(Hansen 1959): “potential of opportunities for interaction”

$$S_i = \sum_j O_j \cdot f(c_{ij})$$

A Family of Accessibility Measures:
Bringing the units back

Anastasia Soukhov B.Eng. MASc.
(Supervisor: Antonio Páez)
PhD Candidate in Transport Geography
McMaster University, Canada

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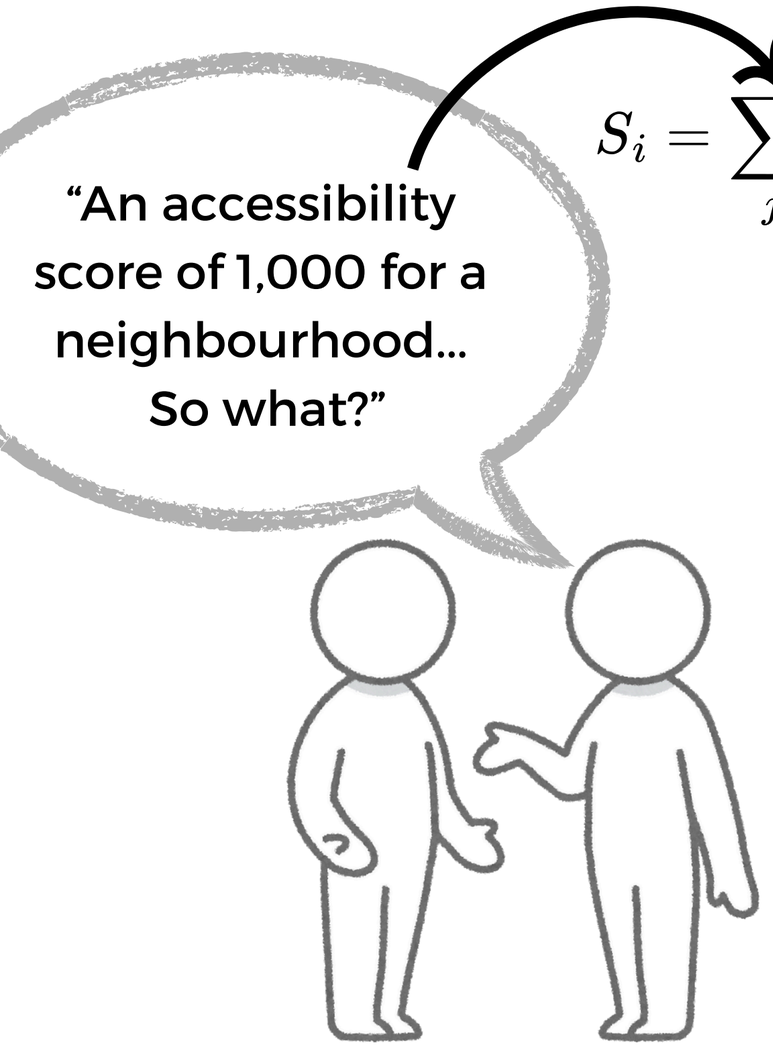
Deciphering accessibility scores:

$$S_i = \sum_j O_j \cdot f(c_{ij})$$



The problem:

- What does the accessibility score mean? The units are uninterpretable!

A solution:

- (Re)introducing balancing factors to bring units back to accessibility
- e.g., "100 accessible jobs out of 500"

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Evolution of gravity-based accessibility: what about G?

1687 — Newton's Law of Universal Gravitation

$$F_{ij} \propto \frac{M_i M_j}{D_{ij}^2}$$

1798 — (Carey, 1859), from physics to social science

$$F_{ij} = G\frac{M_i M_j}{D_{ij}^2}$$

1940-1959 — (Stewart 1947), sets G = 1 and defined "Population Potential" (V):

