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 $\boldsymbol{x}_{t,v}$ 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 $\{r_{t,v} = 0 \; or \; 1 | v \in A_t\}$, where $E[r_{t,v} | \boldsymbol{x}_{t,v}] = \boldsymbol{x}_{t,v}^T \boldsymbol{\theta}$ and $\boldsymbol{\theta}$ is fixed but unknown.
- Goal
  - Find an arrangement A_t for each user u_t 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 → event-participant arrangement
- Each round (for each new-coming user)
  - Values of factors are observed → contexts are observed
  - Arrange a set of events → play a subset of arms
  - User chooses to accept the arranged events or not → observe rewards

Thompson Sampling Based Solution

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

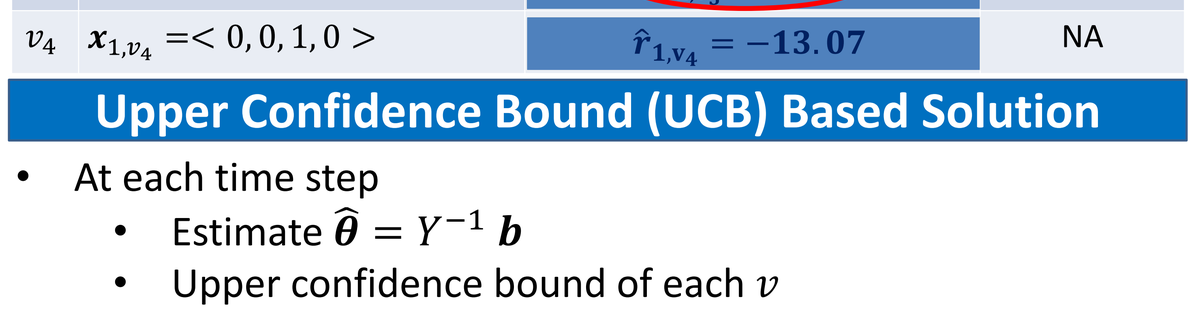
	Round 1 ($c_u = 2$)	Round 2 ($c_u = 1$)	Conflicts
v_1	$\boldsymbol{x}_{1,v_1} =< 0.1, 0, 0.5, 0.2 >$	$\hat{\boldsymbol{r}}_{\mathbf{1},\mathbf{v_1}} = \mathbf{-3.94}$	v_2
v_2	$\boldsymbol{x}_{1,v_2} =< 0.2, 0.1, 0, 0.1 >$	$\hat{\boldsymbol{r}}_{\mathbf{1},\mathbf{v_2}} = \mathbf{-0.30}$	v_1
v_3	$\boldsymbol{x}_{1,v_3} =< 0.2, 0.3, 0, 0.2 >$	$\hat{\boldsymbol{r}}_{\mathbf{1},\mathbf{v_3}} = \mathbf{1.74}$	NA
v_4	$\boldsymbol{x}_{1,v_4} =< 0, 0, 1, 0 >$	$\hat{\boldsymbol{r}}_{\mathbf{1},\mathbf{v_4}} = \mathbf{-13.07}$	NA

Upper Confidence Bound (UCB) Based Solution

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

	Round 1 ($c_u = 2$)	Round 2 ($c_u = 1$)	Conflicts
v_1	$\boldsymbol{x}_{1,v_1} =< 0.1, 0, 0.5, 0.2 >$	$\hat{\boldsymbol{r}}_{\mathbf{1},\mathbf{v_1}} = \mathbf{1.10}$	v_2
v_2	$\boldsymbol{x}_{1,v_2} =< 0.2, 0.1, 0, 0.1 >$	$\hat{\boldsymbol{r}}_{\mathbf{1},\mathbf{v_2}} = \mathbf{0.49}$	v_1
v_3	$\boldsymbol{x}_{1,v_3} =< 0.2, 0.3, 0, 0.2 >$	$\hat{\boldsymbol{r}}_{\mathbf{1},\mathbf{v_3}} = \mathbf{0.82}$	NA
v_4	$\boldsymbol{x}_{1,v_4} =< 0, 0, 1, 0 >$	$\hat{\boldsymbol{r}}_{\mathbf{1},\mathbf{v_4}} = \mathbf{2.00}$	NA

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

Acknowledgment

This work is supported in part by the Hong Kong RGC Project 16202215, National Grand Fundamental Research 973 Program of China under Grant 2014CB340303, NSFC Grant No. 61502021, 61328202, 61300031 and 61532004, Microsoft Research Asia Collaborative Grant and NSFC Guang Dong Grant No. U1301253.