elastic

Search & AI:
a new era

David Pilato | @dadoonet

Agenda

- "Classic" search and its limitations
- ML model and usage
- Vector search or hybrid search in Elasticsearch
- OpenAI's ChatGPT or LLMs with Elasticsearch

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Elasticsearch

You Know, for Search

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Elasticsearch

Lucene

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> These are not the droids you are looking for.

```
GET /_analyze
{
  "char_filter": [ "html_strip" ],
  "tokenizer": "standard",
  "filter": [ "lowercase", "stop", "snowball" ],
  "text": "These are <em>not</em> the droids
           you are looking for."
}
```

These are not the **droids** **you** are **looking** for.


```
{ "tokens": [{
      "token": "droid",
      "start_offset": 27, "end_offset": 33,
      "type": "<ALPHANUM>", "position": 4
    },{
      "token": "you",
      "start_offset": 34, "end_offset": 37,
      "type": "<ALPHANUM>", "position": 5
    }, {
      "token": "look",
      "start_offset": 42, "end_offset": 49,
      "type": "<ALPHANUM>", "position": 7
    }]}
```

Semantic
search
≠
Literal
matches

TODAY

X-wing starfighter squadron

TOMORROW

What ships and crews do I need to destroy an almost finished death star?
Or is there a secret weakness?

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You Know, for Vector Search

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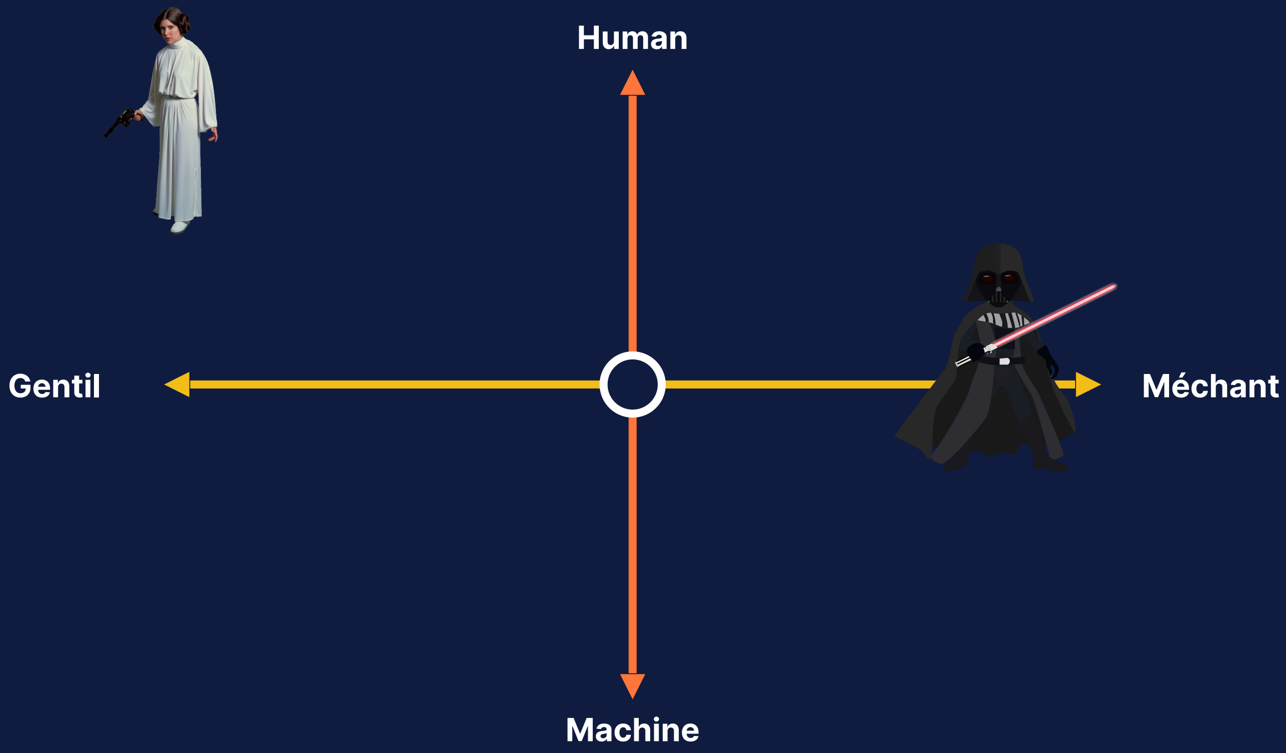
What is a **Vector**?

Embeddings represent your data

Example: 1-dimensional vector

Character	Vector
	[-1]
	[1]

Multiple dimensions
represent different data aspects



Character	Vector
	[-1, 1]
	[1, 0]

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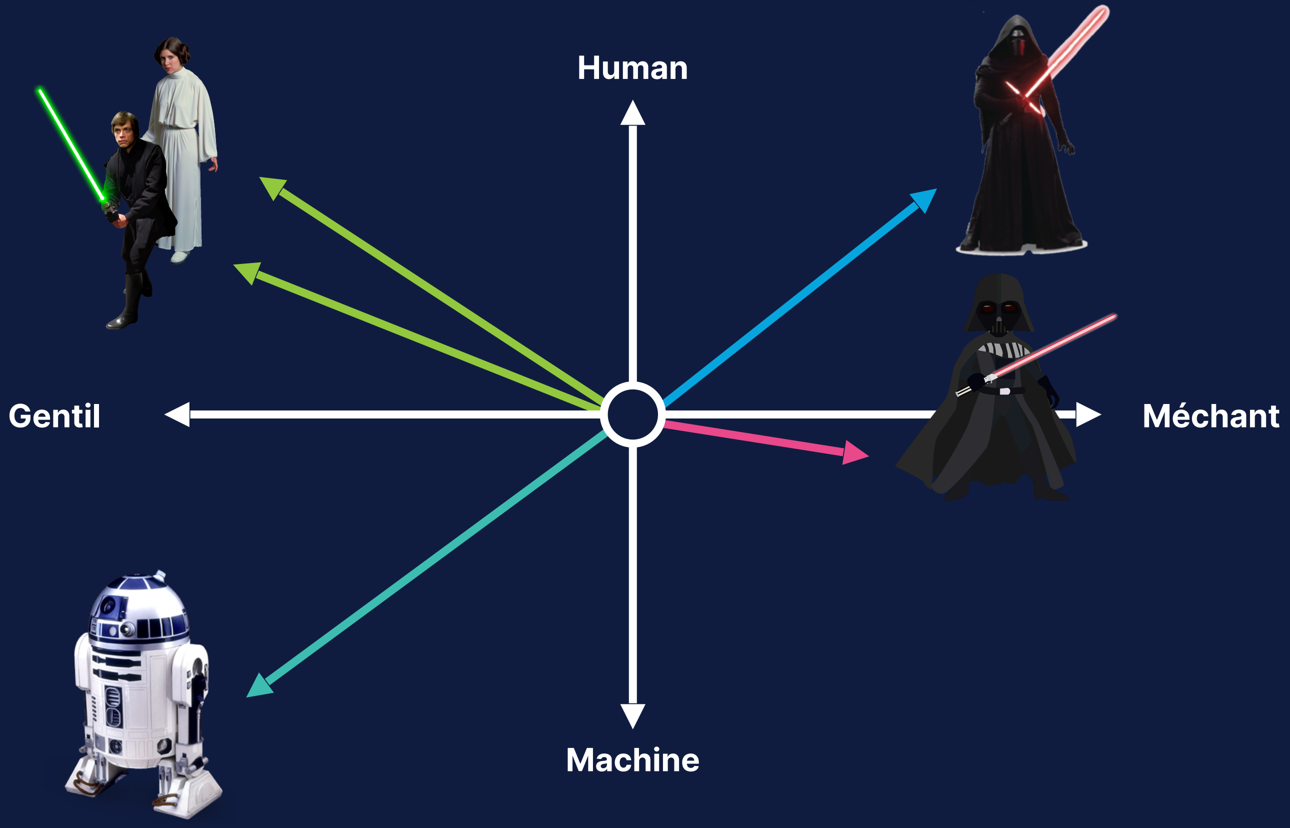
Similar data
is grouped together



