

Search For E-Commerce: *(Not) Solved (Yet)*

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Machine Learning Solutions for **Search, Recommendation** and **Computational Advertising**
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 - **Senior Manager of Research at Yahoo Research** in Sunnyvale, CA (2013 – 2016)
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-
- Multi-modal Deep-learning based Search Solution (KDD 2016)
 - Probabilistic Graphical Model based Personalization Recommendation (KDD 2014)
 - Ensemble Learning based CTR Prediction Solution (AdKDD 2017/KDD 2017)
 - Buzzsaw: A System for High Speed Feature Engineering (SysML 2018)
 - Learning Within-Session Budgets from Browsing Trajectories for Item Recommendations (RecSys 2018)

Agenda

- **An Introduction to Etsy**
- **Challenges to Search for E-Commerce**
- **Etsy's Efforts on Search Ranking**

An Introduction to Etsy



OUR MISSION

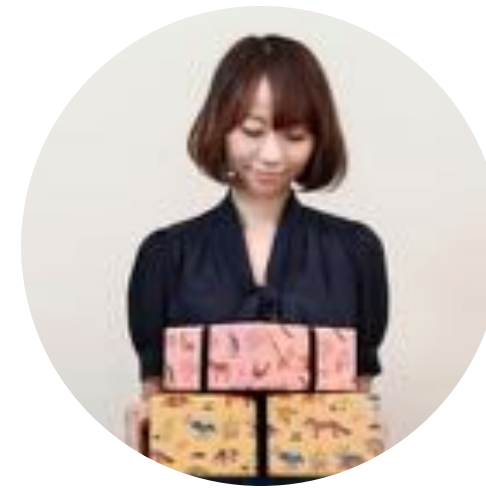
Reimagine commerce in
ways that build a more
fulfilling and lasting world

Etsy – A Global Marketplace



Artifact Bags
Omaha, NE

Photo by: Dana Damewood and Jackie Sterba



Clap Clap
Los Angeles, CA

Photo by: Bert Youn and Mimi Kim



redravenstudios
Pittsburgh, PA

Photo by: Janelle Bendycki



Little Hero Capes
Somerset, MA

Photo by: Rich Vintage Photography



Cattails Woodwork
Hermitage, PE, Canada

Photo by: Cattails Woodwork



Room for Emptiness
Berlin, Germany

Photo by: Room for Emptiness



sukrachand
Brooklyn, NY

Photo by: sukrachand



Nicole Porter Design
Saint Paul, MN

Photo by: Nicole Porter Design



noemiah
Montreal, QC, Canada

Photo by: noemiah



Lorgie
Fremantle, WA, Australia

Photo by: Lorgie



Jeremiah Collection
San Francisco, CA

Photo by: Matthew Reamer



Docksmith
Brunswick, ME

Photo by: Docksmith



purlBKnit
Brooklyn, NY

Photo by: purlBKnit



Julia Astreou
Nicosia, Cyprus

Photo by: Panagiotis Mina



Moira K. Lime
Omaha, NE

Photo by: Moira K. Lime



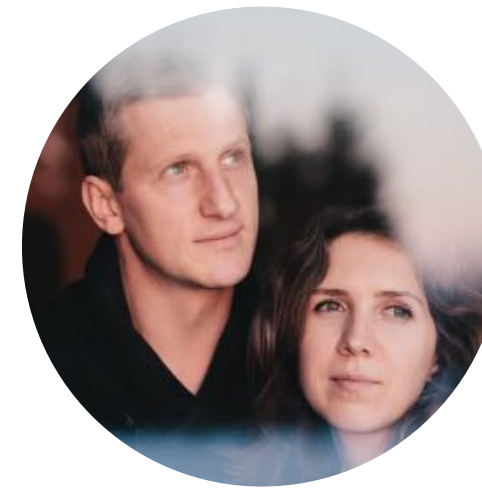
Nested Yellow
Portland, OR

Photo by: Jessica Dremov and Nested Yellow



Habitables
Madrid, Spain

Photo by: Habitables



Woodstorming
Kaunas, Lithuania

Photo by: Ilona & Martynas from Instudija



karoArt
Dublin, Ireland

Photo by: Christine Burns



ADIKILAV
Jerusalem, Israel

Photo by: Shlomit Koslowe



My A La Mode Boutique
Ecuador

Photo by: My A La Mode Boutique

Etsy – A Global Marketplace

What can you sell on Etsy?



Handmade Goods



Vintage

(20 years or older)



