Optimal Location Queries in Road Network Databases

Xiaokui Xiao[1], Bin Yao[2], Feifei Li[2]

[1]School of Computer Engineering
Nanyang Technological University, Singapore

[2]Department of Computer Science
Florida State University, USA

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Introduction and Motivation

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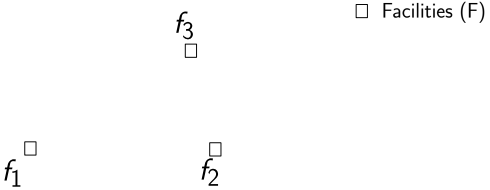

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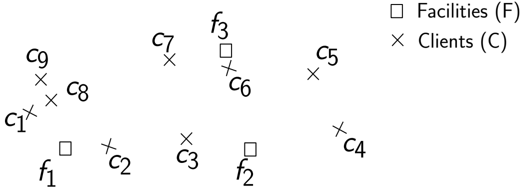

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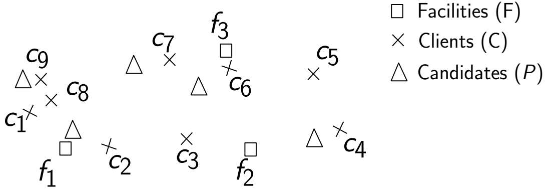

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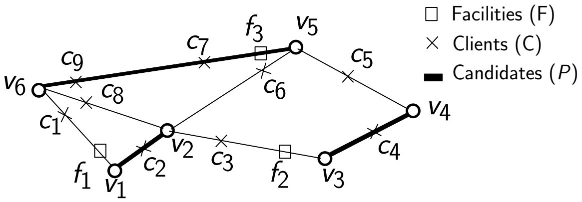

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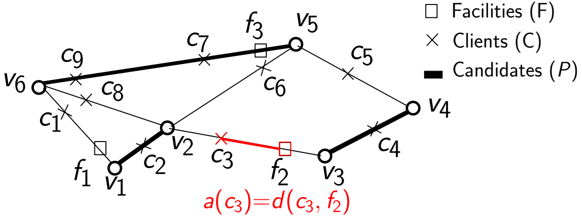

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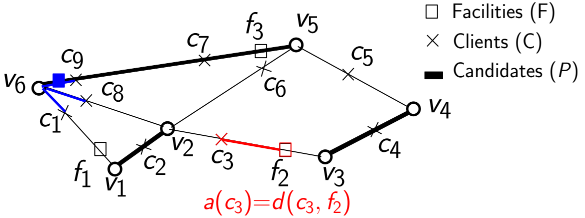

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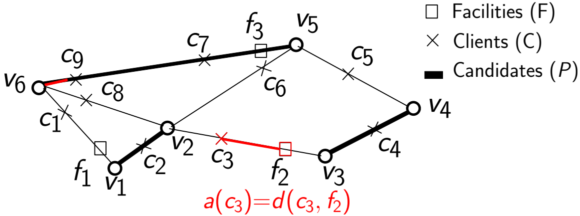

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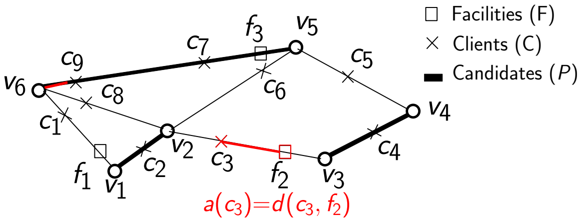

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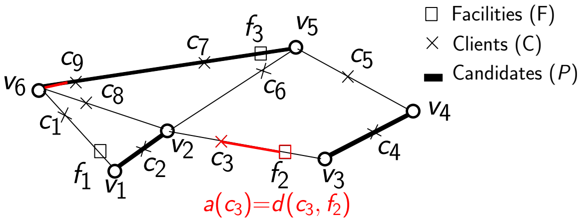

- Cabello et al. [1] and Wong et al. [2] deal with competitive location queries in the L_2 space
- Du et al. [3] and Zhang et al. [4] investigate competitive and MinSum location queries in the L_1 space, respectively.

