IR in Practice

(a.k.a. Elastic 4 IR)

https://github.com/ielab/afirm2019

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Plan of the Session

- The architecture of a typical IR system — and that of Elasticsearch
- Intro to Elasticsearch: functionalities, installation and basic interaction (Activity 0)
- IR in Practice: Hands on with Elastic Search (most in Python/some in Java). Activities:

    1. Basic Indexing and Search in Elasticsearch
    2. Boolean retrieval
    3. Produce a TREC Run
    4. Access a Term Vector
    5. Implement a New Retrieval Model
    6. Document Priors and Boosting (e.g. Link Analysis)
    7. Text Snippetting for Search Results

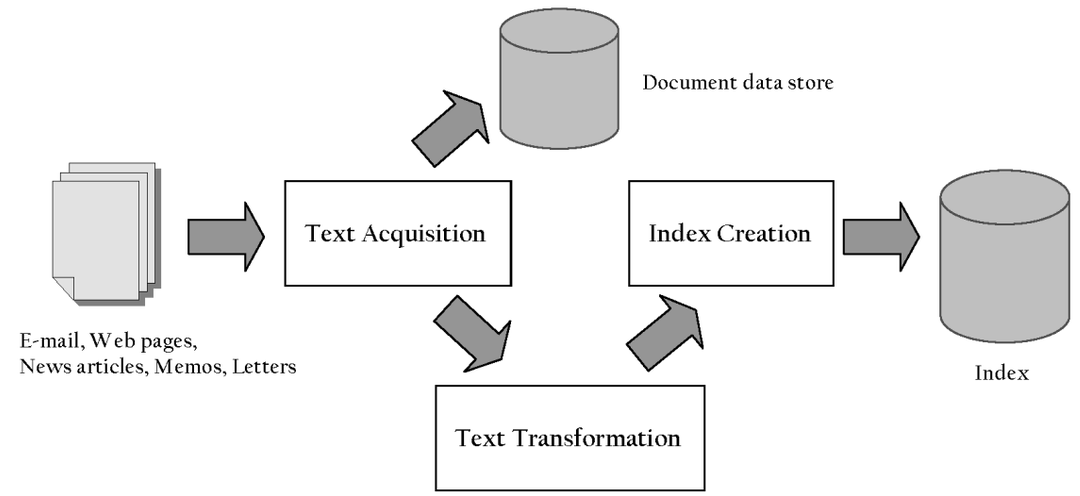
Practical activities

- Material is in GitHub: https://github.com/ielab/afirm2019
    - Including these slides, links to data, practical instructions, code
- The folder `hands-on` contains a subfolder for each of the activities
- Usually an activity has a README.md file with explanation, instructions and exercises. Most activities come with code
- Code is often in the form of a Python notebook (jupyter). One activity relies on Java code.
- When necessary, links to download data are provided

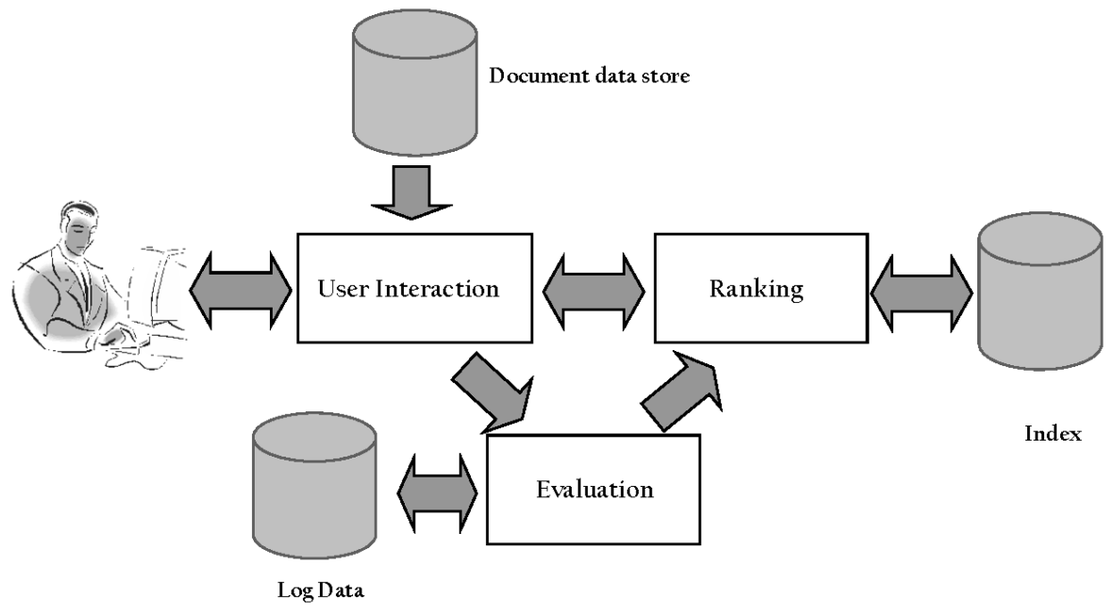
Search Engine Architecture

Basic building blocks:

