Powering Monitoring Analytics with ELK stack

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References

online Tutorials

- Elasticsearch Reference:
  https://www.elastic.co/guide/en/elasticsearch/reference/current/index.html
- Elasticsearch, The Definitive Guide:
  https://www.elastic.co/guide/en/elasticsearch/guide/current/index.html
- Logstash Reference:
  https://www.elastic.co/guide/en/logstash/current/index.html
- Kibana User Guide:
  https://www.elastic.co/guide/en/kibana/current/index.html

Books

- Rafal Kuc, Marek Rogozinski: Mastering Elasticsearch, Second Edition, February 27, 2015

Monitoring data

Machine-generated data

- Nagios logs
- Snort and suricata logs
- Web server and ssh logs
- Honeypots logs
- Network event logs: NetFlow, IPFIX, pcap traces

Snort log

```
[**] [1:2000537:6] ET SCAN NMAP -sS [**] [Classification: Attempted Information Leak]
[Priority: 2] 11/08-11:25:41.773271 10.2.199.239:61562 -> 180.242.137.181:5222 TCP TTL:38
TOS:0x0 ID:9963 IpLen:20 DgmLen:44 ******S* Seq: 0xF7D028A7 Ack: 0x0 Win: 0x800 TcpLen: 24
TCP Options (1) => MSS: 1160
```

Web server log

```
128.1.0.0 - - [30/Apr/1998:22:38:48] "GET /english/venues/Paris/St-Denis/ HTTP/1.1" 404 333
```

Monitoring data: properties

- Variety of data sources: flows, logs, pcap data
- Structure: structured, non structured
- Massive volume: grow at Moore's Law kinds of speeds

Who is looking into them ?

- IT administrators
- Researchers and scientists

Why ?

- Continous monitoring tasks
- Extract useful information and insights: finding meaningful events leading to new discoveries
- Looking for a needle in a haystack: forensics and Incident Handling
- Data search, aggregation, correlation
- Predictive modelling, statistical analysis, anomaly detection

Traditional tools and techniques

Storage

- Text files, binary files
- Relational databases: MySQL, PostgreSQL, MS Access
- New trends: NoSQL databases (Redis, MongoDB, HBase, ...)

```
May 31st 2015, 15:44:06.039     com.whatsapp    10.29.12.166    50048   184.173.179.38  443
May 31st 2015, 15:55:40.268     com.facebook.orca   10.29.12.166    47236   31.13.64.3    443
```

Tools and commands

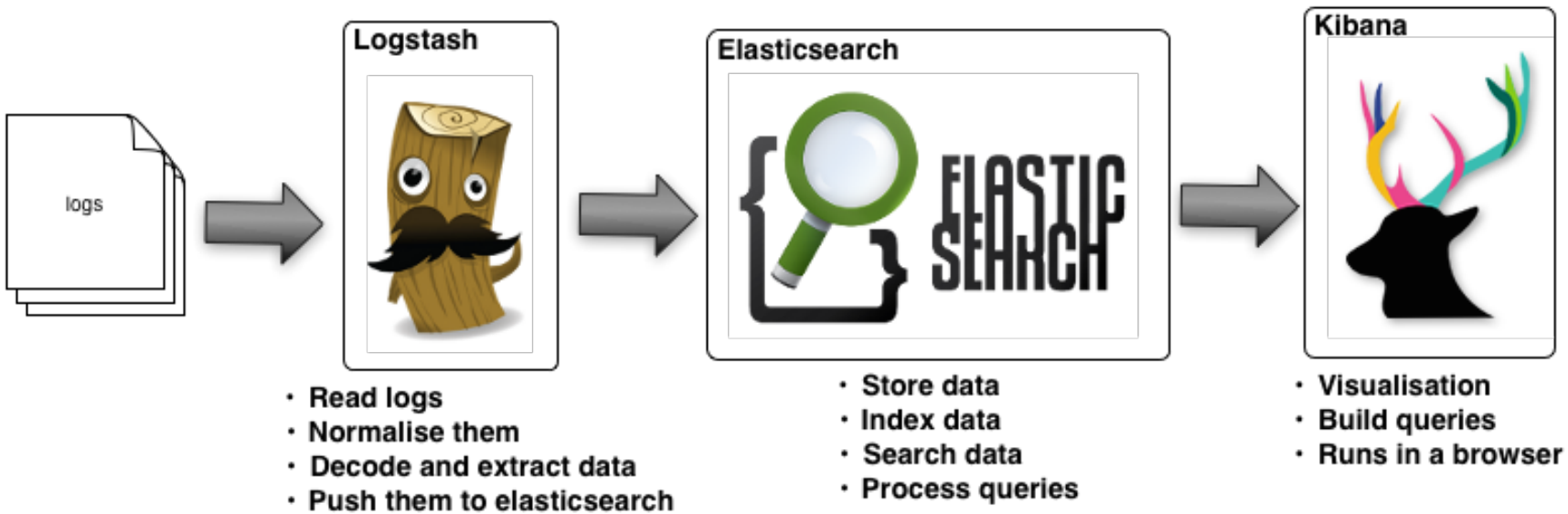
- SQL, Grep, sed, awk, cut, find, gnuplot
- Perl, Python, Shell

```
perl -p -e 's/\t/ /g' raw | cut -d ' ' -f5-
```

