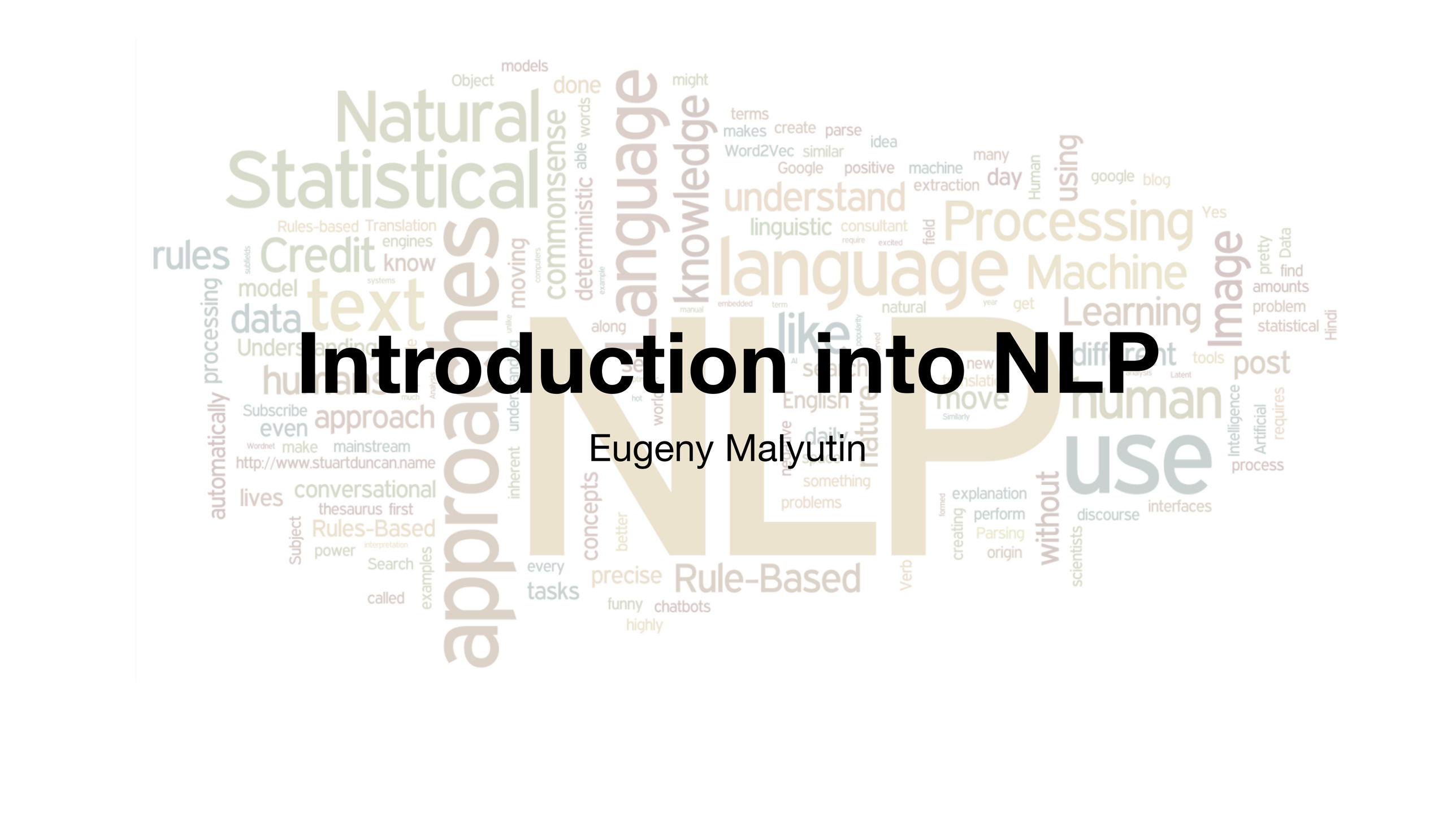

Introduction into NLP
Eugeny Malyutin
NLP
Natural
Statistical
approaches
Language
knowledge
commonsense
deterministic
understand
language
Processing
Machine
Learning
Image
text
data
rules
Credit
human
use
Rule-Based
Rules-Based
conversational
approach
concepts
tasks
precise
every
called
examples
Search
power
Rules-based
Translation
engines
know
model
processing
automatically
lives
thesaurus
first
Subject
Wordnet
make
mainstream
http://www.stuartduncan.name
Subscribe
even
inherent
moving
along
like
English
nature
move
without
discourse
interfaces
explanation
perform
Parsing
origin
scientists
Verb
creating
problems
something
process
post
tools
Intelligence
Artificial
requires
statistical
problem
amounts
find
pretty
Data
Hindi
Yes
google
blog
using
Human
day
many
extraction
machine
positive
Google
Word2Vec
similar
idea
terms
makes
create
parse
Object
models
done
might
able
words
linguistic
consultant
field
natural
get
chatbots
funny
highly
Latent
Similarity
Understanding

Used/Recommended materials:

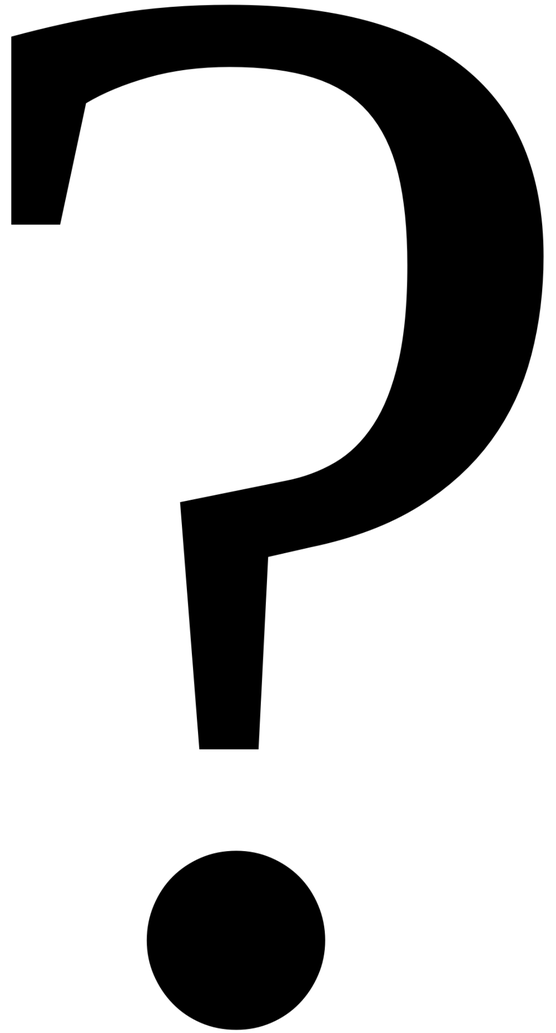
- Anton Alekseev’s lectures at NRU ITMO, St Petersburg
- Introduction to Information Retrieval,
  Chr. Manning, Pr. Raghavan and H. Schütze. Cambridge University Press. 2008
- *…*

Final score:

- Your labs
- Exam
- «Huge project presentation»

Why should someone learn NLP?