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Problem Formulation

Competitive location query:

$$p = \operatorname*{argmax}_{p \in P} |C_p|,$$

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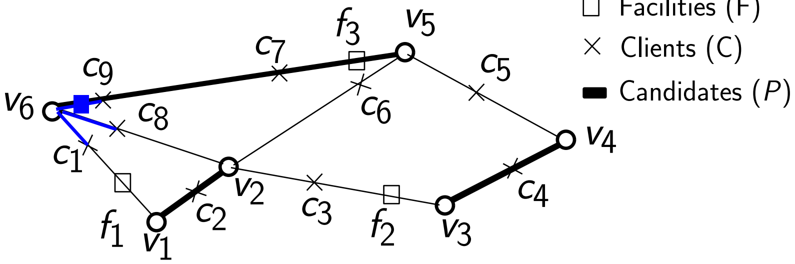

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Example 1: Given existing supermarkets F (residential locations C) in a city, Julie want to open a new supermarket that can attract as many customers as possible.

Problem Formulation

MinSum location query:

$$p = \operatorname*{argmin}_{p \in P} \sum_{c \in C} a(c).$$

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Example 2: John owns a set F of pizza shops that deliver to a set C of places in a city. He looks for a location to add another pizza shop to minimize the average distance from the place in C to their respective nearest shops.

Problem Formulation

MinMax location query:

$$p = \operatorname*{argmin}_{p \in P} \left(\max_{c \in C} a(c) \right).$$

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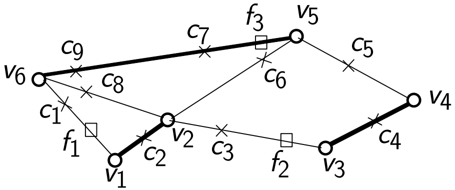
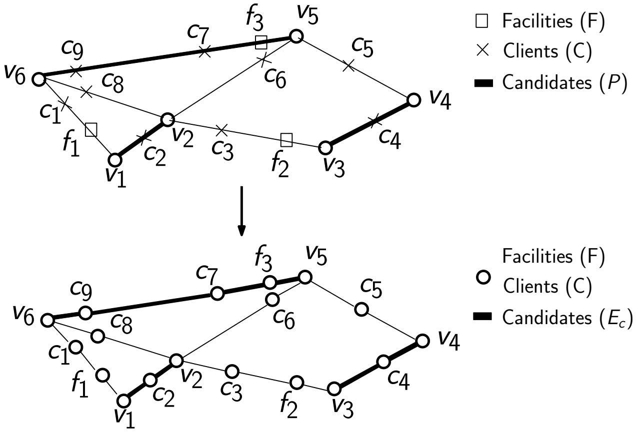
Example 3: Given the set F (C) of existing fire stations (buildings) in a city, the government may seek a candidate location that minimizes the maximum distance from any building to its nearest fire station.

Solution Overview



□ Facilities (F)
× Clients (C)
▬ Candidates (P)

Solution Overview



- Construct the road intervals.

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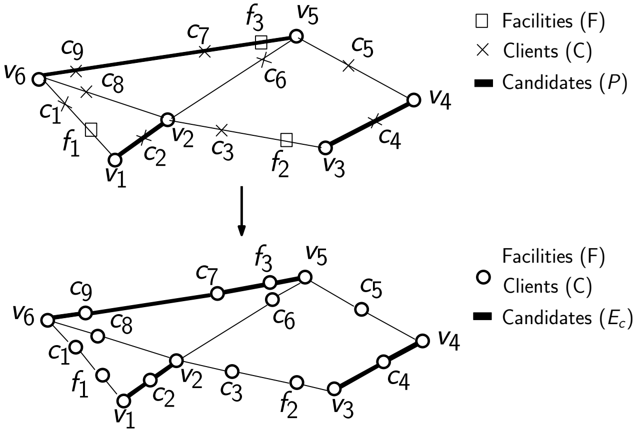

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- Traverse the candidate road intervals in a certain order.

