

# **Public Transportation Modelling: Planning Bus Lines Routes**

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PONTIFICAL CATHOLIC UNIVERSITY OF RIO GRANDE DO SUL, BRAZIL

AUTOMATED PLANNING

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PORTO ALEGRE, OCTOBER 2019



# WHY?

## 68% of the world population projected to live in urban areas by 2050, says UN

16 May 2018, New York

Com aumento de frota, Porto Alegre tem 1 veículo para cada 1,8 habitante

G1

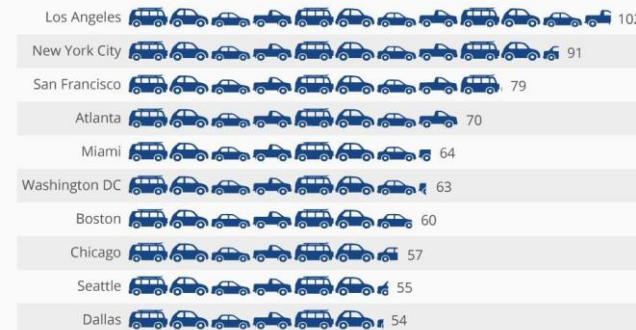
Números do Detran-RS correspondem ao índice de motorização de 2013. Problemas na malha viária e facilidade na compra contribuem para dados.

**Paulistano demora quase 3 horas por dia no trânsito, e 88% dos pedestres se sentem inseguros, diz pesquisa**

Estudo do Ibope Inteligência encomendado pela Rede Nossa São Paulo mostra também que 44% dos paulistanos têm ou já tiveram problemas de saúde relacionados à poluição.

### America's Most Congested Cities

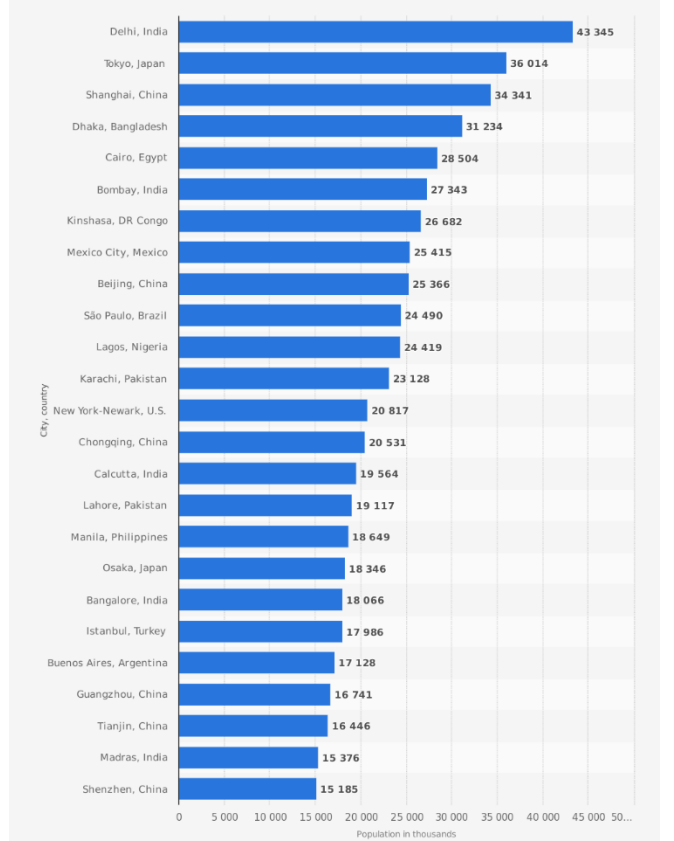
Major U.S. cities by peak hours spent in traffic congestion in 2017



Source: Inrix

Forbes statista

### Population of the largest urban agglomerations worldwide in 2035 (in 1,000s)\*



Source: UN DESA © Statista 2018

Additional Information: Worldwide, 2035

statista

# References

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<https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html>


<https://www.forbes.com/sites/niallmccarthy/2018/02/08/the-cities-where-u-s-drivers-spend-the-most-time-stuck-in-traffic-infographic/#63aa403016d8>