- It’s fun
- It’s paid
- Internet is made from text (and cats)



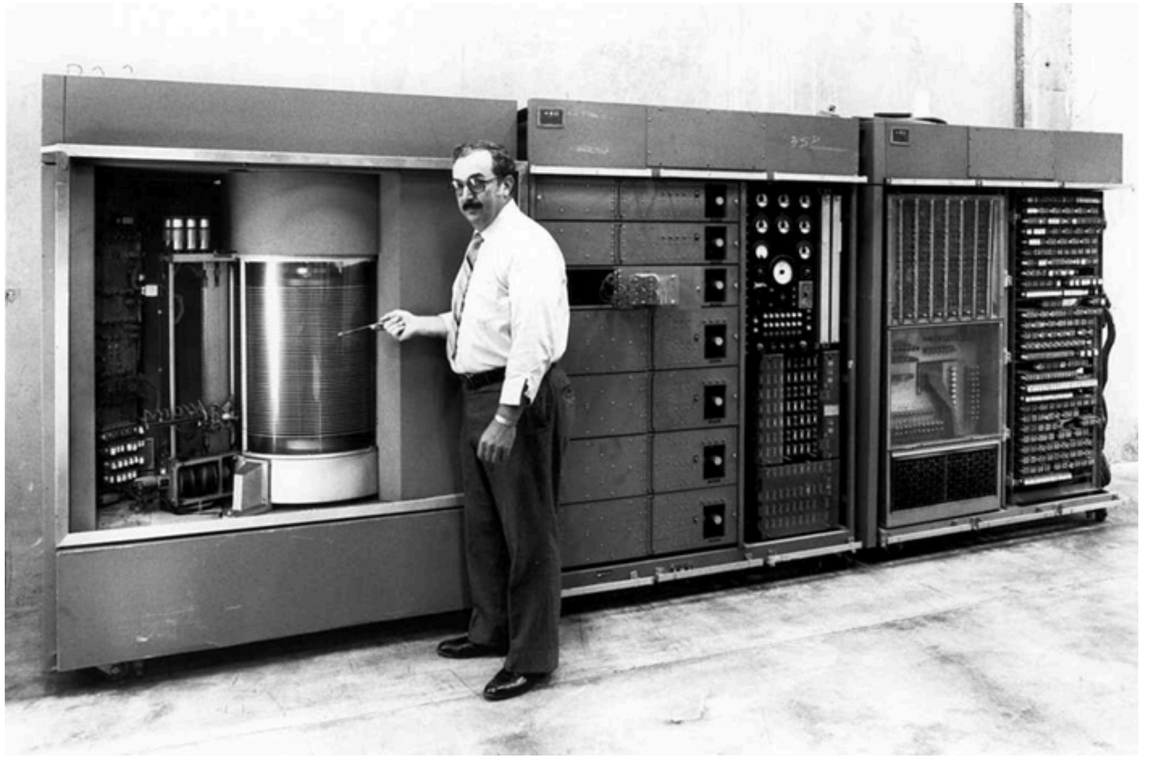
NLP tasks:

- Language modeling
- Part-of-speech tagging
- Named entity recognition
- Text (topic) classification
- Keyword extraction
- Spelling checking
- Syntax parsing
- Dependency parsing
- Machine translation
- Stemming Lemmatization
- Distributional semantics
- Text generation
- Text clustering
- Wikification
- QA systems
- dialogue systems
- Plagiarism detection
- Morpheme analysis
- Grammar check
- Relation extraction
- Entity linking
- Sentiment analysis
- Topic modeling
- Text summarization
- Semantic role labeling
- Information retrieval
- Speech Recognition / Synthesis

Back to the roots

- Established opinion: CompLing was born in 1950s thanks to the machine translation task (both in the USA and the USSR)

- Georgetown experiment 60+ sentences, 6 rules 1954, IBM + Georgetown University, ”the task will be solved in 3-5 years”

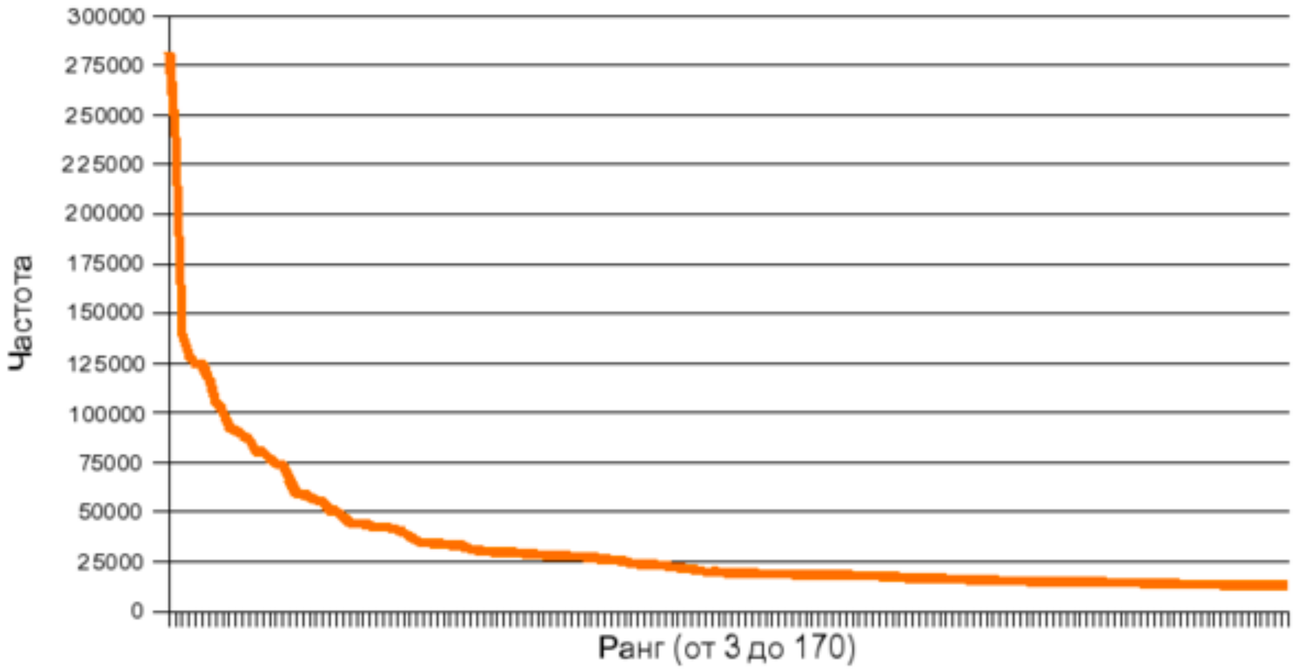


Vyelyichyina ugla opryedyelyayetsya otnoshyenyiyem dlyini dugi k radyiusu.
Magnitude of angle is determined by the relation of length of arc to radius.

