Couchbase

5교시.
Vector Search 개요, 실습

1 AI & Vector Search

2 Hybrid Search

3 Vector Search 실습 : RGB 모델

5-1. AI & Vector Search

Key Milestones in the History of AI | 20th Century

AI is born → Early Developments → Expert Systems → Machine Learning

Can a Machine think?

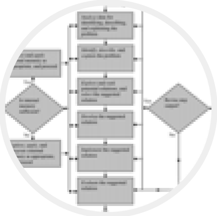
1950

Alan Turing test - if a machine tricks a human into thinking it's a human, then it's intelligence.

AI term coined

1956

John McCarthy introduced the term 'Artificial Intelligence' at The Dartmouth Conference.



Gen. Problem Solver

1957

General Problem Solver is the first AI algorithm. It can solve formalized problems (e.g. Towers of Hanoi).

The chatbot Eliza

1965

Eliza is the first chatterbot - or "chatbot" modernly. It can simulate a human conversation.

R1, an Expert System

1980

R1 uses 2500 rules to ensure that the customer's order is complete, saving the company $25M a year.

Deep Blue

1997

IBM's Deep Blue supercomputer defeats the world chess champion Garry Kasparov.

Kismet

1998

Cynthia Breazeal at MIT creates Kismet, a robot that can detect and respond to people's feeling.

1st AI Winter
1974-1980

2nd AI Winter
1987-1993

Key Milestones in the History of AI | 21st Century

Machine Learning | Deep Learning | Generative Models

Watson

2006

IBM's Watson question-answering system is created. In 2011, it defeats Jeopardy!'s champion.

Siri & Alexa

2011

Apple released Siri, an AI assistant that can respond to voice. 3 years later, Amazon launched Alexa.

Google AI

2014

Google AI recognizes cats from 10 million Youtube videos with almost 75% accuracy in 3 days.

AlphaGO

2016

AlphaGo defeats top Go player Lee Sedol in Seoul. Go is incredibly difficult given the vast number of positions.

AlphaFold

2020

DeepMind's AlphaFold system can predict protein structure, with implications for drug discovery and biology.

DALL.E

2021

DALL·E, and a year later Midjourney and StableDiffusion, can generate images from textual descriptions.

ChatGPT

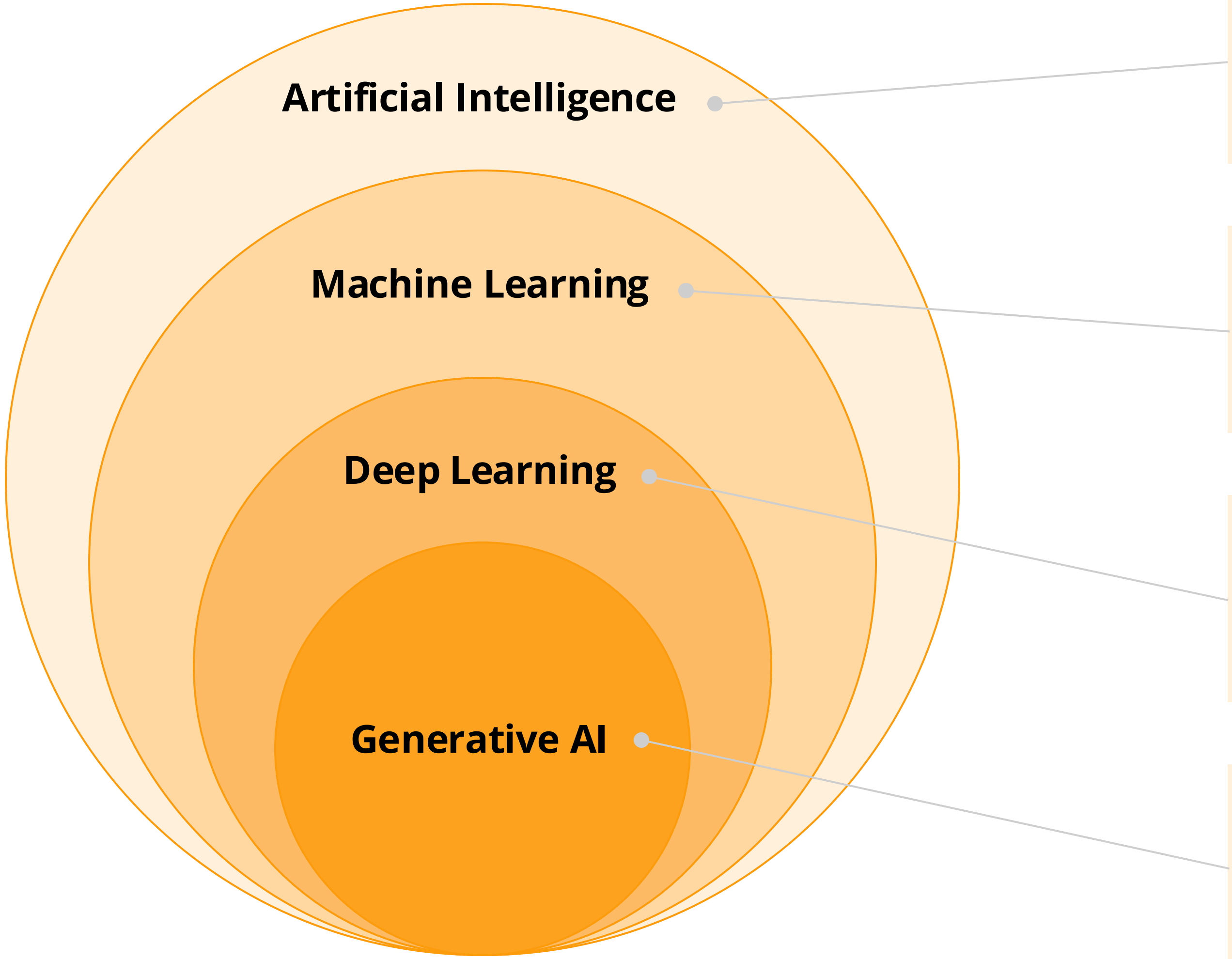
2022

OpenAI releases the AI chatbot ChatGPT.
It is based on the Large Language Model GPT-3 created in 2020.

AI Boom

AI Explosion

The Technology behind AI



Artificial Intelligence (AI)
Techniques that allows computers to emulate human behavior (e.g. learn, recognize patterns, solve complex problems).

Machine Learning (ML)
A subset of AI, using advanced algorithms to detect patterns in large data sets, allowing machines to learn and adapt for prediction or content generation use cases.

Deep Learning (DL)
A subset of ML, using multiple layers of artificial neural networks that simulate human brains for in-depth data processing.

Generative AI (GenAI)
A subset of DL, using models that generate content like text, images, or code based on provided input.

Powering Apps: A Combination of Predictive & Generative AI

Predictive AI

Outcomes and Insights driven by ML

- Predict Outcomes based on historical data
- Utilize ML algorithms for pattern recognition
- Learns patterns and correlations from data
- Drives decision making and Future planning
- High ROI, trained on proprietary data

- Predictive Insights
- Dynamic Pricing
- Fraud Detection
- Inventory Optimization

+

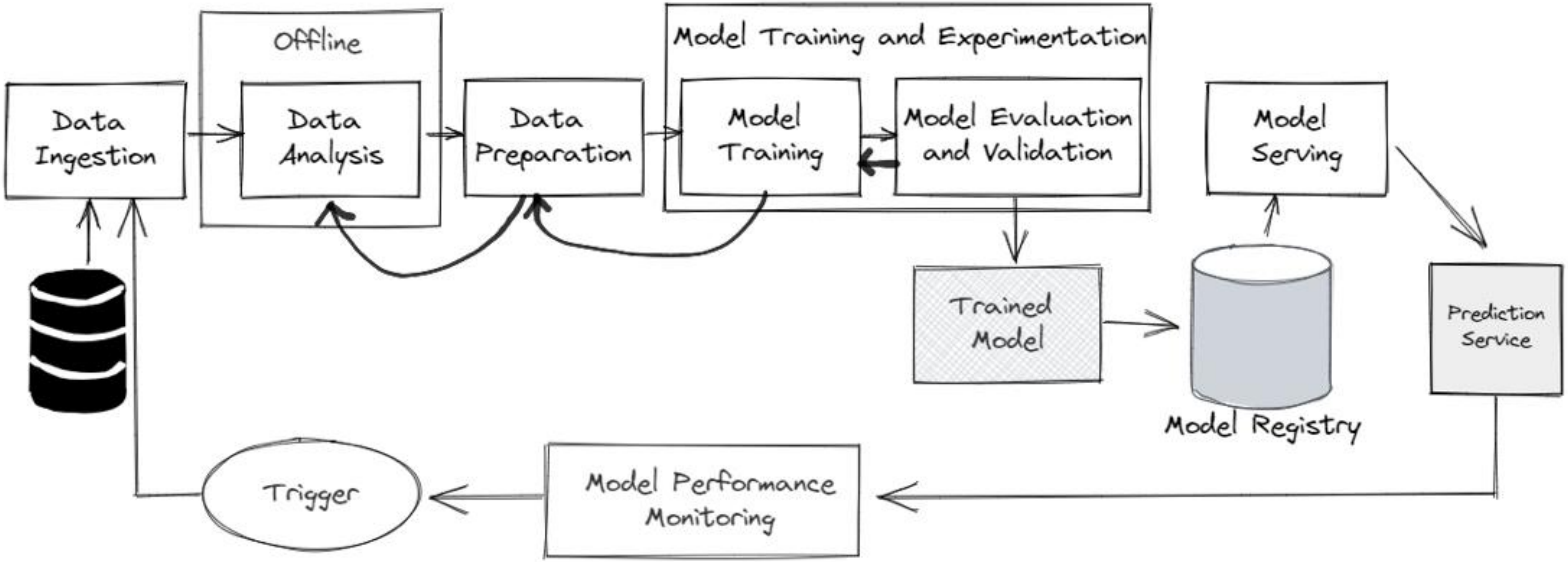
Generative AI

Generate Content and Experiences

- Generate or Synthesize content
- Needs large amounts of unlabeled data for training
- Generates new data probabilistically
- Fosters creativity, innovation
- Accelerates human productivity

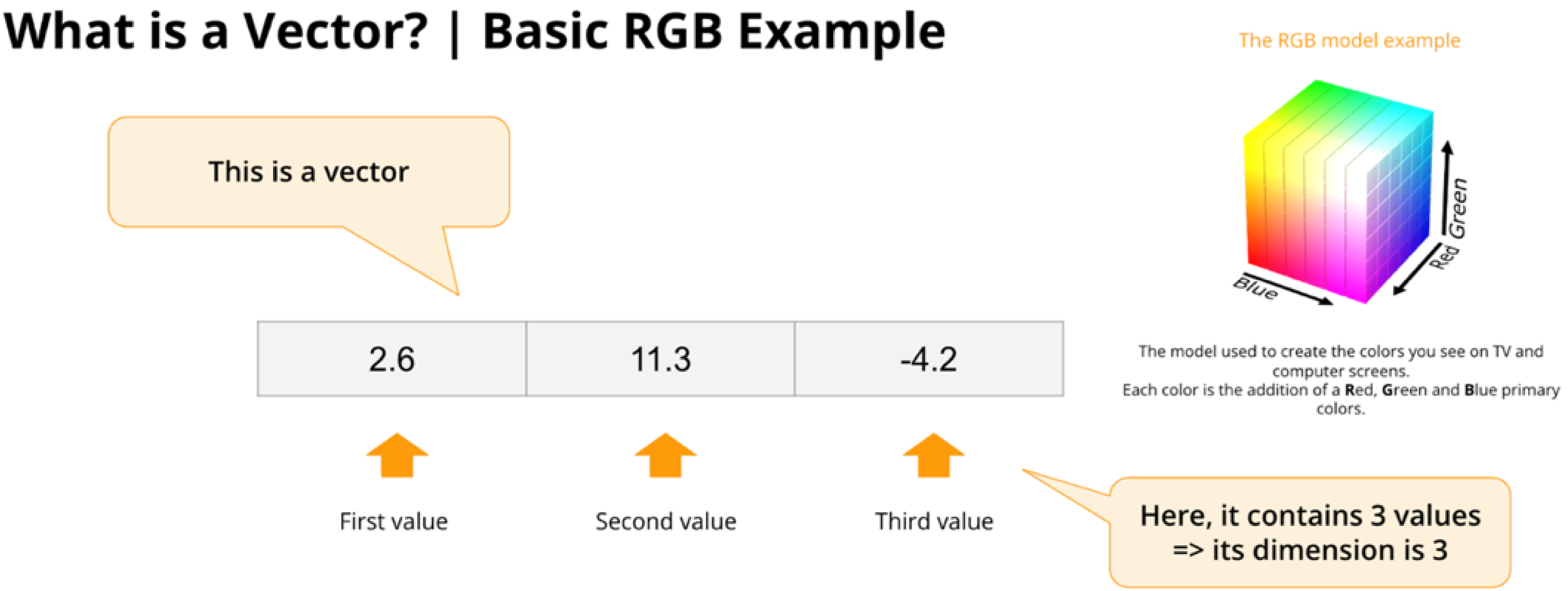
- Hyper-personalized experiences
- Contextualized content
- Chatbots and CoPilots
- Synthetic data and Summarization

Model? Machine Learning Workflow



출처 : https://www.iguazio.com/blog/ml-workflows-what-can-you-automate/
https://cloud.google.com/architecture/mlops-continuous-delivery-and-automation-pipelines-in-machine-learning

What is a Vector



What is a Vector? | Basic RGB Example

This is a vector

2.6	11.3	-4.2

First value

Second value

Third value

Here, it contains 3 values => its dimension is 3

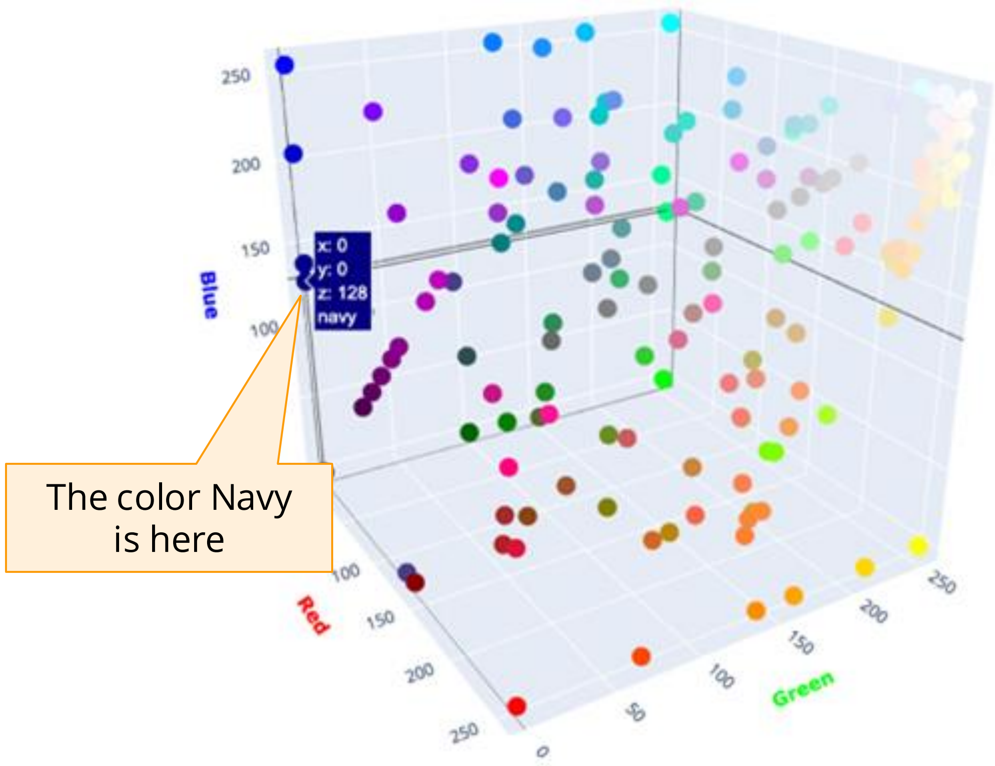
The RGB model example

The model used to create the colors you see on TV and computer screens.
Each color is the addition of a **R**ed, **G**reen and **B**lue primary colors.

