Data Driven Analysis of the Potentials of Dynamic Ride Pooling

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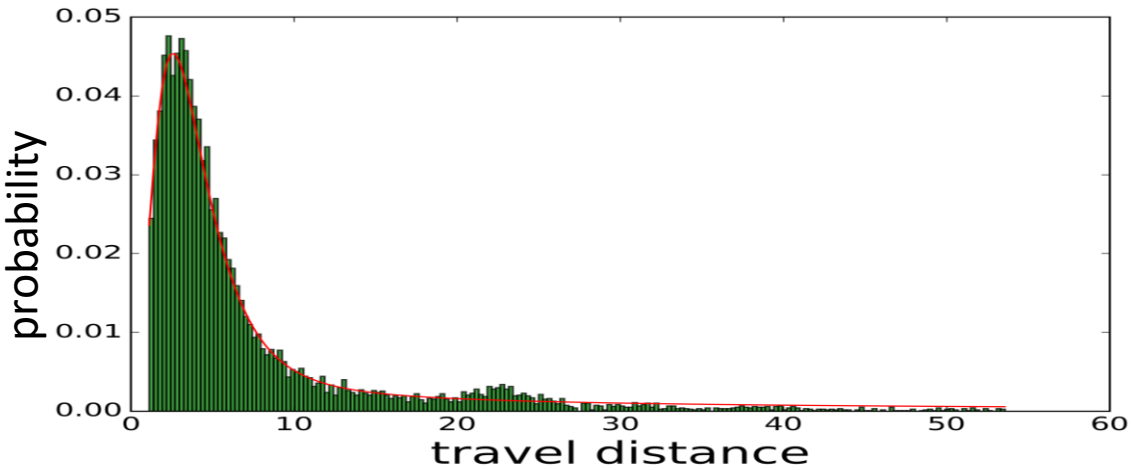
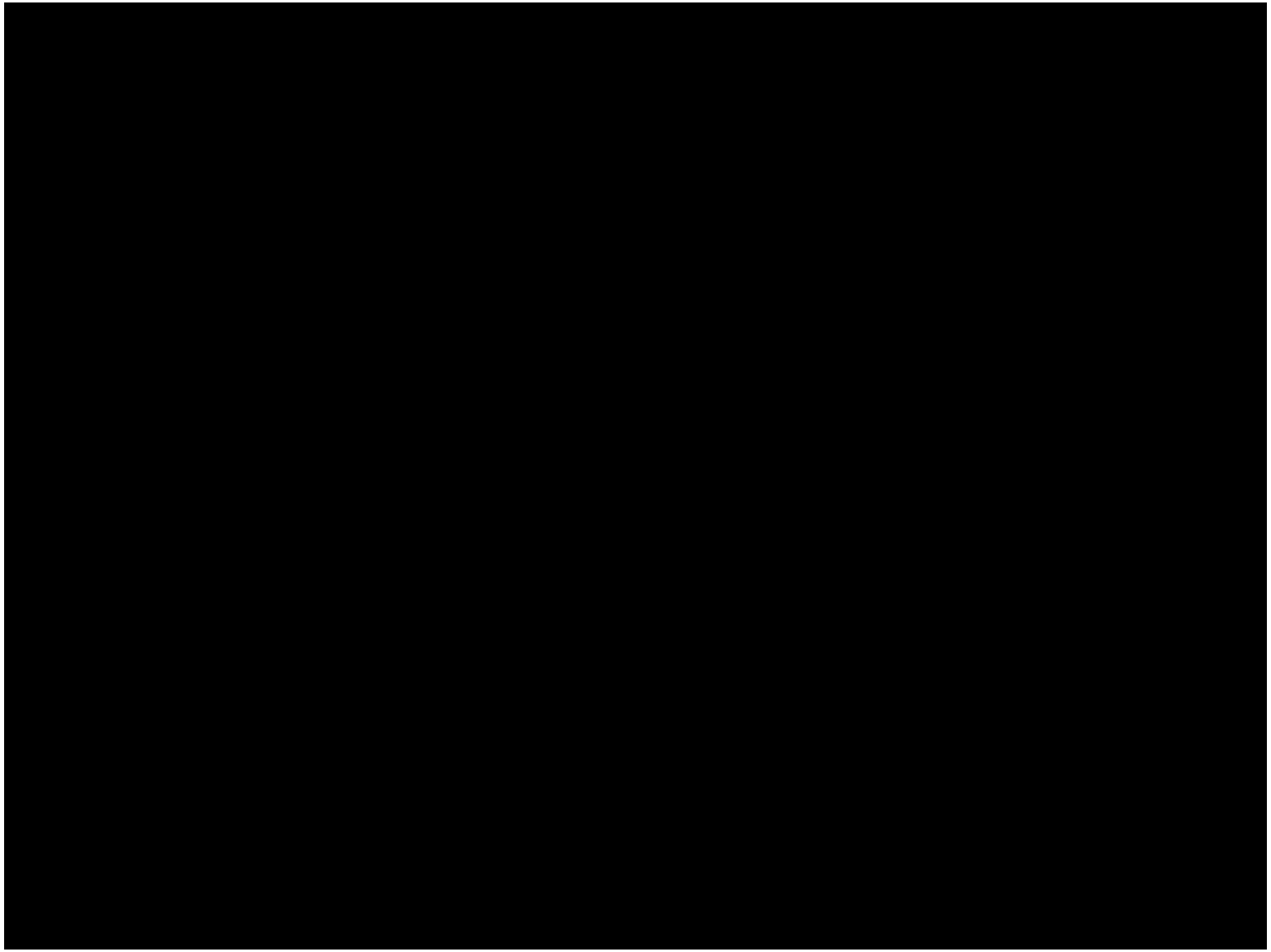
Our Contributions

