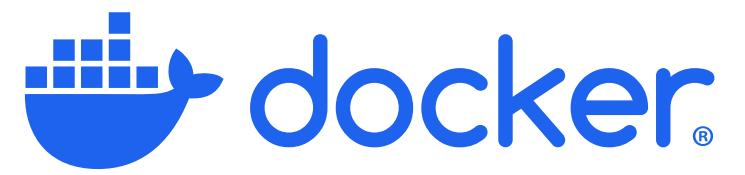
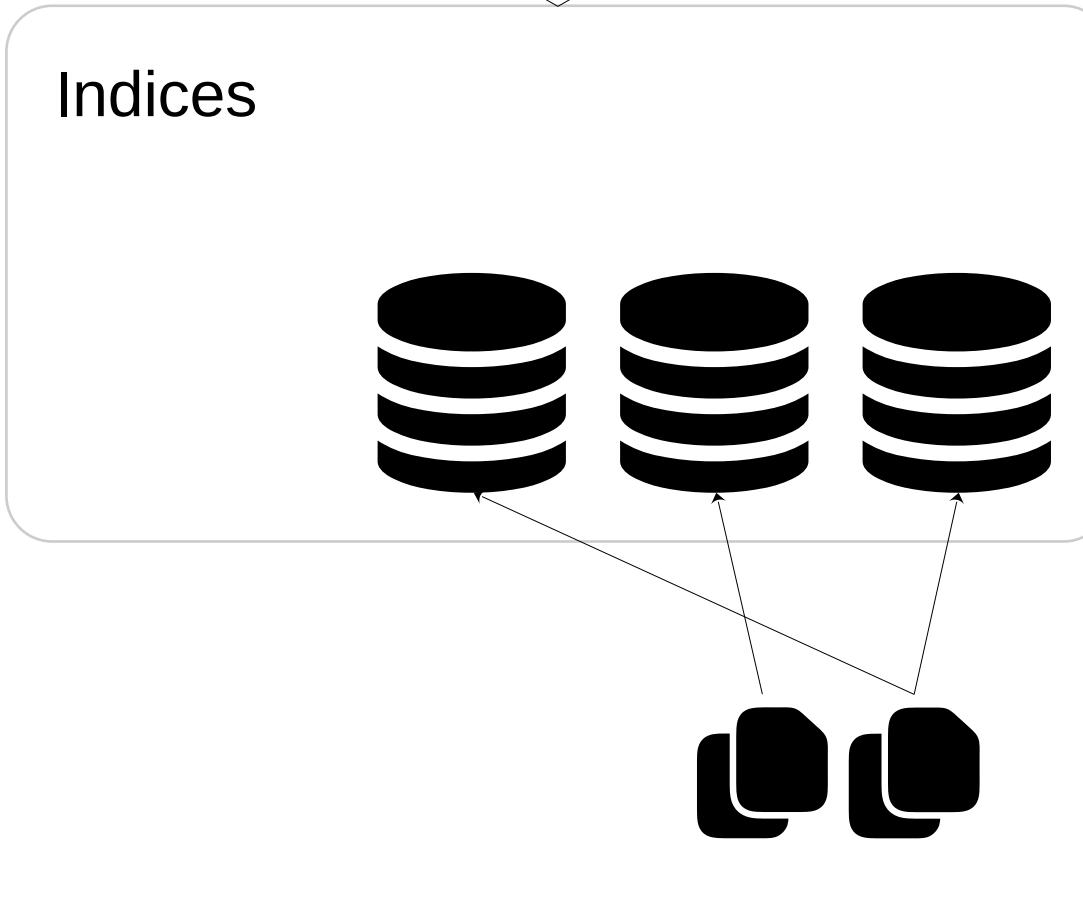
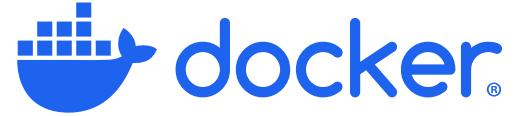




elasticsearch

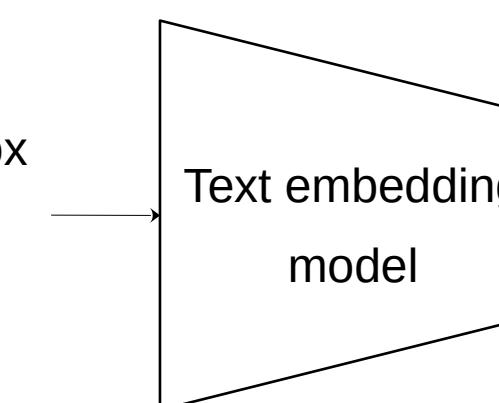


elasticsearch



- The quick brown fox jumped over the lazy dog
- 3.14
- 15/09/2024

The quick brown fox
jumped over the
lazy dog

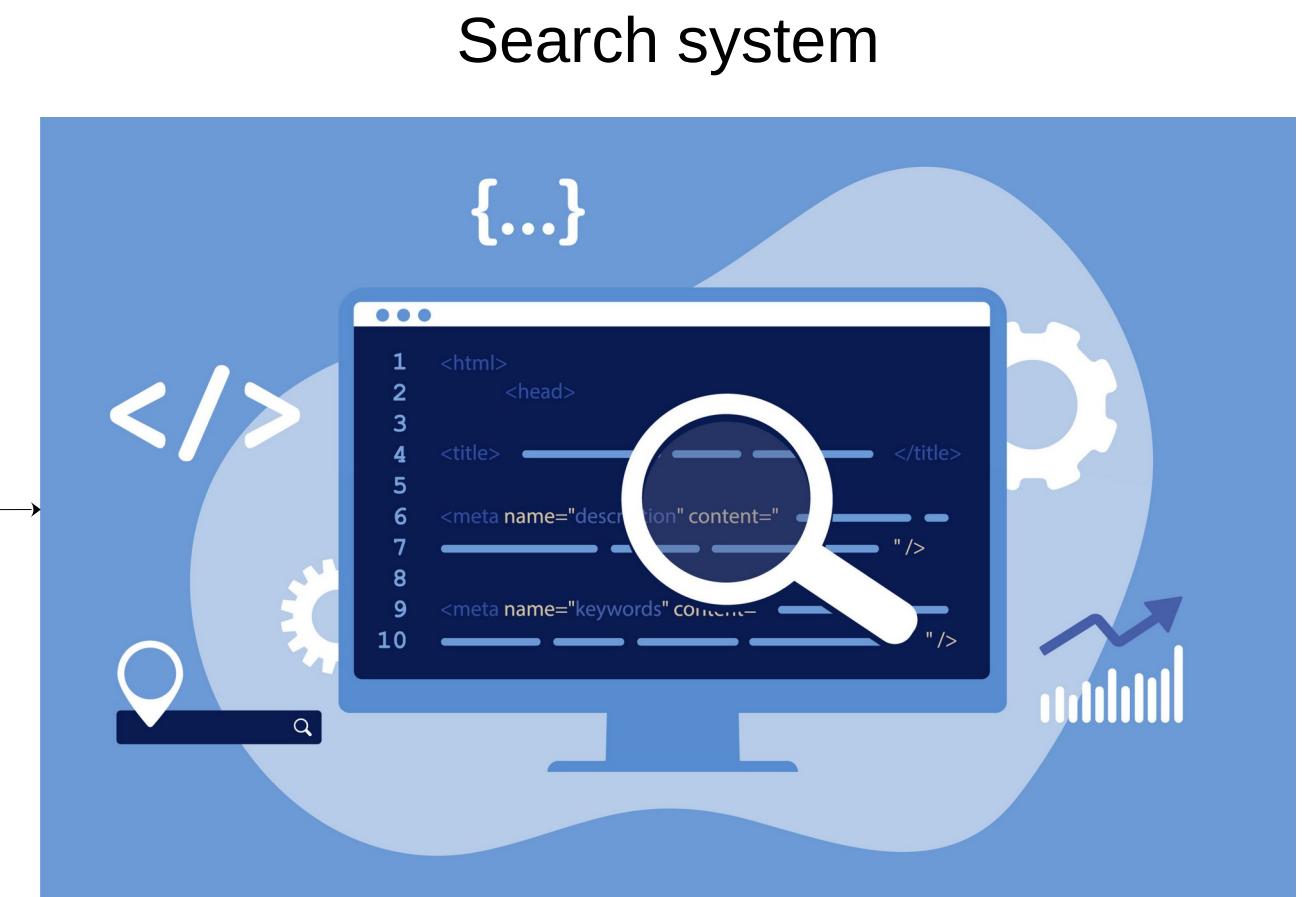
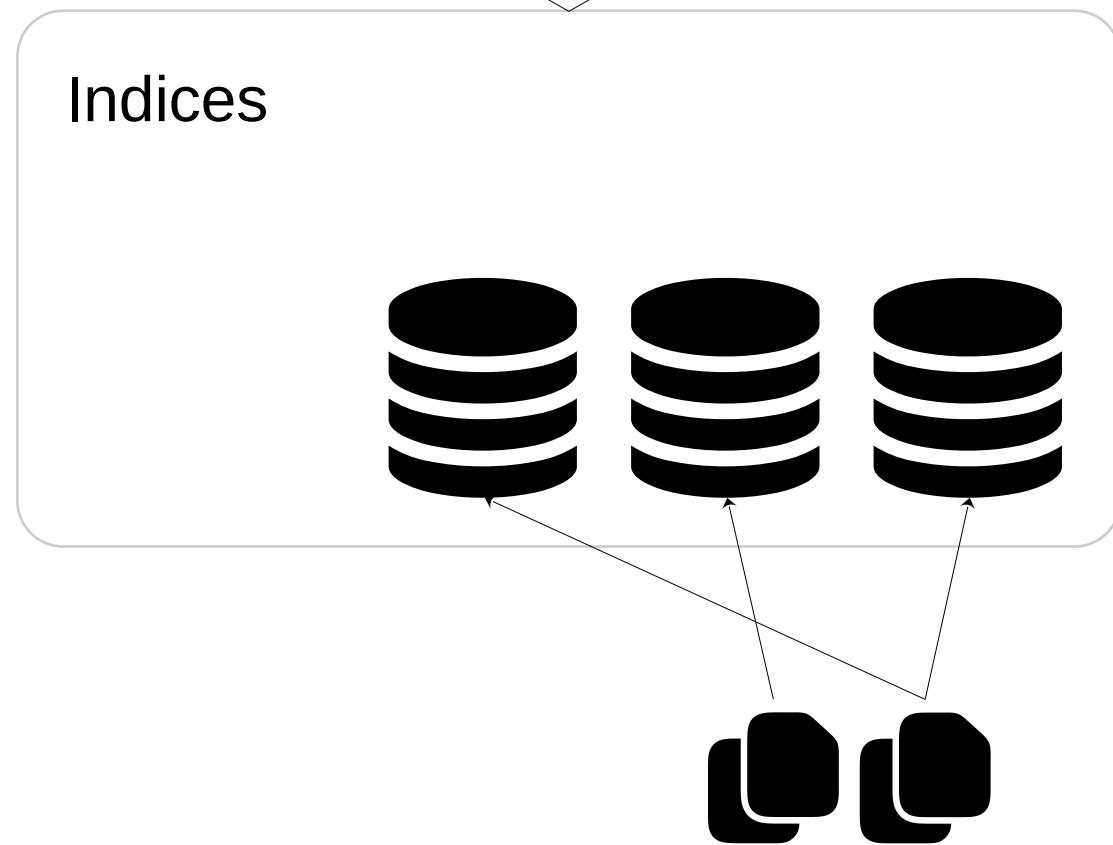


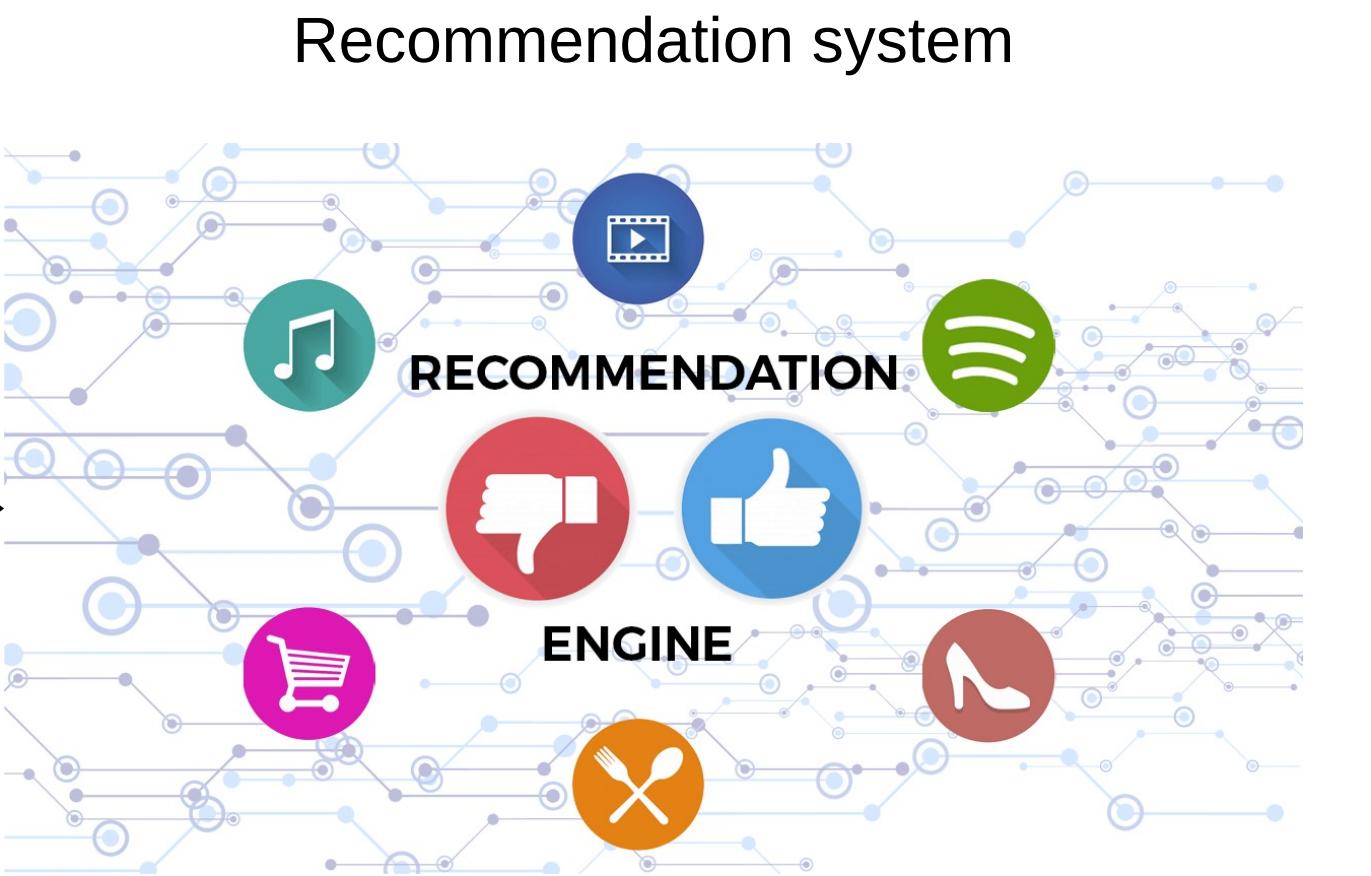
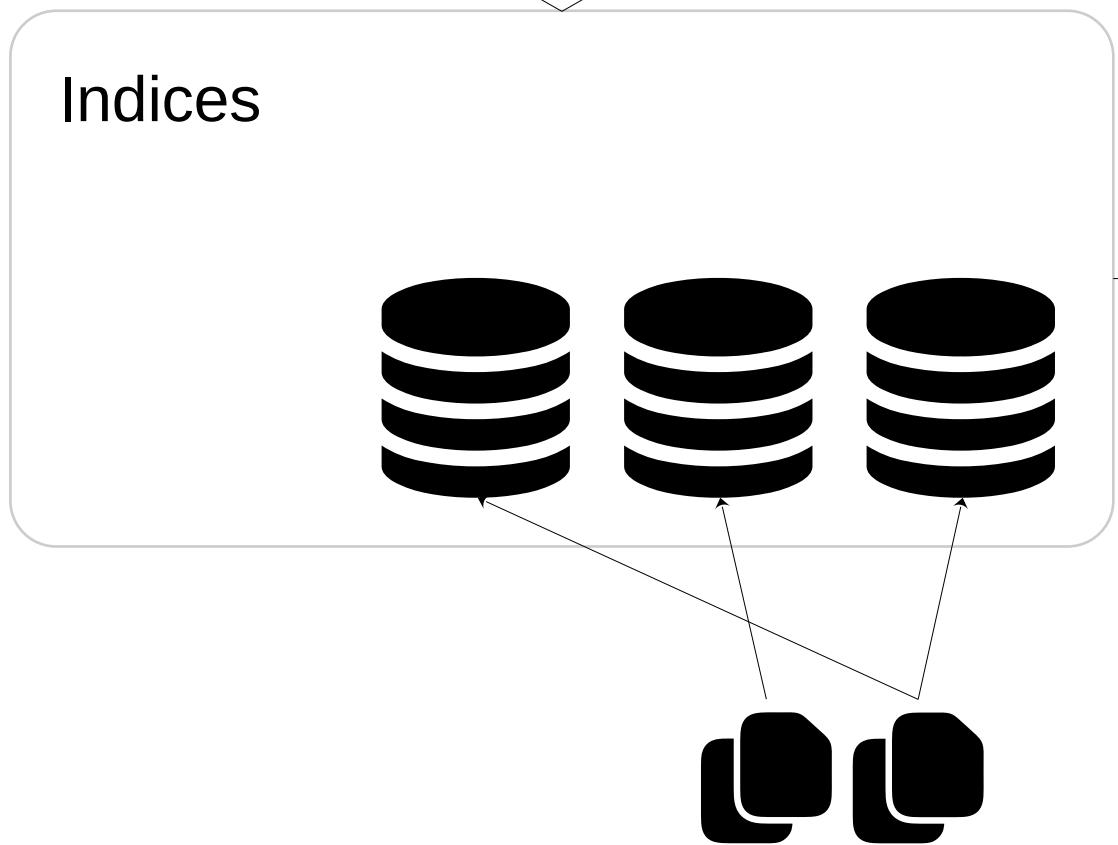
[-0.1, 2.5, ..., -1.67]



 **elasticsearch**


 **elasticsearch**



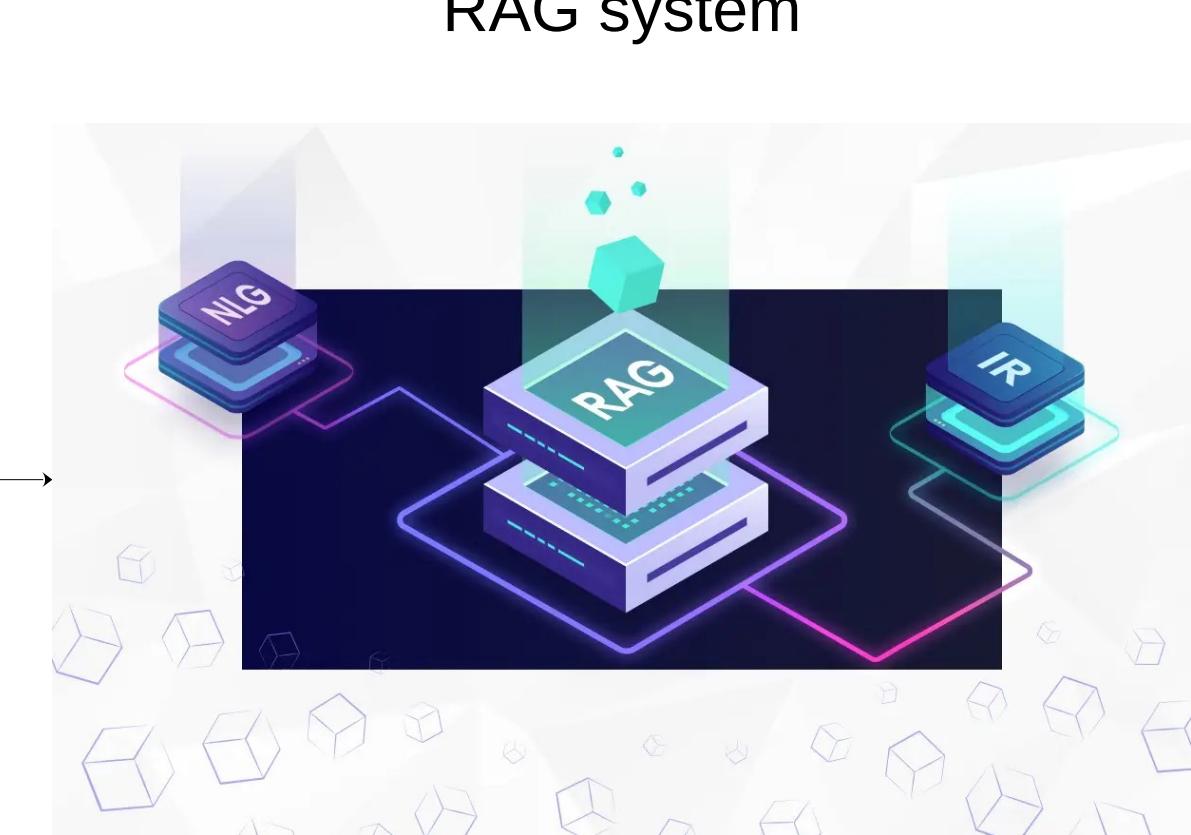
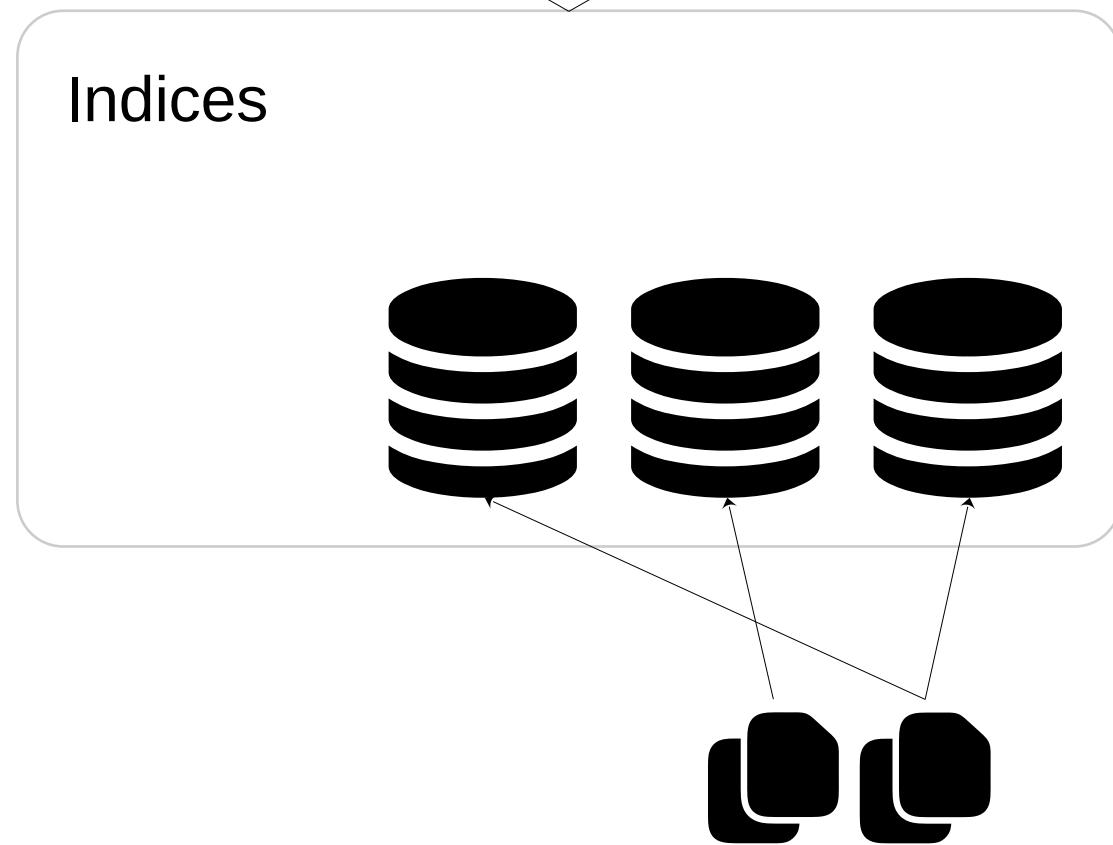


<https://www.shopagain.com/blog/product-recommendation-engines-what-is-it-how-it-work/>

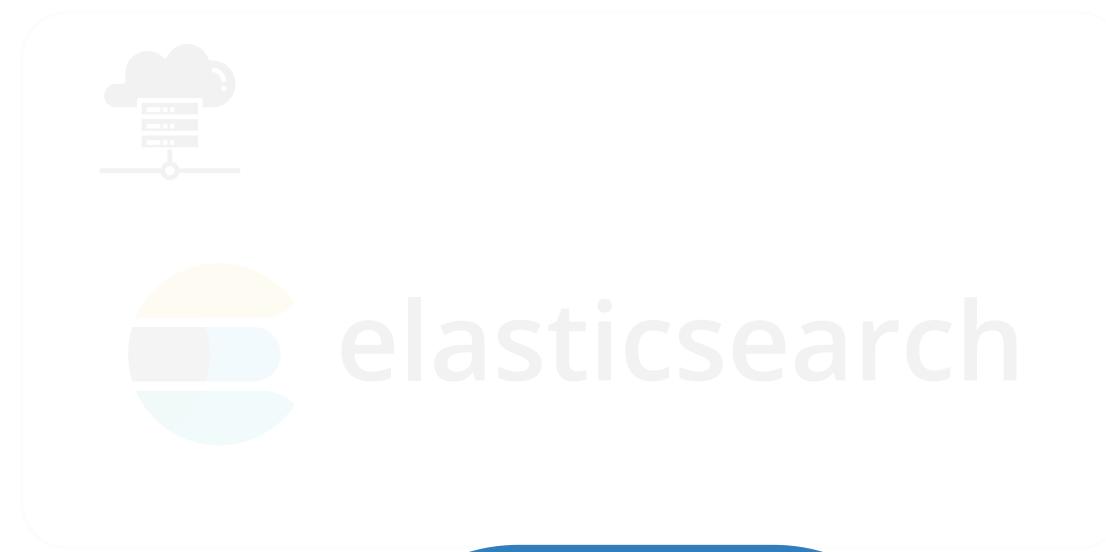


 **elasticsearch**


 **elasticsearch**



<https://www.superannotate.com/blog/rag-explained>



RAG system

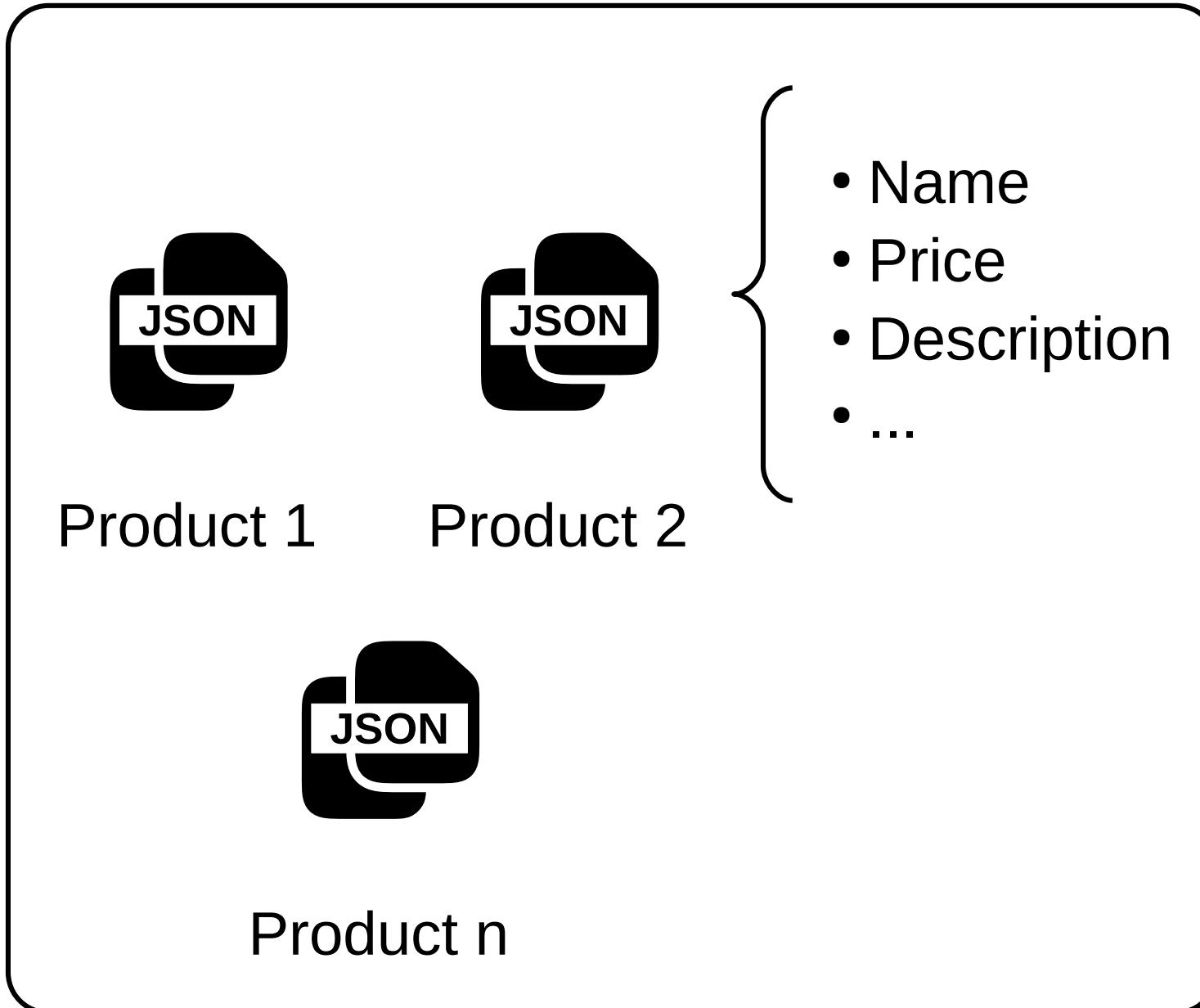


<https://www.superannotate.com/blog/rag-explained>

3

Create an index

What is an index ?



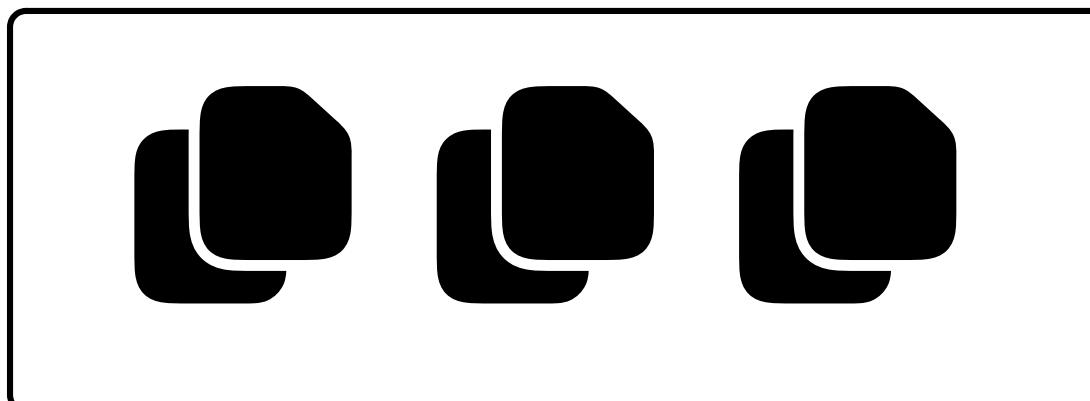
Product Index

```
1 from pprint import pprint
2 from elasticsearch import Elasticsearch
3
4 es = Elasticsearch('http://localhost:9200')
5 client_info = es.info()
6 print('Connected to Elasticsearch!')
7 pprint(client_info.body)
✓ 0.0s
Connected to Elasticsearch!
{'cluster_name': 'docker-cluster',
 'cluster_uuid': 'DLYG5m9gR3upn7qgaYyAJA',
 'name': '3d37442d2591',
 'tagline': 'You Know, for Search',
 'version': {'build_date': '2024-08-05T10:05:34.233336849Z',
             'build_flavor': 'default',
             'build_hash': '1a77947f34deddb41af25e6f0ddb8e830159c179',
             'build_snapshot': False,
             'build_type': 'docker',
             'lucene_version': '9.11.1',
             'minimum_index_compatibility_version': '7.0.0',
             'minimum_wire_compatibility_version': '7.17.0',
             'number': '8.15.0'}}
```

```
1 es.indices.create(index='my_index')
```

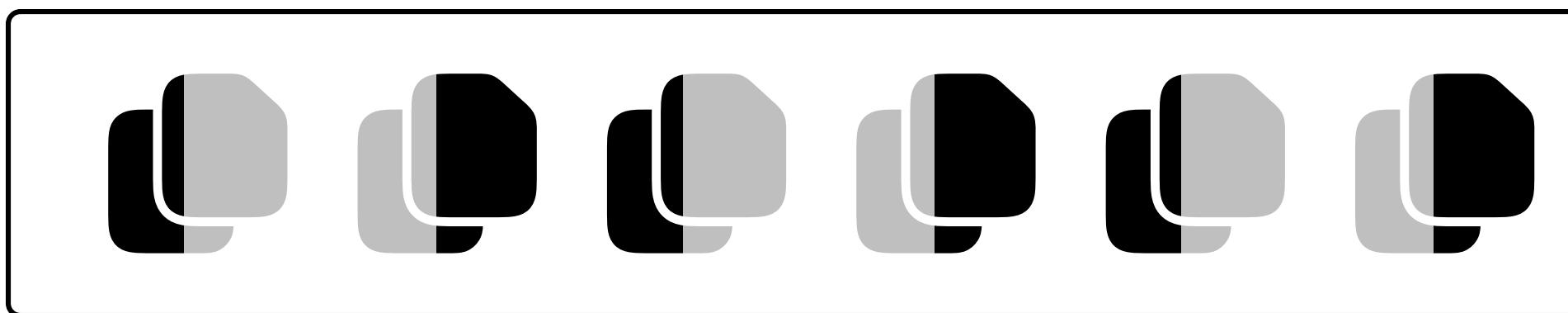
Shards & replicas

Number of shards = 2



Product Index

Sharding



Product Index

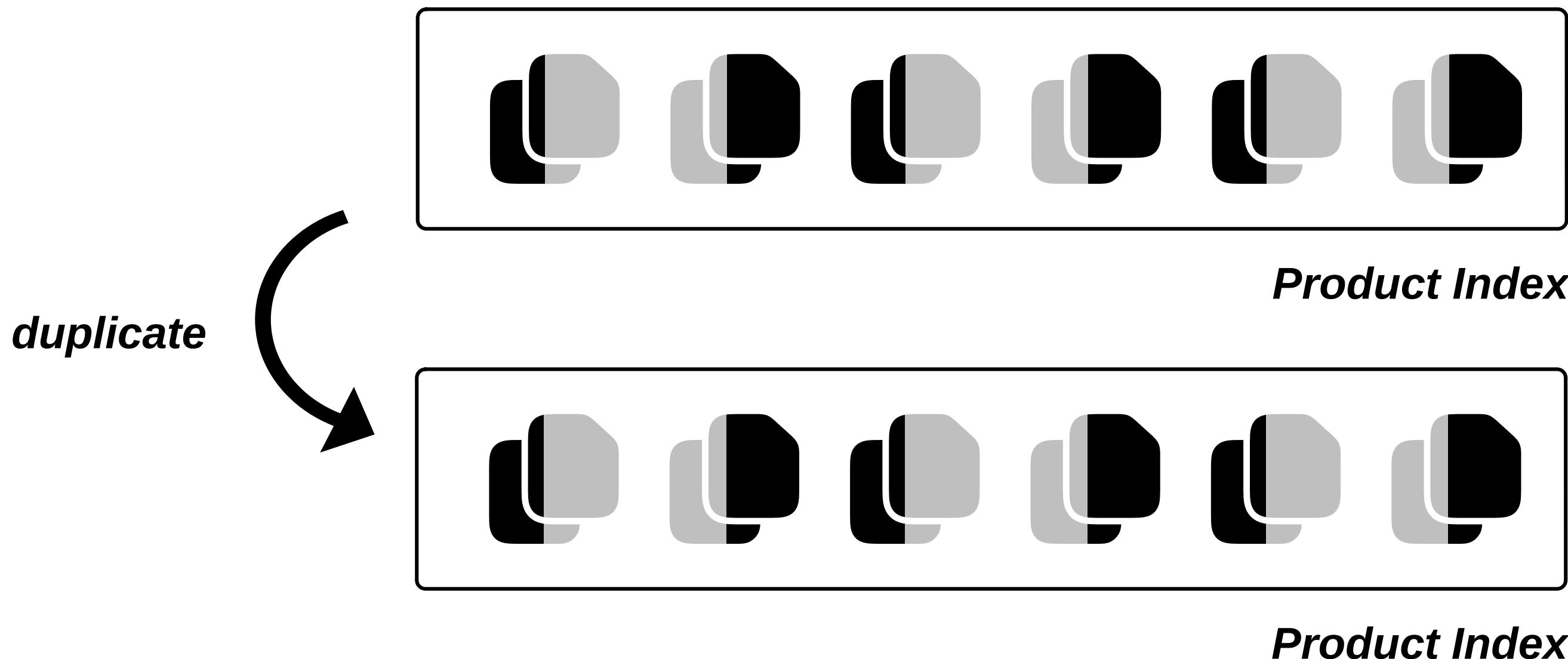
```
1 es.indices.delete(index='my_index', ignore_unavailable=True)
2 es.indices.create(
3     index="my_index",
4     settings={
5         "index": {
6             "number_of_shards": 3, # how many pieces the data is split into
7         }
8     },
9 )
```

Shards & replicas

Number of shards = 2

Number of replicas = 1

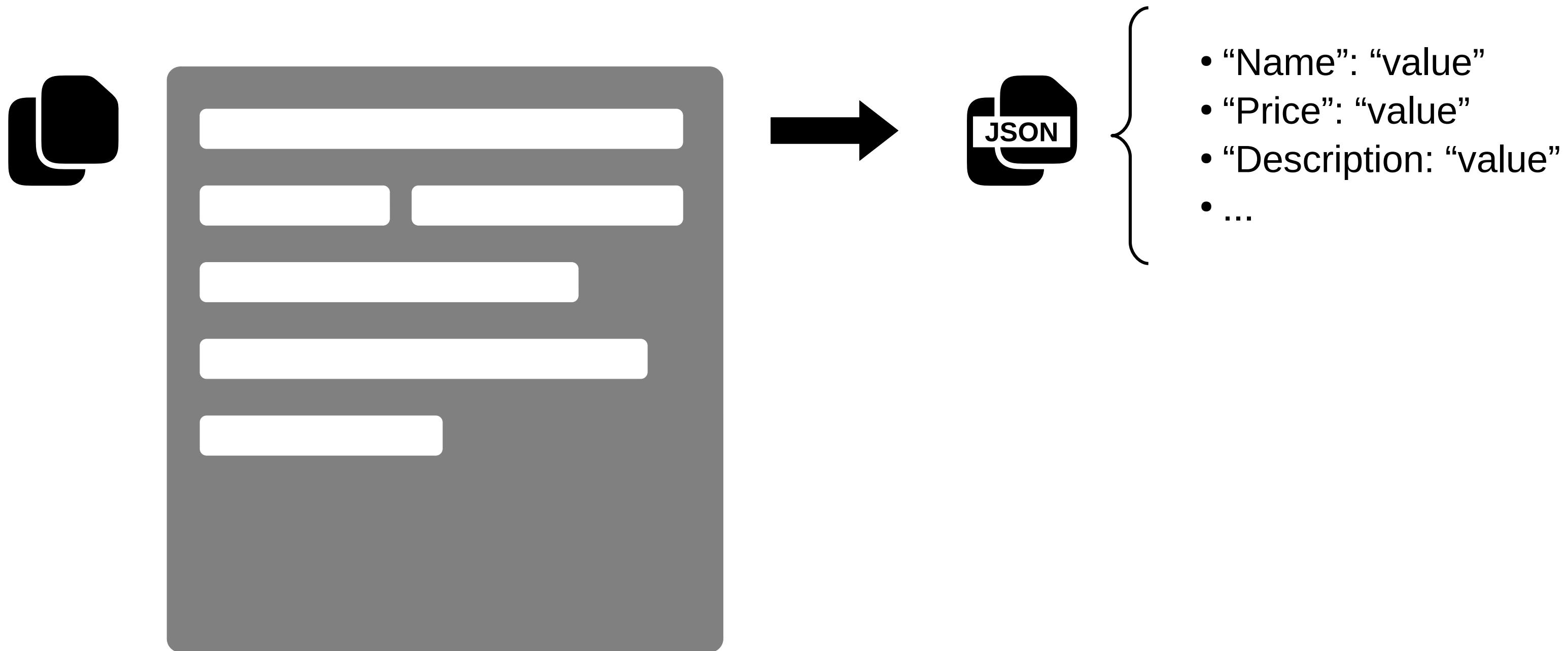
```
1 es.indices.delete(index='my_index', ignore_unavailable=True)
2 es.indices.create(
3     index="my_index",
4     settings={
5         "index": {
6             "number_of_shards": 3, # how many pieces the data is split into
7             "number_of_replicas": 2 # how many copies of the data
8         }
9     },
10 )
```



