



Bypassing the Popularity Bias: Repurposing Models for Better Long-Tail Recommendation



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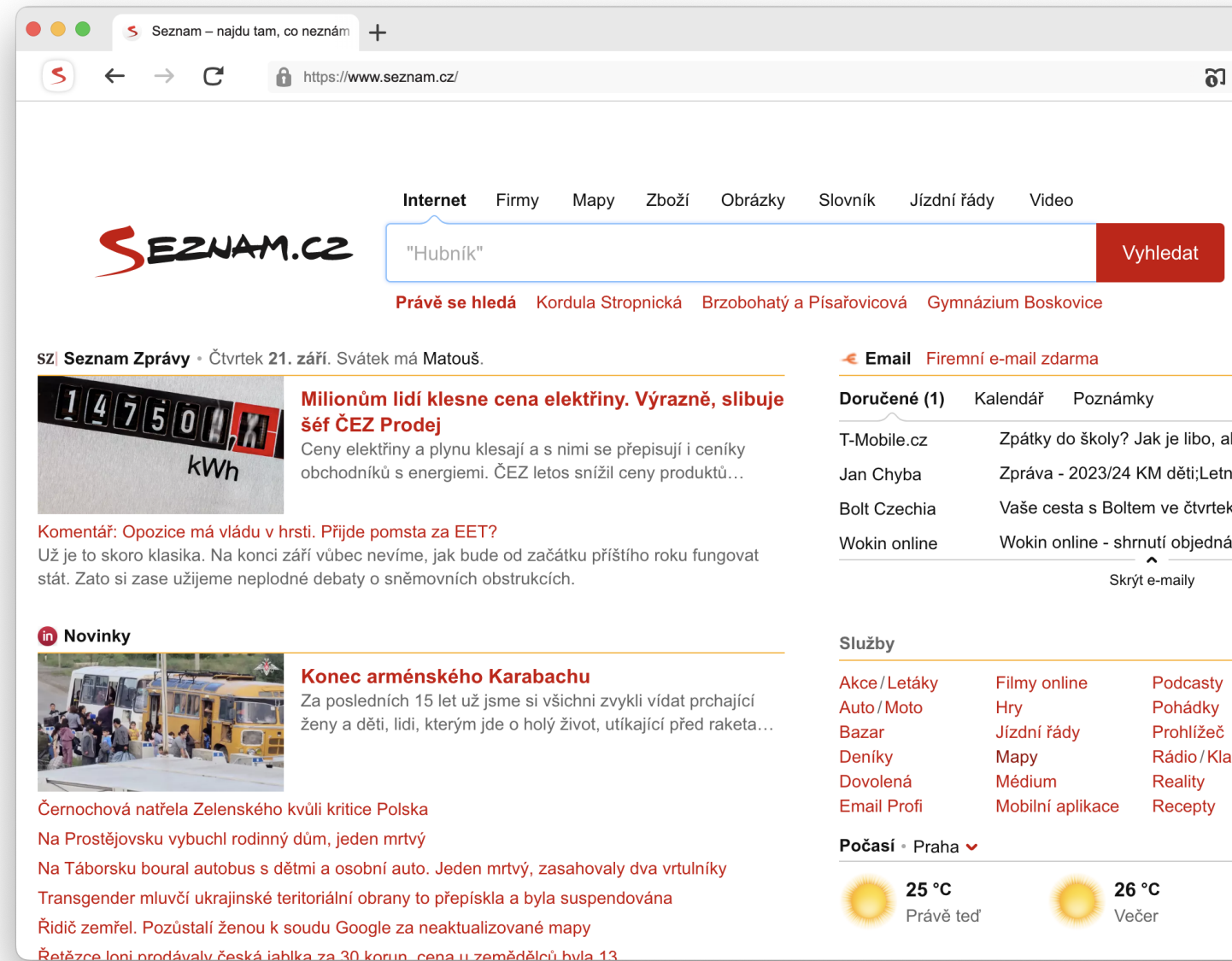
Product Manager, Seznam.cz, a.s.

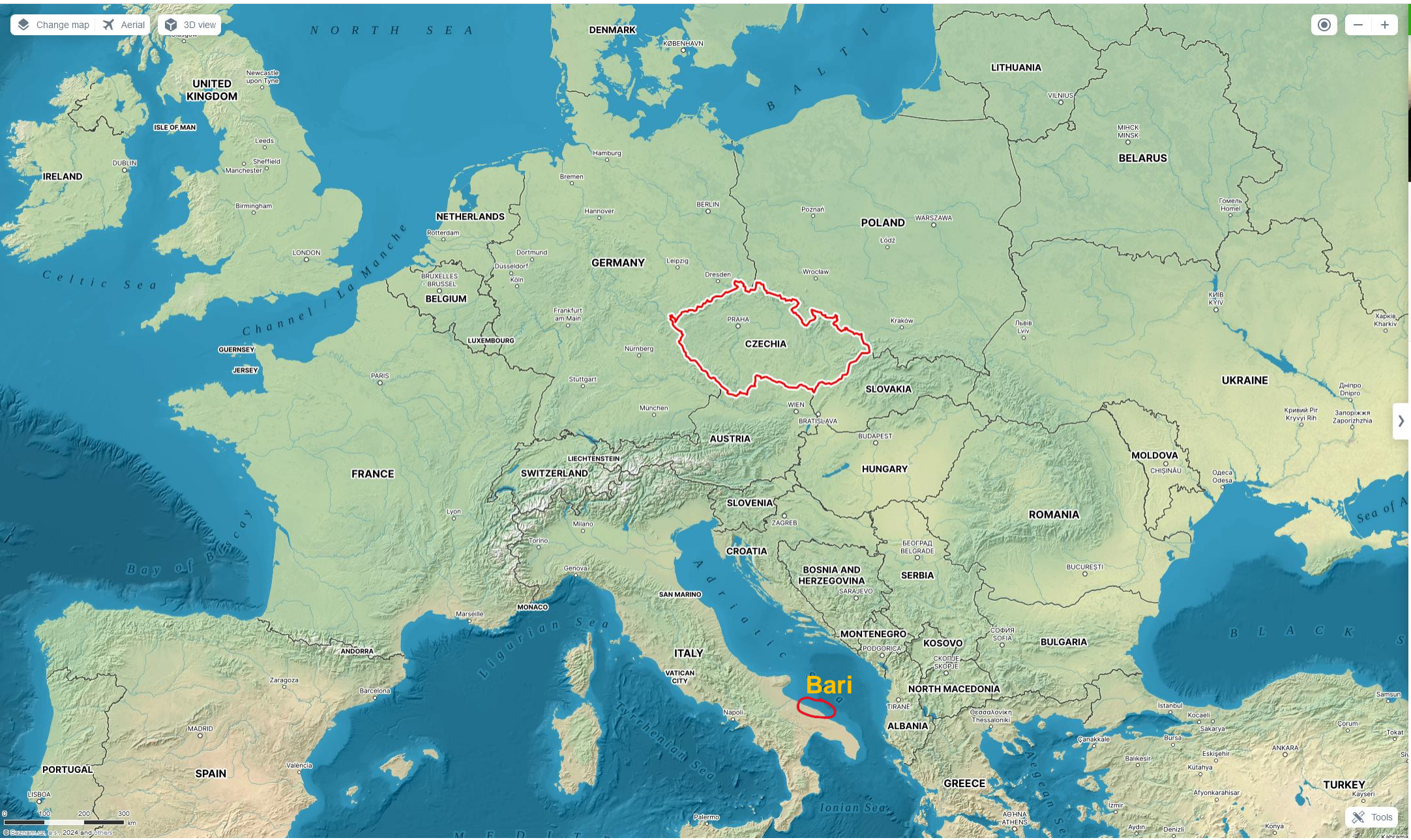
7th FAccTRec Workshop on Responsible Recommendation at RecSys 2024
October 14th, Bari, Italy



