Result Diversification

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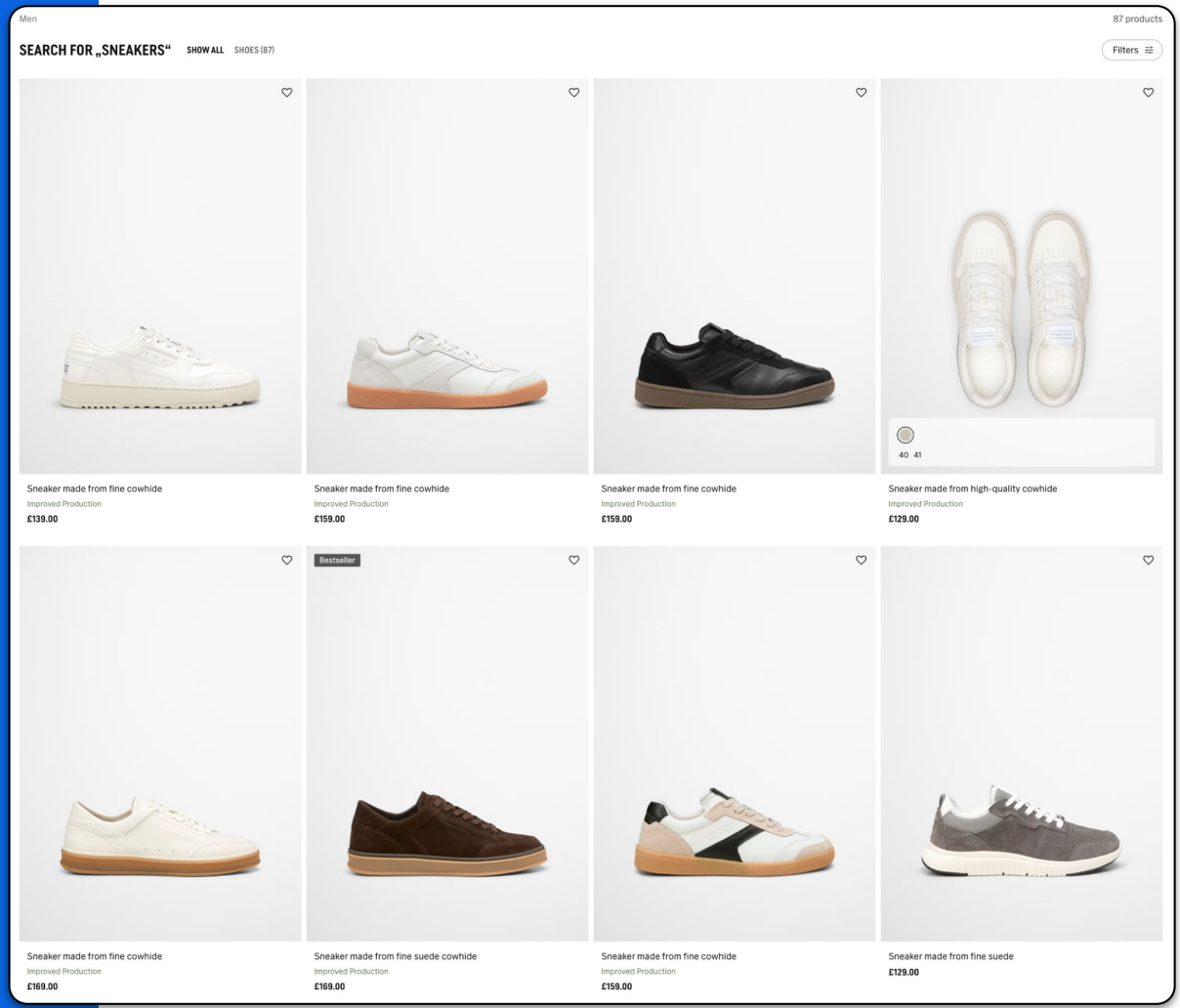
elastic | The Search AI Company

