Optimal passenger-seeking strategy of taxi drivers with E-hailing

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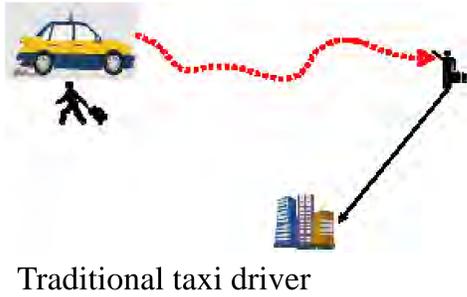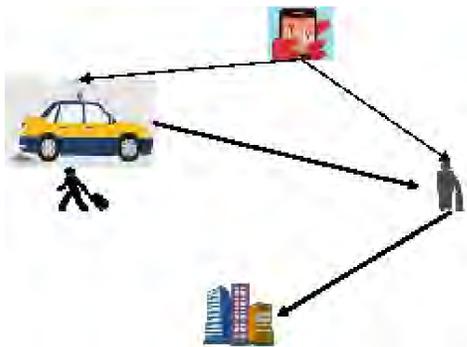The Fu Foundation School of Engineering and Applied Science
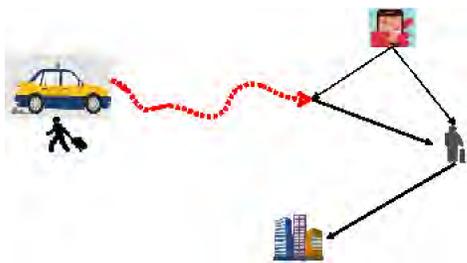
Introduction

- taxi drivers usually have to spend 35-60 percent of their time on cruising to find the next potential passenger

Traditional taxi driver

E-hailing driver: no searching

E-hailing driver: picking up in a different location

Markov Decision Process (MDP)

- (S, A, R, P, s_0) — Initial state

  State Action Reward   State transition matrix

- State transition matrix
  $$P(s, a, s') = \Pr(s_{t+1} = s' | s_t = s, a_t = a)$$

- Policy π: a mapping from a state s and an action a to the probability $\pi(a|s)$

- Value $V_\pi(s) = E[\sum_{k=0}^{K} \gamma^k r_{t+k+1} | s_t = s]$

- Q $Q_\pi(s,a) = E[\sum_{k=0}^{K} \gamma^k r_{t+k+1} | s_t = s, a_t = a]$

MDP for e-hailing drivers

- State $s = (l, t, I)$

  Grid index Time   Indicator $I \in \{0,1\}$

- Action   – stay   ○ wait

- State transition (by a numerical example)

