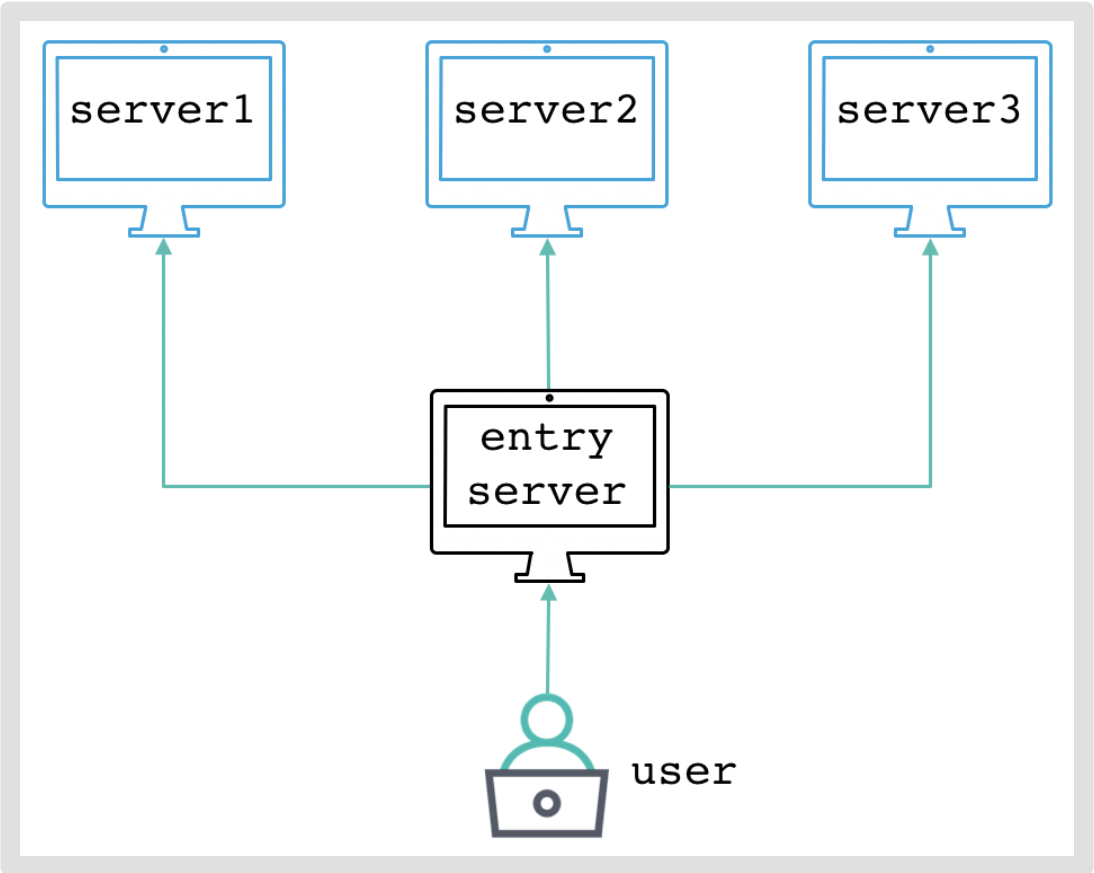
Lab Guide: Elasticsearch Engineer I

Lab 1.1: Elastic Stack Overview

Objective: The goal of this lab is to introduce you to the Strigo lab environment and give you a brief overview of its architecture.

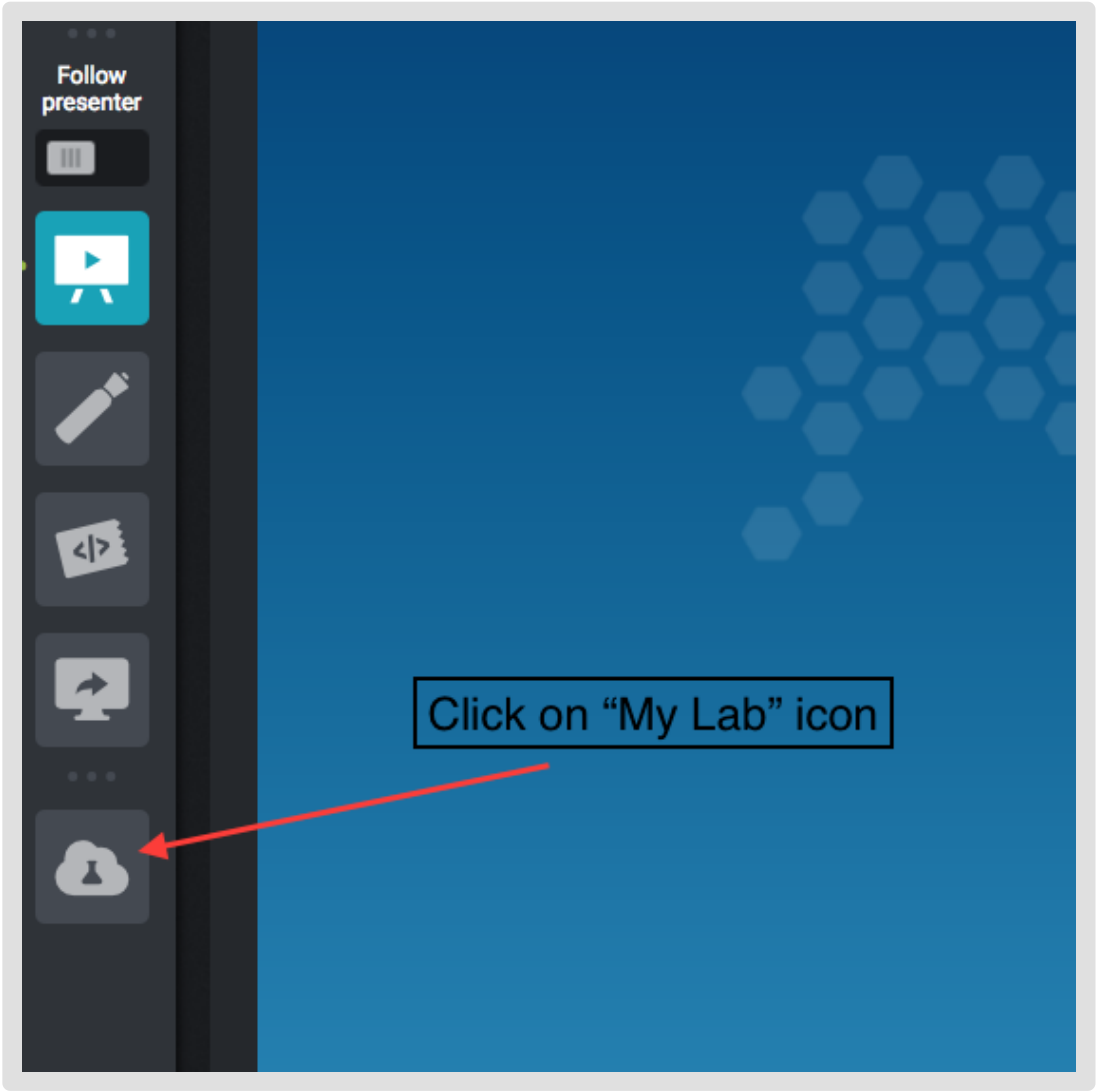
NOTE: All labs will be done using the Strigo environment. The lab environment was tailored for this training and has everything you need to complete the labs successfully. After the course is completed and your lab environment is no longer available, you will be able to complete the labs on your local machine by downloading the zip file available in your course page at training.elastic.co. Use these instructions as a reference on how to run the labs in your own machine.

1. Take a moment to look at the picture below, which shows the server architecture you are going to use in the labs:



Notice there are four different servers available. The `entry server` is an entry point to the other three servers, and it is the server in which you are automatically logged in to every time you open a new terminal tab in your lab environment.

2. From within the Virtual Environment UI, click on the **"My Lab"** icon in the left toolbar:



A command prompt will open, and you will be logged in to a Linux machine that is configured to provide easy SSH access to three servers: `server1`, `server2` and `server3`. You will deploy an Elasticsearch cluster on these 3 servers throughout the *Engineer I* course. For this first lab, you will perform all of the tasks on `server1`.

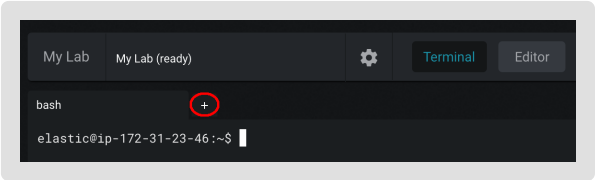
3. SSH onto `server1`:

```
ssh server1
```

4. View the contents of the **elastic** user home folder by entering `ls -l` . You should see Elasticsearch, Filebeat, Kibana and Logstash tar files, which were all simply downloaded from our website. (You will see other files in the home folder as well):

```
[elastic@server1 ~]$ ls -l
total 1502160
drwxrwxr-x 5 elastic elastic      4096 Sep 26 20:43 dat
-rw-rw-r-- 1 elastic elastic 285082863 Sep 26 20:43 ela
-rw-rw-r-- 1 elastic elastic  25265083 Sep 26 20:43 fil
-rw-rw-r-- 1 elastic elastic 236770201 Sep 26 20:43 kib
-rw-rw-r-- 1 elastic elastic 171784034 Sep 26 20:43 log
-rw-rw-r-- 1 elastic elastic    551290 Sep 26 20:43 pos
```

5. Within Virtual Environment, open a new console by clicking the plus sign **"+"** next to the tab of your current console, and you should see a command prompt:



6. Use your new console window to SSH onto `server1` .

Show answer

7. In the next labs you will start Elasticsearch, use Filebeat and Logstash to ingest data into Elasticsearch, as well as visualize data with Kibana.

Summary: In this lab you familiarized yourself with the lab environment, which you are going to use throughout this course.

End of Lab 1.1

Lab 1.2: Getting Started with Elasticsearch

Objective: In this lab, you will start and stop Elasticsearch and update some of the configuration settings.

1. Extract Elasticsearch using the following command:

```
tar -xf elasticsearch-7.3.1-linux-x86_64.tar.gz
```

2. Start Elasticsearch:

```
./elasticsearch-7.3.1/bin/elasticsearch
```

3. Wait for Elasticsearch to startup. You should see a message showing that it started. (The output order may vary a bit.)

```
[2019-10-02T21:22:29,879][INFO ][o.e.h.AbstractHttpServ
[2019-10-02T21:22:29,880][INFO ][o.e.n.Node
[2019-10-02T21:22:29,979][INFO ][o.e.g.GatewayService
[2019-10-02T21:22:30,228][INFO ][o.e.c.m.MetaDataIndexT
[2019-10-02T21:22:30,302][INFO ][o.e.c.m.MetaDataIndexT
[2019-10-02T21:22:30,328][INFO ][o.e.c.m.MetaDataIndexT
[2019-10-02T21:22:30,360][INFO ][o.e.c.m.MetaDataIndexT
[2019-10-02T21:22:30,409][INFO ][o.e.c.m.MetaDataIndexT
[2019-10-02T21:22:30,450][INFO ][o.e.c.m.MetaDataIndexT
[2019-10-02T21:22:30,480][INFO ][o.e.c.m.MetaDataIndexT
[2019-10-02T21:22:30,517][INFO ][o.e.c.m.MetaDataIndexT
```

```
[2019-10-02T21:22:30,543][INFO ][o.e.x.i.a.TransportPut
[2019-10-02T21:22:30,656][INFO ][o.e.l.LicenseService
[2019-10-02T21:22:30,659][INFO ][o.e.x.s.s.SecurityStat
```

4. Using the other tab that you connected to **server1** in the previous lab, enter the following request to get basic cluster and node information:

```
curl -X GET "http://localhost:9200/"
```

When you execute this request, you should see a response similar to:

```
{
  "name" : "server1",
  "cluster_name" : "elasticsearch",
  "cluster_uuid" : "UCvdeCOgTJ2UEa__qmcP5w",
  "version" : {
    "number" : "7.3.1",
    "build_flavor" : "default",
    "build_type" : "tar",
    "build_hash" : "4749ba6",
    "build_date" : "2019-08-19T20:19:25.651794Z",
    "build_snapshot" : false,
    "lucene_version" : "8.0.0",
    "minimum_wire_compatibility_version" : "6.8.0",
    "minimum_index_compatibility_version" : "6.0.0-beta
  },
  "tagline" : "You Know, for Search"
}
```

- What is the version of your Elasticsearch instance?

  Show answer

- What is the name of your node?

  Show answer

- What is the name of your cluster?

  Show answer

- How did these names get assigned to your node and cluster?

  Show answer

5. Stop Elasticsearch by hitting **Ctrl+c** in the terminal tab where you have Elasticsearch running. You should see the following output, and the command prompt should also appear:

```
[2019-10-02T21:40:09,926][INFO ][o.e.x.m.p.NativeContro
[2019-10-02T21:40:09,927][INFO ][o.e.n.Node
[2019-10-02T21:40:09,934][INFO ][o.e.x.w.WatcherService
[2019-10-02T21:40:10,004][INFO ][o.e.n.Node
[2019-10-02T21:40:10,004][INFO ][o.e.n.Node
[2019-10-02T21:40:10,016][INFO ][o.e.n.Node
[elastic@server1 ~]$
```

6. The current cluster and node names have been automatically defined. Let's change both to values that make more sense:

   - Open the `elasticsearch.yml` file using a text editor of your choice: nano, emacs, or vi. If you are not familiar with command-line editors, we suggest you use nano (click here for tips on using nano). You will find the file in the `elasticsearch-7.3.1/config` directory. For example, if you want to use nano:

```
nano elasticsearch-7.3.1/config/elasticsearch.yml
```

   - Notice that every line in this file is commented out. This is a good reference if you want to quickly lookup settings names.

However, having a configuration file with so many comments in between the settings can be confusing. At the end of the file, Set the name of the cluster to `my_cluster` :

Show answer

- Save your changes to `elasticsearch.yml` . To save changes to a file using nano, hit **Ctrl+x** to exit nano, then press "**y**" to save your changes. Hit "**Enter**" when prompted for a file name.

- Now, start Elasticsearch again, with the node name `node1` .

Show answer

7. Now check the cluster information to see what changed:

Show answer

8. Let's take a look at the log files that Elasticsearch produces.

   - First, list the contents of the log folder.

   Show answer

   - There are a lot of different log files in there. Some file names start with `elasticsearch` while others start with `my_cluster` . Why is that?

   Show answer

9. Elasticsearch is running using the default heap size, which is 1GB. Let's change it to 512MB. Open the `elasticsearch-7.3.1/config/jvm.options` file using a text editor of your choice. Update both initial (**-Xms**) and max (**-Xmx**) heap sizes to 512MB:

Show answer

10. Next, you need to restart the node so your changes can take effect, so stop the Elasticsearch process again, by hitting **Ctrl+c** in the terminal tab where Elasticsearch is running.

11. Start Elasticsearch ***with this exact command***:

```
./elasticsearch-7.3.1/bin/elasticsearch -E node.name=no
```

We will discuss what the `http.host` setting means later.

Summary: In this lab you started and stopped Elasticsearch and updated some of the configuration settings.

End of Lab 1.2

Lab 1.3: CRUD Operations

Objective: In this lab, you will install Kibana, define the structure of a few documents, and use Kibana **Console** to perform CRUD operations.

1. Using Elasticsearch from the command line can be hard and time consuming. Kibana **Console** allows you to write Elasticsearch commands efficiently. First, on `server1` , extract Kibana with the following command:

```
tar -xf kibana-7.3.1-linux-x86_64.tar.gz
```

2. Start Kibana:

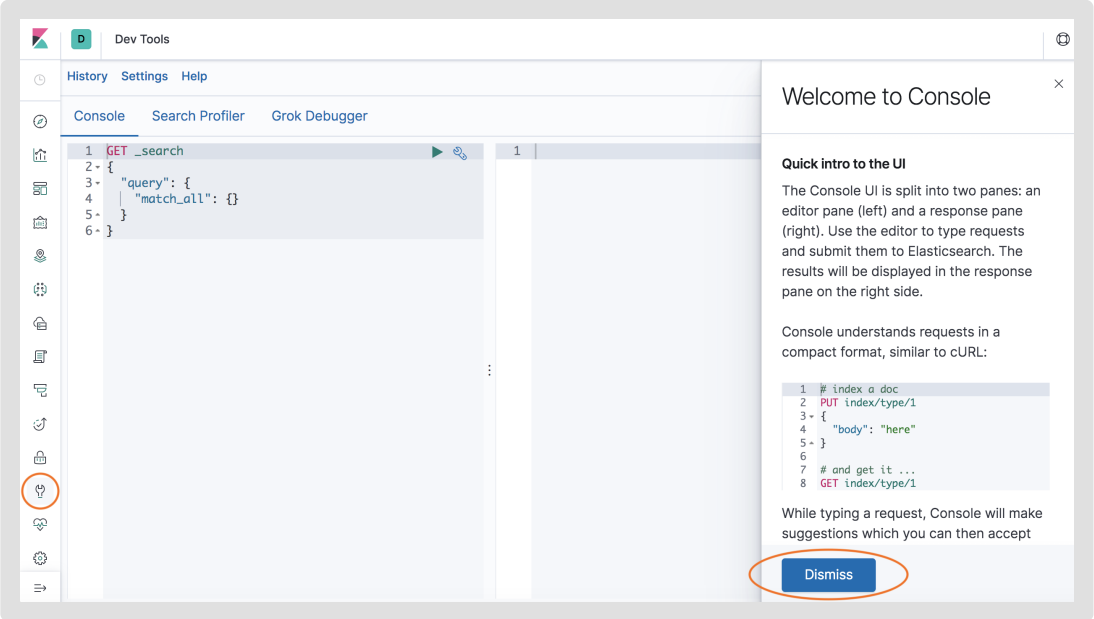
```
./kibana-7.3.1-linux-x86_64/bin/kibana --host=0.0.0.0
```

You should see the following output:

```
log   [21:11:37.412] [info][listening] Server running a
log   [21:11:37.418] [info][server][Kibana][http] http
```

3. Now that Kibana is running, click here to connect.

4. In Kibana, click on the **Dev Tools** button in the side navigation pane to open the **Console** application:



5. Kibana has several handy keyboard shortcuts that will make your time spent in **Console** more efficient. To view the keyboard

shortcuts, click on **"Help"** in the upper-right corner. For example, pressing **Ctrl + Enter** (**Cmd + Enter** on a Mac) submits a request without having to use your mouse.

