

Optimization of crosswalk locations in urban street network

街路ネットワークにおける横断歩道設置箇所の最適化

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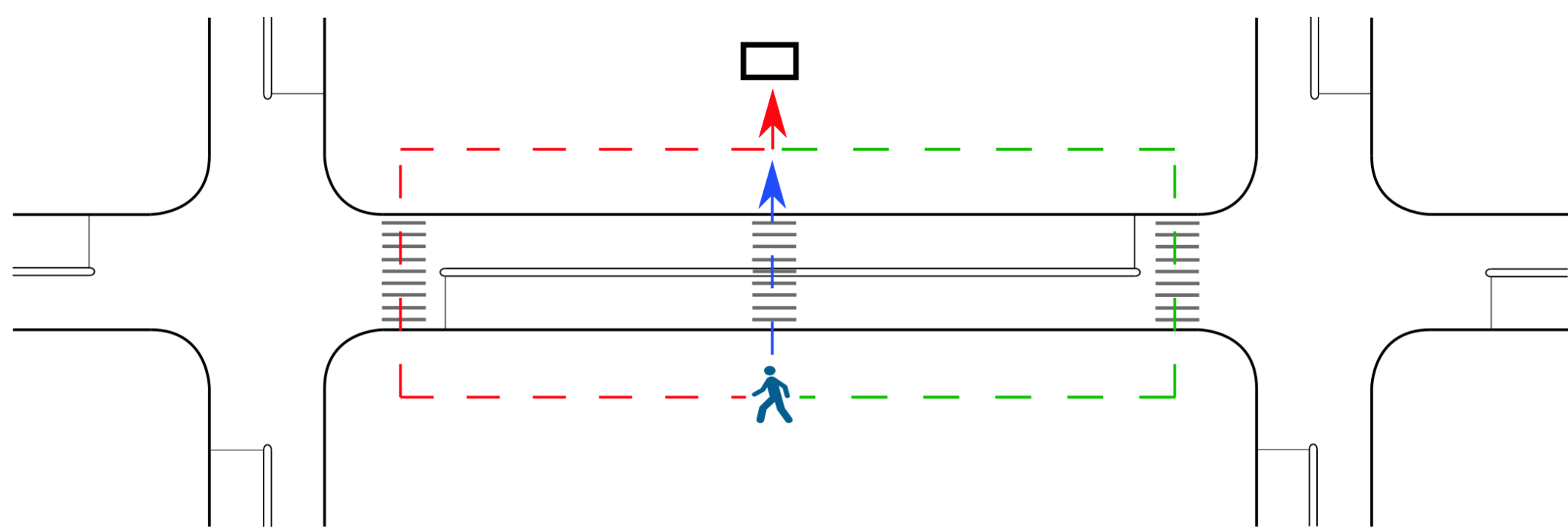
<http://www.transport.iis.u-tokyo.ac.jp/>

Muhammad Abdullah and Takashi Oguchi



What is a crosswalk?

- Crosswalk: a pedestrian facility for crossing the vehicular lane.



An example of crosswalk

- Position: could be either within or out of the intersection.
- Signal: Signaling the crosswalk is for both safety and efficiency.

Motivations

- Current Situation:
 - Related design manuals suggest the crosswalk position considering only safety while ignoring the impact to the network efficiency.
 - Previous studies commonly ignore crosswalk alternatives. Even with consideration, the network-level evaluation have not been done.
- Objectives:
 - To formulate a model to optimize crossing facilities design in networks from the operational efficiency.
 - To propose an integrated approach of crosswalk design considering stochastic choice of pedestrians.