ELK Components

Elasticsearch Logstash Kibana

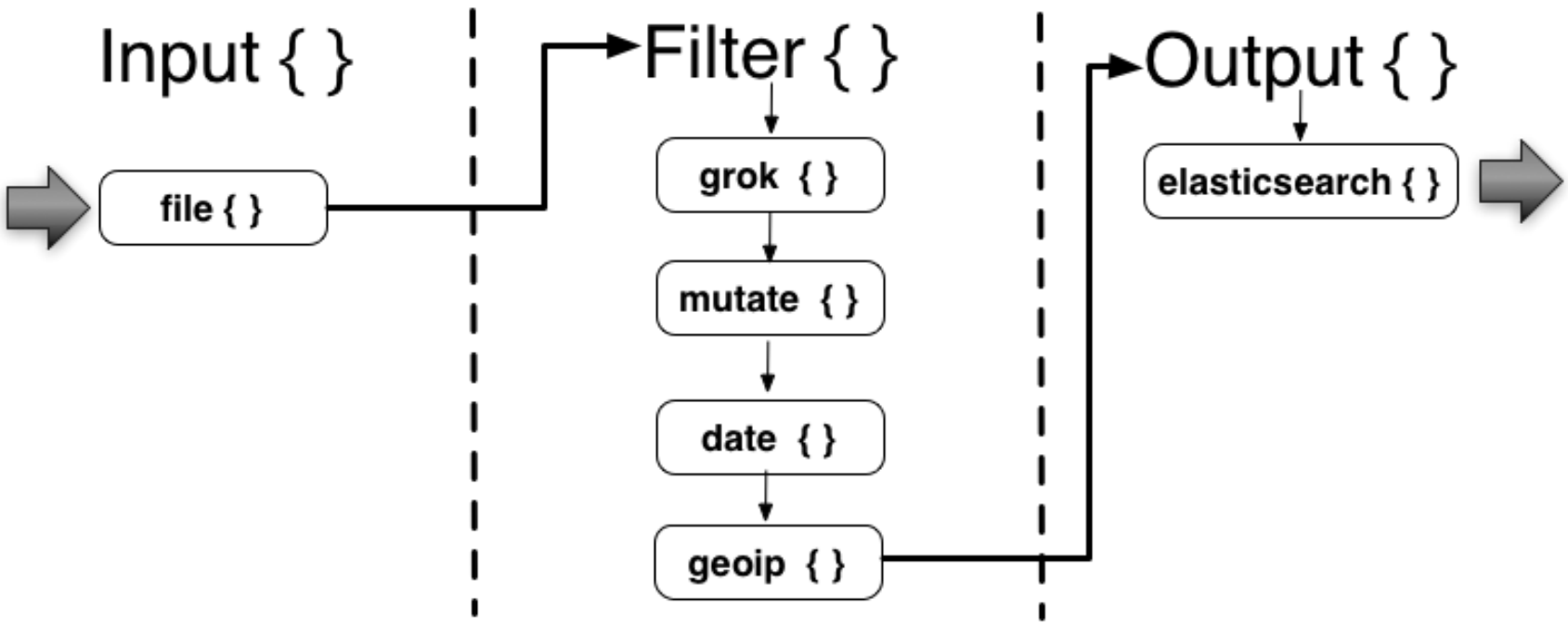
- end to end solution for logging, analytics, search and visualisation