- How to leverage travel pattern to perform real-time ride pooling?
- Define the parameter space and method for dynamic ride pooling.
- Evidence of significant societal benefit based on actual ride request data.

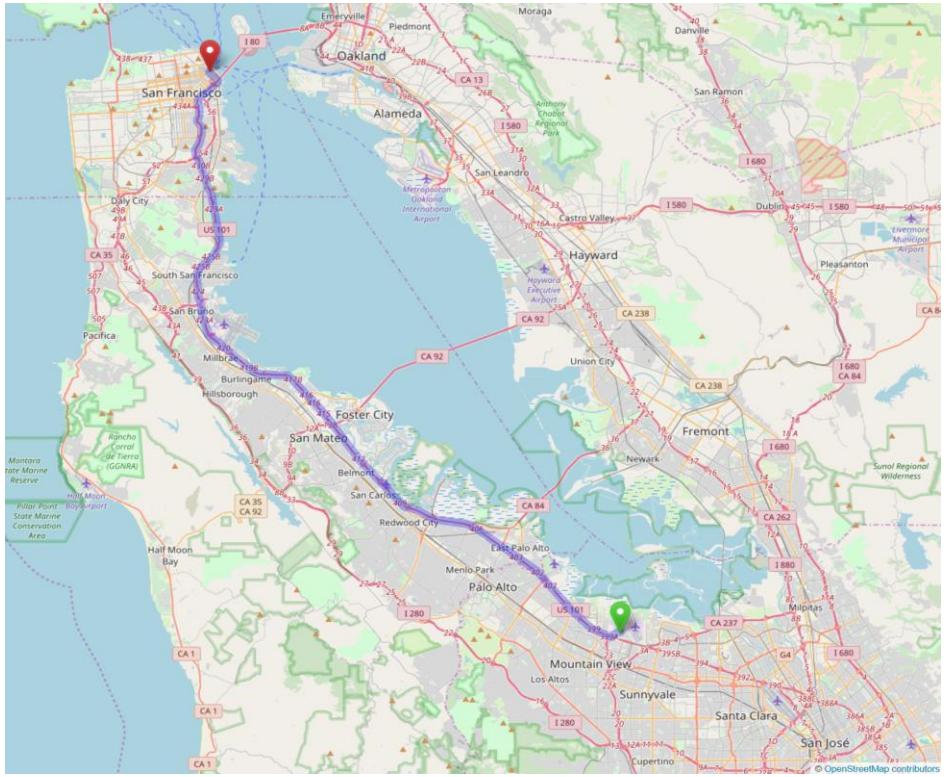




Ride Requests

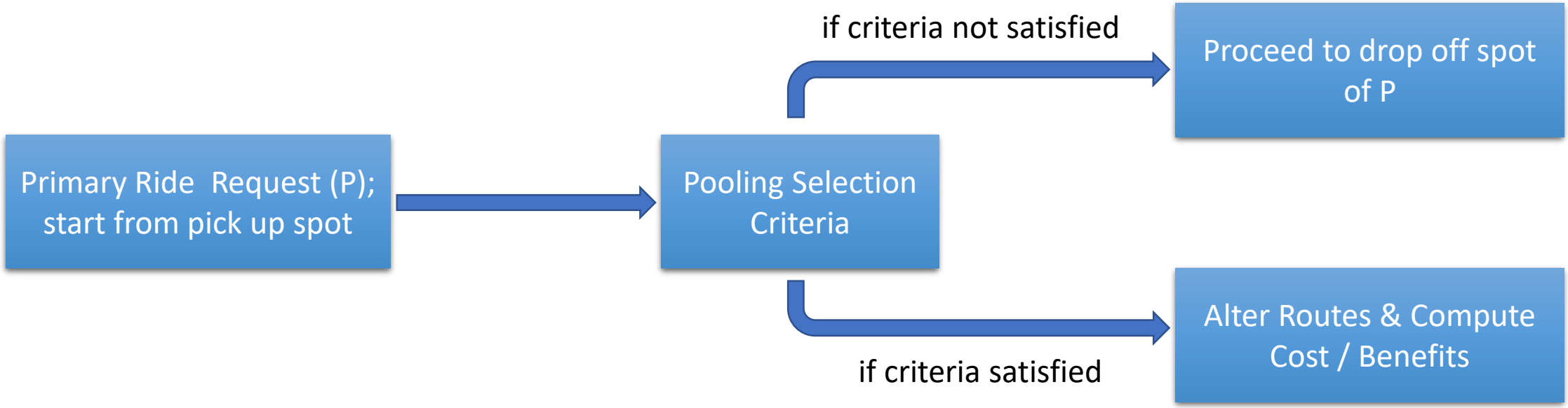
Ride request is represented by:

1. Time of request
2. Pickup Location
3. Drop-off location



Ride request in Bay Area

Pooling & Evaluation Framework

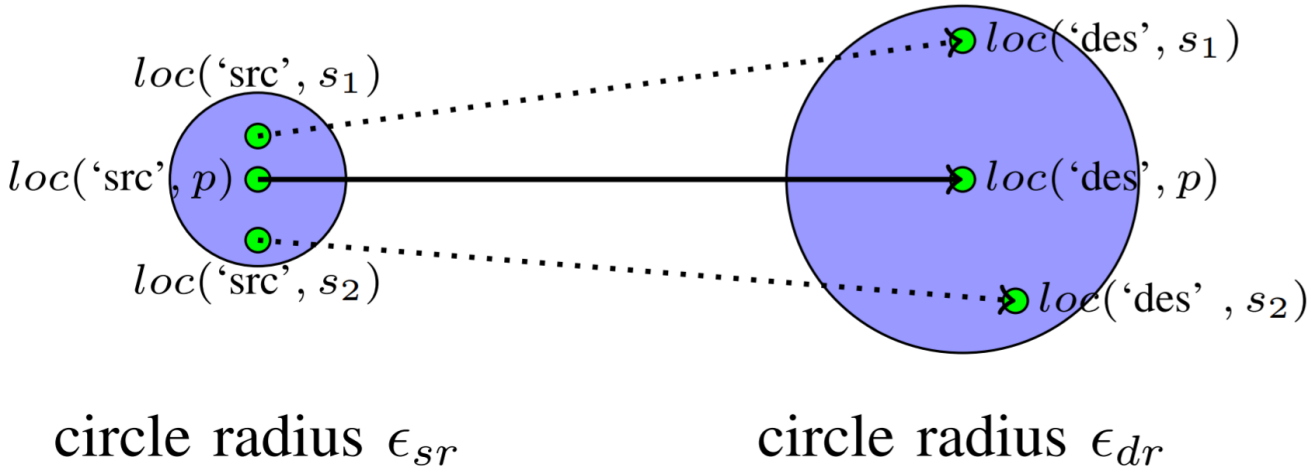


Dynamic Pooling Objectives

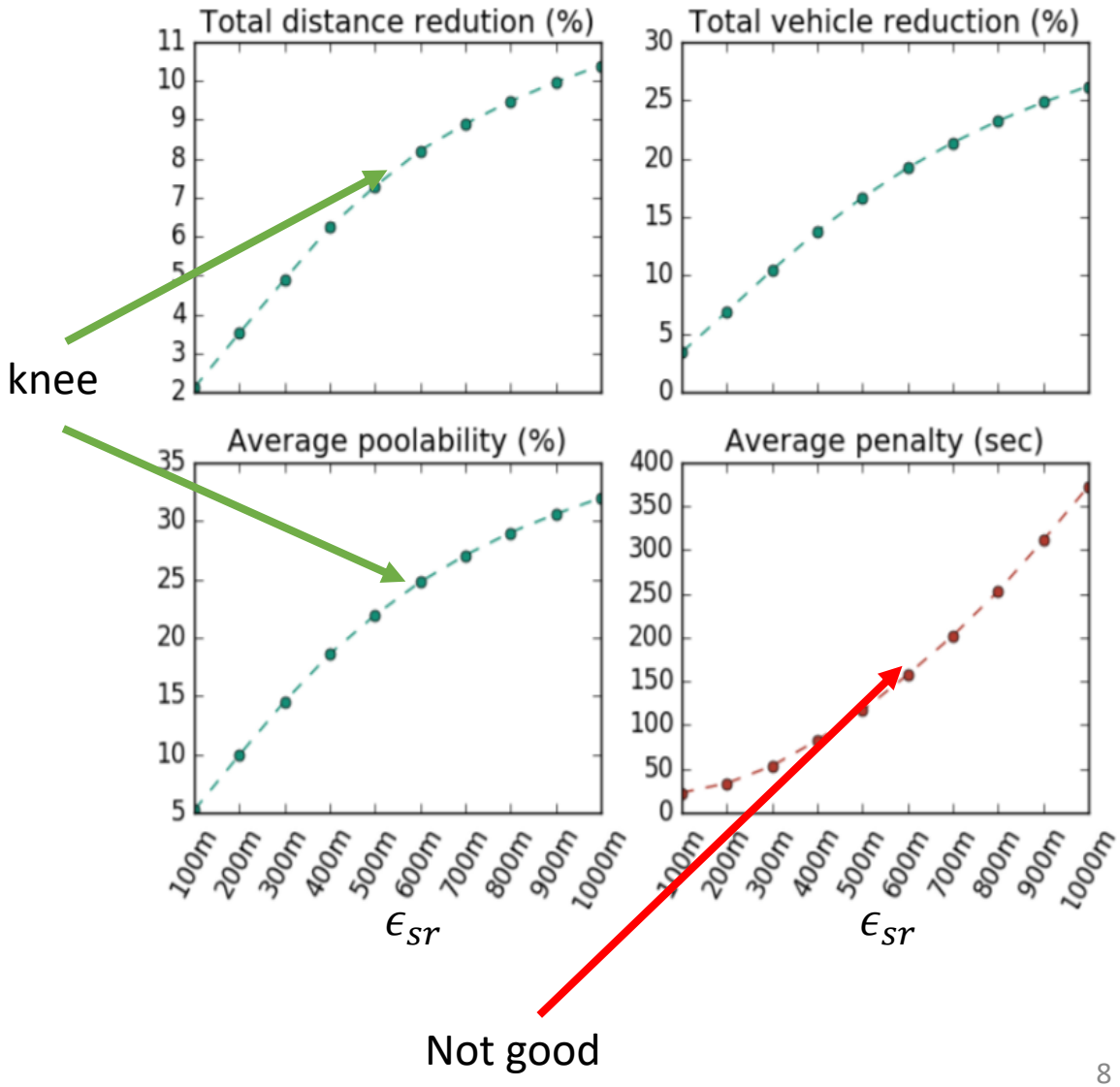
1. Reduce Total Travel Distance
2. Reduce Total Vehicles Needed
3. Increase Poolability of Rides
4. Travel Time Overhead Bounded

Pooling Selection Criteria – Phase I

- Time Interval (ϵ_t)
- Distance from pickup (ϵ_{sr})
- Distance from drop off (ϵ_{dr})

