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METAHEURISTIC ALGORITHMS FOR TRANSIT NETWORK DESIGN

Ni Luh Putu Satyaning Pradnya Paramita

FULBRIGHT
[Pre-Academic Program 2019]

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INTRODUCTION

- Public transportation is a crucial part in developing sustainable transportation in urban areas.
- Without a good public transportation system, private vehicle ownership increases, which lead to many problems: traffic congestion, air pollution, energy exploitation. [1]
- Planning and designing efficient public transportation is essential.

Fig. 1. Traffic congestion in urban area [2]

Fig. 2. Public transportation modes [3]

TRANSIT NETWORK DESIGN

As the first activity in transportation planning process, network design may be considered as the most crucial and important stage, with aims to designate a set of routes in a specific area which is determined by a sequence of transit points [4, 5].

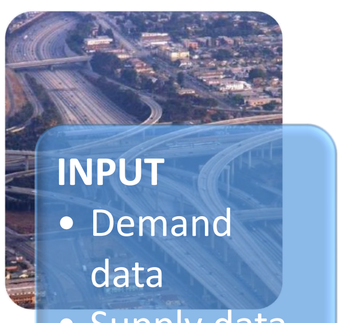


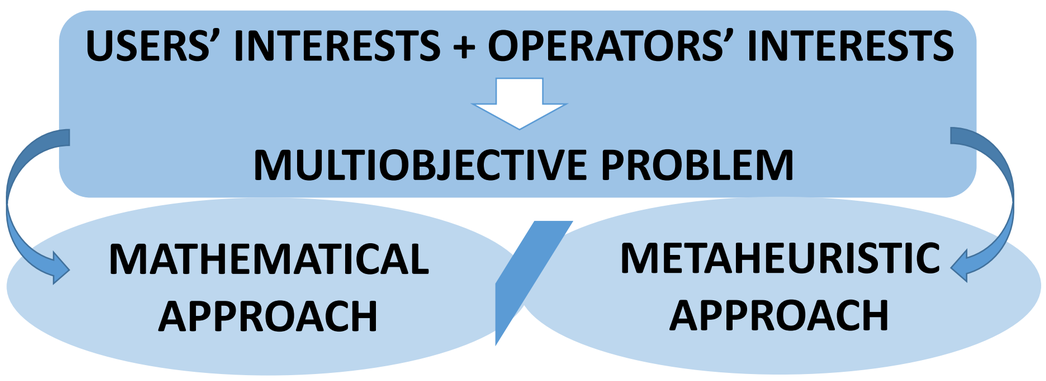
Fig. 3. US' road network (as background) [6]

Fig. 4. Binary codes (as background) [7]

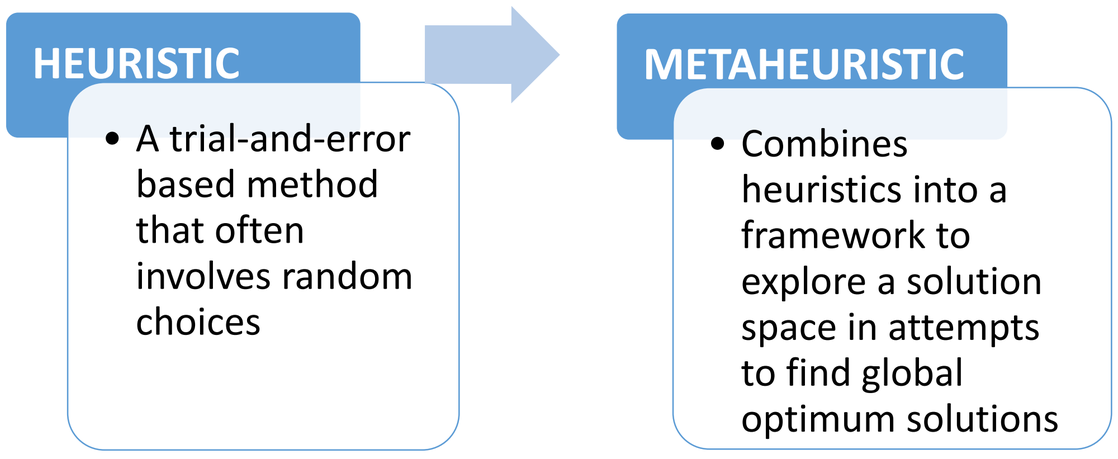
Fig. 5. Topographic map of the London Underground (as background) [8]

