Route Choice Modelling on Metro Networks

A comparison between Santiago and London

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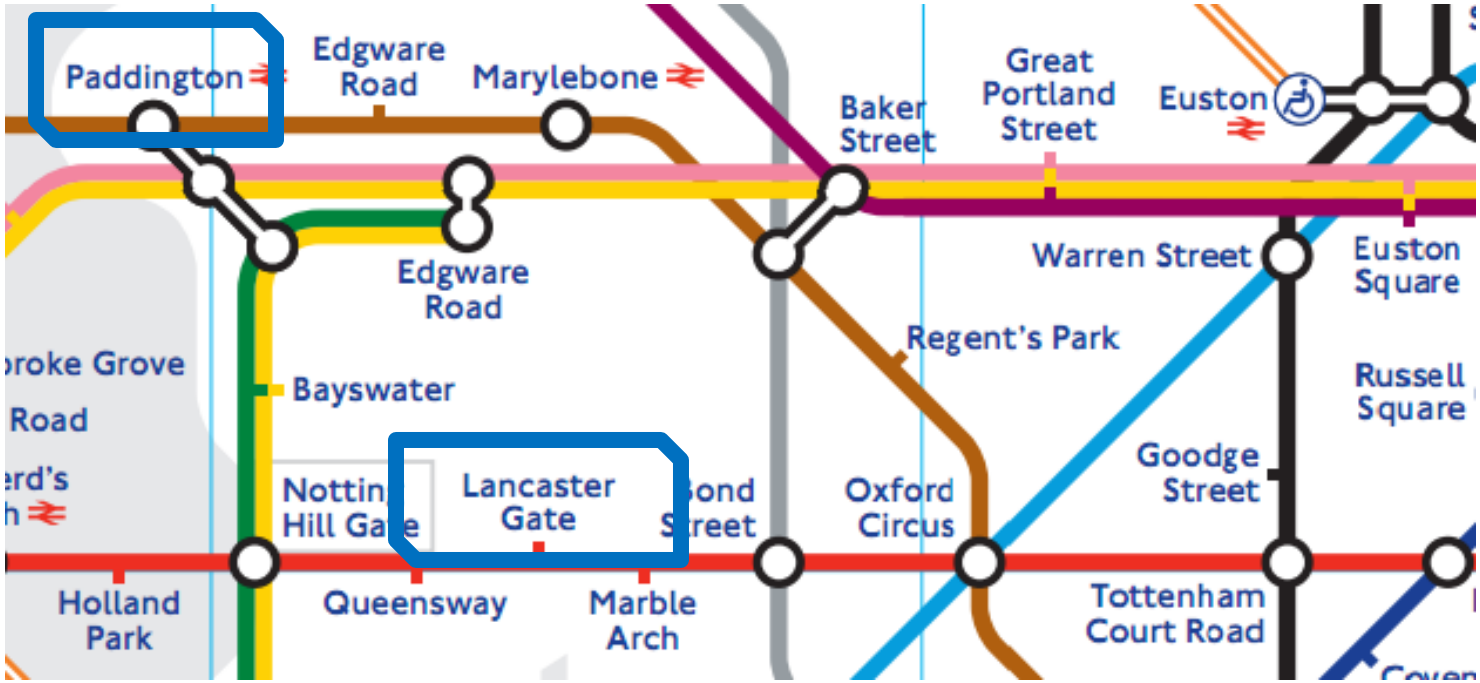
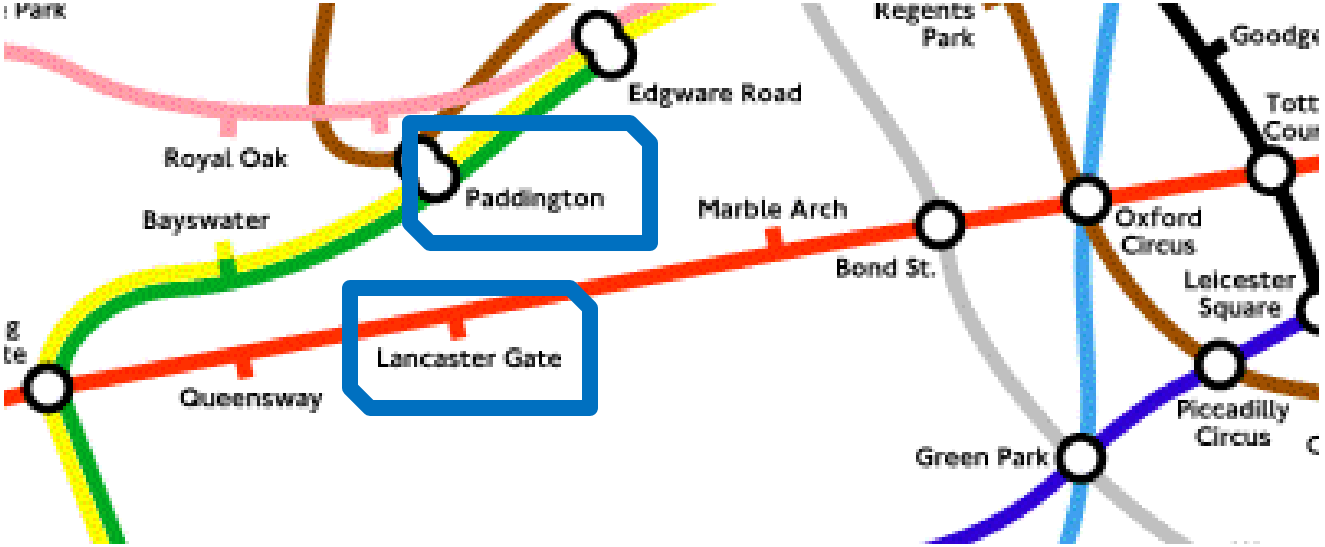
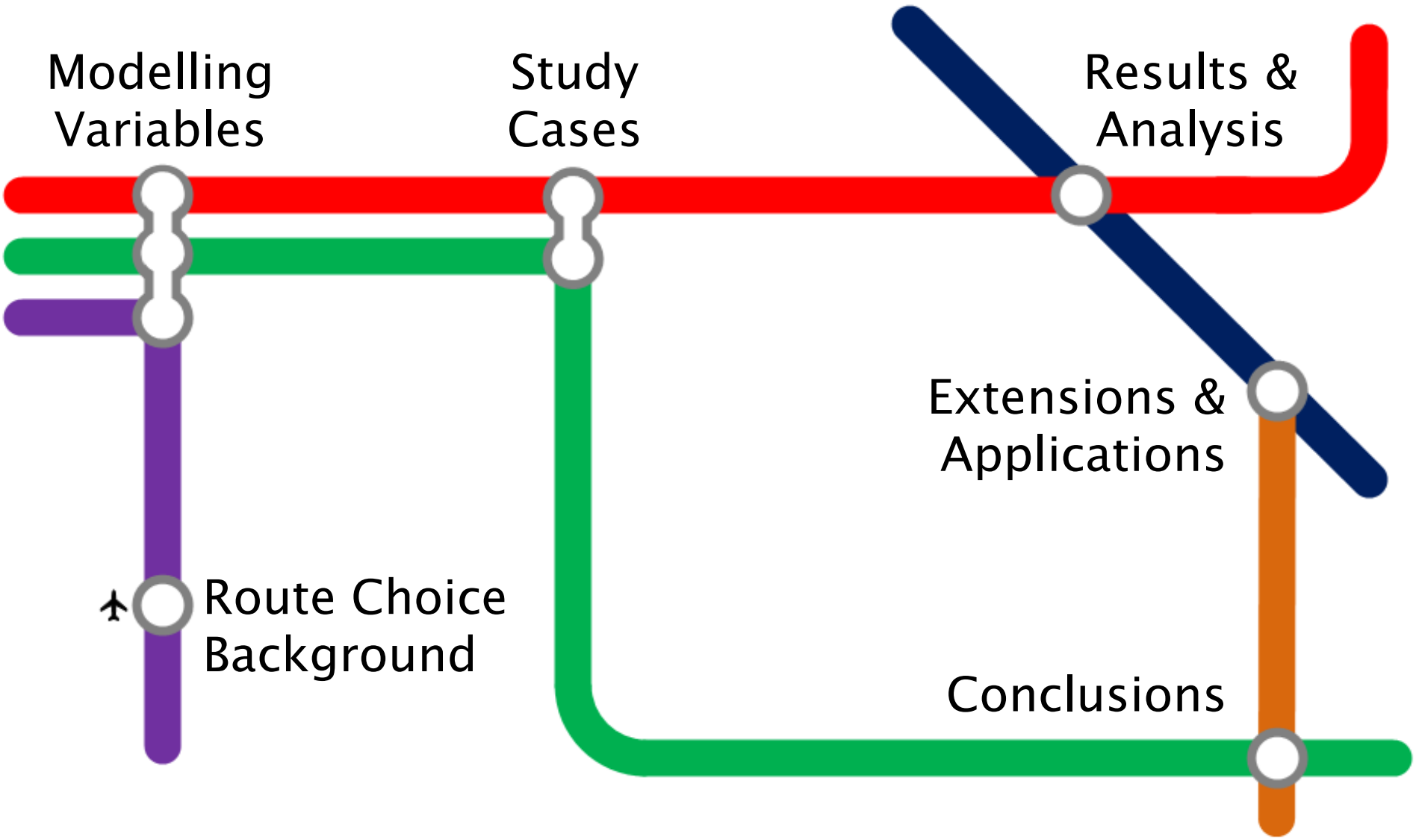

