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

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Solution 1
Solution 2
Solution 3

Shelter has vacancy

Comm. center up

Road not blocked

DECISION

Disease controlled

Medic team staffed

Food store not flooded

Road not blocked

Food store not flooded

Disease controlled

Shelter has vacancy

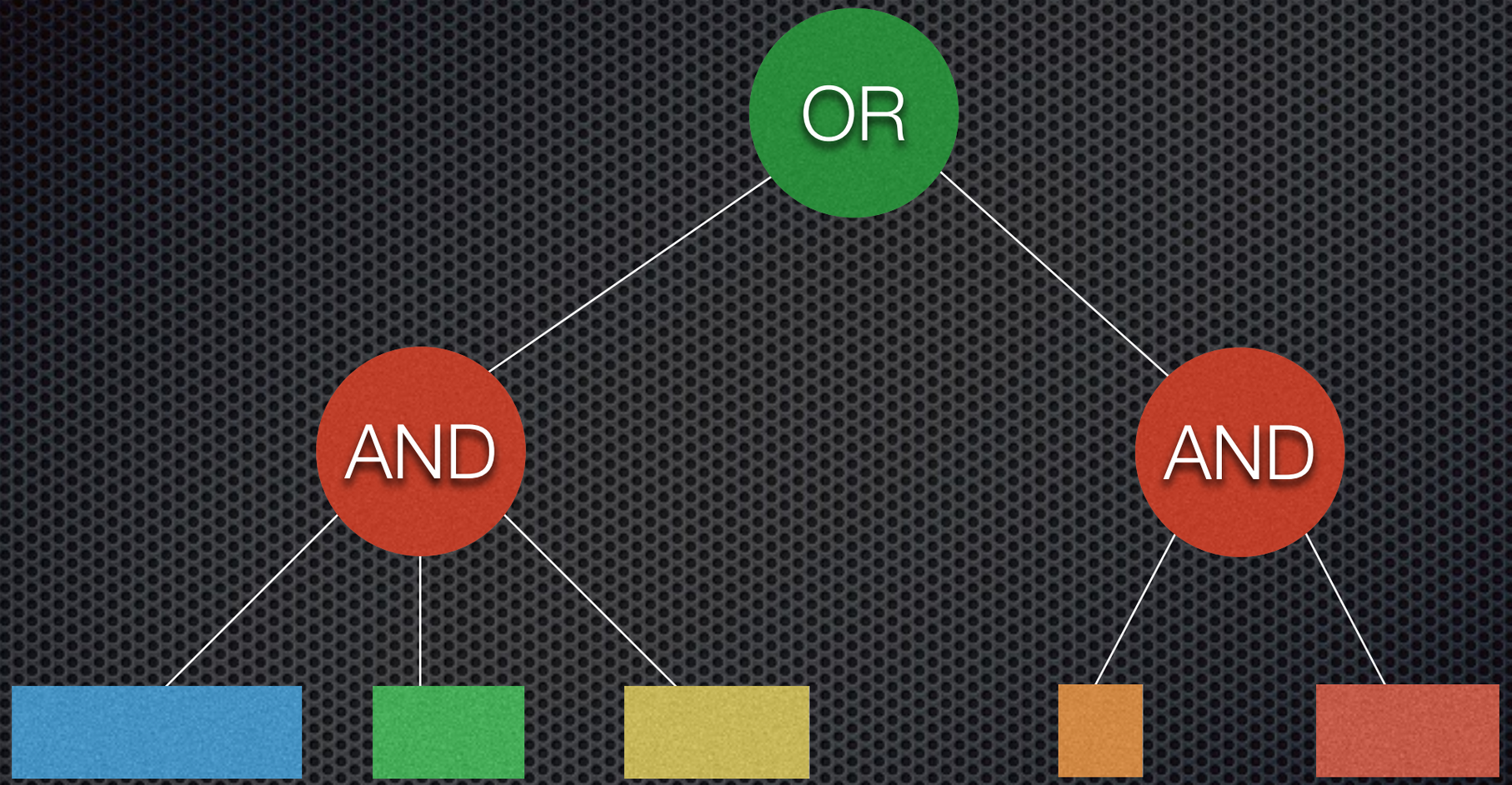
Comm. center up

Medic team staffed

DECISION

Decision Maker

1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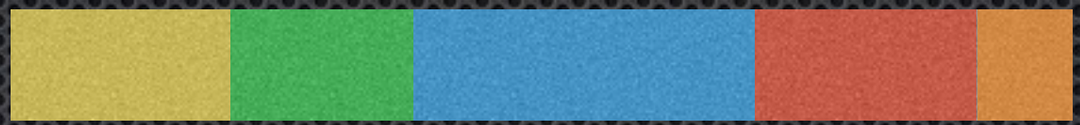
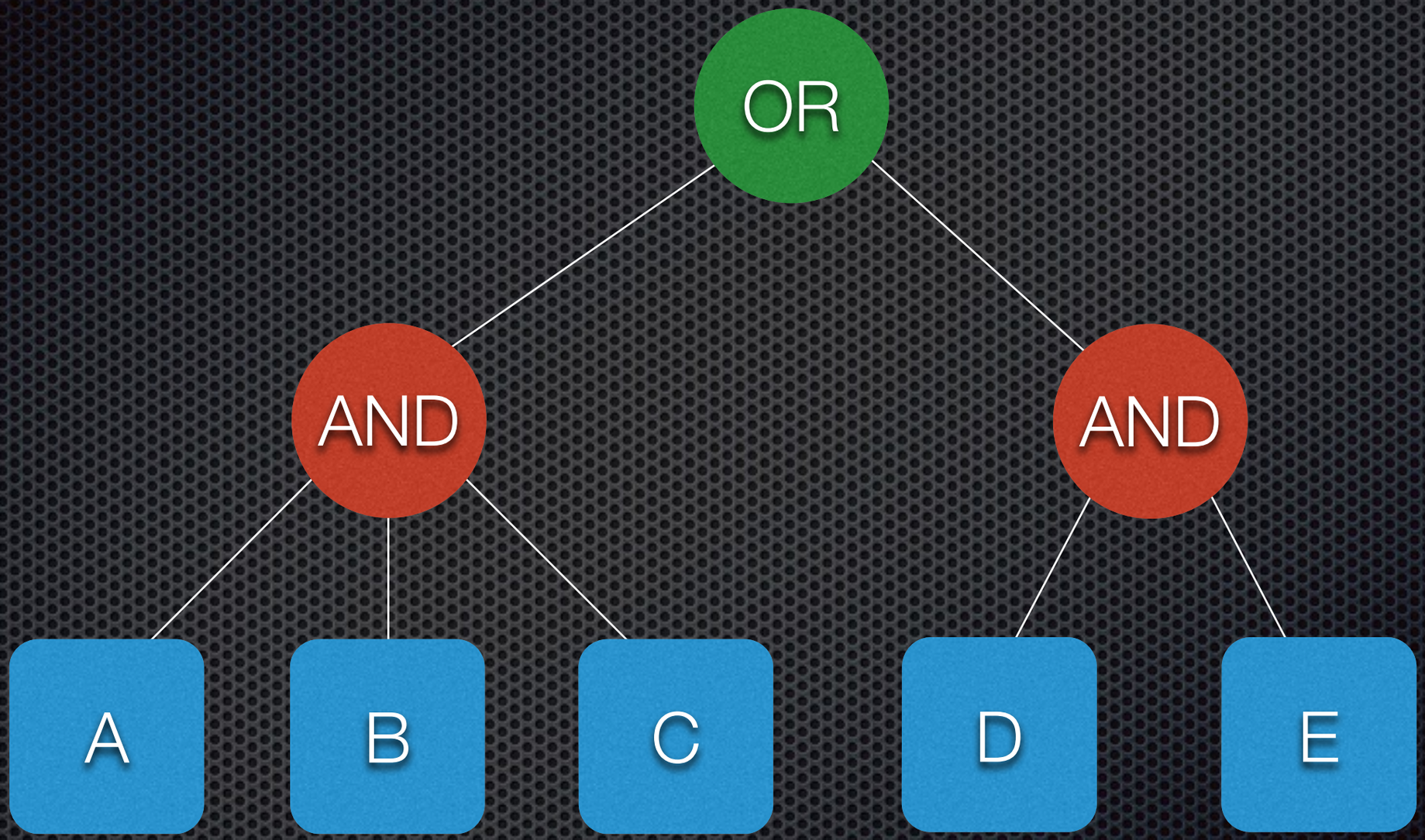
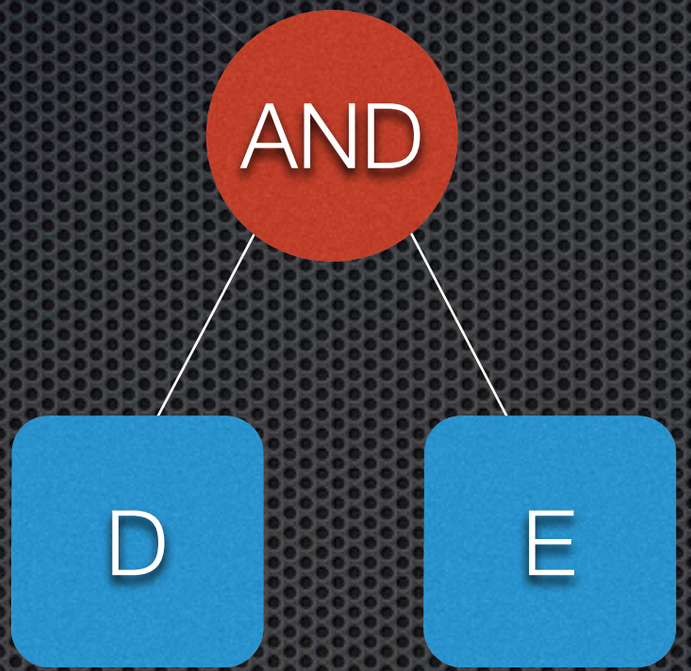
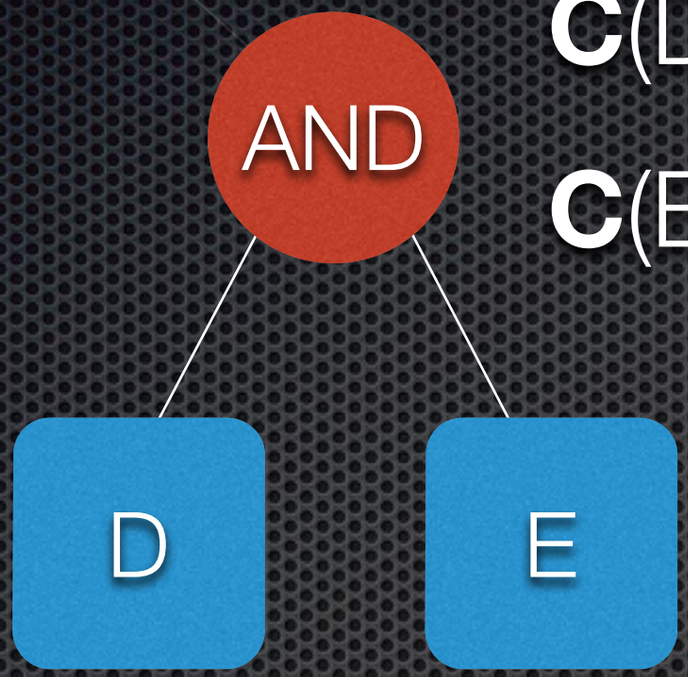


Order?


