



Analysing route choice decisions on Metro networks

A comparison between Santiago and London

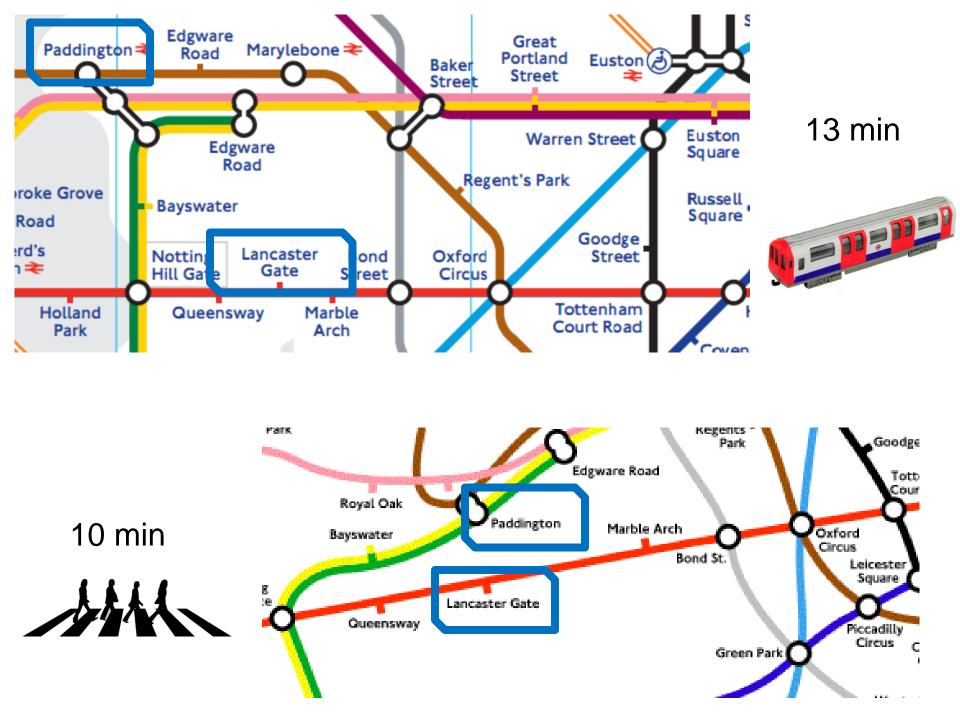
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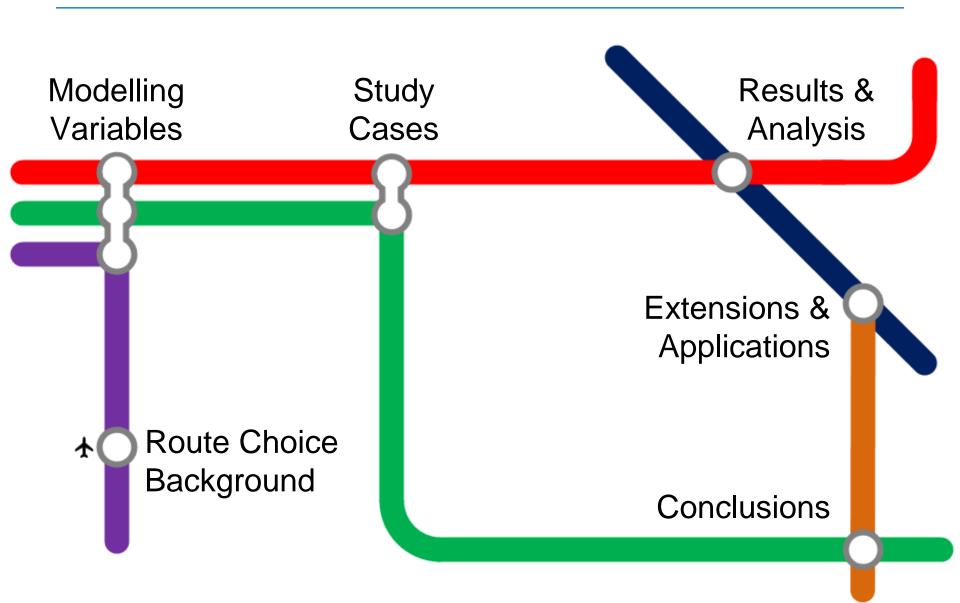
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Contents



Traditional route choice models usually consider just tangible variables related to the level of service

travel time

fare

number of transfers

These models are sometimes refined including socioeconomic variables of the travelers However, this approach ignores other relevant elements that influence route choice as:

