LA RECHERCHE À L'ÈRE DE L'IA

DAVID PILATO | @DADOONET

Agenda

Commercial

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

elastic

Elasticsearch

You Know, for Search

elastic

Elasticsearch

Lucene

elastic

> 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
    }]}
```


elastic

Semantic
search
≠
Literal
matches

Elasticsearch

You Know, for Search

elastic

Elasticsearch

You Know, for Vector Search

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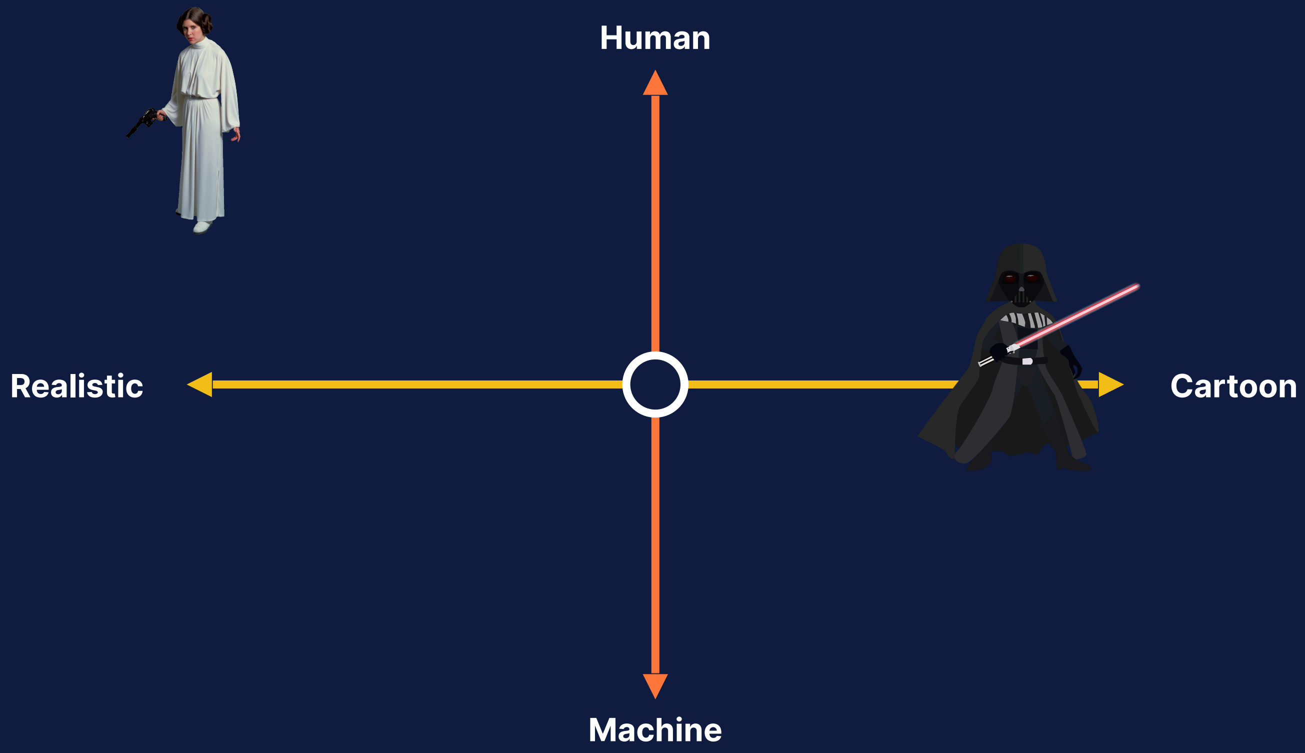
What is a **Vector**?

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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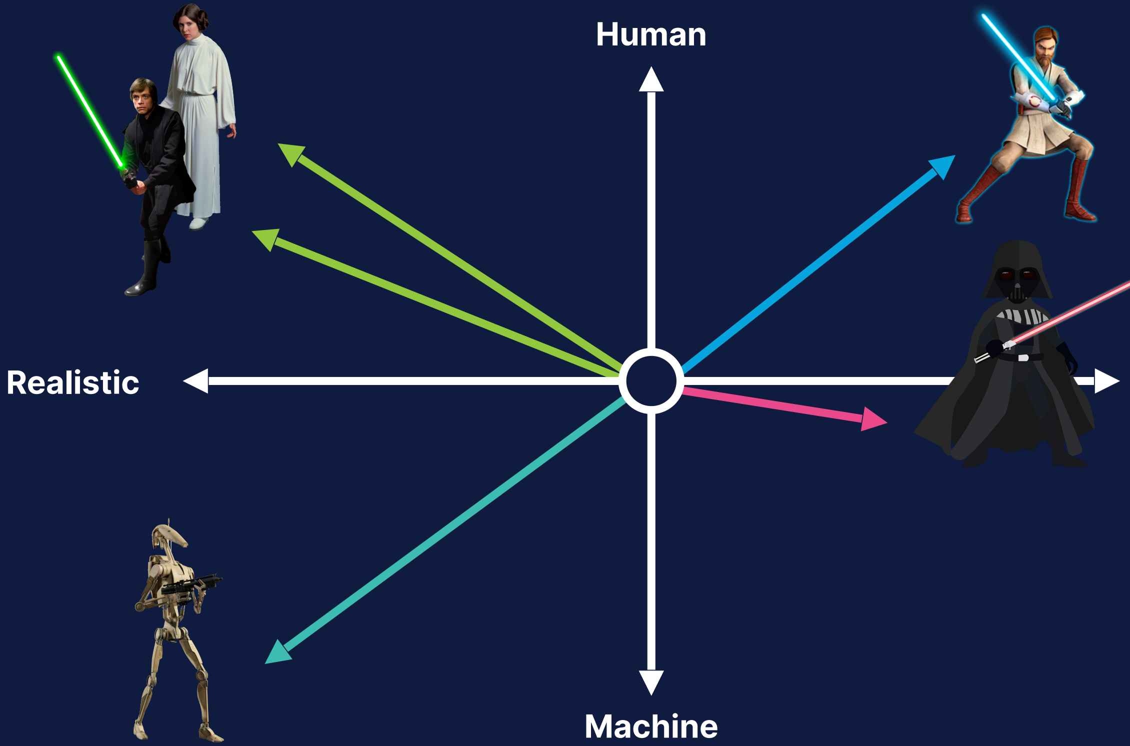
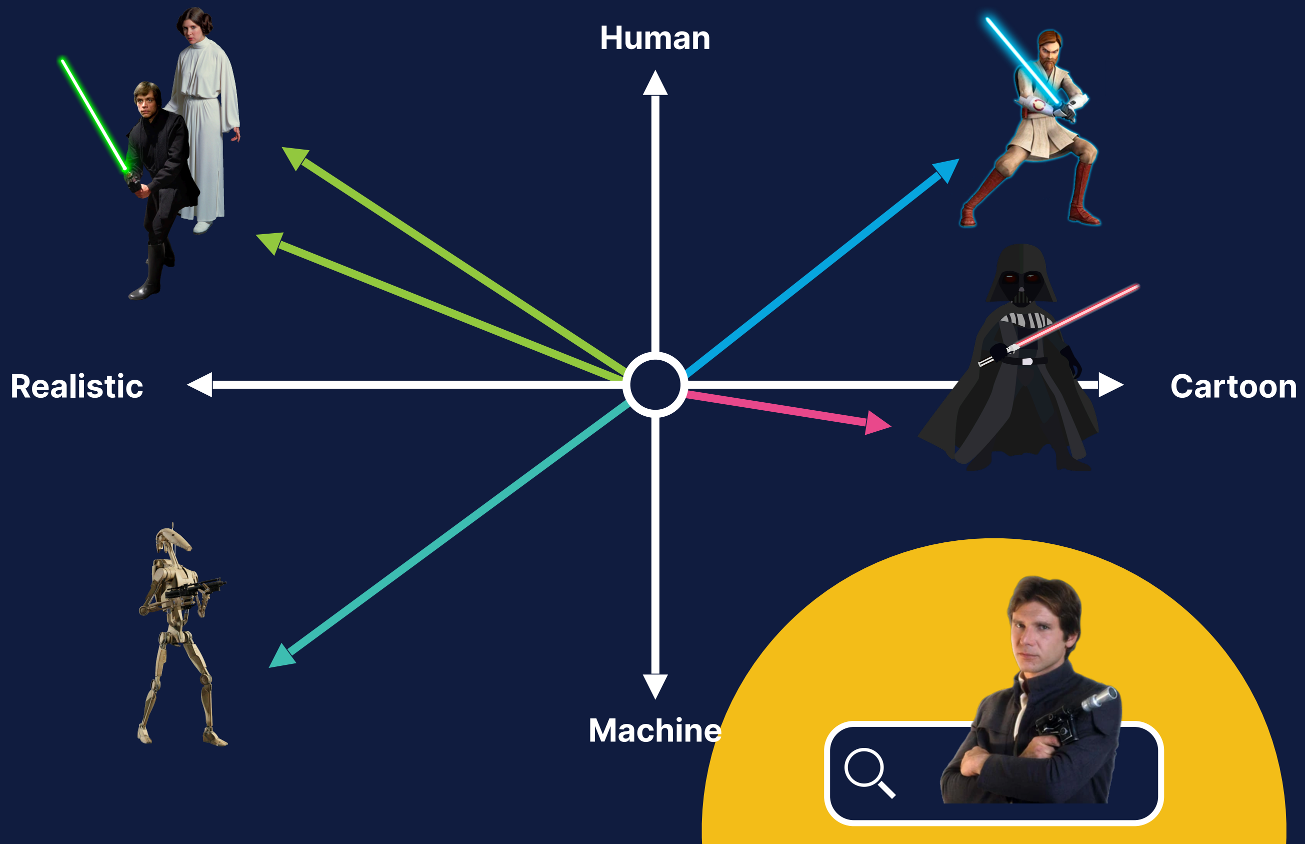
Similar data
is grouped together



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