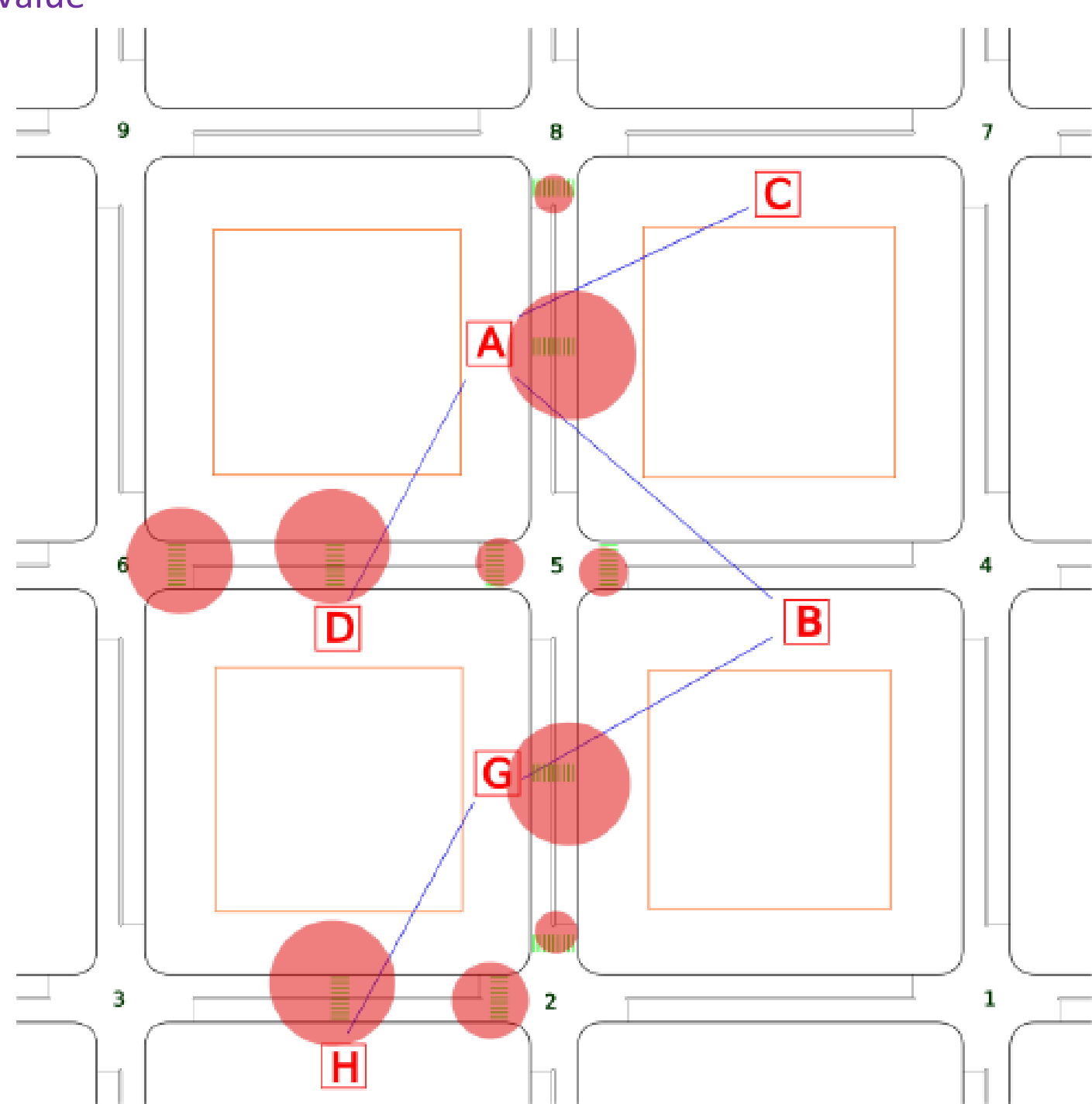
Basic problem modeling

- From the point of efficiency, the target is to minimize the delay of both vehicle users and pedestrians.

