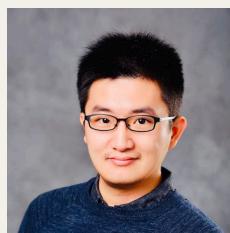




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# Jointly Learning to Recommend and Advertise



Xiangyu Zhao



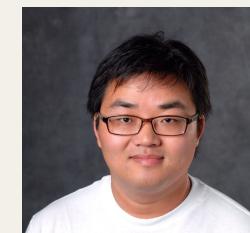
Xudong Zheng



Xiwang Yang



Xiaobing Liu



Jiliang Tang

1: Data Science and Engineering Lab, Michigan State University

2: Bytedance



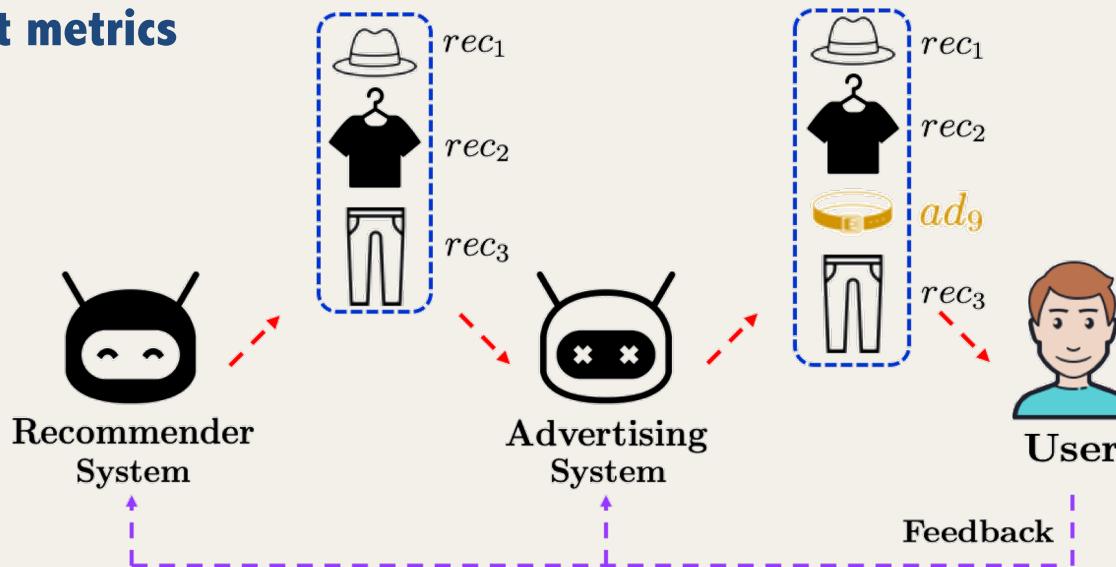
Data Science and Engineering Lab



# Motivation

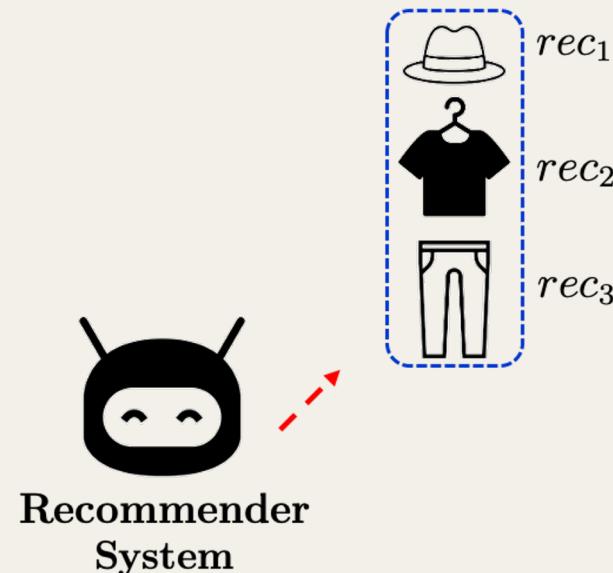
## ■ Recommending and advertising algorithms