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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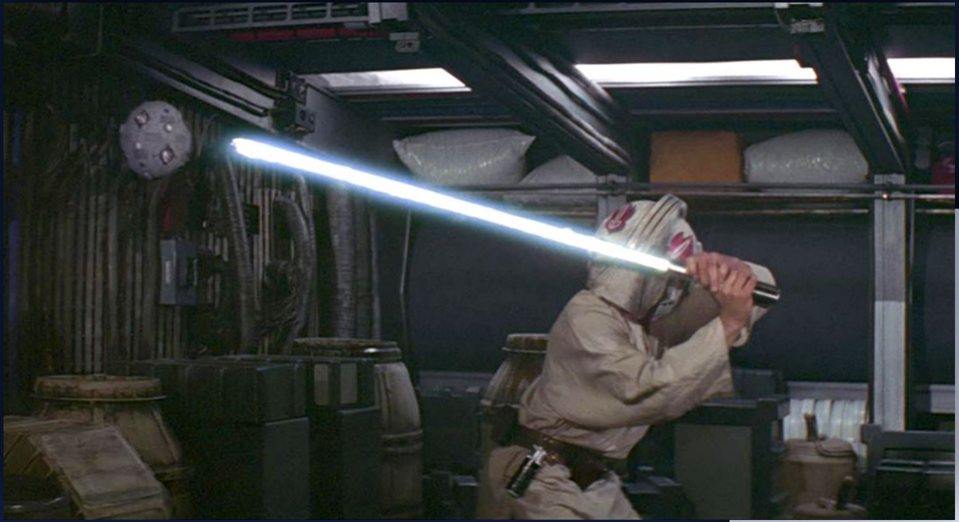
Problem

training vs actual use-case



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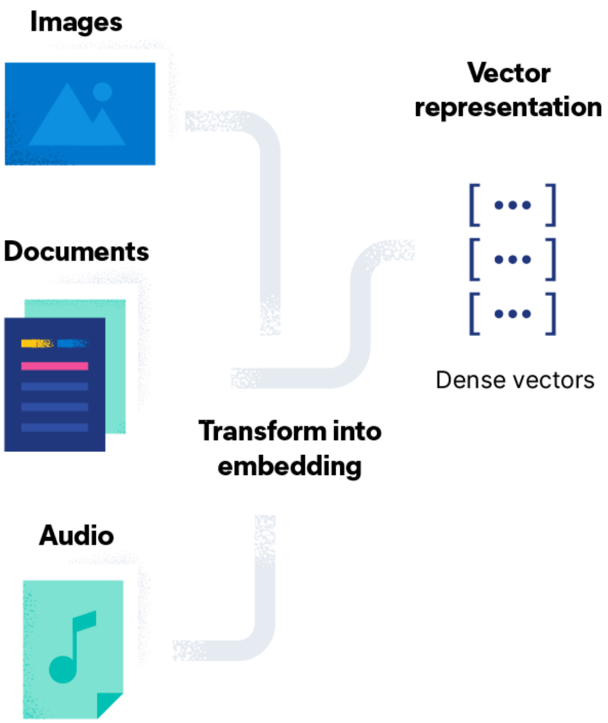
Architecture of Vector Search

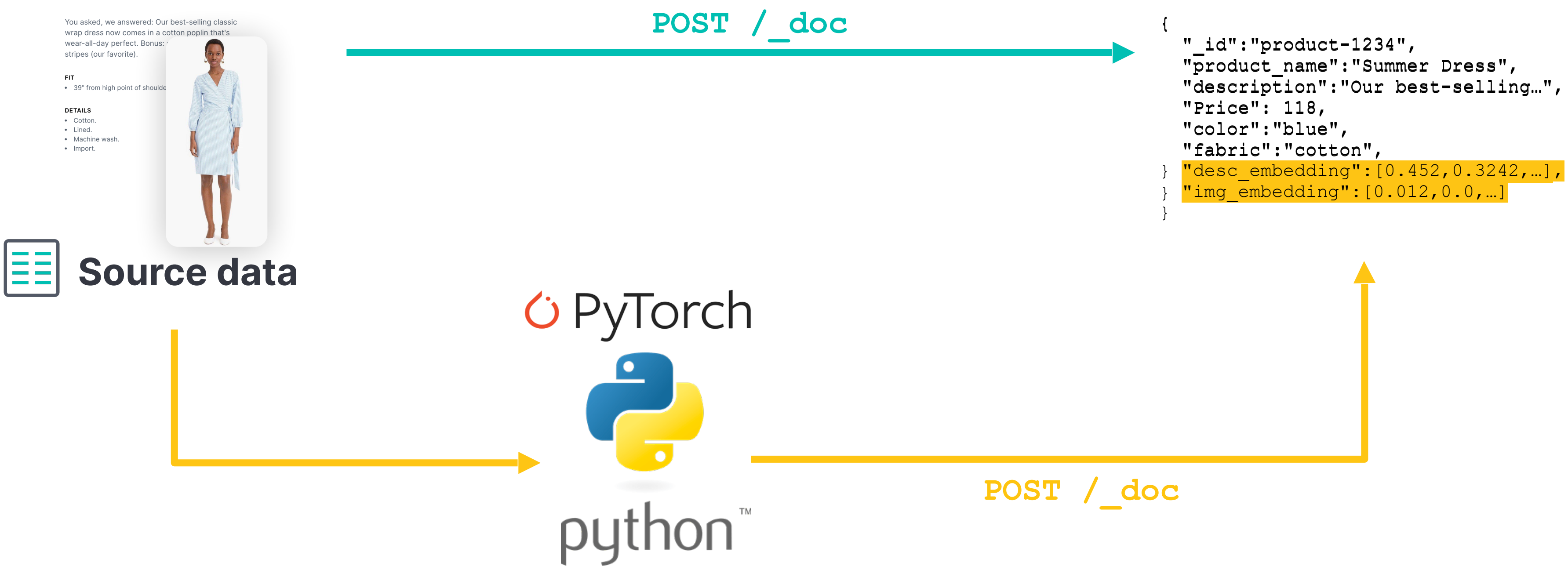


How do you

index **vectors**?

elastic

Data Ingestion and Embedding Generation



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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 shoulder

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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Eland Imports PyTorch Models

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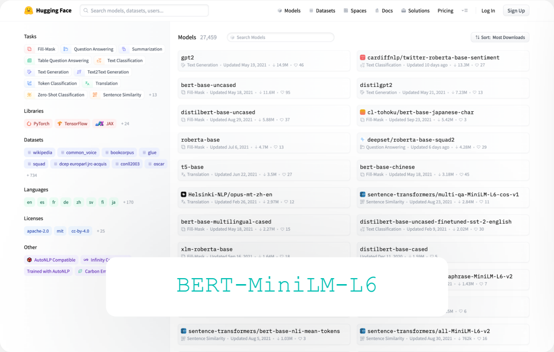
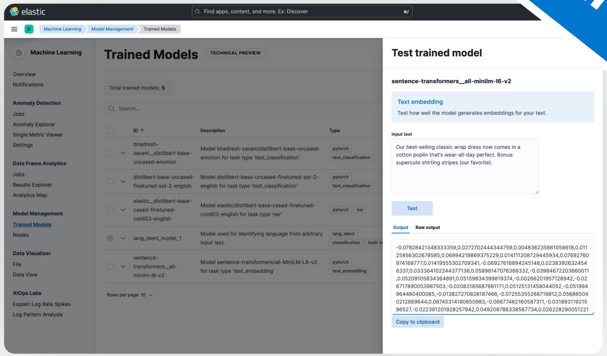