Character	Vector
	[-1.0, 1.0]
	[1.0, 0.0]
	[-1.0, 0.8]
	[1.0, 1.0]
	[-1.0, -1.0]

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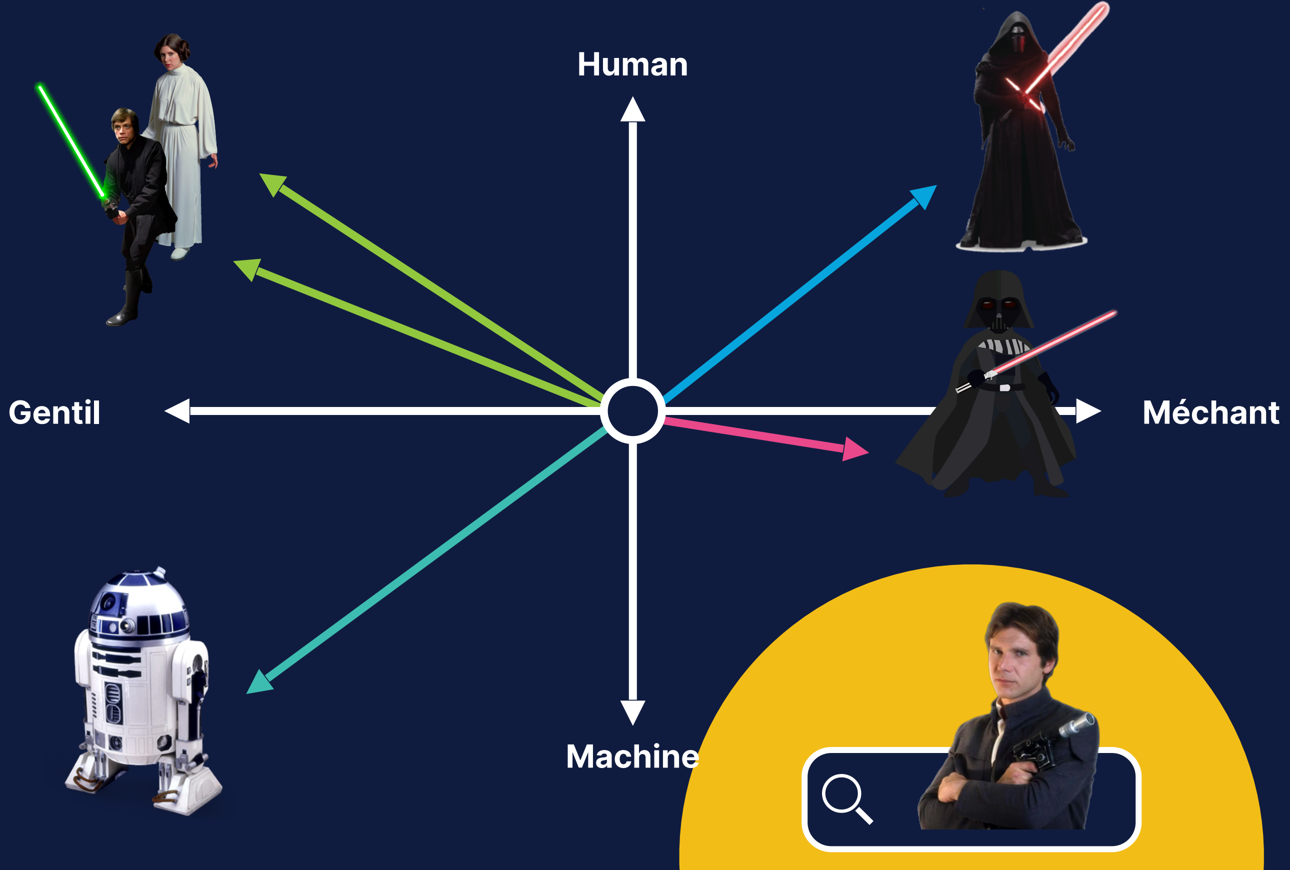
Vector search ranks objects
by similarity (~relevance) to the query



Rank	Result
Query	
1	
2	
3	
4	
5	

Choice of Embedding Model

Start with Off-the Shelf Models

- Text data: Hugging Face (like Microsoft's E5)
- Images: OpenAI’s CLIP

Extend to Higher Relevance

- Apply hybrid scoring
- Bring Your Own Model: requires expertise + labeled data

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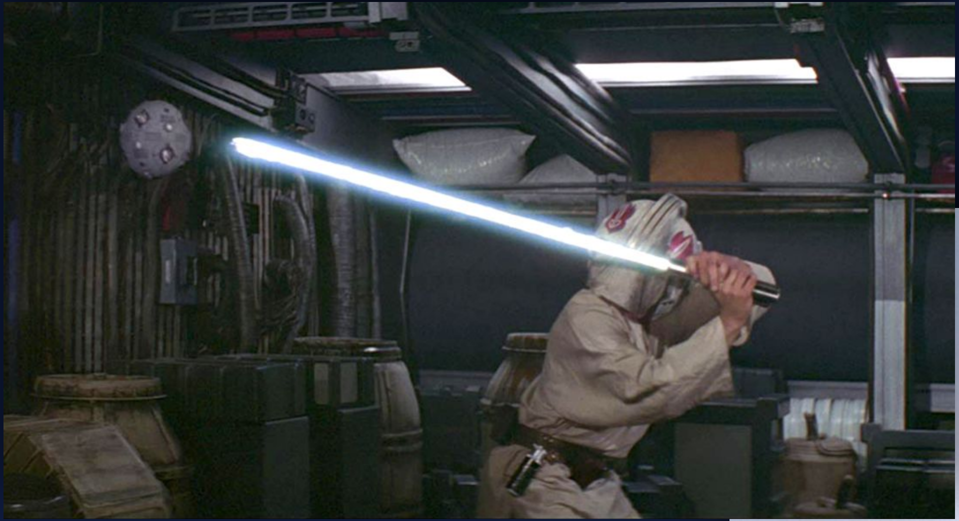
Problem

training vs actual use-case



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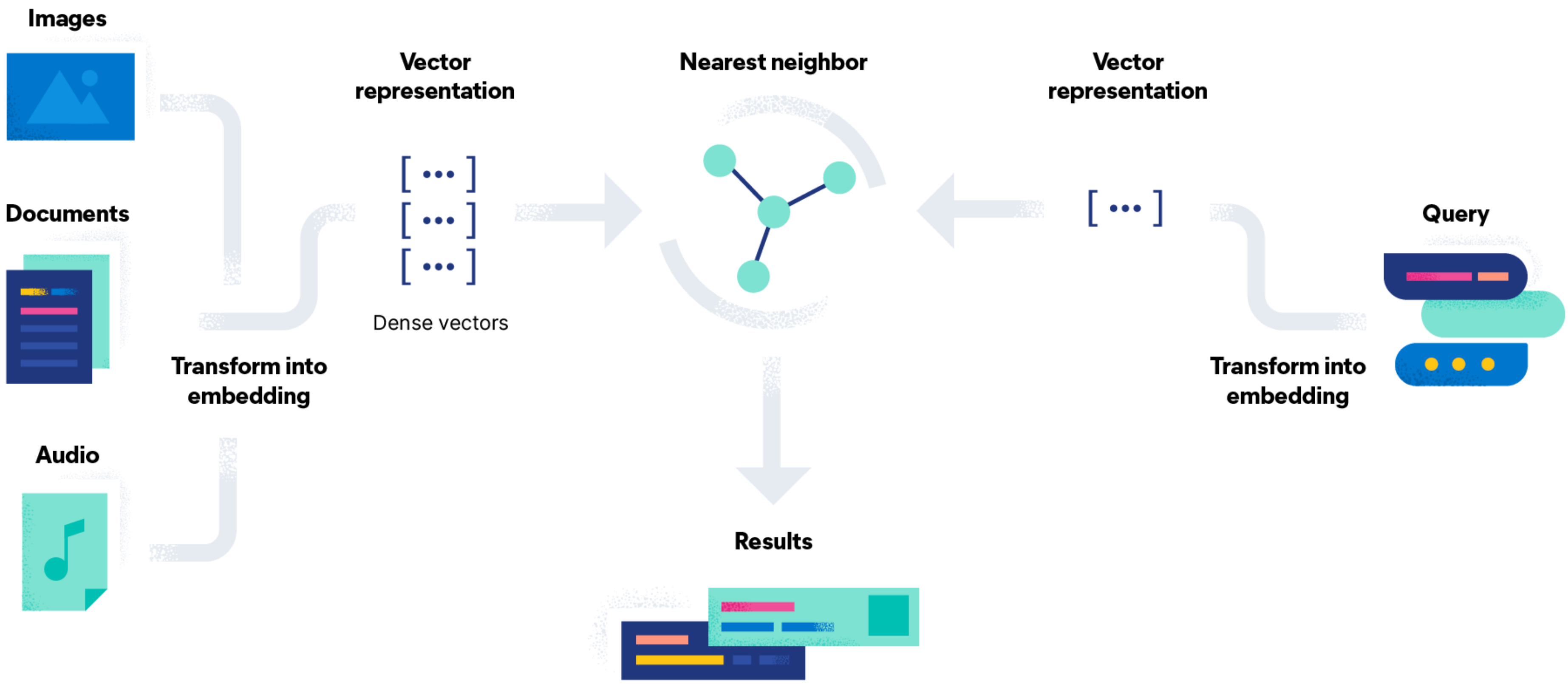
Architecture of Vector Search