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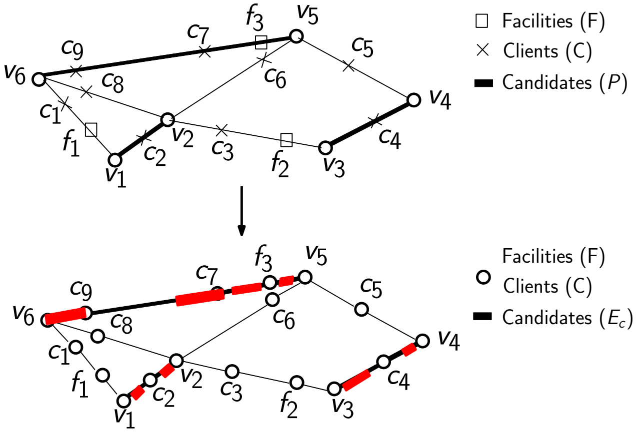

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- Traverse the candidate road intervals in a certain order.
- Identify the local optimal locations.

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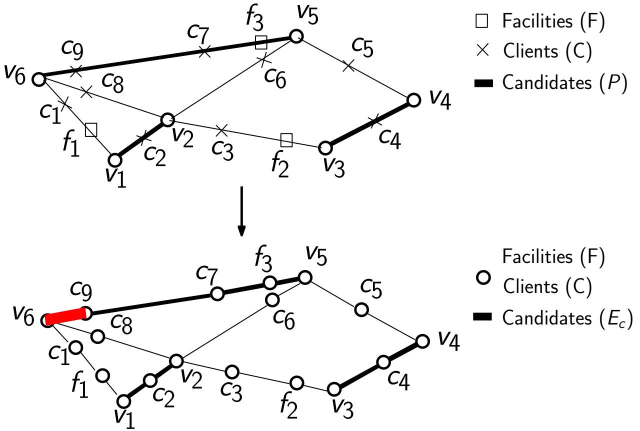

- Construct the road intervals.
- Traverse the candidate road intervals in a certain order.
- Identify the local optimal locations.
- Return the global optimal locations.

Local optimal locations: competitive location queries

Lemma

A client c is attracted by a point p on an edge $e \in E_c$, iff there exists an entry $\langle c, d(c, v) \rangle$ in the attraction set of an endpoint v of e, such that $d(c, v) + d(v, p) \leq a(c)$.

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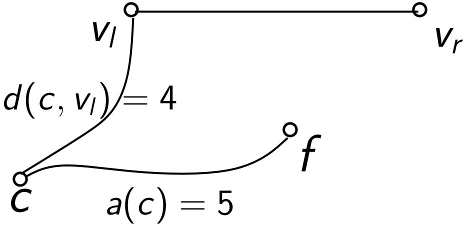

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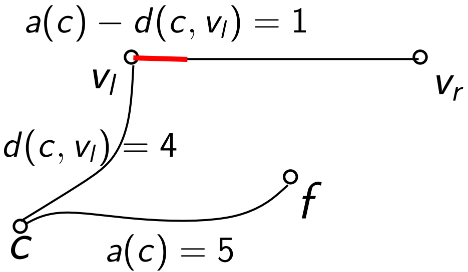

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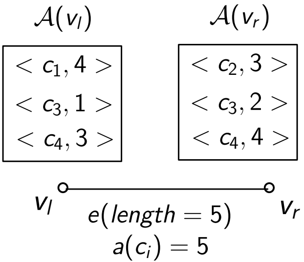

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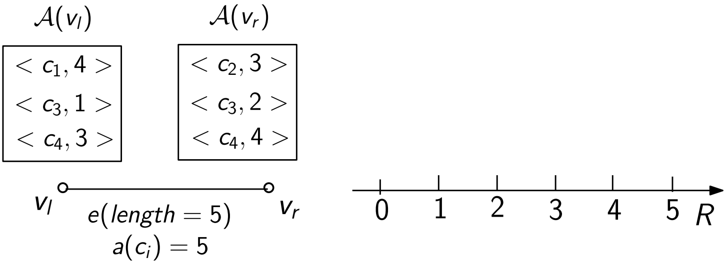

