LT5: Modeling reliability, cost, travel times, safety, comfort and other relevant variables of modal choice

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BUS RAPID TRANSIT
ACROSS LATITUDES AND CULTURES

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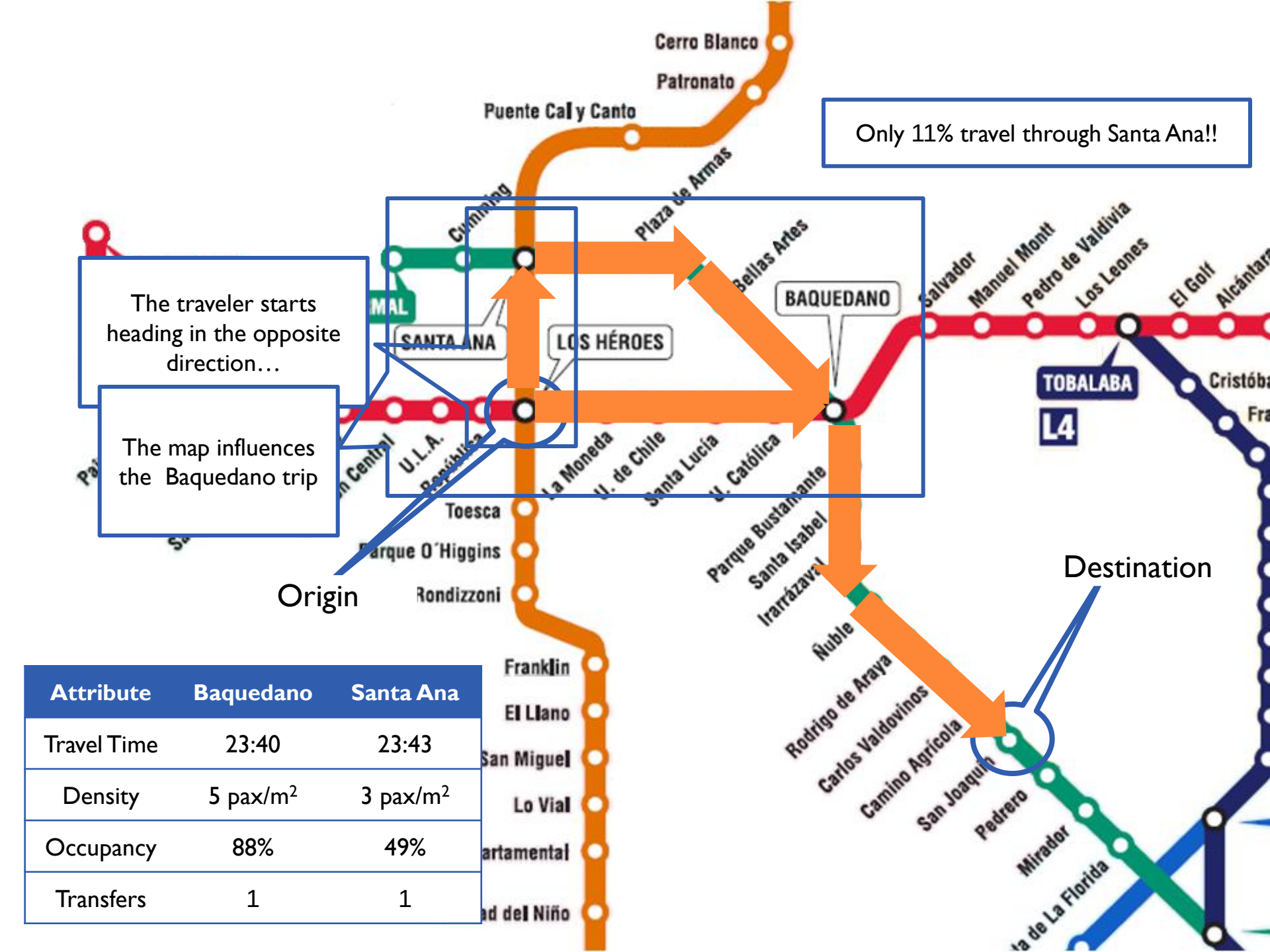
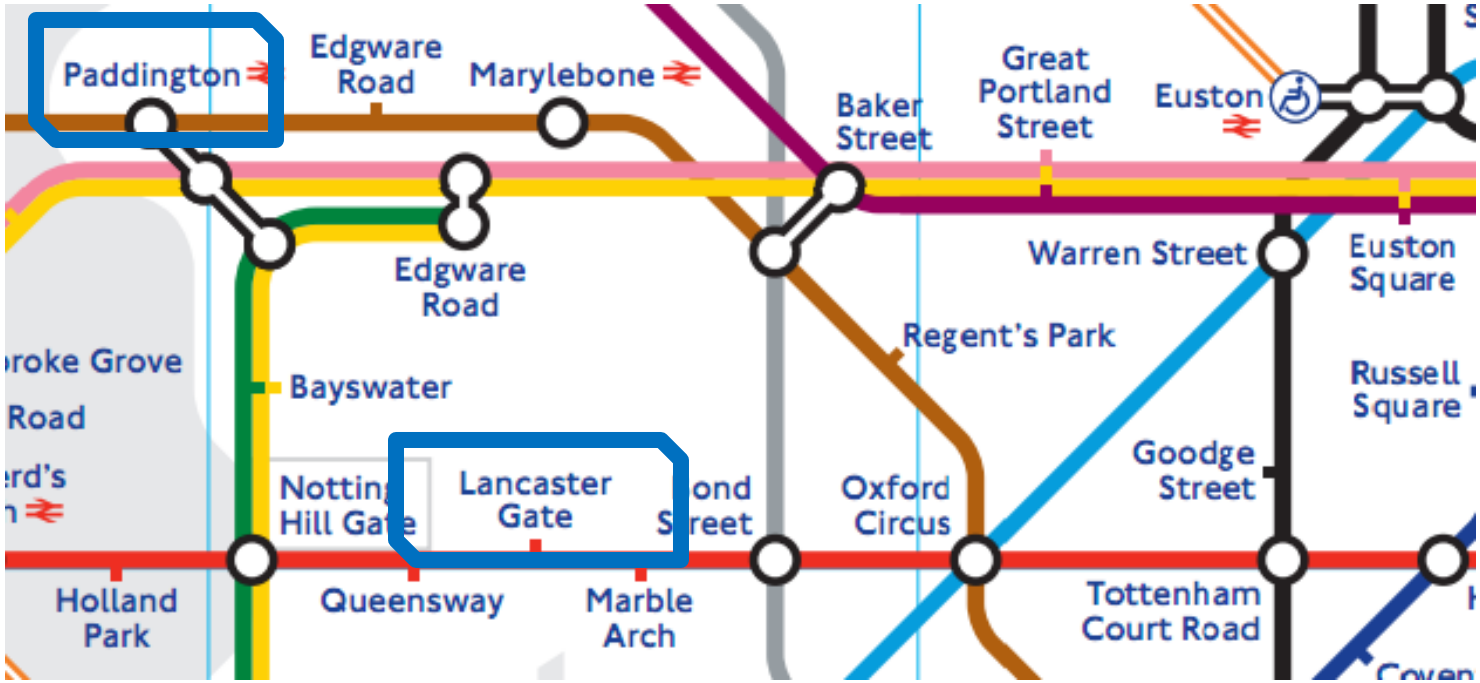
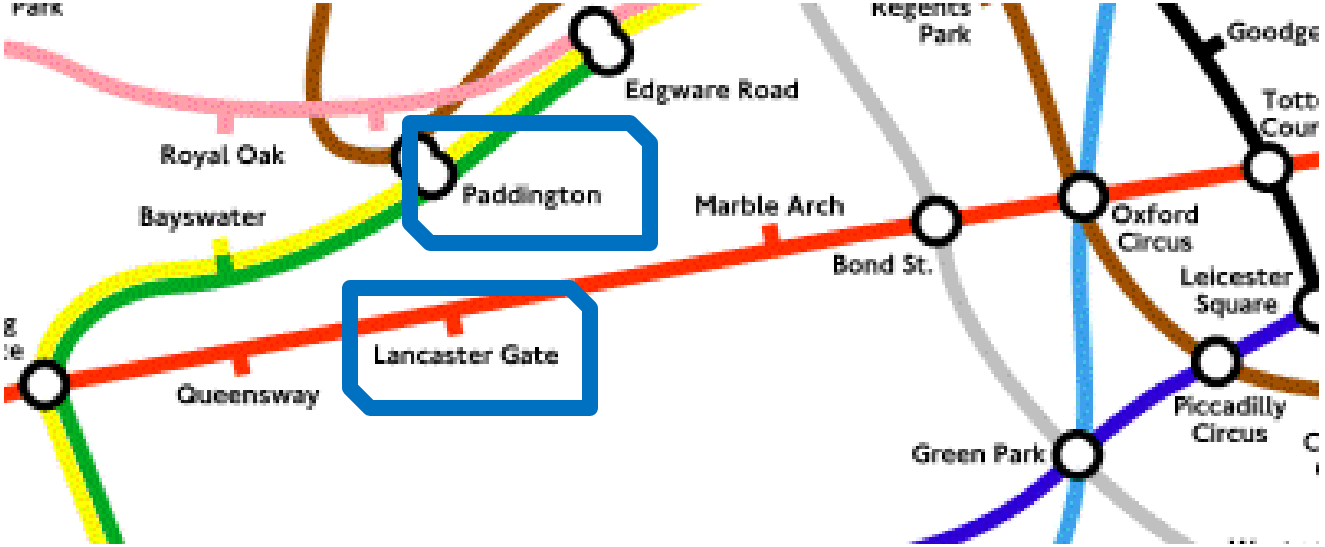