The Problem

Exploration is limited



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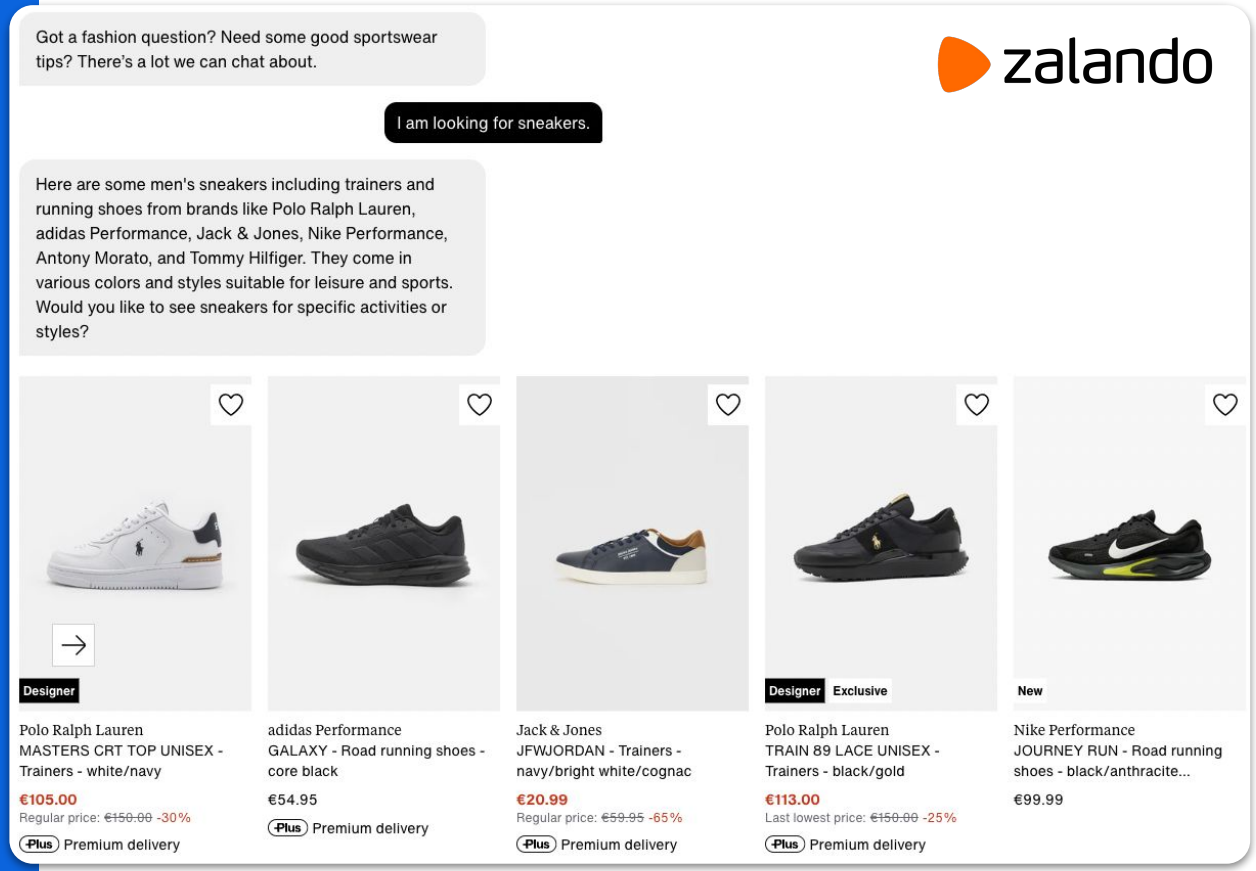
Browsing and discoverability is encouraged