Seznam?

- „The homepage of czech internet“
- Search engine, e-mail service, news and entertainment content publisher, video streaming platform, maps, internet browser, TV, radio...
- Private company
- Online advertisement platform
- Czech market





PHOTOS 3D VIEW

Czechia

Česko

Country

Europe

Directions

Save

Share

Travel tips

Find hotel nearby

www.czechia.eu

Suggest data modification

The Czech Republic, also known as Czechia, is a landlocked country in Central Europe. Historically known as Bohemia, it is bordered by Austria to the south, Germany to the west, Poland to the northeast, and Slovakia to the southeast. The Czech Republic has a hilly landscape that covers an area of 78871 km2 with a mostly temperate continental and oceanic climate.

[Wikipedia](#)


Capital:	Prague
Currency:	Czech koruna
Country calling code:	+420
Population:	10,900,555
Area:	78,866 km²
Head of state:	Petr Pavel
Head of government:	Petr Fiala
Basic form of government:	parliamentary republic
Official language:	Czech

Data sources

Seznam Newsfeed

- Personalized, infinite feed of content
- News, entertainment articles, videos, podcasts, photos, user comments...
- In-house produced content
- **External partner content**


F Finance



Jaká je dnes výše důchodu přiznaného v roce 2010?
Před 15 hodinami
Odešli jste do důchodu v roce 2010? Důchodové valorizace jsou velmi důležité a zvyšují výši důchodů. Podívejte se, j...

Libí se 18 Komentáře 1

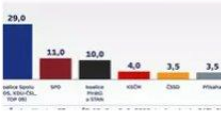
A Aktuálně



Nos mu stále roste, nový Pinocchio ale lže jinak. Disney umrtvil další klasiku
Před 5 hodinami
Disney převedl další svou klasickou pohádku do hrané podoby. Tom Hanks v roli řezbáře Geppetta do ní vnáší ...

Libí se 9 Komentáře 3


E Echo24



Volby do sněmovny by vyhrálo ANO, TOP 09 a lidovci by neuspěli
Před 1 dnem
Podle nového volebního průzkumu společnosti STEM by volby nyní vyhrálo s náskokem hnutí ANO s 30,5 procenty...

Libí se 217 Komentáře 149


Český rozhlas - Válka na Ukrajině



PODCAST O češtině od A do Z: Která varianta je správně - tamní nebo tamější?
Před 1 dnem - 3 minuty
Praktická škola naší mateřštiny s humorem a nadhledem. Každou neděli jedna poučka, kterou jste už možná ...

Libí se 4 Komentáře

Malinagroup.cz



Akce pro nové zákazníky
Nyní dostanete k nově uzavřené smlouvě baterii Gen2 v hodnotě 30 000 Kč zcela zdarma!

Libí se Komentáře

Reklama



Seznam Newsfeed in numbers



1.8 M

daily active users



2 000

daily published items



450

publishers

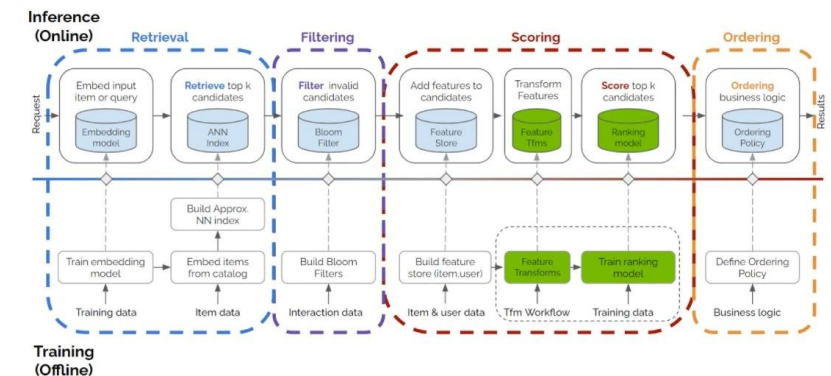
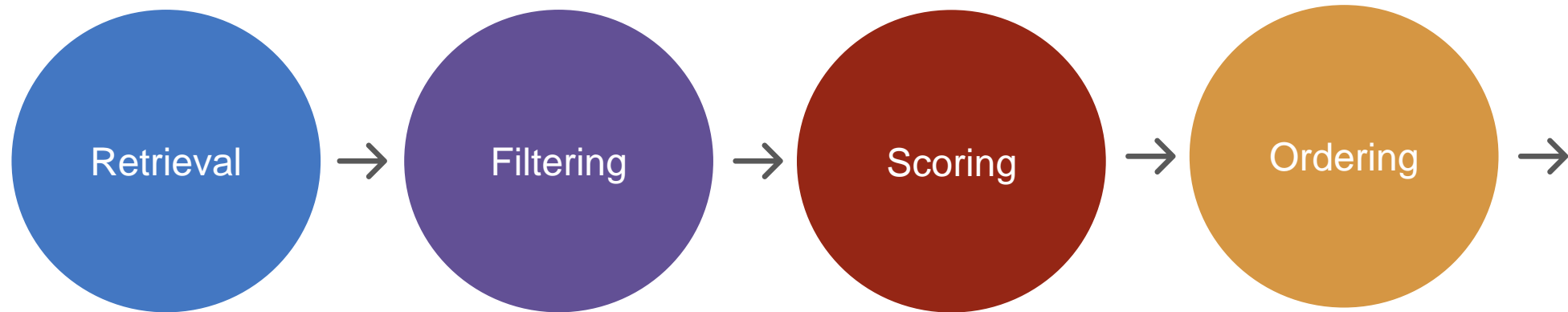


