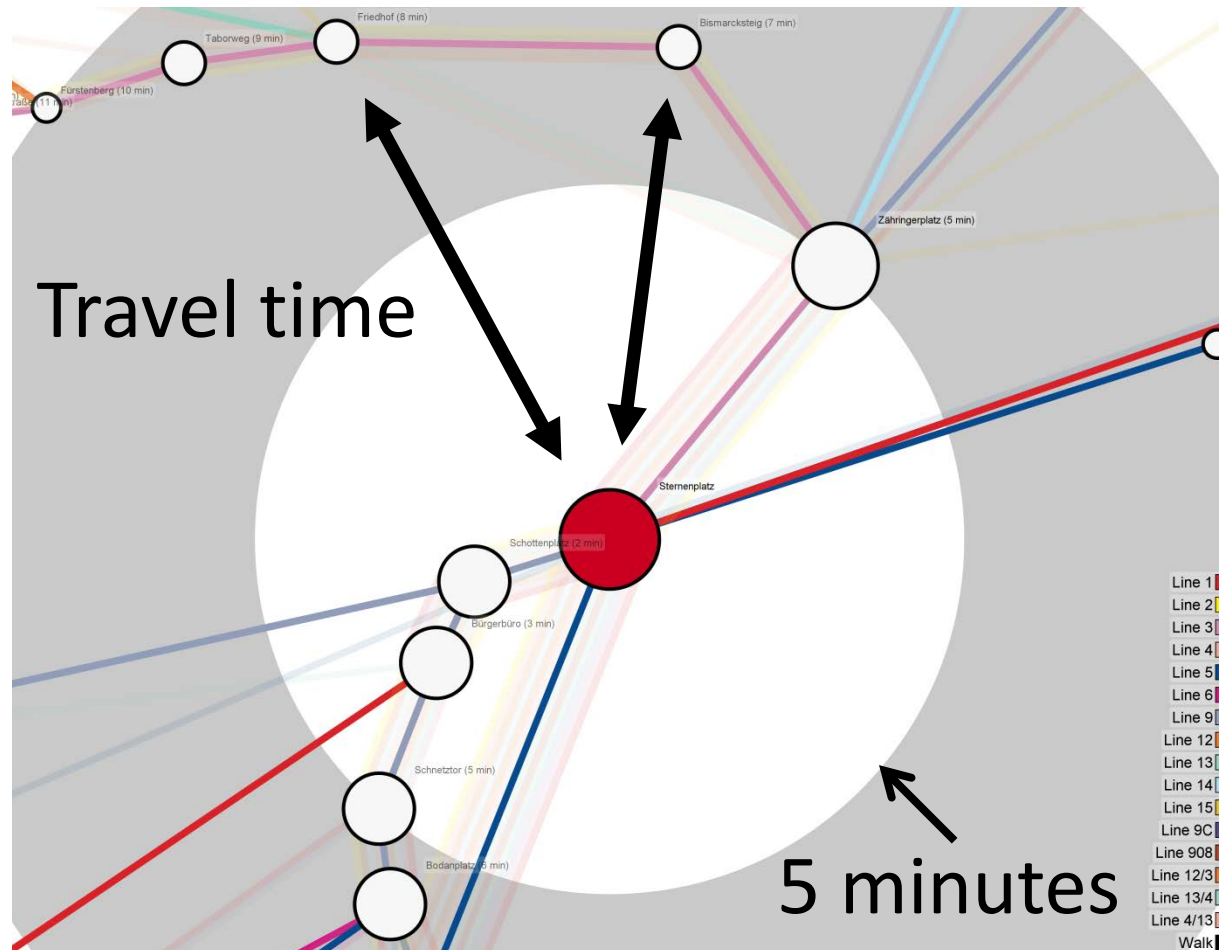
Routing

- Store routes instead of distances
- Split periodic schedule into tours to reduce number of considered edges
- Reduce edges by considering those in a time window defined by the first outgoing edge
- Achieves real-time interaction ($< 100\text{ms}$)