https://en.zalando.de/assistant

* Slightly modified to fit on screen

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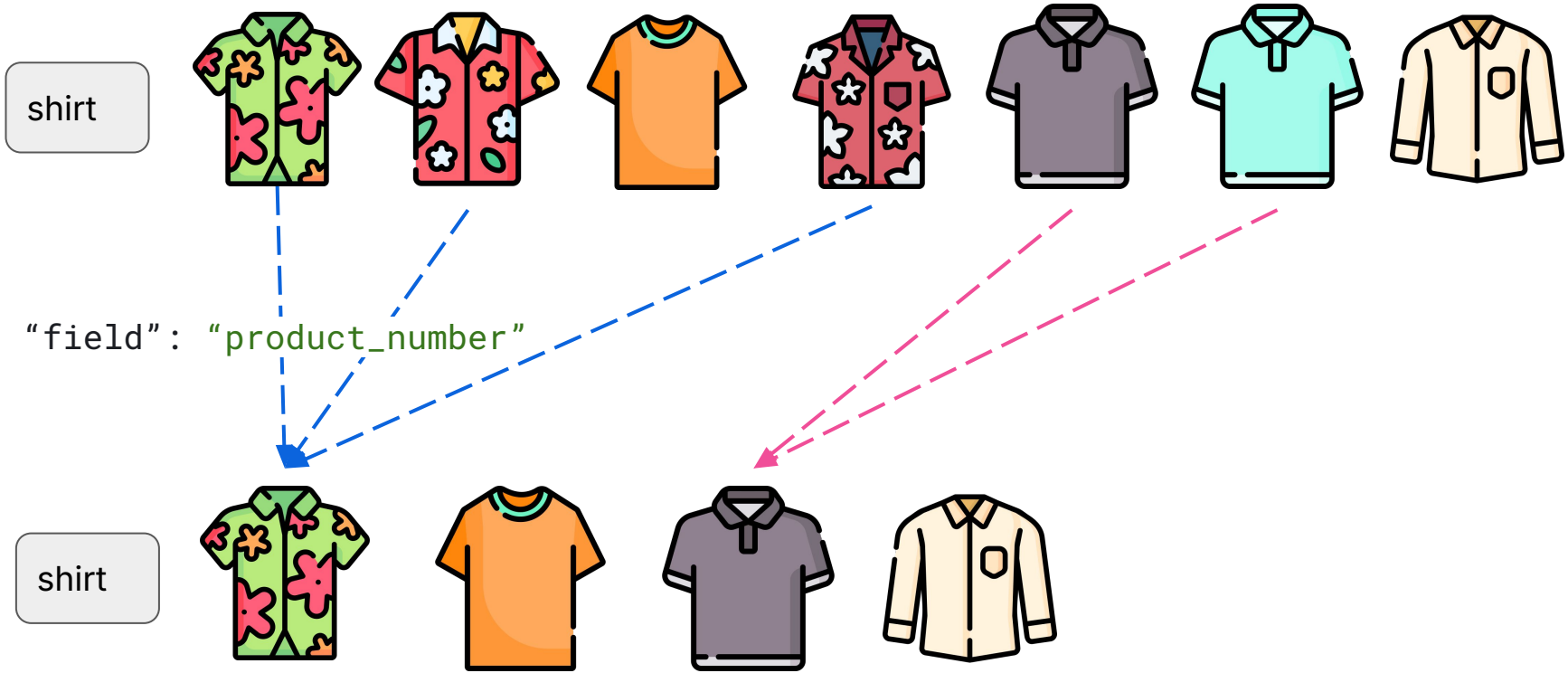
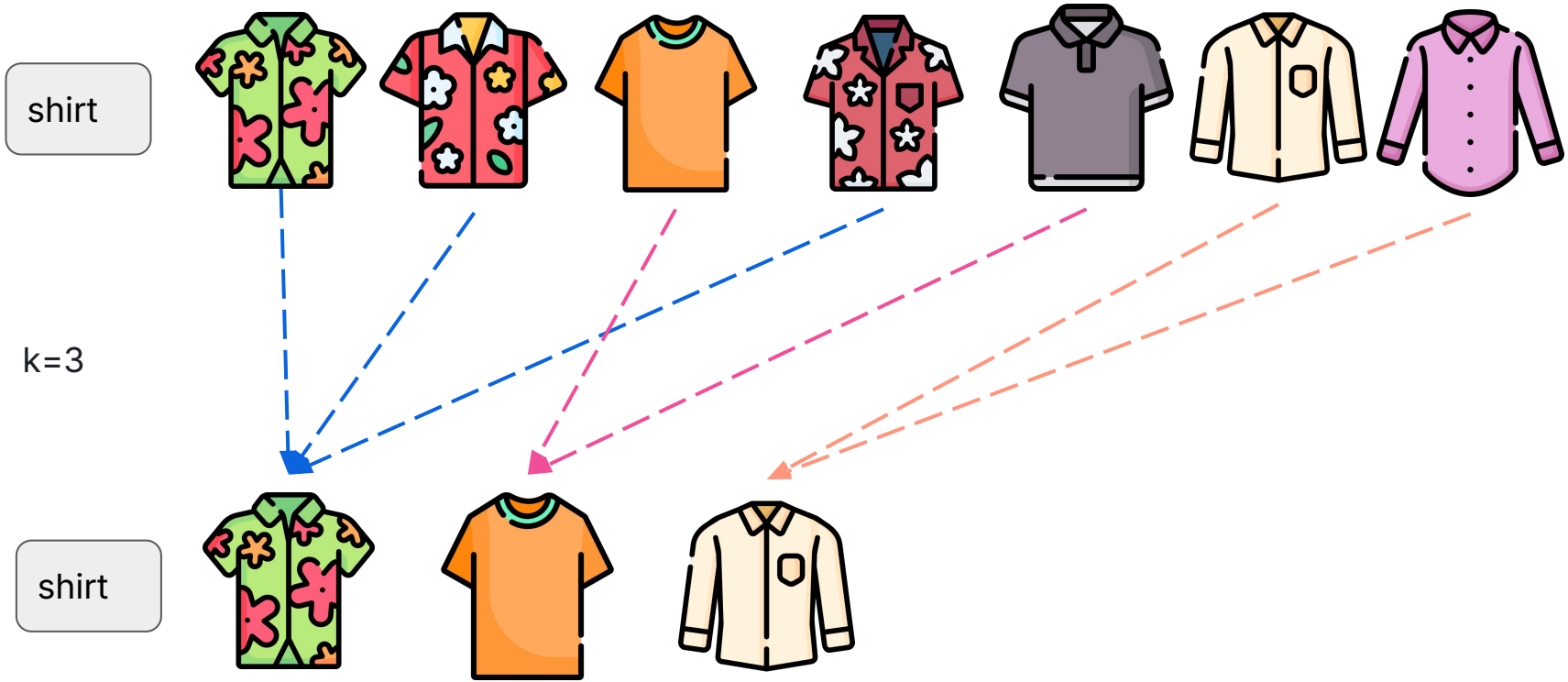
How can we achieve it?