3 000

peak requests per second



4-stage recommender system



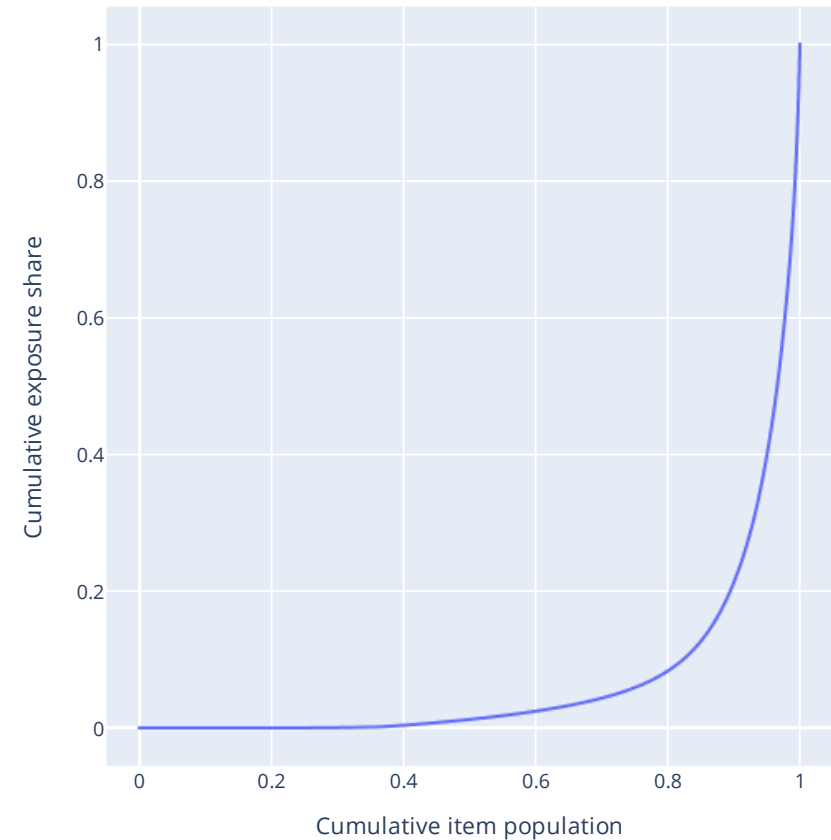
Source: Karl Higley, Even Oldridge, Ronay Ak, Sara Rabhi, and Gabriel de Souza Pereira Moreira. 2022. Building and Deploying a Multi-Stage Recommender System with Merlin. In Proceedings of the 16th ACM Conference on Recommender Systems (RecSys '22). Association for Computing Machinery, New York, NY, USA, 632–635. <https://doi.org/10.1145/3523227.3551468>



Problem:
Popularity bias
and long-tail content exposure

Publisher and item exposure

- Item exposure – # of visible impressions
- Popularity bias ~ long-tail items
- Publisher diversity is important