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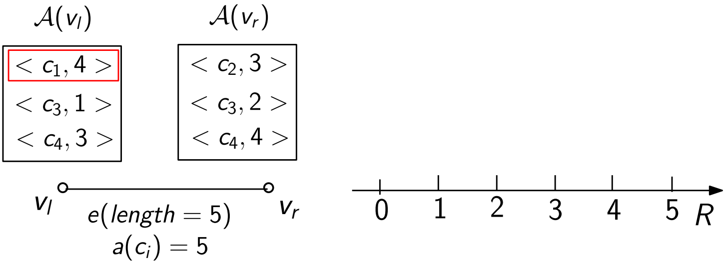

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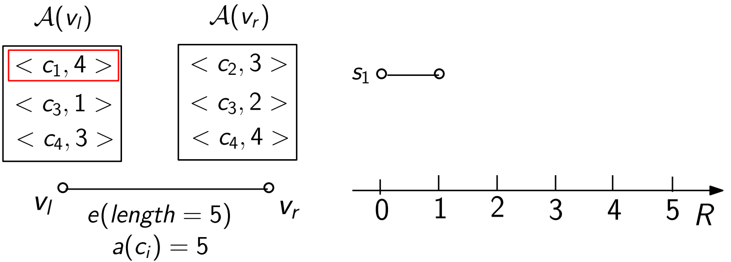

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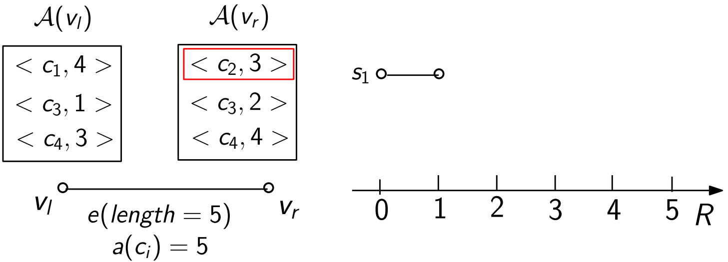

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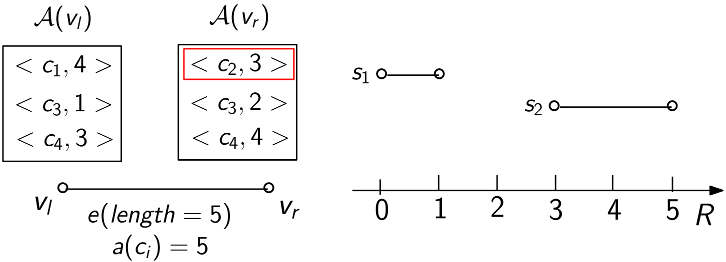

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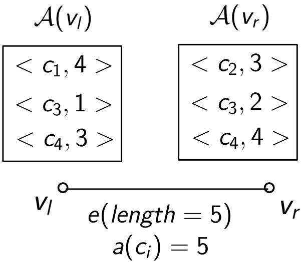

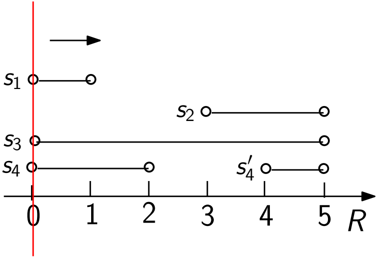

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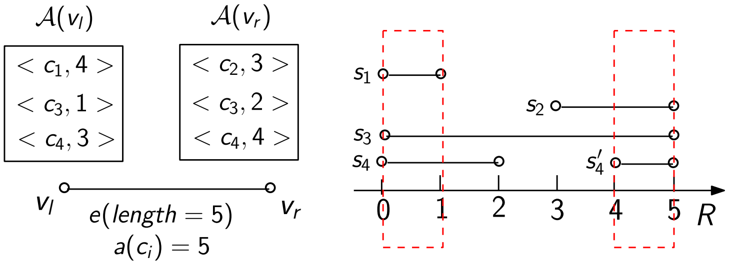