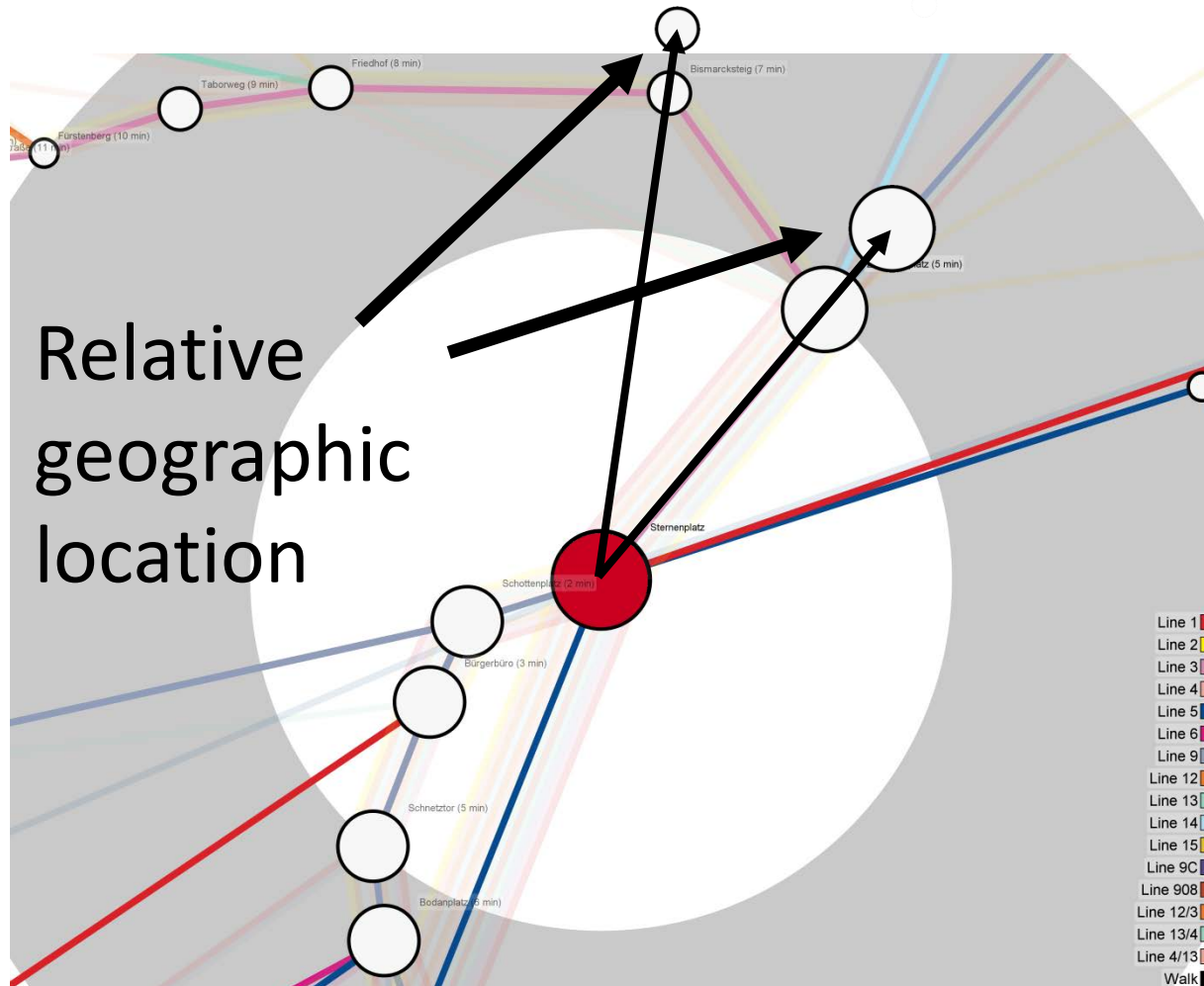
Radial Layout



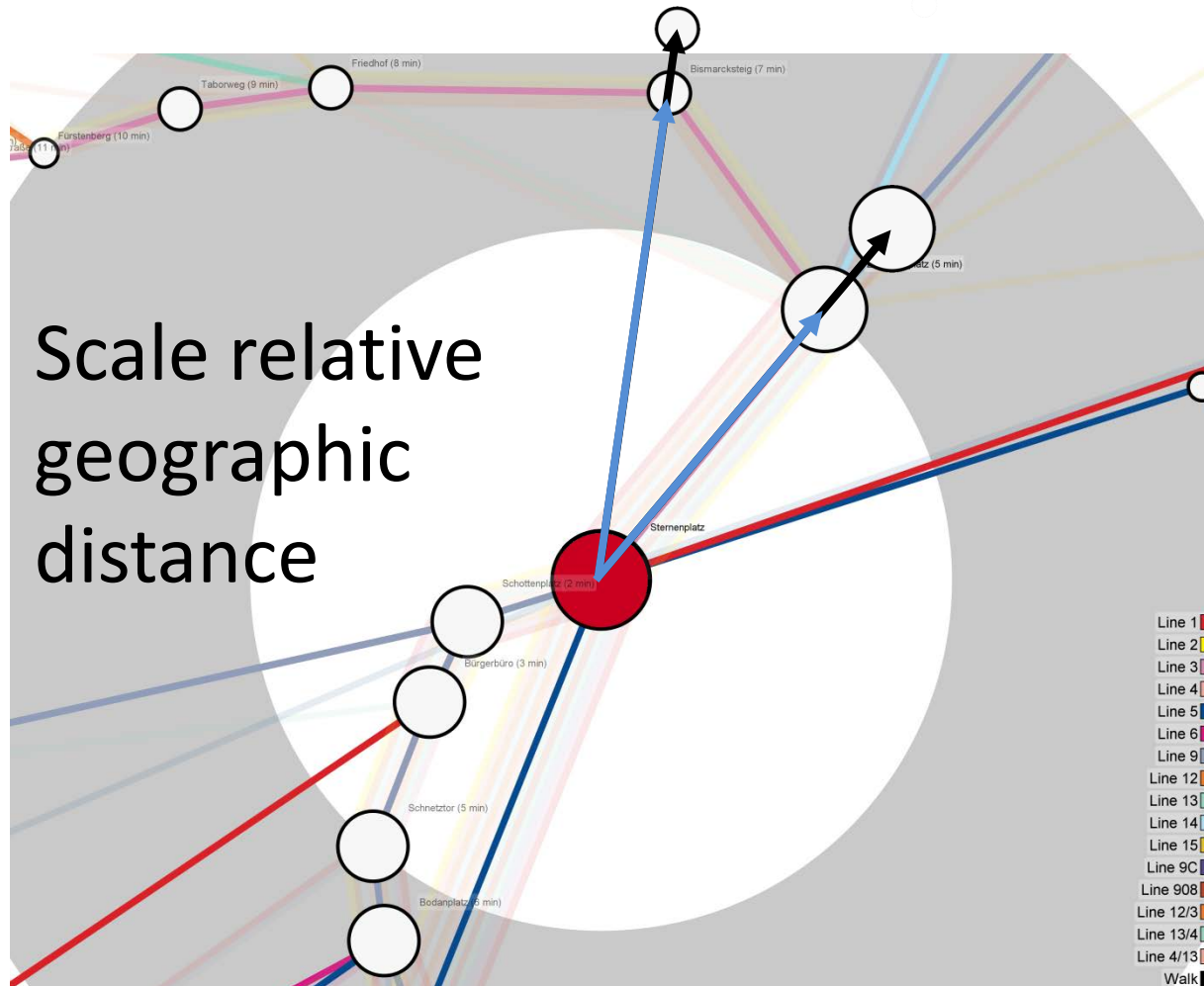
Distance to Center maps to Travel Time