Inputs:
- **Topology**
- **Origin-destination matrices**

Constraint and objectives:
- **Historical background**
- **Area coverage**
- **Route & trip directness**
- **Demand satisfaction**
- **Number of lines / total of route length**
- **Operator-specific objectives**



METAHEURISTIC APPROACH



In some complex optimization problems where the best solution is considered computationally expensive, a heuristic and a metaheuristic offer ways of searching "the sufficiently good solution" by sacrificing optimality, completeness, accuracy, or precision for speed [9].

GENETIC ALGORITHM

Because the important feature of metaheuristics is randomization, like most phenomena found in nature, most successful metaheuristics are the ones inspired by nature systems: **genetic algorithm**, particle swarm optimization, tabu search, simulated annealing, ant colony optimization, bee colony optimization.

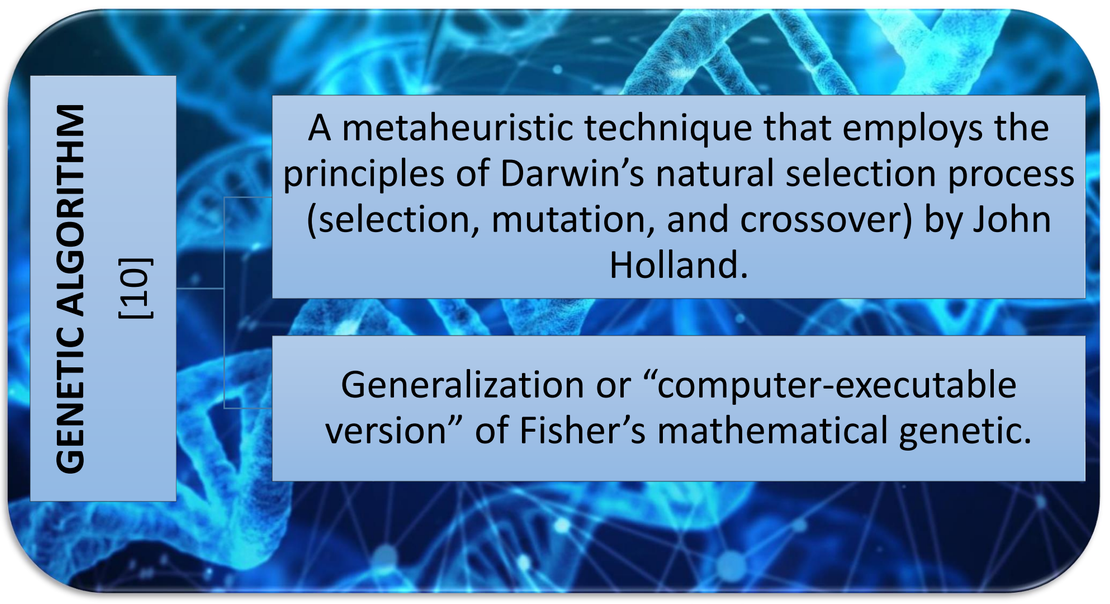
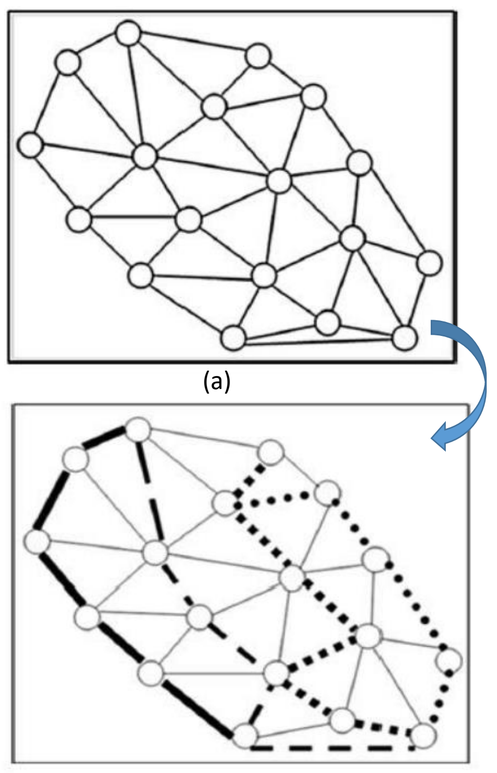