- The indexing process

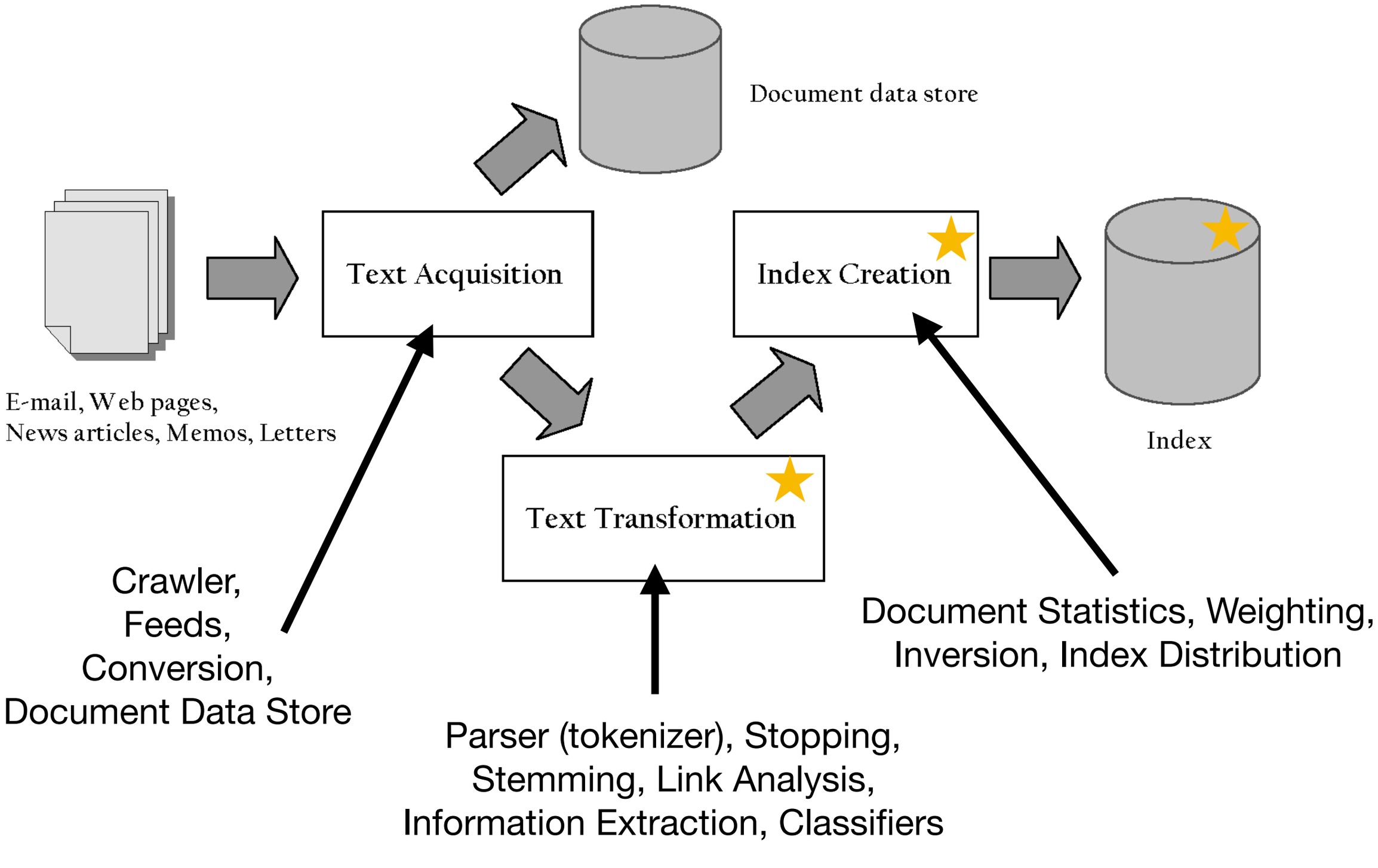


- The querying process

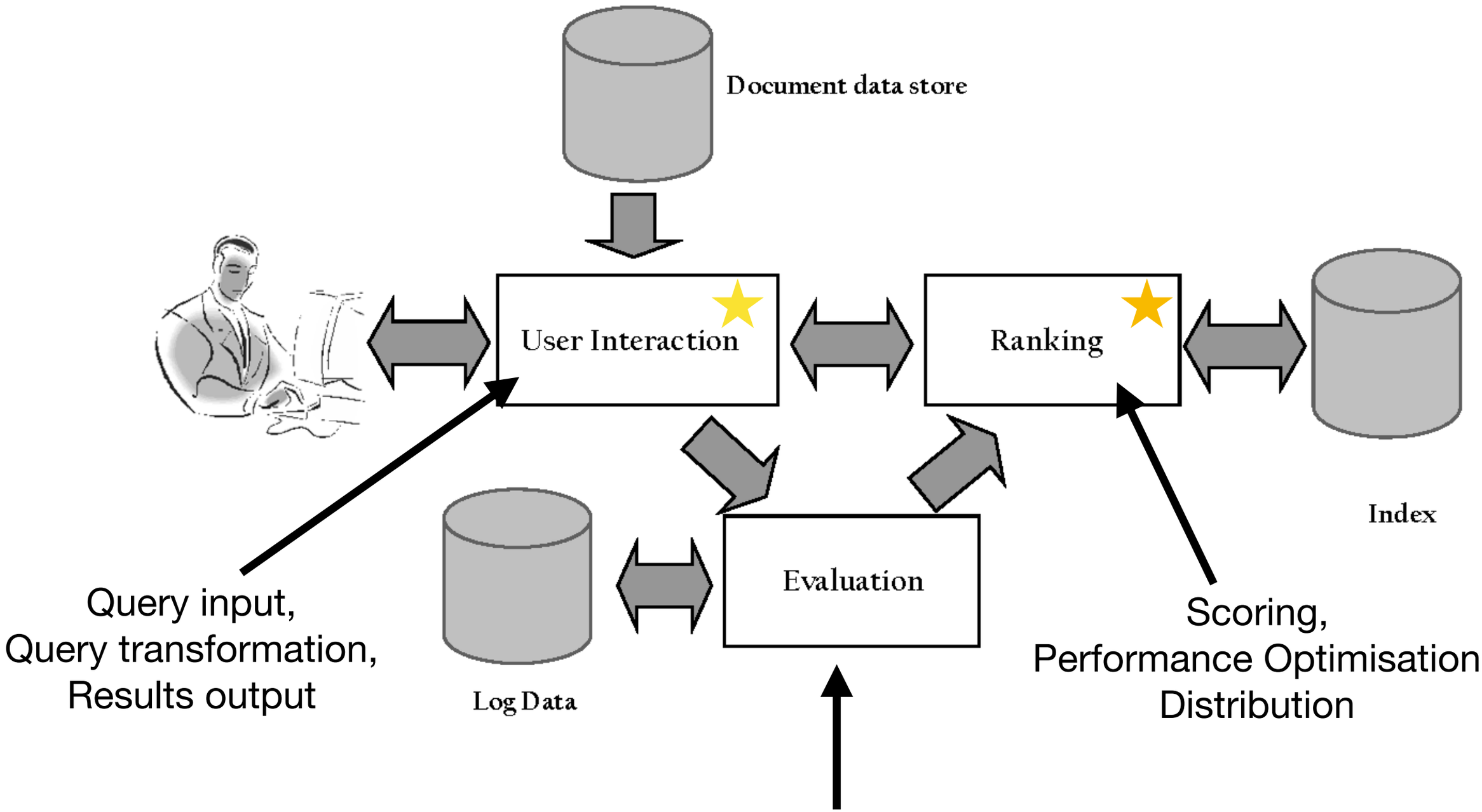


* Figures from Croft, Metzler, Strohman, “Search Engines: Information Retrieval in Practice” Free download at:

The indexing process

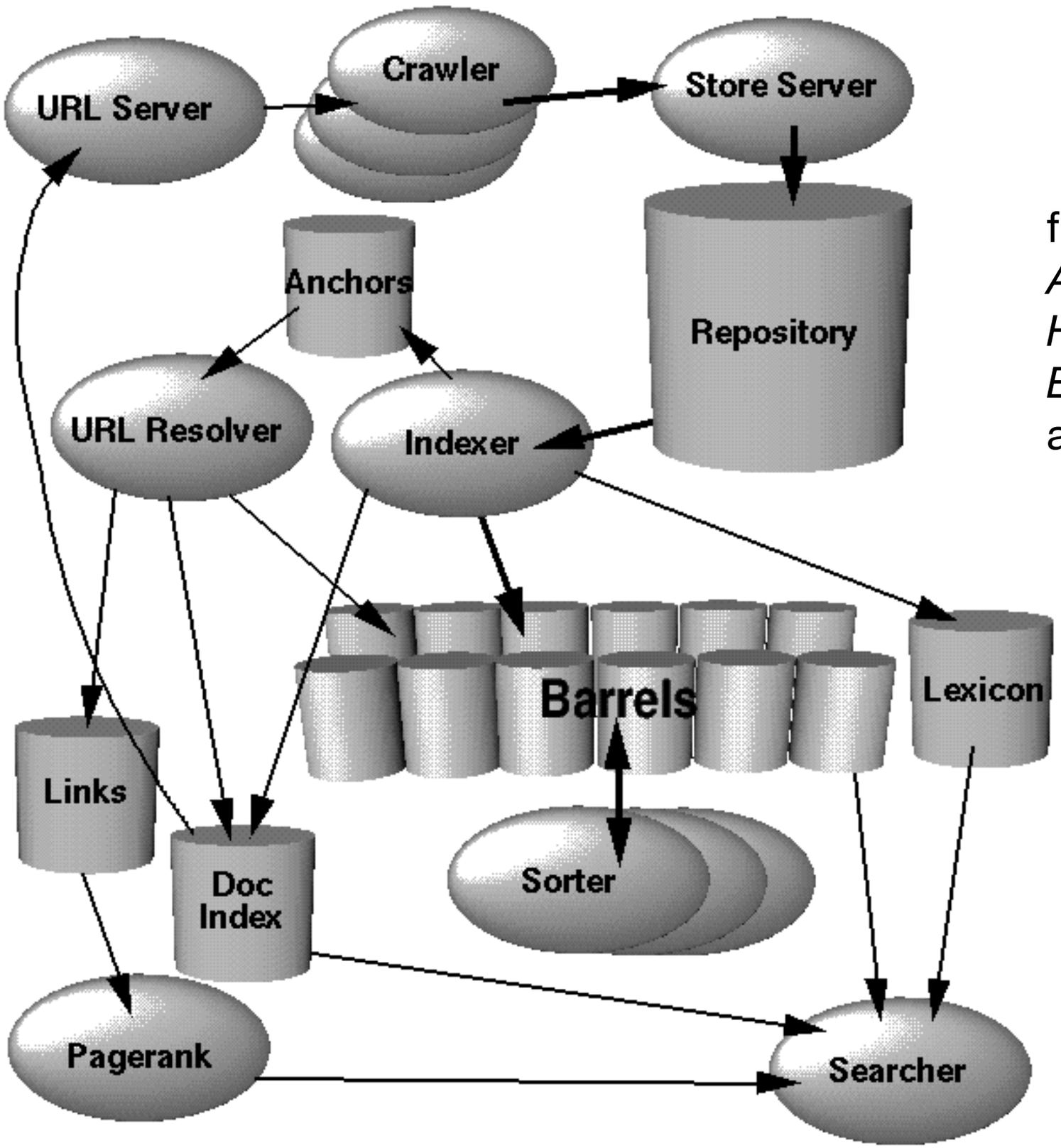


The querying process



The Architecture of Google

(in the early days)



from: S Brin, L Page, *The Anatomy of a Large-Scale Hypertextual Web Search Engine*, Computer networks and ISDN systems, 1998