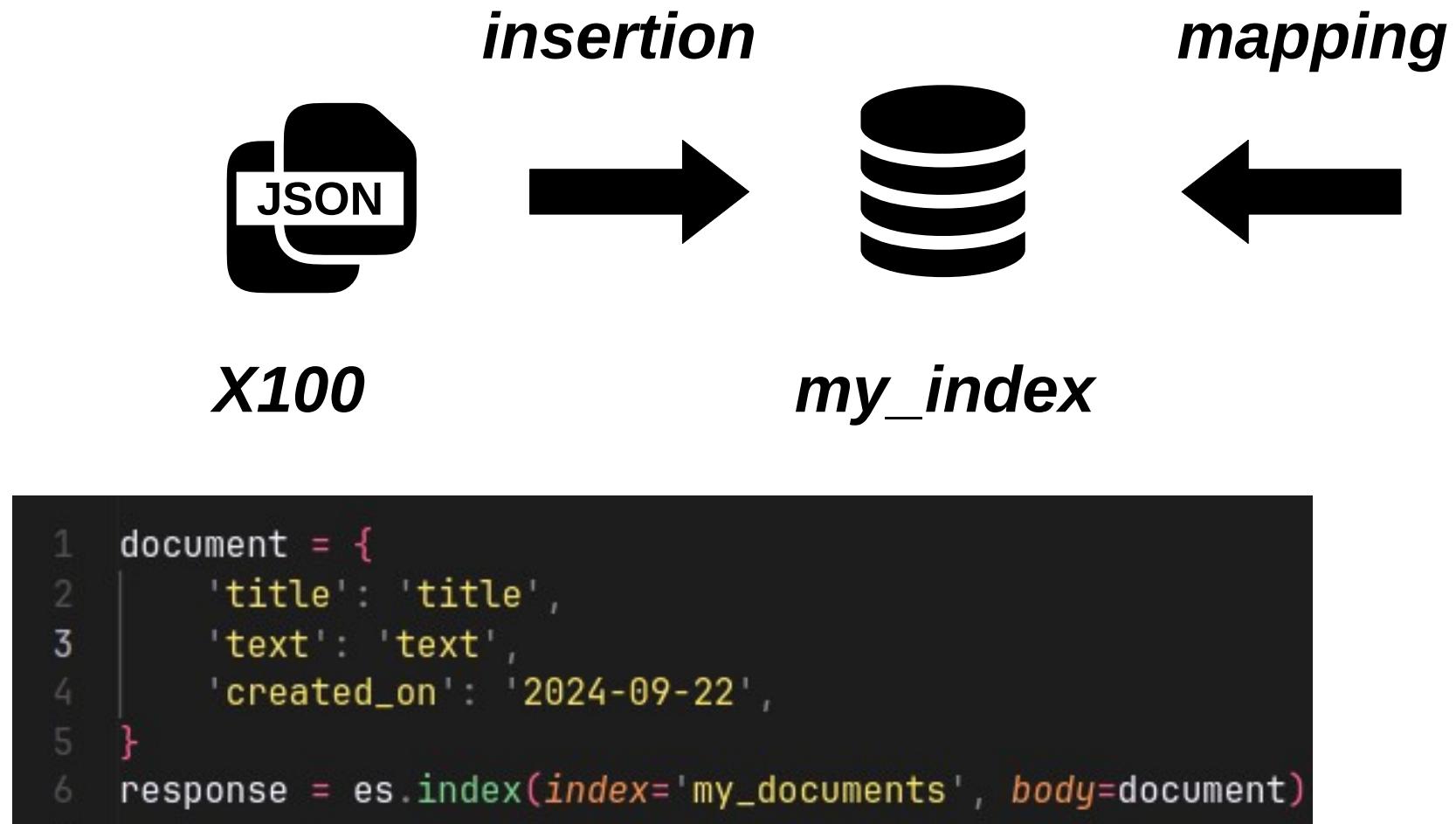
4

Inserting documents

Document



Document



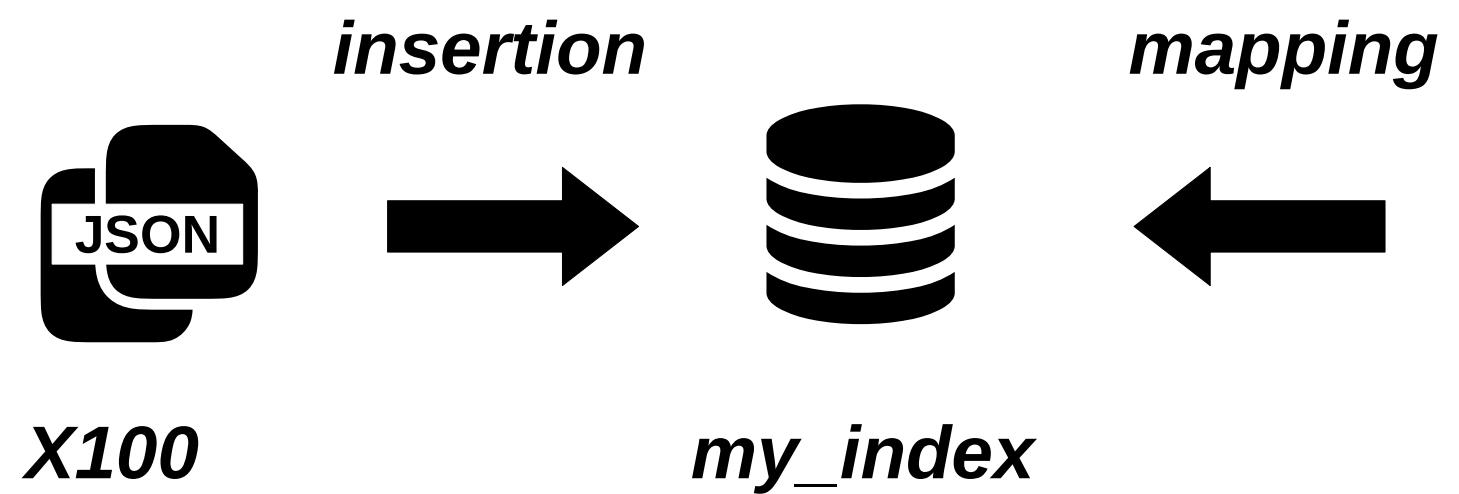
Field	Type
created_on	date
text	text
title	text

- ① This process is called ***mapping*** and can be done ***automatically*** or ***manually***. By ***default***, ElasticSearch does it ***automatically***.

5

Field data types

Field data types

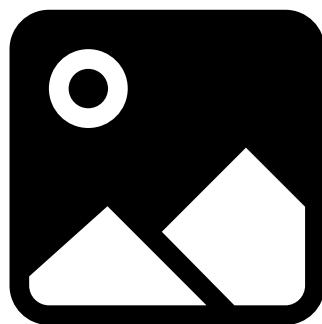


Field	Type
created_on	date
text	text
title	text

Field data types

1) Common types

- **Binary**
 - Accepts a binary value as a **Base64** encoded string.
 - Is not searchable and is not stored.
 - Use **_source (i.e., document)** to get the data back.



encoding
→

```
IVBORw0KGgoAAAANSUhEUgAAA  
OEAADhCAIAAAADIvBORw0KGgo  
AAAANSUhEUgAAAOEAAADhCAI  
A....
```

*Base64
representation*

Field data types

1) Common types

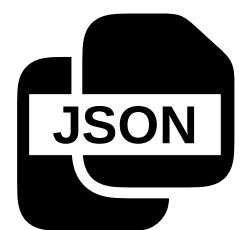
- **Binary**
- **Boolean** (True / False)
- **Numbers** (long, integer, byte, short, etc)
- **Dates**
- **Keyword** (IDs, email addresses, status codes, zip codes, etc)



Field data types

2) Objects types (JSON)

- Object



```
{  
    "region": "US",  
    "manager": {  
        "age": 30,  
        "name": {  
            "first": "John",  
            "last": "Smith"  
        }  
    }  
}
```

indexation



```
{  
    "region": "US",  
    "manager.age": 30,  
    "manager.name.first": "John",  
    "manager.name.last": "Smith"  
}
```

Field data types

2) Objects types (JSON)

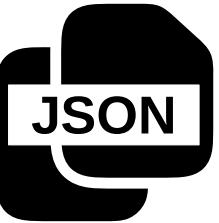
- **Object**
- **Flattened**
 - Efficient for deeply nested JSON objects.
 - Hierarchical structure is not preserved.
- **Nested**
 - Cases where you have array of objects.
 - Maintains relationship between the object's fields.



Field data types

2) Objects types (JSON)

- Flattened / Nested object example



```
{  
  "group": "fans",  
  "user": [  
    {  
      "first": "John",  
      "last": "Smith"  
    },  
    {  
      "first": "Alice",  
      "last": "White"  
    }  
  ]  
}
```

indexation



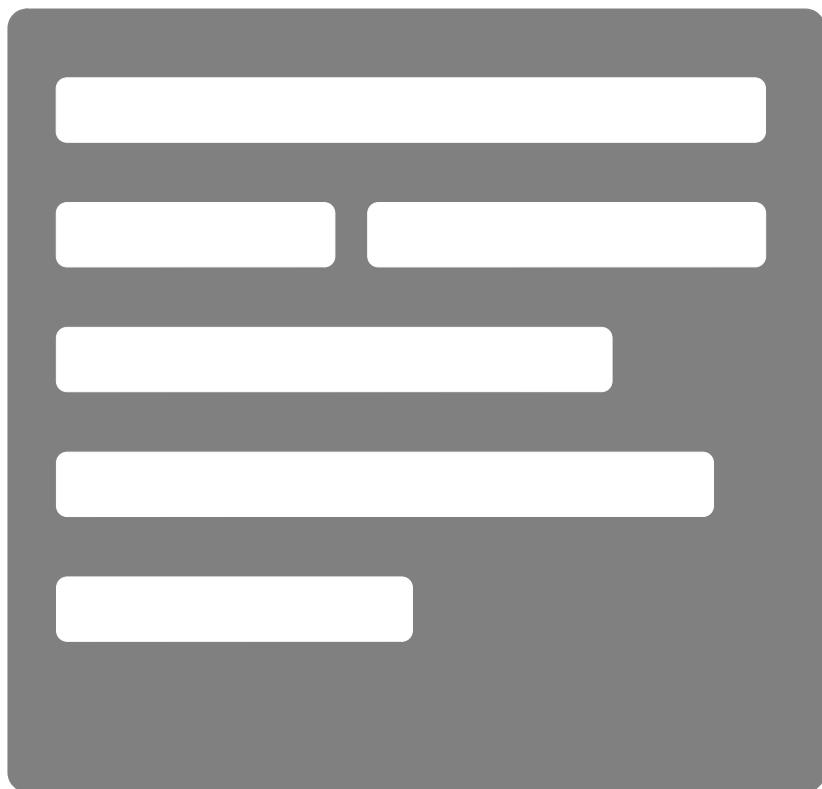
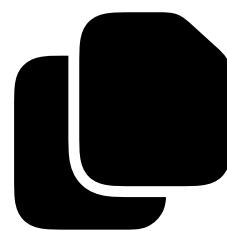
```
{  
  "group" : "fans",  
  "user.first" : [ "alice", "john" ],  
  "user.last" : [ "smith", "white" ]  
}
```



Field data types

3) Text search types

- **Text**
 - Used for full-text content.
 - Examples: Body of an email or the description of a product.



analyzer



Structured format that's optimized for search.

Unstructured format

Field data types

3) Text search types

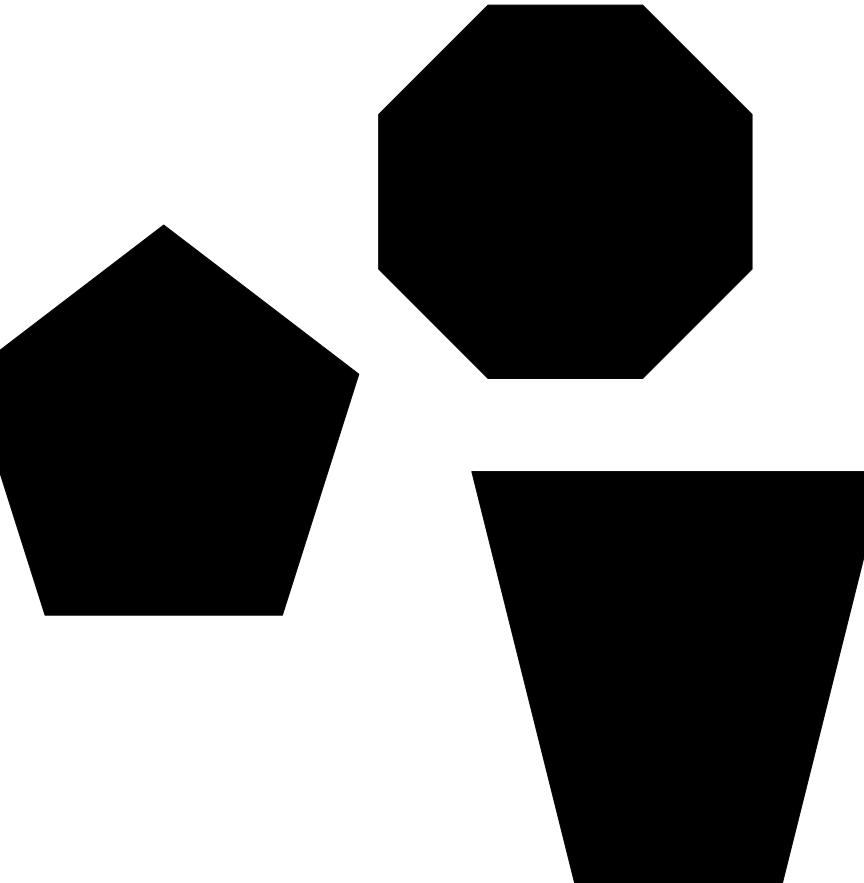
- **Text**
 - Used for full-text content.
 - Examples: Body of an email or the description of a product.
- **Completion**
- **Search as you type**
- **Annotated text**



Field data types

4) Spatial data types

- **Geo point**
- **Geo shape**
- **Point** (Cartesian point)
- **Shape** (Cartesian geometry)



Field data types



Elasticsearch Guide: [8.15 \(current\)](#)

What's new in 8.15

Elasticsearch basics

Quick starts

Set up Elasticsearch

Upgrade Elasticsearch

Index modules

Mapping

Platform Solutions Customers Resources Pricing Docs

Elastic Docs > Elasticsearch Guide [8.15] > Mapping

Field data types

edit

Each field has a *field data type*, or *field type*. This type indicates the kind of data the field contains, such as strings or boolean values, and its intended use. For example, you can index strings to both `text` and `keyword` fields. However, `text` field values are [analyzed](#) for full-text search while `keyword` strings are left as-is for filtering and sorting.

Field types are grouped by *family*. Types in the same family have exactly the same search behavior but may have different space usage or performance characteristics.

Currently, there are two type families, `keyword` and `text`. Other type families have only a single field type. For example, the `boolean` type family consists of one field type: `boolean`.

On this page

- Common types
- Objects and relational types
- Structured data types
- Aggregate data types
- Text search types
- Document ranking types
- Spatial data types
- Other types
 - Arrays
 - Multi-fields

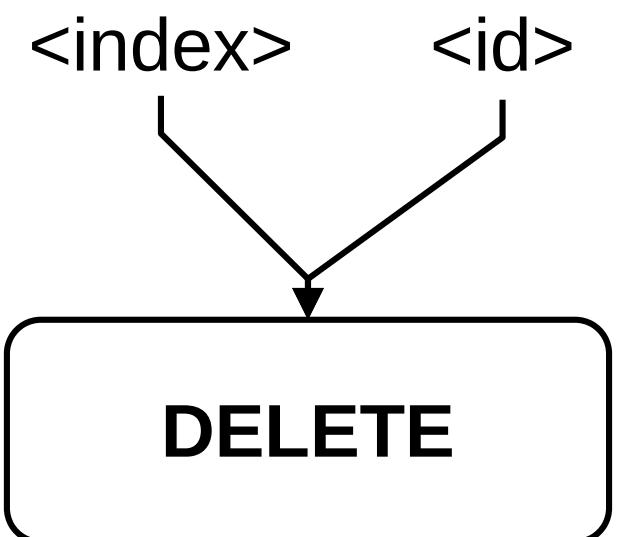
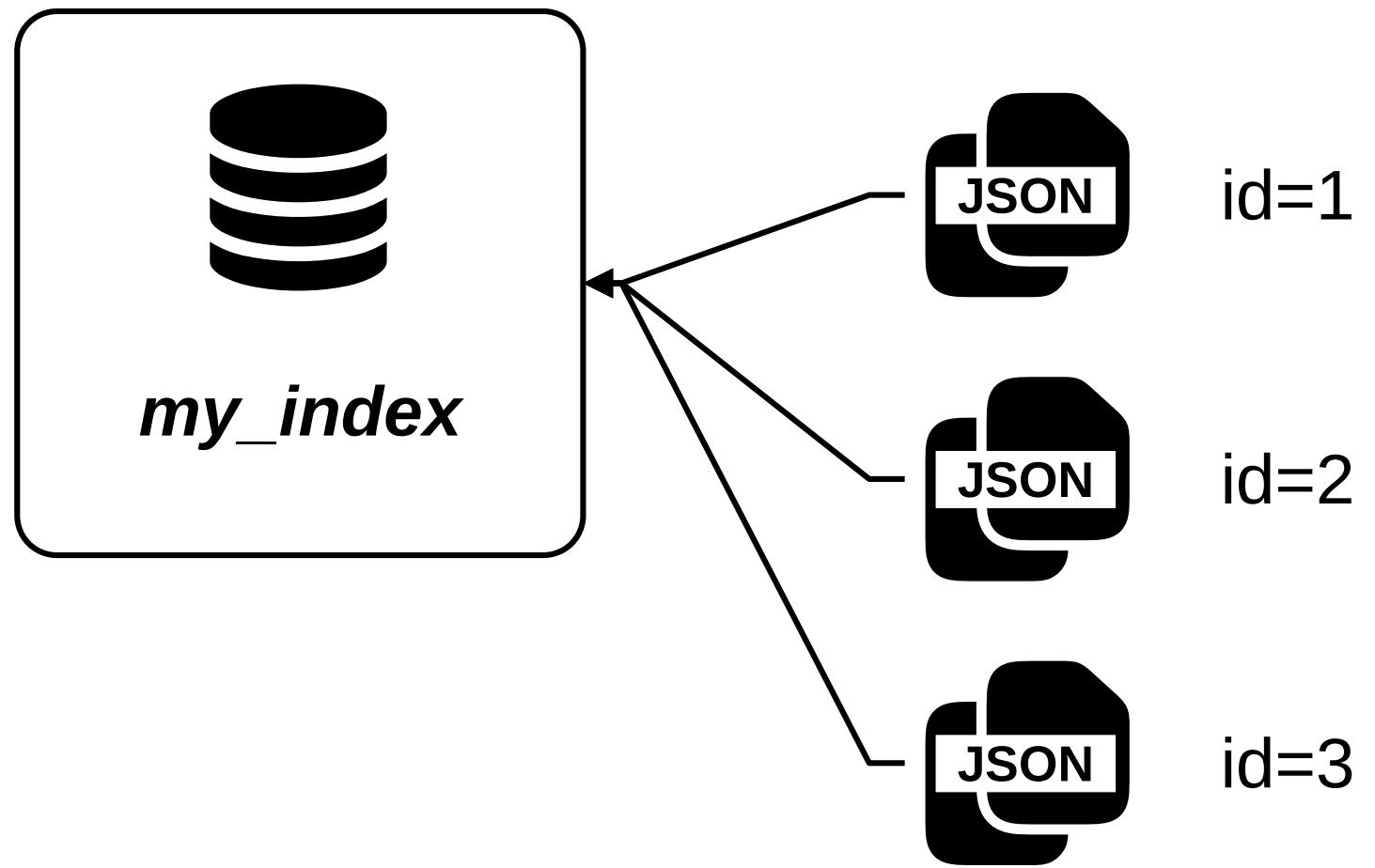
Most Popular

VIDEO

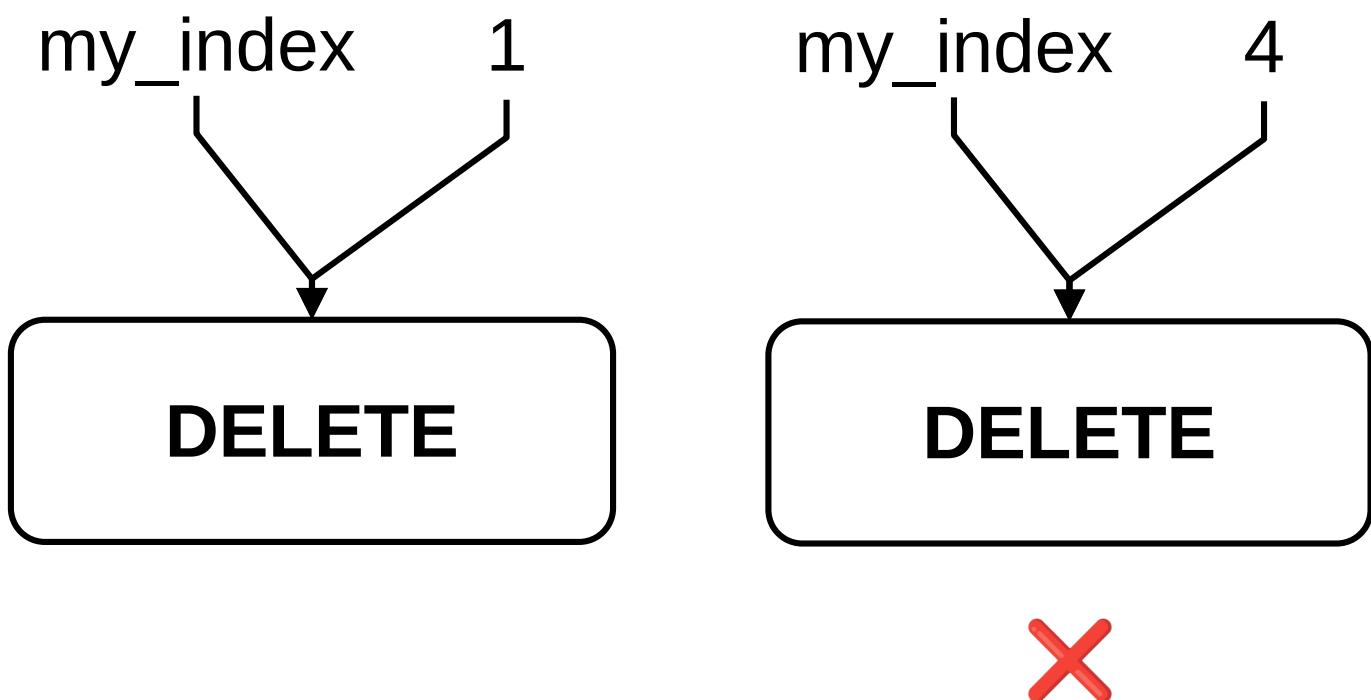
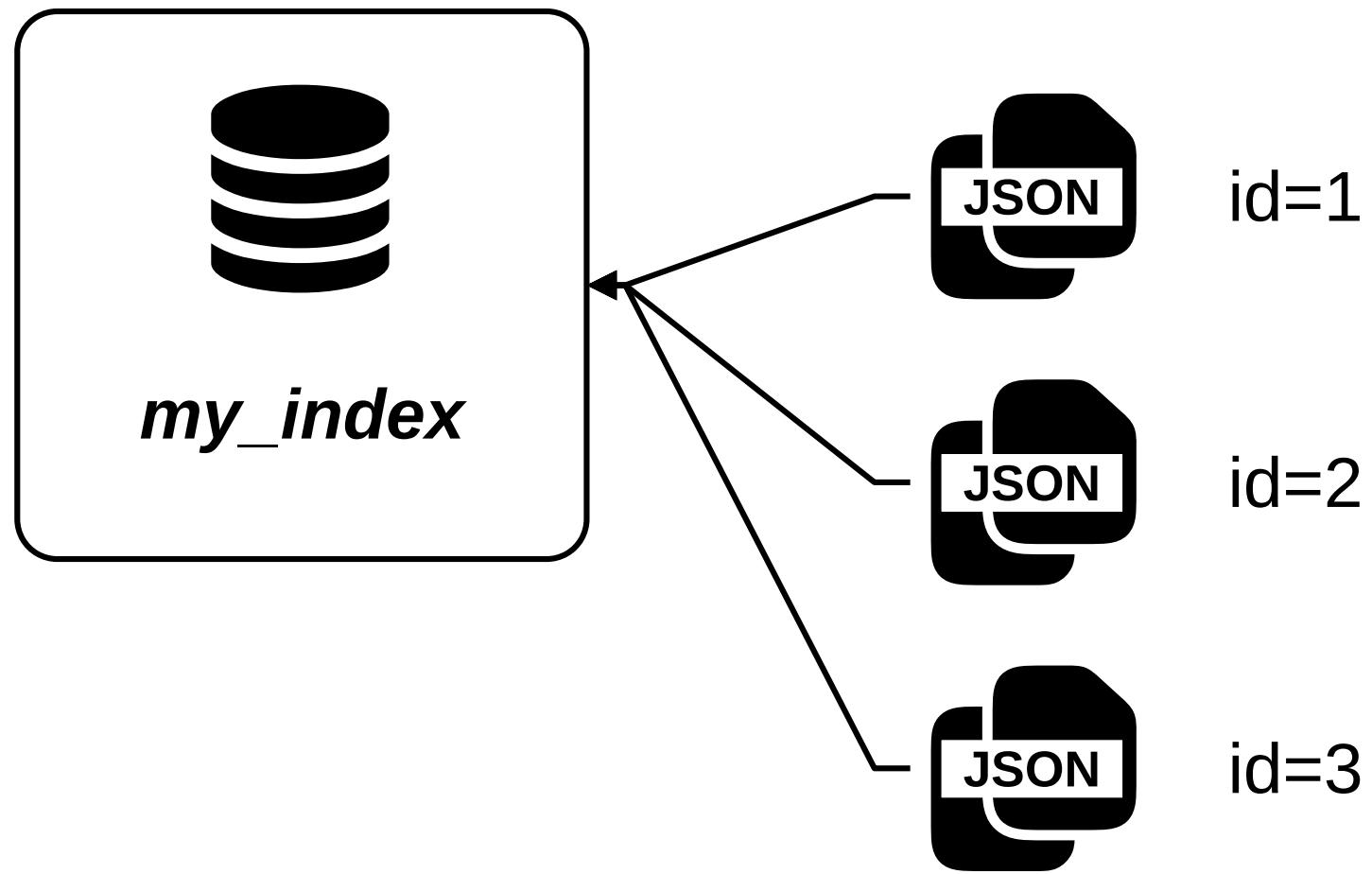
6

Delete documents

Delete documents



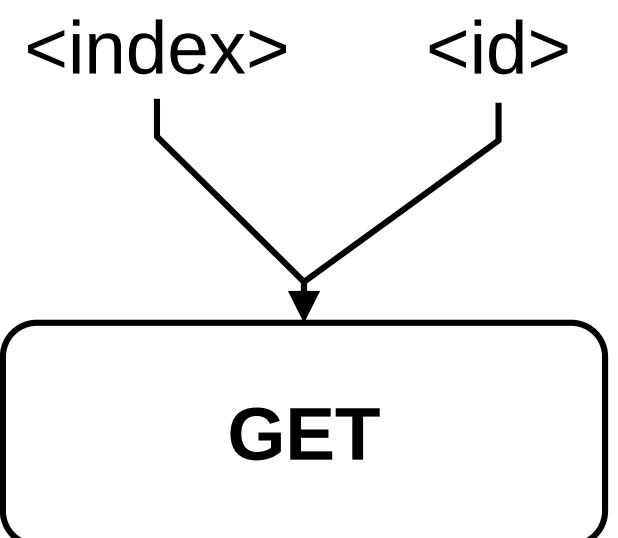
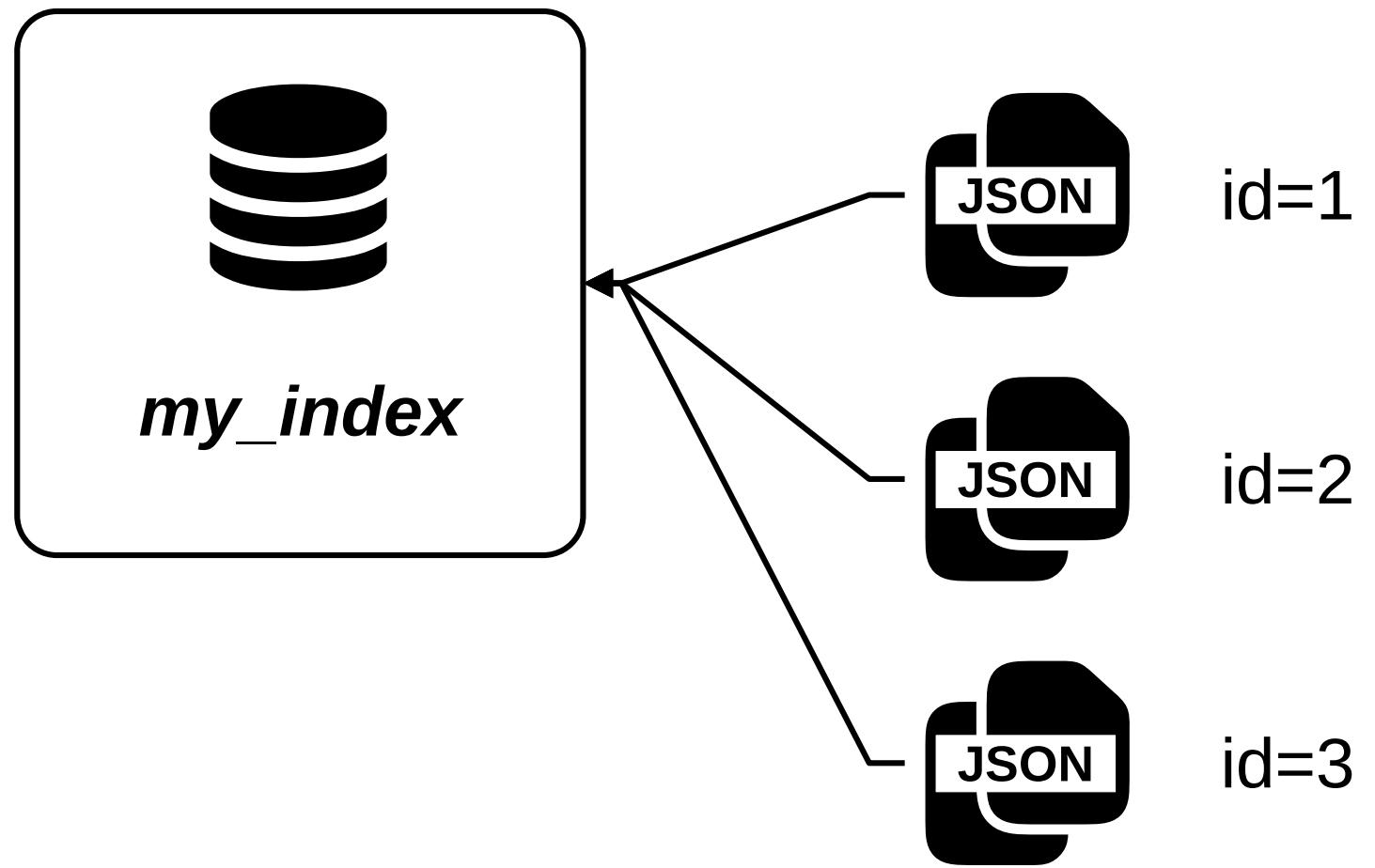
Delete documents



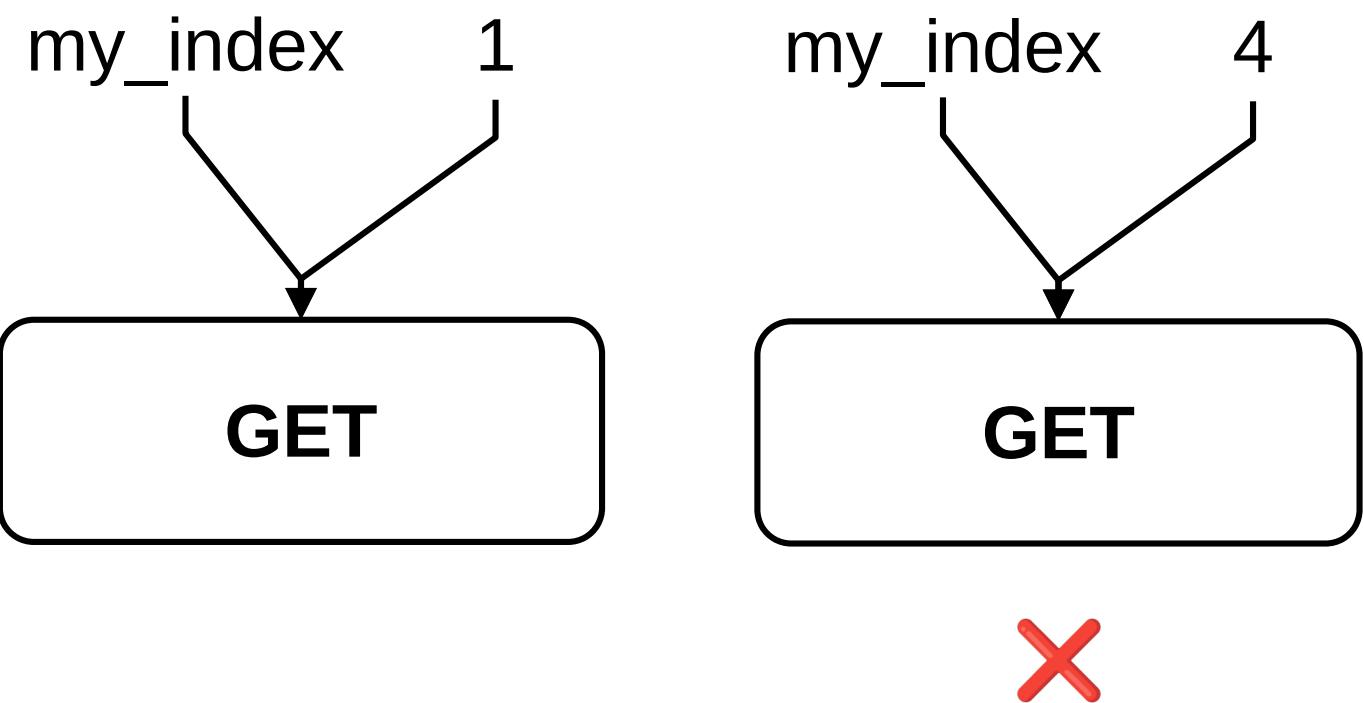
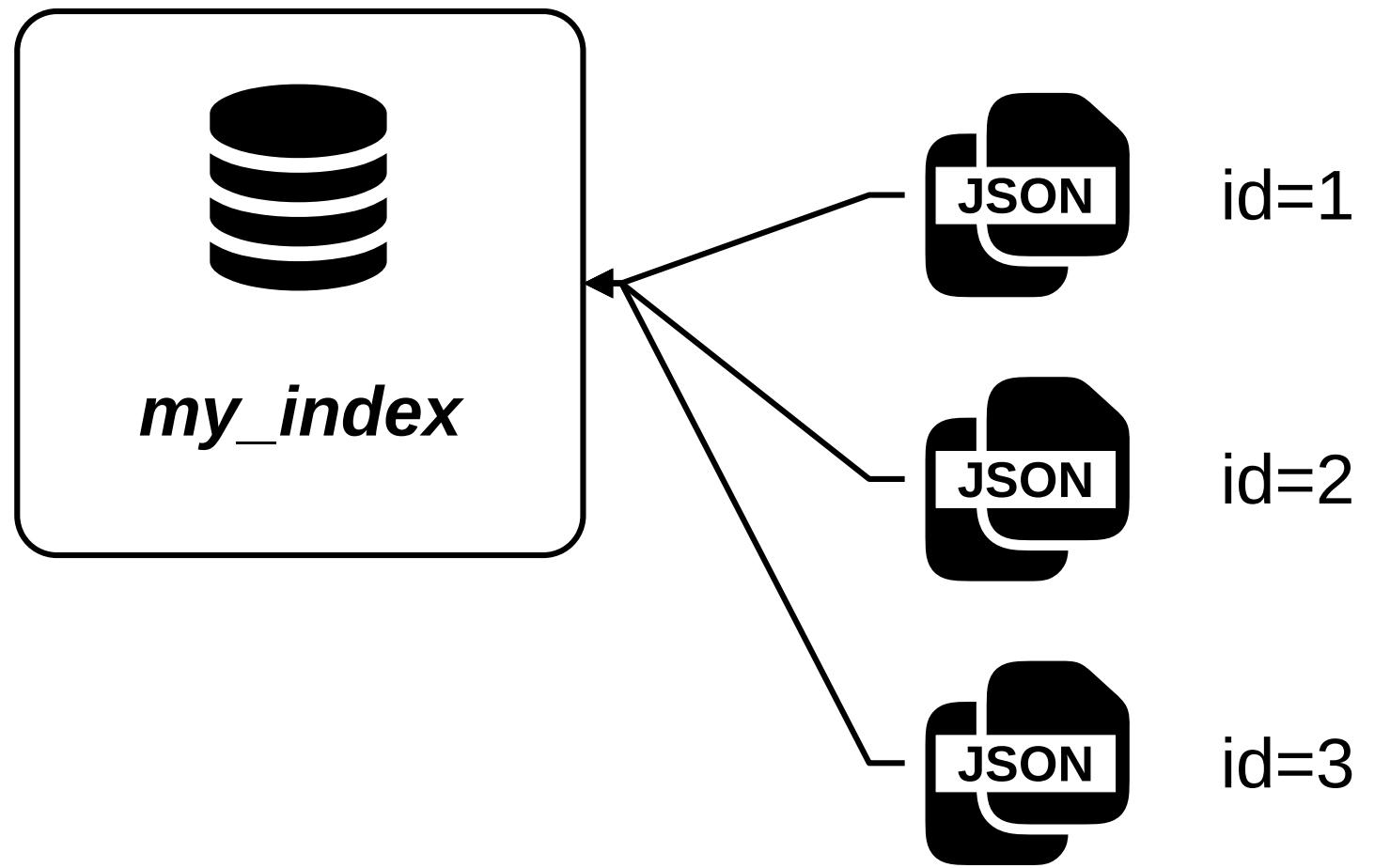
7

