Searching & Indexing Text Data & Beyond

Michael Stewart

The Plan

- Web search engines
  - Aspects of text
  - Ranking
  - Setting up Lucene
- Non-text data

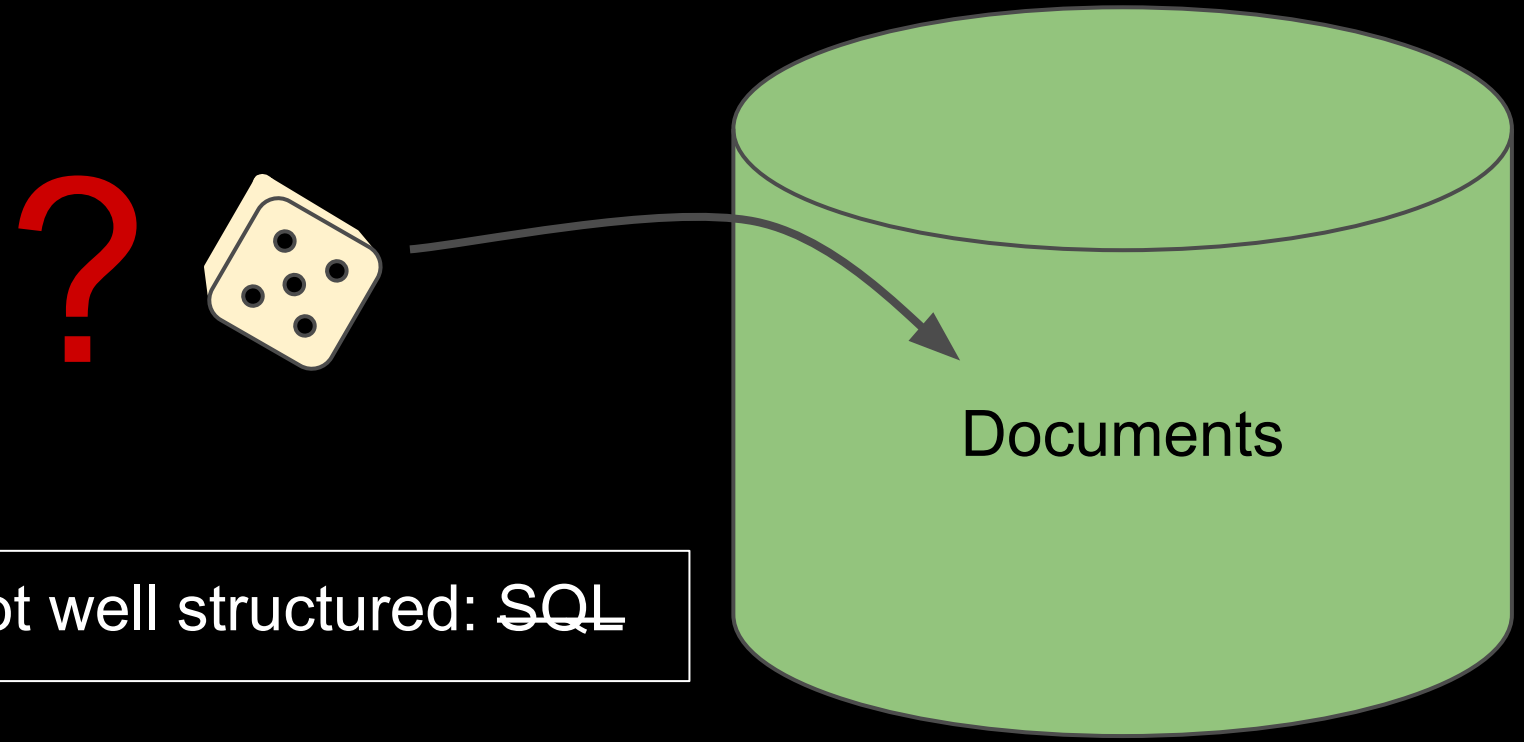
time permitting:

- Alternate search paradigms
  - User-driven exploration

Not covered

- sharding
- hadoop
- advanced text processing

When would I use a search engine?



Not well structured: ~~SQL~~

Web search

Design issue: What does the user want?

Retrieval?

Exploration?

Web search

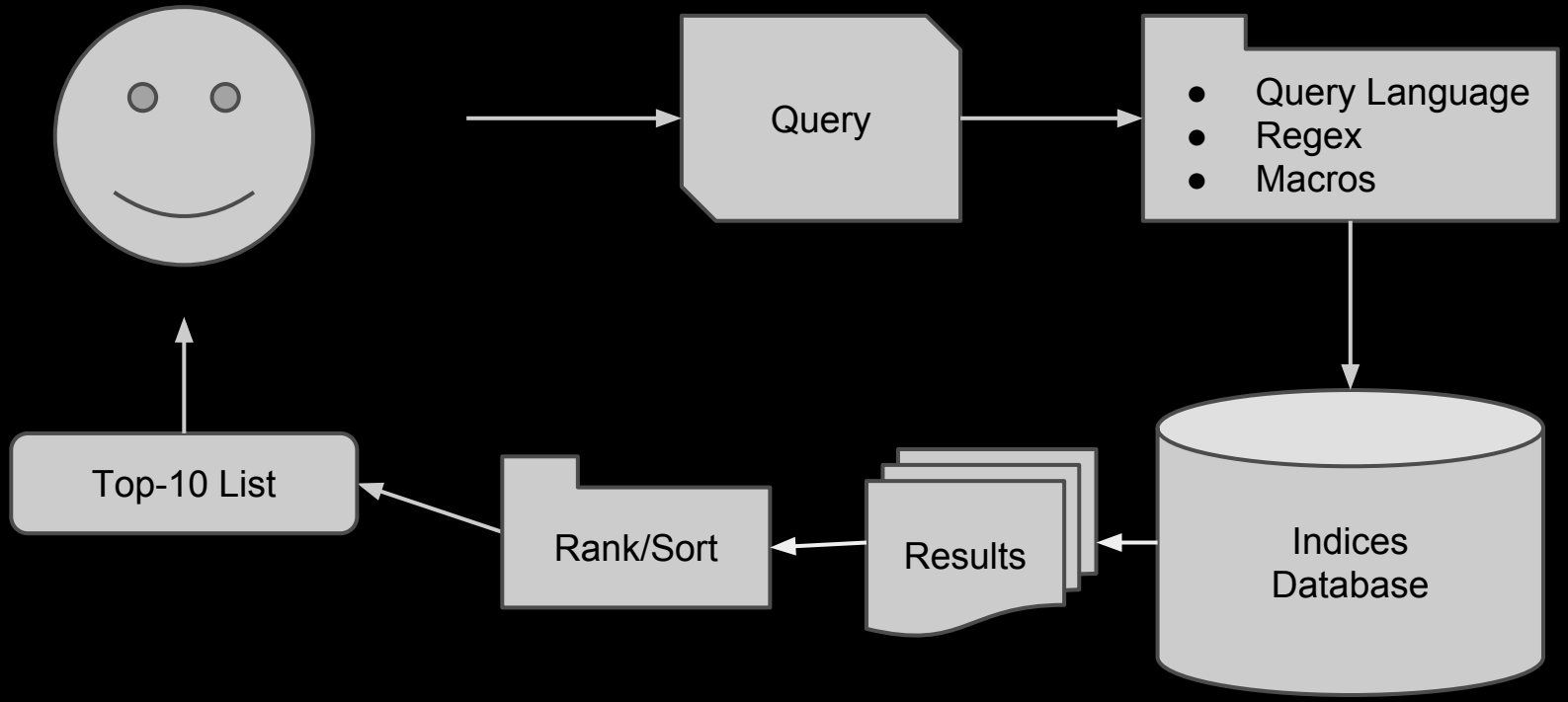
People issues:

Evil Spiders

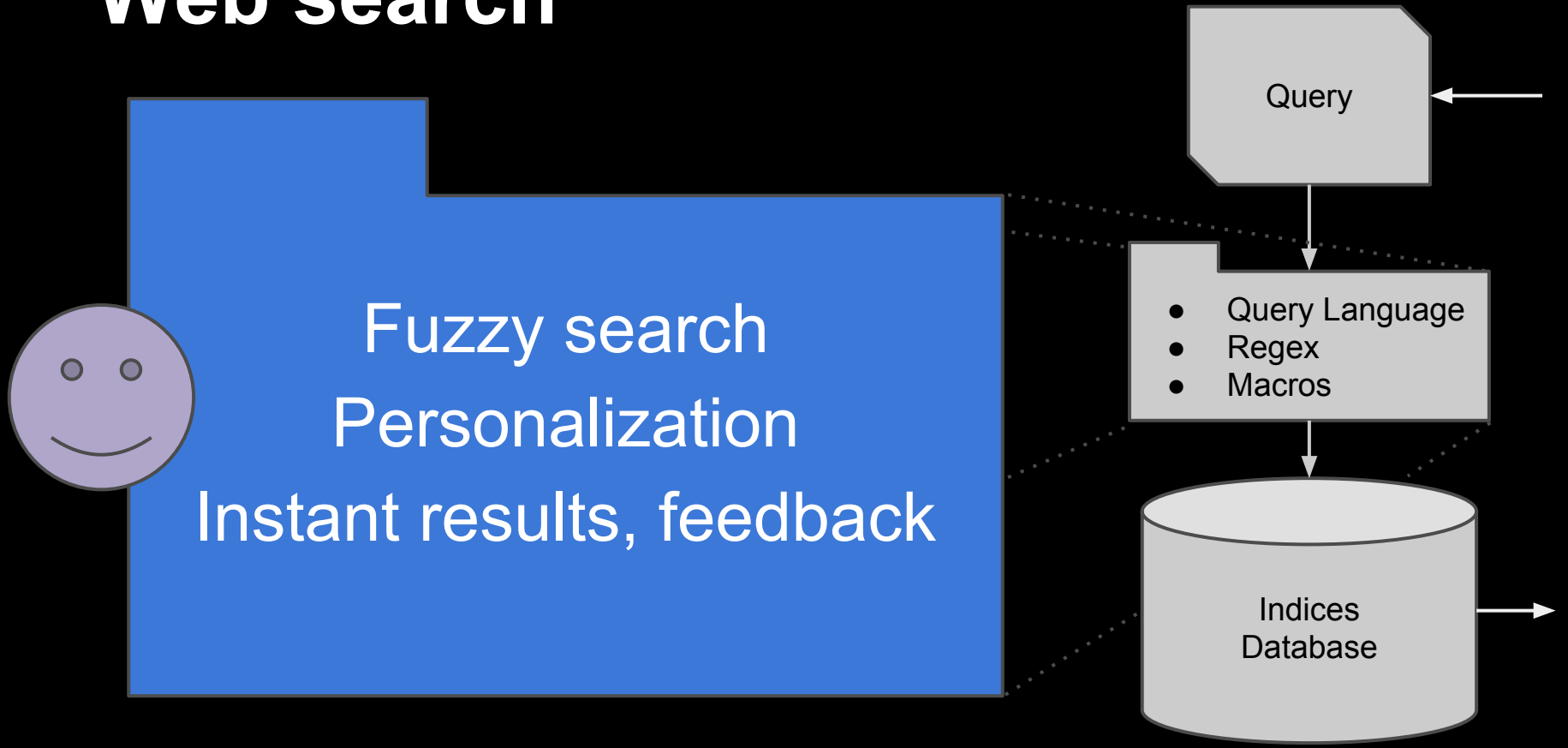
Adversaries

Exploitation?