<https://g1.globo.com/sp/sao-paulo/noticia/2018/09/18/paulistano-demora-quase-3-horas-por-dia-no-transito-e-88-dos-pedestres-se-sentem-inseguros-diz-pesquisa.ghtml>

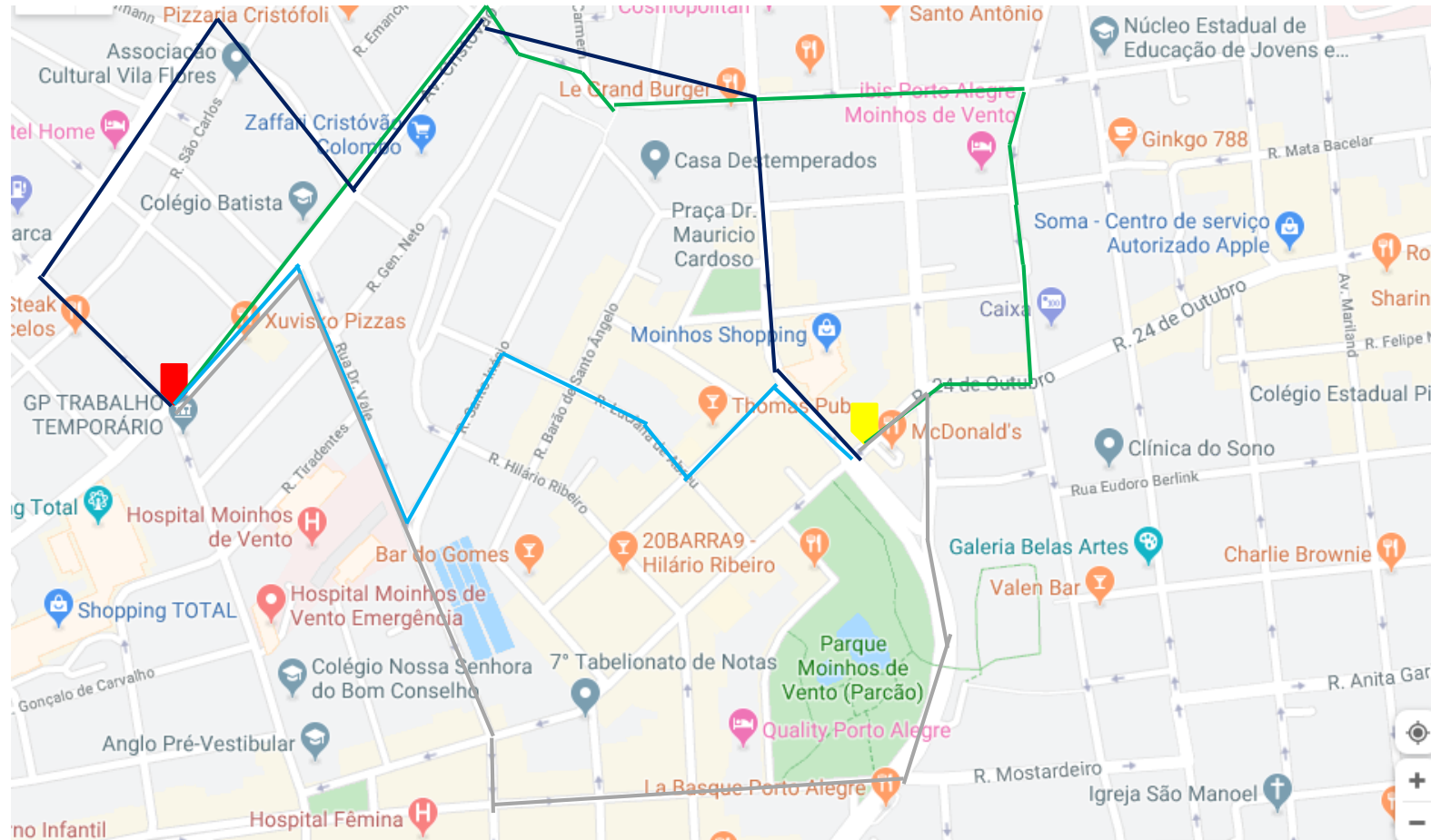
<https://www.un.org/en/sections/issues-depth/population/>

<http://stdetranrs.rs.gov.br/conteudo/23660>

# Diverse Planning

-  A
-  B
-  path1
-  path2
-  path3
-  path4

{path1,path2,path3,path4,.....}



# Diverse Planning

Which criteria to use to compare plans?