Attribute	Baquedano	Santa Ana
Travel Time	23:40	23:43
Density	5 pax/m^2	3 pax/m^2
Occupancy	88%	49%
Transfers	1	1

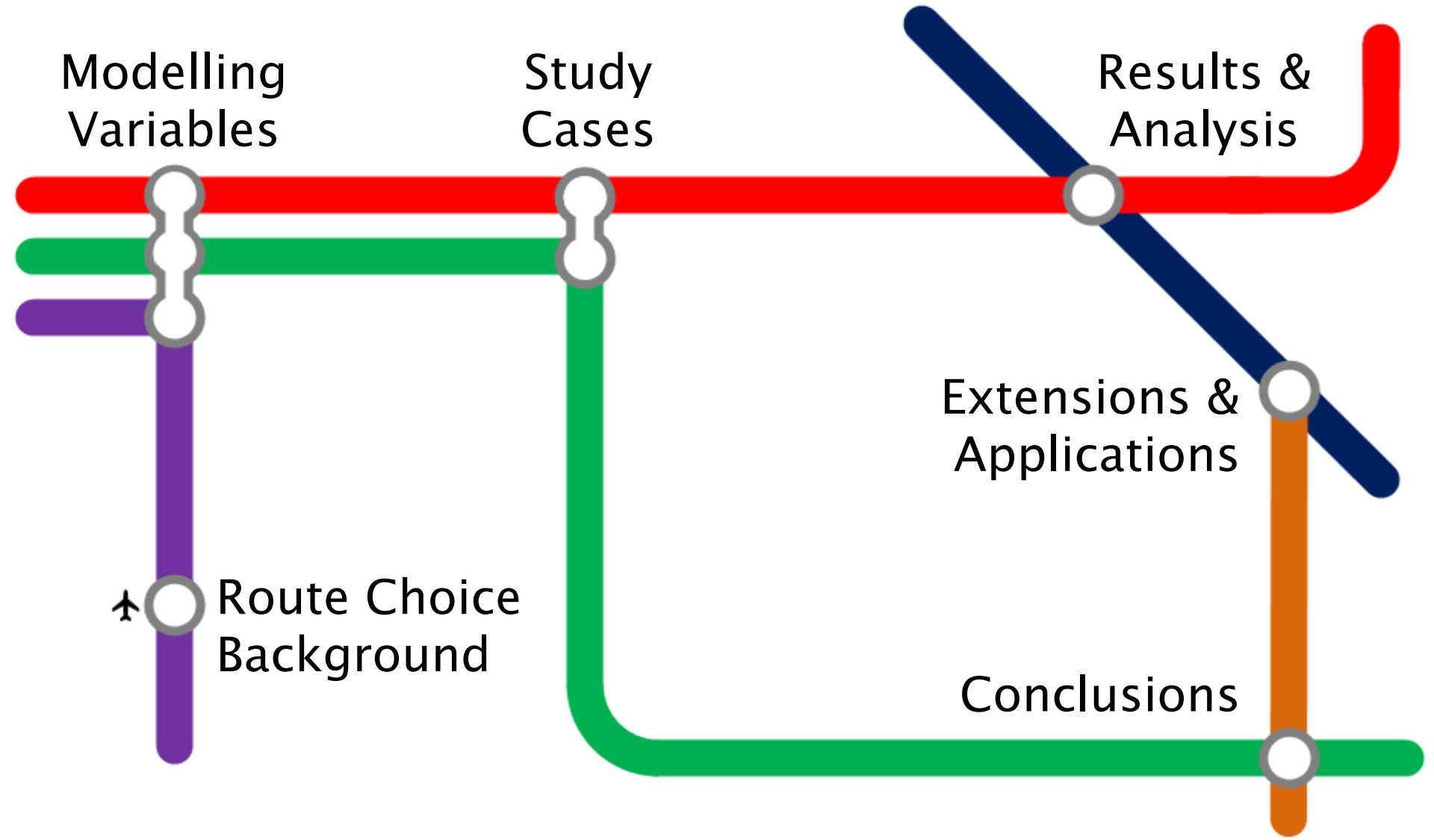

Paddington
Edgware Road
Marylebone
Baker Street
Great Portland Street
Euston
Edgware Road
Warren Street
Euston Square
Regent's Park
Bayswater
Russell Square
Lancaster Gate
Oxford Circus
Goodge Street
Holland Park
Queensway
Marble Arch
Tottenham Court Road

13 min

10 min


Edgware Road
Royal Oak
Paddington
Bayswater
Marble Arch
Bond St.
Oxford Circus
Leicester Square
Lancaster Gate
Queensway
Piccadilly Circus
Green Park

Contents


Modelling Variables
Study Cases
Results & Analysis
Extensions & Applications
Route Choice Background
Conclusions

Route choice modelling

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 socio-economic variables of the travelers