Approach 1: collapse, group_by, etc.



Approach 2: kmeans aka. “semantic grouping”



Approach 3: Maximum Marginal Relevance

shirt

shirt

Maximum Marginal Relevance

High Level Definition

MMR is an iterative algorithm that selects for each position how similar the current document is to the user query and how dissimilar to the already selected results.

Maximum Marginal Relevance

$$MMR^{def} = \arg \max_{D_i \in R \setminus S} \left[\lambda \cdot Sim_1(D_i, Q) - (1 - \lambda) \cdot \max_{D_j \in S} (Sim_2(D_i, D_j)) \right]$$

https://www.cs.cmu.edu/~jgc/publication/The_Use_MMR_Diversity_Based_LTMIR_1998.pdf

Maximum Marginal Relevance

shirt

0.91 0.88 0.85 0.83 0.82

$$= \arg\max_{D_i \in R \setminus S} \left[\lambda \cdot Sim_1(D_i, Q) - (1 - \lambda) \cdot \max_{D_j \in S}(Sim_2(D_i, D_j)) \right]$$

$$= \arg\max_{D_i \in R \setminus S} \left[\lambda \cdot Sim_1(D_i, Q) - (1 - \lambda) \cdot \max_{D_j \in S}(Sim_2(D_i, D_j)) \right]$$

$$= \arg\max_{D_i \in R \setminus S} \left[\lambda \cdot Sim_1(D_i, Q) - (1 - \lambda) \cdot \max_{D_j \in S}(Sim_2(D_i, D_j)) \right]$$