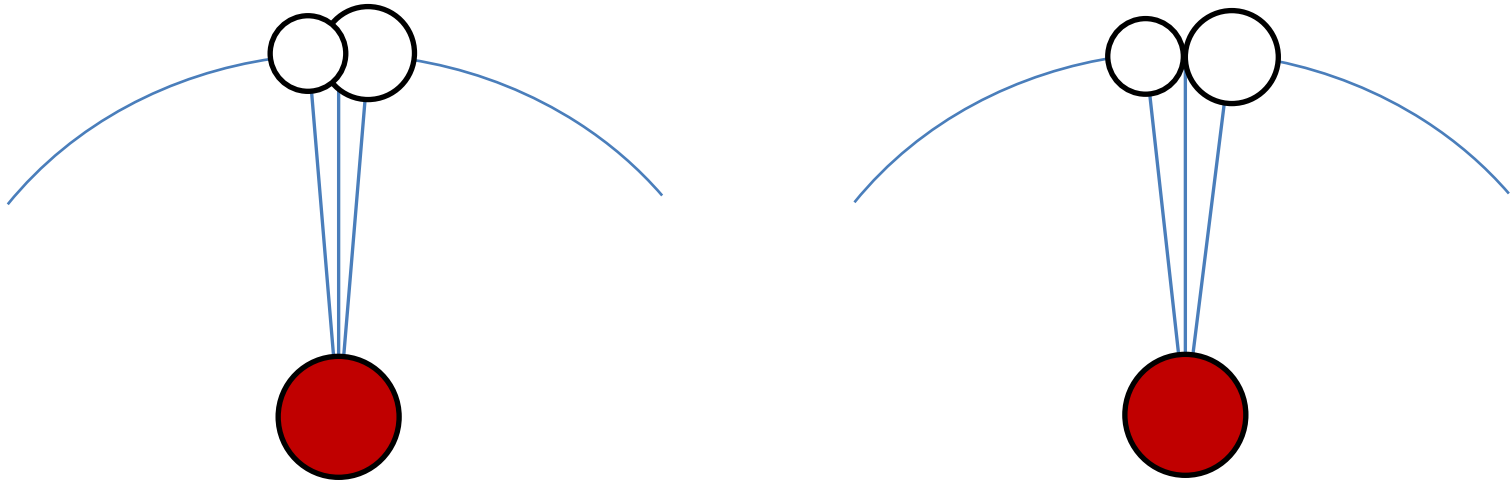
Mental Map Preservation



Mental Map Preservation

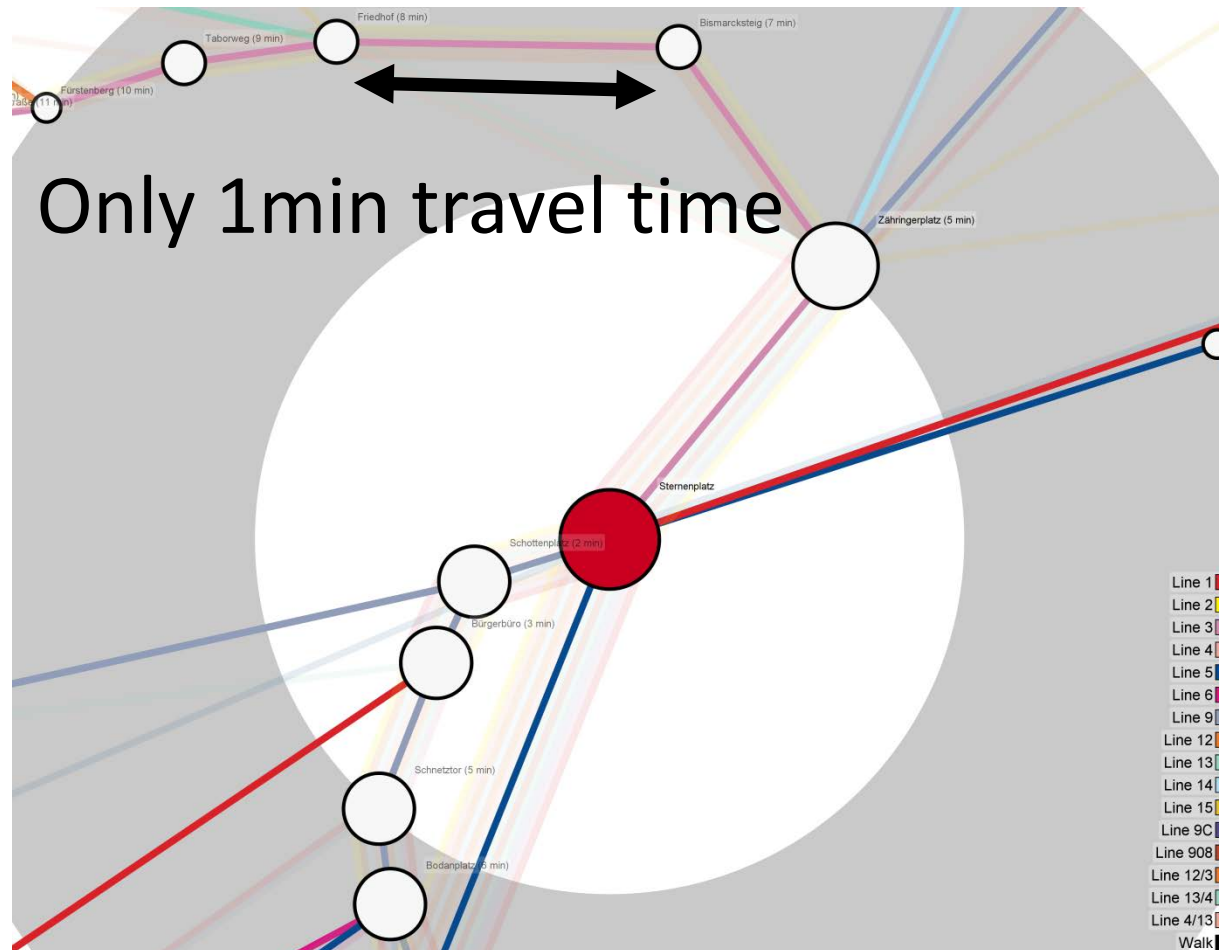