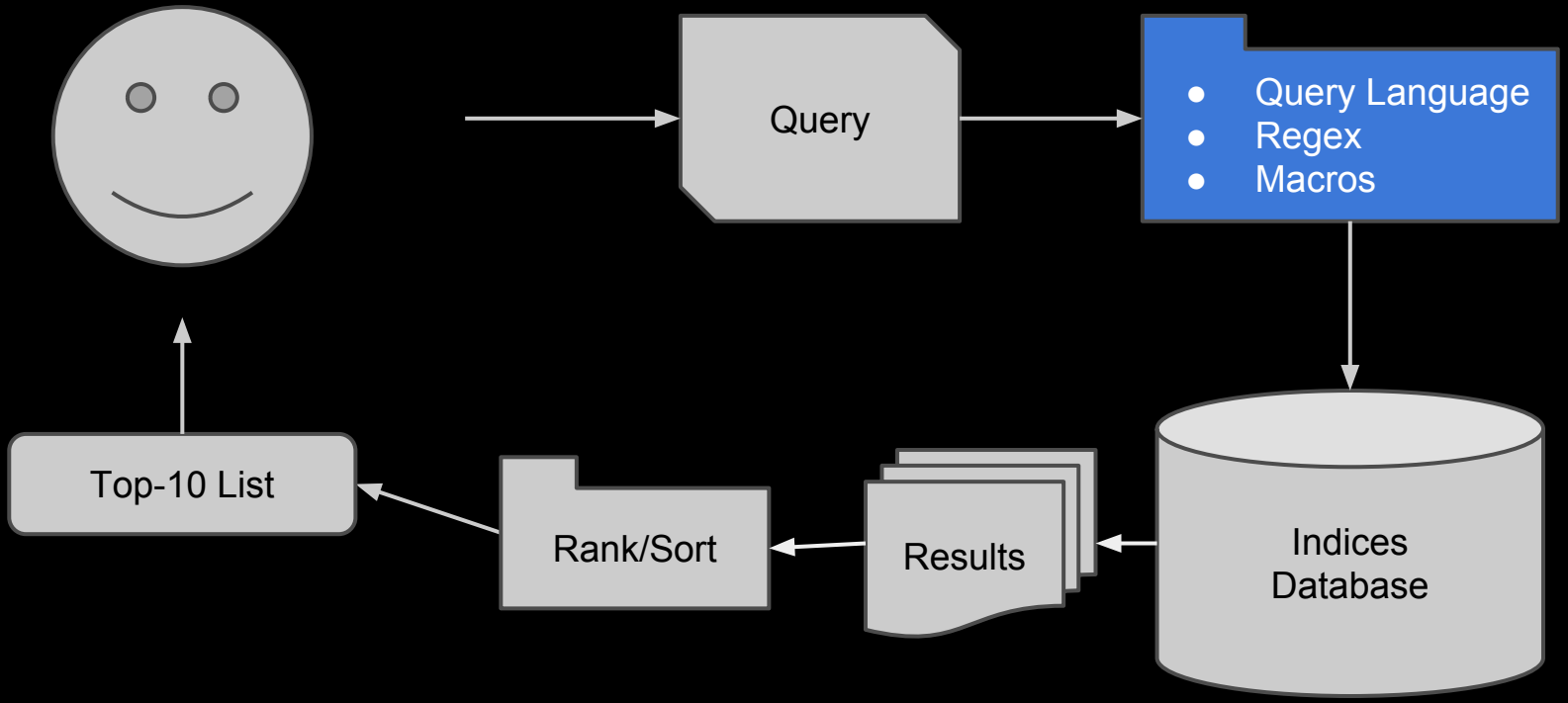
Web search


Query
Query Language
Regex
Macros
Indices
Database
Results
Rank/Sort
Top-10 List

Web search


Fuzzy search
Personalization
Instant results, feedback
Query
Query Language
Regex
Macros
Indices
Database

Web search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Web search - What's an Index?

Usually a vector-space mapping.

Doc+Term → Score

e.g. Bag of words frequency

	Doc 1	Doc 2	Doc 3
Word 1	5	8	8
Word 2	2	0	6
Word 3	1	7	0

On disk sparse matrix:

```
1 1 5
1 2 8
1 3 8
2 1 2
2 3 6
3 1 1
3 2 7
```

Web search - What's an Index?

"Block Sort-Based Indexing"