Paddington
Edgware Road
Marylebone
Baker Street
Great Portland Street
Euston
Edgware Road
Warren Street
Euston Square
Regent's Park
Bayswater
Russell Square
Lancaster Gate
Oxford Circus
Goodge Street
Holland Park
Queensway
Marble Arch
Tottenham Court Road

13 min

10 min


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

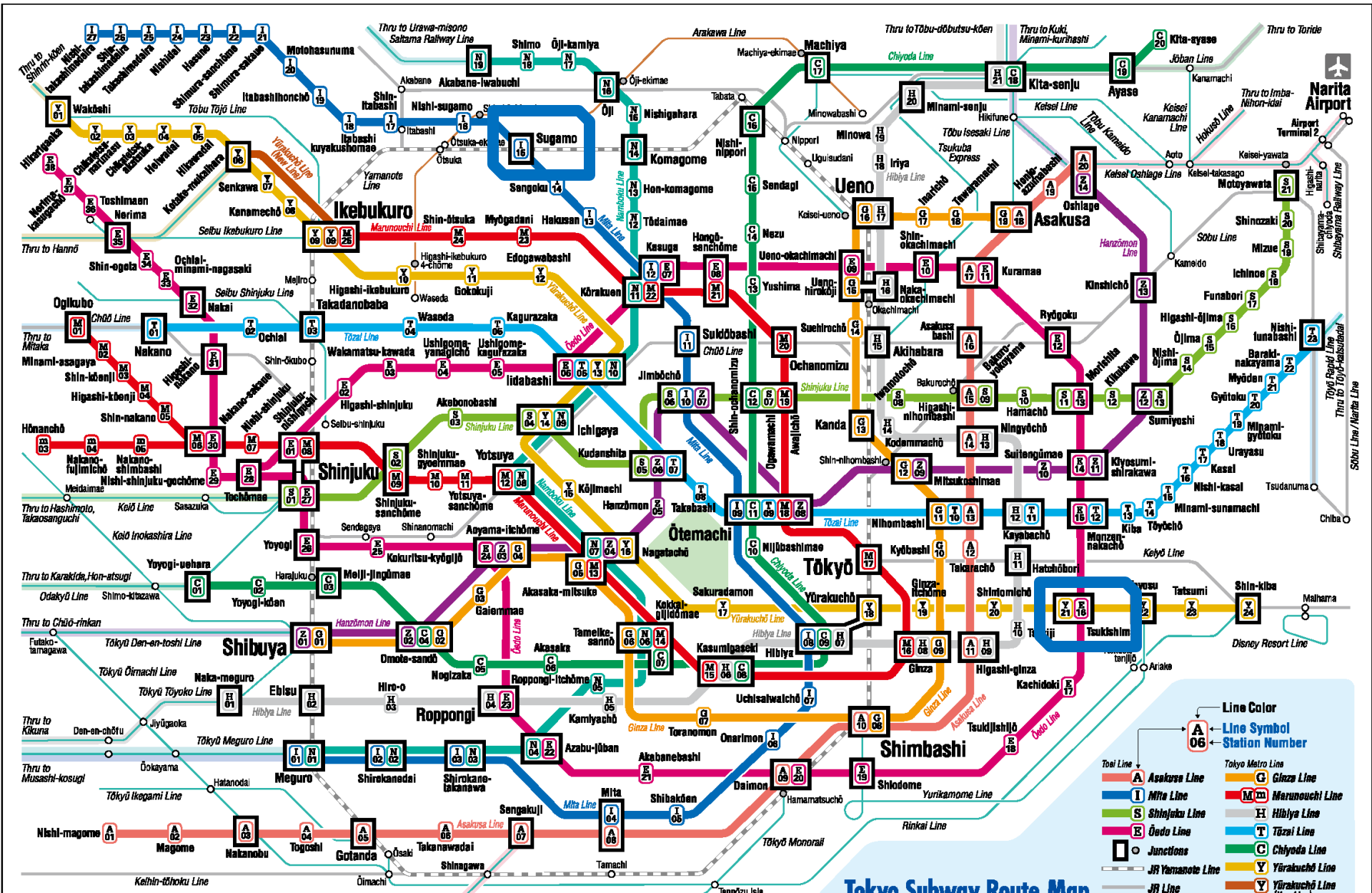
Route choice modelling

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

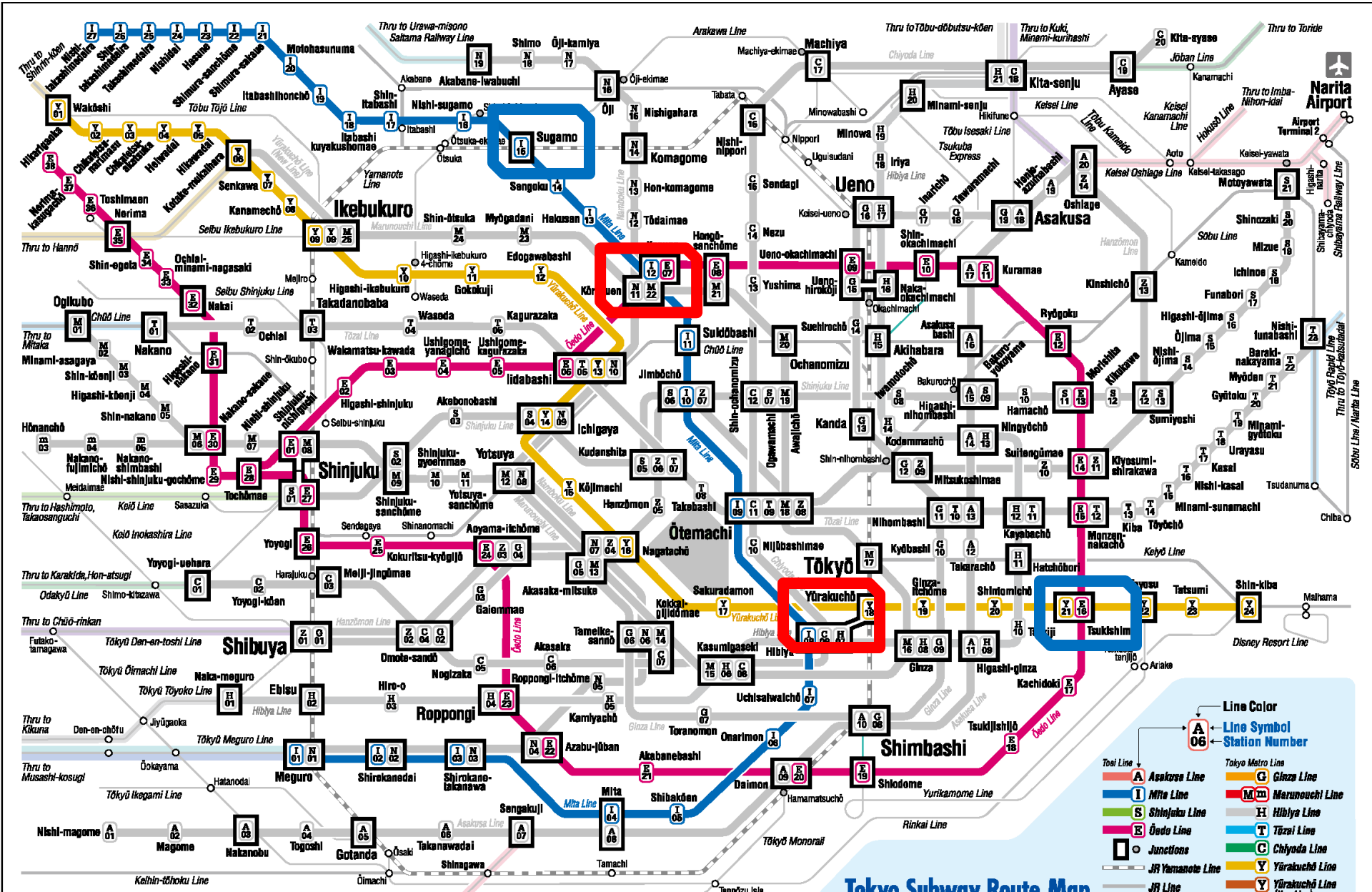
- comfort and safety
- transfers accessibility
- network topology
- aesthetics