comfort and safety

transfers accessibility

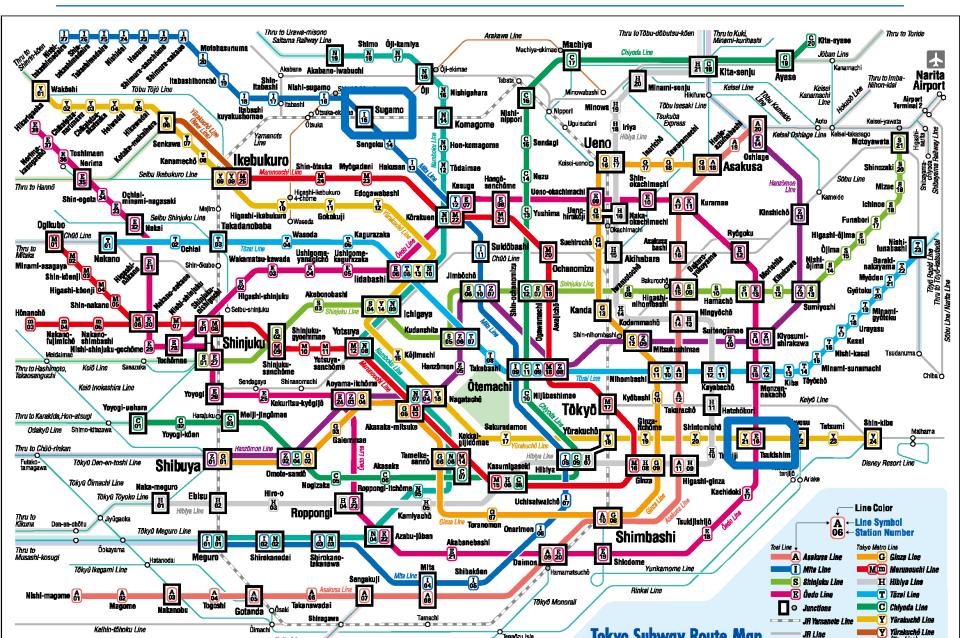
network topology

aesthetics

These variables are subjective and hard to quantify

Pathfinding Criteria

Route Choice Background



Pathfinding Criteria

Thru to Urawa-misono Thru toTõbu-dõbutsu-kõer Thru to Kuki. Thru to Toride Arakawa Line S Kita-ayase Saltama Raliway Line Minemi-kuriheshi Shimo Öji-kamiya Machiya olohasunuma Machiya-ekimae N Chivoda Line Jöban Line **C** C 19 H C 21 18 Kanamachi 🔾 Öji-ekimae kabane Akahane-Iwabuci N 16 Kita-seniu Avase Thru to Imba-Nihon-idai Varita Tabata O 붪 itabashihoncho Shin-Itabashi Airport Nishi-sugamo Minami-seniu Keisel Line Töbu Tõjõ Line ÓII Keisei Kanamachi ð Nishigahara Inter tangets C 16 Minowahashi O Hikifune O Airport Terminal 2 itabashi Line Minowa 문 Tõbu Isesaki Line litabashi kuyakushomae Sugamo O Nippori ⊙Ótsuka-ek Nishi-nippori N 14 Tsukuba Exoress **X** Uguisudani Acto Kaisei-vawata Ōtsuka Komagome 🖁 iriya Az O O Kelsel Oshlage Line Kelsel-takasago Yamanote Line Senkawa 07 Ueno **Z** 14 Notovawata 🔓 Sendaci N Hon-komagome Sangoku (14 Toshimaen Kanamecho 🖉 Oshlage Ikebukuro G H 16 17 S Asakusa Nerima Keisei-ueno 🔿 Shin-ölsuka Myögadani Hakusan N Tödaimae Shibayama-chlyoda Shinozaki 🕺 Selbu Ikebukuro Line 14 Nezu E Y M Shin-okachimach Hongô-sanchôme Sābu Line Mizue 3 Thru to Hannö Higashi-ikebukuro Edogawabashi Shin-egola 34 Ueno-okachimach Ochlal-minami-nagasaki 5 . Kameido E 08 A . ichinoe s Kuramae ž MalimÖ S Yushima Ueno-hirakoii H 16 Kinshichö **Z** 13 Higashi-ikebukuro M Seibu Shinjuku Line Gokokuji Kňr ÓWaseda Funabori **sachimachi** Oplicubo Takadanobaba Nakai Okachimach Ryögoku Higashi-òjima 🤶 M Chũð Line Waseri Kagurazaka ochial T. **5**1 Suehirochō G Asakusa bashi Nishi-Iunahachi Suidőbash Öjima 🐒 Thru to Mitaka H M 甚 **A** Æ Wakamatsu-kawada yanagicho Ushigome-kagulazaka Nakano Chũô Line Akihabara Nishi-ojima 8 14 Baraki-nakayama T A Thru to Toyo Raptd L Thru to Toyo Kath Sobu Line / Nartha Line Minami-asagaya Shin-ökubo 🖯 E T Y N Ochanomizu Shin-koʻenii ⁰³ Myöden T Jimböchö idahash Migashi-kōenii ⁰⁴ 8 1 Z C 5 M 12 07 19 A 8 S E Z S 12 13 Gyötoku 🝸 Akebonobashi Hinsehi-ehiniuka Higashi nihombash Shin-nakano ^M Hamachi 5 03 8 Y N 04 14 09 Kanda [¹⁹ Minami-gyötöku Ę Ó Selbu-shiniuku H Ningvöchö Hônanchô ichioava ME A # T. Kodemmachö 83 8 Urayasu Shinjuku-gyoemmae Yotsuya Kudanchib Suitencümae Ţ 82 Nakano-shimbashi Nakano-fulimichô Shin-nihombashio 8 Z T 05 06 07 14 II Kiyosumi-shirakawa G Z Shiniuku Kasal M 99 M N 12 08 M Nishi-shiniuku-oochome Mitsukoshimar Tsudanuma O (ishi-kasal Meidaima Köjimachi S E Yotsuya-sanchôma O Sasazuka Tochômae Hanzômon 🄏 Takebashi Shinjuku I C T M 09 11 09 18 Keið Line Thru to Hashimoto, Minami-sunamachi E 12 G T A H 11 (**T**3) 14 Takaosanguchi Chiba O Sendagava Shinanomachi Kiba Töyöchö Aovama-ilchôme Ötemachi Kayabach Keiö Inokashira Line Monzen-0 E N Z Y 🔓 Nijūbashimae Yoyogi Kyöbashi 10 A Tōkyō 🖪 Nagatachö Kelyö Line Kokuritsu-kvõgi jõ H Yoyogi-uehara G M Takarachô latehőbor Melji-jingumae Thru to Karakida,Hon-atsugi Harajuku 👵 ß G VOSU 2 Ginza-Itchome Shin-kiba Akasaka - milisuka Shimomichë Tatsumi G Sakuradamon Odakyū Line Shimo-kitazawa Yürakuchö Yoyogi-kdan Malhama 24 Kokkal-oliidomae ¥7 1 20 **Y** E 21 16 Gaien Thru to Chūō-rinkar H Ta Tsukishim O Futako-tamagawa Z C G Tamelke-sannð G N M 06 06 14 Hibiva Z G Tökvü Den-en-toshi Line Shibuya A H 11 09 M H G **Disney Resort Line** Akasaka Kasumigaseki Hiblys tənjijā O O Ariakə Omote-sando 8 ŝ M H C Ginza Higashi-ginza Tökyü Öimachi Line Nogizaka Roppongi-Itchôme X Naka-meguro Kachidoki E Hiro-o Tōkyū Tōyoko Line Ebisu Uchisalwaichő 벖 벖 甚통 H H 05 Kamiyachô Line Color Roppongi 8 A G 10 06 Thru to Kikuna O Jiyügaoka Tsukijishijā -Line Symbol Den-en-chöfu O Toranomon Onarimon A Tõkyü Meguro Line 06 Station Number N E Shimbash 18 18 Azabu-lüban I N 61 01 I N l N C Akabanebashi Toei Line Tokyo Metro Line Öokavama Thru to H A E Meauro Shirokane A Asaiansa Line G Ginza Line Shirakanada Musashi-kosuo Hatanodai Shiodome Daimon Yurikamome Lin I Mha Line Mm Marunouchi Line Tőkyű lkegami Line Shibakõen Hamamatsuchö Mita Lin Sengakuj I 04 S Shininin Lim H Hibiya Lina A Rinkai Line E Öedo Line A 04 T Tozai Line Nishi-magome 🗛 â Tōkyō Monorail Togoshi Magom Takanawadai 🔘 Chiyoda Line Junctions lakanobu Gotanda **A**ñeak Shinaqawa Tamachi O Y Yürakuchö Lini JR Yamanote Line Kelhin-tõhoku Line **Öimach** Takyo Subway Pouto Ma Yürzkuchó Line JR Line