Others support features e.g. RegEx

	Doc 1	Doc 2	Doc 3
Word 1	5	8	8
Word 2	2	0	6
Word 3	1	7	0

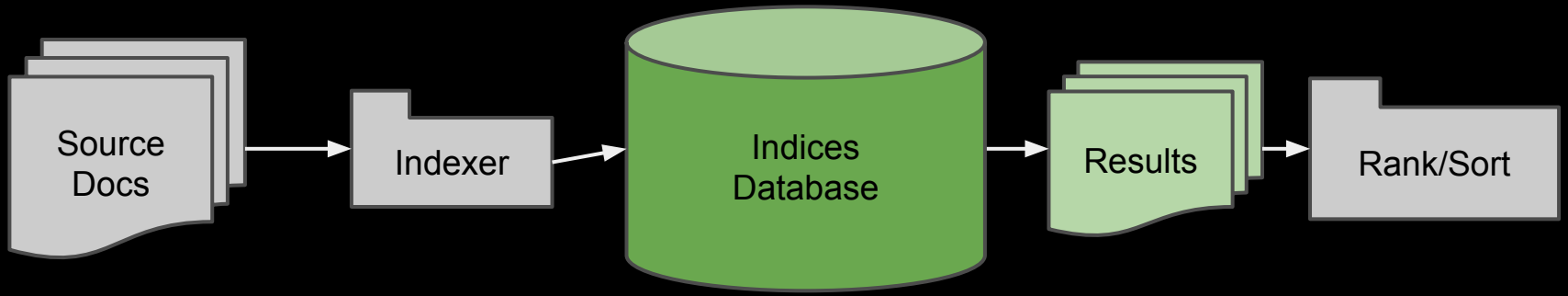
Indices

	TF	DF
Word 1	21	3
Word 2	8	2
Word 3	8	2

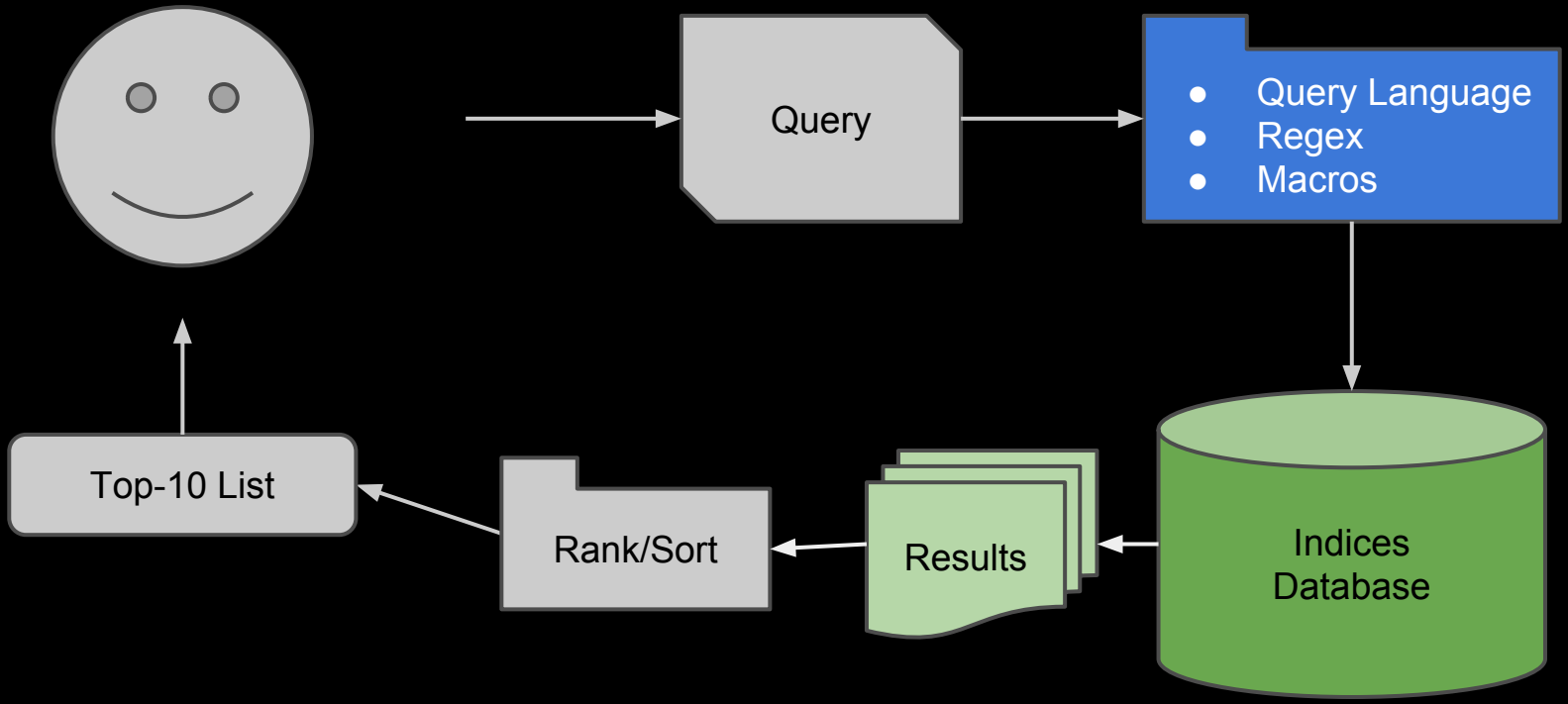
Web search - What's an Index?

Helpful to index other ranking/scoring methods:

- PageRank
- TF-IDF
- Vector space for cosine similarity
- Latent semantic analysis -> LSI



Web search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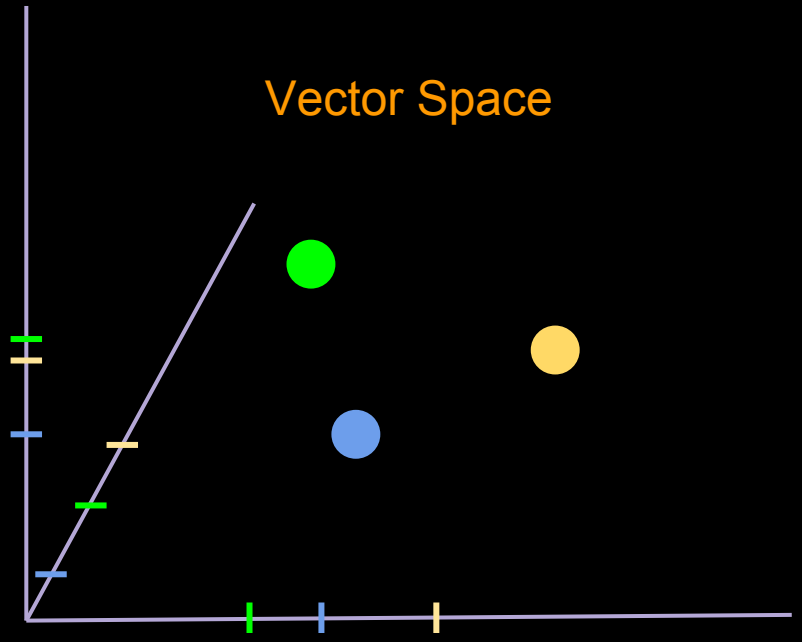
Ranking

$R(D,Q) = h_1(D,Q) + h_2(D,Q) + h_3(D)...$

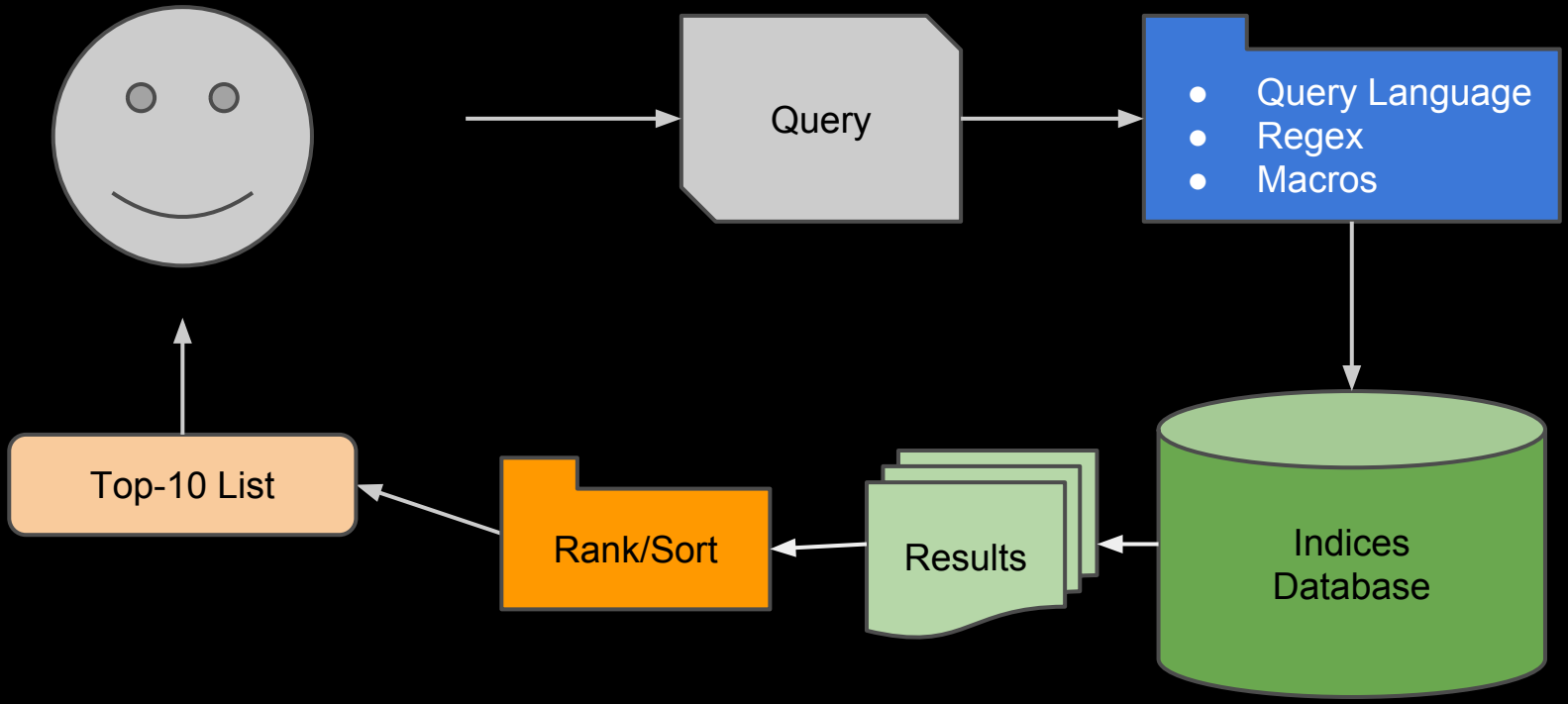
Heuristics:

- TF-IDF
- PageRank

… and return top 10.



Web search


Query
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Top-10 List
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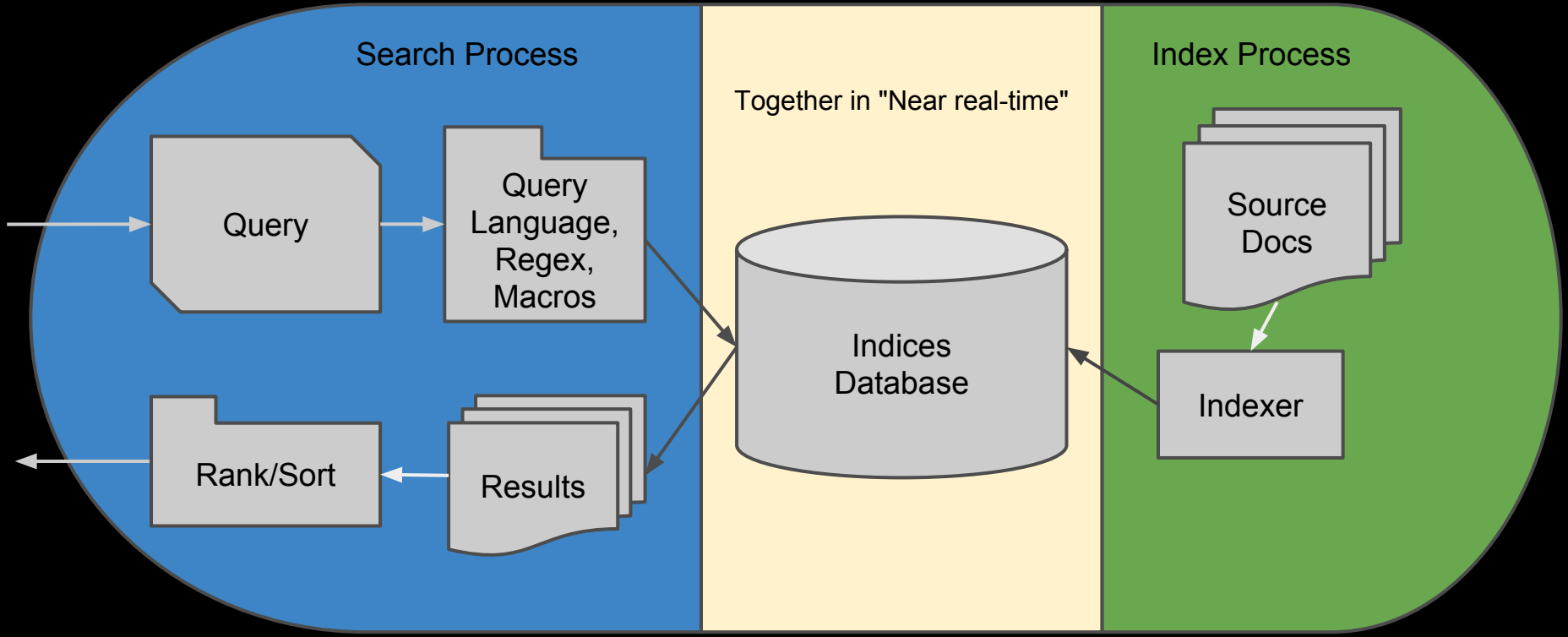
Web search


Search Process
Together in "Near real-time"
Index Process
Query
Query Language, Regex, Macros
Rank/Sort
Results
Indices Database
Source Docs
Indexer

Intro to Lucene

Lucene is the backend. Others build on top.