Craft Supplies

By The Numbers

1.9M

active sellers

31.7M

active buyers

\$2.8B

annual GMS

45+M

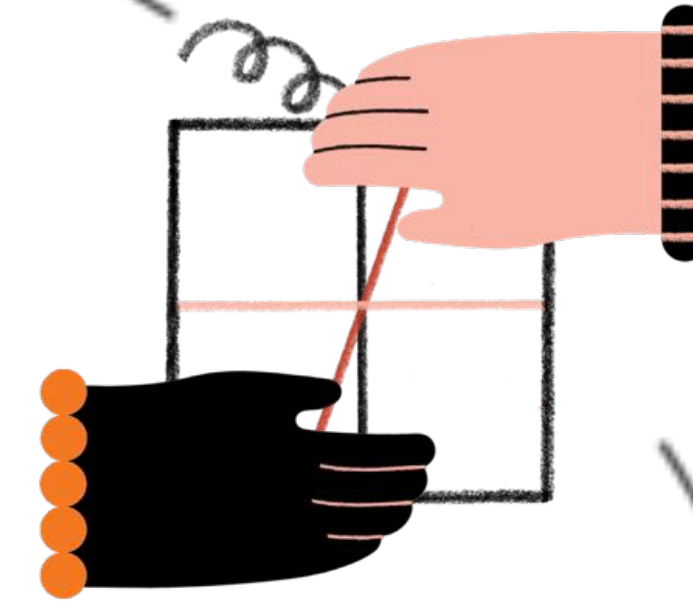
items for sale



SELLER
Pursues craft,
grows business



ETSY
Facilitates the
transaction

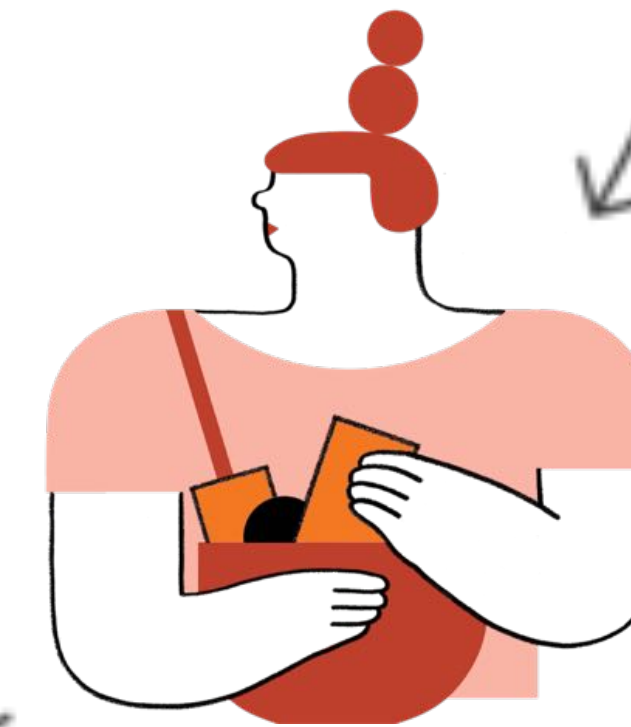


Etsy Empowerment Loop

ETSY
Invests in the
platform and
delivers a
global base of
buyers



BUYER
Funds unique
goods that are
hard to find
elsewhere



Challenges to Search for E-Commerce



Challenges to Search for E-Commerce

Generic Search

Google search results for "sigir 2018". The search bar shows "sigir 2018" and the results indicate "About 298,000 results (0.50 seconds)". The top result is "SIGIR 2018 | Ann Arbor, Michigan - July 8-12" from sigir.org/sigir2018/. Below this, there are sections for "Program at a Glance", "Accepted Papers", and "Ann Arbor". A Twitter link for "@sigir2018" is also visible.

Bing search results for "donald trump". The search bar shows "donald trump" and the results indicate "66,706,000 Results". The top result is "News about Donald Trump" from Bing.com/news. Below this, there are sections for "Senators Divided Over Trump's Approach to NATO" and "Donald J. Trump | Twitter".

Baidu search results for "北京" (Beijing). The search bar shows "北京" and the results indicate "百度为您找到相关结果约100,000,000个". The top result is "北京_百度百科" (Beijing - Baidu Encyclopedia). Below this, there are sections for "2018超实用北京旅游攻略_百度旅游_带你玩转北京" and "北京天气预报_一周天气预报_中国天气网".

Advertisement for Super-in London. The website features a large image of the London skyline with the text "Super-in London". Below the image, there is a description of the website and a list of "北京著名景点" (Famous Beijing Attractions) including the Great Wall, Tiananmen, and the Summer Palace.

Challenges to Search for E-Commerce

Generic Search

The image shows a Google search results page for the query "barack obama". The search bar at the top contains the text "barack obama" and shows "About 127,000,000 results (0.27 seconds)". Below the search bar are navigation tabs for "All", "News", "Images", "Videos", "Books", and "More", along with "Settings" and "Tools".

The "Top stories" section features three news items:

- Pol: Barack Obama Was the Greatest President of Our Lifetime** (NYMag, 5 hours ago)
- Obama Tops Public's List of Best President in Their Lifetime, Followed by Clinton, Reagan** (Pew Research Center, 6 hours ago)
- Obama 'best' president of recent years, Pew survey finds** (Politico, 17 mins ago)

Below the top stories is a "More for barack obama" link. The "Barack Obama (@BarackObama) | Twitter" section shows a link to his profile and a snippet of a tweet: "Low plastic stool, cheap but ... Congratulations to the ... Barack Obama on Twitter". The "The Office of Barack and Michelle Obama" section provides a link to the official website and a welcome message.

The "2008 Presidential Candidates" section displays a grid of candidate portraits including Joe Biden, John McCain, Ralph Nader, Cynthia McKinney, Bob Barr, Chuck Baldwin, and Gene Amodeo.

The "Harvard University Notable alumni" section displays a grid of portraits including Michelle Obama, Mark Zuckerberg, Mitt Romney, Bill Gates, Jared Kushner, Stephen K. Bannon, and Benjamin Netanyahu.

The "Searches related to barack obama" section lists related queries such as "barack obama ar", "barack obama biography", "barack obama education", "barack obama twitter", "barack obama parents", "barack obama net worth", "barack obama facts", and "barack obama mother".

At the bottom of the page, there is a "Go" button with a search icon, a footer with "© 2017 Google", and a "Sign in" button.

Challenges to Search for E-Commerce

Generic Search

- **Classic Information Retrieval (1950 – 1990)**
TF-IDF, BM25, Language Models
- **Learning To Rank (2000 – 2010)**
RankSVM, GBDT, LambdaMART
- **Neural Learning To Rank (2013 – Present)**
DSSM, DESM, IRGAN

Challenges to Search for E-Commerce

Generic Search

- **Cranfield Paradigm and Test Collections (1950 – Present)**

TREC (1992 – Present)

Microsoft Learning To Rank (2007 – 2009)

Yahoo Learning To Rank Challenge (2011)

- **Understanding Implicit Feedback and Relevance (2000 – Present)**

Thorsten Joachims's Work

Eugene Agichtein's Work

Challenges to Search for E-Commerce

Search for E-Commerce

The image displays three overlapping e-commerce search results, illustrating the challenges of finding relevant products across different platforms.