Fig. 6. DNA (as background) [11]

PROBLEM FORMULATION

- **Road network:** G=(N, A)
  N: set of nodes (potential bus stops, e.g. inter-sections, zone centroids);
  A: set of links (street segments)
- **Origin–destination matrix:** D
  $D = \{d_{ij} | i, j \epsilon [1,2, \dots, |N|]\}$, d_{ij} is # of trips between node *i* and node *j*
- **Travel time matrix**: TR
  TR= $\{tr_{ij} | i, j \epsilon [1,2, \dots, |N|]\}$, tr_{ij} is in-vehicle travel time between node *i* and node *j*
- **Objective:** find a set of routes *R* such that "total travel time of all passengers in the network" is minimized.

[12, 13]

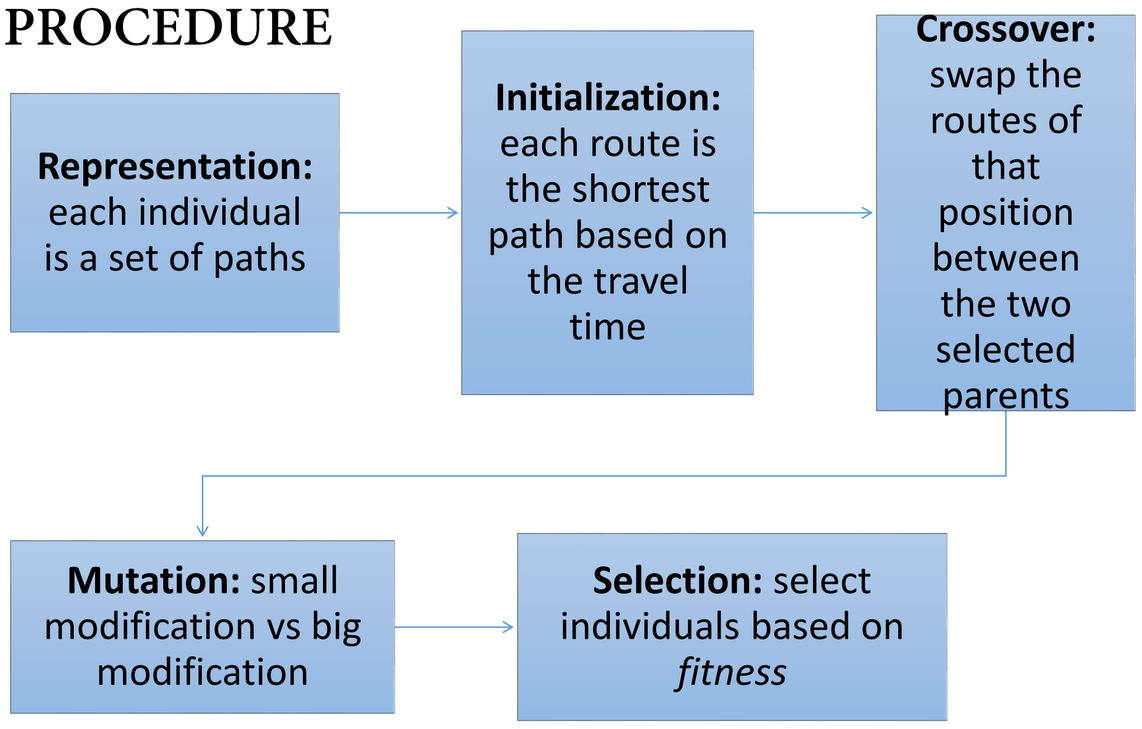


(a)

(b)

Fig. 7. (a) Road network(b) Public transit network [13]

PROCEDURE



RECOMMENDATION

- Consider other objectives for future research, such as traffic jam and performance of vehicles or routes
- Consider other constraints, such as available number of vehicles and number of lines .

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