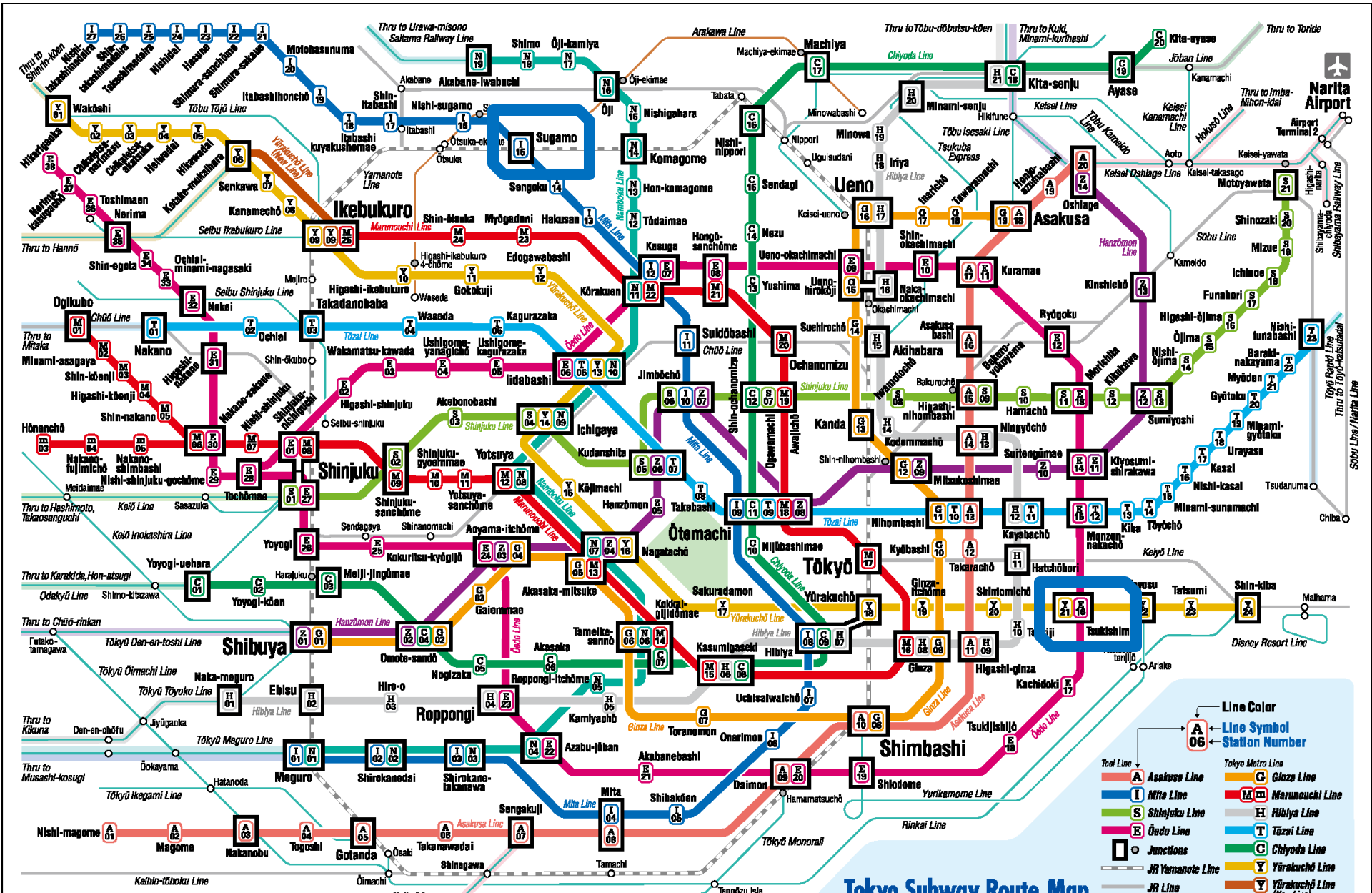
Route choice modelling

However, this approach ignores other relevant elements that influence route choice as:

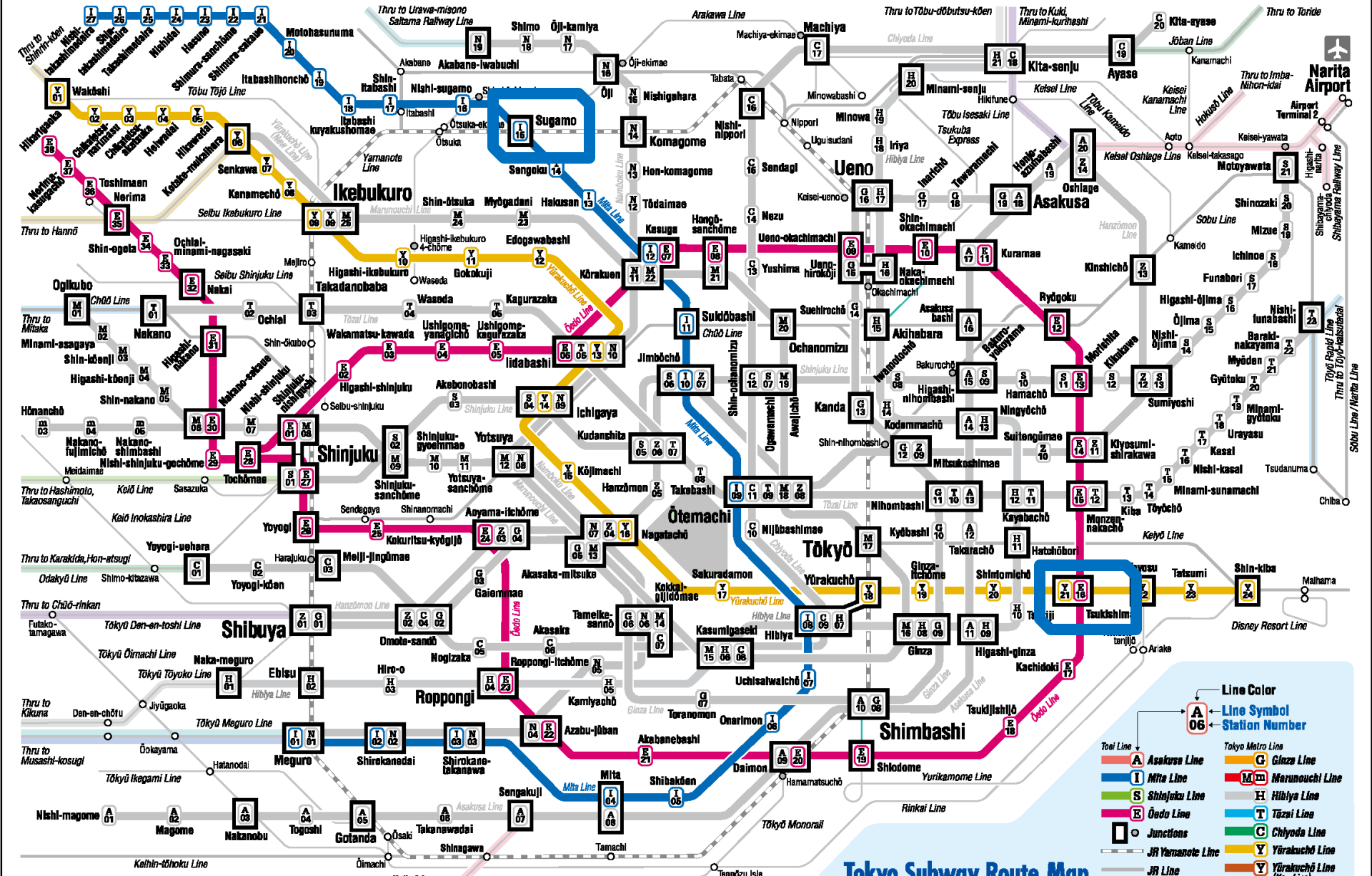
- comfort and safety
- transfers accessibility
- network topology
- aesthetics

These variables are subjective and hard to quantify

Pathfinding Criteria



Pathfinding Criteria



Pathfinding Criteria

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 many factors at the same time!

Study's objectives

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

What do people take into account?

In-vehicle time
Waiting time
Walking time (when transferring)

travel time components

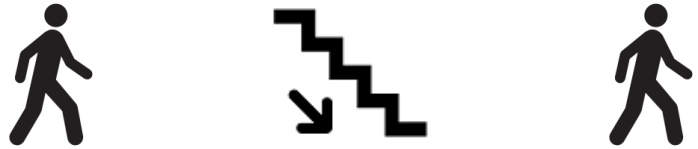
Number of transfers

Transfer stations layout

ascending

at level

descending



What do people take into account?

In-vehicle time
Waiting time
Walking time (when transferring)

travel time components

Number of transfers

Transfer stations layout

Transfer stations infrastructure

assisted  or 

semi-assisted  or  and 

non-assisted 

What do people take into account?

In-vehicle time	travel time components
Waiting time	
Walking time (when transferring)	
Number of transfers	transfer experience
Transfer stations layout	
Transfer stations infrastructure	

Mean occupancy

Possibility of not boarding

in London — initial occupancy ≥ 70%

in Santiago — initial occupancy ≥ 85%

What do people take into account?

In-vehicle time	travel time components
Waiting time	
Walking time (when transferring)	
Number of transfers	transfer experience
Transfer stations layout	
Transfer stations infrastructure	

Mean occupancy

Possibility of not boarding

Possibility of getting a seat

in London	initial occupancy ≤ 20%
in Santiago	initial occupancy ≤ 15%

What do people take into account?

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

Route distance

Number of stations

Angular cost

What do people take into account?