Elasticsearch / Solr = HTTP interface

Blender = Twitter's proprietary frontend

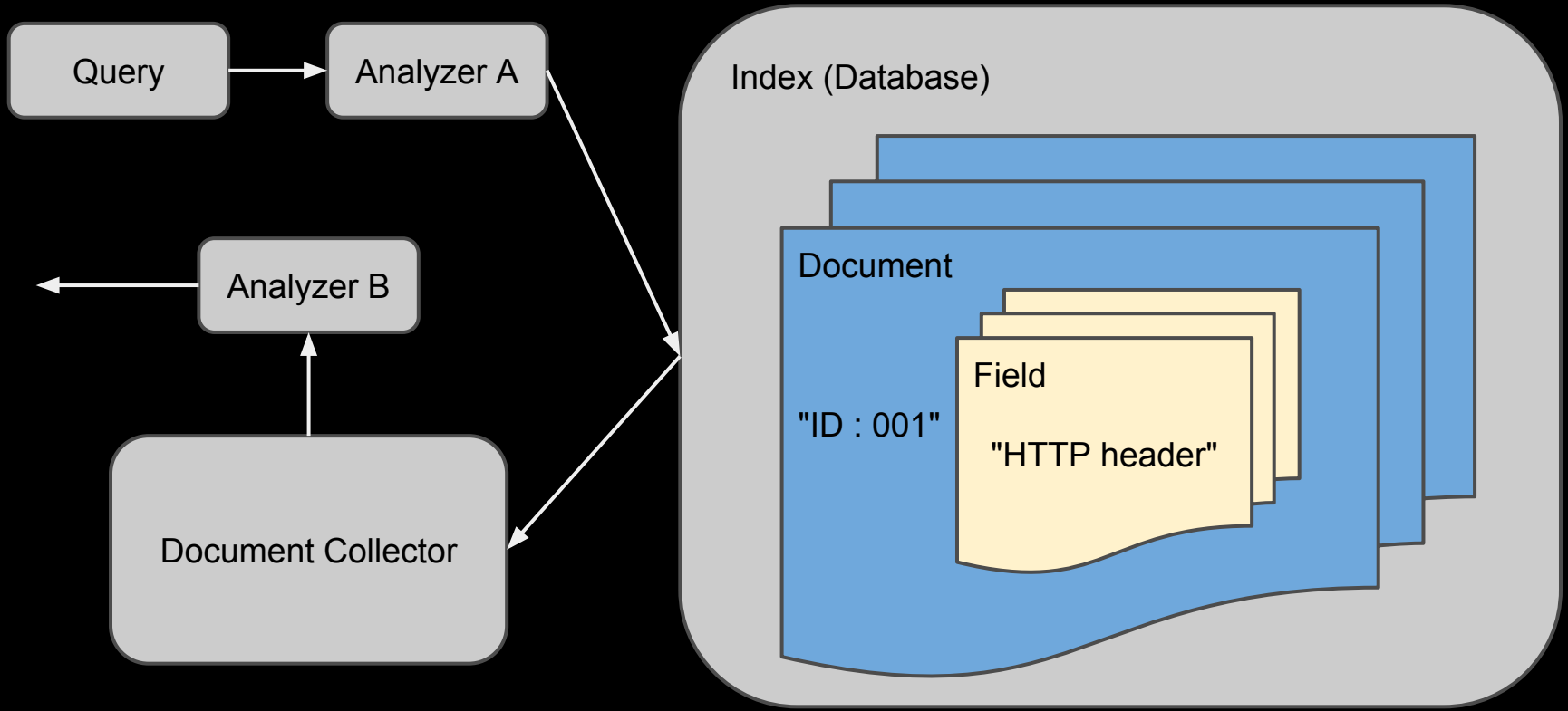
Who uses Lucene

- Twitter
- LinkedIn
- ...

Who uses Solr

- Netflix
- eBay
- ...

Lucene model



Lucene code example - Indexing

```
public class OurIndexer
{
    public static void main( String[] args ) throws IOException
    {
        OurIndexer indexer = new OurIndexer();
        indexer.makeIDMaps();
        indexer.indexFileOrDirectory("../run2/crawl/text");
        indexer.closeIndex();
    }
}
```

Lucene code example - Indexing

```
public class OurIndexer
{
    public OurIndexer() throws IOException
    {
        StandardAnalyzer analyzer = ...;          // Preprocessing
        IndexWriterConfig config =
                                    new IndexWriterConfig(analyzer);
        writer = new IndexWriter(dir, config);
    }
}
```

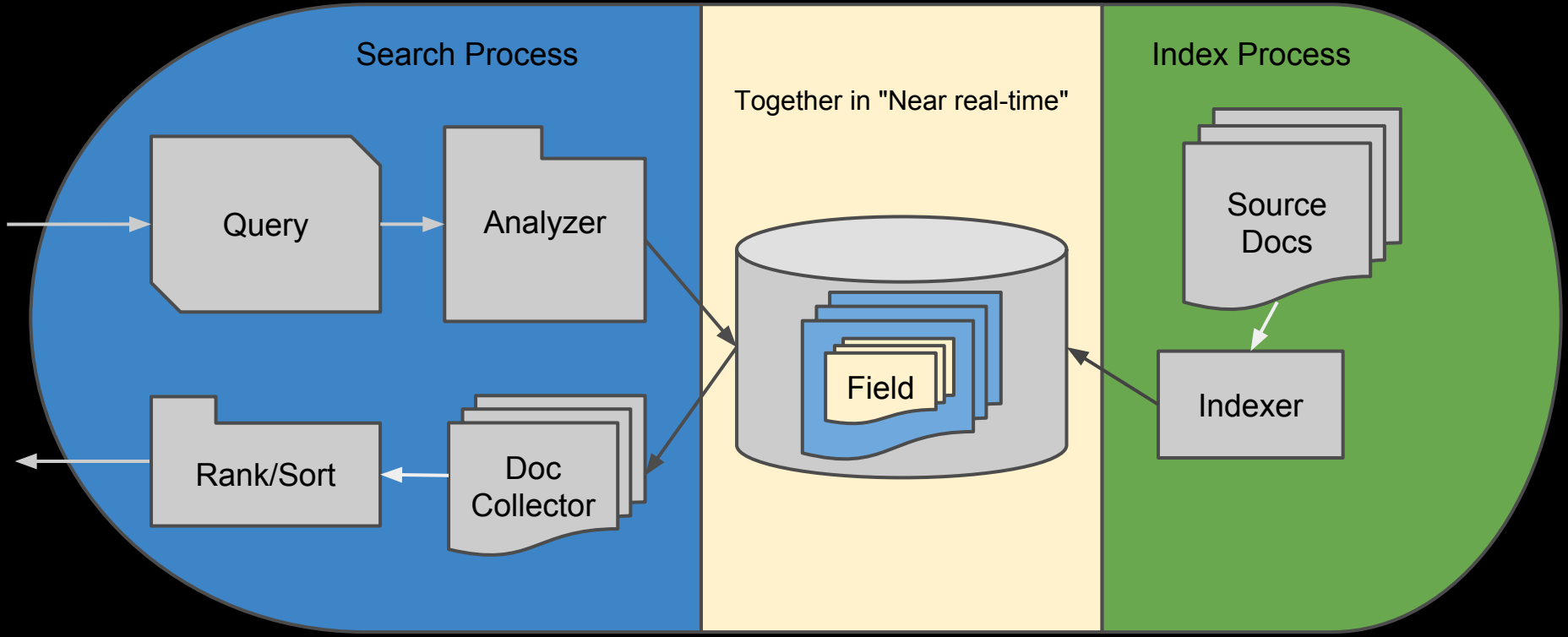
Lucene code example - Indexing

```
public void indexFileOrDirectory(String resourcePath) throws IOException
{
    ...
    Document doc = new Document(); fr = new FileReader(f);
    String docid = … ; String url = id2url.get(docid); String title = id2title.get(docid);

    String[] spliturl = url.split("/");                              // Heuristic for ranking boost.
    float boost = (1 / (float) spliturl.length);

    TextField content_field = new TextField("contents", fr);// Tokenize or Stem?
    content_field.setBoost(boost);
    doc.add(content_field);

    StringField idfield = ...;     doc.add(idfield);
    StringField urlfield = …;           doc.add(urlfield);
    TextField titlefield = ...;         doc.add(titlefield);

    writer.addDocument(doc);
}
```

