Jointly Learning to Recommend and Advertise

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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
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

Historical Rec $p_t^{rec}$

Historical Ads $p_t^{ad}$

Context $c_t$

Rec items $a_t^{rs}(1:j)$

$\forall j \in [1,k]$
Novel DQN for AS

- interpolate an ad?
- the optimal location
- the optimal ad
## Tiktok short video dataset

<table>
<thead>
<tr>
<th>Object</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td># session</td>
<td>1,000,000</td>
</tr>
<tr>
<td># user</td>
<td>188,409</td>
</tr>
<tr>
<td># normal video</td>
<td>17,820,066</td>
</tr>
<tr>
<td># ad video</td>
<td>10,806,778</td>
</tr>
<tr>
<td>rec-list with ad</td>
<td>55.23%</td>
</tr>
</tbody>
</table>

## Overall performance

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Values</th>
<th>Algorithms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>W&amp;D</td>
</tr>
<tr>
<td>$R^{es}$</td>
<td>value</td>
<td>17.61</td>
</tr>
<tr>
<td></td>
<td>improv. (%)</td>
<td>11.35</td>
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<tr>
<td></td>
<td>p-value</td>
<td>0.000</td>
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<td>$R^{as}$</td>
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<td></td>
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</tbody>
</table>
Thanks

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