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

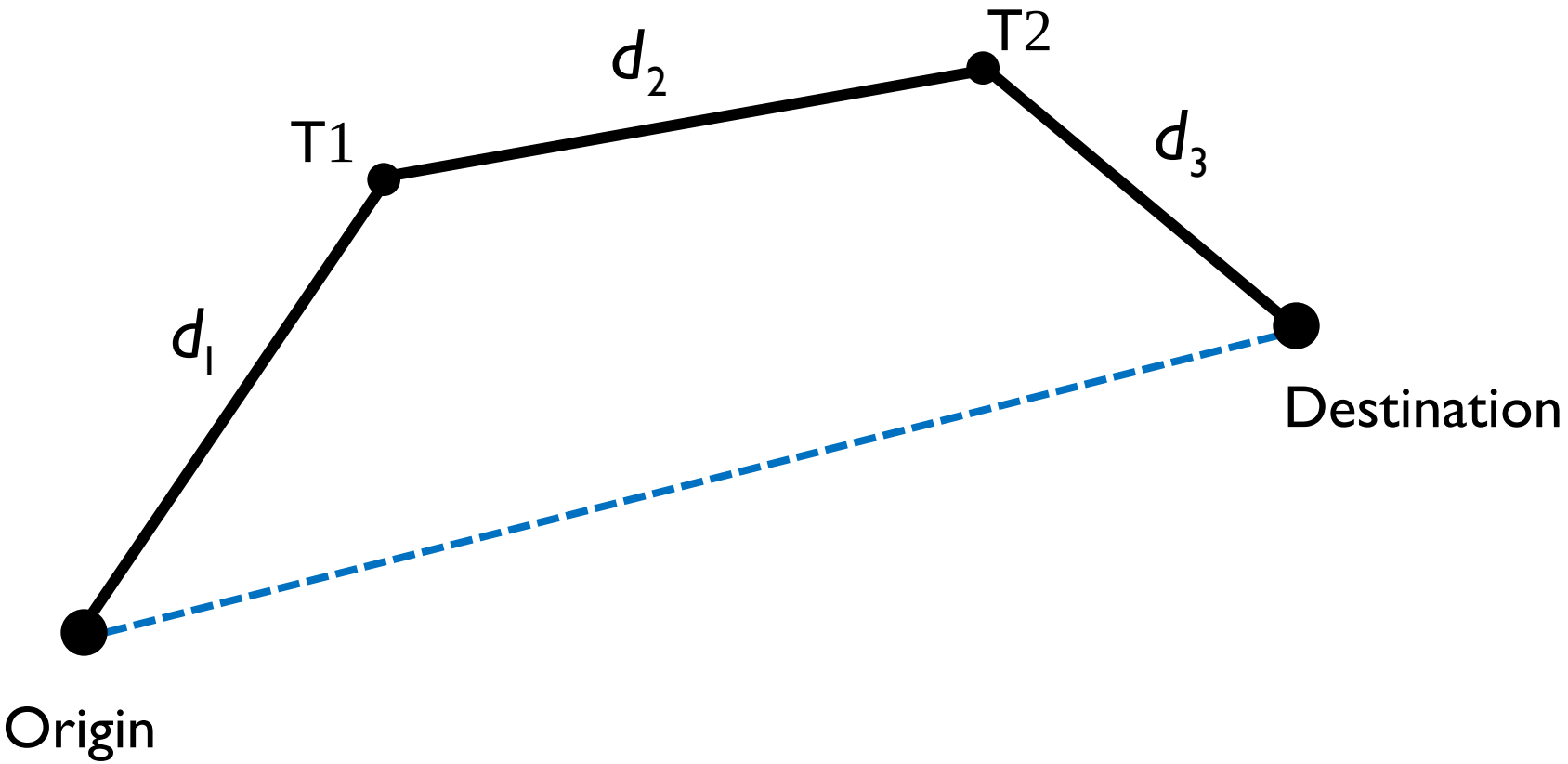
Route distance

Number of stations

Angular cost

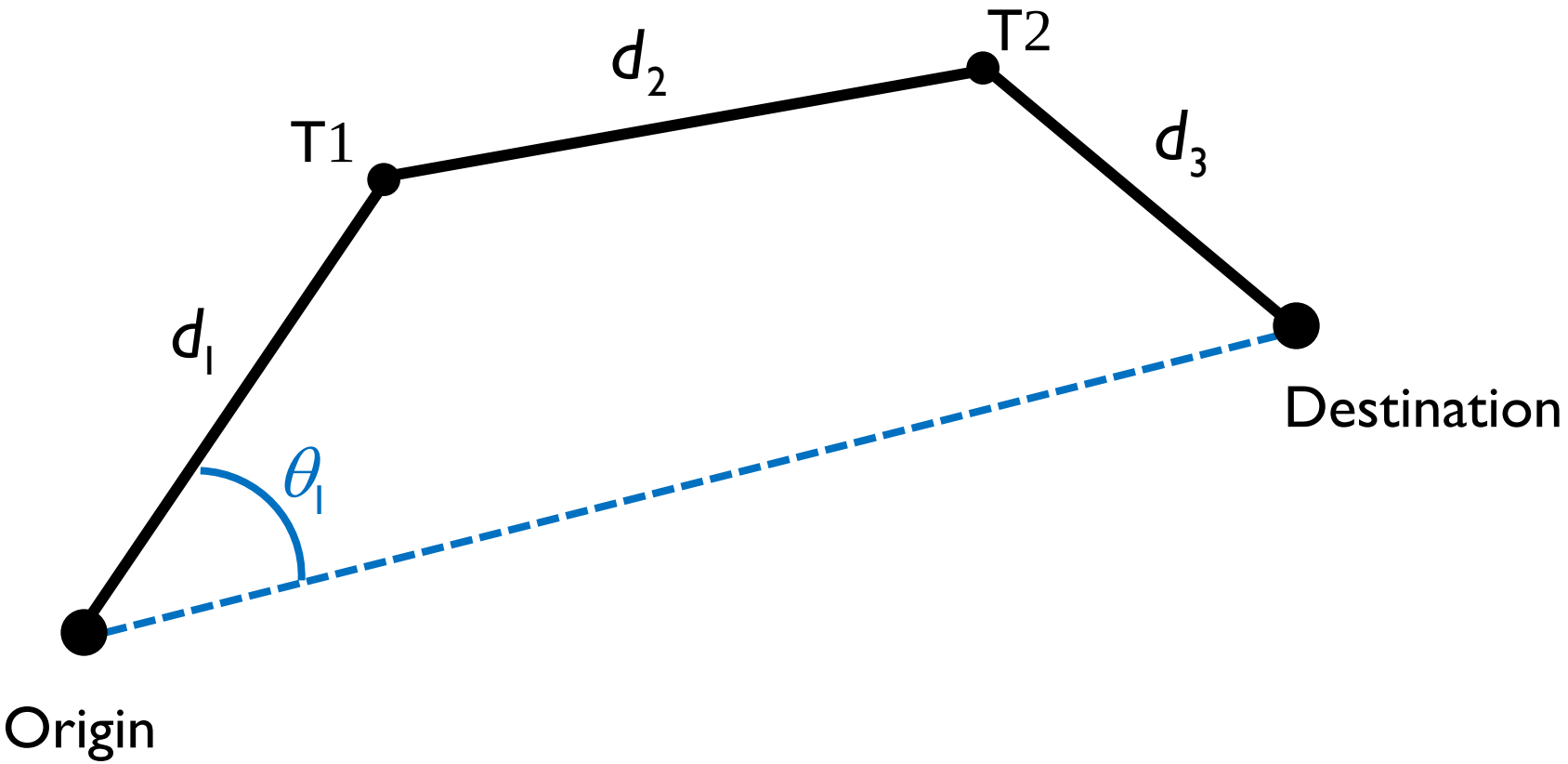
$$\sum d \cdot \sin\left(\frac{\theta}{2}\right)$$

What do people take into account?