How do you

index vectors?

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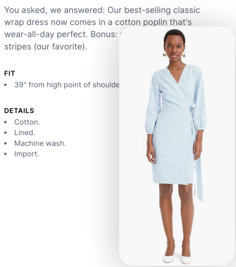
Data Ingestion and Embedding Generation



Source data

POST /_doc


```
{
  "_id":"product-1234",
  "product_name":"Summer Dress",
  "description":"Our best-selling…",
  "Price": 118,
  "color":"blue",
  "fabric":"cotton"
}
```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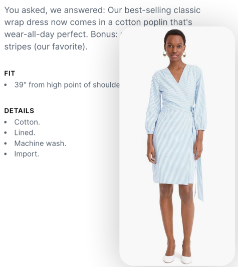
Data Ingestion and Embedding Generation



Source data

PyTorch

python™


```
{
  "_id":"product-1234",
  "product_name":"Summer Dress",
  "description":"Our best-selling…",
  "Price": 118,
  "color":"blue",
  "fabric":"cotton",
  "desc_embedding":[0.452,0.3242,…],
  "img_embedding":[0.012,0.0,…]
}
```


POST /_doc

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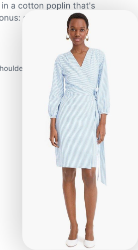
With Elastic ML

You asked, we answered: Our best-selling classic wrap dress now comes in a cotton poplin that's wear-all-day perfect. Bonus: stripes (our favorite).

FIT
- 39" from high point of shoulde

DETAILS
- Cotton.
- Lined.
- Machine wash.
- Import.



Source data

POST /_doc

ML Inference pipelines

Add inference pipeline

Inference pipelines will be run as processors from the Enterprise Search Ingest Pipeline

ml-inference-embedding-generation Actions

Deployed | pytorch | text_embedding

ml-inference-emational-analysis Actions

Deployed | pytorch | text_classification

Learn more about deploying ML models in Elastic


```
{
  "_id":"product-1234",
  "product_name":"Summer Dress",
  "description":"Our best-selling…",
  "Price": 118,
  "color":"blue",
  "fabric":"cotton",
  "desc_embedding":[0.452,0.3242,…]
}
```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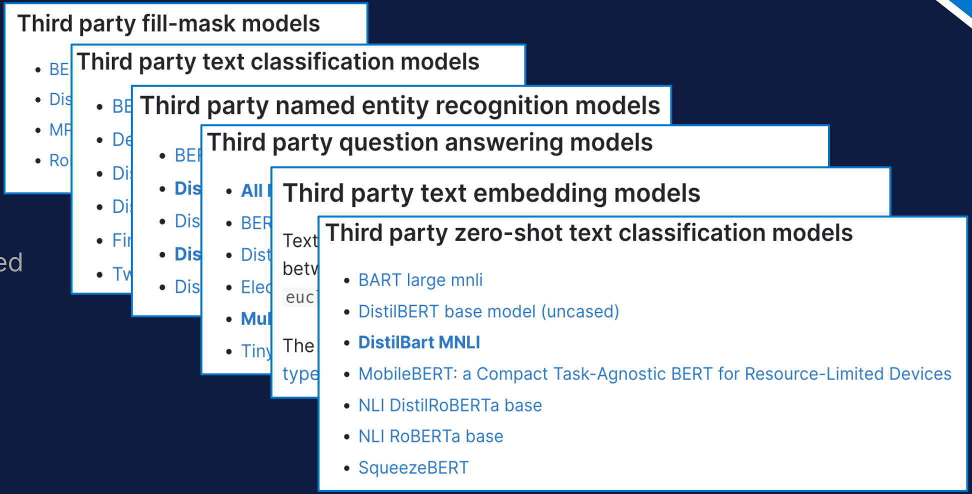
Elastic’s range of supported NLP models

- **Fill mask model**
  Mask some of the words in a sentence and predict words that replace masks
- **Named entity recognition model**
  NLP method that extracts information from text
- **Text embedding model**
  Represent individual words as numerical vectors in a predefined vector space
- **Text classification model**
  Assign a set of predefined categories to open-ended text
- **Question answering model**
  Model that can answer questions given some or no context
- **Zero-shot text classification model**
  Model trained on a set of labeled examples, that is able to classify previously unseen examples



Full list at: ela.st/nlp-supported-models

How do you

search vectors?

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Vector Query

summer clothes

PyTorch

python™

```
GET product-catalog/_search
{
 "query" : {
    "bool": {
      "must": [{
         "knn": {
           "field": "desc_embbeding",
           "num_candidates": 50,
           "query_vector": [0.123, 0.244,...]



         }
      }],
      "filter": {
        "term": {
          "department": "women"
        }
      }
    }
  },
  "size": 10
}
```

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Vector Query

Commercial

summer clothes

Transformer model

PyTorch

```
GET product-catalog/_search
{
 "query" : {
    "bool": {
      "must": [{
         "knn": {
           "field": "desc_embbeding",
           "num_candidates": 50,
           "query_vector_builder": {
             "text_embedding": {
               "model_text": "summer clothes",
               "model_id": <text-embedding-model>
             }
           }
         }
      }],
      "filter": {
        "term": {
          "department": "women"
        }
      }
    }
  },
  "size": 10
}
```

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But how does it

really work?