- different teams
- different techniques
- different metrics



# Recommender System

- Goal: long-term user experience or engagement
- Challenge: combinatorial action space



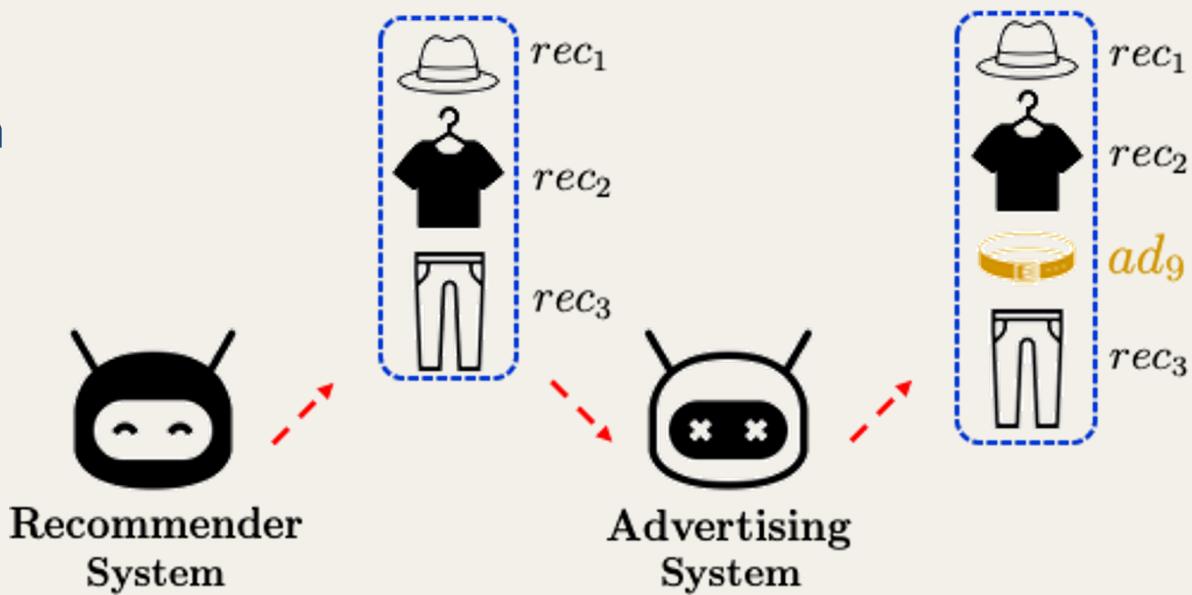
# Advertising System

- **Goal:**

- maximize the advertising revenue
- minimize the negative influence of ads on user experience