Overlap Removal

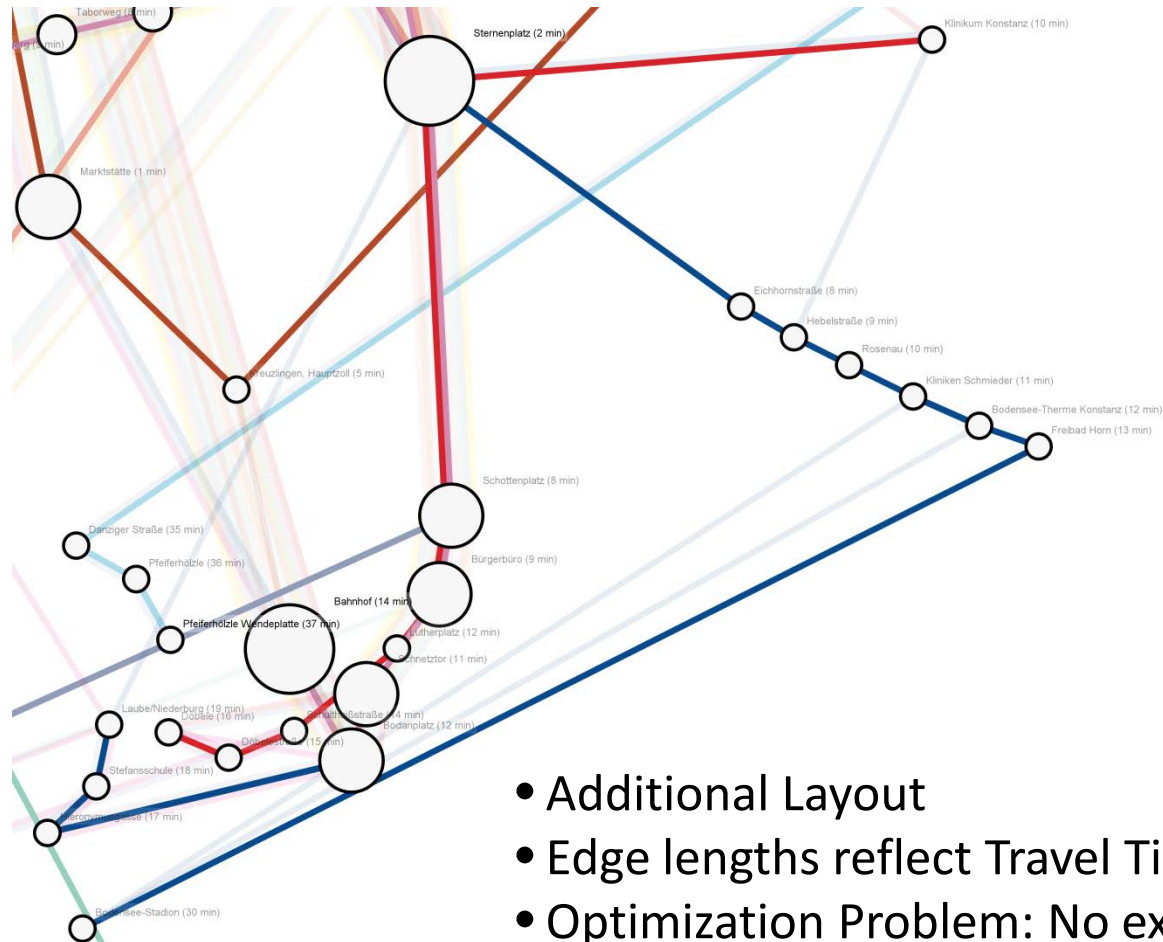


- Changing angles removes overlaps