TIP: Click on **"Help"** again to close the Help panel.

6. Notice there is a `match_all` query already written in the **Console**. Just skip it for now. We will talk about it later. Below the `match_all` query, write a request that returns the node's basic information. Then run it by clicking the green "play" button that appears to the right of the command (or using the **Ctrl/Cmd + Enter** keyboard shortcut).

   Show answer

7. Next, you will focus on the dataset. Imagine a dataset that is row-oriented (e.g. spreadsheet or a traditional database). How would you write a JSON document based on sample entries that look like the following? Think about field structure and empty fields:

id	title	category	date	author_first_name	author_last_name	author_company
1	Better query execution	Engineering	July 15, 2015	Adrien	Grand	Elastic
2	The Story of Sense		May 28, 2015	Boaz	Leskes	

   Show answer

8. **EXAM PREP**: Now that we have defined the documents, let's index them. Notice that the `id` field defined inside the documents is just a normal field like any other. The actual document `_id` is defined in the request URL when you index the documents. Index both JSON documents into the `my_blogs` index using their respective ids.

   Show answer

9. **EXAM PREP**: The index operation can also be executed without specifying the `_id` . In such a case, you use a **POST** instead of a **PUT** and an `_id` will be generated automatically. Index the following document without an id and check the `_id` in the response. (Make sure you use **POST**.)

```
{
  "id": "57",
  "title": "Phrase Queries: a world without Stopwords",
  "date":"March 7, 2016",
  "category": "Engineering",
  "author":{
    "first_name": "Gabriel",
    "last_name": "Moskovicz"
  }
}
```

   Show answer

10. **EXAM PREP**: Use a **GET** command to retrieve the document with `_id` of **1** from the `my_blogs` index.

    Show answer

11. **EXAM PREP**: Delete the document with the `_id` of **1** from the `my_blogs` index. Verify it was deleted by trying to **GET** it again. You should get the following response:

```
{
  "_index": "my_blogs",
  "_type": "_doc"
  "_id": "1",
  "found": false
}
```

Show answer

12. **OPTIONAL**: Perform a bulk operation that executes the following operations on the `my_blogs` index from the previous step:

    - Update document 2: set `category` to "**Engineering**" and set `author.company` to "**Elastic**"
    - Index a new document with `_id` of 3 that contains the following fields and values:

```
{
  "title": "Using Elastic Graph",
  "category": "Engineering",
  "date": "May 25, 2016",
  "author": {
    "first_name": "Mark",
    "last_name": "Harwood",
    "company": "Elastic"
  }
}
```

Show answer

13. **OPTIONAL**: Use `_mget` to retrieve the documents with the ids **2** and **3** from your `my_blogs` index and verify your two bulk operations were both successful.

    Show answer

14. **OPTIONAL**: What happens if you copy and paste the following curl request to **Console**?

    ```
    curl -X GET "http://localhost:9200/"
    ```

    Show answer

15. **OPTIONAL**: Sometimes it is also handy to copy from **Console** to the terminal. Click the wrench icon close to the play button and select **Copy as cURL**. Now go back to a terminal and paste it.

16. Finally, delete the `my_blogs` index.

    Show answer

Summary: In this lab, you installed Kibana, defined the structure of a few documents, and used Kibana **Console** to perform CRUD operations.

End of Lab 1.3

Lab 1.4: Searching Data

Objective: In this lab, you will see how quickly and easily the Elastic Stack can be used to ingest data from a database, collect data from log files, and search data. You will use Logstash to ingest the blogs from a Postgres database into Elasticsearch and use Filebeat to ingest the web access log data from log files.

1. If you completed the previous labs, Elasticsearch and Kibana should be running in the foreground at two separate tabs. Next, you are going to start Logstash. Open a new tab and SSH onto `server1` :

   ```
   ssh server1
   ```

   WARNING: If you are running the labs in your own environment click `Show answer` to see how to load the data.

   `Show answer`

2. The first dataset you are going to ingest into Elasticsearch is the blogs dataset using Logstash, which has been downloaded already. Extract Logstash using the following command:

   ```
   tar -xf logstash-7.3.1.tar.gz
   ```

3. Logstash is going to retrieve the blogs from a SQL database and index them into your running Elasticsearch instance. This is accomplished using a Logstash config file that has been provided for you named `blogs_sql.conf` . You do not need to modify this file in any way, but here are its contents. Notice the `input` is all

blogs from a table named `blogs`, and the `output` is an Elasticsearch index named `blogs`:

```
input {
  jdbc {
    jdbc_connection_string => "jdbc:postgresql://db_ser
    jdbc_driver_class => "org.postgresql.Driver"
    jdbc_driver_library => "/home/elastic/postgresql-42
    jdbc_user => "postgres"
    jdbc_password => "password"
    statement => "SELECT * from blogs"
  }
}

filter {
  mutate {
    remove_field => ["@version", "host", "message", "@t
  }
}

output {
  stdout { codec => "dots"}
  elasticsearch {
    index => "blogs"
  }
}
```

4. To run Logstash with this config file, execute the following command:

```
./logstash-7.3.1/bin/logstash -f datasets/blogs_sql.con
```

Logstash will take some time to start, so make sure to wait before you go to the next step. Eventually the output will show dots, and each dot represents a document being indexed into Elasticsearch. When Logstash is finished, you will see a "Logstash shut down" message:

```
.....................................................
..[2019-09-23T09:46:31,407][INFO ][logstash.runner
```

5. The `blogs` table in the database contains 1594 entries. Verify that all those entries are in Elasticsearch.

   Show answer

6. Every `_search` request to Elasticsearch will have a query when executed. The `match_all` query is implicit if no query is defined. Scroll up in **Console** and execute the default `match_all` query and see that the results include all indices, because you reached the `_search` endpoint without specifying an index.

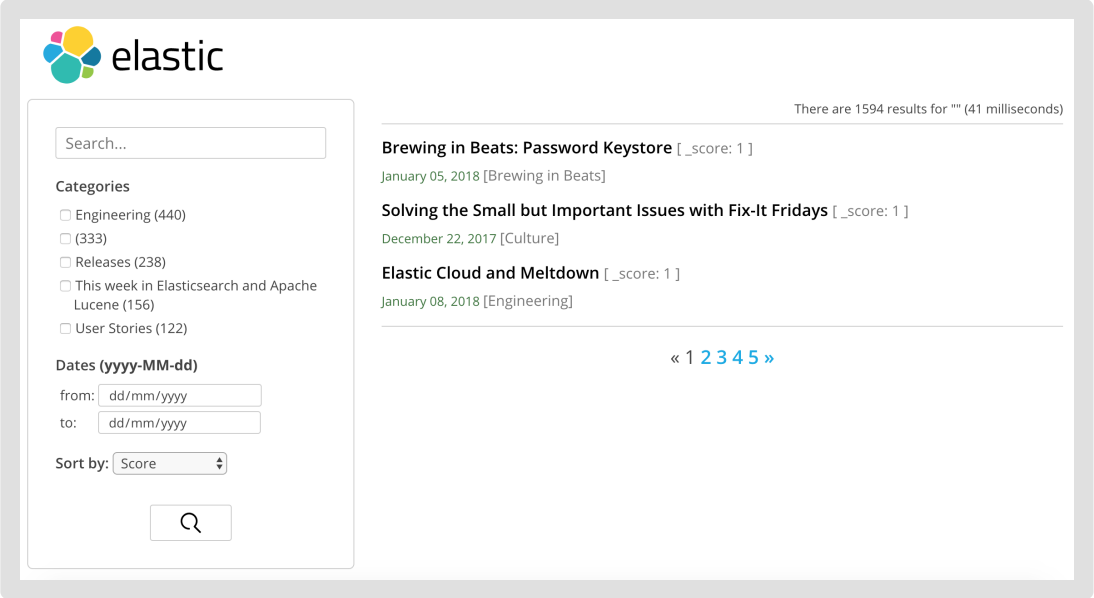
7. Another option is to execute a `_count` request instead of a `_search` . Try the following example:

   ```
   GET blogs/_count
   ```

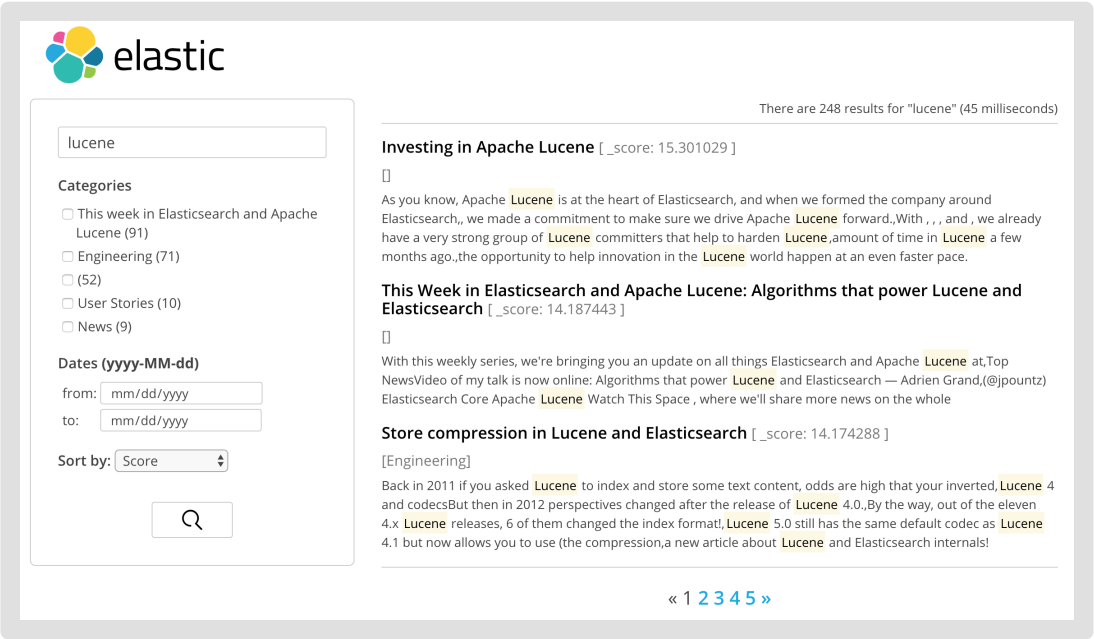
   You should see a slightly different output. Because you are executing a count, no hits are returned in the response. Notice, the `match_all` query is still implicit.

```
{
  "count" : 1594,
  "_shards" : {
    "total" : 1,
    "successful" : 1,
    "skipped" : 0,
    "failed" : 0
  }
}
```

8. Now that we have all blogs indexed, let's see how the search page works. Access the blogs search page and play around with it.



Congratulations, the blogs data are in Elasticsearch and the webpage is working! Make sure to familiarize yourself with different searches, filtering by category and date, and also paging. Over the next chapters you are going to learn how to write the queries and aggregations used to build this application.



9. Next, let's index the access logs dataset. You will use Filebeat to monitor the log files and ingest every line. Filebeat is downloaded already on `server1`. Open a new Terminal tab and extract it using the following command:

```
tar -xf filebeat-7.3.1-linux-x86_64.tar.gz
```

WARNING: If you are running the labs in your own environment click `Show answer` to see how to load the data.

`Show answer`

10. Run the following command to start Filebeat using the `filebeat.yml` configuration file that has been provided. There will be no output - the command prompt will just hang:

```
./filebeat-7.3.1-linux-x86_64/filebeat -c datasets/file
```

11. There are 1,751,476 events that occurred between **2017-04-01** and **2017-09-01** across multiple log files. They will be ingested into 3 indices called `logs_server1`, `logs_server2` and `logs_server3`. Use one of the following commands to check how many files have been ingested so far:

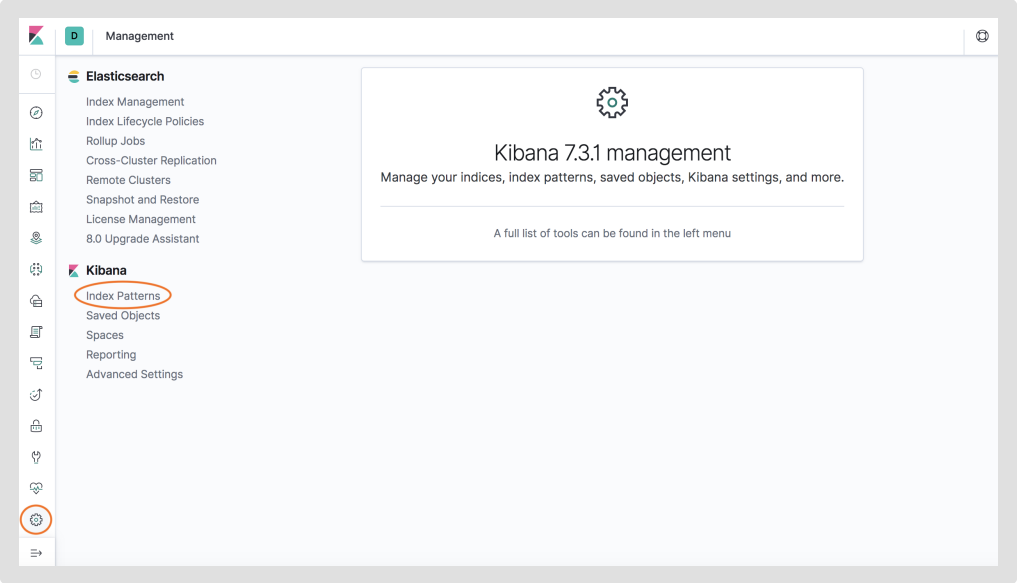
```
GET logs_server1,logs_server2,logs_server3/_count
GET logs_server*/_count
```

    The ingestion might take a few minutes, feel free to go to the next task before all logs are indexed. When all of the log events are indexed, you can kill the Filebeat process using **Ctrl+c**.

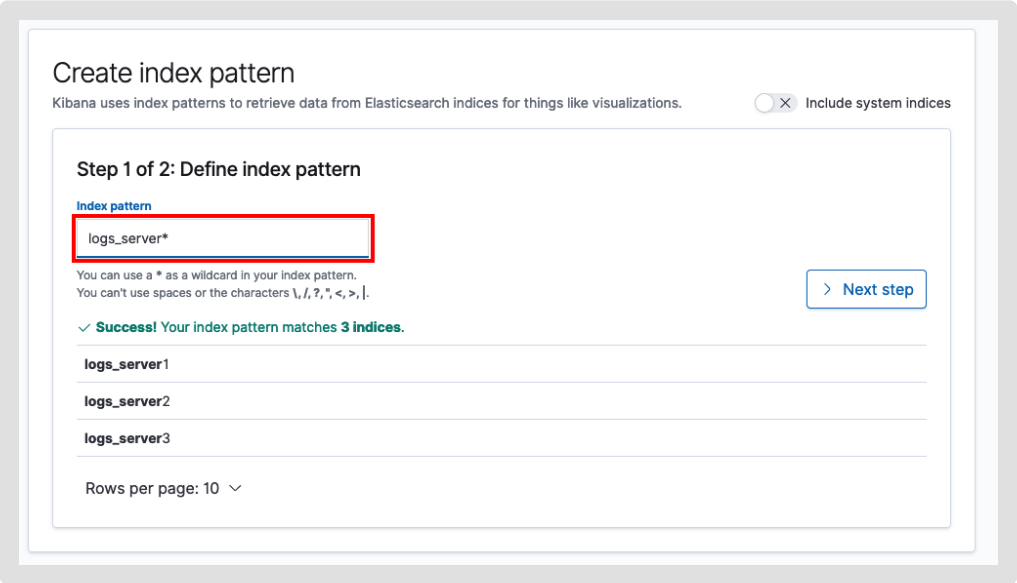
12. **OPTIONAL**: Now that you have the blogs and access log data in Elasticsearch, you will use Kibana to analyze it. Click here to connect to Kibana.