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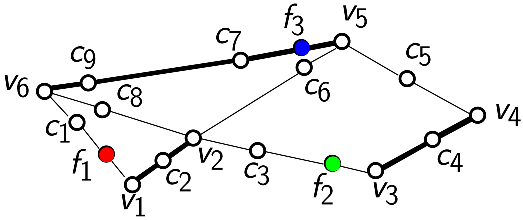

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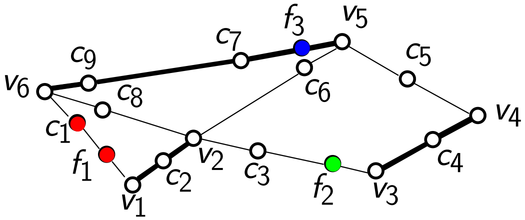

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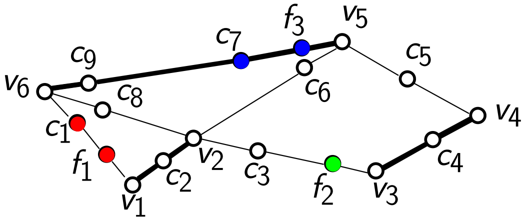

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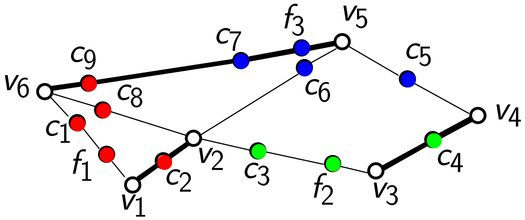

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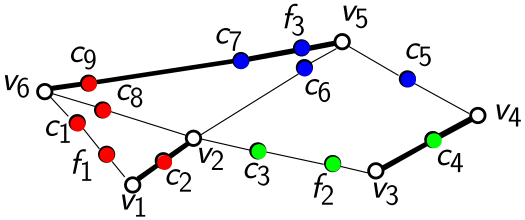

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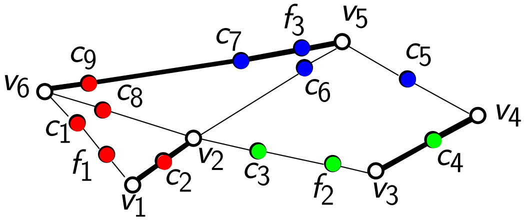

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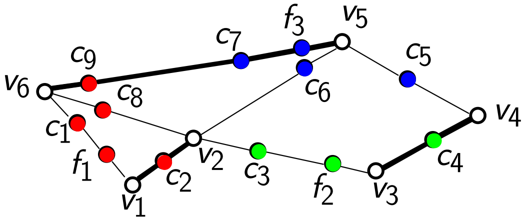

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- A straightforward solution:
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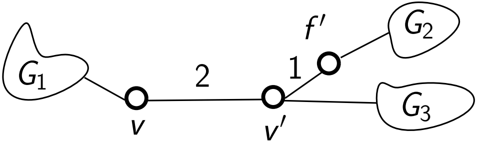

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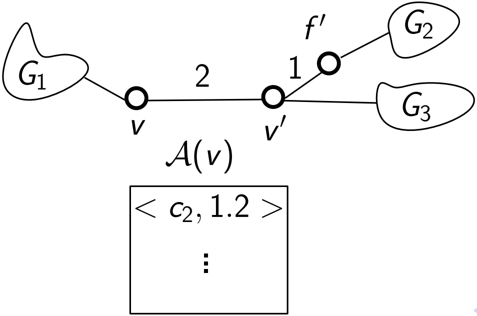

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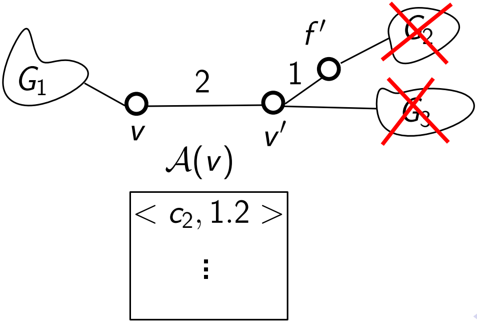