$$\min(\alpha \times \beta \times (D_v + T_v) + \gamma \times (D_p + T_p))$$

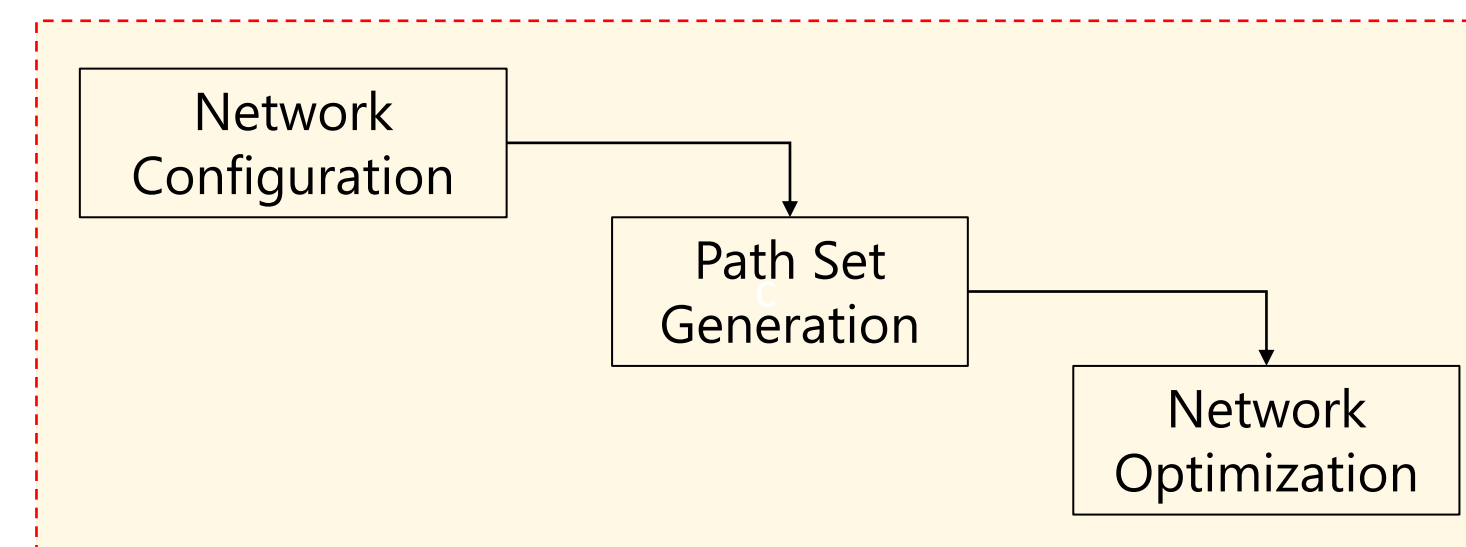
Vehicle Occupancy
Delay
Time Value
Travel Time

- Using both deterministic and heuristic algorithm, we obtained system optimum of routes, crosswalk positions, signals and pedestrian volumes of crosswalks.

