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In-Session Personalization

Hands-on Workshop on ML for Retail

Jacopo Tagliabue

Lead A.I. Scientist

Toronto Machine Learning Society (TMLS)

Machine Learning in Retail Summit

April 21st

Agenda

1. Pleased to meet you!
   Hope you guessed my name!
2. From personalization to in-session personalization
   Why sessions are the most important partition for our models
3. (Product) space, the final frontier
   How to build product embeddings, and why they are so important
4. One representation to rule them all
   How session representation can enrich all kinds of models
5. Hands-on coding
   “Talk is cheap, show me the code”
6. What’s next?
   The Future is not what it used to be

Pleased to meet you!

360° relevance in Commerce, Service, Website and Workplace

$325M
Capital raised since 2018
for R&D, growth and acquisitions

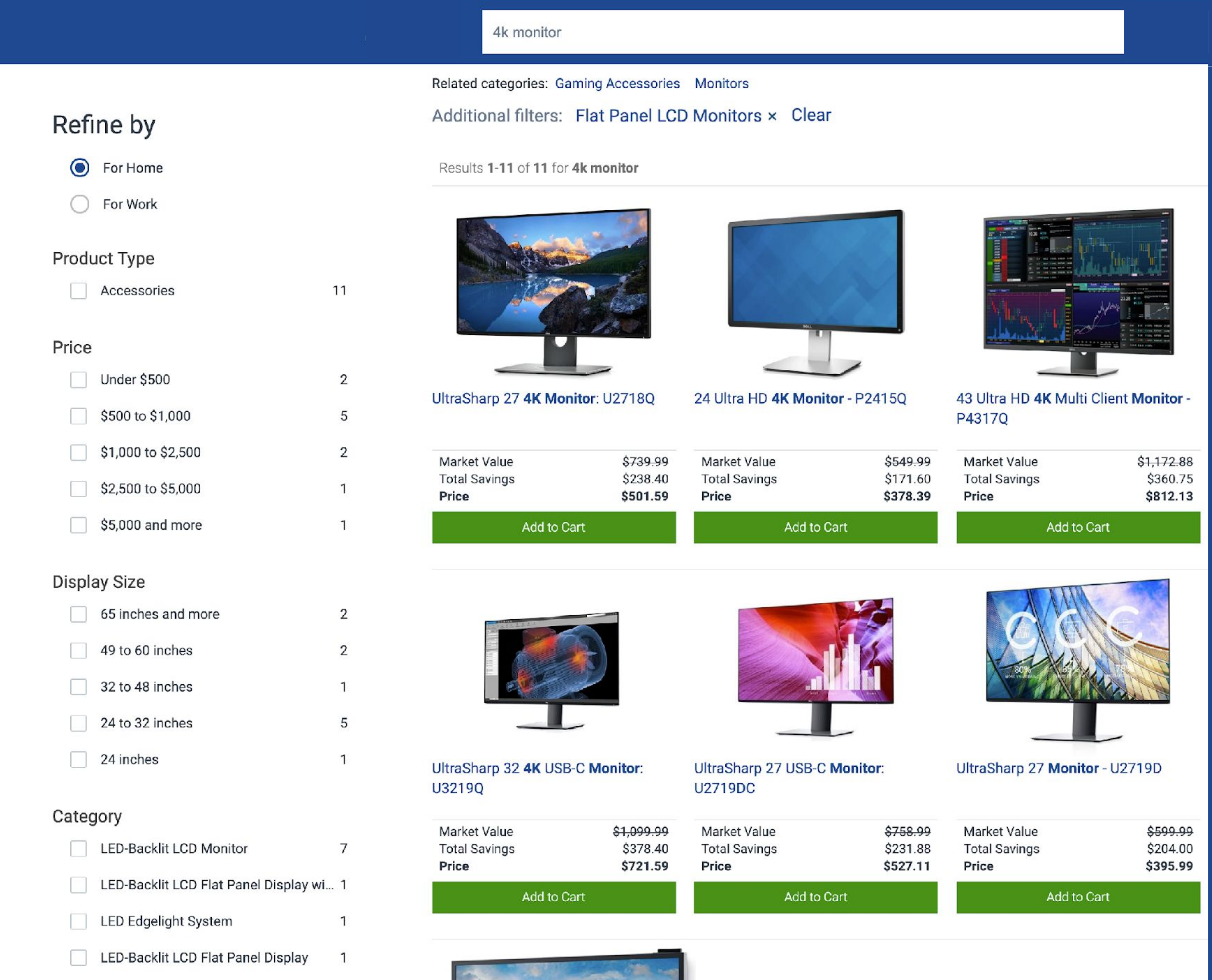
1,500
Customer Deployments
globally & across multiple use cases

150
Certified SI Partners And Integrations
+strategic alliances & integrations with key ISVs

#1
US/Gartner/Forrester leader
FORRESTER Gartner
#1 applied AI platform company in Canada

Global
7 offices, 4 Data Centers around the world
for scale, performance, local compliance

ROI
Proven Customer Success
measured business value



Coveo's typical integration for Commerce:

- Search
- Query suggestions
- Recommendations
- Category listing

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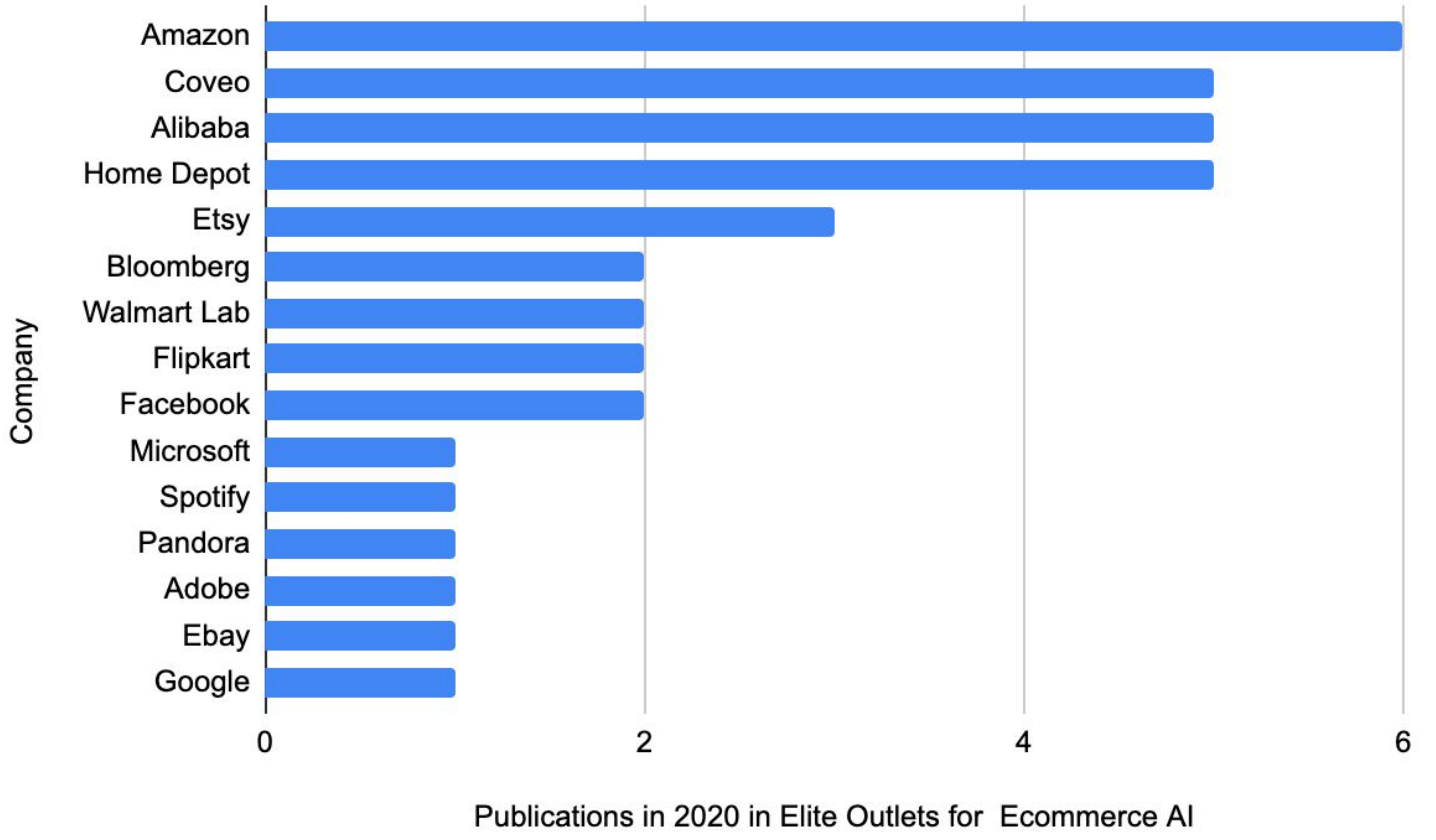
Publishing in Leading Outlets for AI & NLP

