



# Using AI to Understand Search Intent

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## About Me

Aritra Mandal is an applied researcher on the Search team at eBay. He focuses on search quality and is leveraging AI/ML, structured data, and knowledge graphs to improve the search engine that powers eBay's marketplace. Aritra received his BEng in computer science from Birla Institute of Technology and his MS in computer and information science from Indiana University–Purdue University Indianapolis.



# Agenda

- What is Query Understanding?
- Using AI to Understand Search Intent
  - Query Categorization
  - Query Equivalence and Similarity
- Summary

# What is Query Understanding?

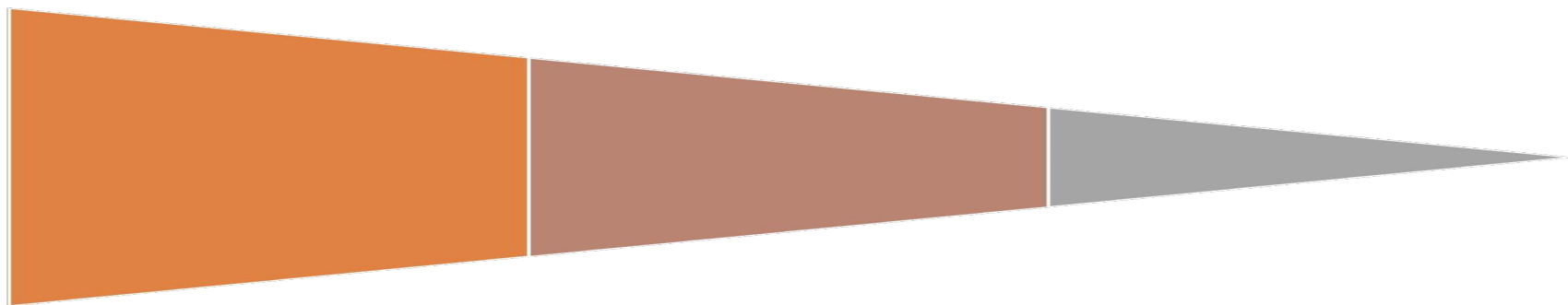


Query understanding is the process of inferring the **intent** of a search query from the searcher's keywords.

It takes place **before** the search engine retrieves and ranks results.

Query understanding is useful not only for retrieval and ranking, but also for interface decisions, recommendations, promotions, analytics, etc.

# Spectrum of Query Intent



- Coarse-Grained
  - Query Categorization
  - Broad vs. Narrow



- Fine-Grained
  - Entity Recognition
  - Query Equivalence

# Query Categorization

ebay Shop by category **gaming chair** Chairs & Stools Search Advanced

Related: [office chair](#) [gaming chair racing](#) [gaming chair with footrest](#) [gaming desk](#) [gaming chair pink](#) [computer chair](#) [gaming chair with ma...](#) ☐ Include description

**Category**

All

< Business & Industrial

< Office

< Office Furniture

**Chairs & Stools**

Desks & Tables

Other Office Furniture

Computer Furniture

Footrests

Home & Garden

Video Games & Consoles

Show More

**Brand**

☐ Unbranded (4,017)

☐ DXRacer (180)

☐ Black (88)

☐ OFM (376)

☐ GoPlus (128)

☐ Boss (22)

☐ Vertagear (16)