Route Choice Background

Route Choice

Background

Some people follow different criteria when deciding how to get from one point to another

the fastest way

the cheapest way

In a transit context, there are some additional factors

avoid walking

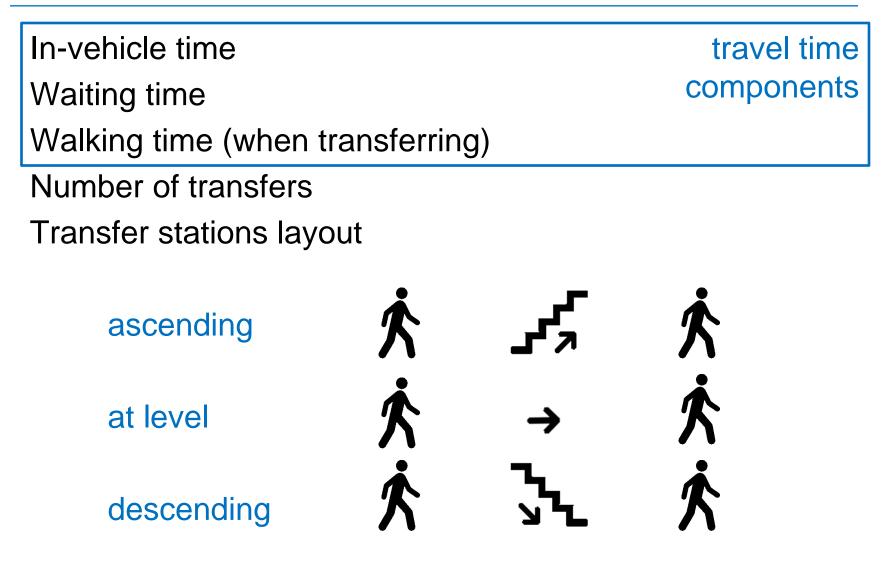
avoid transferring

But most consider <u>many</u> factors at the same time!