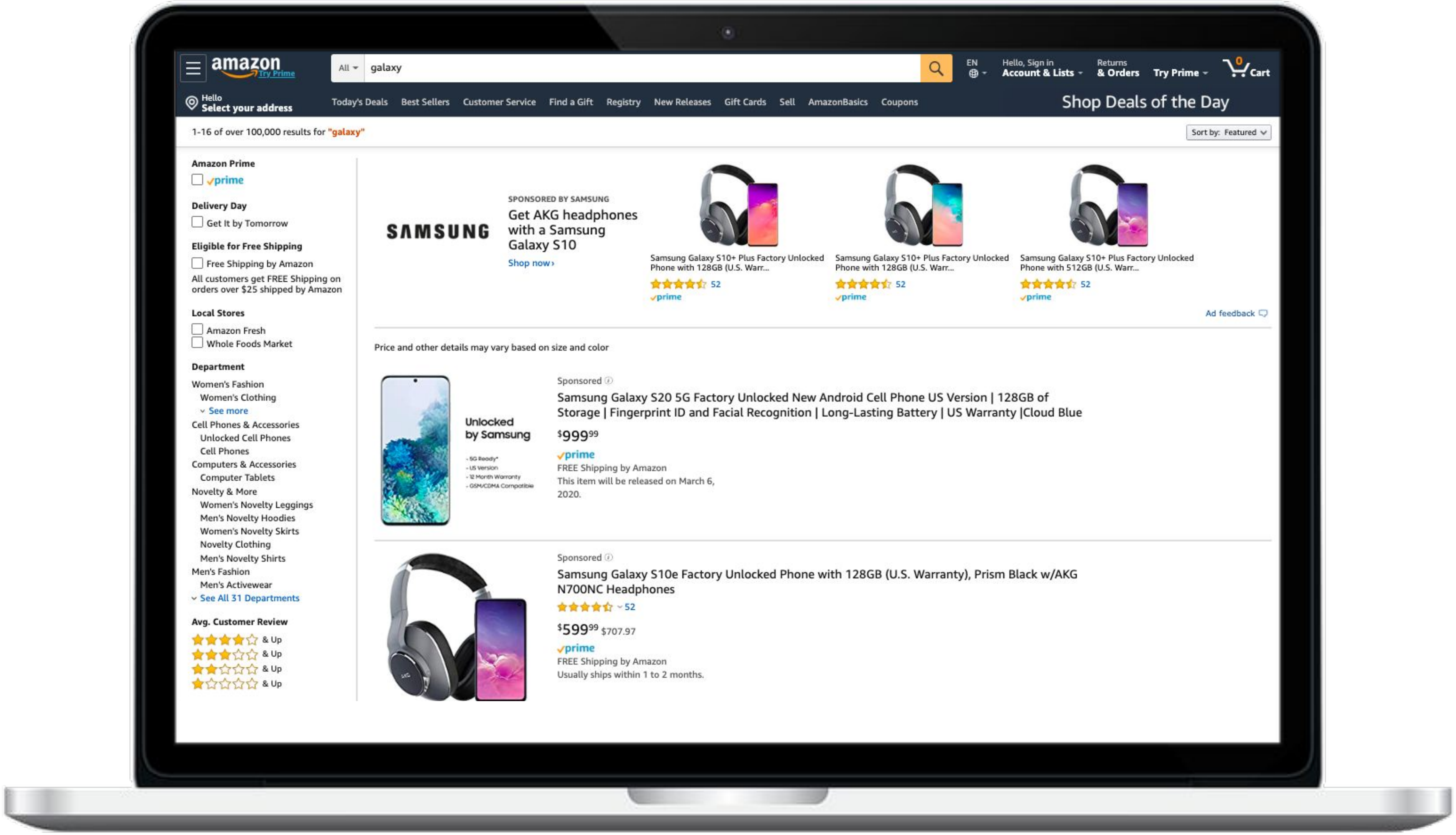
Leading **AI research** in Ecommerce



From personalization to in-session personalization

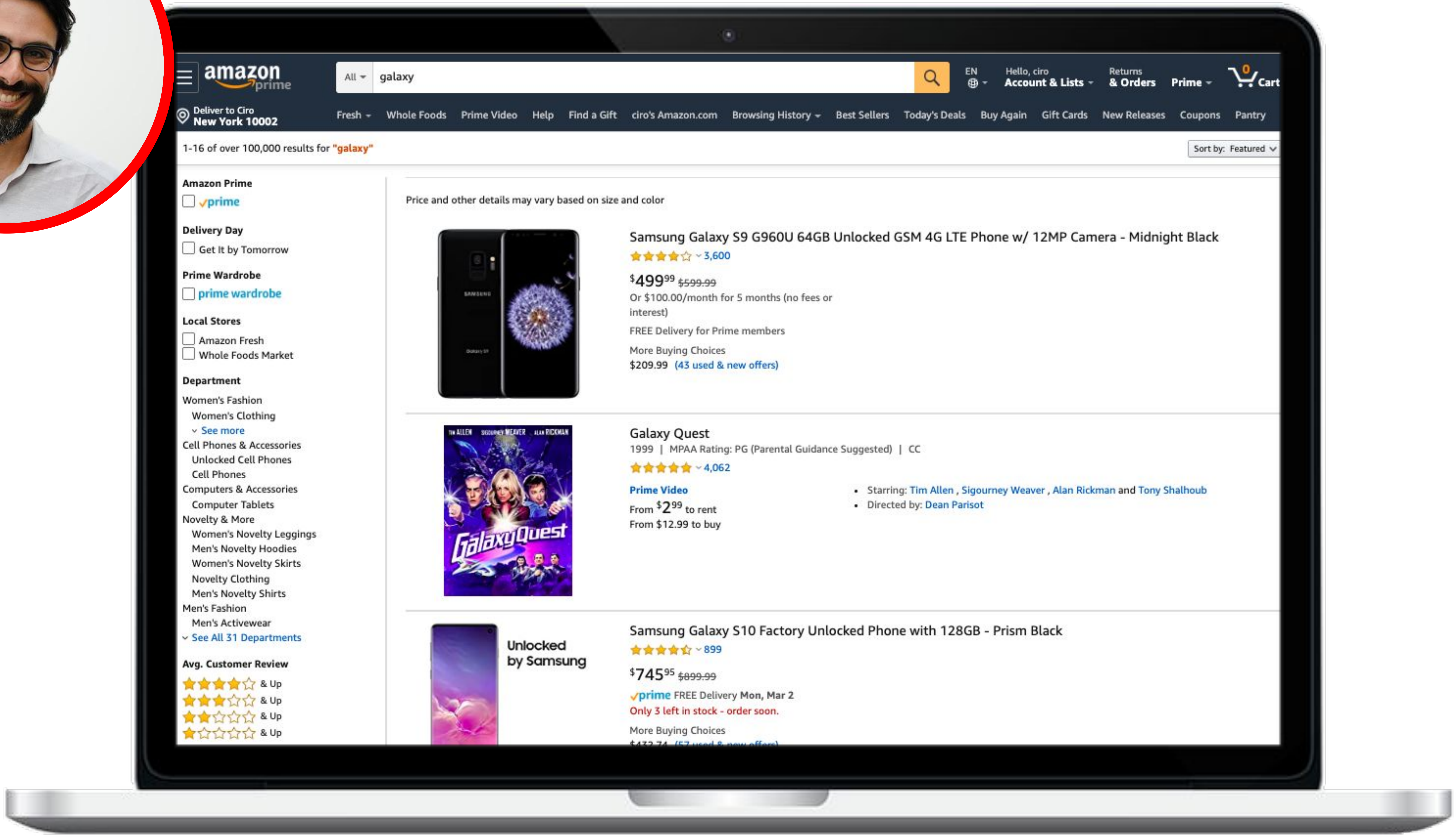
Personalization at the time of Amazon

galaxy



Personalization at the time of Amazon

galaxy



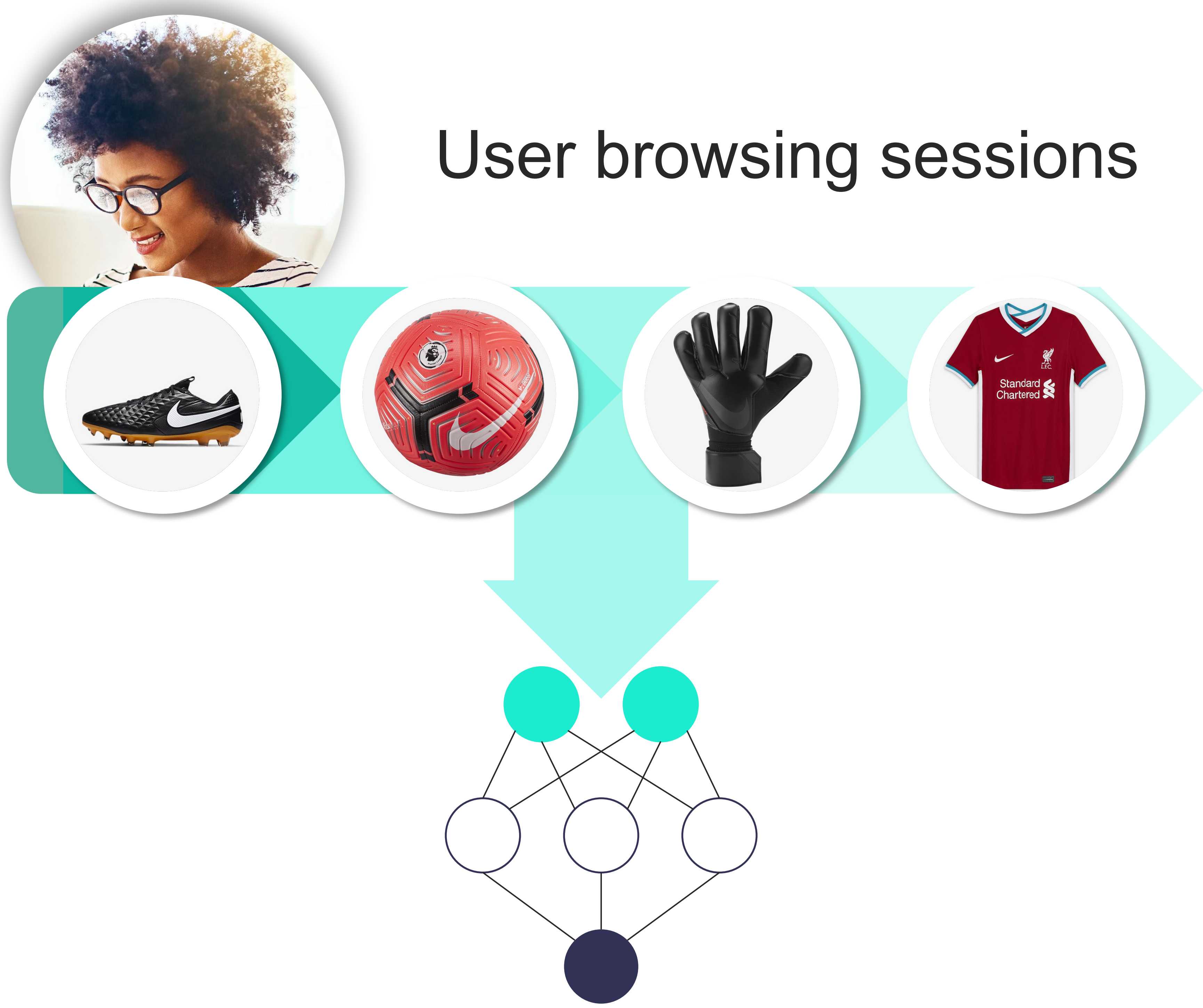
Goals

- Personalization in digital experience has a direct impact on conversion rate and average cart value.
- Many e-commerce players need personalized search and recommendations but cannot build them themselves.
- Our goal is to develop effective personalization strategies for mid-to-large market segment.

Constraints

- Most shops don’t generate massive amount of data.
- Shoppers are almost never logged-in and don’t come back often.
- Personalization needs to happen as early as possible and with as little data as possible.
- The session becomes the natural boundary for our ML models to work.