Logstash: architecture

Event processing engine: data pipeline

- Inputs: collect data from variety of sources
- Filters: parse, process and enrich data
- Outputs: push data to a variety of destinations



Logstash: Inputs and codecs

Receive data from files, network, etc

- Network (TCP/UDP), File, syslog, stdin
- Redis, RabbitMQG, irc, Twitter, IMPA, xmpp
- syslog,ganglia, snmptrap, jmx, log4j

```
input {
  file {
    path => "/var/log/messages"
    type => "syslog"
  }

  file {
    path => "/var/log/apache/access.log"
    type => "apache"
  }
}
```

Logstash: Filters

Enrich and process the event data

- grok, date, mutate, elapsed, ruby
- dns, geoip,useragent

```
filter {
  grok {
    match => { "message" => "%{COMBINEDAPACHELOG}" }
  }
  date {
    match => [ "timestamp" , "dd/MMM/yyyy:HH:mm:ss Z" ]
  }
}
```

Logstash: Outputs

Send event data to other systems

- file, stdout, tcp
- elasticsearch, MongoDB, email
- syslog, Ganglia

```
output {
  stdout { codec => rubydebug }
  elasticsearch { host => localhost }
}
```

Elasticsearch: better than Grep!

Search engine

- Built on top of Apache Lucene: full-text-search engine library
- Schema-free
- JSON document oriented: store and REST API
- index, search, sort and filter documents

Distributed search and store

- scaling up (bigger servers) or scaling out (more servers)
- coping with failure: replication

RESTfull API

- store, fetch, alter, and delete data
- Easy backup with snapshot and restore
- No transactions nor rollback

Elasticsearch: glossary

- **Document**: main data unit used during indexing and searching, contains one or more fields
- **Field**: section of the document, a couple of name and value
- **Term**: unit of search representing a word from the text
- **Index**: named collection of documents (Like a database in a relational data base)
- **type**: a class of similar documents (like a table in in a relational data base)
- **Inverted index**: data structure that maps the terms in the index to the documents
- **Shard**: a separate Apache Lucene index. Low level "worker" unit.
- **Replica**: an exact copy of a shard

```
Relational DB => Databases => Tables => Rows      => Columns
Elasticsearch => Indices   => Types  => Documents => Fields
```

Elasticsearch: indexes and documents

Create Index

```
curl -XPUT 'localhost:9200/logs'  -d {
     "settings": {
        "number_of_shards" :   1,
        "number_of_replicas" : 0
    }
}
```

Indexing a document

```
curl -XPUT 'localhost:9200/logs/apachelogs/1'  -d {
          "clientip" => "8.0.0.0",
          "verb" => "GET",
          "request" => "/images/comp_stage2_brc_topr.gif",
          "httpversion" => "1.0",
          "response" => "200",
          "bytes" => "163"
}
```

Retrieving a document

```
curl -XGET 'localhost:9200/logs/apachelogs/1'
```

Elasticsearch: mapping

Define the schema of your documents

- elasticsearch is able to dynamically generate a mapping of fields type
- It is better to provide your own mapping: date fields as dates, numeric fields as numbers string fields as full-text or exact- value strings

Create a mapping

```
curl -XPUT 'localhost:9200/logs' {
    "mappings": {
     "apachelogs" : {
      "properties" : {
        "clientip" : {
          "type" :    "ip"
        },
        "verb" : {
          "type" :   "string"
        },
        "request" : {
          "type" :   "string"
        },
        "httpversion" : {
          "type" :   "string"
        }
        "response" : {
          "type" :   "string"
        }
```