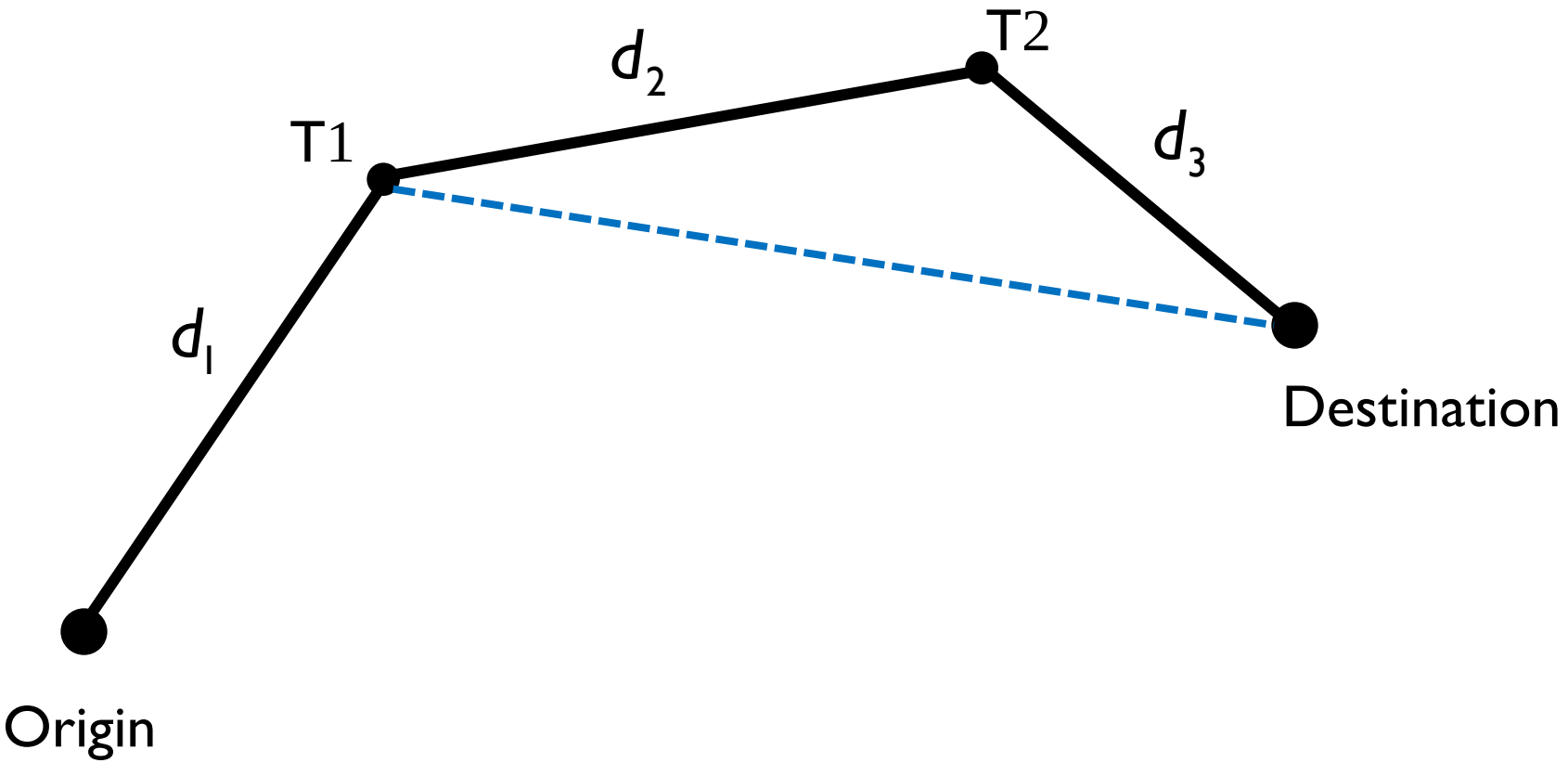
Angular Cost =

What do people take into account?



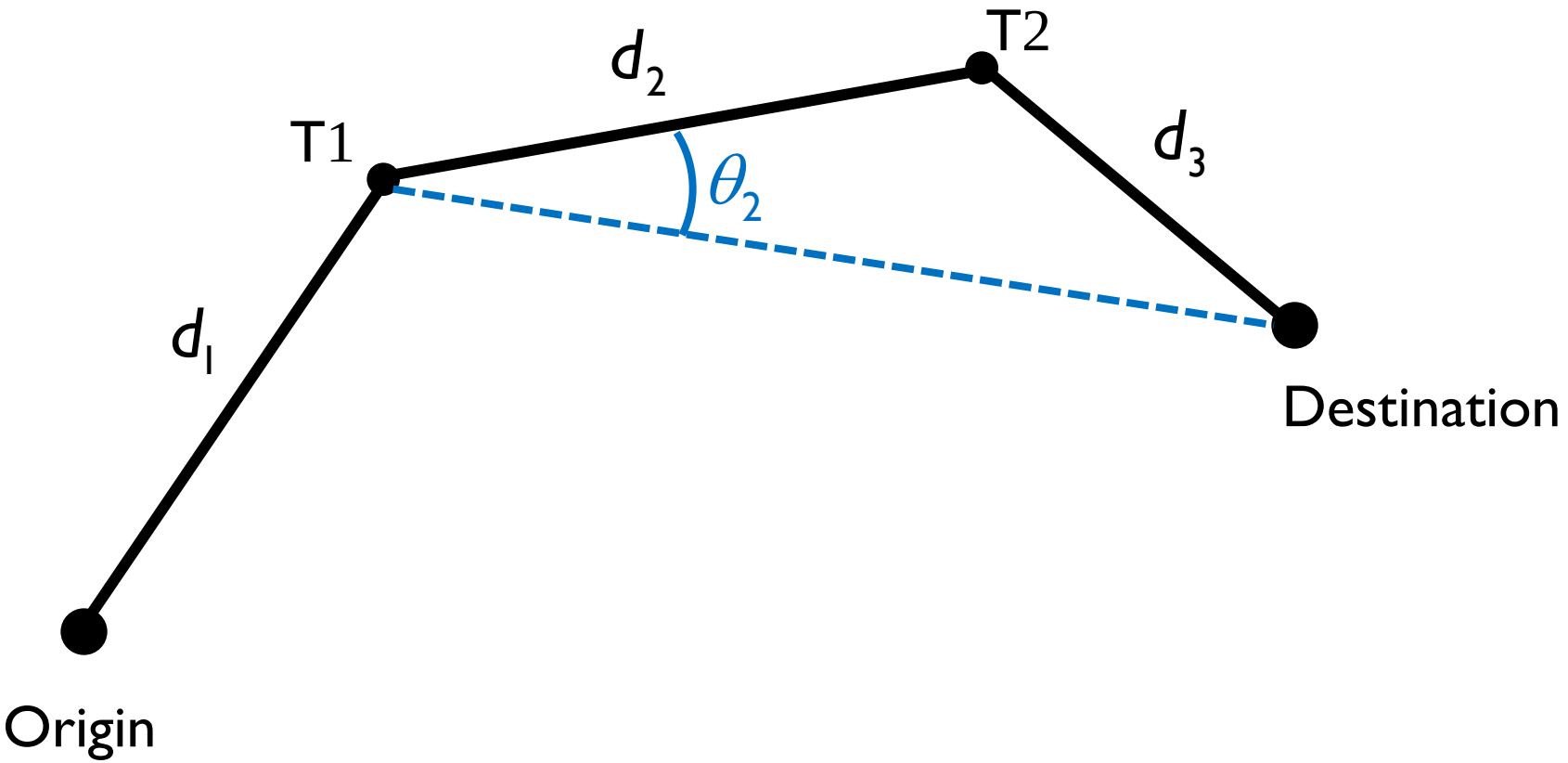
Angular Cost =

What do people take into account?



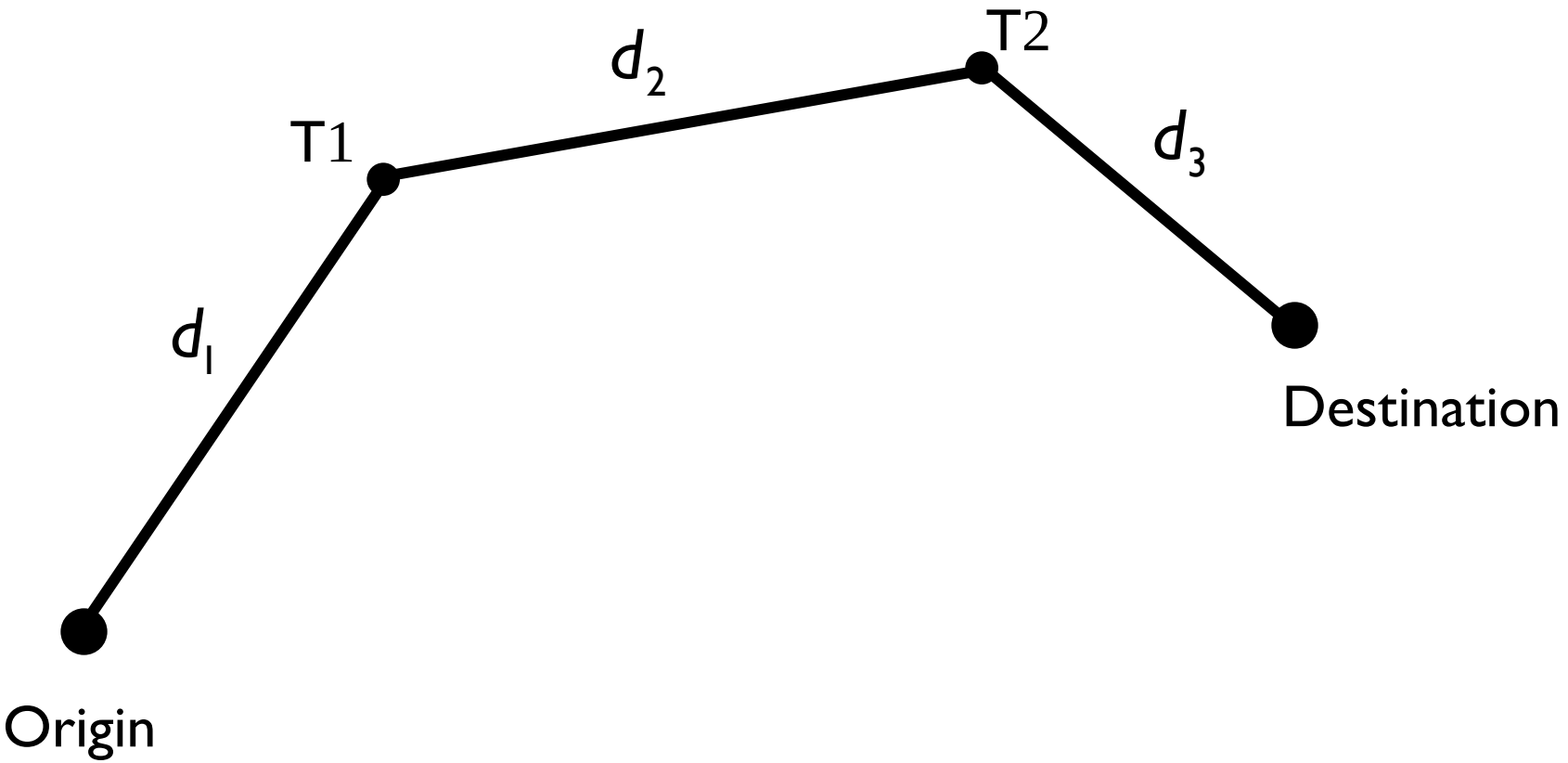
$$\text{Angular Cost} = d_1 \cdot \sin\left(\frac{\theta_1}{2}\right)$$