A research program for session-based inference



User browsing sessions

Session representation

Use cases

Search	COLING 2020, NAACL 2021
Recommendations	RecSys
Query suggestion	ACL
Causal Attribution	SIGIR 2020
Intent Detection	KDD

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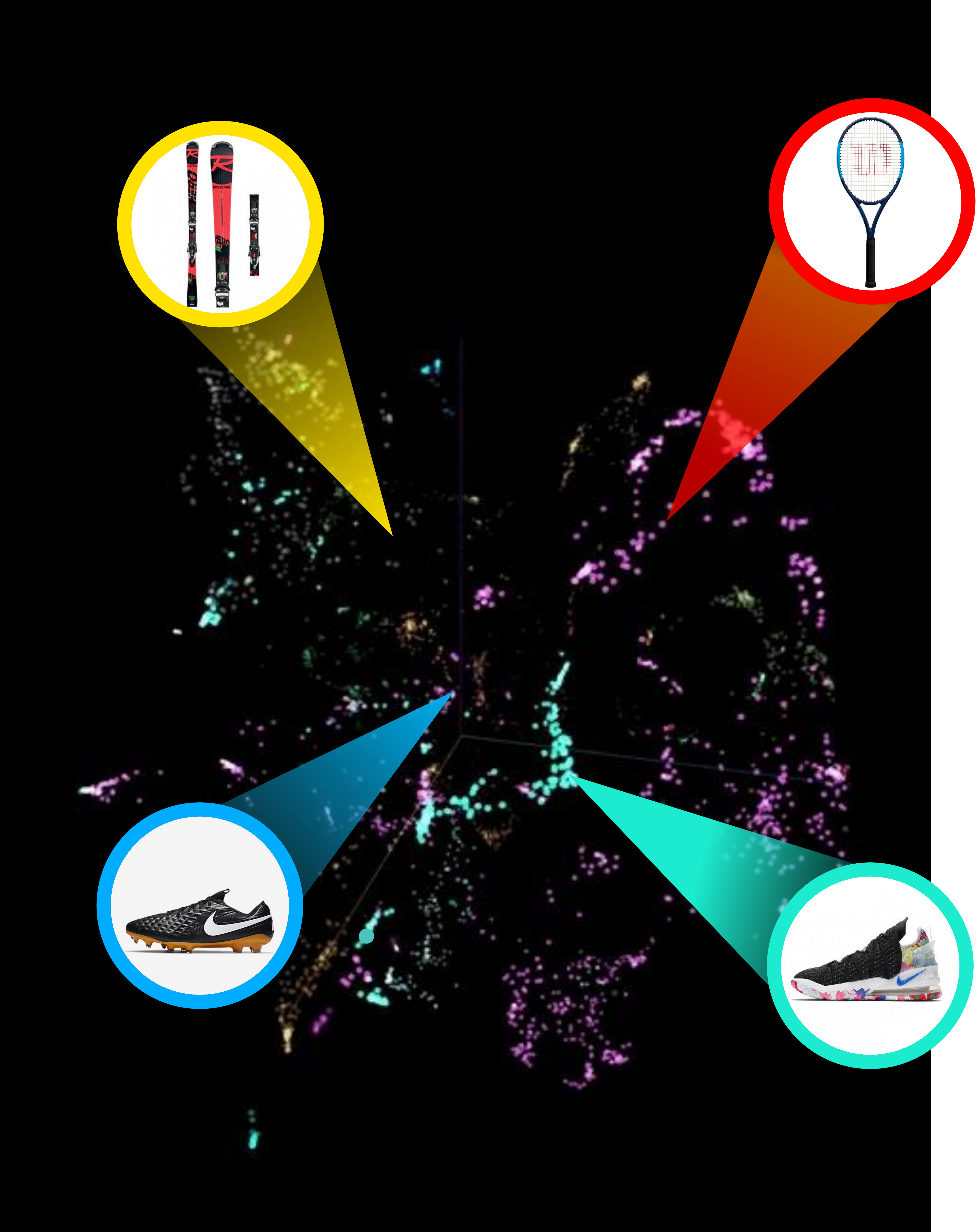
(Product) space, the final frontier

Product embeddings

word2vec

The → cat → is → on →

prod2vec

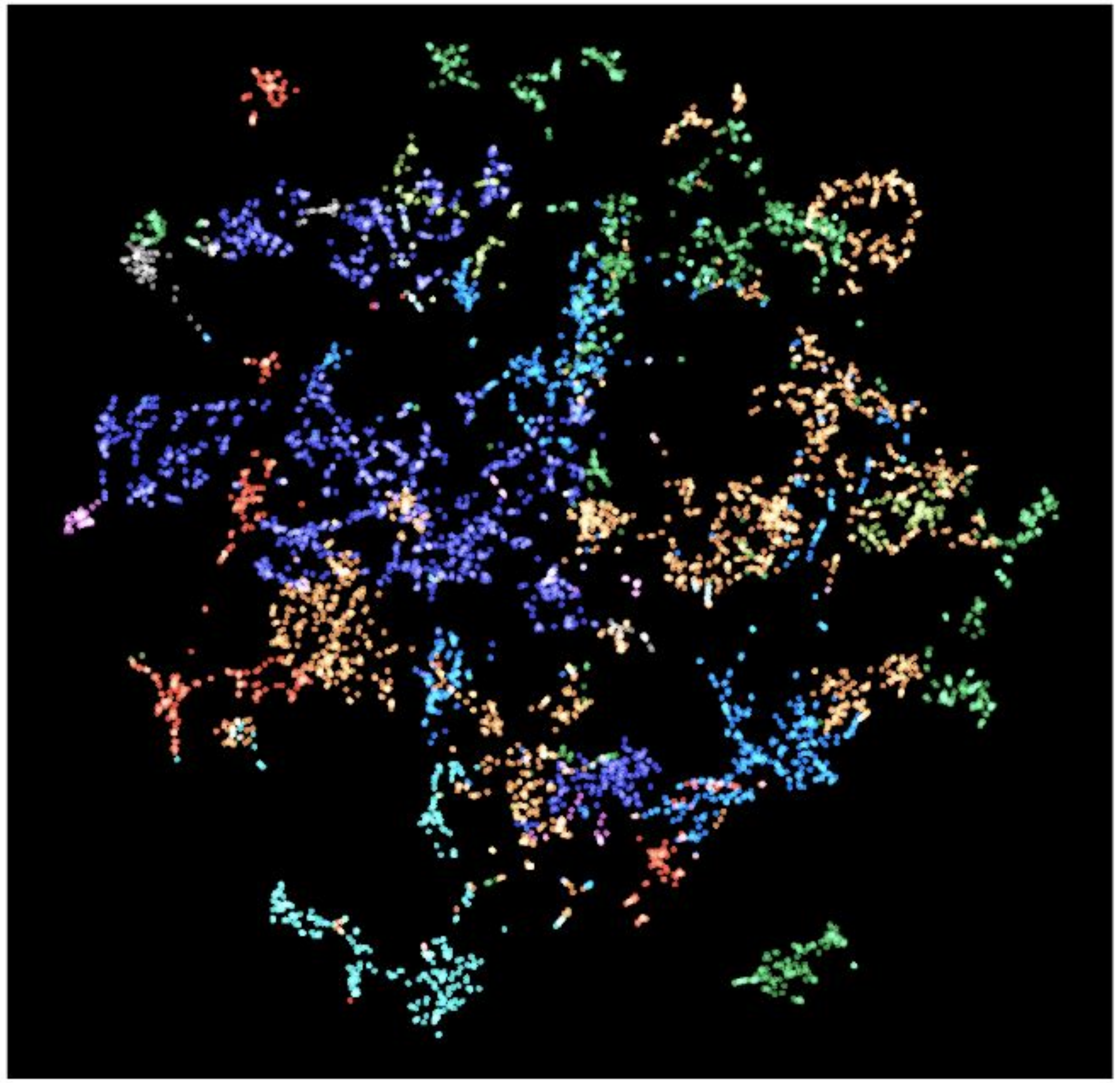


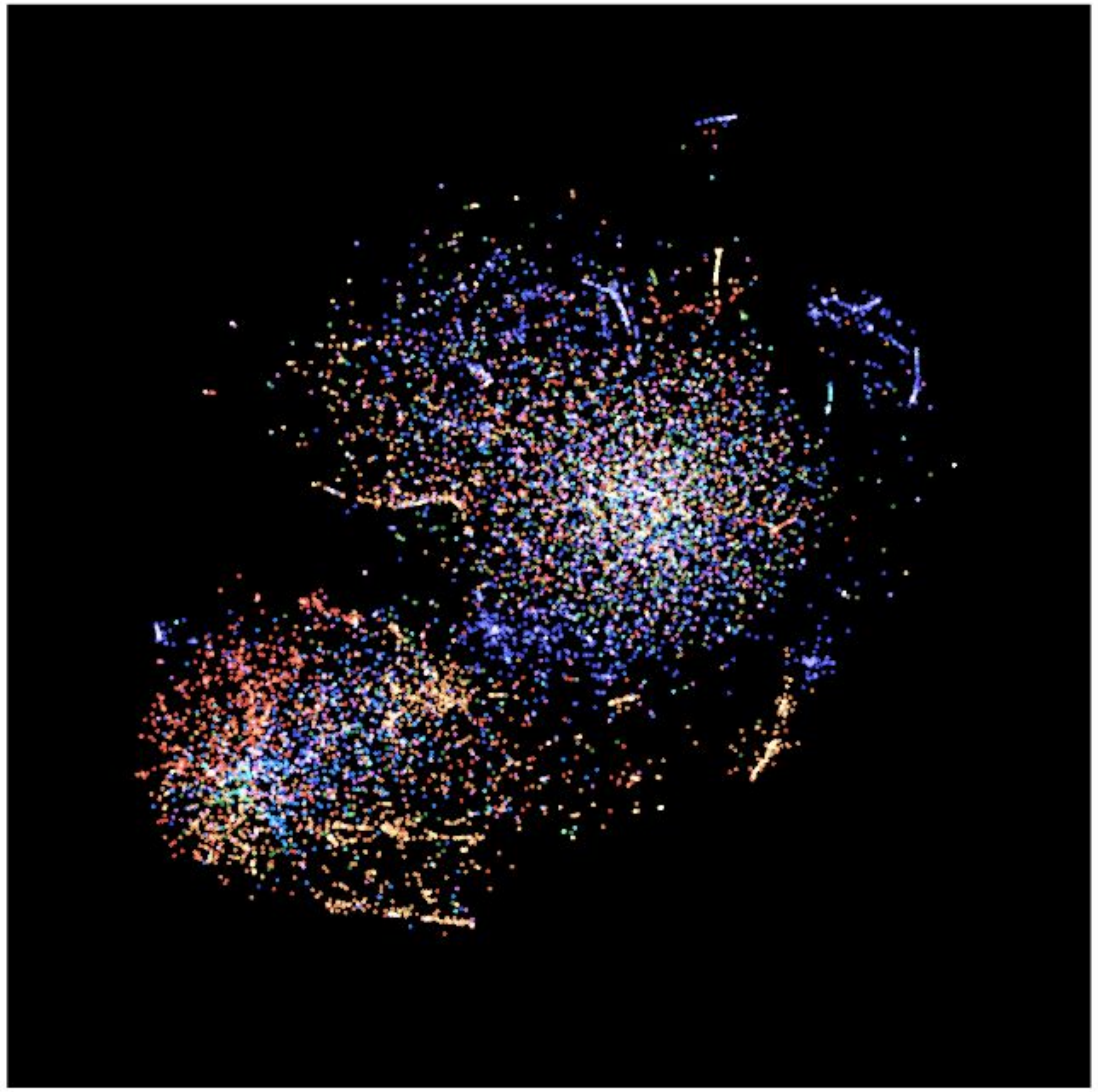
The product space

- Intent is represented as the products users interact with within a session.
- Products are represented as a multi-dimensional vector space: similar products that are “closer” in the space.
- Building such a space can be done in a purely unsupervised manner.