Understanding travelers is essential in Transportation Planning

Identify and quantify the factors that affect the transit users' behaviour

Compare the preferences of transit users in London and Santiago



In-vehicle time				travel	time
Waiting time			CC	ompon	ents
Walking time (when transferrin	g)				
Number of transfers					
Transfer stations layout					
Transfer stations infrastructure					
assisted	ÿ	or			
semi-assisted	ÿ	or		and	大
non-assisted	Ķ				

In-vehicle time	travel time
Waiting time	components
Walking time (when transferring	I)
Number of transfers	transfer
Transfer stations layout	experience
Transfer stations infrastructure	
Mean occupancy	
Possibility of not boarding	
in London	initial occupancy ≥ 70%
in Santiago	initial occupancy ≥ 85%

In-vehicle time	travel time
Waiting time	components
Walking time (when transferring)
Number of transfers	transfer
Transfer stations layout	experience
Transfer stations infrastructure	
Mean occupancy	
Possibility of not boarding	
Possibility of getting a seat	
in London	initial occupancy $\leq 20\%$

in Santiago

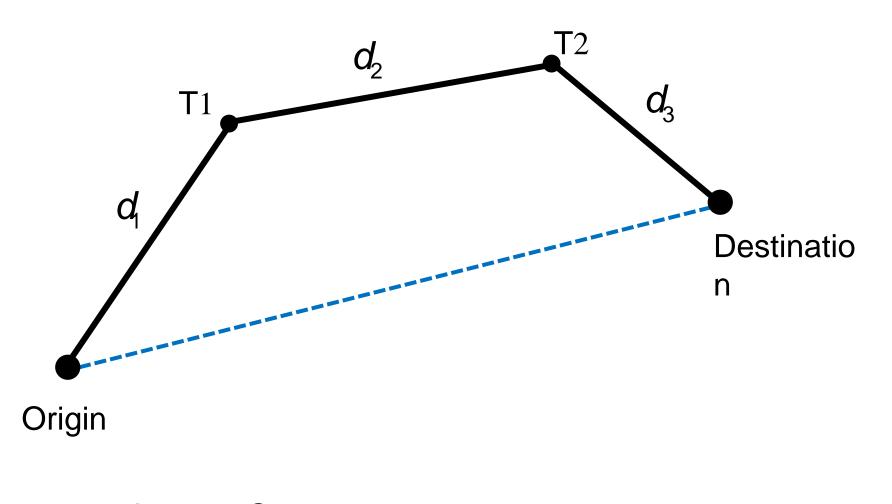
initial occupancy $\leq 20\%$

In-vehicle time	travel time
Waiting time	components
Walking time (when transferring)	
Number of transfers	transfer
Transfer stations layout	experience
Transfer stations infrastructure	
Mean occupancy	comfort and
Possibility of not boarding	crowding
Possibility of getting a seat	
Route distance	
Number of stations	
Angular cost	

In-vehicle time	travel time
Waiting time	components
Walking time (when transferring)	
Number of transfers	transfer
Transfer stations layout	experience
Transfer stations infrastructure	
Mean occupancy	comfort and
Possibility of not boarding	crowding
Possibility of getting a seat	
Route distance	
Number of stations	
Angular cost $\sum d \cdot \sin\left(\frac{\theta}{2}\right)$	

What do people take into account?

