A STRATEGIC USER EQUILIBRIUM FOR INDEPENDENTLY DISTRIBUTED ORIGIN-DESTINATION DEMANDS

Highlights of the model
1) It accounts for demand uncertainty in users’ routing mechanism.
2) Network performance measures are provided analytically, therefore they can be computed directly from model results.
3) The uniqueness of link flow distribution and the strategic link choice are guaranteed, which ensures its applicability in transportation planning process.
4) A solution algorithm is proposed to compute the link flow parameter and the strategic link choice.

What is the Strategic User Equilibrium model?
✓ The strategic user equilibrium is defined such that the expected travel costs are equal on all used paths, and this commonly expected travel time is less than the actual expected travel time on any unused path.
✓ In other words, given user equilibrium expected path cost, any deviation from the existing expected path flows cannot reduce the expected path cost.
✓ Users have the experiences (or are informed) of the demand distribution, but not the realization on any given day. Therefore, traditional equilibrium may not be observed in this model.

Model assumptions
Two statistical assumptions are made to ensure a unique solution:
1. The actual OD demand on any given day is independently distributed and follows a Poisson distribution.
2. Conditional on the realized demand on any given day, each user (driver) is assumed to choose independently between the alternative paths with a fixed strategic path choice.

Implementation algorithms
1. Initialization
   - Assumptions
   - Assignment
   - Update the expected flows
   - Update the expected travel time
   - Check for convergence
2. All or nothing assignment
   - Repeat until convergence
3. Local search
   - Repeat until convergence

Numerical results
Monte Carlo simulation:
i. 100 randomly selected demand scenarios are sampled from the given demand distribution.
ii. For each realized demand scenario, 100 sets of multinomially distributed path flows are sampled based on the strategic path choices.
iii. As a result, we have 10000 sets of sampled path flows and 10000 sets of corresponding sampled link flows, which represents the unconditional distributions of link flow. These results are indicated as simulated results, and those ones computed from the analytical equations will be indicated as estimated results.

Possible future research
• Future research will investigate the use of the covariance of loop counts.
• Treat demand proportions as variables and calibrate them in the framework simultaneously.

Limitations of the model
The assumption of Poisson distributed OD demands forces the expected demand to be equal to variance of demand, and this assumption may limit the applicability of the model.