Get document

Get documents



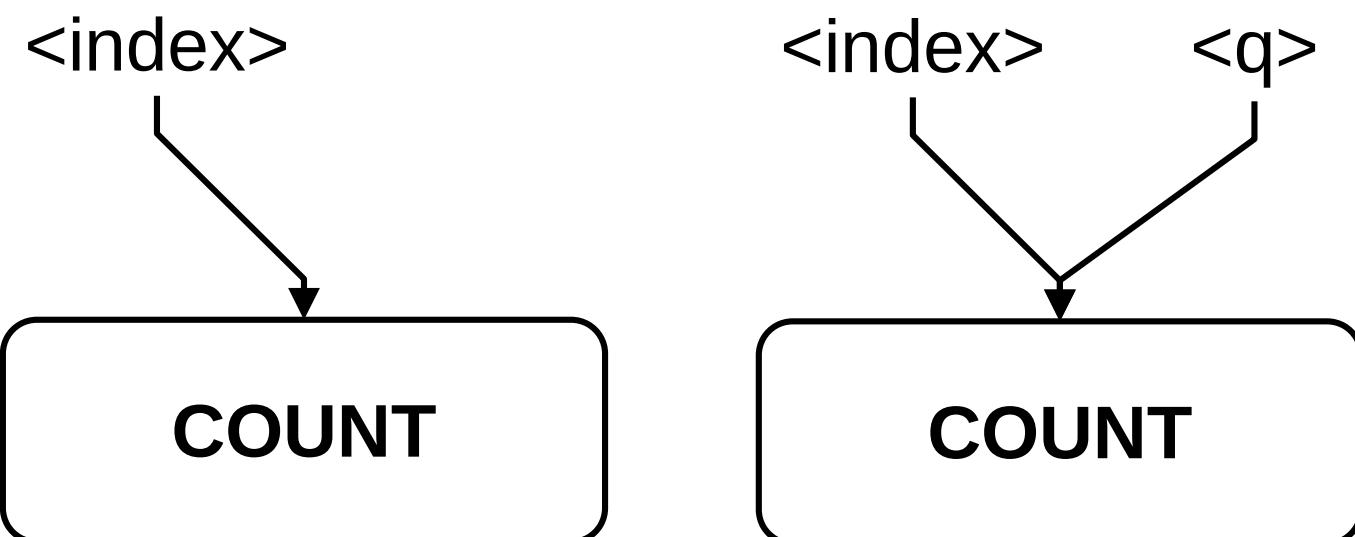
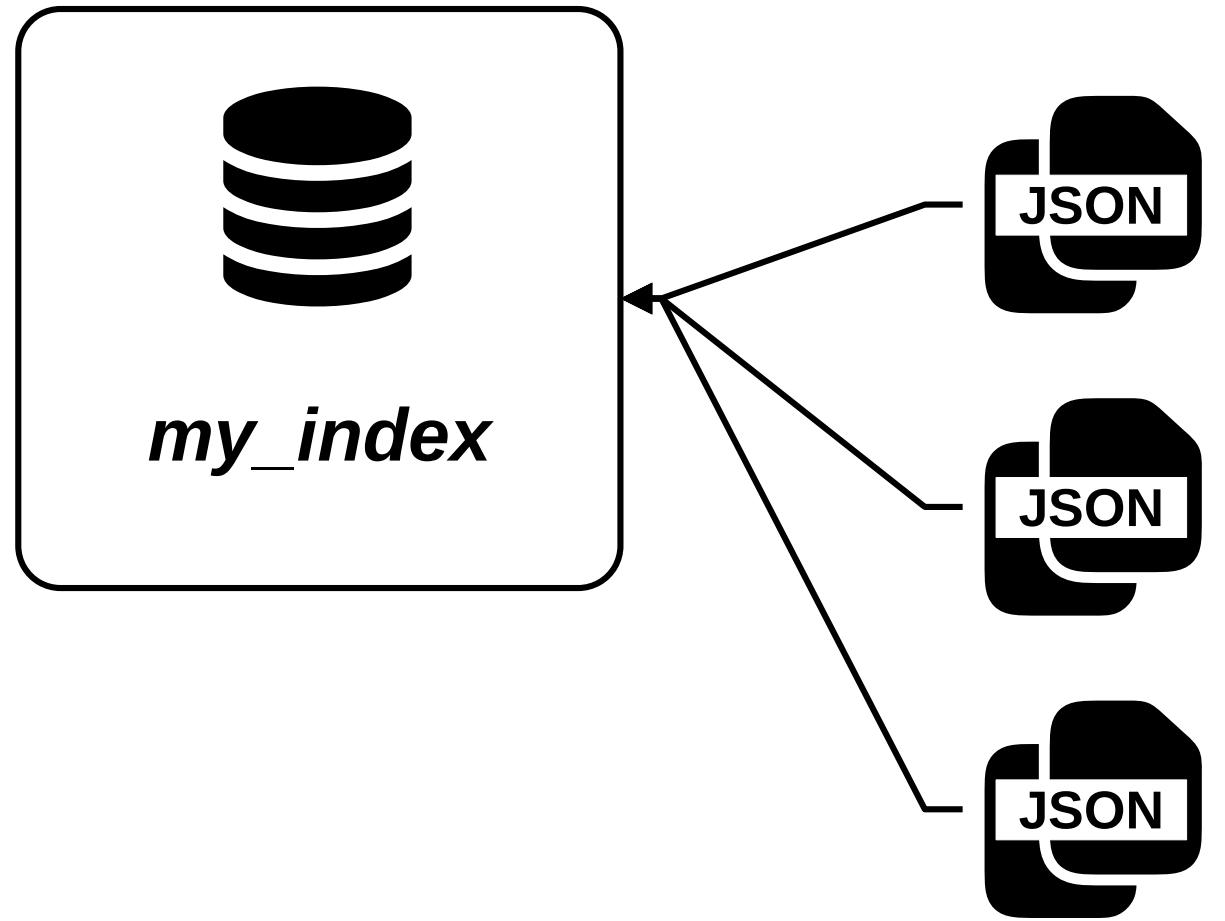
Get documents



8

Count documents

Count documents



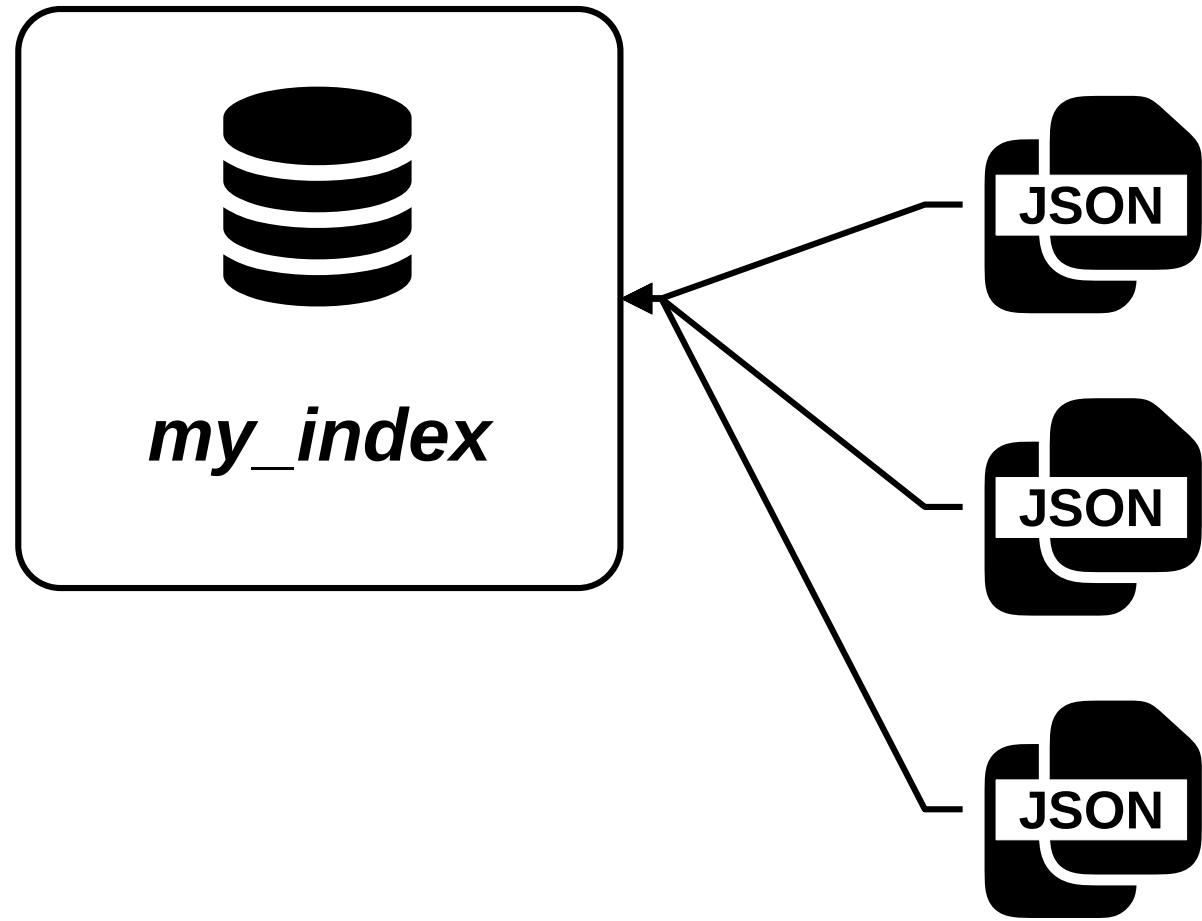
① The **query** parameter is used to match certain criteria



9

The exists API

The exists API



`<index>`

`client.indices.exists`

① This checks if an **index exists** in ElasticSearch.

`<index>`

`client.exists`

① This checks if a **document exists** in an index.

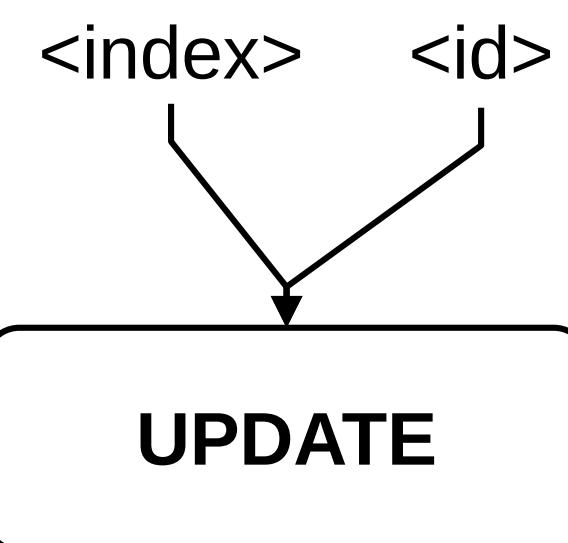
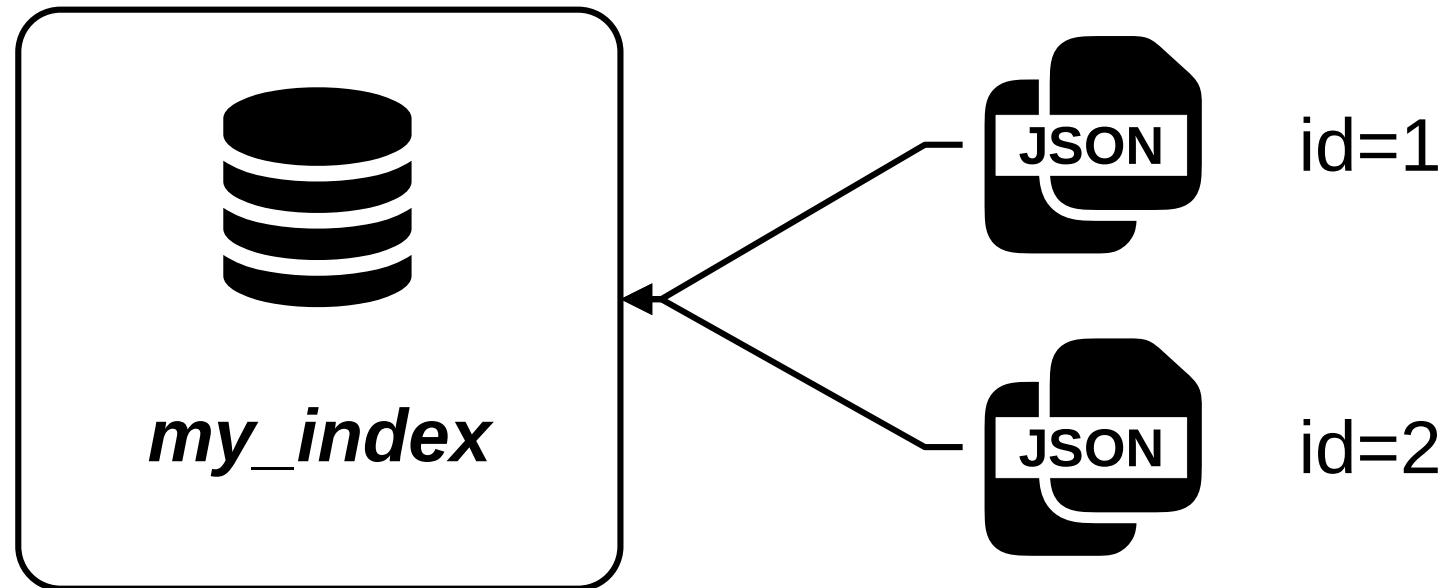


10

Update document

Update documents

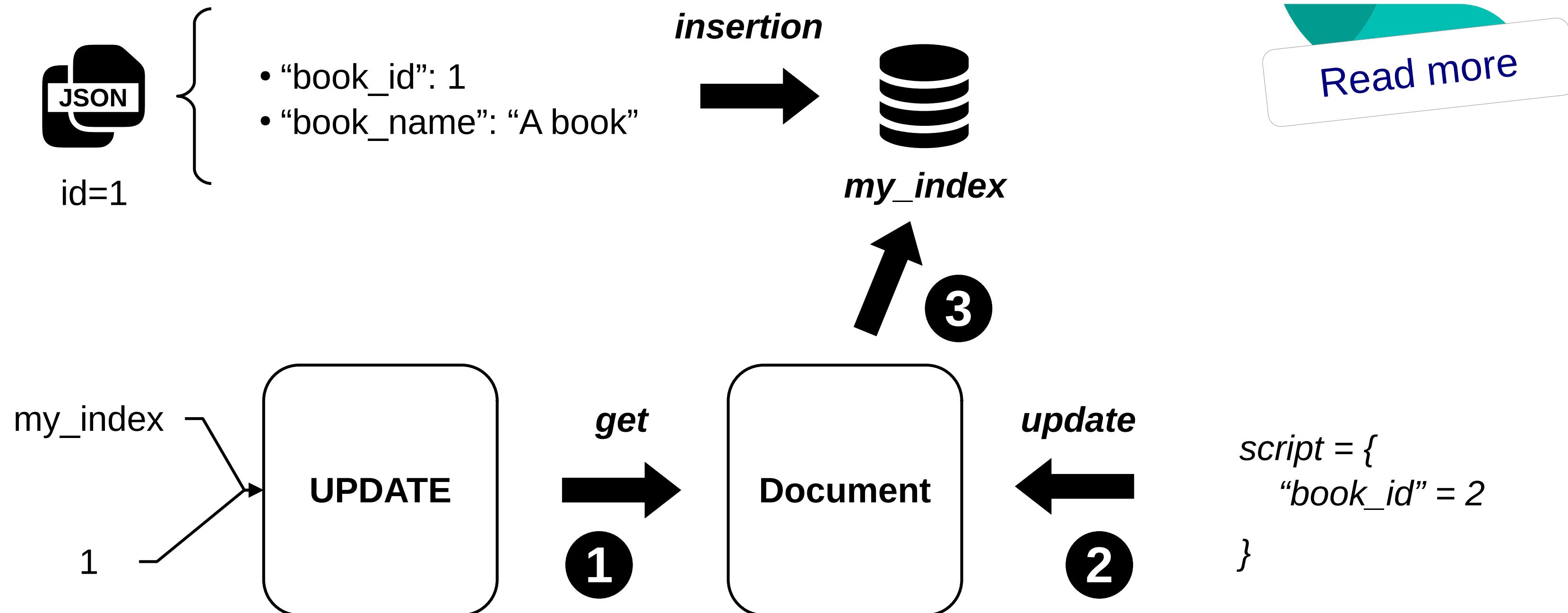
1) Documents exists in the index



- ⓘ The update operation follows these steps:
1. Get the document.
 2. Update it (e.g. **Add a new field**, **remove a field**, or **update a field**)
 3. Re-index the result.

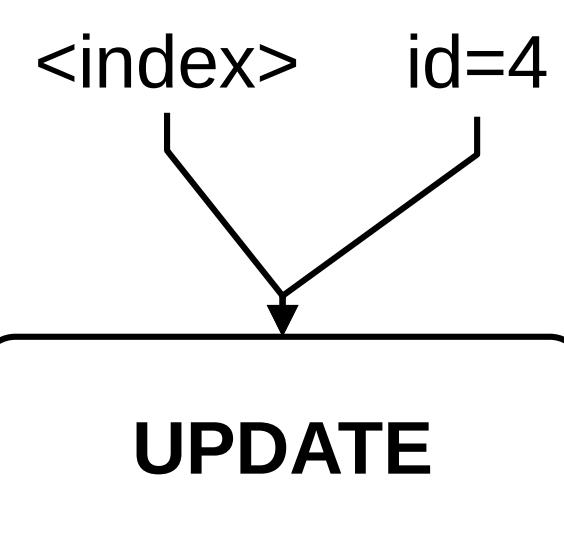
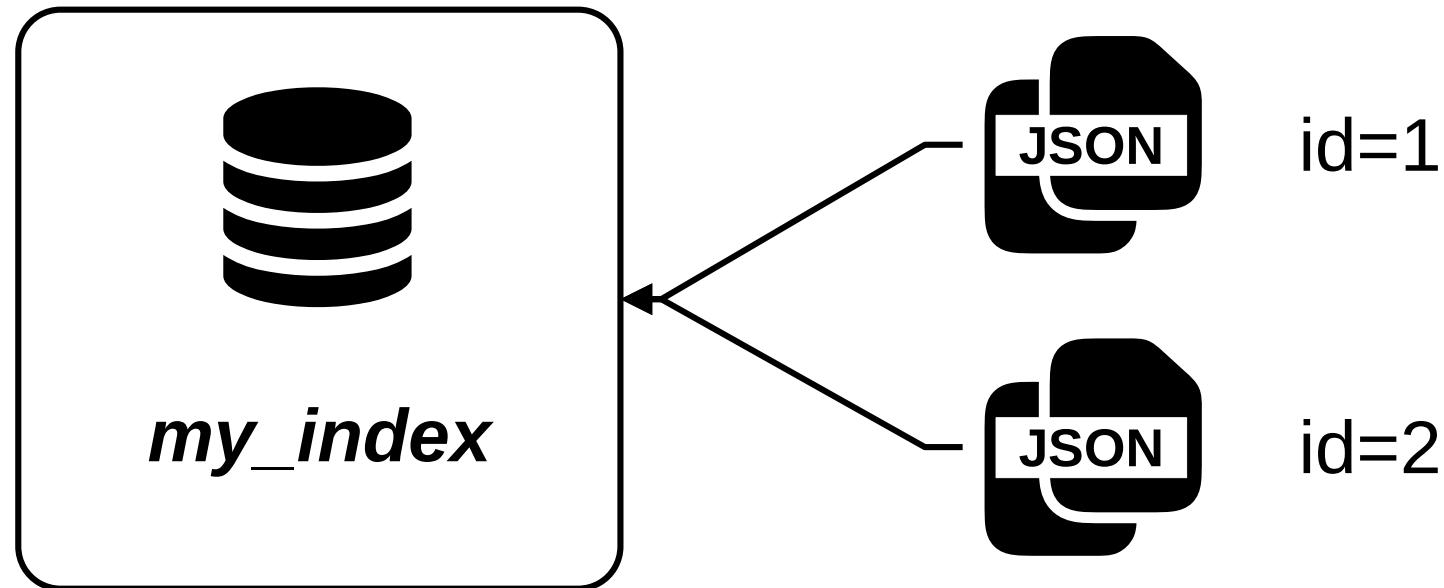
Update documents

But how do you update the document?



Update documents

2) Document doesn't exist

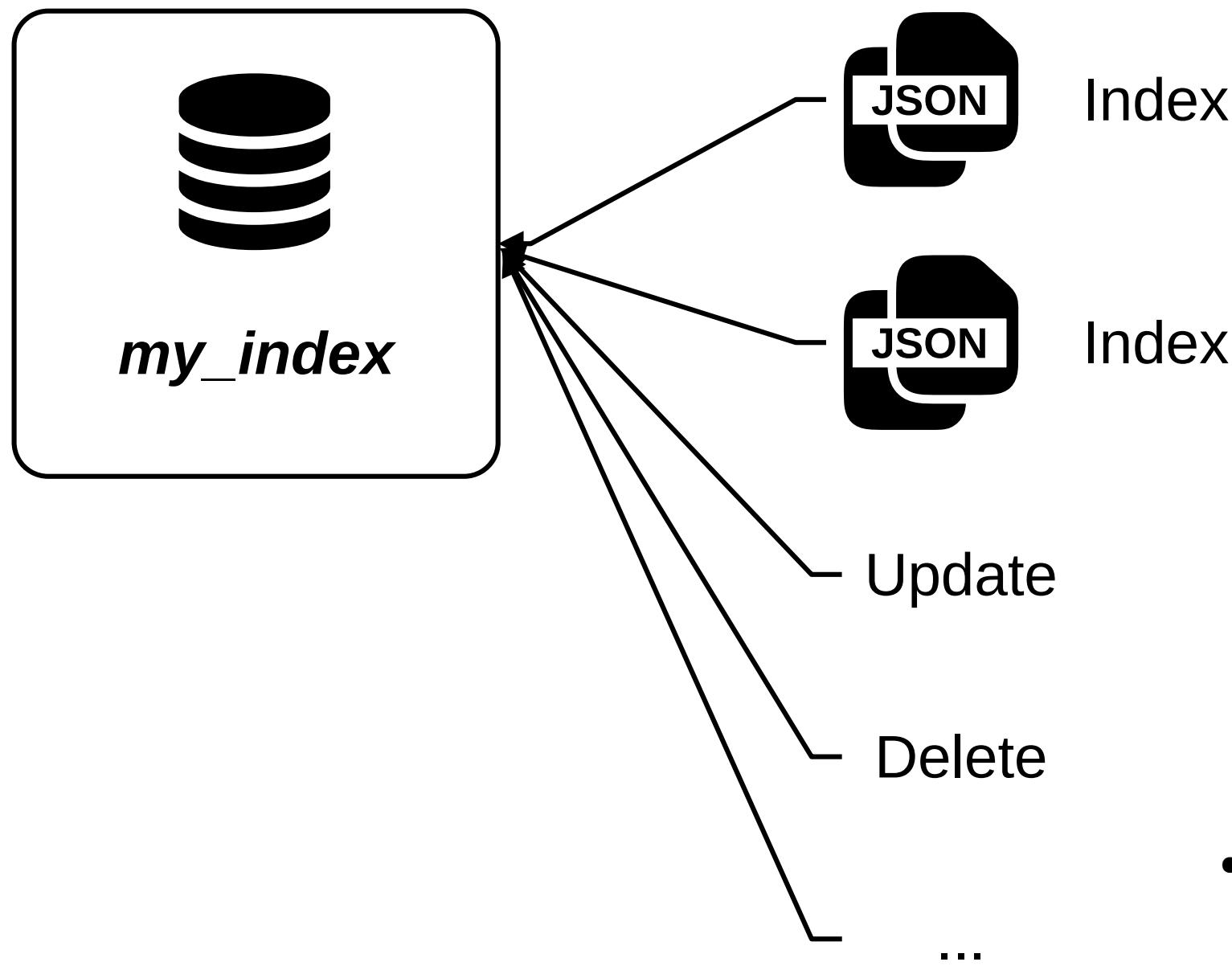


- ⓘ The update operation can create the document if it doesn't exist
 - 1. Add the values you want to insert.
 - 2. Set ***doc_as_upsert*** to true.

11

Bulk API

The bulk API



- Each operation (**index, update, delete**) makes a **separate API call**.
- The **bulk API** performs multiple operations in **one API call**.
This increases indexing speed.



The bulk API - Syntax

- action and metadata\n
 - optional source\n
- action and metadata\n
 - optional source\n
- ...
- action and metadata\n
 - optional source

- ① The source is required for:
- update
 - index
 - create

① The action can be one of the following:

- | | |
|----------|----------|
| • index | • update |
| • create | • delete |



The bulk API - Example

```
response = es.bulk(  
    operations=[  
        {  
            "index": {  
                "_index": "test",  
                "_id": "1"  
            }  
        },  
        {  
            "field1": "value1"  
        },  
        {  
            "delete": {  
                "_index": "test",  
                "_id": "2"  
            }  
        },  
        {  
            "create": {  
                "_index": "test",  
                "_id": "3"  
            }  
        },  
        {  
            "field1": "value3"  
        },  
        {  
            "update": {  
                "_id": "1",  
                "_index": "test"  
            }  
        },  
        {  
            "doc": {  
                "field2": "value2"  
            }  
        }  
    ]  
)
```

Action
Source

① The source is required for:

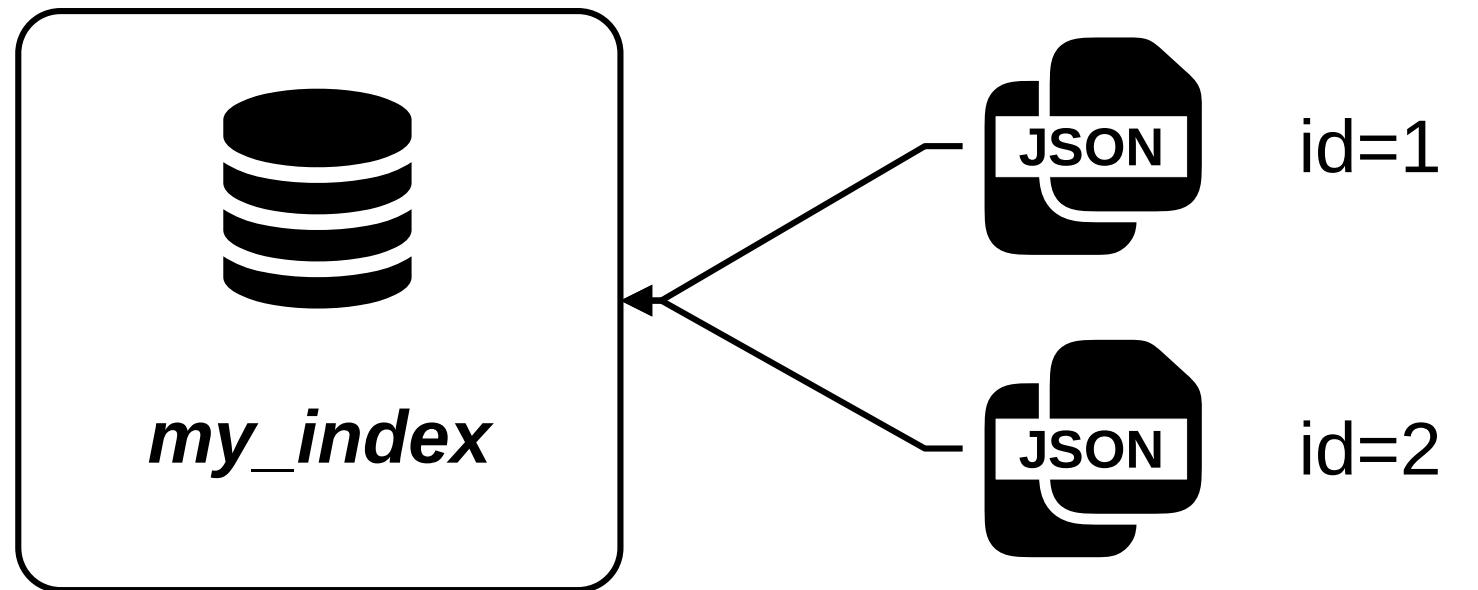
- update
- index
- create



12

The search API – Part 1

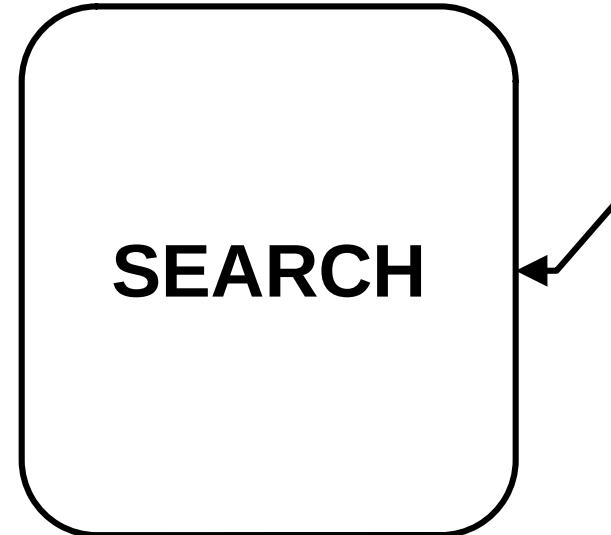
The search API



You use the search API to build:

- Search engines
- Recommendation systems
- Real-time dashboards
- Log data analysis
- ...

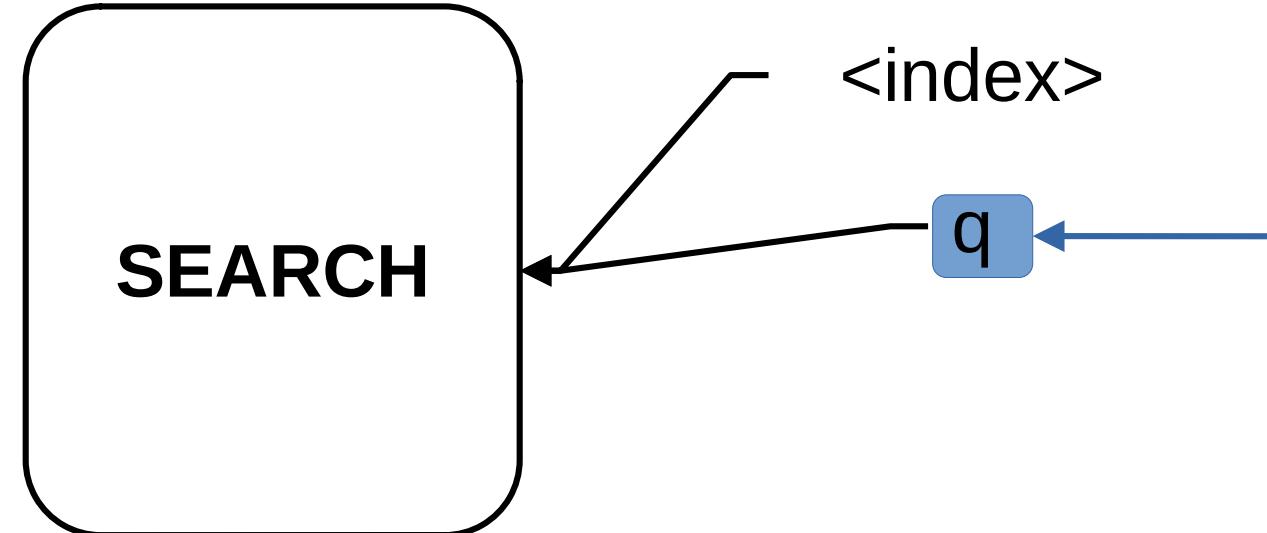
The search API



- my_index
- index_1,my_index
- index*
- _all



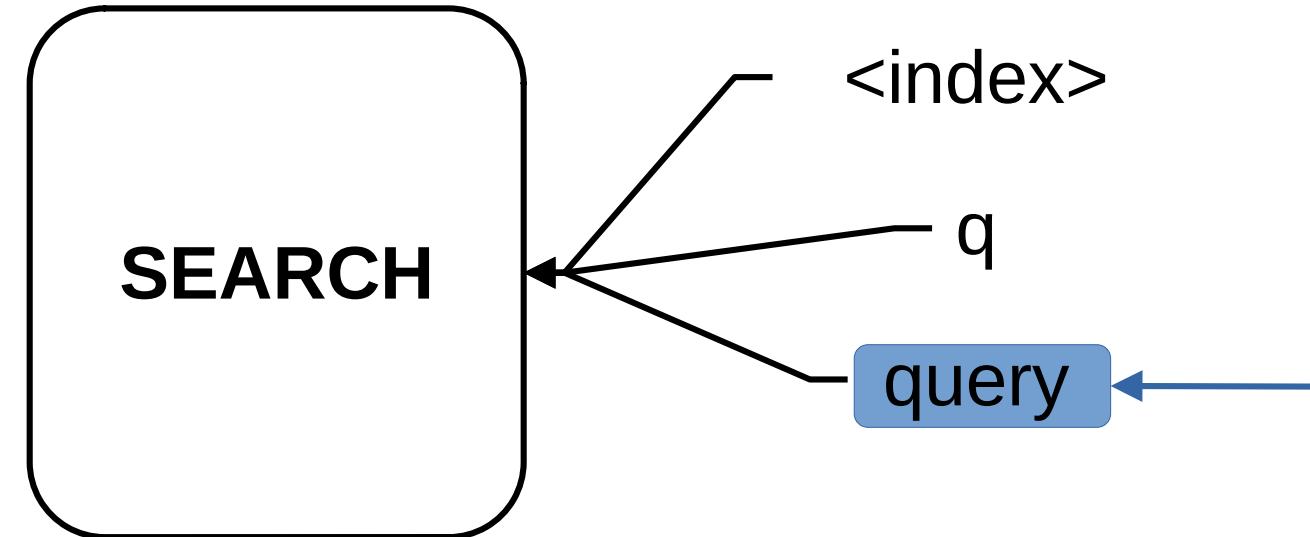
The search API



- Use it for simple searches.
- Uses the **Lucene** syntax.



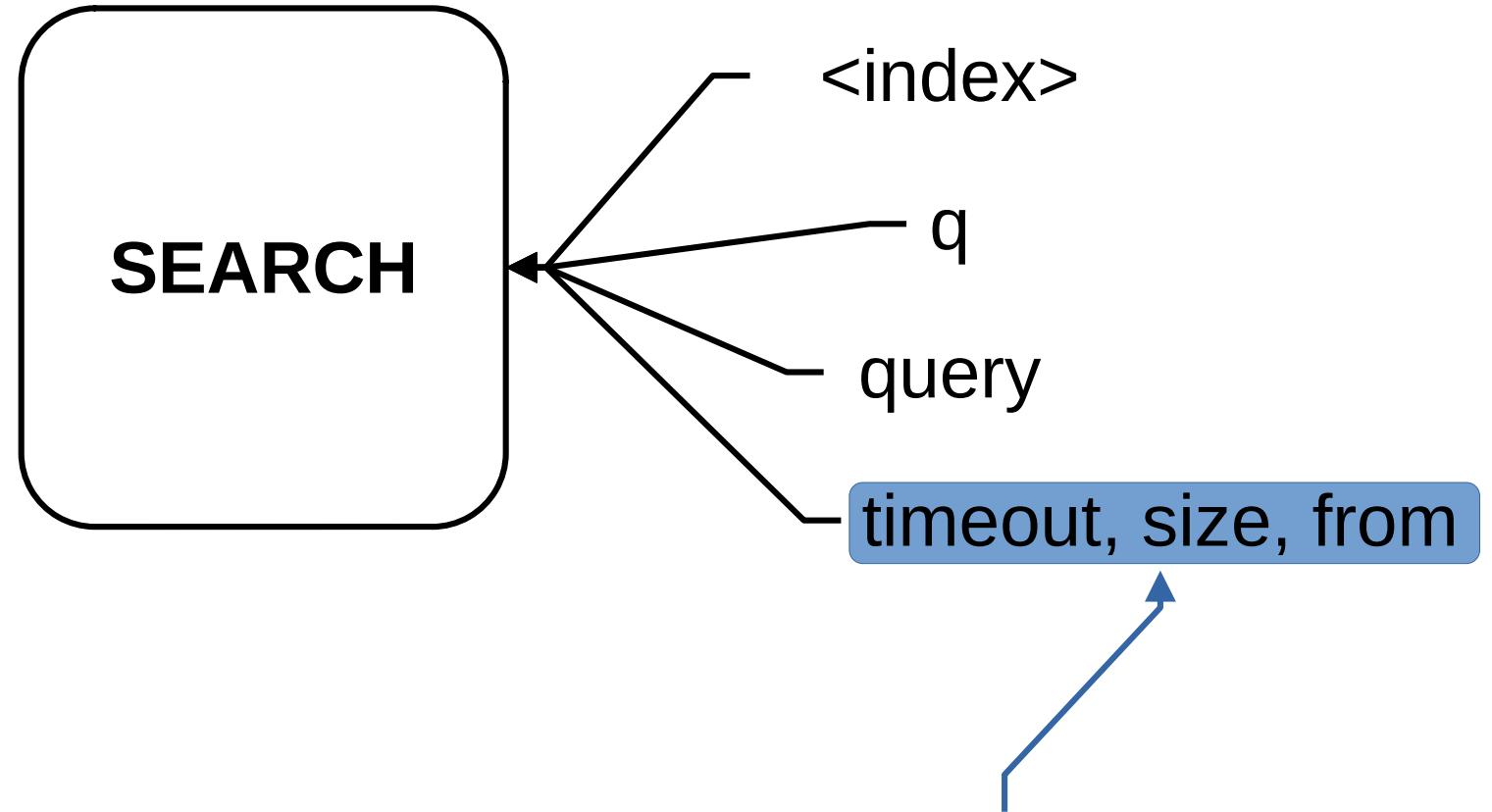
The search API



- Use it for complex, structured queries.
- Uses the **Query DSL** language.
- Default value is **match all**.

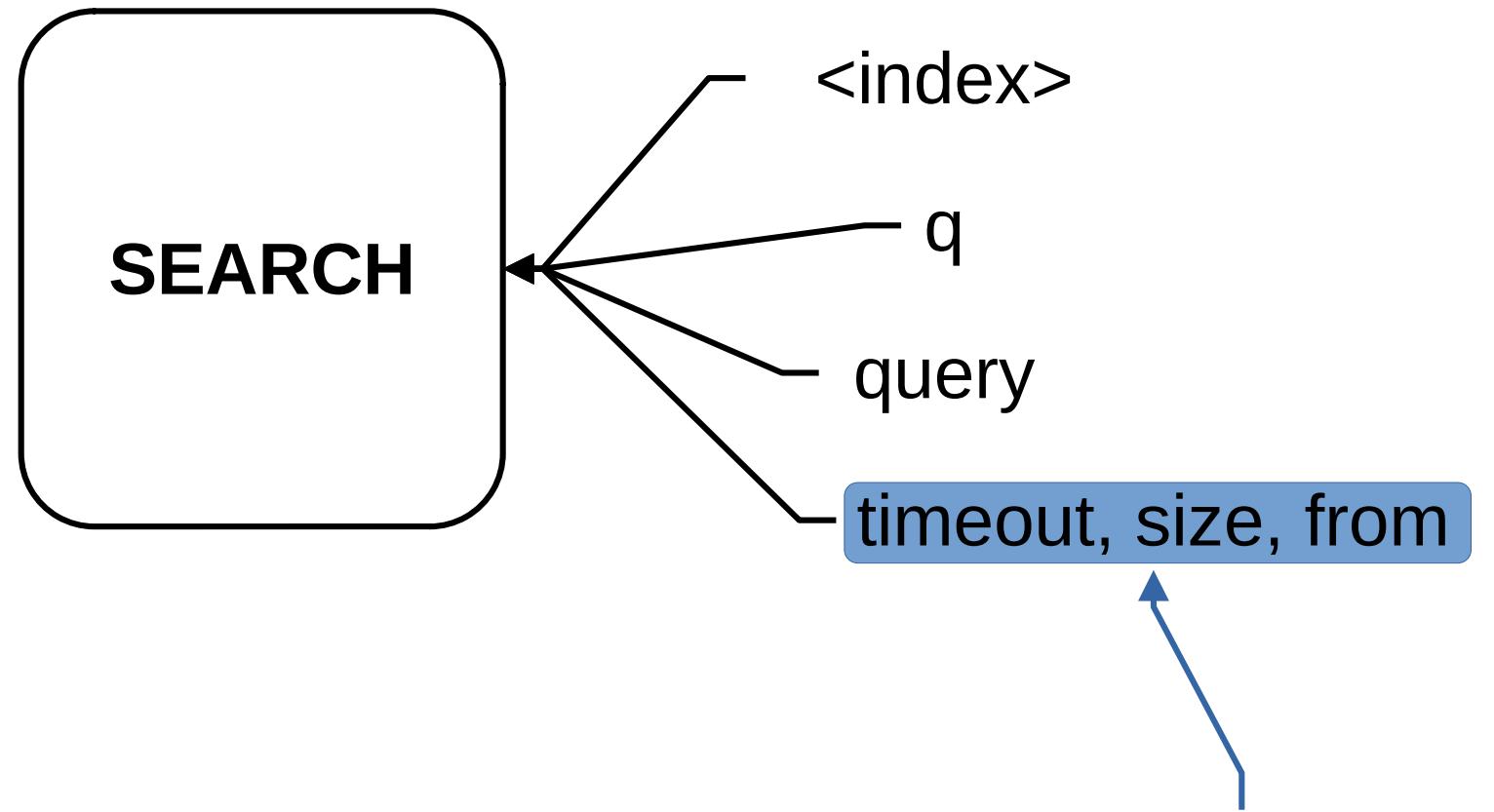


The search API



- **Timeout:**
 - The maximum time to wait for a search request to complete.
 - [Time units](#) (seconds, milliseconds, days, etc) .
- **Size:**
 - Defines the number of hits (documents) to return.
 - Default value is 10. Max value is 10000.

