PROFIT MAXIMIZATION FOR A CARPOOL SCENARIO

IE 537- DISCRETE OPTIMIZATION MODELS AND ALGORITHMS

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INTRODUCTION

- Carpooling is a promising mode of transportation which addresses the problem of congestion to a great extent.

- Intelligent carpool systems have become more prominent nowadays and it becomes even more pressing to improve customer satisfaction and retain our customers in this competitive market.

- As generally perceived, the customer satisfaction is influenced not only by the optimized route chosen by the driver to drop him/her at the destination but also by two other important factors “driver rating” and “waiting time of the customer (ETA)”

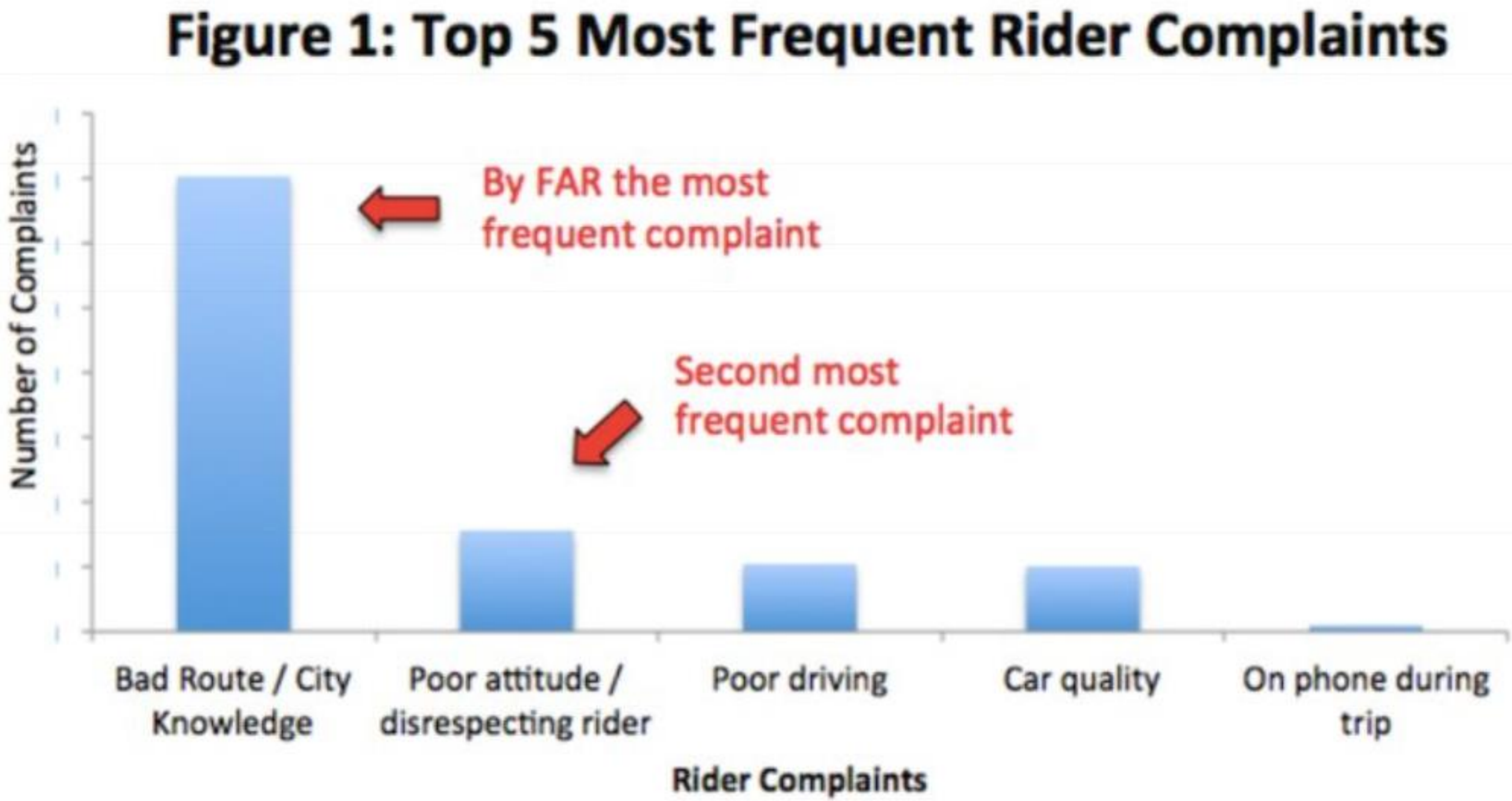


Figure 1: Top 5 Most Frequent Rider Complaints
Number of Complaints
By FAR the most frequent complaint
Second most frequent complaint
Bad Route / City Knowledge
Poor attitude / disrespecting rider
Poor driving
Car quality
On phone during trip
Rider Complaints

GREEDY APPROACHES

- In this greedy approach, drivers pick up passengers as and when requests are made, in the decreasing order of “drivers ratings”

- Drivers with higher ratings pick up passengers until they have no remaining seats left.