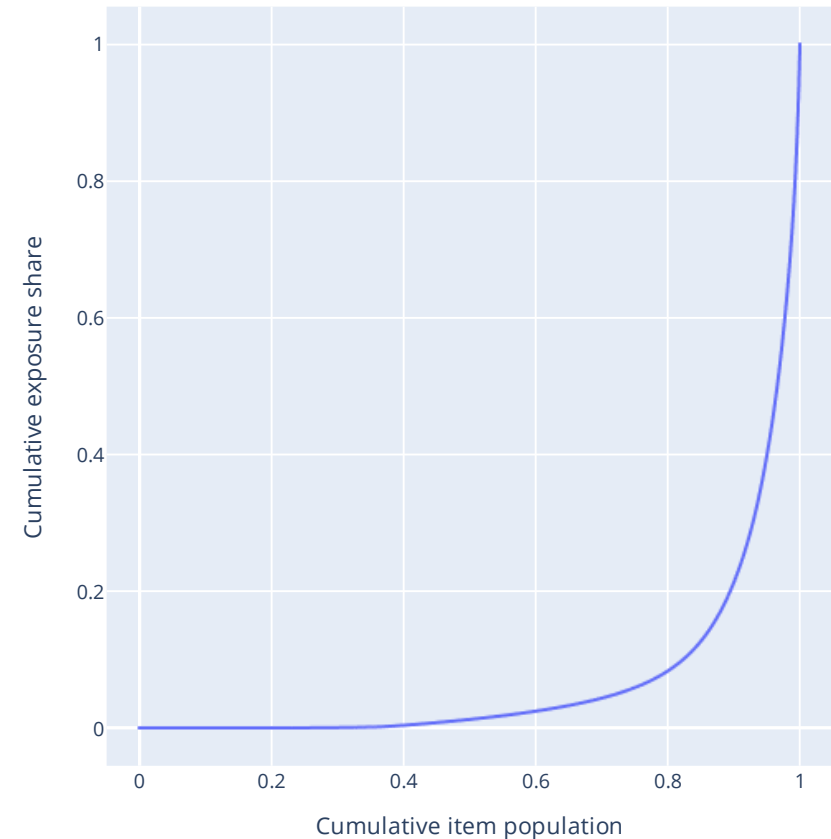


Publisher and item exposure

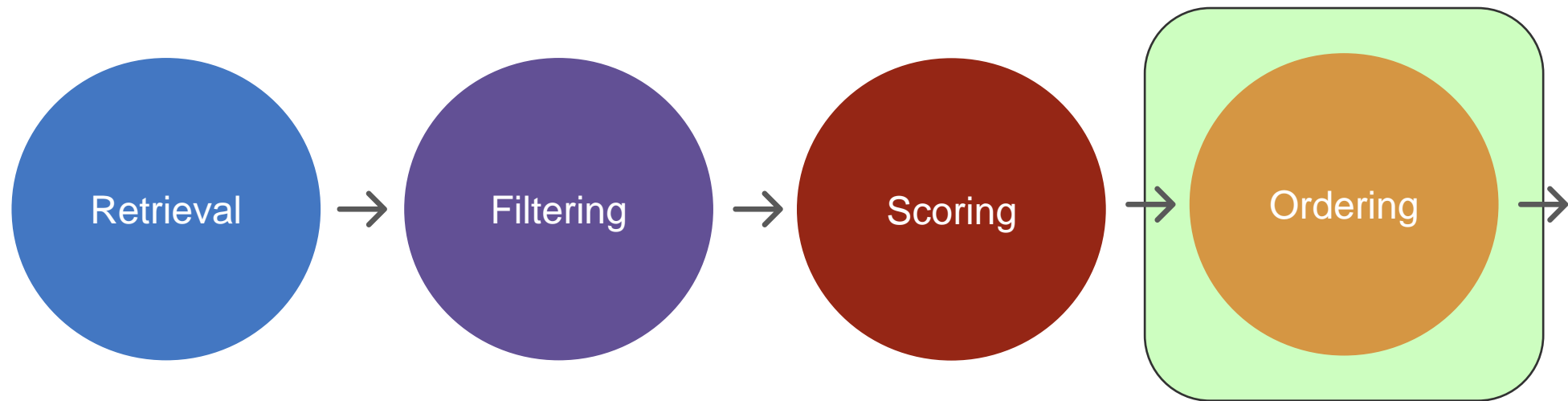
- Item exposure – # of visible impressions
- Popularity bias ~ long-tail items
- Publisher diversity is important

Goal:

Deliver relevant exposure to unfairly underexposed items



Randomization after ranking



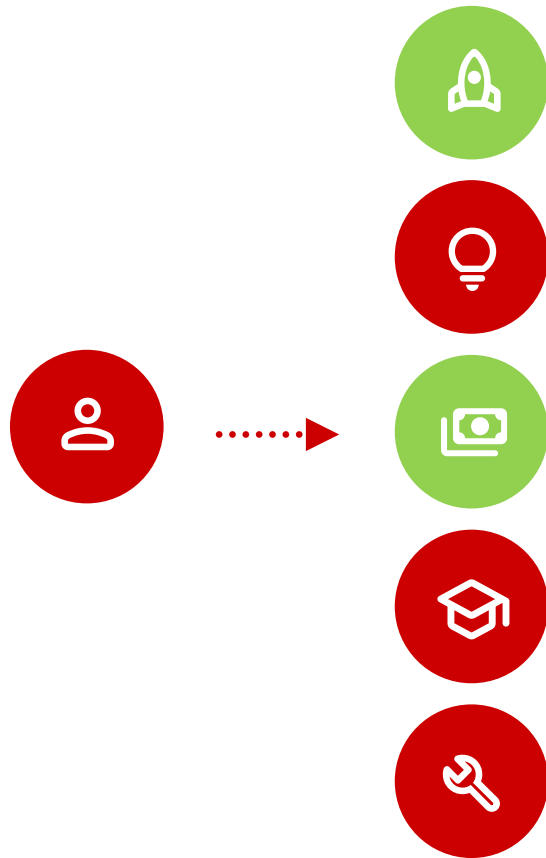
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**Proposed solution:
Inverse recommendation**