- Does not affect distance to center

Issue of Radial Layout

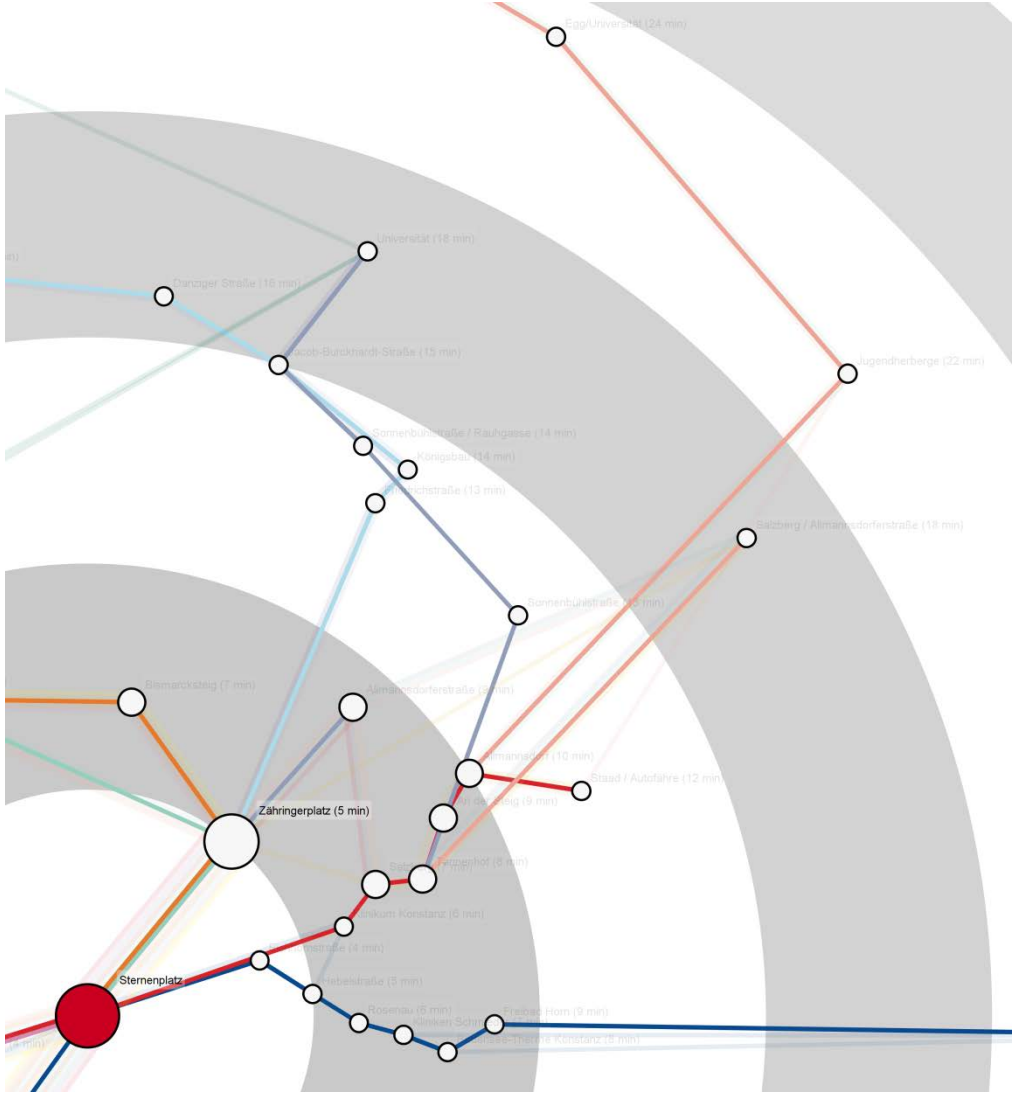


Stress-Majorization Layout