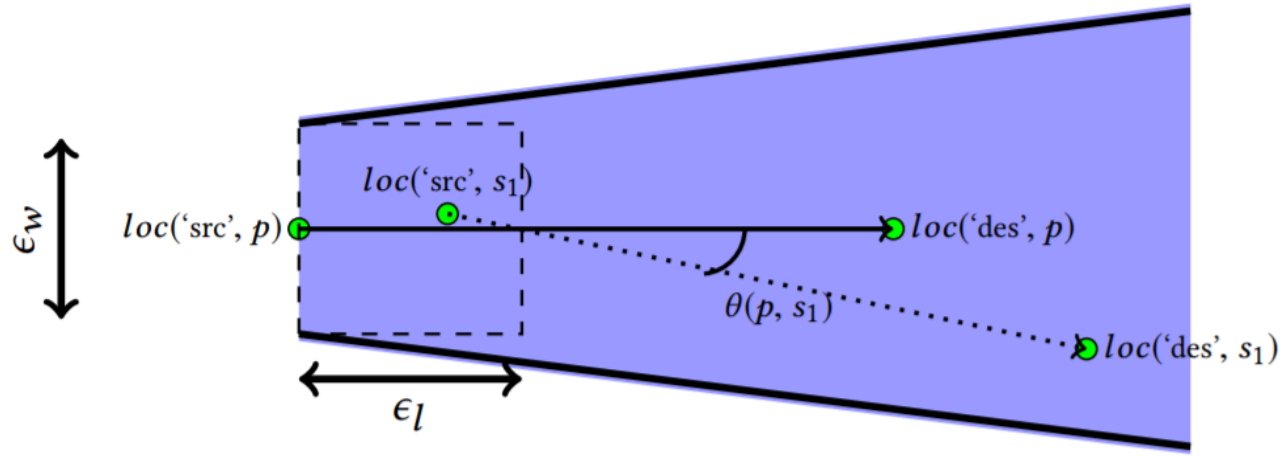


Limitation of Phase I

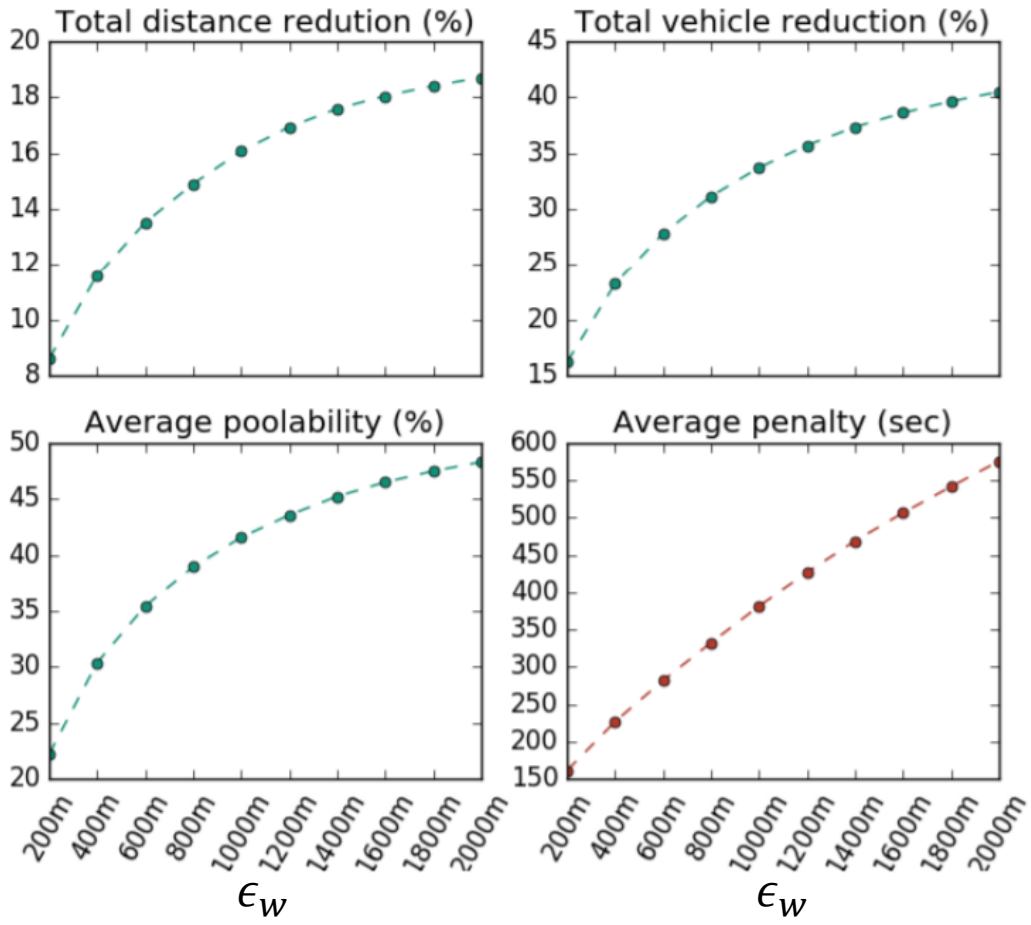


Pooling Selection Criteria – Phase II