The search API



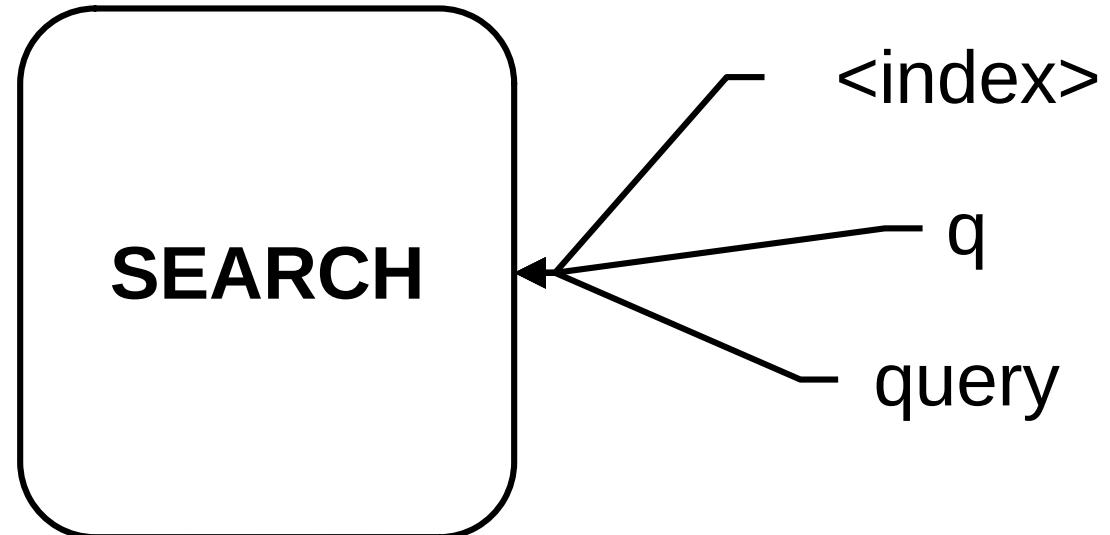
- **from:**
 - Starting point from which to return search results (**pagination**) .
 - Useful if you want to implement **skip** functionality.



13

The search API – Part 2

The search API – Query DSL



Query DSL is used to create complex, structured queries.

Query DSL consists of two types of clauses:

- Leaf clauses (**match, term, or range**)
- Compound clauses (**bool**)

ⓘ Query DSL means Query (Domain Specific Language)

The search API – Query DSL

Leaf clauses

1. **match**:

- Is used to perform **full-text search**.
- Returns documents that match a provided **text, number, date, or bool**.
- The field must be mapped to a **text** data type.

2. **term**:

- Returns documents that contain an **exact** term in a provided field.
- The field must be mapped to a **keyword** data type or a **numeric/date** type.
- Example usage : product ID, book ID, username, etc.

3. **range**:

- Returns documents that contain terms within a provided range.



The search API – Query DSL

- Example for match query:

```
response = es.search(  
    index="my_index",  
    body={  
        "query": {  
            "match": {  
                "description": "A description."  
            }  
        }  
    }  
)
```



The search API – Query DSL

- Example for term query:

```
response = es.search(  
    index="my_index",  
    body={  
        "query": {  
            "term": {  
                "product_id": "PRODUCT_12345"  
            }  
        }  
    }  
)
```



The search API – Query DSL

- Example for range query:

```
response = es.search(  
    index="my_index",  
    body={  
        "query": {  
            "range": {  
                "publication_date":  
                    {  
                        "gte": "2023-01-01",  
                        "lte": "2023-12-31"  
                    }  
            }  
        }  
    }  
)
```



The search API – Query DSL

Compound clauses

- **bool:**
 - Combines multiple queries using boolean logic:
 - **must, filter, should, must_not.**
 - The field must be mapped to a **text** data type.



The search API – Query DSL

- Example for bool query:

```
response = es.search(index="my_index", body={  
    "query": {  
        "bool": {  
            "must": [  
                {  
                    "match": {  
                        "title": "Elasticsearch"  
                    }  
                }  
            ],  
            "filter": [  
                {  
                    "term": {  
                        "status": "published"  
                    }  
                }  
            ],  
            "should": [  
                {  
                    "match": {  
                        "tags": "search"  
                    }  
                }  
            ],  
            "must_not": [  
                {  
                    "term": {  
                        "deleted": True  
                    }  
                }  
            ]  
        }  
    }  
})
```



The search API – Query DSL

- Example for bool query:

```
response = es.search(index="my_index", body={  
    "query": {  
        "bool": {  
            "must": [  
                {  
                    "match": {  
                        "title": "Elasticsearch"  
                    }  
                }  
            ],  
            "filter": [  
                {  
                    "term": {  
                        "status": "published"  
                    }  
                }  
            ],  
            "should": [  
                {  
                    "match": {  
                        "tags": "search"  
                    }  
                }  
            ],  
            "must_not": [  
                {  
                    "term": {  
                        "deleted": True  
                    }  
                }  
            ]  
        }  
    }  
})
```

Keeping documents where title is equal to
Elasticsearch



The search API – Query DSL

- Example for bool query:

```
response = es.search(index="my_index", body={  
    "query": {  
        "bool": {  
            "must": [  
                {  
                    "match": {  
                        "title": "Elasticsearch"  
                    }  
                }  
            ],  
            "filter": [  
                {  
                    "term": {  
                        "status": "published"  
                    }  
                }  
            ],  
            "should": [  
                {  
                    "match": {  
                        "tags": "search"  
                    }  
                }  
            ],  
            "must_not": [  
                {  
                    "term": {  
                        "deleted": True  
                    }  
                }  
            ]  
        }  
    }  
})
```

Filtering documents with a status of
published



The search API – Query DSL

- Example for bool query:

```
response = es.search(index="my_index", body={  
    "query": {  
        "bool": {  
            "must": [  
                {  
                    "match": {  
                        "title": "Elasticsearch"  
                    }  
                }  
            ],  
            "filter": [  
                {  
                    "term": {  
                        "status": "published"  
                    }  
                }  
            ],  
            "should": [  
                {  
                    "match": {  
                        "tags": "search"  
                    }  
                }  
            ],  
            "must_not": [  
                {  
                    "term": {  
                        "deleted": True  
                    }  
                }  
            ]  
        }  
    }  
})
```

This match is optional



The search API – Query DSL

- Example for bool query:

```
response = es.search(index="my_index", body={  
    "query": {  
        "bool": {  
            "must": [  
                {  
                    "match": {  
                        "title": "Elasticsearch"  
                    }  
                }  
            ],  
            "filter": [  
                {  
                    "term": {  
                        "status": "published"  
                    }  
                }  
            ],  
            "should": [  
                {  
                    "match": {  
                        "tags": "search"  
                    }  
                }  
            ],  
            "must_not": [  
                {  
                    "term": {  
                        "deleted": True  
                    }  
                }  
            ]  
        }  
    }  
})
```

Excluding any document where the **deleted** field is set to true



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The search API – Part 3

The search API

Timeout

- It sets the **maximum duration** for a query to execute.
- If the search **takes longer** than the specified time, Elasticsearch will **abort the search**.



The search API

Timeout

- Sets the **maximum duration** for a query to execute.
- If the search **takes longer** than the specified time, Elasticsearch will **abort the search**.

Size

- Controls how many search results are returned.
- Max value is **10000**.



The search API

Timeout

- Sets the **maximum duration** for a query to execute.
- If the search **takes longer** than the specified time, Elasticsearch will **abort the search**.

Size

- Controls how many search results are returned.
- Max value is **10000**.

From

- Used for pagination.
- It tells Elasticsearch how many documents to skip before starting to return results.



The search API

Aggregations

- Performs calculation on the data
- Average, max, min, count.



15

Dense vectors

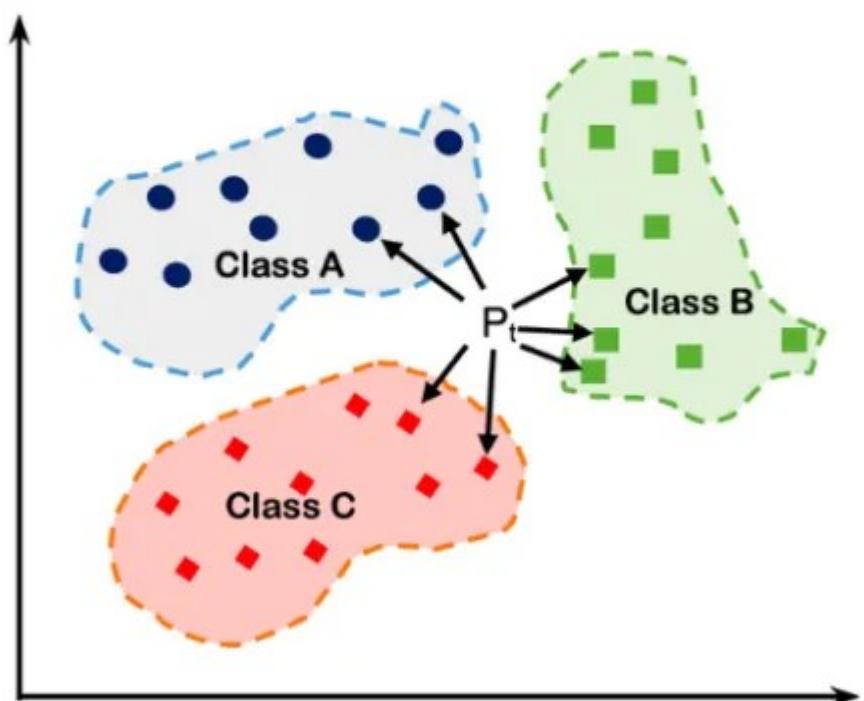
Dense vector field type

- Stores dense vectors of numeric values.
- Use it if you have few or no **zero elements**.
- Does not support **aggregations** or **sorting**.
- It is not possible to store **multiple** values in one dense vector field.
- Use **kNN search** to retrieve the nearest vectors.
- Max size of a dense vector is **4096**.



[2,**0**,1,−5,...,20]

[[...], [**...**], ...]



Dense vector field type

Examples

```
response = client.index(  
    index="my-index",  
    id="1",  
    document={  
        "my_text": "example text",  
        "my_vector": [0.5, 10, 6]  
    }  
)
```

```
response = client.index(  
    index="my-index",  
    id="2",  
    document={  
        "my_text": "example text",  
        "my_vector": [[0.5, 10, 6], [1, 0, -2]]  
    }  
)
```



Dense vector field type

Important

- You have to **manually** do the **mapping**.
- Elasticsearch **does not automatically** infer the mapping for dense vectors.
- It needs to know the **exact number of dimensions**.

```
response = es.indices.create(  
    index="my_index",  
    mappings={  
        "properties": {  
            "sides_length": {  
                "type": "dense_vector",  
                "dims": 4  
            },  
            "shape": {  
                "type": "keyword"  
            }  
        }  
    },  
)
```

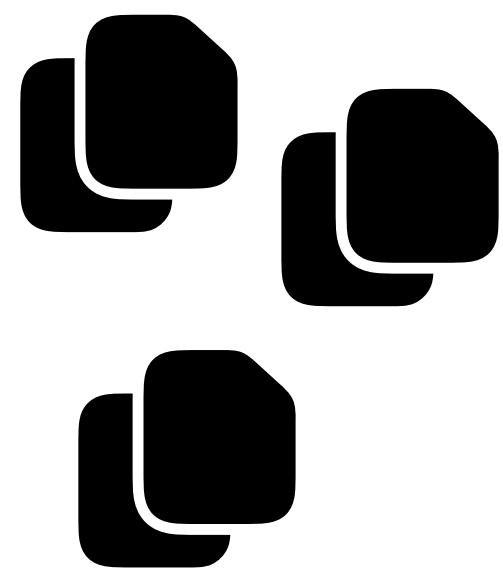


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Embedding documents

Embedding documents

- **Embedding** transforms text into numerical vectors.
- **Deep learning models** are used to embed documents.
- These models preserve the **meaning** of the text.
- Use cases:
 - Recommendation systems
 - Retrieval-Augmented Generation (RAG)



embedding

$[2, 0, 1, -5, \dots, 20]$

$[0.54, -4.2, 0, -0.6, \dots, 1]$

$[3, 0.33, -.98, -1, \dots, -1.1]$

Embedding documents

Deep learning models



- **Closed** models.
- **Paid** (Pay what you use).
- No hardware required (**Cloud**).
- **Open-source** models.
- **Free** to use.
- Hardware is required (**preferably GPU**).



Embedding documents

Embedding size

- Size of the dense vector.
- Larger sizes yield better embeddings.
- Common sizes include **384, 768, 1024**.

Models 6,622 Filter by name

- sentence-transformers/all-MiniLM-L6-v2**
Sentence Similarity • Updated 10 days ago • 49.8M • 2.42k
- sentence-transformers/paraphrase-multilingual-MiniL...**
Sentence Similarity • Updated 9 days ago • 7.38M • 654
- sentence-transformers/all-mpnet-base-v2**
Sentence Similarity • Updated 9 days ago • 102M • 833
- nomic-ai/nomic-embed-text-v1.5**
Sentence Similarity • Updated Aug 26 • 427k • 393
- HIT-TMG/KaLM-embedding-multilingual-mini-v1**
Sentence Similarity • Updated 6 days ago • 434 • 5
- intfloat/multilingual-e5-base**
Sentence Similarity • Updated Feb 15 • 600k • 226

all-MiniLM-L6-v2

This is a [sentence-transformers](#) model: It maps sentences & paragraphs to a **384 dimensional** dense vector space and can be used for tasks like clustering or semantic search.



Embedding documents

Input size

- Size of the **input text** that the model can process.
- Text will be **truncated** if it exceeds the model's capacity.
- Common values include 256, 512 **tokens**.

Models 6,622 Filter by name

- sentence-transformers/all-MiniLM-L6-v2**
Sentence Similarity • Updated 10 days ago • 49.8M • 2.42k
- sentence-transformers/paraphrase-multilingual-MiniL...**
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Sentence Similarity • Updated 6 days ago • 434 • 5
- intfloat/multilingual-e5-base**
Sentence Similarity • Updated Feb 15 • 600k • 226



Intended uses

Our model is intended to be used as a sentence and short paragraph encoder. Given an input text, it outputs a vector which captures the semantic information. The sentence vector may be used for information retrieval, clustering or sentence similarity tasks.

By default, input text longer than 256 word pieces is truncated.



Embedding documents

Text language

- Some models can translate **specific languages**.
- Others support multiple languages and are **multilingual**.



A screenshot of a user interface showing a list of supported languages. The top navigation bar includes "Tasks 1", "Libraries", "Datasets", "Languages 3" (which is highlighted), "Licenses", and "Other". Below the navigation is a search bar with "Filter Languages by name" and a "Reset Languages" button. The main area displays a grid of language names, each with a small globe icon and a close button (an 'x'): English, Polish, French, Portuguese, Spanish, Russian, Korean, German, Italian, Vietnamese, Arabic, Japanese, Chinese, Indonesian, Turkish, multilingual, Dutch, Swedish, Czech, Hindi, Hungarian, Thai, Bulgarian, Catalan, Finnish, Marathi, Serbian, Danish, Greek, Gujarati, Hebrew, and Ukrainian.

Embedding documents

Search Bar (separate multiple queries with `;`)
Search for a model and press enter... 

Model types
 Open Proprietary Sentence Transformers Cross-Encoders Bi-Encoders
 Uses Instructions No Instructions

Model sizes (in number of parameters)
 <100M 100M to 250M 250M to 500M
 500M to 1B >1B

Overall Bitext Mining Classification Clustering Pair Classification Reranking Retrieval STS Summarization MultilabelClassification Retrieval w/Instructions

English Chinese French Polish Russian

Overall MTEB English leaderboard 🏆
Metric: Various, refer to task tabs
Languages: English



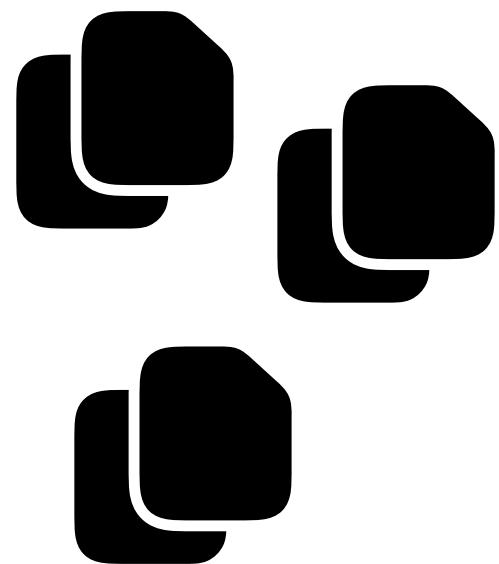
Rank	Model	Model Size (Million Parameters)	Memory Usage (GB, fp32)	Embedding Dimensions	Max Tokens	Average (56 datasets)	Classification Average (12 datasets)	Clustering Average (11 datasets)	PairClassification Average (3 datasets)
6	stella_en_400M_v5	435	1.62	8192	8192	70.11	86.67	56.7	87.74
7	dunzhang-stella_en_400M_v5	435	1.62	1024	8192	70.11	86.67	56.7	87.74
24	gte-large-en-v1.5	434	1.62	1024	8192	65.39	77.75	47.96	84.53
26	cde-small-v1	143	0.53	768	512	65	81.71	48.32	84.69
29	mxbai-embed-large-v1	335	1.25	1024	512	64.68	75.64	46.71	87.2
31	UAE-Large-V1	335	1.25	1024	512	64.64	75.58	46.73	87.25
37	GIST-large-Embedding-v0	335	1.25	1024	512	64.34	76.01	46.55	86.7
38	bge-large-en-v1.5	335	1.25	1024	512	64.23	75.97	46.08	87.12
39	bge-large-en-v1.5	335	1.25	1024	512	64.23	75.97	46.08	87.12
40	blade-embed	335	1.25	1024	512	64.21	75.16	46.46	87.07

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KNN search

k-nearest neighbor (kNN) search

- How do we search for embedded documents?
- We use the **kNN** search for fields mapped as **dense vectors**.
- Important, you can't use the **query** parameter in this case.



embedding

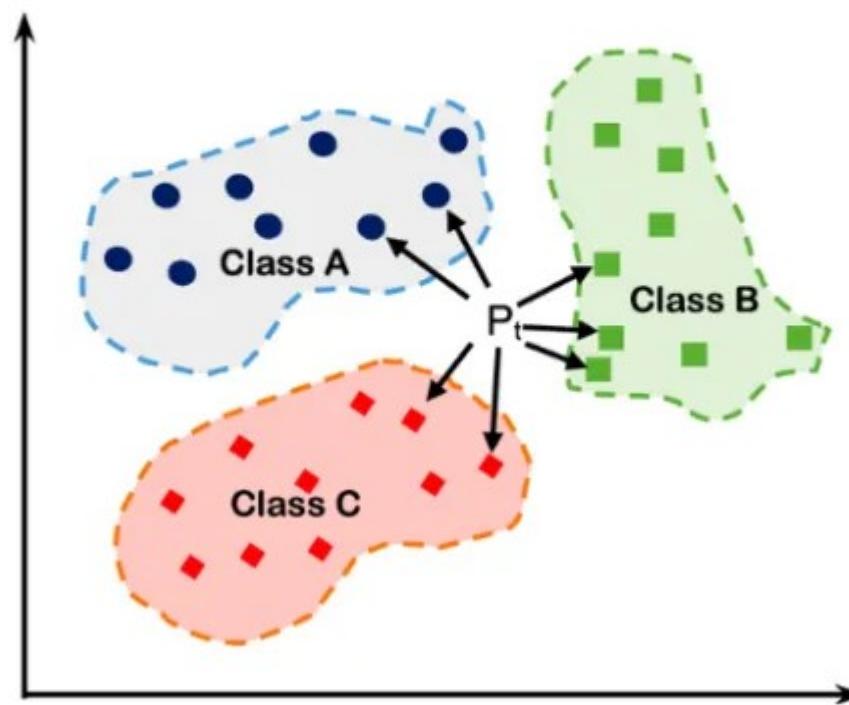
[2,0,1,-5,...,20]

[0.54, -4.2, 0, -0.6, ..., 1]

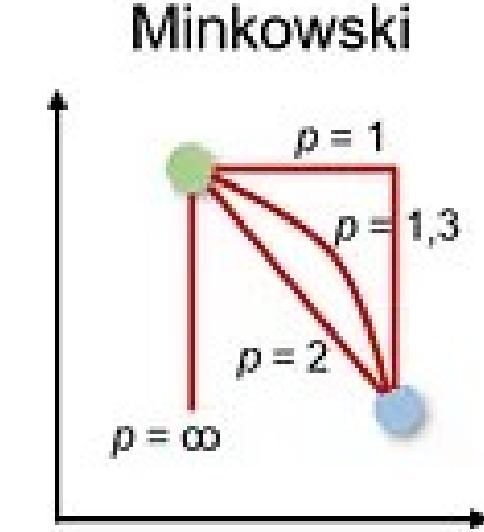
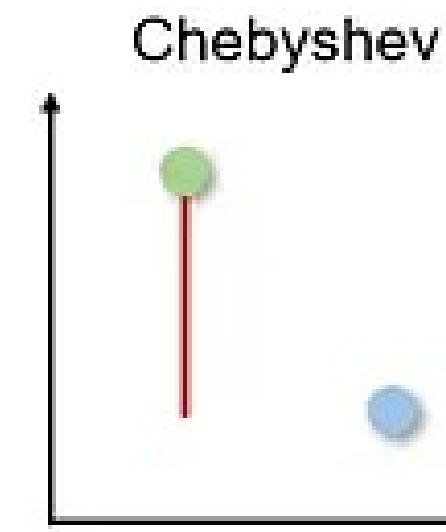
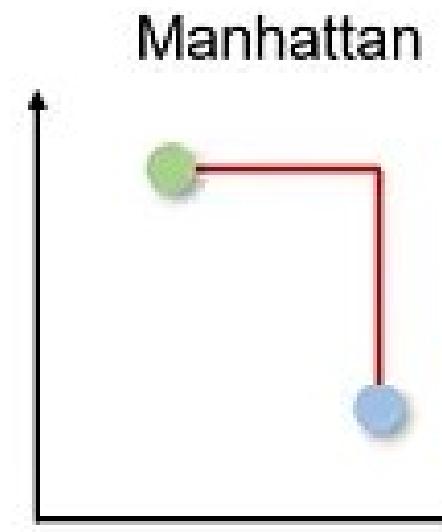
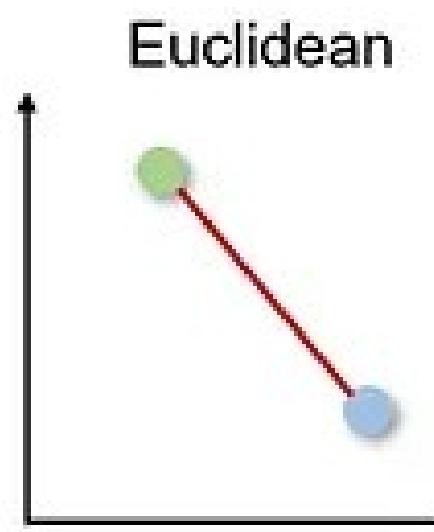
[3,0.33,-.98,-1,...,-1.1]

k-nearest neighbor (kNN) search

- The kNN algorithm is used for **classification** and **regression** tasks.
- It **classifies new data points** by comparing them with the **k nearest points** from the training data.
- Commonly distances metrics: **Euclidean**, **Manhattan** or **Minkowski**.
- This algorithm is **simple** and effective.

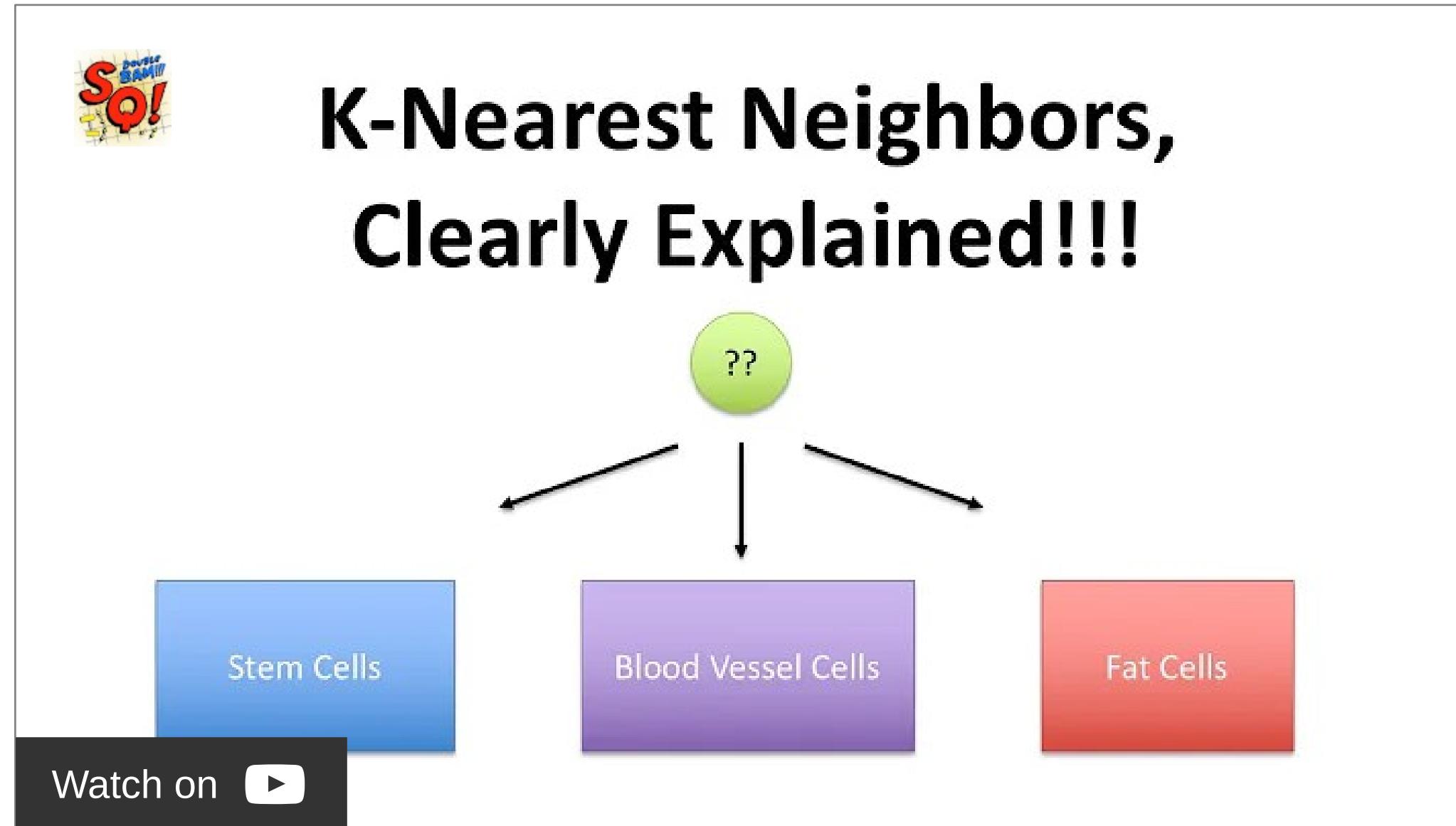


Medium article by Sachinsoni



Medium article by Dancker

k-nearest neighbor (kNN) search



k-nearest neighbor (kNN) search

Example

```
results = es.search(  
    knn={  
        'field': 'embedding',  
        'query_vector': es.get_embedding(parsed_query),  
        'num_candidates': 50,  
        'k': 10,  
    }  
)
```

- ① Should be a **dense_vector**



k-nearest neighbor (kNN) search

Example

```
results = es.search(  
    knn={  
        'field': 'embedding',  
        'query_vector': es.get_embedding(parsed_query),  
        'num_candidates': 50,  
        'k': 10,  
    }  
)
```



① The query should be a vector.

k-nearest neighbor (kNN) search

Example

```
results = es.search(  
    knn={  
        'field': 'embedding',  
        'query_vector': es.get_embedding(parsed_query),  
        'num_candidates': 50,  
        'k': 10,  
    }  
)
```



- ① Retrieves 50 **potentially relevant** documents
before applying distance calculations to select
the k best documents.

k-nearest neighbor (kNN) search

Example

```
results = es.search(  
    knn={  
        'field': 'embedding',  
        'query_vector': es.get_embedding(parsed_query),  
        'num_candidates': 50,  
        'k': 10,  
    }  
)
```

- ⓘ Returns up to 10 documents that match your query.

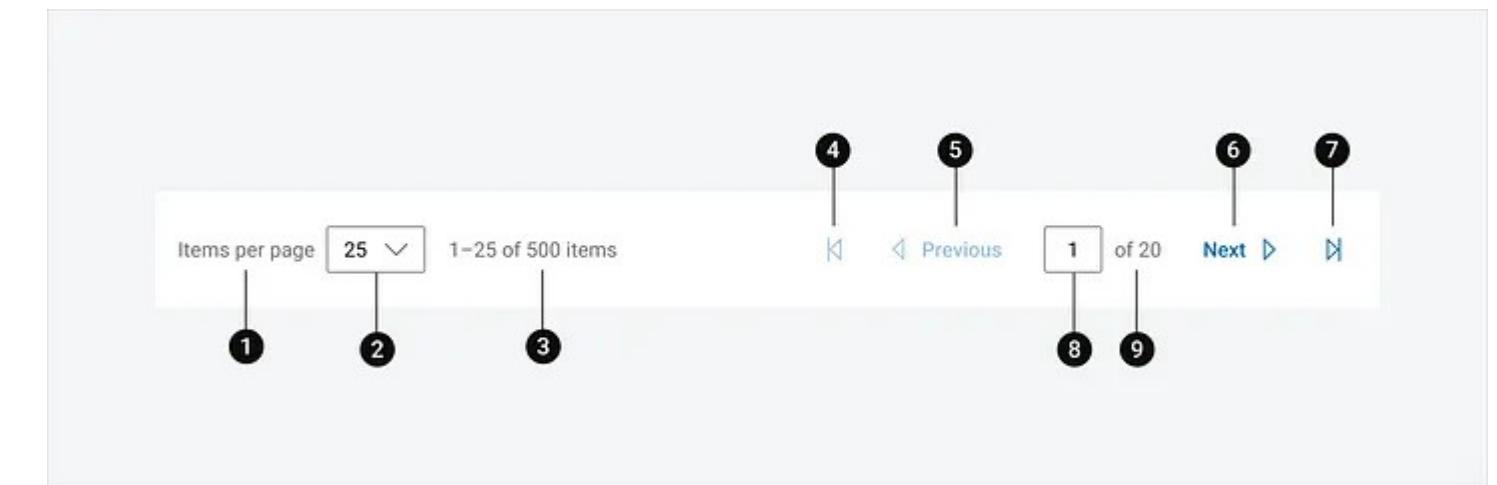
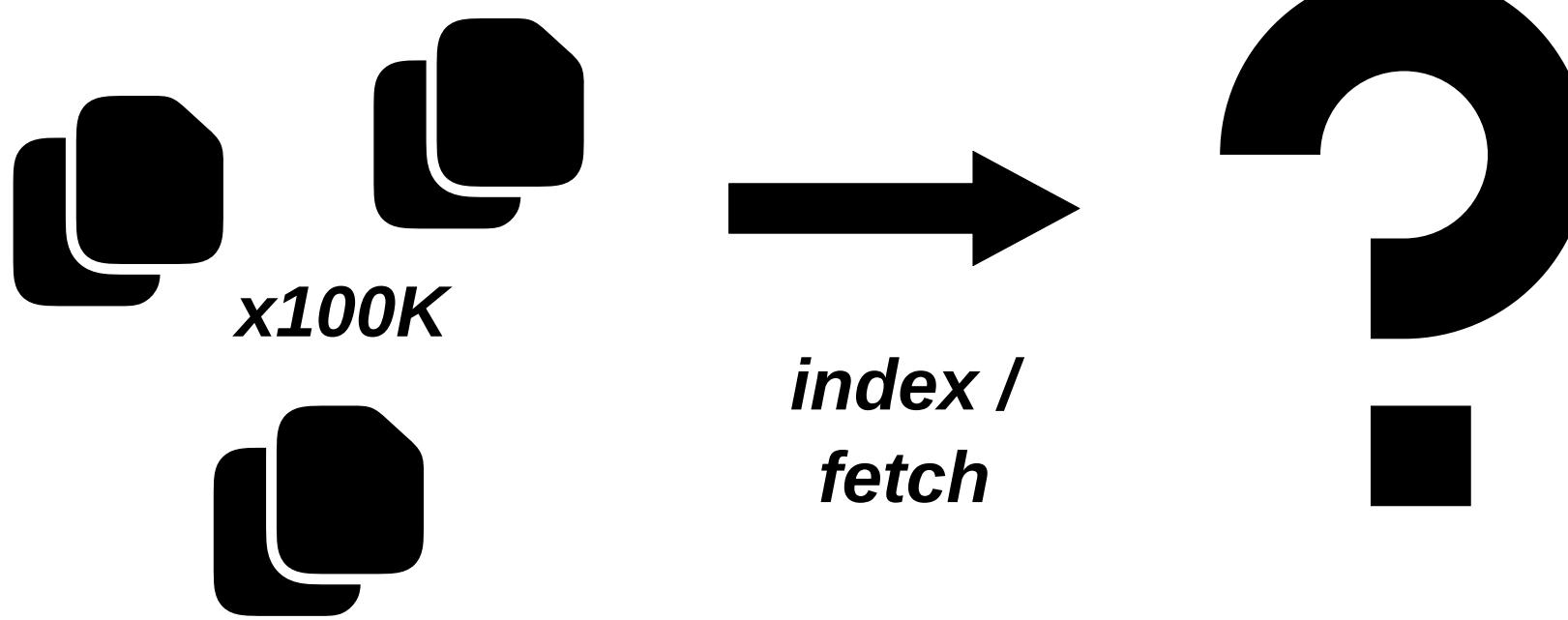


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Deep pagination

Deep pagination

- Indexing / fetching all documents at once is **inefficient** and **slow**.
- **Pagination:**
 - Retrieves data in small chunks from large indexes.
 - Improves performance and efficiency.
 - Fast search experience.
 - Cost effective.



Medium article by Dayanand

Deep pagination

Pagination methods

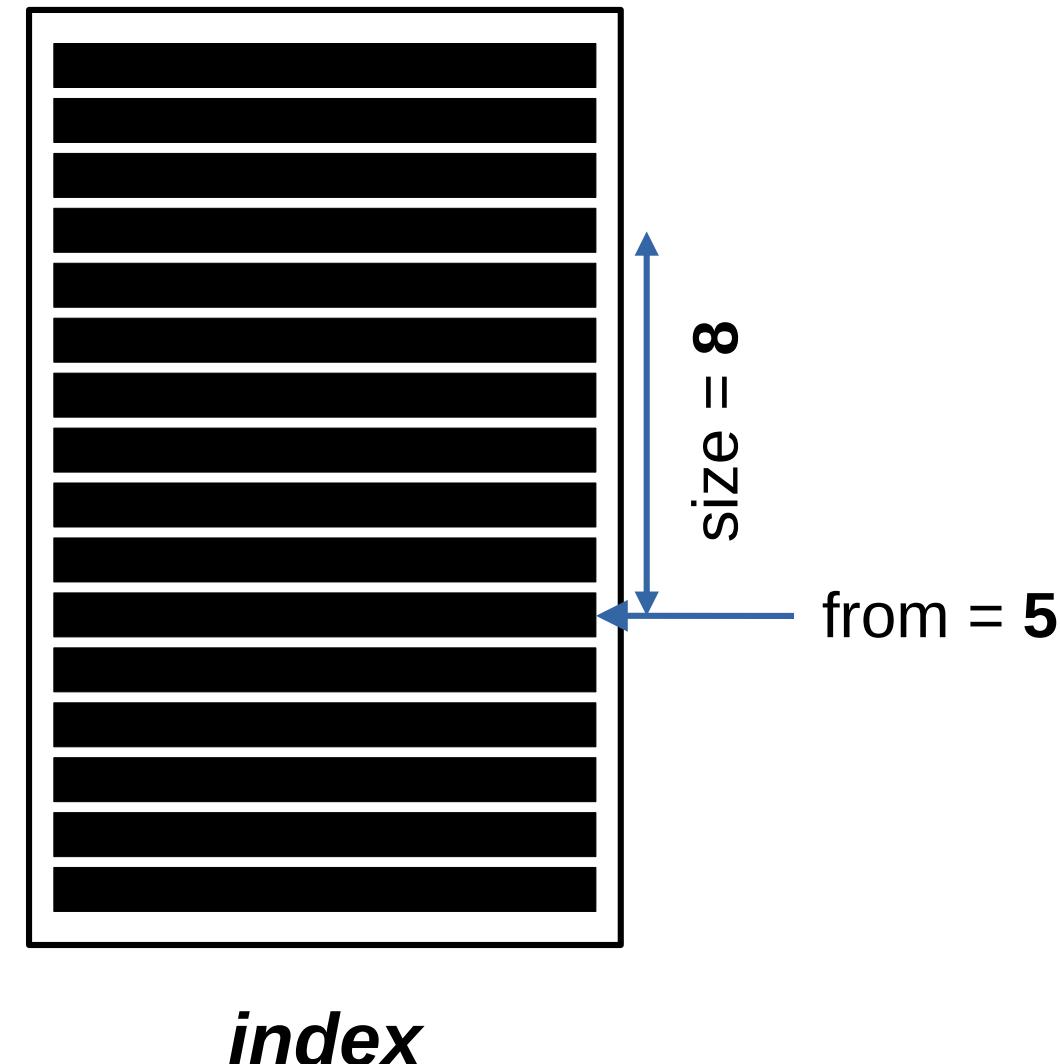
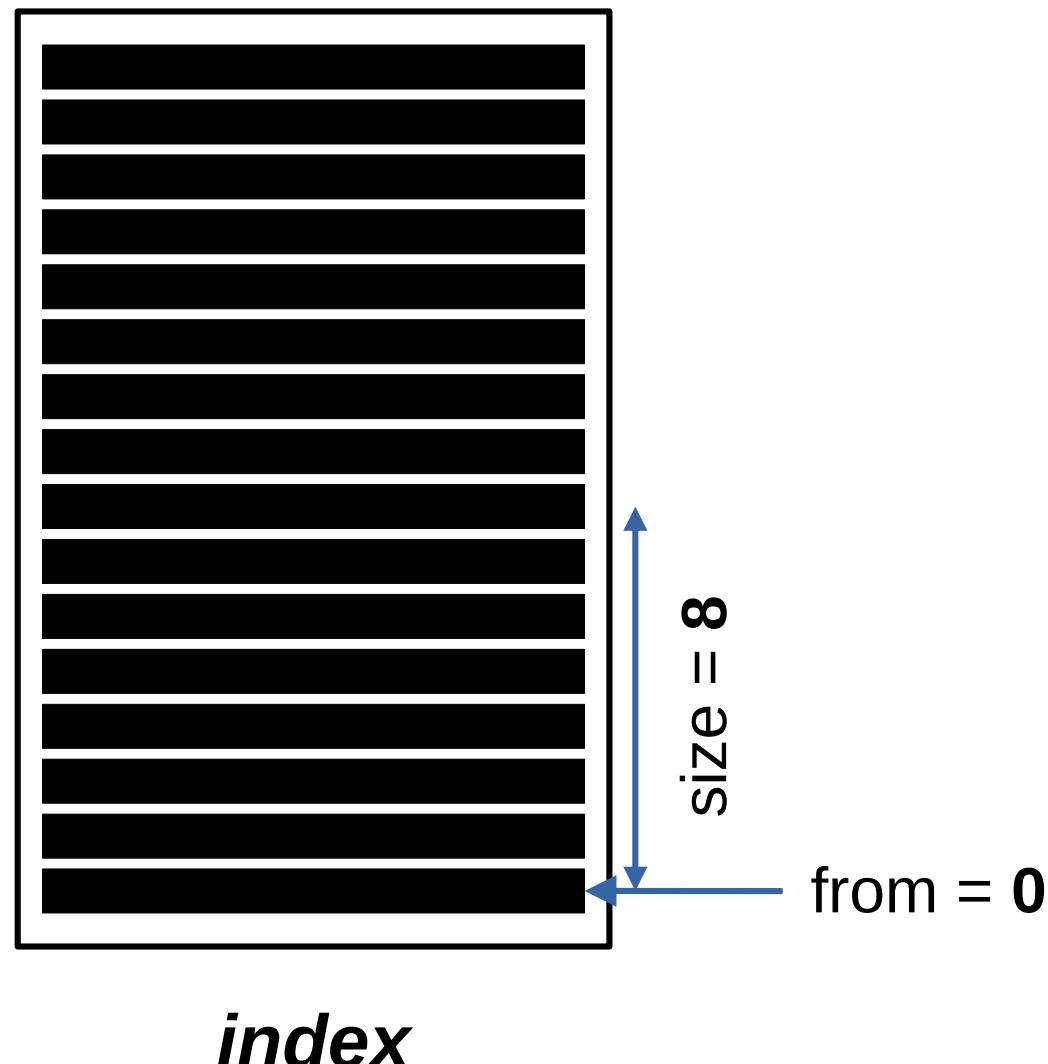
- ***from*/*size***: commonly used for paginating **smaller datasets**.
- ***search_after***: offers more efficient deep pagination for **large datasets**.