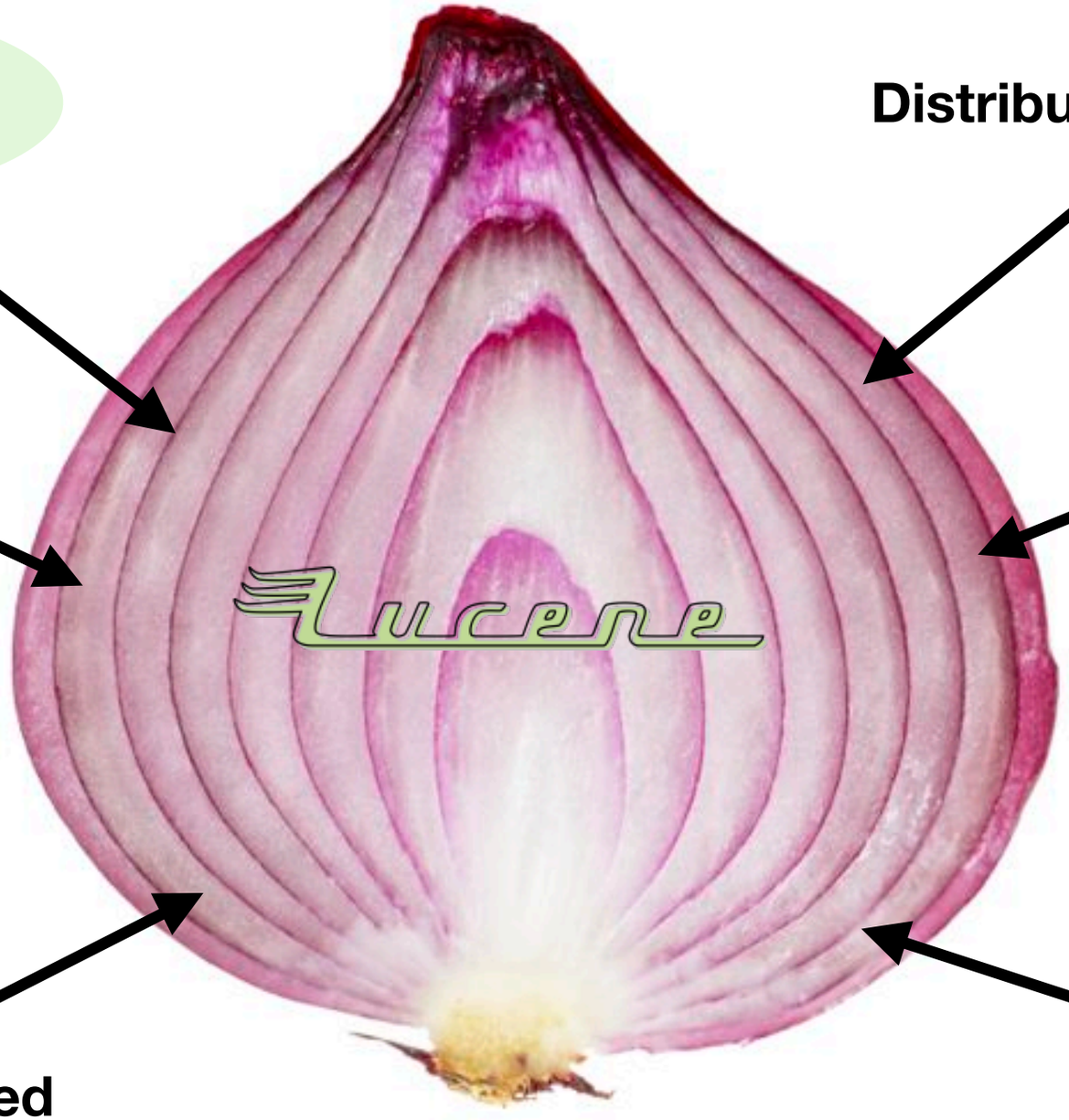
Many IR Toolkits out there

(a non-exhaustive list)

Industry Industry Industry Research

- Apache Lucene / Sorl / Elasticsearch / Anserini: http://lucene.apache.org/, http://lucene.apache.org/solr/, https://www.elastic.co/, http://anserini.io/
- Terrier: http://terrier.org/ Research
- Lemur / Indri / Galago: https://www.lemurproject.org/ (and derivatives/wrappers e.g. Pyindri) Research
- ATIRE & JASS: http://atire.org, https://codedocs.xyz/andrewtrotman/JASSv2/ Research
- Some are less popular/maintained:
  - MG4J: http://mg4j.di.unimi.it/ Research
  - Zettair: http://www.seg.rmit.edu.au/zettair/ Research
  - Etc

What is Elasticsearch?



