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Traffic Assignment Problem for Pedestrian Networks

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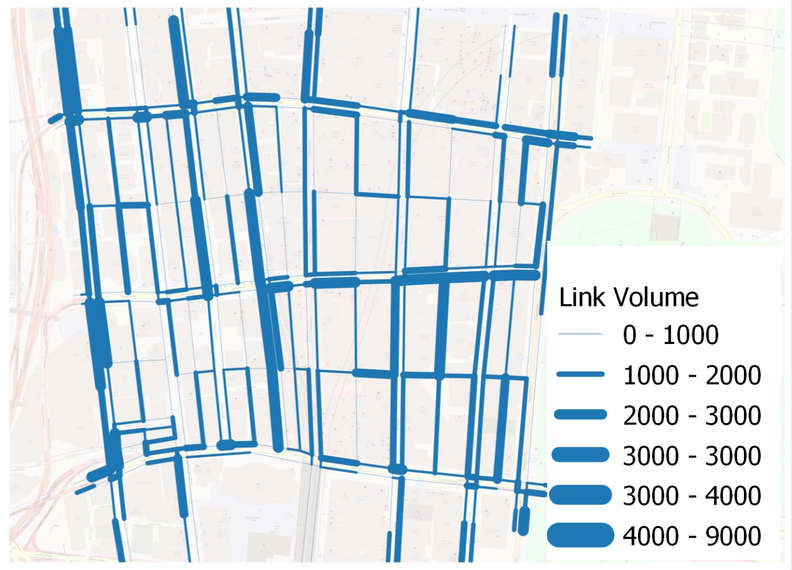
Background and Motivation

The modelling methodologies and tools to estimate pedestrian traffic in cities have been an overlooked area of research in the literature with virtually no study on traffic assignment problem for pedestrians in the urban context that takes into account the microscopic behavior of pedestrian crowds such as self-organization and formation of lanes. Unlike car traffic, pedestrian traffic does not often follow pre-specified lanes and links in a pedestrian network (e.g. sidewalks) carry a bidirectional flow. Therefore, pedestrian travel time in one direction is dependent on the flow of the same direction as well as the flow of the opposite direction.



Objectives

- Propose a traffic assignment problem (TAP) framework for pedestrian networks that includes a bidirectional link performance function
- Apply the proposed framework onto a sidewalk network in Sydney Central Business District (CBD)