Deep pagination

Pagination methods

- ***from*/*size***: commonly used for paginating **smaller datasets**.
- ***search_after***: offers more efficient deep pagination for **large datasets**.



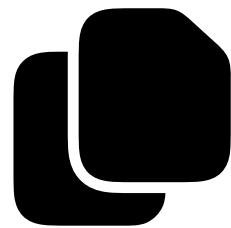
ⓘ Note:

- ***from*/*size*** is limited to **10k** results.
- Requires a lot of memory for deep pages.
- Not suitable for larger indexes.

Deep pagination

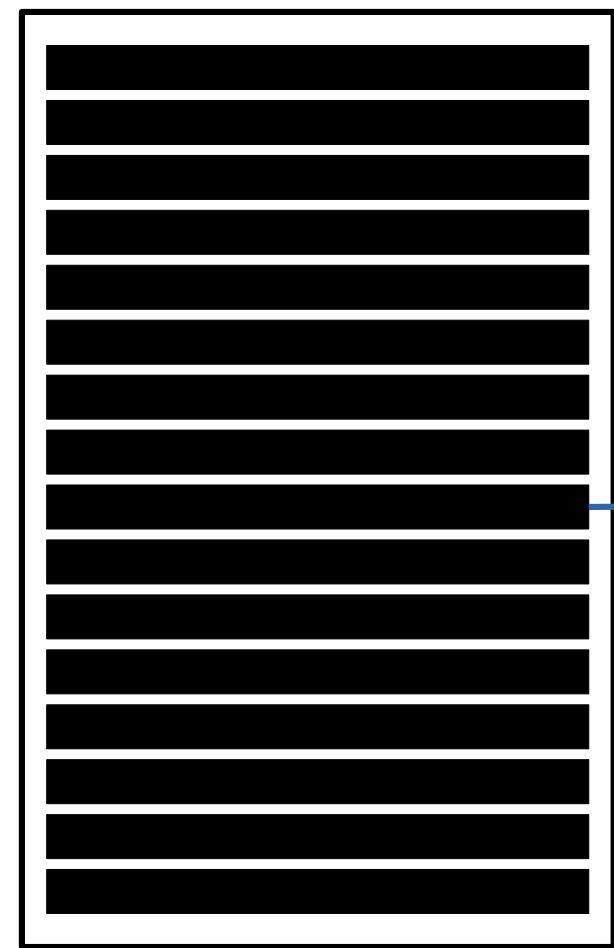
Pagination methods

- *from*/*size*: commonly used for paginating smaller datasets.
- ***search_after***: offers more efficient deep pagination for **large datasets**.

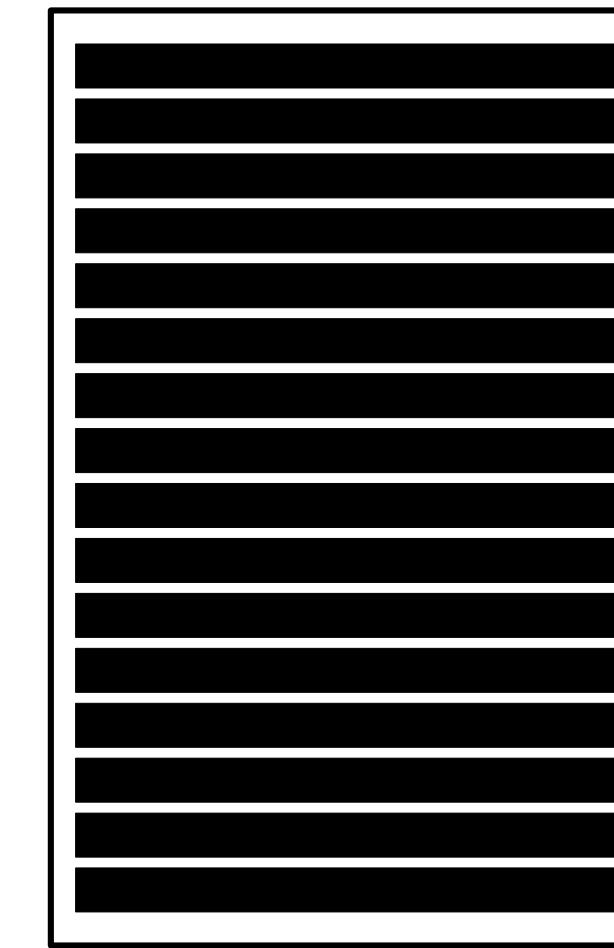


Sortable fields

- timestamp
- id



index



index

Deep pagination

Pagination methods

- ***from*/*size***: commonly used for paginating smaller datasets.
- ***search_after***: offers more efficient deep pagination for **large datasets**.



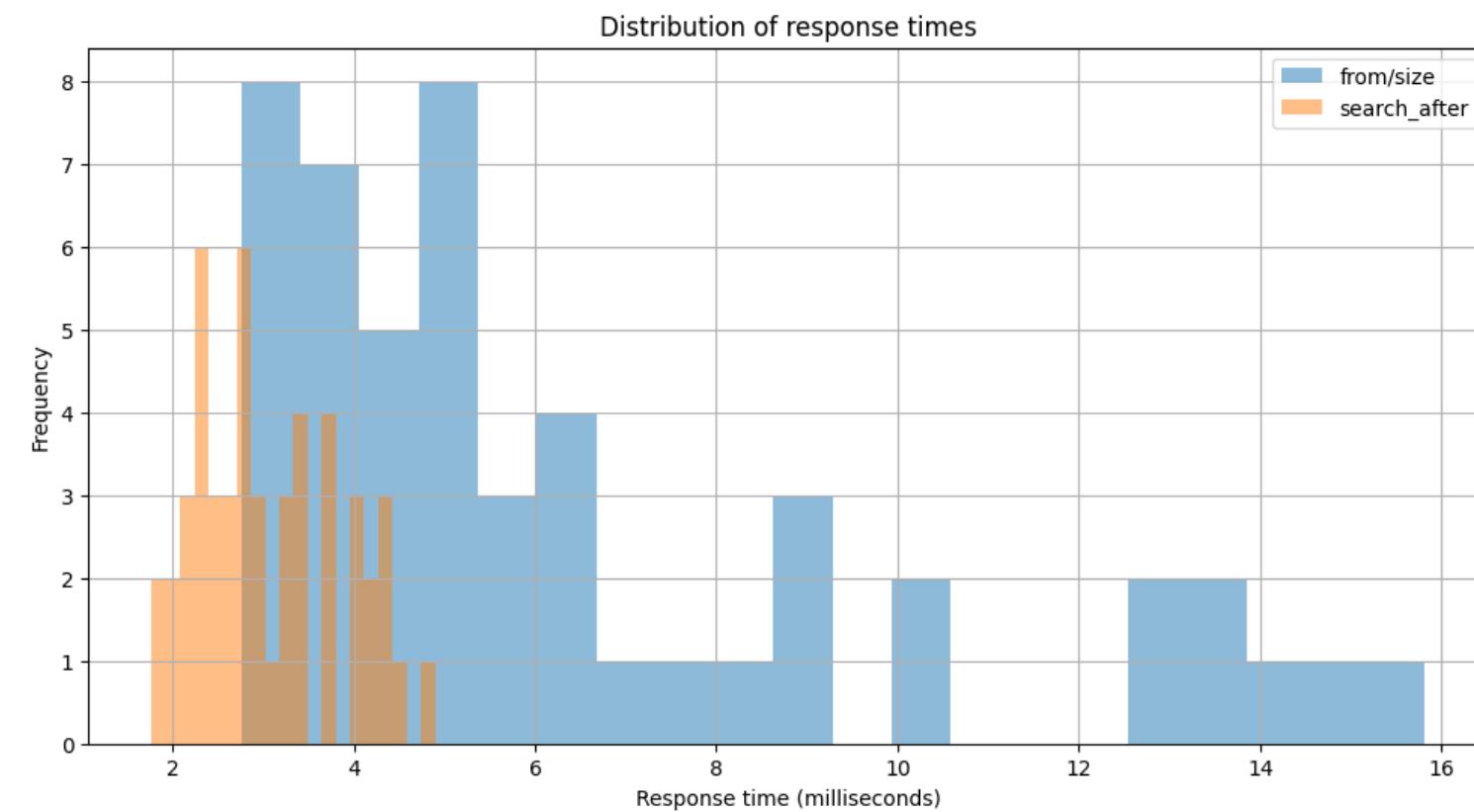
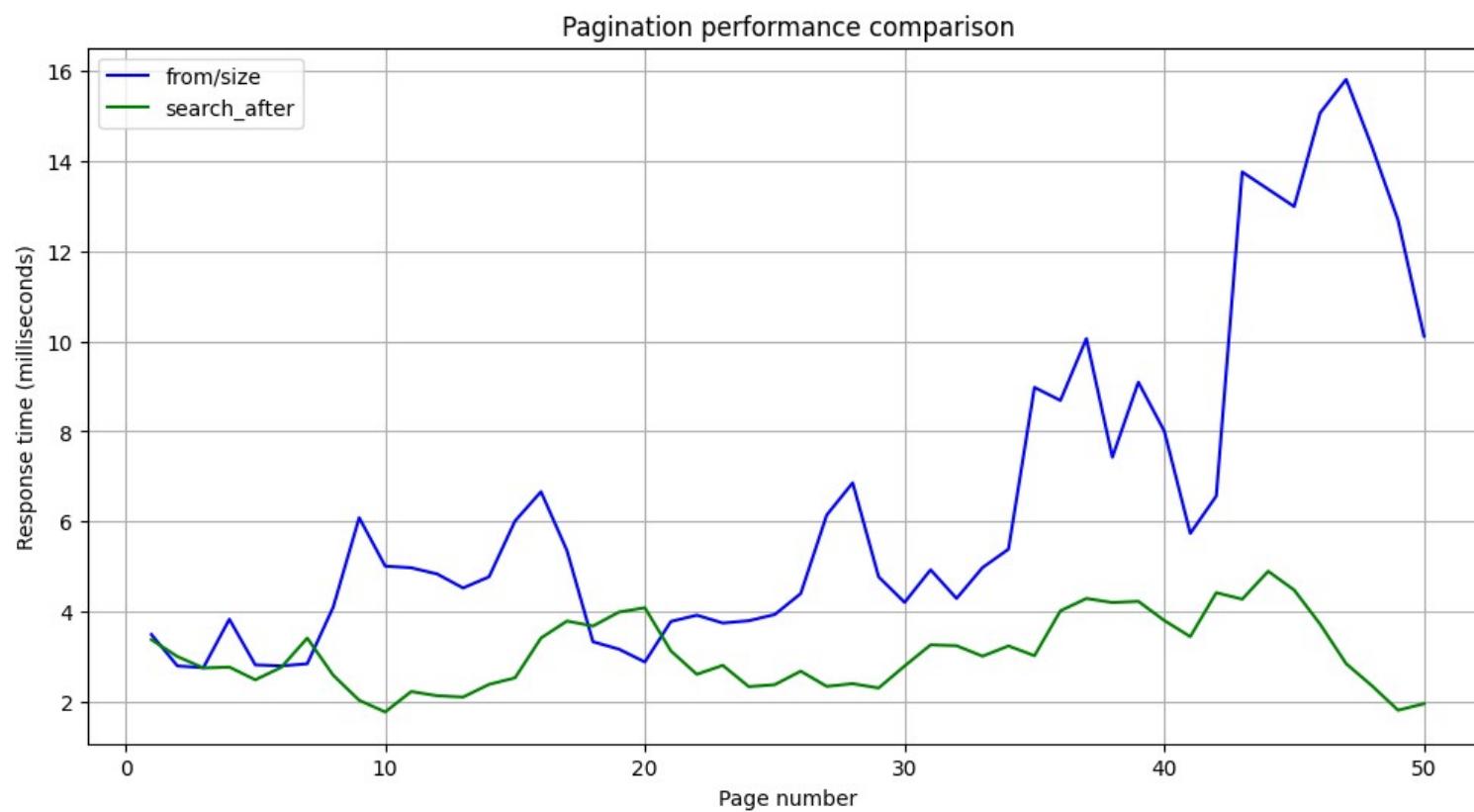
ⓘ Note:

- The ***search_after*** method is not constrained by the **10k** result limit.
- It does not utilize an offset (i.e., the **from** parameter).
- Results **must be sorted** by fields such as ID or timestamp.
- Uses a **pointer** derived from the sort values of the last document on the previous page.
- This approach prevents the **skipping** of documents.
- It is particularly beneficial for handling **larger indexes**.

Deep pagination

Comparison

Below are the results obtained after attempting to retrieve **10,000** documents using the following parameters (**size = 200, iterations = 50**)



Deep pagination

Comparison

	from/size	search_after
Average time (ms)	6.417	3.072
Maximum time (ms)	15.812	4.896
Minimum time (ms)	2.757	1.772

	from/size	search_after
Performance degradation	2.9x	0.58x

ⓘ Performance degradation is calculated like this (last page time / first page time)

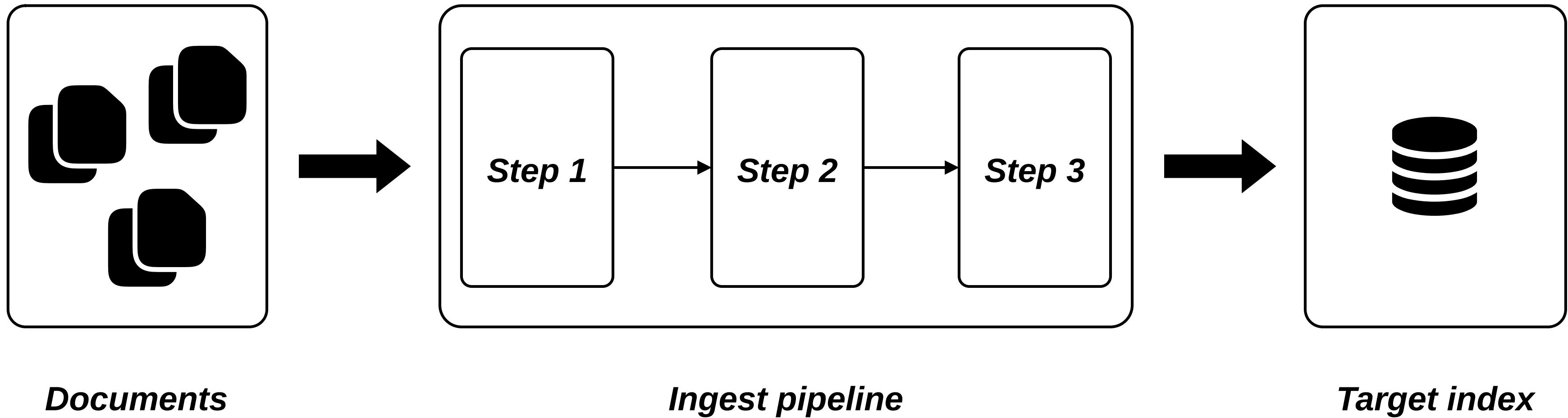


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Ingest pipelines

Ingest pipelines

- You can perform **transformations** on data **before indexing**.
- Common transformations: remove fields, lowercase text, remove HTML tags, and [more](#).



Ingest pipelines

- We use the **ingest API** to:
 - Create or update a pipeline.

```
response = client.ingest.put_pipeline(  
    id="my-pipeline",  
    description="A description",  
    processors=[  
        {  
            "set": {  
                "description": "A description",  
                "field": "field",  
                "value": "value"  
            }  
        },  
        {  
            "lowercase": {  
                "field": "field"  
            }  
        }  
    ],  
)
```



Ingest pipelines

- We use the **ingest API** to:
 - Simulate a pipeline.

```
response = client.ingest.simulate(  
    id="my-pipeline",  
    docs=[  
        {  
            "_index": "index",  
            "_id": "id",  
            "_source": {  
                "foo": "bar"  
            }  
        },  
        {  
            "_index": "index",  
            "_id": "id",  
            "_source": {  
                "foo": "rab"  
            }  
        }  
    ],  
)
```

OR

```
response = client.ingest.simulate(  
    pipeline={  
        "processors": [  
            {  
                "lowercase": {  
                    "field": "field"  
                }  
            }  
        ],  
        ...  
    })
```



Ingest pipelines

- We use the **ingest API** to:
 - Delete a pipeline.

```
response = client.ingest.delete_pipeline(  
    id="my-pipeline",  
)
```



Ingest pipelines

- We use the **ingest API** to:
 - Get a pipeline.

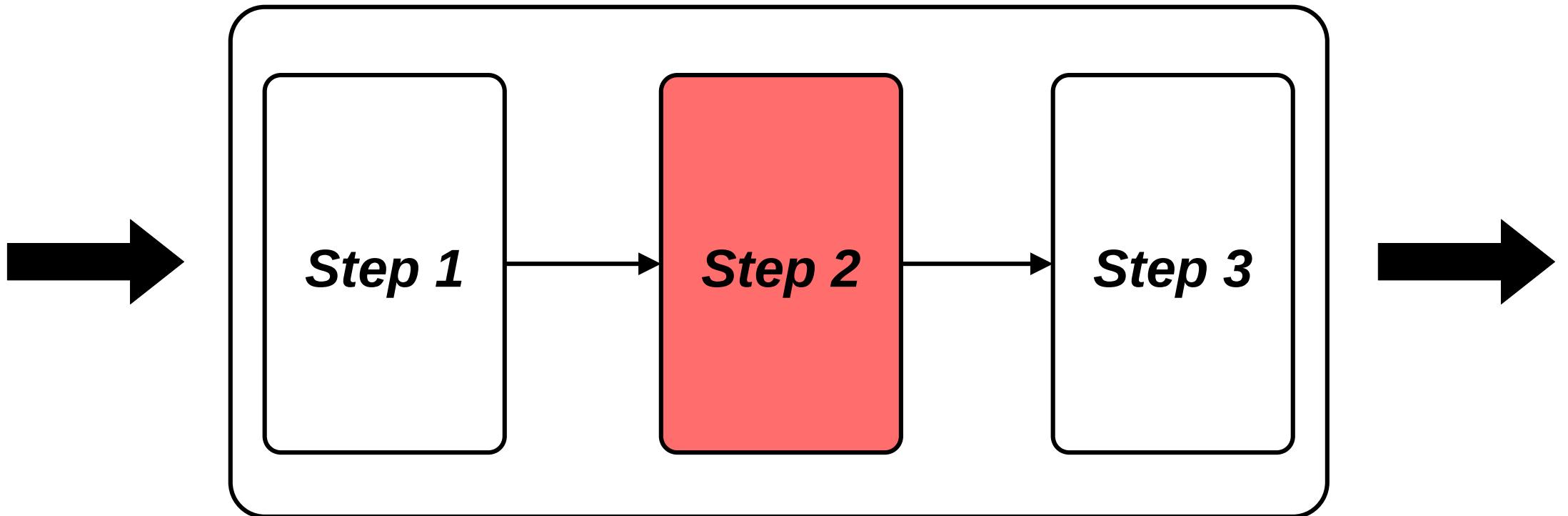
```
response = client.ingest.get_pipeline(  
    id="my-pipeline",  
)
```



Ingest pipelines

- Pipelines **can fail**. You can either **ignore** the failure or **handle** it.
 - If you ignore the failure, the pipeline **will skip over the failed steps**.

```
response = client.ingest.put_pipeline(  
    id="my-pipeline",  
    processors=[  
        {  
            "rename": {  
                "description": "A description",  
                "field": "field",  
                "ignore_failure": True  
            }  
        }  
    ],  
)
```

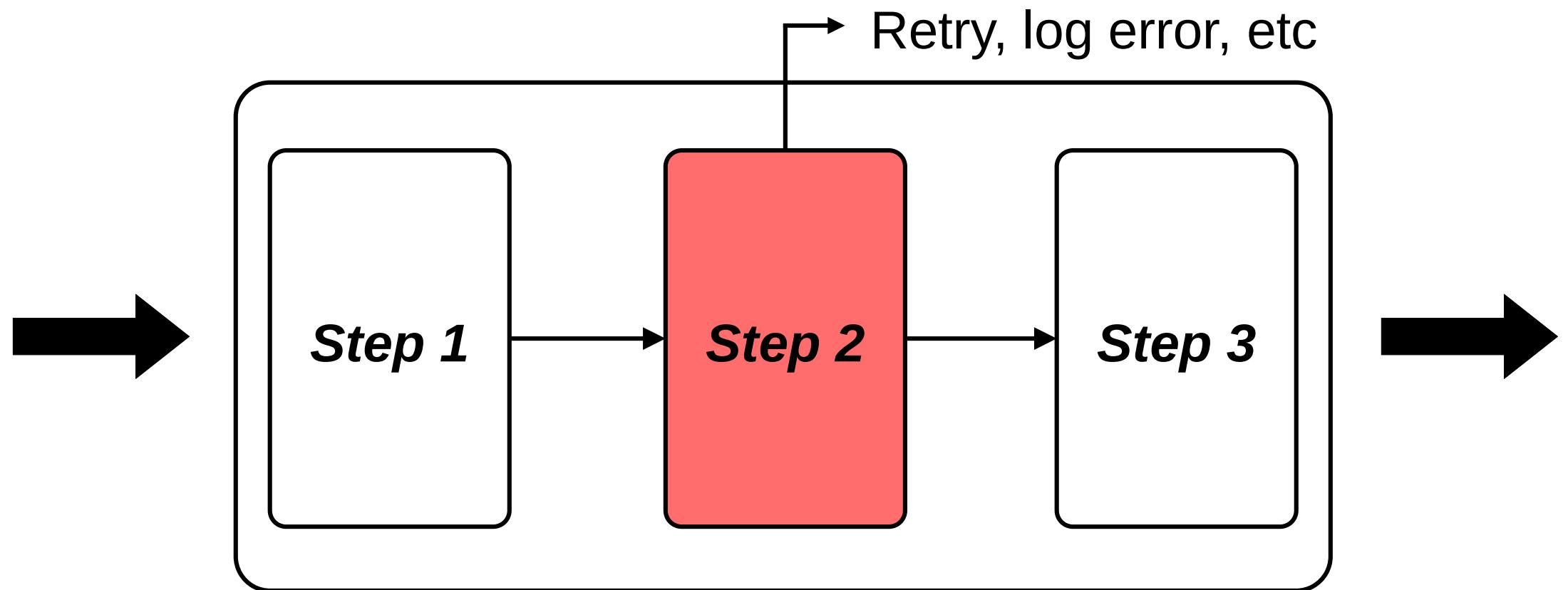


Ingest pipeline

Ingest pipelines

- Pipelines **can fail**. You can either **ignore** the failure or **handle** it.
- Specify custom error-handling steps with ***on_failure***.

```
response = client.ingest.put_pipeline(  
    id="my-pipeline",  
    processors=[  
        {  
            "rename": {  
                "description": "A description",  
                "field": "field",  
                "on_failure": [...]  
            }  
        }  
    ],  
)
```



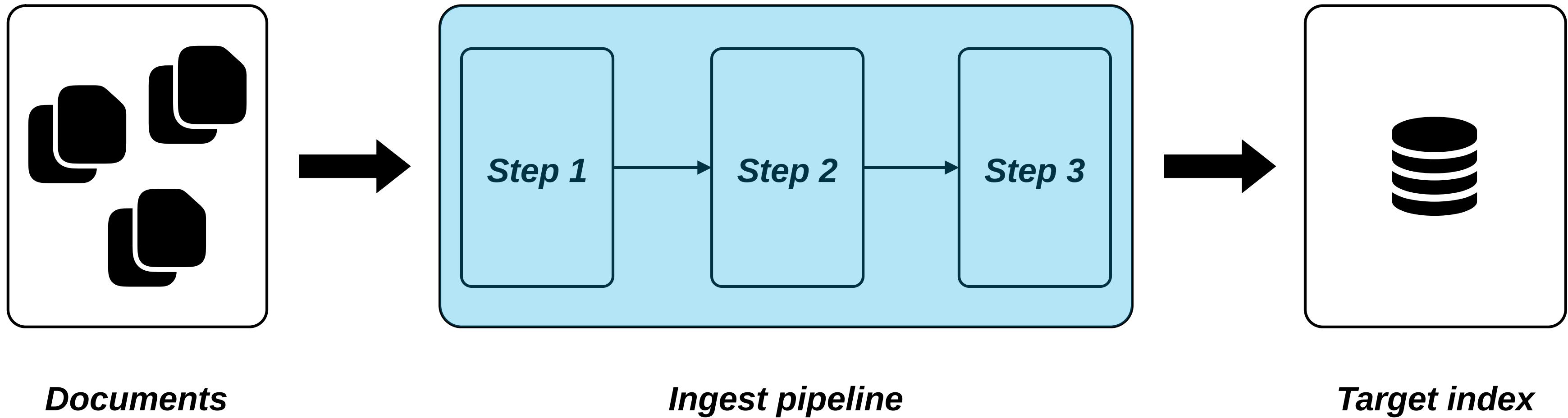
Ingest pipeline

20

Ingest processors

Ingest processors

- Common transformations: remove fields, lowercase text, remove HTML tags, and [more](#).



Ingest processors



Ingest processors by category

- Ingest processors are organized into 5 categories.

Data enrichment

- Append
- Inference
- Attachment
- ...

Array/JSON handling

- For each
- JSON
- Sort

Data transformation

- Convert
- Rename
- Set
- HTML strip
- Lowercase / Uppercase
- Trim
- Split
- ...

Data Filtering

- Drop
- Remove

Pipeline handling

- Fail
- Pipeline

21

Filters in depth

Filters in depth

- When searching in Elasticsearch, you can use either **query context** or **filter context**.



How well does this document
match this query clause ?

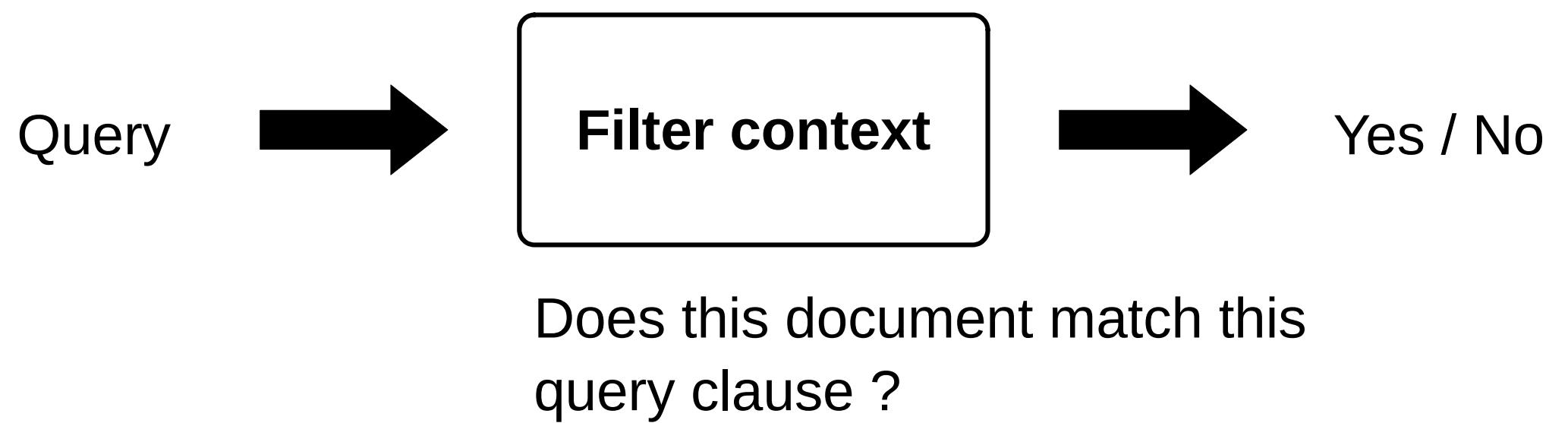


Does this document match this
query clause ?

Filters in depth

Why use the filter context ?

- **Binary matching.**
- **No score** is needed.
- Filters **execute faster** than queries (no score is computed).
- Filters consume **less CPU resources**.

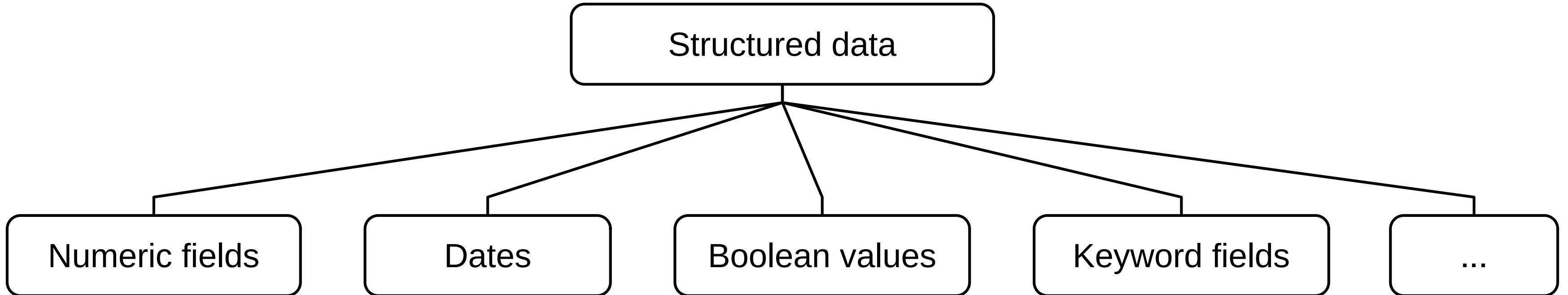


Filters in depth



Use cases

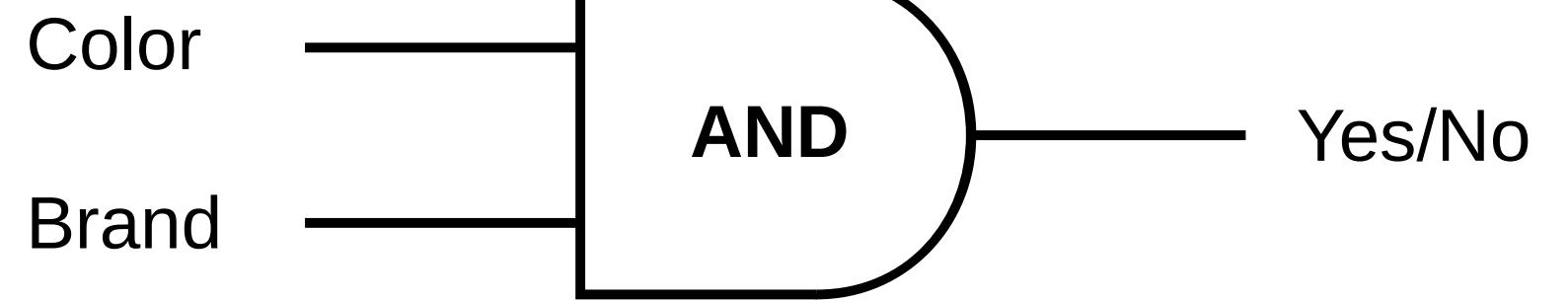
Filters are effective for querying structured data.



Filters in depth

Example 1

```
response = client.search(  
    index="phones",  
    query={  
        "bool": {  
            "filter": [  
                {  
                    "term": {  
                        "color": "black"  
                    }  
                },  
                {  
                    "term": {  
                        "brand": "samsung"  
                    }  
                }  
            ]  
        },  
    }  
)
```

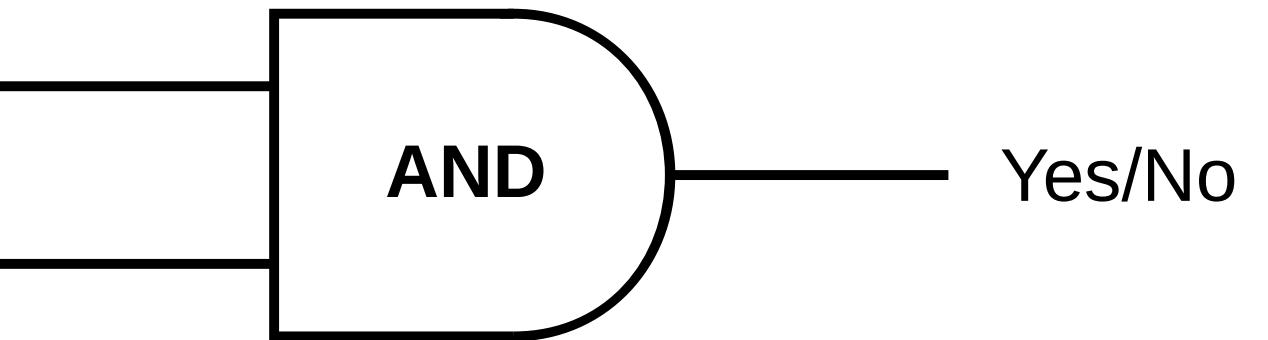


Filters in depth

Example 2

```
response = client.search(  
    query={  
        "bool": {  
            "filter": [  
                {  
                    "term": {  
                        "status": "published"  
                    }  
                },  
                {  
                    "range": {  
                        "publish_date": {  
                            "gte": "2015-01-01",  
                            "lte": "2015-02-01"  
                        }  
                    }  
                }  
            ]  
        }  
    }  
)
```

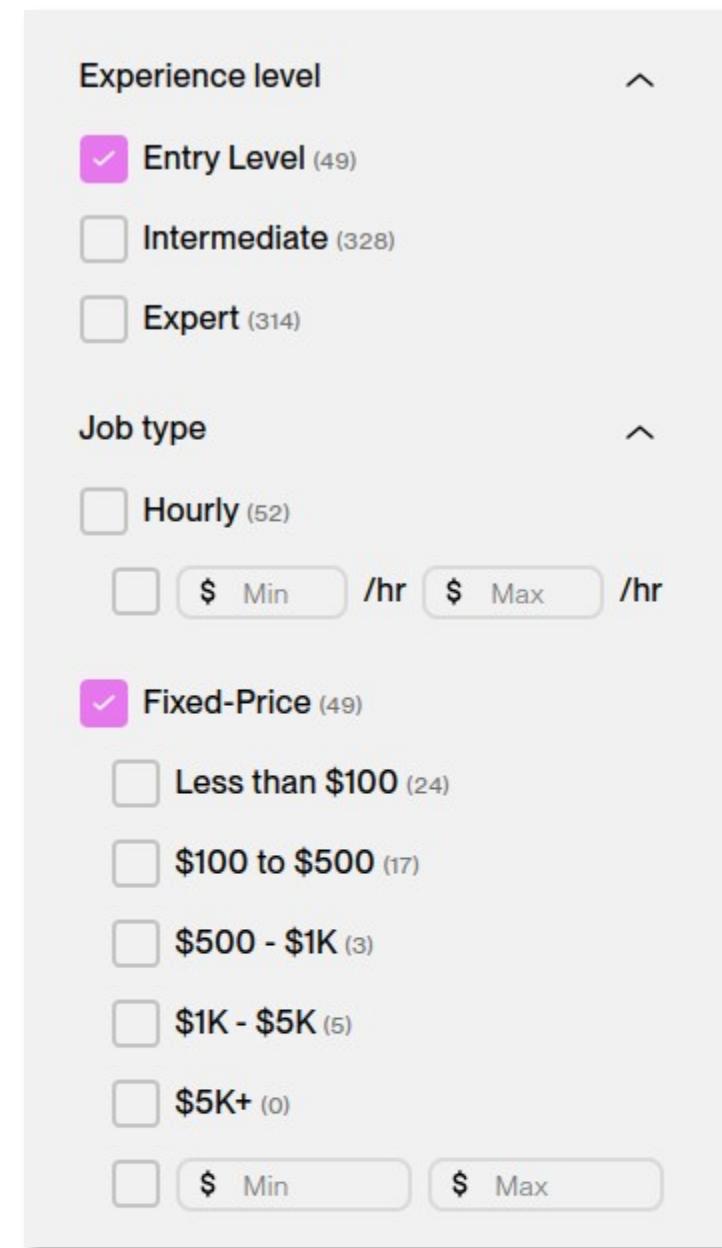
Status
Publish date



Filters in depth

Post filters

- Applies filters after **aggregations** are calculated.
- Does not affect aggregations.
- Only filters the search results.
- ***Let you narrow down what users see without limiting what they can choose from.***