13. **OPTIONAL**: You need to tell Kibana which indices to analyze, which is accomplished by defining an **Index Pattern**:

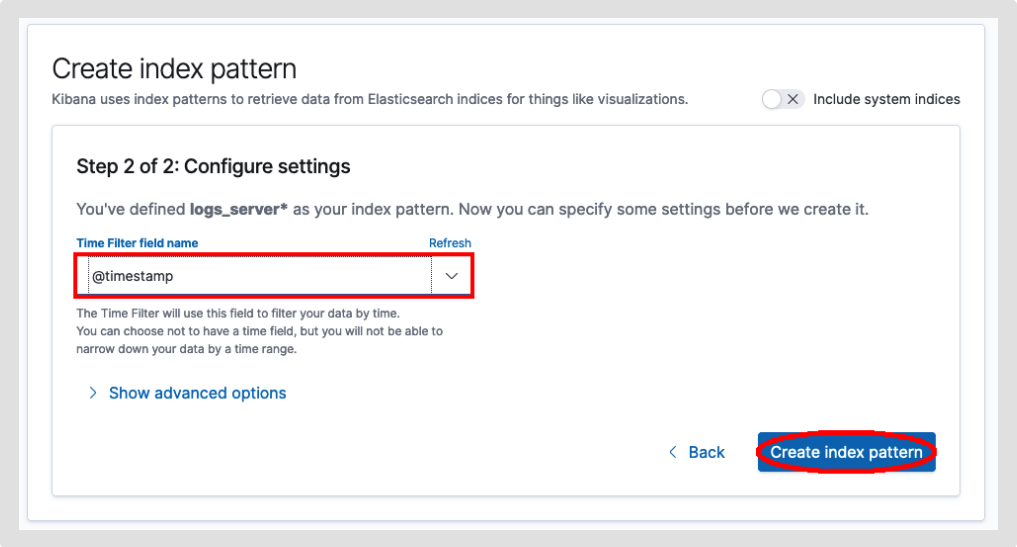
    - Click on the **Management** link in the left-hand toolbar of Kibana, then click on **Index Patterns**:



- Type `logs_server*` in the **Index pattern** field:



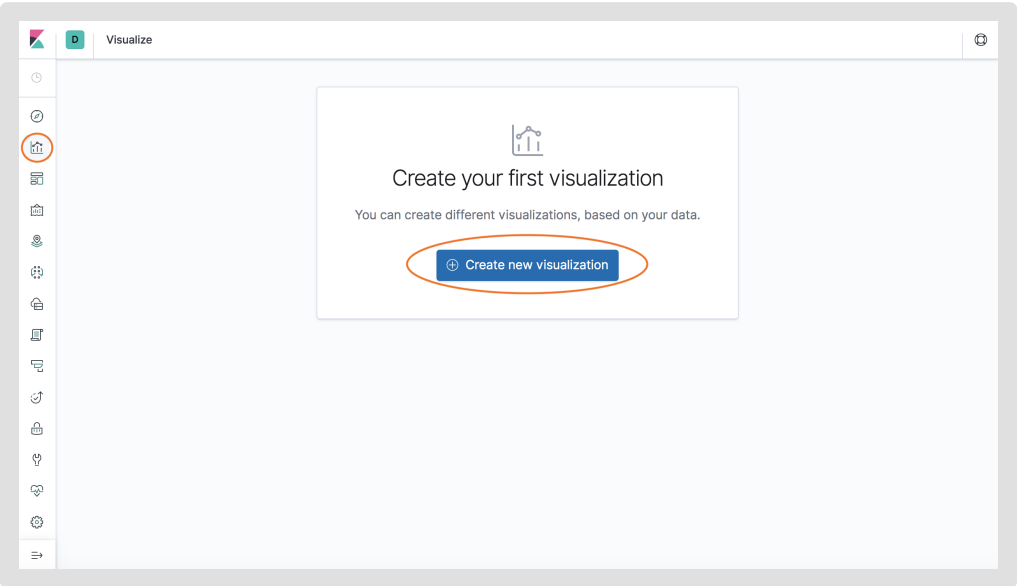
- Click **Next step** and select `@timestamp` as the **Time Filter field name** field:



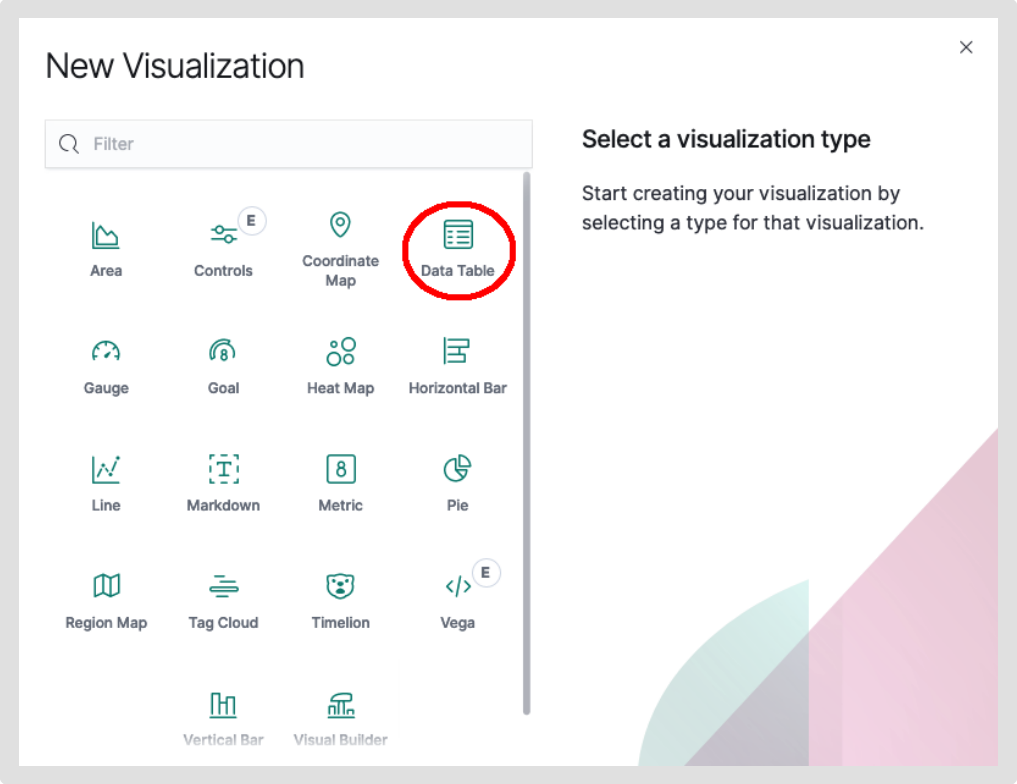
- Click the **Create index pattern** button. You should see a page that shows the 43 fields of the web log documents.

14. **OPTIONAL**: Now that we have set up our index pattern, let's visualize the data. You will first create a table with the top 5 most popular blogs:

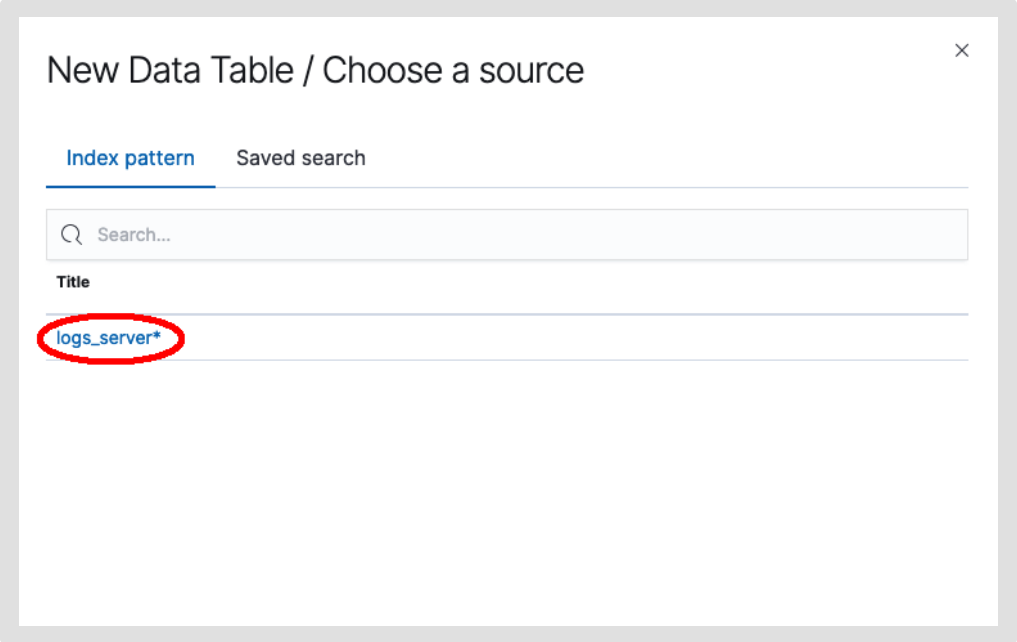
    - Click on **Visualize** in the left-hand toolbar of Kibana, and then click the **Create a visualization** button:



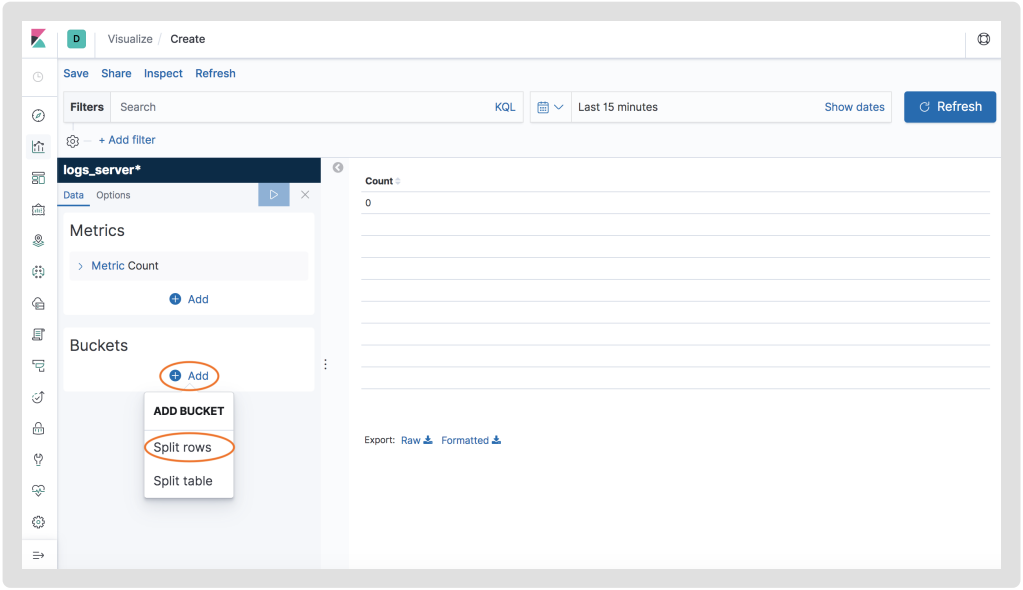
    - Select **Data Table**:



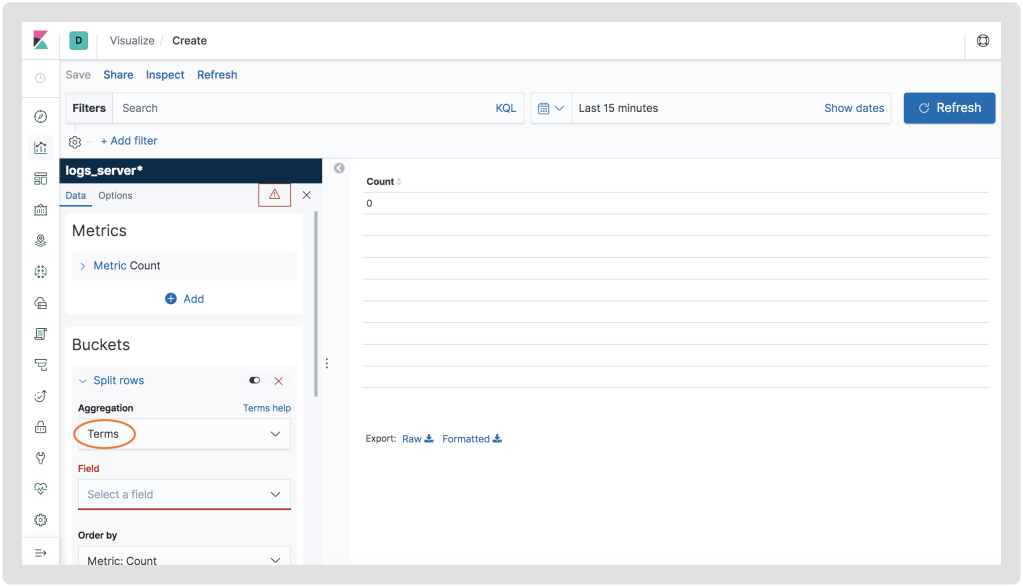
- Click on `logs_server*` . (This is the index pattern we created, which defines from which indices we will read data.)



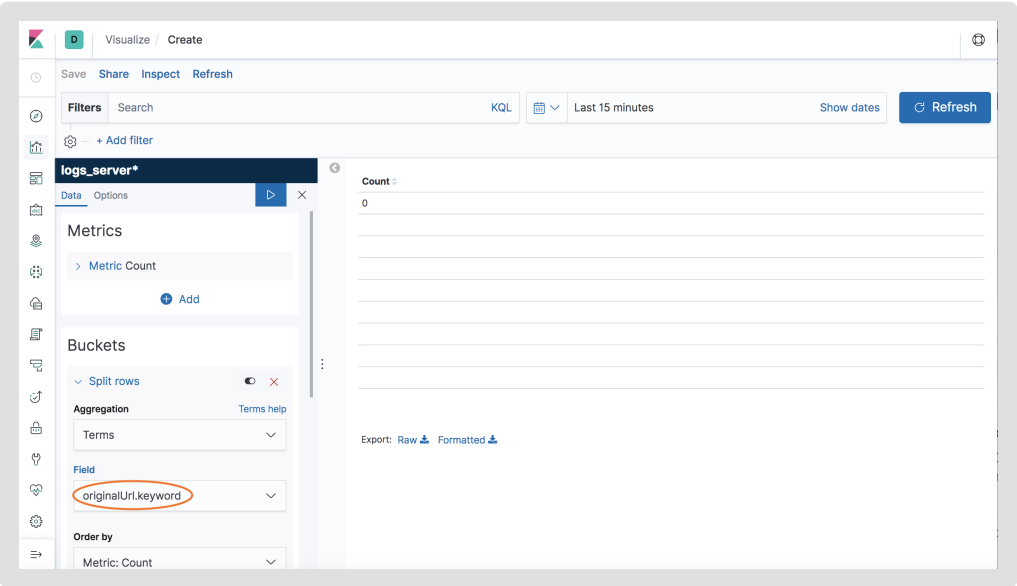
- Click on `Split Rows` under **Buckets**:



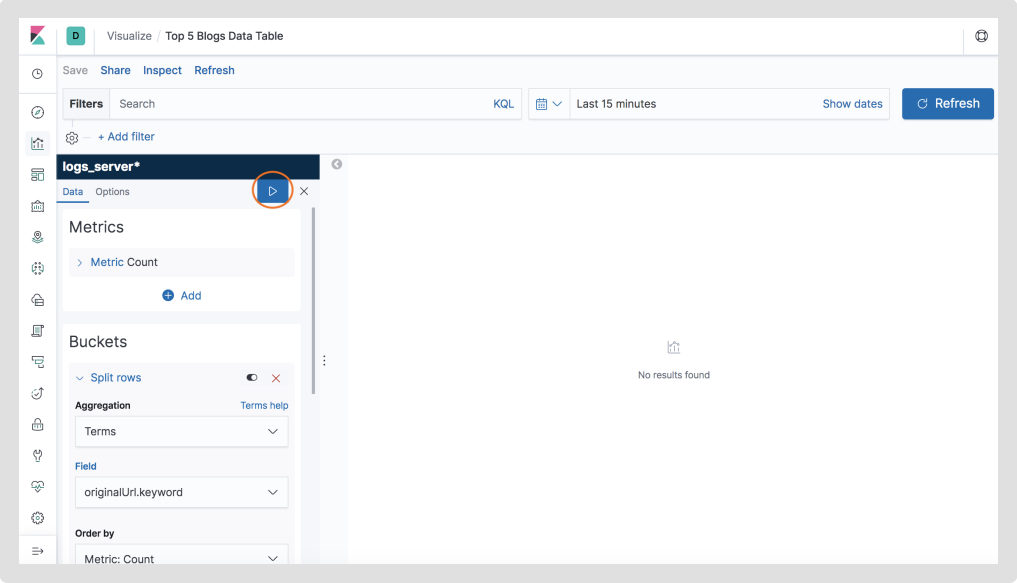
- Select `Terms` under **Aggregation**:



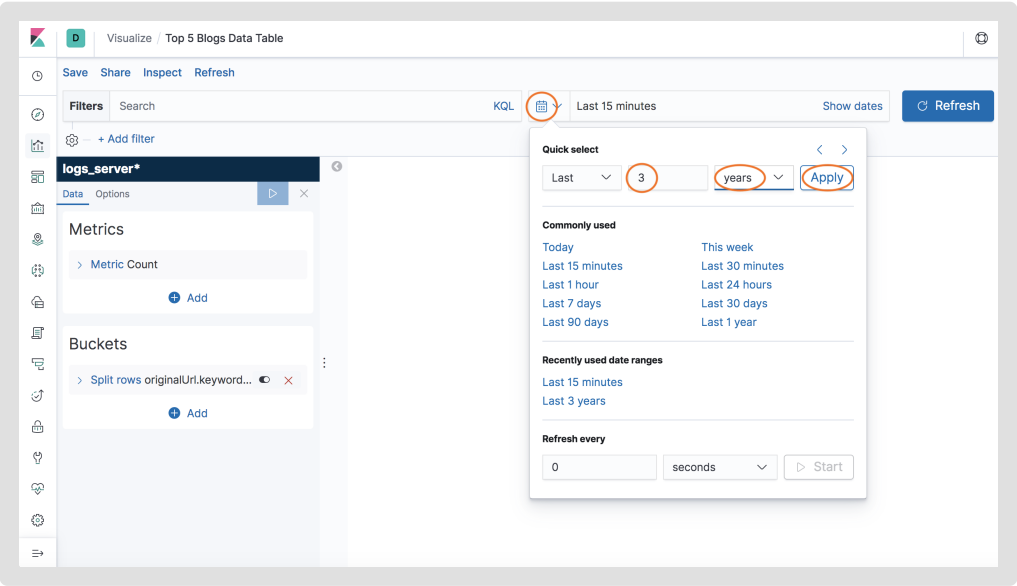
- Select `originalUrl.keyword` under **Field**:



- Click on **Apply changes** (the button that looks like a "play" button):

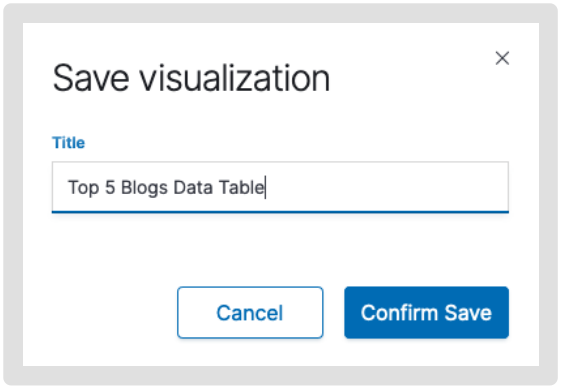


- Kibana tells you "No results found". That's because Kibana defaults to showing the last 15 minutes of data. Our data is older than that. In the top right, use the Time Picker to change **Last 15 minutes** into **Last 3 years**:



You should see the 5 most popular URLs on Elastic's blog site.