Lucene code example - Searching

```
private static void simpleSearch(String queryString) throws ParseException, IOException
{

        TopScoreDocCollector collector = TopScoreDocCollector.create(RESULTS_LENGTH, true);

        Query query = new QueryParser(DOC_CONTENT_FIELD, analyzer ).parse(queryString);

        searcher.search(query, collector);

        ScoreDoc[] hits = collector.topDocs().scoreDocs;

        // return or print results
        …

}
```

You've done Lucene



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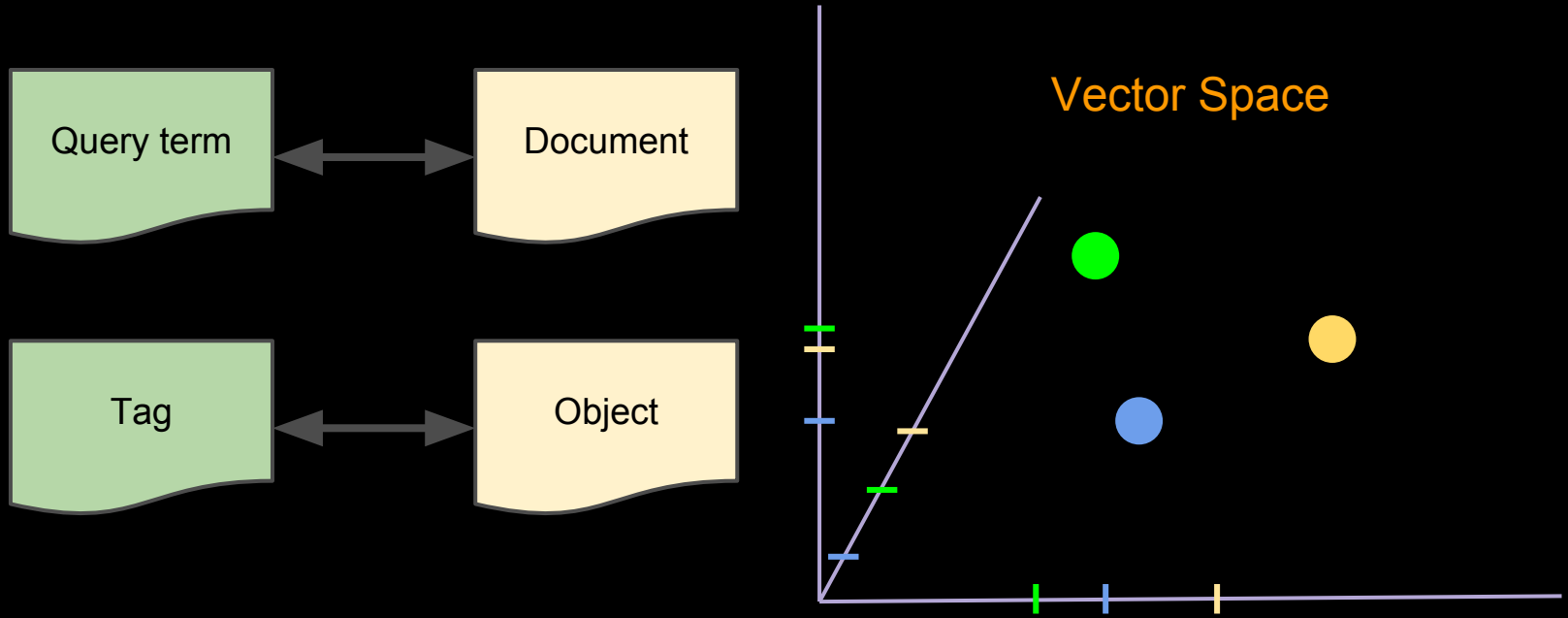
What about searching ____ ?