Practical Tip #1: [tune your hyperparameters]

- Embeddings from a sport apparel e-commerce website (colors represent sport activities).





Practical Tip #2: pay attention to low-count items

- Due to the long-tail of interactions, not all product vectors have the same quality...

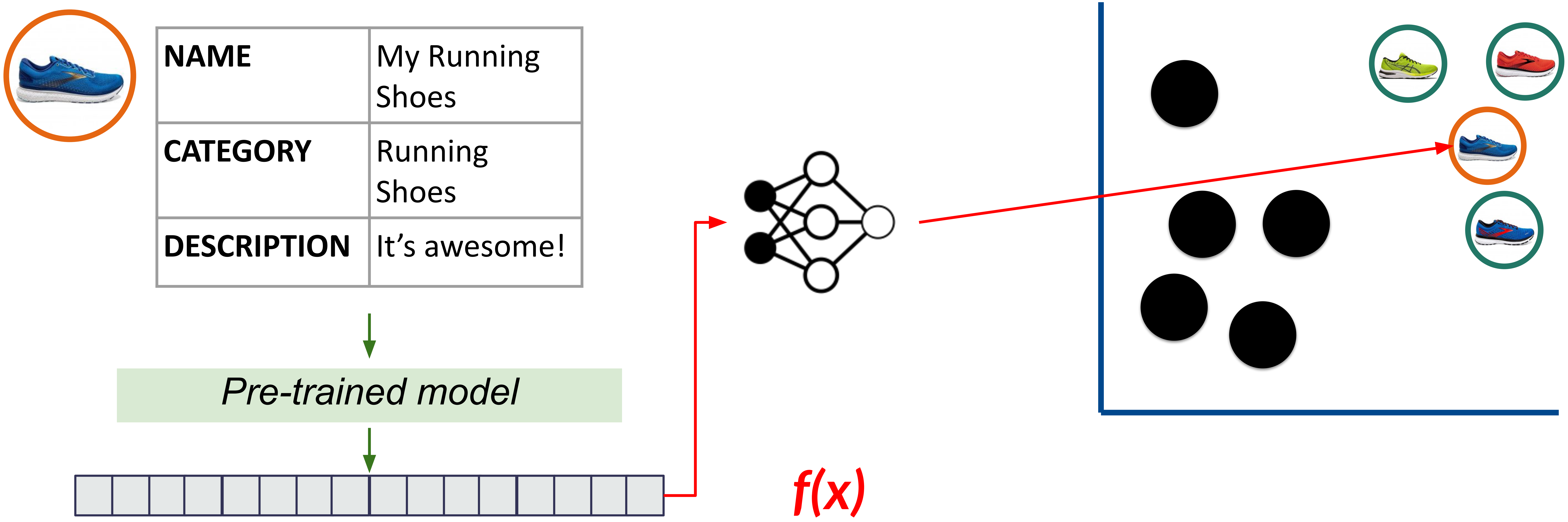
kNN of a popular product

kNN of a rare product

Plus, new products have no interactions!

“Faking” high quality vectors through content

- First, we learn a mapping between meta-data and the space by using *popular products only*.

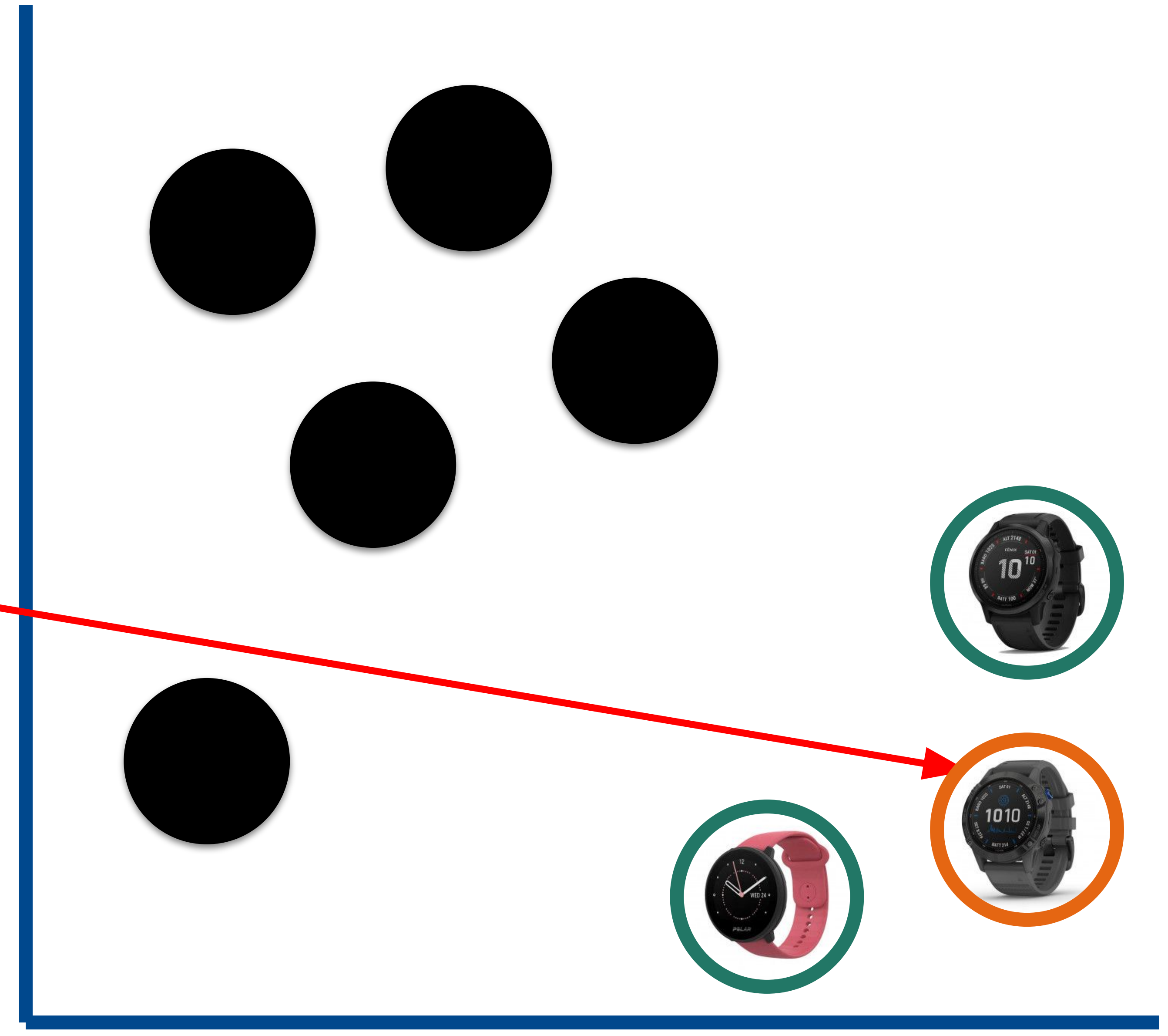


"Faking" high quality vectors through content

- First, we learn a mapping between meta-data and the space by using *popular products only*.
- Then, we apply the mapping to *rare products* and obtain new vectors!

NAME	My GPS Watch
CATEGORY	Running Accessories
BRAND	Garmin
DESCRIPTION	Very punctual!

$f(x)$



Practical Tip #3: be *less wrong*

- Considering the use of vectors directly (e.g. kNN for in-session recommendations) or in downstream tasks (e.g. conditional language models), we want our model to be, when not right, *less wrong.*
- When making a mistake on a *rare target item,* we keep track of the *Average Cosine Distance* in the space between the target and prediction

TARGET *PREDICTION*

reasonable

super wrong

Practical Tip #4: read more!

SIGIR 2020
XI'AN·CHINA

Fantastic Embeddings and How to Align Them: Zero-Shot Inference in a Multi-Shop Scenario

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ABSTRACT

This paper addresses the challenge of leveraging multiple embedding spaces for multi-shop personalization, proving that zero-shot inference is possible by transferring shopping intent from one website to another without manual intervention. We detail a machine learning pipeline to train and optimize embeddings *within shops* first, and support the quantitative findings with additional qualitative insights. We then turn to the harder task of using learned embeddings *across shops*: if products from different shops live in the same vector space, user intent - as represented by regions in this space - can then be transferred in a zero-shot fashion across websites. We propose and benchmark unsupervised and supervised methods to "travel" between embedding spaces, each with its own assumptions on data quantity and quality. We show that zero-shot personalization is indeed possible at scale by testing the shared embedding space with two downstream tasks, event prediction and type-ahead suggestions. Finally, we curate a cross-shop

ACM Reference Format:
Federico Bianchi, Jacopo Tagliabue, Bingqing Yu, Luca Bigon, and Ciro Greco. 2020. Fantastic Embeddings and How to Align Them: Zero-Shot Inference in a Multi-Shop Scenario. In *Proceedings of ACM SIGIR Workshop on eCommerce (SIGIR eCom'20).* ACM, New York, NY, USA, 11 pages.