RESTful API

Distributed indexing/querying

Large, powerful query syntax

Transaction logs

Multi-tenancy enabled

Horizontal scalable

A bit of vocabulary

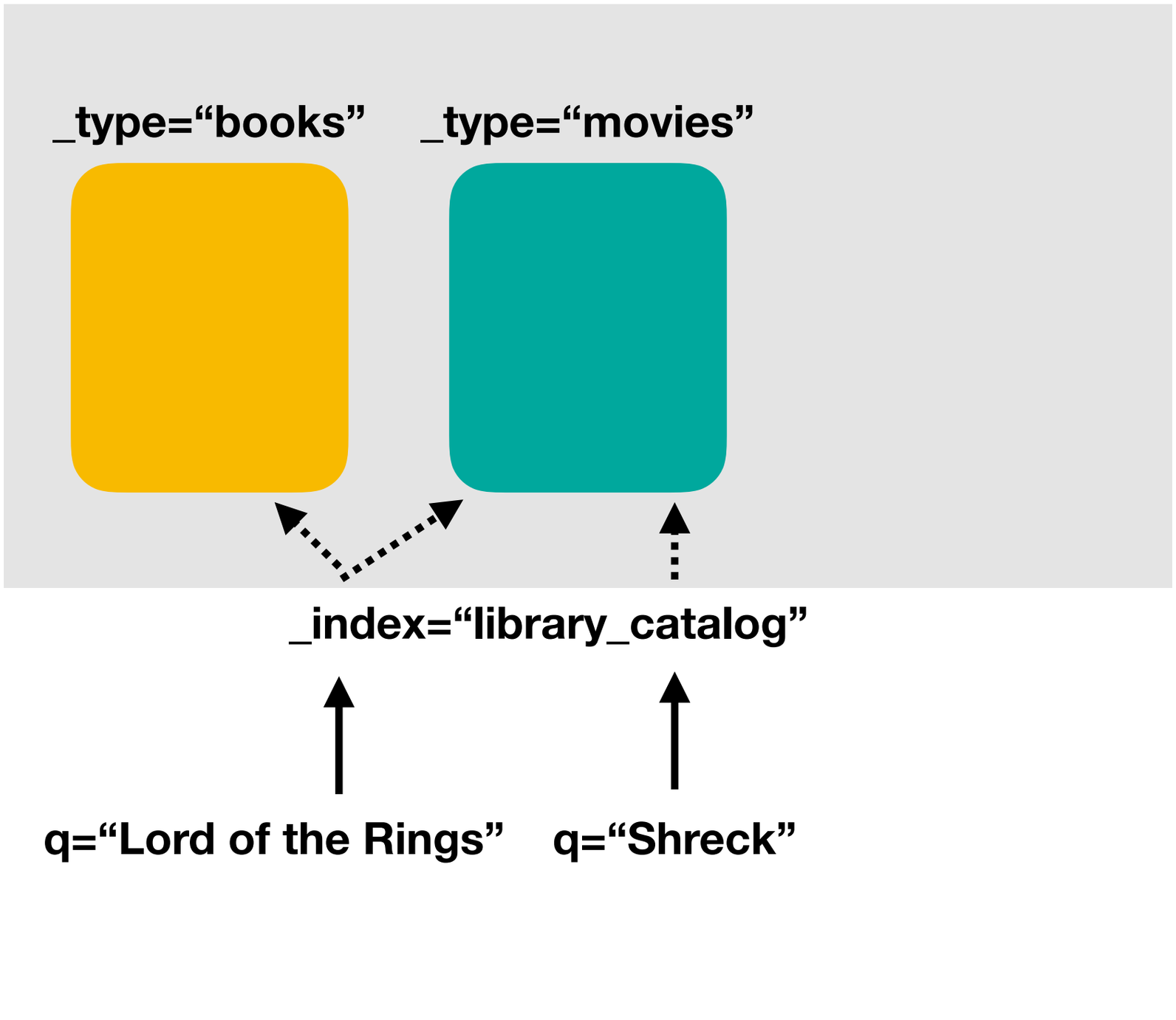
- **Node:** a JVM process executing Elasticsearch. Typically one node per machine