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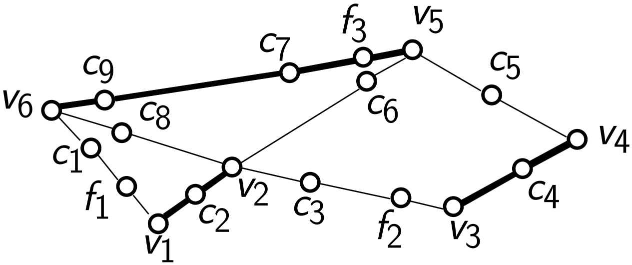

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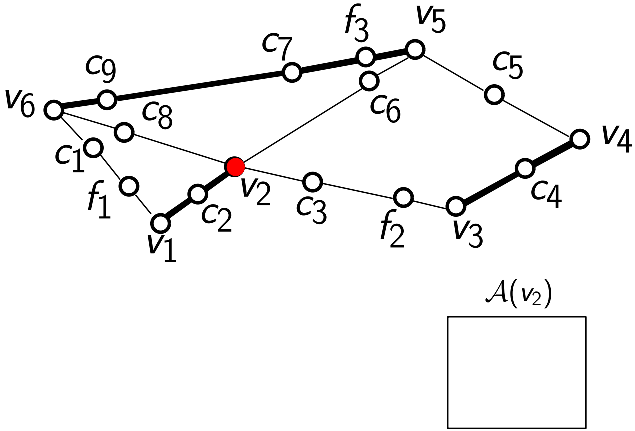

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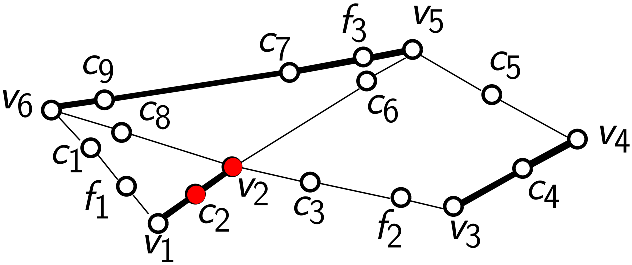

$d(v_2, c_2) \leq a(c_2)$

$\mathcal{A}(v_2)$

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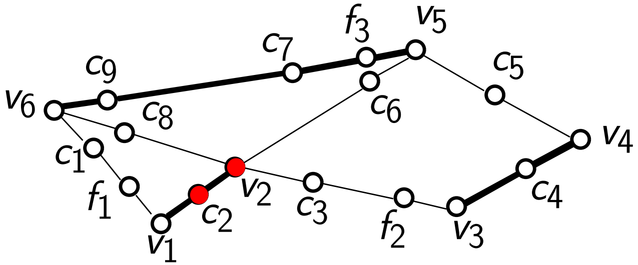

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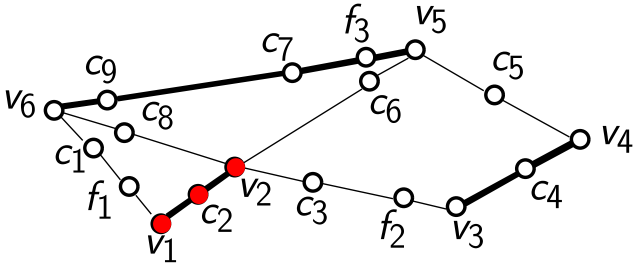

$d(v_2, v_1) > d(v_1, f_1)$

$\mathcal{A}(v_2)$

$< c_2, 1 >$

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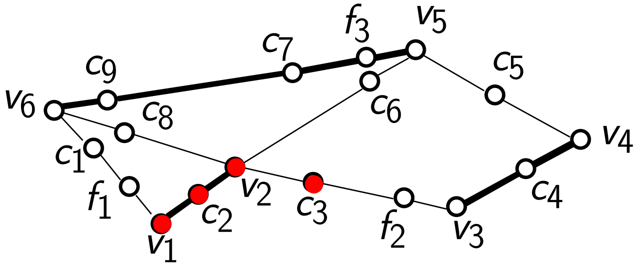