1 INTRODUCTION

Inspired by the similarity between words in sentences and products in browsing sessions, recent work in recommender systems re-adapted the NLP CBOW model [20] to create *product embeddings* [17], i.e. low-dimensional representations which can be used alone or fed to downstream neural architectures for other machine learning tasks. Product embeddings have been mostly investigated as static entities so far, but, exactly as words [10], products are all but static. Since the creation of embeddings is a stochastic process, training embeddings for similar products in different digital shops

RecSys

The Embeddings That Came in From the Cold: Improving Vectors for New and Rare Products with Content-Based Inference

JACOPO TAGLIABUE*† and BINGQING YU*, Coveo, United States
FEDERICO BIANCHI*, Bocconi University, Italy

Training *product embeddings* in a multi-tenant scenario involves solving the challenges of ever changing catalogs across dozens of deployments, without supervision. In *this* work, we detail how we deal with new and rare products when building neural representations at scale: we show how to inject product knowledge into behavior-based embeddings to provide the best accuracy with minimal engineering changes in existing infrastructure and without additional manual effort.

CCS Concepts: • **Information systems** → *Clustering; Recommender systems.*

Additional Key Words and Phrases: product embeddings, neural networks, cold-start recommendations

ACM Reference Format:
Jacopo Tagliabue, Bingqing Yu, and Federico Bianchi. 2020. The Embeddings That Came in From the Cold: Improving Vectors for New and Rare Products with Content-Based Inference. In *Fourteenth ACM Conference on Recommender Systems (RecSys '20), September 21–26, 2020, Virtual Event, Brazil.* ACM, New York, NY, USA, 4 pages. https://doi.org/xx.xxxx/xxxxxx.xxxxxxx

1 INTRODUCTION

Product embeddings [5, 12] recently became an important part of downstream recommendation [2] and personalization systems [11] given that they capture latent product properties. Embeddings are trained with a CBOW model [8] (*prod2vec*) from behavioral data, resulting in representation of heterogeneous quality – due to the nature of gradient-based training, rare products have lower quality projections [4]. While most research and industry papers focus on producing embeddings at a given time, we address a realistic multi-tenant scenario, in which product spaces evolve *over time* and *across* organizations.

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One representation, to rule them all

Session representation

- Different users walk in different regions of the space.
- **Session vectors** are functions of the product vectors shoppers interact with:

$$SV = f(\,p_1\_v,\ p_2\_v,\ \ldots\ p_n\_v)$$

[*f* can be the (unweighted/weighted) average, or something more complex]


4k monitor
Search
Results 1-15 of 96 for 4k monitor
Sort By: Relevance
Refine by
For Home
For Work
Product Type
Accessories 96
Resolution
1366 x 768 2
1600 x 1050 2
1680 x 1050 5
1920 x 1080 12
3840 x 2160 11
Price
Under $500 71
$500 to $1,000 19
$1,000 to $2,500 3
$2,500 to $5,000 2
$5,000 and more 1
Display Size
65 inches and more 2
49 to 60 inches 6
32 to 48 inches 6
24 to 32 inches 22
UltraSharp 27 4K Monitor: U2718Q
Market Value $739.99
Total Savings $238.40
Price $501.59
Add to Cart
24 Ultra HD 4K Monitor - P2415Q
Market Value $549.99
Total Savings $171.60
Price $378.39
Add to Cart
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Market Value $758.99
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Price $527.11
Add to Cart
UltraSharp 27 Monitor: U2719D
Market Value $599.99
Total Savings $204.00
Price $395.99
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4k monitor
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Refine by
For Home
For Work
Product Type
Accessories 102
Desktops & Laptops 6
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Kensington SD1500 USB-C Mobile Dock - 4K HDMI or HD VGA - Windows/Chrome/Mac - Docking station - USB - VGA, HDMI - GigE
Price $74.99
Add to Cart
Targus USB-C DisplayPort Alt-Mode Travel Dock - Docking station - USB-C - VGA, HDMI - GigE
Price $79.99
Add to Cart
Targus USB-C Multiport Video Adapter - External video adapter - USB-C - HDMI - black
Price $79.99
Add to Cart
StarTech.com Thunderbolt 3 to Dual DisplayPort Adapter - 4K 60Hz - Mac and Windows Compatible - External video adapter - Thunderbolt 3 - 2 x DisplayPort - Silver
Price $81.99
Add to Cart
Kensington SD1600P USB-C Mobile 4K Dock with Pass-Through Charging - Docking station - USB-C - VGA, HDMI - GigE
Price $99.99
Add to Cart
StarTech.com Thunderbolt 3 Dual Monitor HDMI Adapter - 4K30 - Windows only - external video adapter
Price $104.99
Add to Cart
StarTech.com Thunderbolt 3 Dual HDMI Adapter - 4K 60Hz - Mac and Windows - external video adapter - silver
Price $135.99
Add to Cart
Belkin Multiport to HDMI Digital AV Adapter 8 ft - 4K Support
Price $149.99
Add to Cart
Docking Station - USB 3.0 (D3100)
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Add to Cart
BUSINESS REVIEW