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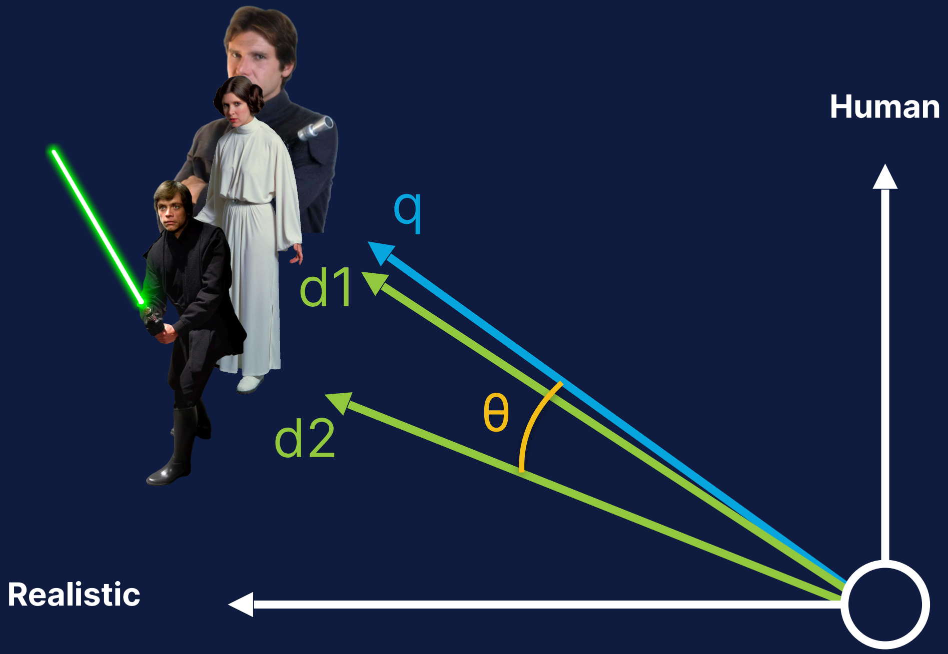
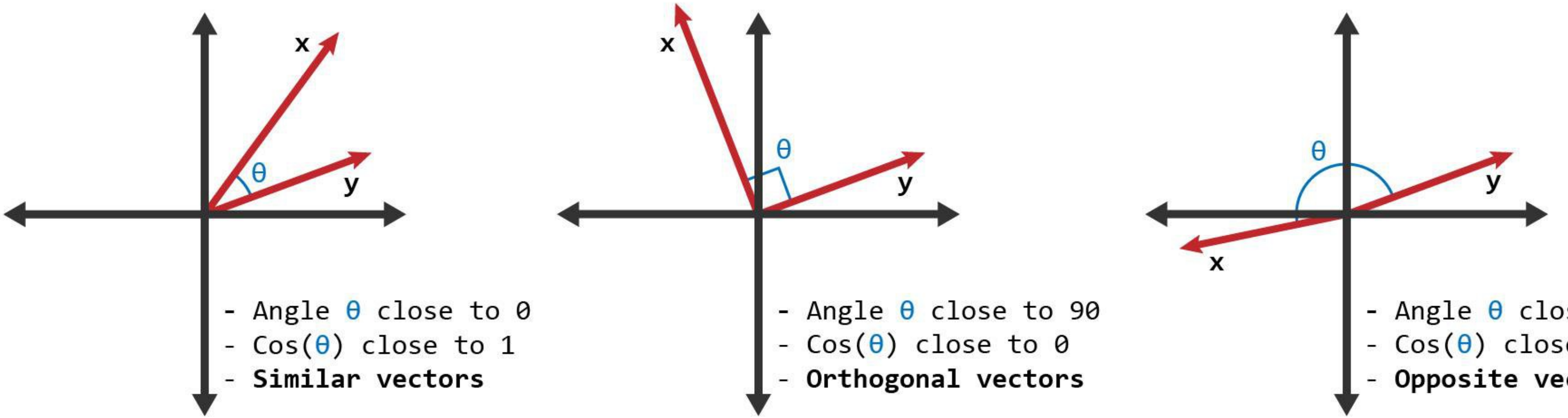
Similarity: cosine (cosine)



$$cos(\theta) = \frac{\vec{q} \times \vec{d}}{|\vec{q}| \times |\vec{d}|}$$

$$\_score = \frac{1 + cos(\theta)}{2}$$

Similarity: cosine (cosine)



$$\_score = \frac{1+1}{2} = 1$$

$$\_score = \frac{1+0}{2} = 0.5$$

$$\_score = \frac{1-1}{2} = 0$$

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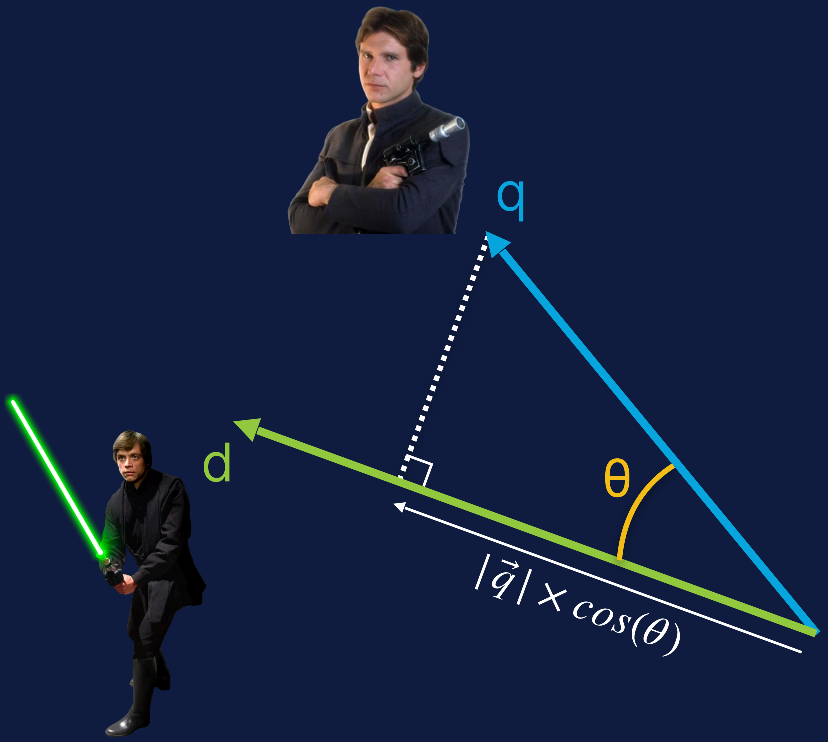
Similarity: Dot Product (dot_product)



$$\vec{q} \times \vec{d} = |\vec{q}| \times cos(\theta) \times |\vec{d}|$$

$$\_score_{float} = \frac{1 + dot\_product(q, d)}{2}$$

$$\_score_{byte} = \frac{0.5 + dot\_product(q, d)}{32768 \times dims}$$

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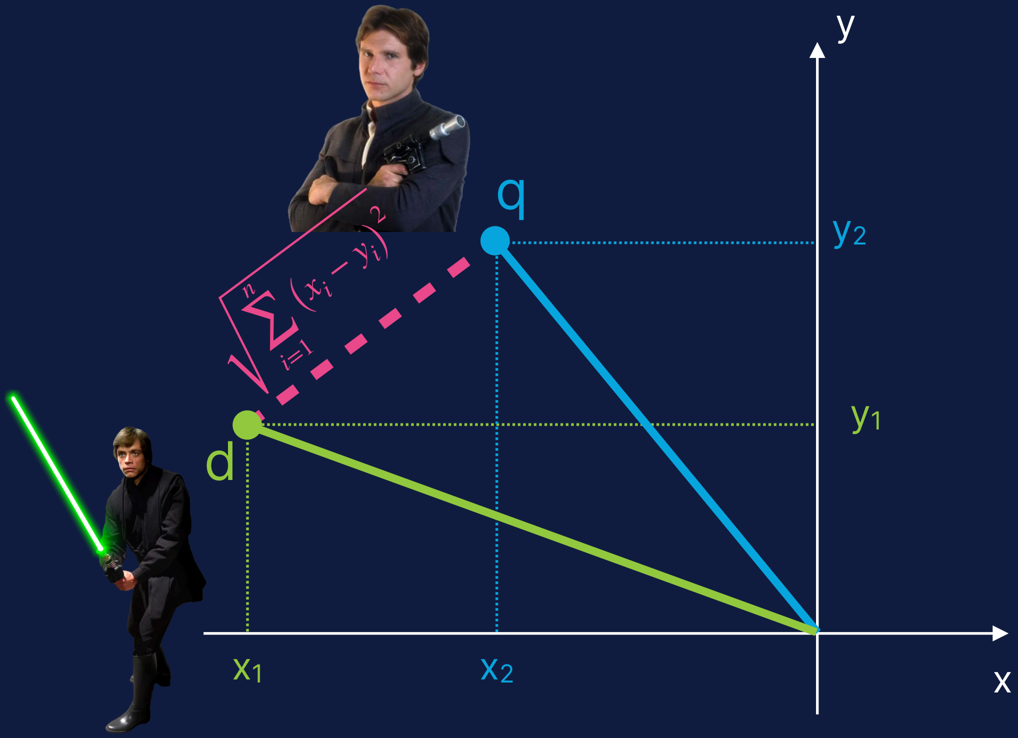
Similarity: Euclidean distance (l2_norm)