- Etsy (Top Left):** Search for "harry potter". Results include "Hogwarts Express Castle Art House D...", "Potions Pillows - Wizard, Witch, Love...", and "Harry Potter Gift - Ravenclaw Crest A...".
- Amazon (Middle):** Search for "cannon camera". Results include a Canon EOS M50 Mirrorless Camera Kit w/EF-M15-45mm and 4K Video (Black) for \$1699.00.
- eBay (Right):** Search for "fashion". Results include "US Fashion Ladies Casual Tops T-Shirt Women Summer Loose...", "Russell Athletic Men's DRI-POWER Fashion Performance...", and "Fashion Women Spaghetti Strap Floral Print Beach Style Skater...".

The collage highlights the difficulty of comparing products and prices across these diverse marketplaces.

Challenges to Search for E-Commerce

Challenge I - Relevancy

The screenshot displays an Amazon search results page for the query "dress". The page is divided into several sections:

- Filters (Left Sidebar):**
 - All categories:** Clothing, Craft Supplies & Tools, Toys & Games, Weddings.
 - Shipping:** Free shipping, Ready to ship in 1 business day, Ready to ship within 2 business days.
 - Special offers:** On sale.
 - Ship location:** Anywhere, United States, Custom.
 - Item type:** All items, Handmade, Vintage.
 - Price (\$):** Any price, Under \$25, \$25 to \$50.
- Search Results (Main Area):**
 - Header: All categories + "dress" (1,443,960 Results). Sort by: Relevancy.
 - Grid of product listings:
 - Bridesmaid Dress Tan Sequin Wedding Dress:** \$129.00, 4.5 stars (11,134 reviews).
 - Bridesmaid Dress Rose Gray Chiffon:** \$138.00, 4.5 stars (761 reviews).
 - Brand Launch Sale! Black high-neck Dress:** \$50.00 (Free shipping), 4.5 stars (1 review).
 - maxi linen dress in aqua green, ruffle:** \$128.00, 4.5 stars (14,092 reviews).
 - Back Y neck linen dress / Summer dress:** \$78.78, 4.5 stars (12,744 reviews).
 - Pre-K outfit, Pre-k dress, first day of p...:** \$29.00, 4.5 stars (1,408 reviews).
 - MIMOSA DRESS / Loose wrap linen d...:** \$82.41, 4.5 stars (12,732 reviews).
 - Hemp Cotton Dress:** \$89.00, 4.5 stars (16,482 reviews).
- Refinement Panel (Right Side):**
 - Office & School Supplies (See All 20 Departments)
 - Refine by: Subscribe & Save, Amazon Prime, Eligible for Free Shipping, Panty.
 - Brand: Beauty, Vics, Brawny, Seventh Generation, Marcal, Sparkle, SCOT, Georgia-Pacific, 365 Everyday Value, Presto!, Panty.
 - Avg. Customer Review: 4.5 stars & up, 4 stars & up, 3 stars & up, 2 stars & up.
 - Condition: New, Used.
 - Kitchen Product Grade: Commercial Grade.
 - Color: Filter.
- Product Detail View (Right Side):**
 - Brawny Tear-A-Square Paper Towels:** 12 Rolls, 12 = 24 Regular Rolls, 3 Sheet Size Options, Quarter Size Sheets. \$24.99 (\$0.80/100 Sheet). 4.5 stars (19 reviews).
 - Top Rated from Our Brands:** Four Presto! paper towel products are featured, including Ultra-Soft Toilet Paper.

Challenges to Search for E-Commerce

Challenge I - Relevancy

The image shows a screenshot of an Etsy search for "scandinavian modern". The search results page displays a grid of various items, including a minimalist end table, a summer art print, large Scandinavian art, and a minimalist art print. A detailed product page for a custom print is shown on the right, featuring a large letter 'A' and an ampersand print. The product page includes a price of \$5.61 (15% off), an "Add to cart" button, and a list of reviews.

Product Details:

- Shop: PrintsMiusStudio (243 items)
- Product: Custom print, Scandinavian Letter, Wall Art Letters, Typography Letters, Affiche scandinave, Alphabet Letters, scandinavian modern, letter A
- Price: \$5.61 (15% off) (You save \$0.99)
- Buttons: Like this item?, Instant download, Add to cart, Ask a question
- Overview:
 - Handmade item
 - Instant Digital Download: 5 JPG included
 - Materials: Download, Instnat
 - Feedback: 222 reviews
 - Favorited by: 108 people
- Share: Share, Save, Tweet

Reviews:

- Reviewed by kdbug88 (Oct 28, 2017): The peony print really complements my master bedroom suite decor. The picture is beautiful!
Product: Peony Black White, Peonies wall prints, Peony Bouquet, Peonies print, Peony Print, Peonies Art, Peonies, Floral Print, Print Poster, petals
- Reviewed by Audrey Driskill (Jul 8, 2018): Easy to download my digital file- got it printed and it looks high quality.
Product: Abstract art print, Landscape art, abstract print, Large scale art, Large abstract, urban style, abstract painting, Giclée Prints, blue art
- Reviewed by Erica (Jul 8, 2018): I love this artwork so much! Can't wait to have it framed and put in my office. Exactly what I wanted <3
Product: Fashion Bedroom Art, Lip Print, Modern Fashion Art, Black lip print, Pink Poster Fashion, Lips wall art, Lipstick Print, Gift for her,
- Reviewed by Esin Tayanc (Jul 3, 2018): great resolution ! Thank you!
Product: Ferris Wheel Decor, London Eye, Great Britain, United Kingdom,