In-session query scoping

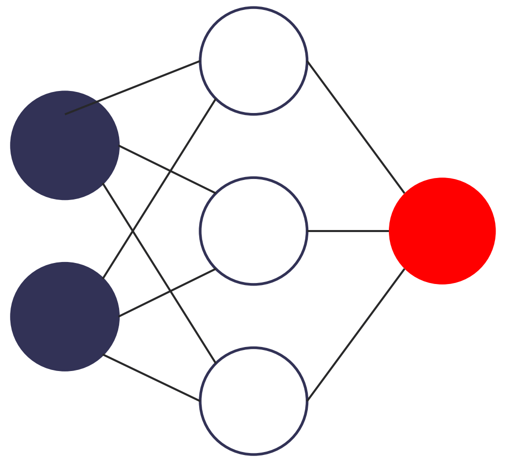
Language

Context

4k monitor

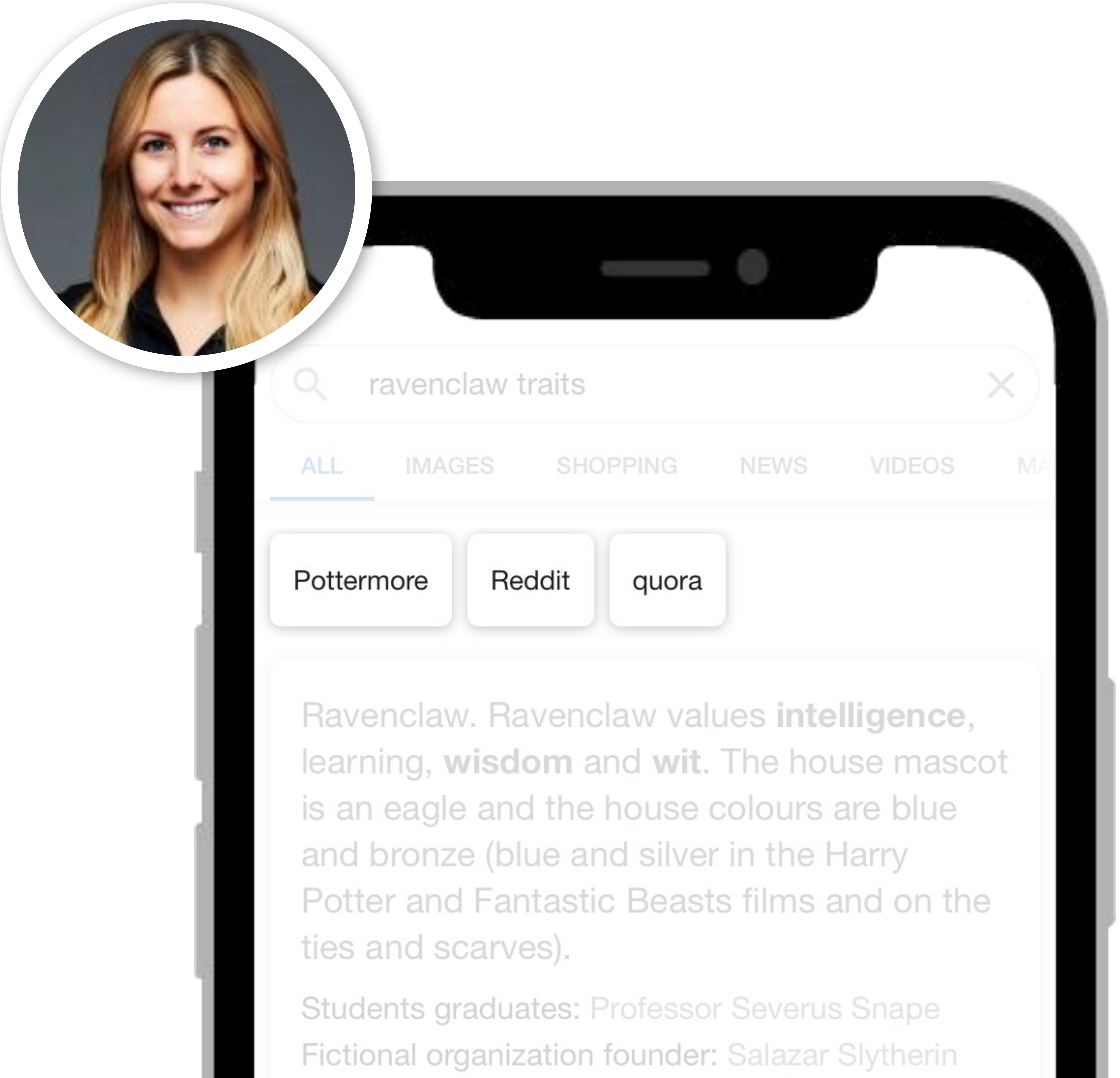
Query vector

Session vector



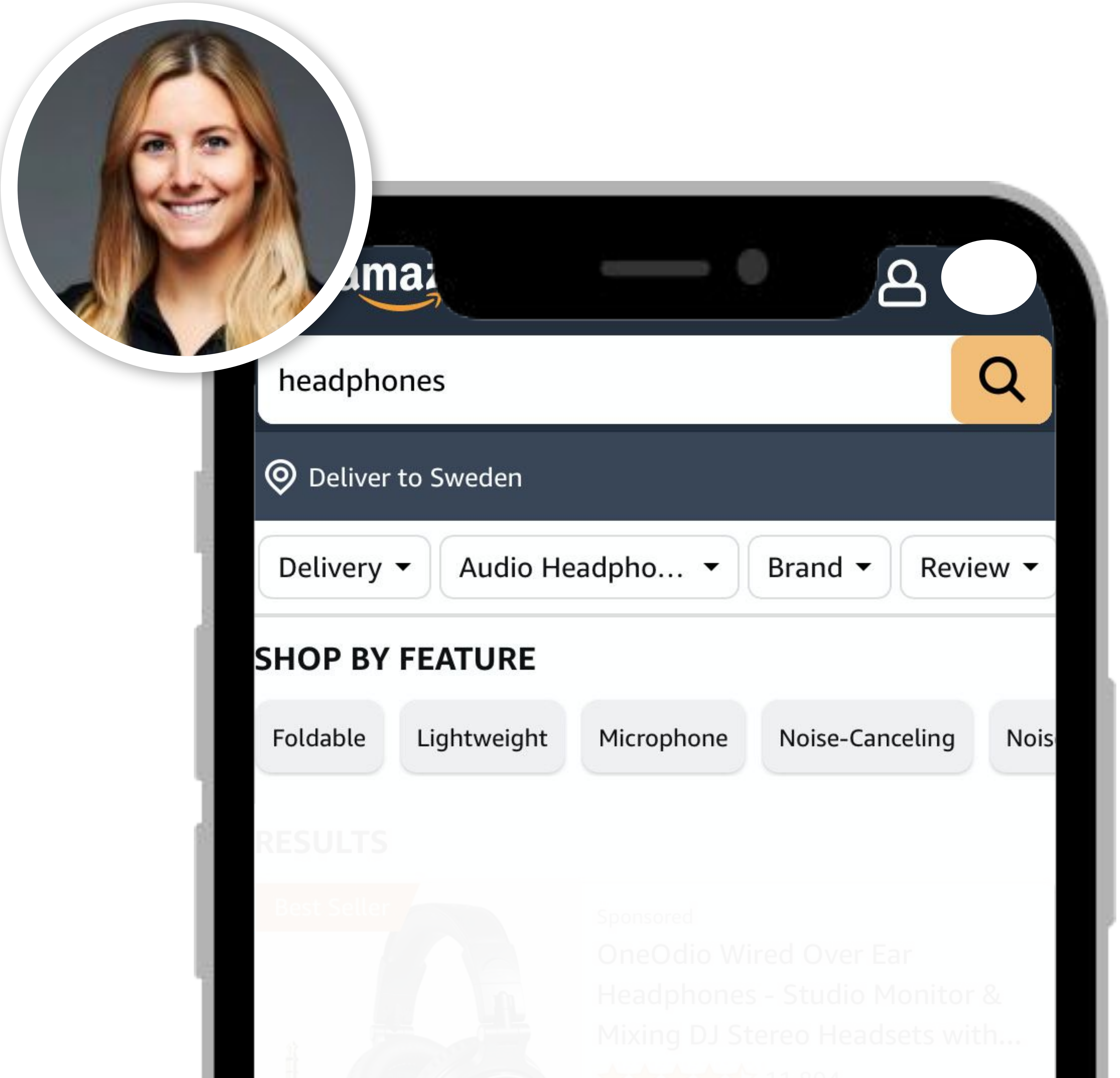
Monitors

Help product discovery with "discovery tags"



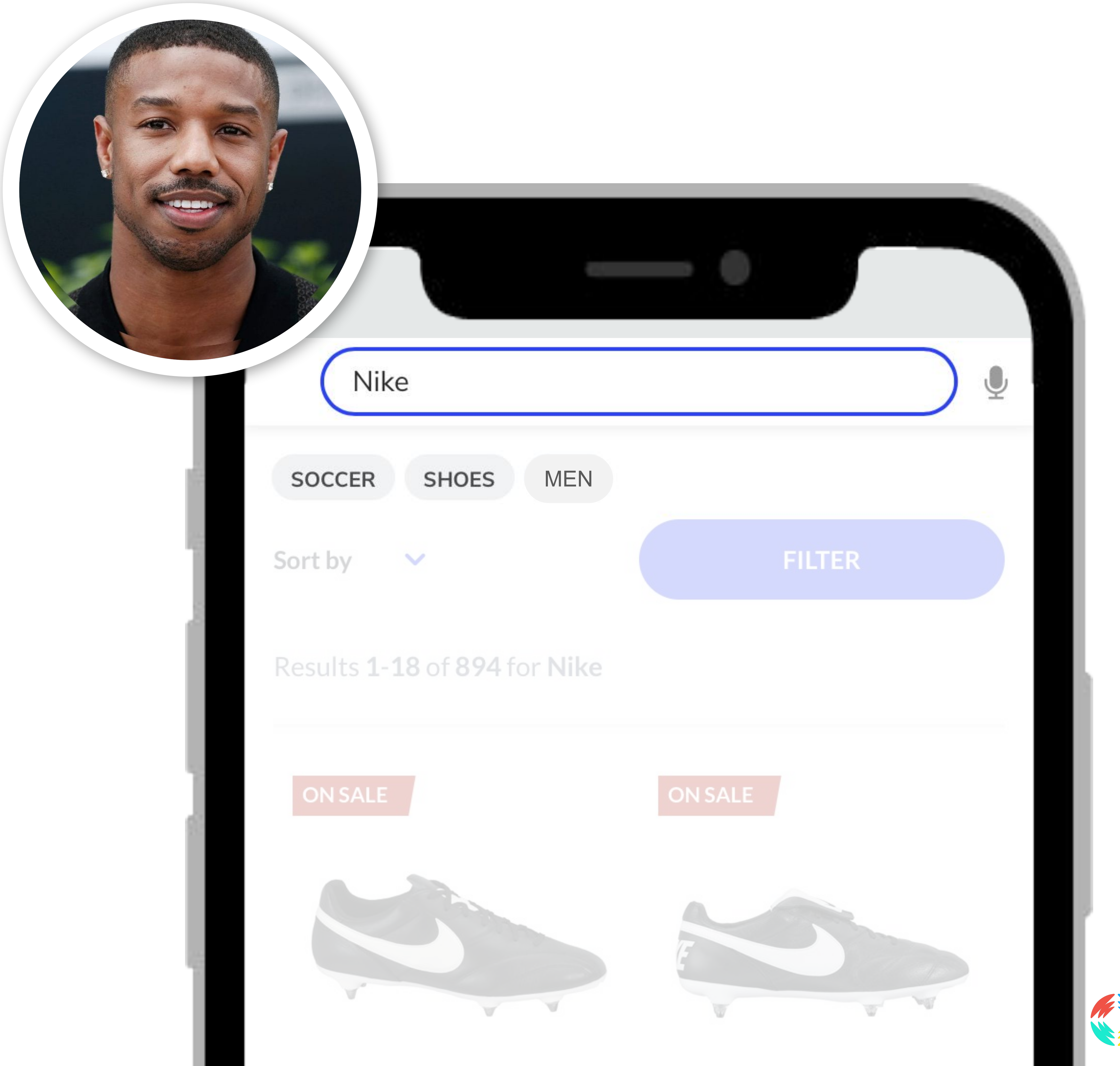
Google introduced mobile-friendly query refinements in 2020...

Help product discovery with “discovery tags”