What do people take into account?



$$\text{Angular Cost} = d_1 \cdot \sin\left(\frac{\theta_1}{2}\right)$$

What do people take into account?



$$\text{Angular Cost} = d_1 \cdot \sin\left(\frac{\theta_1}{2}\right) + d_2 \cdot \sin\left(\frac{\theta_2}{2}\right)$$

What do people take into account?

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

What do people take into account?

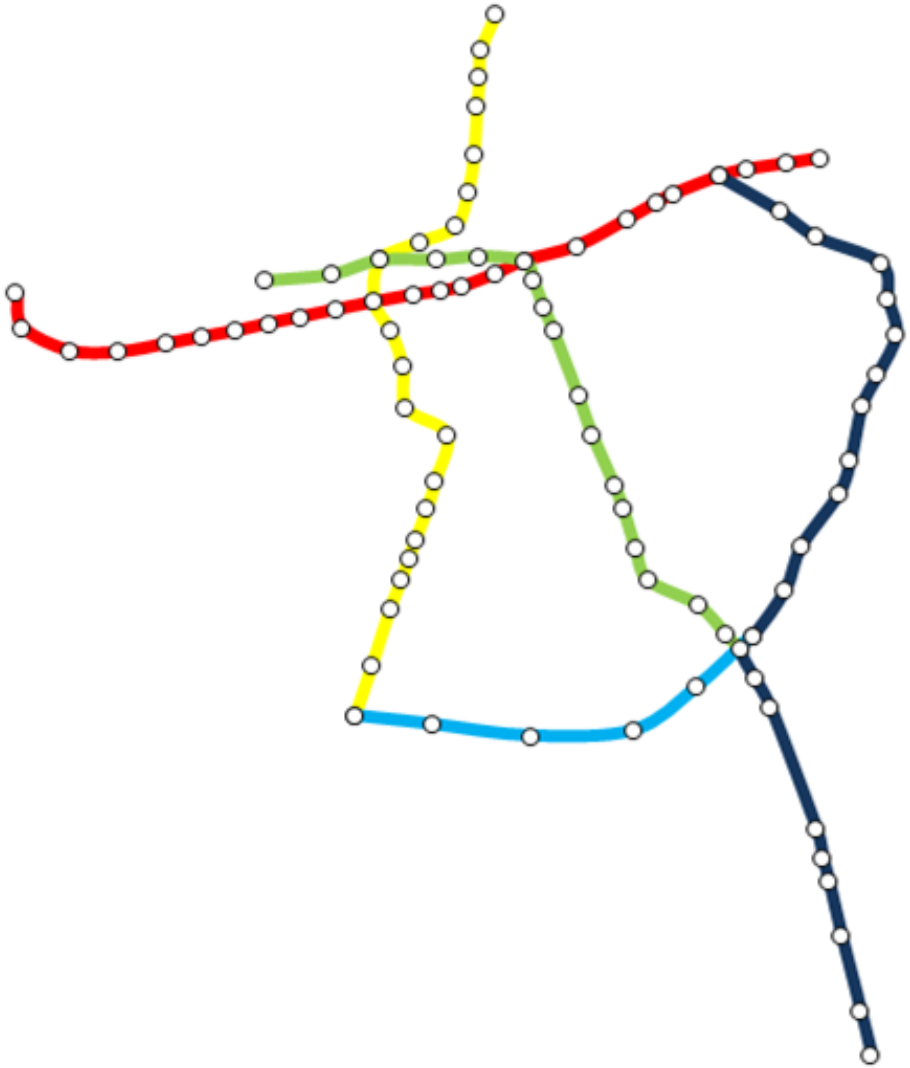
In-vehicle time Waiting time Walking time (when transferring)	travel time components
Number of transfers Transfer stations layout Transfer stations infrastructure	transfer experience
Mean occupancy Possibility of not boarding Possibility of getting a seat	comfort and crowding
Route distance Number of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

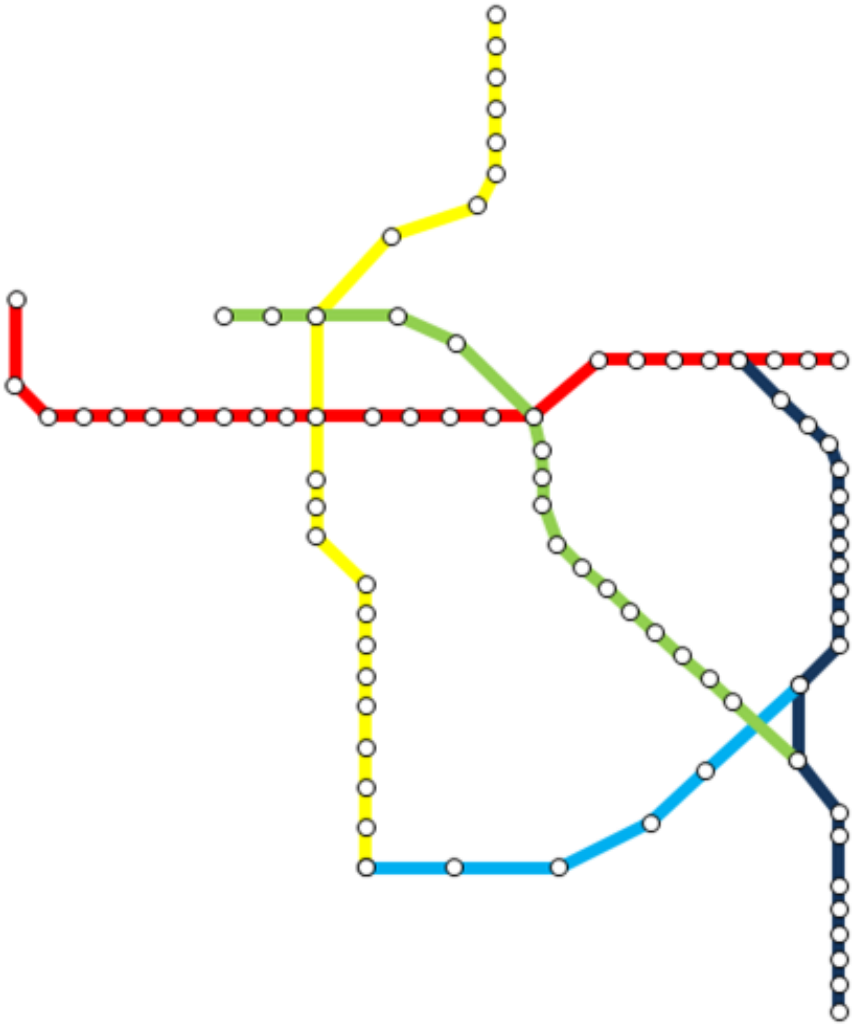
Comparing Santiago and London

	Santiago	London
Survey date	2008	1998-2005
Lines	5	11
Stations	85	255
Transfer stations	7	72
Daily trips	2,300,000	3,400,000
Survey size	28,961	16,300