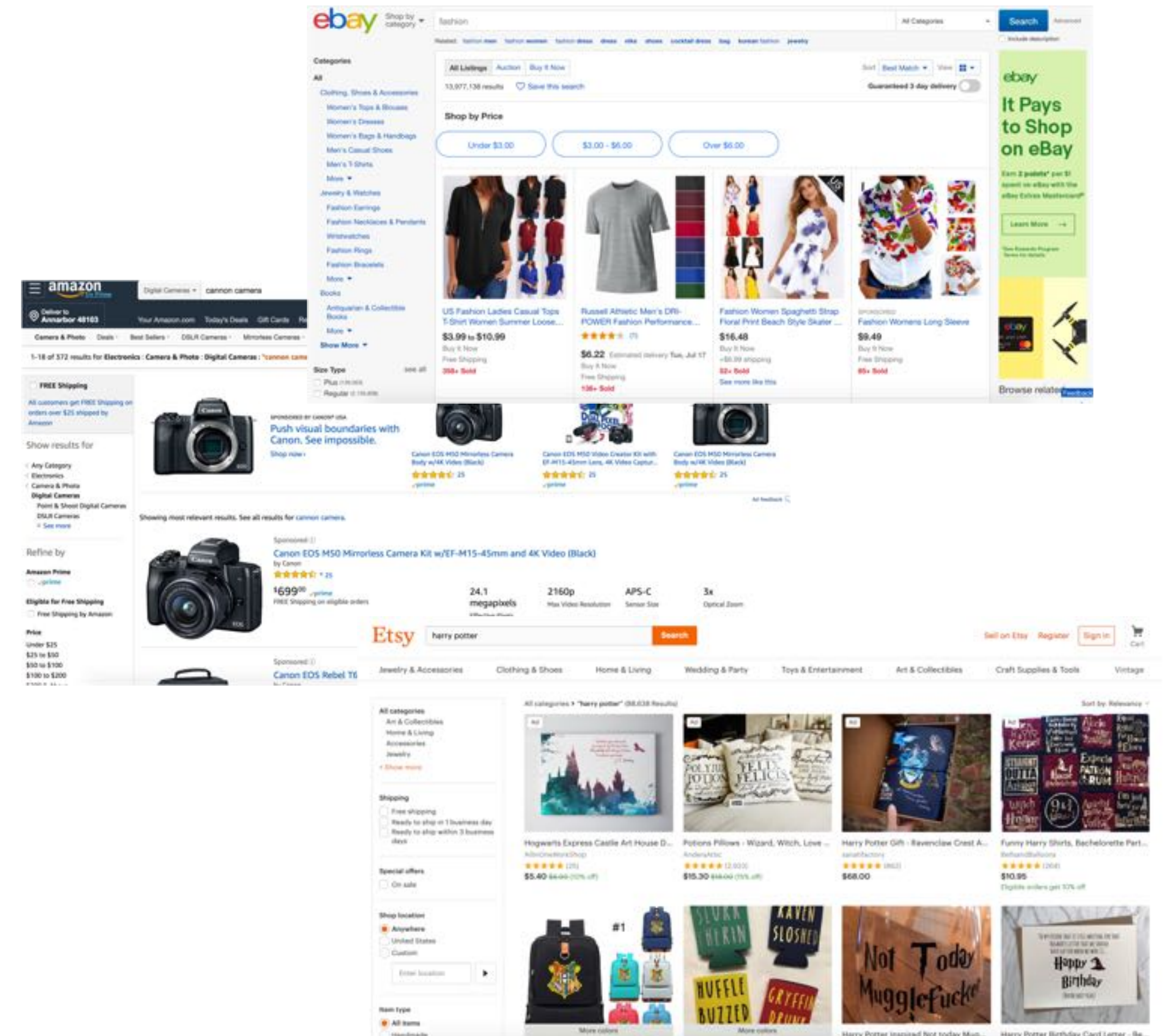
Challenges to Search for E-Commerce

Challenge II – User Satisfaction



Challenges to Search for E-Commerce

Challenge II – User Satisfaction



Challenges to Search for E-Commerce

Challenge III – Discovery

The screenshot shows an Etsy product listing for a signed art print. At the top left, the shop name 'krisblues' is displayed with a 'Favorite shop' button. To the right, there are four small thumbnail images and a '174 items' indicator. The main image is a whimsical illustration of a white rabbit sleeping on a tree stump in a forest, with glowing yellow fireflies and mushrooms. The product title is 'Midsummer - Signed Art Print' with a price of '\$30.00' and an 'Ask a question' button. Below the price are 'Buy it now >' and 'Add to cart' buttons. A warning icon indicates 'Almost gone. There's only 1 left.' The 'Overview' section lists: 'Handmade item', 'Material: art panel', 'Feedback: 1860 reviews', 'Favorited by: 961 people', and 'Gift message available'. It also notes 'This shop accepts Etsy gift cards'. The 'Shipping & returns' section states 'Get it fast! Ready to ship in 1-3 business days.', 'From Brooklyn, New York', and '\$3.50 shipping to United States_11201'. A 'See shipping and return policy' link is provided. At the bottom, there are social sharing options for Facebook, Pinterest, and Twitter, and a 'zoom' button.

krisblues
Favorite shop

174 items

Midsummer - Signed Art Print
\$30.00
Ask a question

Buy it now >
Add to cart

Almost gone. There's only 1 left.