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

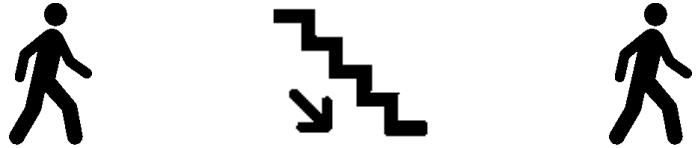
Number of transfers

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	

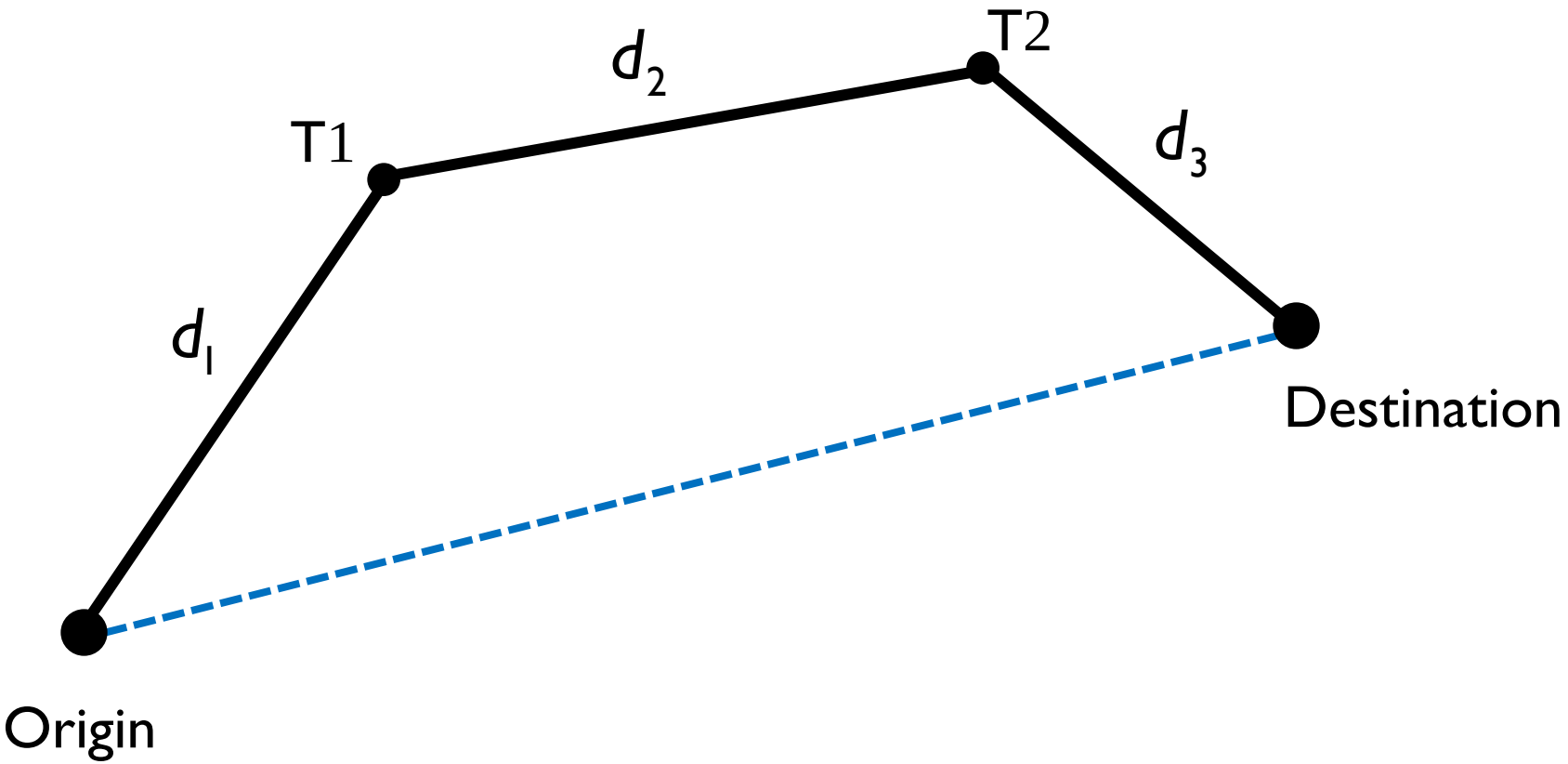
Route distance

Number of stations