$$l2\_norm_{q,d} = \sqrt{\sum_{i=1}^{n} \left(x_i - y_i\right)^2}$$

$$\_score = \frac{1}{1 + (l2\_norm_{q,d})^2}$$

Brute Force

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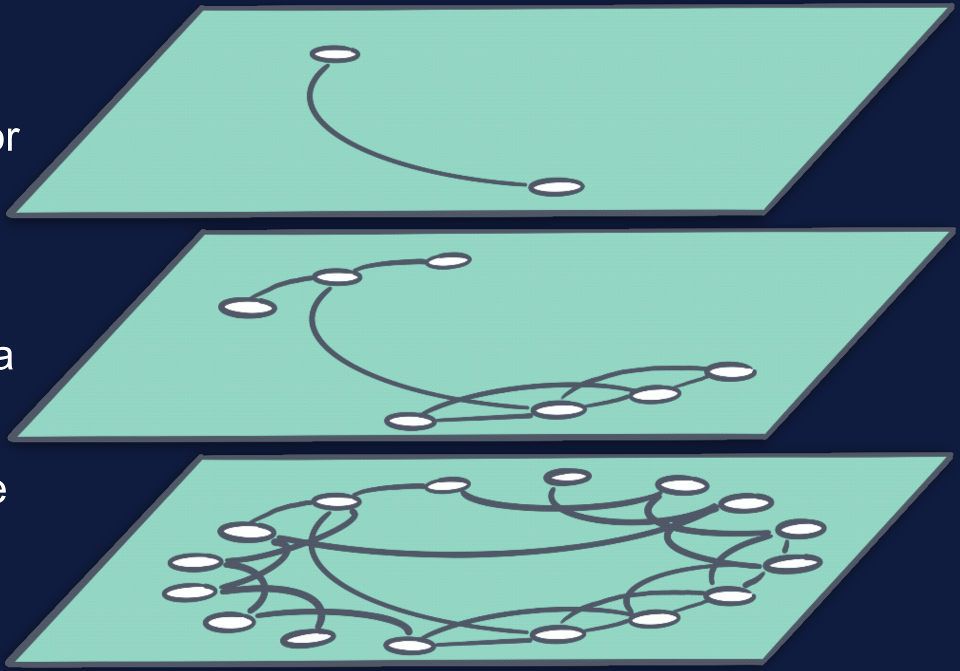
Hierarchical Navigable Small Worlds (HNSW)

One popular approach

- **HNSW:** a layered approach that simplifies access to the nearest neighbor
- **Tiered:** from coarse to fine approximation over a few steps
- **Balance:** Bartering a little accuracy for a lot of scalability
- **Speed:** Excellent query latency on large scale indices



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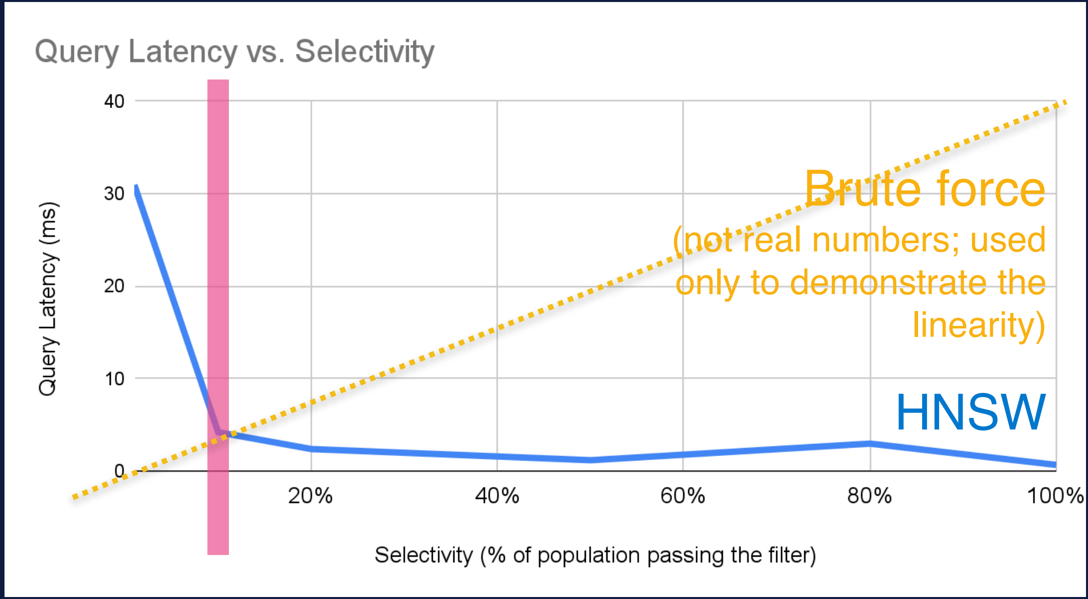
Filtering KNN Vector Similarity

Automatically choose between brute force and HNSW



Bound worst case to 2*(brute force)

- Brute force scales O(n) of filtered
- HNSW scales ~O(log(n)) of all docs

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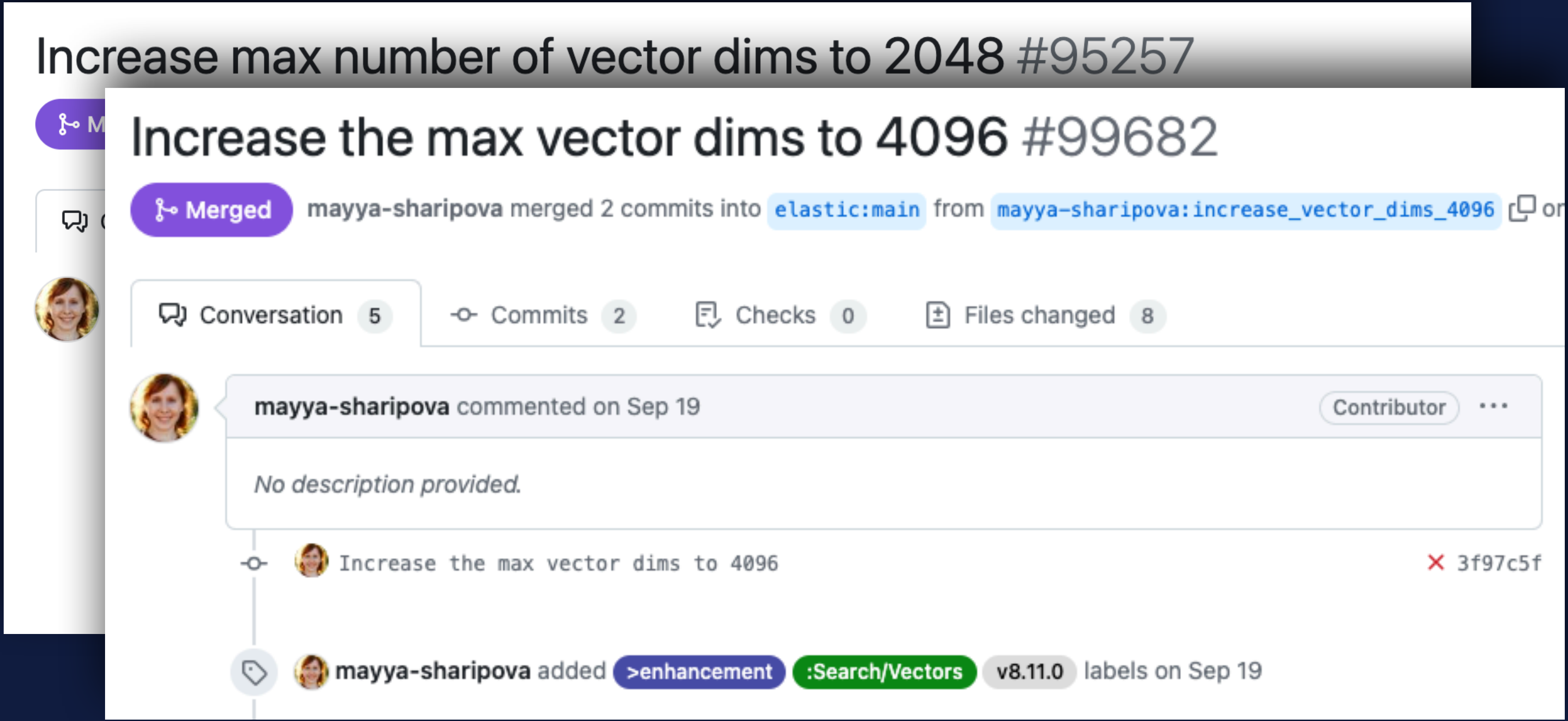
Elasticsearch + Lucene = fast progress ❤️