- **Index**: a Lucene Index, which contains documents

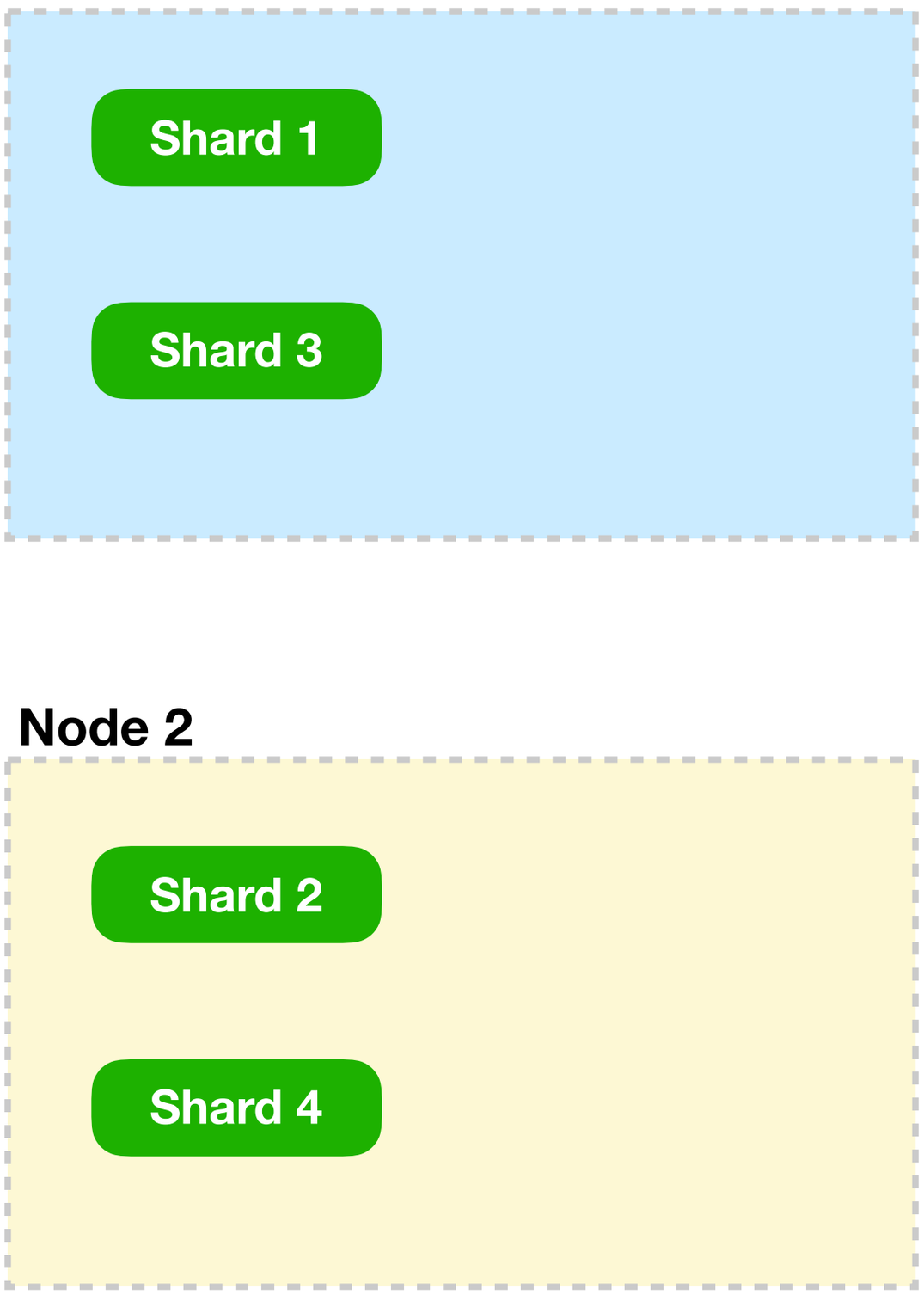
- **Document:** a JSON object

- **Type:** each document has a “_type” field used for filtering when searching on a specific type: this is used to include in an index data that is related, but of different nature (this has been phased out recently)

_type

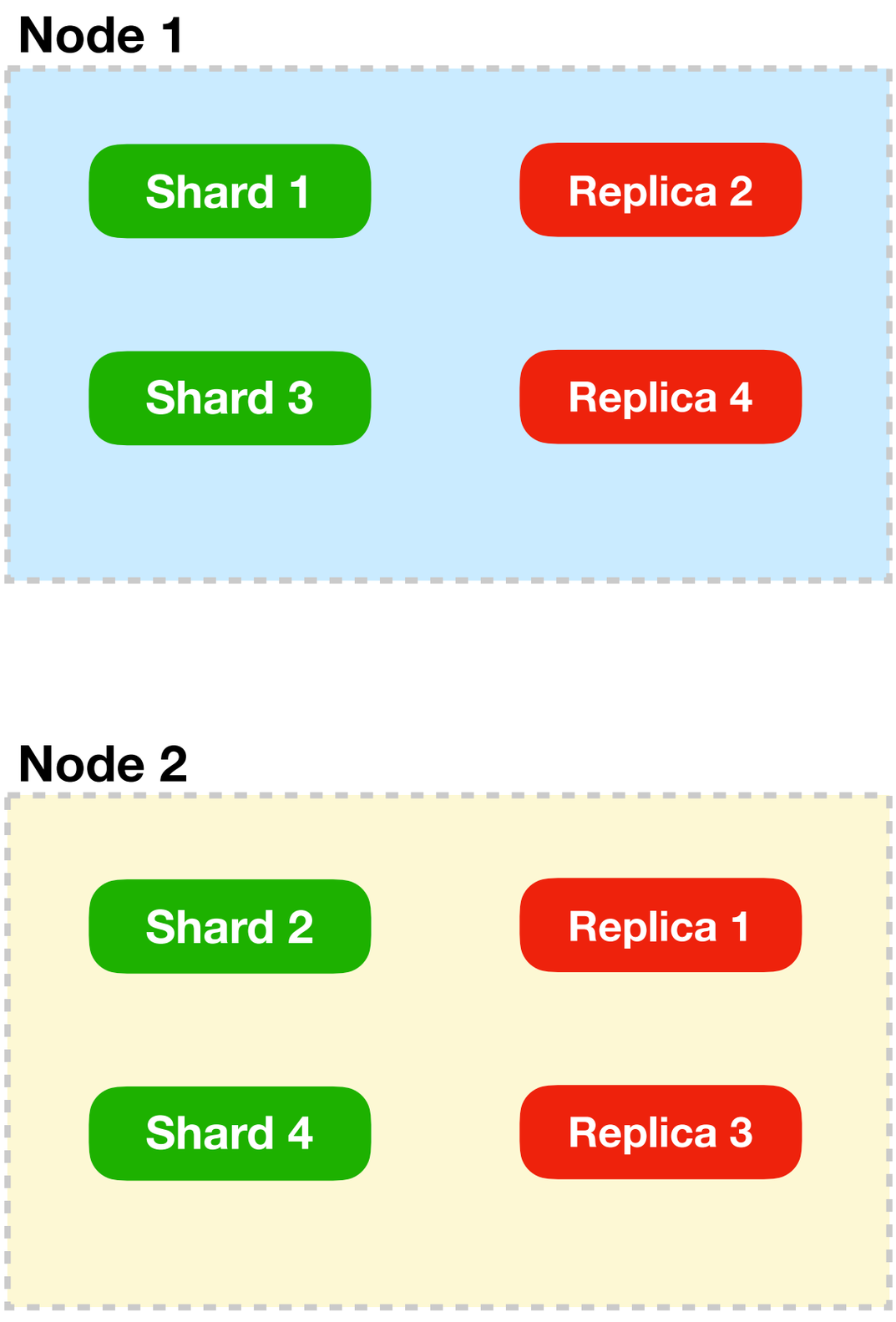

_type="books"
_type="movies"
_index="library_catalog"
q="Lord of the Rings"
q="Shreck"

Sharding



- sharding allows to address the hardware limits of each node, by splitting a data index across multiple nodes.
- each node may contain multiple shards
- sharing also allows for parallalisation of operations (also within the same node): multiple machines (or cores in one machine) can work on the same query at the same time.
- number of shards specified at index creation (default is 5).