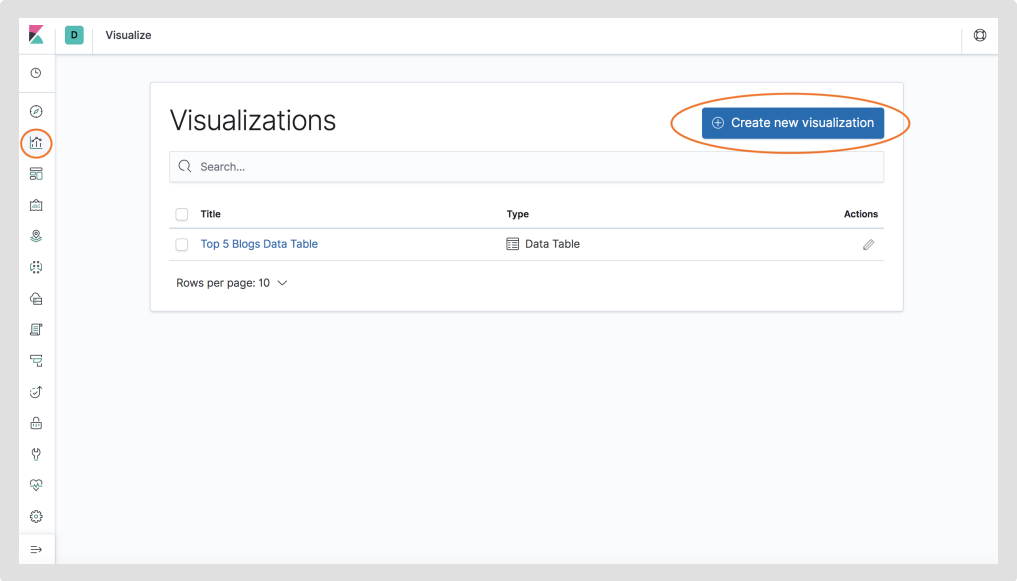
- Save your visualization by clicking on **Save** in the top-left menu and name the visualization **"Top 5 Blogs Data Table"**. Then click the **Confirm Save** button to save the visualization.



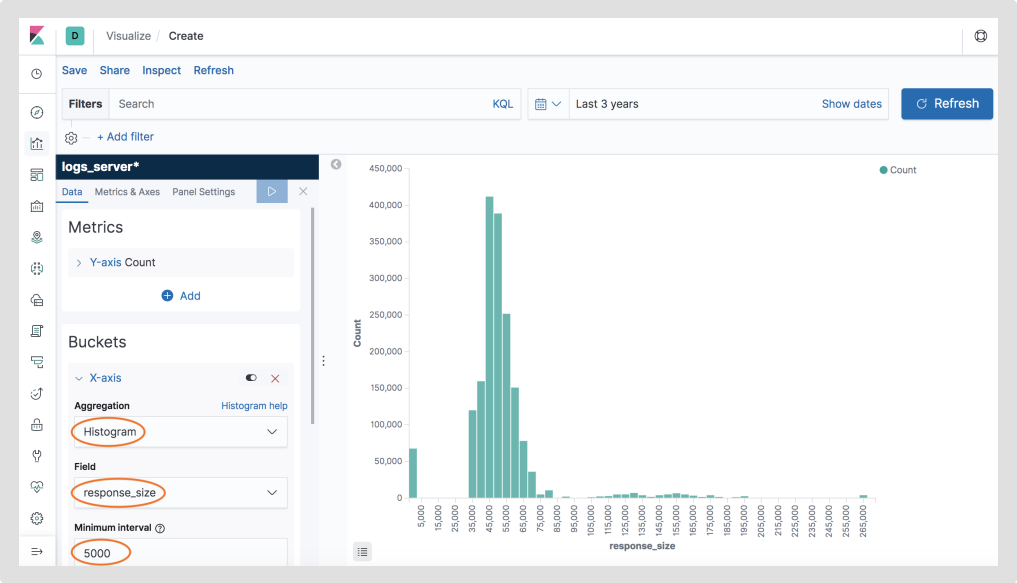
- Click the **"Visualize"** link in the left-hand column of Kibana and you should see your data table in the list of saved visualizations.

15. **OPTIONAL**: Let's build another visualization - a histogram that shows the distribution of the size of the responses from our website:

- Click on **Visualize** and then on the "**+**" button to create a new visualization:



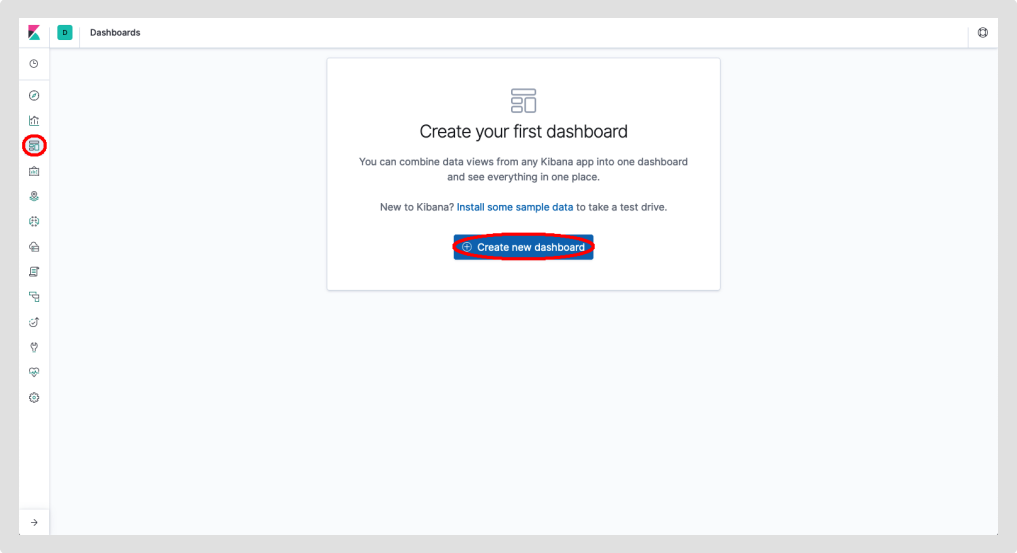
- Select **Vertical Bar**, then select the `logs_server*` index pattern.
- Under **Buckets** choose **X-Axis**
- Under **Aggregation**, choose **Histogram**.
- Select **Field: response_size** and enter 5000 for the **Minimum Interval**.
- Click **Apply changes** to view the bar chart:



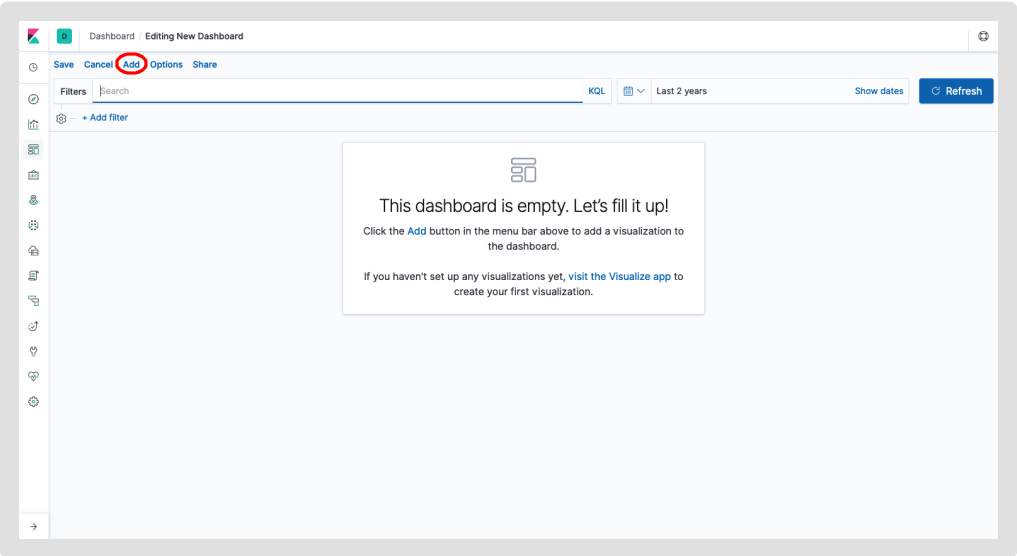
- Save the visualization, giving it the name **"Response Size Bar Chart"**

16. **OPTIONAL**: After creating visualizations, you can combine them onto a single dashboard:

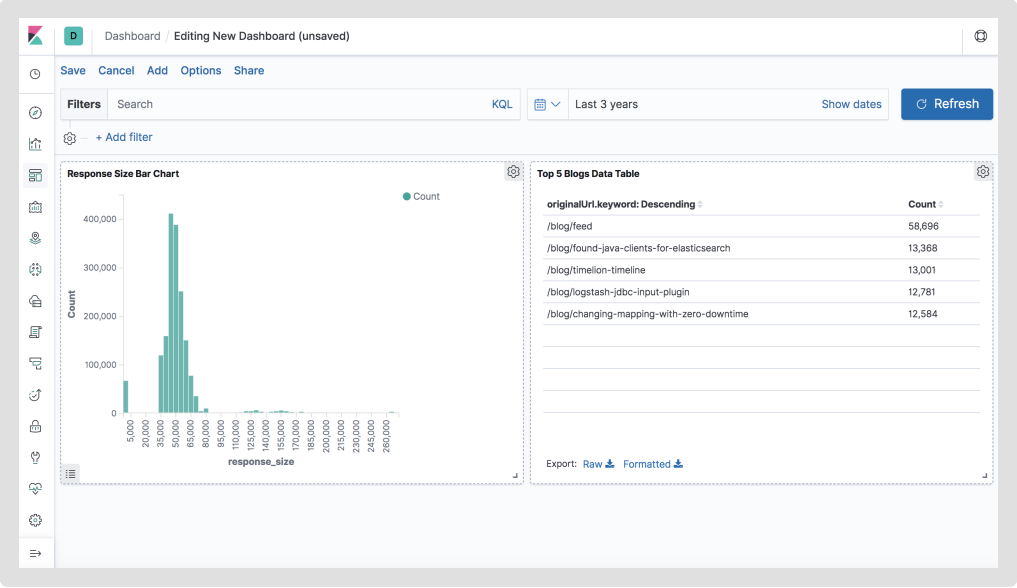
    - Click on **Dashboard** in the left-hand toolbar of Kibana, then click on the **Create new dashboard** button:



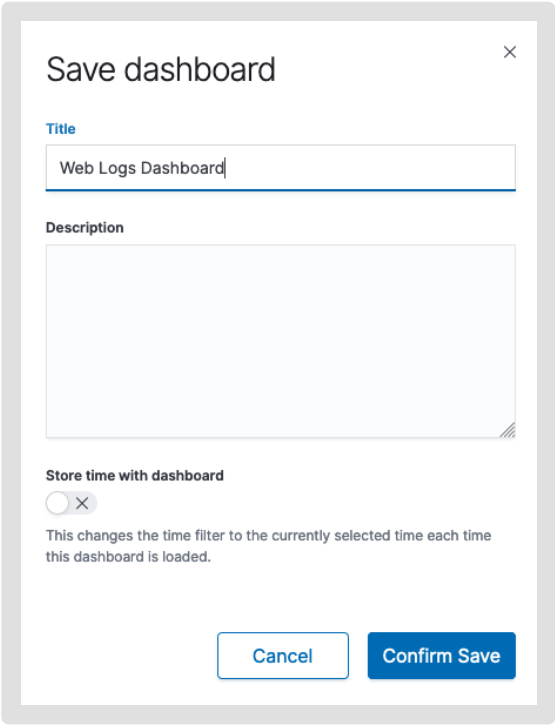
    - Click on the **Add** menu item and add both of the visualizations that you saved earlier:



- Close the **"Add Panels"** dialog.
- Feel free to resize the visualizations and move them around:



- Save your dashboard by clicking **Save** in the menu and naming your dashboard **"Web Logs Dashboard"**. Then click the **Confirm Save** button to save the dashboard.



- You should now see your saved dashboard on the **"Dashboard"** page of Kibana, so you can come back and view the dashboard at any time.

Summary: In this lab, you used the Elastic Stack to ingest data from a database, to collect data from log files, and to search data. You used Logstash to ingest the blogs from a Postgres database into Elasticsearch and used Filebeat to ingest the web access log data from log files.

End of Lab 1.4

Lab 2.1: Relevance

Objective: In this lab, you will familiarize yourself with the Query DSL. You will write various queries that search documents in the `blogs` index using the Search API and the `match` query.

1. Write and execute a query that matches all the documents in the blogs index. You should have a total of 1594 hits:

```
"hits": {
  "total": 1594
```

Show answer

2. Add the `size` parameter to your previous request and set it to `100` . You should now see 100 blogs in the results.

Show answer

3. You probably noticed that the `content` field is large, which makes it more difficult to navigate the result set. In these cases where the output is too verbose you can use `_source` to filter the output, but keep in mind that this is done in the JSON level and therefore it adds overhead to Elasticsearch (though it decreases the amount of data transferred in the network).
    - You can use `_source` with `excludes` pattern to remove the fields you don't want. For example, run the query below, which does not include the content field in the output:

```
GET blogs/_search
{
  "size": 100,
  "_source": {
```

```
    "excludes": ["content"]
  },
  "query": {
    "match_all": {}
  }
}
```

- You can also use `_source` with `includes` pattern to specify the fields you want. For example, run the following query below, which includes only the fields `author` and `title` in the output:

```
GET blogs/_search
{
  "size": 100,
  "_source": {
    "includes": ["author","title"]
  },
  "query": {
    "match_all": {}
  }
}
```

- Alternatively, when just including fields you can list them in an array without the `includes` clause. For example, the previous query can be simplified as follows:

```
GET blogs/_search
{
  "size": 100,
  "_source": ["author","title"],
```

```
  "query": {
    "match_all": {}
  }
}
```

4. Write and execute a `match` query for blogs that have the term "**elastic**" in the `title` field. Your should get 260 hits:

```
"hits": {
    "total": 260,
```

Show answer

5. Now run a `match` query for "**elastic stack**" in the `title` field. Why did the number of hits go up by adding a term to the `match` query?

```
"hits": {
    "total": 263,
```

Show answer

6. Your search for "**elastic stack**" cast a very wide net. The top hits look good, but the precision is not great for many of the lower-scoring hits, especially those products that have "**elastic**" in the name but not "**stack**". Change the `operator` of your previous `match` query to `and`, then run it again. Notice this increases the precision, as there are now only 70 hits:

```
"hits": {
    "total": 70,
```

Show answer

7. Run a query that answers the question: *"Which blogs have **performance** or **optimizations** or **improvements** in the **content** field?"* You should get the following hits:

```
"hits": {
    "total": 374,
```

Show answer

8. **OPTIONAL**: Run a query that answers the question: *"Which blogs have a **content** field that includes **at least 2** of the terms **performance** or **optimizations** or **improvements**?"* You should get the following hits this time:

```
"hits": {
    "total": 82,
```

Show answer

9. **OPTIONAL**: Let's analyze the hits from the "**performance optimizations improvements**" search:
    - What was the maximum `_score` ?

    Show answer

- If you were searching for "**performance optimizations improvements**" to do some fine tuning in your deployment, do you see any issues with some of the results from the group of documents with the highest score?

  Show answer

Summary: In this lab, you became familiar with the Query DSL. You wrote various queries that searched documents in the `blogs` index using the Search API and the `match` query.

End of Lab 2.1

Lab 2.2: Full-Text Queries

Objective: In this lab, you will deepen your Query DSL knowledge. You will write various queries that search documents in the `blogs` index using queries like `match`, `match_phrase`, and `multi-match`.

1. Write a query for each of the following searches:

   - blogs that have the word "**search**" in their `content` field.

     Show answer

   - blogs that have "**search**" *or* "**analytics**" in their `content` field.

     Show answer

- blogs that have "**search**" *and* "**analytics**" in their `content` field.

Show answer

2. Run a `match_phrase` search for "**search analytics**" in the `content` field that returns the top 3 hits. You should get 6 hits total.

Show answer

3. The phrase "**search and analytics**" is fairly common in the blog content. Update the previous `match_phrase` query so that it allows for 1 term (any word - not just "**and**") to appear between "**search**" and "**analytics**". How many hits do you see now?

Show answer

4. Run a query on the `blogs` index for "**open source**" in the `content` field. Then run a second query for "**open source**" on the `title` field. Compare the total hits and top hits returned from both queries. Do the top hits look relevant? Which query had more hits?

Show answer

5. Combine the hits of the last two searches by writing a `multi_match` query that searches both the `content` and `title` fields for "**open source**". Does the `multi_match` deliver more or fewer hits? How did this affect the relevance?

Show answer

6. **EXAM PREP**: Modify your `multi_match` query by giving the `title` field a boost of 2. How does the score of the top hit compare to the previous query without the boost?

   Show answer

7. **EXAM PREP**: Boost affects the score without impacting recall or precision. Remove the boost and modify your `multi_match` query to perform a `phrase` query, which increases precision (perhaps at the expense of recall). Did the increase in precision return more or fewer hits?

   Show answer

8. **OPTIONAL**: Let's see what happens when a user misspells their query. Run the following request, which searches for "**oven sauce**" in the `title` field. Notice `_source` is used to filter the JSON response to show only the `title` field of the document:

```
GET blogs/_search
{
  "_source": "title",
  "query": {
    "match": {
      "title": "oven sauce"
    }
  }
}
```

   Were there any hits returned?

   Show answer

9. **EXAM PREP**: Try increasing the recall (perhaps at the expense of precision) by adding the `fuzziness` parameter, permitting a maximum of 2 edits per word. Did the increased recall return more of fewer hits? How relevant are they?

   Show answer

10. **EXAM PREP**: Modify your query so that Elasticsearch uses the `auto` fuzziness level. Were more or fewer hits returned? How relevant are they?

    Show answer

Summary: In this lab, you deepened your Query DSL knowledge. You wrote various queries that searched documents in the `blogs` index using queries like `match`, `match_phrase`, and `multi-match`.