Angular cost

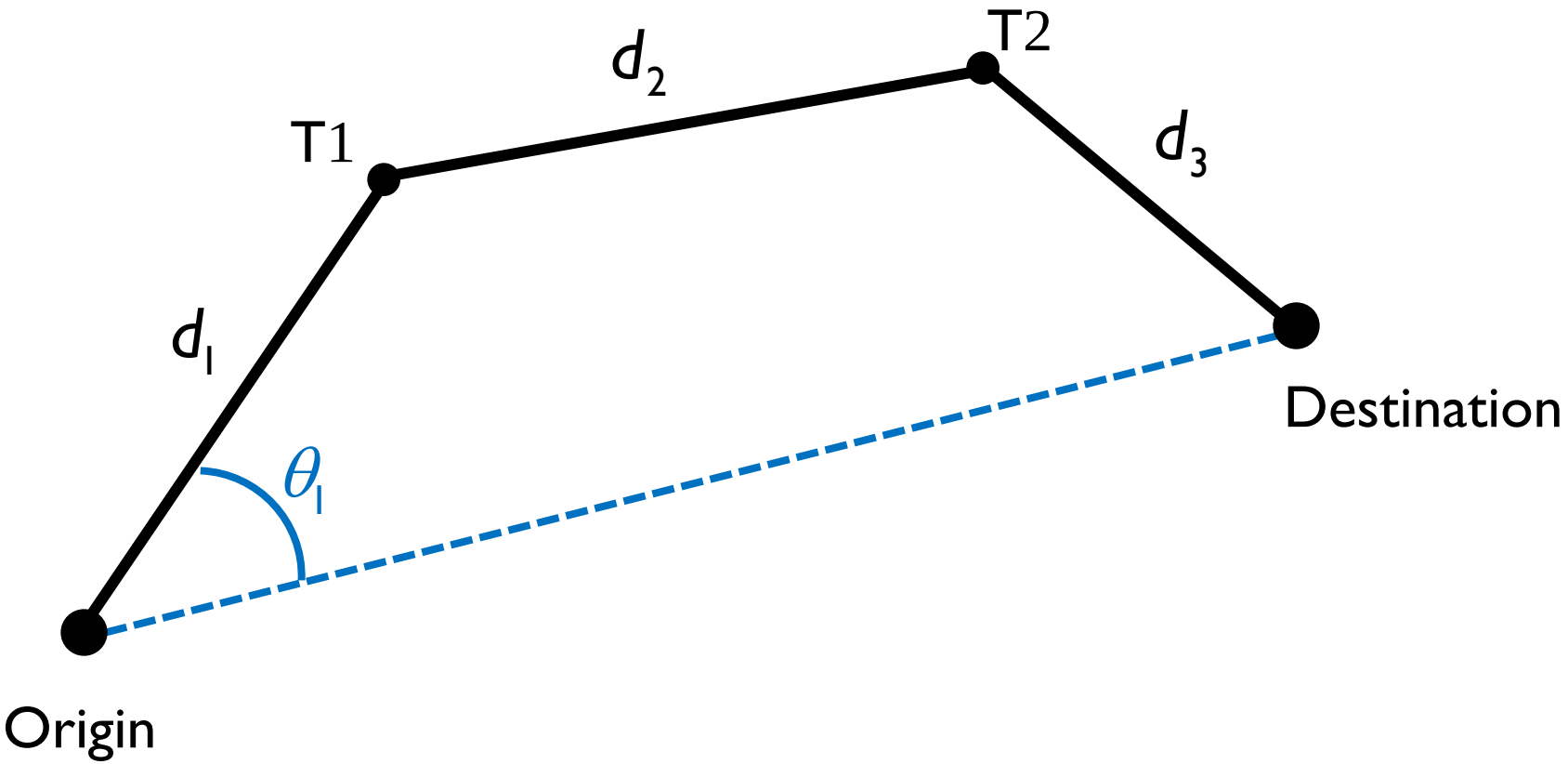
$$\sum d \cdot \sin\left(\frac{\theta}{2}\right)$$

What do people take into account?



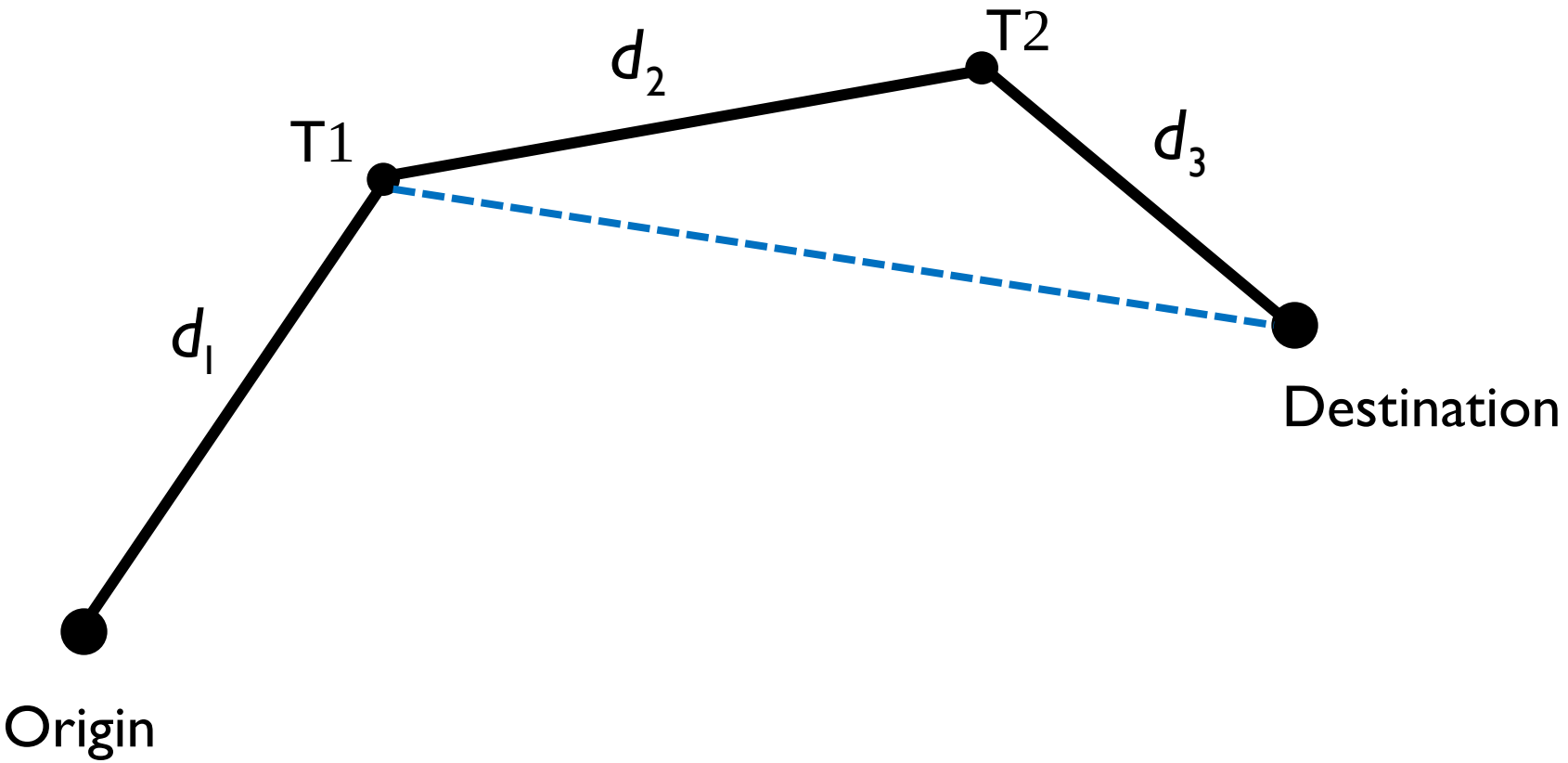
Angular Cost =

What do people take into account?