Replication



- shards are copied across nodes to create replica shards
- replication delivers high reliability and increased performance for search queries,
- searches can be performed on the replicas in parallel
- number of replicas is defined at indexing (default 1)

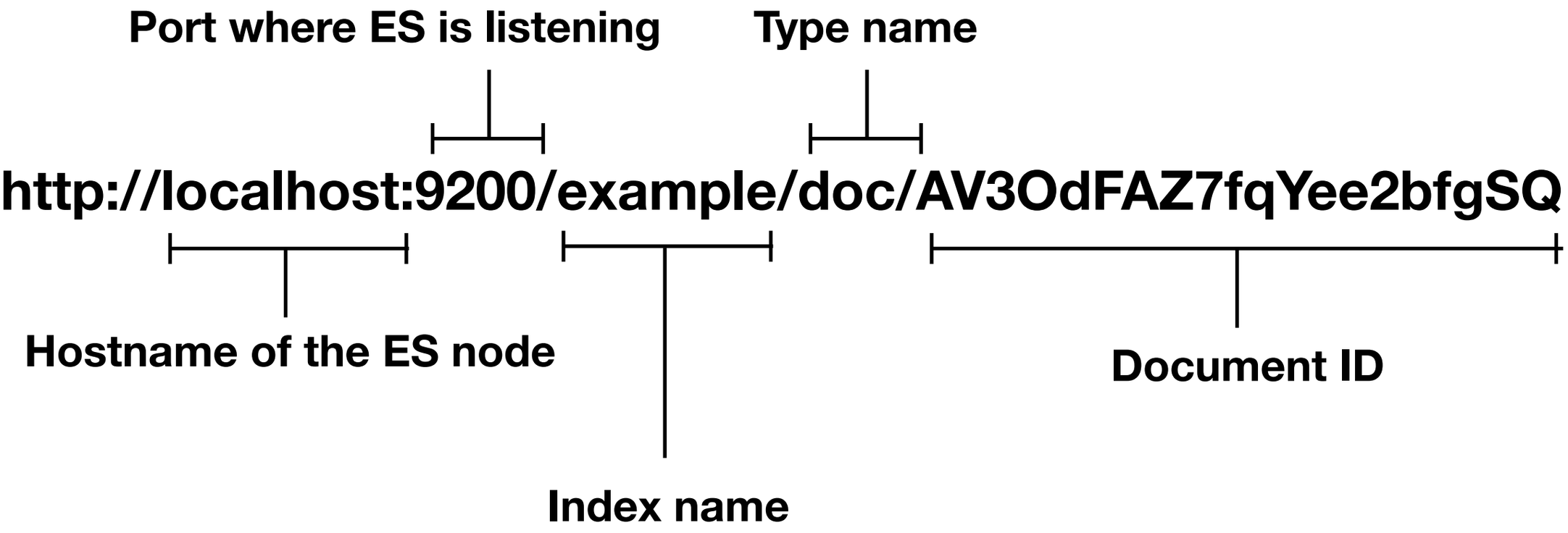
Interacting with Elasticsearch

- Interaction occur as HTTP requests to the RESTful API
- Can use any RESTful client: curl, Postman, Kibana's Dev Tool Console (from Elastic developers)
- Commands are in the form:

```
<REST verb> /<indexname>/<API>
```

- For example: GET /myindex/_search
- (In *curl*: curl -XGET “http://localhost:9200/my_index/_search")

Structure of ES URL



APIs

- **Indeces** API: Create, Delete, Get, Open / Close, Shrink, etc.
    - `PUT test?wait_for_active_shards=2`
- **Document** API: Index, Get, Delete, Update (also variants for multi-document)
    - `POST twitter/tweet/ {"user" : “guidozuc"}`
- **Search** API: execute a search query and get back search hits that match the query. Can pass complex queries
    - `GET /twitter/_search?q=user:guidozuc`
- **Cat** API: get information about the cluster in human readable format
    - `GET /_cat/indeces?v`
- **Explain** API: score explanation for a query and a specific document
- **Cluster** API: node specifications

Hands-on Activity 0: Installation and Basic Interaction

- All material is at https://github.com/ielab/afirm2019
- Activities are in folder hands-on: https://github.com/ielab/afirm2019/tree/master/hands-on
- Visualise Activity 0 readme

Take home from Activity 0

Hands-on Activity 1:
Basic Indexing and Search in Elasticsearch

- What we will learn:
    - How to create an index, add documents
    - How to perform searches
    - How to index a TREC collection (example with ClueWeb12)
- Activity at https://github.com/ielab/afirm2019/hands-on/activity-1/

Take home from Activity 1

Hands-on Activity 2: Boolean Retrieval

- What we will learn:
    - How to perform searches according to the Boolean model

- Activity at https://github.com/ielab/afirm2019/hands-on/activity-2/

Take home from Activity 2

Hands-on Activity 3: Produce a TREC Run

- What we will learn:
    - How to produce a valid TREC formatted run, using the default retrieval model

- Activity at https://github.com/ielab/afirm2019/hands-on/activity-3/

Take home from Activity 3

Hands-on Activity 4: Access a Term Vector

- What we will learn:
    - How to access the term vector of a document. This can be used e.g. to extend retrieval models

- Activity at https://github.com/ielab/afirm2019/hands-on/activity-4/

Take home from Activity 4

Hands-on Activity 5: Implement a New Retrieval Model

- What we will learn:
    - How to access implement a new retrieval model and run searches with it via Elasticsearch
        - There are two version of this: one for Elasticsearch 5.x.x (uses Java) and one for 6.x.x (uses Python/ script similarity). We shall see the one for Elasticsearch 6.x.x