End of Lab 2.2

Lab 2.3: Combining Queries

Objective: In this lab, you will learn how to logically combine multiple query clauses to query multiple fields effectively and to manage precision and recall to refine or broaden the query scope.

1. In one of the previous labs you wrote a query that answers the question: *"Which blogs have a **content** field that includes **at least 2** of the terms **performance** or **optimizations** or*

***improvements**?"* Write a query that answers the same question, but using `bool` instead of `match`. You should get the following hits:

```
"hits": {
    "total": 82,
```

Show answer

2. **EXAM PREP**: It looks like releases usually come with performance optimizations and improvements. Assuming that you are not interested in upgrading your deployment, change the previous query (the `should` version) so that it `must_not` contain "**released**" or "**releases**" or "**release**" in the `title` field. Your top hits look better now, and notice the number of total hits dropping down to 47.

Show answer

3. **EXAM PREP**: In the previous query, let's say you are more interested in blogs about Elasticsearch. How could you rank the results so that the documents that mention "**elasticsearch**" in the `title` score higher? (*TIP: you must have two separate `should` clauses. One clause with a `minimum_should_match` will work like a `must`. The other clause will influence the score.*)

Show answer

4. **OPTIONAL**: If you are curious about what your query actually means when executed in Lucene, you can use the `_validate` API along with the `rewrite` parameter as shown below.

```
GET blogs/_validate/query?rewrite=true
{...}
```

The validate API allows a user to validate a potentially expensive query without executing it. You can read more about it here.

- Use the header above to compare the `match` and `should` versions of the first step in this lab (copied below). Are they the same query?

```
GET blogs/_search
{
  "query": {
    "match": {
      "content": {
        "query" : "performance optimizations improv
        "minimum_should_match" : 2
      }
    }
  }
}
```

```
GET blogs/_search
{
  "query": {
    "bool": {
      "should": [
        {
          "match": {
            "content": "performance"
```

```
        }
      },
      {
        "match": {
          "content": "optimizations"
        }
      },
      {
        "match": {
          "content": "improvements"
        }
      }
    ],
    "minimum_should_match": 2
  }
 }
}
```

Show answer

Summary: In this lab, you learned how to logically combine multiple query clauses to query multiple fields effectively and to manage precision and recall to refine or broaden the query scope.

End of Lab 2.3

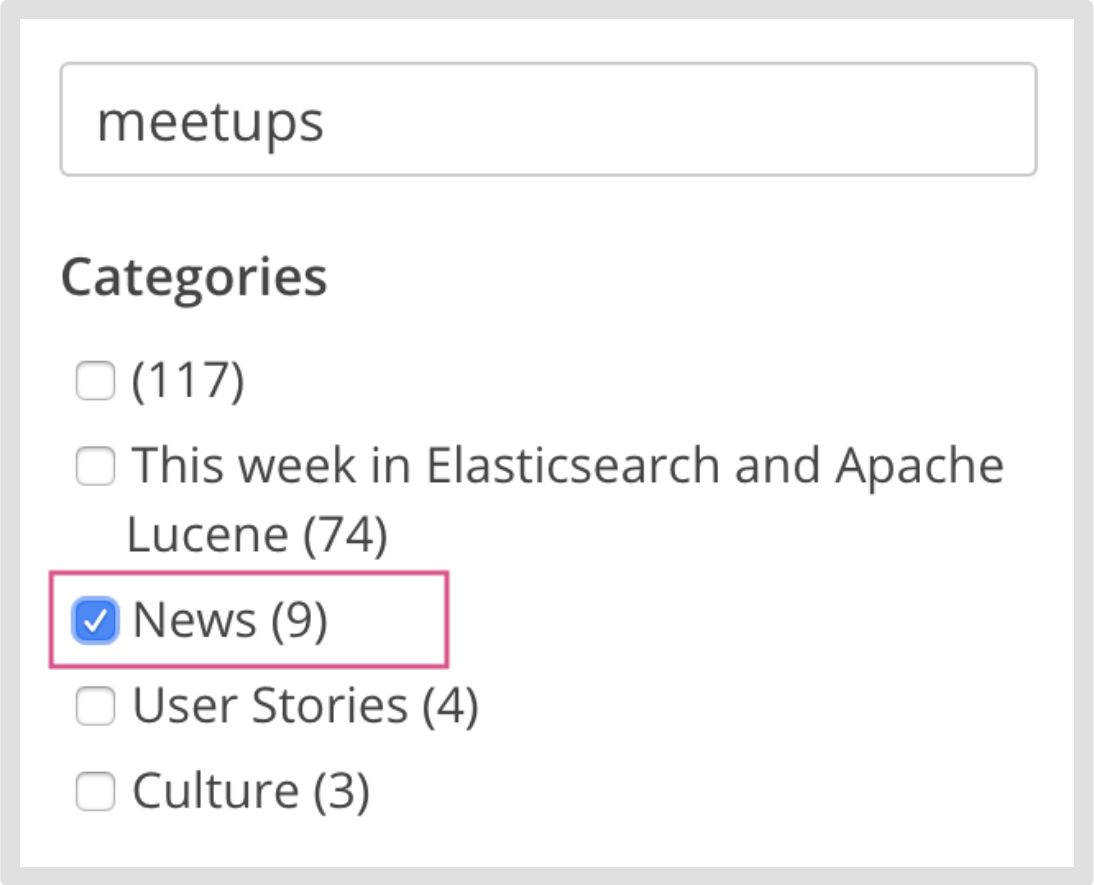
Lab 2.4: Implementing a Search Page

Objective: In this lab, you will learn how to implement some features that users would expect to find in any good search application, which might enable them to explore and retrieve the documents most relevant to their needs using correct ergonomics and efficient use of system resources.

1. Imagine the blogs search page is implemented using the `multi_match` query below and that a user is searching for "**meetups**".

```
GET blogs/_search
{
  "query": {
    "bool": {
      "must": [
        {
          "multi_match": {
            "query": "meetups",
            "fields": ["title", "content"]
          }
        }
      ]
    }
  }
}
```

2. Now, imagine the user selected **News** on the left side bar. Update the query above to add the user selection. The result should be 5 documents.



Show answer

3. **EXAM PREP**: Next, imagine the user also selected **Culture** on the left side bar. Update the query above to add the new user selection. The result should be 7 documents. (*TIP: you need to implement an OR logic combined with an AND logic. Which boolean query allows you to run ORs?*)

Show answer

4. You might be thinking: *"Is this the best solution for such a common problem?"*. The answer is no. There is a better way to implement the query above. There is a set of Term Level Queries

that don't perform analysis. The **Terms Query** is a great option to implement faceting filters. The query would then look like the one below:

```
GET blogs/_search
{
  "query": {
    "bool": {
      "must": [
        {
          "multi_match": {
            "query": "meetups",
            "fields": [
              "title",
              "content"
            ]
          }
        }
      ],
      "filter": [
        {
          "terms": {
            "category.keyword": [
              "News",
              "Culture"
            ]
          }
        }
      ]
    }
```

```
    }
  }
```

5. **EXAM PREP**: Next, imagine the user adds a date to the search, so only blogs published in **2017** are returned. Update the query above to only return blogs published in **2017**. The result should be 2 documents.

   Show answer

6. Write a `match_phrase` query that searches for "**elastic stack**" in the `content` field. Sort the results so that they are returned from newest to oldest (based on the `publish_date` field).

   Show answer

7. **EXAM PREP**: Modify your previous query so that the results are sorted first by author name ascending, and then from newest to oldest.

   Show answer

8. Our web application only shows three blog hits at a time. Modify the previous query so that it only returns the top 3 hits.

   Show answer

9. **EXAM PREP**: Suppose a user clicks on page 4 of the search results from your previous query. Write a query that returns the 3 hits of page 4.

   Show answer

10. **EXAM PREP**: Modify the previous query to implement highlighting on the `content` field. It should enclose the matched search terms with a `<mark>` HTML tag.

    Show answer

Summary: You have implemented most of the search features used in our blog search web application! In this lab, you controlled the presentation of search hits using sort, pagination and highlighting, as well as filtering results by category.

End of Lab 2.4

Lab 3.1: Metrics Aggregations

Objective: In this lab, you will become familiar with writing metrics aggregations to answer some questions about the `logs_server*` indices.

1. What is the runtime of the fastest request? (**TIP:* set `size` to 0.*)

   Show answer

2. What is the runtime of the slowest request?

   Show answer

3. You can use the `stats` aggregation when you want to calculate all the main metrics (min, max, avg, and sum). Update the aggs above to use `stats` instead of `max`. What is the average runtime?

   Show answer

4. Median often is a better option than average, as a single result can significantly impact the average. Calculate the median runtime and verify if 95% of the requests take less than 500 milliseconds.

   Show answer

5. Assuming 500 milliseconds is our runtime goal, what percentage of the requests is within this time?

   Show answer

6. How many distinct URL requests were logged in the `logs_server*` indices? URL requests are indexed in the `originalUrl` field. You should get around 37,000 as the result.

   Show answer

7. **EXAM PREP**: Add a query that limits the scope of your aggregation in the previous step to only documents that contain the term "**elastic**" in the `originalUrl` field. You should get around 4,500 as the result.

   Show answer

Summary: In this lab, you became familiar with writing metrics aggregations to answer some questions.

End of Lab 3.1

Lab 3.2: Bucket Aggregations

Objective: In this lab, you will become familiar with writing bucket aggregations to answer some questions.

1. How many requests are there for each of the 6 `status_code` values? (**TIP:* set size to 0.*)

   Show answer

2. **EXAM PREP**: A `terms` aggregation is sorted by `doc_count` by default. Modify your previous search so that its `terms` are sorted alphabetically.

   Show answer

3. The following query has 165 hits. Our search page has a UI that allows users to filter those hits by category, and notice that our UI shows how many hits belong to each category. Add an aggregation to the following query that returns the number of hits in each category.

```
GET blogs/_search
{
  "query": {
```

```
    "bool": {
      "must": {
        "multi_match": {
          "query": "open source",
          "fields": [
            "title^2",
            "content"
          ],
          "type": "phrase"
        }
      }
    }
  },
  "highlight": {
    "fields": {
      "title": {},
      "content": {}
    },
    "require_field_match": false,
    "pre_tags": [
      "<mark>"
    ],
    "post_tags": [
      "</mark>"
    ]
  }
}
```

Show answer

4. Write an aggregation that returns the `response_size` distribution for the logs indices with an interval of 10000.

   Show answer

5. **EXAM PREP**: Notice that some of the returned buckets have few documents. Update the aggregation to exclude the buckets that have less than 1000 documents.

   Show answer

6. How many log requests are there for each week?

   Show answer

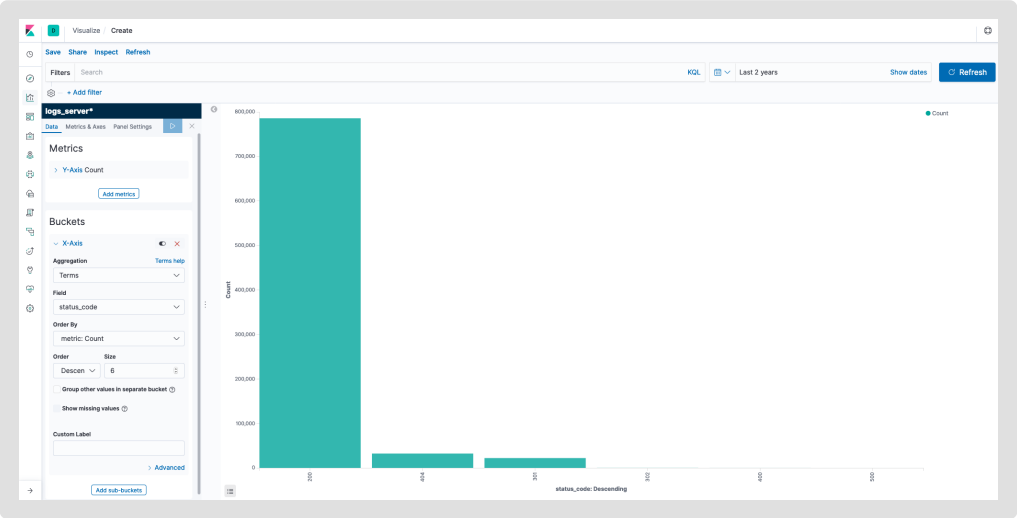
7. Modify the previous aggregation to return how many requests per minute. What happened?

   Show answer

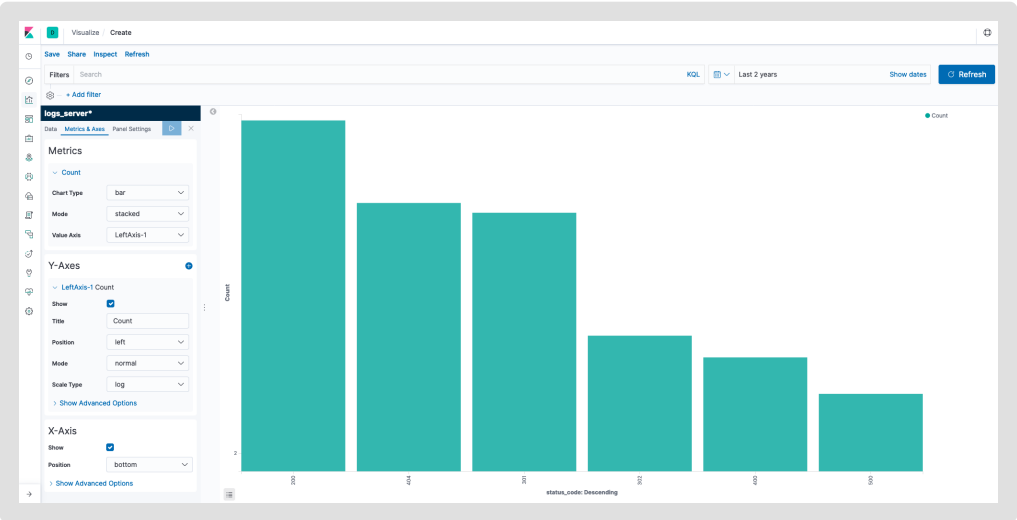
8. **OPTIONAL:** Congratulations, you have answered a lot of questions using aggregations in Elasticsearch. Now you will render an aggregation in Kibana:

   - Click on the **Visualize** icon on the left hand side bar
   - Click on **+** to create a visualization
   - Click on the **Vertical Bar** icon
   - Click on the hyperlinked index pattern `logs_server*`
   - In the **Buckets** control select Buckets type X-Axis

- In the **Aggregation** drop-down select Terms (you may have to scroll down)
- In the **Field** drop-down select `status_code`
- Set **Size** to 6
- Click on **the Apply Changes** icon and you should see the following bar chart (make sure your time range is "Last 5 years"):



- Now Click on **Metrics & Axes**
- In the Y-Axes control click on **LeftAxis-1**
- Change **Scale Type** from **linear** to **log** and click **Apply Changes** again to improve visibility of the smaller buckets:



Summary: In this lab, you became familiar with writing bucket aggregations to answer some questions.

End of Lab 3.2

Lab 3.3: Combining Aggregations

Objective: In this lab, you will become familiar with writing aggregations that combine multiple metrics and/or bucket aggregations to answer some questions.

1. How many blog requests are there for each week? (**TIP:* set `size` to 0.*)

Show answer

2. **EXAM PREP**: For each week of blog requests, how many requests were received from each of the 6 values of `status_code` ?

   Show answer

3. **EXAM PREP**: What is the median runtime for each `status_code` ? (**TIP:** This is not per week.)

   Show answer

4. **EXAM PREP**: What are the top 3 URLs accessed from each of the top 20 cities? Analyze the results closely and notice there is a common set of URLs for most cities.

   Show answer

5. Change the `terms` aggregation of the top 3 URLs to a `significant_terms` aggregation and compare the results of the two different queries. Notice how the URLs have changed to be less generic and more specific topics.

   Show answer

6. **EXAM PREP**: Write a query that searches for "**elasticsearch siem**" in the `content` field and use this scope of documents to list only the `title` field of the top three blogs of each one of the top 5 categories.

   Show answer

Summary: In this lab, you became familiar with writing aggregations that combine multiple metrics and/or bucket aggregations to answer some questions.

End of Lab 3.3

Lab 4.1: What is a Mapping?

Objective: In this lab, you will become familiar with how to read an index mapping and how to define your own mappings.

1. Let's start this lab by analyzing the dynamic mapping behavior. Index the following sample document into a temporary index named `tmp_index` :

```
PUT tmp_index/_doc/1
{
  "@timestamp": "2019-07-08T03:00:00.000Z",
  "ip" : "105.32.126.44",
  "bytes" : 8261,
  "coordinates" : {
    "lat" : 30.42769722,
    "lon" : -87.70082
  }
}
```

2. View the mappings of `tmp_index` that were dynamically created.

Show answer

3. The `@timestamp` field was mapped as type `date`, `bytes` as type `long`, `coordinates` as an `object` with two properties `lat` and `lon` of type `float`, and finally `ip` was mapped as type `text` (which will be discussed in the next lesson).

   Which of the fields' mappings could be improved?

   Show answer

4. To illustrate why the mapping of the `ip` field needs to be improved, execute the following query to find documents with an IP within the `105.32.0.0/16` range:

```
GET tmp_index/_search
{
  "query": {
    "term": {
      "ip": "105.32.0.0/16"
    }
  }
}
```

   Even though the IP in our document falls within this range, the document is not a match. This is because it has been mapped as type `text` instead of `ip`. Let's improve the mapping!

5. **EXAM PREP**: Create a new index `my_logs` with the `ip` field mapped explicitly as type `ip`.

   Show answer

6. Index the following document with the same IP as before into `my_logs` :

```
POST my_logs/_doc
{
  "ip" : "105.32.126.44"
}
```

7. Execute the query again, now against the new index. The document should now be returned as a hit:

```
GET my_logs/_search
{
  "query": {
    "term": {
      "ip": "105.32.0.0/16"
    }
  }
}
```

8. Let's also fix the `location` field. To see why, execute the following `geo_distance` query on the `tmp_index` index.

```
GET tmp_index/_search
{
  "query": {
    "geo_distance": {
      "distance": "200km",
      "coordinates": {
```

```
        "lat": 30,
        "lon": -87
      }
    }
  }
}
```

What is the result?