OR
AND
AND
A
B
C
D
E



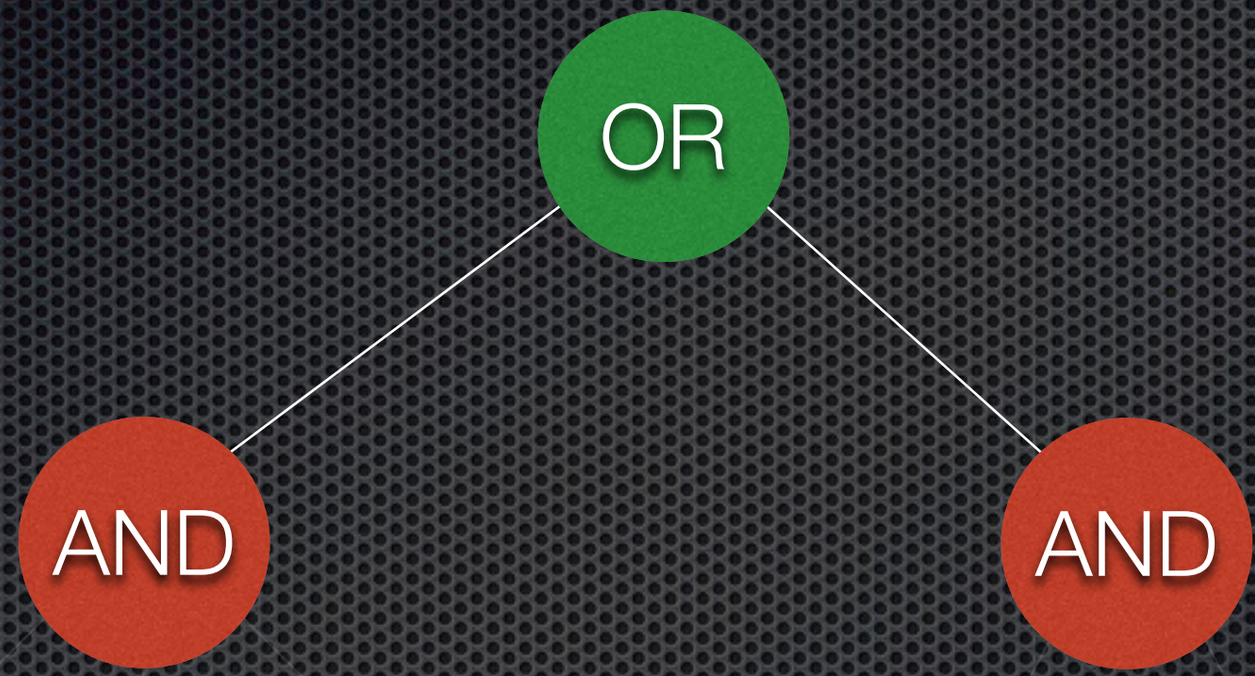
C	4	3
P(*True*)	0.3	0.6



C(D->E) = 4+0.3(3) = **4.9**

C(E->D) = 3+0.6(4) = **5.4**

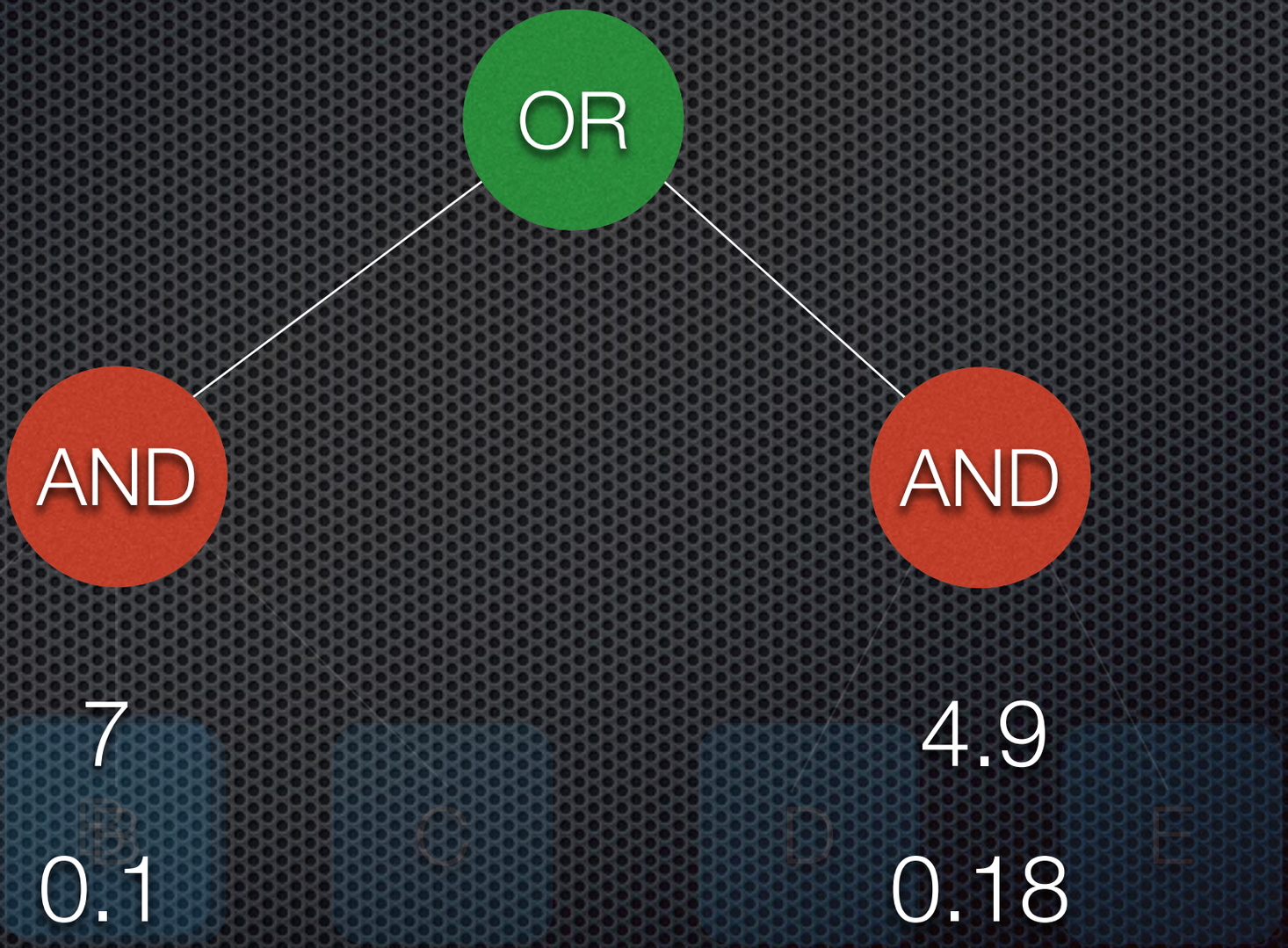
	D	E
C	4	3
P(*True*)	0.3	0.6



C	7	4.9
P(*True*)	0.1	0.18

C(L->R) = 7+(1-0.1)x4.9 = **11.41**

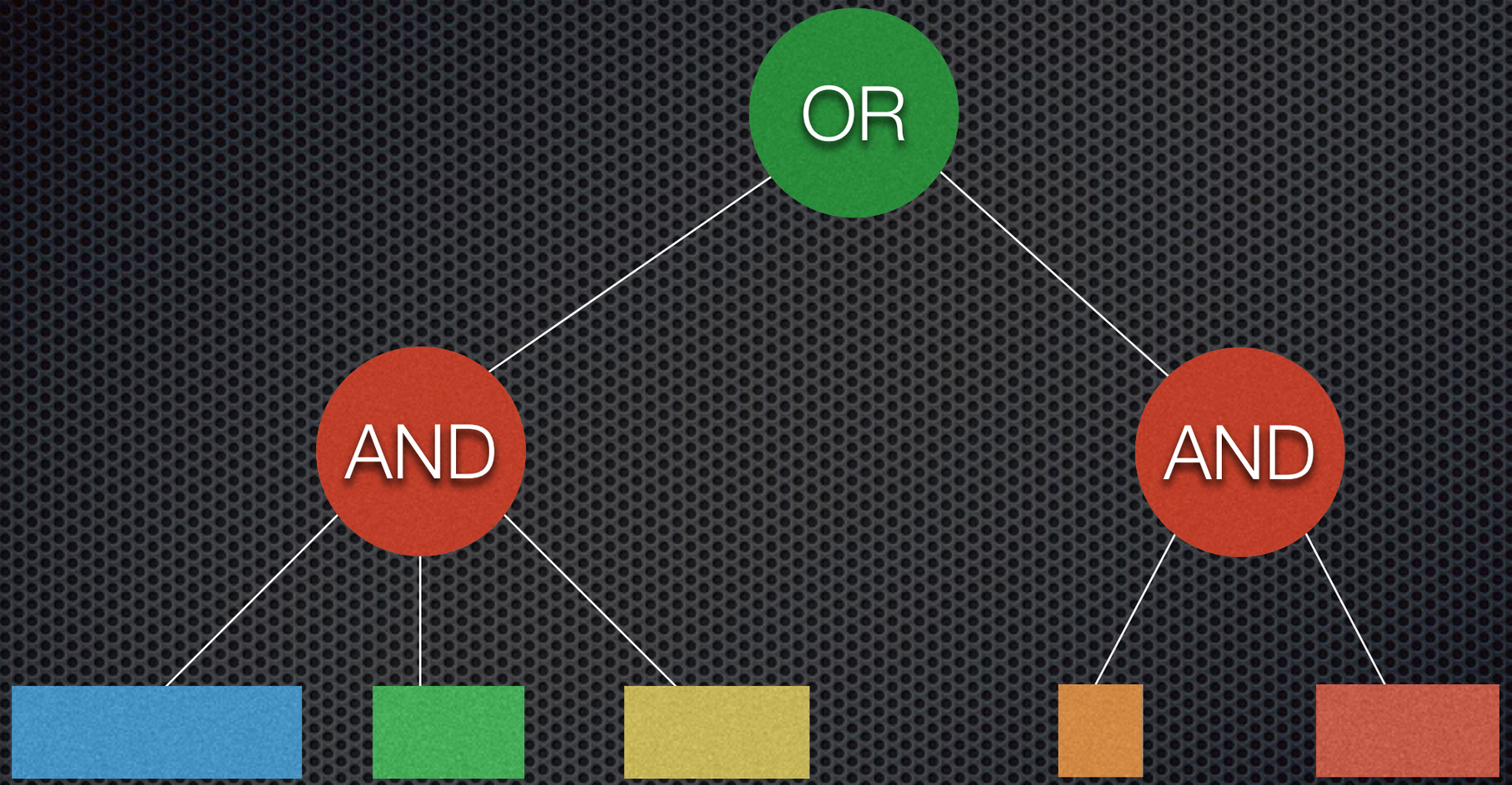