Maximum Marginal Relevance

shirt

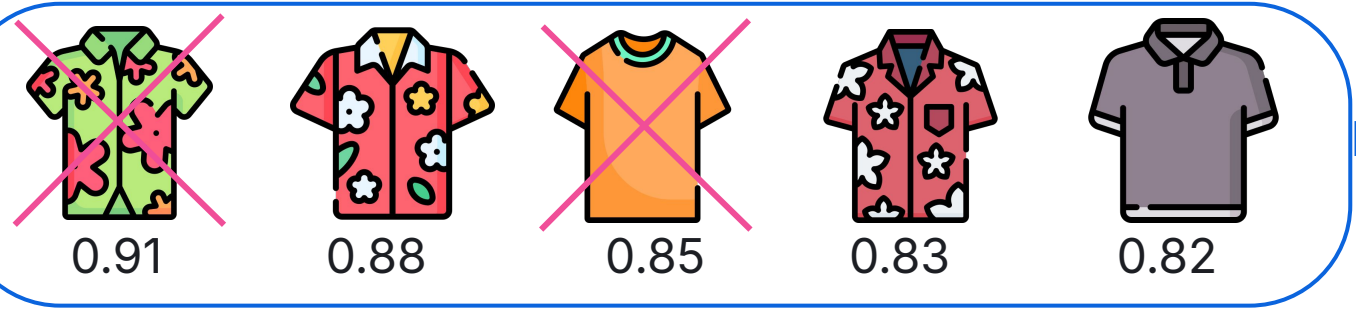
0.91 0.88 0.85 0.83 0.82

Results (R)

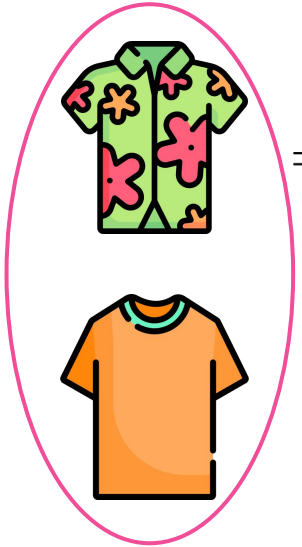
$$= \arg \max_{D_i \in R \setminus S} \left[\lambda \cdot Sim_1(D_i, Q) - (1 - \lambda) \cdot \max_{D_j \in S} (Sim_2(D_i, D_j)) \right]$$

Maximum Marginal Relevance: **Similarity Function**

shirt



S



$$= \arg \max_{D_i \in R \setminus S} \left[\lambda \cdot Sim_1(D_i, Q) - (1 - \lambda) \cdot \max_{D_j \in S} (Sim_2(D_i, D_j)) \right]$$

Candidates for position 3 (D_i)

Maximum Marginal Relevance: **Similarity Function**

Q shirt

$$\lambda \cdot Sim_1(D_i, Q) - (1 - \lambda) \cdot \max_{D_j \in S}(Sim_2(D_i, D_j))$$

0.5 * 0.88
- 0.5 * max(0.95, 0.70)
=-0.035

0.5 * 0.83 -
0.5 * max(0.85, 0.70)
=-0.01

0.5 * 0.82 -
0.5 * max(0.60, 0.70)
=0.06

Maximum Marginal Relevance: Similarity Function

What is Sim()

Sim() can be any numerical value that we would like:

- Ranking model
- Document property
- BM25 or TF/IDF
- **Vector Similarity**

Maximum Marginal Relevance: **Max Dissimilarity Function**

Selected (S) = 

$$\lambda \cdot Sim_1(D_i, Q) - (1 - \lambda) \cdot \max_{D_j \in S}(Sim_2(D_i, D_j))$$

0.5 * 0.88 -
0.5 * max(0.95, 0.70)
=-0.035

0.5 * 0.83 -
0.5 * max(0.85, 0.70)
=-0.01

0.5 * 0.82 -
0.5 * max(0.60, 0.70)
=0.06

Maximum Marginal Relevance: **Lambda Parameter**

$$\lambda \cdot Sim_1(D_i, Q) - (1 - \lambda) \cdot \max_{D_j \in S}(Sim_2(D_i, D_j))$$

0.5 * 0.88 -
0.5 * max(0.95, 0.70)
=-0.035

0.5 * 0.83 -
0.5 * max(0.85, 0.70)
=-0.01

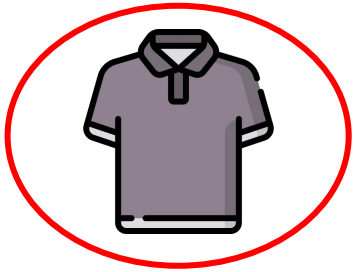
0.5 * 0.82 -
0.5 * max(0.60, 0.70)
=0.06

Maximum Marginal Relevance: **Selected Result**

$$= \arg \max_{D_i \in R \setminus S} \left[\lambda \cdot Sim_1(D_i, Q) - (1 - \lambda) \cdot \max_{D_j \in S} (Sim_2(D_i, D_j)) \right]$$