**All Listings** Accepts Offers Auction Buy It Now Condition Shipping Local

Best Match

Shipping to: 94041


**9,641 results for gaming chair** Save this search

**Price**

Under \$45.00 \$45.00 to \$90.00 Over \$90.00

**Brand**


DXRacer Unbranded Black OFM GoPlus Boss Vertagear



**OHHAO Ergonomic Computer Gaming Chair with Footrest Lumbar Massage...**

**\$129.99 to \$139.99**


Buy It Now



**Gaming Chair Racing Ergonomic Recliner Office Computer Seat Swivel Footrest**

**\$129.99**

Was: \$152.99 15% off



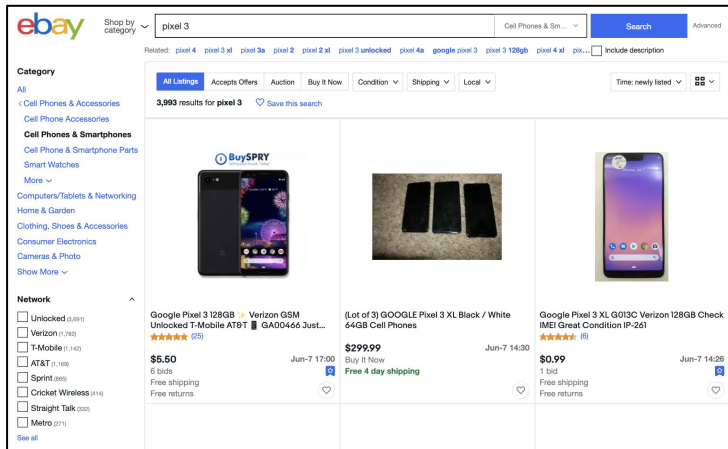
**GREAT PRICE**

**High Back Home Office Desk Chair Ergonomic Swivel Task Chair Gaming...**

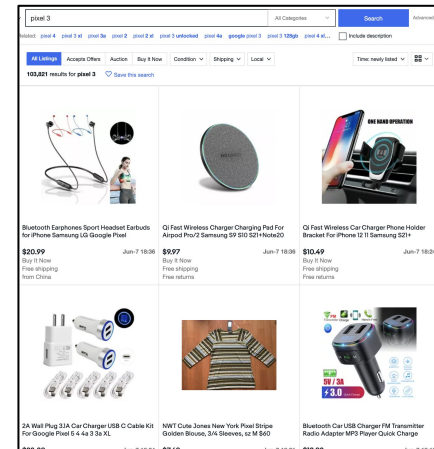
**\$54.99**

# Benefits of Query Categorization

- Relevance filtering: excludes out-of-category results that match keywords.
  - Especially useful for non-default sorts, like sorting by price.
- Helps provide searchers accurate summary information about query results.
  - Accurate numbers for total number of results and category / facet counts.
  - Contextual appropriate sub-categories and facets, sorts, filters, etc.

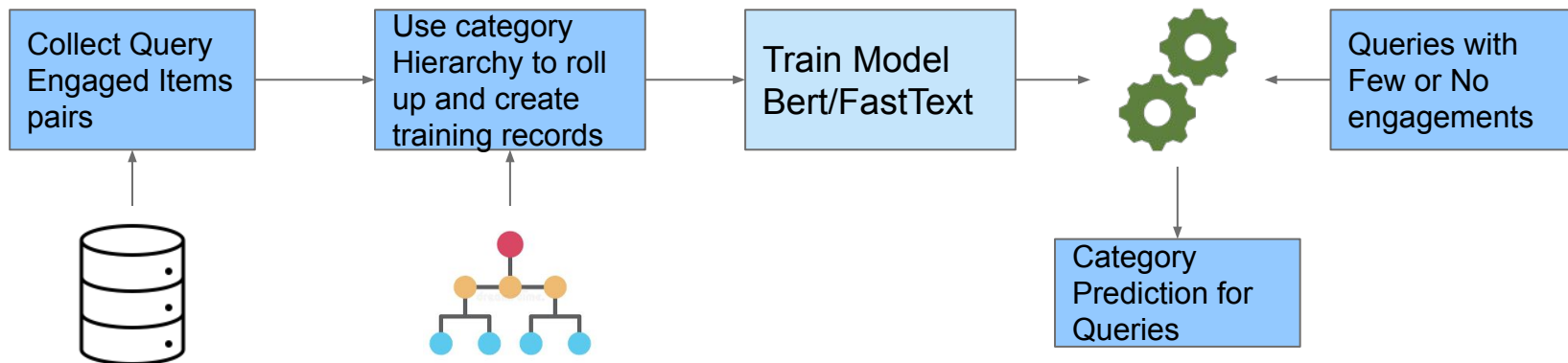


VS.



