Feedback-Aware Social Event-Participant Arrangement

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Introduction

- Event-Based Social Networks
  - Online platforms that facilitate offline event organization and participation, e.g. Meetup
- Motivation
  - The satisfaction scores are hard to learn
  - Different factors, e.g. price and distance, have different weights, which are hard to know
  - Users may not accept the arrangements
  - Alex who likes rock and roll may reject the arrangement of a piano concert
  - Feedbacks of users should be considered to improve quality of services

The FASEA Problem

- Given
  - A set of events \( V \)
  - Each \( v \in V \) with capacity \( c_v \).
  - A set of conflicting event pairs \( CF \)
- Each time step \( t \), a user \( u \) arrives
  - Capacity \( c_u \) and a context \( x_{t,v} \) for each \( v \in V \) are revealed.
  - Arrange at most \( c_u \) feasible events \( A_t \).
  - Receive feedbacks of accepting/rejecting the arranged event, i.e. observe rewards \( r_{t,v} = 0 \text{ or } 1 | v \in A_t \), where \( E[r_{t,v}|x_{t,v}] = x_{t,v}^T \bar{\theta} \) and \( \bar{\theta} \) is fixed but unknown.
- Goal
  - Find an arrangement \( A_t \) for each user \( u \) such that the total number of accepted events is maximized and the following constraints are satisfied:
    - Invariable constraint.
    - Capacity constraint.
    - Conflict constraint.

Background: MAB

- Given a set of \( m \) arms
  - Each arm is associated with an unknown distribution of rewards
  - Repeatedly play one arm in \( T \) rounds
  - Observe the reward of the arm played
  - Maximize the total rewards: exploration and exploitation trade-off
- A variant: contextual combinatorial bandit
  - Combinatorial: play a subset of arms in each round
  - Contextual: before playing, a context (feature vector) of each arm is observed in each round
  - The reward of an arm depends on the context
  - Linear payoff: mean of reward is a linear combination of the features with unknown weights

Problem Reduction

- Contextual combinatorial bandit \( \rightarrow \) event-participant arrangement
- Each round (for each new-coming user)
  - Values of factors are observed \( \rightarrow \) contexts are observed
  - Arrange a set of events \( \rightarrow \) play a subset of arms
  - User chooses to accept the arranged events or not \( \rightarrow \) observe rewards

Thompson Sampling Based Solution

- At each time step
  - Sample \( \bar{\theta} \sim \mathcal{N}(Y^{-1}b,q^2Y^{-1}) \).
  - Estimated reward of each \( v: \hat{r}_{t,v} = x_{t,v}^T \bar{\theta} \)
  - Arrange at most \( c_u \) feasible events \( A_t \) greedily based on \( \{\hat{r}_{t,v}|v \in V\} \)

Upper Confidence Bound (UCB) Based Solution

- At each time step
  - Estimate \( \bar{\theta} = Y^{-1}b \)
  - Upper confidence bound of each \( v \)
    - \( \hat{r}_{t,v} = x_{t,v}^T \bar{\theta} + \alpha \sqrt{x_{t,v}^T Y^{-1} x_{t,v}} \)
  - Arrange at most \( c_u \) non-conflicting events \( A_t \) greedily based on \( \{\hat{r}_{t,v}|v \in V\} \)

Experimental Evaluation

Experimental finding: TS that is reported to work well under basic multi-armed bandit does not perform well under FASEA while UCB is the best in overall

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