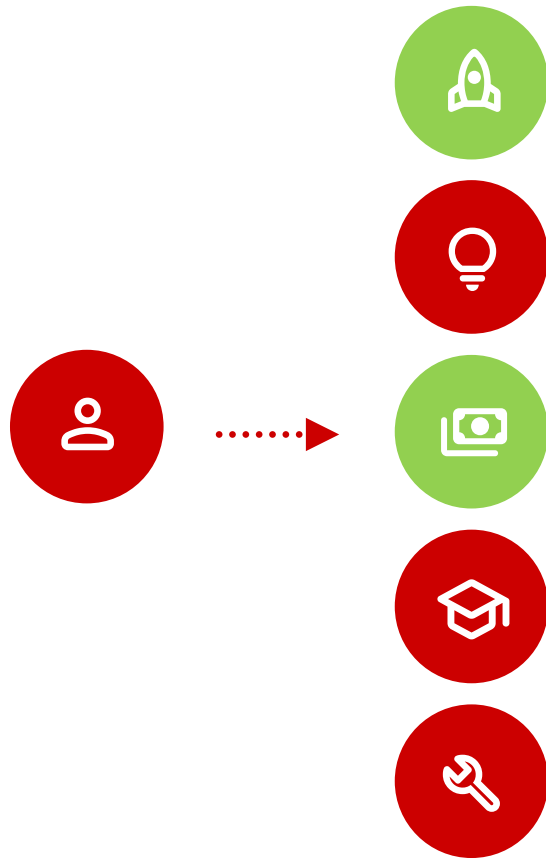
Traditional recommendation



Top items for a user

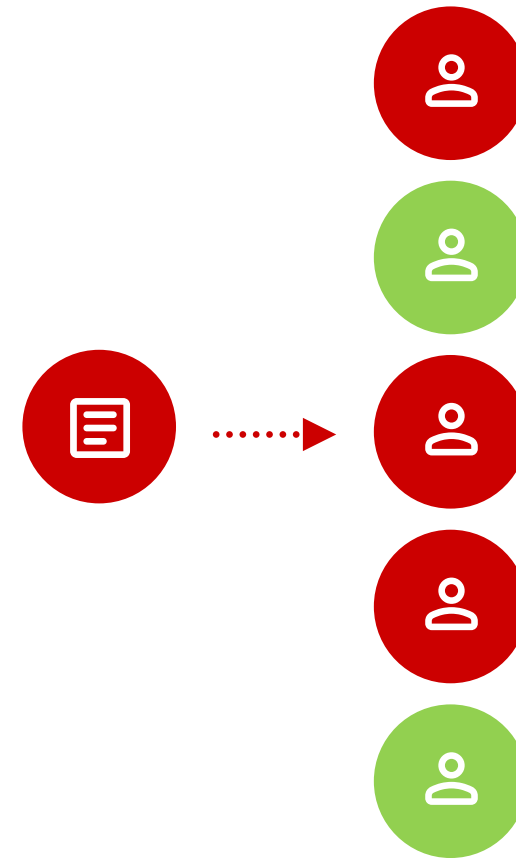


Traditional recommendation



Top items for a user

Inverse recommendation a.k.a. reverse k-MIPS [0]

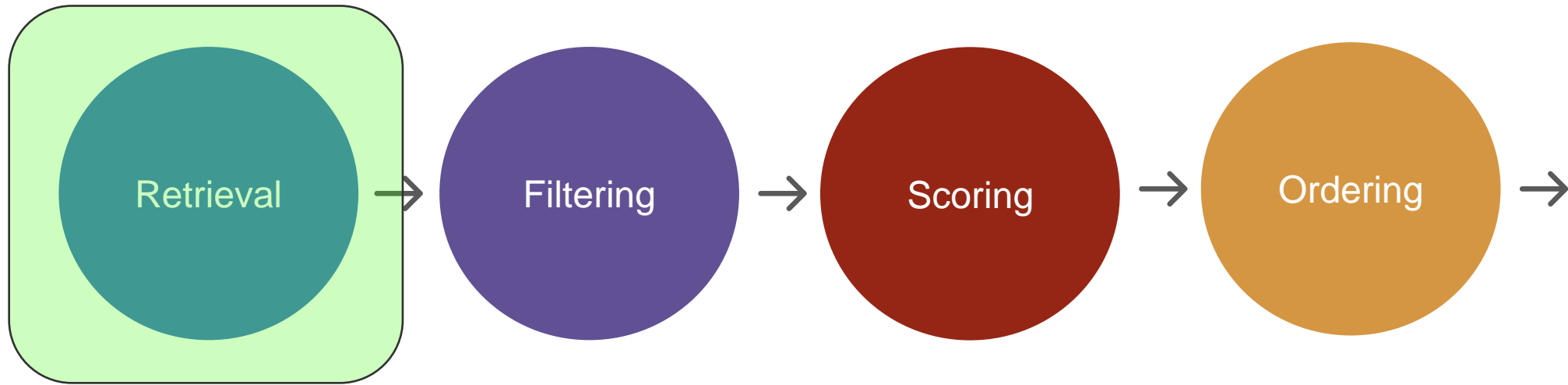


Top users for an item

[0] Daichi Amagata and Takahiro Hara. 2021. Reverse Maximum Inner Product Search: How to efficiently find users who would like to buy my item? In Proceedings of the 15th ACM Conference on Recommender Systems (RecSys '21). Association for Computing Machinery, New York, NY, USA, 273–281.
<https://doi.org/10.1145/3460231.3474229>