A Vector is a just an **array of numerical values**

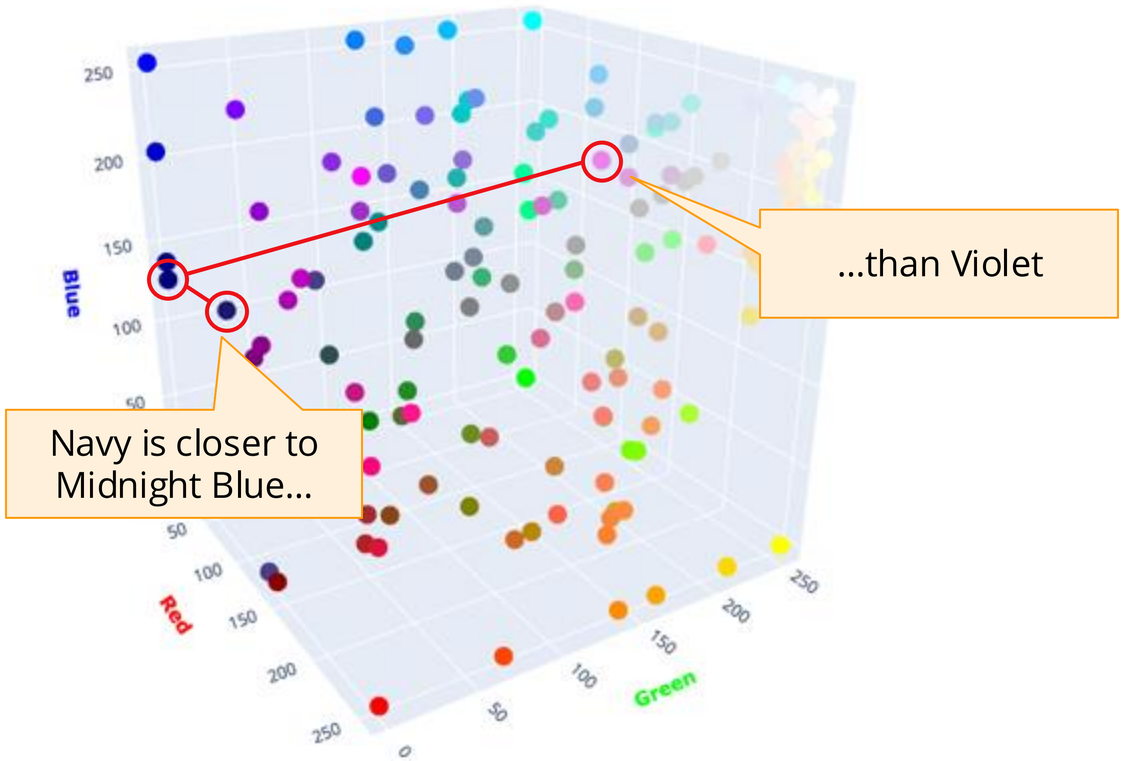
Vectors Similarity

Example of 123 vectors of RGB colors



The color Navy is here

Similar colors are closer to each other



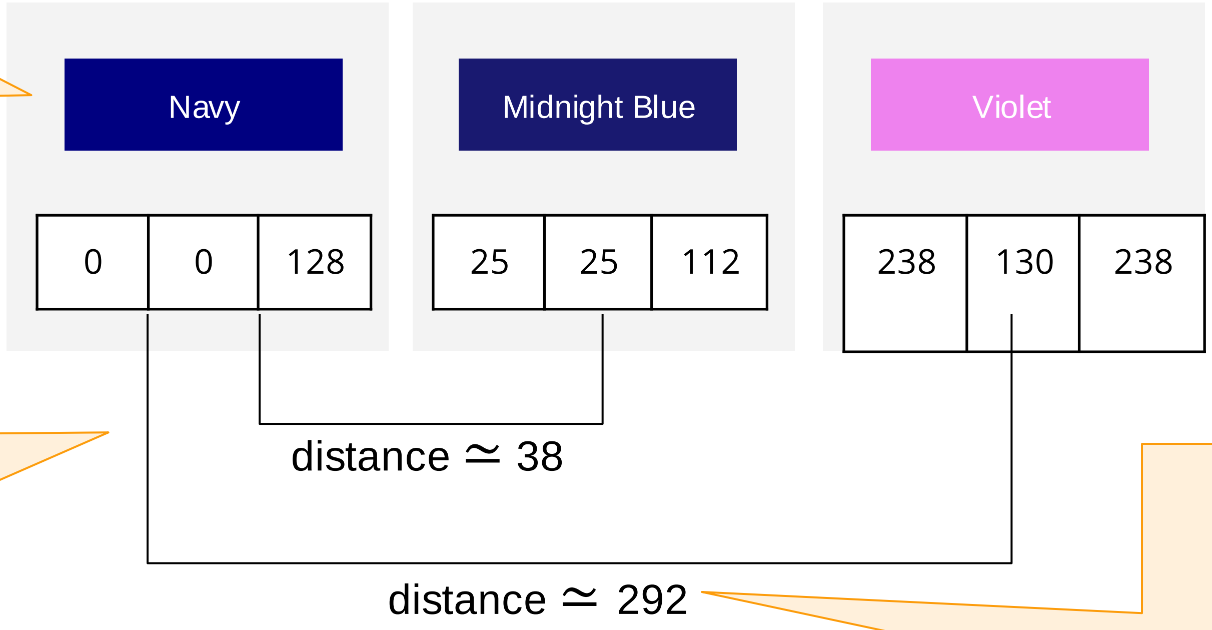
Navy is closer to Midnight Blue…

…than Violet

Vectors make it possible to translate **similarity** as perceived by humans to **proximity in a vector space**.

How does Similarity works

To the human eyes, Navy is closer to Midnight Blue than Violet



Mathematically, we got the same result by comparing the vectors

Vectors are compared using **a similarity distance.**

Here the *euclidean distance*

$292{\simeq}\surd(238-0)^2+(130-0)^2+(238-128)^2$

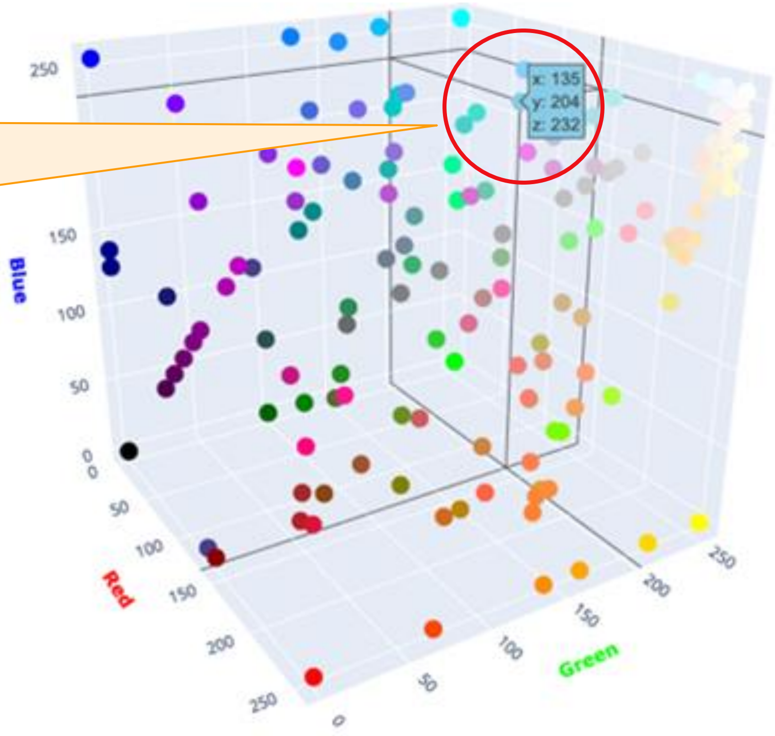
Vectors can easily be compared mathematically using a **similarity distance**

Similarity Search with K-NN (K-Nearest Neighbors)

Which are the top k nearest neighbors to this color?

[135,204,232]

Example of 123 vectors of RGB colors



Top k-NN results of the query

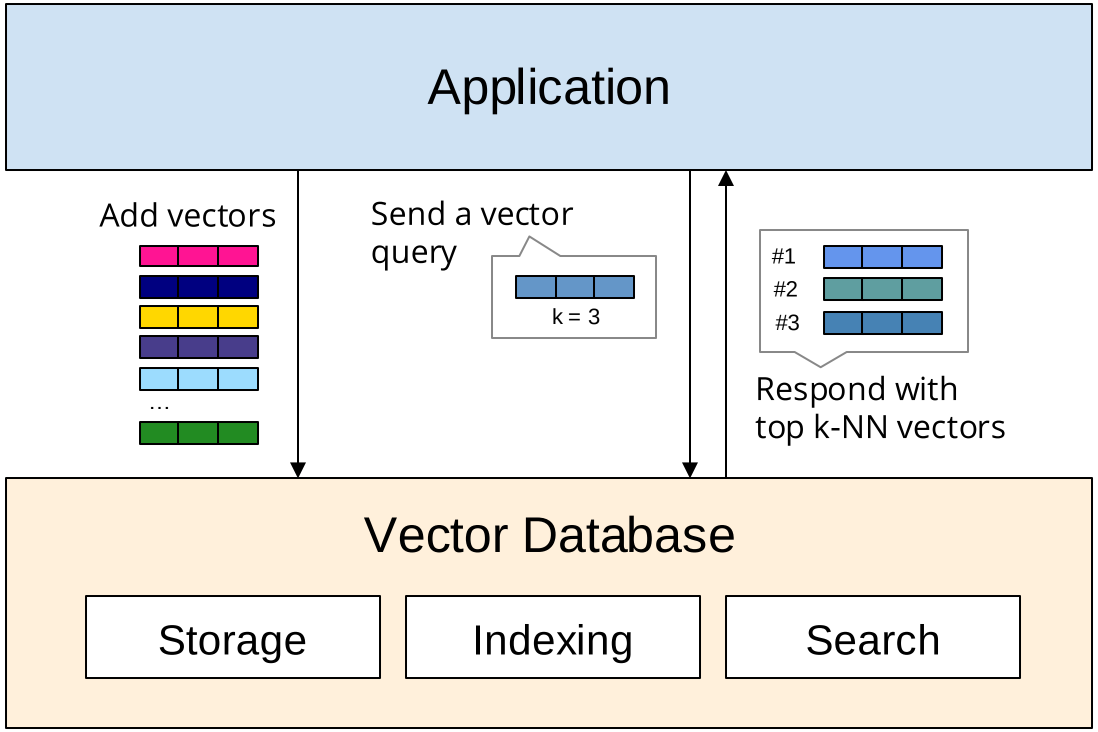
#1 sky blue [135,206,235]

#2 light sky blue [135,206,250]

#3 light blue [173,216,230]

A similarity search is a query that **finds the k nearest neighbors to a vector**, as measured by a similarity metric

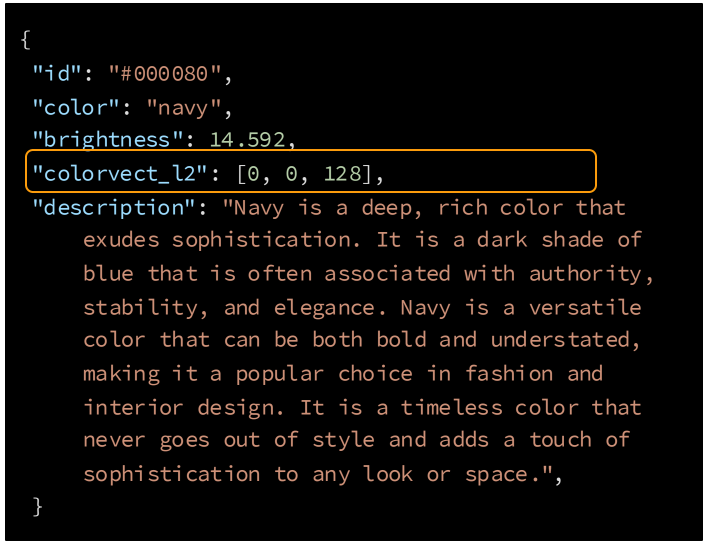
What is Vector Database



Vector databases provide the ability to **store, index and search vectors** using similarity search

Couchbase Vector Search

The vectors are stored as **a field in JSON** documents

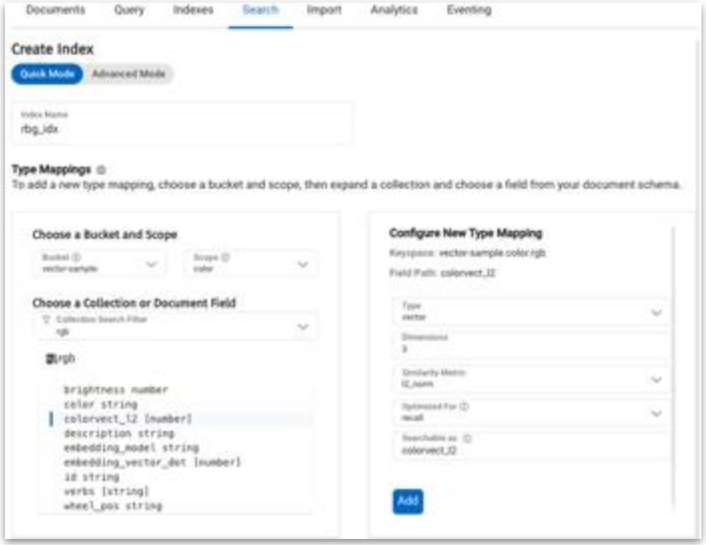


```
{
 "id": "#000080",
 "color": "navy",
 "brightness": 14.592,
 "colorvect_l2": [0, 0, 128],
 "description": "Navy is a deep, rich color that
     exudes sophistication. It is a dark shade of
     blue that is often associated with authority,
     stability, and elegance. Navy is a versatile
     color that can be both bold and understated,
     making it a popular choice in fashion and
     interior design. It is a timeless color that
     never goes out of style and adds a touch of
     sophistication to any look or space.",
 }
```

JSON Storage

Data Service

A **Vector Index** must created to allow the vectors to be searched



Create Index

Index Name
rbg_idx

Type Mappings
To add a new type mapping, choose a bucket and scope, then expand a collection and choose a field from your document schema.

Choose a Bucket and Scope

Bucket: vector-sample
Scope: color

Choose a Collection or Document Field

Collection Search Filter: rgb

rgb

```
brightness number
color string
colorvect_l2 [number]
description string
embedding_model string
embedding_vector_dot [number]
id string
verbs [string]
wheel_pos string
```

Configure New Type Mapping

Keyspace: vector-sample.color.rgb

Field Path: colorvect_l2

Type: vector
Dimensions: 3
Similarity Metric: l2_norm
Optimized For: recall
Searchable as: colorvect_l2

Vector Index

Search Service

A **Vector Query** can now search for the top k-NN of a color

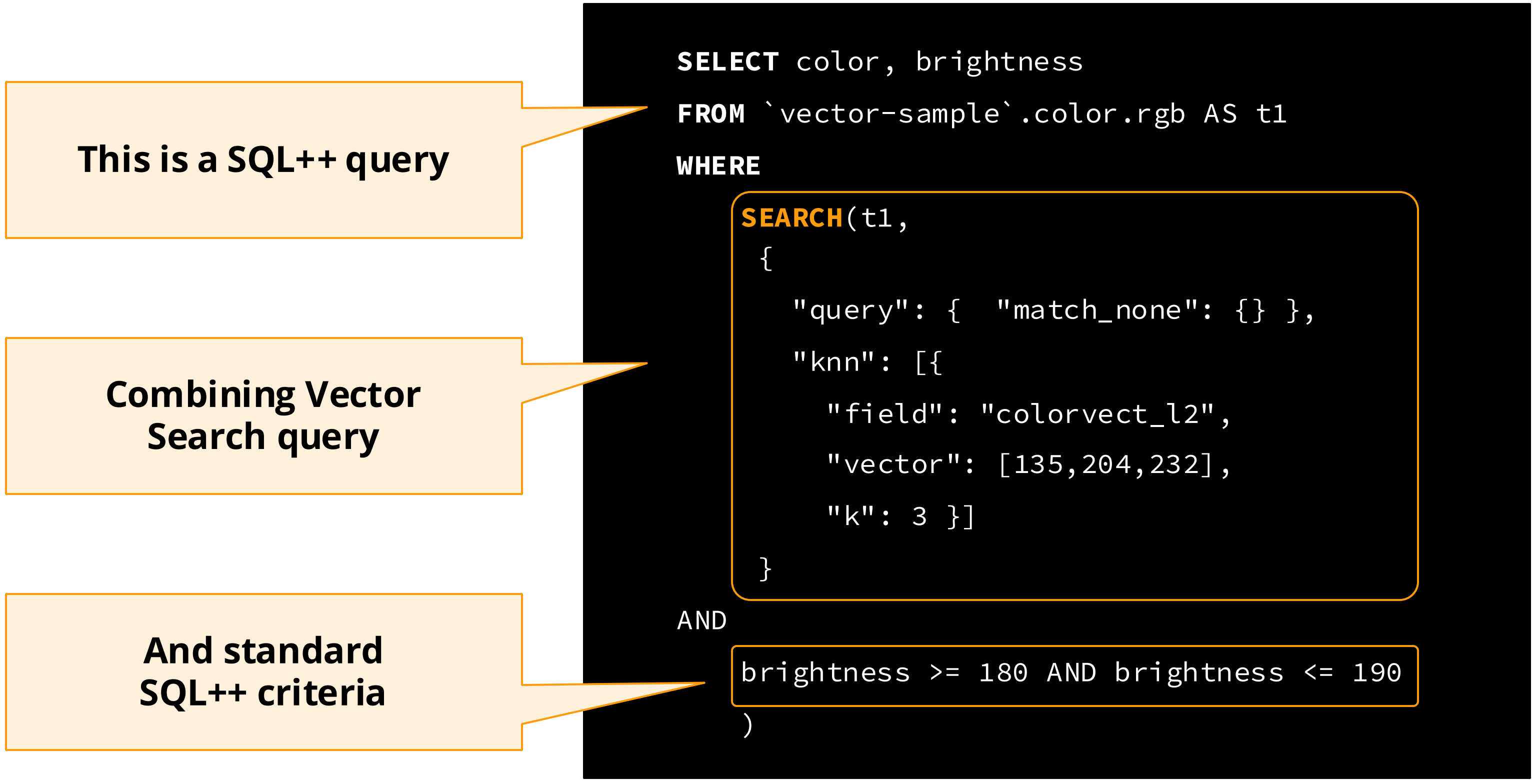
```
{
  "query": { "match_none": {} },
  "knn": [
     {
       "field": "colorvect_l2",
       "vector": [135, 204, 232],
       "k": 3
     }
  ],
  "fields": ["color"]
}
```

Vector Query

Couchbase uses the **Data Service to store vectors**, and the **Search Service to index and query vectors**

