Flexible Online Task Assignment in Real-Time Spatial Data

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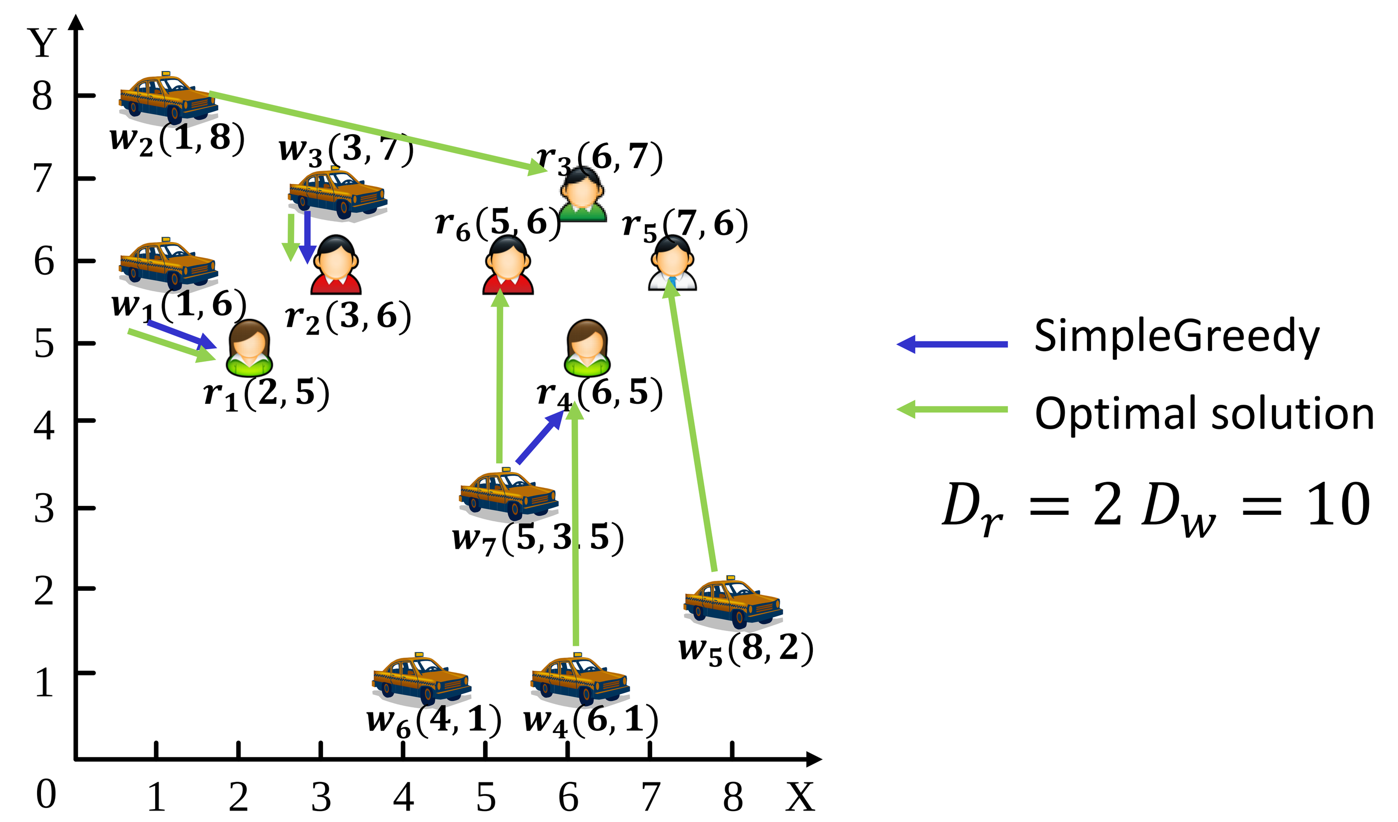
Introduction

- Real-time spatial data is ubiquitous.
  - Online platforms that facilitate spatial tasks to be assigned and performed by workers, e.g. O2O applications.
- Motivation
  - Most O2O applications need to do task assignment in real-time:
    - Real-Time Taxi-Calling Service.
    - Food Delivery Service.
  - The flexibility of workers has not been considered.