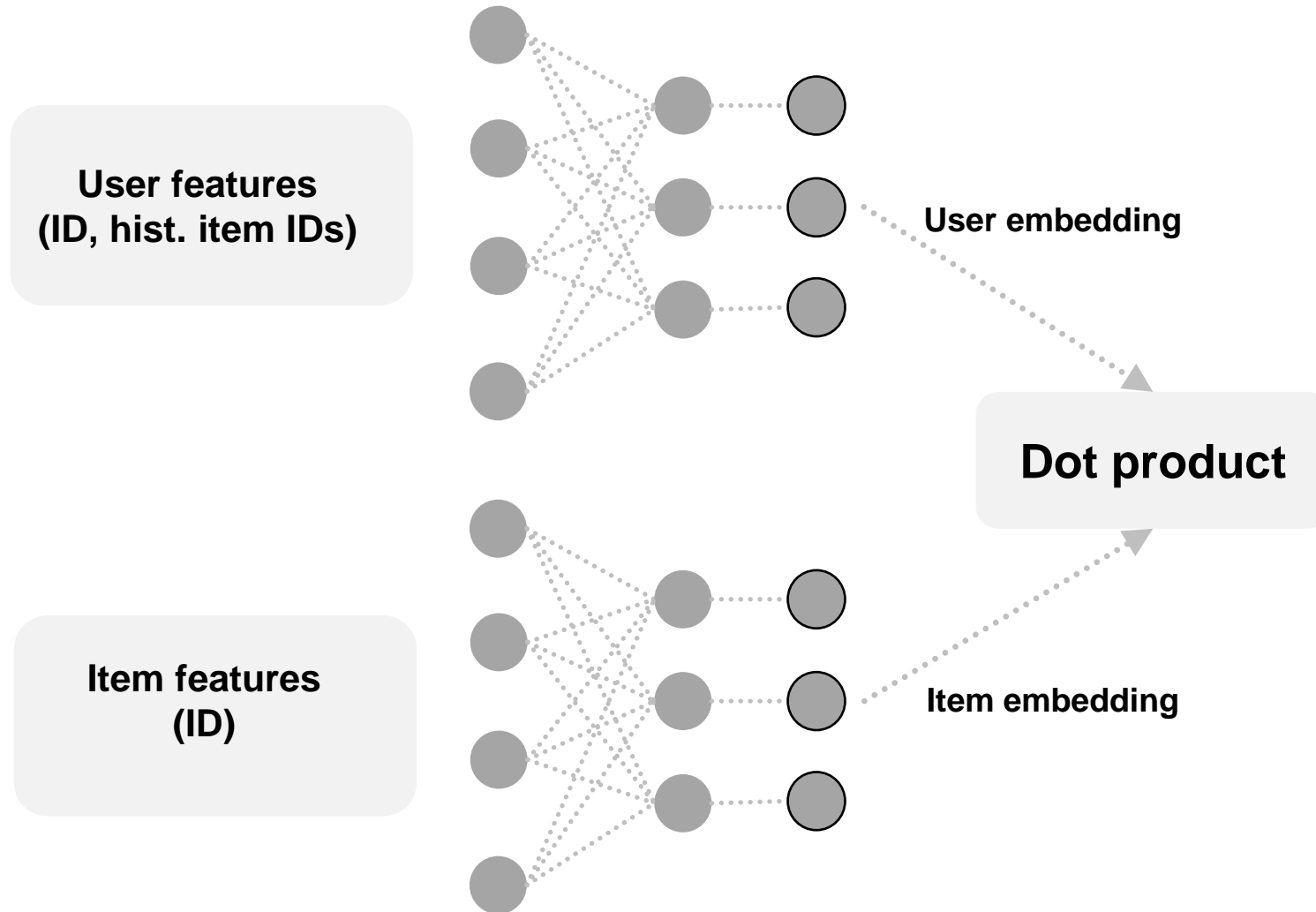
Retrieval model



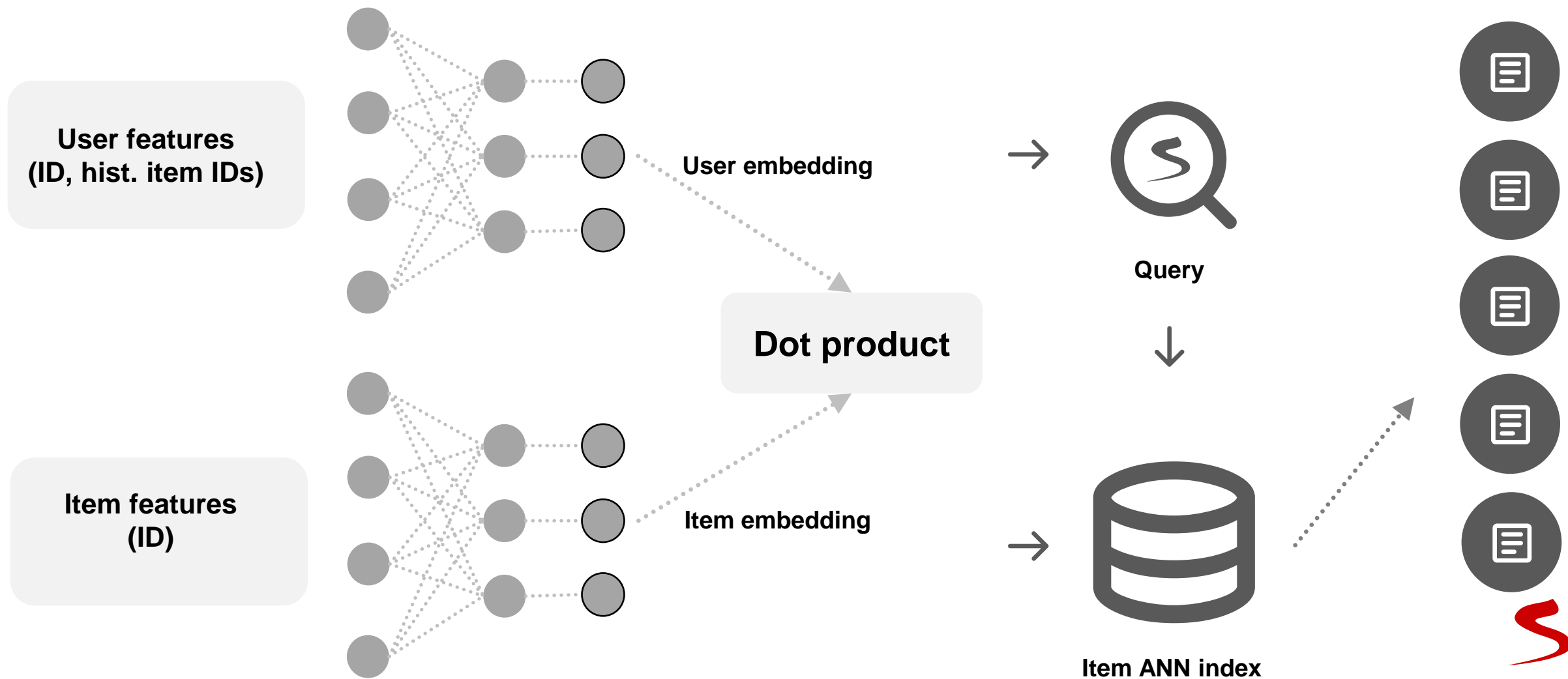
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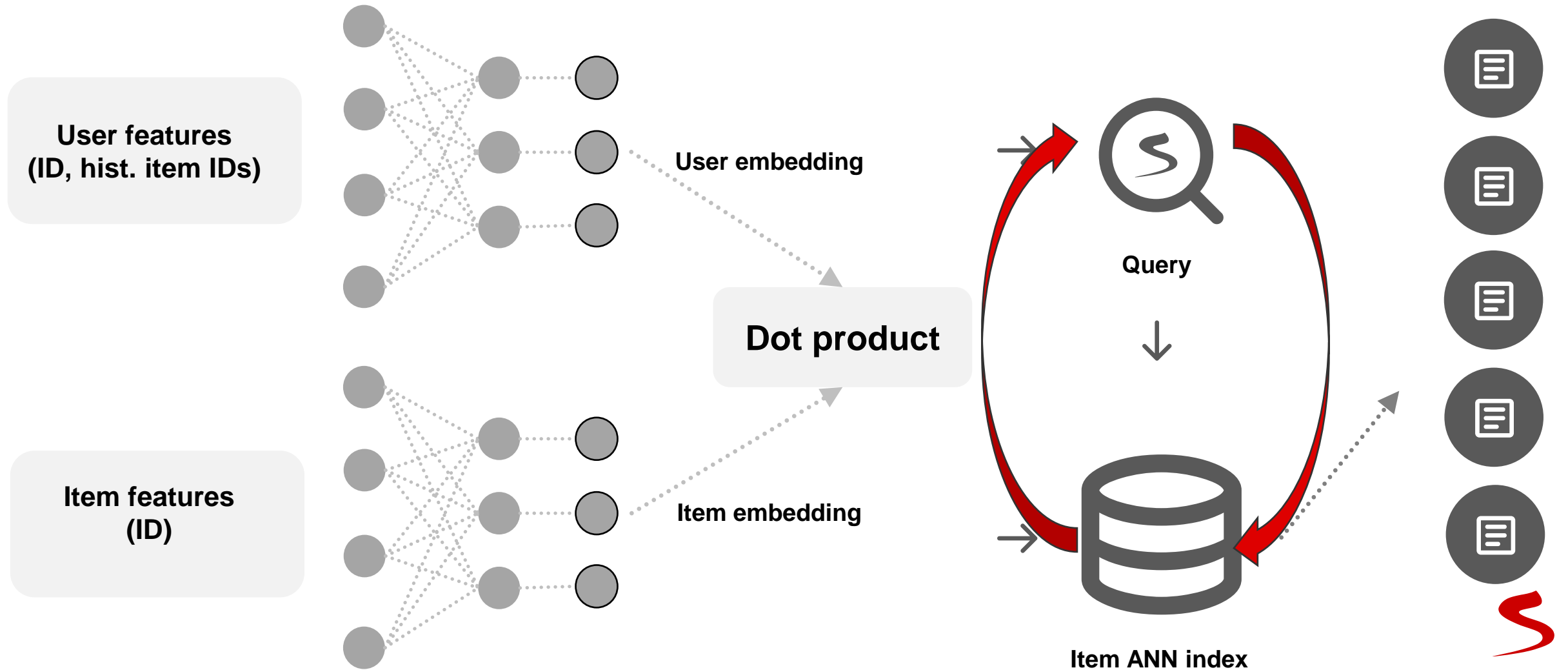
Two-tower retrieval model