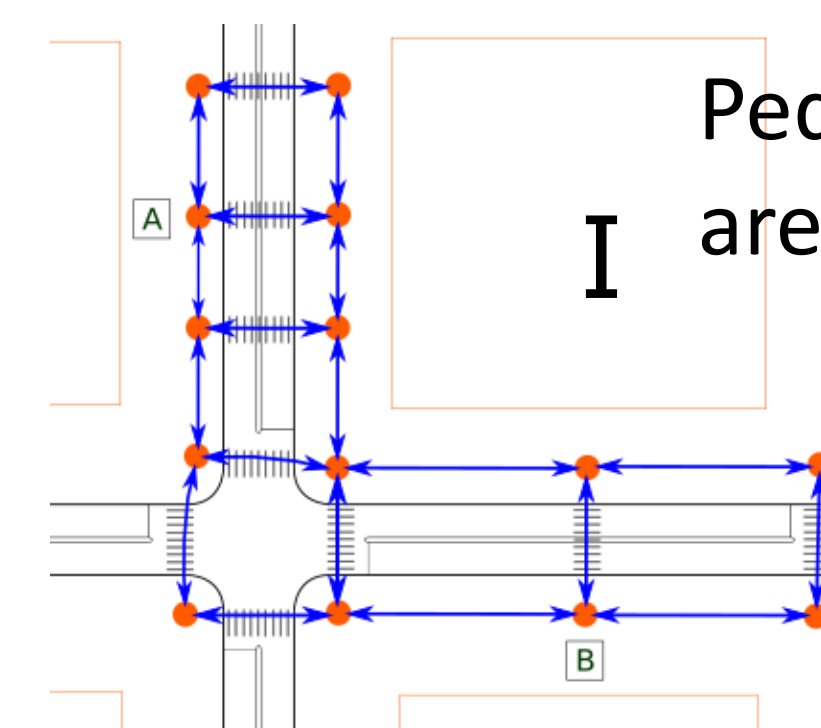


Combine with pedestrians' behaviors

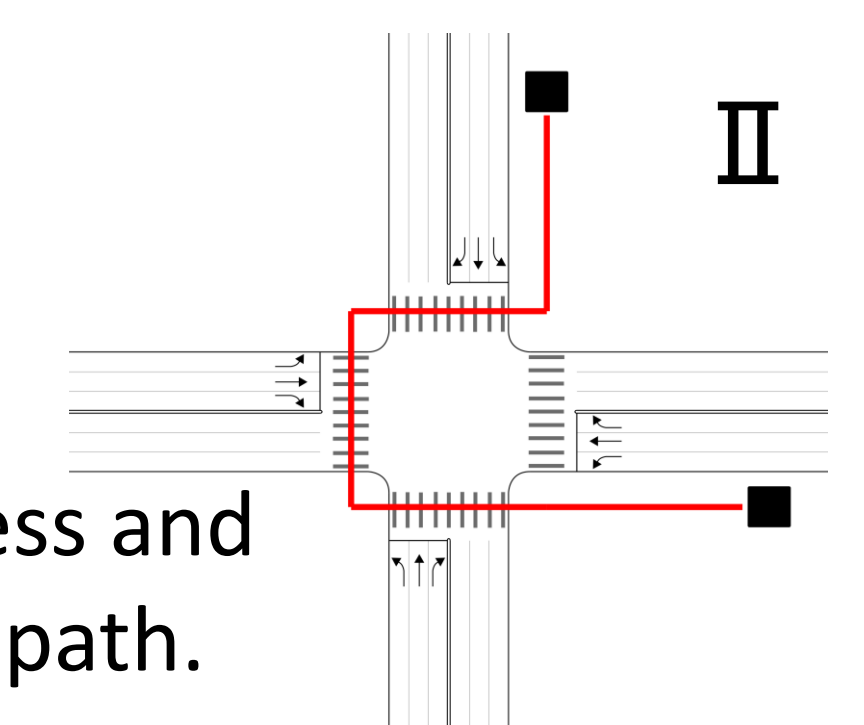
- Pedestrians choose the path with perspective cost but not the full information. The choice behaviors are considered following 3-step integrate approach.