```
$ eland_import_hub_model
--url https://cluster_URL --hub-
model-id BERT-MiniLM-L6 --task-
type text_embedding --start
```



PyTorch

eland

Select the appropriate model

Load it

Manage models

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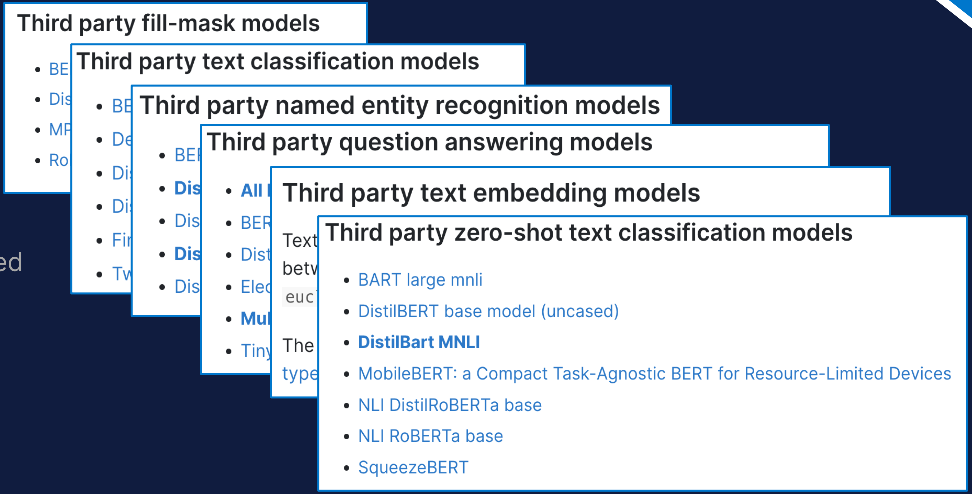
Elastic’s range of supported NLP models

- **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

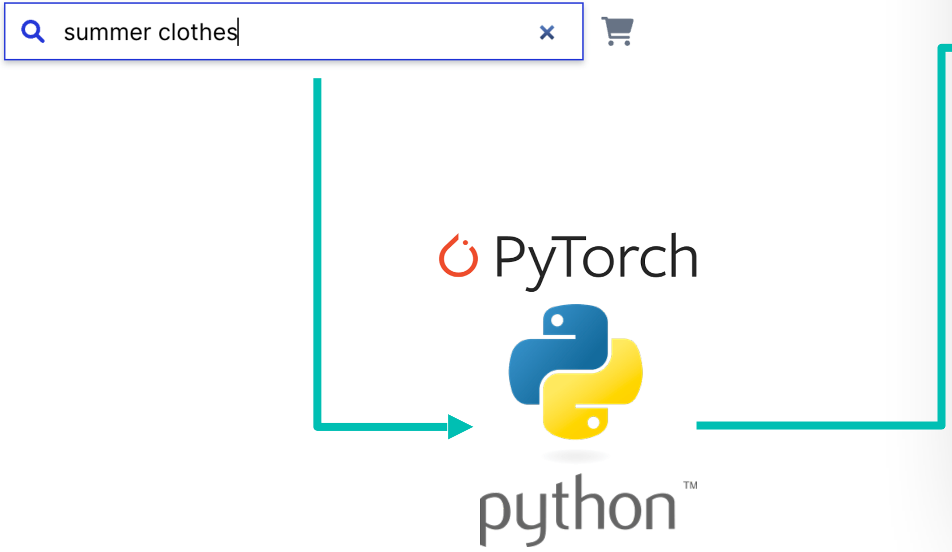


Full list at: ela.st/nlp-supported-models

How do you

search vectors?

Vector Query