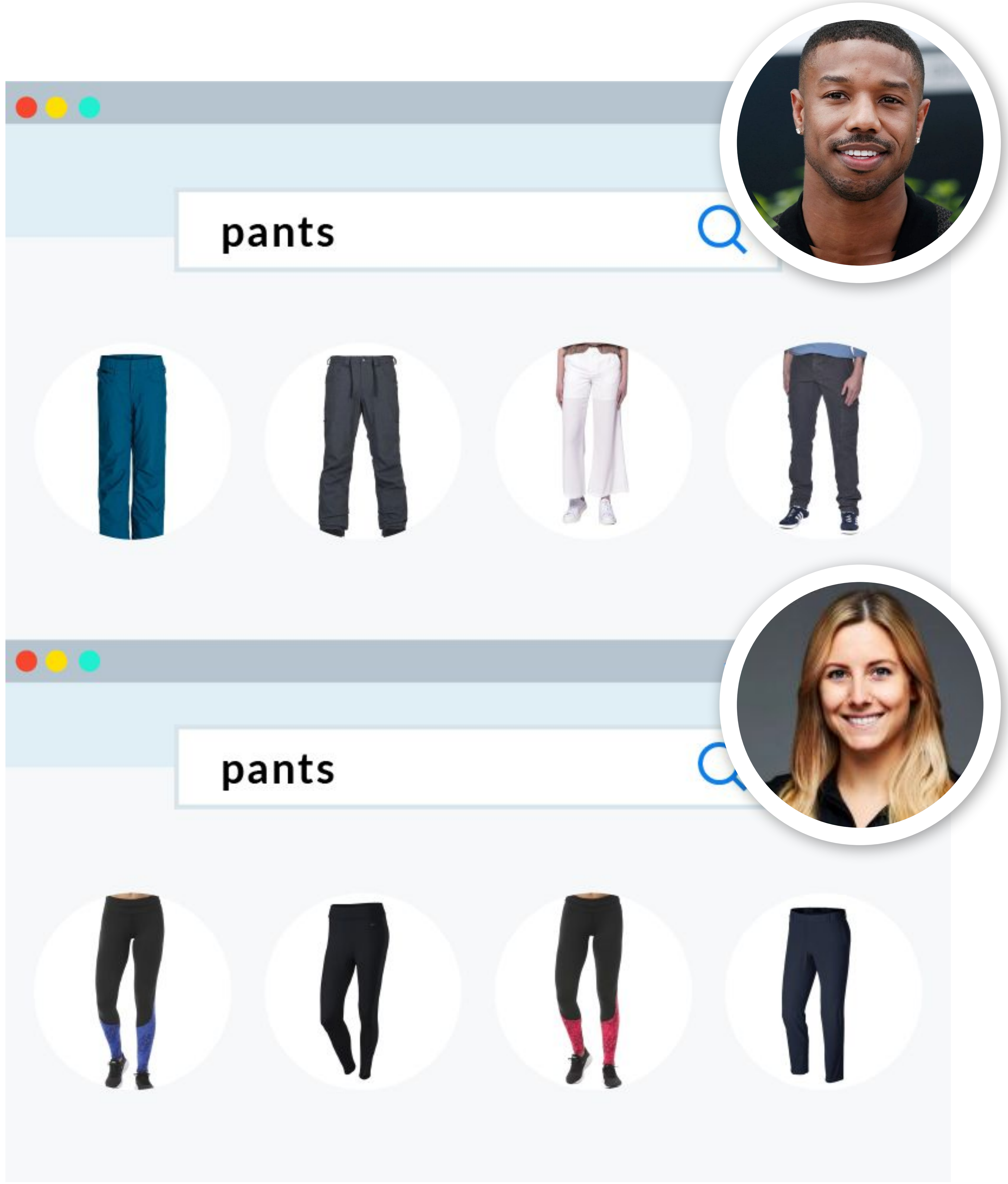


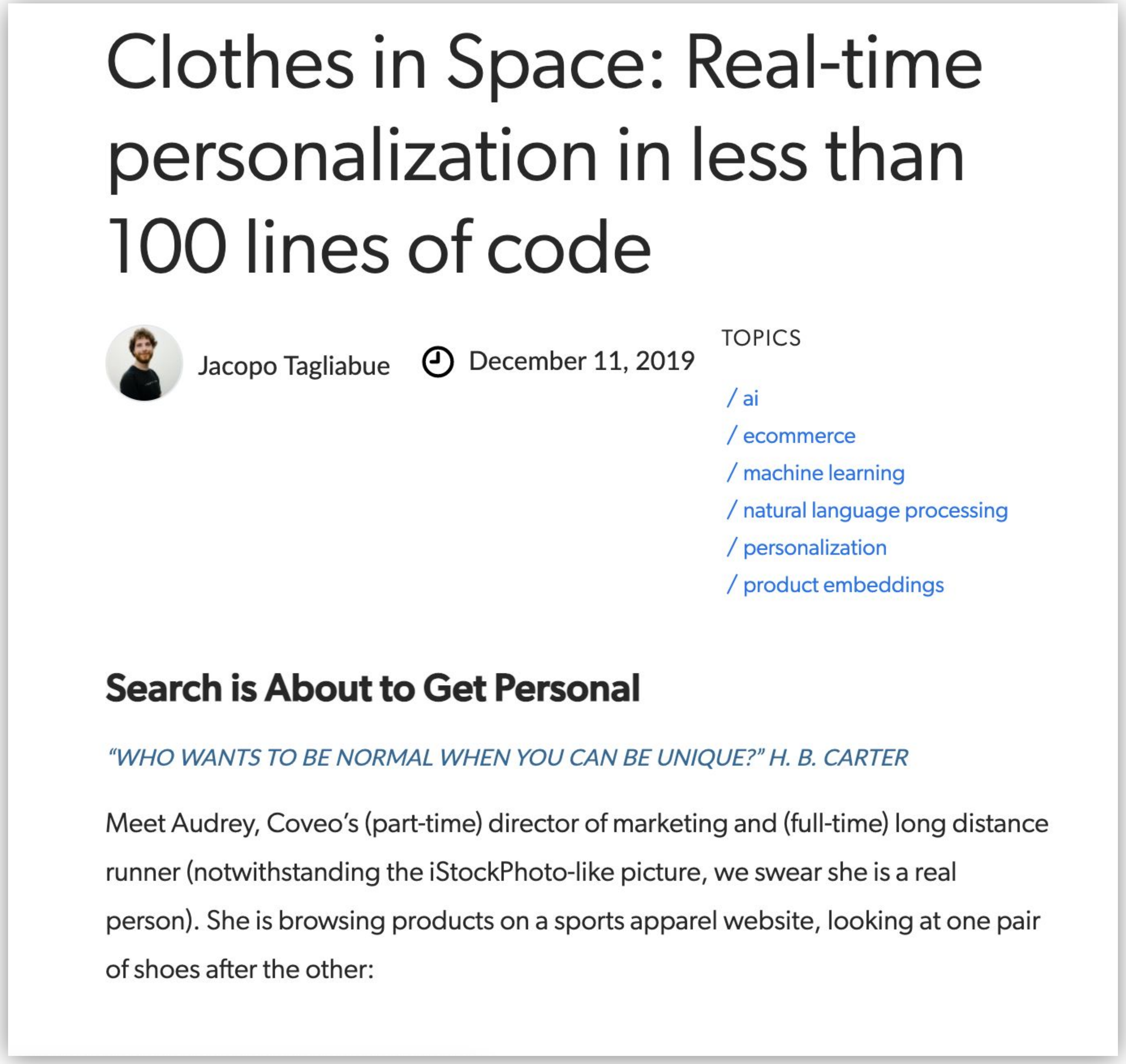
...and Amazon followed immediately afterwards!

Help product discovery with “discovery tags”



Dynamically re-rank search results




Clothes in Space: Real-time personalization in less than 100 lines of code

Jacopo Tagliabue December 11, 2019

TOPICS

/ ai
/ ecommerce
/ machine learning
/ natural language processing
/ personalization
/ product embeddings

Search is About to Get Personal

"WHO WANTS TO BE NORMAL WHEN YOU CAN BE UNIQUE?" H. B. CARTER

Meet Audrey, Coveo's (part-time) director of marketing and (full-time) long distance runner (notwithstanding the iStockPhoto-like picture, we swear she is a real person). She is browsing products on a sports apparel website, looking at one pair of shoes after the other:

...and more!

- There are many other use-cases related to in-session personalization and, generally, a clever use of the product space.

- Have a look at our latest papers to know more, or get in touch with us!

17 Dec 2020

BERT Goes Shopping:
Comparing Distributional Models for Product Representations

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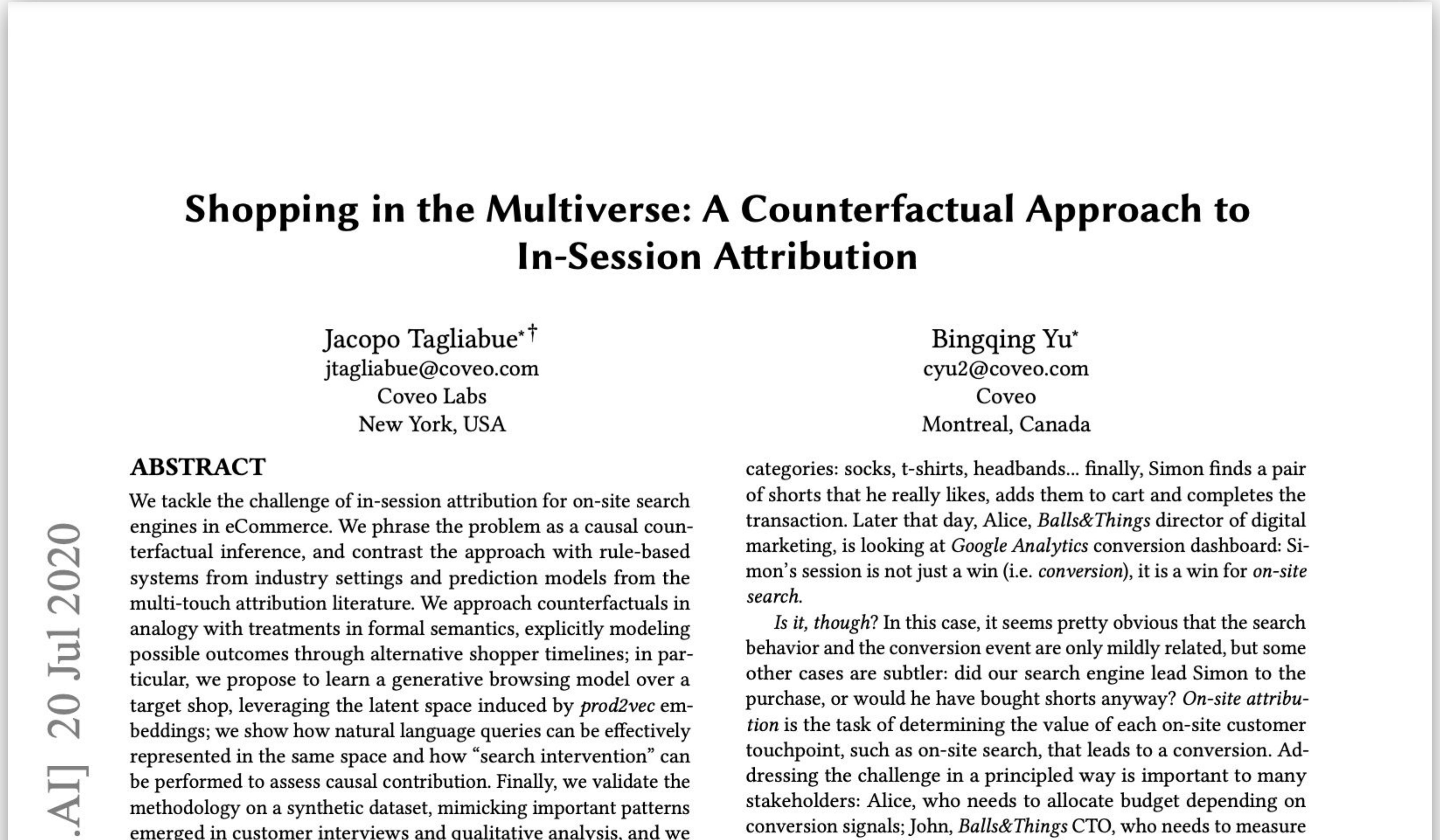
Abstract

Word embeddings (e.g., word2vec) have been applied successfully to eCommerce products through *prod2vec*. Inspired by the recent performance improvements on several NLP tasks brought by contextualized embeddings, we propose to transfer BERT-like architectures to eCommerce: our model – *ProdBERT* – is trained to generate representations of products through masked session modeling. Through extensive experiments over multiple shops, different tasks, and a range of design choices, we

and Information Retrieval (IR) use cases for eCommerce (Vasile et al., 2018; Bianchi et al., 2020).

As a key improvement over *word2vec*, the NLP community has recently introduced *contextualized representations*, in which a word like *play* would have different embeddings depending on the general topic (e.g. a sentence about *theater* vs *soccer*), where as in *word2vec* the word *play* is going to have only one vector. Transformer-based architectures (Vaswani et al., 2017) in large-scale models - such as BERT (Devlin et al., 2019) - achieved



AI] 20 Jul 2020

Shopping in the Multiverse: A Counterfactual Approach to In-Session Attribution

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ABSTRACT

We tackle the challenge of in-session attribution for on-site search engines in eCommerce. We phrase the problem as a causal counterfactual inference, and contrast the approach with rule-based systems from industry settings and prediction models from the multi-touch attribution literature. We approach counterfactuals in analogy with treatments in formal semantics, explicitly modeling possible outcomes through alternative shopper timelines; in particular, we propose to learn a generative browsing model over a target shop, leveraging the latent space induced by *prod2vec* embeddings; we show how natural language queries can be effectively represented in the same space and how "search intervention" can be performed to assess causal contribution. Finally, we validate the methodology on a synthetic dataset, mimicking important patterns emerged in customer interviews and qualitative analysis, and we

categories: socks, t-shirts, headbands... finally, Simon finds a pair of shorts that he really likes, adds them to cart and completes the transaction. Later that day, Alice, *Balls&Things* director of digital marketing, is looking at *Google Analytics* conversion dashboard: Simon's session is not just a win (i.e. *conversion*), it is a win for *on-site search*.