0.5 * 0.88 -
0.5 * max(0.95, 0.70)
=-0.035

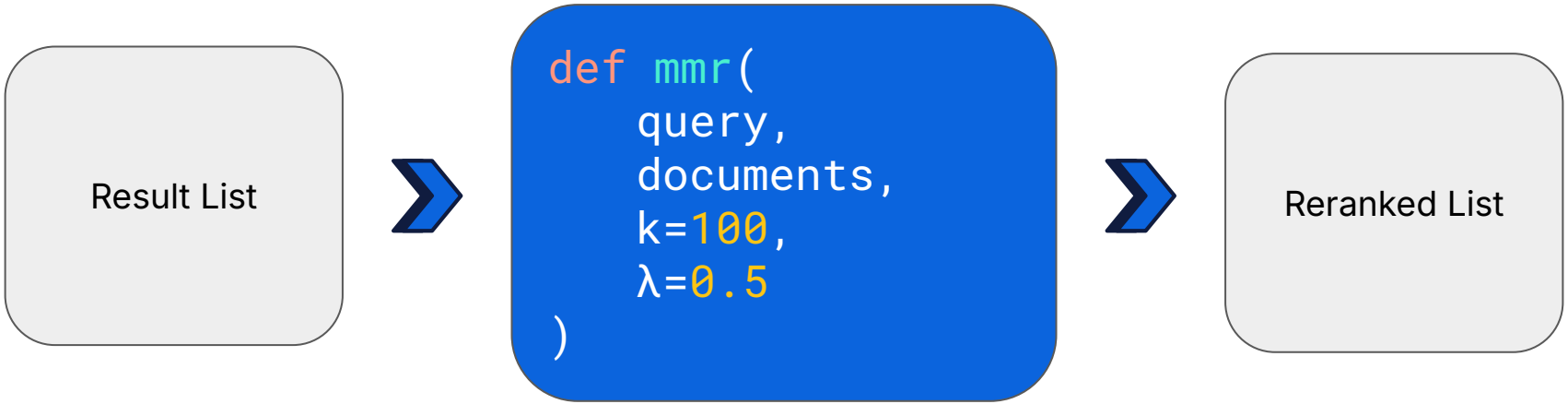
0.5 * 0.83 -
0.5 * max(0.85, 0.70)
=-0.01



0.5 * 0.82 -
0.5 * max(0.60, 0.70)
=0.06

Maximum Marginal Relevance

What do I need to know?



Remember: λ=1.0 ⇒ Relevancy, λ=0.0 ⇒ Diversity

Pants

Pure Relevance

ID: 9785
Urban Yoga Women Summer B...
Track Pants - Navy Blue
Score: 0.862

ID: 7128
Urban Yoga Women Bottom B...
Track Pants - Black
Score: 0.861

ID: 19242
Puma Women Grey Capri Pan...
Capris - Grey
Score: 0.858

ID: 3921
Urban Yoga Men's Bottom B...
Track Pants - Black
Score: 0.857

ID: 52529
Pepe Jeans Men Grey 3/4 L...
Shorts - Grey
Score: 0.856

ID: 4826
ADIDAS Men's Woven Dark N...
Track Pants - Navy Blue
Score: 0.855

ID: 44664
Wills Lifestyle Women Cha...
Trousers - Charcoal
Score: 0.854

ID: 7133
Urban Yoga Men Bottom Gre...
Track Pants - Grey
Score: 0.854

ID: 43522
French Connection Women N...
Trousers - Navy Blue
Score: 0.854

ID: 18869
Puma Women Black Core Tra...
Track Pants - Black
Score: 0.854

MMR(λ=0.5)

ID: 9785
Urban Yoga Women Summer B...
Track Pants - Navy Blue
Score: 0.862

ID: 41163
Allen Solly Woman Khaki T...
Trousers - Khaki
Score: 0.839

ID: 13255
Palm Tree Kids Boys Check...
Shorts - White
Score: 0.835

ID: 4774
ADIDAS Women 3S Pink Trac...
Track Pants - Pink
Score: 0.837

ID: 52529
Pepe Jeans Men Grey 3/4 L...
Shorts - Grey
Score: 0.856

ID: 22466
Myntra Women Cream Patial...
Leggings - Cream
Score: 0.836

ID: 44906
Puma Men White 3/4 Length...
Shorts - White
Score: 0.853

ID: 32406
Arrow Woman Black Trouser...
Trousers - Black
Score: 0.853

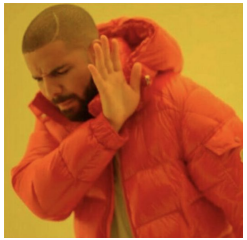
ID: 57824
United Colors of Benetton...
Trousers - Green
Score: 0.842

ID: 30919
Fabindia Women Pink Harem...
Trousers - Pink
Score: 0.840

Is this always a good idea?