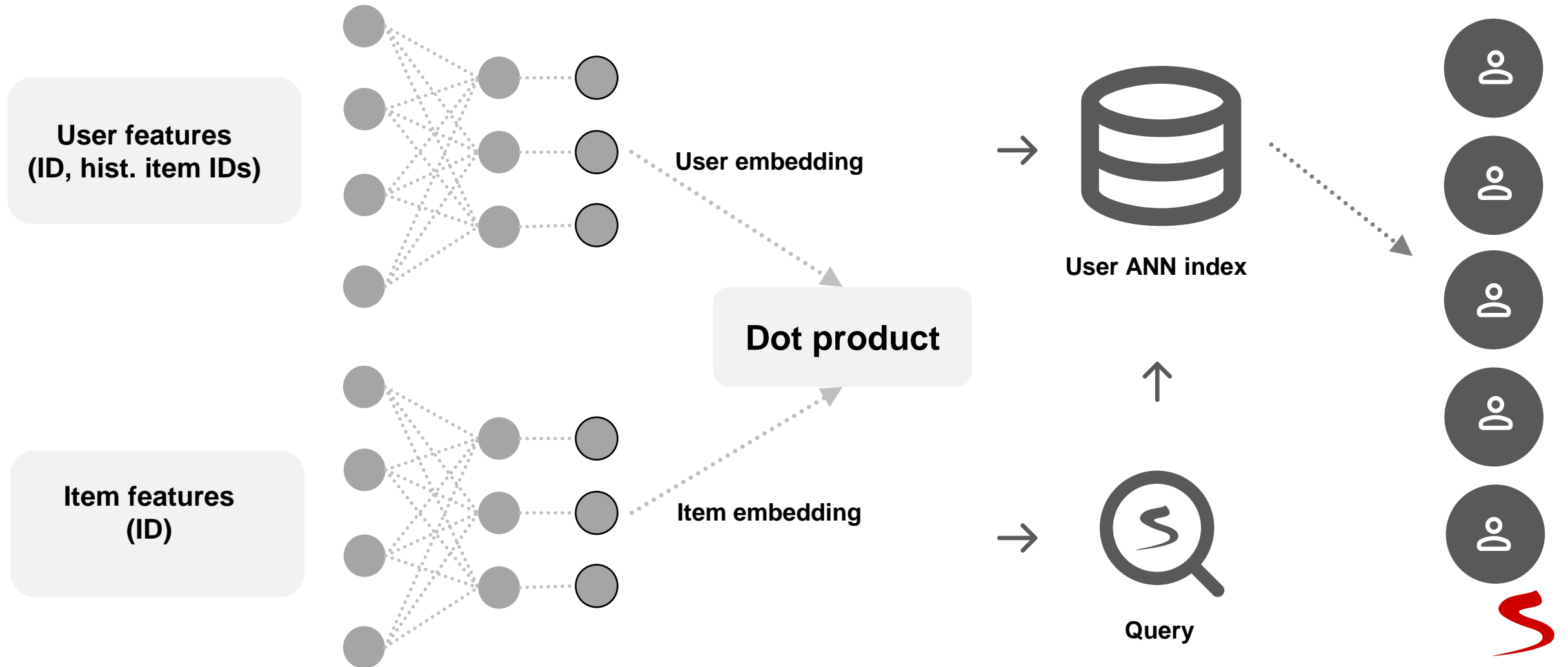
Two-tower retrieval model



Two-tower retrieval model



Two-tower *inverse* retrieval model (InvR)



Results ordering

- Multiple items per user
- **Score sort**
 - Use the similarity (dot product) value
 - Biased



Results ordering

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- **Score sort**
 - Use the similarity (dot product) value
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- **Random sort**
 - Most fair?