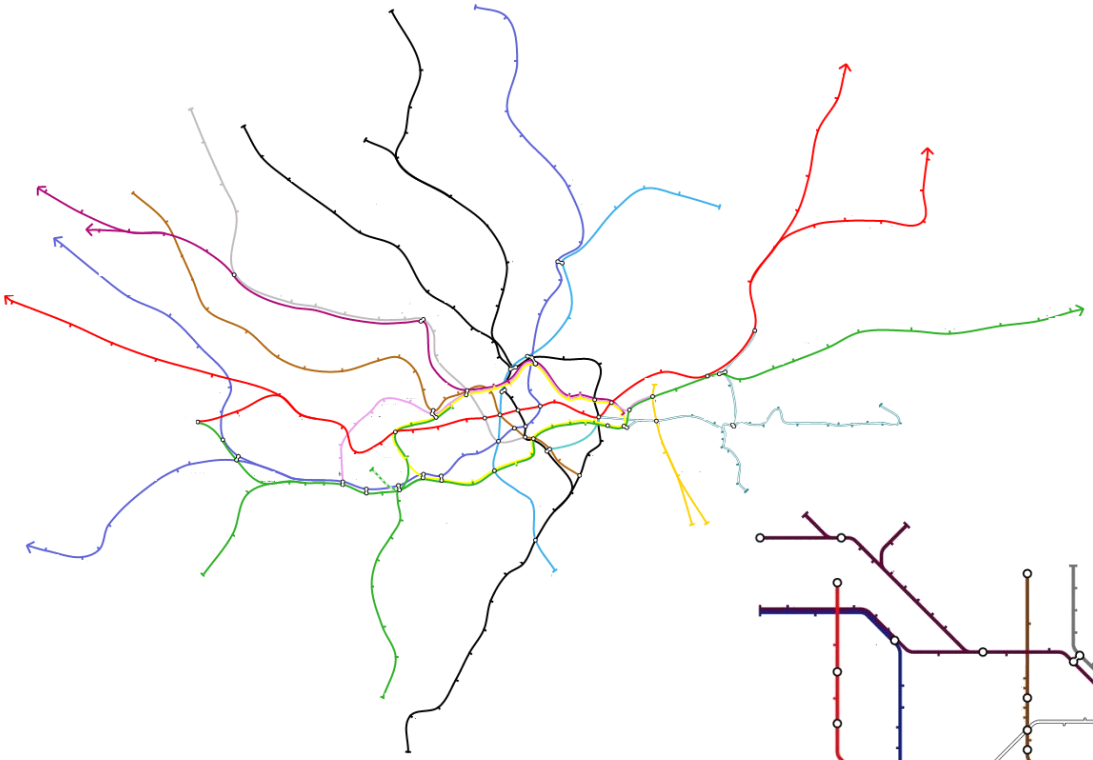
Comparing Santiago and London

Santiago Metro

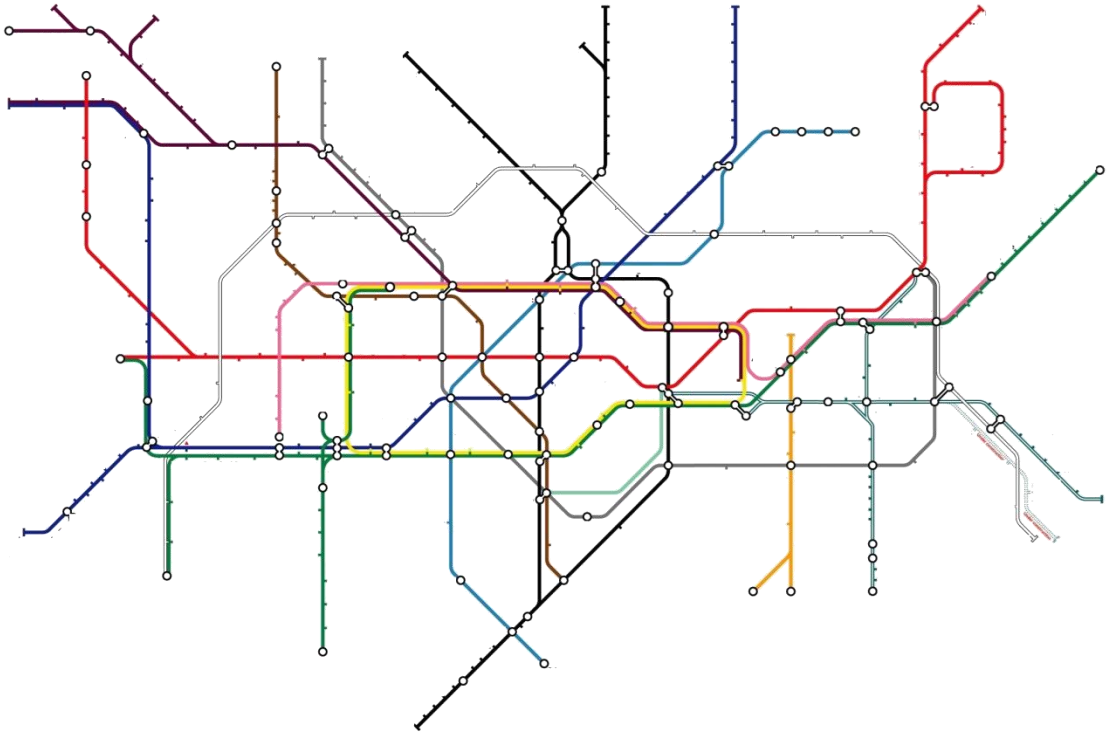




Comparing Santiago and London



London Underground



Modelling approach

We use a Multinomial Logit for modeling the route choice

Probabilistic model for discrete choices

Every route has an *utility level* based on its characteristics

People choose the route with maximum *utility level*

Estimation results

Attribute	London Underground		Santiago Metro	
Travel Time	- 0.188	- 16.02	- 0.095	- 19.57
Waiting Time	- 0.311	- 7.39	- 0.139	- 5.07
Walking Time	- 0.216	- 6.14	- 0.155	- 8.23
Number of Transfers	- 1.240	- 4.37	- 0.632	- 4.06
				- 2.73
				n. a.
				n. a.
				n. a.
Semi-Assisted Transfers	- 0.328	- 6.83	n. a.	n. a.
Non-Assisted Transfers	- 0.541	- 6.79	- 0.262	- 6.23
Mean Occupancy	- 2.911	- 3.48	- 1.018	- 5.60
				3.41
				- 2.97
				- 5.48
Map Distance	- 0.358	- 5.76	- 0.274	- 5.69
Number of Stations	- 0.316	- 5.52	- 0.147	- 3.10
Turning Back	- 0.725	- 8.12	- 0.141	- 9.76
Turning Away	- 0.968	- 8.00	- 0.226	- 7.11
Adjusted ρ^2	0.566		0.382	

Parameter's signs ☺ OK

Parameter's significances ☺ OK

Marginal rates of substitution

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

Map impact

The topological variables can be specified using the real (geographic) information or the schematic maps

Statistic	London		Santiago	
	Real	Map	Real	Map
Corrected ρ^2	0.564	0.566	0.378	0.382
Mean Squared Error	0.348	0.342	0.613	0.611
θ_{wait} / θ_{travel}	2.44	1.65	1.98	1.46
θ_{walk} / θ_{travel}	1.90	1.15	1.94	1.62
t-test Angular Cost	- 1.60	- 5.87	- 4.28	- 5.48

What did you learn today?

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

What did you learn today?

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

Publications and working papers

- Raveau, S., J.C. Muñoz, and L. de Grange (2011) A topological route choice model for metro. **Transportation Research Part A**, Vol 45 (2), 138–147
- Raveau, S., Z. Guo, J.C. Muñoz and N.H. Wilson. (2012) Route Choice Modelling on Metro Networks: time, Transfer, crowding, and topology. To be submitted to **Transportation Research Part A**.
- Navarrete, F. and J. de D. Ortúzar (2012) Subjective valuation of the transit transfer experience: the case of Santiago de Chile. Submitted to **Transport Policy**.

2012

In-progress or future research I

- Comparison of route choice models for Metro of London and Santiago. A paper should be submitted to Trans Res A this month.
- Extend the study for a route and mode choice models within a transit system. We made an 1,800 people survey in Santiago with this purpose. This research is being developed by PhD student Sebastian Raveau.
- Develop a similar survey in Bogota, Colombia to understand the role played by a BRT-based network in passengers´ choices.
- Compare results between Santiago and Bogota to understand how much of a Metro service BRT provides in Bogota.