Overview

- Handmade item
- Material: art panel
- Feedback: 1860 reviews
- Favorited by: 961 people
- Gift message available

This shop accepts Etsy gift cards

Shipping & returns
Get it fast! Ready to ship in 1-3 business days.
From Brooklyn, New York
\$3.50 shipping to United States_11201
See shipping and return policy

Share Save Tweet

zoom

Challenges to Search for E-Commerce

Challenges

- Relevancy
- User Satisfaction
- Discovery

Publications

- [1] Huizhong Duan, ChengXiang Zhai, Jinxing Cheng, and Abhishek Gattani. **Supporting Search in product database: a probabilistic approach**. In VLDB 2013.
- [2*] Christophe Van Gysel, Maarten de Rijke, and Evangelos Kanoulas. **Learning Latent Vector Spaces for Product Search**. In CIKM 2016.
- [3] Shubhra Kanti Karmaker Santu, Parikshit Sondhi, and ChengXiang Zhai. **On Application of Learning to Rank for E-Commerce Search**. In SIGIR 2017.
- [4*] Qingyao Ai, Yongfeng Zhang, Keping Bi, Xu Chen, and W. Bruce Croft. **Learning a Hierarchical Embedding Model for Personalized Product Search**. In SIGIR 2017.
- [5] Shichen Liu, Fei Xiao, Wenwu Ou, and Luo Si. **Cascade Ranking for Operational E-commerce Search**. In KDD 2017.
- [6] Liang Wu, Diane Hu, Liangjie Hong, and Huan Liu. **Turning Clicks into Purchases: Revenue Optimization for Product Search in E-Commerce**. In SIGIR 2018.

Etsy's Efforts on Search Ranking



Search Ranking at Etsy

The image shows a screenshot of the Etsy website's search results for 'bohemian womens clothing'. The page features a search bar at the top with the query 'bohemian womens clothing' and a 'Search' button. Navigation links for 'Sell on Etsy', 'Register', 'Sign in', and 'Cart' are visible in the top right. A horizontal menu below the search bar lists various categories: Jewelry & Accessories, Clothing & Shoes, Home & Living, Wedding & Party, Toys & Entertainment, Art & Collectibles, Craft Supplies & Tools, and Vintage.

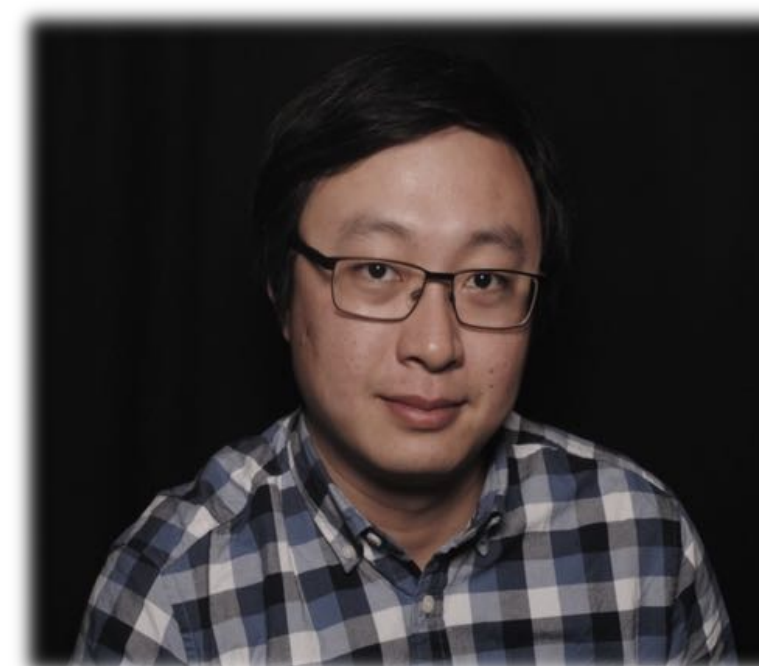
On the left side, there are filter sections for 'All categories', 'Shipping', 'Special offers', 'Shop location', and 'Item type'. The main content area displays a grid of search results. The first row includes items like 'Gypsies never get tied down - fortun...', 'Palazzo pants, Wide Leg Pants, Hand...', and 'Embroidered Mexican B...'. The second row features 'Festival Clothing, Boho Clothing, Gift...', 'Breezy Boho Maxi Skirt Bohemian Clo...', and 'Hippie Pants Harem Pan...'. A shop profile for 'Shovava' is highlighted, showing a 'Favorite shop' button and a '101 items' count.

The detailed view of the 'Festival Clothing' item is shown on the right. It includes a 'Like this item?' section with a 'Add to your favorites to revisit it later.' prompt. The main image shows a woman in a colorful, layered bohemian shawl sitting on a cliff overlooking the Golden Gate Bridge. The product title is 'Festival Clothing, Boho Clothing, Gift For Her, Bohemian Scarf, Feather Wing Scarf, Women Shawl, Sarong Women Scarf, Festival Wrap'. The price is '\$56.00+'. There is an 'Add to cart' button and a note that 'Other people want this. Over 20 people have this in their carts right now.' The 'Material' dropdown is set to 'Select a material' and the quantity is '1'.

Search Ranking at Etsy

Turning Clicks into Purchases: Revenue Optimization for Product Search in E-Commerce (SIGIR 2018)

- **Liang Wu**, PhD Student from Arizona State University
- **Diane Hu**, Staff Data Scientist at Etsy
- **Liangjie Hong**, Head of Data Science at Etsy



Search Ranking at Etsy

Turning Clicks into Purchases: Revenue Optimization for Product Search in E-Commerce (SIGIR 2018)

How to Optimize *Gross-Merchandise-Value* (GMV)?