Scaling Vector Search

Vector search

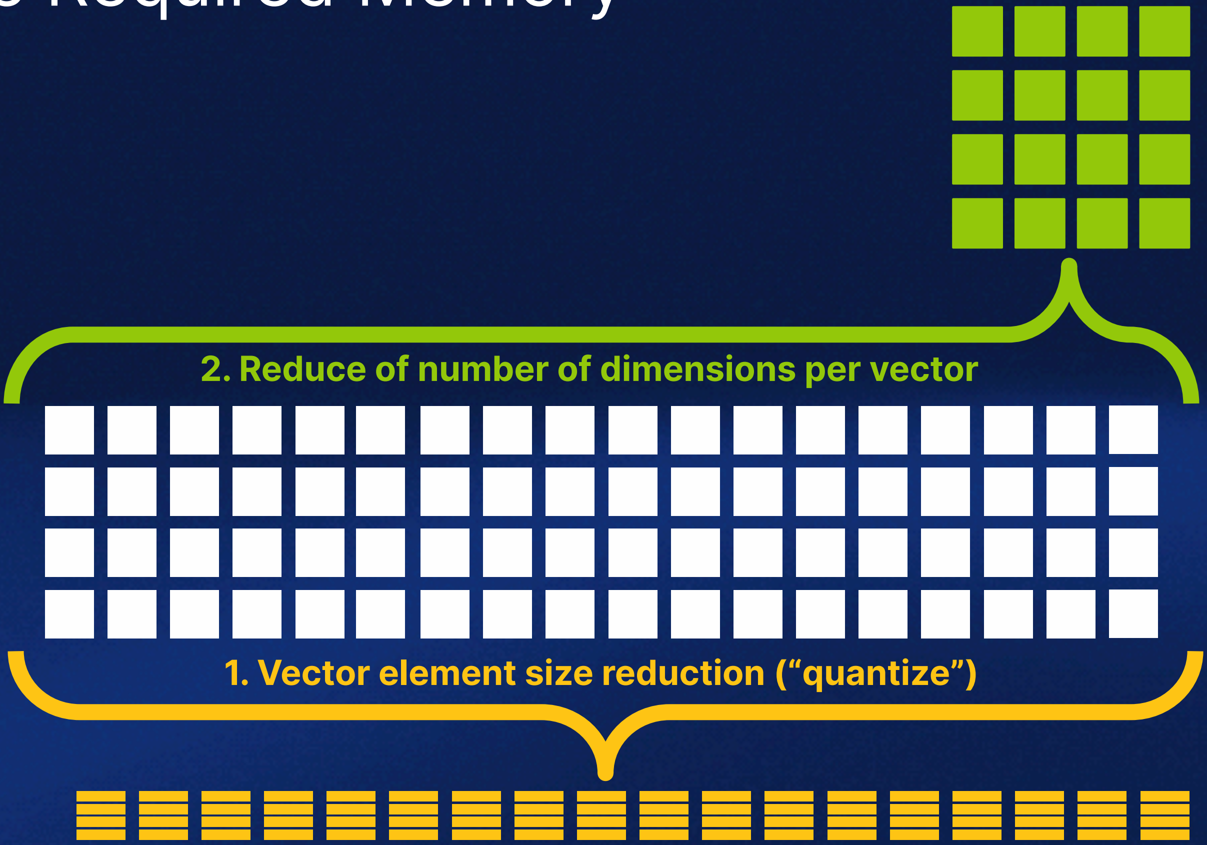
1. Needs lots of memory
2. Indexing is slower
3. Merging is slow

* Continuous improvements in Lucene + Elasticsearch

Best practices

1. Avoid searches during indexing
2. Exclude vectors from _source
3. Reduce vector dimensionality
4. Use byte rather than float

Reduce Required Memory



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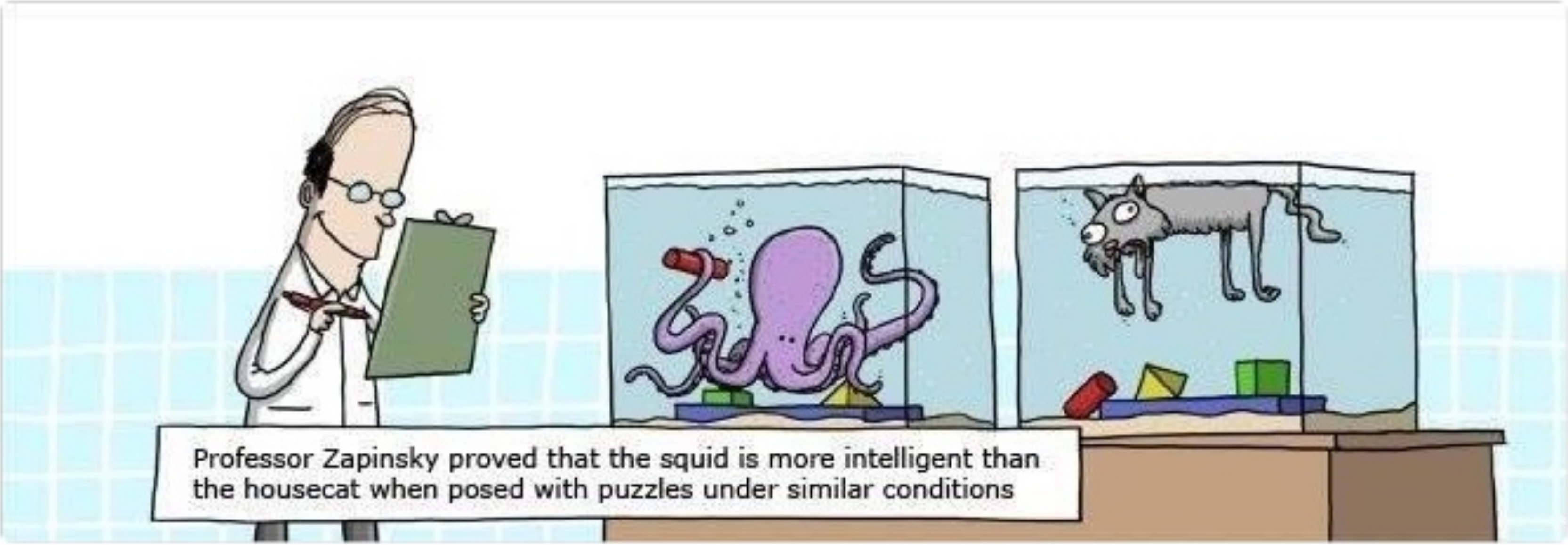
Benchmarketing



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You Know, for **Hybrid** Search