- **Challenge:**

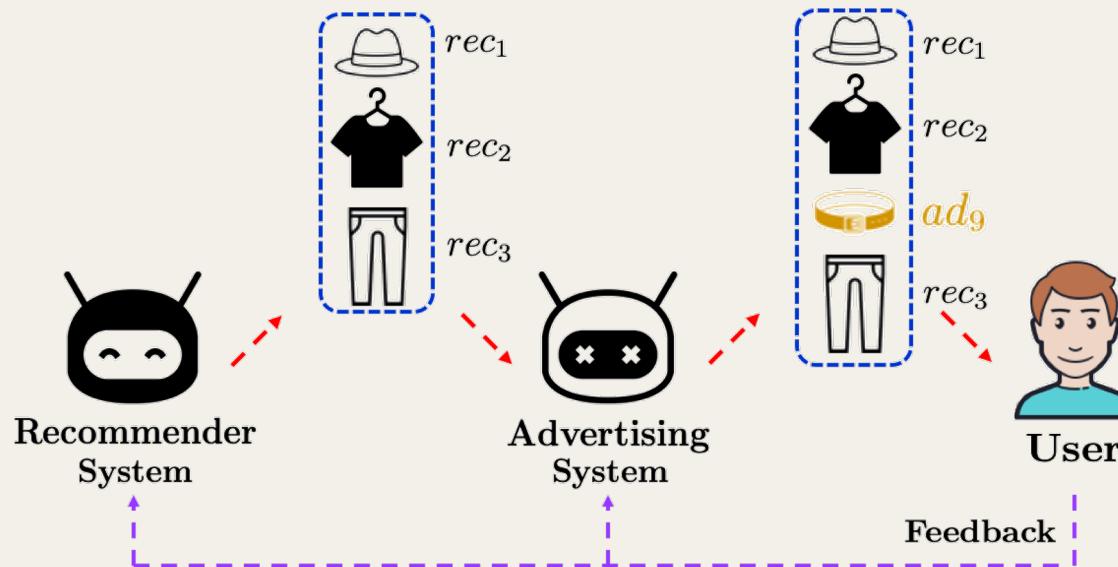
- interpolate an ad?
- the optimal location
- the optimal ad



# Systems Update

## ■ Target User:

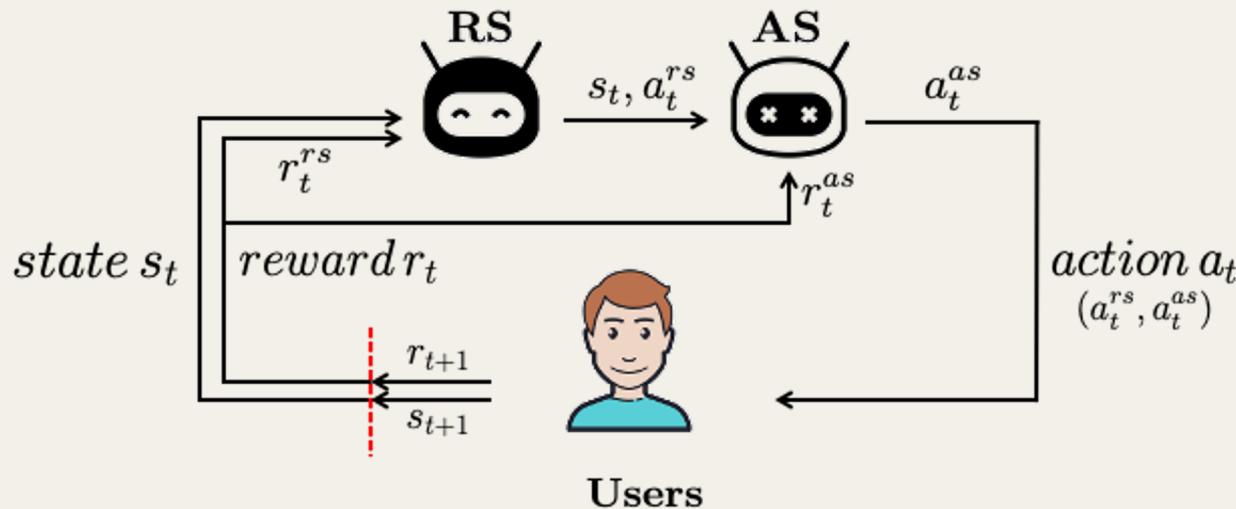
- browses the mixed rec-ads list
- provides her/his feedback