5-2. Hybrid Search

Hybrid SQL++ and Vector Search with Couchbase

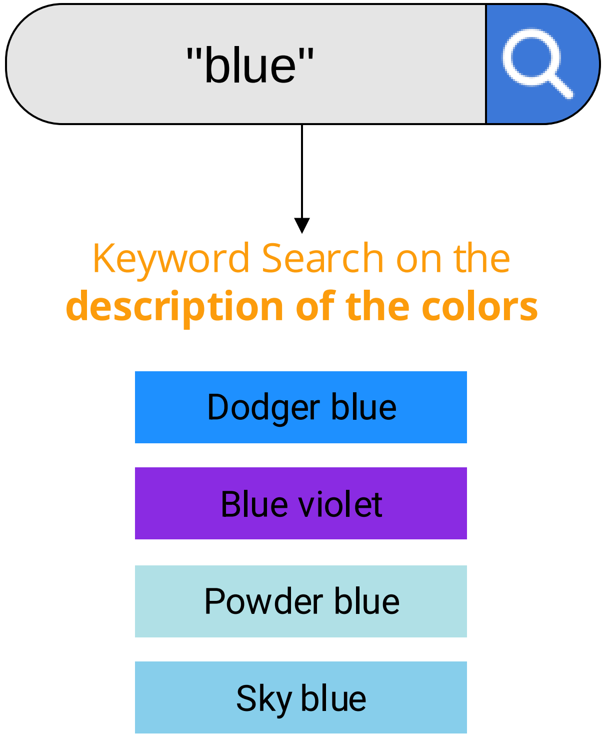


```
SELECT color, brightness
FROM `vector-sample`.color.rgb AS t1
WHERE
    SEARCH(t1,
     {
       "query": {  "match_none": {} },
       "knn": [{
         "field": "colorvect_l2",
         "vector": [135,204,232],
         "k": 3 }]
     }
AND
    brightness >= 180 AND brightness <= 190
    )
```

- ✓ SQL++ is easy and familiar to developers
- ✓ You can filter vector search results with other criteria
- ✓ **You don't have to run 2 separate databases, one for Documents and one for Vector Search!**

Couchbase can run hybrid SQL++ and Vector Search queries to **facilitate application development**

Comparison between Keyword Search and Vector Search



"blue"

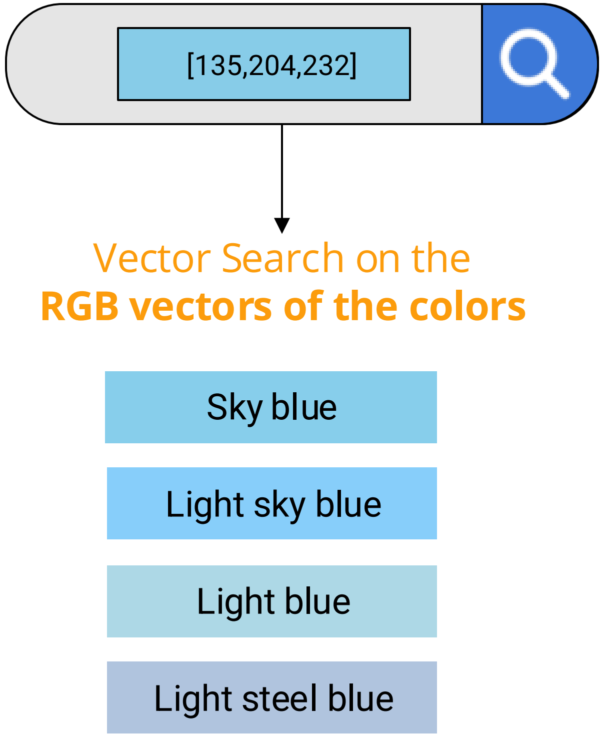
Keyword Search on the **description of the colors**

Dodger blue

Blue violet

Powder blue

Sky blue



[135,204,232]

Vector Search on the **RGB vectors of the colors**

Sky blue

Light sky blue

Light blue

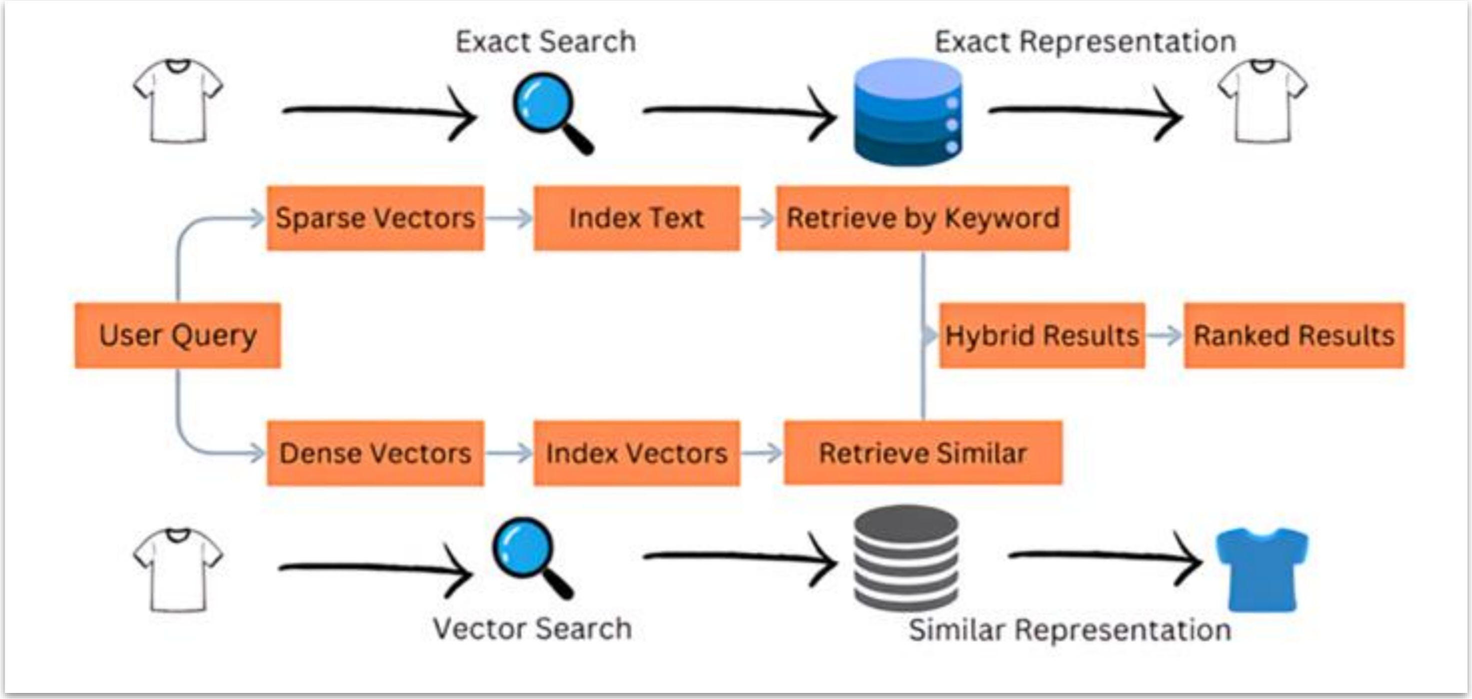
Light steel blue

A Keyword search looks for **terms** that match

A Vector search looks for **similarity**

Hybrid Search to get the best of both worlds

Hybrid Search Architecture



Hybrid Search with Couchbase

```
{
  "query": {
      "match": "blue",
      "field": "description"
   },
  "knn": [
     {
    "field": "colorvect_l2",
     "vector": [135,204,232],
     "k": 4
     }
   ],
  "fields": ["color","description"],
  "size": 4
}
```

Keyword search

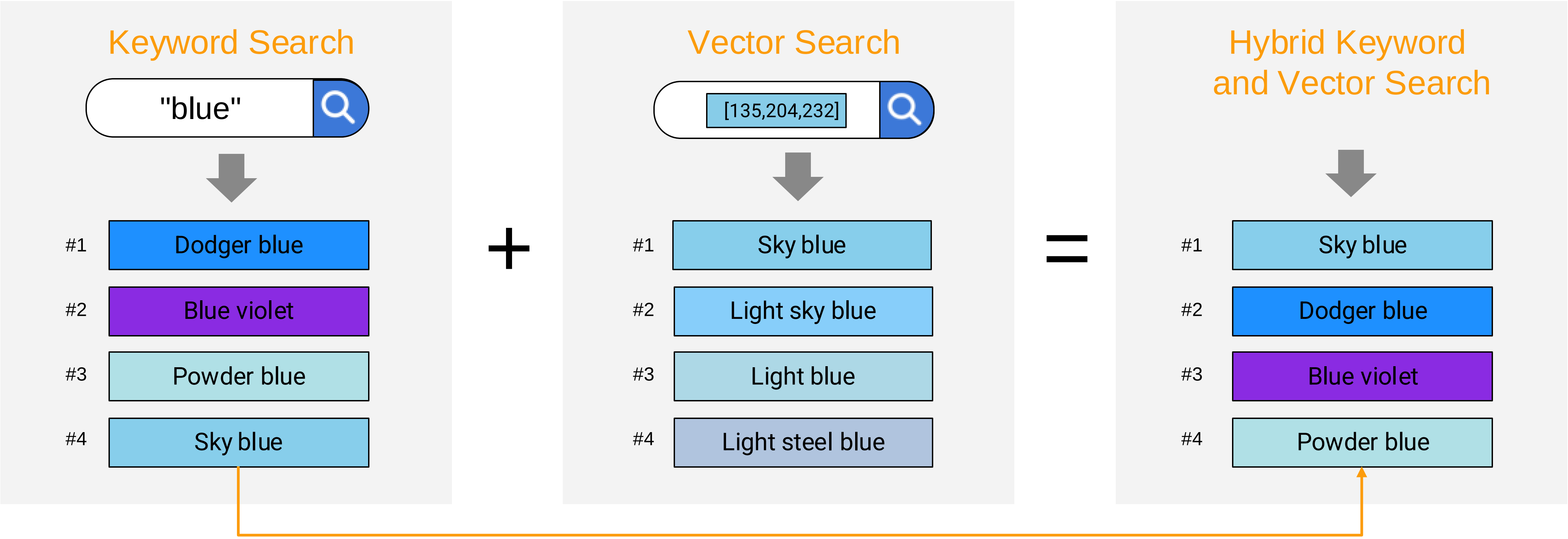
Vector search

Results to return

Vector search in conjunction with traditional Keyword search delivers the most complete and relevant results

Source: Couchbase

Hybrid Keyword and Vector Search Example

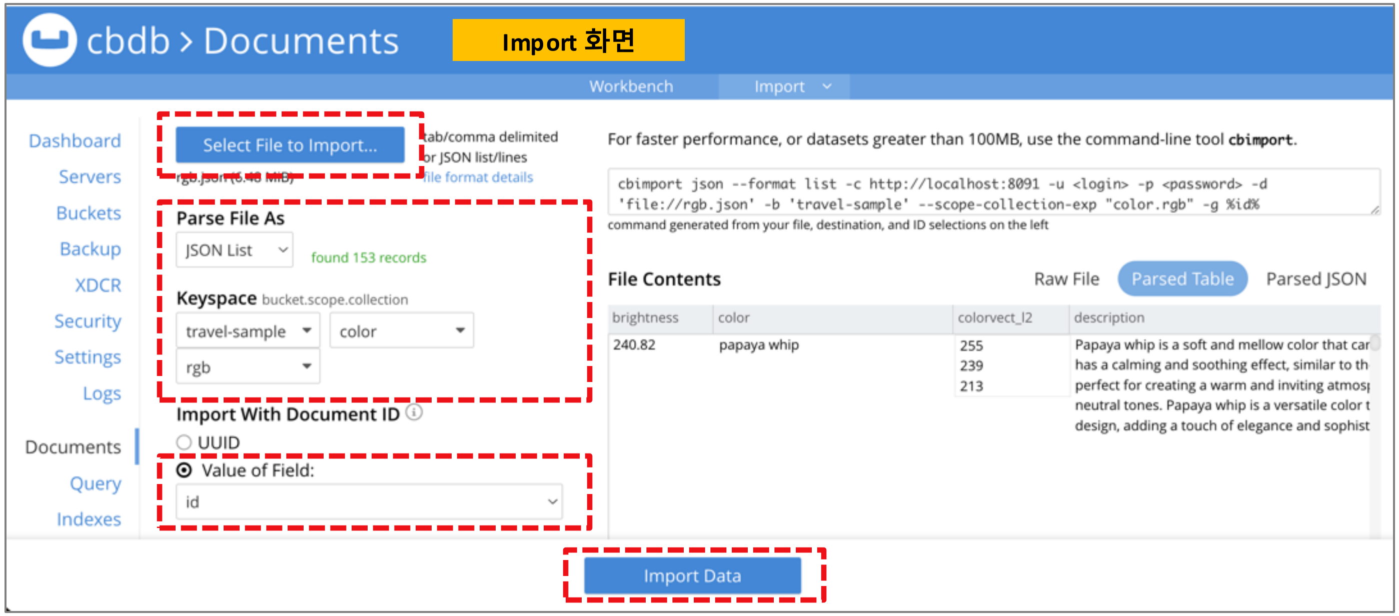


Results are reordered (aka. *reranking*)

Results from the Keyword search are **boosted** if they appear in the Vector Search results

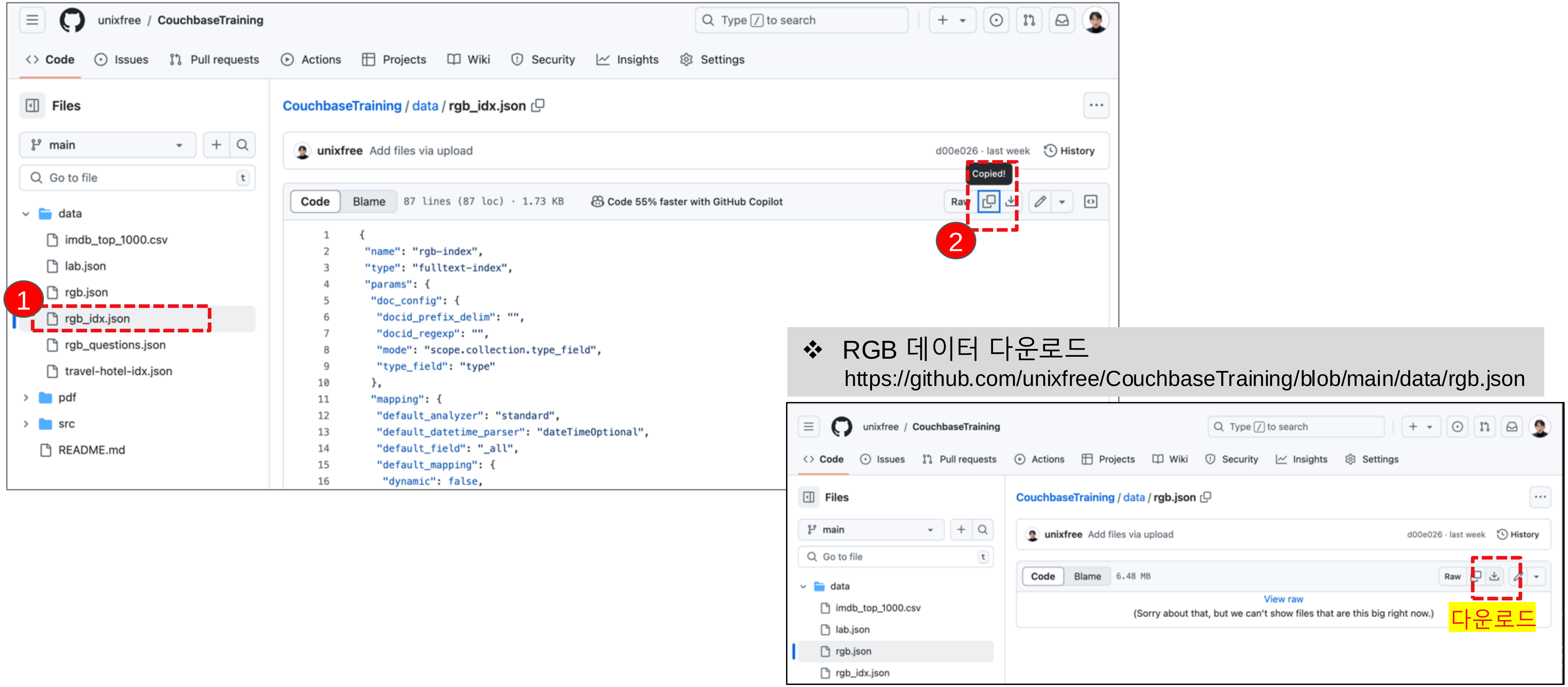
5-3. Vector Search 실습 : RGB

실습

	실습 항목	상세 실습 내용	기타
1	Scope, Collection 생성	1. travel-sample 버킷에 2. color Scope 생성 3. rgb Collection 생성	travel-sample > color > rgb
2	Data Import	1. Github에 있는 json 파일을 내 노트북으로 다운로드 https://github.com/unixfree/CouchbaseTraining/blob/main/data/rgb.json 2. Couchbase Document 페이지 이동. 3. Import 선택 4. Import 수행, Document ID 는 id 로 지정	 cbdb > Documents Import 화면 Workbench · Import Dashboard · Servers · Buckets · Backup · XDCR · Security · Settings · Logs · Documents · Query · Indexes Select File to Import... rgb.json (6.48 MiB) tab/comma delimited or JSON list/lines file format details Parse File As: JSON List — found 153 records Keyspace bucket.scope.collection: travel-sample · color · rgb Import With Document ID ○ UUID ● Value of Field: id For faster performance, or datasets greater than 100MB, use the command-line tool **cbimport**. `cbimport json --format list -c http://localhost:8091 -u <login> -p <password> -d 'file://rgb.json' -b 'travel-sample' --scope-collection-exp "color.rgb" -g %id%` command generated from your file, destination, and ID selections on the left File Contents — Raw File · Parsed Table · Parsed JSON brightness · color · colorvect_l2 · description 240.82 · papaya whip · 255 239 213 · Papaya whip is a soft and mellow color that car has a calming and soothing effect, similar to th perfect for creating a warm and inviting atmos neutral tones. Papaya whip is a versatile color t design, adding a touch of elegance and sophist Import Data
3	**검색 Index 생성**	• 21페이지에서 24페이지 참고하여 인덱스 생성 https://github.com/unixfree/CouchbaseTraining/blob/main/data/rgb_idx.json	
4	Vector Search 수행	• 26페이지에서 31페이지 참고하여 벡터 검색 수행	
5	**검색 Index 수정**	• 32페이지에서 33페이지 참고하여 벡터 검색 수행	
6	Vector Search 수행	• 34페이지에서 38페이지 참고하여 벡터 검색 수행	