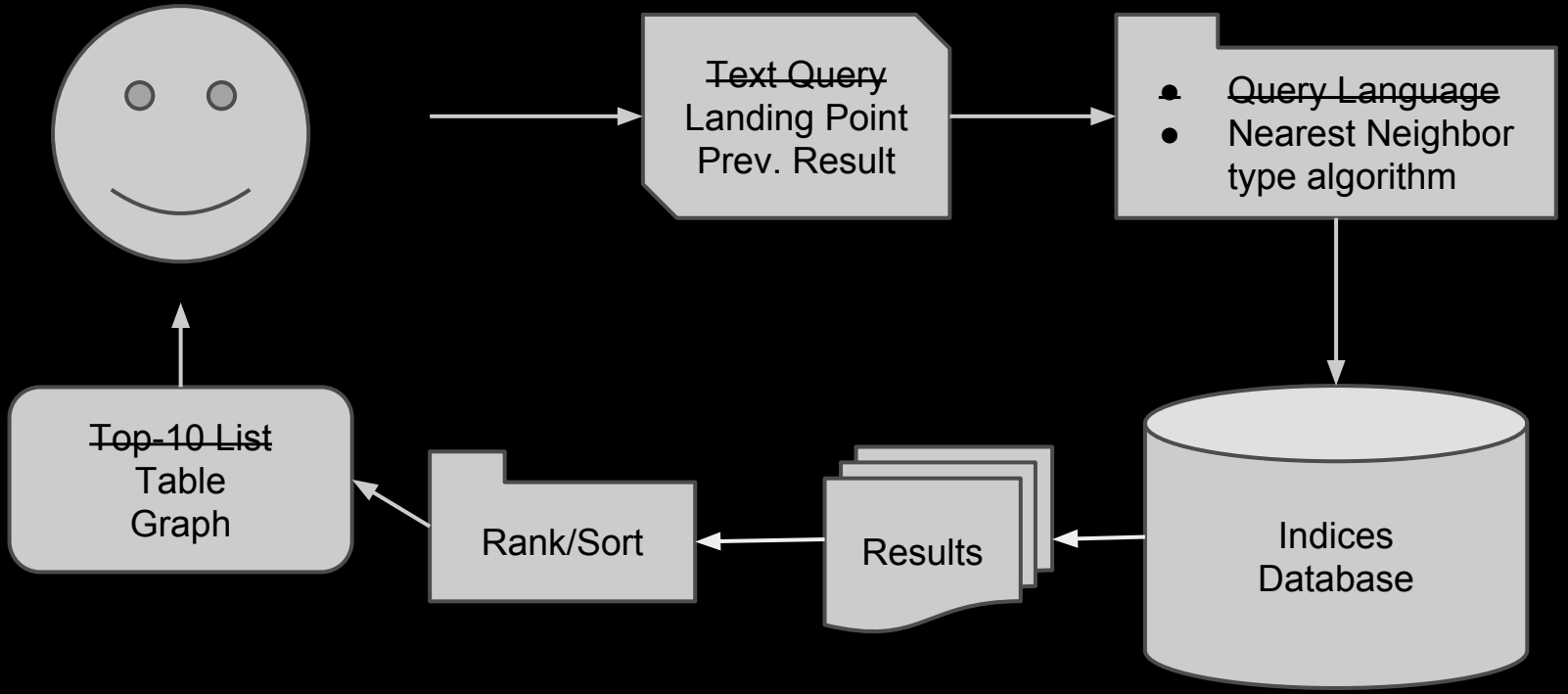


What about searching _____ ?

Extend this model using vector-space indexing.

	~~Doc 1~~ Object 1	~~Doc 2~~ Object 2	~~Doc 3~~ Object 3
~~Word 1~~ Tag 1	5	8	8
~~Word 2~~ Tag 2	2	0	6
~~Word 3~~ Tag 3	1	7	0

Search as Network Exploration



Searching movies?

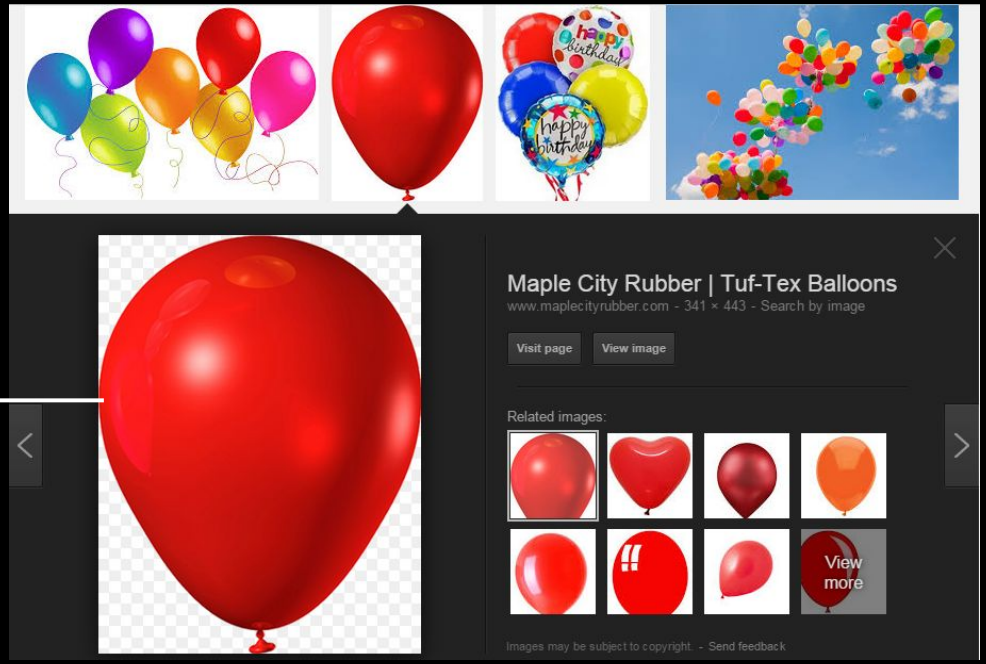
Exploring movies

Top Picks for Michael

More Like *Starship Troopers*

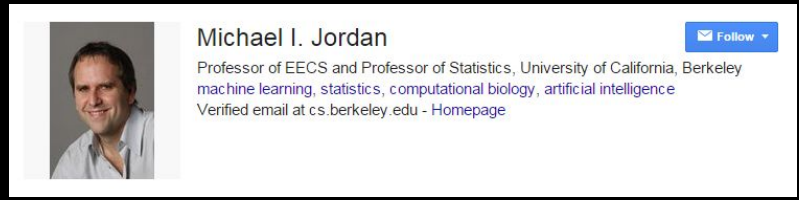
Searching pictures?

	~~Doc 1~~ Link 1	~~Doc 2~~ Link 2
~~Word 1~~ URL	5	8
~~Word 2~~ Filename	2	0
~~Word 3~~ Tag 1	1	7
...		



Searching network profiles?

	Profile 1	Profile 2
em algorithm	191	...
machine learning	113	...
computational biology	191	...
graphical models	80	



em algorithm

Scholars that used it: 242
Instances : 6388

Scholars	Frequency of the concept under the scholar
nikos_vlassis	196
michael_i_jordan	191
zoubin_ghahramani	174
robert_d_nowak	133
nando_de_freitas	101
chris_williams	99
cédric_archambeau	98
maya_gupta	96
yair_weiss	87

Where to get tags?

By hand

- crowdsource
  - #hashtag
  - mechanical turk
- technician logging

ML text processing

- Neural Nets for Image Captioning
- Text Segmentation
- Summarization

The End

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Recommended References

RegEx Engine Mechanics

Dealing with Malicious Bots/Crawlers

The Engineering Behind Twitter's New Search

Michael's Notes