```
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
}
```

elastic

Vector Query

summer clothes

Transformer model

PyTorch

Commercial

```
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
}
```

elastic

Vector Search components

Search	Index	Generate
Query	**Mapping**	**Embedding**
`kNN`	`dense_vector`	Text embedding model (3rd party, local, in Elasticsearch)

But how does it

really work?

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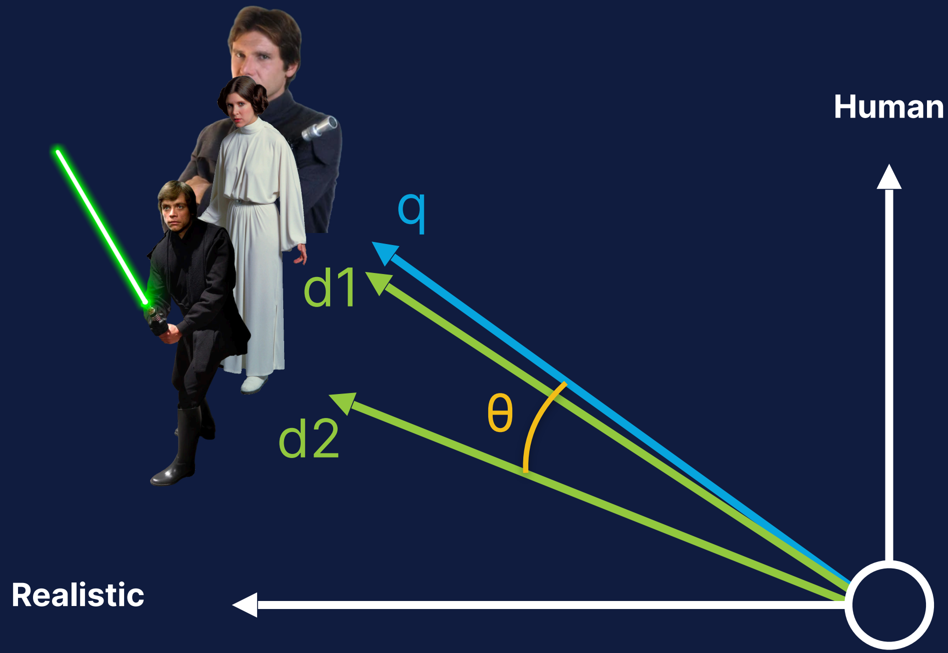
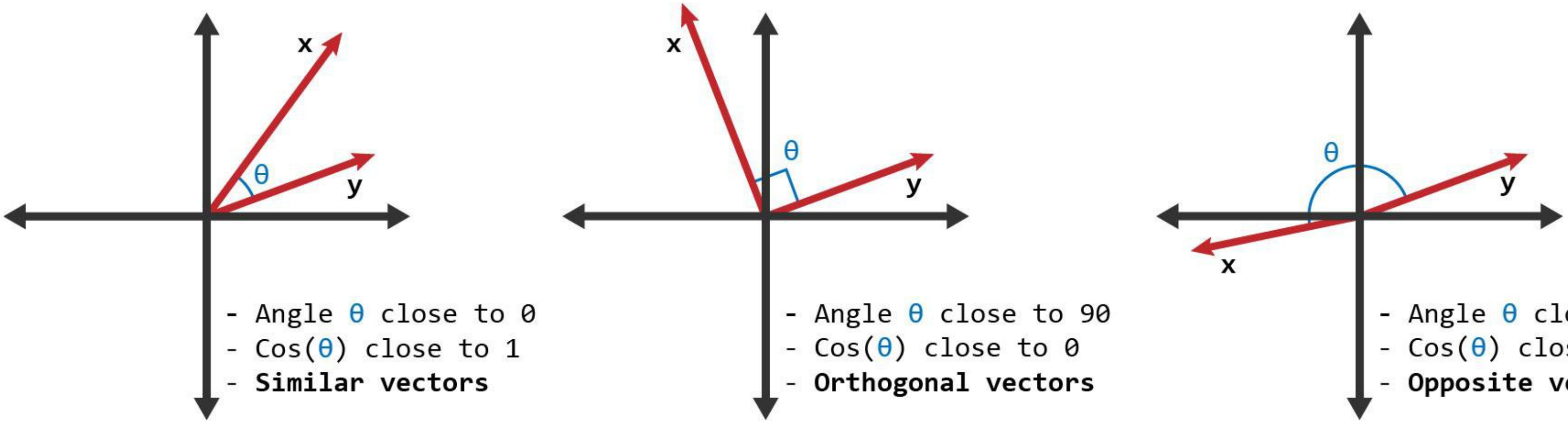
Similarity: cosine (cosine)



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

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

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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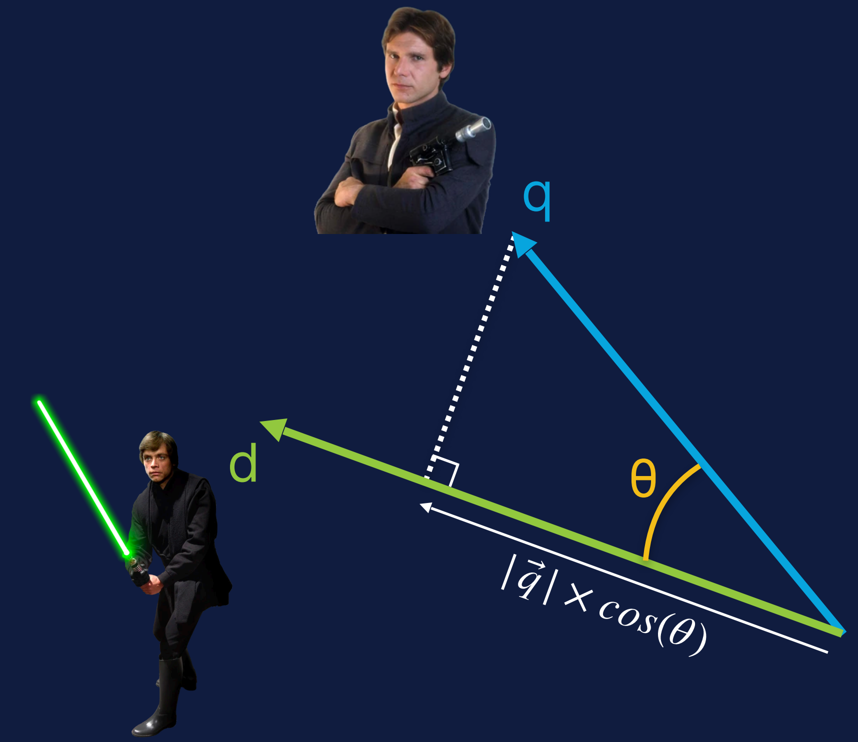
Similarity: Dot Product (dot_product)



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

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

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

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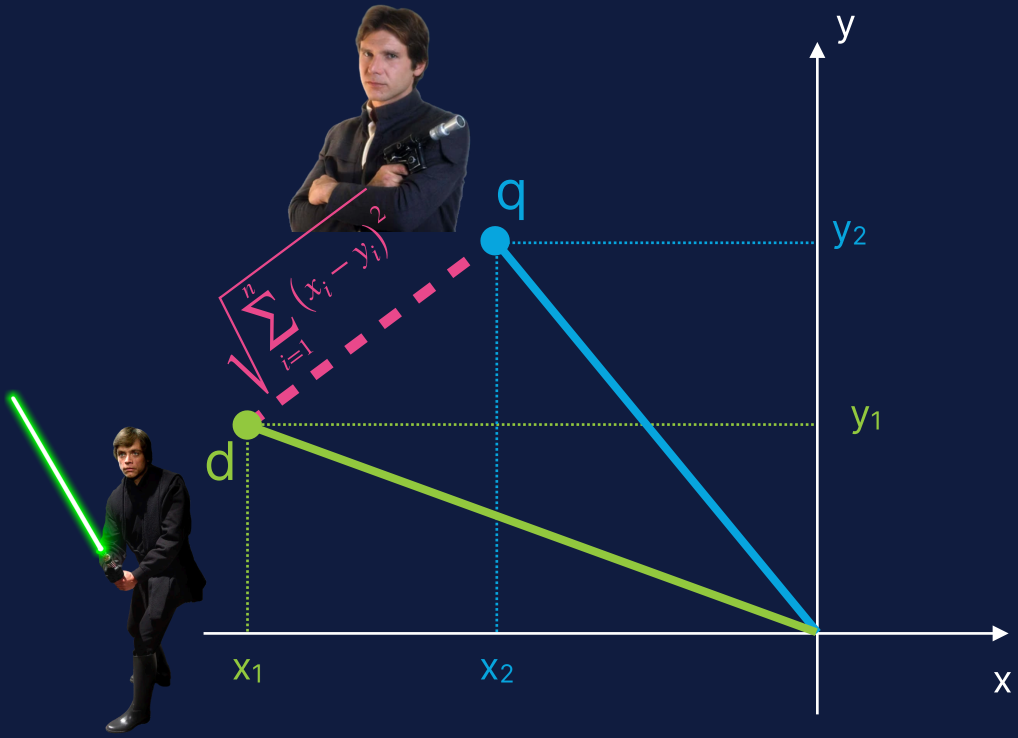
Similarity: Euclidean distance (l2_norm)



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

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