Elasticsearch: Quering

Search Lite

```
curl -XPUT 'localhost:9200/logs/apachelogs/_search'
curl -XPUT 'localhost:9200/logs/apachelogs/_search?q=response:200'
```

Search with Query DSL: match, filter, range

```
curl -XPUT 'localhost:9200/logs/apachelogs/_search' -d {
  "query" : {
    "match" : {
      "response" : "200"
    }
  }
}
curl -XPUT 'localhost:9200/logs/apachelogs/_search' -d {
  "query" : {
    "filtered" : {
        "filter" : {
         "range" : {
        "bytes" : { "gt"  : 1024}
      }
        },
        "query" : {
      "match" : {
        "response" : "200"
      }
        }
```

Elasticsearch: Aggregation

Analyze and summarize data

- How many needles are in the haystack?
- What is the average length of the needles?
- What is the median length of the needles, broken down by manufacturer?
- How many needles were added to the haystack each month?

Buckets

- Collection of documents that meet a criterion

Metrics

- Statistics calculated on the documents in a bucket

SQL equivalent

```
SELECT COUNT(response) FROM table GROUP BY response
```

- COUNT(response) is equivalent to a metric
- GROUP BY response is equivalent to a bucket

Aggregation: buckets

- partioning document based on criteria: by hour, by most-popular terms, by age ranges, by IP ranges

```
curl -XPUT 'localhost:9200/logs/apachelogs/_search?search_type=count
    ' -d {
"aggs" : {
        "responses" : {
            "terms" : {
              "field" : "response"
            }
        }
    }
}
```

- Aggregations are placed under the top-level aggs parameter (the longer aggregations will also work if you prefer that)
- We then name the aggregation whatever we want: responses, in this example
- Finally, we define a single bucket of type terms
- Setting search_type to count avoids executing the fetch phase of the search making the request more efficient

Aggregation: metrics

- metric calculated on those documents in each bucket: min, mean, max, quantiles

```
curl -XPUT 'localhost:9200/logs/apachelogs/_search?search_type=count
    ' -d {
"aggs": {
      "responses": {
         "terms": {
            "field": "response"
         },
         "aggs": {
            "avg_bytes": {
               "avg": {
                  "field": "bytes"
               }
            }
         }
      }
   }
}
```

Aggregation: combining them

An aggregation is a combination of buckets and metrics

- Partition document by client IP (bucket)
- Then partition each client bucket by verbe (bucket)
- Then partition each verbe bucket by response (bucket)
- Finally, calculate the average bytes for each response (metric)
- **Average bytes per <client IP, verbe, response>**