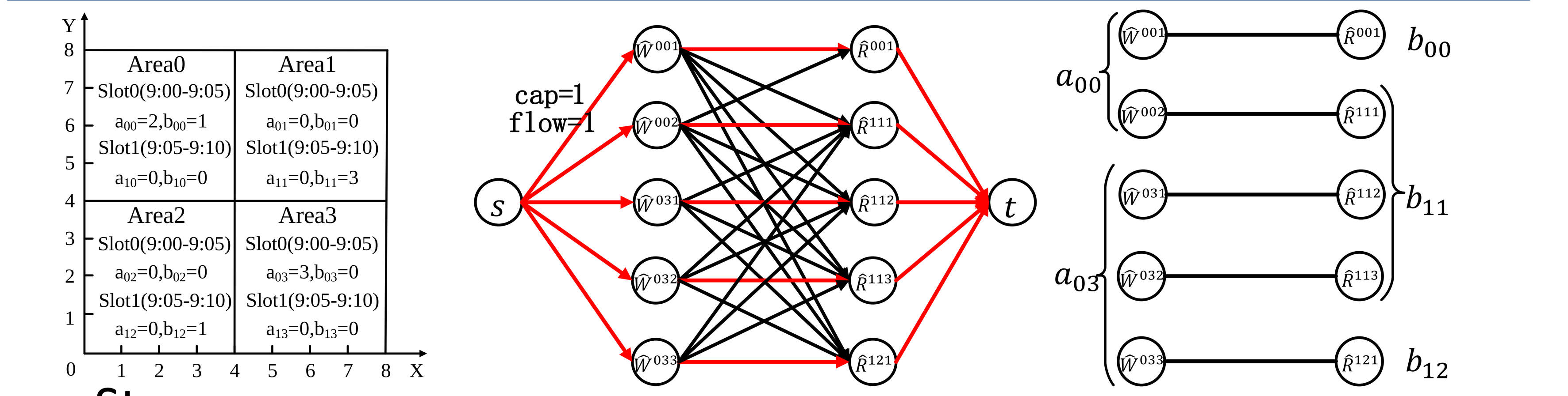
The FTOA Problem

- Given
  - A set of crowd workers W
    - Each $w \in W$: location L_w, arriving time S_w, deadline D_w.
  - A set of spatial tasks R
    - Each $r \in R$: location L_r, arriving time S_r, deadline D_r.
- Find an online allocation M to maximize the assigned pairs *MaxSum(M)*$=\sum_{w\in W, r\in R} I(w,r)$. $I(w,r)=1$ if the following constraints are satisfied.
  - Deadline Constraint.
  - Worker's decision Constraint.
  - Task's decision Constraint.
  - Invariable Constraint: Once a task r is assigned to a worker w, the assigned pairs of (w,r) cannot be changed.
- Online Algorithm Evaluation: Competitive Ratio (CR)
  - IID Model (Stochastic case Analysis):
    - $CR_{iid} = min_{\forall v \in V \ follows\ D_R\ and\ D_W} \frac{MaxSum(M)}{MaxSum(OPT)}$

9:00	9:00	9:01	9:01	9:02	9:03	9:03	9:03	9:04	9:05	9:06	9:07	9:08
w_1	r_1	w_2	w_3	r_2	w_4	w_5	w_6	w_7	r_3	r_4	r_5	r_6