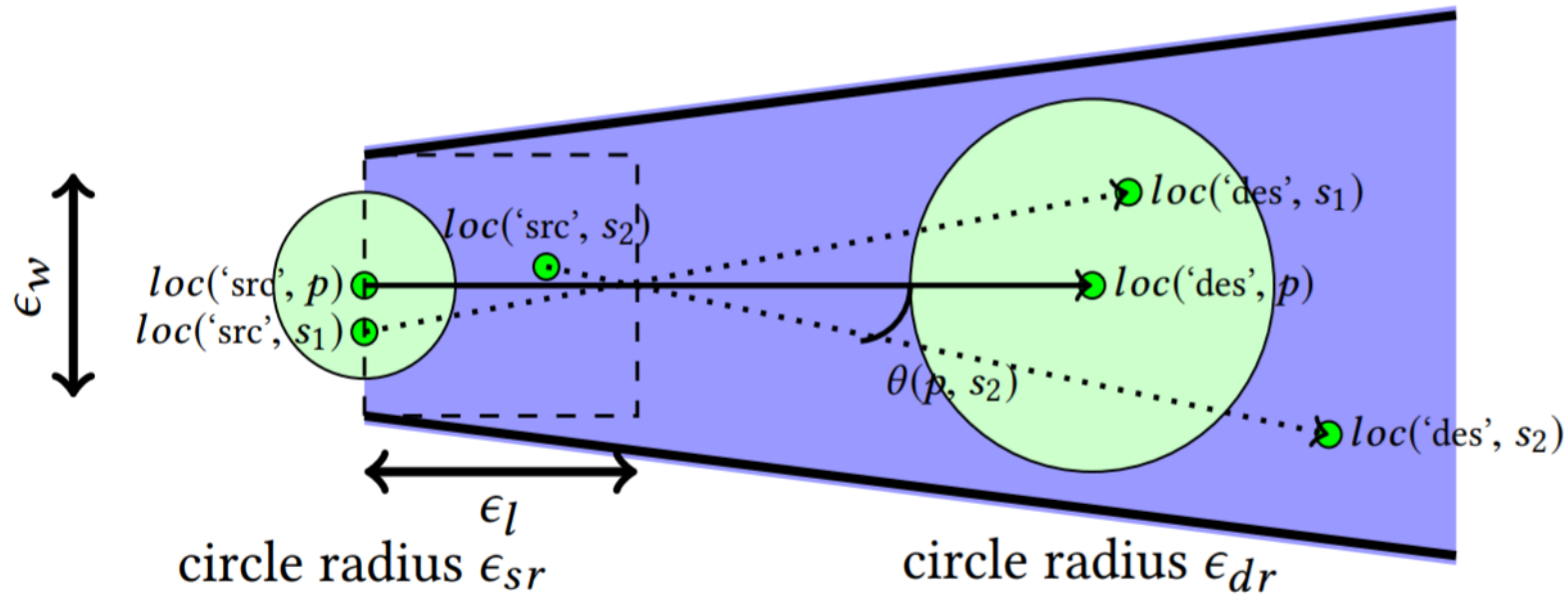
- Time Interval (ϵ_t)
- Rectangular width (ϵ_w)
- Rectangular length (ϵ_l)
- Anglular difference (ϵ_θ)