$\mathcal{A}(v_2)$

$< c_2, 1 >$
$< c_3, 2 >$

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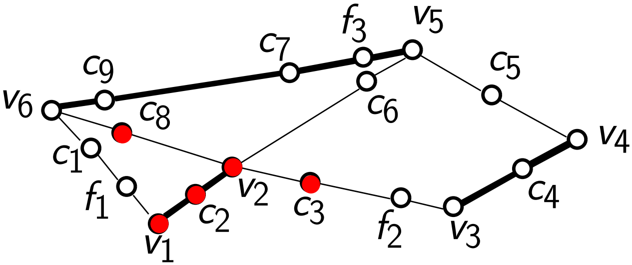

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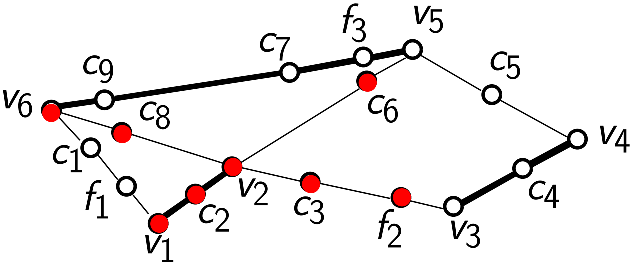

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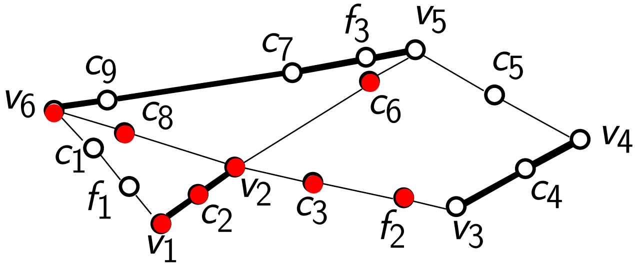

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- Time: $O(n^2 \log n)$, space: $O(n)$

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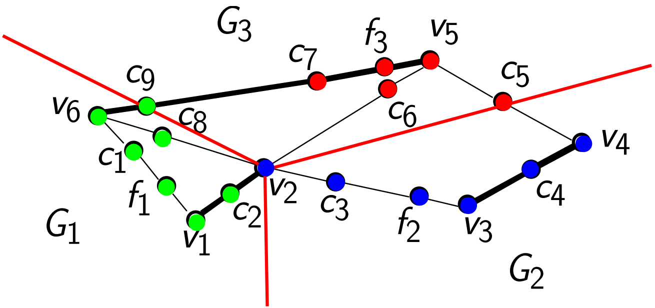

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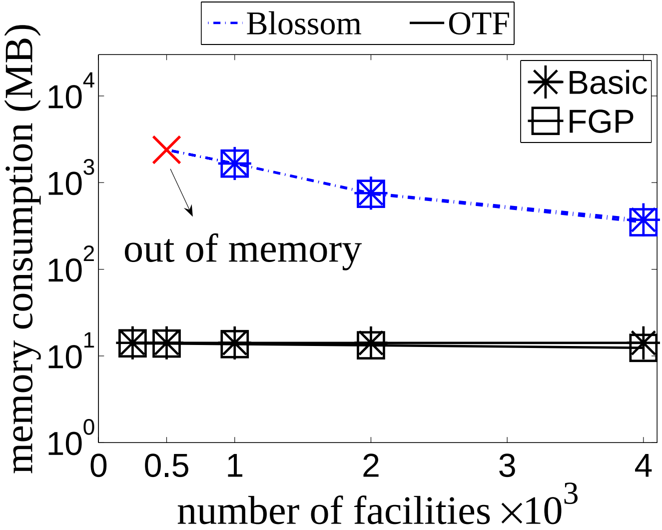
- Default settings.