- Now, when drivers with higher ratings are busy and occupied, drivers with lower ratings are assigned to meet requests made by passengers.

- Is this a good approach...? NO
- Why?

ILP FORMULATION:

Time feasibility:

- $f d1 = L(d1) - E(d1) - t$

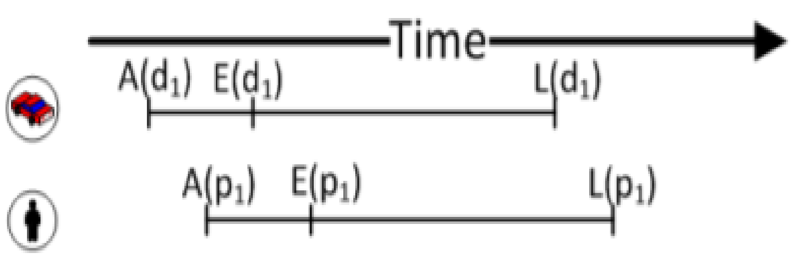
- Assigned Departure time is:

$$H\ (Si) = min[L(p1) - T(M(p1),N(p1)) - T(M(d1),M(p1)), L(d1) - T(M(p1),N(p1)) - T(M(d1),M(p1)) - T(N(p1),N(d1))]$$

$H(Si) \geq E(d1)$

$H(Si) + T(M(d1),M(p1)) \geq E(d1)$

$H(Si) \geq t$



ILP FORMULATION:

Cost feasibility:

- $C(\text{sij}) = \{(Le(M(sij),N(sij))/\Sigma Le(M(sij'),N(sij'))*[total\ cost]\}\ \forall\ sij \in S$

- For example, considering the one driver-one passenger scenario,

$C(d1) = \{(Le(M(d1),N(d1))/(Le(M(d1),N(d1)) + Le(M(p1),N(p1)))\}*\{Le(M(d1),M(p1)) + Le(M(p1),N(p1)) + Le(N(p1),N(d1)))\}$ $C(p1) = \{(Le(M(p1),N(p1))/(Le(M(d1),N(d1)) + Le(M(p1),N(p1)))\}*\{Le(M(d1),M(p1)) + Le(M(p1),N(p1)) + Le(N(p1),N(d1)))$

C(sij) ≤ (Le(M(sij),N(sij)).

WHY GENETIC ALGORITHM?

- From the ILP we can see that this problem is an assignment problem with a nested shortest path problem.

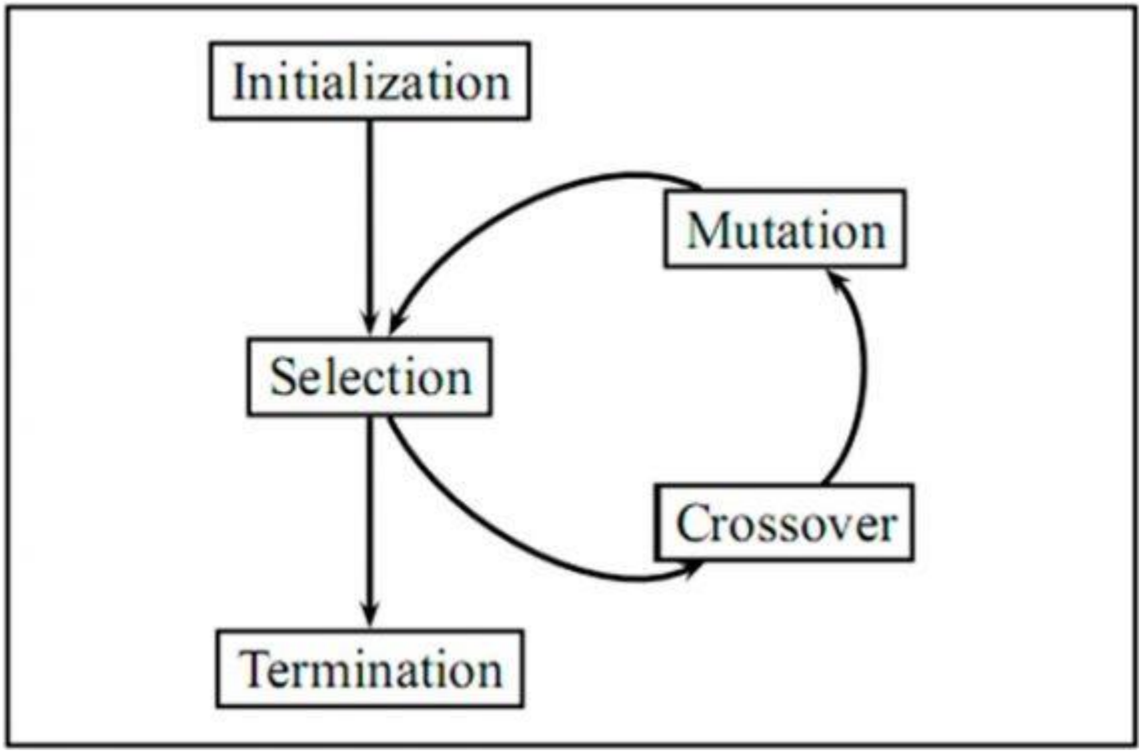
- Integer programming, which belongs to the family of exact optimization, is a deterministic method that always obtains same approximate solutions in different runs. It is not very effective at generating adequate solutions for a large number of carpool users.