Search Ranking at Etsy

Turning Clicks into Purchases: Revenue Optimization for Product Search in E-Commerce (SIGIR 2018)

How to Optimize *Gross-Merchandise-Value* (GMV)?

$$GMV = \sum_{\underbrace{\forall s \in S}_{\text{A search session}}} \sum_{\underbrace{\forall i^s}_{\text{An item in } s}} \underbrace{Price(i^s)}_{\text{Price of } i^s} \underbrace{Pr(\Phi = 1 | i^s, q^s)}_{\text{Prob of purchase}},$$

Search Ranking at Etsy

Turning Clicks into Purchases: Revenue Optimization for Product Search in E-Commerce (SIGIR 2018)

Purchase Decision Process

The image shows a screenshot of an Etsy search page for "rosy wedding dress". At the top, there is a search bar with the text "rosy wedding dress" and a "Search" button. Below the search bar, it says "All categories + 'rosy wedding dress' (72 Results)". There are four product listings in a 2x2 grid:

- Top-left:** A long, flowing, bright pink dress. Title: "60 Colors Chiffon Rosy Long Party Dress Evening...". Price: \$51.50. Rating: 5 stars (309).
- Top-right:** A long, flowing, light pink dress with a bow back. Title: "Rosy Brown Dress Chiffon Party Dress Long Sleeve...". Price: \$39.00. Rating: 5 stars (1387).
- Bottom-left:** A short, puffy, light pink dress with a floral pattern. Title: "Ivory Mauve Flower Girl Dress - Flower girl Dress...". Price: \$69.00. Rating: 5 stars (207).
- Bottom-right:** A light pink dress with a large bow at the waist. Title: "Rosy Mauve Satein Bowknot Sash - Rosy Mauve We...". Price: \$14.00. Rating: 5 stars (17).

Two product pages are shown on the right, connected to the listings by orange arrows:

- Top Product Page:** Corresponds to the top-right listing. Title: "Rosy brown dress chiffon party dress rosy brown prom dress chiffon cocktail dress bow back dress rosy brown bridesmaid dresses chiffon dress". Price: \$39.00. Features an "Ask a question" button and a "Style" dropdown menu with "Select a style" as the selected option.
- Bottom Product Page:** Corresponds to the bottom-left listing. Title: "Ivory Mauve Flower Girl Dress - Flower girl Dress Rosy Mauve - Flower Girl Dress - Dress for Flower Girls - flower girls Pink Mauve". Price: \$69.00+. Features an "Ask a question" button, "Only 1 available" text, and a "Size" dropdown menu with "Select a size" as the selected option.

Labels "Search Page" and "Product Page" are centered below their respective sections.

Search Ranking at Etsy

Turning Clicks into Purchases: Revenue Optimization for Product Search in E-Commerce (SIGIR 2018)

- Click Decision(s) from Search-Result-Page (SERP)
- Purchase Decision(s) from Listing Page

$$Pr(\Phi = 1|i, q) = \underbrace{Pr(\Psi = 1|i, q)}_{\text{click model}} \underbrace{Pr(\Phi = 1|\Psi = 1, i, q)}_{\text{purchase model}},$$

Search Ranking at Etsy

Turning Clicks into Purchases: Revenue Optimization for Product Search in E-Commerce (SIGIR 2018)

- Click Decision(s) from Search-Result-Page (SERP)
- Purchase Decision(s) from Listing Page

$$NDCG_K(\rho) = N_{max}^{-1} \sum_{r=0}^{K-1} \frac{2^{l(r^{-1})}}{\log(1+r)},$$

Search Ranking at Etsy

Turning Clicks into Purchases: Revenue Optimization for Product Search in E-Commerce (SIGIR 2018)

- Click Decision(s) from Search-Result-Page (SERP)
- Purchase Decision(s) from Listing Page

$$NDCG_K(q) = N_{max}^{-1} \sum_{r=0}^{K-1} \frac{2^{l(r^{-1})}}{\log(1+r)},$$

- l is transformed from *empirical GMV*.
- r is approximated by the product of a click model and a purchase model where the click model is a RankNet model and the purchase model is *price-weighted* logistic regression.

Search Ranking at Etsy

Turning Clicks into Purchases: Revenue Optimization for Product Search in E-Commerce (SIGIR 2018)

Relevance	Low Level	Sum of TF
		Sum of Log TF
		Sum of Normalized TF
		Sum of Log Normalized TF
		Sum of IDF
		Sum of Log IDF
		Sum of ICF
		Sum of $TF-IDF$
		Sum of Log $TF-IDF$
		TF -Log IDF
		$Length$
	Log $Length$	
	High Level	$BM25$
		Log $BM25$
LM_{DIR}		
LM_{JM}		
LM_{ABS}		
Revenue	$Price$	
	$Price - Cat.Mean$	
	$(Price - Cat.Mean)/Cat.Mean$	

Sessions	Queries	Items	Avg. Items per Session
334,931	239,928	6,347,251	19.0
Keywords	Buyers	Sellers	Avg. Items per Query
631,778	270,239	550,025	26.5

Click	RankNet [2]	RNet
	RankBoost [8]	RBoost
	AdaRank [36]	ARank
	LambdaRank [3]	LRank
	ListNet [4]	LNet
	MART [10]	MART
	LambdaMART [35]	LMART
Purchase	SVM [5]	SVM
	Logistic Regression [25]	LR
	Random Forest [19]	RM
Both	Weighted Purchase [41]	WT
	LMART+RM	LMRM
	LETORIF	LETORIF

Search Ranking at Etsy

Turning Clicks into Purchases: Revenue Optimization for Product Search in E-Commerce (SIGIR 2018)