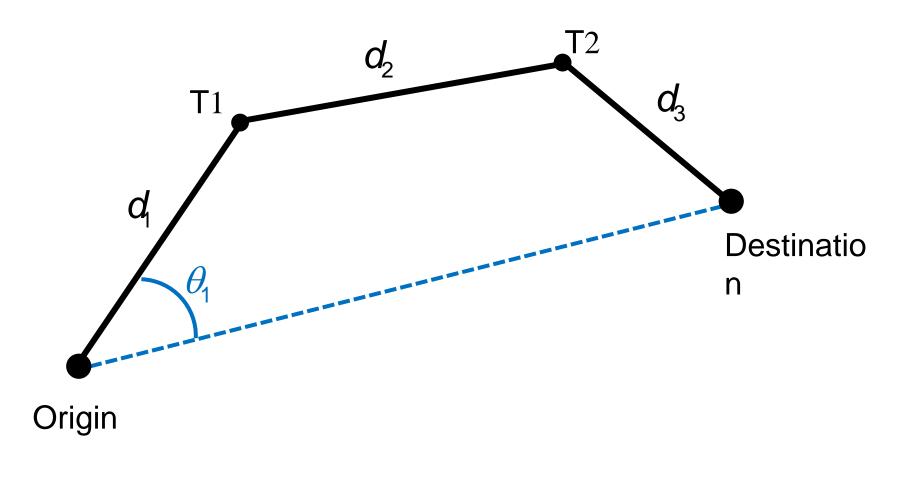
Modelling Variables



Angular Cost =

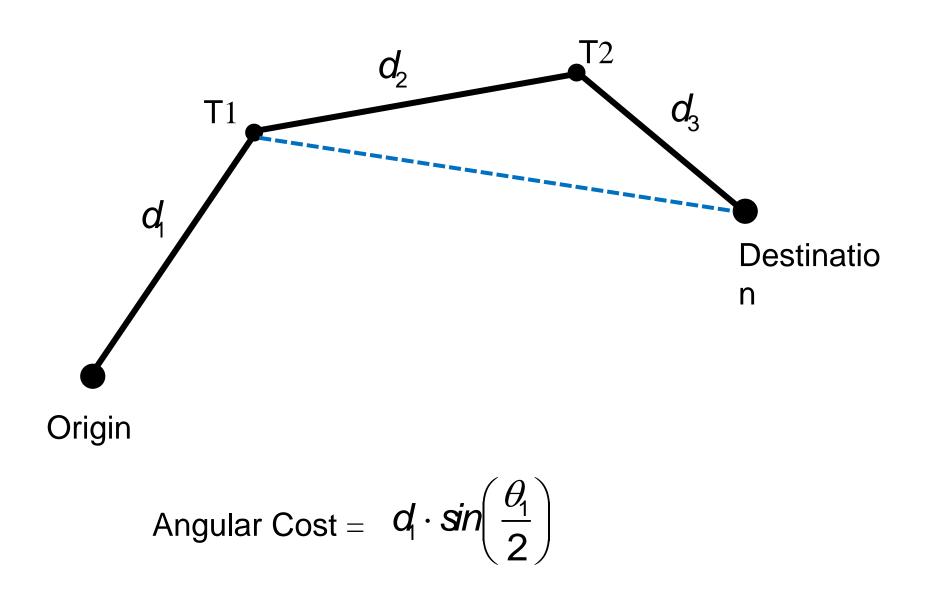
What do people take into account?

Modelling Variables

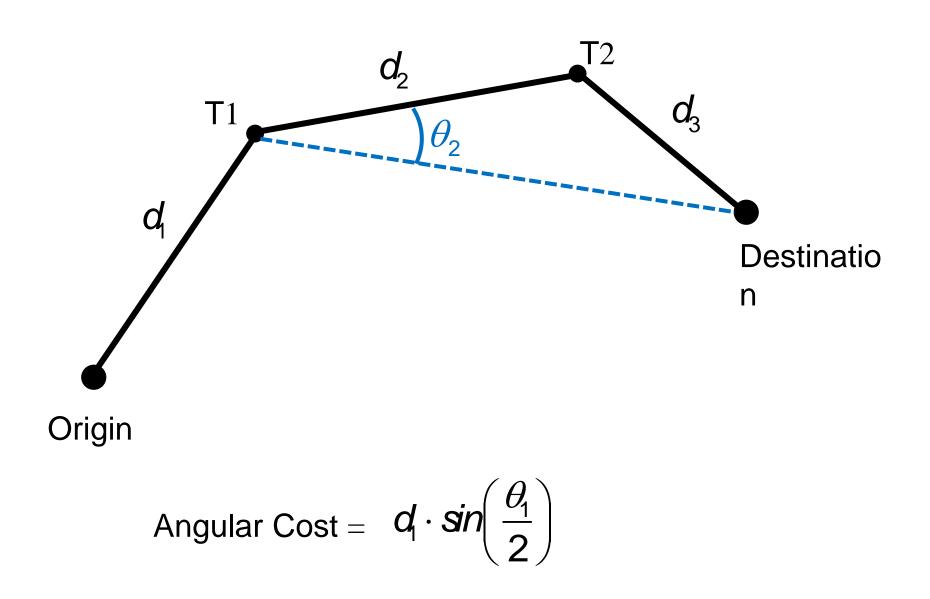


Angular Cost =

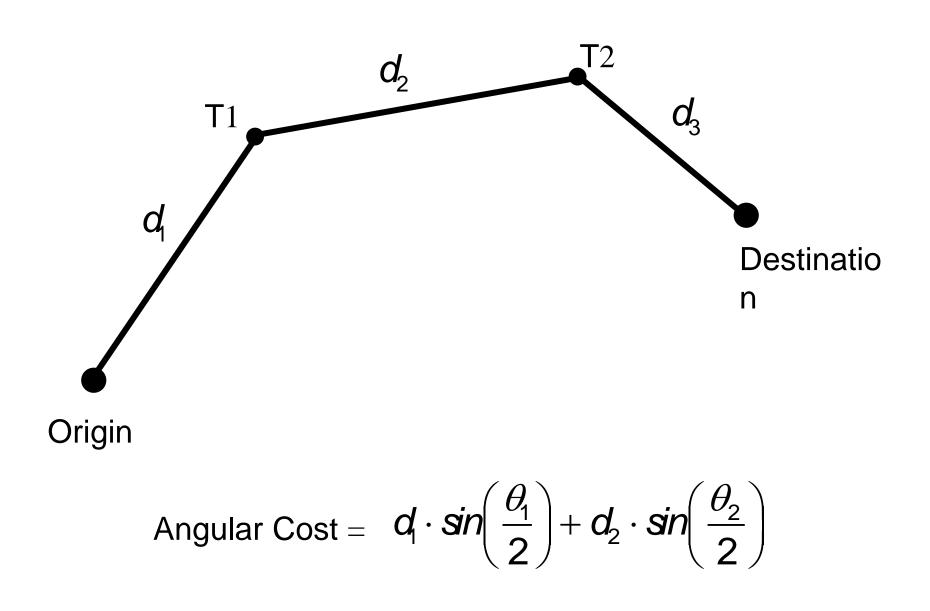
What do people take into account?



