National University of Singapore
School of Computing

WING Reading Group (CS6101)

Causal Estimation
for Conversational Recommendation

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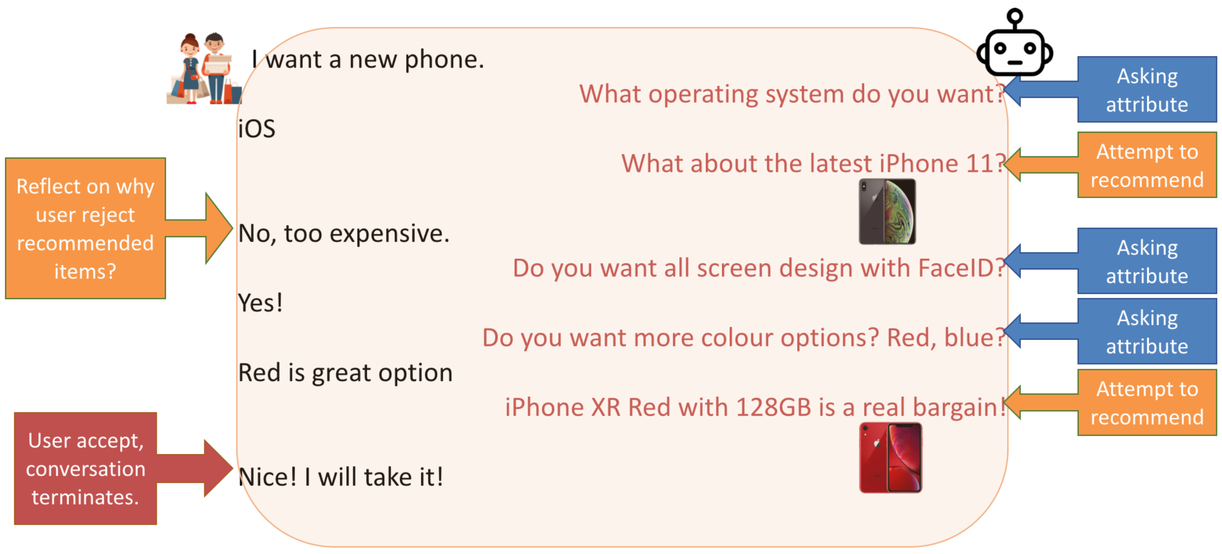
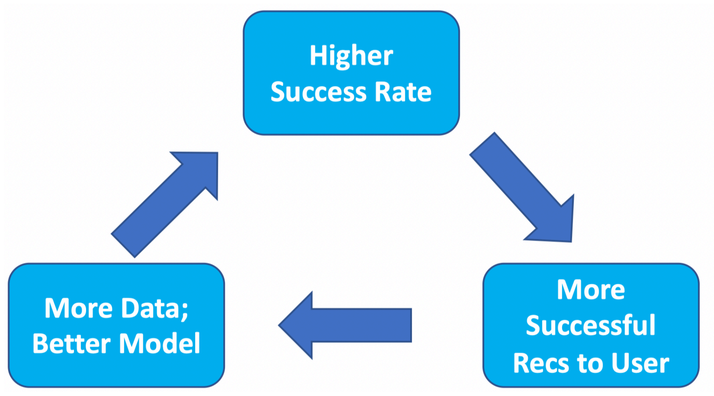
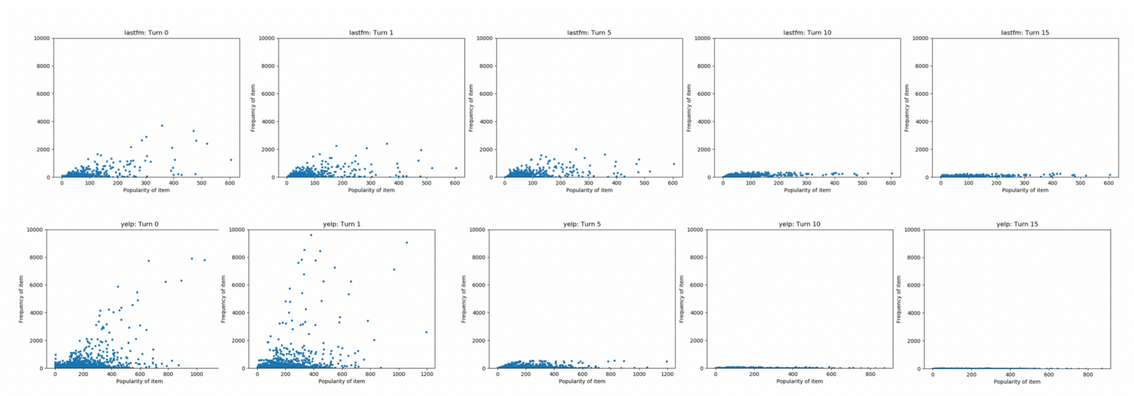
Introduction to Conversational Recommender System (CRS)