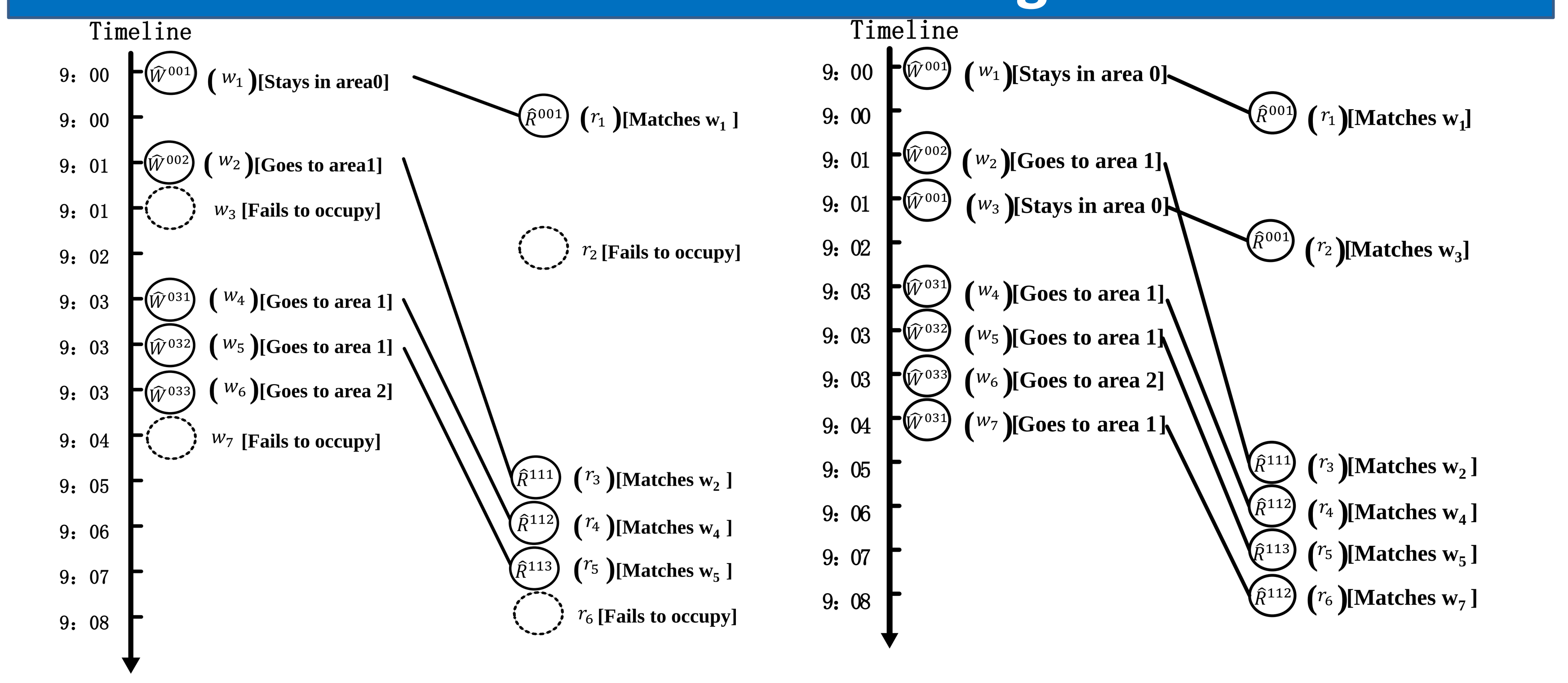


Offline Guide Generation Algorithm



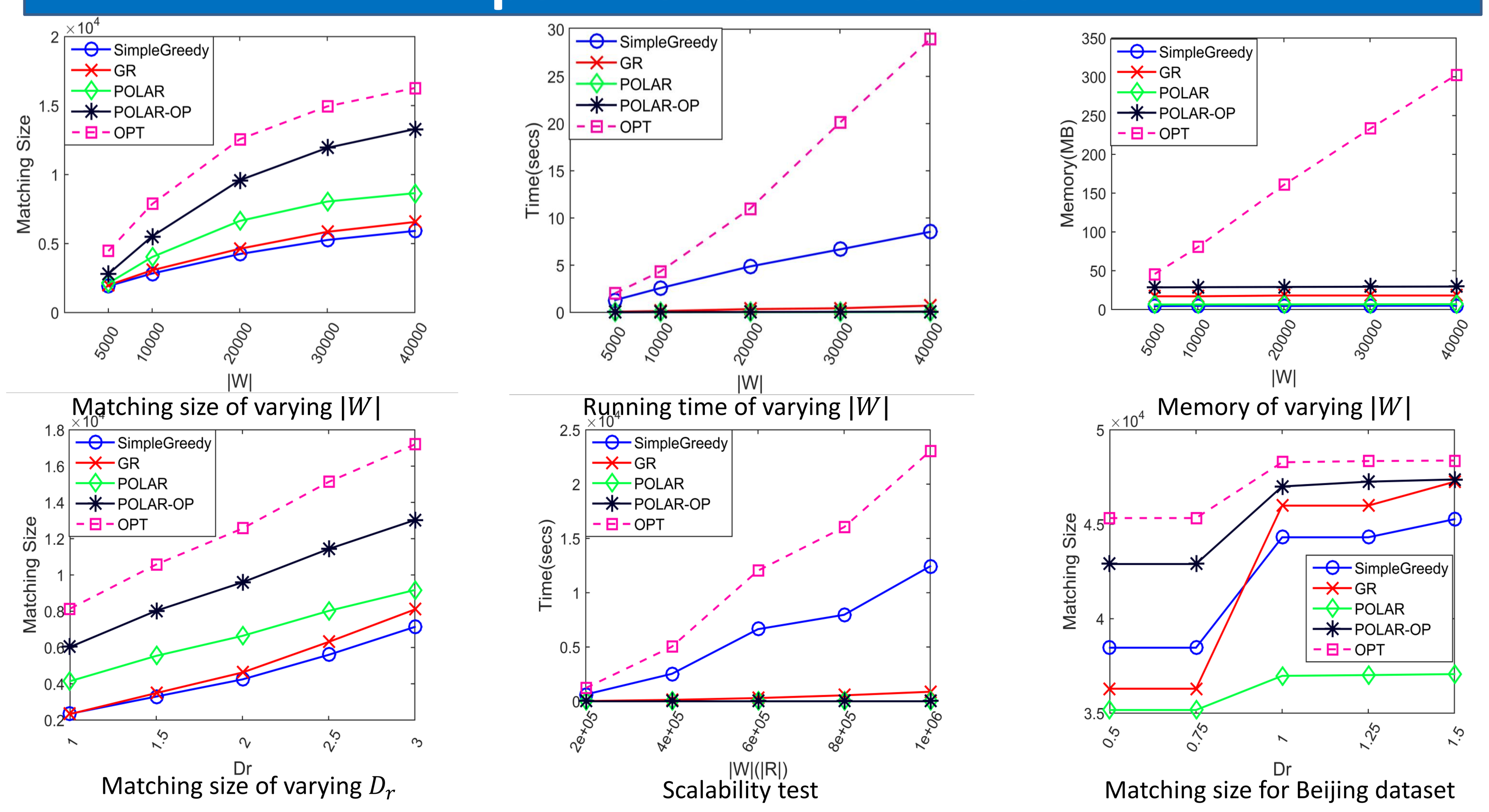
- Steps
  - 1. Construct the bipartite graph according to the prediction.
  - 2. Run the network algorithm to generate the guide.

POLAR and POLAR-OP Algorithm



- POLAR: $CR_{iid} = 0.4$
  - 1. When a new object arrives, occupy a node $w(r)$ in the offline guide.
  - 2. Find the neighbor node $r(w)$ in the offline guide.
  - 3. Match the object who occupies the neighbor node $r(w)$.
- POLAR-OP: $CR_{iid} = 0.47$
  - 1. When a new object arrives, associate the object to its corresponding node $w(r)$ in the offline guide.
  - 2. Find the neighbor node $r(w)$ in the offline guide.
  - 3. Match the object associated to the neighbor node $r(w)$.

Experimental Evaluation



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