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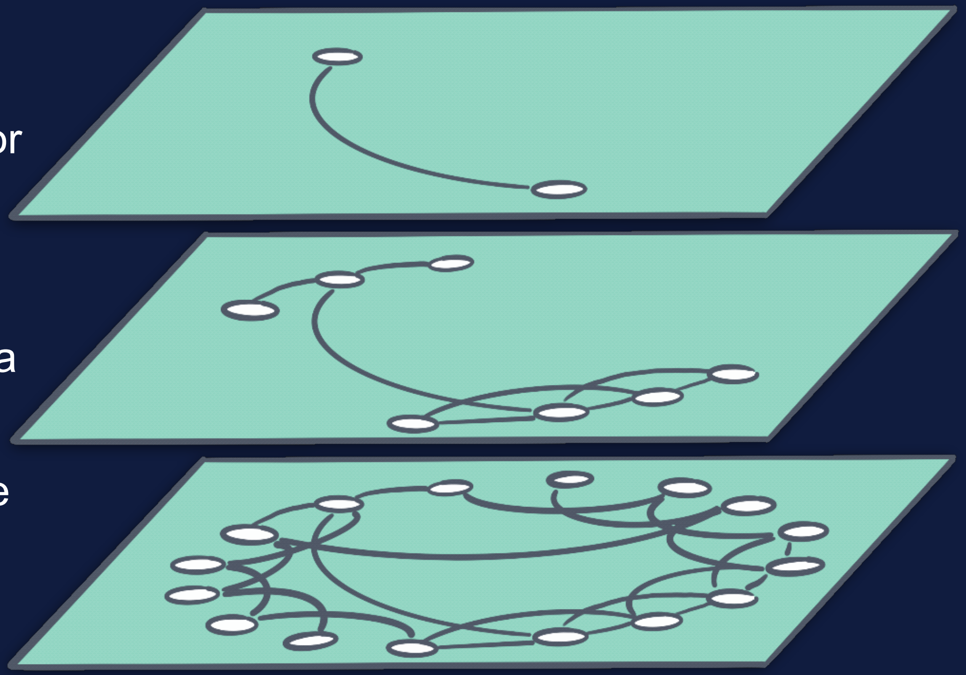
Brute Force

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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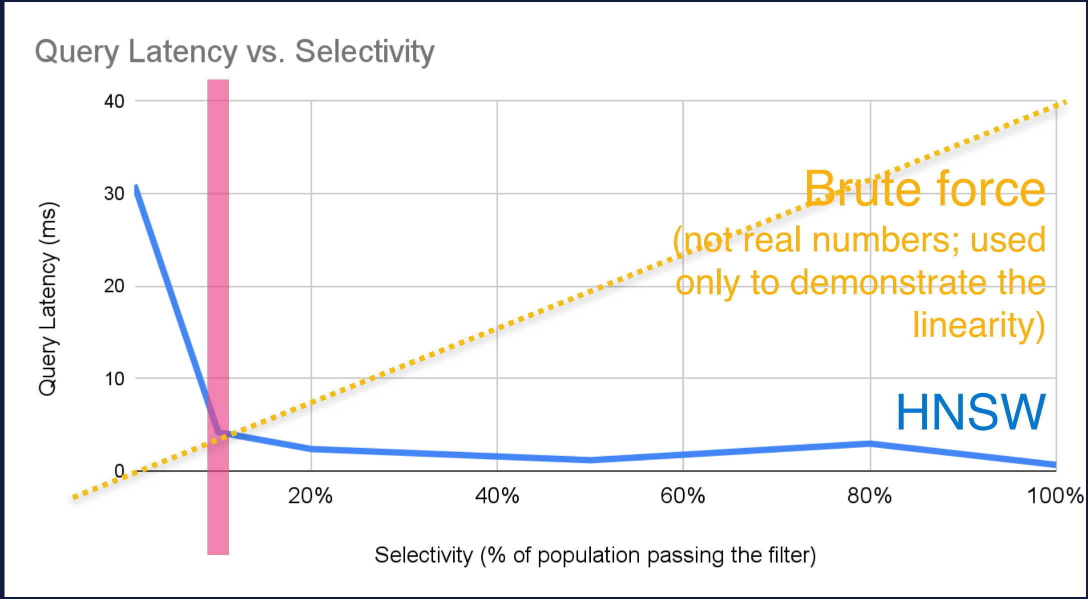
Filtering KNN Vector Similarity

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

Elasticsearch + Lucene = fast progress ❤️

Increase max number of vector dims to 2048 #95257

Increase the max vector dims to 4096 #99682

Merged mayya-sharipova merged 2 commits into `elastic:main` from `mayya-sharipova:increase_vector_dims_4096`

Conversation 5 · Commits 2 · Checks 0 · Files changed 8

mayya-sharipova commented on Sep 19 · Contributor

No description provided.

`Increase the max vector dims to 4096` · `3f97c5f`

mayya-sharipova added >enhancement :Search/Vectors v8.11.0 labels on Sep 19

elastic

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

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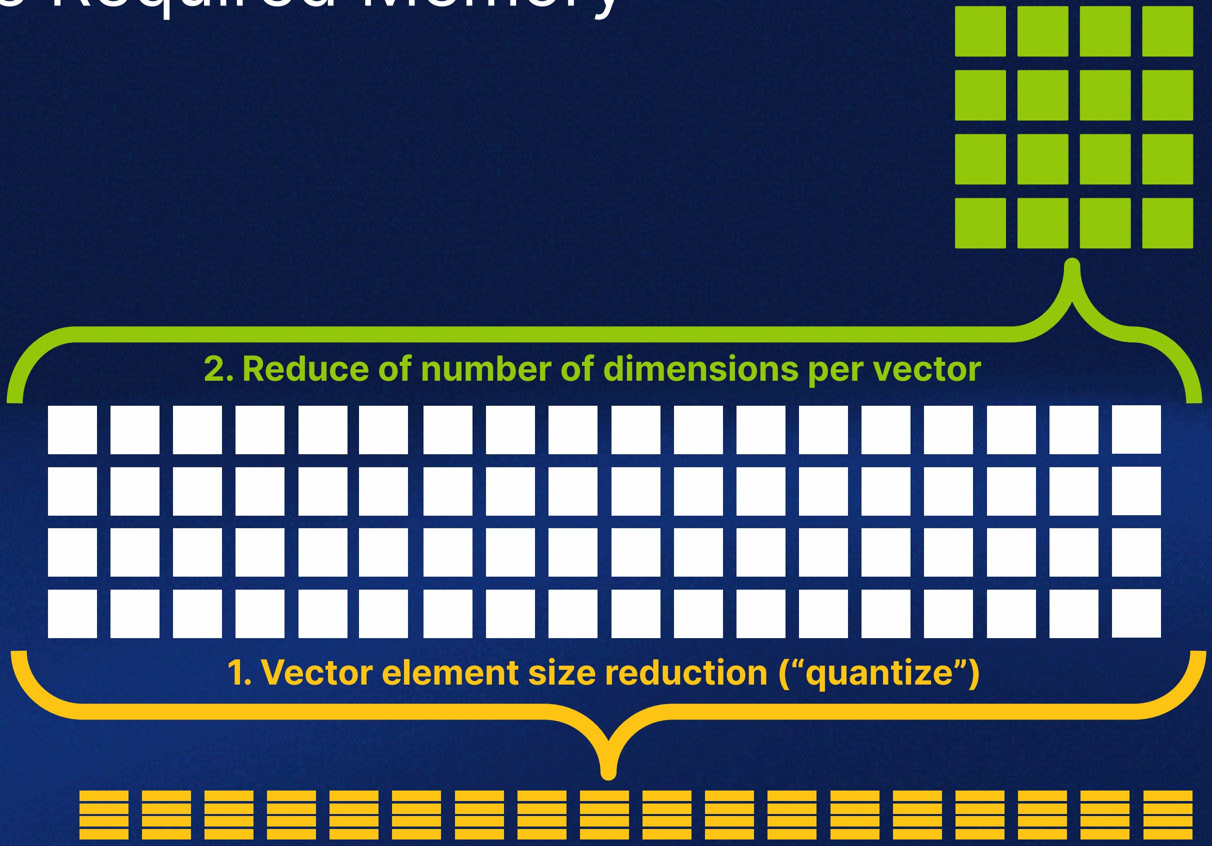
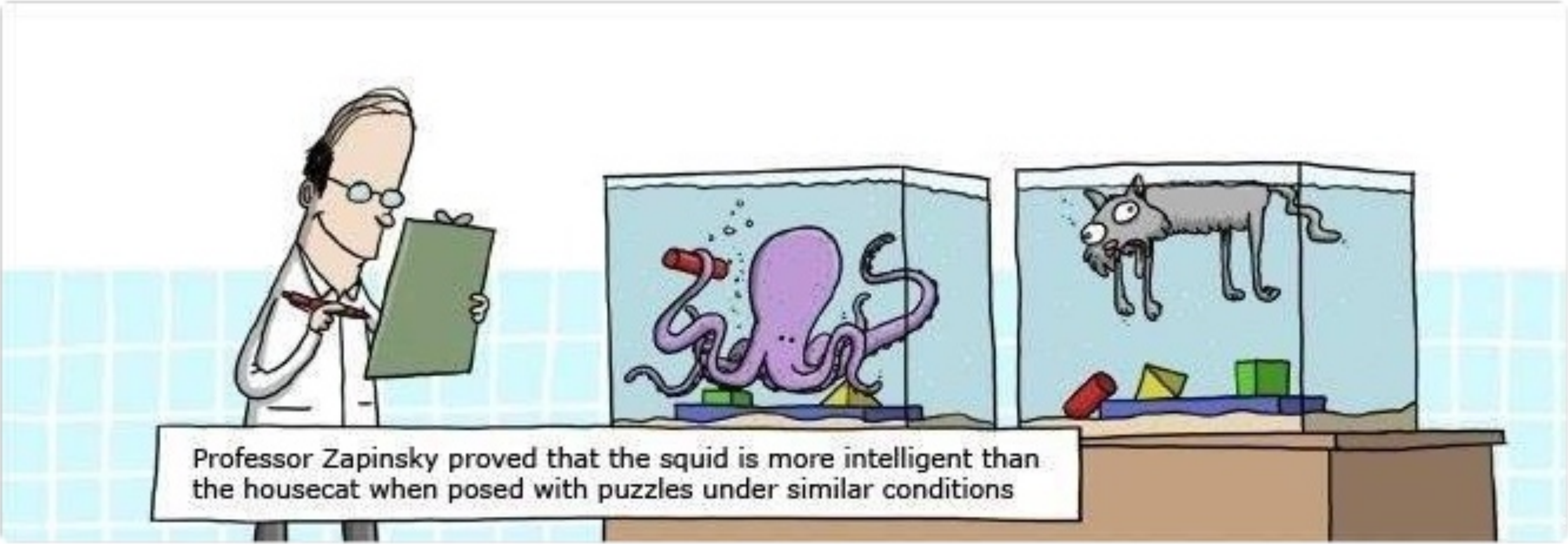
Reduce Required Memory



Benchmarketing



Elasticsearch

You Know, for Hybrid Search

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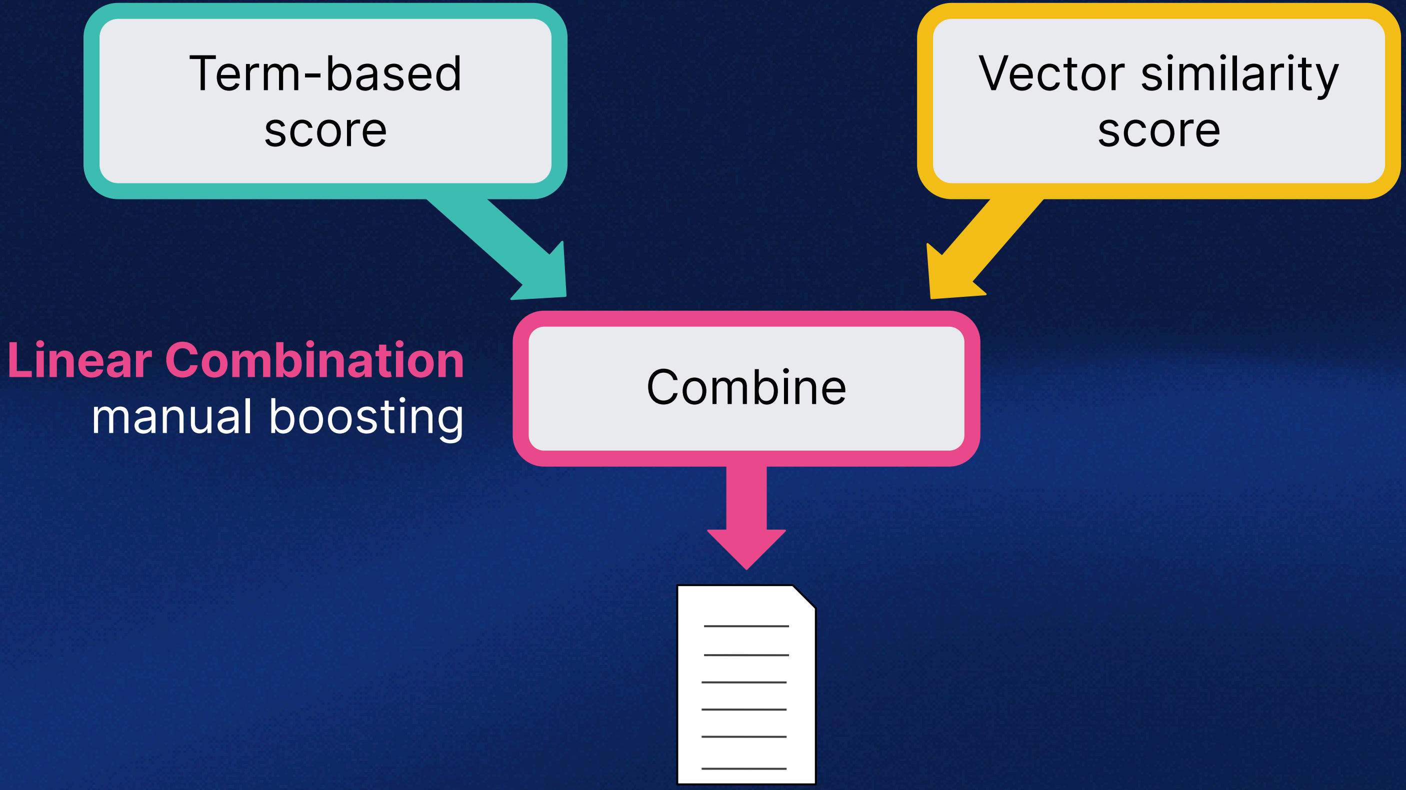
Hybrid scoring