실습 > Inverted Index 생성

1. 인덱스 설정 파일 복사
   https://github.com/unixfree/CouchbaseTraining



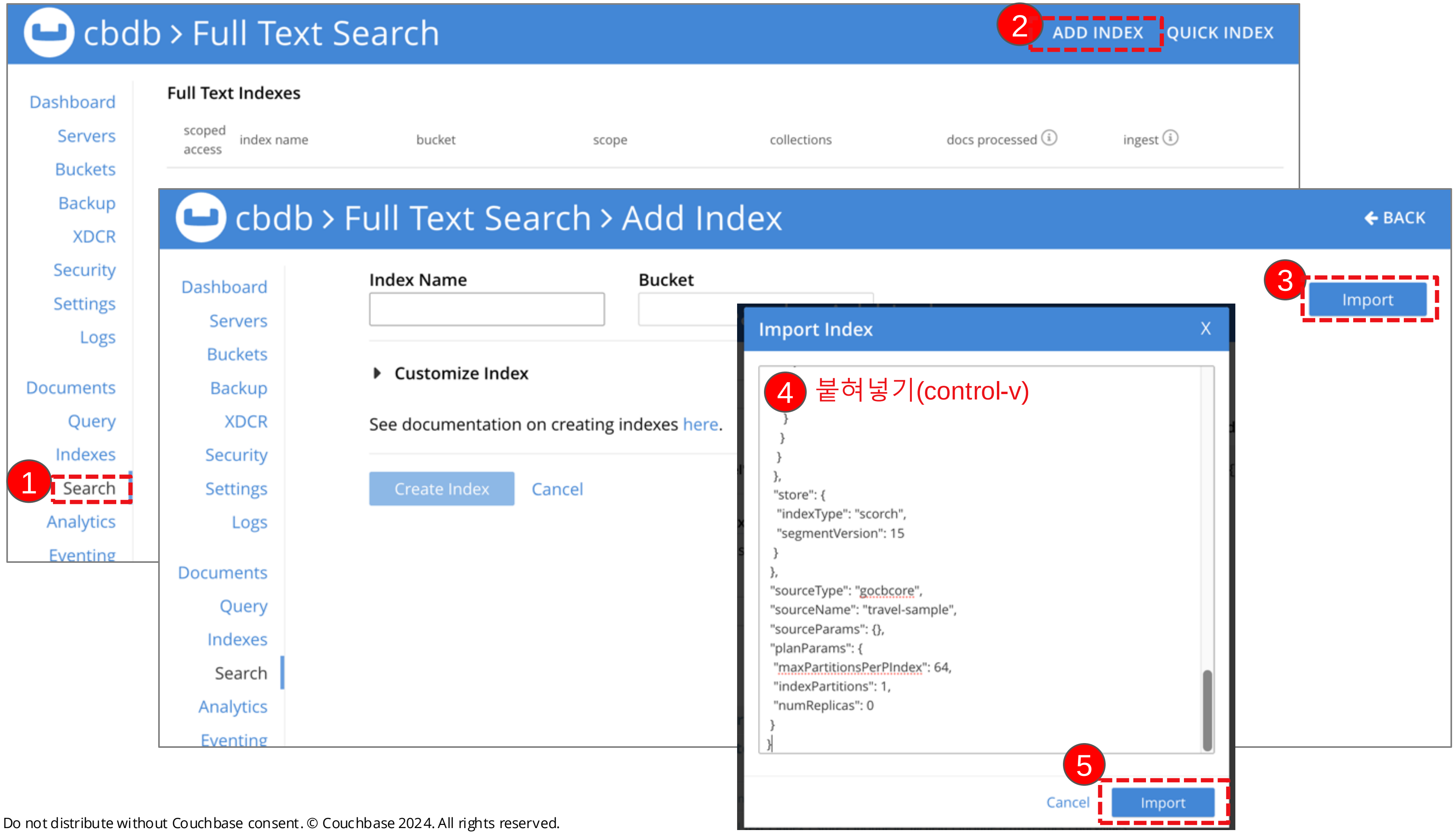
```
{
 "name": "rgb-index",
 "type": "fulltext-index",
 "params": {
  "doc_config": {
   "docid_prefix_delim": "",
   "docid_regexp": "",
   "mode": "scope.collection.type_field",
   "type_field": "type"
  },
  "mapping": {
   "default_analyzer": "standard",
   "default_datetime_parser": "dateTimeOptional",
   "default_field": "_all",
   "default_mapping": {
    "dynamic": false,
```

❖ RGB 데이터 다운로드
https://github.com/unixfree/CouchbaseTraining/blob/main/data/rgb.json

실습 > Inverted Index 생성 (계속)

2. 인덱스 설정 파일 Import로 인덱스 생성

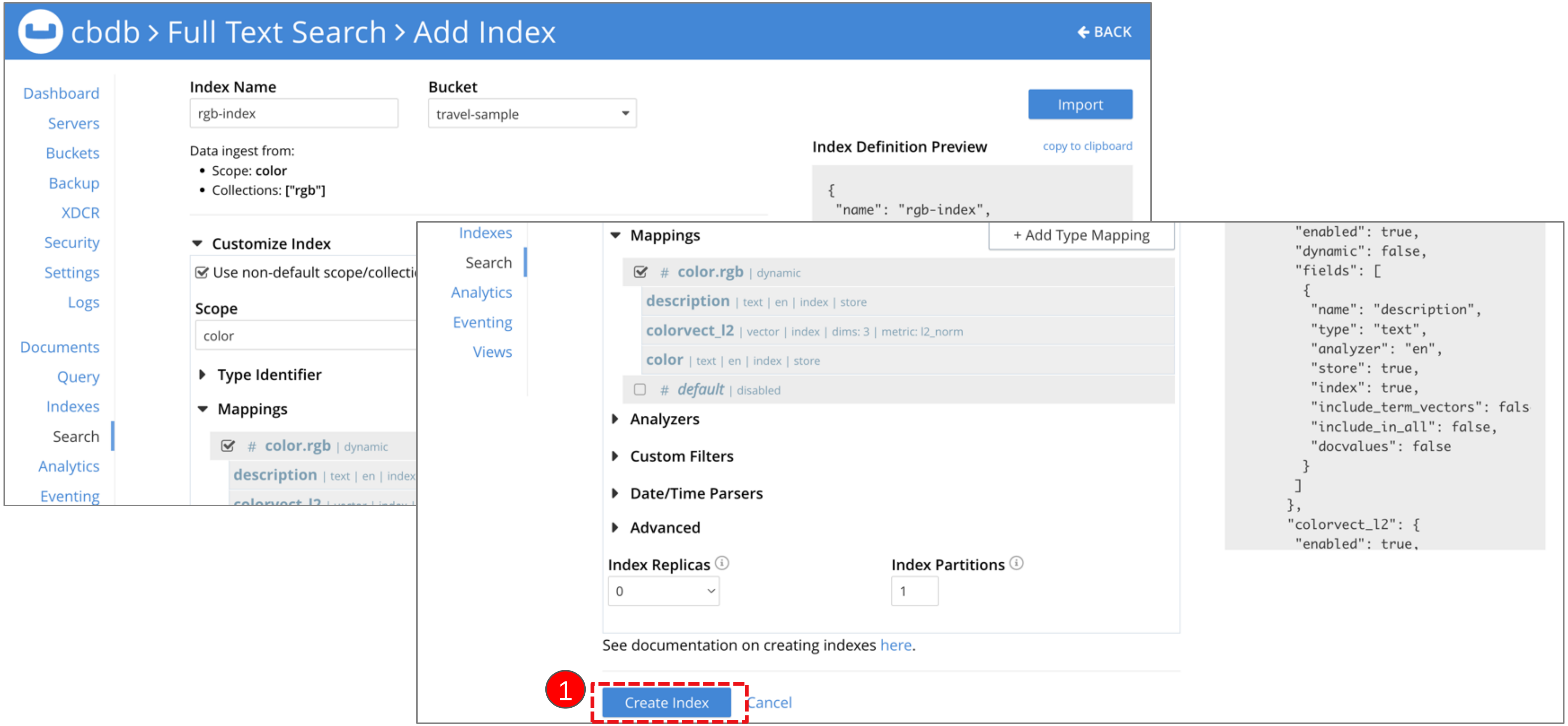
1) Search > 2) ADD INDEX > 3) Import > 4) 붙혀넣기(control-v) > 5) Import



```
    }
   }
  }
 },
 "store": {
  "indexType": "scorch",
  "segmentVersion": 15
 }
},
"sourceType": "gocbcore",
"sourceName": "travel-sample",
"sourceParams": {},
"planParams": {
 "maxPartitionsPerPIndex": 64,
 "indexPartitions": 1,
 "numReplicas": 0
}
}
```

실습 > Inverted Index 생성 (계속)

2. 인덱스 설정 파일 Import로 인덱스 생성
   1) 아래와 같이 각 항목이 채워짐 > 2) 화면 스크롤 다운 후, 3) Create Index 클릭



Index Name: rgb-index

Bucket: travel-sample

Data ingest from:
- Scope: color
- Collections: ["rgb"]

Index Definition Preview

```
{
 "name": "rgb-index",
```

▼ Customize Index

☑ Use non-default scope/collecti

Scope: color

▶ Type Identifier

▼ Mappings

- ☑ # color.rgb | dynamic
  - description | text | en | index | store
  - colorvect_l2 | vector | index | dims: 3 | metric: l2_norm
  - color | text | en | index | store
- □ # *default* | disabled

▶ Analyzers

▶ Custom Filters

▶ Date/Time Parsers

▶ Advanced

Index Replicas ⓘ: 0

Index Partitions ⓘ: 1

See documentation on creating indexes here.

```
   "enabled": true,
   "dynamic": false,
   "fields": [
    {
     "name": "description",
     "type": "text",
     "analyzer": "en",
     "store": true,
     "index": true,
     "include_term_vectors": fals
     "include_in_all": false,
     "docvalues": false
    }
   ]
  },
  "colorvect_l2": {
   "enabled": true,
```

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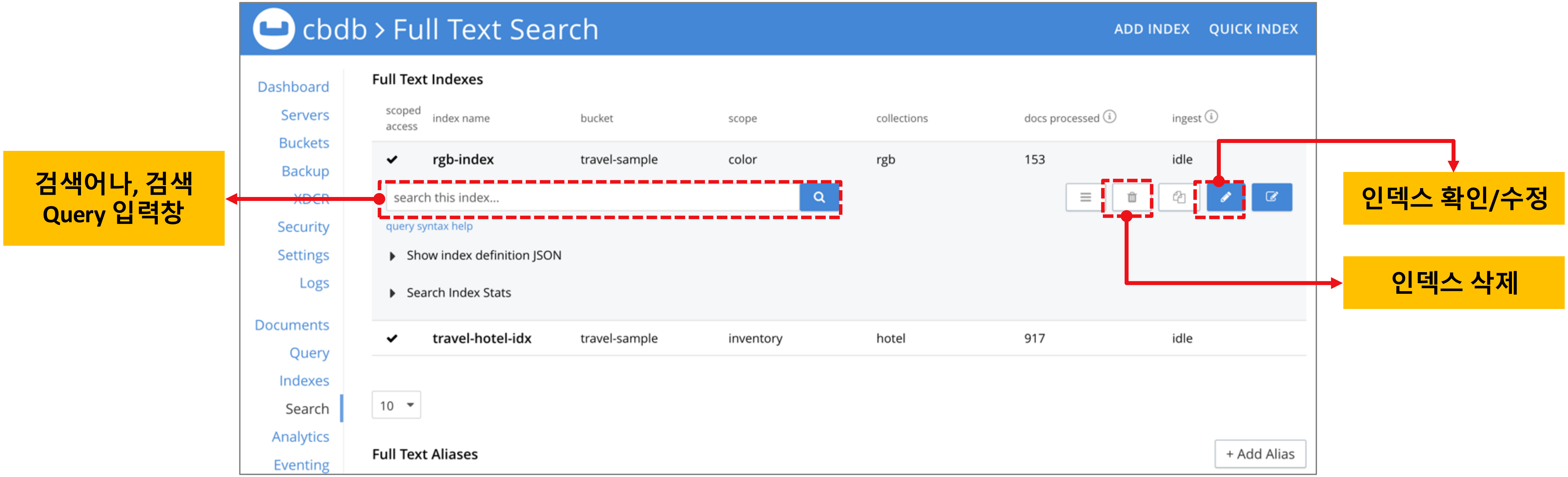
실습 > Inverted Index 생성 (계속)

2. 인덱스 설정이 완료.
   인덱스가 만들어 지면 아래와 같이 화면(UI)가 보임.



Full Text Indexes

scoped access	index name	bucket	scope	collections	docs processed	ingest
✓	rgb-index	travel-sample	color	rgb	153	idle
✓	travel-hotel-idx	travel-sample	inventory	hotel	917	idle