It’s about **user intent**

Pixel 10 pro	<KNOWN_ITEM>
Sneakers	<EXPLORATION>
Present for moms birthday?	<INSPIRATIONAL>



OTTO classifiers: https://youtu.be/g6NQwYbLzP4?si=SmfgJU8eP6Lv-RLC&t=696

It’s about **performance**

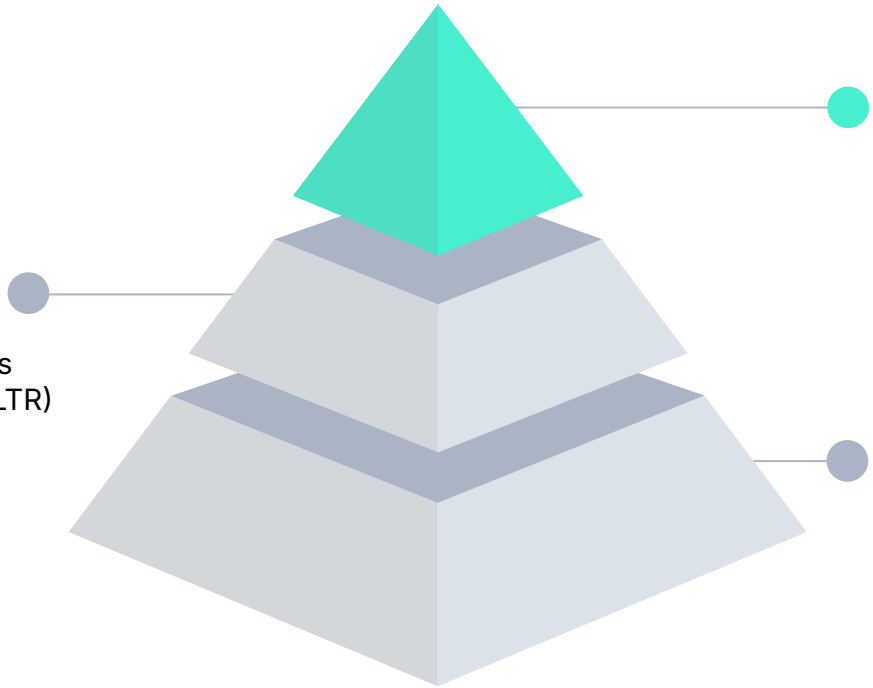
Resources

Late stage reranking
HUNDREDS

- Semantic ReRanking
- Multi-Vector Rescore
- **MMR rescoring**

Fine tuning
THOUSANDS

- Query Rules
- Query Rescorers
- Algorithm Rerankers
- Learning To Rank (LTR)