```
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

elastic

```
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
        }
      }]
    }
  }
}
```

ELSER

Elastic Learned Sparse EncodER

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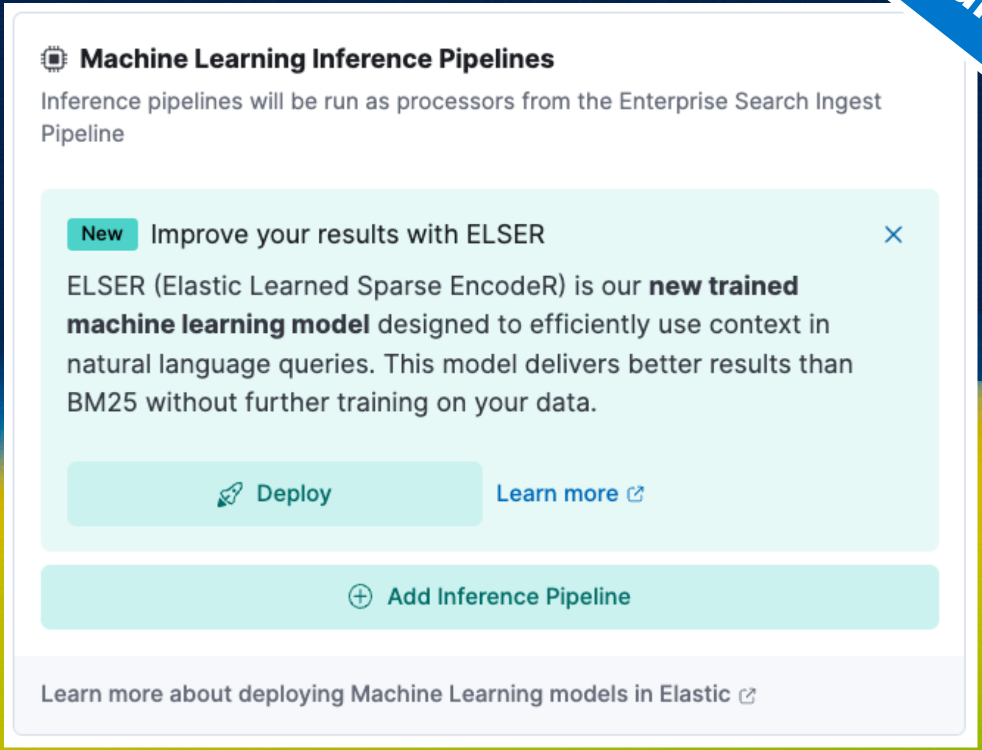
text_expansion

Not BM25 or (dense) vector

Sparse vector like BM25

Stored as inverted index



elastic

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```
PUT /_inference/sparse_embedding/my_elser_model
{
  "service": "elser",
  "service_settings": {
    "num_allocations": 1,
    "num_threads": 1
  },
  "task_settings": {}
}
```

```
PUT /_inference/text_embedding/openai_embeddings
{
    "service": "openai",
    "service_settings": {
        "api_key": "<api_key>"
    },
    "task_settings": {
       "model": "text-embedding-ada-002"
    }
}
```

```
PUT /_inference/text_embedding/hugging_face_embeddings
{
    "service": "hugging_face",
    "service_settings": {
       "api_key": "<access_token>",
       "url": "<url_endpoint>"
    }
}
```

Commercial

```
POST /_inference/sparse_embedding/my_elser_model
{
  "input": [
    "These are not the droids you are looking for.",
    "Obi-Wan never told you what happened to your father."
  ]
}
```

↓

```
{
  "sparse_embedding": [{
                "lucas": 0.50047517,
                "ship": 0.29860738,
                "dragon": 0.5300422,
                "quest": 0.5974301,
                "dr": 2.1055143,
                "space": 0.49377063,
                "robot": 0.40398192,
                ...
```

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Hybrid ranking

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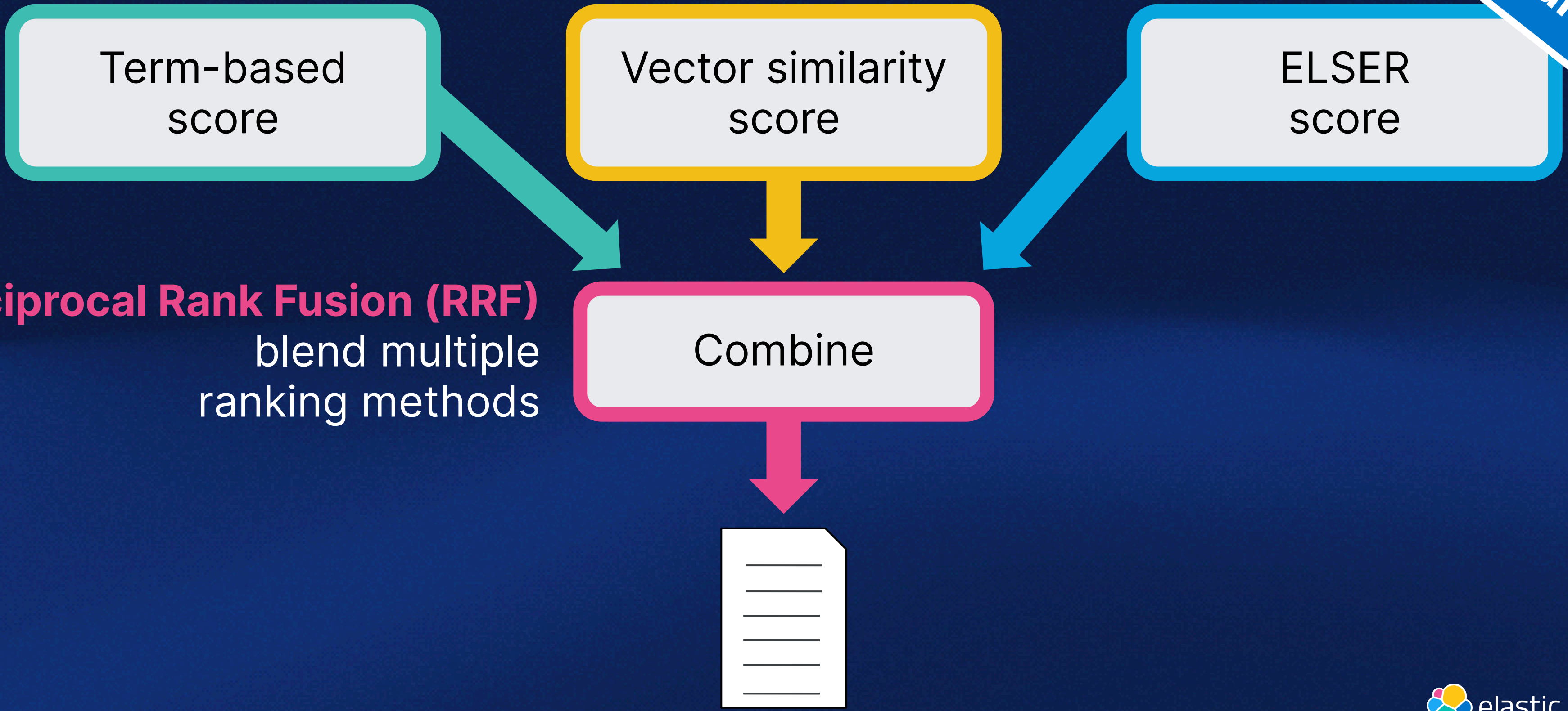

Reciprocal Rank Fusion (RRF)
blend multiple
ranking methods

elastic