In-progress or future research II

- Build a tactic tool to predict passenger flows in a multimodal transit system. Such a model would have to deal with endogeneity since passengers flows affect travelers´ choices.
- Build a tool to advise passengers how to travel in a complex multimodal transit system.
- Develop a methodology to feed our route and mode choice models with feedback provided by users of the Passenger Travel Advising Tool.

Grants obtained

- FONDEF (2012-2014). A tactic-strategic tool for urban transit systems planning and management. Total funding of US$800,000. Involvement of Metro and Alsacia (bus operator)

  Juan Carlos Muñoz and Juan de Dios Ortúzar

- PUC (2011-2012). Interdisciplinary research project to understand how to improve the users transfer experience on a transit system (US$10,000).

  Ricardo Giesen, Juan de Dios Ortúzar, Juan Carlos Muñoz, Patricia Galilea, Juan Carlos Herrera, Margarita Greene, Rossana Forray, José Allard

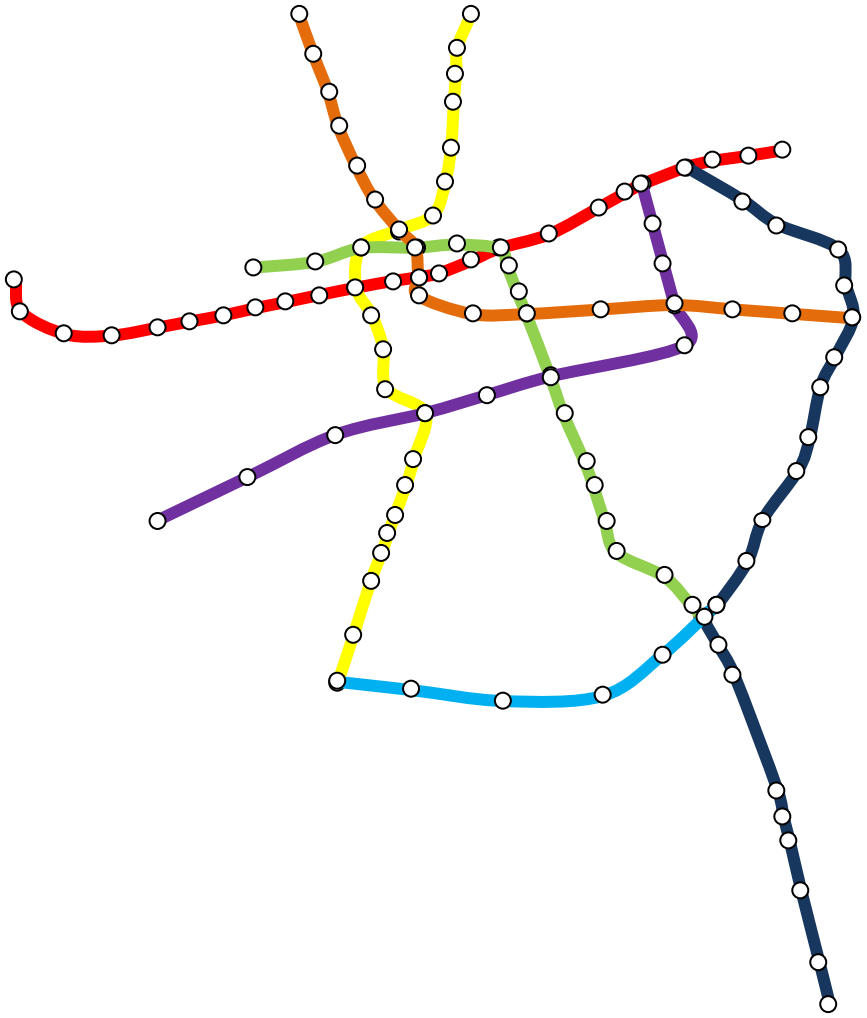
From the papers to the streets

- Several interviews with the media during 2011
- Interviews with Metro and government authorities during 2011
- Metro de Santiago changed its map based on our results to induce a more socially optimal behavior

So… what can we do with this?

Change in the Santiago Metro schematic map

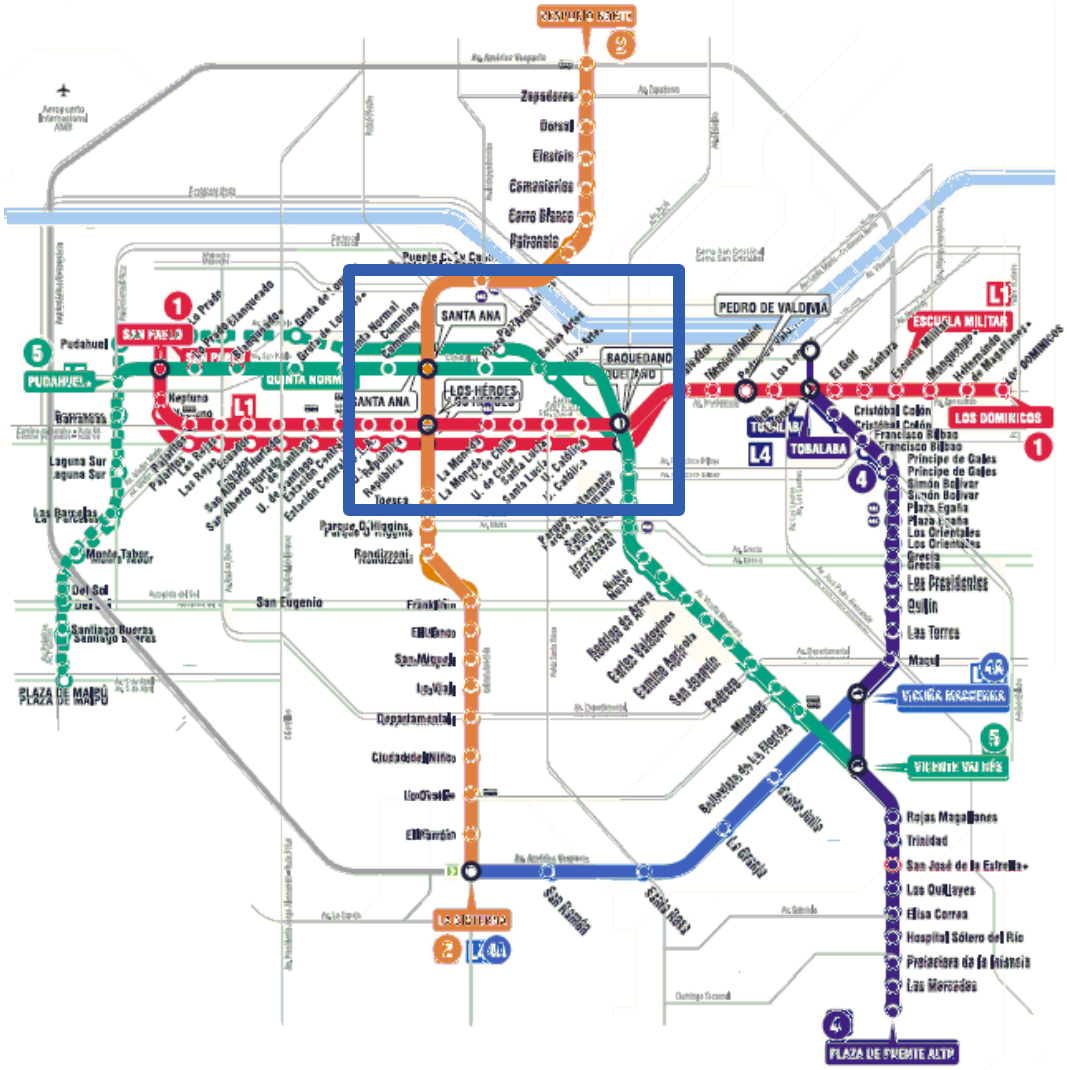
So… what can we do with this?



Demand analysis for the design of transfer stations

Applications

- Changes in the Santiago Metro Map



From the papers to the streets

- Several interviews with the media during 2011
- Interviews with Metro and government authorities during 2011
- Metro de Santiago changed its map based on our results to induce a more socially optimal behavior
- We are now working un using our assignment model to design interchange stations and predict flows for the Metro network in Santiago that will consider two extra lines in 2016.


END OF LINE