Results ordering

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- **User rank sort**
 - Use the rank of user w.r.t. item



Results ordering

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- **Score sort**
 - Use the similarity (dot product) value
 - Biased
- **Random sort**
 - Most fair?
- **User rank sort**
 - Use the rank of user w.r.t. item



score	user rank
0.51	1 924
0.85	5 124
0.46	265
0.64	945
0.28	1 324



Incorporating in recommendations

- Offline InvR pipeline
- Inserted into slate after business logic



Source: Karl Higley, Even Oldridge, Ronay Ak, Sara Rabhi, and Gabriel de Souza Pereira Moreira. 2022. Building and Deploying a Multi-Stage Recommender System with Merlin. In Proceedings of the 16th ACM Conference on Recommender Systems (RecSys '22). Association for Computing Machinery, New York, NY, USA, 632–635. <https://doi.org/10.1145/3523227.3551468>



Business-level hyperparameters

- Set of treated publishers
- Minimum exposure
- Slate positions
- Capping



Evaluation



A/B testing

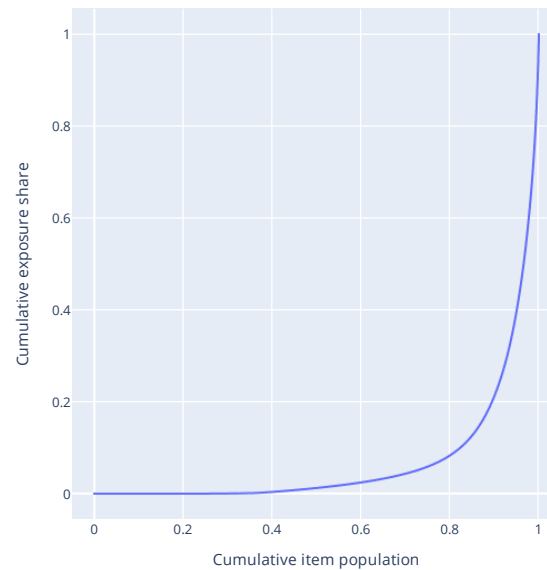
- Randomized A/B tests on live traffic
- A/A variants included
- Empirically sufficient variant sizes and duration
- Randomization unit = user



Metrics

Fairness-oriented

- Bottom 50 % share (B50PS)
 - Whole item set
- Percentage of sufficiently exposed items (PSEI)
 - Treated items only
- Top 1 % share (T1PS)
 - Whole item set



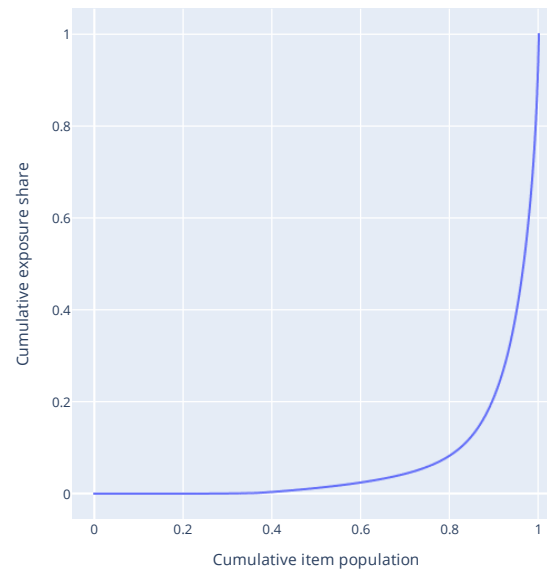
Metrics

Fairness-oriented

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 - Whole item set
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- Top 1 % share (T1PS)
 - Whole item set

KPIs (InvR-only)

- CTR
 - per user
- Clicks
 - per user



Variants

- Baseline
 - No InvR
- Random
 - **Ablation study**
 - Pick users for the item randomly
- Score sort
- Random sort
- User rank sort



Results



Main results

Variant	B50PS	PSEI	T1PS	CTR (InvR)	Clicks (InvR)
Baseline	0 %	0 %	0 %	-	-
Random	+9.2 %	+181 %	-1.0 %	0 %	0 %
InvR Random	+9 %	+43 %	-0.5 %	+271 %	+106 %
InvR Score	+9.9 %	+41 %	-0.9 %	+261 %	+103 %
InvR User rank	+33.3 %	+45 %	-1.6 %	+300 %	+120 %

All reported changes are relative.

B50PS – Bottom 50 % share

PSEI – Percentage of sufficiently exposed items

T1PS – Top 1 % share

CTR (InvR) – click-through rate per user, InvR recommendations only

Clicks (InvR) – clicks per user, InvR recommendations only



Cost of deployment

InvR User rank variant

-1.04 %

CTR per user

-1.67 %

clicks per user

All reported changes are relative.



Side-effects

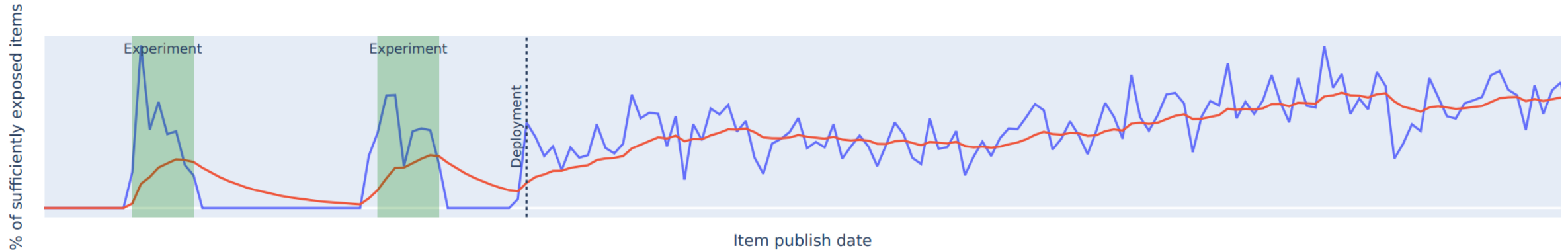
+18 %

unique items recommended
by main recommender

All reported changes are relative.



Long-term experience



- Only 40 % of min. exposure generated by InvR



Considerations, limitations, future work

- Cold-start item embeddings
 - Employ content-based solution instead of IDs
- Popularity bias in user set
 - Truncated user representation
- Model hyper-opt
- Treatment of all items
- User-centered analysis



Thank you!

Questions?

Paper at:



<https://arxiv.org/abs/2410.02776>



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