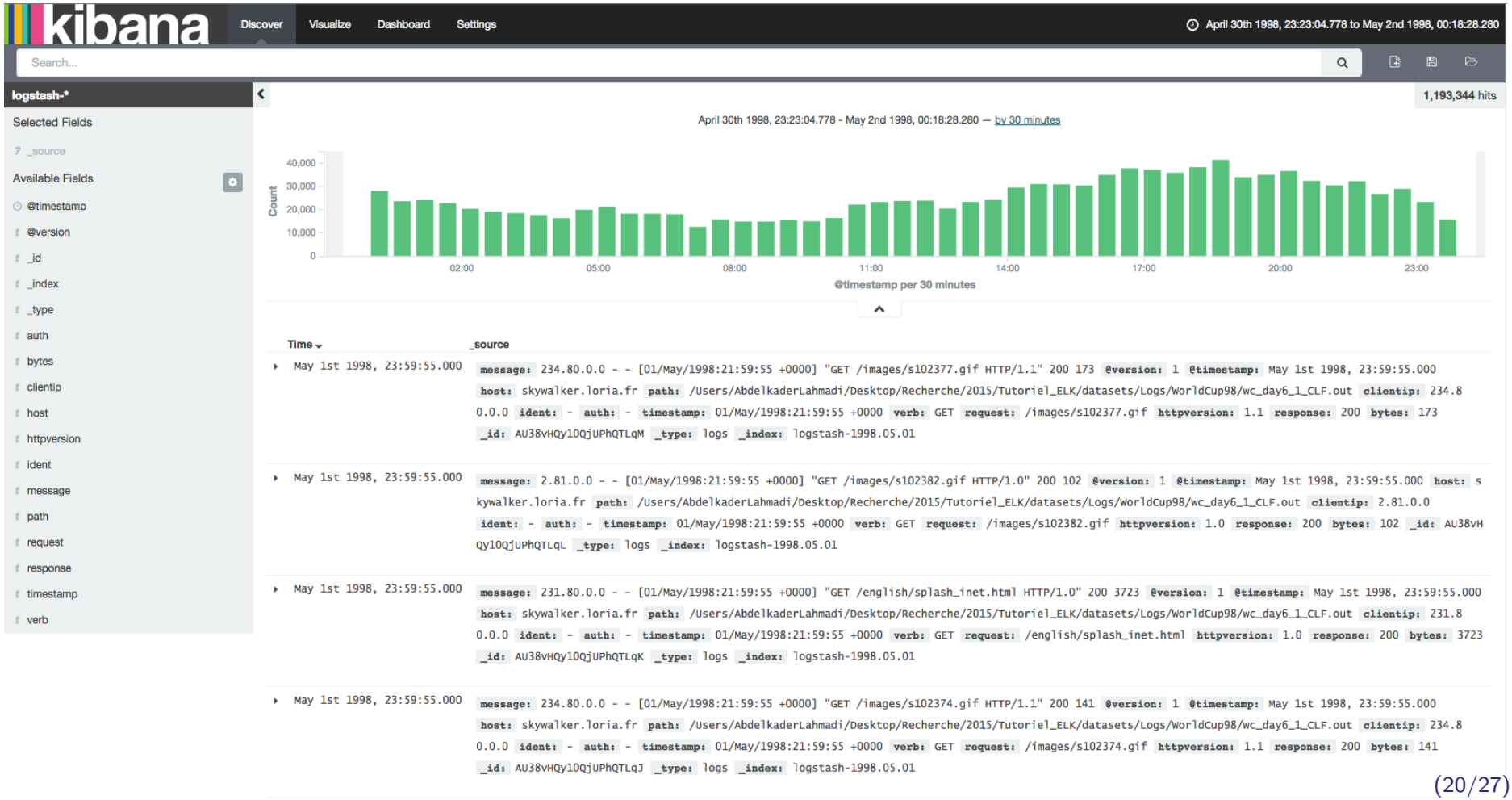
Many types are available

- terms
- range, date_range, ip_range
- histogram, date_histogram
- stats/avg, min, max, sum, percentiles