- Activity at https://github.com/ielab/afirm2019/hands-on/activity-5/

Take home from Activity 5

Hands-on Activity 6: Document Priors and Boosting

- What we will learn:
    - How to add document priors to an Elasticsearch index
    - How to boost document scores by including document priors
- Activity at https://github.com/ielab/afirm2019/hands-on/activity-6/

Take home from Activity 6

Hands-on Activity 7:
Text Snippeting for Search Results

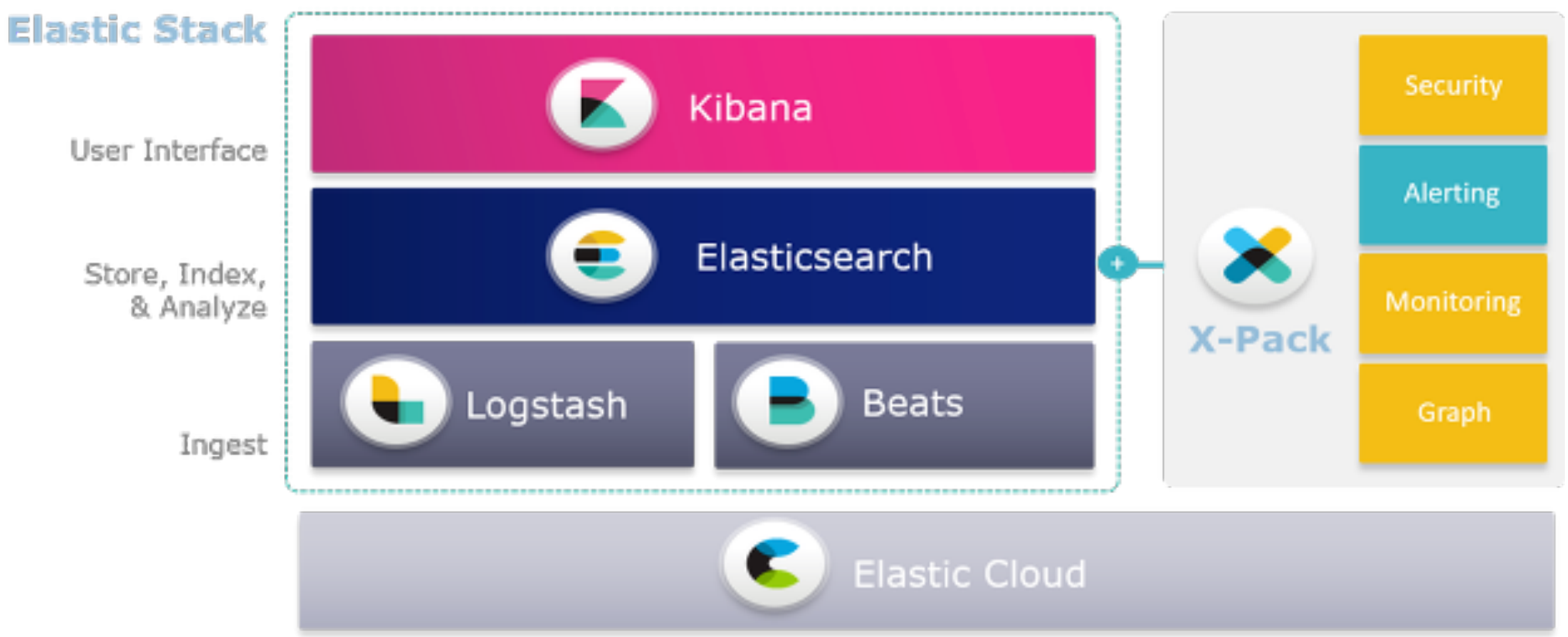
- What we will learn:
    - How to make Elasticsearch produce SERP snippets, that you can use in a search engine GUI
      (e.g. for a user-based experiment)

- Activity at https://github.com/ielab/afirm2019/hands-on/activity-7/

Take home from Activity 7

Beyond Elasticsearch: The ELK Stack

- Elasticsearch is one of the components within a larger stack for ingesting, search analyse and visualise data from any source, in any format, and in real time.



Other tools - Terrier

- Developed in Java, mainly for research purposes
- Developed and maintained by Terrier team at University of Glasgow
- Implements a large number of indexing retrieval methods, including for streams/tweet, diversity, learning to rank
- Fairly good documentation; rigour in implementation wrt theoretical definition of model

Other tools - Lemur/Indri/ Galago

- Lemur and Indri: Developed in C++, mainly for research purposes
    - Developed and maintained by University of Massachusetts, Amherst, and the Language Technologies Institute at Carnegie Mellon University.
    - Implements a large number of indexing retrieval methods, but less than Terrier
    - Not maintained anymore; problematic to install on modern MacOSx
    - Fairly good documentation; rigour in implementation wrt theoretical definition of model
- Galago: developed in Java; much more scalable to large collections than Lemur/ Indri
    - Still maintained (though last release 12/21/2016), but not large community

Other tools - Anserini

- Developed in Java and Python, mainly for research purposes, on top of Lucene
- Developed and maintained by University of Waterloo
- Implements a good number of retrieval models, and aims to set standard state-of-the-art benchmarking
- Fairly good documentation; rigour in experimentation

Questions?

If you have questions or follow ups from this practical session, you can **contact me at g.zuccon@uq.edu.au**

Thanks to the ielab team for developing parts of the activities we have seen today; in particular Harrisen Scells, Jimmy, Anton van der Vegt, Daniel Locke

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