C(R->L) = 4.9+(1-0.18)x7 = **10.64**



key: $\frac{\text{Shortcut probability}}{\text{cost}}$

2


DEADLINE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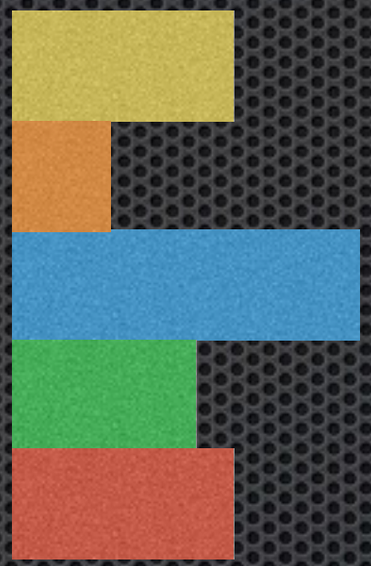
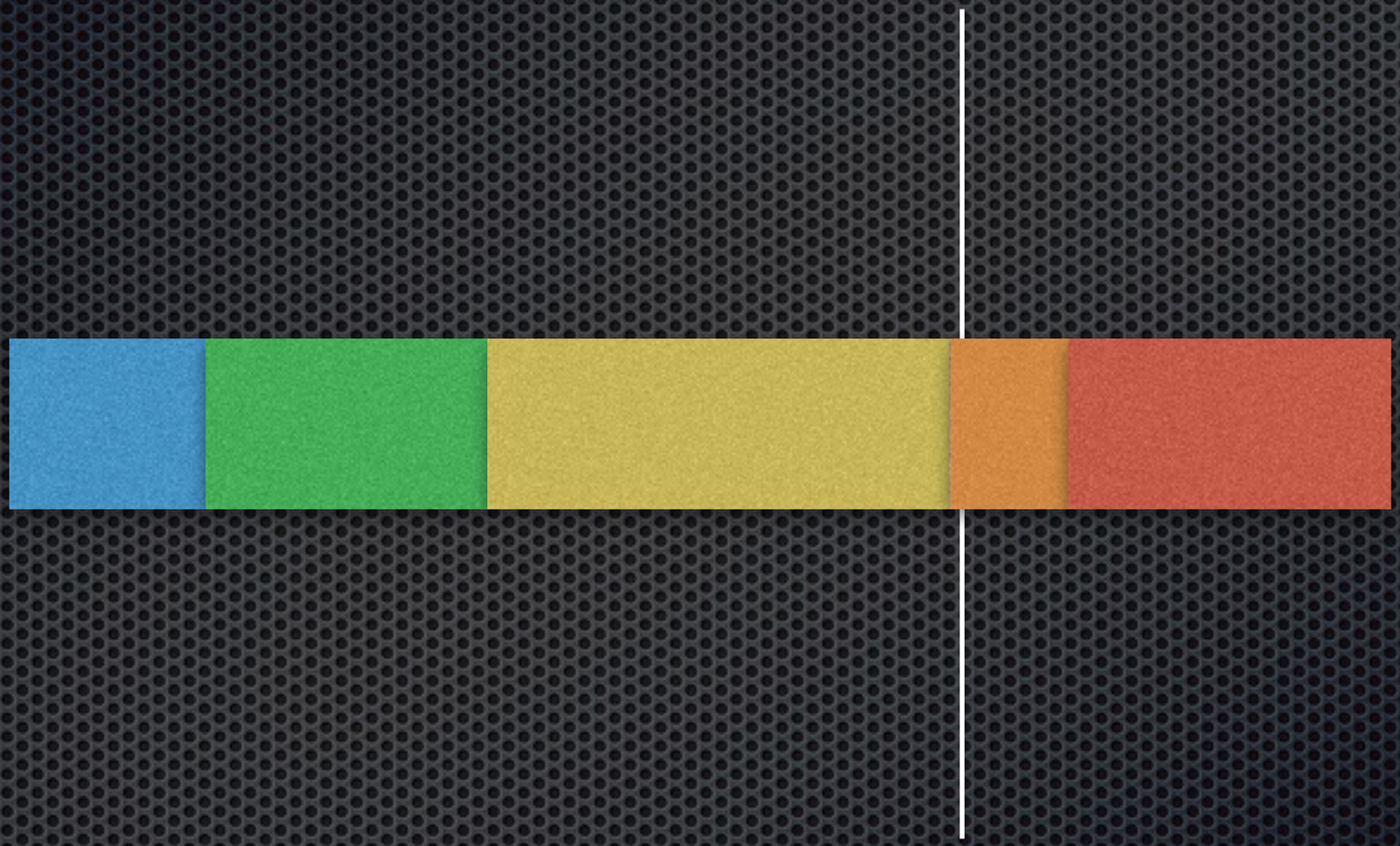
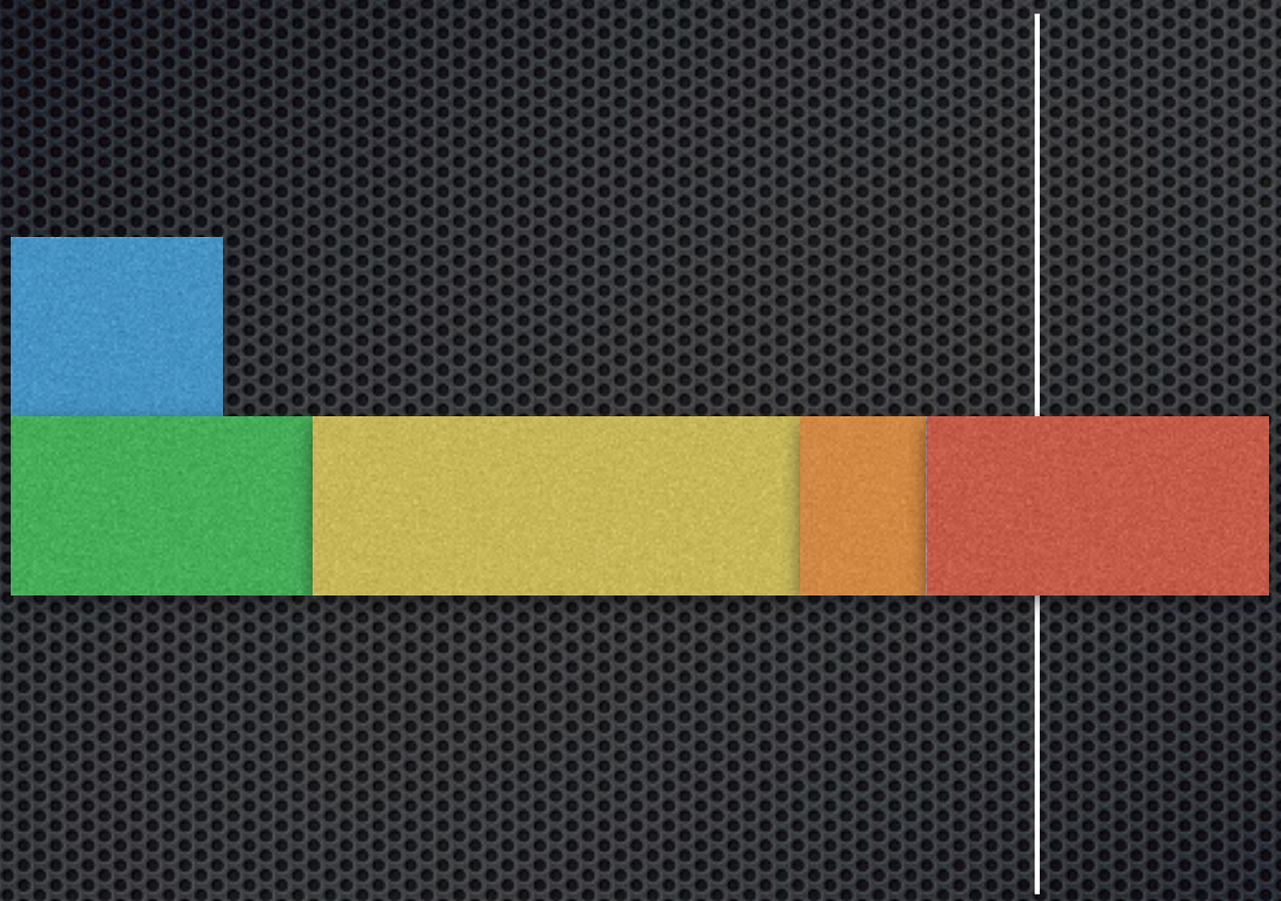
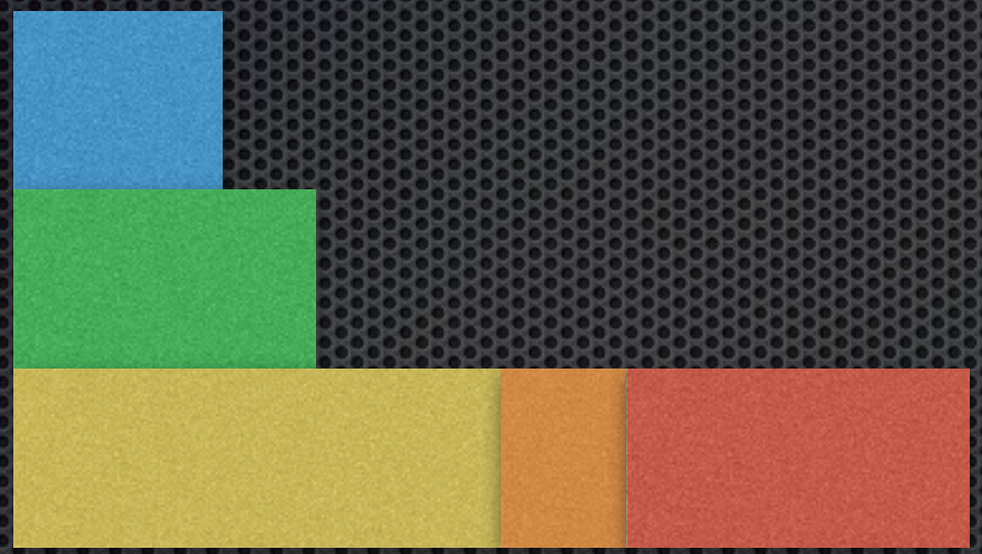


How much?