Kibana: visualisation

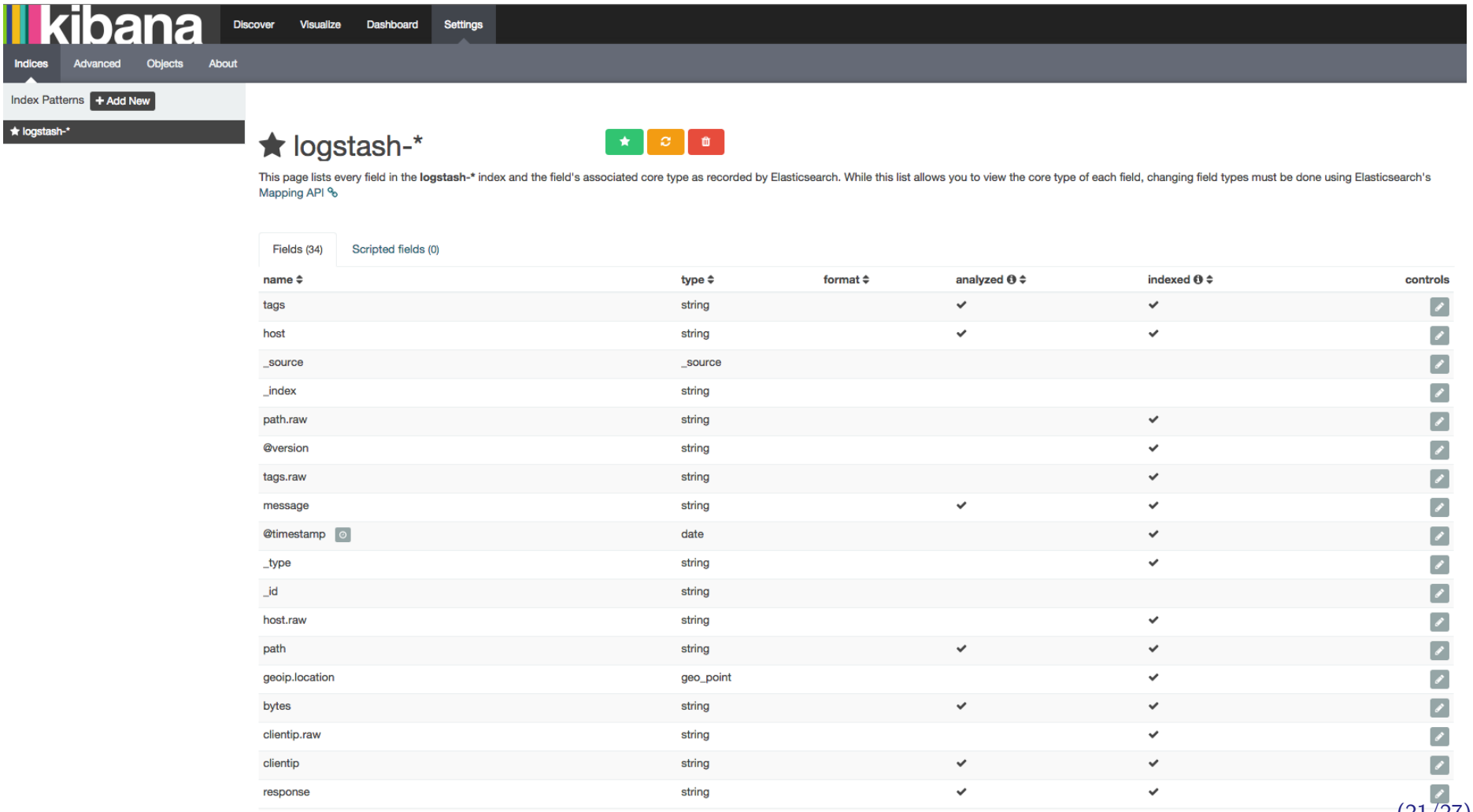
Data visualisation

- browser-based interface
- search, view, and interact with data stored in Elasticsearch indice
- charts, tables, and maps
- dashboards to display changes to Elasticsearch queries in real time



