A High Performing and Scalable Model for   
Computing and Visualizing Urban Transit Accessibility

**Yuxuan Cui**  
Computer Science and Statistics  
Faculty of Science  
University of British Columbia

[cuiyuuxuan@gmail.com](mailto:cuiyuuxuan@gmail.com)

**Luka Vukovic**  
Computer Science and Statistics  
Faculty of Science  
University of British Columbia

[luka.vuko@outlook.com](mailto:luka.vuko@outlook.com)

**Rain Shen**  
Computer Science and Statistics  
Faculty of Science  
University of British Columbia

[rain.ya1213@gmail.com](mailto:rain.ya1213@gmail.com)

**Graham Paul Kerford**  
Computer Science and Statistics  
Faculty of Science  
University of British Columbia

[graham.kerford@gmail.com](mailto:graham.kerford@gmail.com)

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**2 BACKGROUND**

**Measurement of Accessibility**

The concept of accessibility was first brought up by Hansen (1959) as “the potential of opportunities for interaction”. As such, accessibility refers to the physical access to goods, services, activities, and destinations (Saif et al., 2019). It provides a measurement of number of the destinations that can be reached from a specific point (Deboosere and El-Geneidy, 2018). In the context of urban systems, accessibility is an essential component of transportation network. In general, there are three common metrics of accessibility. First one is measuring the number of destinations which can be reached from a certain point within a time threshold using one specific transportation mode (Morris et al., 1979). Second one is measuring the destination by distance, in which the further the destination is, the less accessible it is (Koenig, 1980). The last one is assigning a certain utility to each destination and computing the logsum of all destinations (Handy and Niemeier, 1997). Among these three metrics, the first one is the most interpretable measure and is the easiest one to compute as well (Deboosere and El-Geneidy, 2018). According to the metrics, in the most recent studies, accessibility is usually measured by the distance between the origin and the destination, or by the time the trip takes from the origin to the destination (Cheng and Chen 2015, Saghapour et al., 2016).

**Public Transit**

In the past few decades, the way of transportation has gradually moved from private vehicles to more sustainable modes, for example, public transit, walking, and cycling (Albacete et al., 2017). In Canada, the percentage of population who use public transit as the primary transportation mode has significantly increased since 1996, especially in the large metropolitan areas (Statistics Canada, 2017). In the largest metropolitan cities, like Toronto, Montreal, and Vancouver, approximately 22.3% of the population use public transit for their daily commuting (Statistics Canada, 2017). Therefore, a well-developed public transit system will increase the accessibilities to various destinations in the cities. In this regard, high levels of accessibility for public transit will increase the connectivity of the city’s system mobility, which assists in improving social inclusion (Saif et al., 2019). An assessment of the public transit can estimate the transportation efficiency and equity, which directly effect the social opportunities in the urban economic system (Wang and Chen, 2015).

**Cultural and Art Amenities**

Besides the public transportation network, the types of destinations in the cities also have impacts on the overall accessibility. Cultural and art amenities are usually considered to increase the quality of life in the community (Sheppard, 2014), in which case, more cultural facilities make the community a more attractive place to live. Hence, measuring the accessibility to various types of cultural and art amenities will be an effective way to assess the social opportunities and connections in the local communities. There are numerous researches focusing on measuring accessibility of other types of places. In a study conducted in 2007, Burns and Inglis calculated travel time to supermarkets and fast-food outlets by driving, walking, and public transit. The travel time of public transit was computed according to the frequency of buses and the types of roads. However, there has been limited studies regarding the cultural and art amenities. On the other hand, the mass of the amenity is another essential component of considering the accessibility. In a study from Statistics Canada, mass of an amenity can be thought as the amount of service the amenity provides (Statistics Canada, 2021). In case of cultural and art amenities, for example, libraries with larger space and higher volume provide services to more people, which should be weighted more than smaller libraries, as well as popular public galleries would be expected to hold more visitors than private ones. In this paper, we will use travel time as the measure of accessibility based on public transit schedules by obtaining the GTFS data. With regard to weights of amenities, we present a new index to take account the amount of service provided by different amenities and describe its impact on the accessibility via public transit.

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