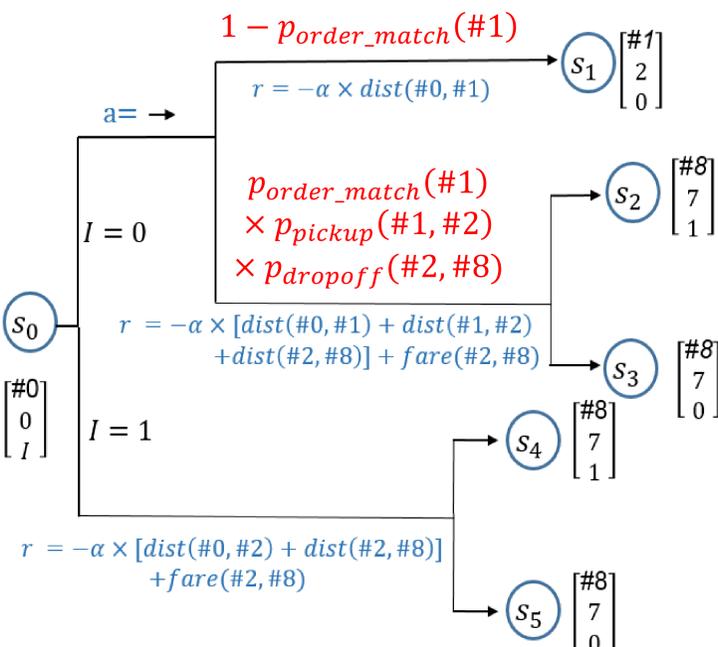⋯⋯ idling   – – Pick up   —— On trip
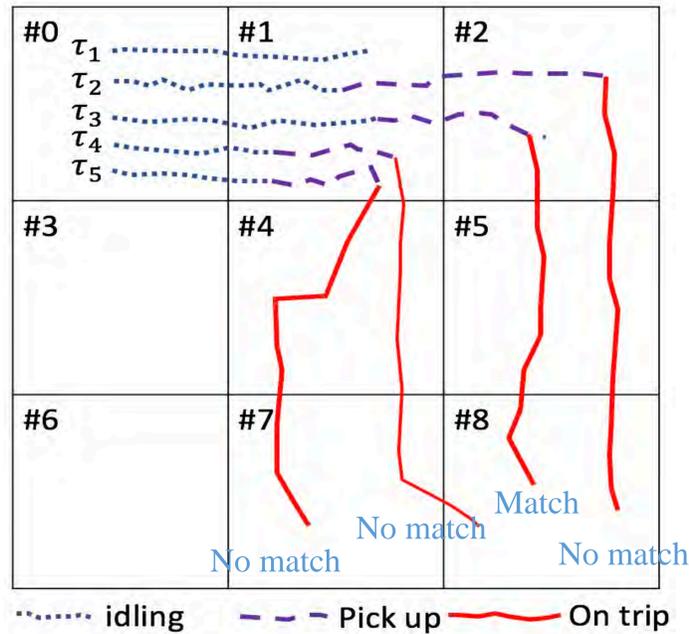
$$p_{order\_match}(\#1) = 4/5 = 80\%$$
$$p_{pickup}(\#1, \#2) = 2/4 = 50\%$$
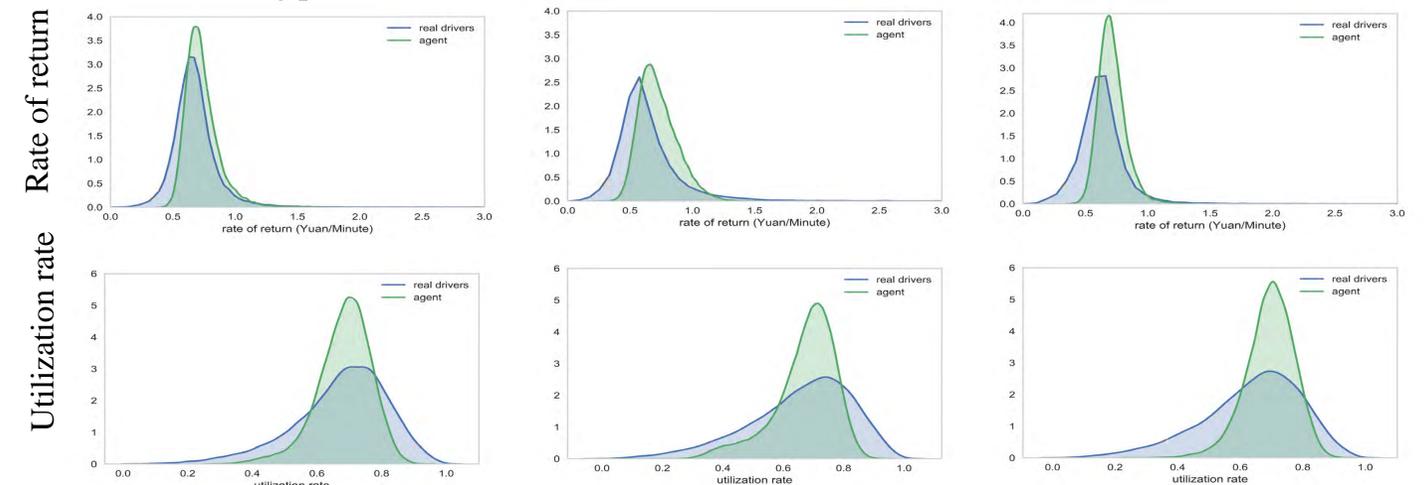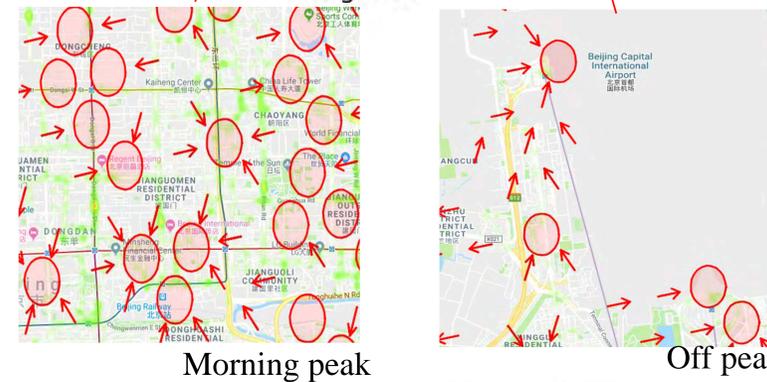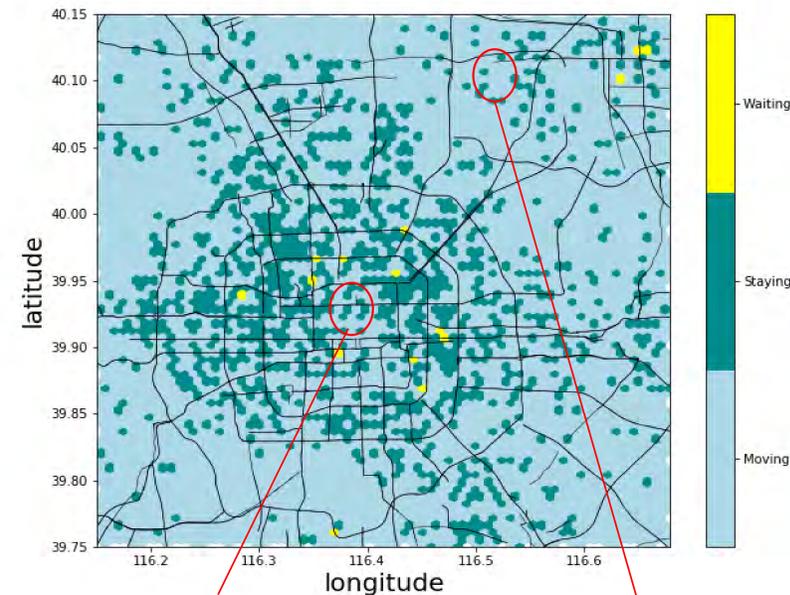$$p_{dropoff}(\#1, \#7) = 1/2 = 50\%$$
$$p_{match}(\#8) = 1/2 = 50\%$$

- Objective

Maximize driver's profit within the time interval

Data description

- GPS traces collected in Beijing on weekdays during Nov. 1st to Nov. 30th
- 53,673 e-hailing vehicles and 7,711,820 e-hailing orders
- 3-hour time intervals: morning peak (7AM, 10AM), off peak (10PM, 3PM), and evening peak (5PM, 8PM)
- Hexagonal grid setup with the length of the diagonal of a hexagon approximately 700 meters

Results

Morning peak   Off peak   Evening peak

Number of orders

Number of idling cells

Fare

Rate of return

Utilization rate

Acknowledgements