Sketching Dynamic User-Item Interactions for Online Item Recommendation

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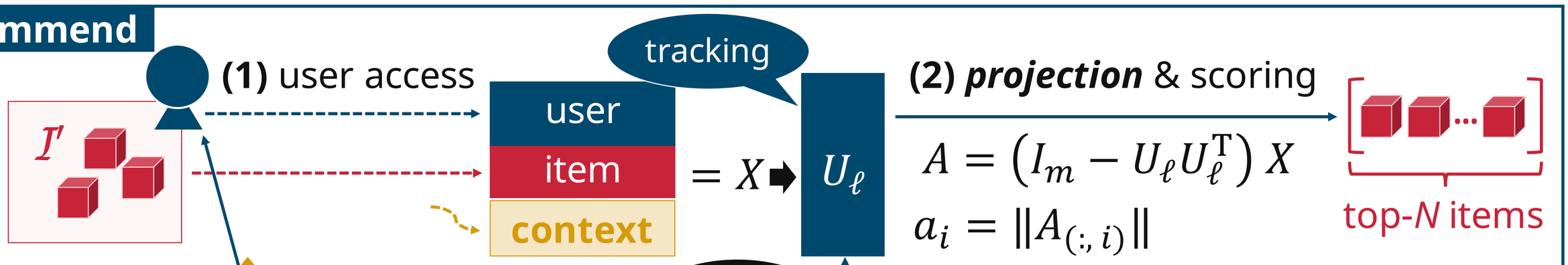
Recommend



Update

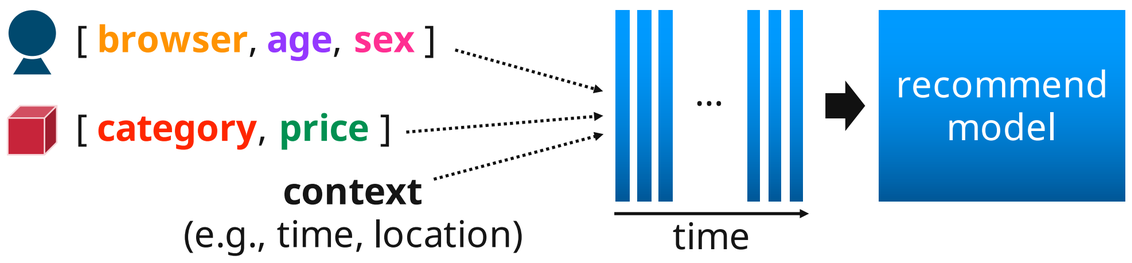
$$\hat{\Sigma}_\ell \leftarrow \mathrm{diag}\left(\sqrt{\sigma_1^2 - \sigma_\ell^2}, \sqrt{\sigma_2^2 - \sigma_\ell^2}, \ldots, \sqrt{\sigma_{\ell-1}^2 - \sigma_\ell^2}, 0\right)$$

$$B \leftarrow U_\ell \hat{\Sigma}_\ell$$

Problem & Requirements

Persistent cold-start in real-world services
online ad [1], hotel reservation [2], golf package [3]

➡ **Online learning** for **feature vectors** (e.g. [1])