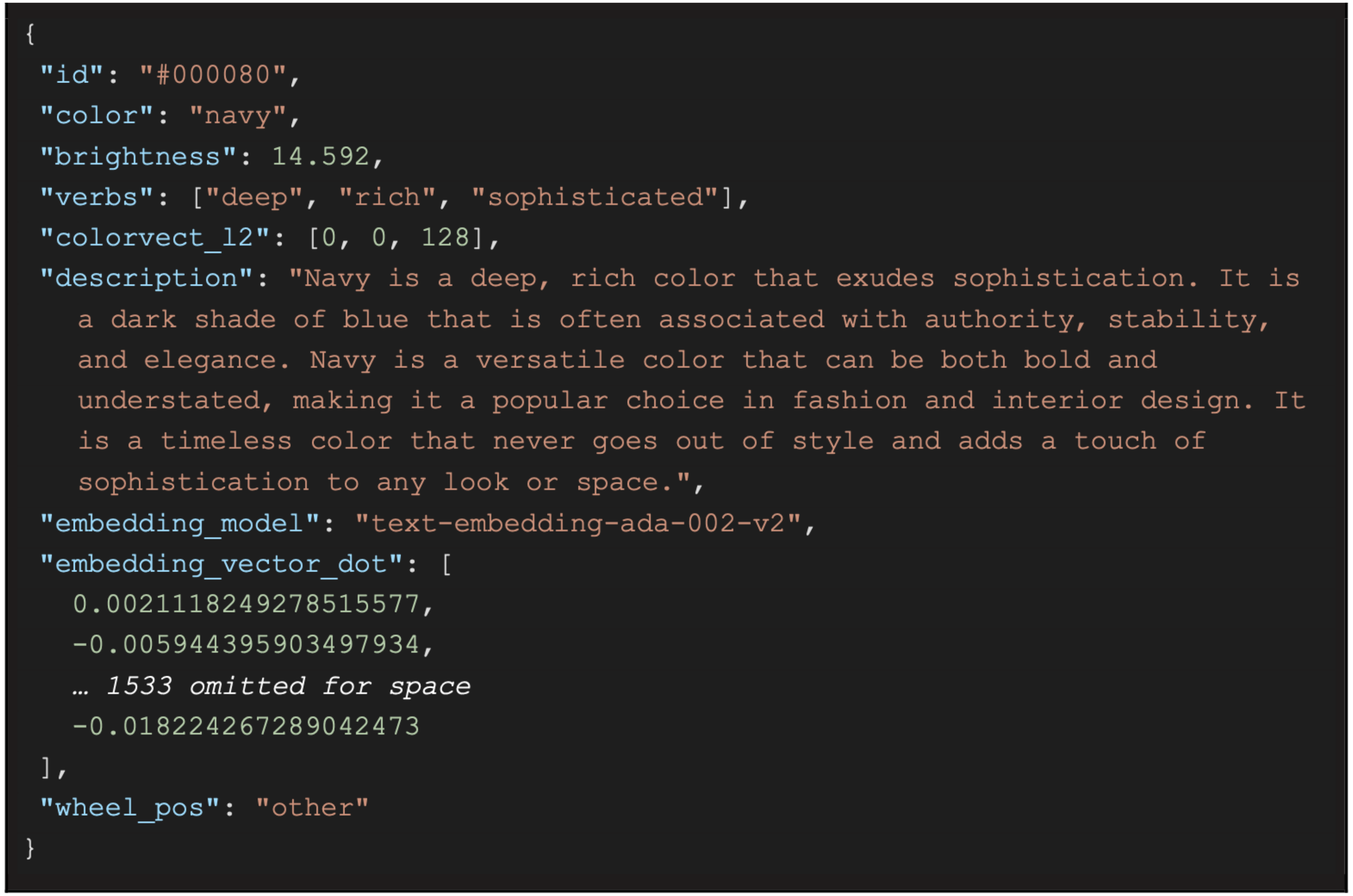
Full Text Aliases

검색어나, 검색 Query 입력창

인덱스 확인/수정

인덱스 삭제

실습 > color.rgb 데이터 설명

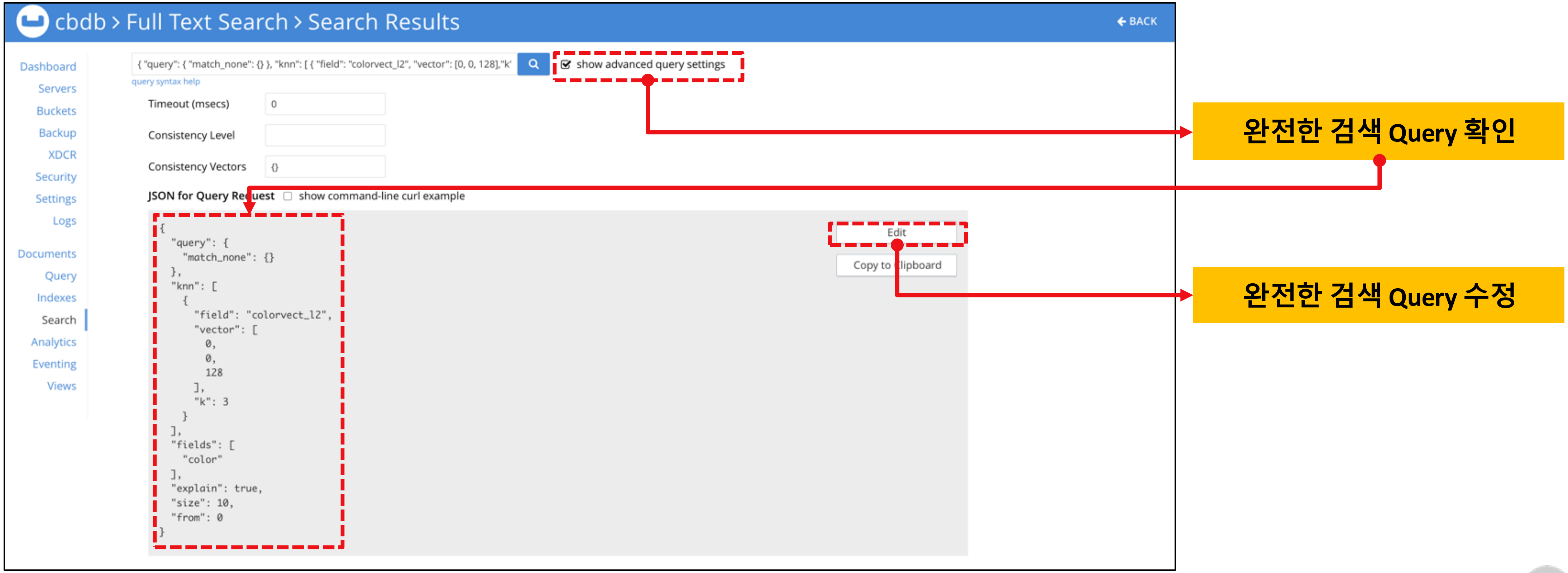


```
{
 "id": "#000080",
 "color": "navy",
 "brightness": 14.592,
 "verbs": ["deep", "rich", "sophisticated"],
 "colorvect_l2": [0, 0, 128],
 "description": "Navy is a deep, rich color that exudes sophistication. It is
   a dark shade of blue that is often associated with authority, stability,
   and elegance. Navy is a versatile color that can be both bold and
   understated, making it a popular choice in fashion and interior design. It
   is a timeless color that never goes out of style and adds a touch of
   sophistication to any look or space.",
 "embedding_model": "text-embedding-ada-002-v2",
 "embedding_vector_dot": [
   0.0021118249278515577,
   -0.005944395903497934,
   … 1533 omitted for space
   -0.018224267289042473
 ],
 "wheel_pos": "other"
}
```

○ **id**: the hex code of the color
○ **color**: the name of the color
○ **brightness**: a calculation of the brightness to the human eye
○ **colorvect_l2**: vector based on the RGB color
○ **description**: a text describing the color
○ **embedding_model**: the model used to encode the embedding_vector_dot vector
○ **embedding_vector_dot** : vector based on the field “description” encoded via the text-embedding-ada-002 OpenAI model
○ **verbs**: list of qualifiers

실습 > Vector Search (RGB)

```
{
"query": { "match_none": {} },
"knn": [
{ "field": "colorvect_l2", "vector": [0, 0, 128],"k": 3 }
],
"fields": ["color"]
}
```



{ "query": { "match_none": {} }, "knn": [{ "field": "colorvect_l2", "vector": [0, 0, 128],"k'

☑ show advanced query settings

Timeout (msecs): 0

Consistency Level:

Consistency Vectors: {}

JSON for Query Request □ show command-line curl example

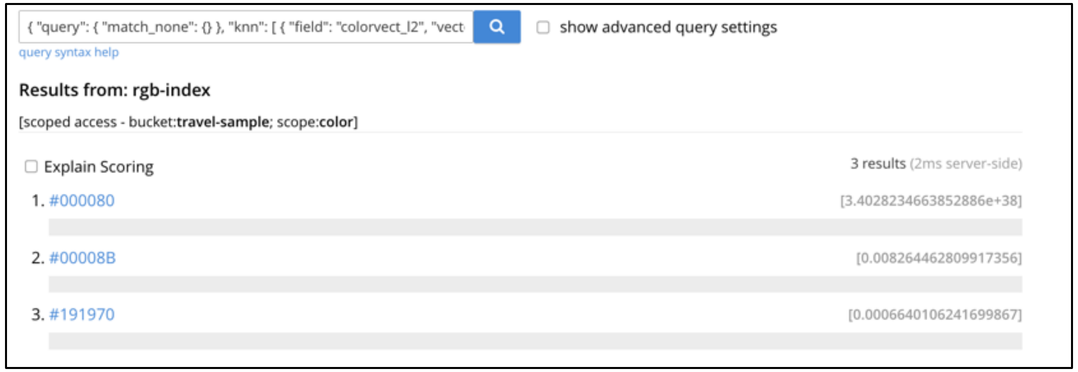
```
{
  "query": {
    "match_none": {}
  },
  "knn": [
    {
      "field": "colorvect_l2",
      "vector": [
        0,
        0,
        128
      ],
      "k": 3
    }
  ],
  "fields": [
    "color"
  ],
  "explain": true,
  "size": 10,
  "from": 0
}
```

완전한 검색 Query 확인

완전한 검색 Query 수정

실습 > Vector Search (RGB)

```
{
"query": { "match_none": {} },
"knn": [
{ "field": "colorvect_l2", "vector": [0, 0, 128],"k": 3 }
]
}
```



{ "query": { "match_none": {} }, "knn": [{ "field": "colorvect_l2", "vect

□ show advanced query settings

query syntax help

Results from: rgb-index

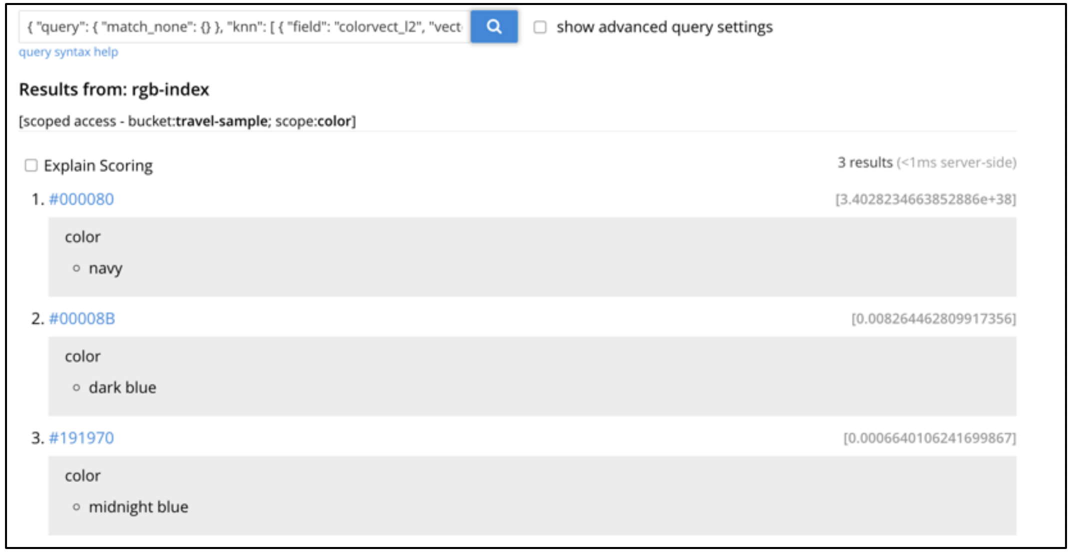
[scoped access - bucket:**travel-sample**; scope:**color**]

□ Explain Scoring

3 results (2ms server-side)

1. #000080 [3.4028234663852886e+38]
2. #00008B [0.008264462809917356]
3. #191970 [0.0006640106241699867]

```
{
"query": { "match_none": {} },
"knn": [
{ "field": "colorvect_l2", "vector": [0, 0, 128],"k": 3 }
],
"fields": ["color"]
}
```



{ "query": { "match_none": {} }, "knn": [{ "field": "colorvect_l2", "vect

□ show advanced query settings

query syntax help

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

□ Explain Scoring

3 results (<1ms server-side)

1. #000080 [3.4028234663852886e+38]

   color
   - navy

2. #00008B [0.008264462809917356]

   color
   - dark blue

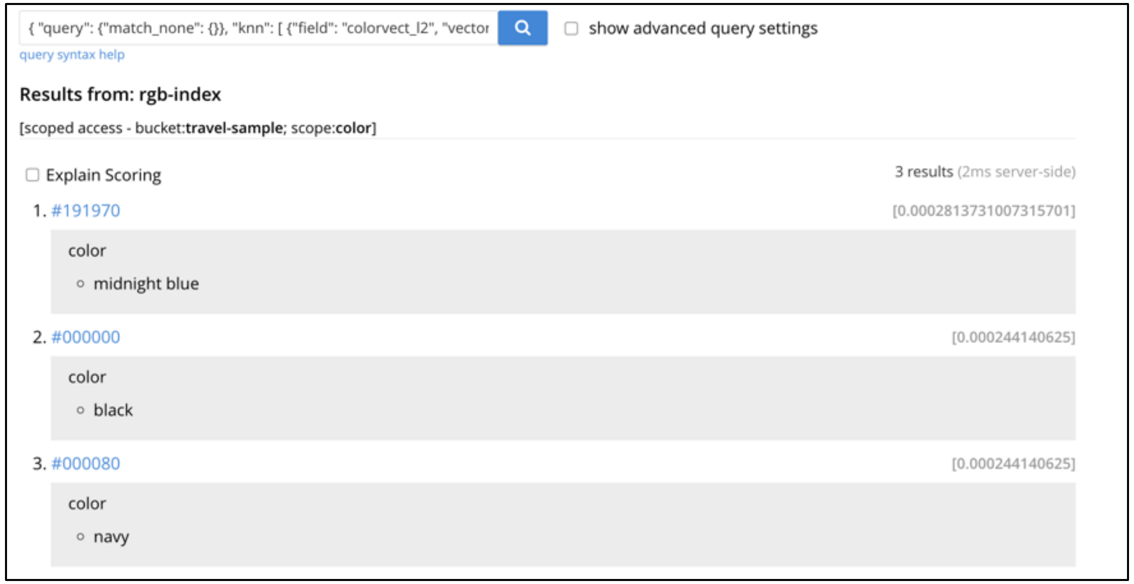
3. #191970 [0.0006640106241699867]

   color
   - midnight blue

실습 > Vector Search (RGB)

- 유사도에 따른 결과 수 지정 : 3

```
{
"query": {"match_none": {}},
"knn": [ {"field": "colorvect_l2", "vector": [0,0,64], "k": 3}],
"fields": ["color"]
}
```



{ "query": {"match_none": {}}, "knn": [{"field": "colorvect_l2", "vector

query syntax help

□ show advanced query settings

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

□ Explain Scoring

3 results (2ms server-side)

1. #191970 [0.0002813731007315701]

   color

   ○ midnight blue

2. #000000 [0.000244140625]

   color

   ○ black

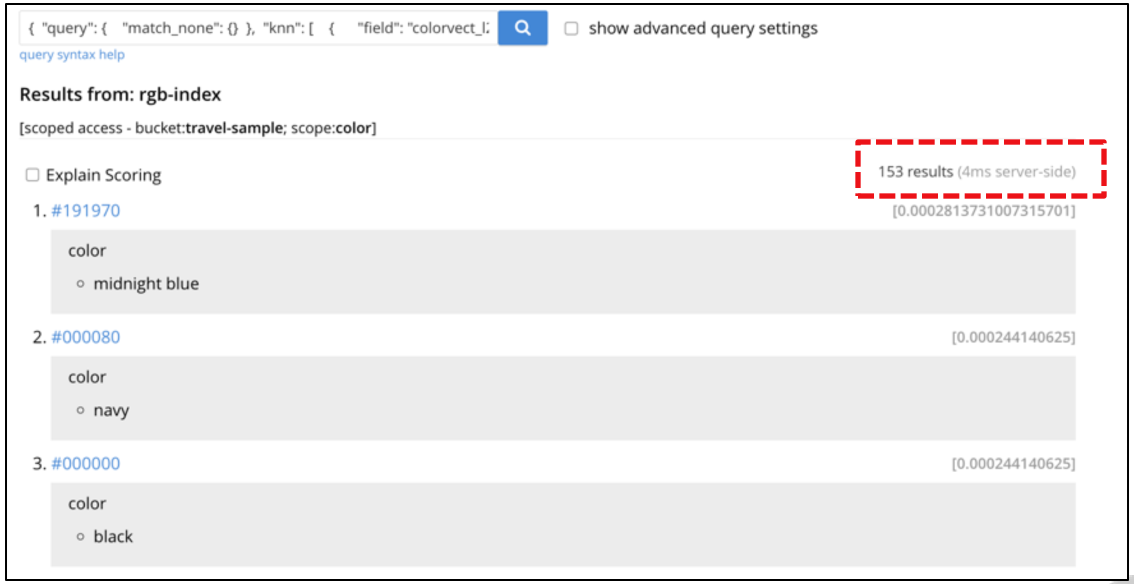
3. #000080 [0.000244140625]

   color

   ○ navy

- 유사도에 따른 결과 수 지정 : 153

```
{
"query": {"match_none": {}},
"knn": [ {"field": "colorvect_l2", "vector": [0,0,64], "k": 153}],
"fields": ["color"]
}
```



{ "query": { "match_none": {} }, "knn": [{ "field": "colorvect_l:

query syntax help

□ show advanced query settings

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

□ Explain Scoring

153 results (4ms server-side)

1. #191970 [0.0002813731007315701]

   color

   ○ midnight blue

2. #000080 [0.000244140625]

   color

   ○ navy

3. #000000 [0.000244140625]

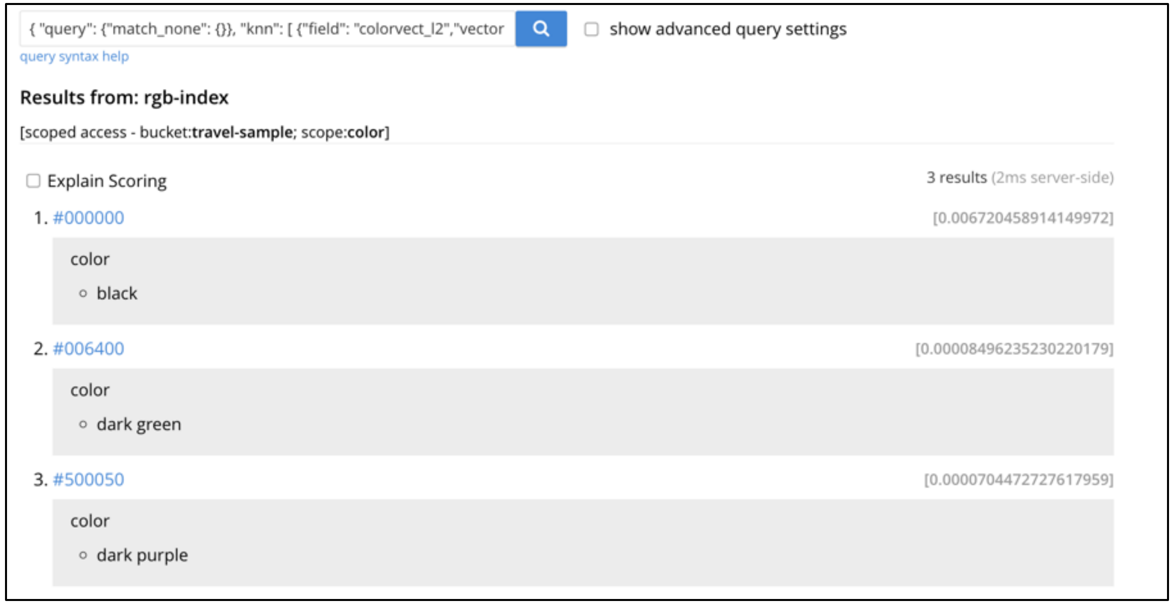
   color

   ○ black

실습 > Vector Search (RGB)

- 없는 벡터 값

```
{
"query": {"match_none": {}},
"knn": [
{"field": "colorvect_l2","vector": [1.241999836687228,-8.105597595174153,-9.030840590925482],
"k": 3} ],
"fields": ["color"]
}
```



