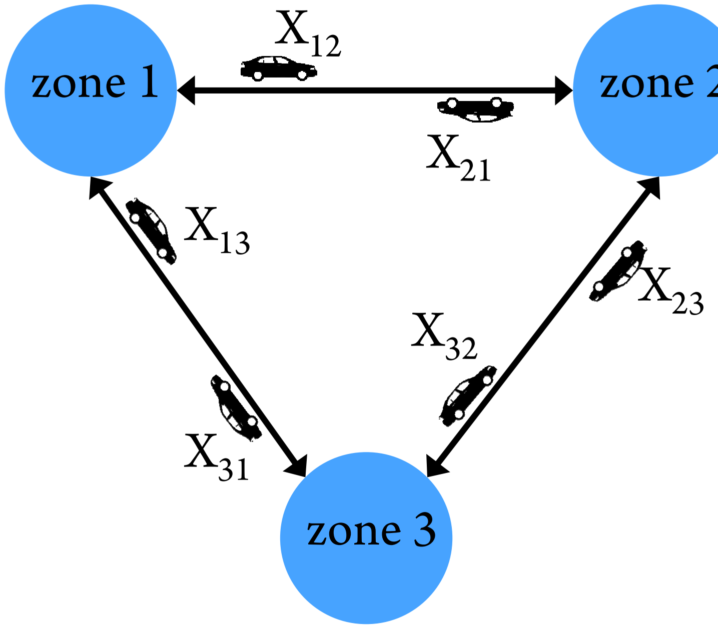
Forecasting an Origin-Destination (OD) Distribution

Image of OD distribution

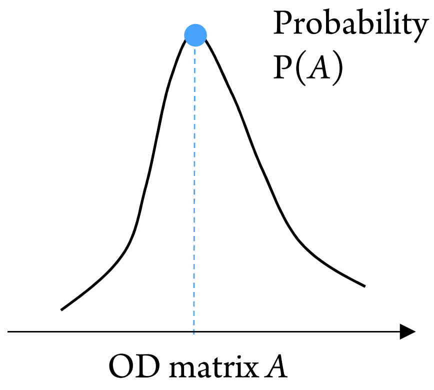


OD matrix (distribution)

	Zone 1	Zone 2	Zone 3	Sum
Zone 1	X_{11}	X_{12}	X_{13}	O_1
Zone 2	X_{21}	X_{22}	X_{23}	O_2
Zone 3	X_{31}	X_{32}	X_{33}	O_3
sum	D_1	D_2	D_3	

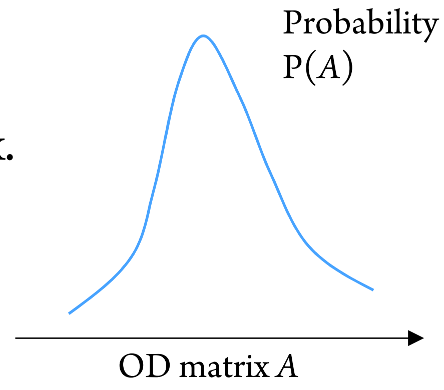
Approach : a set of OD matrix

Previous studies obtain *"one"* OD matrix which has the highest likelihood and utilize the OD matrix for road planning.



I try to obtain a set of OD matrix which show a distribution of OD matrix.

- Only one estimated OD matrix cannot correspond to a real one.
- A set of calculated OD matrices can contain a real one.
- Apply a Monte Carlo sampling and Get a distribution of OD matrix.



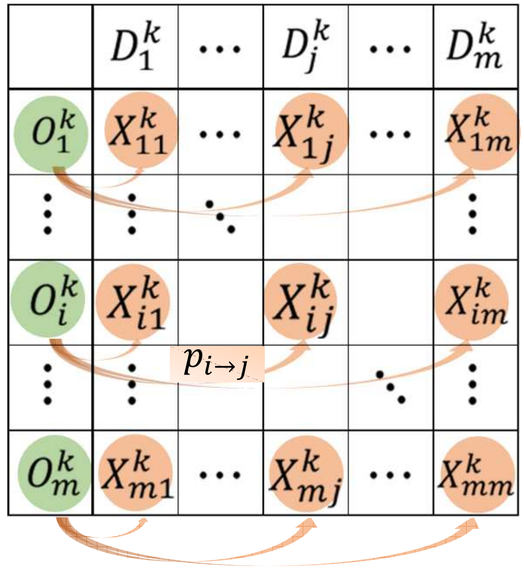
Destination choice & Sampling

- Individual at zone *i* choose their destination *j* according to:

Destination choice probability

$$p_{i\to j} = \frac{\exp(G_j + \nu_{i\to j} + c_{i\to j})}{\sum_{\forall j} \exp(G_j + \nu_{i\to j} + c_{i\to j})}$$

G_j: observed utility (attractiveness of destination j)
$c_{i\to j}$: travel cost
$\nu_{i\to j}$: unobserved spatial variation and given by normal distribution



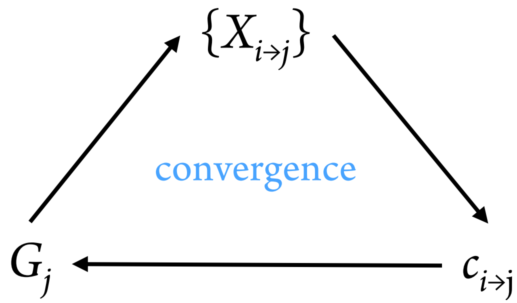
- Total departure volume and probability $p_{i\to j}$ give $X_{i\to j}$

[Application : Monte Calro method, Alias method]

- One OD matrix is obtained by this process in all zones and I apply iterative calculation to obtain many OD matrix

Convergence process

- Attractiveness G_j and travel cost $c_{i\to j}$ are related to a OD matrix
- Need a convergence of G_j, $c_{i\to j}$ and $X_{i\to j}$



- To obtain G_j, I need to solve non-linear simultaneous equations

$$f_j(\boldsymbol{G}) = D_j - \sum_i E\left[X_{ij}(\boldsymbol{G})\right], \forall j$$

[Application : quasi-Newton method, numerical differentiation]

Travel cost (user equilibrium approach)

Equilibrium state (Wardrop's first principle ≅ Nash equilibrium) :
- Drivers should prefer a fastest route
- All drivers successfully choose shortest routes for them in a final situation

Traffic assignment method (Franc-Wolfe method)
- Shortest path serach
- Line search (all-or-nothing approach)

Test network (Philadelphia)

Link: 40,003 Node: 13,389 OD: 18,503,872