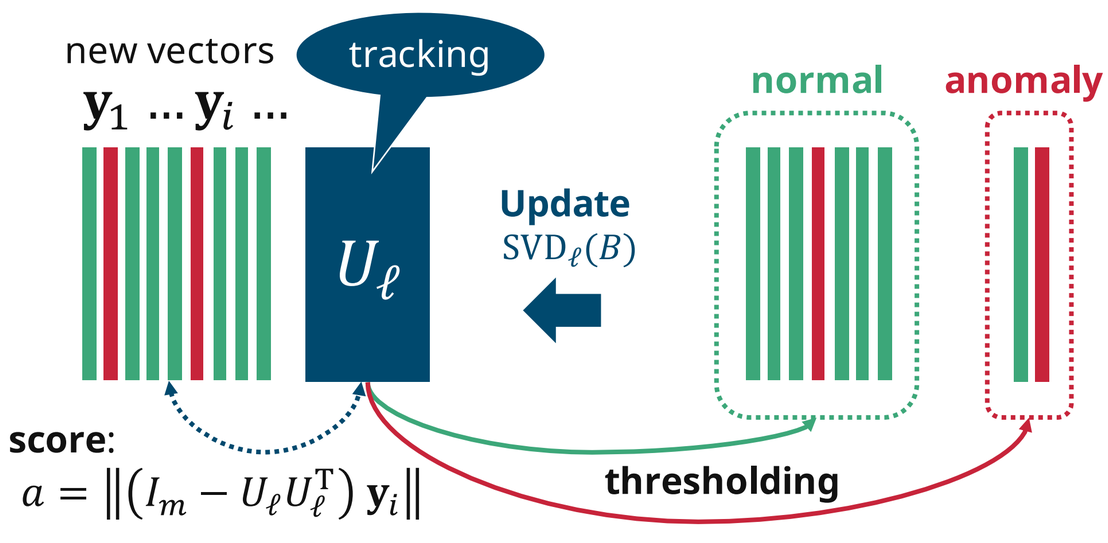
Still incomplete in terms of some of:

1. **Online-updating**
2. **Implicit feedback**
3. **Feature expressiveness**
4. **Usability** (simple, interpretable) *
5. **Parallelizability**

Connect to Anomaly Detection

State-of-the-art anomaly detector [4]:

- **Subspace method**
- Efficient **matrix sketching**: $AA^T \approx BB^T$
  for $A \in \mathbb{R}^{m \times n}$ $(m \ll n)$, $B \in \mathbb{R}^{m \times \ell}$ $(\ell < m)$



Task: **Find** { **similar** (recommend) / **dissimilar** (anomaly) } **vectors**

Characteristics of Proposed Method

- ✓ **Feature representation**: $\mathbf{x} \in \mathbb{R}^m$
- ✓ **Single hyper-parameter**: ℓ (e.g., $\sqrt{m}$)
- ✓ **Time** & **space efficient**: $\ell \ll n$
- ✓ **Parallelizable**: $B' = \mathrm{sketch}([B_1, B_2])$

Experimental Results

Incremental ***test-then-learn*** evaluation

- iMF [5]: **matrix**-based classical method
- iFMs [6]: **feature**-based, but **complex**

$\mathbf{x}$ = [age | sex | geo (state) | (ad ID) | category]

$\mathbf{x}$ = [(user ID) | demographics | (movie ID) | genre | last rated genre | day of week | last rated day of week]

Method	Recall@N	Update [sec]
Synthetic Click (@1)		
iMF	0.27251	0.00003
iFMs	0.29612	0.00026
Sketch	**0.30092**	0.00066
MovieLens 100k (@10)		
iMF	0.02318	0.00003
iFMs	**0.03349**	0.00142
Sketch	0.03005	0.00039
MovieLens 1M (@10)		
iMF	0.01249	0.00003
iFMs	0.01379	0.00605
Sketch	**0.02451**	0.00044

best
x 0.41
x 0.81
efficient
robust

[1] M. Aharon et al. In ***Proc. of RecSys 2013***, pp. 375-378.
[2] L. Bernardi et al. In ***Proc. of CBRecSys 2015***, pp. 30-33.
[3] R. Swezey and Y. Chung. In ***Proc. of CIKM 2015***, pp. 1779-1782.
[4] H. Huang and S. P. Kasiviswanathan. ***PVLDB***, 9(3):192–203, 2015.
[5] J. Vinagre et al. In ***Proc. of UMAP 2014***, pp. 459-470.
[6] T. Kitazawa. ***RecProfile 2016*** (arXiv:1607.02858 [cs.LG]).