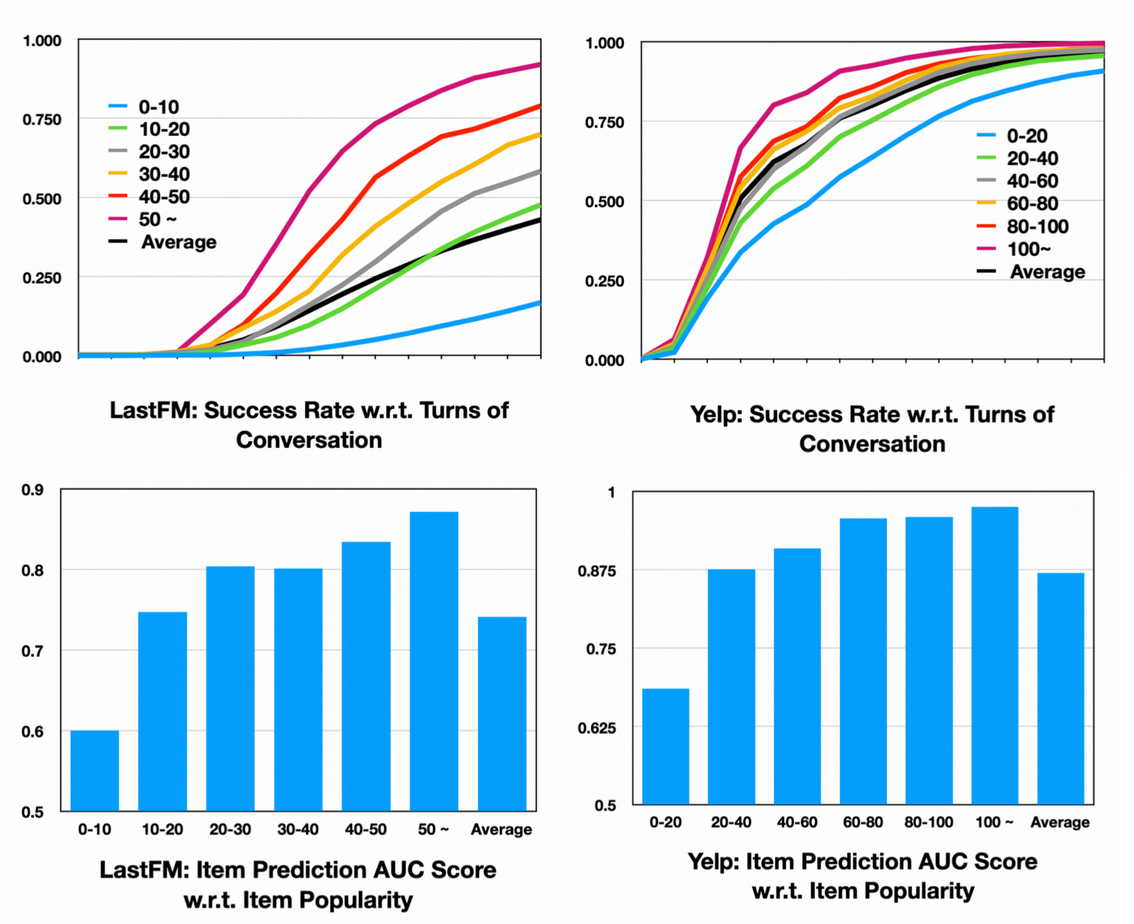
Unwanted Loop. Matthews Effect.

Popularity Bias in CRS



Popularity & Recommended Frequency on LastFM (upper) and Yelp (lower)

Conversation help mitigate the popularity bias in RS



CRS also suffer from popularity bias

Hypothesis: Two Independent Causes from Interest and Popularity

Proposed Methods

Disentangled Representation

- **Disentangled Item Prediction**

$$S_{u,v,\mathcal{P}_u} = S_{uv} + S_{v\mathcal{P}_u} = S^I_{uv} + S^C_{uv} + S^I_{v\mathcal{P}_u} + S^C_{v\mathcal{P}_u}$$

$$S_{uv} = S^I_{uv} + S^C_{uv}$$

$$S_{v\mathcal{P}_u} = S^I_{v\mathcal{P}_u} + S^C_{v\mathcal{P}_u}$$

- S_{uv} : DICE model
- $S_{v\mathcal{P}_u}$: how EAR matches incoming item with known attributes
- $S^I_{v\mathcal{P}_u}$: attributes matches item's intrinsic properties
- $S^C_{v\mathcal{P}_u}$: attributes conformity towards item's popularity

- **Disentangled Attribute**

$$S_{p,u,\mathcal{P}_u} = S_{up} + S_{p\mathcal{P}_u} = S^I_{up} + S^C_{up} + S^I_{p\mathcal{P}_u} + S^C_{p\mathcal{P}_u}$$

$$S_{up} = S^I_{up} + S^C_{up}$$

$$S_{p\mathcal{P}_u} = S^I_{p\mathcal{P}_u} + S^C_{p\mathcal{P}_u}$$

- S_{up} : how EAR matches a user and an incoming attribute; S^I_{up} : user's real interest toward an attribute; S^C_{up} : user's conformity towards the popularity of an attribute
- $S_{p\mathcal{P}_u}$: EAR matches an incoming attribute with the set of known attribute; $S^I_{p\mathcal{P}_u}$: incoming attribute's suitability for known attribute; $S^C_{p\mathcal{P}_u}$: popularity

Learning Signals from Two Sets of Inequalities

- **Item-level cause modelling**

Positive item a is more popular than negative item b

$$M^C_{ua} > M^C_{ub}, M^C_{ap_1} > M^C_{bp_1}$$

Positive item a is less popular than negative item b

$$M^C_{ua} < M^C_{ub}, M^C_{ap_1} < M^C_{bp_1}$$

$$M^I_{ua} + M^I_{ap_1} > M^I_{ub} + M^I_{bp_1}$$

- **Attribute-level cause modelling**

Positive attribute c is more popular than negative attribute d

$$M^C_{uc} > M^C_{ud}, M^C_{p_1c} > M^C_{p_1d}$$

Positive attribute c is less popular than negative attribute d

$$M^C_{uc} < M^C_{ud}, M^C_{p_1c} < M^C_{p_1d}$$

$$M^I_{uc} + M^I_{p_1c} > M^I_{ud} + M^I_{p_1d}$$

Experiment in Progress.

Stay tuned with us on:
- https://github.com/YisongMiao/cs6101