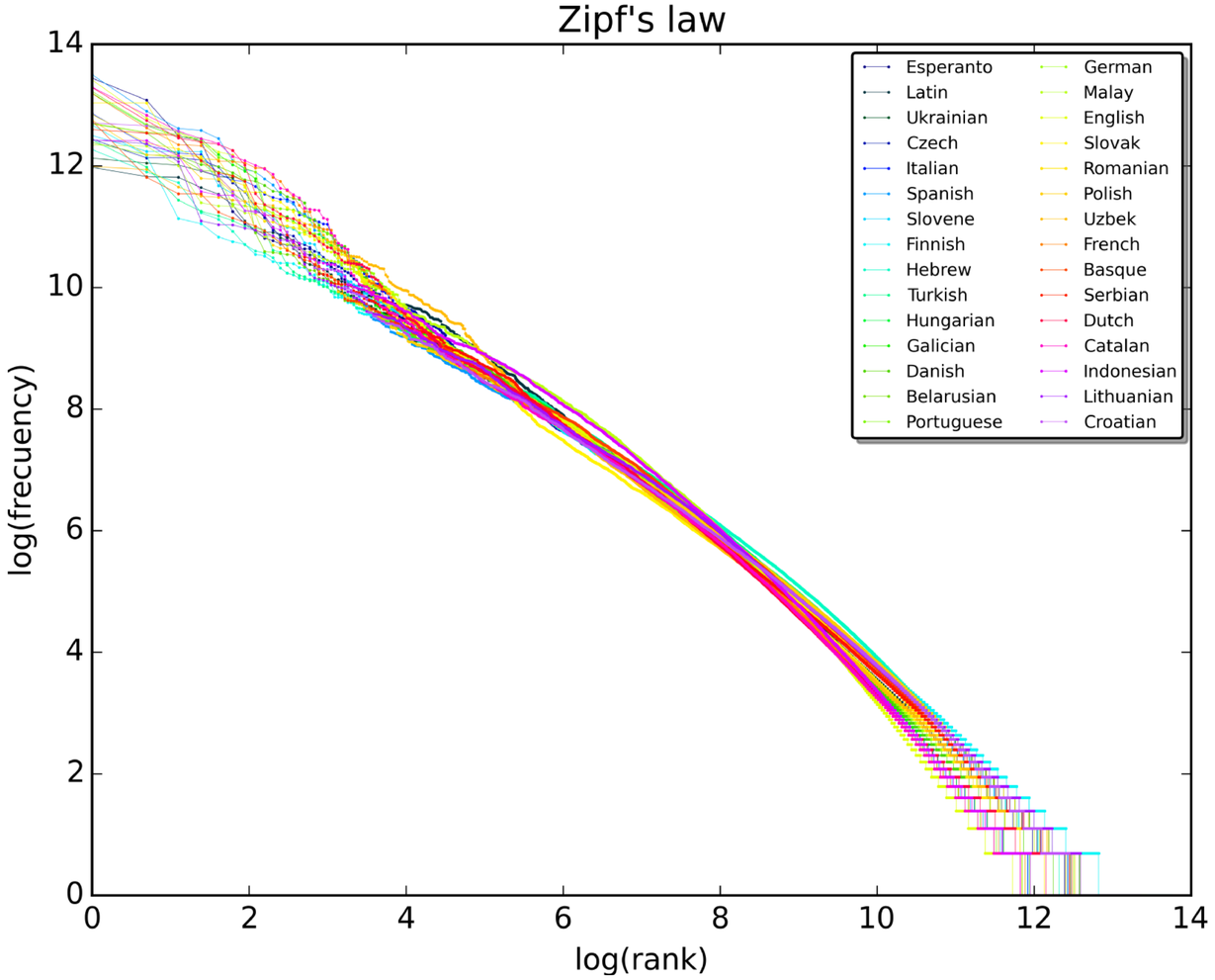
Myezhdunarodnoye ponyimanyiye yavlyayetsya vazhnim faktorom v ryeshyenyiyi polyityichyeskix voprosov.
International understanding constitutes an important factor in decision of political questions

https://en.wikipedia.org/wiki/Georgetown%E2%80%93IBM_experiment

Zipf law [1949]: rank * freq ~ const



Russian WIkipedia corpus frequency



10 top languages logrank vs logfreq

Progress

50-e: first attempts, Information Theory, Formal Grammars

60-70-e: ‘Syntactic Structures’, AI, bayesian models, first corpora

80-e: structured models (speech!), first distributional semantics approaches, data-driven research

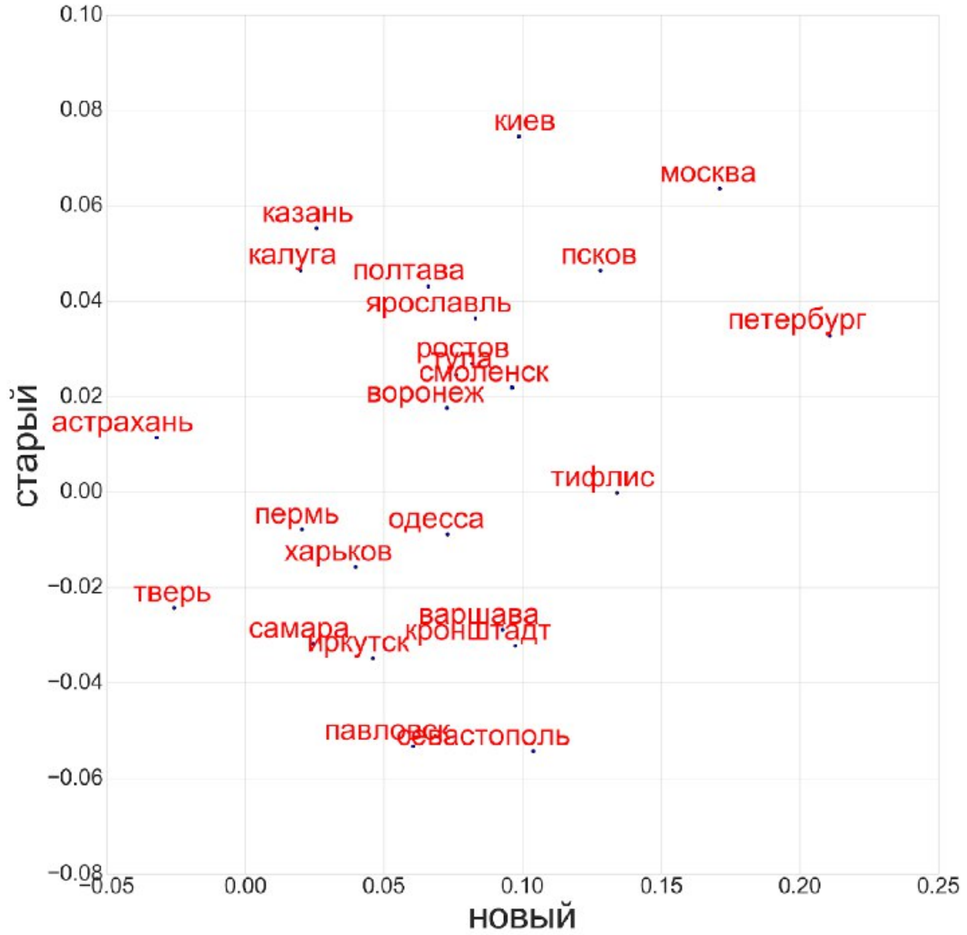
90-e: models evaluation tracks, applications for wide range of users

2000-e: web! data! machine learning, unsupervised approaches

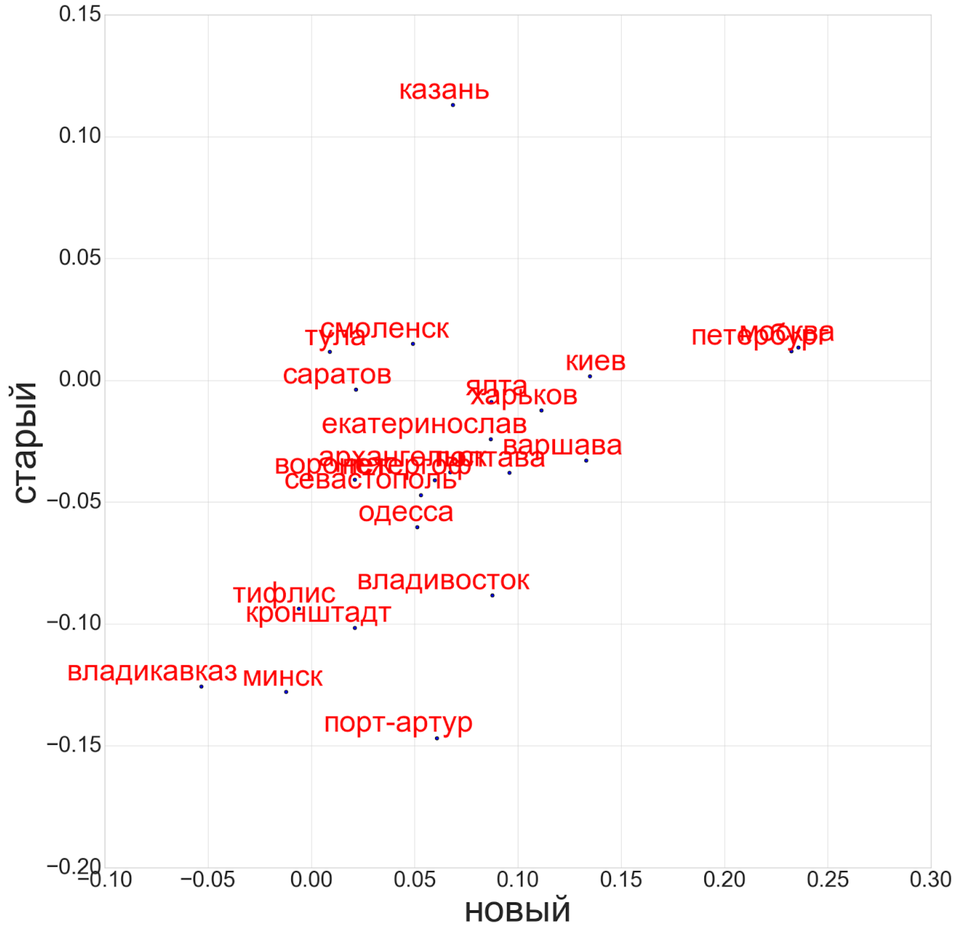
2010-e: Deep Learning feast, tons of applications in various fields