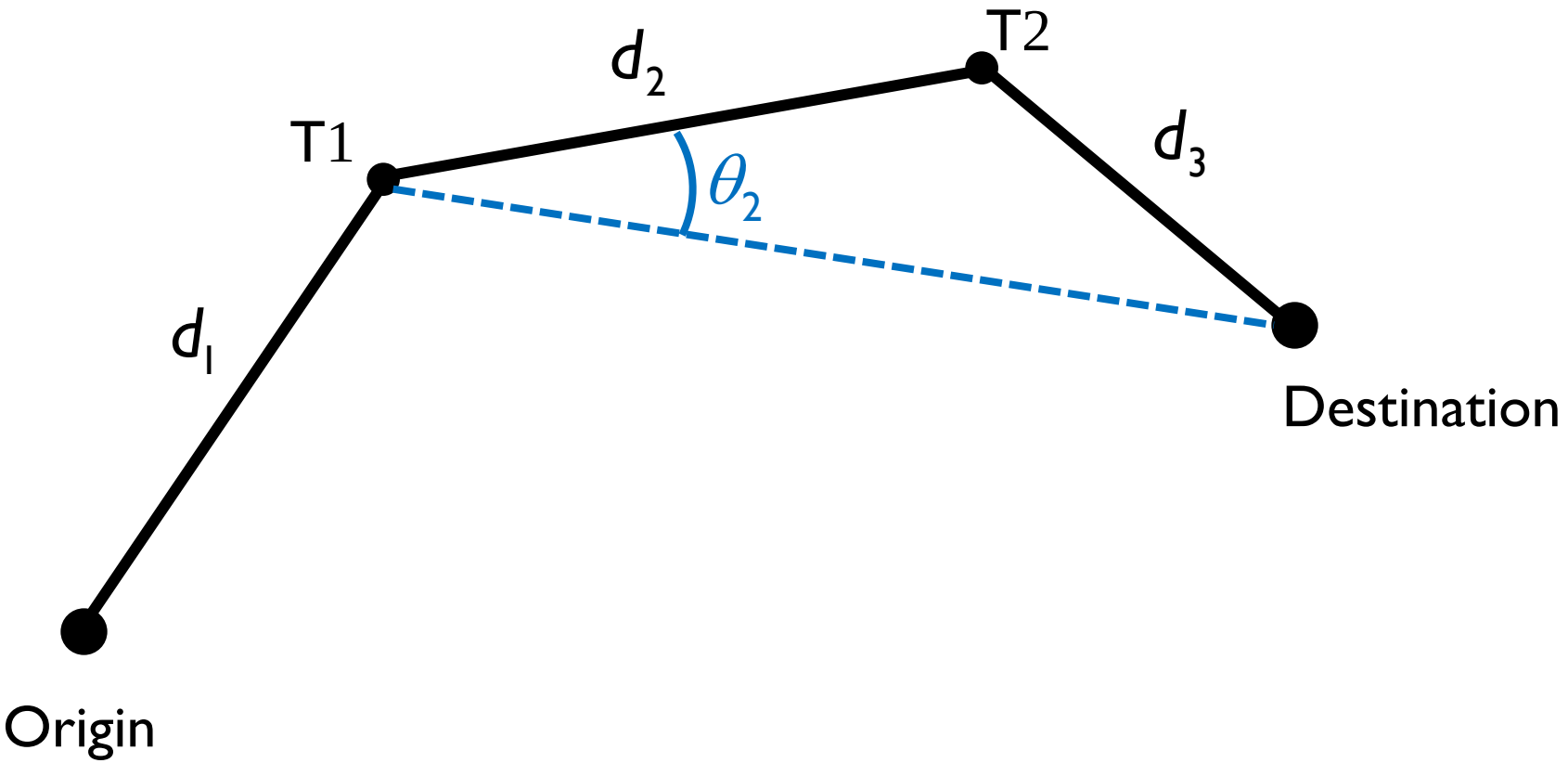
Angular Cost =

What do people take into account?



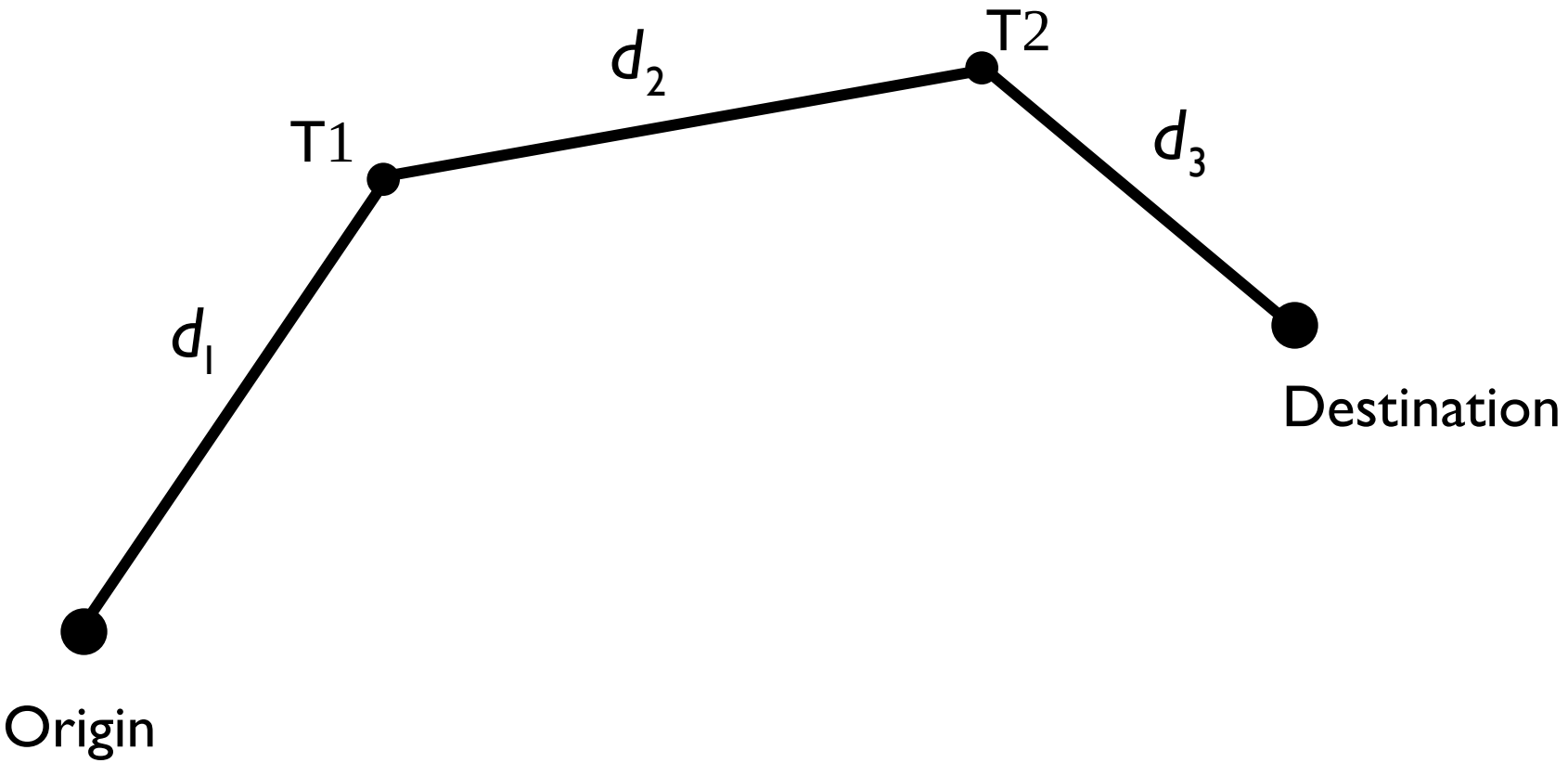
$$\text{Angular Cost} = d_1 \cdot \sin\left(\frac{\theta_1}{2}\right)$$