```
GET product-catalog/_search
{
  "sub_searches": [
    {
      "query": {
        "match": {...}
      }
    },
    {
      "query": {
        "text_expansion": {...}
      }
    }
  ],
  "knn": {...},
  "rank": {
    "rrf": {
      "window_size": 50,
      "rank_constant": 20
    }
  }
}
```

Commercial

BM25f

+

ELSER

+

Vector

Hybrid Ranking

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Reciprocal Rank Fusion (RRF)

$$RRFscore(d \in D) = \sum_{r \in R} \frac{1}{k + r(d)}$$

D - set of docs
R - set of rankings as permutation on 1..|D|
k - typically set to 60 by default

Ranking Algorithm 1

Doc	Score	r(d)	k+r(d)
A	1	1	61
B	0.7	2	62
C	0.5	3	63
D	0.2	4	64
E	0.01	5	65

Ranking Algorithm 2

Doc	Score	r(d)	k+r(d)
C	1,341	1	61
A	739	2	62
F	732	3	63
G	192	4	64
H	183	5	65

Doc	RRF Score
A	1/61 + 1/62 = 0,0325
C	1/63 + 1/61 = 0,0323
B	1/62 = 0,0161
F	1/63 = 0,0159
D	1/64 = 0,0156

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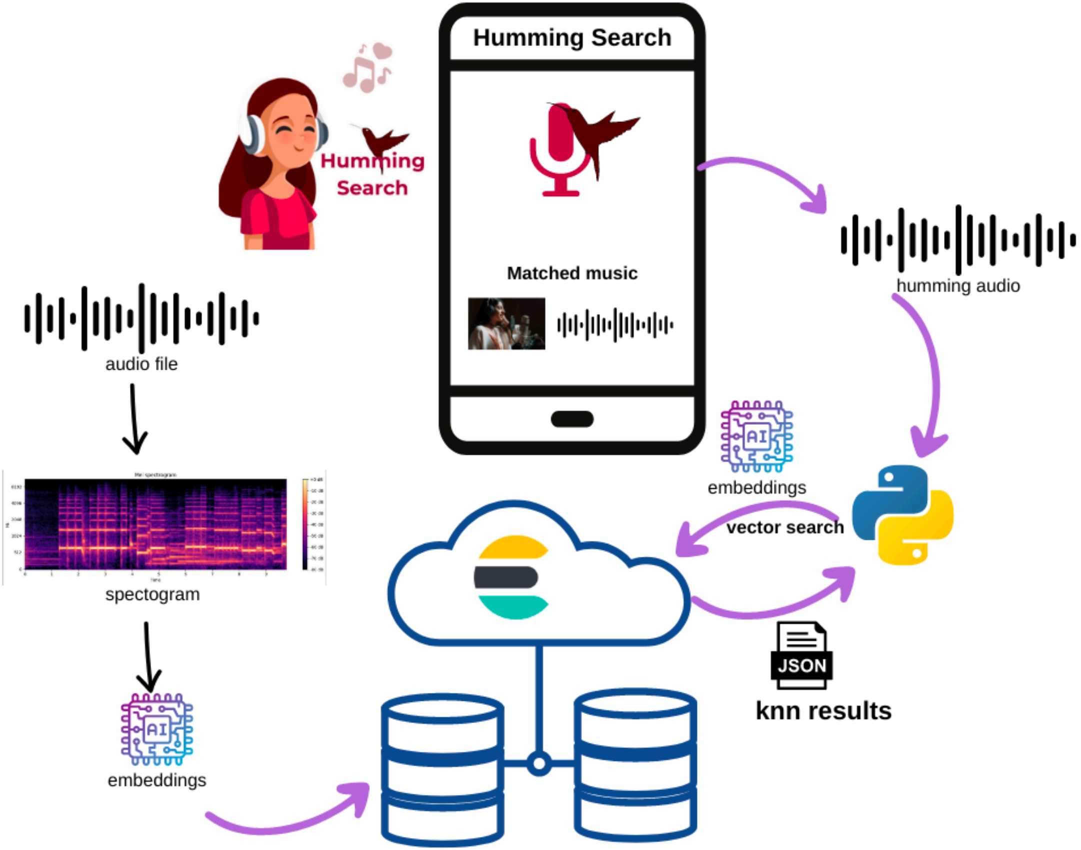
https://djdadoo.pilato.fr/

elastic



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

elastic

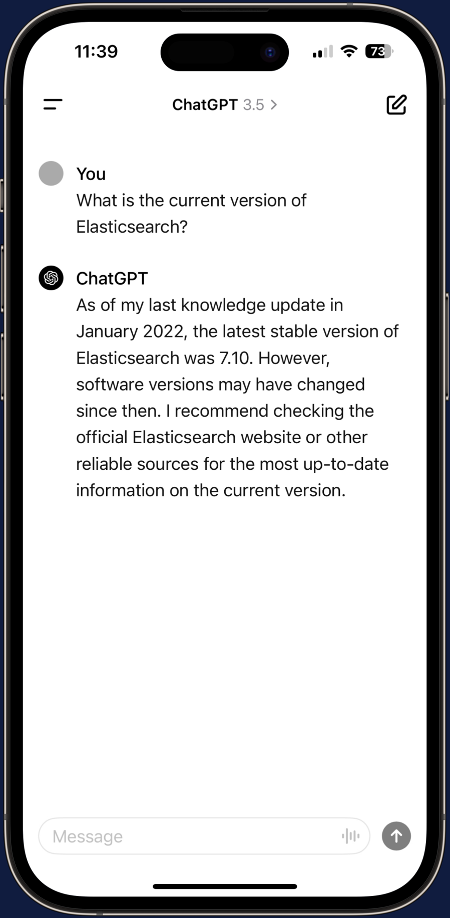
ChatGPT

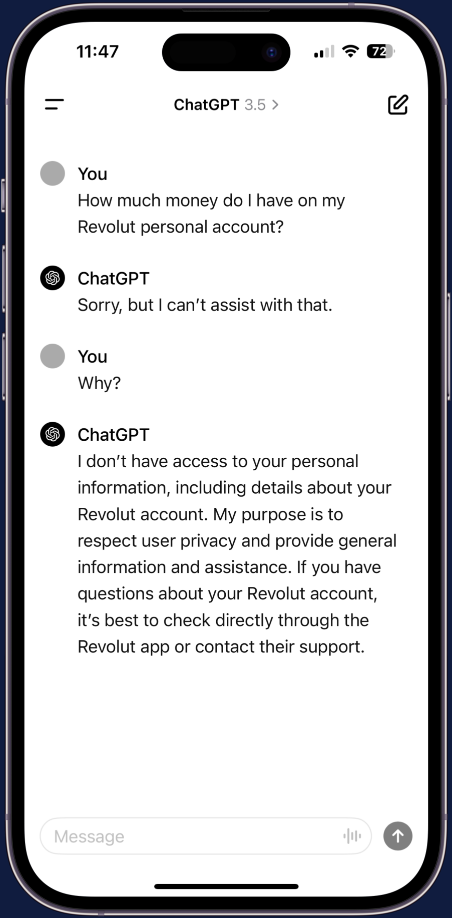
Elastic and LLM

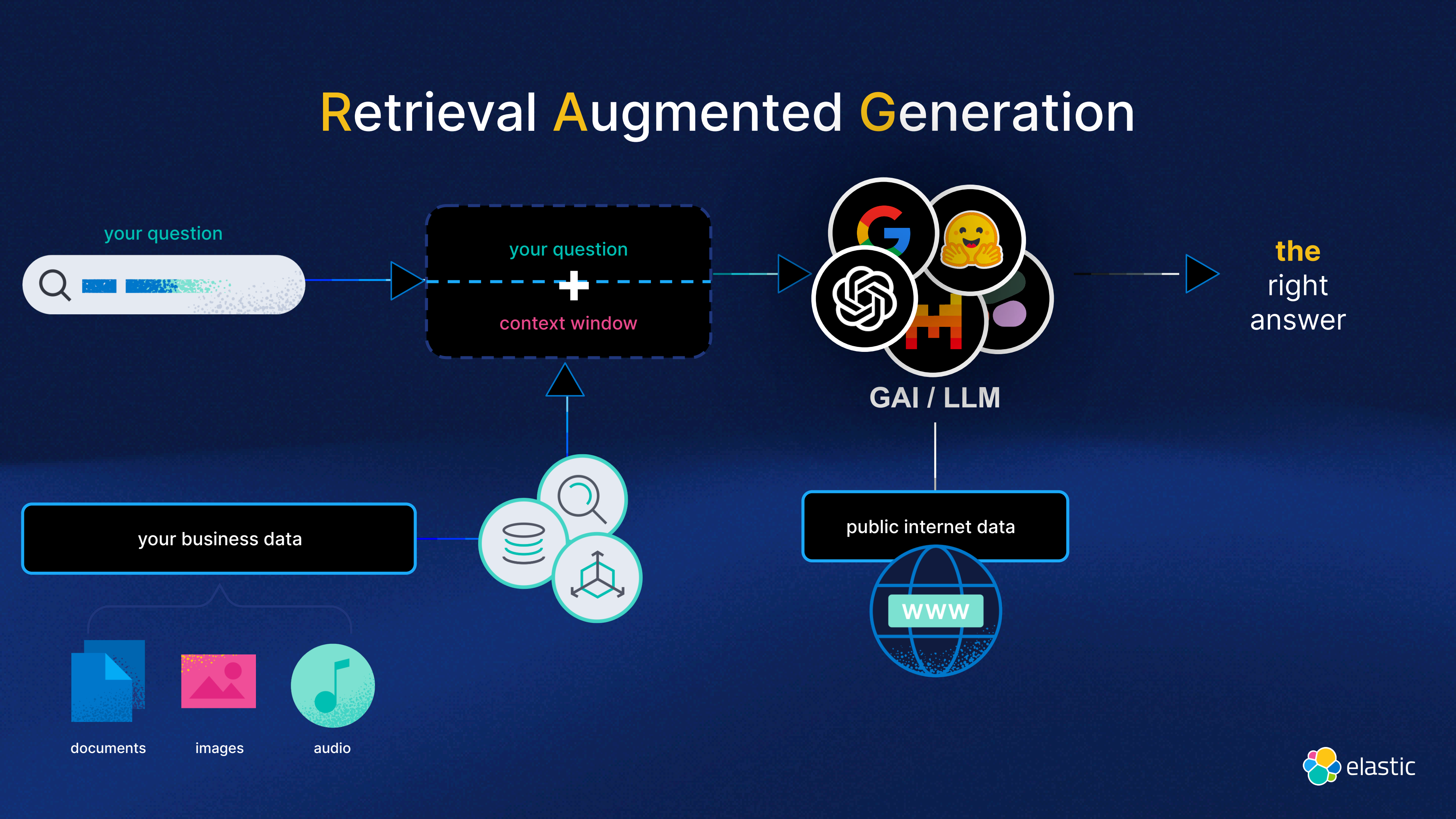

Gen AI
Search engines

LLM: opportunities and limits

elastic


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