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

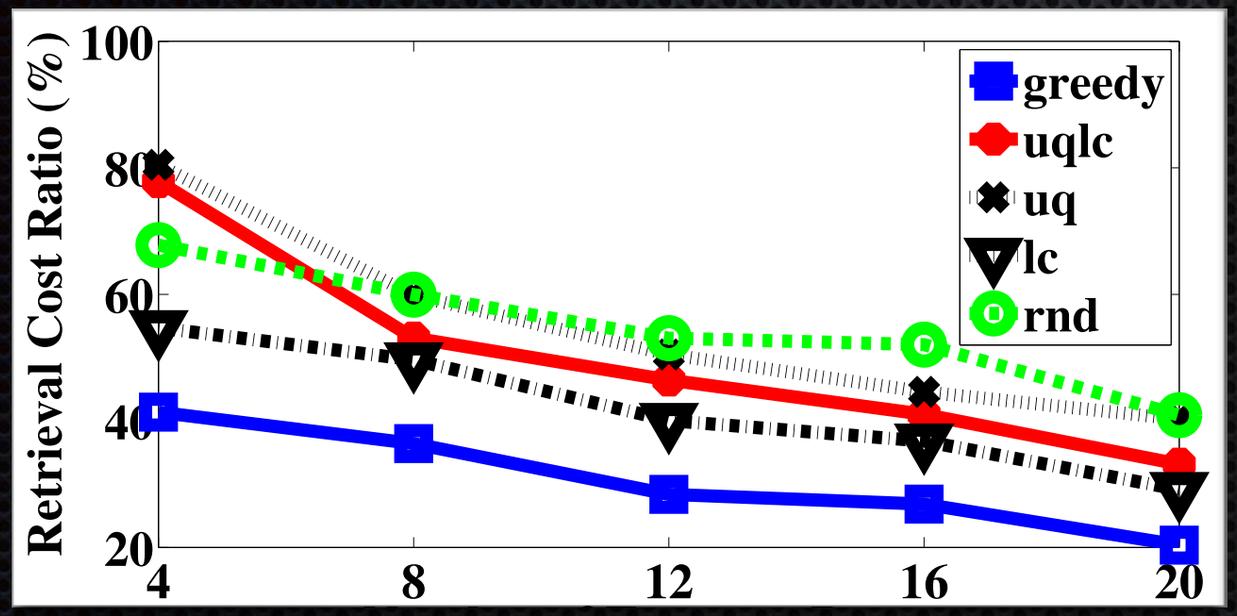
Evaluation

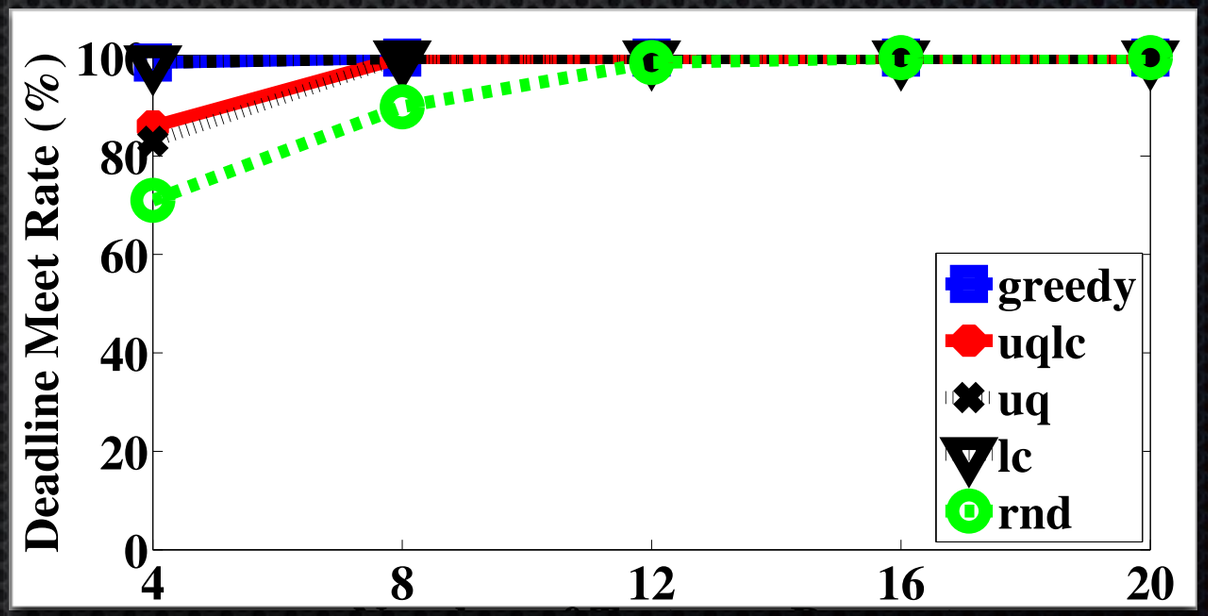
- Simulation experiments
- An application scenario