{ "query": {"match_none": {}}, "knn": [{"field": "colorvect_l2","vector

query syntax help

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

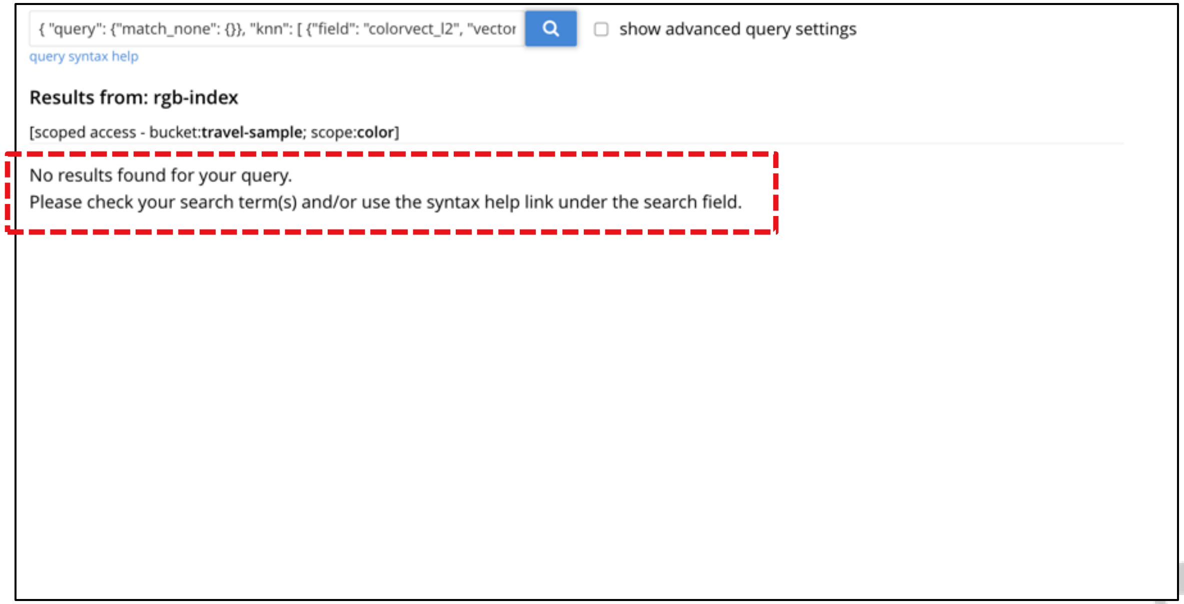
□ Explain Scoring

3 results (2ms server-side)

1. #000000 [0.006720458914149972]
   color
   - black
2. #006400 [0.0000849623523022017 9]
   color
   - dark green
3. #500050 [0.0000704472727617959]
   color
   - dark purple

- 벡터 차원(dimension)이 다를 때

```
{
"query": {"match_none": {}},
"knn": [
{"field": "colorvect_l2",
"vector": [0,64],
"k": 3} ],
"fields": ["color"]
}
```



{ "query": {"match_none": {}}, "knn": [{"field": "colorvect_l2", "vector

query syntax help

Results from: rgb-index

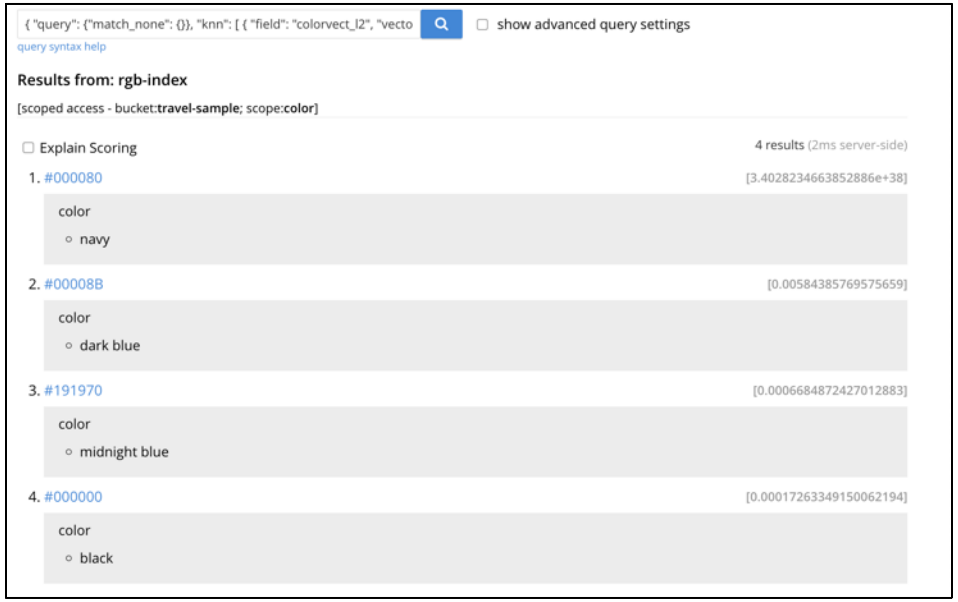
[scoped access - bucket:**travel-sample**; scope:**color**]

No results found for your query.
Please check your search term(s) and/or use the syntax help link under the search field.

실습 > Vector Search (RGB)

- OR 조건

```
{
"query": {"match_none": {}},
"knn": [
{ "field": "colorvect_l2", "vector": [0, 0, 128], "k": 3 },
{ "field": "colorvect_l2", "vector": [0, 0, 64], "k": 3 }
],
"fields": ["color"]
}
```



{ "query": {"match_none": {}}, "knn": [{ "field": "colorvect_l2", "vecto

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

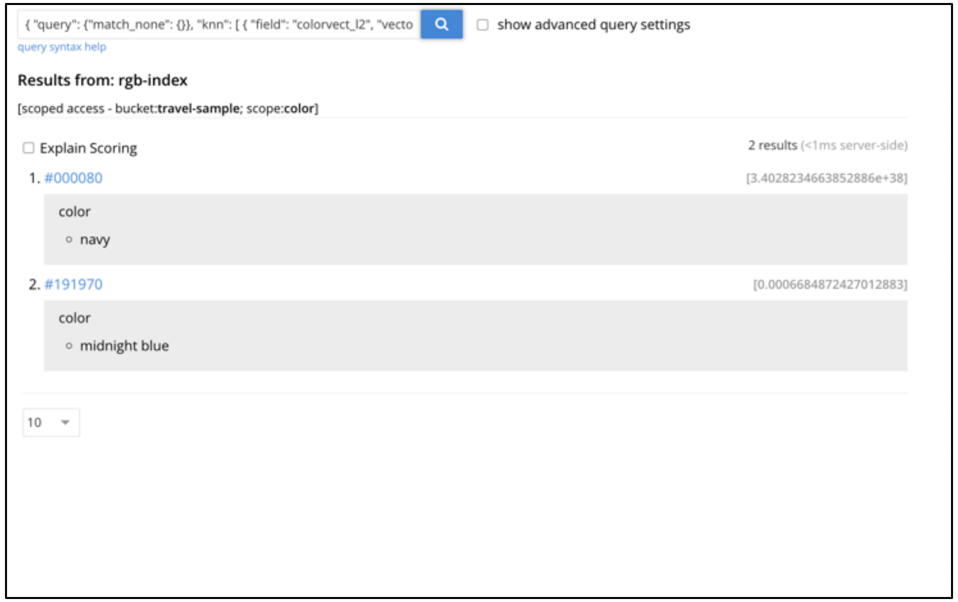
☐ Explain Scoring

4 results (2ms server-side)

1. #000080 [3.4028234663852886e+38]
   color
   - navy
2. #00008B [0.00584385769575659]
   color
   - dark blue
3. #191970 [0.0006684872427012883]
   color
   - midnight blue
4. #000000 [0.00017263349150062194]
   color
   - black

- AND 조건

```
{
"query": {"match_none": {}},
"knn": [
{ "field": "colorvect_l2", "vector": [0, 0, 128], "k": 3},
{ "field": "colorvect_l2", "vector": [0, 0, 64], "k": 3}],
"knn_operator": "and",
"fields": ["color"]
}
```



{ "query": {"match_none": {}}, "knn": [{ "field": "colorvect_l2", "vecto

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

☐ Explain Scoring

2 results (<1ms server-side)

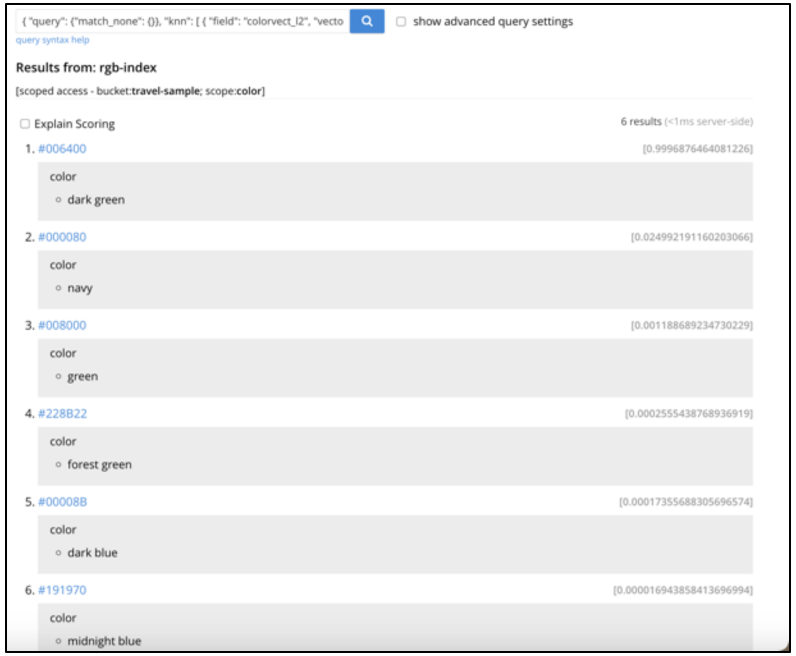
1. #000080 [3.4028234663852886e+38]
   color
   - navy
2. #191970 [0.0006684872427012883]
   color
   - midnight blue

실습 > Vector Search (RGB)

- Boost 조건

❖ 1보다 작으면, 가중치 감소시키고, 1보다 크면 가중치 증가시킴

```
{
"query": {"match_none": {}},
"knn": [
{ "field": "colorvect_l2", "vector": [0, 0, 127], "k":3, "boost": 0.1},
{ "field": "colorvect_l2", "vector": [0, 99, 0], "k":3, "boost": 4.0}
],
"fields": ["color"]
}
```



```
{ "query": {"match_none": {}}, "knn": [ { "field": "colorvect_l2", "vecto
```

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

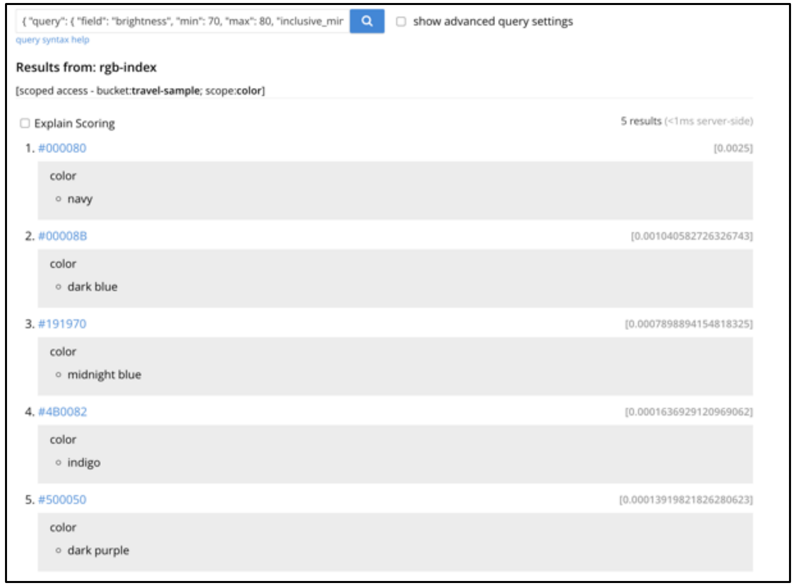
☐ Explain Scoring

6 results (<1ms server-side)

1. #006400 [0.9996876464081226]
   color
   - dark green
2. #000080 [0.024992191160203066]
   color
   - navy
3. #008000 [0.0011886892347302291]
   color
   - green
4. #228B22 [0.0002555438768936919]
   color
   - forest green
5. #00008B [0.00017355688305696574]
   color
   - dark blue
6. #191970 [0.000016943858413696994]
   color
   - midnight blue

- Hybrid Search 조건

```
{
"query": {
    "field": "brightness", "min": 70, "max": 80,
    "inclusive_min": false, "inclusive_max": true },
"knn": [ {"field": "colorvect_l2", "vector": [0.0, 0.0, 108.0], "k": 5} ],
"fields": ["color","brightness"],
"size": 5
}
```



```
{ "query": { "field": "brightness", "min": 70, "max": 80, "inclusive_mir
```

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

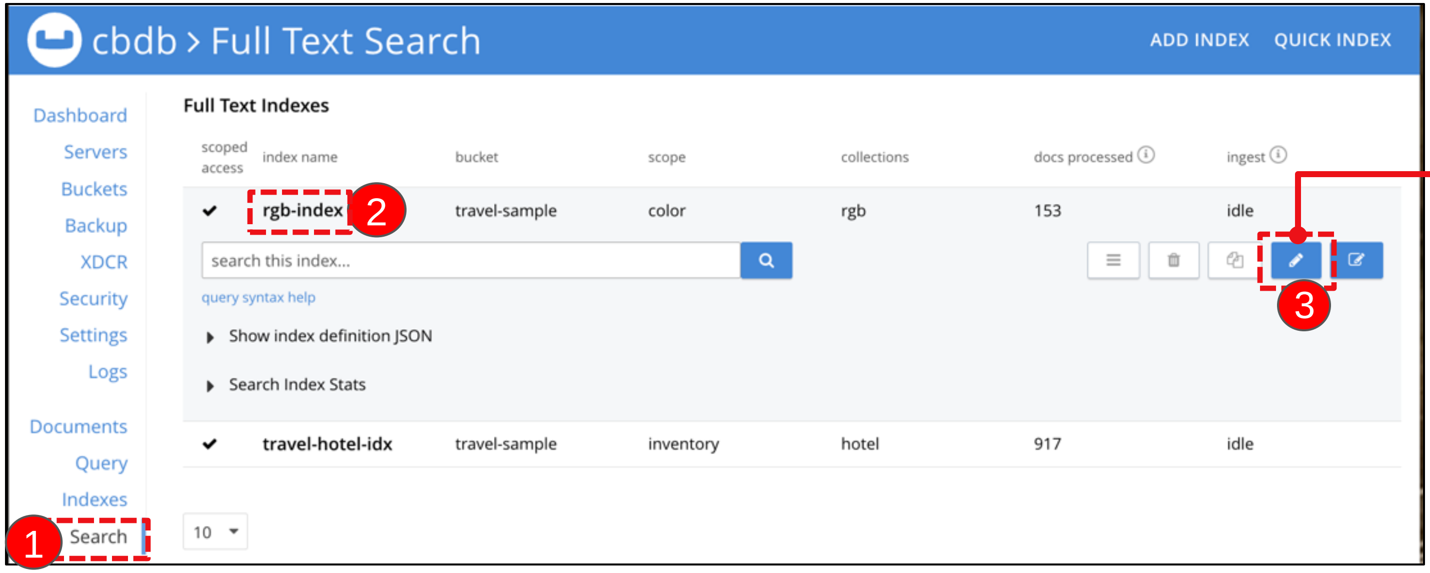
☐ Explain Scoring

5 results (<1ms server-side)

1. #000080 [0.0025]
   color
   - navy
2. #00008B [0.001040582726326743]
   color
   - dark blue
3. #191970 [0.0007898894154818325]
   color
   - midnight blue
4. #4B0082 [0.0001636929120969062]
   color
   - indigo
5. #500050 [0.00013919821826280623]
   color
   - dark purple

실습 > 인덱스 변경

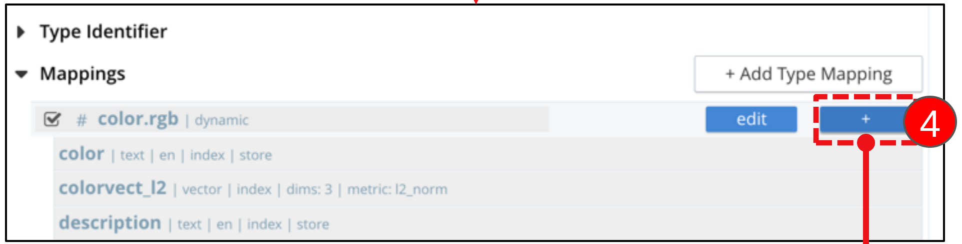
1. 인덱스 설정 파일 Import로 인덱스 생성
   1) Search > 2) rgb-index > 3) 수정(연필) 클릭 > 마우스를 color.rgb로 이동하면 edit 와 + 가 나타남, 4) +를 선택, 5) insert child field 선택



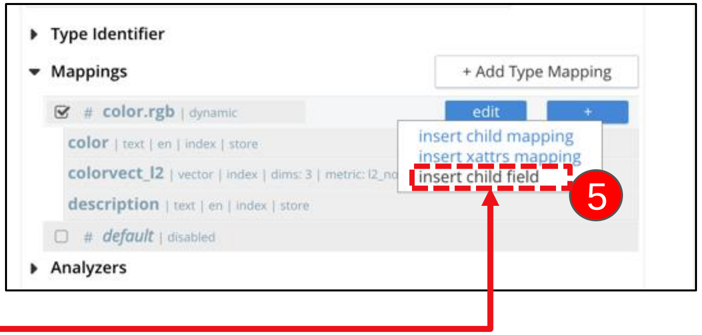
Full Text Indexes

scoped access	index name	bucket	scope	collections	docs processed	ingest
✓	rgb-index	travel-sample	color	rgb	153	idle
✓	travel-hotel-idx	travel-sample	inventory	hotel	917	idle