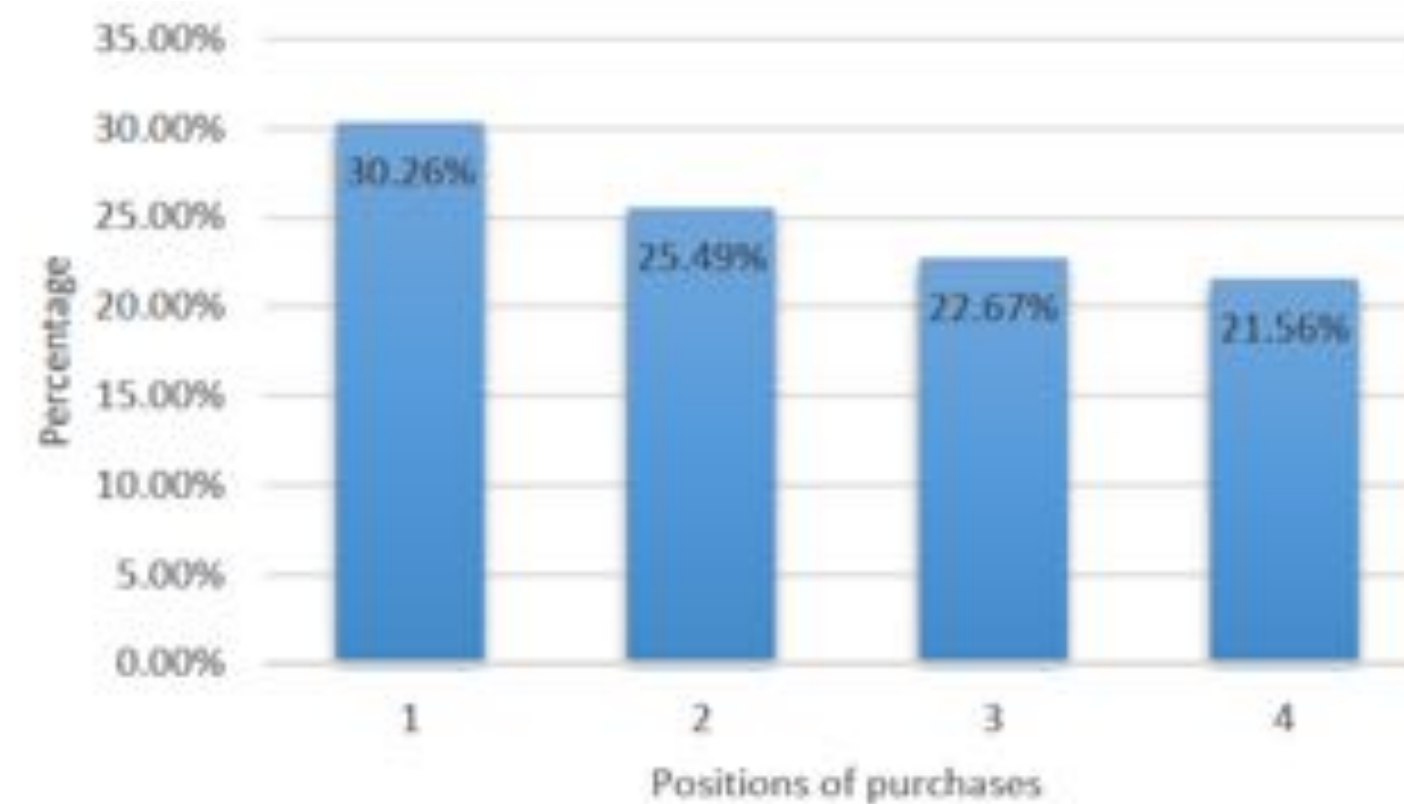


Figure 2: Position distribution of items being purchased in the top 4 spots of a search result page. The first position achieves the most purchases, while nearly 70% of purchases are in the lower positions.

Search Ranking at Etsy

Category	Method	Click NDCG@5			Purchase NDCG@5			Revenue NDCG@5		
		Train	Vali	Test	Train	Vali	Test	Train	Vali	Test
Click	RNet	0.1743	0.1731	0.1378**	0.1672	0.1721	0.1676**	0.1692	0.1700	0.1356**
	RBoost	0.2150	0.1768	0.1323**	0.2150	0.1768	0.1715**	0.2150	0.1768	0.1311**
	ARank	0.1718	0.1711	0.1351**	0.1718	0.1711	0.1706**	0.1718	0.1711	0.1358**
	LRank	0.1694	0.1688	0.1360**	0.1678	0.1711	0.1672**	0.1713	0.1719	0.1366**
	LNet	0.1665	0.1703	0.1355**	0.1601	0.1682	0.1620**	0.1646	0.1696	0.1348**
	MART	0.2700	0.1758	0.1380**	0.2155	0.1803	0.1796*	0.2696	0.1688	0.1408**
	LMART	0.3056	0.1777	0.1412	0.3056	0.1777	0.1717**	0.3056	0.1777	0.1370**
Purchase	SVM	0.1785	0.1772	0.1336**	0.1831	0.1754	0.1755**	0.1816	0.1752	0.1320**
	LR	0.1978	0.1739	0.1310**	0.1978	0.1739	0.1782**	0.1978	0.1739	0.1332**
	RM	0.3359	0.1698	0.1363**	0.3329	0.2305	0.1798**	0.3327	0.1685	0.1376**
Both	WT	0.1970	0.1682	0.1334**	0.1815	0.1763	0.1761**	0.1781	0.1648	0.1375**
	LMRM	0.2943	0.2597	0.1354**	0.3087	0.2530	0.1688**	0.2943	0.2594	0.1332**
	LETORIF	0.1765	0.1550	0.1351**	0.2731	0.1841	0.1801	0.2039	0.1698	0.1494