Cases: digital humanities

Word2Vec Rus Corpora projection on axes represented by words «new» and «old»

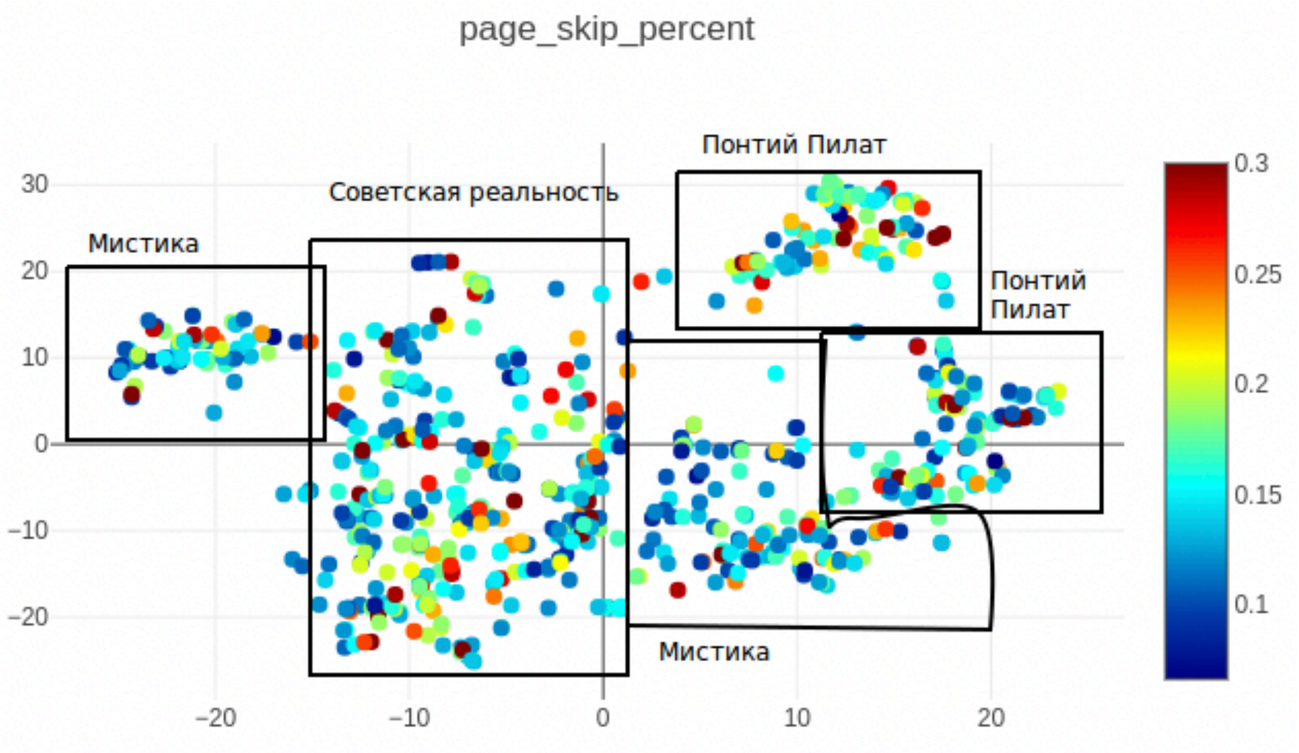


НКРЯ 1897-1916



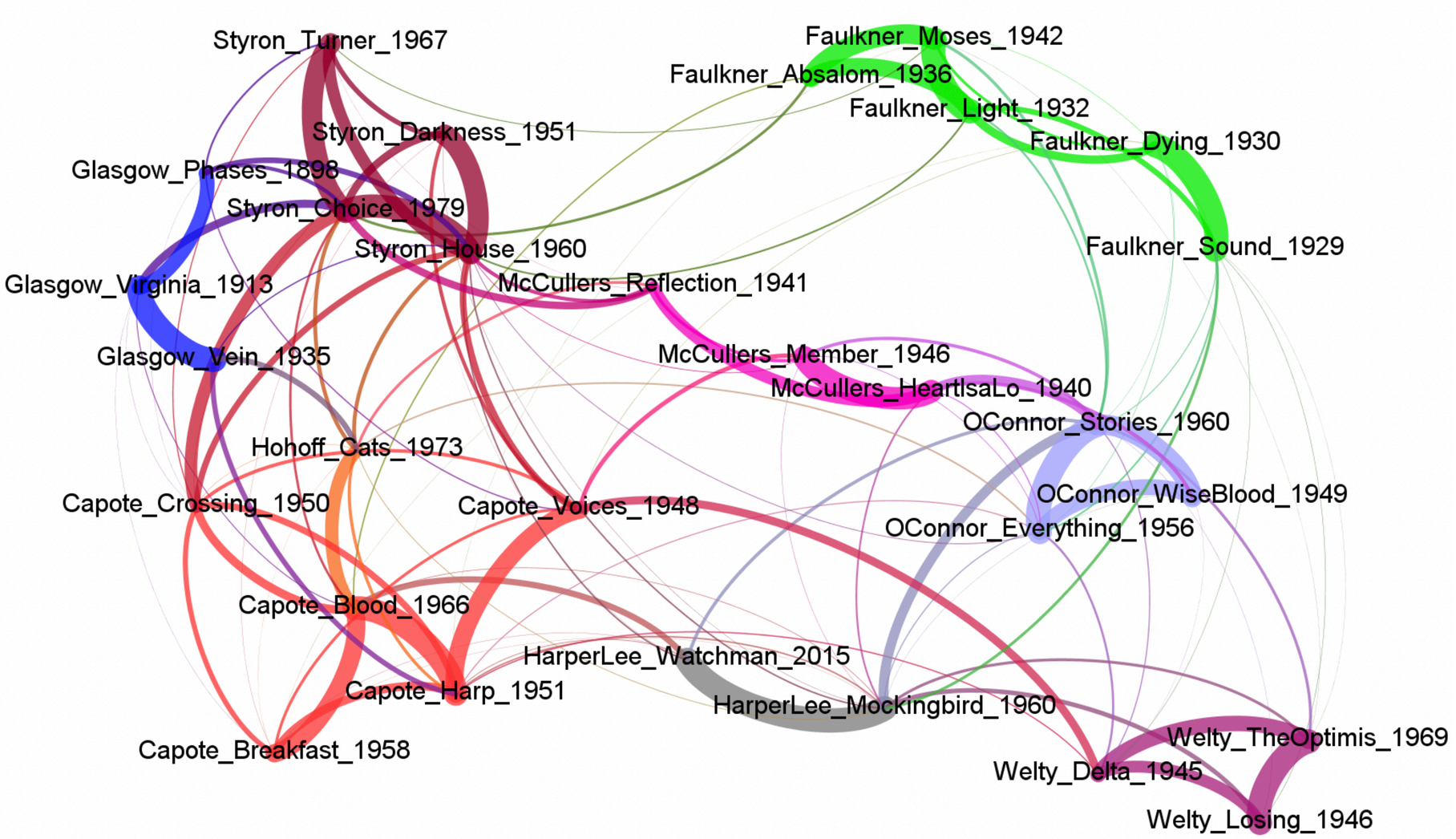
НКРЯ 1917 -1929

Cases: digital humanities



T-SNE clustering for word2vec embeddings for pages of «The Master and Margarita»