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

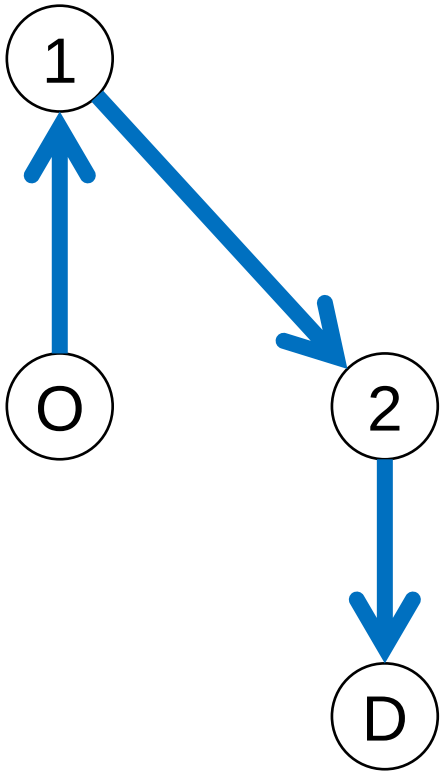
Number of stations

Angular cost

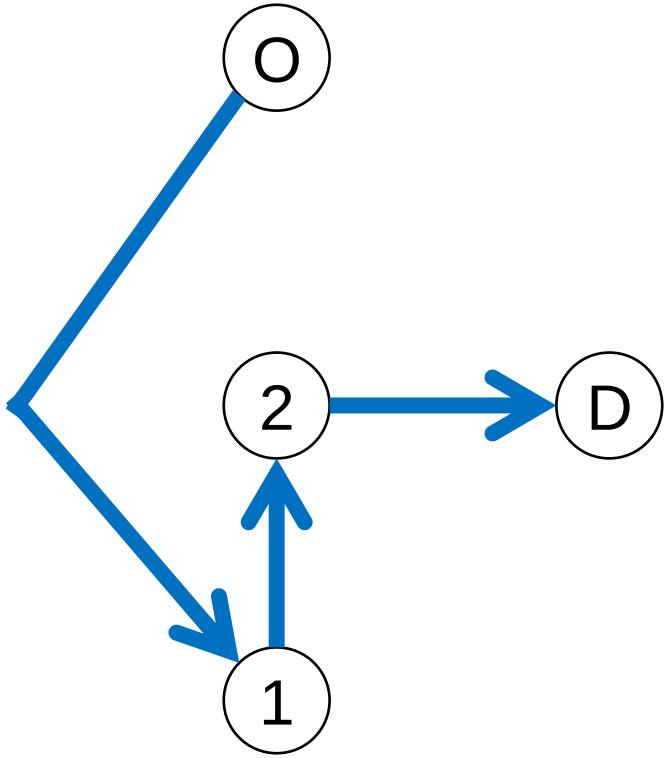
Reasonable route

What do people take into account?

turning away from the destination



turning back to the origin



What do people take into account?

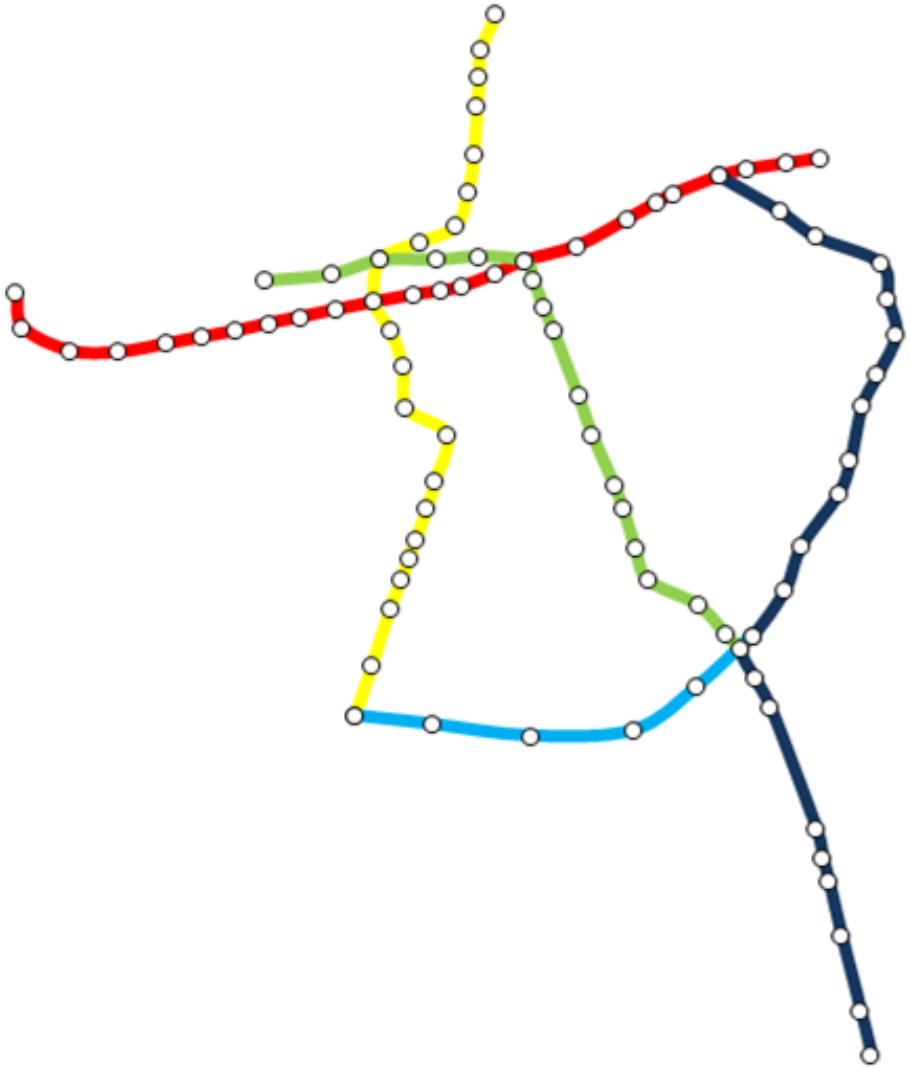
In-vehicle time	travel time components
Waiting time	
Walking time (when transferring)	
Number of transfers	transfer experience
Transfer stations layout	
Transfer stations infrastructure	
Mean occupancy	comfort and crowding
Possibility of not boarding	
Possibility of getting a seat	
Route distance	topological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

