On Exploiting Logical Dependencies for Minimizing Additive Cost Metrics in Resource-Limited Crowdsensing

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Road not blocked
Shelter has vacancy
Comm. center up
Disease controlled
Medic team staffed
Food store not flooded
Road not blocked
Shelter has vacancy
Disease controlled
Food store not flooded
Comm. center up
Medic team staffed
DECISION
Order?
OR

AND

A

B

C

AND

D

E
\[ C \quad \begin{array}{c} 4 \\ P(True) \end{array} \quad \begin{array}{c} 3 \\ 0.3 \\ 0.6 \end{array} \]
\[ C(D \rightarrow E) = 4 + 0.3(3) = 4.9 \]
\[ C(E \rightarrow D) = 3 + 0.6(4) = 5.4 \]
\[ C_{\text{L-R}} = 7 + (1-0.1) \times 4.9 = 11.41 \]
\[ C_{\text{R-L}} = 4.9 + (1-0.18) \times 7 = 10.64 \]
key: Shortcut probability cost
DEADLINE
How much?
Complete Algorithm Sketch

- Concurrent queries with deadlines

- Greedy approach:
  - Compute most cost-effective object to retrieve next
  - Check expected latencies against deadlines
    - Increase parallel retrieval level if misses expected
Evaluation

- Simulation experiments
- An application scenario
Simulation Experiments

- **Baselines**
  - Random order
  - Lowest cost object first
  - Most urgent query first
  - Most urgent query’s lowest cost object first

- **Settings**
  - # Objects per query: 4, 8, 12, 16, 20
  - # ANDs per query: 1, 3, 5, 7
  - # concurrent queries: 5, 10, 15, 20, 25
  - Deadline levels (\( \frac{\text{deadline}}{\sum \text{latencies}} \)): 0.5, 1, 2, 4, 8
Simulation Results

Varying # objects per query
Simulation Results

Varying # ANDs per query
Simulation Results

Varying # concurrent queries
Simulation Results

Varying queries’ deadline levels
Application: Route Finding

- Find routes for \(<\text{src}, \text{dst}>\) pairs
  - Each candidate route: **AND** of its segments
  - Routing result: **OR** of all candidate routes
- Visual verification for route segment conditions
Route Finding Example Run

- 3 disaster response teams’ computed candidate routes
All relevant roads

Retrieved by *lc*

Retrieved by *greedy*
<table>
<thead>
<tr>
<th># Road conditions retrieved</th>
<th>Greedy</th>
<th>Least-cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrieval cost ratio (%)</td>
<td>28.95</td>
<td>58.56</td>
</tr>
<tr>
<td>Deadline meet rate (%)</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Conclusion

- Data retrieval algorithms for crowdsensing under resource constraints
- Minimizing cost under timeliness requirements
- Promising results through simulations and concrete route finding application scenario
Thanks
backup
Team 1
Team 2
Team 3