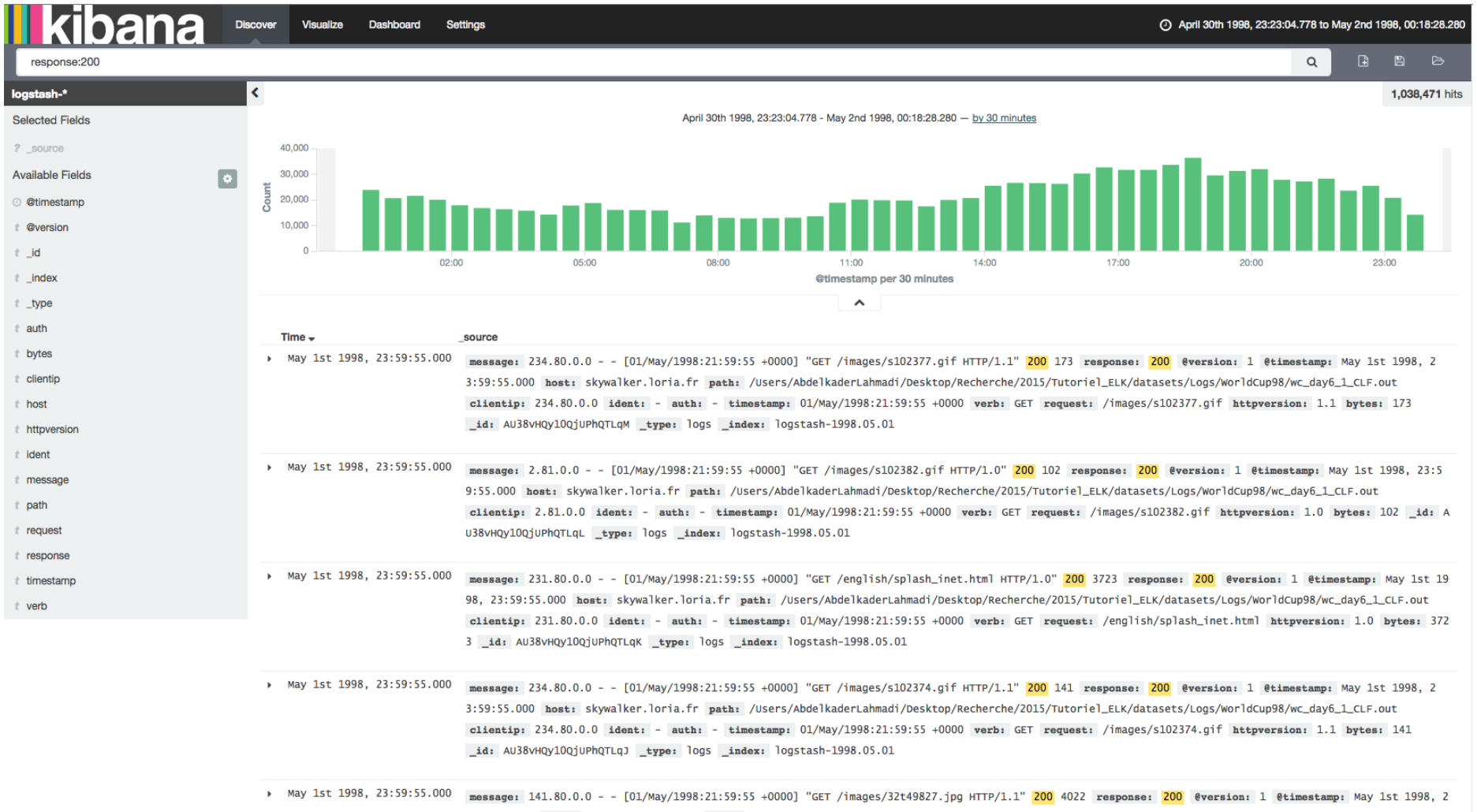
Kibana: setting your index

```
curl 'localhost:9200/_cat/indices?v'
index pri rep docs.count docs.deleted store.size pri.store.size
logstash-1998.04.30   5   1     98434     0     20.6mb         20.6mb
logstash-1998.05.01   5   1     1094910   0     205.8mb       205.8mb
```



Kibana: discover

- Explore you data with access to every document
- Submit search query, filter the search
- Save and Load searches



Kibana: search

Query language

lang:en	to just search inside a field named "lang"
lang:e?	wildcard expression
user.listed_count:[0 to 10]	range search on numeric fields
lang:ens	regular expression search (very slow)