More diverse

{path1,path4}



# Diverse Planning

Which criteria to use to compare plans?

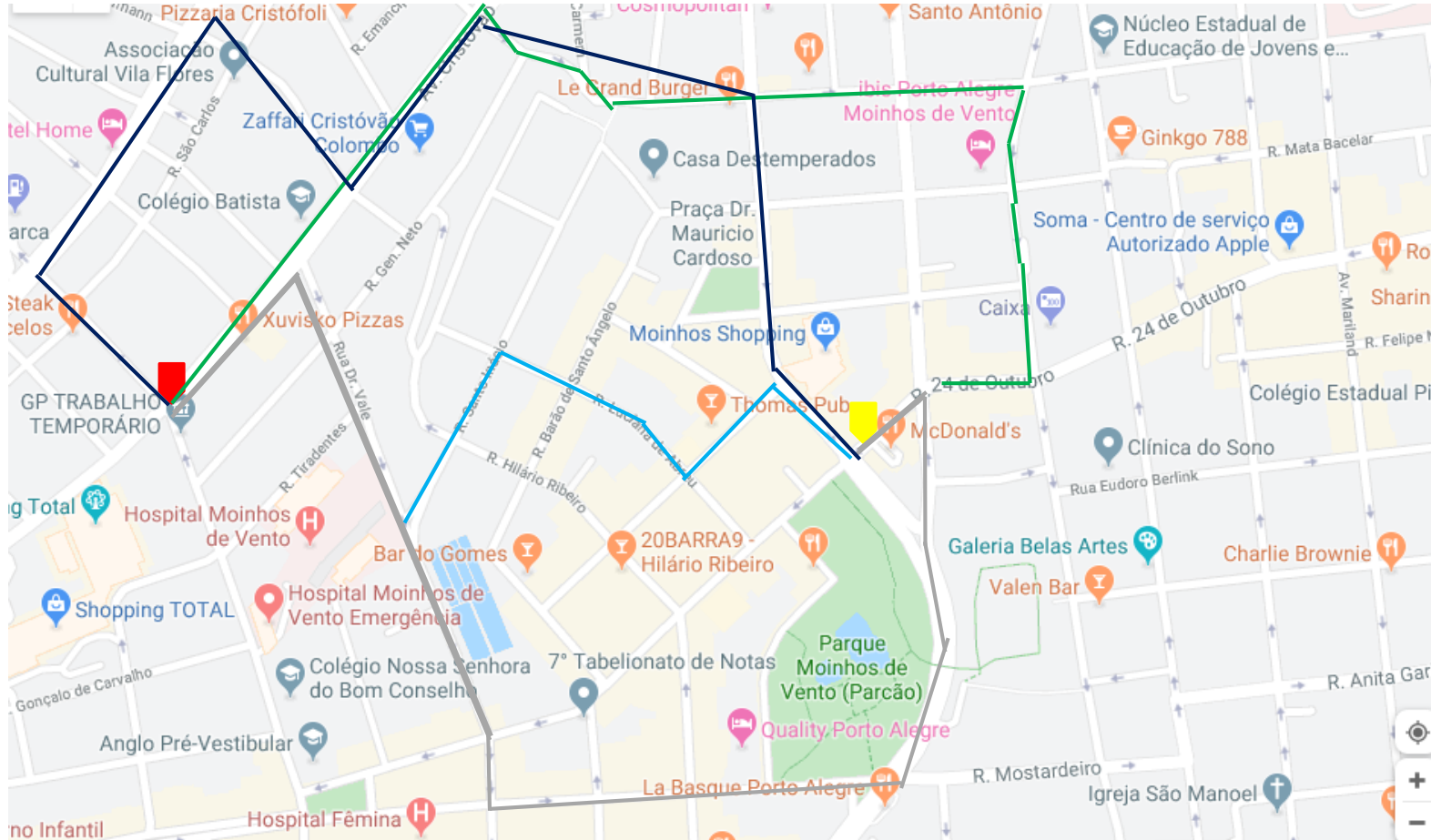
More diverse

{path1,path4}