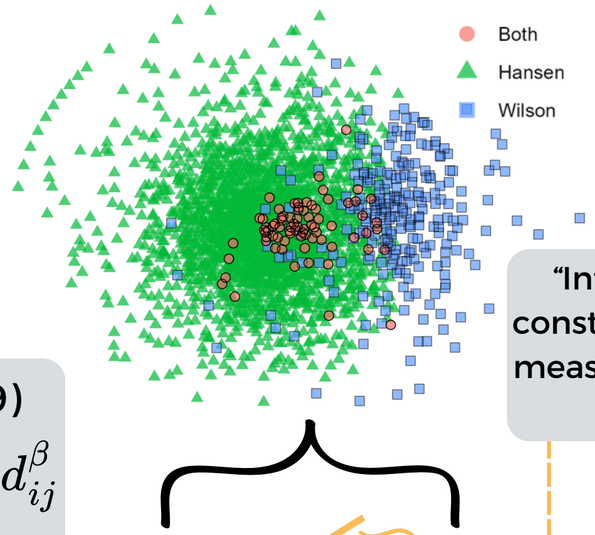
$$V_i = G\sum_j \frac{M_j}{d_{ij}}$$

(Hansen 1959)

$$S_i = \sum_j O_j \cdot d_{ij}^{\beta}$$

1970 — "The Family of Gravity Models" (Wilson 1971)

$$T_{ij} = kW_i^{(1)}W_j^{(2)}f(c_{ij})$$



TODAY — "Introducing singly-constrained accessibility measure" (Soukhov et al. 2023)

"A family of accessibility measures" (Soukhov et al., forthcoming)

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A “family” of accessibility measures

Gravity model’s formulation:

$$T_{ij} = kW_i^{(1)}W_j^{(2)}f(c_{ij})$$

$$W_i^{(1)} \rightarrow P_i$$

$$W_j^{(2)} \rightarrow O_j$$

$$V_{ij} = kO_j f(c_{ij})$$

$$V_i = k\sum_j O_j f(c_{ij})$$

k is a set of balancing factors defined by zonal/region constraints.

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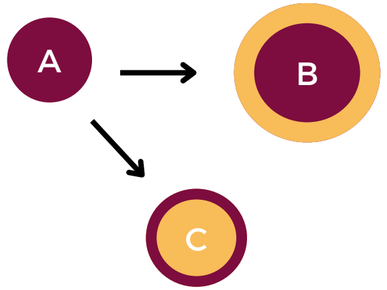
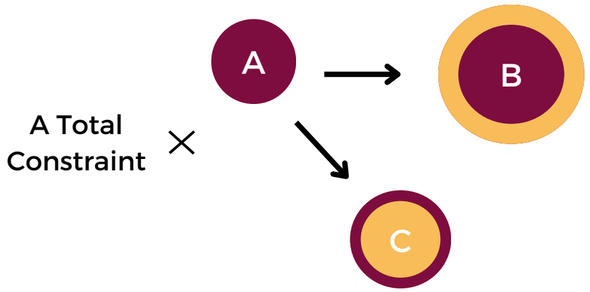
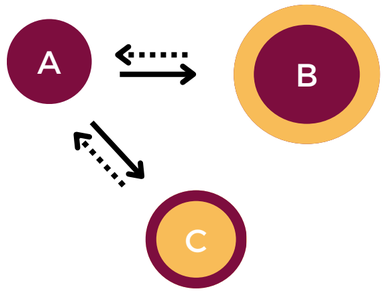
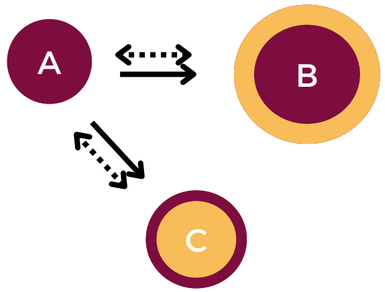
Proportionality constraints in accessibility matter:

Unconstrained (all people to all jobs)	Total Constrained (all people to all jobs; balanced)	Singly-constrained (all people to jobs at each zone)	Doubly-constrained (people at each zone to jobs at each zone)
			
1,000 'accessible' jobs at A	100 accessible jobs at A (out of 500)	200 accessible jobs at A (out of 500)	250 accessible jobs at A (out of 500)

By balancing the units, an accessibility "family" framework can add:

1. Enhanced interpretation,
2. Comparability across spatial and temporal cases
3. Robustness to spatial analysis (e.g., Vi adds up to 100%)

$$V_i = k \sum_j O_j f(c_{ij})$$

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