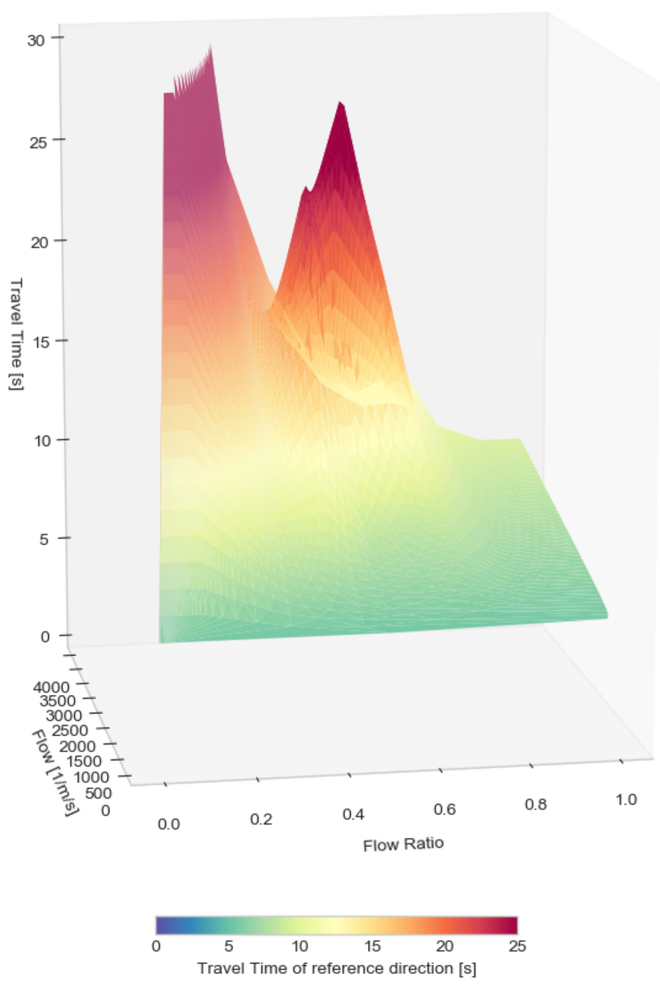
Link Performance Function

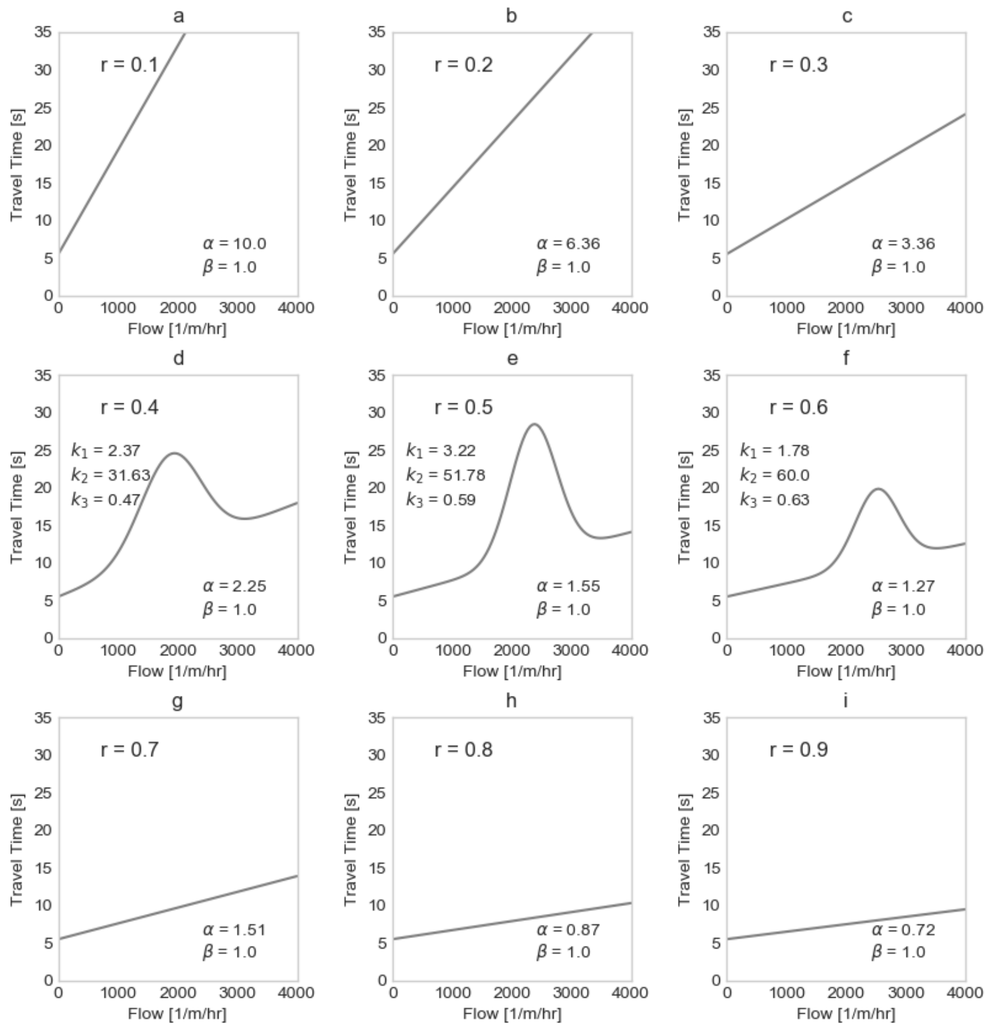
$$tt_{link} = tt_{BPR} + tt_{bidirectional} \qquad tt_{BPR} = tt_{ff} * \left(1 + \alpha * \left(\frac{q_{reference}}{capacity * r}\right)^{\beta}\right)$$

$$tt_{bidirectional} = tt_{ff} * k_1 * e^{-k_2 * (\frac{q_{reference}}{capacity} - k_3)^2}$$

Bidirectional Volume Delay Function

If the flow ratio is between 0.4 to 0.6, both modified BPR term and bidirectional term are utilized. If the flow ratio is lower than 0.4 or higher than 0.6 only BPR term is utilized. Bidirectional term becomes negligible when flow ratio different between major and minor flows are large (r is less than 0.2 or r is higher than 0.8). A figure below show bidirectional volume delay function under an assumption that the width is 4m and the length is 10m.





Conclusion

The proposed TAP can successfully capture impact of bidirectional streams of pedestrians. The application of proposed TAP framework can inform major infrastructure with major pedestrian loads in the CBD such as train station, bus transit hub, or shopping mall.
We found that when pedestrian streams are balance (r = 0.5), travel time show high variability depending on the degree of self-organized lane formation. While lane formation helps reduce congestion and improve walking efficiency, the level degree of lane formation is difficult to predict and hence a stochastic VDF should be considered to capture such variability.