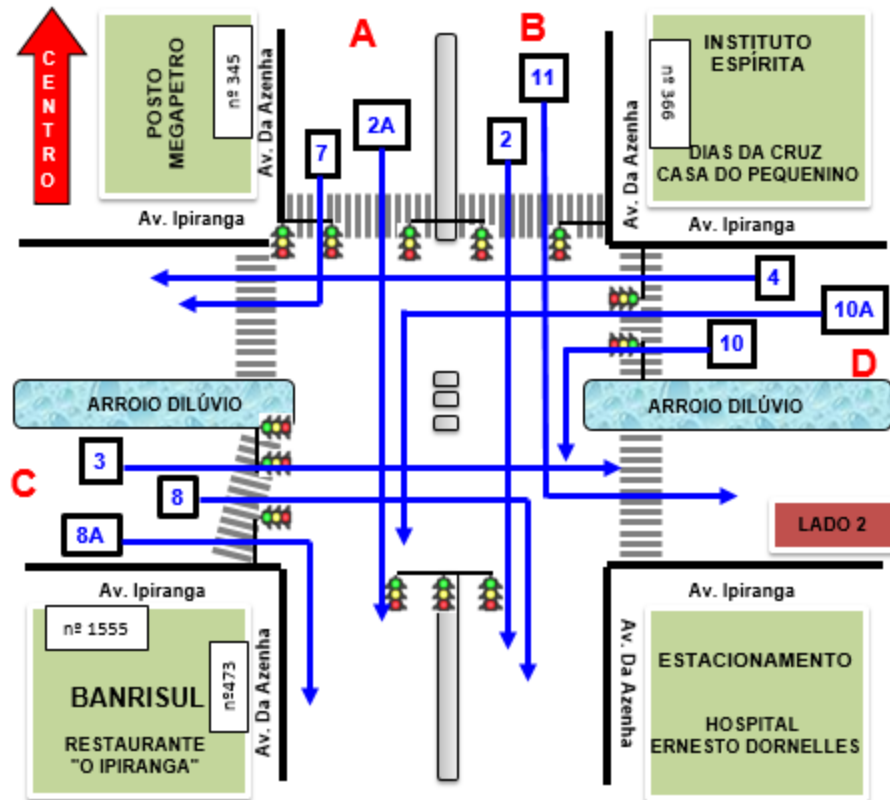
Less diverse

{path1,path2,path3}





# Traffic Flow Model

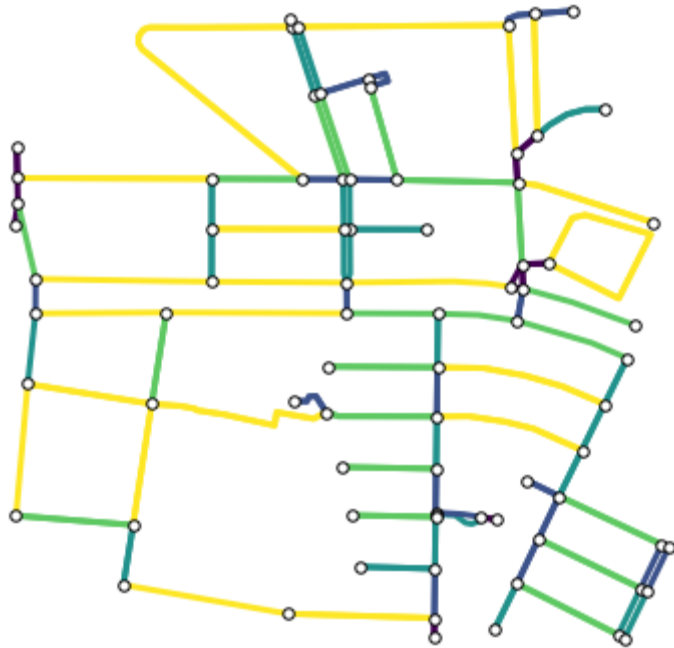


Lighthill Whitham Richards  
(LWR):