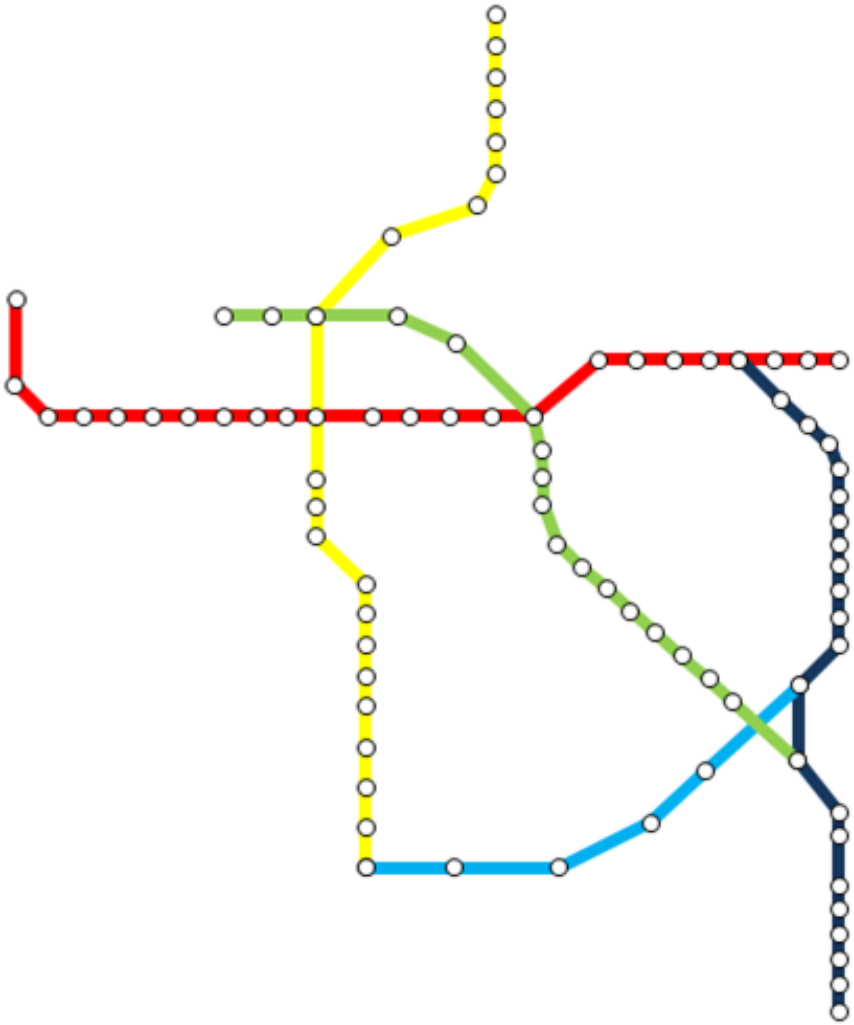
Comparing Santiago and London

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

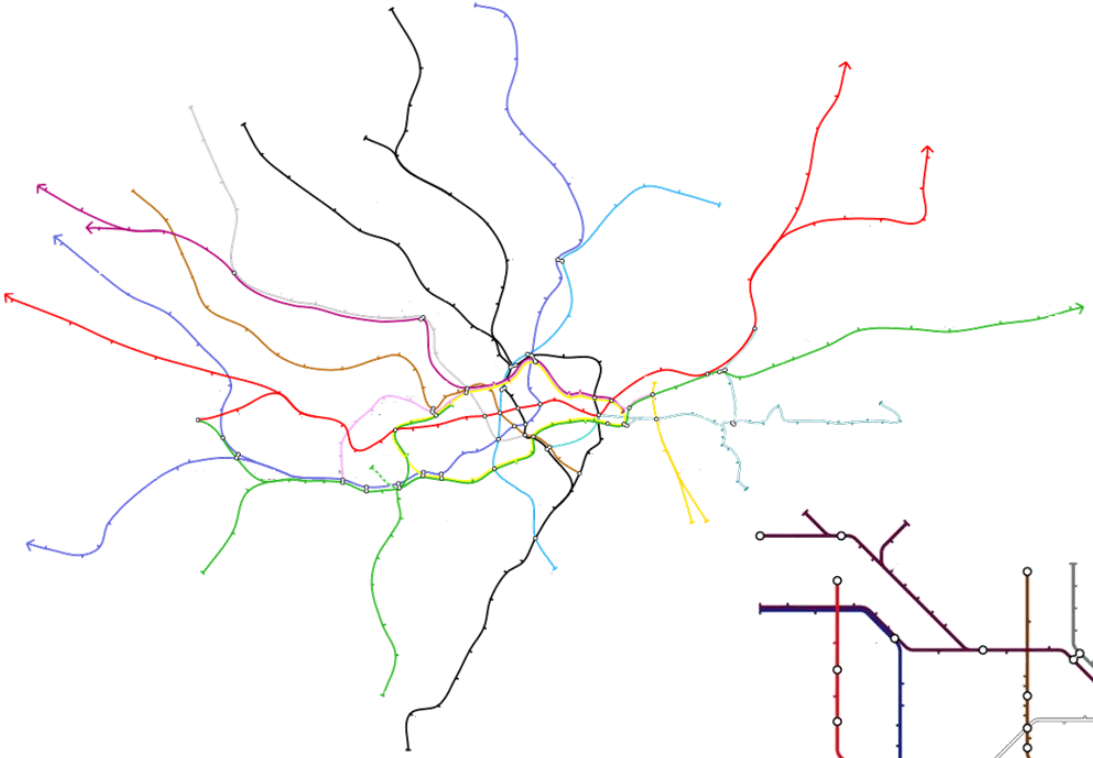
Comparing Santiago and London

Santiago Metro

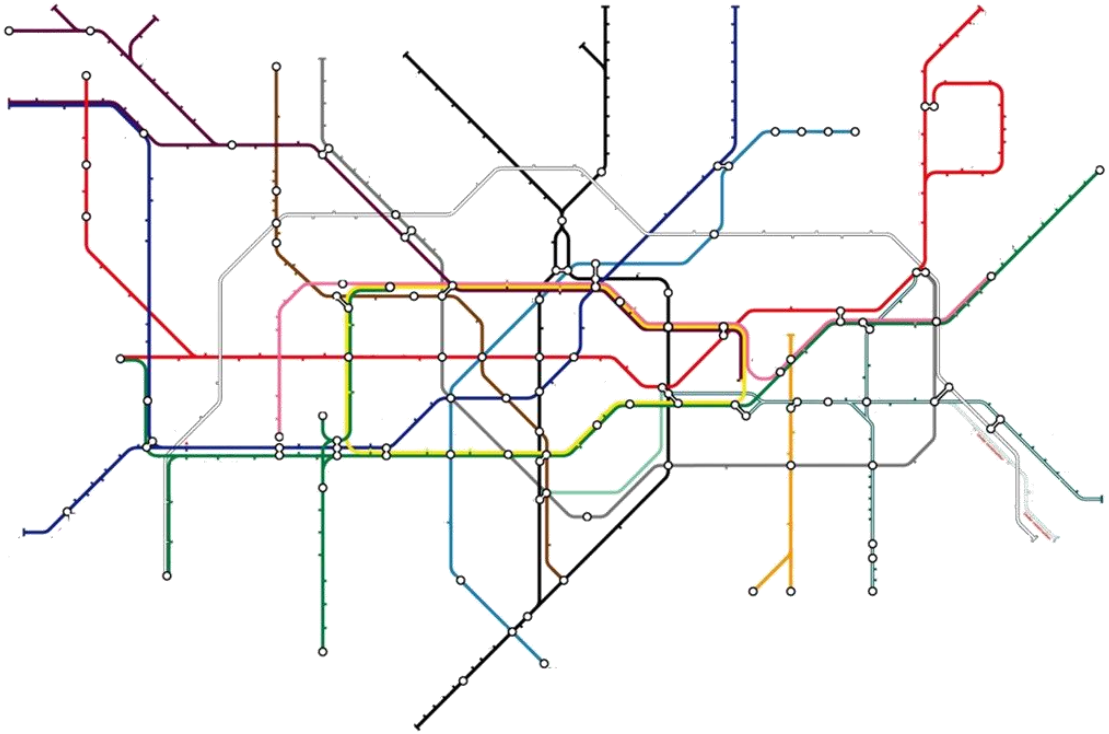




Comparing Santiago and London



London Underground



Set of alternative routes

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
→ 2 to 4 alternative routes

London

generated based on a labeling approach
→ 2 to 6 alternative routes

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

Marginal rates of substitution

Transferring valuations in London

Transfer Type		Getting a seat	Intermediate	Not boarding
Ascending	Assisted	6.81 min	7.33 min	9.62 min
	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
Descending	Assisted	6.08 min	6.60 min	8.88 min
	Semi-assisted	7.82 min	8.34 min	10.63 min
	Non-assisted	8.95 min	9.47 min	11.76 min

Marginal rates of substitution

Transferring valuations in Santiago

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

range in London 3.35 to 12.49 min

range in Santiago 5.67 to 16.76 min

Information omission bias

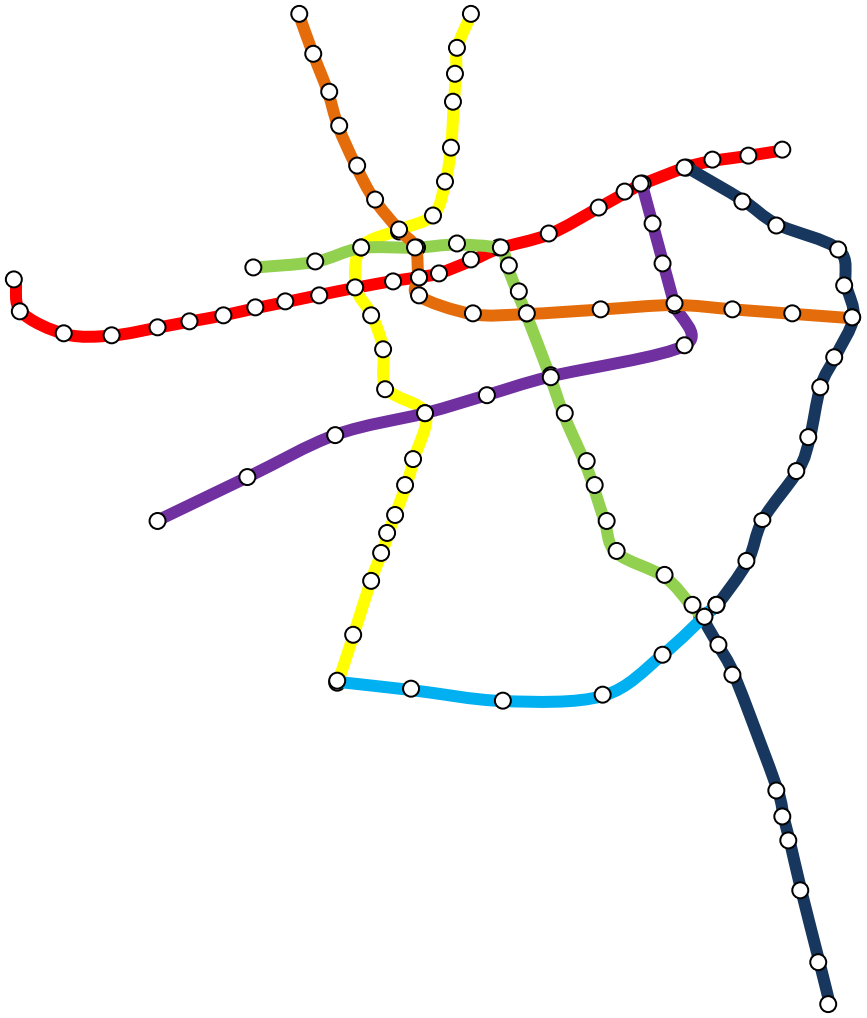
The omission of relevant information produces bias in the results