Is it, though? In this case, it seems pretty obvious that the search behavior and the conversion event are only mildly related, but some other cases are subtler: did our search engine lead Simon to the purchase, or would he have bought shorts anyway? *On-site attribution* is the task of determining the value of each on-site customer touchpoint, such as on-site search, that leads to a conversion. Addressing the challenge in a principled way is important to many stakeholders: Alice, who needs to allocate budget depending on conversion signals; John, *Balls&Things* CTO, who needs to measure

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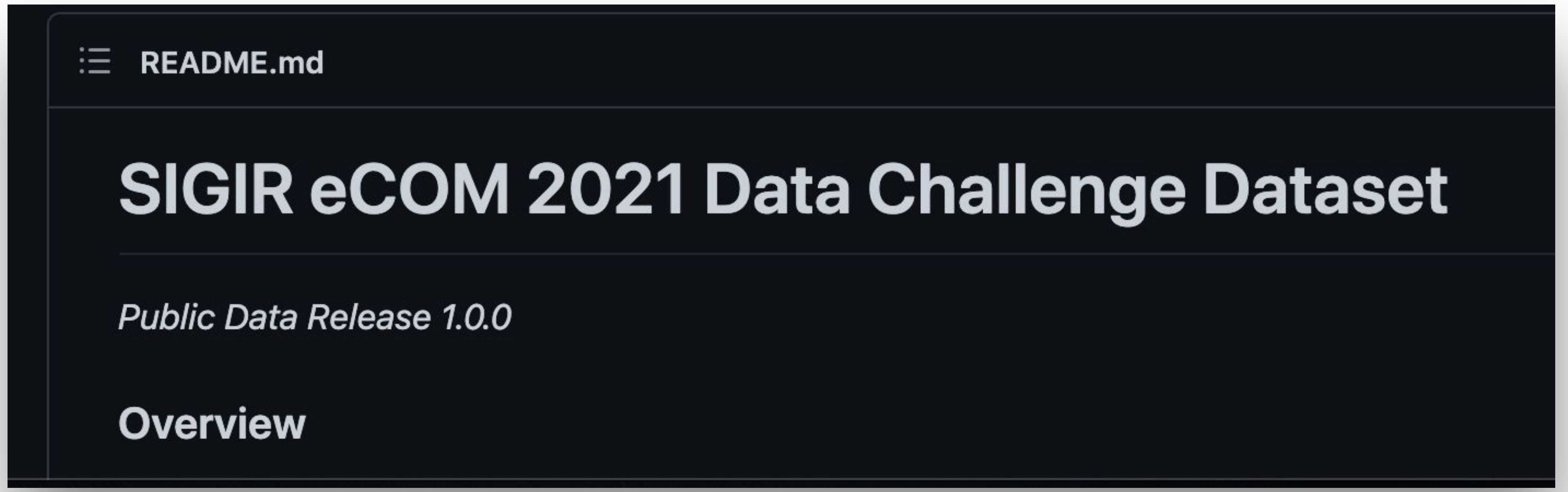
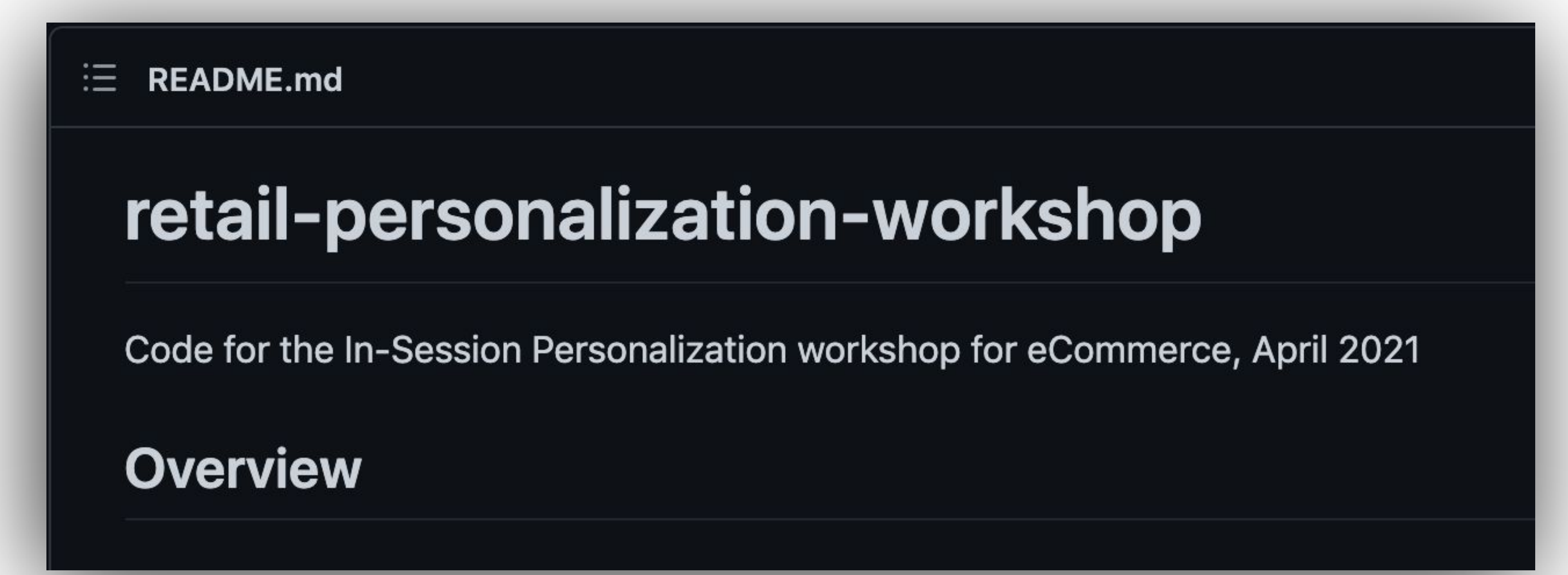
Hands-on coding

Open source and open data workshop

- Let's see some of these ideas at work with *real code* AND *real data!*
- Code is shared freely under MIT license on Github
- If you want to start playing along with some real data, you can download the SIGIR Data Challenge dataset from Coveo's Github!

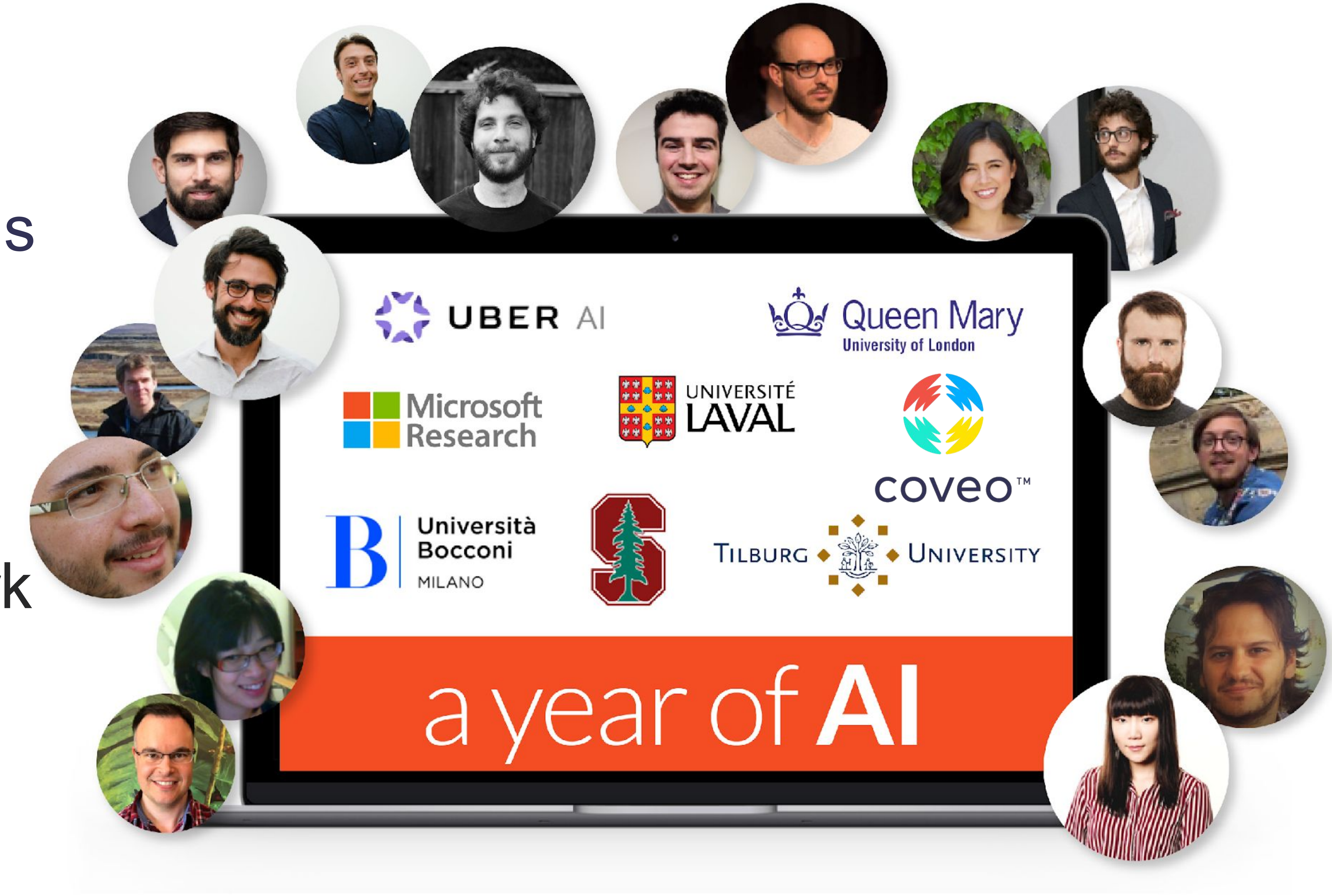




What's next for us?

What’s next?

- In 2021, we will be working on query semantics, small-data recommendations and our experimental platform.
- We have a small-but-expanding network of collaborations.
- See something you like? Let’s join forces!



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See you, space cowboys.

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