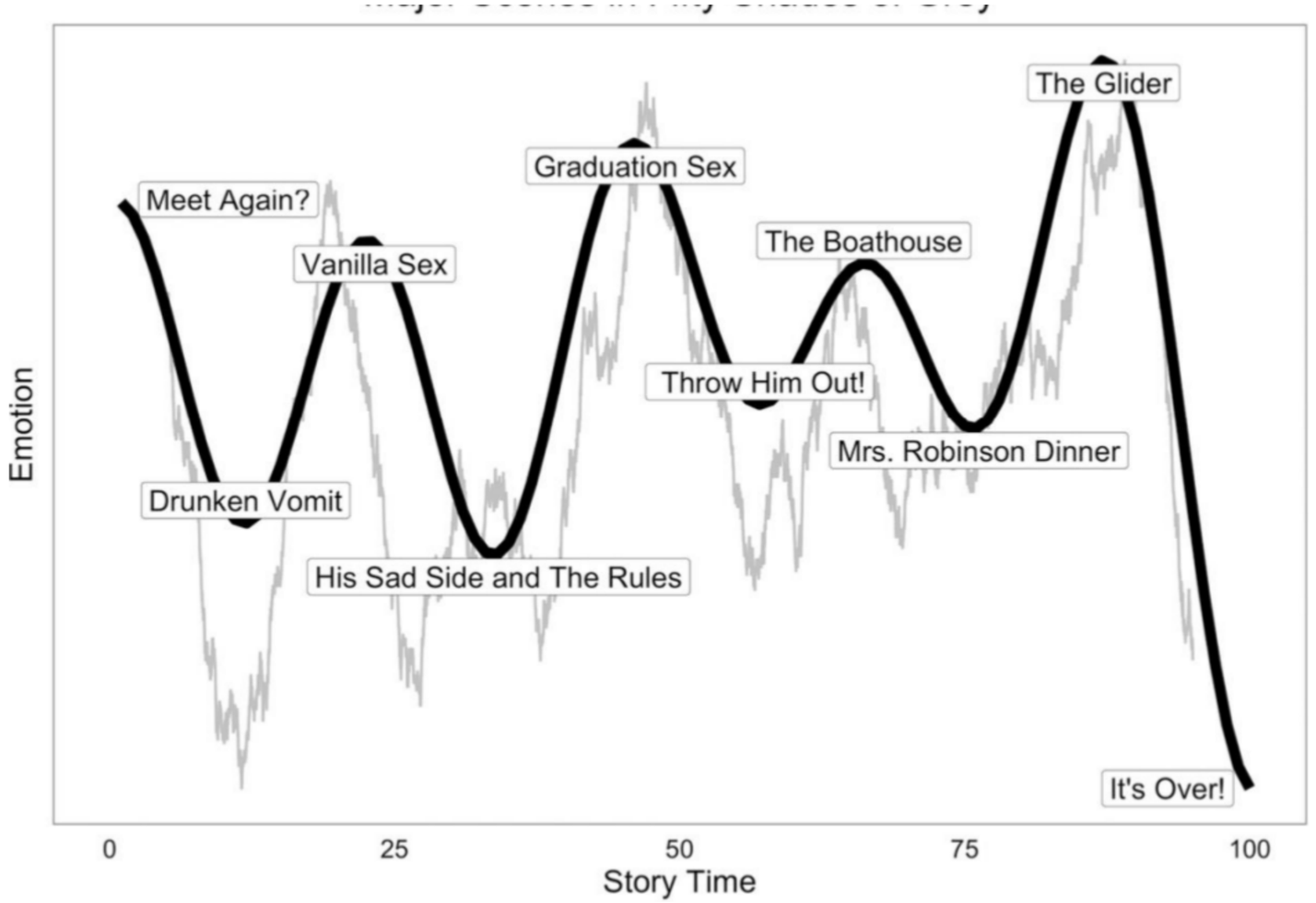
Cases: stylometry



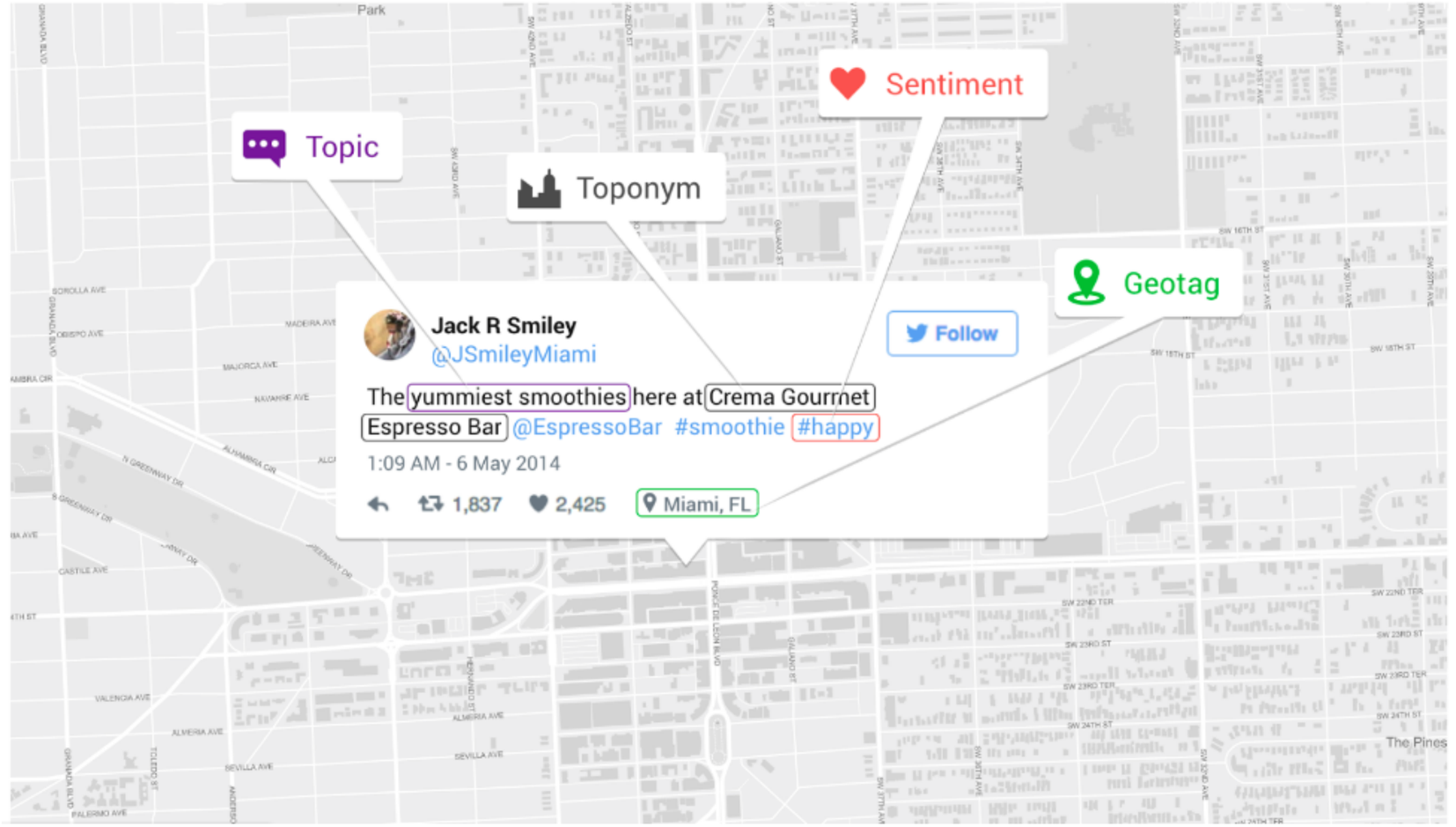
Stylo, Jan Rybicki

Cases: tonality plot

Mattew Jockers and «50 shades of black» tonality graph.