인덱스수정



☑ # color.rgb | dynamic
color | text | en | index | store
colorvect_l2 | vector | index | dims: 3 | metric: l2_norm
description | text | en | index | store

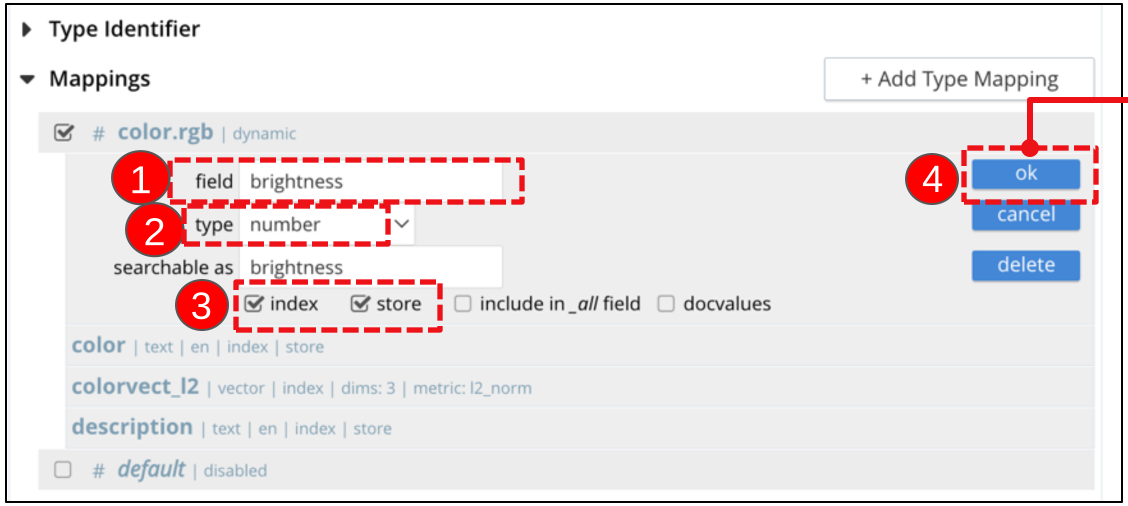


☑ # color.rgb | dynamic
color | text | en | index | store
colorvect_l2 | vector | index | dims: 3 | metric: l2_no
description | text | en | index | store
□ # default | disabled

실습 > 인덱스 변경

2. 새로운 필드에 대한 인덱스 추가

1) field 에 brightness 입력 > 2) type을 *number* 선택 3) *index, store* 선택, 4) ok 를 선택, 5) Update index 를 클릭



▸ Type Identifier

▾ Mappings — + Add Type Mapping

☑ # color.rgb | dynamic

1 field: brightness

2 type: number

searchable as: brightness

3 ☑ index ☑ store □ include in _*all* field □ docvalues

4 ok

cancel

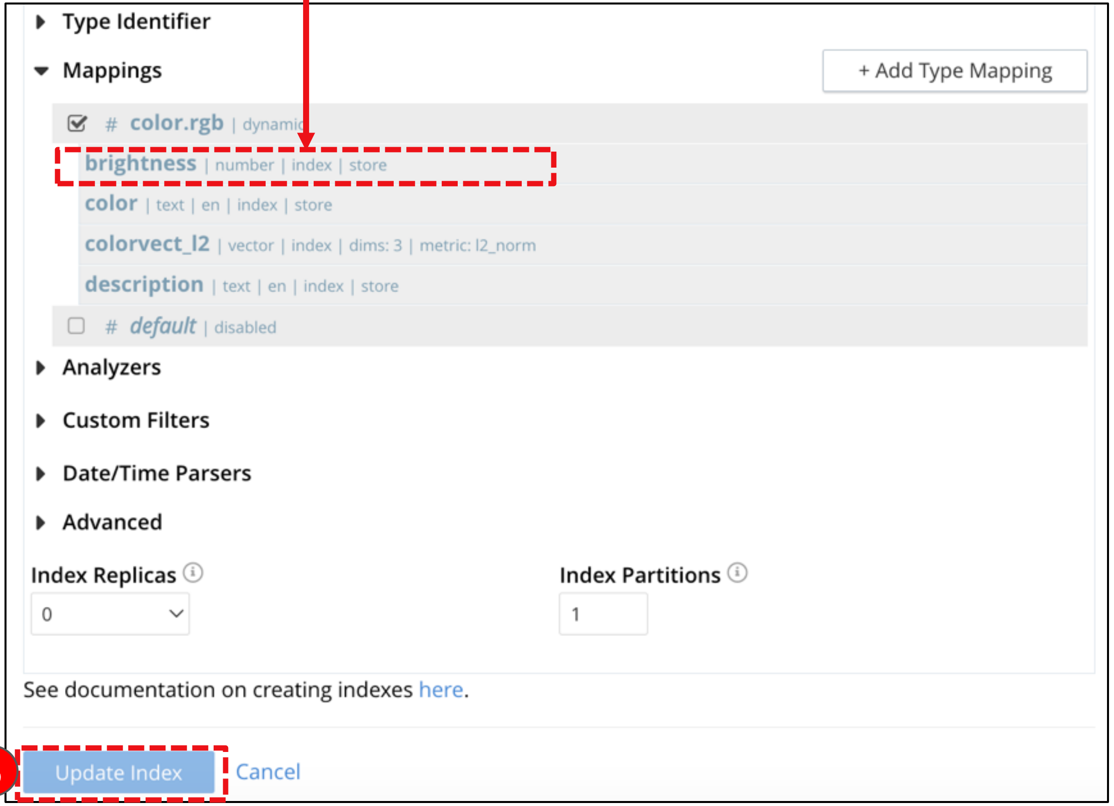
delete

color | text | en | index | store

colorvect_l2 | vector | index | dims: 3 | metric: l2_norm

description | text | en | index | store

□ # *default* | disabled



▸ Type Identifier

▾ Mappings — + Add Type Mapping

☑ # color.rgb | dynamic

brightness | number | index | store

color | text | en | index | store

colorvect_l2 | vector | index | dims: 3 | metric: l2_norm

description | text | en | index | store

□ # *default* | disabled

▸ Analyzers

▸ Custom Filters

▸ Date/Time Parsers

▸ Advanced

Index Replicas ⓘ: 0

Index Partitions ⓘ: 1

See documentation on creating indexes here.

5 Update Index — Cancel

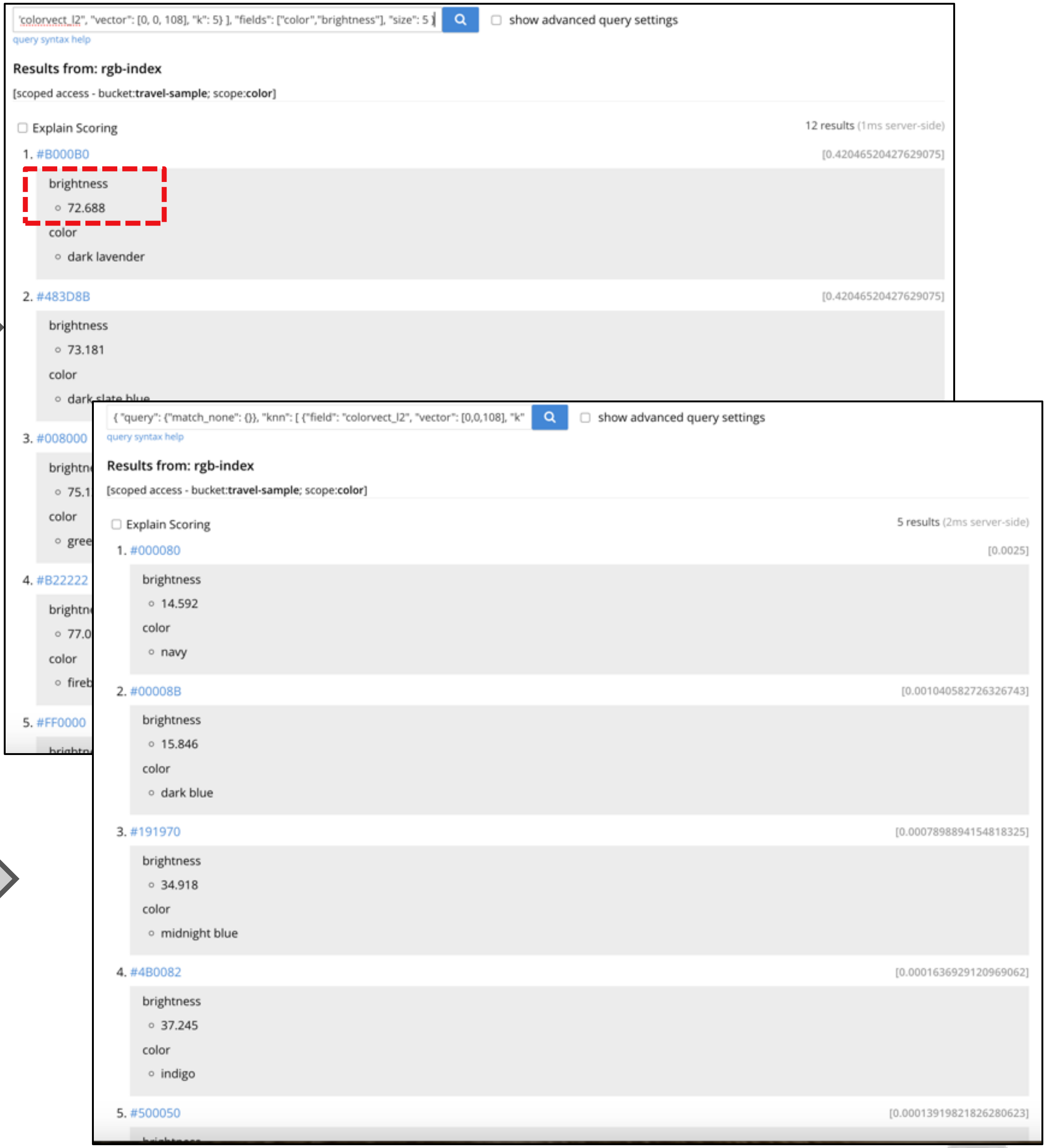
실습 > Vector Search (RGB)

- Hybrid Search, 결과 출력 변경

```
{
"query": {
   "field": "brightness", "min": 70, "max": 80,
   "inclusive_min": false, "inclusive_max": true },
"knn": [ {"field": "colorvect_l2", "vector": [0, 0, 108], "k": 5} ],
"fields": ["color","brightness"],
"size": 5
}
```

- Vector Search, 결과 출력 변경

```
{
"query": {"match_none": {}},
"knn": [ {"field": "colorvect_l2", "vector": [0,0,108], "k": 5} ],
"fields": ["color","brightness"]
}
```



'colorvect_l2", "vector": [0, 0, 108], "k": 5}], "fields": ["color","brightness"], "size": 5 }

□ show advanced query settings

query syntax help

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

□ Explain Scoring

12 results (1ms server-side)

1. #B000B0 [0.42046520427629075]
   brightness
   - 72.688

   color
   - dark lavender
2. #483D8B [0.42046520427629075]
   brightness
   - 73.181

   color
   - dark slate blue
3. #008000
   brightne
   - 75.1

   color
   - gree
4. #B22222
   brightne
   - 77.0

   color
   - fireb
5. #FF0000
   brightne

{ "query": {"match_none": {}}, "knn": [{"field": "colorvect_l2", "vector": [0,0,108], "k"

□ show advanced query settings

query syntax help

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

□ Explain Scoring

5 results (2ms server-side)

1. #000080 [0.0025]
   brightness
   - 14.592

   color
   - navy
2. #00008B [0.0010405827263267743]
   brightness
   - 15.846

   color
   - dark blue
3. #191970 [0.0007898894154818325]
   brightness
   - 34.918

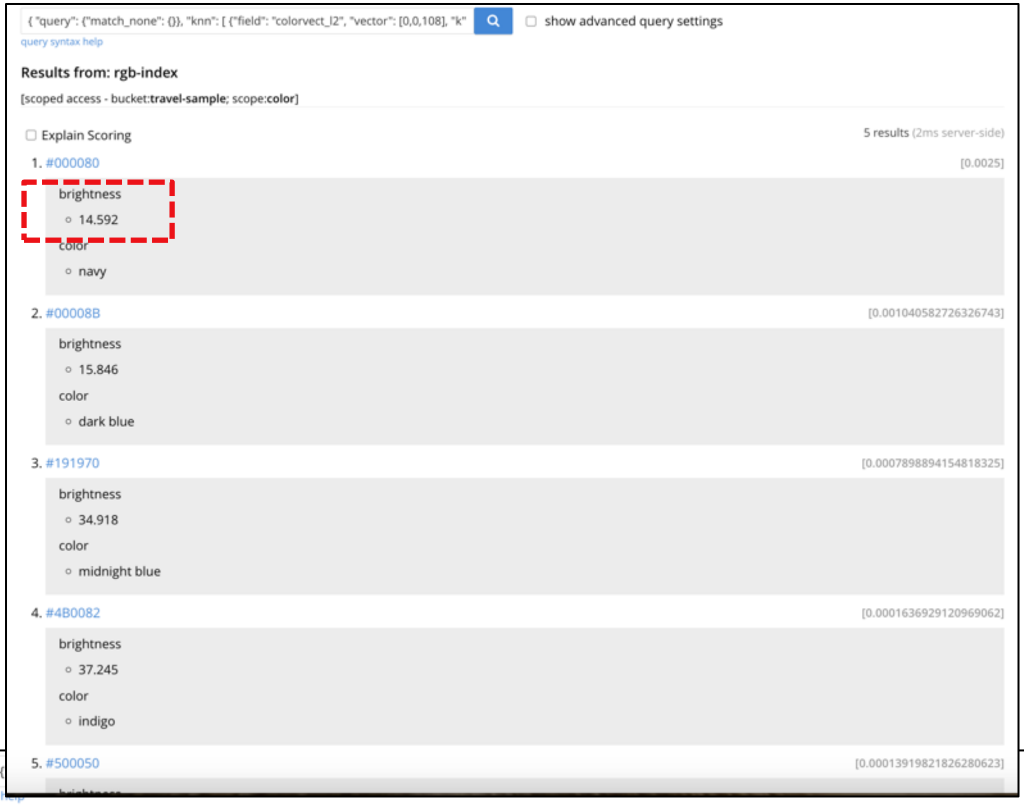
   color
   - midnight blue
4. #4B0082 [0.0001636929120969062]
   brightness
   - 37.245

   color
   - indigo
5. #500050 [0.0001391982182628O623]
   brightness

실습 > Vector Search (RGB)

- Hybrid Search, 결과 출력 변경

{
"query": {
"field": "brightness", "min": 10, "max": 20,
"inclusive_min": false, "inclusive_max": true },
"knn": [{"field": "colorvect_l2", "vector": [0.0, 0.0, 108.0], "k": 5}],
"fields": ["color","brightness"],
"size": 5
}



{ "query": {"match_none": {}}, "knn": [{"field": "colorvect_l2", "vector": [0,0,108], "k"

□ show advanced query settings

Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

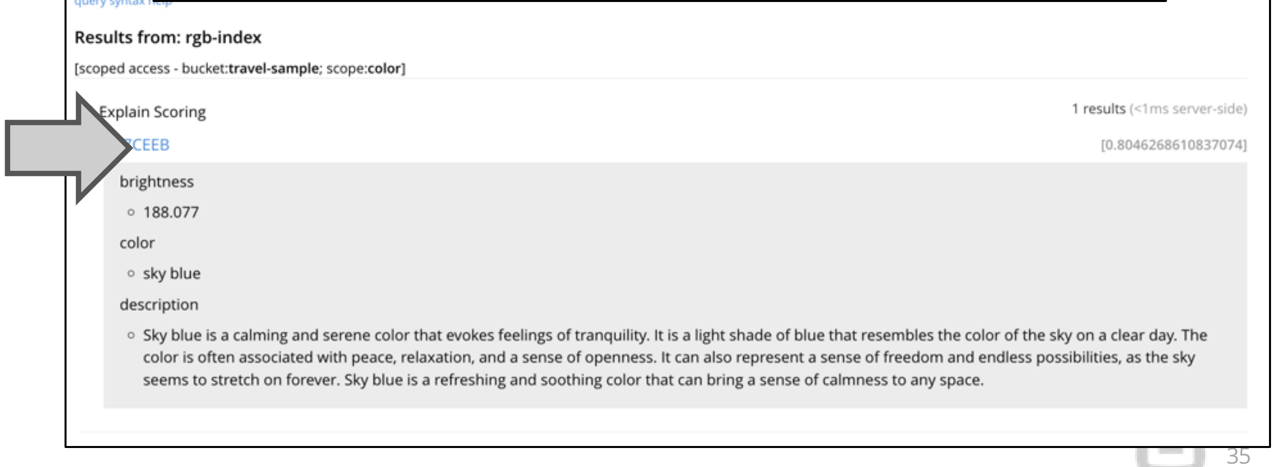
□ Explain Scoring

5 results (2ms server-side)

1. #000080 [0.0025]
   brightness
   - 14.592
   color
   - navy
2. #00008B [0.001040582726326743]
   brightness
   - 15.846
   color
   - dark blue
3. #191970 [0.0007898894154818325]
   brightness
   - 34.918
   color
   - midnight blue
4. #4B0082 [0.0001636929120969062]
   brightness
   - 37.245
   color
   - indigo
5. #500050 [0.00013919821826280623]