- Heuristic methods like genetic algorithms can give us **nearly** optimal solutions.

- The genetic algorithm has been successfully applied in many situations, and is able to determine solutions with near-optimal quality within a reasonable amount of time.

GENETIC ALGORITHM

- Initialization: We take a population of n varied solutions. Each of this solution is in this format.



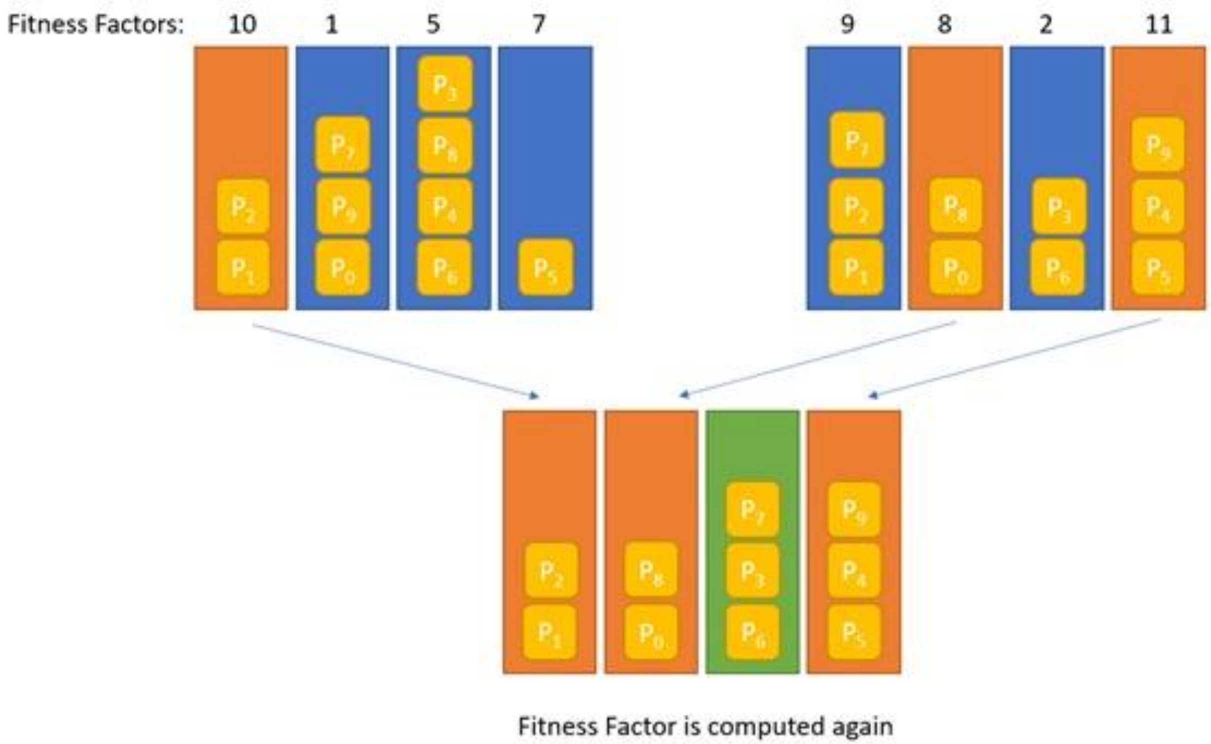
GENETIC ALGORITHM

- Selection and Fitness : Fitness in this algorithm is the value of our objective function and here we compute the objective values for each route and select the route with the best fitness value.

- Crossover: We combine the routes which have the best fitness factors to give us the children population

- Mutation: We switch passengers or drivers in this child (very low value though) to keep the population varied. Variation ensures we take into consideration most the possibilities, while arriving at a solution.

GENETIC ALGORITHM



OBSERVATION AND CONCLUSION

- Case-1: Single driver, Single passenger (S-S): Our algorithm returned shortest path between the point of origin and destination.

- Case-2: Single Driver, Multiple passengers (S-M): Our algorithm returned the shortest path route which yielded maximum profit.

- Case-3: Multiple Drivers, Single passengers (M-S): Our Algorithm returned the shortest path route which yielded maximum profit considering the "least waiting time of the passenger"

- Case-4: Multiple Drivers, Multiple passengers (M-M): Our algorithm returned an optimal assignment and shortest path route while minimizing the overall waiting time of passengers and maximizing Profit respectively.

ANY QUESTIONS ??