Efficient Scheduling of Generalized Group Trips in Road Networks

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Introduction

- We introduce generalized group trip scheduling (GGTS) queries that enable friends and families to perform activities at different points of interest (POIs), such as a shopping center, a restaurant and a pharmacy with the minimum total travel distance
- Since finding the answer for a GGTS query is an NP-hard problem, we propose two heuristic Solutions which reduce the processing overhead significantly in return for sacrificing the accuracy slightly.

Motivation

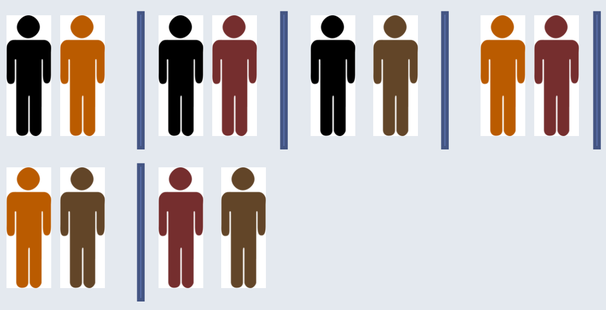
- Sharing multiple tasks in a family
- Event management

4 Group Members

TO DO List: Organize an event
Obj: total travel dis minimum

1. Everyone starts from their source locations
2. Everyone goes to a bank for withdrawing and distributing money
3. Two members go to a supermarket for shopping
4. One member goes to a pharmacy
5. One member goes to a restaurant and orders food in advance
6. The other three members join him in the
7. After dinner everyone departs for their respective destinations

Which of the Two members will visit a supermarket?



Which supermarket will the members visit?

- Practically there are always hundreds of options.
  California dataset which we used for experimentation has 63 different POI types, on average 1300 POIs for each type

GGTS Queries

Input:

- Source and destination locations of members, required poi types and how many members will visit them, sequence of visiting pois and additional constraints: if a specific group member must visit a specific poi type

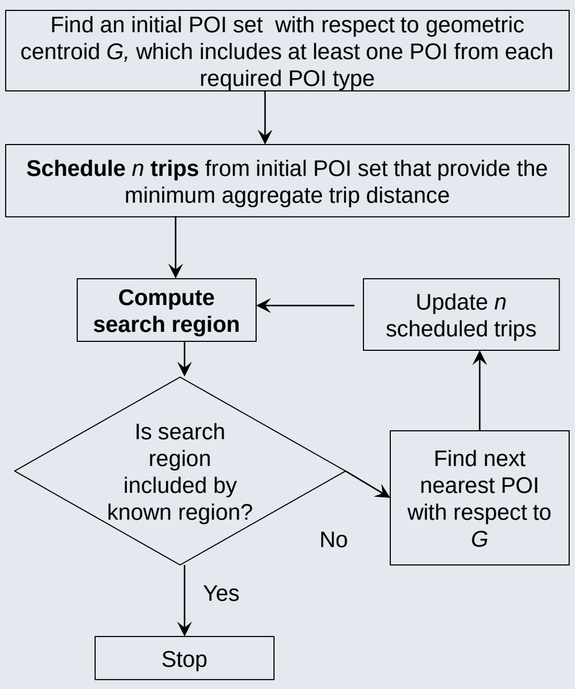
Output:

- A set of *n* trips for *n* members such that total trip distance covered by the group members is minimum

Optimal Approach

Known region:
Region that that has already been explored, all the pois inside the region have been retrieved from database.

Search Region:
Region that we need to search for optimal solution



Solution Overview of optimal approach

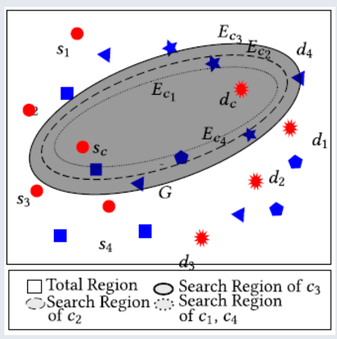
Important Steps:

- Refinement of the search region
- Trip scheduling

Refinement of Search Region

Technique1:
m ellipses for m poi types, E_{c_m}

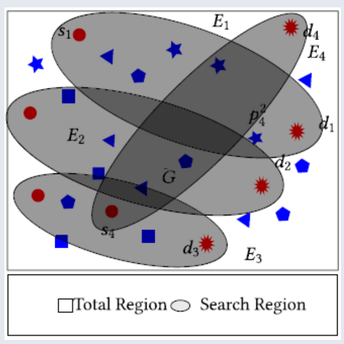
We prove that the POIs outside the ellipses can not yield an optimal solution.



Search regions(Technique1)

Technique2:
n ellipses for n group members, E_n

We prove that the POIs outside the ellipses can not yield an optimal solution.