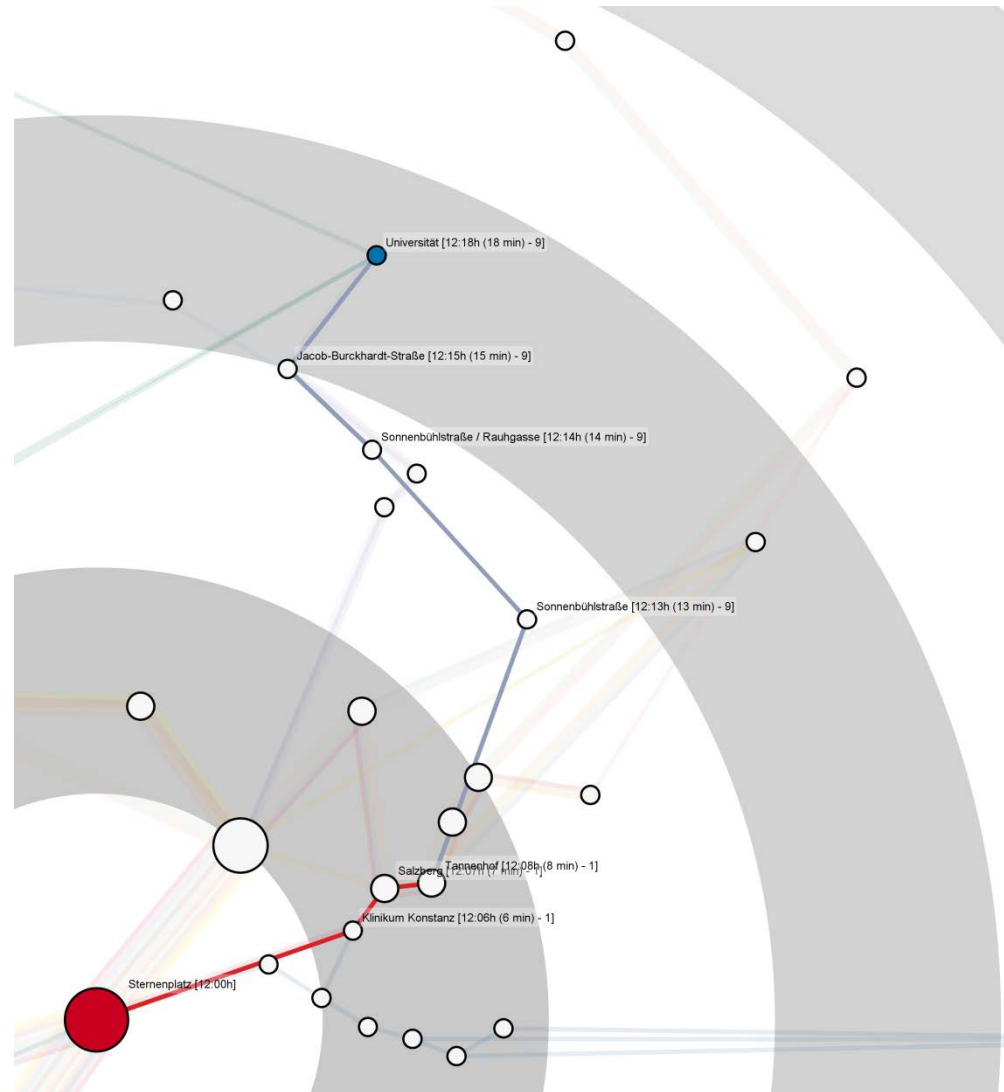


- Additional Layout
- Edge lengths reflect Travel Time
- Optimization Problem: No exact solution

