# Using gravity-based measures to plan equitable transportation

‘Accessibility” can be defined as a measure of transportation. In this context, it defines ‘potential interaction’ with opportunities. First proposed by Hansen (1959), it can be considered as an ‘unconstrained’ measure that counts the number of opportunities that can be reached (metered by a distance-decay function). Cumulative opportunity accessible measures simplifies the distance-decay function by setting a travel threshold (i.e., only count all the opportunities that can be reached within 1 km, for example). Cumulative opportunity measures are more simply to implement, and correlates highly (when the correct travel threshold is selected) with empirically observed travel distance impedance function.

\*\*graph of cumulative opportunities vs. travel distance impedance function\*\*

But what about opportunities when counting ALL the potential interaction doesn’t make sense? For instance, I live in Toronto. In my neighbourhood I have transit-access to 10,000 potential jobs. But I also live near 20,000 people who can access these same jobs. What does that mean for me? Jobs or other exclusive opportunity-types are an excellent case to use competitive accessibility measure. These measures include floating catchment approaches (FCA) that meter demand for opportunities (all my neighbours in my neighbourhood) with supply of opportunities (all the jobs in my neighbourhood).

\*\*map of neighbourhood I live in Toronto, accessibility vs. spatial availability \*\*

This is where spatial availability comes in. If considering gravity-based measures as ‘unconstrained’ accessibility, spatial availability is ‘constrained’ accessibility. It measures the potential of interaction, but meters the count of interaction by the neighbourhood demand for reachable opportunities. Similar to a destination-constrained spatial interaction model, the spatial availability ‘value’ is the number of opportunities available to each origin. There is an availability value for each origin, and it is proportion of the total opportunities in the region allocated based on the demand from each origin (population-based demand relative to the amount of opportunity-seeking population in all origins) and the travel cost from each origin (relative to travel distance to the opportunities from all origins). Balancing factors

What makes spatial availability also interesting…? Because it proportionally constrains the opportunities in the region and assigned a proportional value to each origin, it can be divided by population at that origin. This can be interpreted as an opportunity per capita value. This value can be used as a benchmark to compare again opportunity per capita across areas of the region and between regions. For instance, Hamilton has more opportunities per capita available that Toronto

\*\*map of neighbourhood I live in Toronto, accessibility vs. spatial availability \*\*

Openness is legitimacy. If interested, see the open access PDF of the full article (which includes the mathematical formulation for the spatial availability function) here (). We also calculate spatial availability for the city of Toronto using 2016 Transportation Tomorrow Survey employment data. We created a R data package that contains the empirical data used in the R data package {TTS2016R} which is discussed in this open access publication here ().

Still interested in gravity-based measures? Or the differences between 'unconstrained' measures vs. competitive measures? Check out our published paper (@paezha, @higgicd, @Moataz\_MMohamed) on 💖Spatial Availability💖(open access) https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0278468 and this thread:

The manuscript and related code, as well as the empirical data used are openly available here:

🕸️: https://github.com/soukhova/Spatial-Availability-Measure

📦: https://github.com/soukhova/TTS2016R

Special mention! A paper describing the data set used has also been published (open access).

<https://www.doi.org/10.1177/23998083221146781>

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A couple weeks ago our data paper (@paezha) was published! This paper discusses the {2016TTSR} #R data package. {2016TTSR} is a fusion of objects. Check out the open access paper here:

🕸️https://www.doi.org/10.1177/23998083221146781

The {TTS2016R} package contains analysis ready commuting data: commute flows sourced from the 2016 Transportation Tomorrow Survey (TTS), estimated car travel times (calculated using {r5r}) and boundary files from the TTS and the Canadian Census.

📦: https://github.com/soukhova/TTS2016R

What's the value? Fusing data can be cumbersome! So {TTS2016R} offers a slice of pre-processed TTS data that can be immediately used by #R users to analysis patterns of commuting in the region.

Thank you to the anonymous reviewers, production team, and editorial team @darriabs, @S\_Alvanides, @jmichaelbatty, @AndyCrooks, @LindaMSee, @levijohnwolf for helping to create a home for Open Data Products in the “Urban Data/Code” section of @envplanb.

And,💖special mention💖! {TTS2016R} is also used for the empirical example in the newly published “Introducing Spatial Availability: a singly constrained accessibility measure” paper. Access this paper freely, here: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0278468>

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**#Accessibility** has many definitions. From a transport planning perspective, it often refers to the ease of reaching destinations using transport systems. So, people who are in places that are highly ‘accessible’ can reach many destinations easily (e.g., through lower financial cost, travel distance, travel time, etc.). Conversely, people who are in ‘inaccessible’ places can reach fewer places in the same amount of travel cost unit.

Related to this definition of accessibility, a paper recently written by myself and co-authors [**Antonio Paez**](https://www.linkedin.com/feed/), [**Chris Higgins**](https://www.linkedin.com/feed/) and [**Moataz Mohamed**](https://www.linkedin.com/feed/) is now live! This paper introduces a competitive accessibility measure, ⭐spatial availability⭐ and briefly discusses how it could be used for **#equitable** accessibility planning (that is on the agenda for further investigation 😎). The paper is open access and available here:

🕸️: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0278468

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