Search regions(Technique2)

Optimal Approach

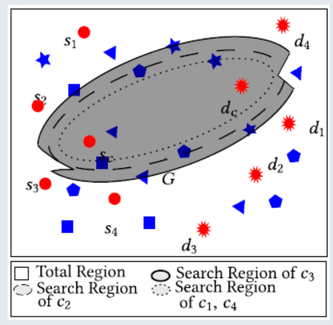
Combining technique *1* and *2* final search region for a POI type c_i : $E_{c_i} \cap (E_1 \cup E_2 \cup \ldots \cup E_n)$

Trip Scheduling

Construct the combination and index table

Calculate the trip distances for each combination with initial POI set

Check with combinations in the combination table after the retrieval of a POI *p* required POI type to update the trip distances



Search regions(Combined)

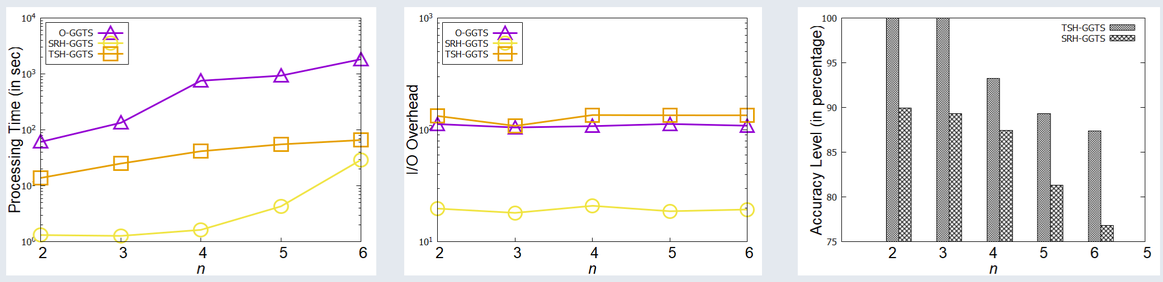
Heuristic Approaches

Why Heuristic Approaches?
For lager parameter size the processing overhead of optimal approach is high and can't find the answer in real time

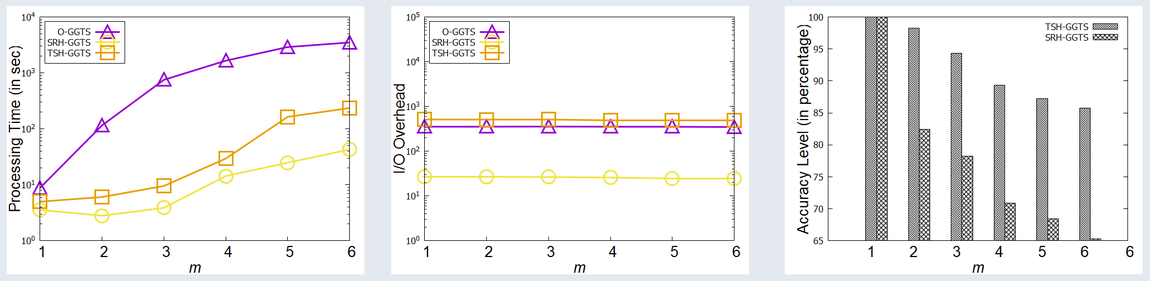
Trip Scheduling Heuristic(TSH)
Search Region Heuristic(SRH)

Topic	TSH	SRH
Search region refinement technique	Uses the concept, same as optimal	does not use the concept, finds at least one POI of all required POI types for each group member
Candidate POI sets	contains optimal solution	may or may not contain optimal solution
Trip Scheduling	checks best *t* Combinations of group members	checks all possible Combinations of group members, same as optimal

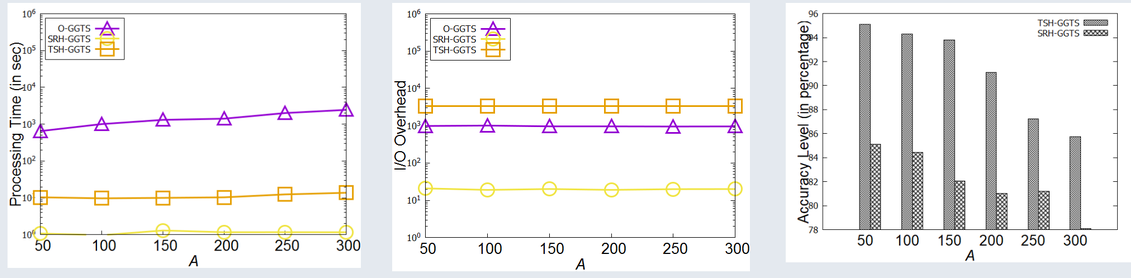
Experiments



Effect of group-size(*n*)



Effect of number of poi types(*m*)



Effect of query area size(*A*)

Conclusion

- Optimal approach can find the exact query answers in real time when the group size is reasonable(<4). However, heuristic solutions are preferable for larger parameter settings(>4)
- TSH has a higher accuracy than SRH, but SRH takes 6.23 times less processing time than TSH.
- TSH is preferred when a very high accuracy (i.e., close to optimal) is required, and SRH is preferred when a GGTS query needs to be evaluated in real time.

Journal Paper

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