

# **Lesson 10: Spatial Interaction Models**

**Dr. Kam Tin Seong**

**Assoc. Professor of Information Systems**

**School of Information Systems,  
Singapore Management University**

**2020-5-16 (updated: 2021-10-13)**

# Content

- Characteristics of Spatial Interaction Data
- Spatial Interaction Models
  - Unconstrained
  - Origin constrained
  - Destination constrained
  - Doubly constrained

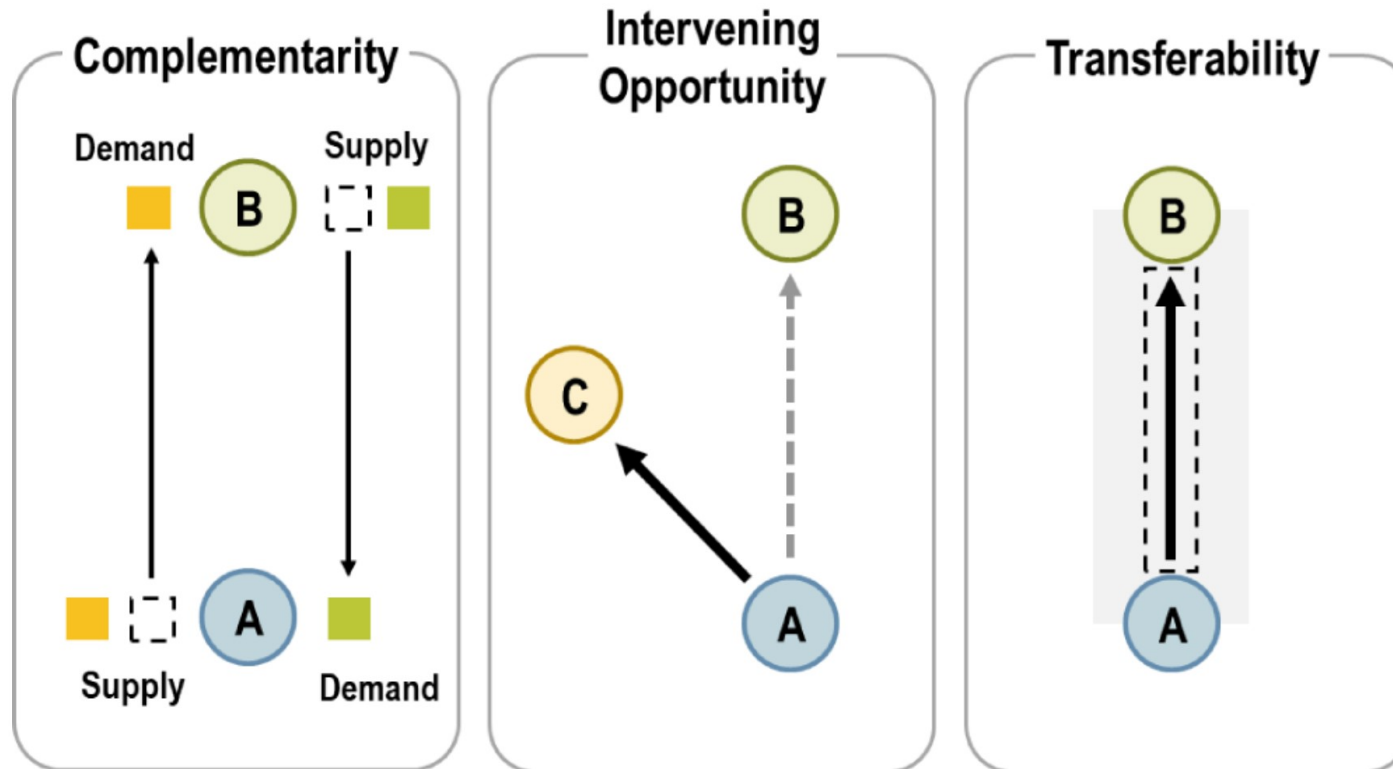
# What Spatial Interaction Models are?

Spatial interaction or “gravity models” estimate the flow of people, material, or information between locations in geographical space.



## Conditions for Spatial Flows

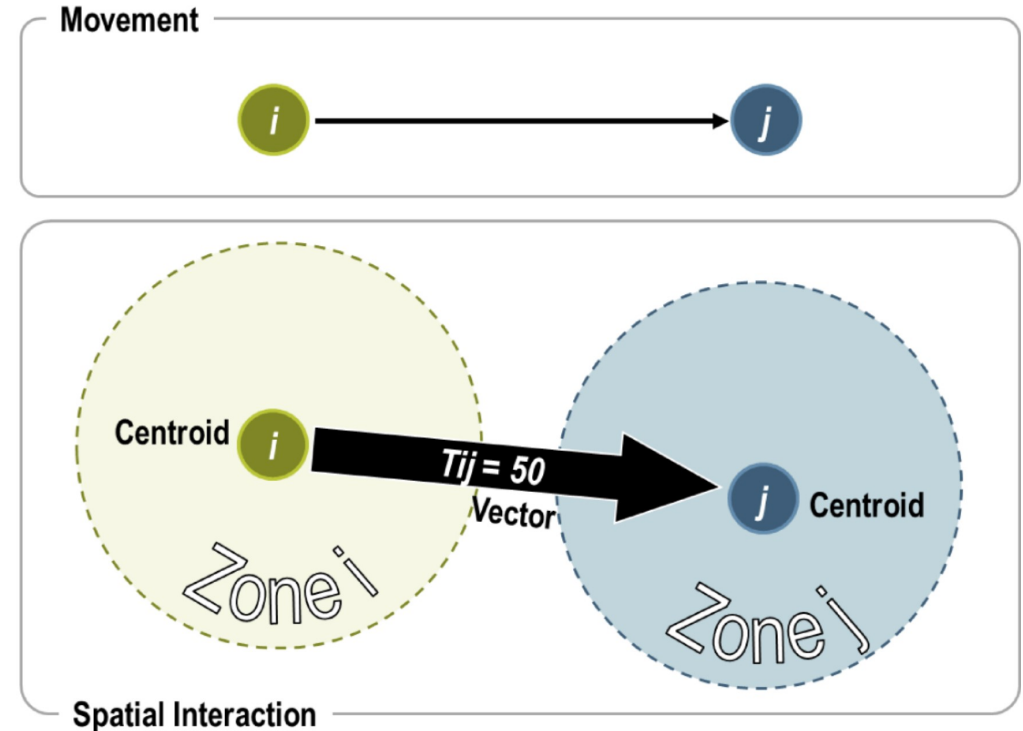
- Three interdependent conditions are necessary for a spatial interaction to occur:



# Representation of a Movement as a Spatial Interaction

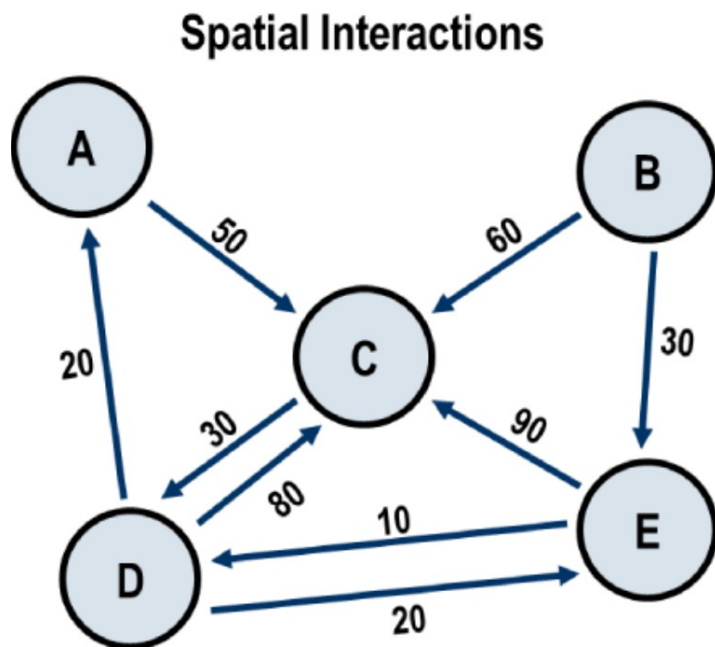
Representing mobility as a spatial interaction involves several considerations:

- Locations. A movement is occurring between a location of origin and a location of destination.  $i$  generally denotes an origin while  $j$  is a destination.
- Centroid. An abstraction of the attributes of a zone at a point.
- Flows. Flows are generally expressed by a valued vector  $T_{ij}$  representing an interaction between locations  $i$  and  $j$ .
- Vectors. A vector  $T_{ij}$  links two centroids and has a value assigned to it (50) which can represent movements.



# Constructing an O/D Matrix

- The construction of an origin / destination matrix requires directional flow information between a series of locations.
- Figure below represents movements (O/D pairs) between five locations (A, B, C, D and E). From this graph, an O/D matrix can be built where each O/D pair becomes a cell. A value of 0 is assigned for each O/D pair that does not have an observed flow.



**O/D Matrix**

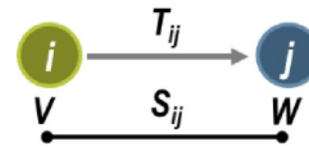
	A	B	C	D	E	Ti
A	0	0	50	0	0	50
B	0	0	60	0	30	90
C	0	0	0	30	0	30
D	20	0	80	0	20	120
E	0	0	90	10	0	100
Tj	20	0	280	40	50	390

# Three Basic Types of Interaction Models

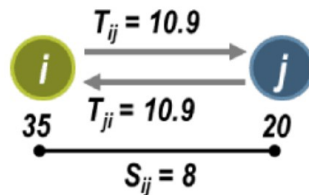
- The general formulation of the spatial interaction model is stated as  $T_{ij}$ , which is the interaction between location  $i$  (origin) and location  $j$  (destination).  $V_i$  are the attributes of the location of origin  $i$ ,  $W_j$  are the attributes of the location of destination  $j$ , and  $S_{ij}$  are the attributes of separation between the location of origin  $i$  and the location of destination  $j$ .
- From this general formulation, three basic types of interaction models can be derived:

## General Formulation

$$T_{ij} = f(V_i, W_j, S_{ij})$$

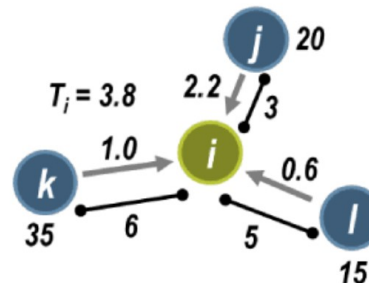


$$T_{ij} = \frac{V_i * W_j}{S_{ij}^2}$$



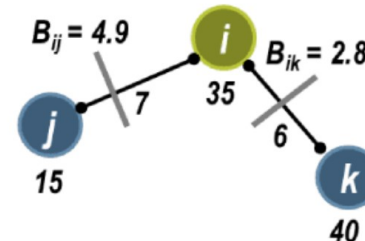
Gravity Model

$$T_i = \sum_j \frac{W_j}{S_{ij}^2}$$



Potential Model

$$B_{ij} = \frac{S_{ij}}{1 + \frac{W_j}{V_i}}$$



Retail Model

# Gravity Models