# Using AI for Query Categorization

- Create labeled training data from clicks or purchases.
  - Query => clicked or purchased product => product category.
  - Identify the appropriate category with sufficient demand for each query.
  - Use fastText, BERT, or any text classification model.
- Apply model to other queries -- especially torso and tail queries.
  - Compute categories for medium to low frequency queries online.





# Query Similarity based on Intent

- Multiple queries often map to the same intent.
  - e.g., *mens shoes* = *shoes for men*.

The screenshot shows the eBay search results for the query "mens shoes". The search bar at the top contains "mens shoes" and "Men's Shoes". The search results page displays a category filter for "Men's Shoes" with sub-categories like Athletic Shoes, Casual Shoes, Dress Shoes, and Boots. The price range is set to "Under \$30.00" to "Over \$45.00". The US Shoe Size (Men's) filter is set to "8". The search results show two sponsored items: "Men's Running Shoes Breathable Athletic Casual Sneakers Sport Tenni..." for \$20.99 and "Water Shoes Men Summer Pump Breathable Sneaker Swimming Boat..." for \$19.99. Both items feature a "USPS FREE SHIPPING" badge.

The screenshot shows the eBay search results for the query "shoes for men". The search bar at the top contains "shoes for men" and "Athletic Shoes". The search results page displays a category filter for "Athletic Shoes" with sub-categories like Casual Shoes, Dress Shoes, and Boots. The price range is set to "Under \$30.00" to "Over \$40.00". The US Shoe Size (Men's) filter is set to "7". The search results show two sponsored items: "Water Shoes Men Summer Pump Breathable Sneaker Swimming Boat..." for \$19.99 to \$21.99 and "Men's Running Shoes Breathable Athletic Casual Sneakers Sport Tenni..." for \$20.99. Both items feature a "USPS FREE SHIPPING" badge.

# Why group of queries with similar intent ?

- If we can recognize queries with the same (or nearly the same) intent, we can:
  - Map poorly performing queries to better-performing equivalent ones.
  - Intelligently recover from queries that return few or no results.
  - Analyze search behavior grouping by intent, rather than by query.
  - Obtain better signals to train machine learning models, e.g., for ranking.
- Recognizing query equivalence and similarity allows us to transform search queries into canonical representations of search intent, establishing a more robust foundation to optimize the search experience.

# Recognizing Query Equivalence: 2 Strategies

- How do we recognize that two queries represent the same search intent?
  - Surface Query Similarity
    - stemming, word order, compounds, noise words
    - e.g., *mens wristwatch* = *wrist watches for men*
  - Post-Search Behavior
    - engagement (clicks, conversions) with similar results
    - requires a way to measure similar results (hold that thought!)



# Surface Query Similarity

- The Good:
  - Easy to recognize queries that differ only in stemming, word order, etc.
  - High precision as a standalone indicator of query equivalence.
  - Decent coverage that can be extended (e.g., low-edit-distance query pairs).
  - Simple and explainable!



- The Bad:
  - There are false positives, e.g., *kiss* != *kisses*; *dress shirt* != *shirt dress*.
  - Need guardrails to avoid embarrassing mistakes.
  - Limited coverage; extending it significantly increases risk of false positives.

# Post-Search Behavior


- The Good:
  - Higher coverage than can be obtained from surface query similarity.
  - Learn from user behavior, which can look far beyond literal query tokens.
  - Use whole-query context for contextual expansion and relaxation.
- The Bad:
  - Complex compared to surface similarity, stochastic, and difficult to explain.
  - Replace simple binary query equivalence with continuous similarity metric.
  - Picking the right similarity threshold is as much an art as a science.
  - Rely on a pipeline of black-box approaches, starting with embeddings.