What do people take into account?



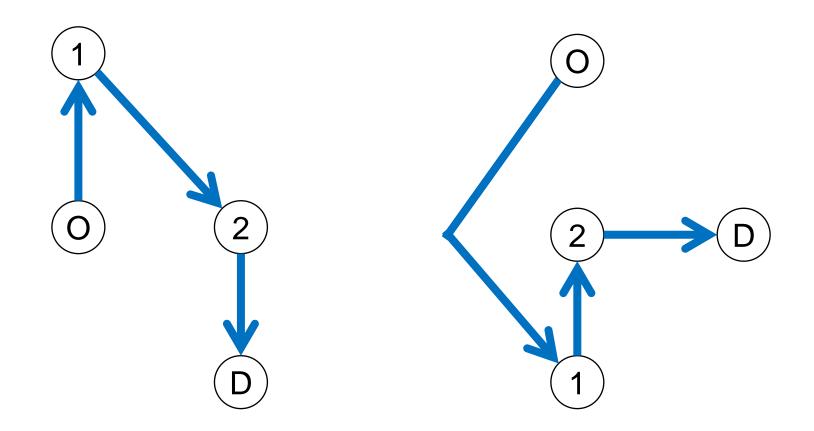
What do people take into account?



In-vehicle time	travel time
Waiting time	components
Walking time (when transferring)	
Number of transfers	transfer
Transfer stations layout	experience
Transfer stations infrastructure	
Mean occupancy	comfort and
Possibility of not boarding	crowding
Possibility of getting a seat	
Route distance	
Number of stations	
Angular cost	
Reasonable route	

What do people take into account?

turning away from the destination turning back to the origin



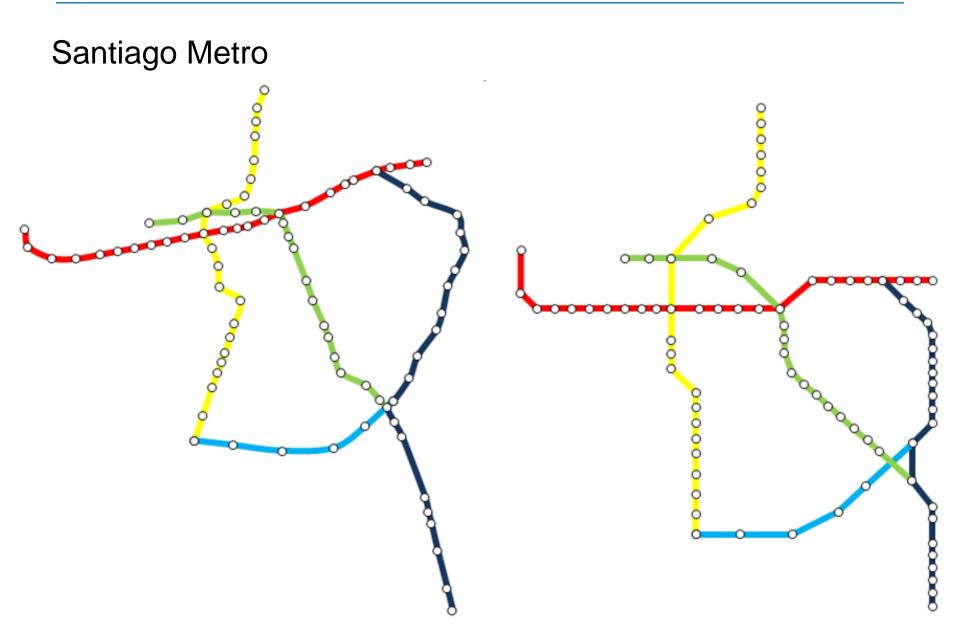
In-vehicle time	travel time
Waiting time	components
Walking time (when transferring)
Number of transfers	transfer
Transfer stations layout	experience
Transfer stations infrastructure	
Mean occupancy	comfort and
Possibility of not boarding	crowding
Possibility of getting a seat	
Route distance	topological variables
Number of stations	
Angular cost	
Reasonable route	based on schematic maps

Comparing Santiago and London

Study Cases

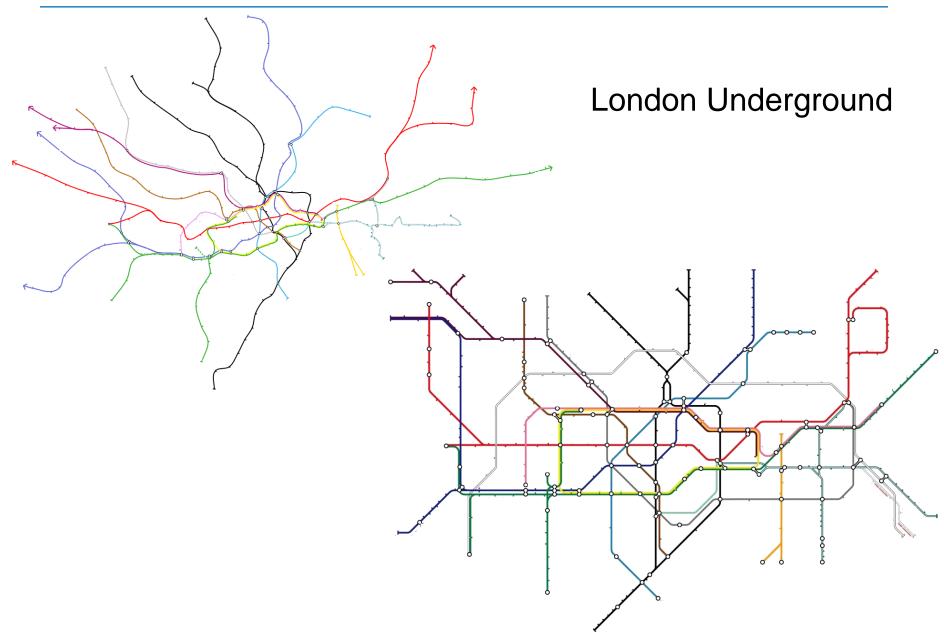
	Santiago 0	
Survey date	2008	1998-2005
Length	78 Km 324 I	Кm
Lines	5	11
Stations	85	255
Transfer stations	7	72
Daily trips	2,300,000	3,400,000
Survey size	28,961	16,300