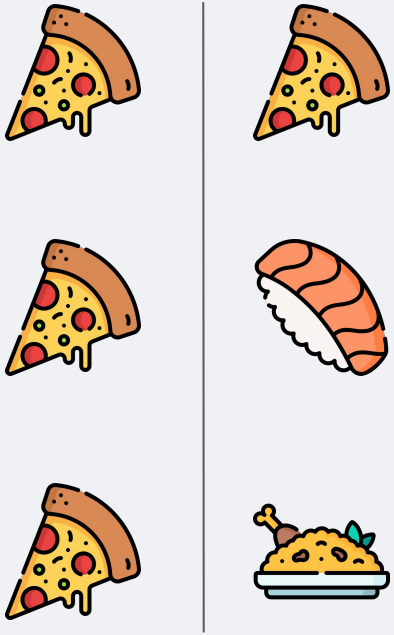


Retrieval
BILLIONS+

- Lexical Search / BM25
- Vector
- Rank Features

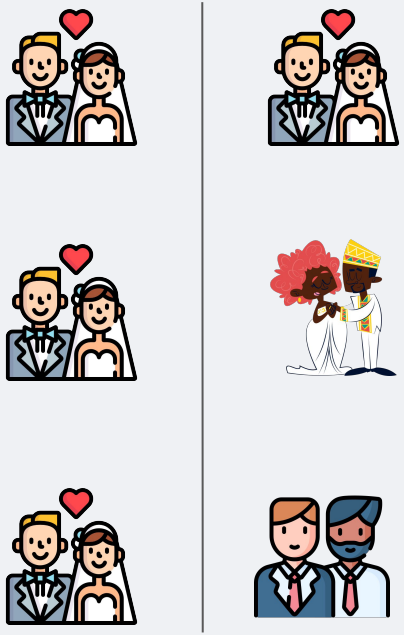
Improve answer quality of RAG applications

Where should I eat?

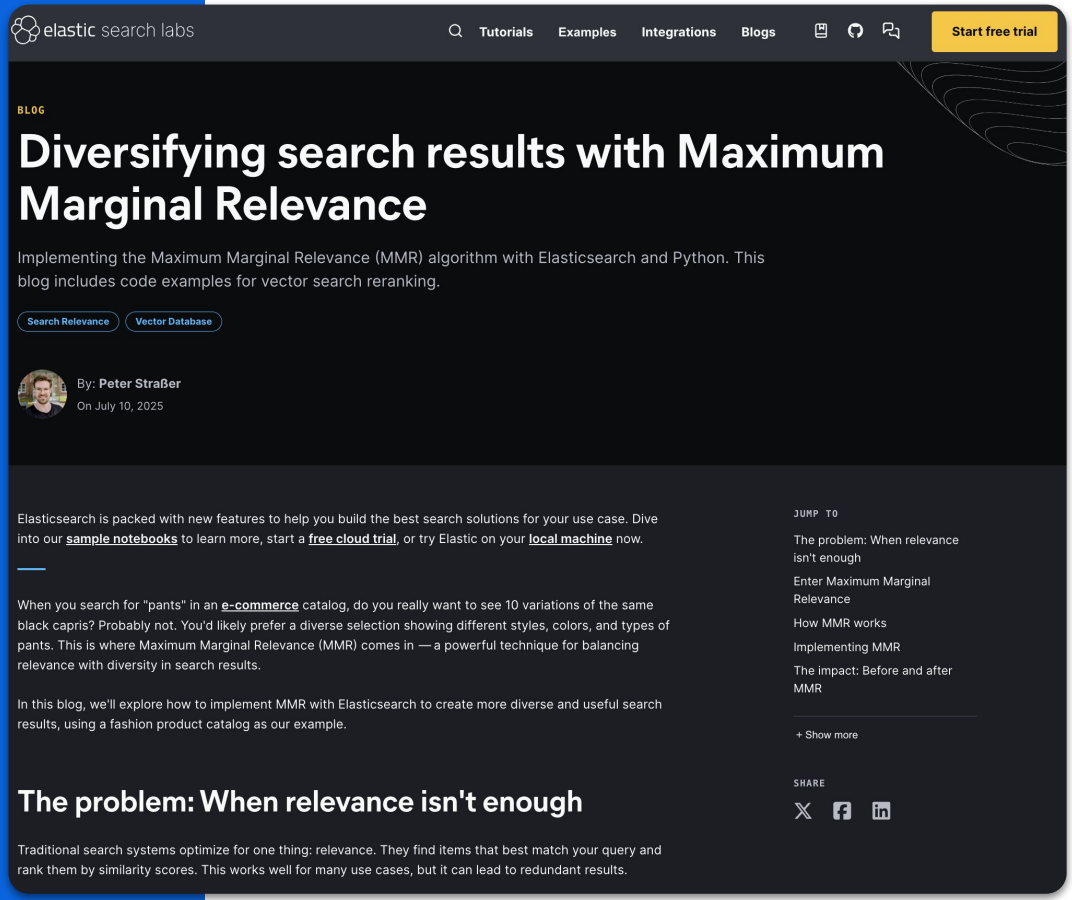


Vacation ideas?

Wedding ceremony?



Want to **learn more?**



https://www.elastic.co/search-labs/blog/maximum-marginal-relevance-diversify-results

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Thank you!