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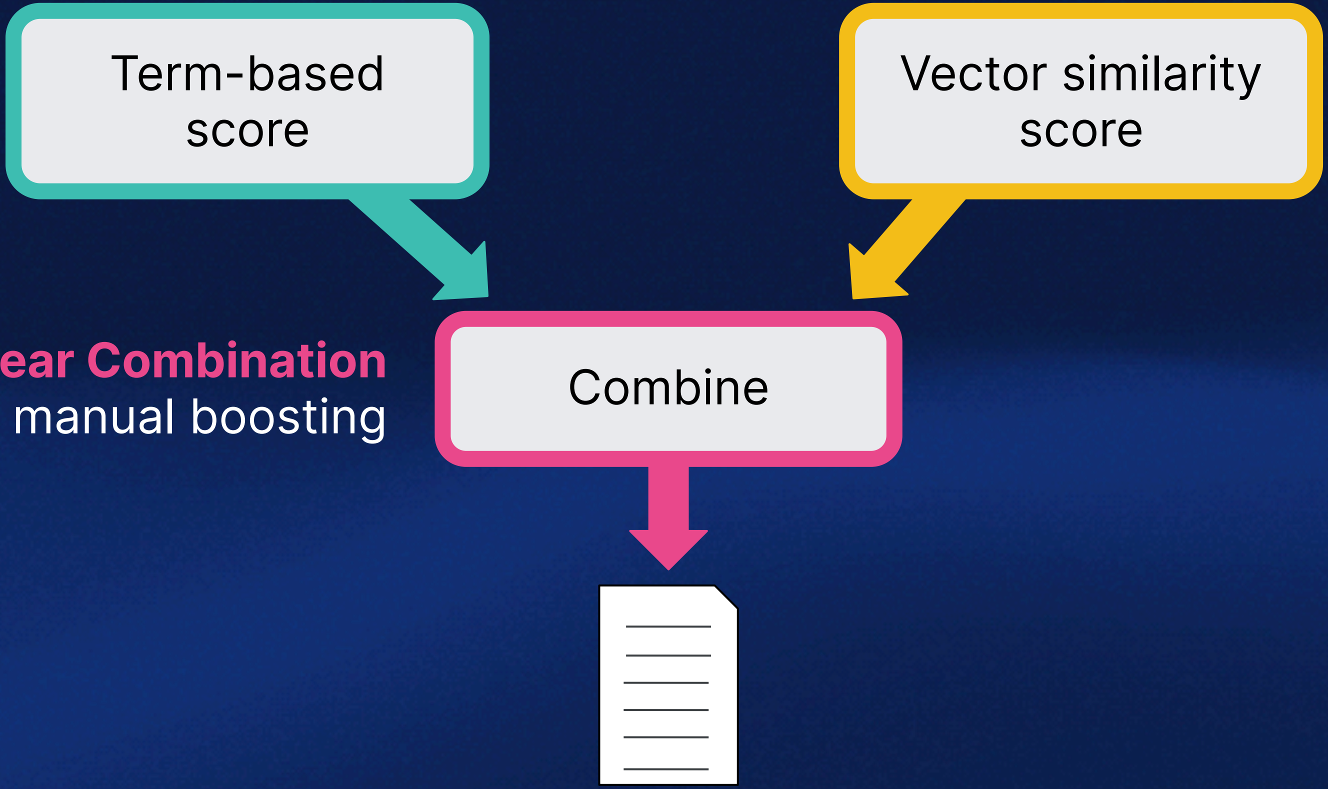
Hybrid scoring



Linear Combination
manual boosting

```
GET product-catalog/_search
{
  "query" : {
    "bool" : {
      "must" : [{
        "match": {
          "description": {
            "query": "summer clothes",
            "boost": 0.9
          }
        }
      },{
        "knn": {
          "field": "desc_embbeding",
          "query_vector": [0.123, 0.244,...],
          "num_candidates": 50,
          "boost": 0.1,
          "filter": {
            "term": {
              "department": "women"
            }
          }
        }
      }],
      "filter" : {
        "range" : { "price": { "lte": 30 } }
      }
    }
  }
}
```