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

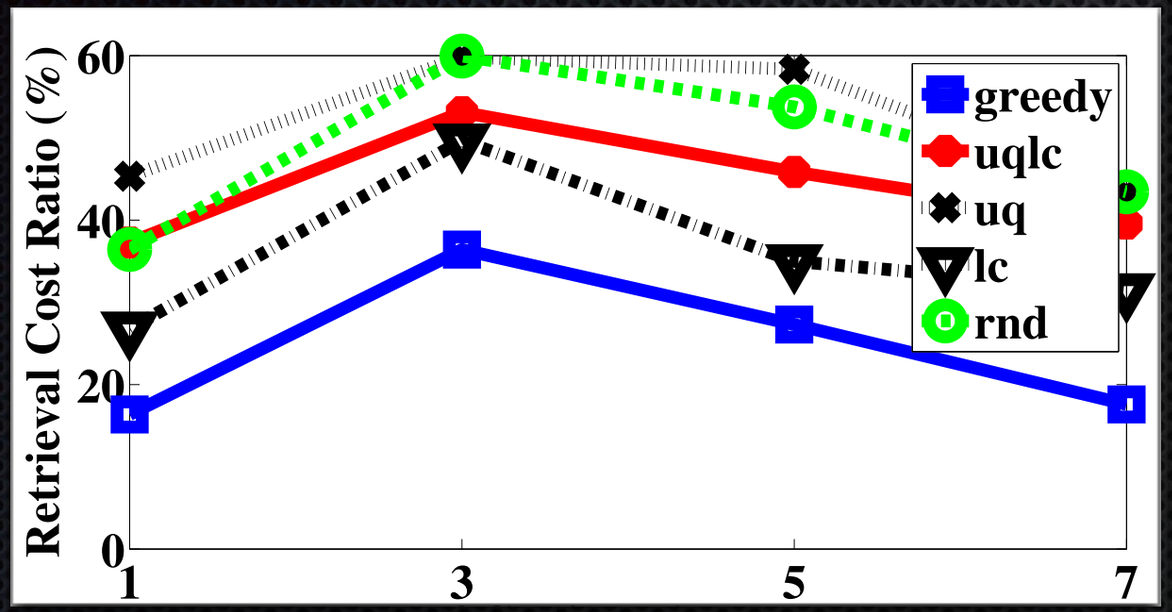
Simulation Results

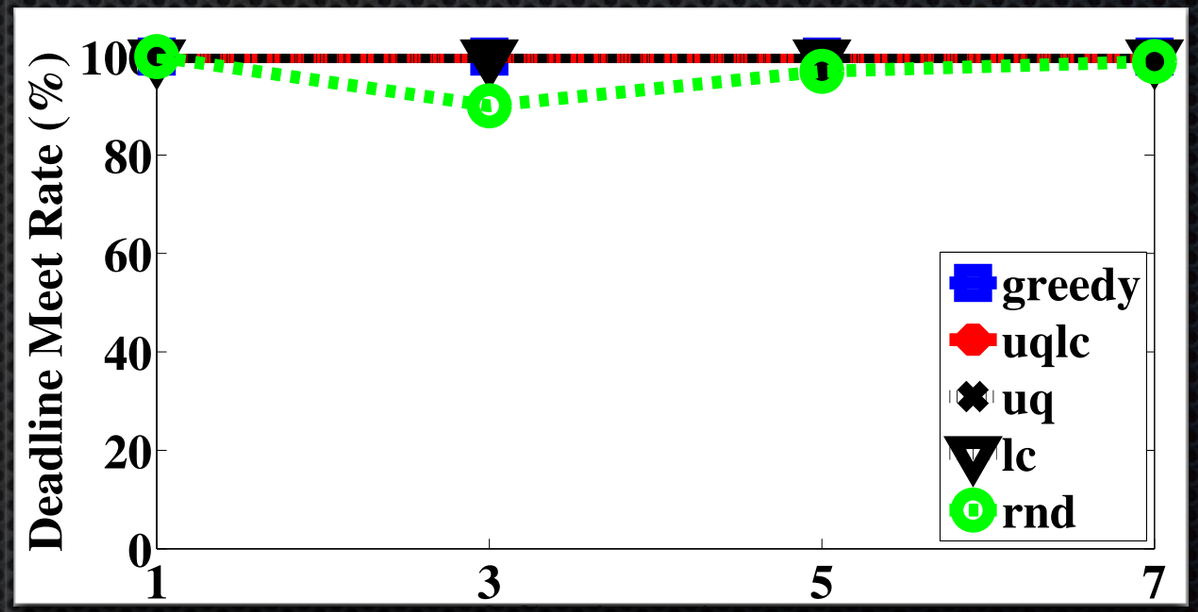




Varying # objects per query

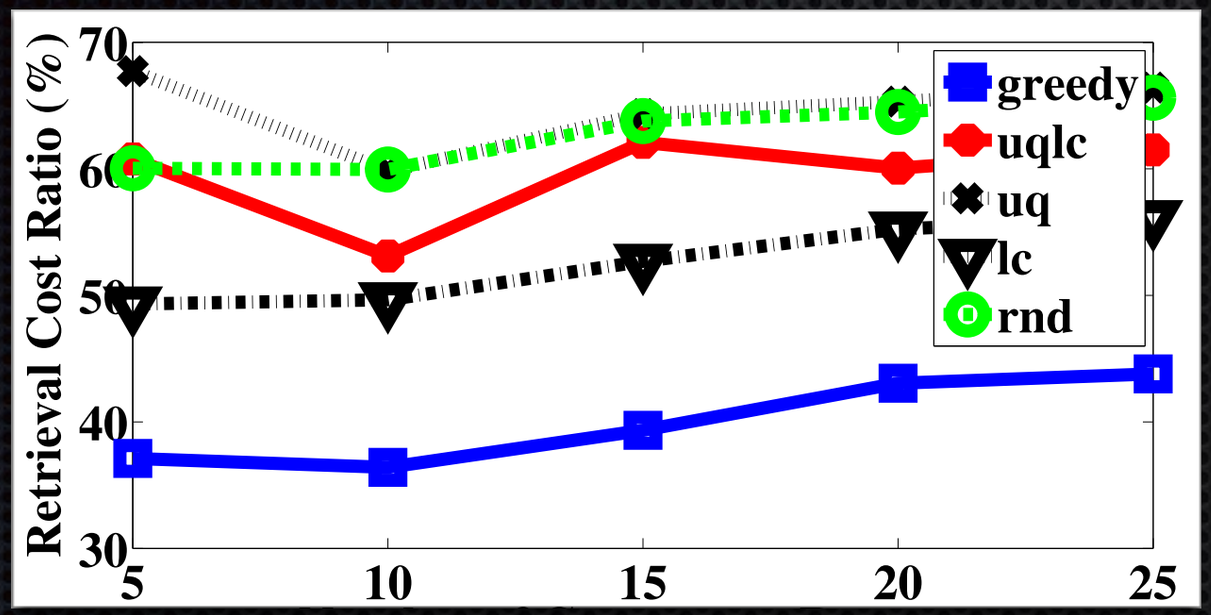
Simulation Results

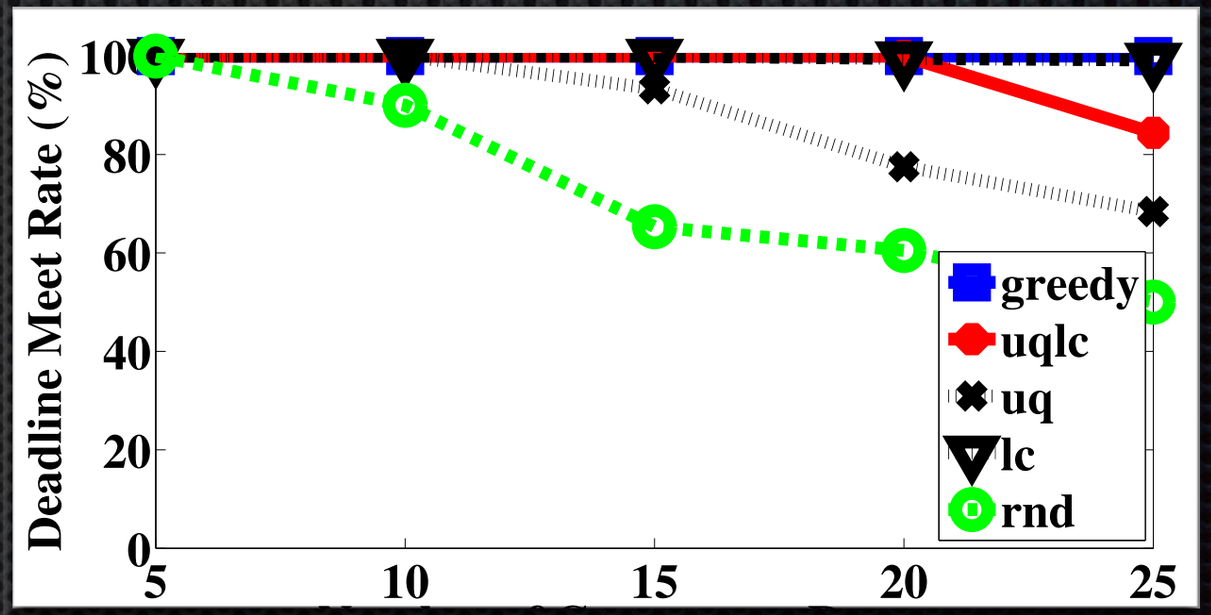




Varying # ANDs per query

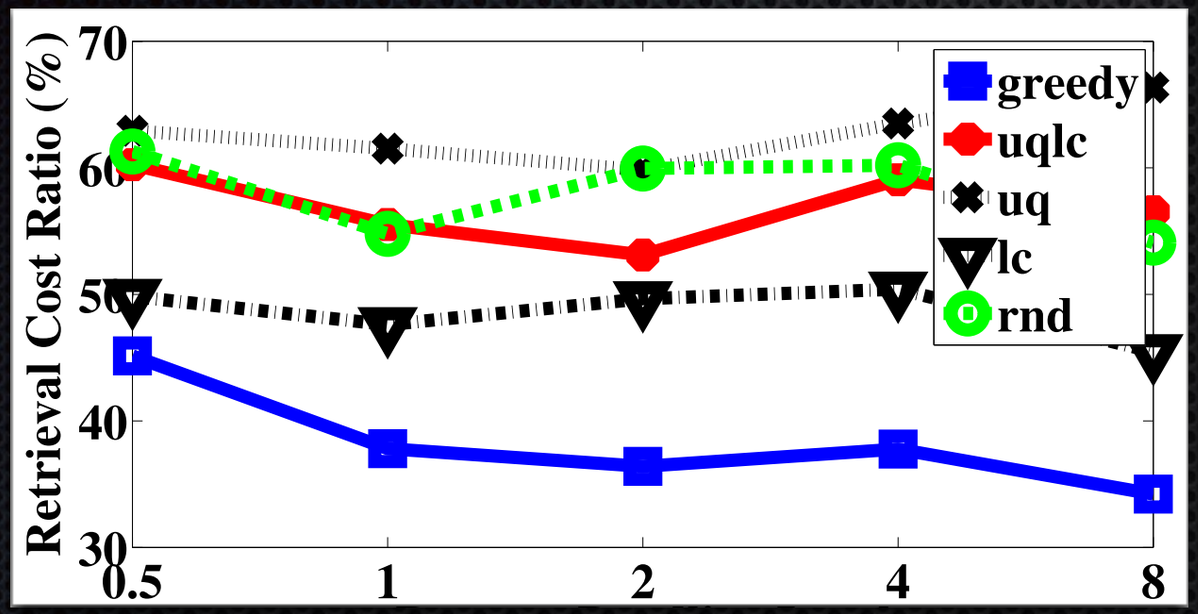
Simulation Results

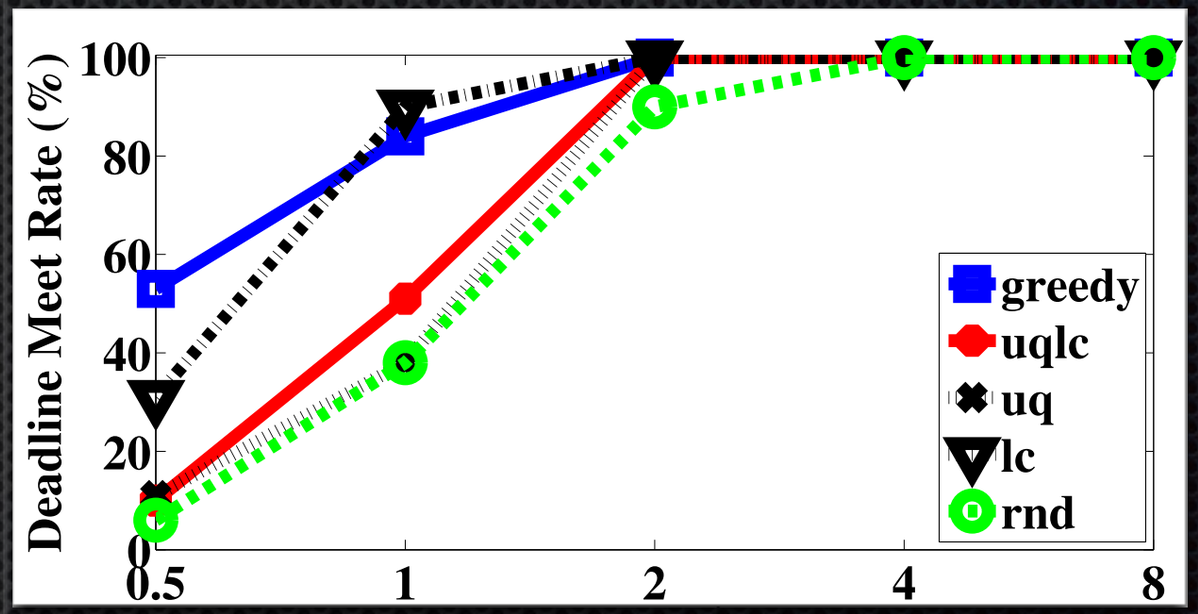




Varying # concurrent queries

Simulation Results





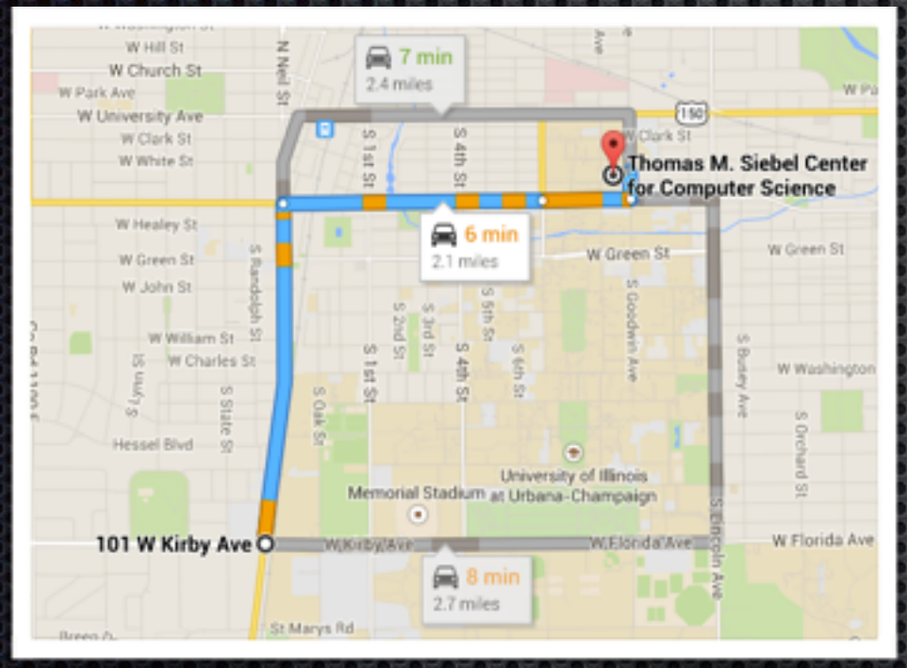
Varying queries' deadline levels

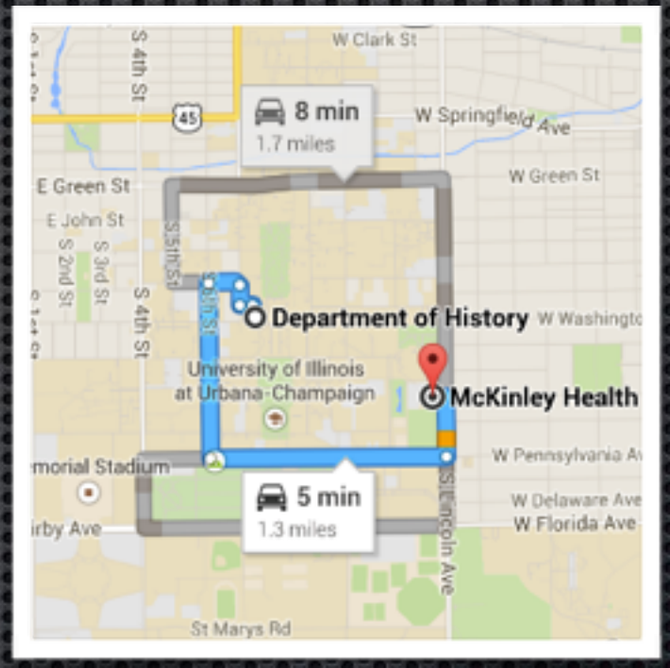
Application: Route Finding

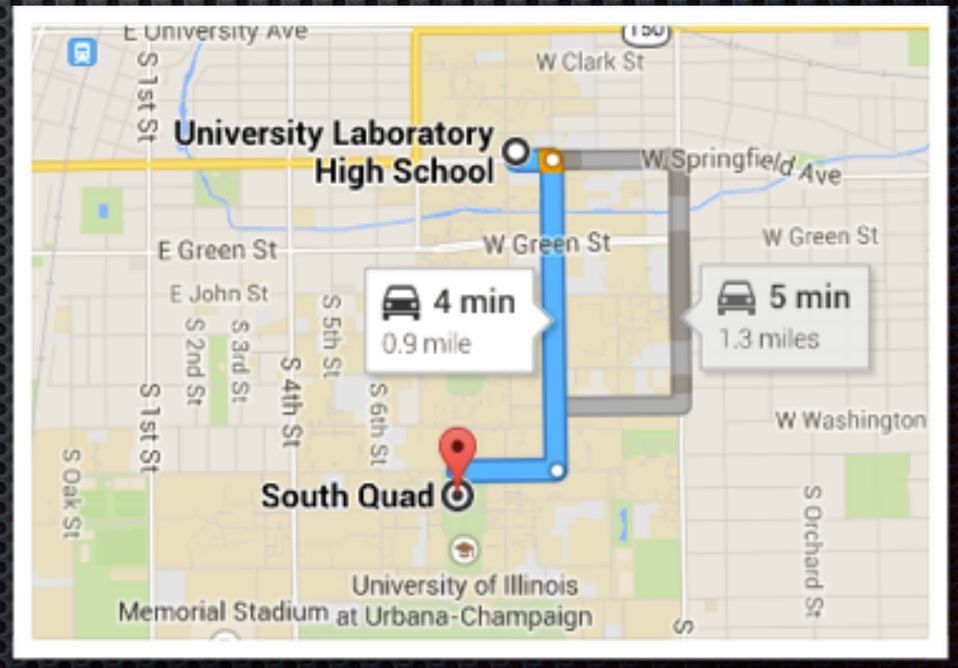
- Find routes for <src, dst> pairs
  - Each candidate route: **AND** of its segments
  - Routing result: **OR** of all candidate routes
- Visual verification for route segment conditions