Advantage of Phase II – Cost does not supersede benefits.



Pooling Selection Criteria – Phase I & II



Parameter Space

Base

- Time Interval (ϵ_t)
- Vehicle occupancy (k)

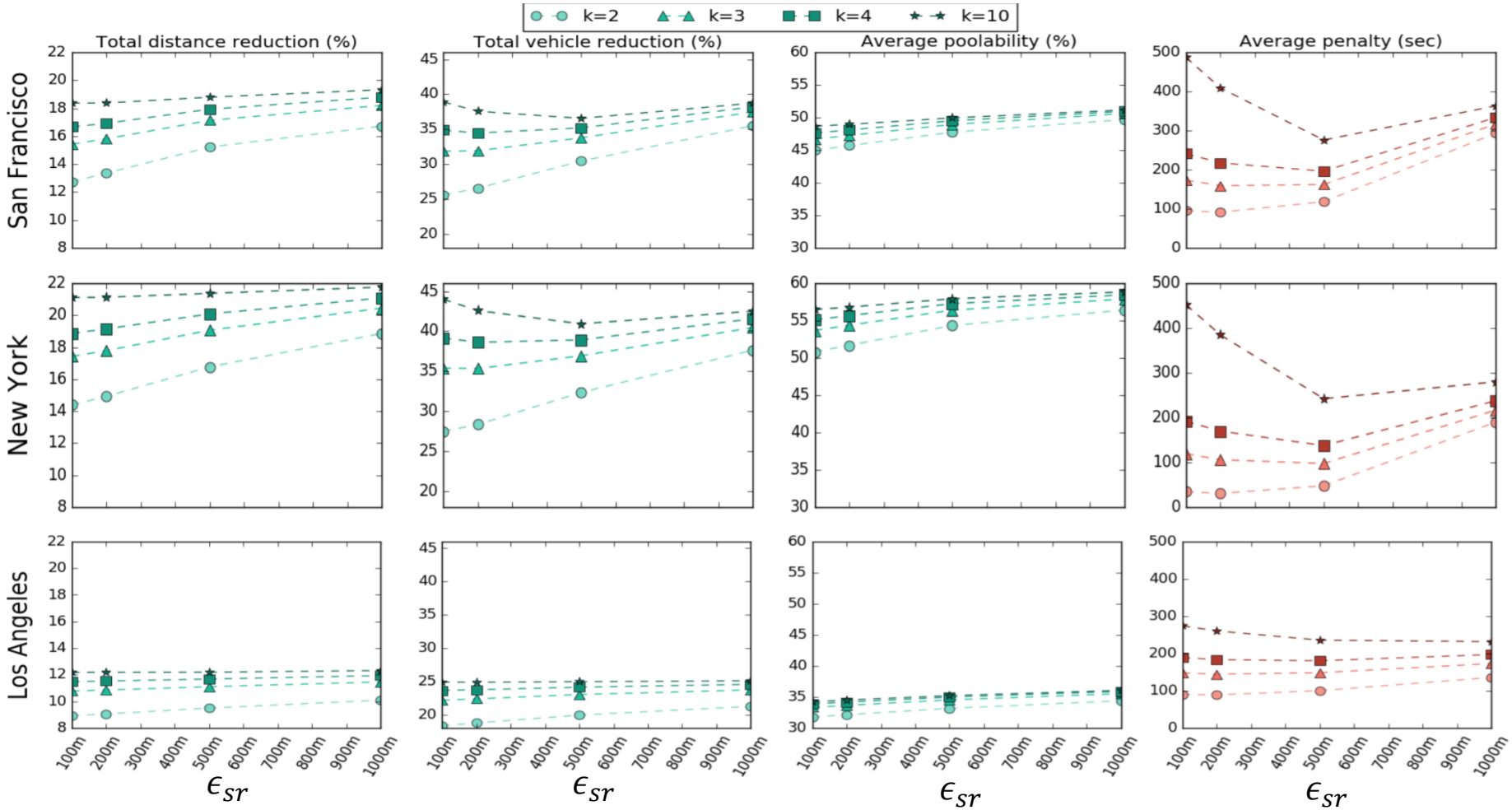
Phase I

- Distance from pickup (ϵ_{sr})
- Distance from drop off (ϵ_{dr})

Phase II

- Rectangular width (ϵ_w)
- Rectangular length (ϵ_l)
- Anglular difference (ϵ_θ)