Cases: urban studies



Habidatum

Cases: urban studies

MUSIC | WORK | INTERNET

FOOD | ENTERTAINMENT

WATCHING SPORTS | EVENTS

enjoying some amazing **#macarons** at **#janetteandco #nutella #venezuelanchocolate**

at burgerfi for awesome burgers! **#burgerfi**

can't wait to dig into this yummy food **@carnaval_miami** !

MUSIC | WORK | INTERNET

FOOD | ENTERTAINMENT

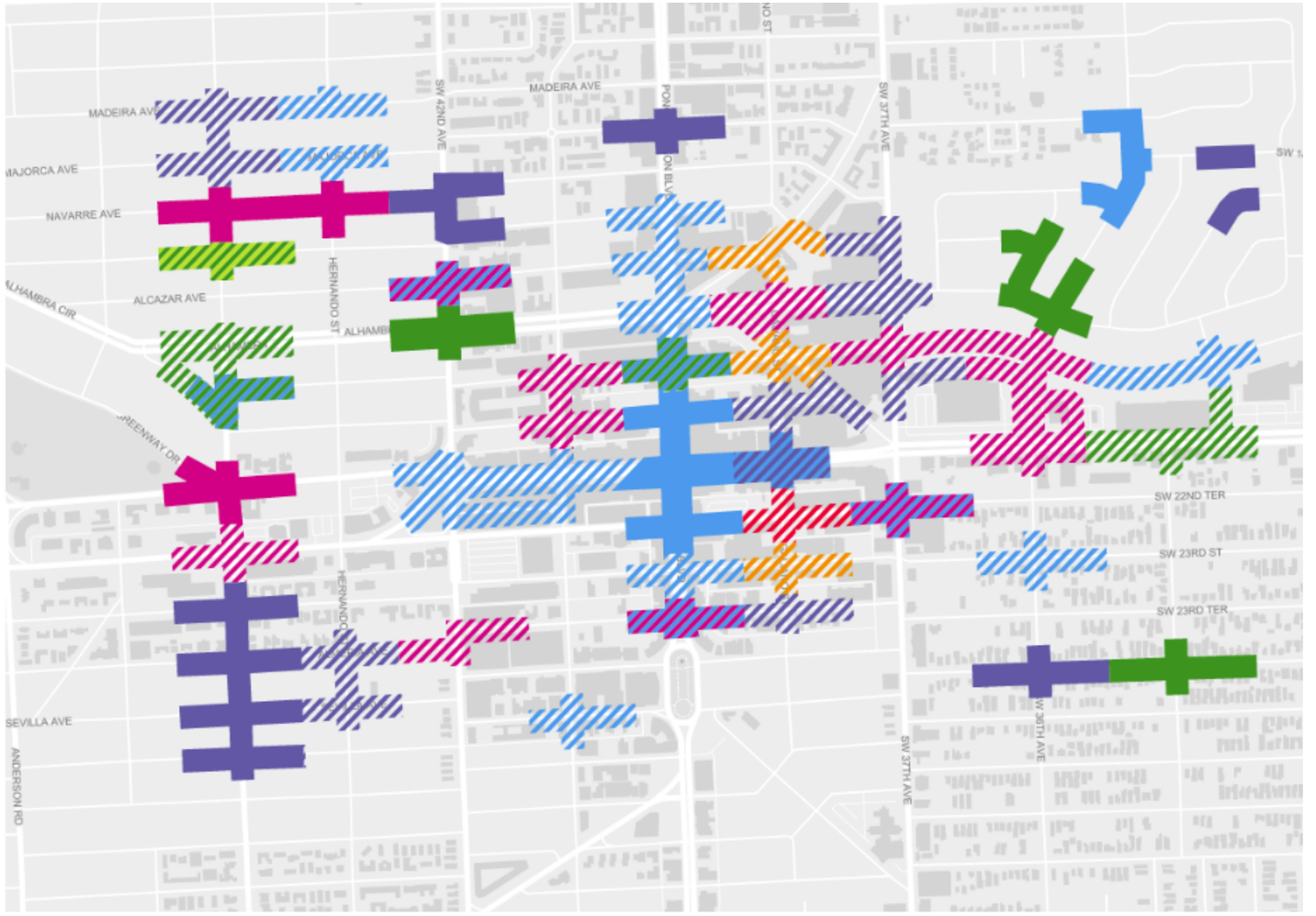
WATCHING SPORTS | EVENTS

@arionnation he has been our best bench guy this year (welp), but he has a lot of passed balls, which piss people off. also, he isn't gattis

anybody who has a choice this week and chooses chip/joe over vin scully to watch braves at dodgers is doing baseball all wrong

@mikenewmanrs lol, the best humor comes from pain (fortunately here, that is just baseball fan pain, not real life pain)

Слайд 20

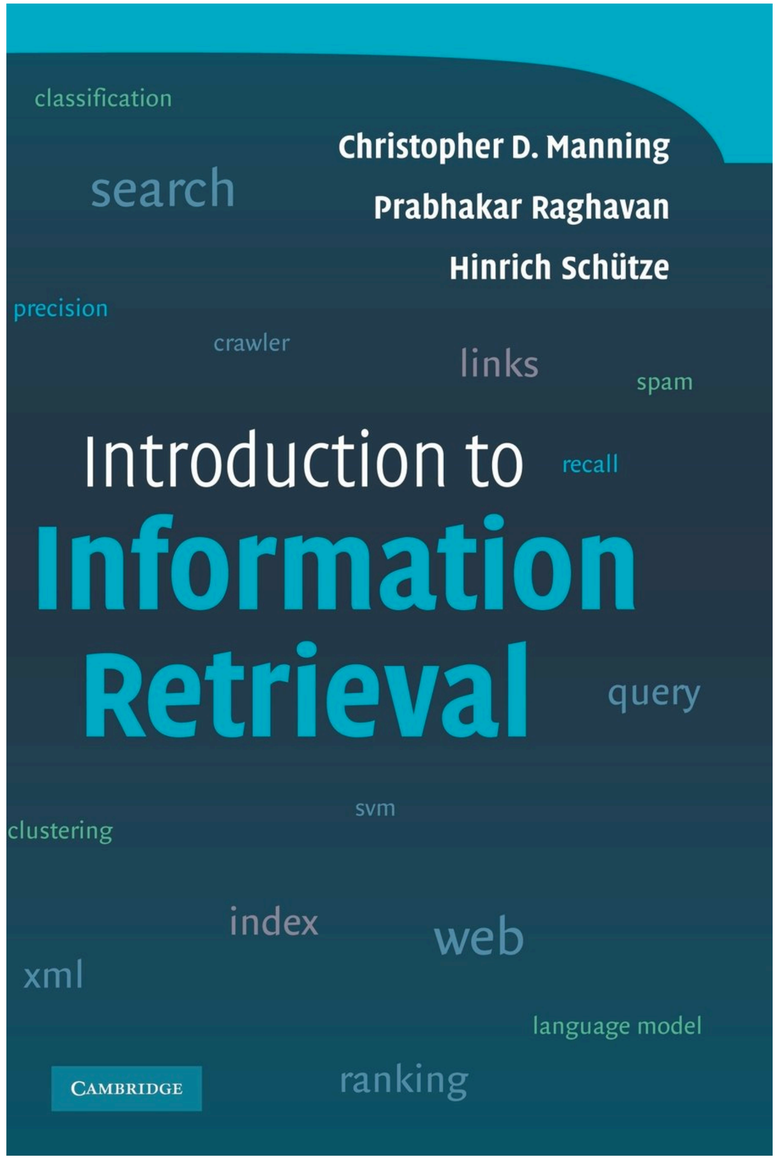


HABIDATUM

Information retrieval

Why?

