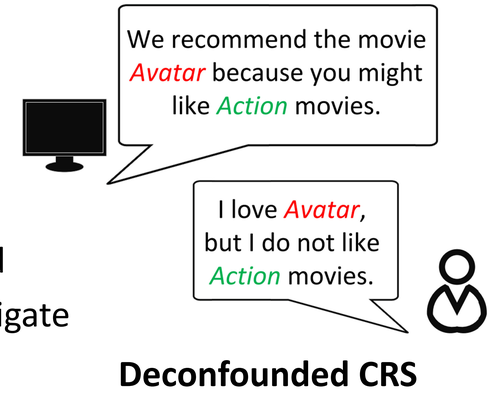
User-Regulation Deconfounded Conversational Recommender System

Yu Xia[1,4], Junda Wu[2], Tong Yu[3]*, Sungchul Kim[3], Ryan A. Rossi[3], Shuai Li[1]
[1]Shanghai Jiao Tong University, [2]New York University, [3]*Adobe Research, [4]University of Michigan

Motivation

- **Conventional CRS:** Asking *key-term* before making *item* recommendation.
- **Potential Bias:** *Key-term* preference does not necessarily imply item preference.
- **Deconfounded CRS:** Asking *item* and related *key-term* at the same time. Identify and mitigate spurious correlation from user feedback.



Deconfounded CRS

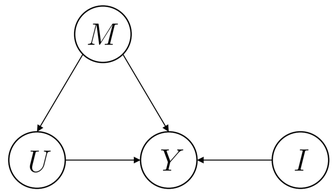
Causal View

U: item-level user preference M: key-term-level user preference
I: item representation Y: prediction score K: user regulation

1. Conventional CRS

- Confounder: key-term-level user preference

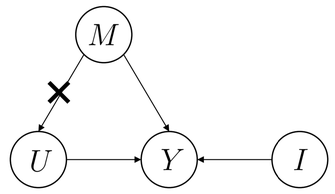
$$P(Y \mid U=u, I=i) = \sum_{m \in \mathcal{M}} P(Y \mid u, i, m) P(m \mid u)$$



2. Deconfounded CRS w. Backdoor Adjustment

- *do*-calculus eliminating confounding effect

$$P(Y \mid do(U=u), I=i) = \sum_{m \in \mathcal{M}} P(Y \mid u, i, m) P(m)$$

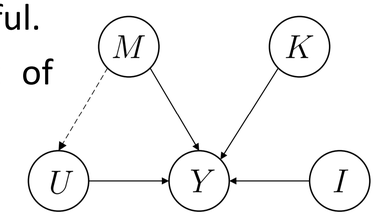


3. Deconfounded CRS w. User-Regulated Backdoor Adjustment

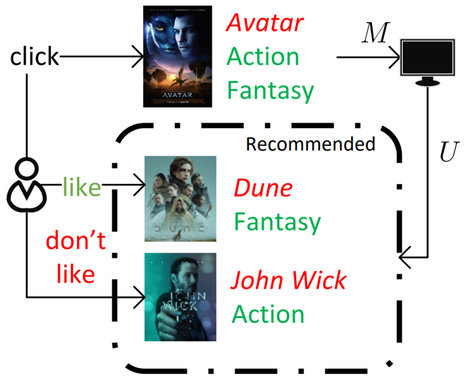
- Not all biases are harmful and some maybe useful.
- Utilize user feedback to regulate the effect of backdoor adjustment.

$$\eta = \frac{\sum_{\mathcal{D}} \mathbf{1}[(Positive, Positive)]}{\sum_{\mathcal{D}} \mathbf{1}}$$

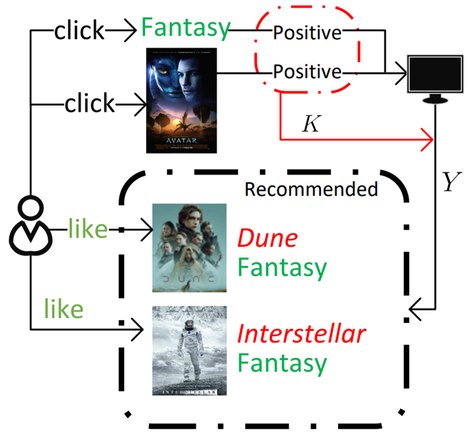
$$\hat{P}(Y \mid U, I) = \eta\, P(Y \mid U, I) + (1-\eta)\, P(Y \mid do(U), I)$$



4. $M \to U$ in Conventional CRS



5. $K \to Y$ in Deconfounded CRS

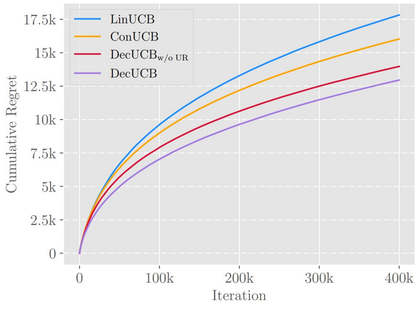


Algorithm

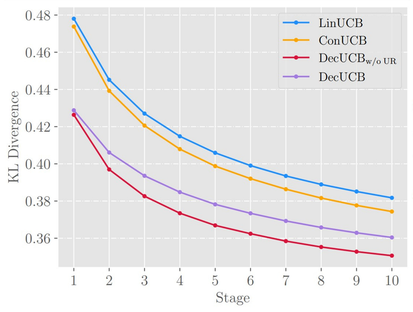
- **DecUCB:** A new upper-confidence-based contextual bandit algorithm for CRS.
- **EE Trade-off:** Balance **E**xploration and **E**xploitation in the cold-start setting.
- **Online Debiasing:** User-regulated backdoor adjustment in an online algorithm.

Experiments (e.g., LastFM)

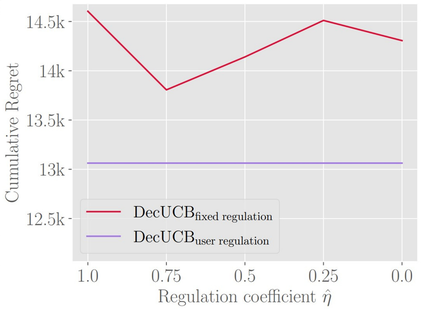
Recommendation Accuracy ↑



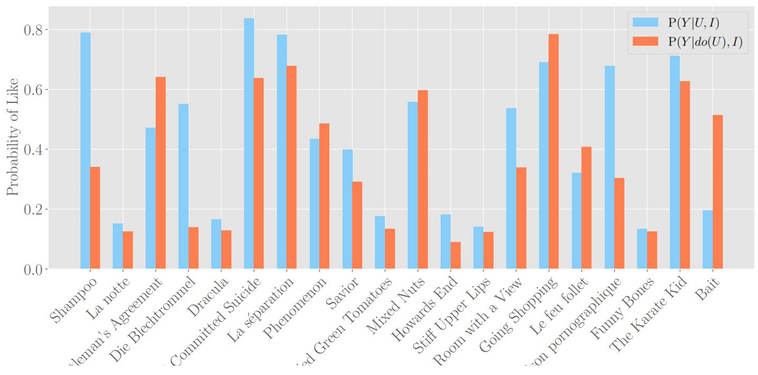
Bias Mitigation ↓



User- *vs* Fixed- Regulation



Prediction Score before *vs* after do-calculus



User-Regulation Coefficient