Parameter Sensitivity Analysis

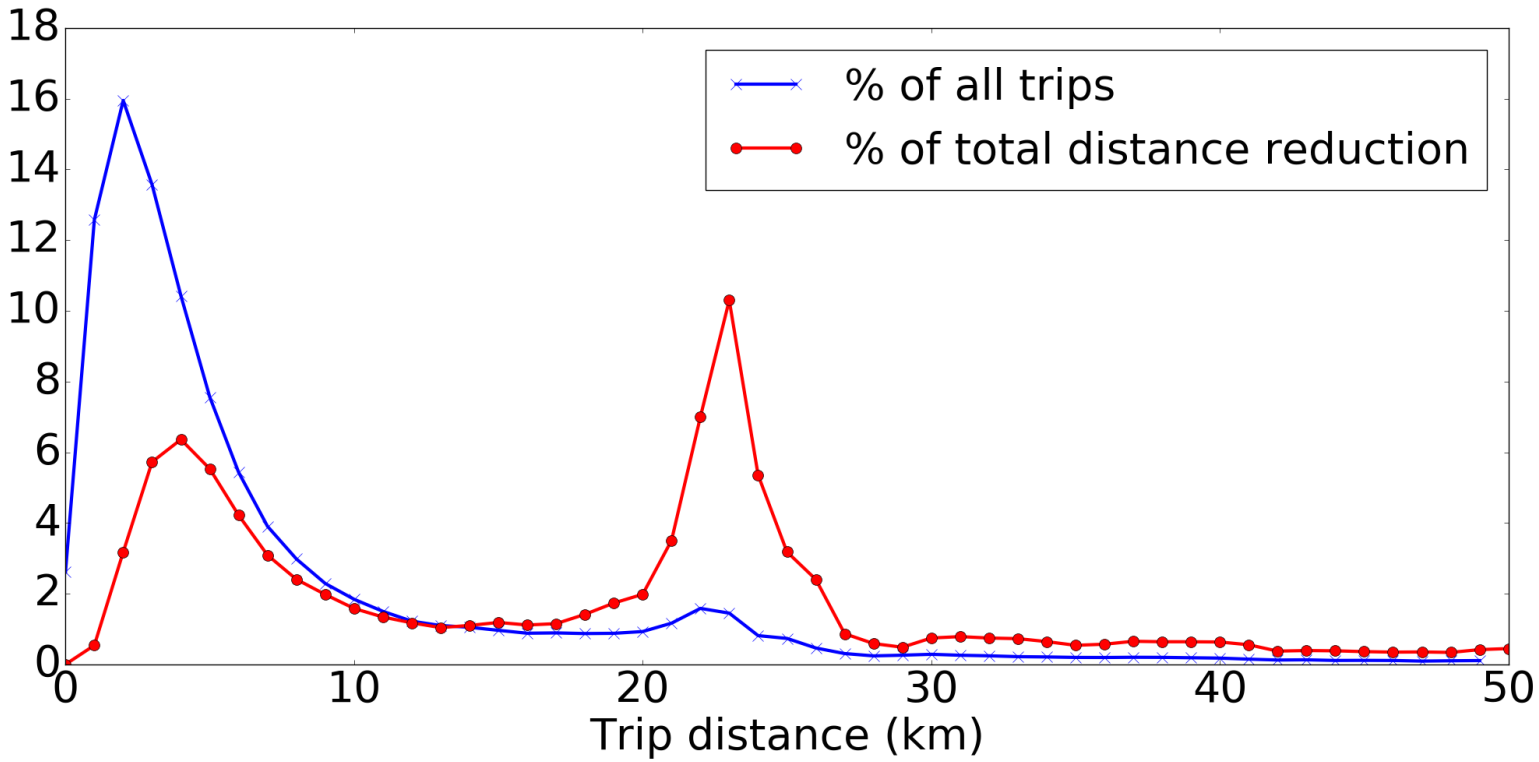


Benefits

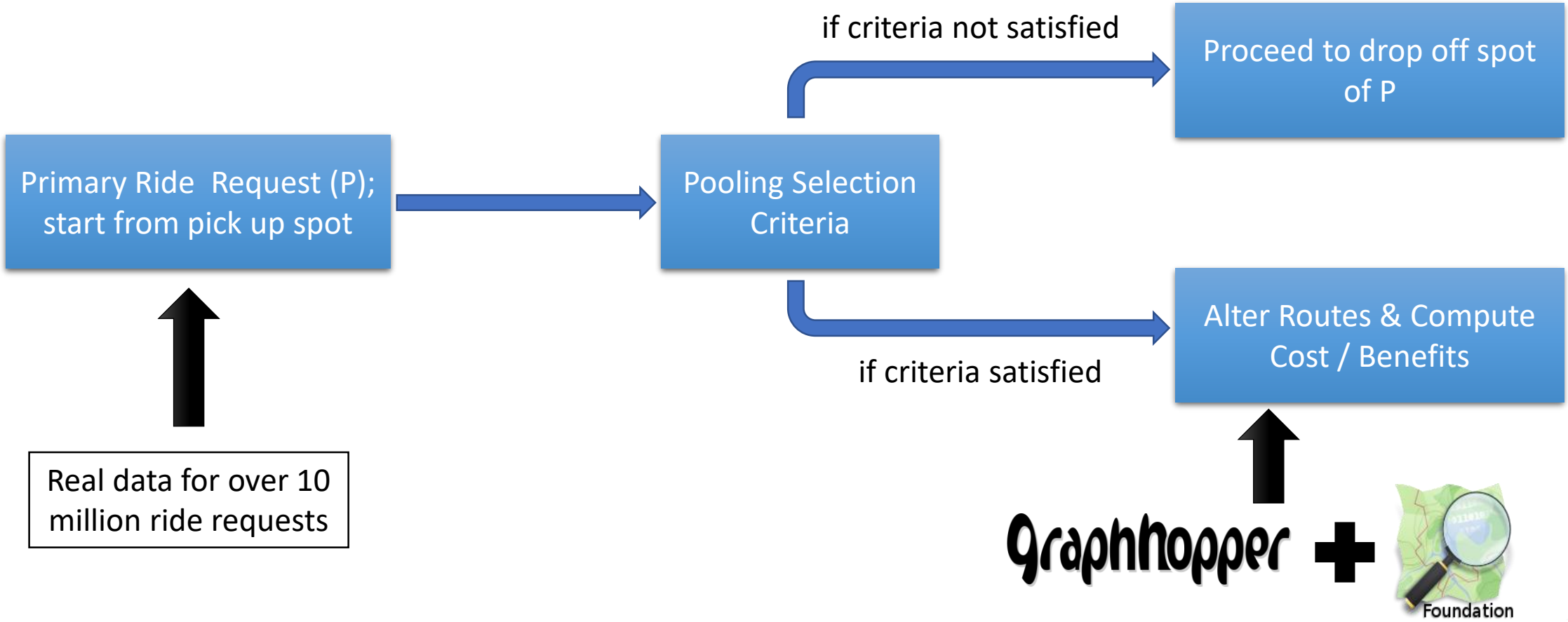
Metric	*San Francisco*	*New York*	*Los Angeles*	*Mean across cities*
Total Travel Distance Reduction (%)	17.13	19.06	11.01	15.76
Total Vehicle Count Reduction (%)	33.76	36.93	23.03	31.23
Mean Poolability (%)	48.94	56.39	34.52	46.61
Mean Travel Time Penalty (sec)	162.12	97.55	148.17	135.94

Summary of benefits and costs. Parameters used $\epsilon_t = 5$ **mins.,** $\epsilon_{sr} = 500m$, $\epsilon_{dr} = 1000m$, $\epsilon_w = 2000m$, $\epsilon_\theta = 20°, k = 3$

Benefits


% of all trips
% of total distance reduction
18
16
14
12
10
8
6
4
2
0
0
10
20
30
40
50
Trip distance (km)

Pooling & Evaluation Framework



Conclusion

- Data-driven approach based on millions of ride request from 3 cities.
- Propose a rigorous formulation of the dynamic ride pooling problem, and an experimental algorithm.
- Highlight potential societal benefits of dynamic ride pooling.

Questions?