$$Q(x, t) = \rho(x, t) * V(x, t)$$

Flow      Vehicles/length      Velocity

# Graph Model

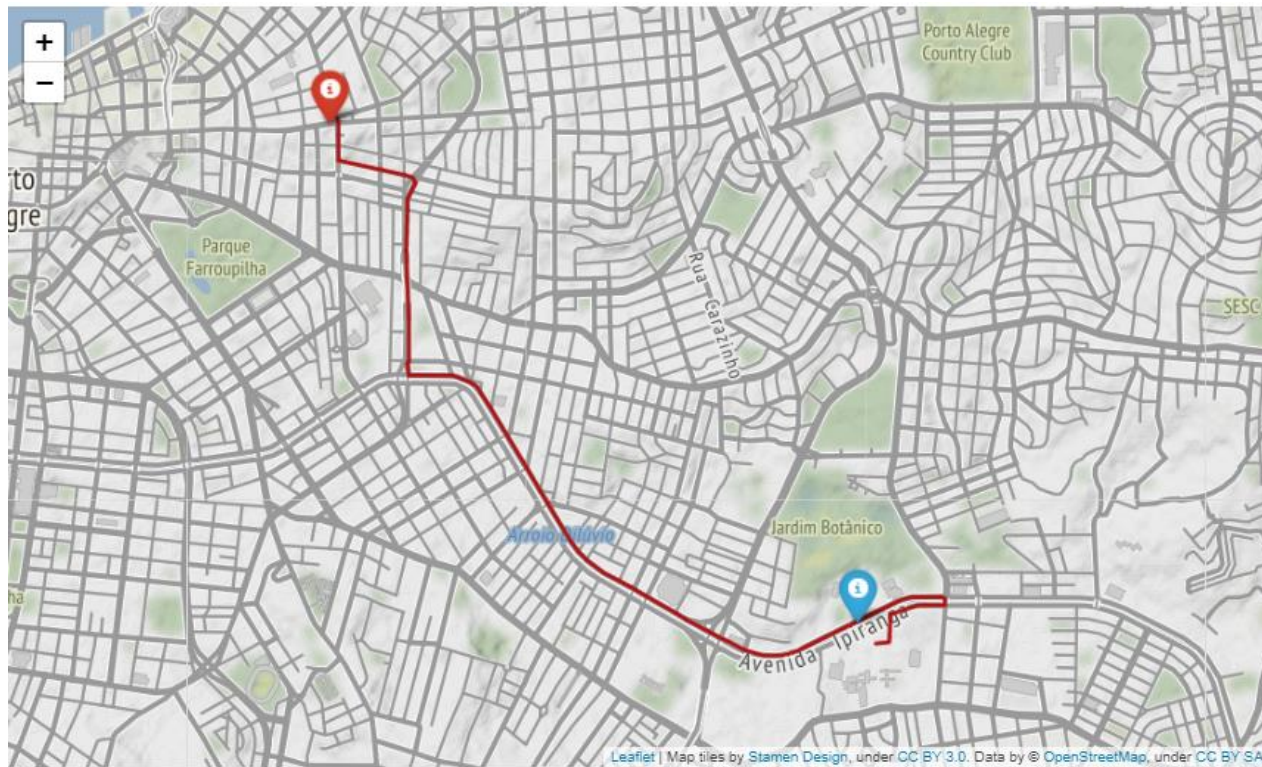


	access	bridge	geometry	highway	junction	key	lanes	length	maxspeed	name	oneway	osmid	ref	service	tunnel	u	v
0	NaN	NaN	LINESTRING (-51.1607587 -30.0621298, -51.16106...	tertiary	NaN	0	NaN	64.744	40	Rua Nelson Zang	False	27806543	NaN	NaN	NaN	312803356	312805987
1	NaN	NaN	LINESTRING (-51.1607587 -30.0621298, -51.16075...	residential	NaN	0	NaN	66.462	NaN	Rua Marcone	False	454586925	NaN	NaN	NaN	312803356	2509018501
2	NaN	NaN	LINESTRING (-51.1607587 -30.0621298, -51.16044...	tertiary	NaN	0	NaN	72.200	40	Rua Nelson Zang	False	477741068	NaN	NaN	NaN	312803356	312803358
3	NaN	NaN	LINESTRING (-51.1607587 -30.0621298, -51.15917...	residential	NaN	0	NaN	170.557	NaN	Rua Artur de Oliveira	False	562353039	NaN	NaN	NaN	312803356	2288379555