Study Cases



Comparing Santiago and London

Study Cases



A key element when dealing with probabilistic route choice models is the definition of the alternatives for the OD pairs of interest

Santiago

generated based on the actual choices \rightarrow 2 to 4 alternative routes

London

generated based on a labeling approach \rightarrow 2 to 6 alternative routes

Results & Analysis

Estimation results

Attribute	London Und	erground	Santiago	Metro
Travel Time	- 0.188	- 16.02	- 0.095	- 19
Waiting Time	- 0.311	- 7.39	- 0.139	- 5.
Walking Time	- 0.216	- 6.14	- 0.155	- 8.
Number of Transfers	- 1.240	- 4.37	- 0.632	- 4.
				- 2.
			OK	n.
Parameter's sig	jns		JK	n.
				n.
Semi-Assisted Transfers	- 0.328	- 6.83	n. a.	n.
Non-Assisted Transfers	- 0.541	- 6.79	- 0.262	- 6.
Mean Occupancy	- 2 911	- 3 48	- 1 018	- 5.
		-		3.4
Parameter's sig	nificances (- 2.
	Juncances			- 5.
Map Distance	- 0.358	- 5.76	- 0.274	- 5.
	- 0.358 - 0.316	- 5.76 - 5.52	- 0.274 - 0.147	- 5. - 3.
Map Distance				- 3.
Map Distance Number of Stations	- 0.316	- 5.52	- 0.147	

Results &

Analysis

Attribute	London	Santiago
1 min waiting	1.65 min in-vehicle	1.46 min in-vehicle
1 min walking	1.15 min in-vehicle	1.62 min in-vehicle
1 (basic) transfer	6.60 min in-vehicle	6.63 min in-vehicle
1 % of occupancy	0.16 min in-vehicle	0.11 min in-vehicle
Seating	0.52 min in-vehicle	0.97 min in-vehicle
Not boarding	2.29 min in-vehicle	3.99 min in-vehicle
1 station	1.68 min in-vehicle	1.54 min in-vehicle
Turning back	3.86 min in-vehicle	1.48 min in-vehicle
Turning away	5.15 min in-vehicle	2.37 min in-vehicle

Transferring valuations in London

Trans	fer Type	Getting a seat	Intermediate	Not boarding
	Assisted	6.81 min	7.33 min	9.62 min
Ascending	Semi-assisted	8.56 min	9.07 min	11.36 min
	Non-assisted	9.69 min	10.21 min	12.49 min
At level		3.35 min	3.87 min	6.15 min
	Assisted	6.08 min	6.60 min	8.88 min
Descending	Semi-assisted	7.82 min	8.34 min	10.63 min
	Non-assisted	8.95 min	9.47 min	11.76 min

Transferring valuations in Santiago

Transf	fer Type	Getting a seat	Intermediate	Not boarding
According	Assisted	9.05 min	10.02 min	14.01 min
Ascending Non-assiste	Non-assisted	11.80 min	12.77 min	16.76 min
Descending	Assisted	5.67 min	6.63 min	10.62 min
Descending	Non-assisted	8.41 min	9.38 min	13.37 min