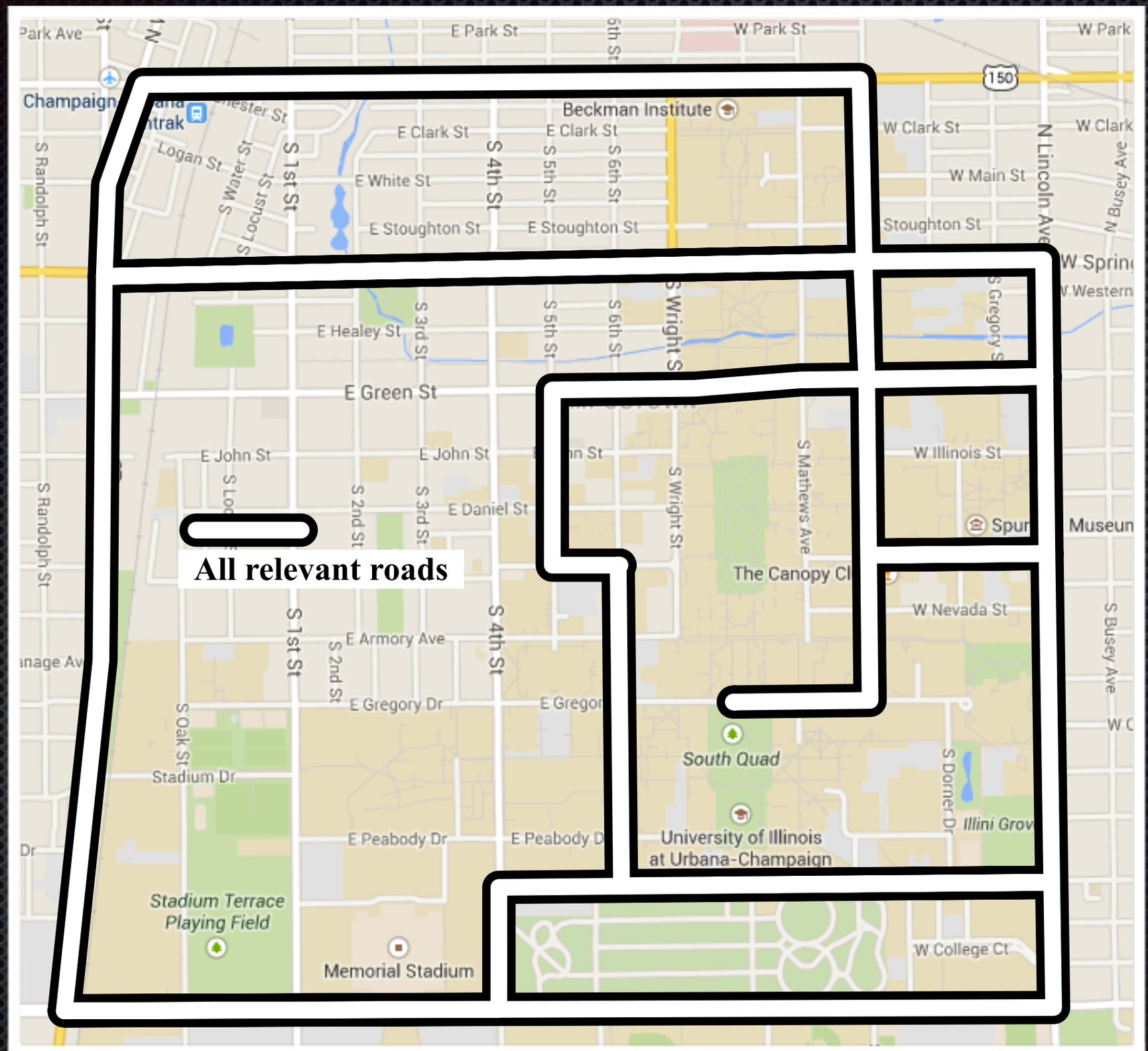
Route Finding Example Run

- 3 disaster response teams' computed candidate routes





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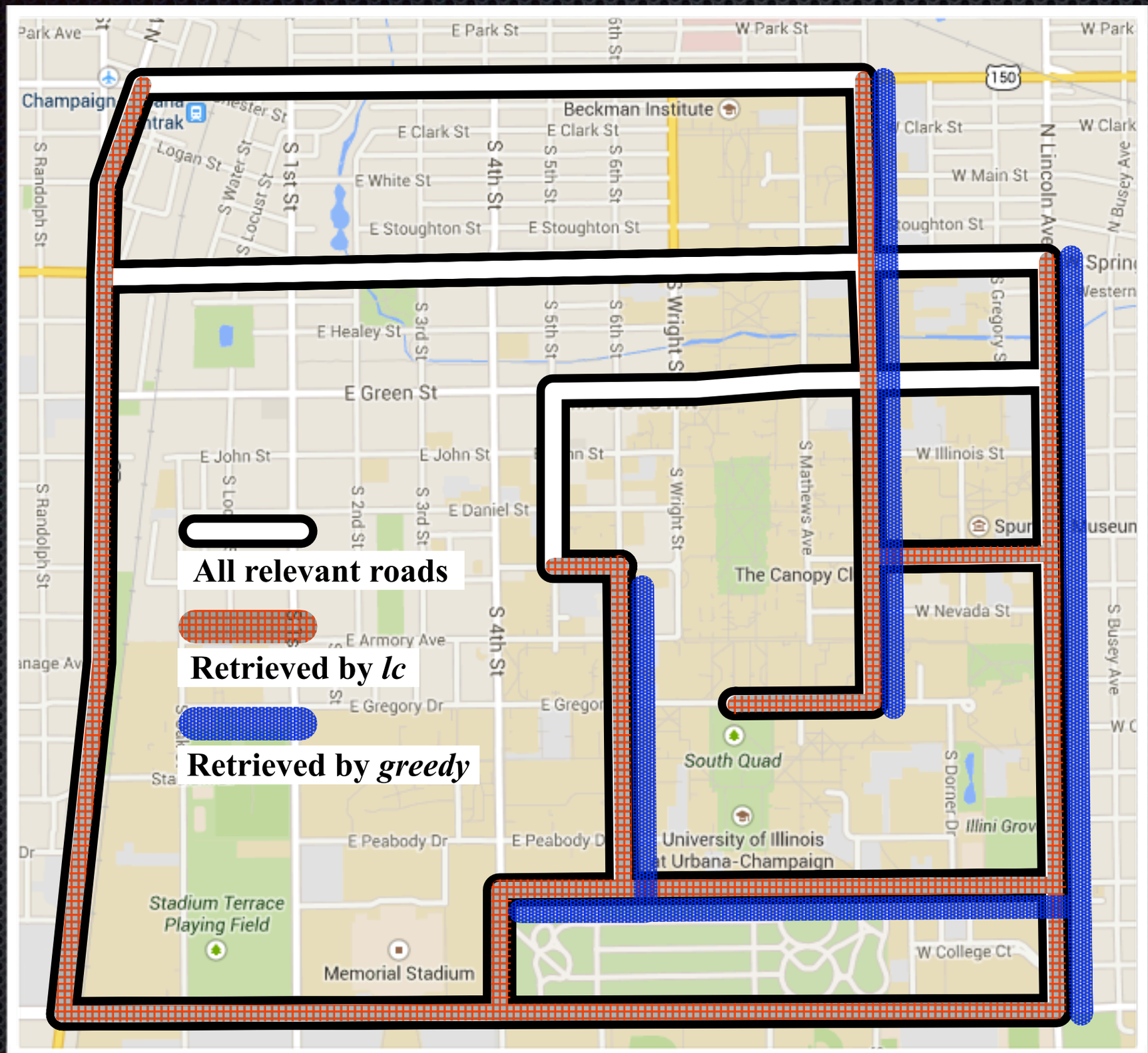
W Park St
W Park
Champaign
Beckman Institute
E Clark St
W Clark St
W Clark
150
N Lincoln Ave
N Busey Ave
W Main St
E White St
E Stoughton St
Stoughton St
S 1st St
S 4th St
S 5th St
S 6th St
S Randolph St
S Wright St
E Healey St
S 3rd St
E Green St
E John St
W Illinois St
S Mathews Ave
E Daniel St
S 2nd St
The Canopy Cl
W Nevada St
S Busey Ave
E Armory Ave
E Gregory Dr
S Oak St
Stadium Dr
South Quad
S Dorner Dr
E Peabody Dr
University of Illinois
at Urbana-Champaign
Stadium Terrace
Playing Field
Memorial Stadium
W College Ct


All relevant roads
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Retrieved by *greedy*
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150

	Greedy	Least-cost
# Road conditions retrieved	**4**	**9**
Retrieval cost ratio (%)	**28.95**	**58.56**
Deadline meet rate (%)	**100**	**100**