- Hybrid Search, 결과 출력 변경

{
"query": {"match": "freedom","field": "description"} ,
"fields": ["color","brightness","description"],
"size": 4
}



Results from: rgb-index

[scoped access - bucket:**travel-sample**; scope:**color**]

Explain Scoring

1 results (<1ms server-side)

CEEB [0.8046268610837074]

brightness
- 188.077

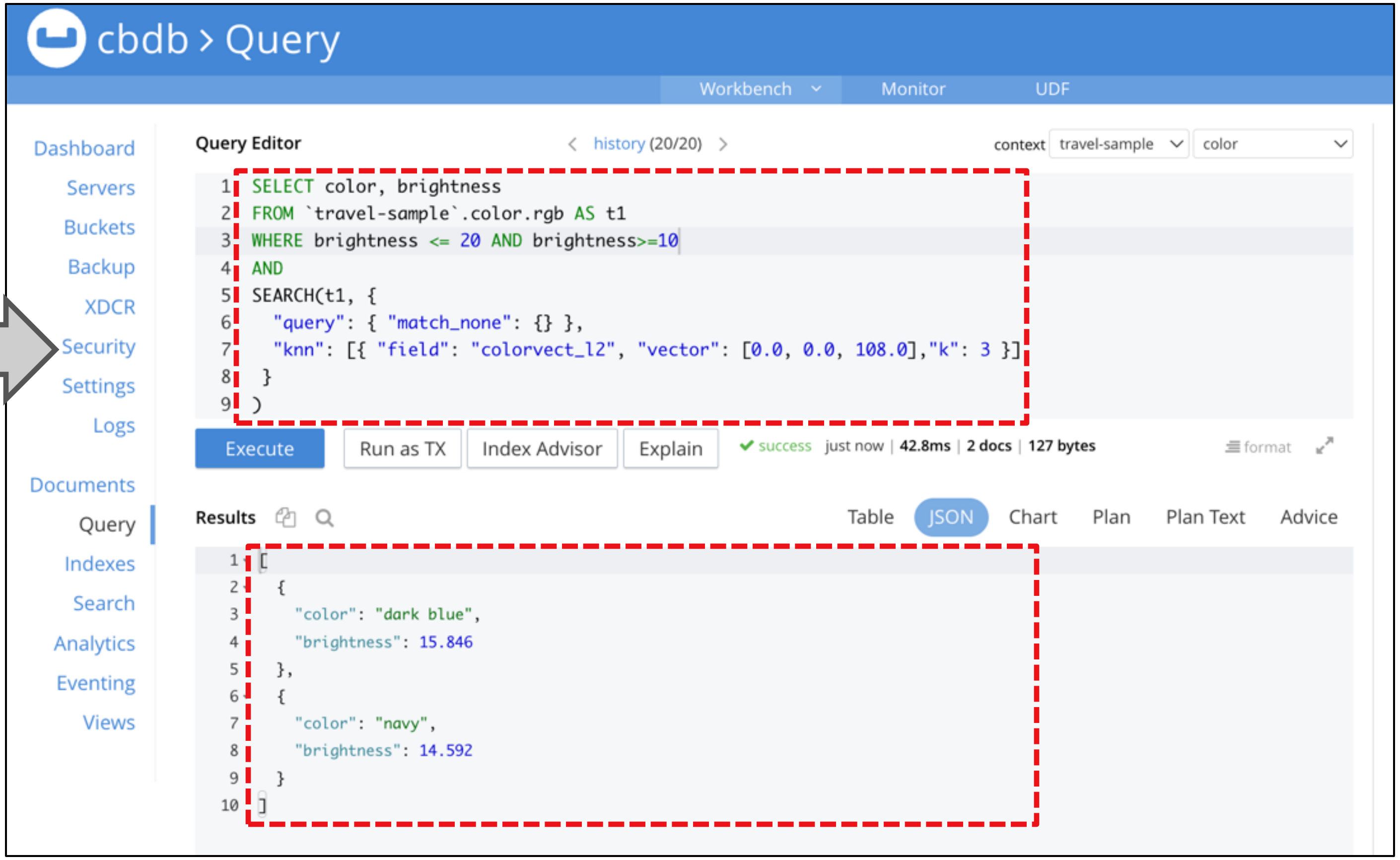
color
- sky blue

description
- Sky blue is a calming and serene color that evokes feelings of tranquility. It is a light shade of blue that resembles the color of the sky on a clear day. The color is often associated with peace, relaxation, and a sense of openness. It can also represent a sense of freedom and endless possibilities, as the sky seems to stretch on forever. Sky blue is a refreshing and soothing color that can bring a sense of calmness to any space.

실습 > SQL++ Hybrid Query (RGB)

- Hybrid Search, 결과 출력 변경

```
SELECT color, brightness
FROM `travel-sample`.color.rgb AS t1
WHERE brightness <= 20 AND brightness>=10
AND
SEARCH(t1, {
  "query": { "match_none": {} },
  "knn": [{ "field": "colorvect_l2", "vector": [0.0, 0.0, 108.0],"k": 3 }]
 }
)
```



```
SELECT color, brightness
FROM `travel-sample`.color.rgb AS t1
WHERE brightness <= 20 AND brightness>=10
AND
SEARCH(t1, {
  "query": { "match_none": {} },
  "knn": [{ "field": "colorvect_l2", "vector": [0.0, 0.0, 108.0],"k": 3 }]
 }
)
```

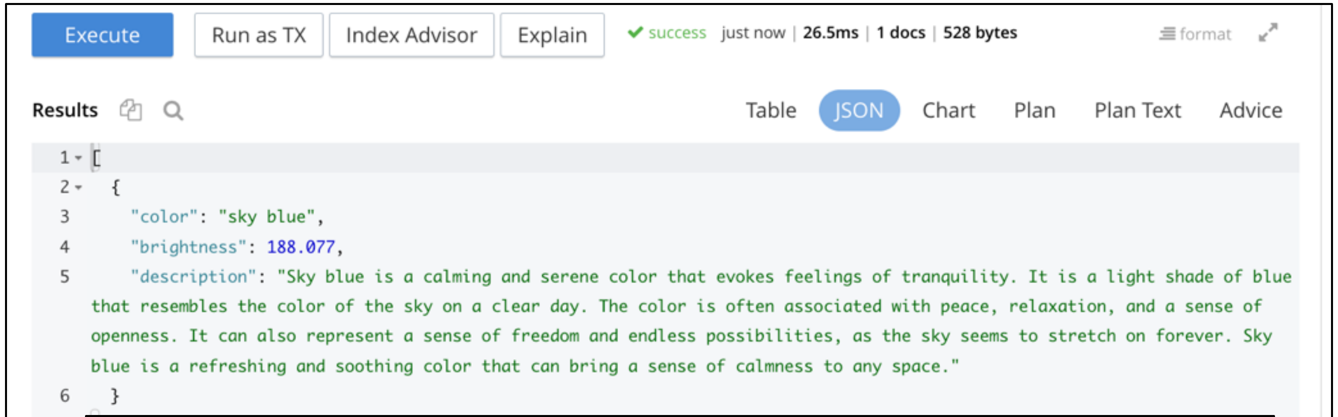
✓ success just now | 42.8ms | 2 docs | 127 bytes

```
[
  {
    "color": "dark blue",
    "brightness": 15.846
  },
  {
    "color": "navy",
    "brightness": 14.592
  }
]
```

실습 > SQL++ Hybrid Query (RGB)

- Hybrid Search, 결과 출력 변경

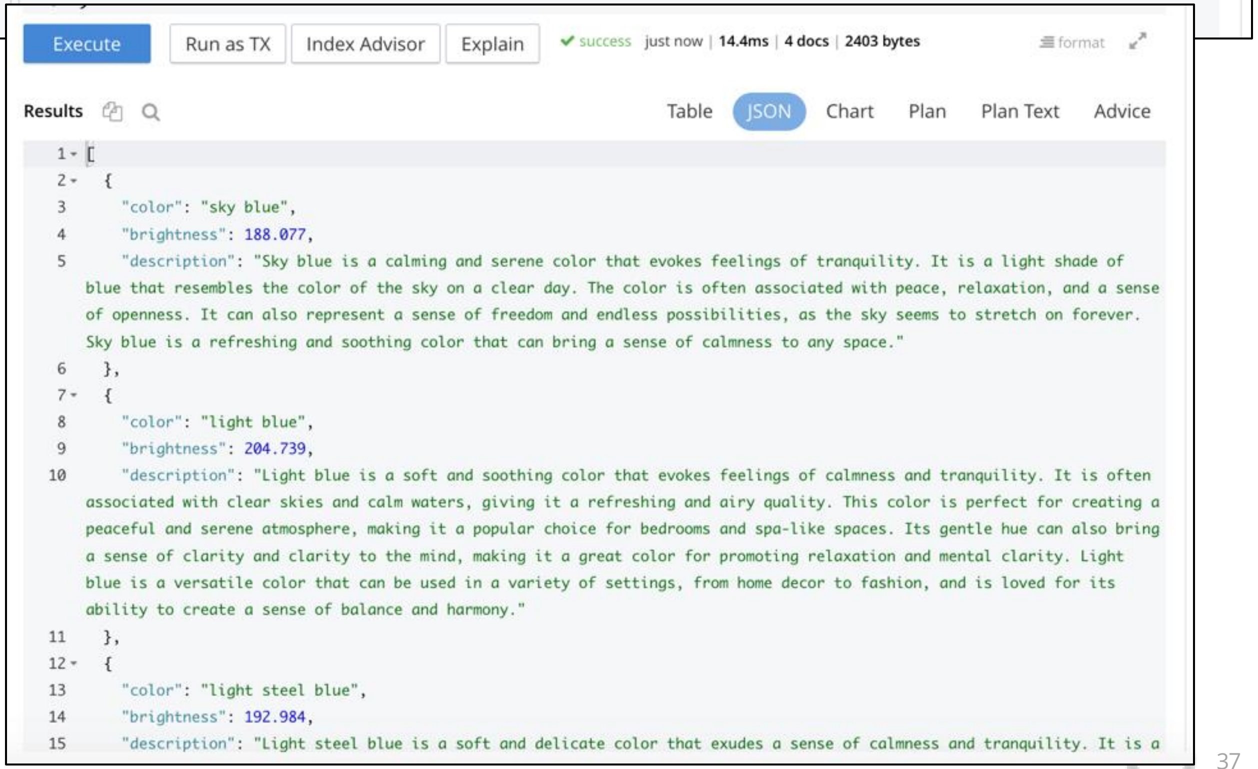
```
SELECT color, brightness, description
FROM `travel-sample`.color.rgb AS t1
WHERE
SEARCH(t1, {
"query": {"match": "freedom","field": "description"} ,
"fields": ["color","description"],"size": 4}
)
```



```
[
  {
    "color": "sky blue",
    "brightness": 188.077,
    "description": "Sky blue is a calming and serene color that evokes feelings of tranquility. It is a light shade of blue that resembles the color of the sky on a clear day. The color is often associated with peace, relaxation, and a sense of openness. It can also represent a sense of freedom and endless possibilities, as the sky seems to stretch on forever. Sky blue is a refreshing and soothing color that can bring a sense of calmness to any space."
  }
```

- Hybrid Search, 결과 출력 변경

```
SELECT color, brightness, description
FROM `travel-sample`.color.rgb AS t1
WHERE
SEARCH(t1, {
"query": {"match": "freedom","field": "description"} ,
"knn": [ { "field": "colorvect_l2", "vector": [135,204,232], "k": 4} ],
"fields": ["color","description"],"size": 4}
)
```

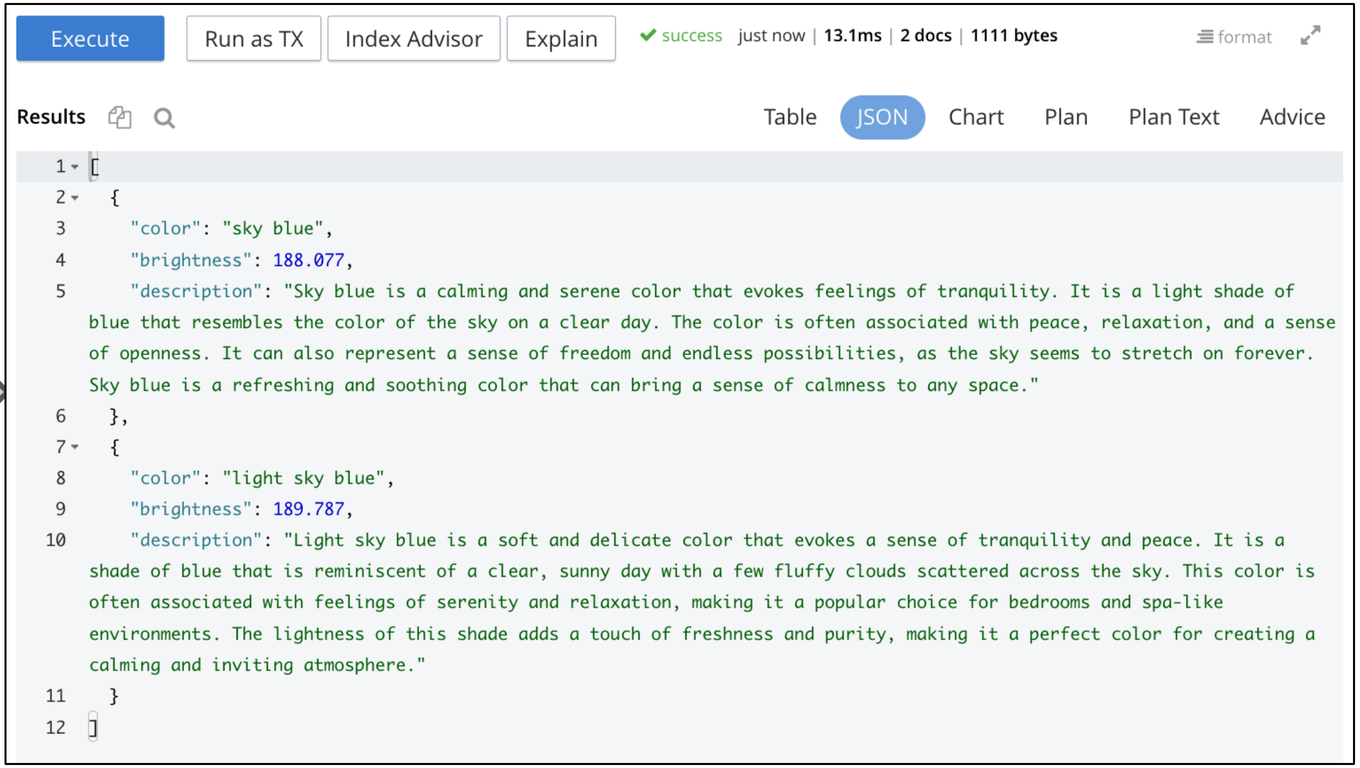


```
[
  {
    "color": "sky blue",
    "brightness": 188.077,
    "description": "Sky blue is a calming and serene color that evokes feelings of tranquility. It is a light shade of blue that resembles the color of the sky on a clear day. The color is often associated with peace, relaxation, and a sense of openness. It can also represent a sense of freedom and endless possibilities, as the sky seems to stretch on forever. Sky blue is a refreshing and soothing color that can bring a sense of calmness to any space."
  },
  {
    "color": "light blue",
    "brightness": 204.739,
    "description": "Light blue is a soft and soothing color that evokes feelings of calmness and tranquility. It is often associated with clear skies and calm waters, giving it a refreshing and airy quality. This color is perfect for creating a peaceful and serene atmosphere, making it a popular choice for bedrooms and spa-like spaces. Its gentle hue can also bring a sense of clarity and clarity to the mind, making it a great color for promoting relaxation and mental clarity. Light blue is a versatile color that can be used in a variety of settings, from home decor to fashion, and is loved for its ability to create a sense of balance and harmony."
  },
  {
    "color": "light steel blue",
    "brightness": 192.984,
    "description": "Light steel blue is a soft and delicate color that exudes a sense of calmness and tranquility. It is a
```

실습 > SQL++ Hybrid Query (RGB)

- Hybrid Search, 결과 출력 변경

```
SELECT color, brightness, description
FROM `travel-sample`.color.rgb AS t1
WHERE brightness >= 180 AND brightness <= 190
AND
SEARCH(t1, {
  "query": {"match": "freedom","field": "description"} ,
  "knn": [ { "field": "colorvect_l2", "vector": [135,204,232], "k": 4} ],
  "fields": ["color","description"],"size": 4}
)
```



```
[
  {
    "color": "sky blue",
    "brightness": 188.077,
    "description": "Sky blue is a calming and serene color that evokes feelings of tranquility. It is a light shade of blue that resembles the color of the sky on a clear day. The color is often associated with peace, relaxation, and a sense of openness. It can also represent a sense of freedom and endless possibilities, as the sky seems to stretch on forever. Sky blue is a refreshing and soothing color that can bring a sense of calmness to any space."
  },
  {
    "color": "light sky blue",
    "brightness": 189.787,
    "description": "Light sky blue is a soft and delicate color that evokes a sense of tranquility and peace. It is a shade of blue that is reminiscent of a clear, sunny day with a few fluffy clouds scattered across the sky. This color is often associated with feelings of serenity and relaxation, making it a popular choice for bedrooms and spa-like environments. The lightness of this shade adds a touch of freshness and purity, making it a perfect color for creating a calming and inviting atmosphere."
  }
]
```

수고하셨습니다.

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