range in London

range in Santiago

3.35 to 12.49 min

5.67 to 16.76 min

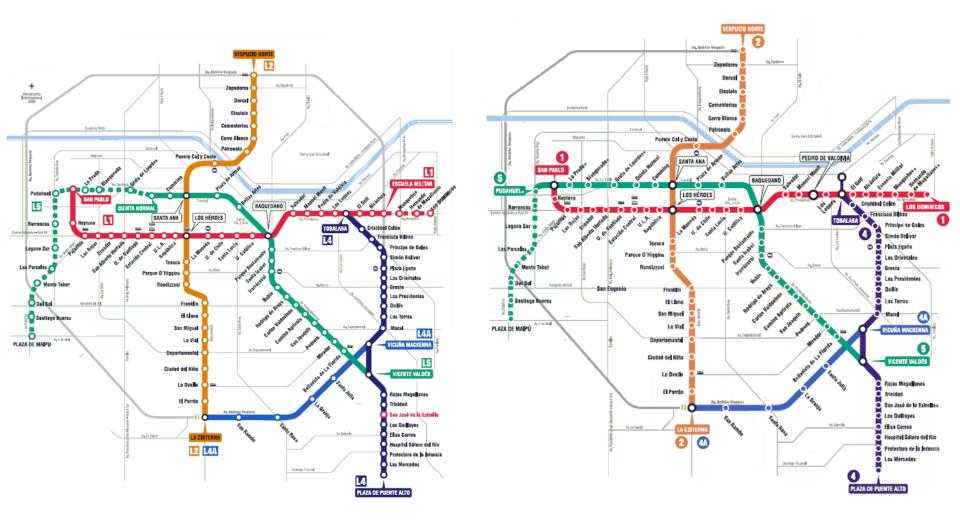
Results &

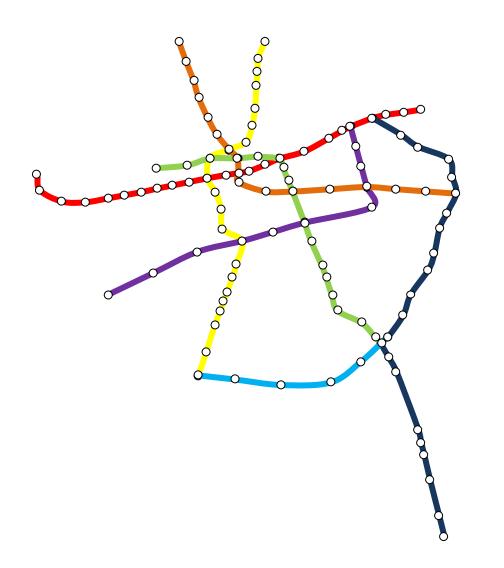
Analysis

The omission of relevant information produces bias in the results

Model Specification	London		Santiago	
	θ_{wait} / θ_{travel}	$\theta_{\text{walk}}/$ θ_{travel}	$\theta_{ m wait}$ / $\theta_{ m travel}$	$\theta_{\text{walk}}/$ θ_{travel}
Complete Model	1.65	1.15	1.46	1.62
without topological	0.61	0.46	2.36	2.09
without occupancy	1.67	1.17	2.48	1.81
without transfers	2.18	1.94	4.32	2.47
without all three	0.80	0.75	4.48	2.64

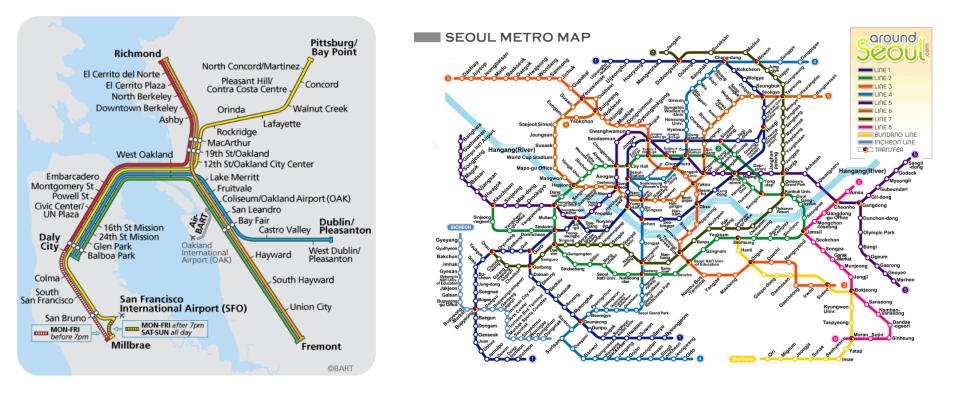
Change in the Santiago Metro schematic map





Demand analysis for the design of transfer stations

Analyze and apply to any kind of transit network



Create a trip planning that not only considers travel time, fare and/or transfers, but much more!

Travelling from	English 🗨 Go	Advanced options		
From	Travelling to	Show me		
start end		Select your preferred option:		
Station or stop in:	Station or stop in:	The fastest routes		
London	London	Routes with the fewest changes		
Post code	Post code	\bigcirc Routes with the least walking between stops		
 Address Place of interest 	 Address Place of interest 	I wish to travel via: Enter location (optional)		
For location help, try the	For location help, try the	Station or stop in: London		
following: Tube map.	following: Tube map.	Post code Address Place of interest		
Street map	Street map	For location help, try the following: Tube map. Street map		
I need to depart on 21 December 2011 at: 17 I 49 hours		My mobility requirements		
		I cannot use stairs		
Walking options		I cannot use escalators		
I don't want to walk for longer than 20 minutes		I cannot use lifts		
		I use wheelchair accessible vehicles		
My walking speed is: Average		Select any of the above statements that apply to you.		
I'd rather walk if it ma	kes my journey quicker	For station access details click here 🗗		

Public transport users take into account a wide variety of attributes when choosing routes

An incomplete model specification can result in biased results, such as attributes valuations

Network's topology, and specially the way it's presented to users on a daily basis, is relevant

Due to bigger distortions in the schematic map, the topological variables are more important in London

Londoners are more willing to transfer, as it is more common to them (bigger and denser network)

Londoners are less willing to travel in crowded trains, but care less about getting a seat





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