Show answer

9. Add a new field `coordinates` to the mapping of the `my_logs` index, and map the field as type `geo_point` .

Show answer

10. Now that the `ip` and `coordinates` fields have been fixed, let's index the same document to `my_logs` .

```
PUT my_logs/_doc/1
{
  "@timestamp": "2019-07-08T03:00:00.000Z",
  "ip" : "105.32.126.44",
  "bytes" : 8261,
  "coordinates" : {
    "lat" : 30.42769722,
    "lon" : -87.70082
  }
}
```

11. To validate that the `coordinates` field is now mapped correctly, run the previous `geo_distance` query again, but now against the new index:

```
GET my_logs/_search
{
  "query": {
    "geo_distance": {
      "distance": "200km",
      "coordinates": {
        "lat": 30,
        "lon": -87
      }
    }
  }
}
```

The document should now be returned as a hit.

Summary: In this lab, you became familiar with how to read an index mapping and how to define your own mappings.

End of Lab 4.1

Lab 4.2: Text and Keyword Strings

Objective: In this lab you will take a close look at how strings are mapped dynamically and learn how different analyzers work.

1. Let's start this lab by indexing this sample document into the temporary index `tmp_index` :

```
PUT tmp_index/_doc/2
{
    "country_name": "United Kingdom"
}
```

2. How has this field been dynamically mapped by Elasticsearch?

Show answer

3. To see the different behavior of the `text` and `keyword` fields, try to query both the `country_name` and the `country_name.keyword` field for the search term `kingdom` . Which of the two queries do you expect to return a hit?

```
GET tmp_index/_search
{
  "query": {
    "match": {
      "country_name": "kingdom"
    }
  }
}

GET tmp_index/_search
```

```
{
  "query": {
    "match": {
      "country_name.keyword": "kingdom"
    }
  }
}
```

Show answer

4. How would you have to rewrite the query so it returns the sample document you indexed earlier?

Show answer

5. To help you understand how text analysis works, Elasticsearch provides an `_analyze` API. For example, to see what would happen to the string `"United Kingdom"` if you applied the `standard` analyzer, you can use:

```
GET _analyze
{
  "text": "United Kingdom",
  "analyzer": "standard"
}
```

What two tokens are the output of the request above?

Show answer

6. Let's take a closer look at analyzers. Compare the output of the `_analyze` API on the string `"Nodes and Shards"` using the `standard` analyzer and using the `english` analyzer.

   Show answer

7. Considering the datasets that you are using in this training, what would be good fields to apply the `english` analyzer to?

   Show answer

8. **EXAM PREP**: Add a new field named `title` to the mapping of the `tmp_index` index. Map the field as type `text` , with the `english` analyzer.

   Show answer

9. Index the following document into the `tmp_index` index:

```
PUT tmp_index/_doc/3
{
  "title": "Nodes and Shards"
}
```

10. Validate that you can indeed find this document when you query the `title` field for `node` (singular):

```
GET tmp_index/_search
{
  "query": {
```

```
    "match": {
      "title": "node"
    }
  }
}
```

Summary: In this lab you learned how to work with `text` and `keyword` fields and took a closer look at the behavior of the `english` analyzer.

End of Lab 4.2

Lab 4.3: The Inverted Index and Doc Values

Objective: In this lab you are going to take a closer look at the inverted index and doc values.

1. In the previous lab you indexed a document with the value `"United Kingdom"` for the `country_name` field. Run the following `terms` aggregation on all the documents in the `tmp_index` index to find the most common values for `country_name` :

```
GET tmp_index/_search
{
  "size": 0,
  "aggs": {
    "top_countries": {
      "terms": {
        "field": "country_name",
        "size": 10
      }
    }
  }
}
```

What is the result?

Show answer

2. Add two new fields `region_name` and `city_name` to the mapping of the `tmp_index` index. Map both as type `keyword`. Disable the inverted index for `region_name`. Disable doc values for `city_name`.

Show answer

3. Index the following sample document:

```
POST tmp_index/_doc/4
{
  "region_name": "Hertfordshire",
```

```
  "city_name": "Hatfield"
}
```

4. Out of the following two operations, which one do you expect to fail? Why?

```
GET tmp_index/_search
{
  "query": {
    "match": {
      "region_name": "Hertfordshire"
    }
  }
}

GET tmp_index/_search
{
  "size": 0,
  "aggs": {
    "top_regions": {
      "terms": {
        "field": "region_name"
      }
    }
  }
}
```

Show answer

5. Try the same for the `city_name` field. Which one will fail now?

```
GET tmp_index/_search
{
  "query": {
    "match": {
      "city_name": "Hatfield"
    }
  }
}

GET tmp_index/_search
{
  "size": 0,
  "aggs": {
    "top_regions": {
      "terms": {
        "field": "city_name"
      }
    }
  }
}
```

Show answer

6. Let's take a close look at the logs in the `logs_server*` indexes, and see how you could optimize the way those documents are indexed. Here is a sample document:

```
{
  "@timestamp" : "2017-05-25T00:30:26.806Z",
  "user_agent" : "Amazon CloudFront",
  "input" : {
    "type" : "log"
  },
  "ecs" : {
    "version" : "1.0.0"
  },
  "level" : "info",
  "response_size" : 54067,
  "log" : {
    "offset" : 40587,
    "file" : {
      "path" : "/home/elastic/datasets/elastic_blog_cur
    }
  },
  "status_code" : 200,
  "geoip" : {
    "city_name" : "Seoul",
    "country_name" : "Republic of Korea",
    "country_code2" : "KR",
    "country_code3" : "KR",
    "continent_code" : "AS",
    "region_name" : "Seoul",
    "location" : {
      "lat" : 37.5111,
      "lon" : 126.9743
    }
  },
```

```
  "http_version" : "1.1",
  "originalUrl" : "/kr/blog/introducing-machine-learnin
  "method" : "GET",
  "host" : "server1",
  "agent" : {
    "version" : "7.1.1",
    "type" : "filebeat",
    "ephemeral_id" : "8c726d99-51d6-4669-bebc-9461e1007
    "hostname" : "server1",
    "id" : "16bc0a64-d4a5-4f90-bcc8-08b76b604b55"
  },
  "runtime_ms" : 107,
  "language" : {
    "url" : "/blog/introducing-machine-learning-for-the
    "code" : "ko-kr"
  }
}
```

There is some information in these logs that you may never use in your Kibana dashboards. In other words, you will never aggregate or query on those fields. For example, the fields inside of the `log` object. These fields contain information about the log file that this entry was ingested from:

```
"log" : {
  "offset" : 40587,
  "file" : {
    "path" : "/home/elastic/datasets/elastic_blog_curat
}
```

Similarly, the `agent` object contains information about the Filebeat instance that shipped the log file:

```
"agent" : {
  "version" : "7.1.1",
  "type" : "filebeat",
  "ephemeral_id" : "8c726d99-51d6-4669-bebc-9461e100731
  "hostname" : "server1",
  "id" : "16bc0a64-d4a5-4f90-bcc8-08b76b604b55"
}
```

7. Let's assume we are never going to query or aggregate on the `log` and `agent` objects. Let's optimize Elasticsearch such that the fields inside these objects don't take up disk space for an inverted index or doc values.

   Create a new index `logs_fixed` with a mapping in which the `log` and `agent` objects have been completely disabled.

   Show answer

In the next lab you are going to continue to optimize the `logs_fixed` index and you will see how much disk space can be saved.

Summary: In this labs, you explored what happens when you disable the inverted index and doc values for a field.

End of Lab 4.3

Lab 4.4: Custom Mappings

Objective: In this lab you are going to further optimize the `logs_fixed` index by using a dynamic template. You are also going to see how some of the mapping parameters work.

1. **EXAM PREP**: Update the mappings for the `logs_fixed` index (that you created in the last lab) with a dynamic template:
   - that matches all unmapped fields with a value of JSON type `string`
   - and maps those as type `keyword`

   Show answer

2. **EXAM PREP**: With the mappings for the `logs_fixed` index in place, let's populate the index. Copy over all documents from the `logs_server1` index to the `logs_fixed` index by using the `_reindex` API:

```
POST _reindex?wait_for_completion=false
{
  "source": {
    "index": "logs_server1"
  },
  "dest": {
    "index": "logs_fixed"
  }
}
```

This will run in the background and may take a few minutes to complete.

3. Retrieve the mapping of the `logs_fixed` index. How have the string fields (like `geoip.country_name`) been dynamically mapped?

   Show answer

4. Use `GET _cat/indices?v` to get a listing of all the indexes in your cluster. Compare the `store.size` of the `logs_fixed` and `logs_server1` indexes. Which `index` takes up less disk space?

   Show answer

5. **EXAM PREP**: Let's review some of the mapping parameters, like `copy_to` and defining default null values. Create a new index named `surveys` that is going to hold some survey results. Create the index with only four fields in its mapping:

   - A field named `all_feedback` of type `text`
   - A field named `instructor_feedback` of type `text` that gets copied to the `all_feedback` field
   - A field named `labs_feedback` of type `text` that is also copied to the `all_feedback` field
   - A field named `course_rating` of type `integer` in which `null` values default to 1, and also has coercion disabled

   Show answer

6. Put the following document into `surveys`:

```
PUT surveys/_doc/1
{
  "instructor_feedback": "She was great!",
  "labs_feedback": "Labs were hard!"
}
```

7. Write a query that searches the `all_feedback` field for the term `great`. The document above should be a hit.

Show answer

8. What is the value of `course_rating` for your document in `surveys`? Write a `range` query that finds all documents with a `course_rating` greater than or equal to 1.

Show answer

9. Review the following two **PUT** commands and predict what the result is of each one. Run each **PUT** command to see if you are correct:

```
PUT surveys/_doc/2
{
  "course_rating": null
}

PUT surveys/_doc/3
{
  "course_rating": "8"
}
```

Show answer

10. It is always a good practice to cleanup your tests. Make sure to delete the indices that were created for practice in this lab.

```
DELETE surveys,tmp_index,my_logs,logs_fixed
```

Summary: In this lab you saw how you can optimize Elasticsearch for more efficient storage using dynamic templates. You also explored some of the mapping parameters like `copy_to` and `coerce`.

End of Lab 4.4

Lab 5.1: Master Nodes

Objective: In this lab, you will add a node to the cluster as well as become familiar with the cluster state and the discovery module.

1. Before you make changes to your cluster, let's start by understanding its current state. Use the Cluster State API to answer the following questions.
    - What is the cluster name?
    - How many nodes are there in the cluster?
    - Which node is the elected master node?

- How many indices are there in the cluster?

You probably know the answers to these questions because your current cluster only has 1 node and uses a lot of default settings, but these are great questions to ask about any cluster.

Show answer

2. Another way to answer some of the previous questions is to use the `_cat` API, which often returns less information per API, but it is typically easier to read. Run each of the following commands:

```
GET _cat/nodes?v
```

The `nodes` command gives you information about all the nodes in the cluster, including their roles. You can see that `node1` is a `data`, `ingest` and `master-eligible` node (**dim**) and that `node1` is the elected-master in the cluster. (Remember to use **?v** to see the header.)

3. Next, you will scale your cluster by adding another node. But first, you need to make a few changes to the `node1` configuration.

   - The `node.name` setting is currently defined in the command line when you execute Elasticsearch. Update the configuration file to have the node name set to `node1`, so you don't need to define it in the command line.

     Show answer

4. Currently, `node1` transport protocol is bound to `localhost` and, therefore, nodes cannot connect to it. Update the configuration

file to bind both transport and HTTP protocols to a site-local address.

Show answer

5. As discussed in this lesson, when you start a brand new Elasticsearch cluster for the very first time, there is a cluster bootstrapping step, which determines the set of master-eligible nodes whose votes are counted in the very first election. Even though this is a one node-only cluster, you should set the `initial_master_nodes` setting.

   Show answer

6. As discussed in this lesson, nodes should be able to discover the cluster using the seed hosts. Even though the cluster currently has a single node, there will be more soon. Update the configuration file so that `node1` discovers the cluster via `server1` or `server2` or `server3`.

   Show answer

7. Now, stop Elasticsearch on `node1` and then start it using the following command:

   ```
   ./elasticsearch-7.3.1/bin/elasticsearch
   ```

8. Notice that Kibana will fail to connect because now the HTTP protocol is not bound to `localhost` anymore:

   ```
   log   [21:06:43.707] [warning][admin][elasticsearch]
   log   [21:06:43.708] [warning][admin][elasticsearch]
   ```

9. To solve this problem, stop Kibana and start it using the following command:

```
./kibana-7.3.1-linux-x86_64/bin/kibana --elasticsearch.
```

10. Next, you need to setup and start `node2`. First, open a new terminal tab in the Virtual Environment UI and `ssh` onto `server2`:

```
ssh server2
```

11. Then, Extract Elasticsearch on `server2`:

```
tar -zxf elasticsearch-7.3.1-linux-x86_64.tar.gz
```

12. Now, configure the node with the following basic characteristics.
    - it joins `my_cluster`
    - the name of the node is `node2`
    - binds and publishes both the transport and HTTP protocols to the site-local address

    Show answer

13. Next, update the configuration file with the following discovery and cluster formation settings.
    - `node1` is the only initial master node in the cluster
    - it discovers the cluster via `server1`, `server2`, or `server3`

Show answer

14. Next, configure `node2` to use only 512 megabytes of memory. (*TIP*: make sure to set both the min and max heap size to **512m**.)

Show answer

15. Finally, start `node2`. You should see the following output:

```
[2018-11-23T19:03:54,245][INFO ][o.e.c.s.ClusterApplier
[2018-11-23T19:03:54,981][INFO ][o.e.x.s.a.TokenService
[2018-11-23T19:03:55,345][INFO ][o.e.x.s.a.TokenService
[2018-11-23T19:03:55,386][INFO ][o.e.l.LicenseService
[2018-11-23T19:03:55,442][INFO ][o.e.x.s.t.n.SecurityNe
[2018-11-23T19:03:55,442][INFO ][o.e.n.Node
```

Show answer

16. Use `_cat/nodes` to view the nodes in the cluster. You should see two nodes now:

```
ip         heap.percent ram.percent cpu load_1m load_5m
172.18.0.2           31          98  11    0.01    0.15
172.18.0.3           37          98  11    0.01    0.15
```

Show answer

17. **OPTIONAL**: Now that you started your 2-node cluster, use the following command to check the voting configuration:

```
GET /_cluster/state?filter_path=metadata.cluster_coordi
```

You should get an output similar to the one below, which shows the id of a single master-eligible node that is allowed to vote within your cluster.

```
{
  "metadata" : {
    "cluster_coordination" : {
      "last_committed_config" : [
        "OvD79L1lQme1hi060uiu7Q",
      ]
    }
  }
}
```

Why the cluster coordination has a single master-eligible node, if there are two master-eligible nodes in the cluster?

Show answer

Summary: In this lab, you started a 2-node cluster as well as became familiar with the cluster state and the discovery module. As discussed in this lesson, having a two node cluster is not a best practice and, in the next lab, you will see a better solution.

End of Lab 5.1

Lab 5.2: Node Roles

Objective: In this lab, you will familiarize yourself with node roles.

1. At the end of the previous lab, we discussed that having an even number of master-eligible nodes is not a good practice. In cases like this, adding a third node is the preferred solution. In this lab, you will configure a dedicated master-eligible node on `server3`. First, open another terminal window in the Virtual Environment UI and `ssh` onto `server3`:

```
ssh server3
```

2. Extract Elasticsearch on `server3`:

```
tar -zxf elasticsearch-7.3.1-linux-x86_64.tar.gz
```

3. **EXAM PREP**: Then, configure the node settings in the appropriate config files (either `elasticsearch.yml` or `jvm.options`) to have the following:
   - it joins `my_cluster`
   - the name of the node is `node3`
   - binds and publishes both the transport and HTTP protocols to the site-local address
   - set the min and max heap size to **512m**

   Show answer

4. **EXAM PREP**: Next, update the node settings to have the following:

- `node1` is the only initial master node in the cluster
- it discovers the cluster via `server1`, `server2`, or `server3`

Show answer

5. Update the node settings with the following to make `node3` a dedicated master-eligible node:

```
node.data: false
node.ingest: false
node.ml: false
node.master: true
```

Show answer

1. Start Elasticsearch on `server3`. You should entries similar to the following output:

```
[2018-11-23T19:13:18,009][INFO ][o.e.c.s.ClusterApplier
[2018-11-23T19:13:18,420][INFO ][o.e.x.s.a.TokenService
[2018-11-23T19:13:18,774][INFO ][o.e.x.s.a.TokenService
[2018-11-23T19:13:18,934][INFO ][o.e.l.LicenseService
[2018-11-23T19:13:19,018][INFO ][o.e.x.s.t.n.SecurityNe
[2018-11-23T19:13:19,019][INFO ][o.e.n.Node
```

Show answer

2. Verify your nodes are configured the way you want:

```
GET _cat/nodes?s=name
```

You should see an output similar to the one as follows:

```
172.18.0.2 10 98 18 0.74 0.93 0.64 dim * node1
172.18.0.3  8 98 18 0.74 0.93 0.64 dim - node2
172.18.0.4 17 98 48 0.74 0.93 0.64 m   - node3
```

The role of `node3` should be only "**m**", while the role of both `node1` and `node2` should be "**dim**".