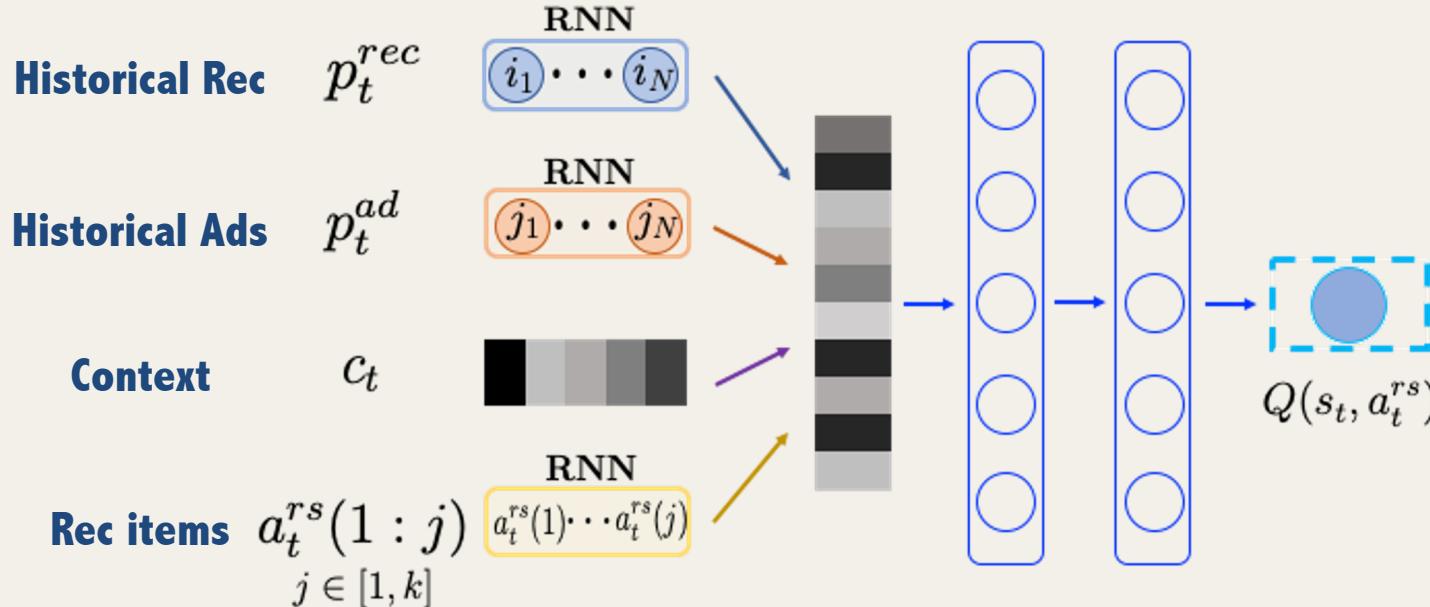
# Reinforcement Learning Framework

- **Two-level Deep Q-networks:**

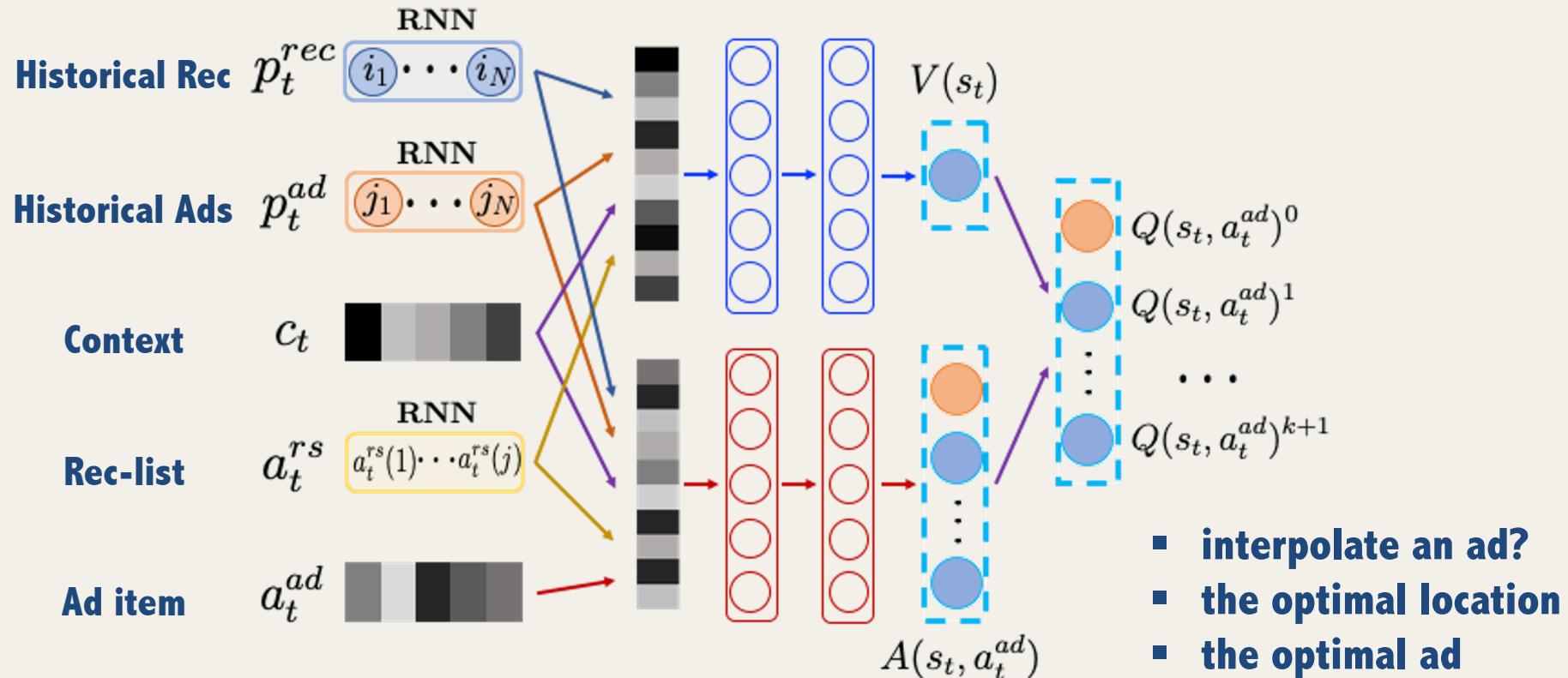
- first-level: recommender system (RS)
- second-level: advertising system (AS)



# Cascading DQN for RS



# Novel DQN for AS



# Experiments

## Tiktok short video dataset

| Object           | Quantity   |
|------------------|------------|
| # session        | 1,000,000  |
| # user           | 188,409    |
| # normal video   | 17,820,066 |
| # ad video       | 10,806,778 |
| rec-list with ad | 55.23%     |

## Overall performance

| Metrics   | Values     | Algorithms |       |       |       |              |             |
|-----------|------------|------------|-------|-------|-------|--------------|-------------|
|           |            | W&D        | DFM   | GRU   | DRQN  | RAM-I        | RAM-n       |
| $R^{rs}$  | value      | 17.61      | 17.95 | 18.56 | 18.99 | <b>19.61</b> | 19.49       |
|           | improv.(%) | 11.35      | 9.25  | 5.66  | 3.26  | -            | 0.61        |
|           | p-value    | 0.000      | 0.000 | 0.000 | 0.000 | -            | 0.006       |
| $R^{as}$  | value      | 8.79       | 8.90  | 9.29  | 9.37  | <b>9.76</b>  | 9.68        |
|           | improv.(%) | 11.03      | 9.66  | 5.06  | 4.16  | -            | 0.83        |
|           | p-value    | 0.000      | 0.000 | 0.000 | 0.000 | -            | 0.009       |
| $R^{rev}$ | value      | 1.07       | 1.13  | 1.23  | 1.34  | 1.49         | <b>1.56</b> |
|           | improv.(%) | 45.81      | 38.05 | 26.83 | 16.42 | 4.70         | -           |
|           | p-value    | 0.000      | 0.000 | 0.000 | 0.000 | 0.001        | -           |





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# Thanks

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