Read more



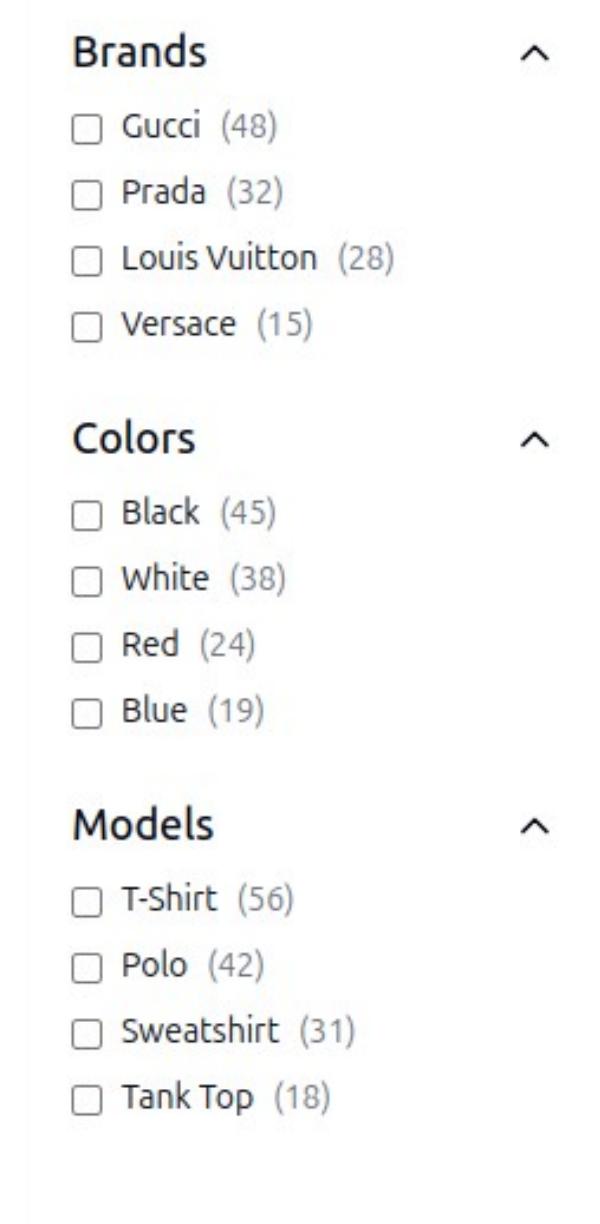
Filters in depth

Example

```
response = client.search(  
    index="shirts",  
    query={  
        "bool": {  
            "filter": {  
                "term": {  
                    "brand": "gucci"  
                }  
            }  
        }  
    },  
    ...  
)
```

```
response = client.search(  
    aggs={  
        "colors": {  
            "terms": {  
                "field": "color"  
            }  
        },  
        "color_red": {  
            "filter": {  
                "term": {  
                    "color": "red"  
                }  
            },  
            "aggs": {  
                "models": {  
                    "terms": {  
                        "field": "model"  
                    }  
                }  
            }  
        },  
        ...  
    })
```

```
response = client.search(  
    post_filter={  
        "term": {  
            "color": "red"  
        }  
    },  
    ...  
)
```

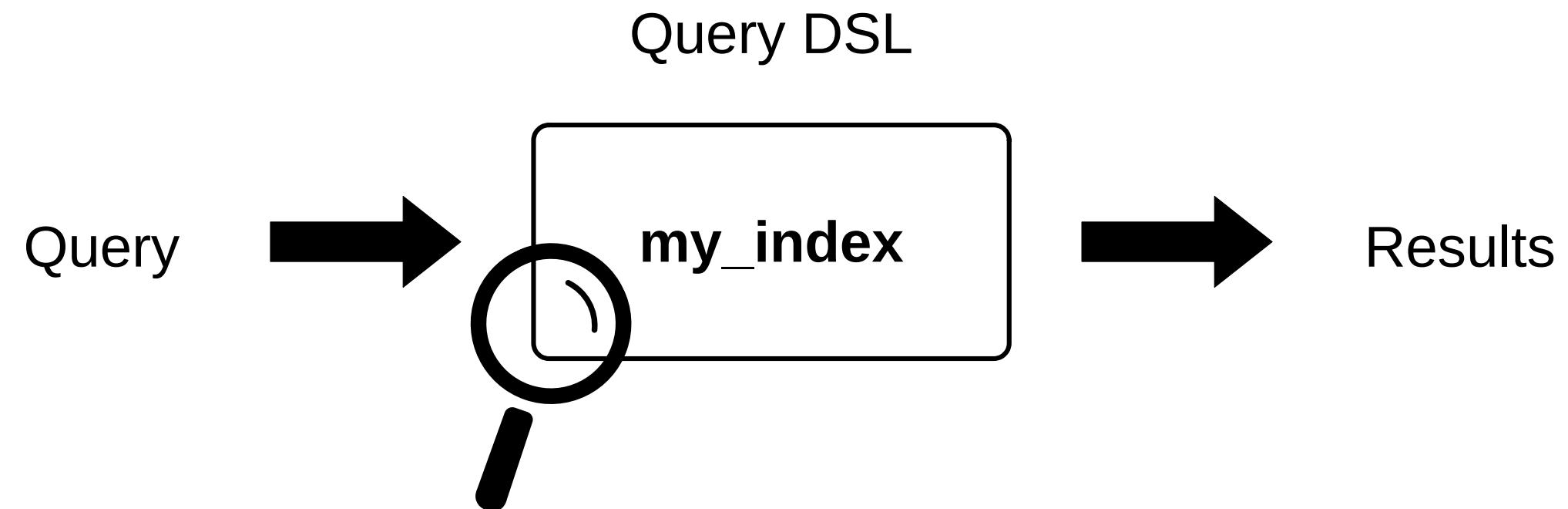


22

SQL search API

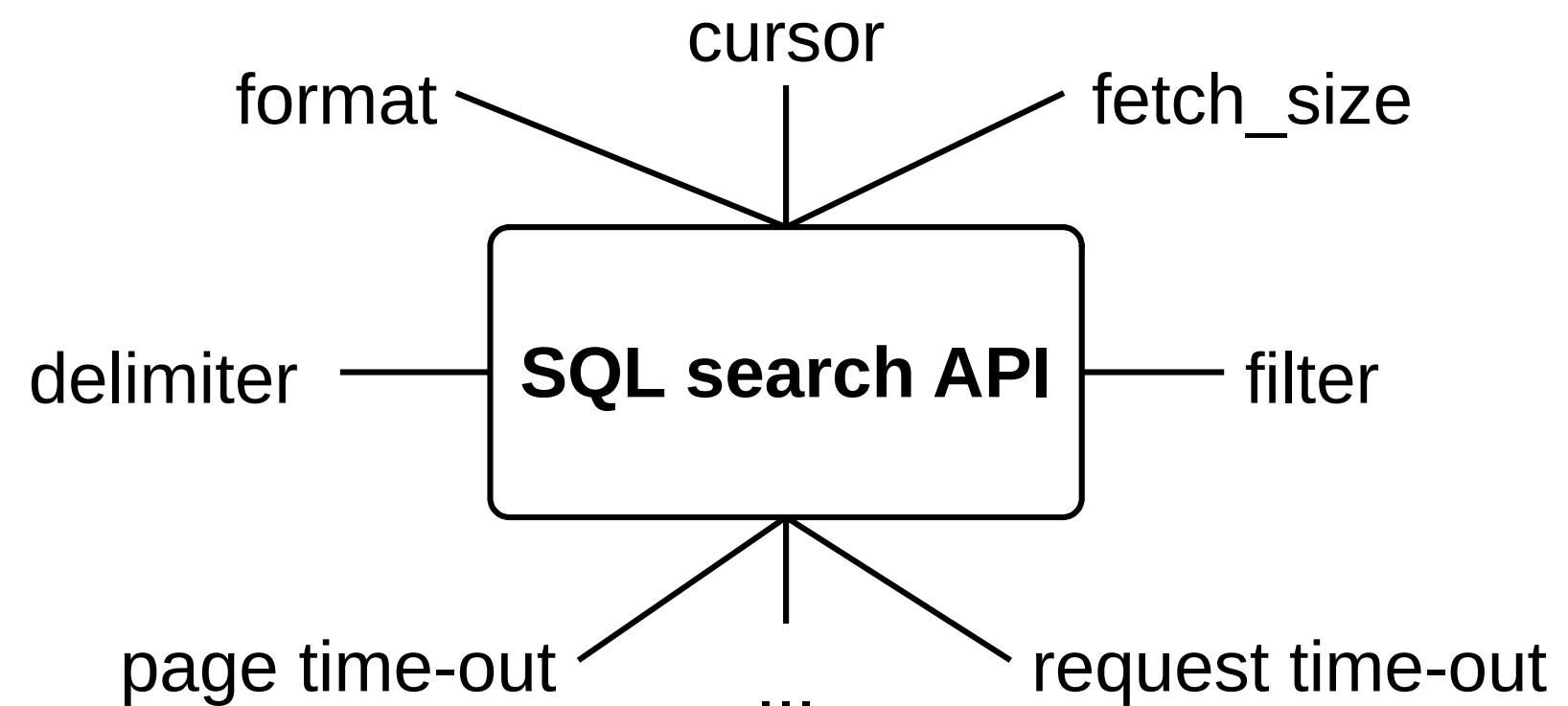
SQL Search API

- We used **Query DSL** to search for documents.
- An alternative method for searching documents is the **SQL Search API**.



SQL Search API

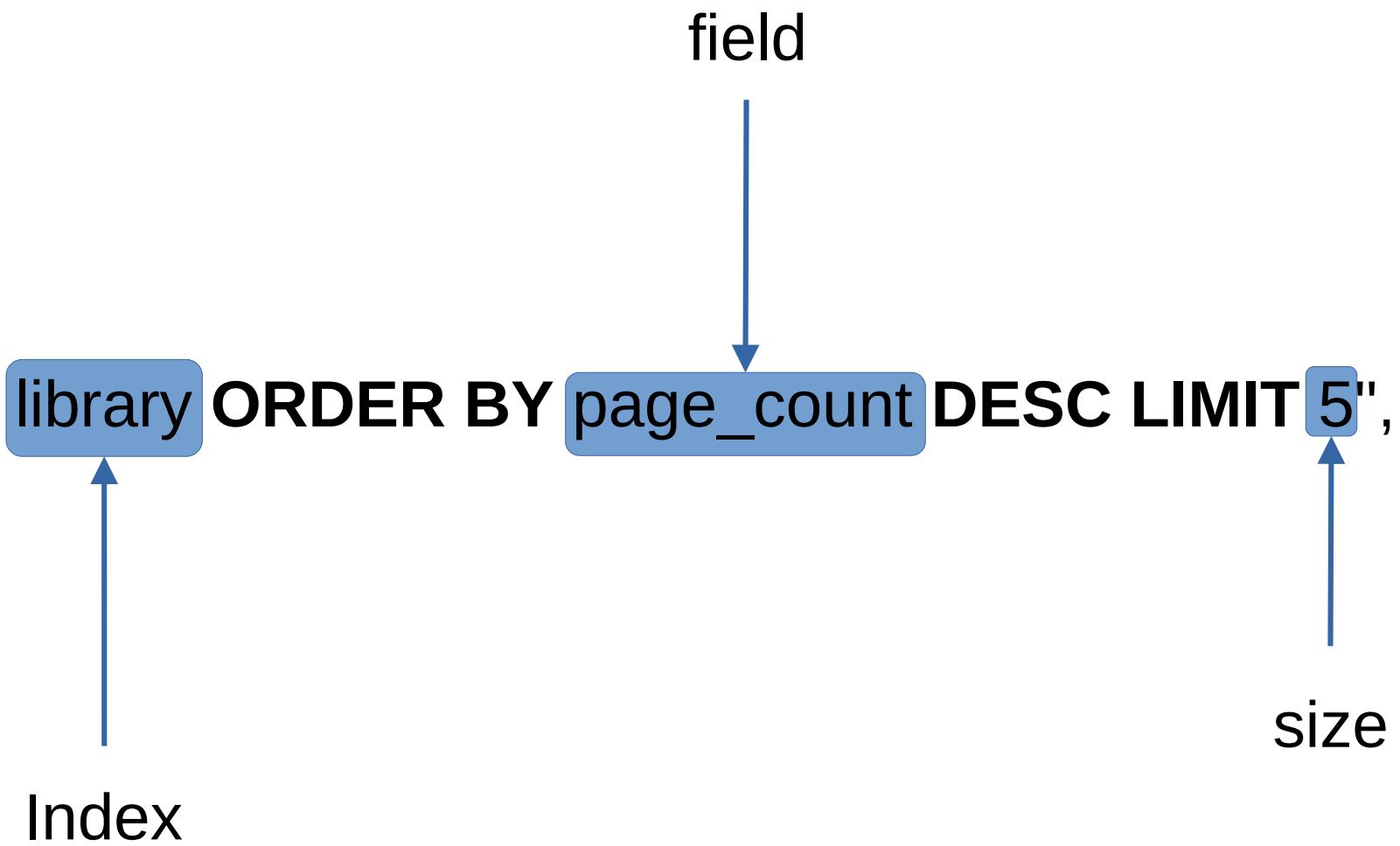
The **SQL search API** supports numerous parameters.



SQL Search API

Example

```
response = client.sql.query(  
    format="txt",  
    query="SELECT * FROM library ORDER BY page_count DESC LIMIT 5",  
)
```



SQL Search API

The available response formats are:

- CSV
- JSON
- TSV
- TXT
- YAML
- CBOR
- SMILE
- Binary formats

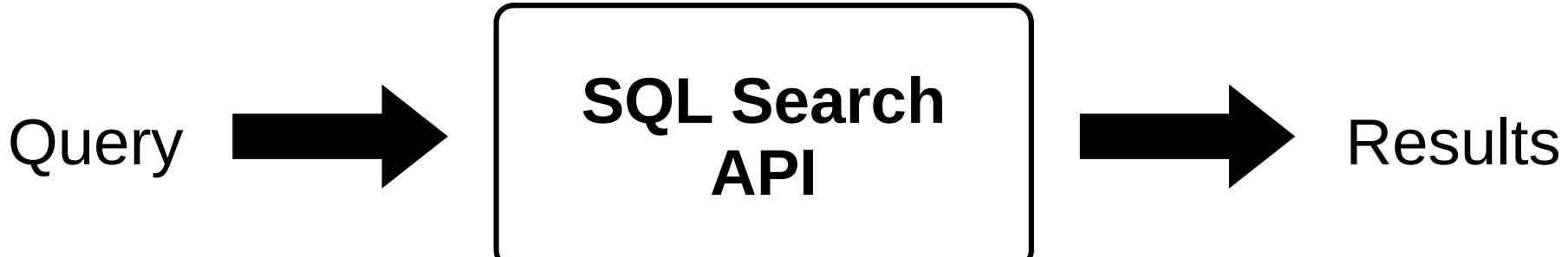
```
response = client.sql.query(  
    format="txt",  
    query="SELECT * FROM library ORDER BY page_count DESC LIMIT 5",  
)
```



SQL Search API

Pagination

```
response = client.sql.query(  
    format="txt",  
    cursor="sDHOSBDISBXMLK...", ?  
)
```



```
{  
  "rows" : [  
    ["Dan Simmons", "Hyperion", 482, "1989-05-26T00:00:00.000Z"],  
    ["Iain M. Banks", "Consider Phlebas", 471, "1987-04-23T00:00:00.000Z"],  
    ["Neal Stephenson", "Snow Crash", 470, "1992-06-01T00:00:00.000Z"],  
    ["Frank Herbert", "God Emperor of Dune", 454, "1981-05-28T00:00:00.000Z"],  
    ["Frank Herbert", "Children of Dune", 408, "1976-04-21T00:00:00.000Z"]  
  ],  
  "cursor" : "sDXF1ZXJ5QW5kRmV0Y2gBAAAAAAAEWODRMaXBUaVlRN21iTlRyWHZWYUdrdw==:BAFmBm"  
}
```

Original example



SQL Search API

Filtering

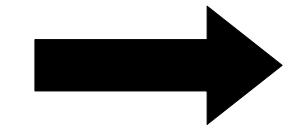
```
response = client.sql.query(  
    format="txt",  
    query="SELECT * FROM library ORDER BY page_count DESC",  
    filter={  
        "range": {  
            "page_count": {  
                "gte": 100,  
                "lte": 200  
            }  
        }  
    },  
    fetch_size=5,  
)
```



SQL Search API

SQL Translate API

```
response = client.sql.translate(  
    query="SELECT * FROM library ORDER BY page_count DESC",  
    fetch_size=10,  
)
```



```
{  
    "size": 10,  
    "_source": false,  
    "fields": [{"field": "author"}, ...],  
    "sort": [  
        {  
            "page_count": {  
                "order": "desc",  
            }  
        }  
    ],  
    "track_total_hits": -1  
}
```



SQL Search API

SQL Limitations



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SQL Limitations

- Scripting >
- Aggregations >
- Geospatial analysis
- Watcher >
- Monitor a cluster >
- Secure the Elastic Stack >
- Set up a cluster for high availability >
- How to >
- Autoscaling >
- Snapshot and restore >

Elastic Docs › Elasticsearch Guide [8.15] › SQL

SQL Limitations

Large queries may throw ParsingException



Extremely large queries can consume too much memory during the parsing phase, in which case the Elasticsearch SQL engine will abort parsing and throw an error. In such cases, consider reducing the query to a smaller size by potentially simplifying it or splitting it into smaller queries.

Nested fields in SYS_COLUMNS and DESCRIBE TABLE



Elasticsearch has a special type of relationship fields called nested fields. In Elasticsearch SQL they can be used by referencing their inner sub-fields. Even though `SYS_COLUMNS` in non-driver mode (in the CLI and in REST calls) and `DESCRIBE TABLE` will still display them as having the type `NESTED`, they cannot be used in a query. One can only reference its sub-fields in the form:

On this page

- [Large queries may throw ParsingException](#)
- [Nested fields in `SYS_COLUMNS` and `DESCRIBE TABLE`](#)
- [Scalar functions on nested fields are not allowed in `WHERE` and `ORDER BY` clauses](#)
- [Multi-nested fields](#)
- [Paginating nested inner hits](#)
- [Normalized keyword fields](#)
- [Array type of fields](#)
- [Sorting by aggregation](#)
- [Using a sub-select](#)

Most Popular

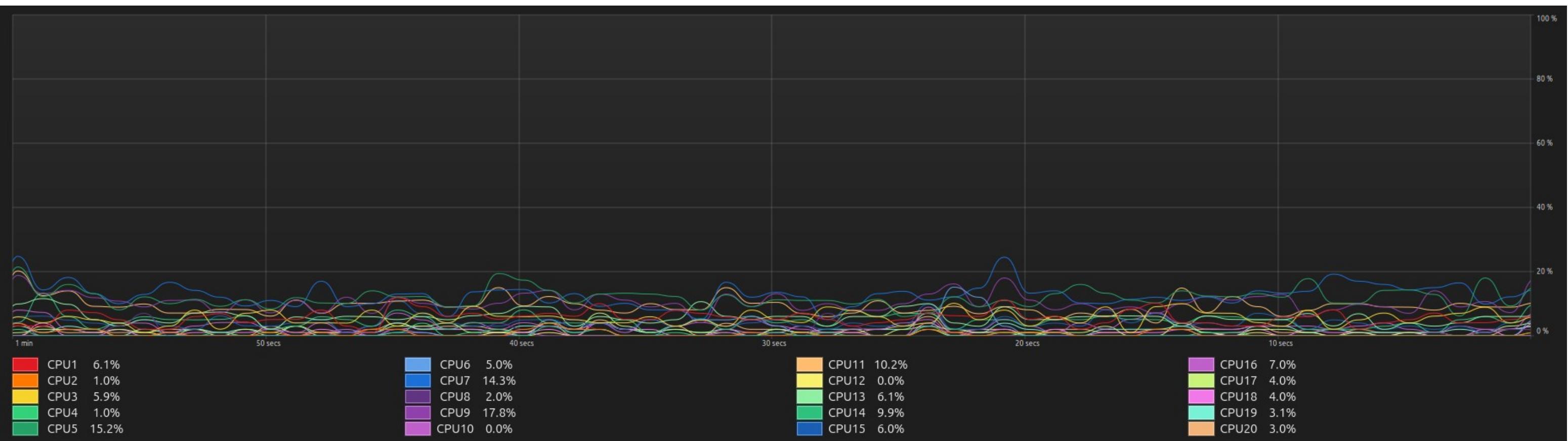
- [VIDEO](#)
- [Get Started with Elasticsearch](#)
- [VIDEO](#)

23

Time Series Data Stream

Time Series Data Stream

- Time series data refers to data points **ordered by time**.
- Data is collected at **regular intervals**.
- Example: CPU usage over time.

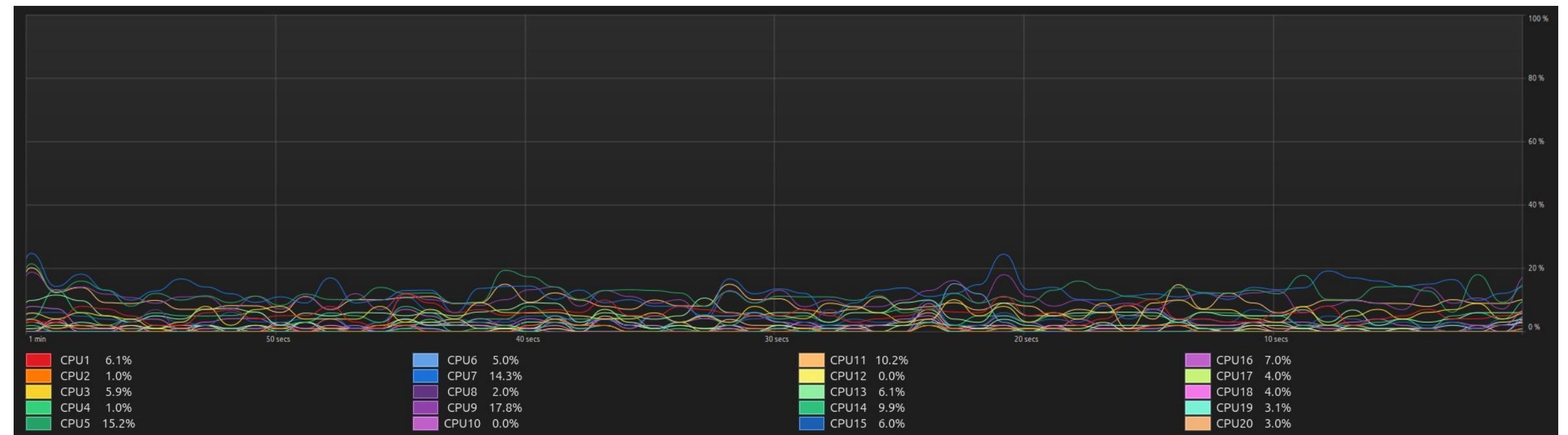
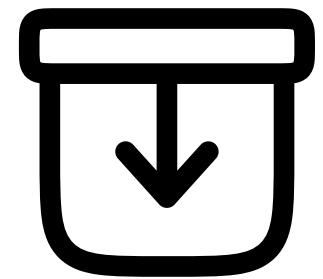


Time Series Data Stream

- Managing time series data is challenging.
 - The data can grow rapidly (high frequency measurements)
 - How to store this large volume efficiently?
 - Deciding which old data to keep and when to delete it.



VS



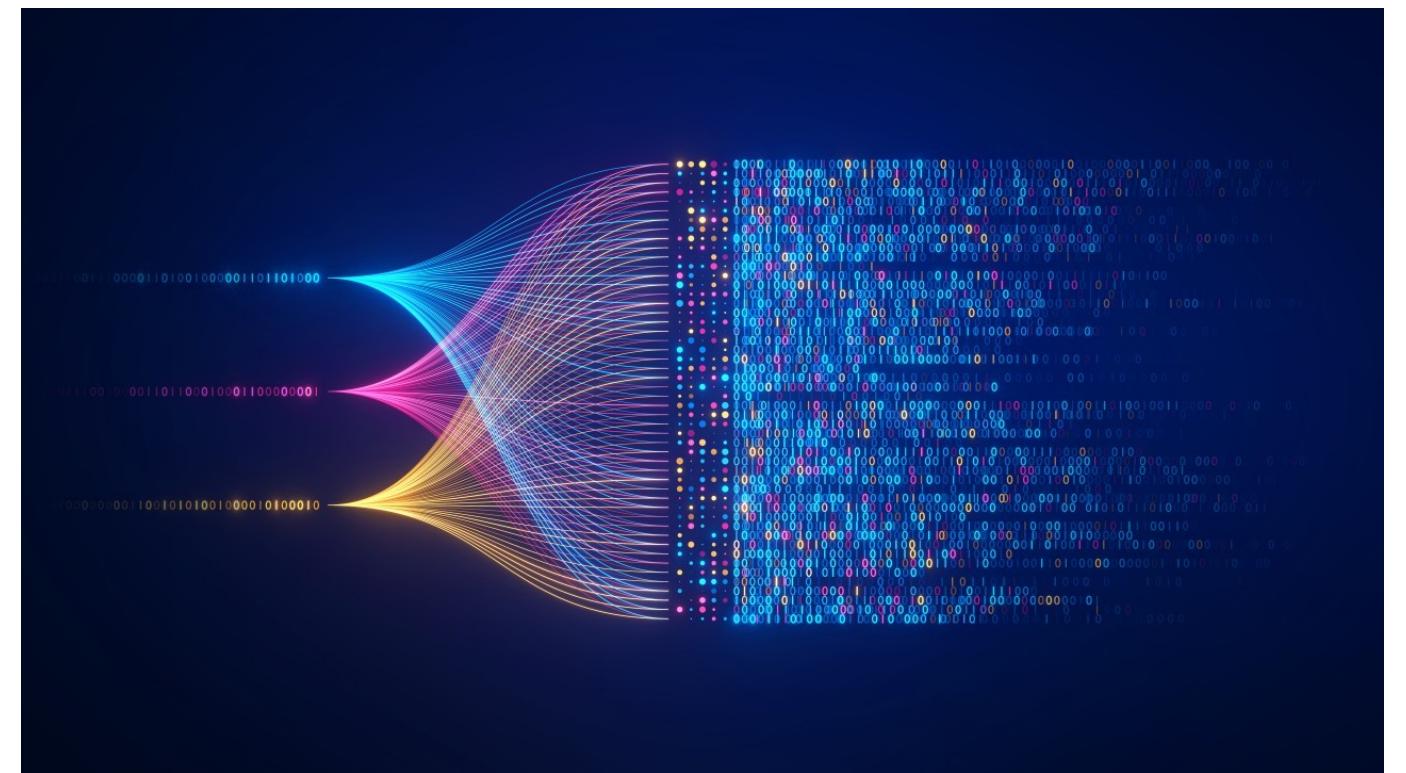
Time Series Data Stream

Why use Elasticsearch for time series data?

- Elasticsearch can handle **massive volumes of data**.
- Supports **real-time** data ingestion and querying.
- **Analyze** time-series.



Original post



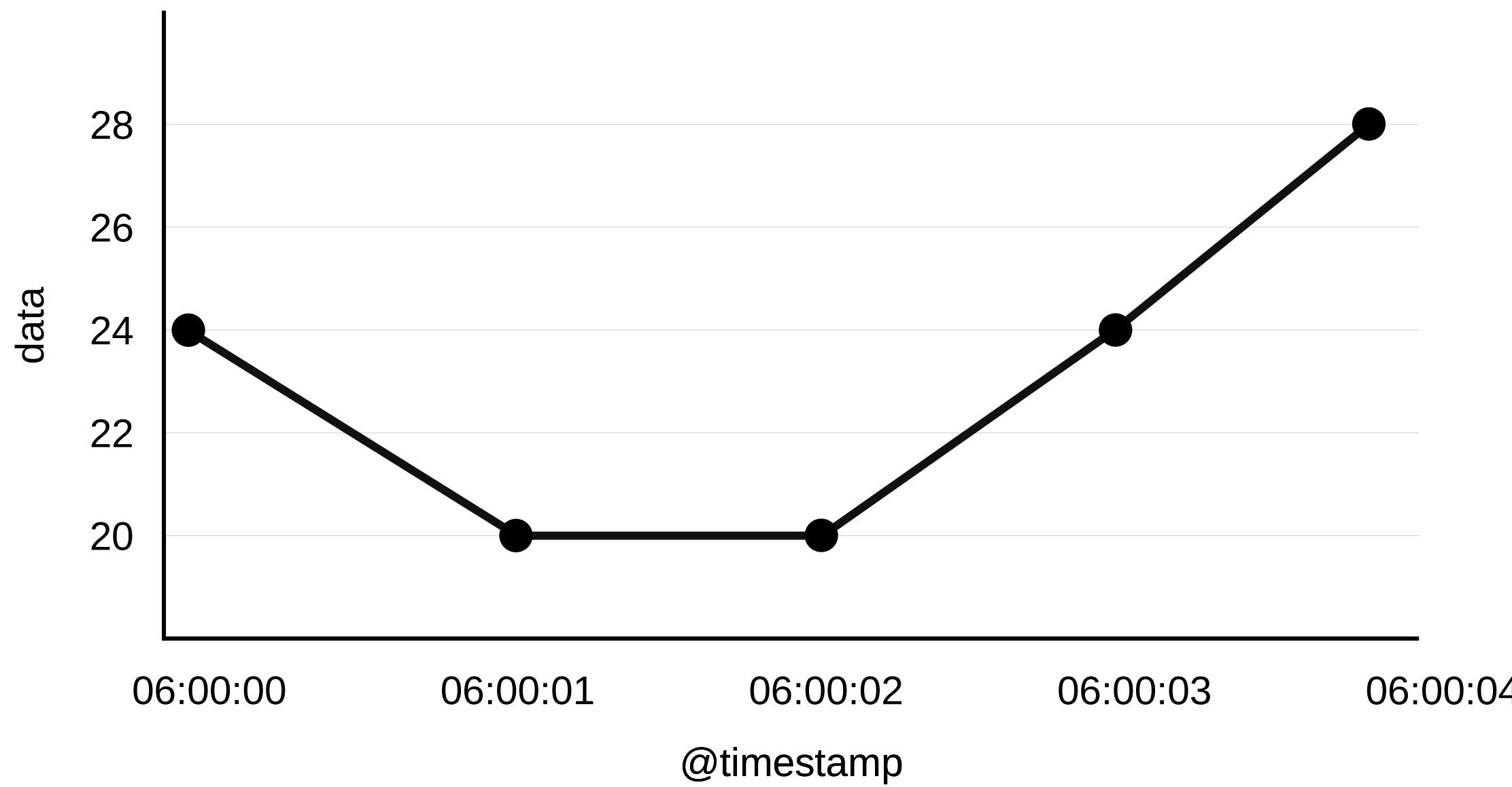
Original post

Time Series Data Stream



Time series data structure

- Each **data point** is a document
- Each **document** contains the **timestamp** field and the **data**.

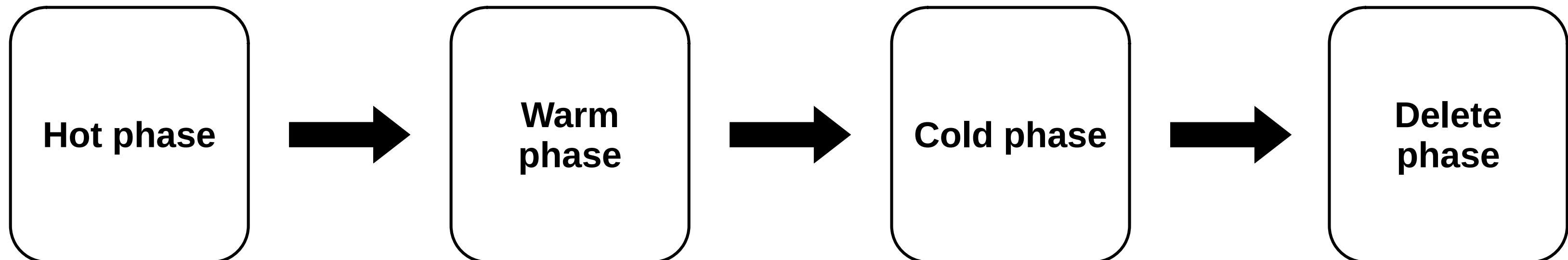


Time Series Data Stream



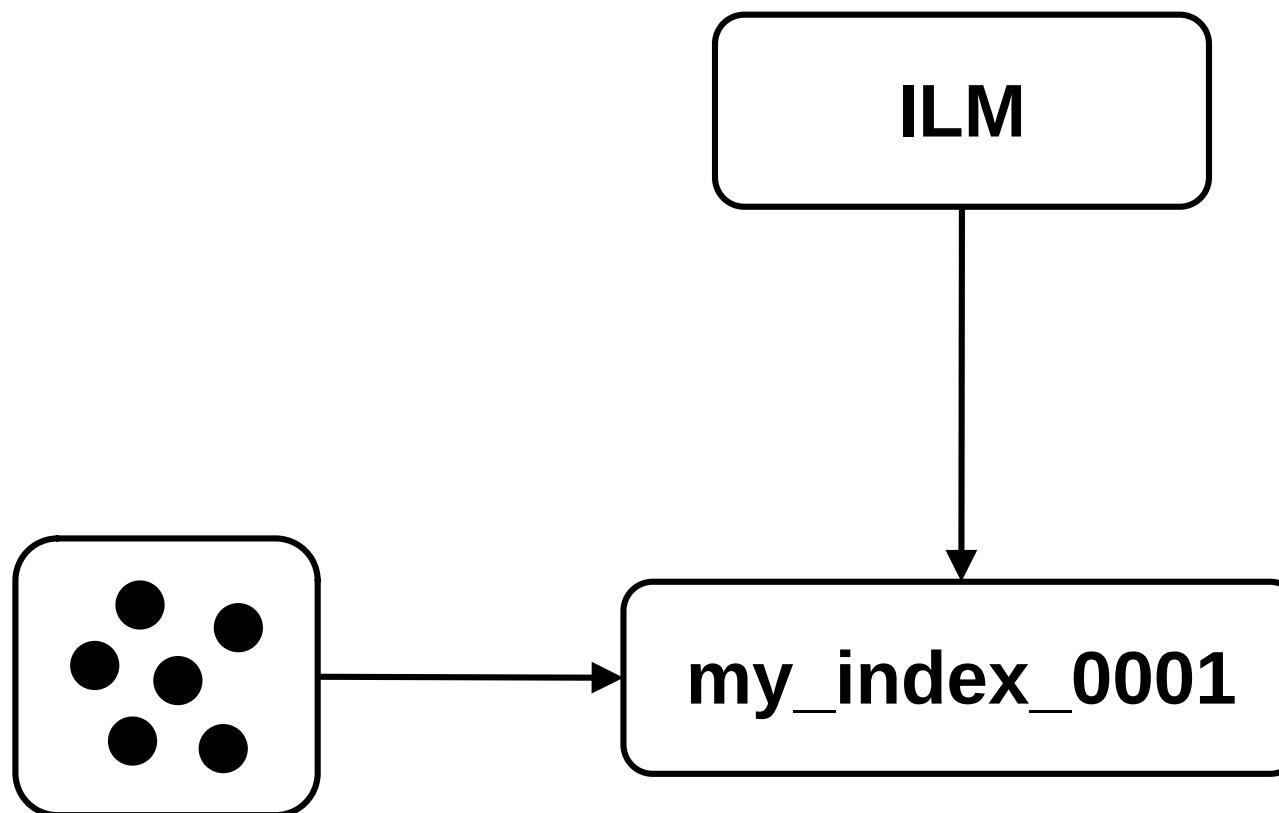
Index Lifecycle Management (ILM)

- ILM automates the **rollover** and **management** of indices.
- **Benefits:** Storage optimization, automated data retention, efficient management of index size.
- Phases of ILM:



Time Series Data Stream

ILM visualized

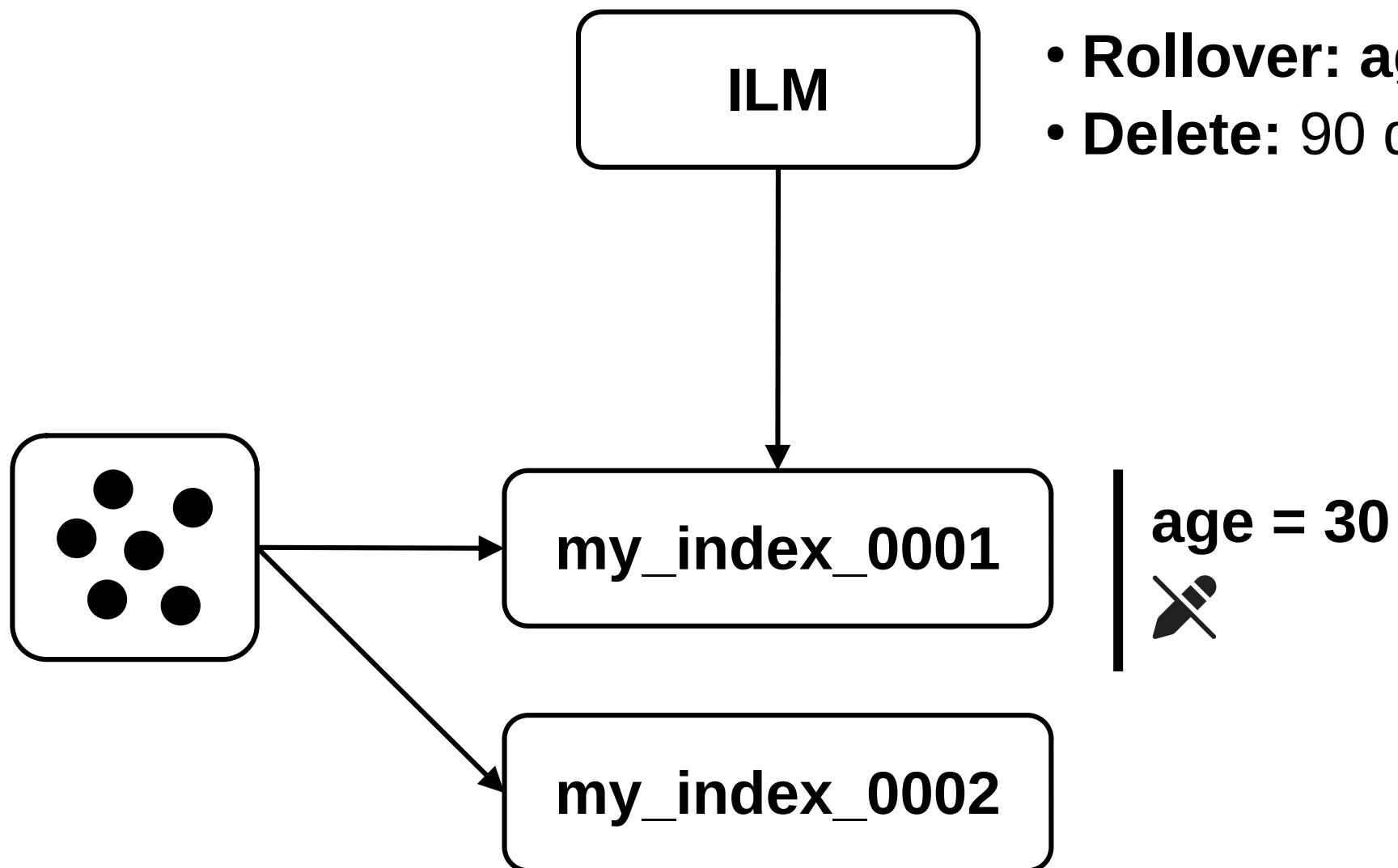


- **Rollover:** age = 30 days & size = 50GB
- **Delete:** 90 days



Time Series Data Stream

ILM visualized

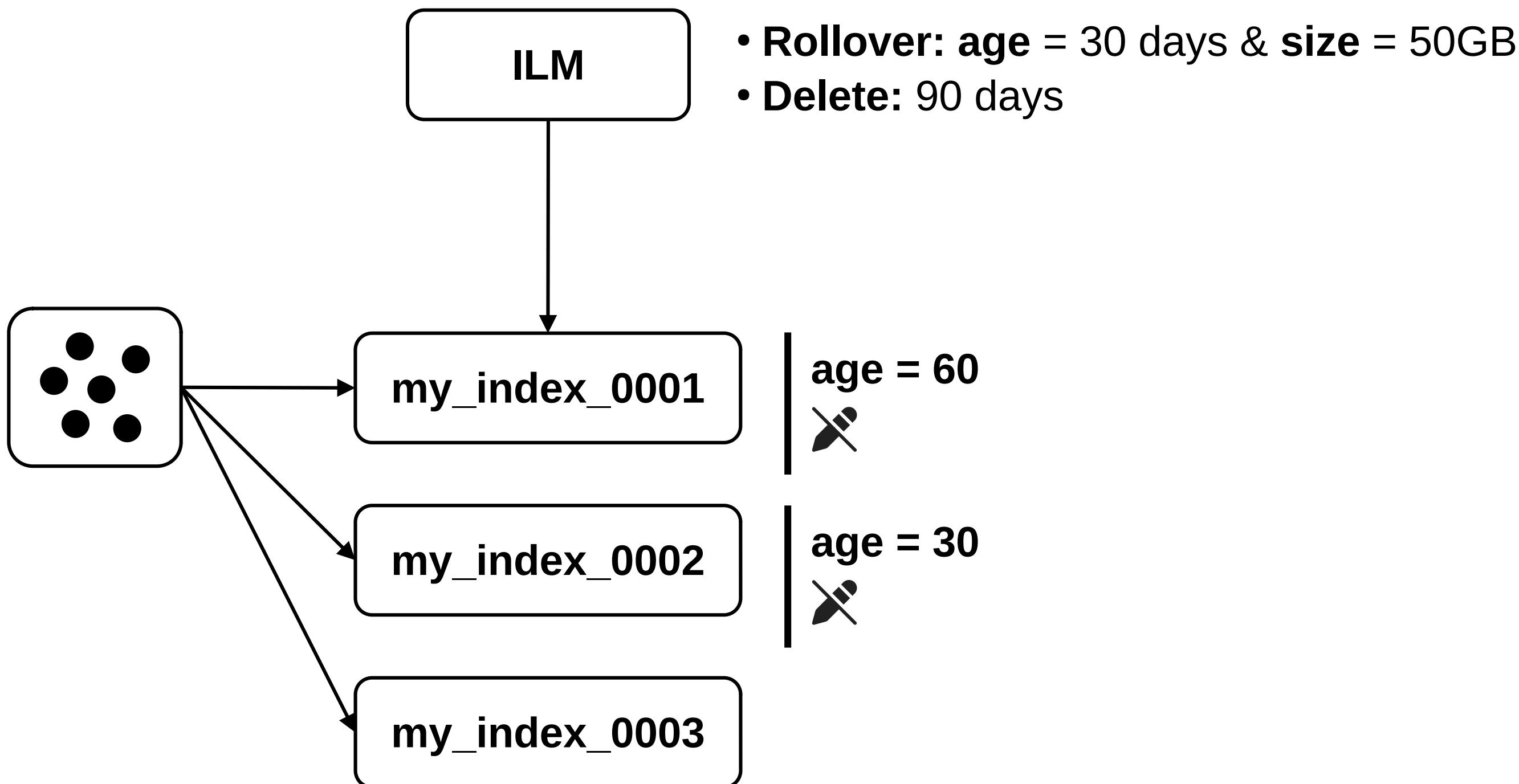


- **Rollover:** age = 30 days & size = 50GB
- **Delete:** 90 days



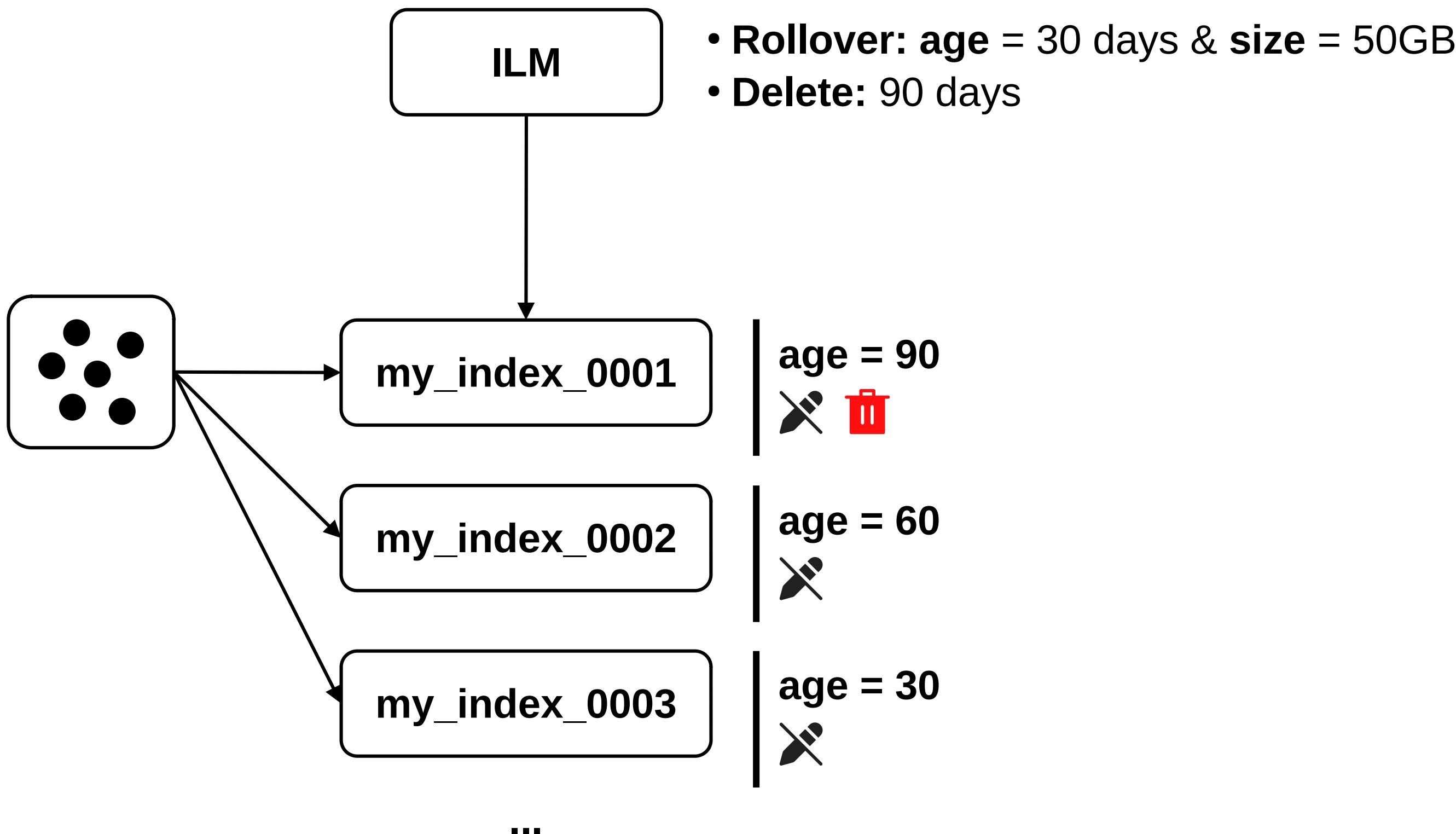
Time Series Data Stream

ILM visualized



Time Series Data Stream

ILM visualized



Time Series Data Stream

Querying time series data

```
{  
  "query": {  
    "range": {  
      "@timestamp": {  
        "gte": "2024-11-01T00:00:00",  
        "lte": "2024-11-07T23:59:59"  
      }  
    }  
  }  
}  
  
{  
  "aggs": {  
    "avg_cpu_usage": {  
      "avg": {  
        "field": "cpu_usage"  
      }  
    }  
  }  
}
```



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Analyzers

Analyzers



- Analyzers **process** text during **indexing** and **searching**.
- They transform text into **tokens**.
- They make the **search** process **efficient** and **accurate**.

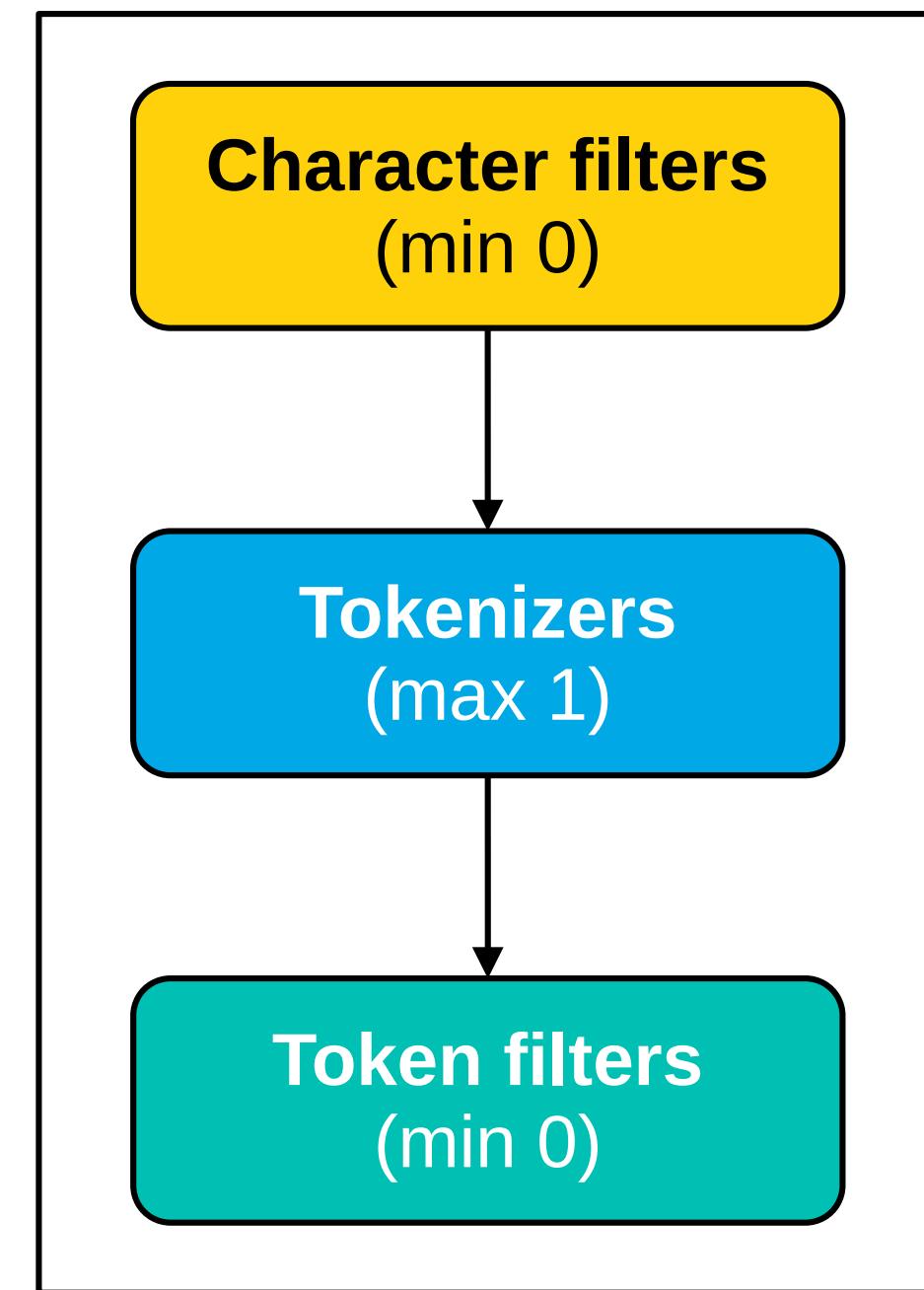


Analyzers



Analyzer components

- An analyzer is a **combination** of 3 components:
 - **Character filter**
 - **Tokenizer**
 - **Token filter**



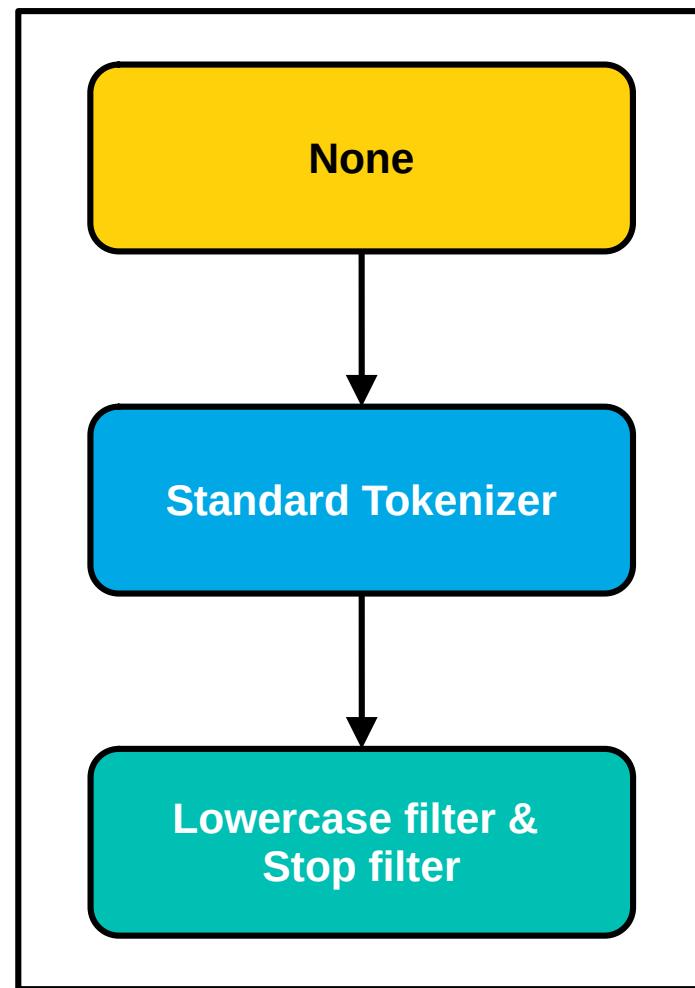
Analyzer

Analyzers

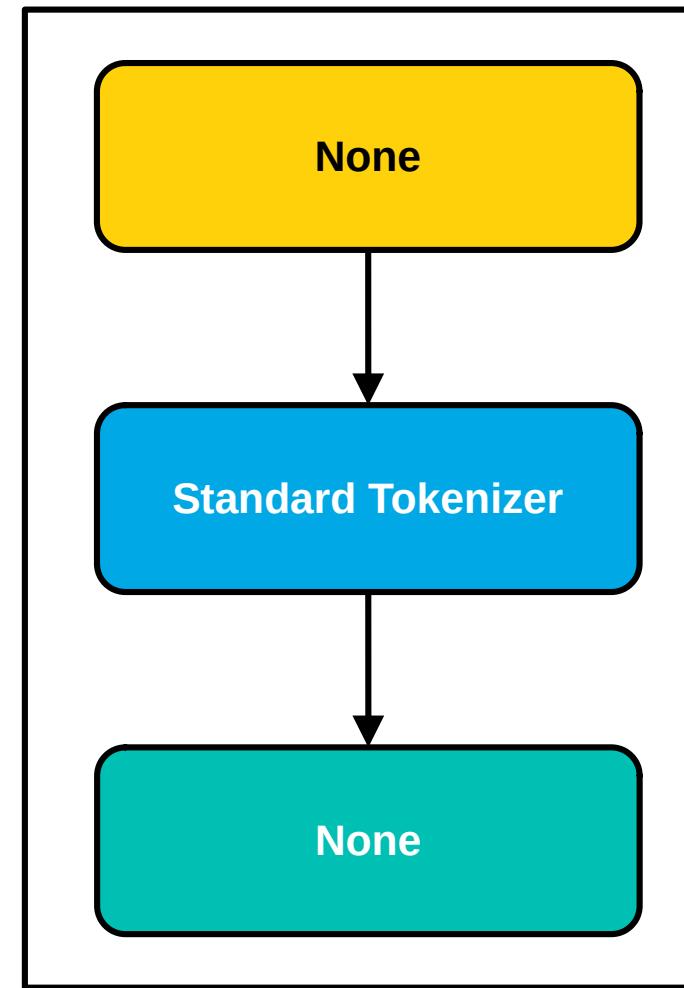


Built-in analyzers

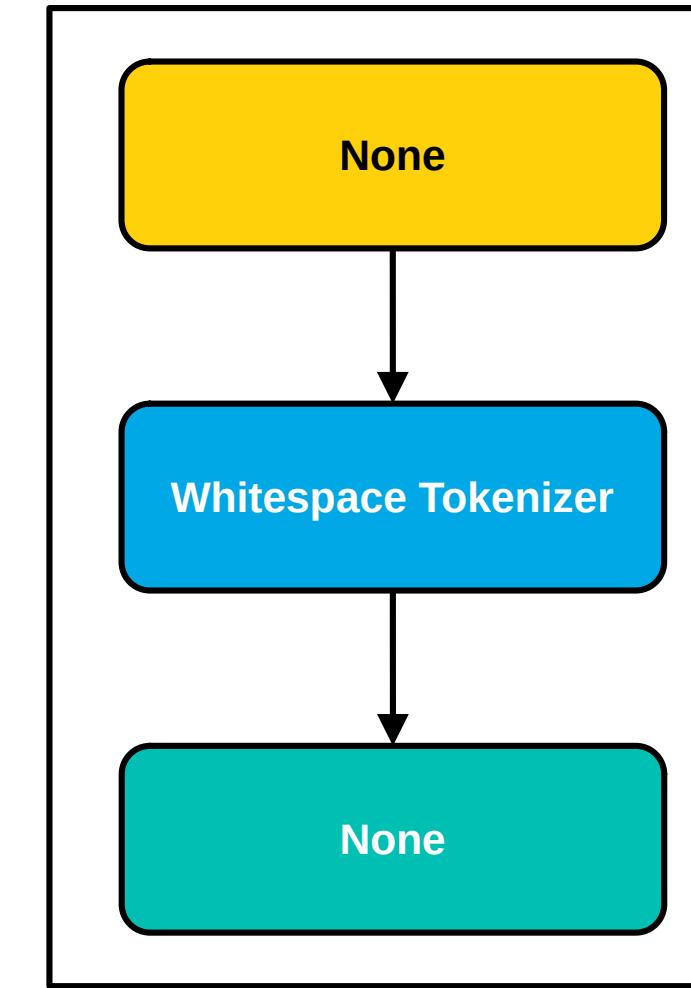
- Provide **ready-made** options for processing text in various ways.
- Each built-in analyzer is designed for specific types of data.
- Common analyzers:



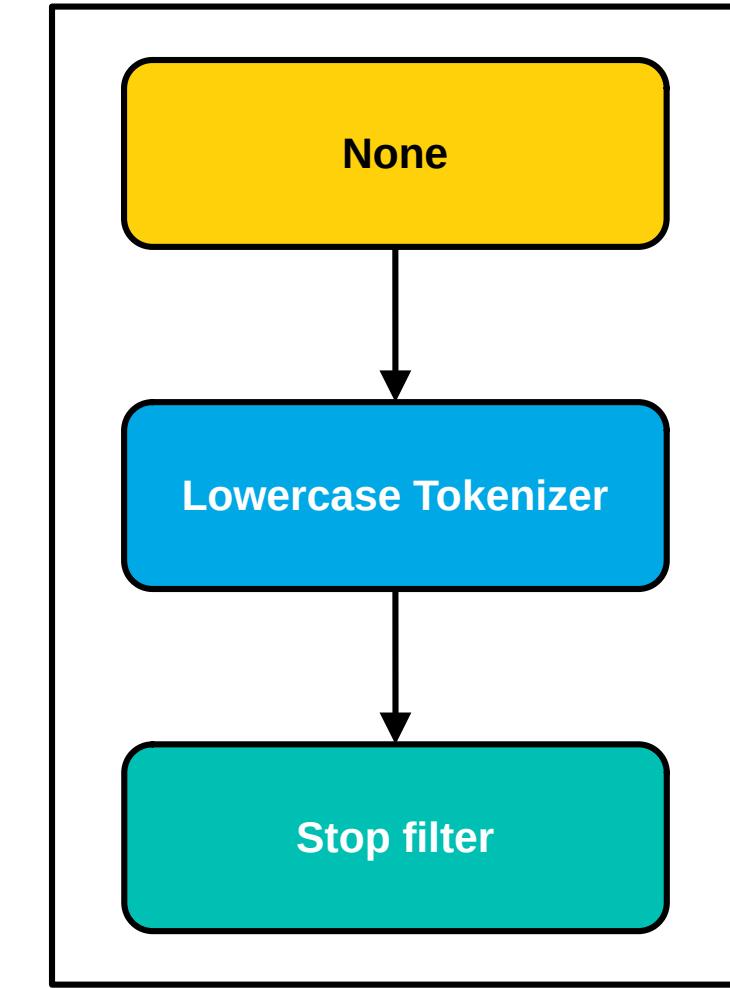
Standard Analyzer



Simple Analyzer



Whitespace Analyzer

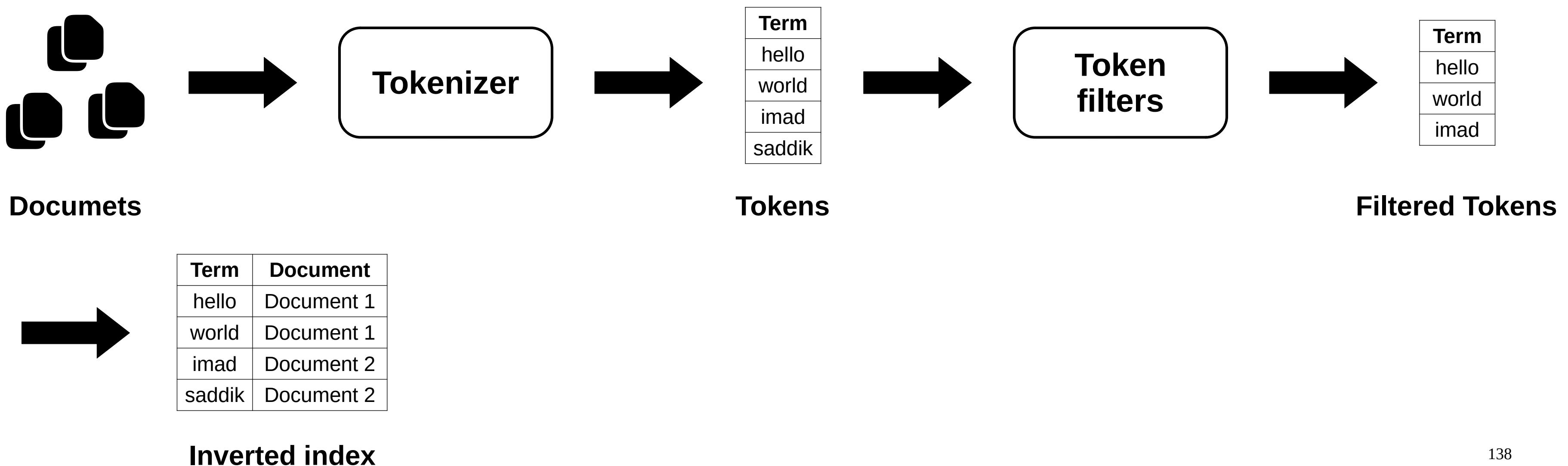


Stop Analyzer

Analyzers

Phases of analysis

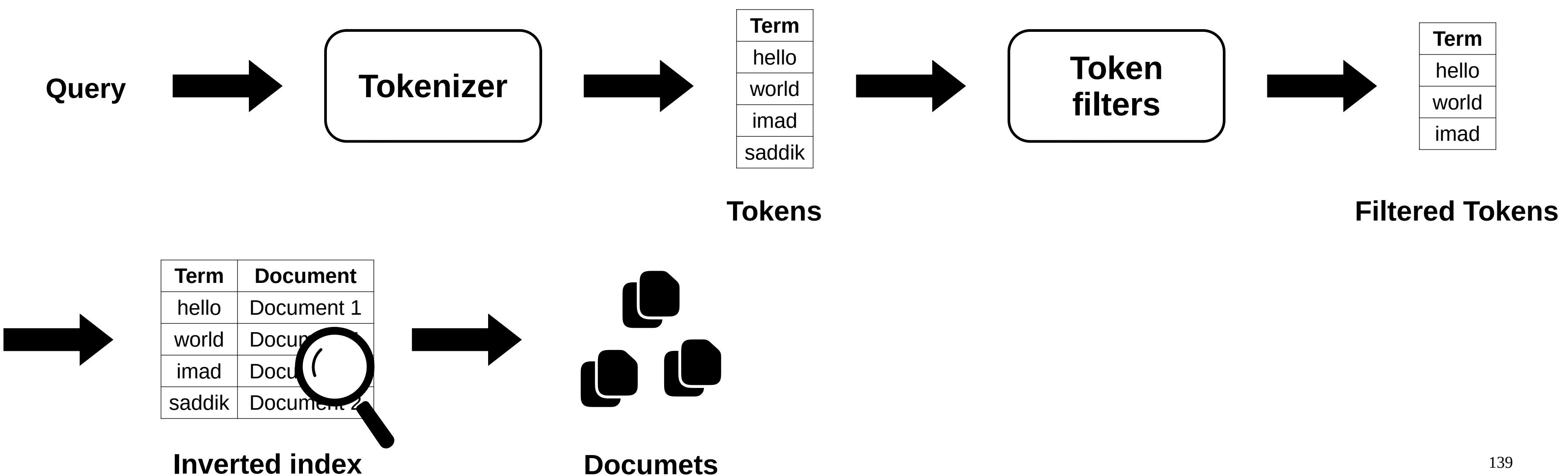
- Index time analysis



Analyzers

Phases of analysis

- Index time analysis
- Search time analysis



Analyzers



Elasticsearch Guide:

- 8.15 (current)
- > Elasticsearch basics
- > Quick starts
- > Set up Elasticsearch

Elastic Docs > Elasticsearch Guide [8.15] > Text analysis

Character filters reference

Character filters are used to preprocess the stream of characters before it is passed to the tokenizer.

Tokenizer reference

- Character group
- Classic
- Edge n-gram
- Keyword
- Letter

Elastic Docs > Elasticsearch Guide [8.15] > Text analysis

Tokenizer reference

A *tokenizer* receives a stream of characters, breaks it up into individual *tokens* (usually individual words), and

Token filter reference

- Apostrophe
- ASCII folding
- CJK bigram
- CJK width
- Classic

Elastic Docs > Elasticsearch Guide [8.15] > Text analysis

Token filter reference

Token filters accept a stream of tokens from a *tokenizer* and can modify tokens (eg lowercasing), delete tokens

Analyzers

Introduction to Analysis and analyzers in Elasticsearch

Phase 02 — indexing, mapping and analysis — Blog 08



Arun Mohan · [Follow](#)

Published in [elasticsearch](#) · 8 min read · Dec 9, 2017

450

2



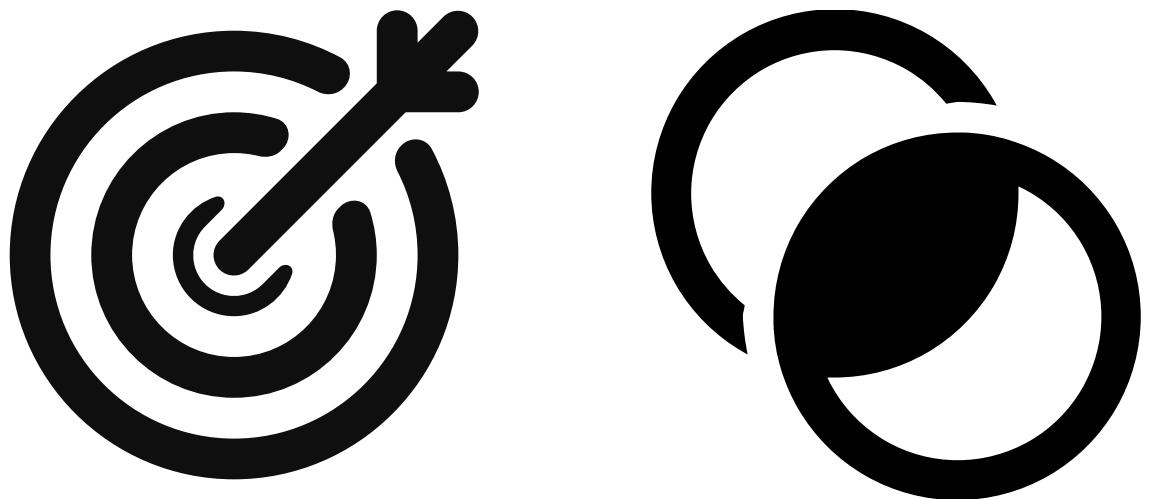
...

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Synonyms

Synonyms

- Synonyms help **enhance search** accuracy.
- Useful for **matching variations or related terms**.
- Synonyms are defined using the **Solr format**.

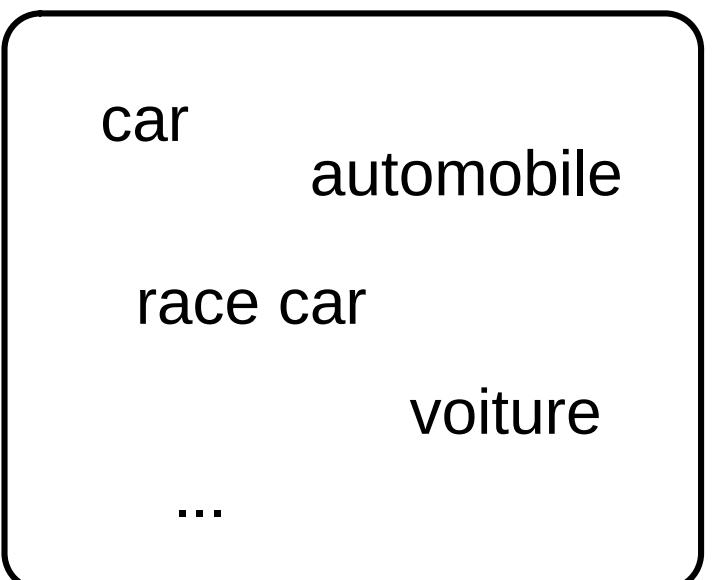


Synonyms



Solr format

- This is a **flexible syntax** for **defining** synonyms.
- It uses **two** different definitions:
 - **Equivalent synonyms:** “term 1, term 2, term 3”
 - **Explicit synonyms:** “term 1, term 2 => term 3”



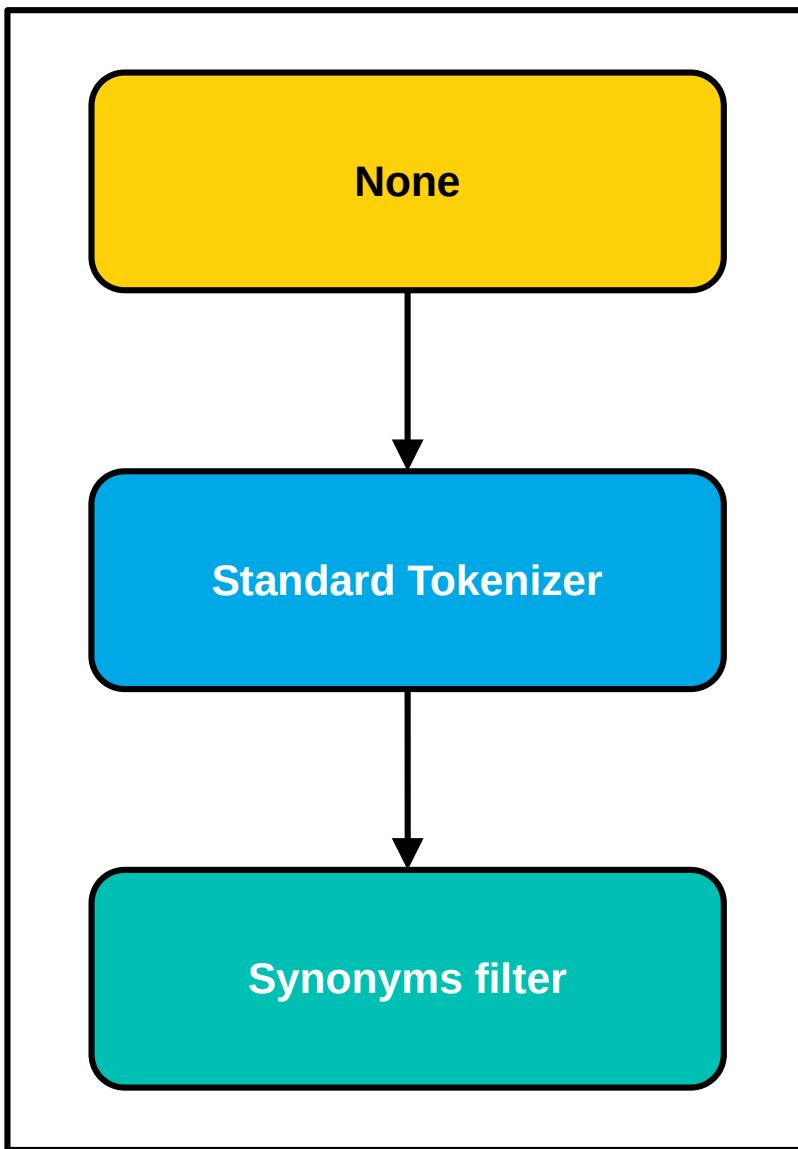
Equivalent terms



Synonyms



- Synonyms are used within **analyzers**.
- You can use synonyms **in index and search time**.
- Synonyms are a custom **token filter**.



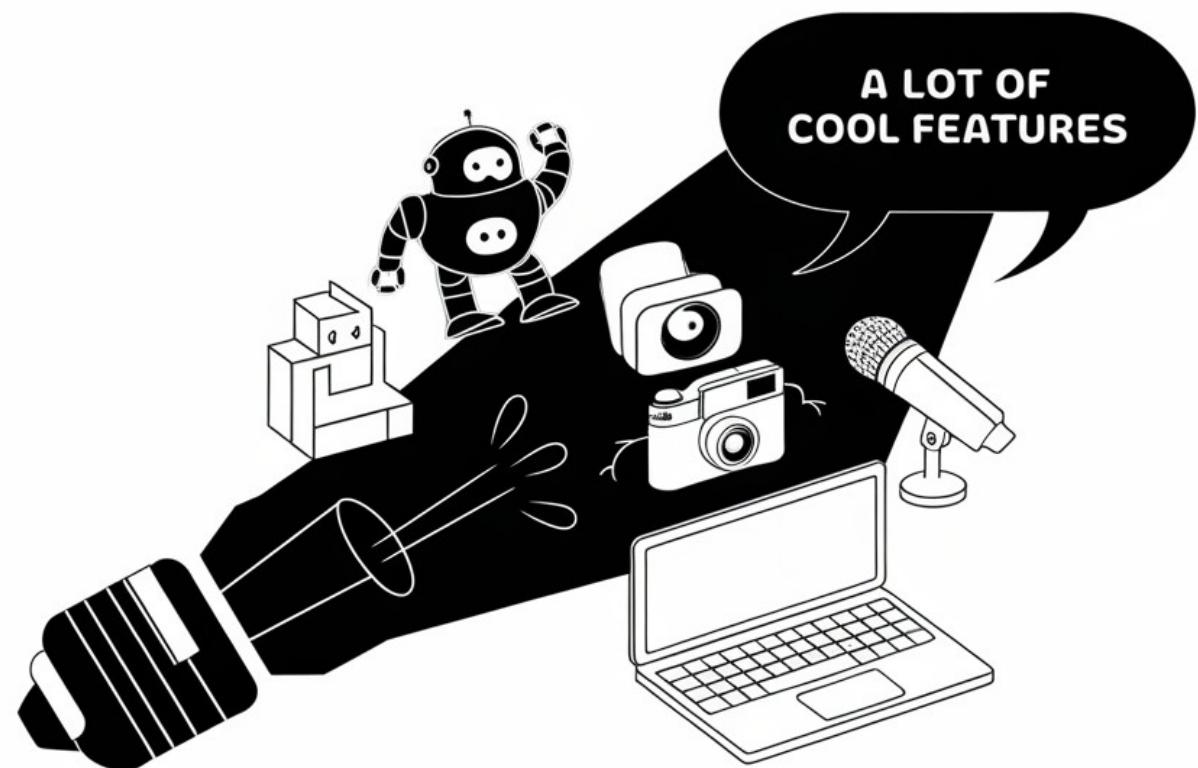
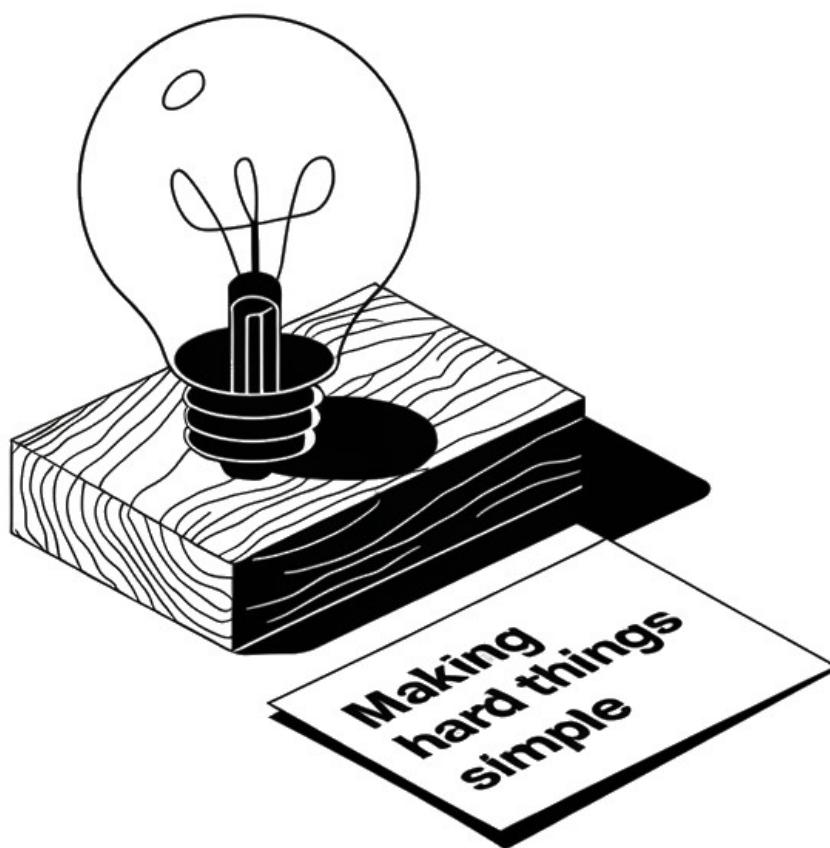
Custom Analyzer

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Common options

Common options

- Simplify Elasticsearch management.
- Provide features like **human-readable output, date math, and filtering**.
- All Elasticsearch **REST APIs** support these common options.



Common options



Human-readable output

- Make **statistics** in a format that **humans can understand**.
- It applies to **disk space, memory, time**, and other metrics.

Example

```
response = es.cluster.stats(human=True)
pprint(response["nodes"]["jvm"])
```

```
{'max_uptime_in_millis': 439500,
'mem': {'heap_max_in_bytes': 8183087104, 'heap_used_in_b
'threads': 81,
'versions': [{bundled_jdk': True,
  'count': 1,
  'using_bundled_jdk': True,
  'version': '22.0.1',
  'vm_name': 'OpenJDK 64-Bit Server VM',
  'vm_vendor': 'Oracle Corporation',
  'vm_version': '22.0.1+8-16'}]}
```

Before

```
{'max_uptime': '6.9m',
'max_uptime_in_millis': 417648,
'mem': {'heap_max': '7.6gb',
  'heap_max_in_bytes': 8183087104,
  'heap_used': '644.3mb',
  'heap_used_in_bytes': 675663848},
'threads': 80,
'versions': [{bundled_jdk': True,
  'count': 1,
  'using_bundled_jdk': True,
  'version': '22.0.1',
  'vm_name': 'OpenJDK 64-Bit Server VM',
  'vm_vendor': 'Oracle Corporation',
  'vm_version': '22.0.1+8-16'}]}
```

After

Common options

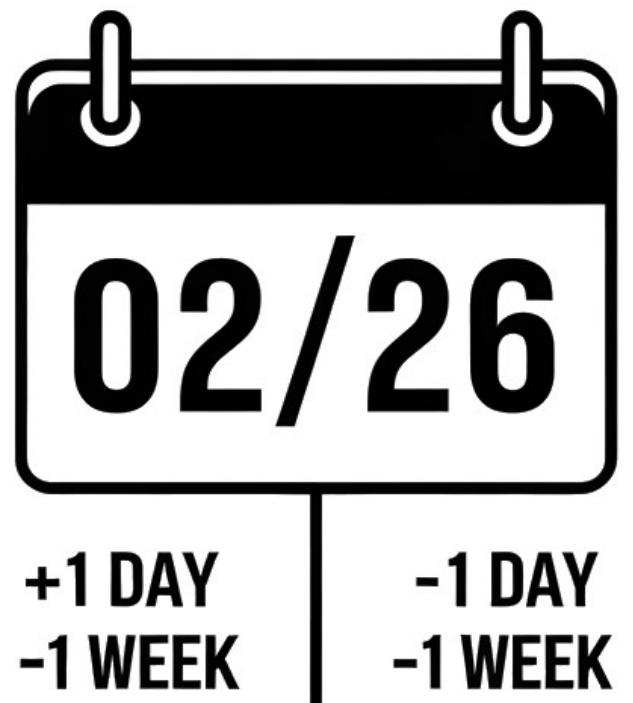
Date math

- Perform **math operations** on dates.
- Operations include: **Add, Subtract, Round down to nearest day**.
- Supported **time units**: **y (years)**, **M (months)**, etc.
- The expression starts with an **anchor date** (“**now**” or a string ending with **||**).