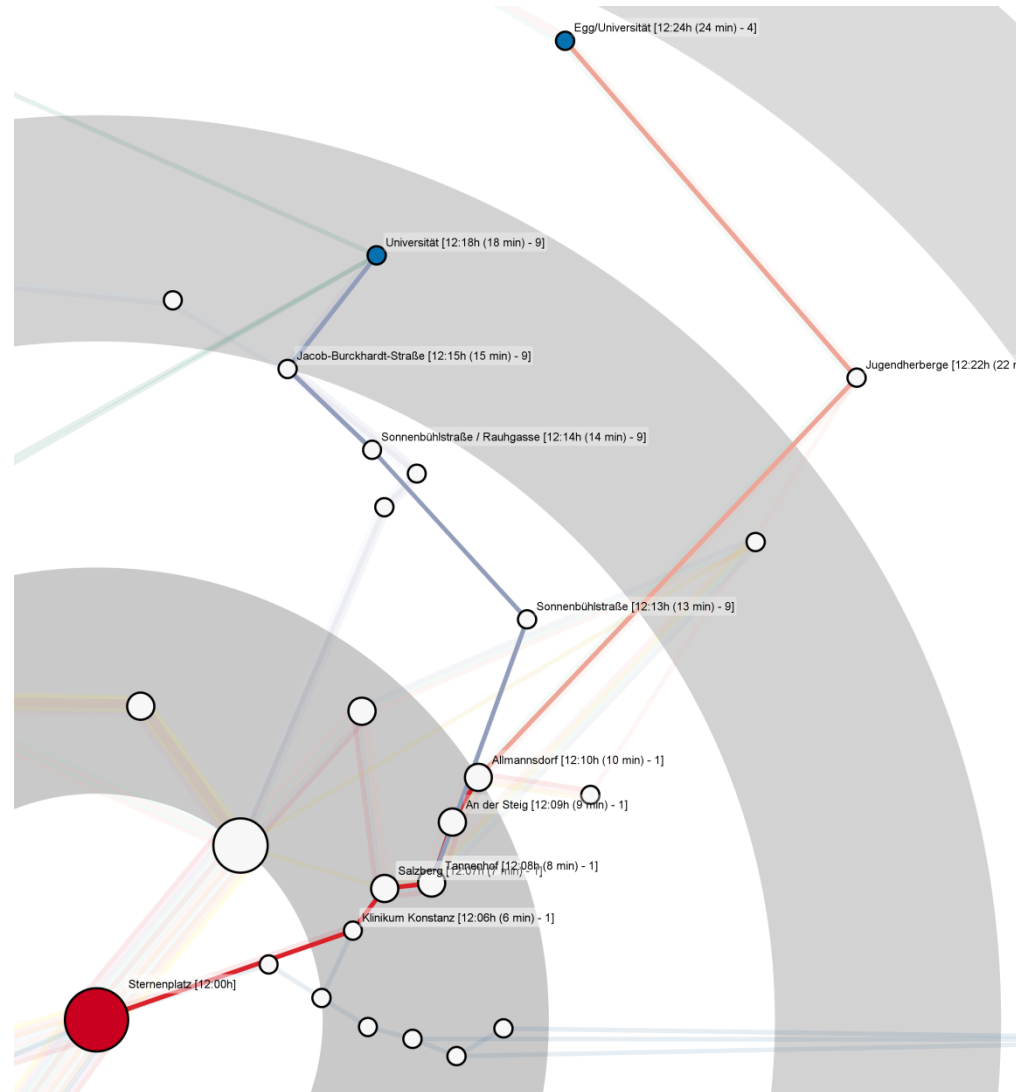
Radial Layout



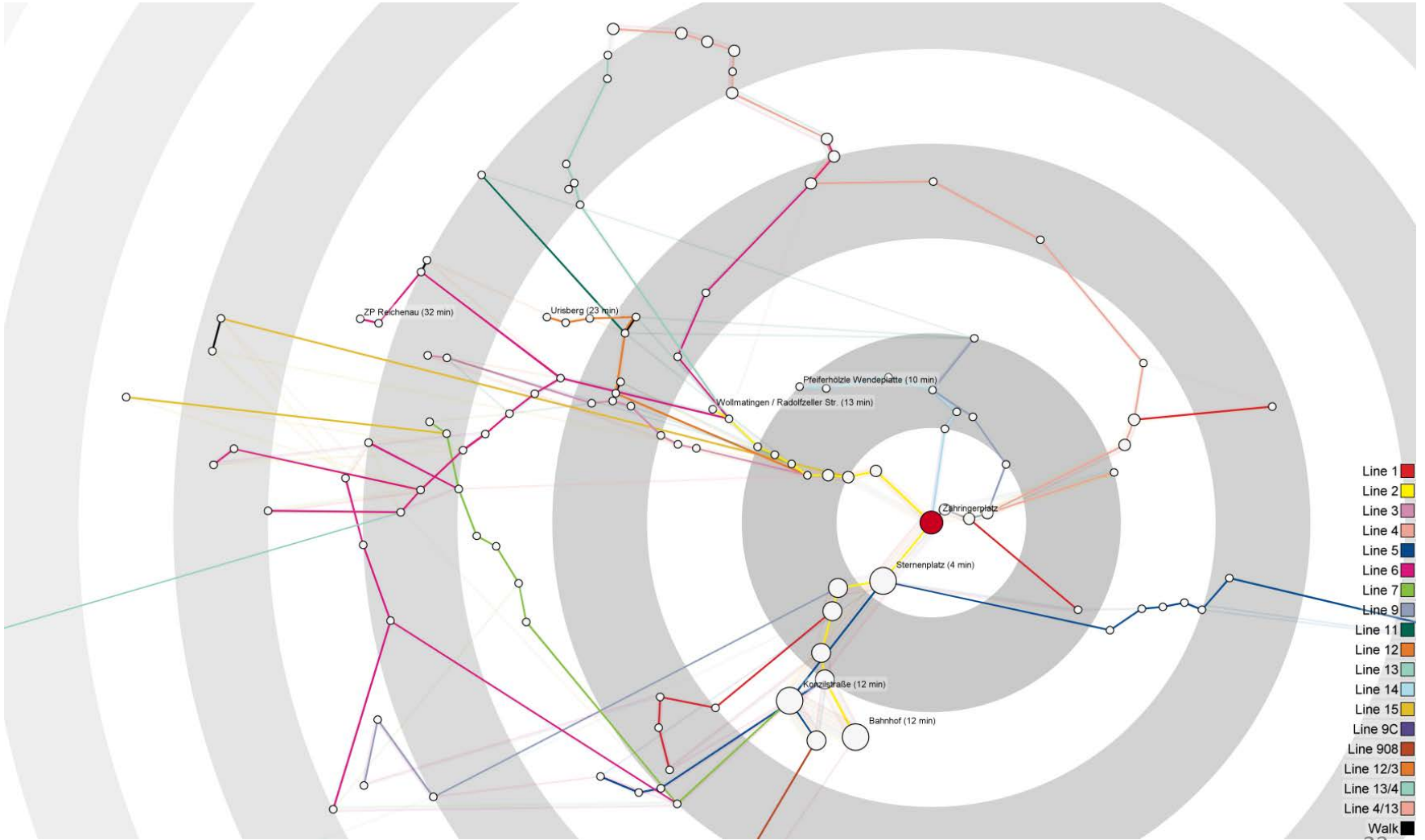
Planning with Single Destination



Planning with Multiple Destinations



Live Demo



Thank you for your attention!

Scalability

- Routing is bottle-neck
- Runtime complexity similar to Dijkstra
- Transit networks relatively sparse
- Number of edges roughly proportional to number of nodes
- New York Subway:
27 lines, 493 stations,
213487 edges, 243048 walking edges

Live Demo

- Node / Edges
- Selection of starting location
- 12:25 – Schnetztor – 0 min Max Walk
- Radial Layout (shows only used edges)
- Use case: Universität vs. Egg (shows routes)
- Real-Time View / Fast-Forward View
- New York (12:00 – 2 min Max Walk)