Retrieval Augmented Generation
your question
your question
context window
GAI / LLM
the right answer
your business data
public internet data
WWW
documents
images
audio
elastic

ATELIER : RAG TIME

DISCUTER AVEC VOS PROPRES DONNÉES

VENDREDI 13H30 - PARIS 243

SYLVAIN WALLEZ

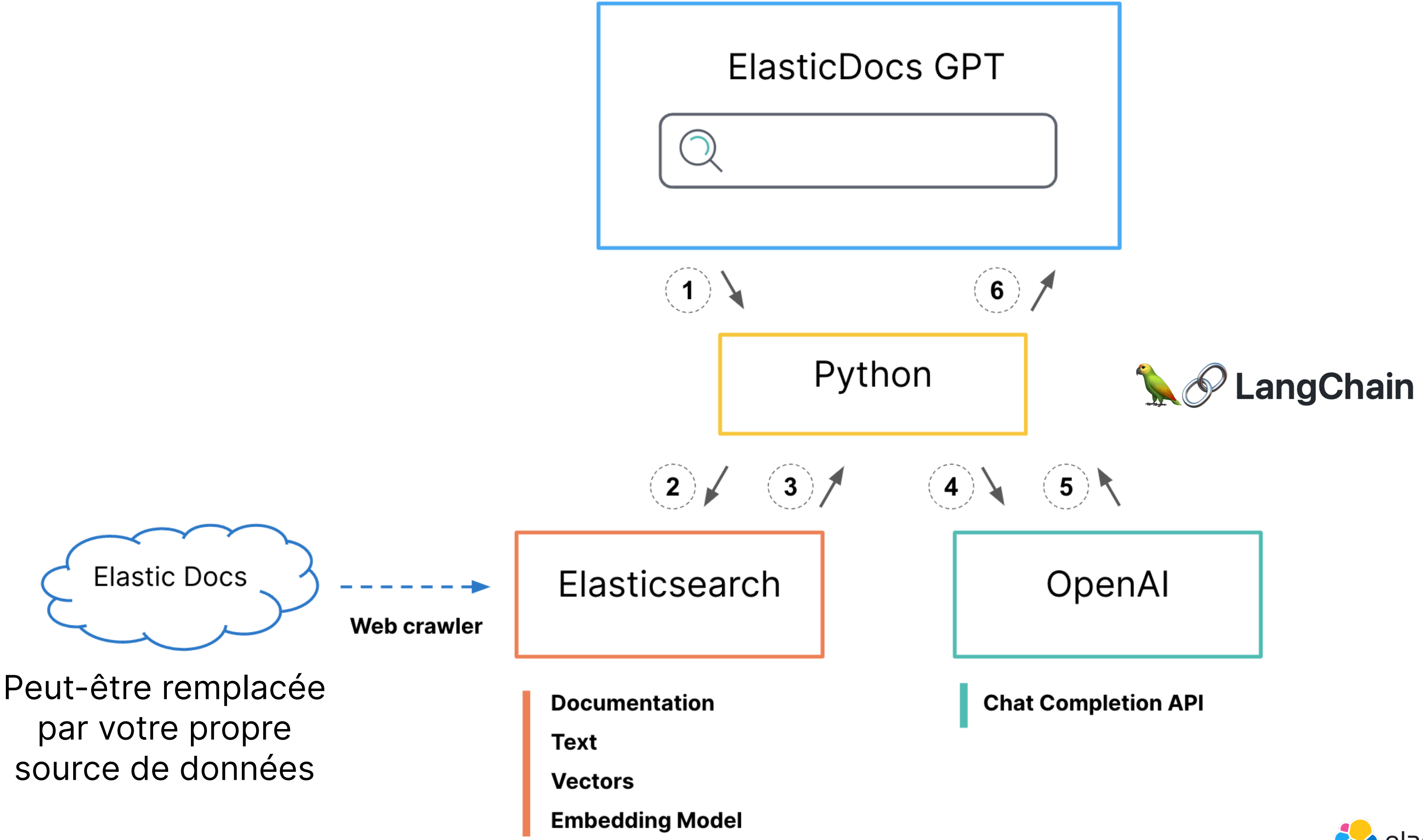
ALINE PAPONAUD

BENJAMIN DAUVISSAT

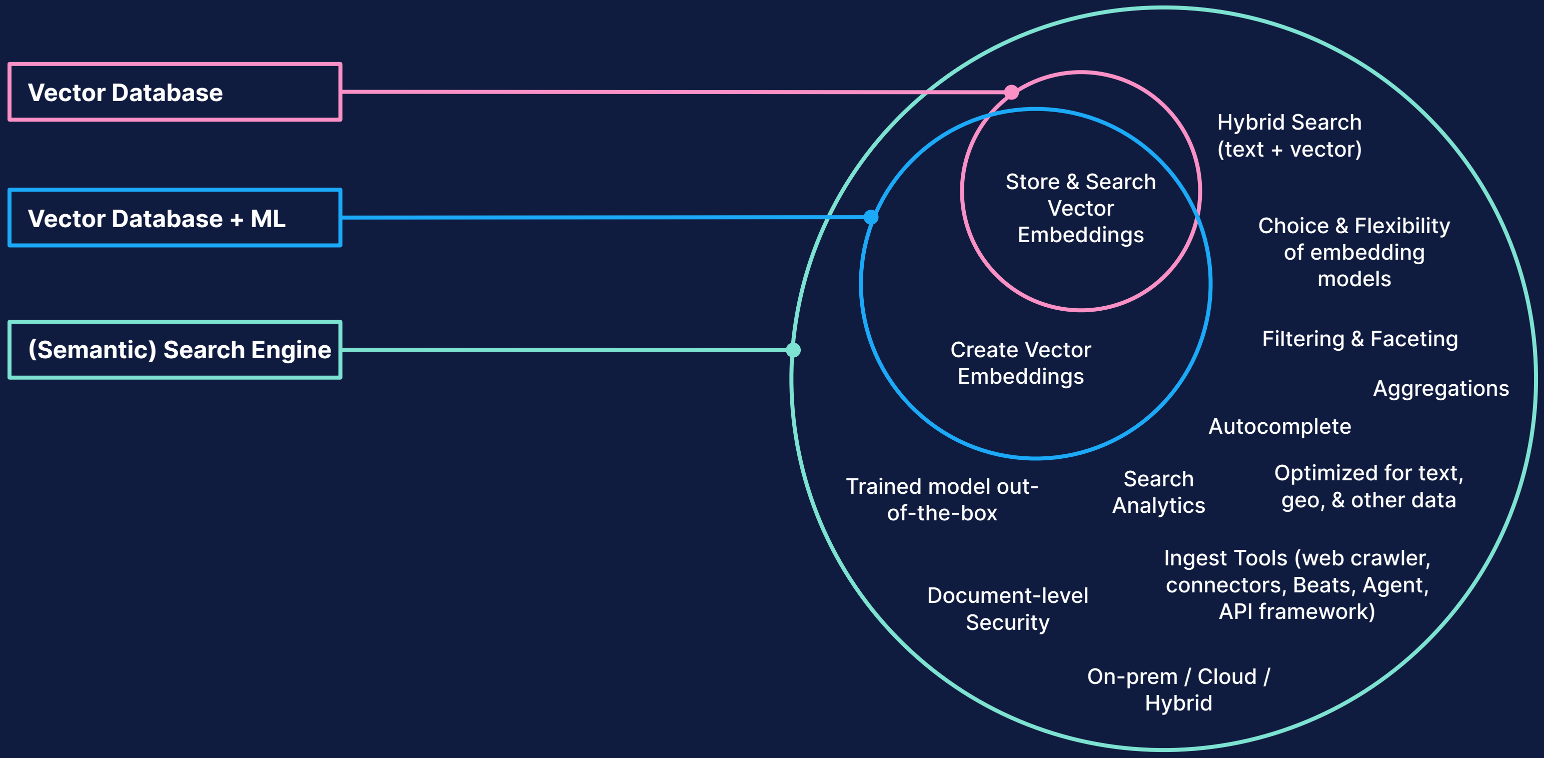
VINCENT BRÉHIN

Demo

Elastic + Azure OpenAI
AWS Bedrock
Google Vertex AI
Mistral AI
Cohere


ElasticDocs GPT
1
6
Python
LangChain
2
3
4
5
Elastic Docs
Web crawler
Elasticsearch
OpenAI
Documentation
Text
Vectors
Embedding Model
Chat Completion API
Peut-être remplacée par votre propre source de données

Conclusion



Vector Database
Vector Database + ML
(Semantic) Search Engine
Store & Search Vector Embeddings
Create Vector Embeddings
Hybrid Search (text + vector)
Choice & Flexibility of embedding models
Filtering & Faceting
Aggregations
Autocomplete
Trained model out-of-the-box
Search Analytics
Optimized for text, geo, & other data
Document-level Security
Ingest Tools (web crawler, connectors, Beats, Agent, API framework)
On-prem / Cloud / Hybrid

elastic

Elasticsearch

You Know, for **Semantic** Search

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LA RECHERCHE
À L'ÈRE
DE L'IA
DEVOXX FRANCE 2024
DAVID PILATO | @DADOONET
elastic