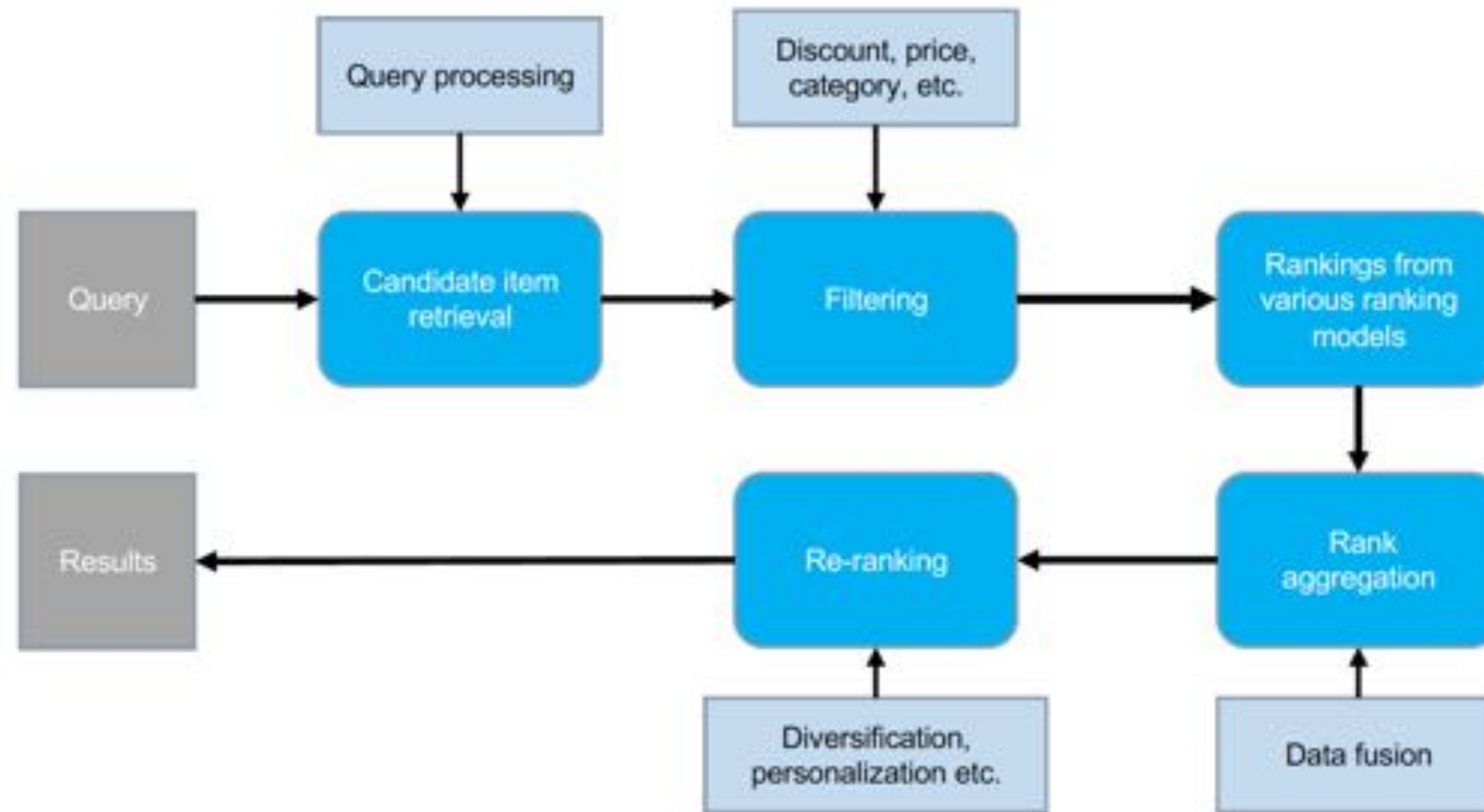
Symbol * indicates that the method is outperformed by the best one by 0.05 statistical significance level, ** indicates 0.01.

Search Ranking at Etsy

Category	Method	Rev@1	Rev@2	Rev@3	Rev@4	Rev@5	Rev@6	Rev@7	Rev@8	Rev@9	Rev@10
Click	RNet	4.47**	4.69**	4.89**	4.91*	5.06**	5.23**	5.21**	5.33**	5.46**	5.55**
	RBoost	4.57**	4.69**	4.69**	4.76**	4.97**	5.17**	5.23**	5.36**	5.49**	5.57**
	ARank	4.37**	4.66**	4.76**	4.90**	5.06**	5.20*	5.33**	5.47**	5.59**	5.67**
	LRank	4.38**	4.61**	4.74**	4.86**	5.07**	5.25**	5.42**	5.42**	5.67**	5.78**
	LNet	4.30**	4.59**	4.78**	4.99**	5.16**	5.35**	5.49**	5.61**	5.63**	5.63**
	MART	4.62	4.72**	4.86**	5.04**	5.26**	5.47**	5.47**	5.64**	5.74**	5.86**
	LMART	4.46*	4.54**	4.73**	5.10**	5.31**	5.56**	5.75**	5.90*	6.01**	6.14**
Purchase	SVM	4.41**	4.54**	4.76**	4.77**	4.95**	5.16**	5.34**	5.50**	5.64**	5.77**
	LR	4.29**	4.65**	4.65**	4.69**	4.74**	4.81*	4.94**	4.97**	5.11**	5.11**
	RM	4.52**	4.82**	4.86**	5.02**	5.18**	5.33*	5.50**	5.66**	5.79**	5.92**
Both	WT	4.52**	4.69**	4.80**	4.85**	5.01**	5.07**	5.23**	5.32**	5.35**	5.41**
	LMRM	4.42**	4.50**	4.72**	5.08**	5.23**	5.41**	5.57**	5.60**	5.73**	5.85**
	LETORIF	4.58**	4.90	5.08	5.47	5.64	5.85	6.02	6.19	6.40	6.54

Symbol * indicates that the method is outperformed by the best one by 0.05 statistical significance level, ** indicates 0.01.

Search Ranking at Etsy



Search Ranking at Etsy

- A simplified 2-Stage model deployed into recommendation, improved GMV +0.8%.
- A weighted purchase model deployed into search ranking, improved GMV +0.9%.
- An extended candidate selection deployed into search ranking, improved GMV +2.0%.
- A model heavily utilizing historical information deployed into search ranking, improved GMV +0.7%.

Conclusion

- **An Introduction to Etsy**
- **Challenges to Search for E-Commerce**
- **Etsy's Efforts on Search Ranking**

Conclusion

- **An Introduction to Etsy**
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- **Incoming Kaggle Competition**