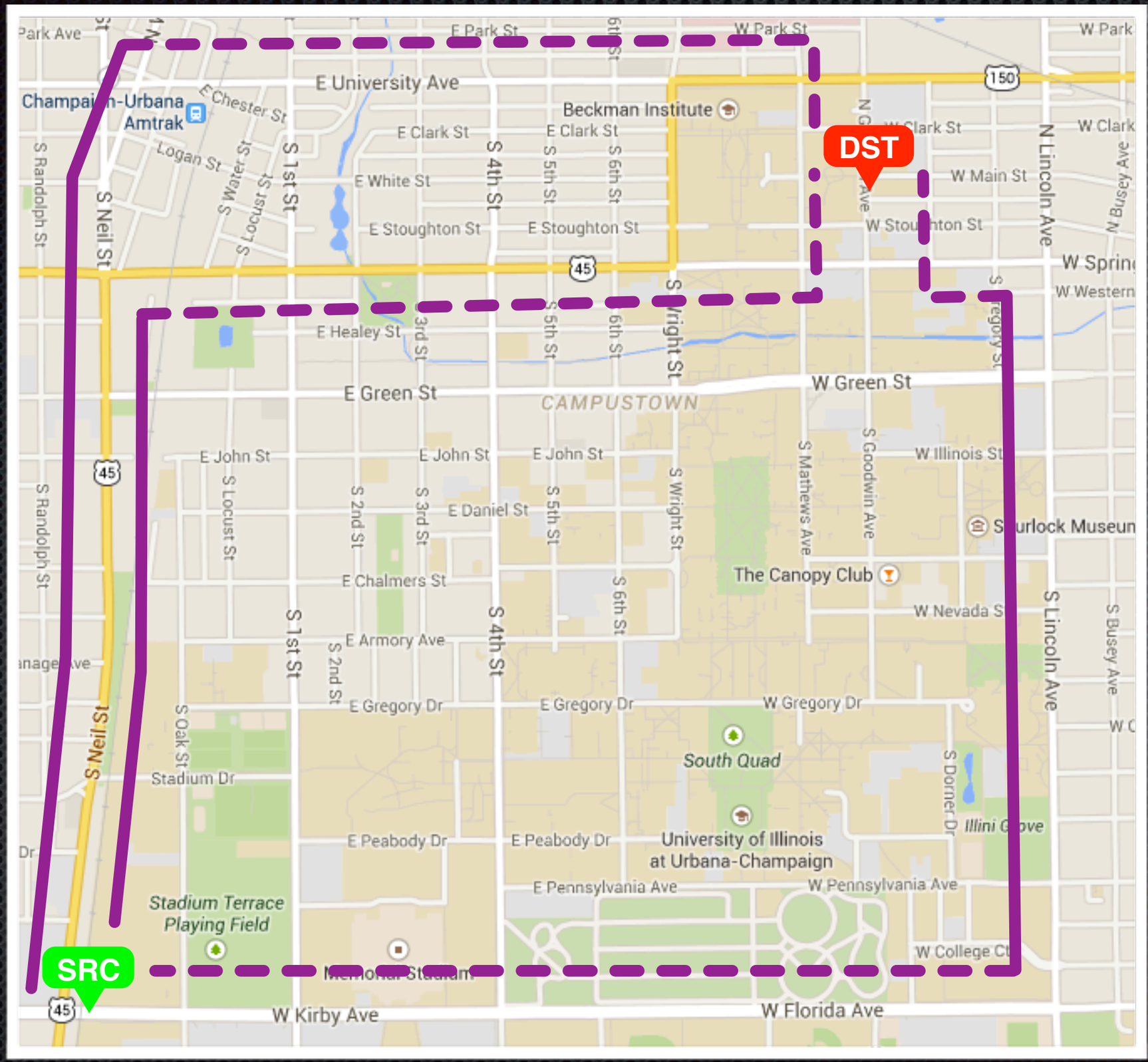
Conclusion

- 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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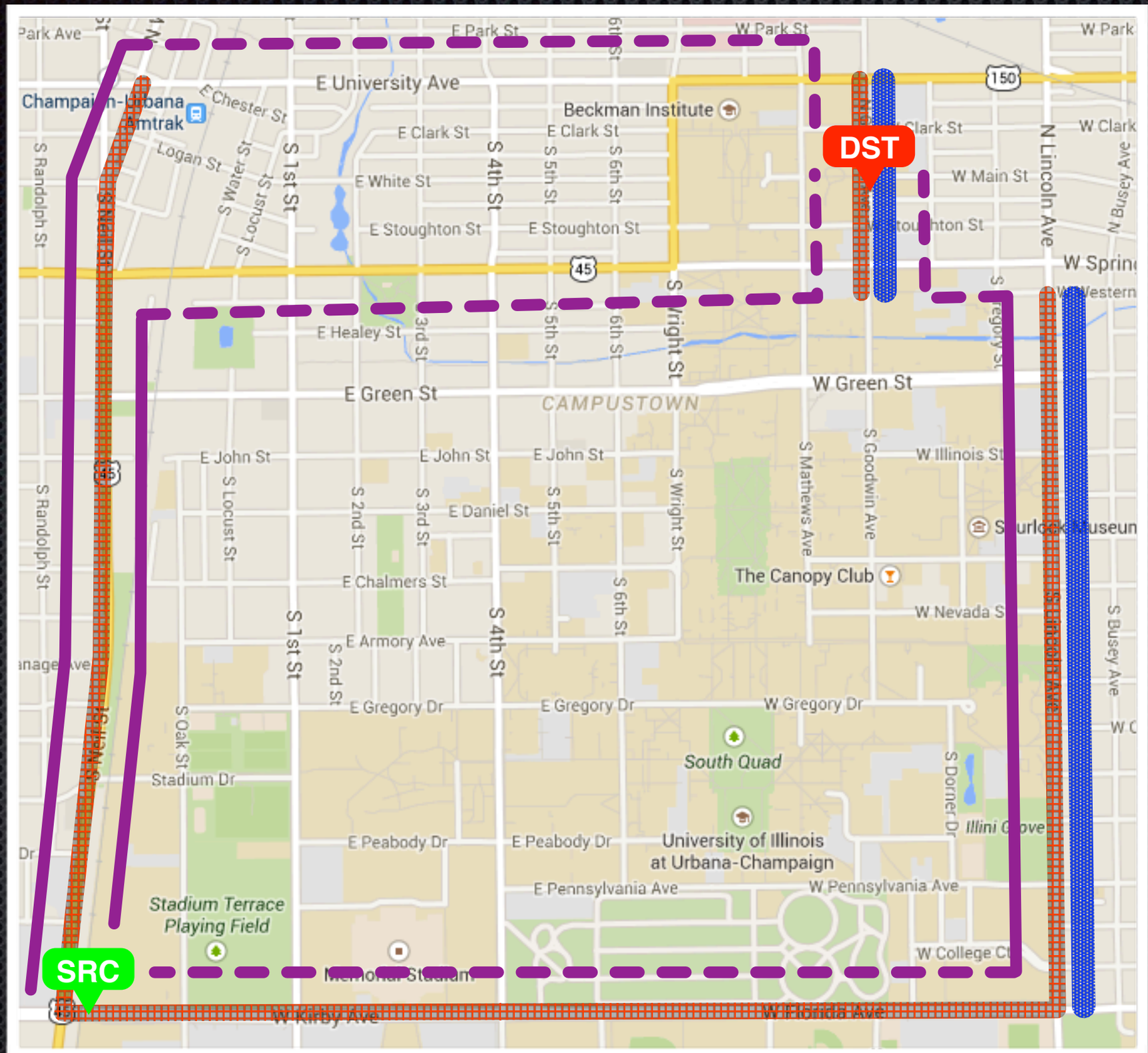
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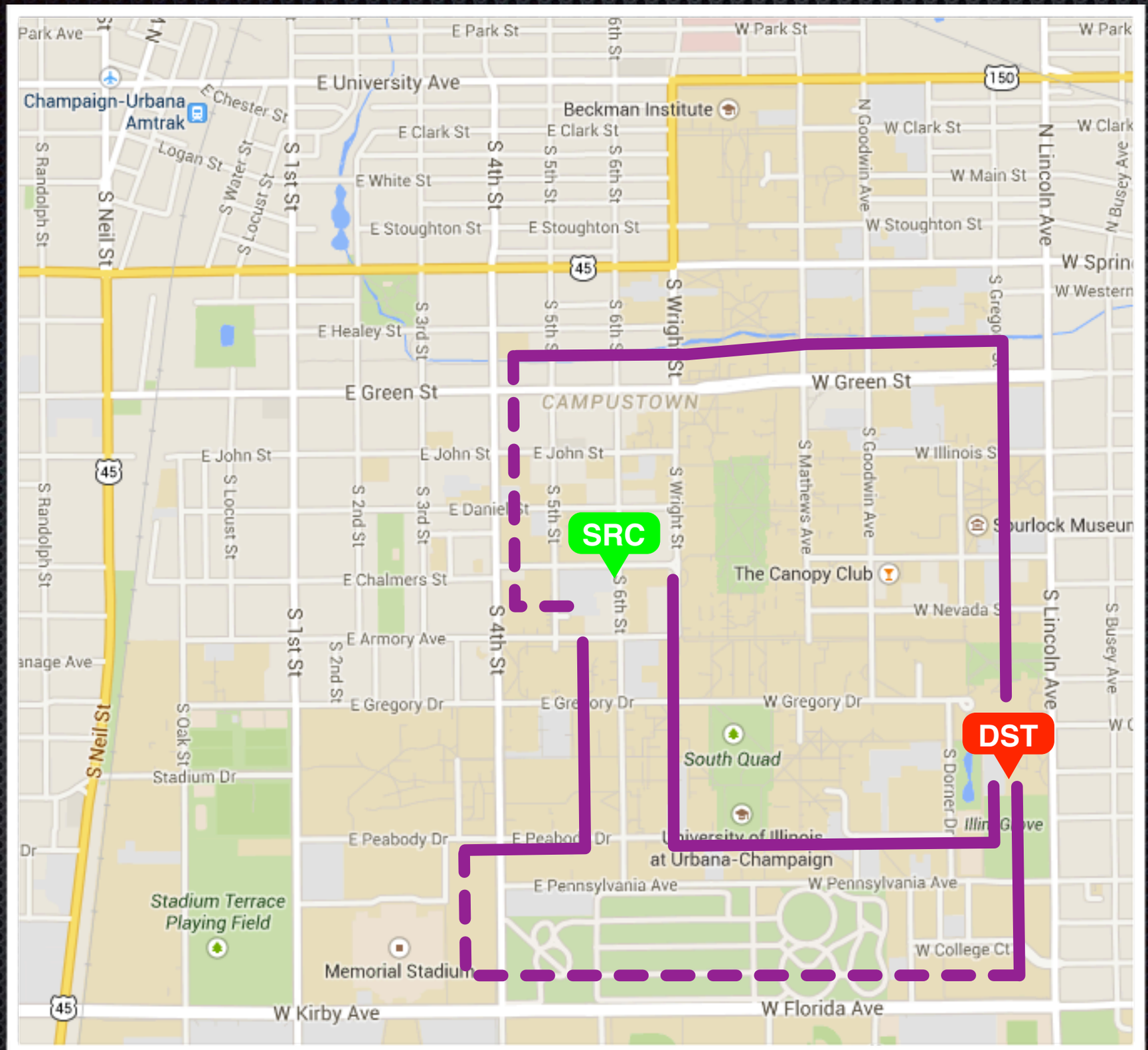