# Study Case

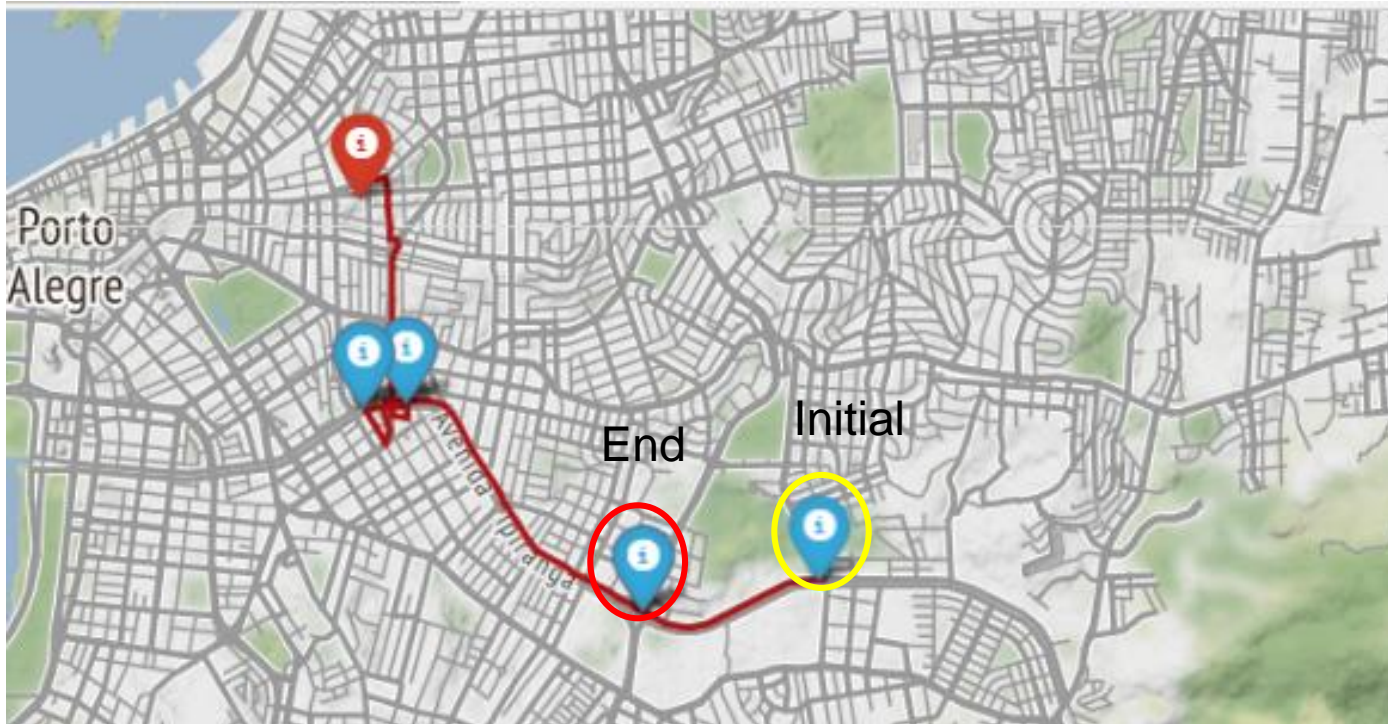
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Using A\* Algorithm.  
Finds the sortest path between two  
points in the graph.