3. Now that you have a 3-node cluster, use the following command to check the voting configuration:

```
GET /_cluster/state?filter_path=metadata.cluster_coordi
```

You should get an output similar to the one below, which shows the ids of three master-eligible nodes that are allowed to vote within your cluster (your ids will be different).

```
{
  "metadata" : {
    "cluster_coordination" : {
      "last_committed_config" : [
        "Xe6KFUYCTA6AWRpbw84qaQ",
        "OvD79L1lQme1hi06Ouiu7Q",
        "e6KF9L1lQUYbw84CTAemQl"
      ]
    }
  }
}
```

4. Check that the voting configuration is working by stopping the master node (probably `node1`) and check the terminal output in the other nodes. Among the logged lines you will see something similar to the following:

```
[2018-11-23T19:15:47,301][INFO ][o.e.d.z.ZenDiscovery
[2018-11-23T19:15:47,303][WARN ][o.e.d.z.ZenDiscovery
   {node2}{7IrQlPdBRJaA12OlrbdpZQ}{0mVQTduVQJuaQavC6PAH
   {node1}{Xe6KFUYCTA6AWRpbw84qaQ}{CKxs8gcTRoiYEiutL4BE
   {node3}{tWpzRPKfTrujh02kPpMHiA}{W4P1zuy_TauS0GGCGMq8

[2018-11-23T19:15:50,432][INFO ][o.e.c.s.MasterService
[2018-11-23T19:15:50,461][WARN ][o.e.d.z.PublishCluster
[2018-11-23T19:15:50,465][INFO ][o.e.c.s.ClusterApplier
```

   Notice the other nodes realized that the elected master left the cluster, and then elected a new master.

5. Next, imagine `node1` is not as powerful as `node2` and you don't want it to run ingest pipelines or machine learning jobs. Update its configuration file to make it a `data` and `master-eligible` only node. *(**NOTE**: don't disable all ingest nodes in your cluster. Ingest nodes are often used in the Elastic Stack ecosystem — e.g. beats and monitoring.)*

   Show answer

6. Finally, restart `node1` and verify your nodes are configured the way you want:

```
GET _cat/nodes?s=name
```

   You should see an output similar to the one as follows:

```
172.18.0.4 11 98  3 0.67 0.22 0.26 m   - node3
172.18.0.3 19 98  3 0.67 0.22 0.26 dim * node2
172.18.0.2 13 98 30 0.67 0.22 0.26 dm  - node1
```

Your master node might be different, but the role of `node2` should be only "**dim**", while the role of `node1` should be "**dm**" and `node3` should still be "**m**".

Summary: In this lab, you familiarized yourself with node roles by updating your current nodes to become dedicated nodes.

End of Lab 5.2

Lab 5.3: Understanding Shards

Objective: In this lab, you will become familiar with shard distribution. You will create new indices with a specific number of shards and replicas and analyze shard allocation along with cluster status.

1. First, use the `_cat` API to see information about the indices in the cluster.

```
GET _cat/indices?v
```

The `indices` command gives you information about the indices in the cluster. You can see the number of primary shards, replica

shards, documents and deleted documents. You can also see the size on disk for primary shards and in total (primary shards + replica shards). Finally, notice that every index has a name and a uuid.

2. Then, use the `_cat` API to see information about the shards in the cluster. How many shards does the index `logs_server2` have? And in which node are they allocated?

   Show answer

3. Now, use `_cluster/health` to check the status of your cluster, which should be green.

   Show answer

4. To better understand shard allocation, create an index named `test1` with 4 primary shards and 2 replicas.

   Show answer

5. Use the following to check the shard allocation of your `test1` index. You should see 4 **STARTED** primary shards, 4 **STARTED** replica shards and 4 **UNASSIGNED** replica shards.

   ```
   GET _cat/shards/test1?v
   ```

   For better readability, you can use the following query to see the results sorted:

   ```
   GET _cat/shards/test1?v&s=shard,prirep
   ```

6. What is the status of your cluster? Why?

   Show answer

7. Update the `test1` index to have 1 replicas and check the new shard distribution.

   Show answer

8. What is the status of your cluster?

   Show answer

9. It is a good practice to run tests on a new index and, then, cleanup the cluster as you finish the test. Therefore, delete the `test1` index, which was created in this lab.

```
DELETE test1
```

Summary: In this lab, you became familiar with shard distribution. You created new indices with a specific number of shards and replicas and analyzed shard allocation along with cluster status.

End of Lab 5.3

Lab 5.4: Distributed Operations

Objective: In this lab, you will use the `refresh_interval` setting and the `refresh` parameter to better understand how Elasticsearch refreshes.

1. The `refresh_interval` setting defines the maximum time that a document can be unavailable for search after an index operation. Create a new index named `my_refresh_test` with a refresh interval of 1 hour. (The refresh interval is very high, but we will use it for test purposes.)

   Show answer

2. Execute the following command to index three documents:

```
PUT my_refresh_test/_bulk
{ "index" : { "_id" : "1"}}
{ "level" : "test"}
{ "index" : { "_id" : "2"}}
{ "level" : "test"}
{ "index" : { "_id" : "3"}}
{ "level" : "test"}
```

3. Execute a search request on `my_refresh_test`. How many documents are returned? Why?

   Show answer

4. Send a GET request to retrieve document 1. Do you think the document will be returned? Why or why not?

   Show answer

5. There is no point in waiting 1 hour for a refresh to happen. Force a refresh and try running the search again. Will you get any hits this time?

Show answer

6. Sometimes in tests (or even in production) you want to write a document and make sure it is available as soon as possible. Regardless of the current `refresh_interval`, you can use the `refresh` parameter in an index request to control it. Index a new document that will be available for search right away, even though the refresh interval is set to 1 hour. The search result should contain 4 documents.

Show answer

7. Using `refresh=true` will likely degrade Elasticsearch performance. To make sure that documents are available as soon as the client receives the response without impacting Elasticsearch performance, use the `refresh=wait_for` option. To test it, first change the `refresh_interval` of the `my_refresh_test` index to ten seconds.

Show answer

8. Next, index a document using the `wait_for` value. What happens to the request? Why?

Show answer

```
PUT my_refresh_test/_doc/5?refresh=wait_for
{
```

```
  "level" : "test"
}
```

1. It is a good practice to run tests on a new index and, then, cleanup the cluster as you finish the test. Therefore, delete the `my_refresh_test` index, which was created in this lab.

```
DELETE my_refresh_test
```

Summary: In this lab, you have used the `refresh_interval` setting and the `refresh` parameter to better understand how Elasticsearch refreshes.

End of Lab 5.4

Lab 6.1: HTTP Response and Shard Allocation Issues

Objective: In this lab you will become familiar with some of the errors that Elasticsearch returns, and how to understand and fix some of them. Then, you will execute search requests that return partial results and hunt down the cause.

1. Let's start with a very common error. Run the following command in Console. What is the error returned? And how can you fix it?

```
PUT test1/_doc/
{
  "test": "test"
}
```

Show answer

2. Run the following command. What is the error returned? And how can you fix it?

```
GET test2/_doc/1
```

Show answer

3. Run the following command. What is the error returned? And how can you fix it?

```
GET blogs/_search
{
  "query": {
    "match": {
      "title": "open source software",
      "minimum_should_match": 2
    }
  }
}
```

Show answer

4. Run the following command. What is the error returned? And how can you fix it?

```
GET blogs/_search
{"query":{"match":{"title":{"query":"open source softwa
```

Show answer

5. Run the following commands that index two documents and run a query. What is the error returned from the query? And how can you fix it? ***NOTE: This step and some of the following steps might have slightly different results when you execute them, because Elasticsearch does not always allocate the same shards to the same nodes.***

```
PUT test2/_doc/1
{
  "date": "2017-09-10"
}

PUT test3/_doc/1
{
  "date": "September 10, 2017"
}

GET test*/_search
{
  "query": {
    "match": {
      "date": "September"
    }
```

```
  }
}
```

Show answer

6. Now, you are going to simulate the failure of primary shards to see how it looks like. So, first create an index named `test4` with 4 primaries and 0 replicas.

Show answer

7. Index the following documents inside `test4` :

```
PUT test4/_doc/1
{
  "test": "document 1"
}

PUT test4/_doc/2
{
  "test": "document 2"
}

PUT test4/_doc/3
{
  "test": "document 3"
}

PUT test4/_doc/4
{
```

```
  "test": "document 4"
}
```

8. Stop `node2` to simulate a node failure and see what's going to happen.

9. Run the following query, check the number of hits, and also check the `_shards` section. How many hits did you get? How many shards successfully executed your query?

```
GET test4/_search
{
  "query": {
    "match": {
      "test": "document"
    }
  }
}
```

Show answer

10. Investigate what is wrong. First, check how the cluster is doing by viewing the cluster health. Is everything ok? What is the problem?

Show answer

11. **EXAM PREP**: Keep digging it. Figure out which index is red and which shard is unassigned. Feel free to use the `_cluster` or `_cat` APIs.

Show answer

12. **EXAM PREP**: Now that we know which shard has the issue, use the Cluster Allocation Explain API to understand it. Can you discover what the problem is?

    Show answer

13. Analyzing the results, you can see that there are some primary shards that couldn't be allocated because the node that used to hold them left the cluster, which was the expected outcome of our simulation. Now, assume that you fixed the issue of `node2` and restart it.

    Show answer

14. Usually it is a good practice to have at least one replica shards to avoid your cluster going red when you lose one node that holds primary shards. Update the settings of `test4` index so it has 1 replica shards.

    Show answer

15. Simulate a failure on `node2` again by stopping it and also rerun the following query, check the number of hits, and check the `_shards` section. How many hits did you get? How many shards successfully executed your query?

```
GET test4/_search
{
  "query": {
    "match": {
```

```
        "test": "document"
      }
    }
  }
```

Show answer

16. Enough of failure simulation on your cluster. Restart `node2` .

    Show answer

17. Now that you have finished your tests and you will not use the created indices anymore, make sure to cleanup your cluster by deleting `test*` indices.

    Show answer

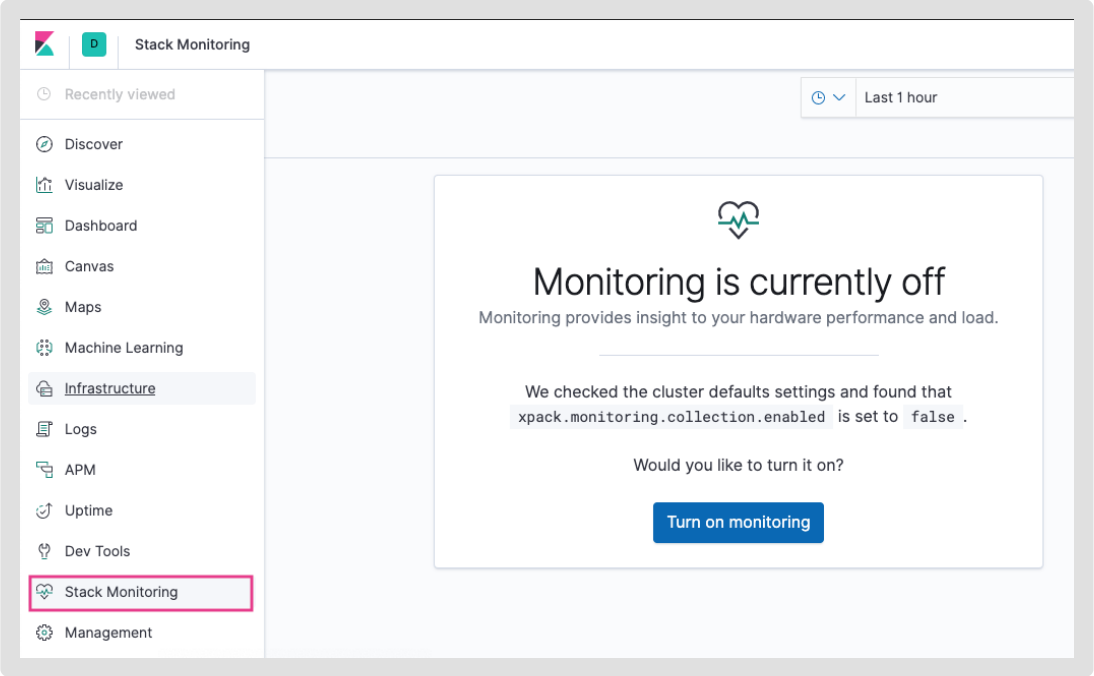
Summary: In this lab you became familiar with some of the errors that Elasticsearch returns, and how to understand and fix some of them. Then you executed search requests that returned partial results and hunted down and fixed the cause.

End of Lab 6.1

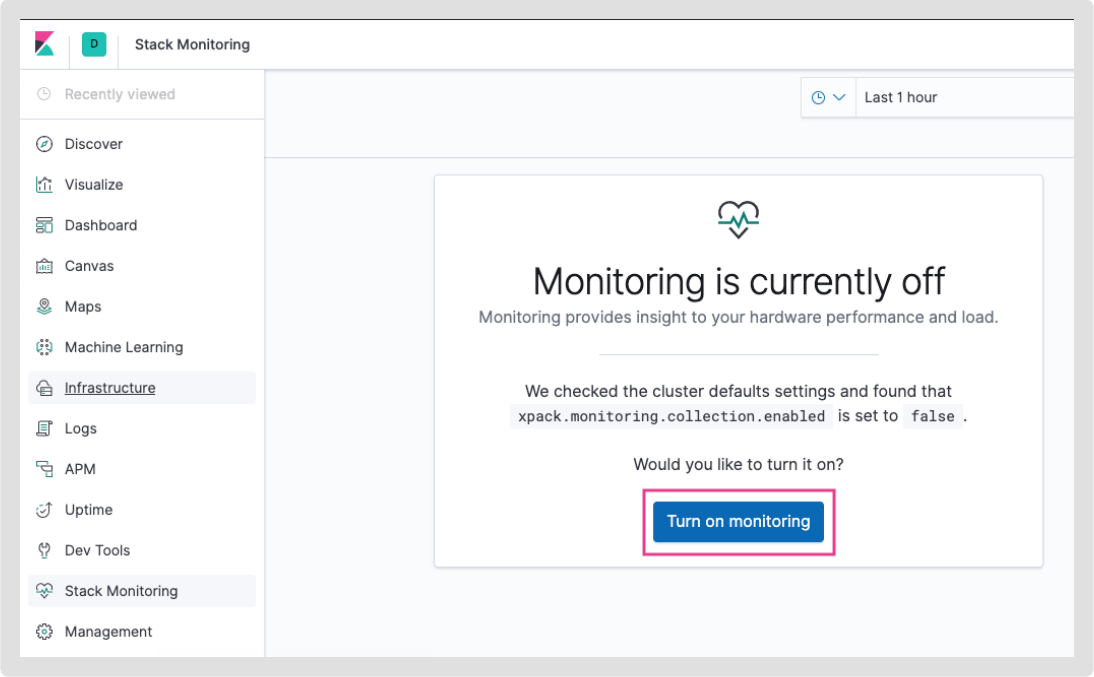
Lab 6.2: Monitoring

Objective: In this lab, you will use the Monitoring UI to monitor the health of your cluster.

1. Even though we have monitoring enabled, data collection is disabled by default. To enable it, click on the Monitoring icon in the left toolbar.



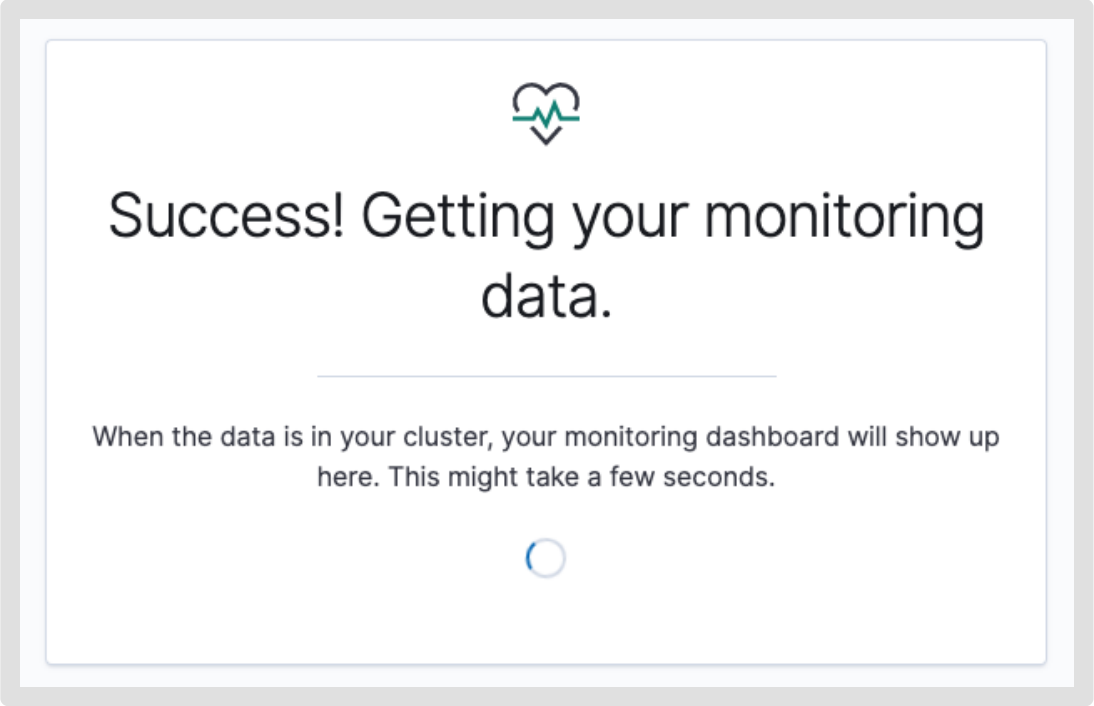
2. Then, click the button **Turn on monitoring** to enable data collection.