Team 2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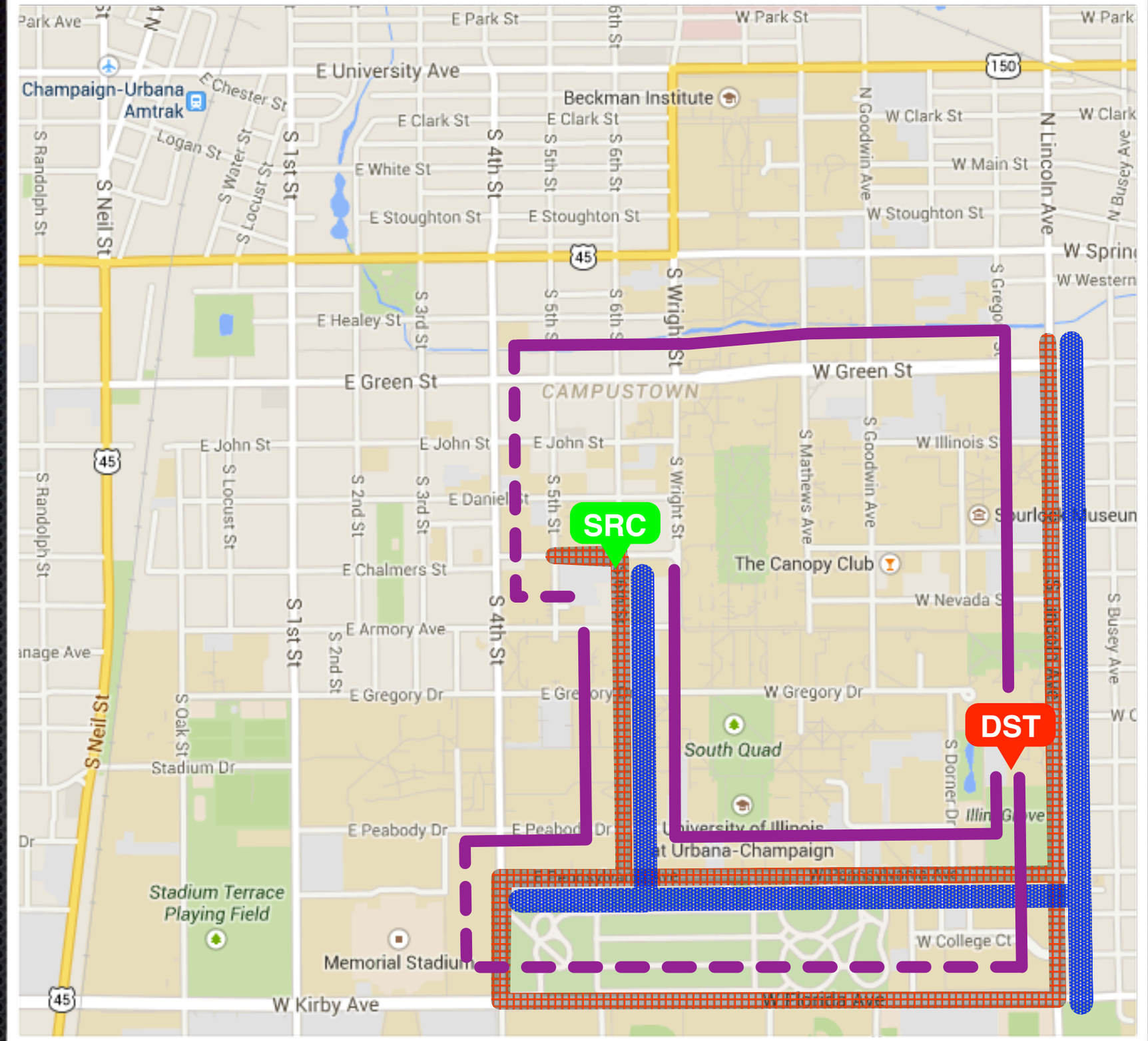
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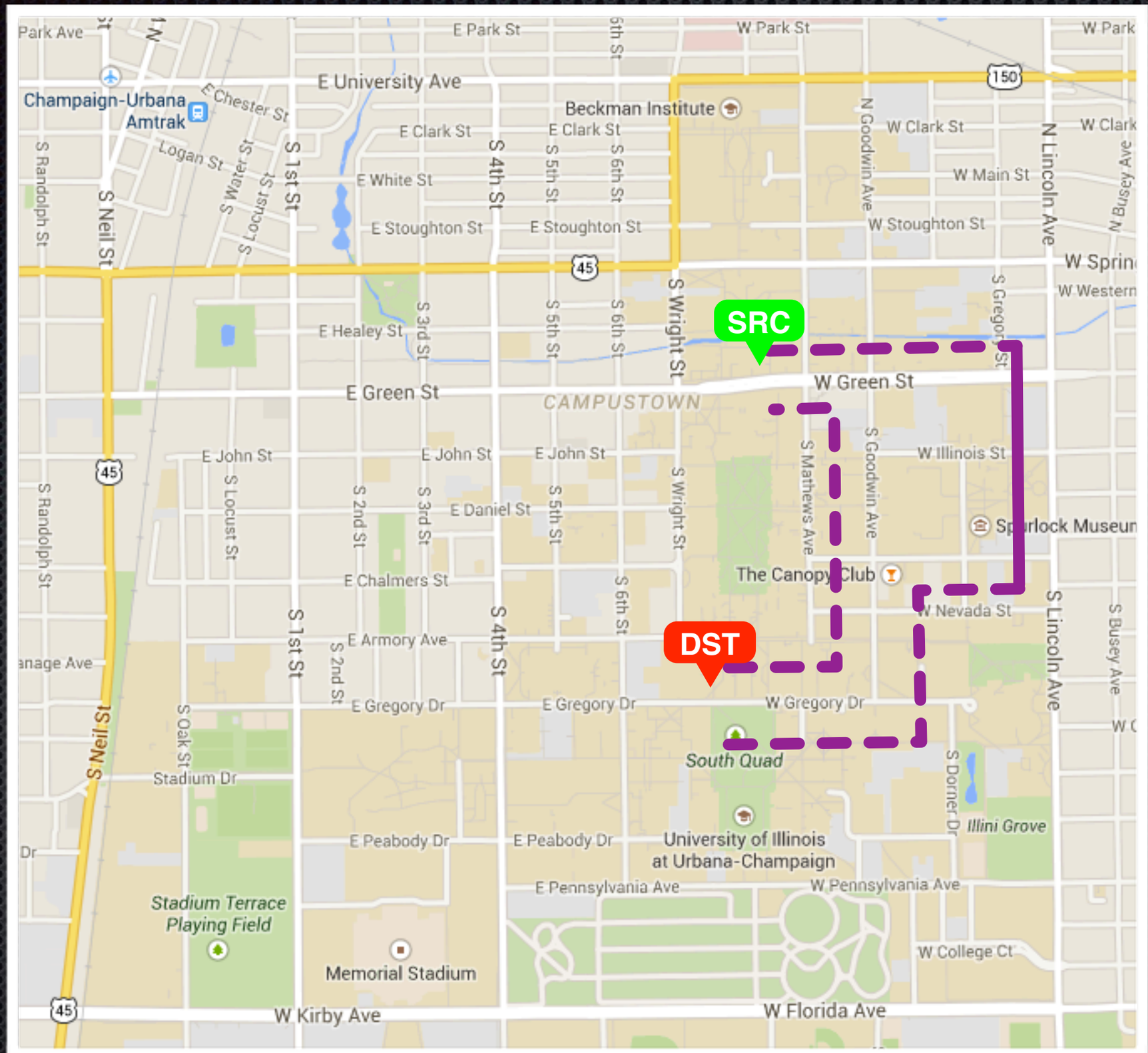
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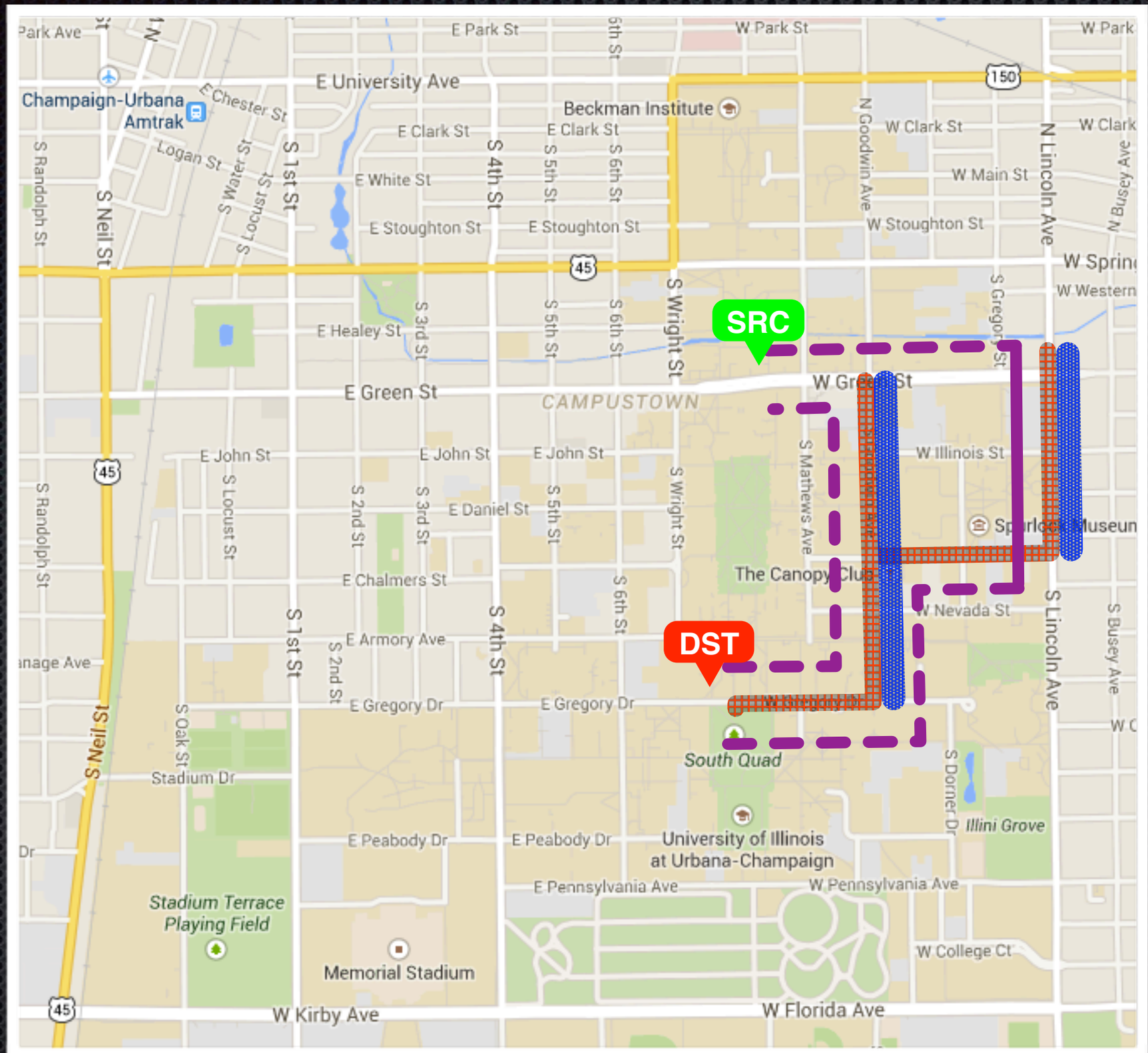
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