

Hamilton, Ontario
September 10, 2024

REF: A proposal for the Doctoral Research Workshop (Transportation Modeling and Travel Behavior Analysis) at 2025 TRB Meeting

A FAMILY OF ACCESSIBILITY MEASURES

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Inquiry into people's interaction in space has been a subject of investigation for over a century. From as far back as the sentiments in (Carey, 1858) on "*man [being] the molecule of society [and their interaction being subject to] the direct ratio of the mass and the inverse one of distance*" [pg. 41,43], the investigation has been coloured by these relationships and some **proportionality constants** to yield a type of attraction force, the features of Newton's Law of Universal Gravitation (1687).

Following this tradition with a focus on *potential* attraction, the concept of accessibility was defined as the "*potential of opportunities for interaction*" in (Hansen, 1959). The work of (Hansen, 1959) proved to be highly-influential, with literature demonstrating a link between Hansen-type measures (i.e., a mass term x distance function, also known as gravity-based accessibility measures) and positive population-based-, sustainability- and economic- outcomes. Moreover, accessibility planning counters mobility-based planning by centering the potential for mobility, arguably the ulterior 'good' provided by transportation systems, not mobility itself. For this theoretical reason, Hansen-type measures are becoming an increasingly popular transportation planning instrument signaling that accessibility-based planning over mobility-based perspectives may be on the horizon. However, an important critique still stands in the way: the difficulty in interpreting the accessibility values themselves.

Notably, the Hansen-type model of today is missing a proportionality constant. My doctoral research hypothesizes that this omission is the source of interpretation difficulty and can be remedied by drawing from related 'gravity-based' transportation literature. Related literature includes spatial interaction models (the gravity model) (Wilson, 1971) as it also traces to the same early 20th century investigations as the accessibility concept (Carrothers, 1956; Grigg, 1977). Unlike the gravity-based accessibility measure, the gravity model still carries all the features of the Newtonian analogy (i.e., proportionality constants as balancing factors, mass term 1, mass term 2, and distance function (Wilson, 1971)): a proportionality constant is crucial for

retaining the output as a tangible unit. For the gravity model, the output units are often the number of trips generated between an origin and destination representing *interaction* between origins and destinations. For accessibility, my doctoral research reckons the units are *potential interaction*, and the output is the number of opportunities that can be potentially interacted with from an origin to all destinations.

If selected, the applicant will introduce a family of accessibility measures in a similar vein as the "*family of spatial interaction models*" (Wilson, 1971) by specifying types of balancing factors, demonstrating simple synthetic examples and visualizations using data using origin-destination employment flows for Toronto, Canada. Though the research is ongoing, the applicant intends to defend this academic year. Additionally, the empirical data for use in this work is already published as an open R data package paper (Soukhov & Páez, 2023), and the singly-constrained and composite singly-constrained examples are fully developed with associated peer-reviewed publications (Paez et al., 2019; Soukhov et al., 2023, 2024).

Word count: (481)

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