Symbol	Definition	Default Value
$\lvert F\rvert$	number of facilities	1000
$\lvert C\rvert$	number of clients	$300,000$
τ	the percentage of candidate edges	100%

Vary $|F|$ (CLQ on SF)



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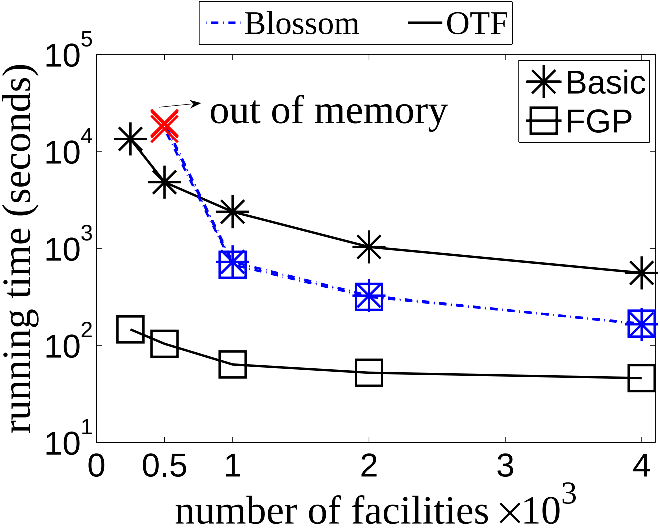
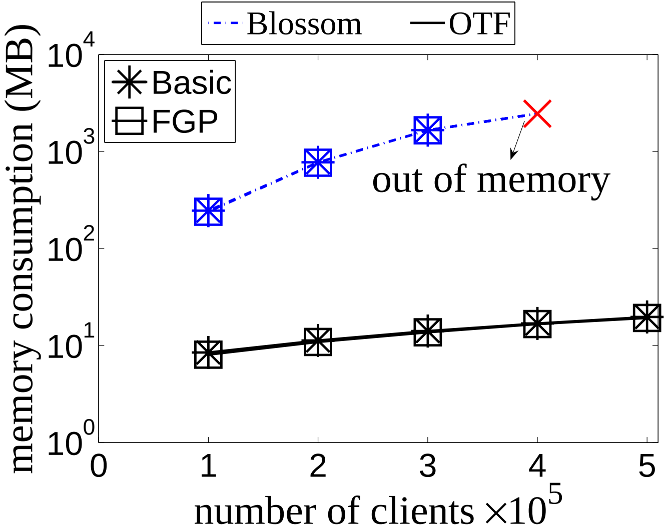
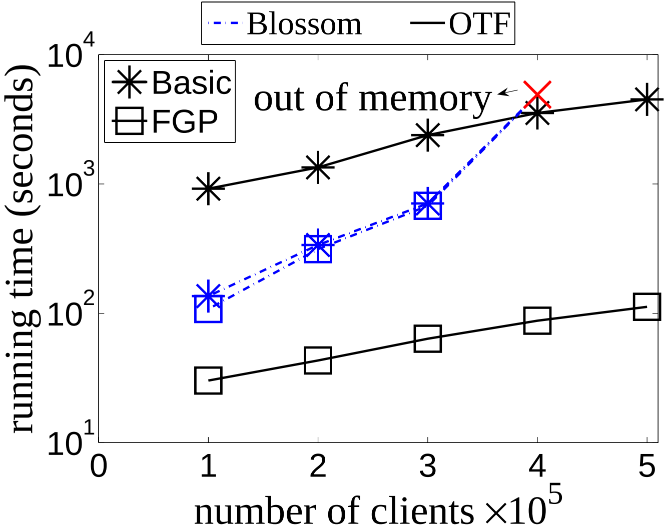


Vary |C| (CLQ on SF)





Blossom
OTF
Basic
FGP
out of memory
running time (seconds)
10^4
10^3
10^2
10^1
0
1
2
3
4
5
number of clients ×10^5

Conclusion

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- Introduce a unified framework that addresses all three query types efficiently.
- Future work
  - the incremental monitoring of the optimal locations when the facility or client sets have been updated.
  - the optimal location queries for moving objects in road networks.

Thank You

Q and A