# Representing Queries as Vectors

- Think of a query as a bag of products associated with the query.
  - Conversions, clicks, or even impressions.
  - Trade-off between signal strength and sparsity.
- Compute query vector as average (mean pooling) of associated product vectors.
  - Assumes that products can be mapped to vectors!
  - Use pre-trained embeddings, fine-tuning, or can train from scratch.
- Product titles tend to be longer and more self-contained than queries.
  - Especially on a marketplace where sellers optimize for findability.

# Representing Queries as Vectors

Baseus 3 in 1 USB to Type-C Micro-USB Charger Cable Charging Lead for iPhone LG  
Brand New



[0.2,0.46,-0.86....-0.7,0.87,-0.8]

Apple Lightning to USB-C Cable Type C Fast Charger iPhone 11 Pro Max MacBook OEM  
100% AUTHENTIC ✓ Type C to Lightning ✓ Model A1655 ✓  
Open Box  
★★★★★ 341 product ratings



[0.1,0.34,-0.8....-0.66,0.7,-0.79]

FAST USB-C to Lightning MFI Certified Cable Charger Data Sync for Apple iPhone 11 12  
✓ SHIPS SAME DAY ✓ FAST 1-3 DAY DELIVERY ✓ USA SELLER  
Brand New  
★★★★★ 12 product ratings



[0.2,0.3,-0.85....-0.66,0.84,-0.9]

NEW USB-C to 8PIN iPhone Cable PD Fast Charger Cord For iPhone 12 11 Pro Max XS iPad  
Super Service ✓ OEM Quality ✓ Same Day Dispatch ✓ Warranty ✓  
Brand New



[0.1,0.3,-0.87....-0.66,0.76,-0.8]

Embedding for *iphone 12 charging cable*  
[0.16,0.35,-0.7....-0.66,0.79,-0.85]

[0.15,0.32,-0.69....-0.6,0.8,-0.9]

Embedding for *lightning to usb c cable*

NEW 8 Pin to USB-C Charger Cable for iPhone 12 11 Pro Max Macbook Fast Charging Cord  
Super Service ✓ OEM Quality ✓ Same Day Dispatch ✓ Warranty ✓  
Brand New




[0.24,0.32,-0.7....-0.6,0.7,-0.85]

1M For Apple - USB Charging cable - 1m - iPhone 6 7 8 X XR XS Max 11 Pro 12 Pro  
Ships from EU ✓ Buy 2 get 1 FREE ✓ Lightning to USB ✓  
Brand New  
★★★★★ 15045 product ratings



[0.08,0.33,-0.7....-0.66,0.9,-0.7]

3 Pack For iPhone 12 11 Pro Max XS iPad USB-C to L iPhone Cable Fast Charger Cord  
Brand New



[0.16,0.38,-0.7....-0.76,0.7,-0.9]

2 Pack Mododo For iPhone 12 Pro Max 11/X/8/7 USB SYNC Charger Coiled Cable Car  
Brand New



[0.1,0.3,-0.87....-0.76,0.87,-0.9]

# The Devil is in the Details!

- Challenging to decide how similar is similar enough for equivalence.
  - Threshold depends on data, application, and specific query.
  - Similarity may not be the only goal, e.g., may be trying to increase recall.
- Evaluation of similarity model is critical -- but also challenging.
  - Use human judgements of query pairs or end-to-end results.
  - Ultimately need to A/B test the end-to-end search application.
- This approach only works when you can pre-compute query vectors offline.
  - Associating queries with results at query time is too slow and expensive.
  - Offline approach works for head and maybe torso, but not for tail.



# Summary

- Query understanding is the process of inferring searcher's intent from keywords.
- Spectrum from coarse-grained categorization to fine-grained equivalence.
- Categorization improves relevance, navigation, presentation, and analytics.
- Train query categorization using the categories of clicked and purchased products.
- Recognizing query equivalence establishes canonical representation of search intent.
- Model a query as average of associated product vectors from an embedding model.