# Study Case

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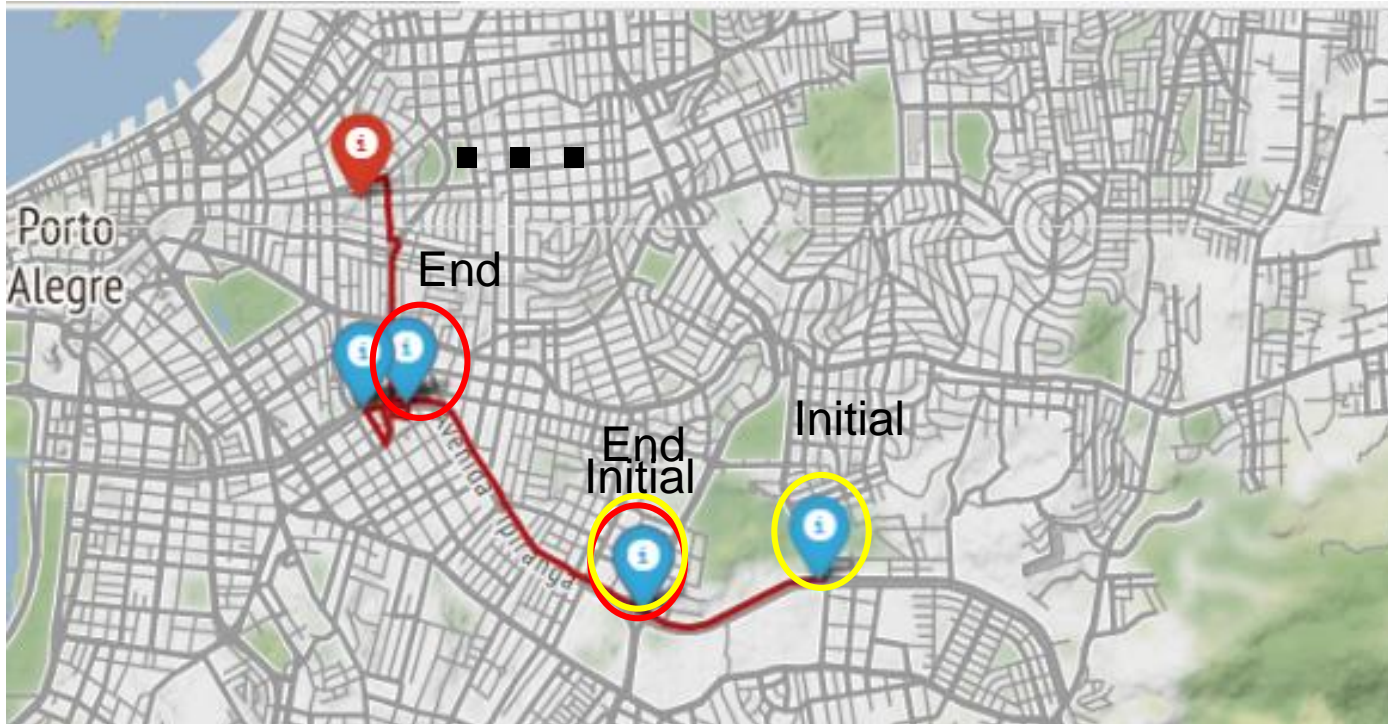


What if we demand that the bus passes through certain bus stops?

Considering every bus stop a initial node and using A\* Algorithm to find the shortest path between each one of the bus stops.