Examples

- **now := 2024-11-16 11:55:00**
- **now+1h := 2024-11-16 12:55:00**
- **now-1h := 2024-11-16 10:55:00**
- **now-1h/d := 2024-11-16 00:00:00**
- **2024.11.16||+1M/d := 2024-12-16 00:00:00**



Common options



Response filtering

- **Inclusive filtering:** Specify fields to include.
- **Exclusive filtering:** Remove unnecessary fields.
- **Combined filtering**

Example

```
response = es.search(  
    index=index_name,  
    body={  
        "query": {  
            "match_all": {}  
        }  
    },  
    filter_path="hits.hits._id,hits.hits._source"  
)  
pprint(response.body)
```

```
{'_shards': {'failed': 0, 'skipped': 0, 'successful': 1, 'total': 1},  
 'hits': {'hits': [{ '_id': '3Eu8ApMB770u3lhz-QPW',  
     '_index': 'my_index',  
     '_score': 1.0,  
     '_source': {'content': 'The Solar System consists of the '  
         'Sun and the objects that orbit it,'  
         'including eight planets, their '  
         'moons, dwarf planets, and '  
         'countless small bodies like '  
         'asteroids and comets.'},  
     'id': 1,  
     'title': 'The Solar System'}},
```

Before

```
{'hits': {'hits': [{ '_id': '3Eu8ApMB770u3lhz-QPW',  
     '_source': {'content': 'The Solar System consists of the '  
         'Sun and the objects that orbit it,'  
         'including eight planets, their '  
         'moons, dwarf planets, and '  
         'countless small bodies like '  
         'asteroids and comets.'},  
     'id': 1,  
     'title': 'The Solar System'}},
```

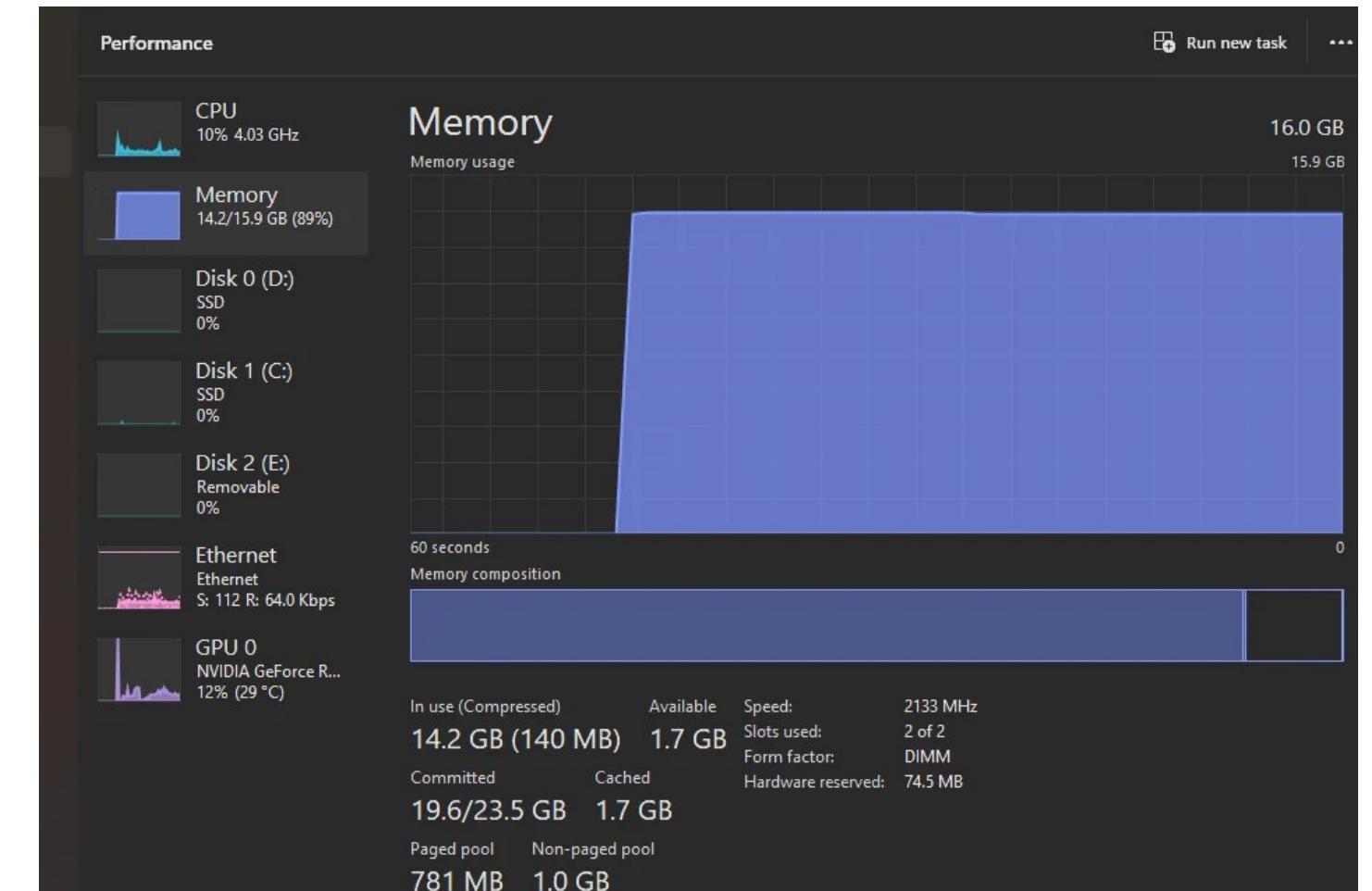
After

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Change heap size

Change heap size

- By default Elasticsearch uses **50% of the available RAM**.
- This can **slow down** your PC.
- You only need **1 or 2GB** when dealing with small indices.



Change heap size

Steps to change the heap size

1. Start the container.

```
sudo docker start elasticsearch
```

```
(base) imad-saddik@saddik:~$ sudo docker start elasticsearch
[sudo] password for imad-saddik:
elasticsearch
```



Change heap size

Steps to change the heap size

1. Start the container.
2. Go inside the container.

```
sudo docker exec -u 0 -it elasticsearch bash
```

```
(base) imad-saddik@saddik:~$ sudo docker start elasticsearch
[sudo] password for imad-saddik:
elasticsearch
(base) imad-saddik@saddik:~$ sudo docker exec -u 0 -it elasticsearch bash
root@3d37442d2591:/usr/share/elasticsearch# 
```



Change heap size



Steps to change the heap size

1. Start the container.
2. Go inside the container.
3. Create the **heap.options** file inside **jvm.options.d** folder and add this.

```
echo "-Xms2g" > /usr/share/elasticsearch/config/jvm.options.d/heap.options
echo "-Xmx2g" >> /usr/share/elasticsearch/config/jvm.options.d/heap.options
```

```
root@3d37442d2591:/usr/share/elasticsearch# echo "-Xms2g" > /usr/share/elasticsearch/config/jvm.options.d/heap.options
root@3d37442d2591:/usr/share/elasticsearch# echo "-Xmx2g" > /usr/share/elasticsearch/config/jvm.options.d/heap.options
```

```
cat /usr/share/elasticsearch/config/jvm.options.d/heap.options
```

```
root@3d37442d2591:/usr/share/elasticsearch# cat /usr/share/elasticsearch/config/jvm.options.d/heap.options
-Xms2g
-Xmx2g
root@3d37442d2591:/usr/share/elasticsearch#
```

Change heap size



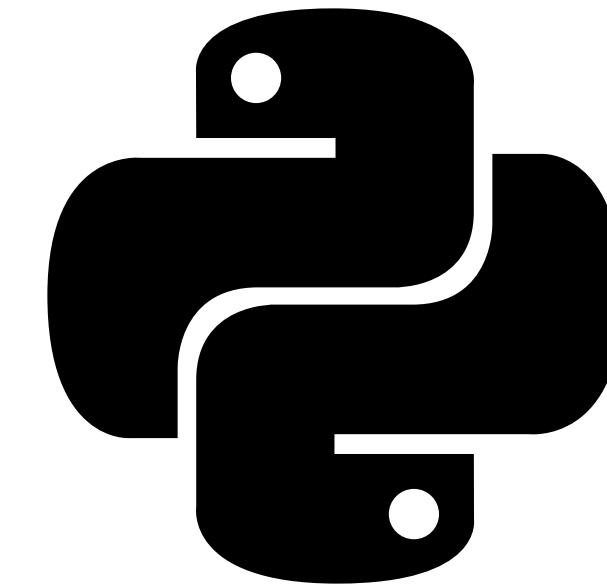
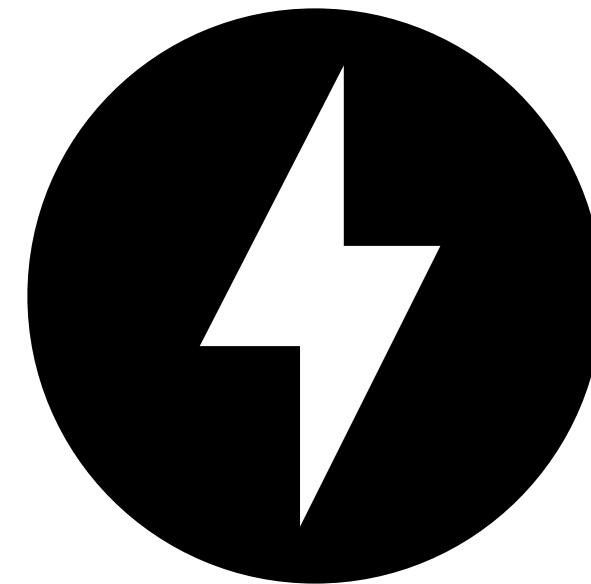
Process Name	User	% CPU	ID	Memory	Disk read total
java	imad-saddik	0.03	14525	2.6 GB	N/A
soffice.bin	imad-saddik	0.00	9690	922.1 MB	145.4 MB

28

Final project – part 0

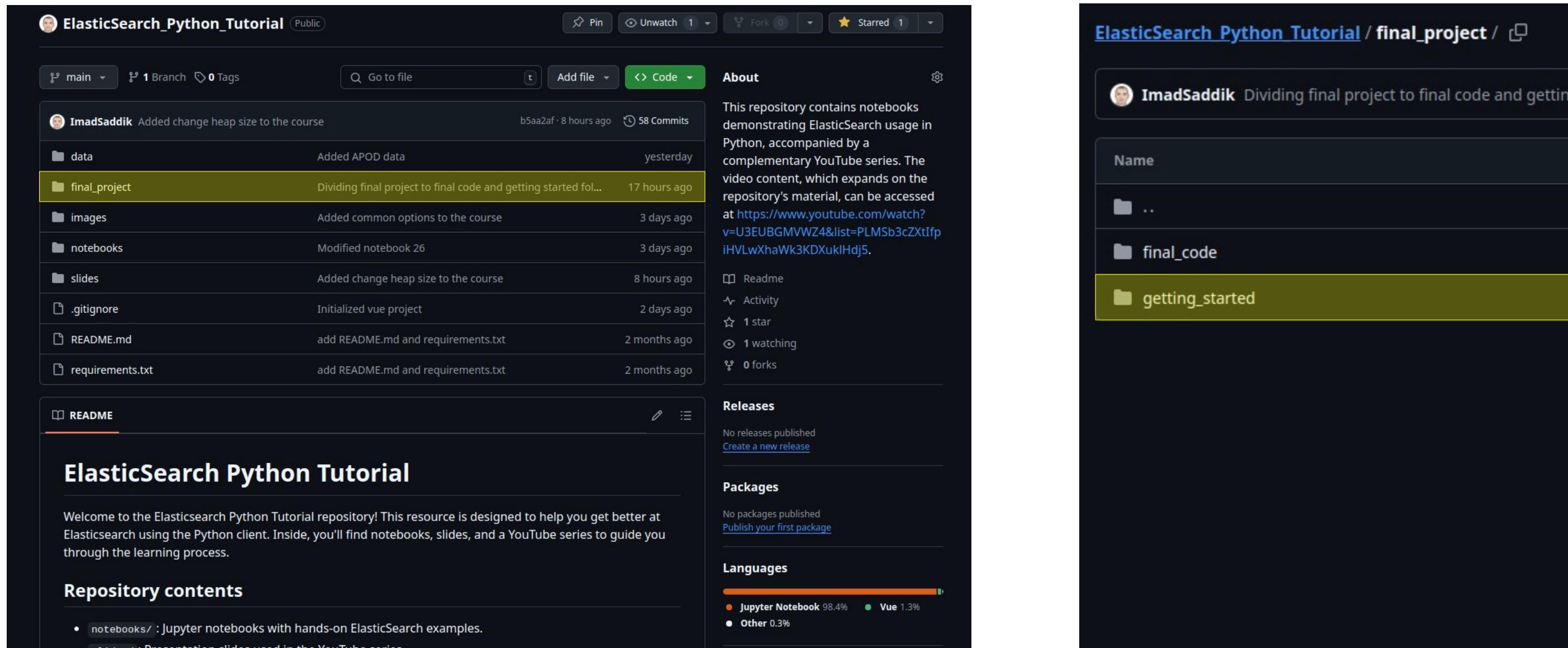
Final project – part 0

- No more videos on Elasticsearch **concepts and APIs**.
- I'll be focusing on the **final project** from now on.
- The final project will cover most of the topics we've learned in previous videos.
- We will be building a **website**.
- Elasticsearch will provide the **search functionality**.



Final project – part 0

Source code



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Final project – part 1

Final project – part 1

- Create an index and index documents.
- Use **size / from** when searching.
- Perform **multi-match queries**.
- The theme of the final project is **Astronomy**.



Image credit: Kent E. Biggs

Final project – part 1

- Frontend is done for you.
- Install dependencies.

The screenshot shows the GitHub repository page for 'ElasticSearch_Python_Tutorial'. The repository is public and has 58 commits. The repository contents include a README file, Jupyter notebooks, APOD data, common options, and a Vue project. The repository is described as containing notebooks demonstrating Elasticsearch usage in Python, accompanied by a complementary YouTube series. It also links to a specific YouTube video. The repository has no releases or packages published, and the languages used are Jupyter Notebook (98.4%), Vue (1.3%), and Other (0.3%).

ElasticSearch_Python_Tutorial Public

main · 1 Branch · 0 Tags

Go to file Add file

About

This repository contains notebooks demonstrating Elasticsearch usage in Python, accompanied by a complementary YouTube series. The video content, which expands on the repository's material, can be accessed at <https://www.youtube.com/watch?v=U3EUBGMVWZ4&list=PLMSb3cZxtIfpiHvLwXhaWk3KDXuklHd5>.

Readme Activity 1 star 1 watching 0 forks

Releases

No releases published [Create a new release](#)

Packages

No packages published [Publish your first package](#)

Languages

Jupyter Notebook 98.4% Vue 1.3% Other 0.3%

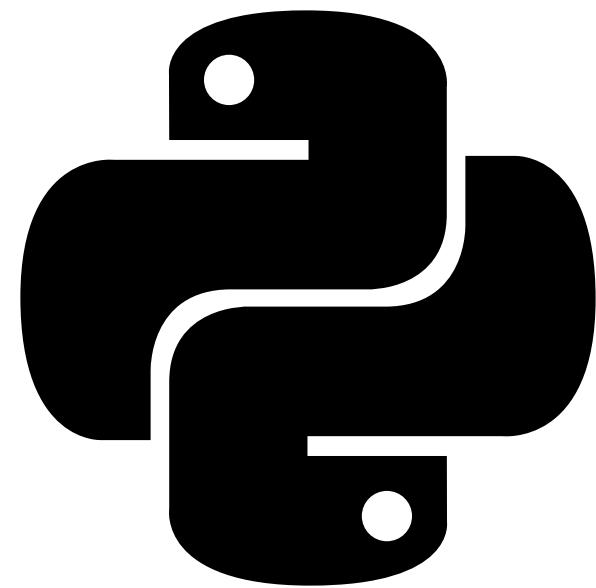
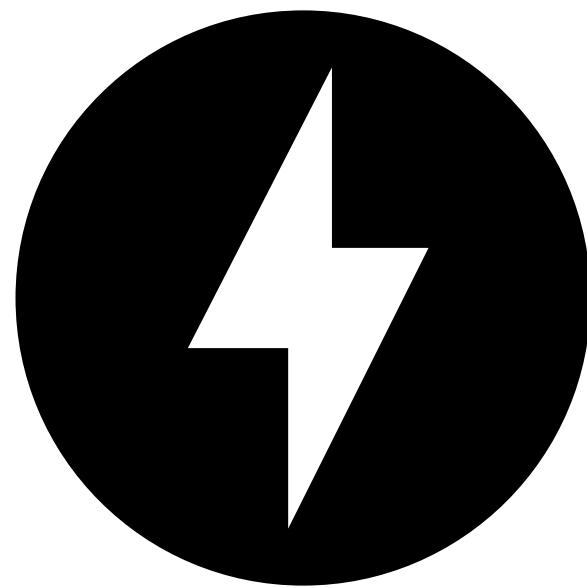
Repository contents

- notebooks/ : Jupyter notebooks with hands-on Elasticsearch examples.



Final project – part 1

- Install dependencies.
- Setup the backend server.
- Configure Elasticsearch.



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Final project – part 2

Final project – part 2

- Add the pagination controls.
- Filter by year.
- Use aggregations.

Andromeda

Year All years ▾ Items per page 10 ▾

2015 (8)
2016 (8)
2017 (6)
2018 (5)
2019 (6)
2020 (11)

Ultraviolet Rings of M31
Explanation: A mere 2.5 million light-years away the Andromeda Galaxy, also known as M31, really is just next door as large galaxies go. So close and spanning some 260,000 light-years, it took 11 different image fields from the Galaxy Evolution Explorer (GALEX) satellite's telescope to produce this gorgeous portrait of the spiral galaxy in ultraviolet light. While its spiral arms stand out invisible light images of Andromeda, the arms look more like rings in the GALEX ultraviolet view, a view dominated by the energetic light from hot, young, massive stars. As sites of intense star formation, the rings have been interpreted as evidence Andromeda collided with its smaller neighboring elliptical galaxy M32 more than 200 million years ago. The large Andromeda galaxy and our own Milky Way are the most massive members of the local galaxy group.

Andromeda

Year All years ▾ Items per page 10 ▾ << First < Previous 1 / 9 Next > >>

Ultraviolet Rings of M31
Explanation: A mere 2.5 million light-years away the Andromeda Galaxy, also known as M31, really is just next door as large galaxies go. So close and spanning some 260,000 light-years, it took 11 different image fields from the Galaxy Evolution Explorer (GALEX) satellite's telescope to produce this gorgeous portrait of the spiral galaxy in ultraviolet light. While its spiral arms stand out invisible light images of Andromeda, the arms look more like rings in the GALEX ultraviolet view, a view dominated by the energetic light from hot, young, massive stars. As sites of intense star formation, the rings have been interpreted as evidence Andromeda collided with its smaller neighboring elliptical galaxy M32 more than 200 million years ago. The large Andromeda galaxy and our own Milky Way are the most massive members of the local galaxy group.

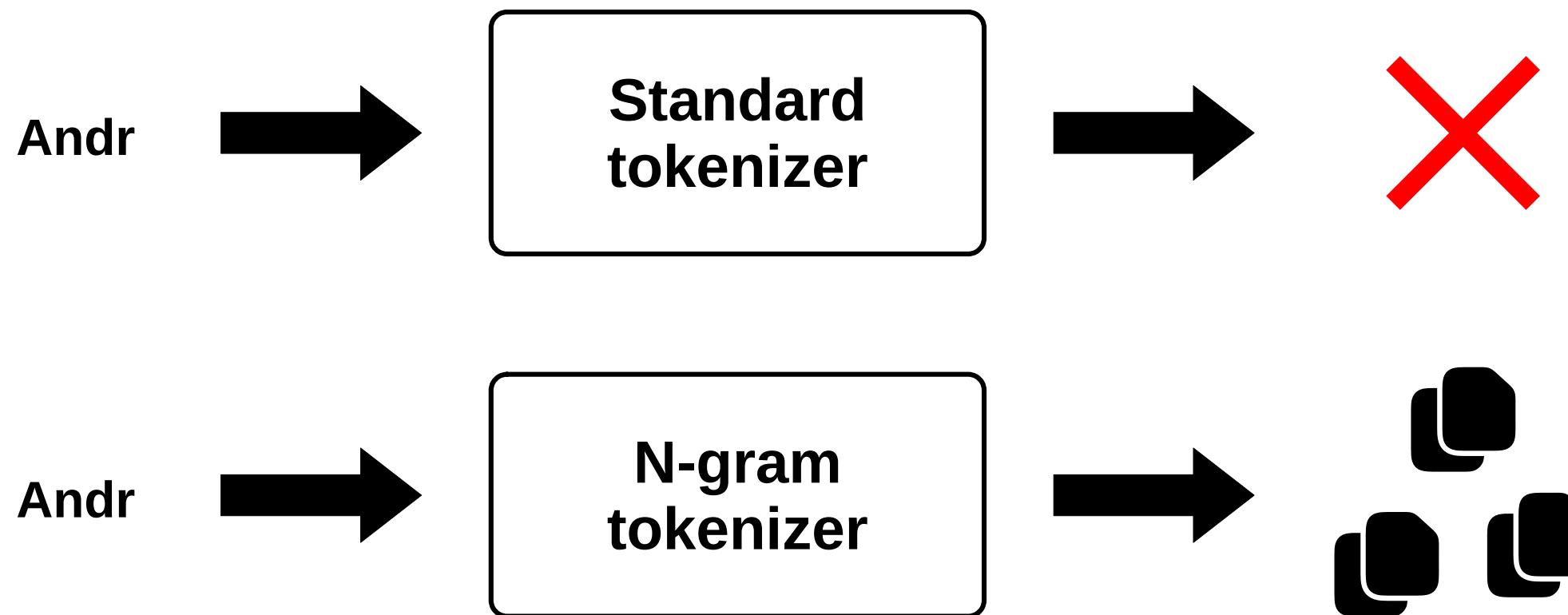
Andromeda Rising over the Alps
Explanation: Have you ever seen the Andromeda galaxy? Although M31 appears as a faint and fuzzy blob to the unaided eye, the light you see will be over two million years old, making it likely the

31

Final project – part 3

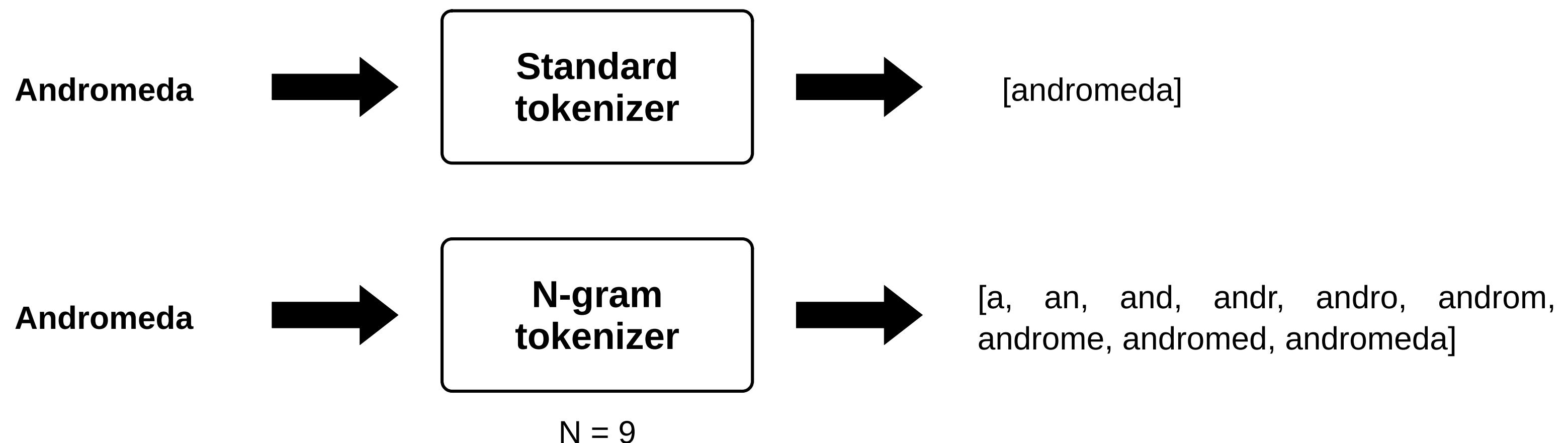
Final project – part 3

- Implement a ***search as you type*** feature.
- Utilize the **N-gram tokenizer**.



Final project – part 3

- Why use the N-gram tokenizer?

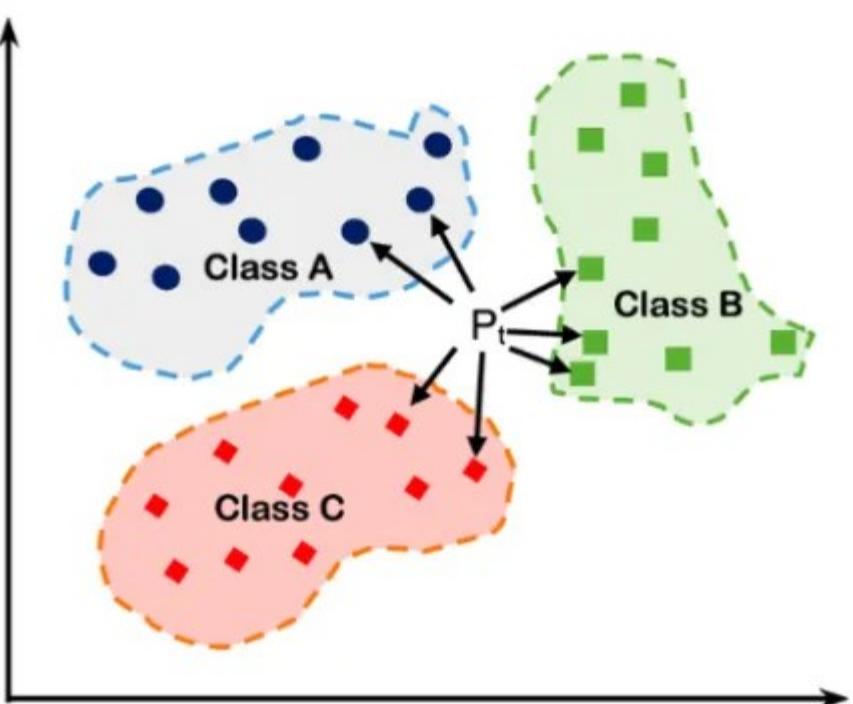


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Final project – part 4

Final project – part 4

- Implement **semantic search**.
- Use an **embedding model** from **HuggingFace**.
- Use **kNN search** to find documents.



Medium article by Sachinsoni



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Final project – part 5

Final project – part 5

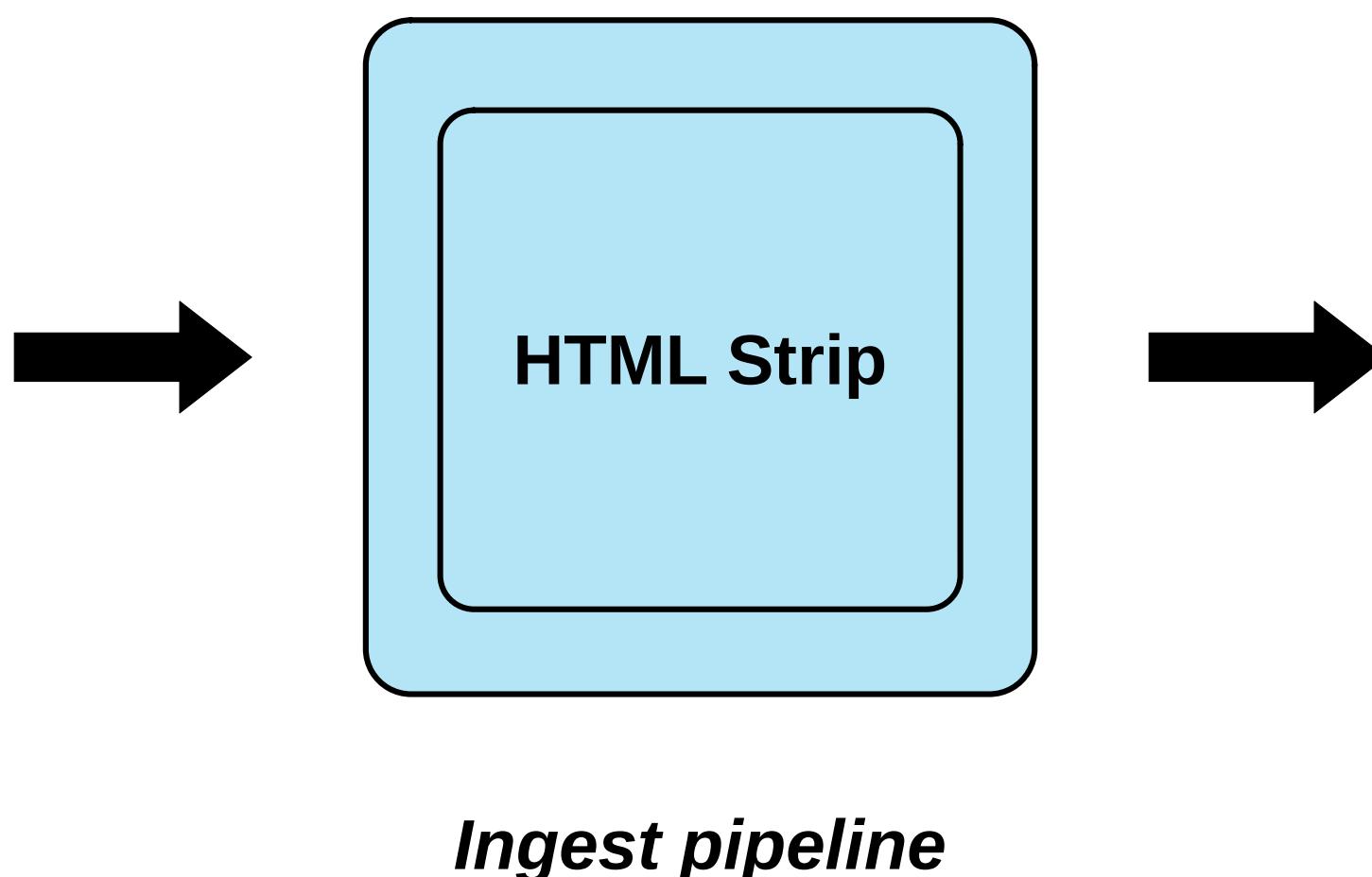
- Add the raw APOD data.
- Contains HTML tags.

```
{  
  "date": "2024-11-30",  
  "title": "<a href=\"ap241130.html\">Winter and Summer on a Little Planet</a>",  
  "explanation": "<p>\n<b>Explanation:</b> \n\nWinter and summer appear to come on a single night to this\n<a href=\"https://www.instagram.com/camille.niel_photography/p/C270AVzrKcp/?img_index=1\">stunning little planet</a>.\\n\\nIt's  
planet Earth of course.\\n\\nThe\\n<a href=\"http://srcematematike.si/2014/03/09/math-behind-tiny-planets/\">digitally mapped</a>,\\n  
anadir centered panorama covers 360x180\\ndegrees and is\\ncomposed of frames recorded during January and July from the\\n<a href=\"https://en.wikipedia.org/wiki/Col_du_Galibier\">Col du Galibier</a> ...  
}
```

Final project – part 5

- Add the raw **APOD** data.
- Contains **HTML tags**.
- Use **pipelines** to remove the **HTML tags**.

```
{  
  "date": "2024-11-30",  
  "title": "<a  
  href=\"ap241130.htm\">Winter and  
  Summer on a Little Planet</a>",  
  "explanation": "<p>\n<b> Explanation:  
  </b> \n\nWinter and summer appear to  
  come on a single night to this<br>  
  <a  
  href=\"https://www.instagram.com/c  
  amille.niel_photography/p/C270AVzr  
  Kcp/?img_index=1\">stunning little  
  planet</a>.\n\nIt's planet Earth of  
  course.\n\nThe<br>  
  <a  
  href=\"http://srcematematike.si/2014/  
  03/09/math-behind-tiny-  
  planets\">digitally mapped...  
  
```



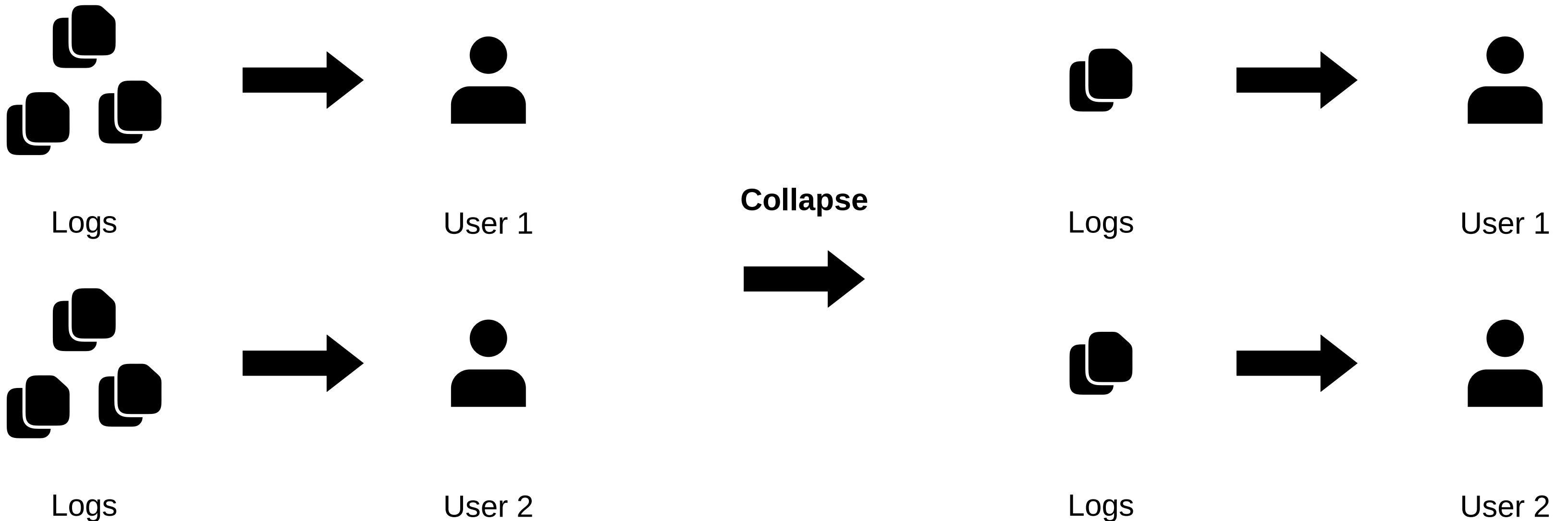
```
{  
  "date": "2024-11-30",  
  "title": "Winter and Summer on a Little  
  Planet",  
  "explanation": "\nExplanation:\n\nWinter and summer appear to come  
  on a single night to this\nstunning little  
  planet.\n\nIt's planet Earth of course.\n\nThe\ndigitally mapped..."  
  
```

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Collapse search results

Collapse search results

- Collapse is used to show only the **best document** for each group.
- It is **useful when many documents are similar**.



Collapse search results

- **Example:**

```
response = es.search(  
    index="my_index",  
    body={  
        "query": {  
            "match": {  
                "message": "My Universe Hub"  
            }  
        },  
        "collapse": {  
            "field": "user_id"  
        },  
    }  
)
```



ⓘ Important

- By default, collapse returns **one document for each user**.
- The returned document has the **highest score**.
- Collapse works with **keyword** and **numeric** fields.

Collapse search results

- After collapsing the search results, you can use **inner hits** to **show related documents within each group**.
- This **changes the default behavior** by giving you a **deeper view into each collapsed group**.
- You can set how many related documents to get per group (using **size**).
- You can also control how these related documents are sorted (using **sort**).



Collapse search results

- Example:

```
response = es.search(  
    index="my_index",  
    body={  
        "query": {  
            "match": {  
                "message": "My Universe Hub"  
            }  
        },  
        "collapse": {  
            "field": "user_id",  
            "inner_hits": {  
                "name": "most_recent",  
                "size": 5,  
                "sort": [ { "@timestamp": "desc" } ]  
            },  
        },  
    }  
)
```

Name given to the inner hit section in the search response

Number of hits (documents) to retrieve per group.

How to sort the document inside the group.



Collapse search results

- You can combine **collapse** with **search_after** but not **scroll**.
- **Example:**

```
response = es.search(  
    index="my_index",  
    body={  
        "query": {  
            "match": {  
                "message": "My Universe Hub"  
            }  
        },  
        "collapse": {  
            "field": "user_id"  
        },  
        "search_after": ["idid3647"]  
    }  
)
```



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Pre-filtering + kNN search

Pre-filtering + kNN search

- **Pre-filtering** means filtering documents before performing the kNN search.
- It is supported through the **filter** parameter of the **kNN query**.

- **Example:**

```
result = es.search(  
    index="apod",  
    knn={  
        "field": "embedding",  
        "query_vector": embedded_query,  
        "num_candidates": 20,  
        "k": 10,  
        "filter": {"term": {"year": 2024}},  
    },  
)
```

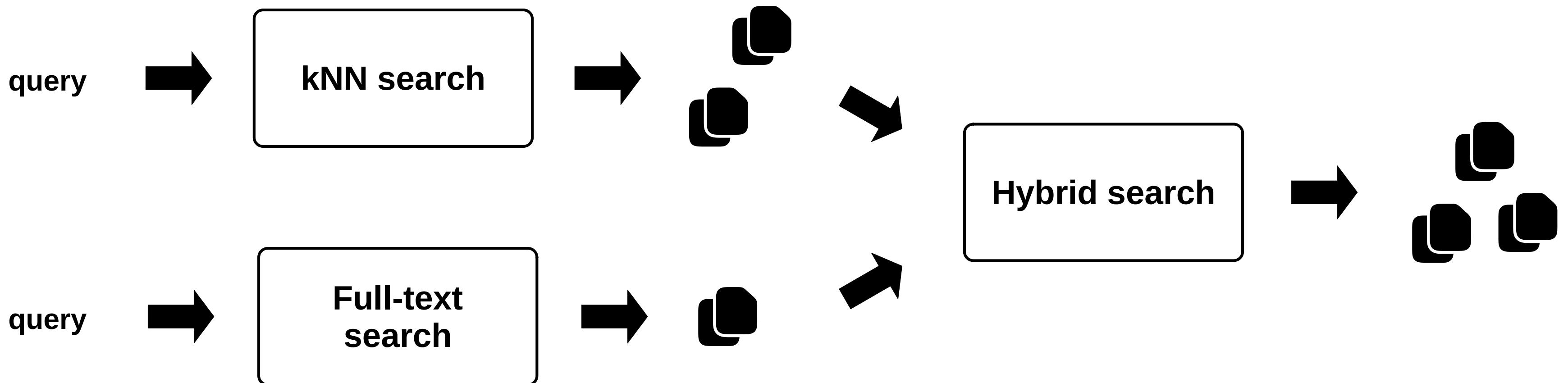


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Hybrid search

Hybrid search

- Hybrid search is a combination of kNN and full-text search.



Hybrid search



- How do we combine the results from kNN and full-text search?
- With a [fusion algorithm](#) like [RRF](#).
- Using RRF in Elasticsearch requires a [paid license](#).
- We will use the [ranx](#) library to perform RRF because it is **free, open source** and **supports a lot of fusion algorithms**.

	Free and open - Basic ^{1,2}	Platinum	Enterprise	Gold (Discontinued) ⁹ ⓘ
SEARCH & ANALYSIS				
Similarity functions for vector fields	✓	✓	✓	✓
Vector search	✓	✓	✓	✓
Reciprocal Rank Fusion (RRF) for hybrid search	—	—	✓	—
Doc-value-only fields	✓	✓	✓	✓
Synonym management	✓	✓	✓	—
Retrievers: Standard, kNN, pinned, rescorer	✓	✓	✓	—
Retrievers: linear, rule, RRF , text similarity re-ranker	—	—	✓	—
Reciprocal Rank Fusion (RRF) for hybrid search	—	—	✓	—