Model Specification	London		Santiago	
	θ_{wait} / θ_{travel}	θ_{walk}/ θ_{travel}	θ_{wait} / θ_{travel}	θ_{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

So… what can we do with this?

Change in the Santiago Metro schematic map

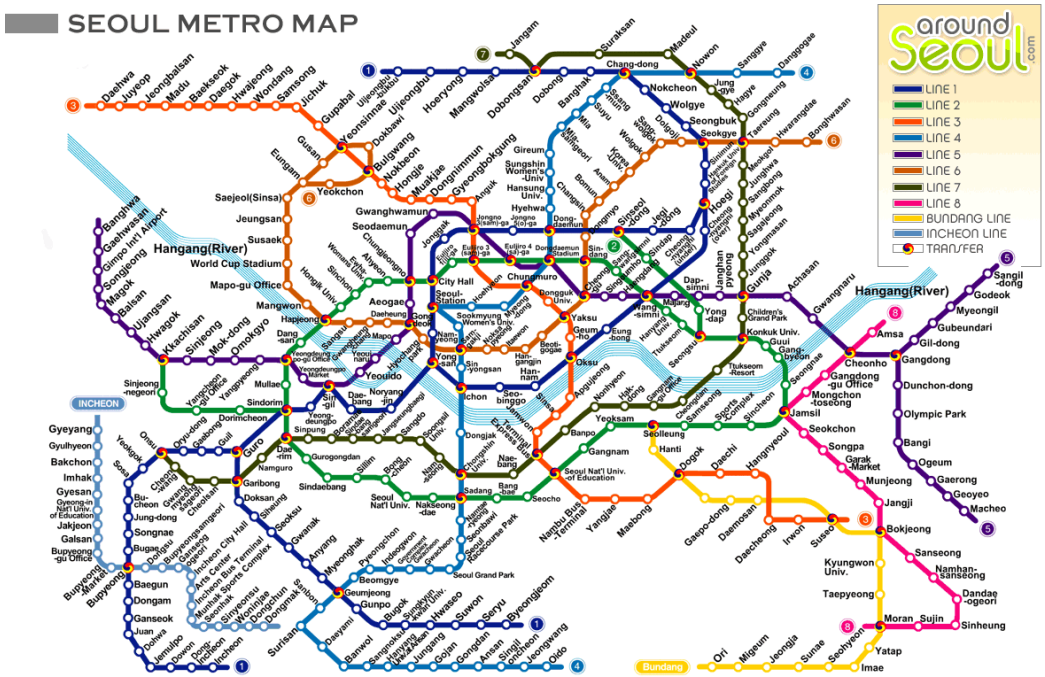
So… what can we do with this?



Demand analysis for the design of transfer stations

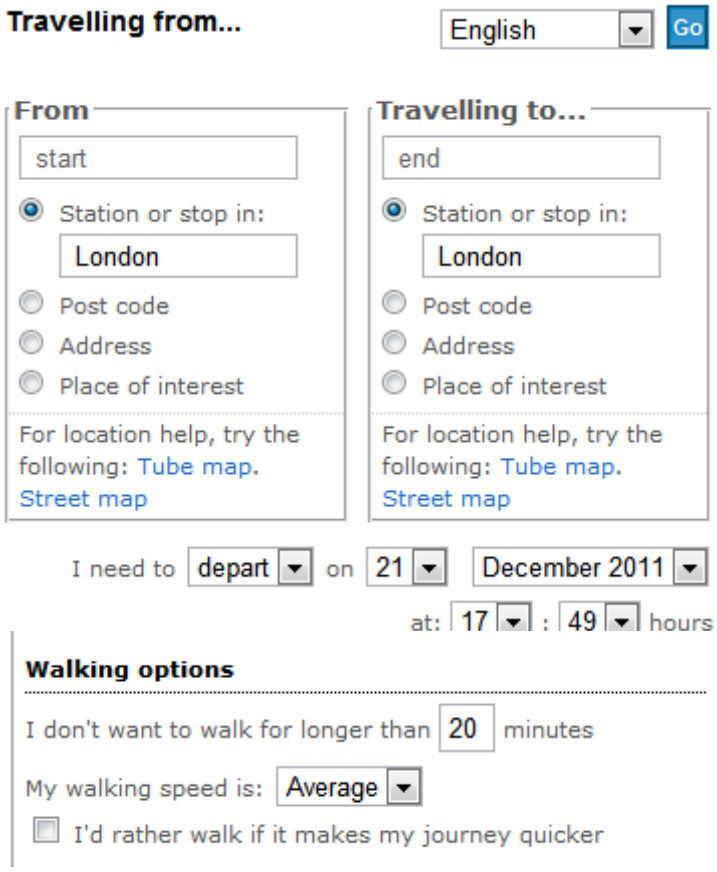
So… what can we do with this?

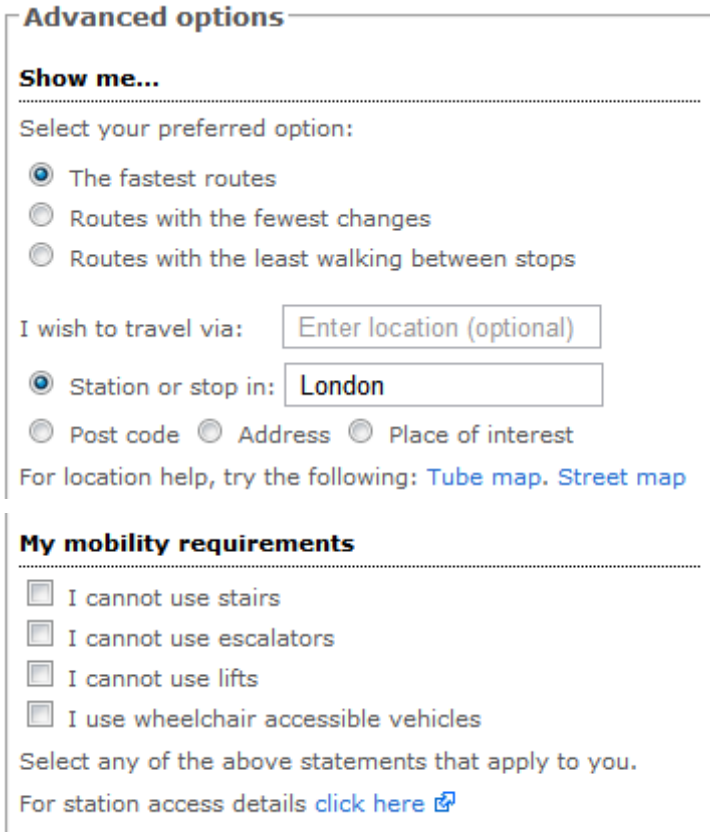
Analyze and apply to any kind of transit network



So… what can we do with this?

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





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

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