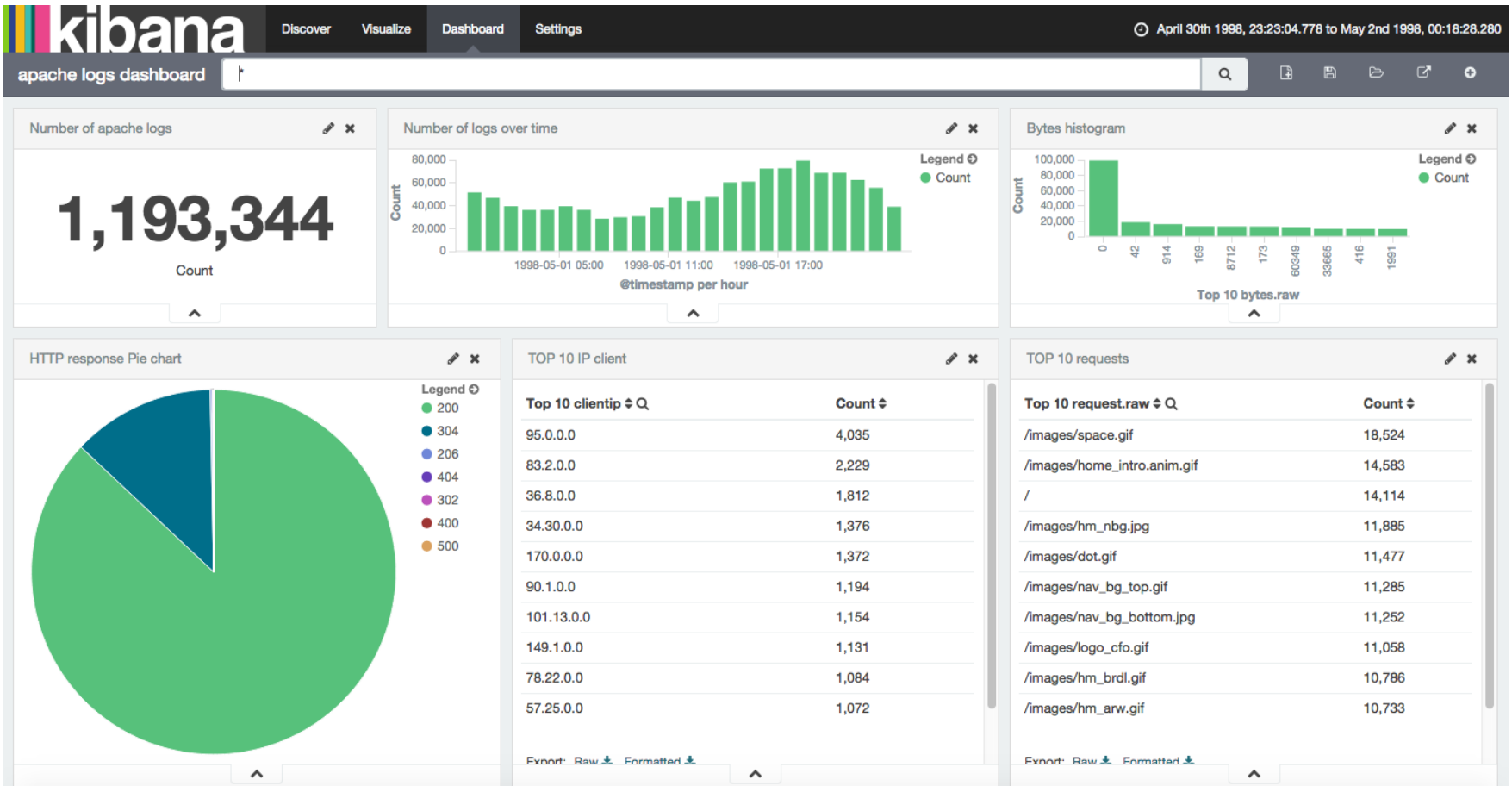
Kibana: visualize

- Area chart: Displays a line chart with filled areas below the lines. The areas can be displayed stacked, overlapped, or some other variations.
- Data table: Displays a table of aggregated data.
- Line chart: Displays aggregated data as lines.
- Markdown widget: Use the Markdown widget to display free-form information or instructions about your dashboard.
- Metric: Displays one the result of a metric aggregation without buckets as a single large number.
- Pie chart: Displays data as a pie with different slices for each bucket or as a donut (depending on your taste).
- Tile map: Displays a map for results of a geohash aggregation.
- Vertical bar chart: A chart with vertical bars for each bucket.

Kibana: dashboard

Displays a set of saved visualisations in groups

- Save, load and share dashboards



What else ?

Elasticsearch is very active and evolving project

- Watchout when using the wildcard !
- Deleting a mapping deletes the data
- Respect procedures to update mappings
- Backup is easy [1], do it!

[1] `https://github.com/taskrabbit/elasticsearch-dump`

Hands-on Lab