III : Share the same objective as before but not decide pedestrian route

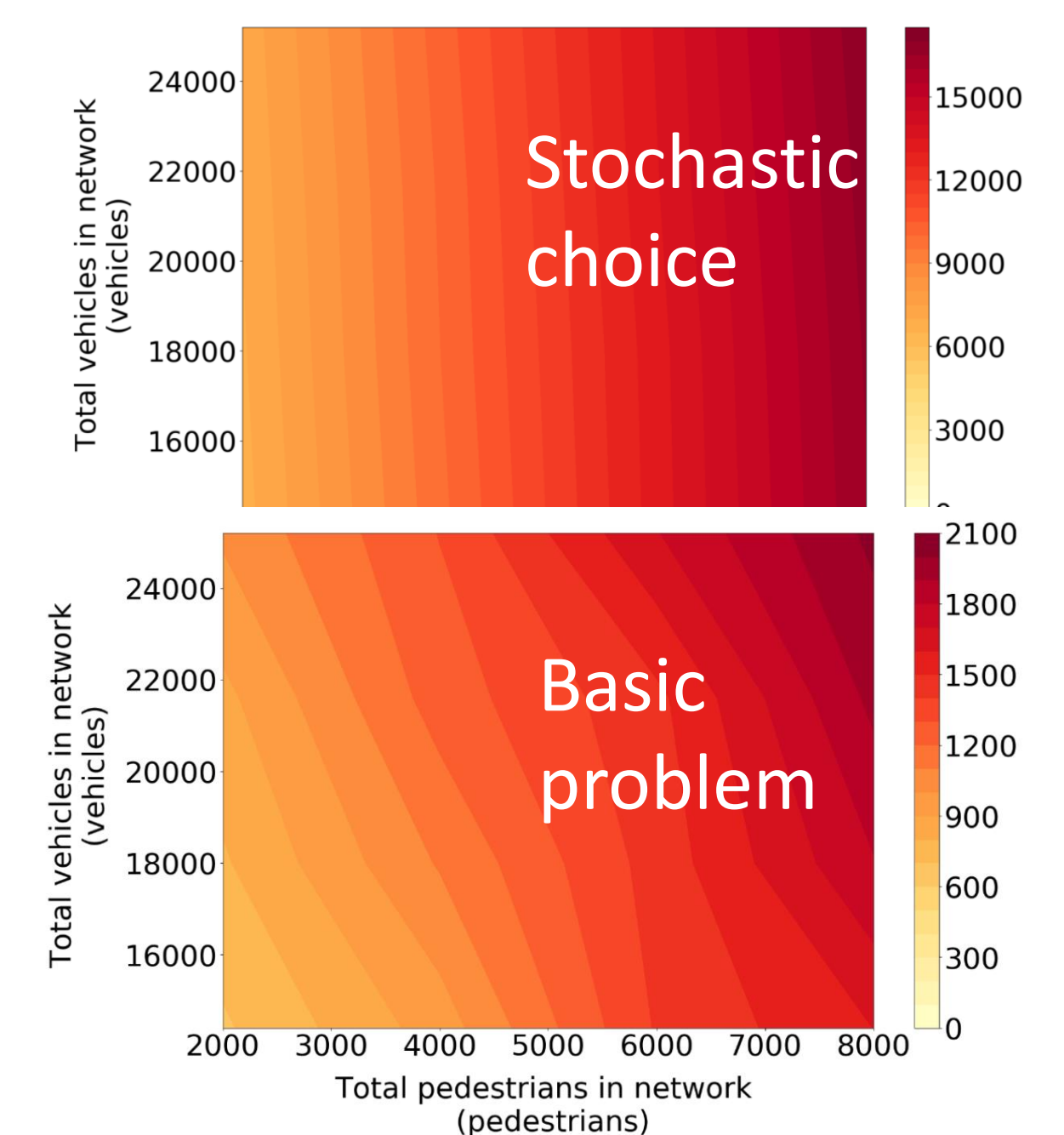


Pedestrian network are present by graph



Find loop-less and reasonable path.

- Due to a better performance, here use genetic algorithm only.
- Pedestrian volumes can influence the network performance much more significantly than the case of basic problem modeling (social optimum) before.



Result: Cost function (Total monetary delay)

Conclusions

- The study answer the core question that how to set crosswalk considering efficiency.
- Contributions:
 - The formula optimize the crosswalk existence, quantity, location and signal settings in urban street network.
 - On the top of system optimum condition, the cases of pedestrian routing behaviors are discussed.
 - Both deterministic and heuristic methods are utilized in optimization. It promise to achieve optimum with reasonable computational time.
- Future Directions:
 - Considering pedestrian space restriction and congestion effect.
 - Consideration of two-stage pedestrian crosswalks
 - Incorporation of signal coordination
 - A comprehensive study on how to locate pedestrian origins and destinations in networks