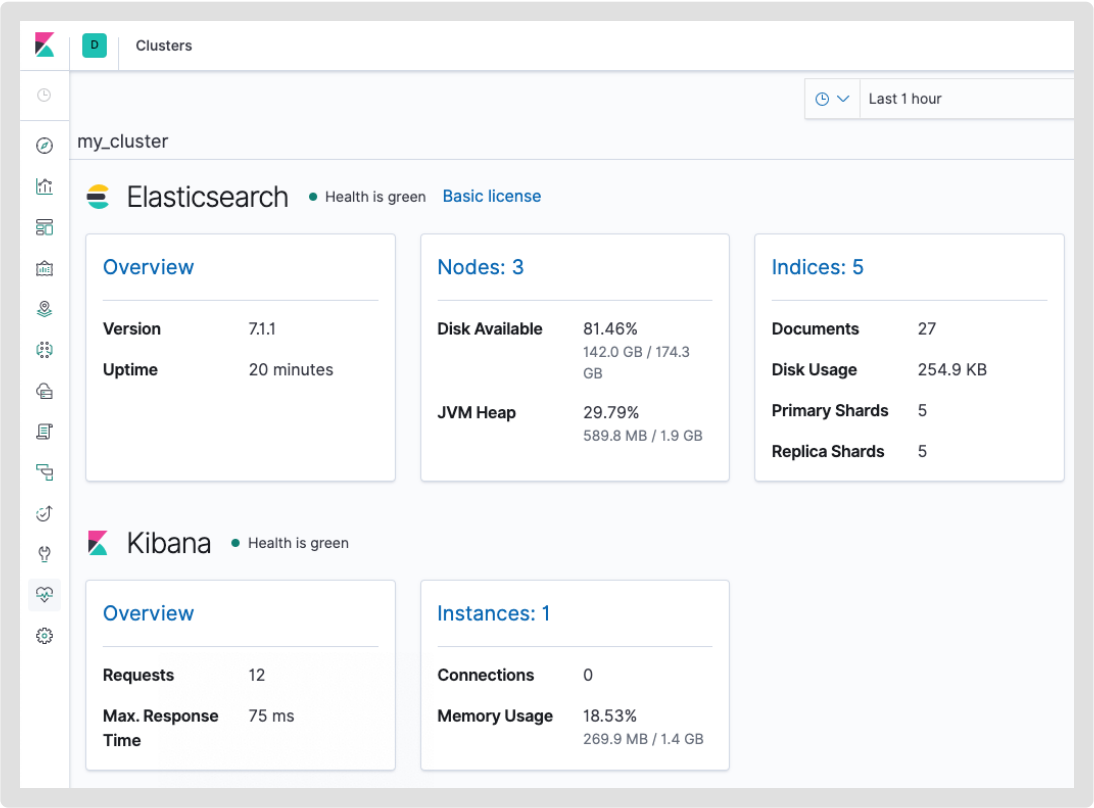
Note that we could have also used the **Cluster Update Settings API** to enable data collection:

```
PUT /_cluster/settings
{
  "persistent" : {
    "xpack.monitoring.collection.enabled" : true
  }
}
```

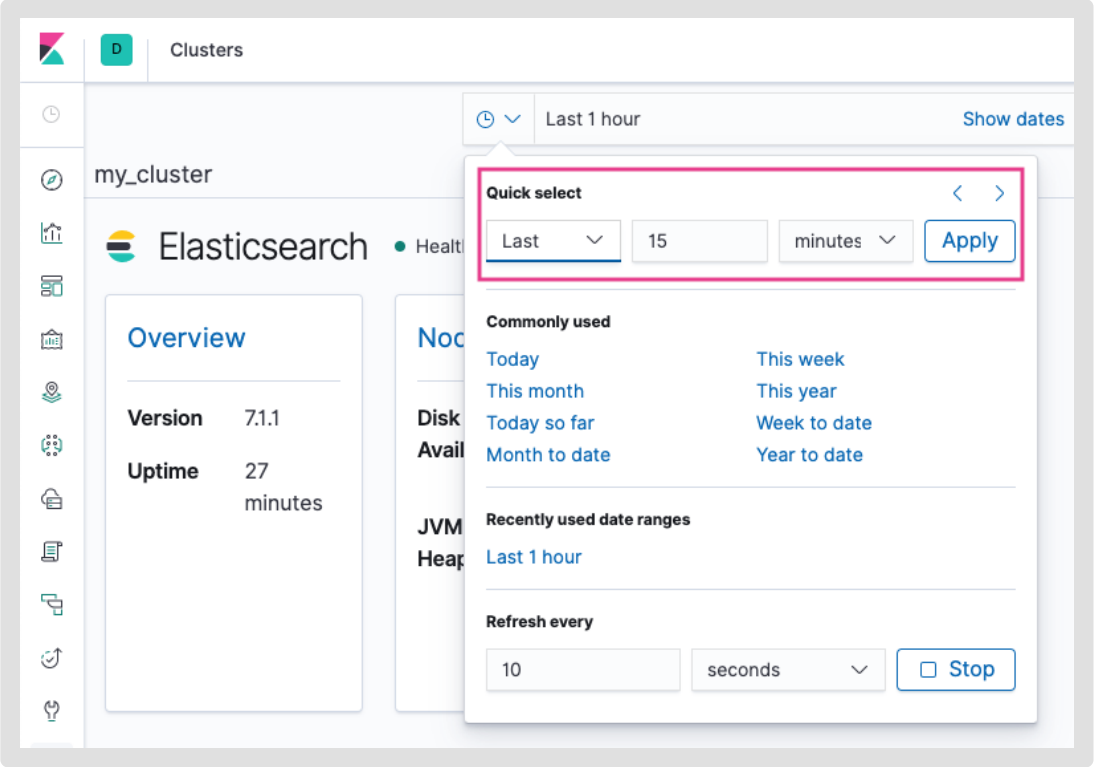
3. After enabling data collection it will take a few seconds to start monitoring and collect some data.



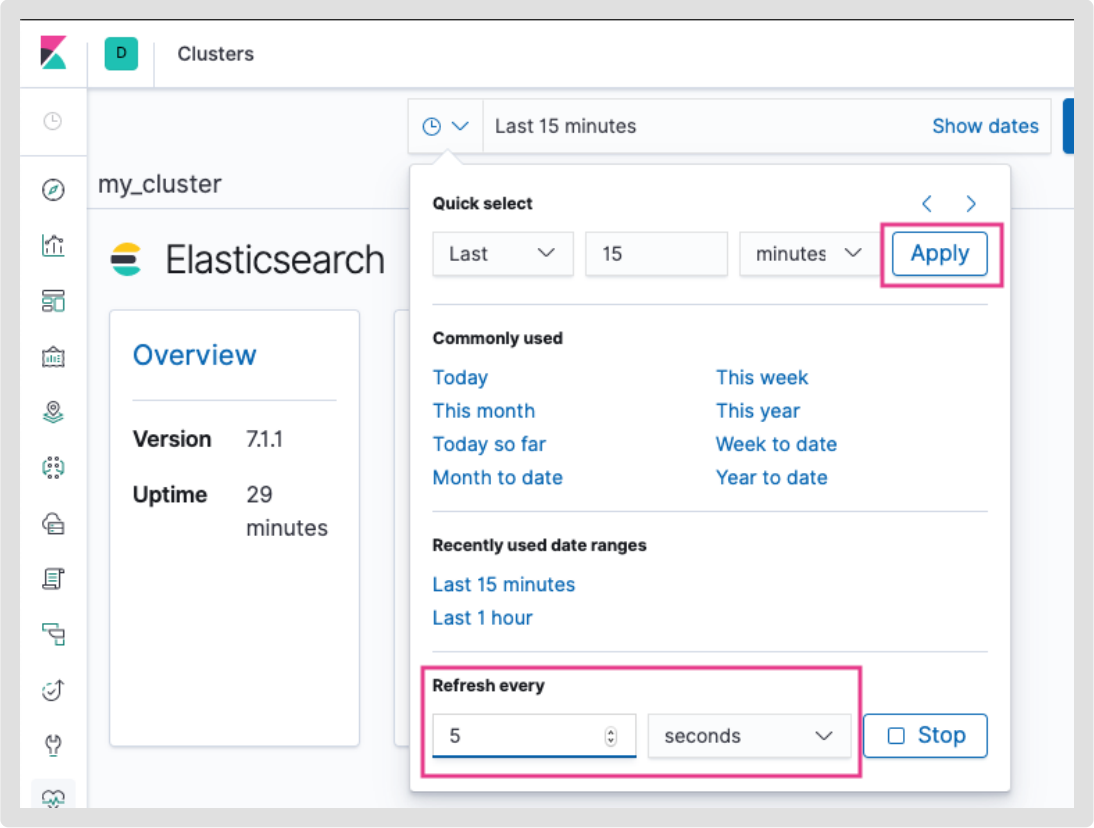
4. Finally, you will be able to view your **Clusters** dashboard.



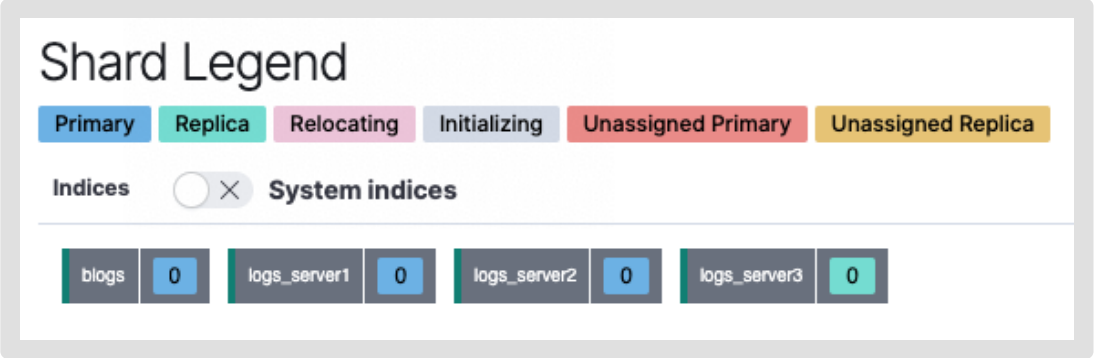
5. Change the time interval from "Last 1 hour" to "Last 15 minutes" to view only the data from the last 15 minutes. Since your cluster is just starting to collect metrics, this view will actually provide more details (until more data is collected over a longer interval).



6. Update the refresh interval to 5 seconds (instead of the current 10 second interval). You should see events come in twice as often now.

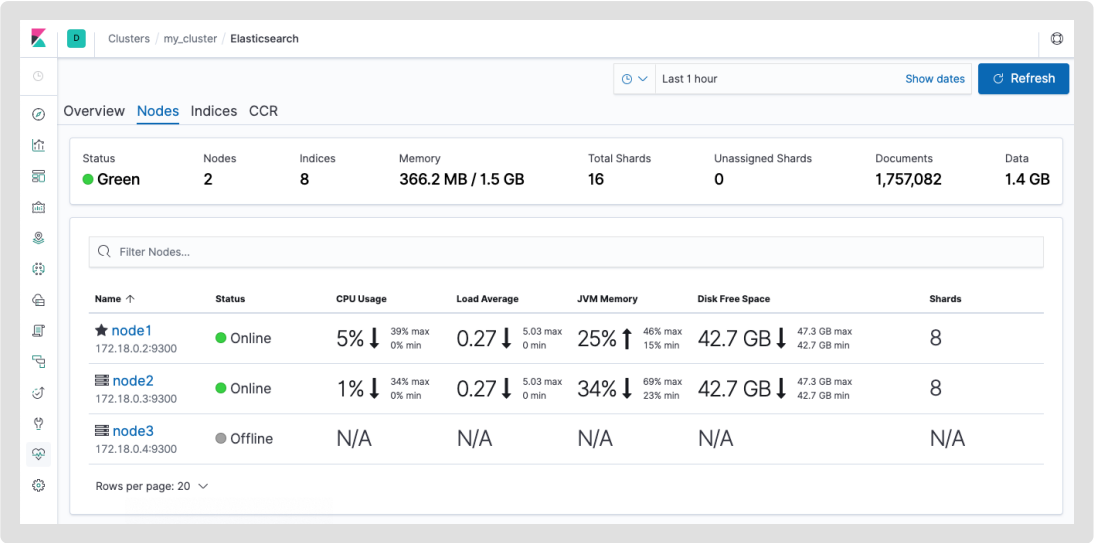


7. From the Monitoring home page, click on **Nodes**, then `node2`. Scroll down to the bottom of the page and view the **Shard Legend** section. You should see all of your indices, each with a mix of primary and replica shards, similar to:



8. Next, you will simulate a node failure in the cluster. Stop `node3`.

9. Go back to the **Nodes** page of Monitoring. Notice that the `node3` is now `offline` and all stats show up as **N/A**.



10. Startup the unavailable node.

11. Next, you will put some stress on your cluster by reindexing some data. Open Kibana Dev Tools on a new tab and execute the command below to reindex all logs data (1.7M documents) into a single index named `logs_test2` .

```
POST _reindex?wait_for_completion=false
{
  "source": {
    "index": "logs_server*"
  },
  "dest": {
    "index": "logs_test2"
  }
}
```

12. What happened to the cluster overview?

    Show answer

13. Feel free to explore the Monitoring UI and try to get a sense of the information being provided as well as how to navigate the UI. Before finishing this lab, remember that in production you probably want to have a dedicated monitoring cluster, though during this lab you enabled monitoring in the same cluster for simplicity.

Summary: In this lab, you enabled data collection to monitor the details of your cluster using the Monitoring UI.

End of Lab 6.2

Lab 6.3: Diagnosing Performance Issues

Objective: In this lab, you will explore the cat and task management APIs. You will also learn how to check for slow operations and profiling queries.

1. JSON is great for computers, but it usually is hard for human eyes. The cat API aims to meet this need, so you can use them to check several information about your cluster on a more user

friendly way. Use the `_cat` command alone to list all the available commands:

```
GET _cat
```

2. The `shards` command is one of the available commands within the cat APIs and it gives you a detailed view of each shard in the cluster. It will tell you whether it is a primary or replica, the number of the docs, the bytes it takes on disk, and the node where it is located. Run `_cat/shards` to check all this shard information about your cluster.

```
GET _cat/shards
```

3. If you are not familiar with cat APIs it might be difficult to grasp what kind information is being returned. To overcome this you can turn on verbose output and it will show you a header along with the results, which makes it easier to identify what all the information returned is about. Run `_cat/shards` again with the query string parameter `v` to turn on verbose output as follows:

```
GET _cat/shards?v
```

4. The cat APIs also allows you to define what columns you want to see in the output. You can use the query string parameter `h` to do that and if you set it to `*` you will see all the available information. Run `_cat/shards` again with verbose output on and also set it to show all available columns as follows:

```
GET _cat/shards?v&h=*
```

5. You probably noticed in the last exercise that showing all the columns might be too much information. If you are not sure what information you want to see, but still don't want to see all of them, you can use the `help` parameter to check what are the available columns. Use the `help` parameter on `_cat/shards` to see what are all the available columns.

```
GET _cat/shards?help
```

6. Suppose you want to see the columns `index`, `shard`, `prirep`, `node`, `search.query_time`, and `search.query_total`. You can run `_cat/shards` again specifying these columns through the `h` parameter as follows.

```
GET _cat/shards?v&h=index,shard,prirep,node,search.quer
```

7. You might also want to sort the output of the cat APIs to make them even easier to read. You can do that through the query string parameter `s` which sorts the table by the columns specified as the parameter value. Run `_cat/shards` again as follows and you will see the output sorted out by `index` and `search.query_time`.

```
GET _cat/shards?v&h=index,shard,prirep,node,search.quer
```

8. Now, you are going to reindex some documents to put some stress on your cluster and use the task management API to check what is going on. So, start by running the following reindex request.

```
POST _reindex?wait_for_completion=false
{
  "source": {
    "index": "logs_server*"
  },
  "dest": {
    "index": "logs_test4"
  }
}
```

9. Even though you can use `_cat/tasks` to check the information about the current tasks in your cluster, it still does not provide all the same tools that are provided by the task management API itself. For this reason, you are going to rely on the JSON back again. Use the `_tasks` command to retrieve all tasks currently running on all nodes in your cluster.

```
GET _tasks
```

10. You probably noticed that `_tasks` might return too much information. Since you know that a `reindex` is going on in your cluster, you can use the `actions` parameter to filter out the results to show only tasks related to reindex processes. Run the command below to check your reindex.

```
GET _tasks?actions=*reindex
```

11. You can also use the `detailed` request parameter to get more information about the running tasks. This is useful when you need to see what is the difference among the tasks running in your cluster, though it is more costly to execute. Run the command below and notice that the `detailed` parameter will show you a `description` about your `reindex` request, which makes a lot easier to understand what is going on.

```
GET _tasks?actions=*reindex&detailed
```

12. You can also use the task API to check information about a specific task. Use the output of the previous exercise to see what is the id of your reindex task and use it in place of `<id>` in the command below.

```
GET _tasks/<id>
```

Show answer

13. You can use the task management API to cancel long-running tasks. Run the command below to cancel your `reindex`. Remember to change `<id>` by the task id that you used in the previous exercise. *(This command will fail if the task has finished.)*

```
POST _tasks/<id>/_cancel
```

14. Now, you are going to update the shard level slow search log and run a slow aggregation query to see how they appear in the logs. Run the command below to update the slow log level to log any queries that take more than `500ms` to run.

```
PUT logs_server*/_settings
{
  "index.search.slowlog" : {
    "threshold.query" : {
      "warn" : "1s",
      "info" : "500ms",
      "debug" : "0ms"
    },
    "level" : "info"
  }
}
```

15. Run the aggregation below. After this aggregation finishes running you can check that it was logged in `elasticsearch-7.3.1/logs/my_cluster_index_search_slowlog.log` .

```
GET logs_server*/_search
{
  "size": 0,
  "aggs": {
    "top_10_countries": {
      "terms": {
        "field": "geoip.country_name.keyword",
        "size": 10
      },
```

```
      "aggs": {
        "top_5_blogs": {
          "significant_text": {
            "field": "originalUrl.keyword",
            "size": 5
          }
        }
      }
    }
  }
}
```

16. When you find a query in your slow logs, a good idea is to use the search profiler in Kibana to check why that query is slow. Use the search profiler in Kibana to check why the query from the previous exercise is slow.

    Show answer

17. Now that you have finished your tests and you will not use the created indices anymore, make sure to cleanup your cluster by deleting `log_test*` indices.

    Show answer

Summary: In this lab, you explored the cat and task management APIs. You also learned how to check for slow operations and profiling queries.

End of Lab 6.3