summer clothes

pre-filter

post-filter

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```
GET product-catalog/_search
{
  "query" : {
    "bool" : {
      "must" : [{
        "match": {
          "description": {
            "query": "summer clothes",
            "boost": 0.9
          }
        }
      },{
        "knn": {
          "field": "image-vector",
          "query_vector": [54, 10, -2],
          "num_candidates": 50,
          "boost": 0.1
        }
      },{
        "knn": {
          "field": "title-vector",
          "query_vector": [1, 20, -52, 23, 10],
          "num_candidates": 10,
          "boost": 0.5
        }
      }]
    }
  }
}
```

https://djdadoo.pilato.fr/

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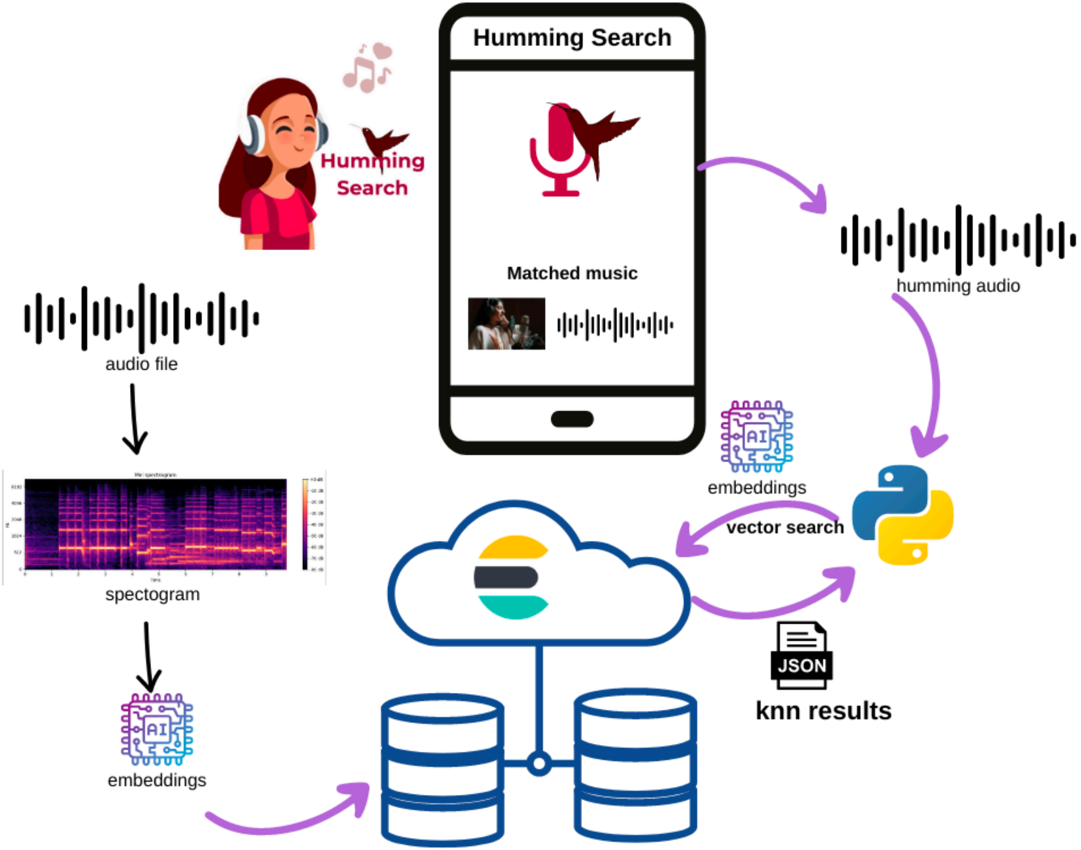

https://github.com/dadoonet/music-search/

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ChatGPT

Elastic and LLM


Gen AI
Search engines

LLM: opportunities and limits

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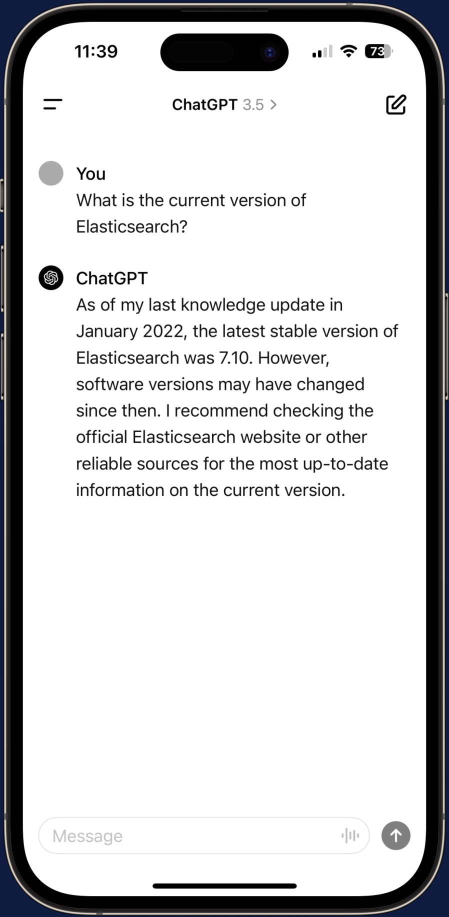
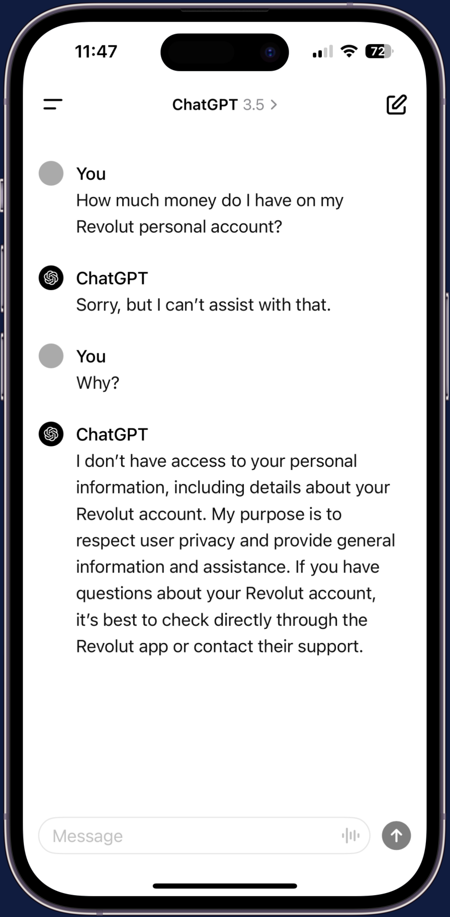

11:39
ChatGPT 3.5 >
You
What is the current version of Elasticsearch?
ChatGPT
As of my last knowledge update in January 2022, the latest stable version of Elasticsearch was 7.10. However, software versions may have changed since then. I recommend checking the official Elasticsearch website or other reliable sources for the most up-to-date information on the current version.
Message


11:47
ChatGPT 3.5 >
You
How much money do I have on my Revolut personal account?
ChatGPT
Sorry, but I can't assist with that.
You
Why?
ChatGPT
I don't have access to your personal information, including details about your Revolut account. My purpose is to respect user privacy and provide general information and assistance. If you have questions about your Revolut account, it's best to check directly through the Revolut app or contact their support.
Message

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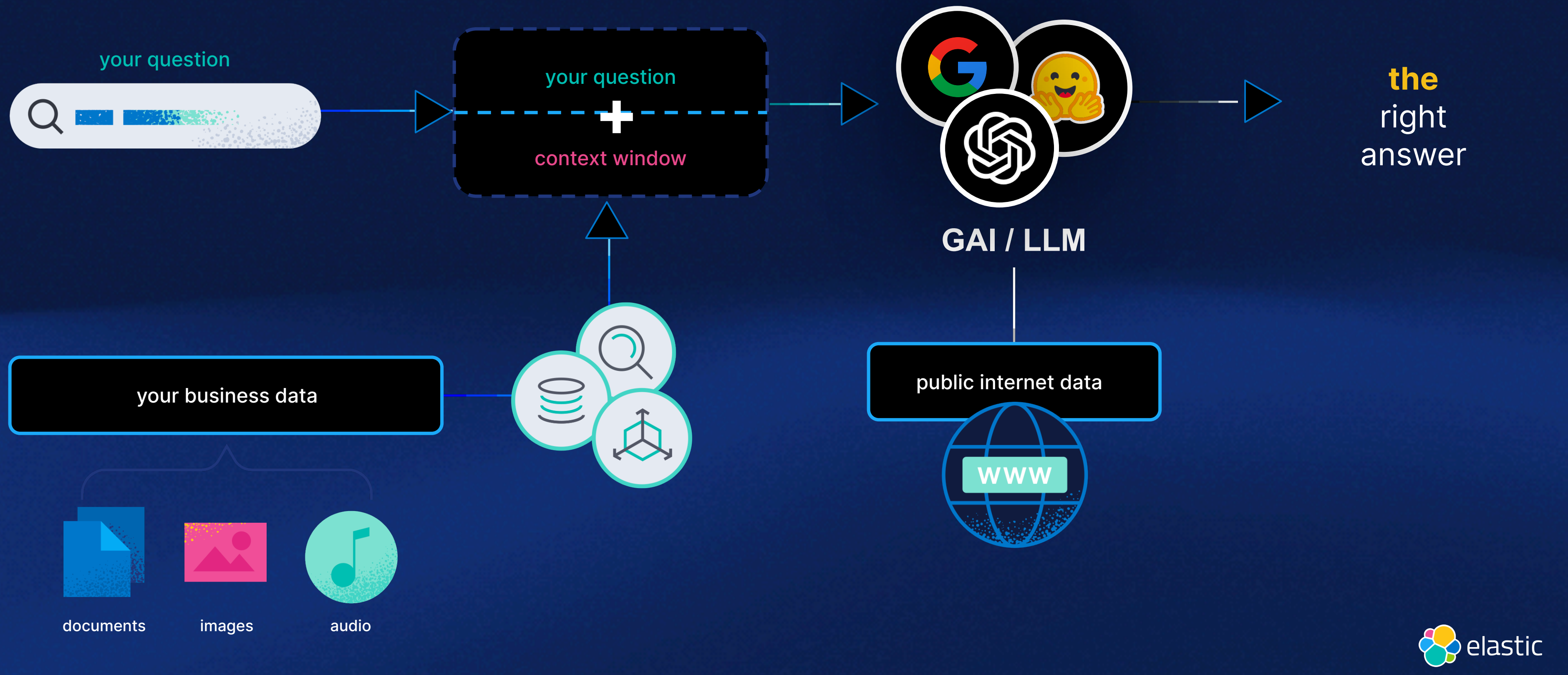
Retrieval Augmented Generation



11:47

ChatGPT 3.5 >

You
How much money do I have on my Revolut personal account?

ChatGPT
Sorry, but I can't assist with that.

You
Why?

ChatGPT
I don't have access to your personal information, including details about your Revolut account. My purpose is to respect user privacy and provide general information and assistance. If you have questions about your Revolut account, it's best to check directly through the Revolut app or contact their support.

Message

Home | Online banking | Enviroment setup

me | Transaction search | Financial summary | Customer support

Search your transactions:

This search is not enabled by Elastic and reflects the kind of functionality available to customers today.

Submit

Date	Account	Description	Value	Opening balance	Closing balance
18/06/24	EL03-130981-Transmission	Inbound payment made from EL03-130981-Transmission, St.james's Plac (STJ): 864dce1b-bb95-47d5-87dd-7d02f3b10c3f	7419.0	-825.0	6594.0
18/06/24	EL03-130981-Transmission	Purchase at merchant: Southeastern Grocers, LLC, location: Fayetteville,AR	82.0	6594.0	6512.0
18/06/24	EL03-130981-Transmission	Purchase at merchant: Müller Holding Ltd. & Co. KG, location: Glendale,AZ	188.0	6512.0	6324.0
17/06/24	EL03-130981-Transmission	Payment made from EL03-130981-Transmission to Elwood Erickson, Mitie Grp. (MTO): d37085fc-1382-4593-9cb8-26e5526bd9a0	533.0	20.0	-513.0
17/06/24	EL03-130981-Transmission	Payment made from EL03-130981-Transmission to Classie Johns, Barclays (BARC): 75b603a2-1c1b-45e9-a7ec-4a551bf98a8d	312.0	-513.0	-825.0
16/06/24	EL03-130981-Transmission	Purchase at merchant: E-MART Inc., location: Fayetteville,AR	31.0	51.0	20.0
14/06/24	EL03-130981-Transmission	Purchase at merchant: Dick's Sporting Goods, Inc., location: Montgomery,AL	182.0	329.0	147.0
14/06/24	EL03-130981-Transmission	Purchase at merchant: Valor Holdings Co., Ltd., location: Louisville,KY	96.0	147.0	51.0
13/06/24	EL03-130981-Transmission	Purchase at merchant: The Save Mart Companies, location:	34.0	363.0	329.0

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Elasticsearch

You Know, for **Semantic** Search

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Search & AI:
a new era

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