# Study Case

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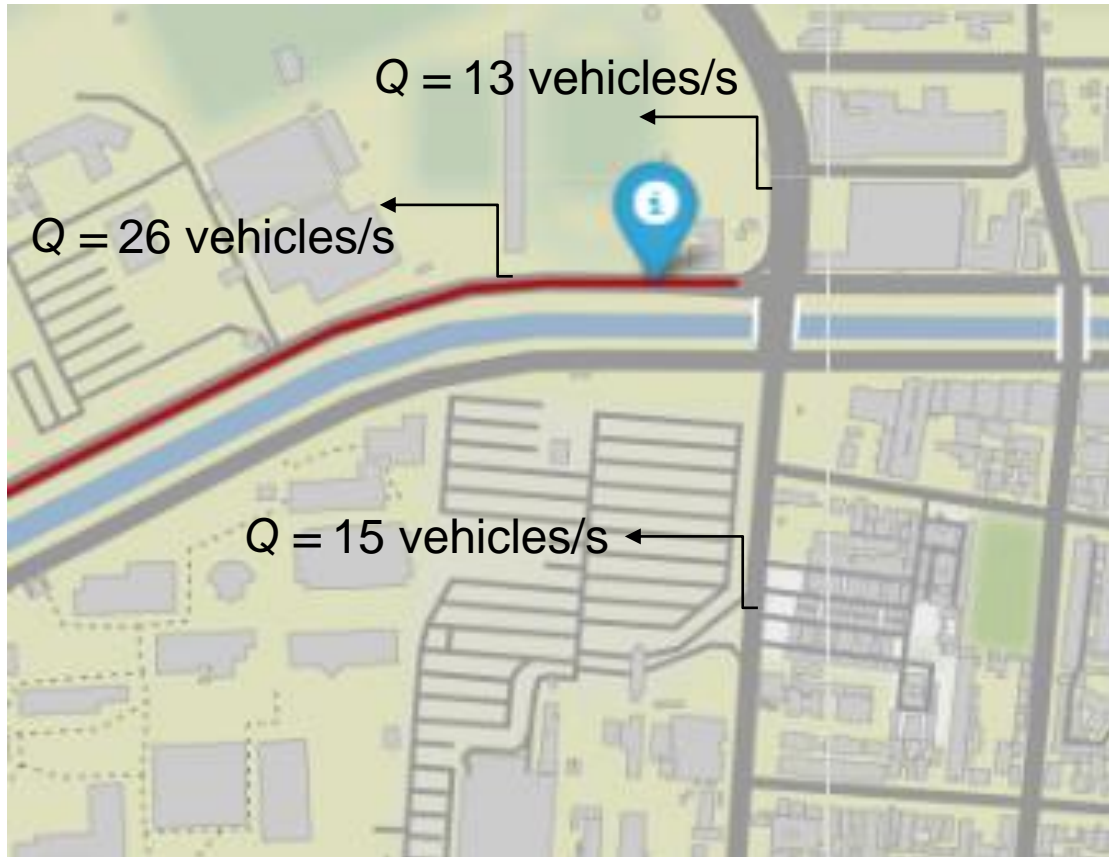


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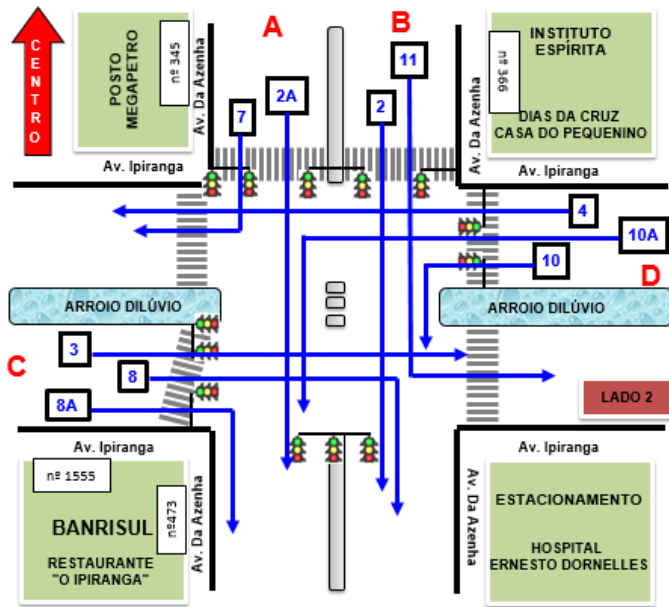


Considering the traffic flow ( $Q$ ), the algorithm is supposed to select the most congested path.

The planner generates multiple plans {path1,path2...} based on the total cost. That means that only the paths highly demanded are considered.

Providing bus lines to busy streets, it is expected that the traffic volume decreases.

# Study Case



The traffic flow model provides the weight that is considered by the planner.

The planner generates a path that the flow model can assess the impact of the proposed bus lines.



# Thank you!

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