- Huge intersection
- NLP is made from IR
- Good enough to start



Information retrieval formalism:

D - a set of documents (that is, texts + possibly some metadata)

Q - a set of queries, also a sequence of terms

We believe there is **Rel**: Q x D -> R — relevance score for document and query (a measure to what extent the user's information need (represented as a query) is satisfied by the document)

The goal is to find best-matching documents (in terms of Rel). On the fly

Information retrieval:

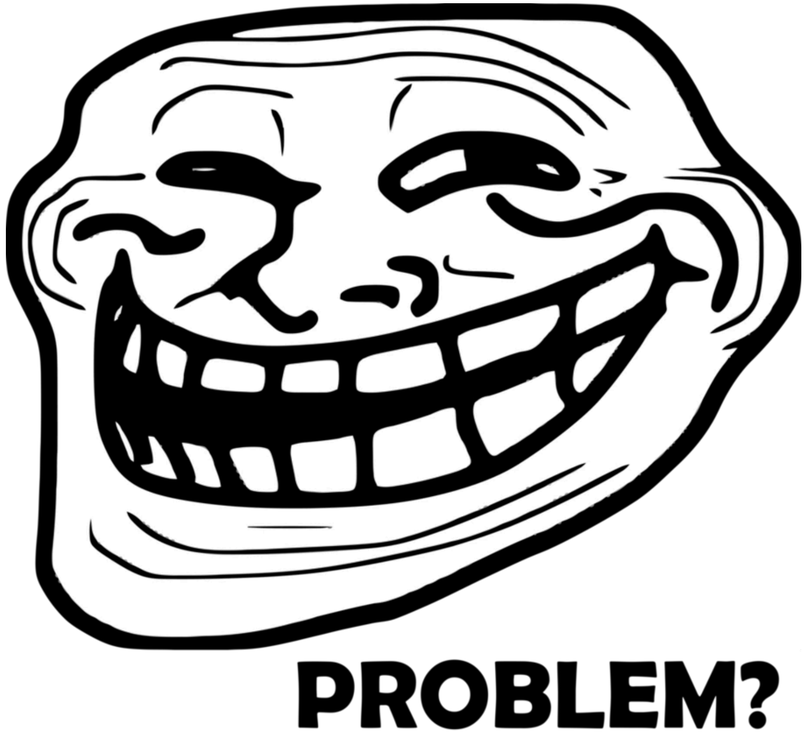
Plan:

1. Download whole internet
2. Invent Rel
3. Scan the database for every query
   and compute Rel for every query-document pair
4. ????
5. PROFIT!

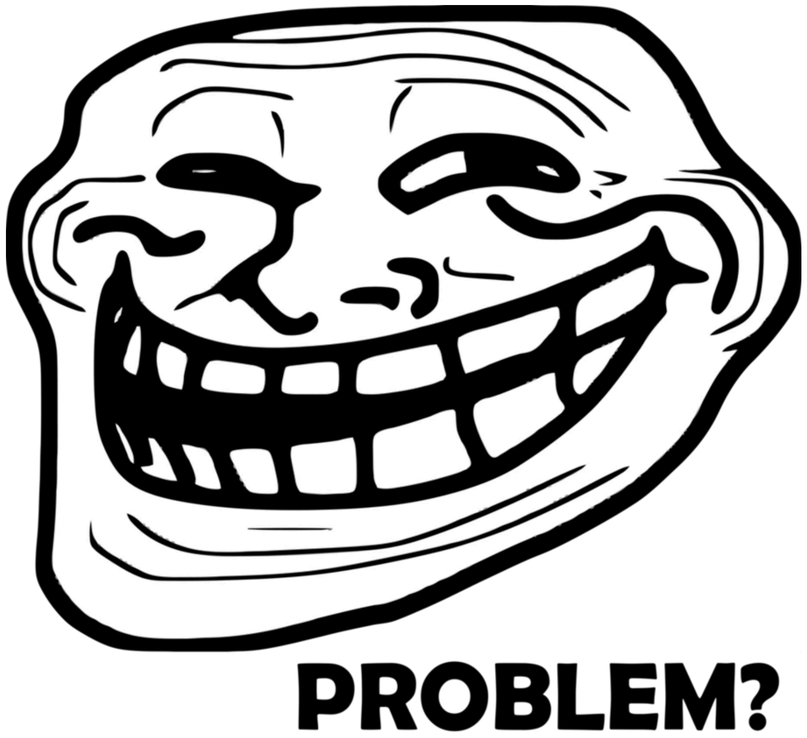
Information retrieval:

Plan:

1. Download whole internet
2. Invent Rel
3. Scan the database for every query
   and compute Rel for every query-document pair
4. ????
5. PROFIT!
6. PROBLEMS?



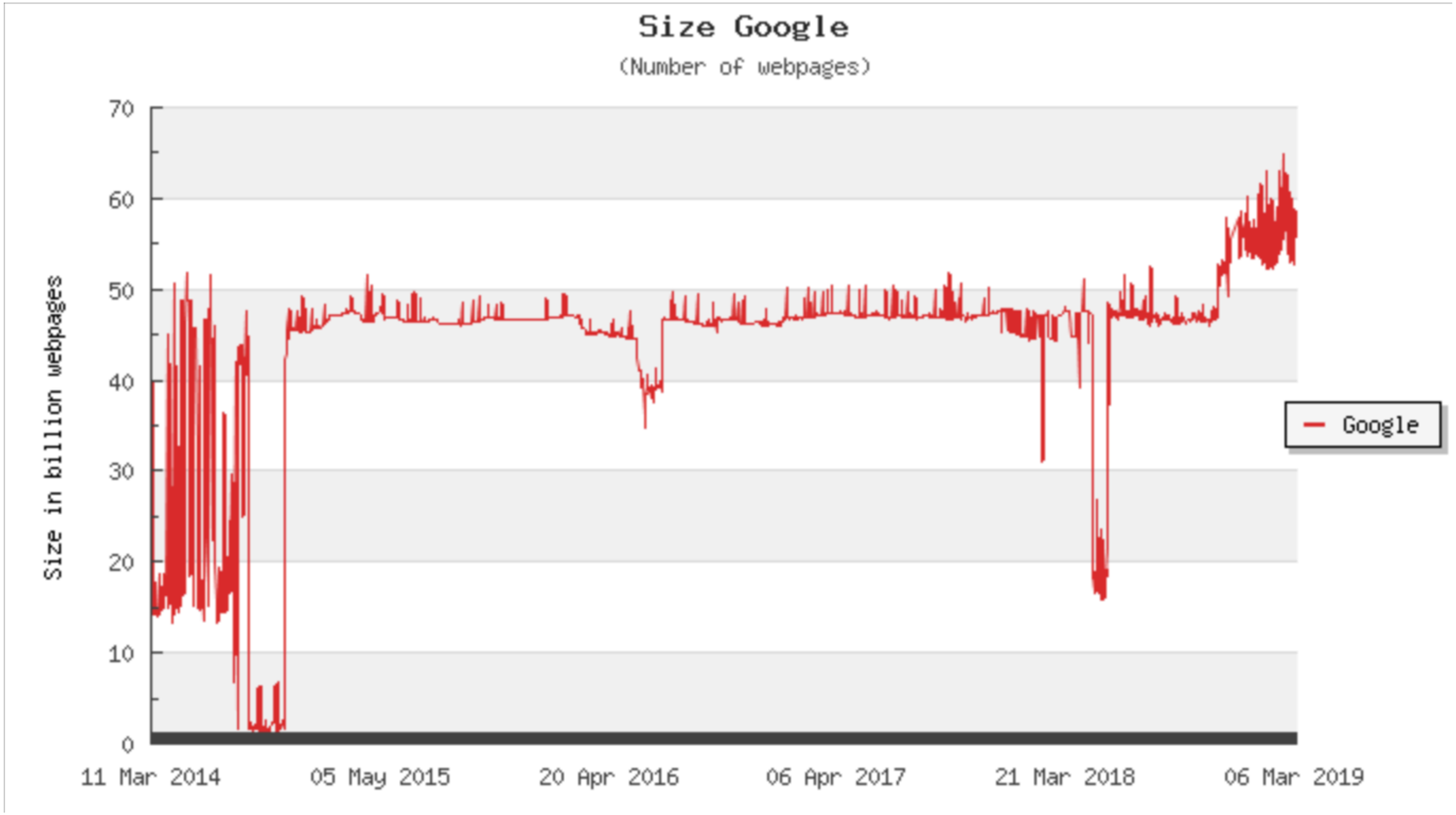
Information retrieval:



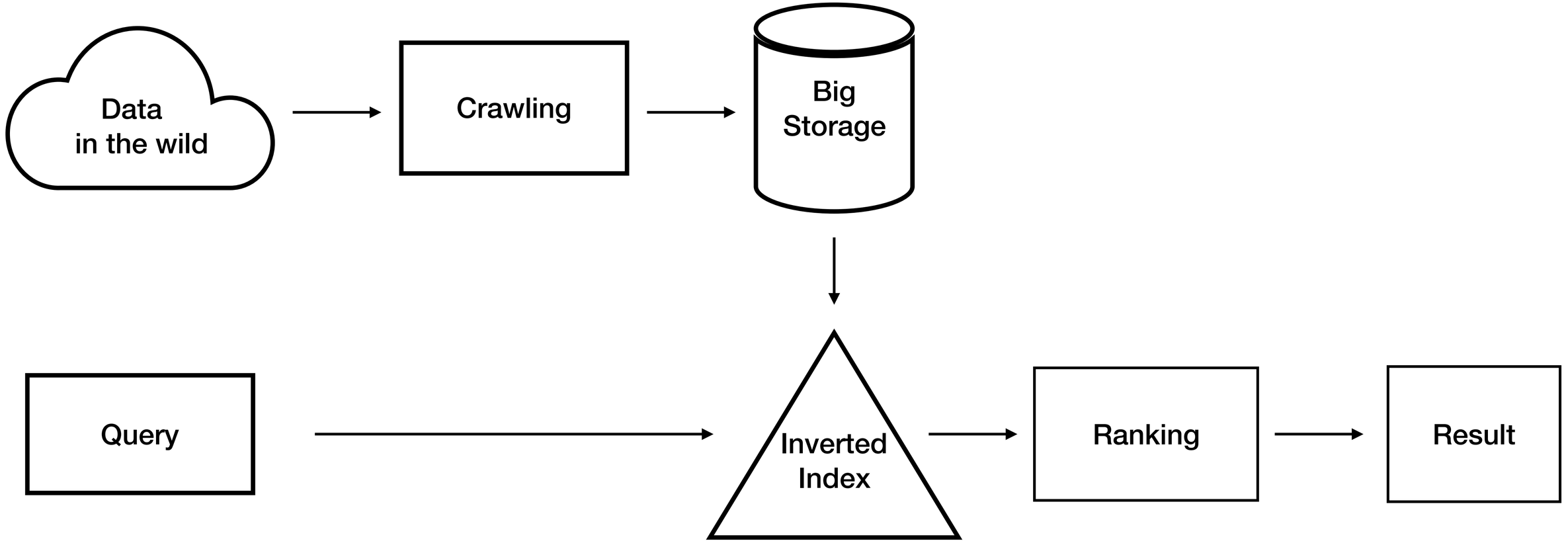
The goal is to find best-matching documents (in terms of Rel). **On the fly**

It’s not so simple

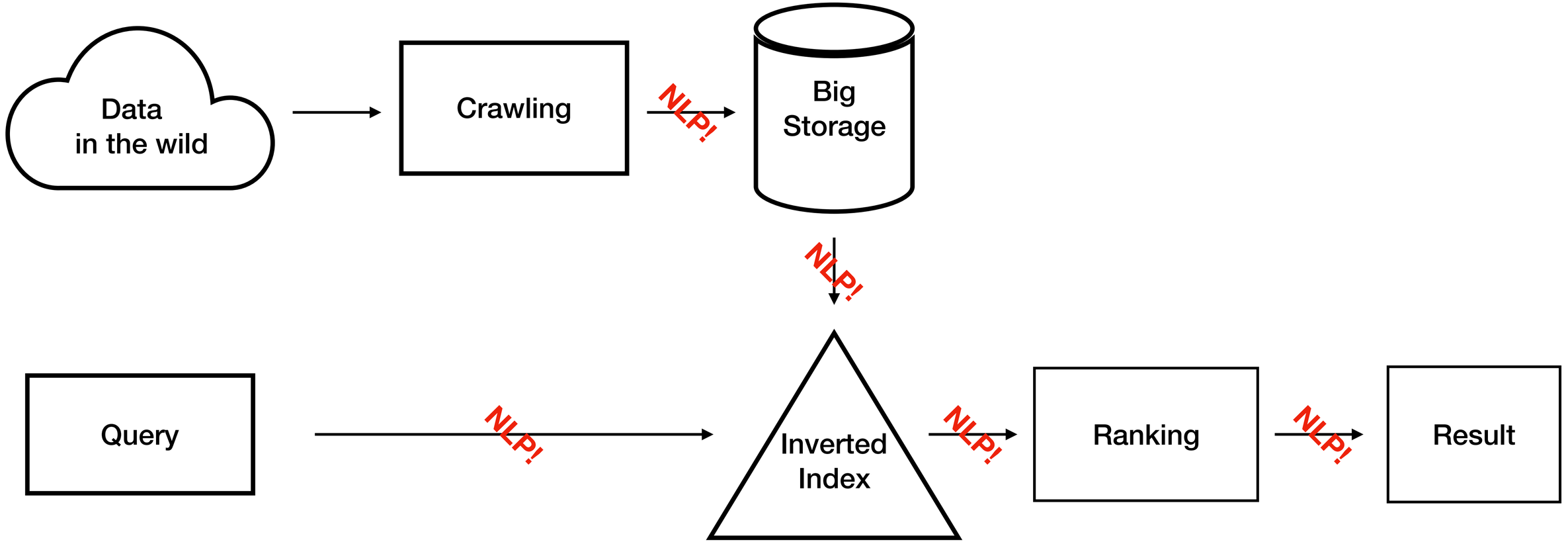
Google have to perform ~60M billion records per query!



General scheme:



General scheme:



By stages:

1. Collect data
2. Prepare documents
3. Process query
4. Retrieve by query
5. Rank documents
6. Prepare results
7. Personalize experience
8. Suggest query
9. Add wizard
10. …

Data preparation:

Dirty text:

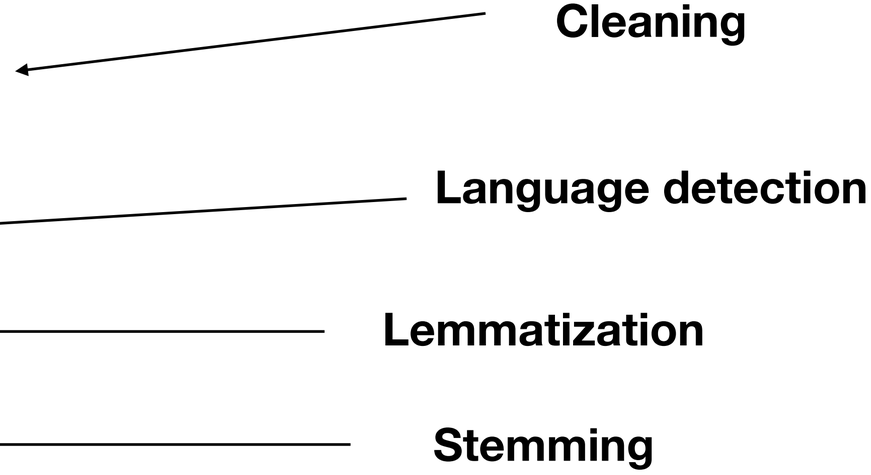
«На&nsbp;берегу пустынных&nsbp;волн»</p>

на берег**у** пустын**ных** волн

<на берег**у** пустын**ных** волн, RU>

на берег пустынный волна

(или: на берег пустын волн)



Data preparation: stemming

- Morphing words so that all possible forms of the word would turn into a single item, stem. Can be solved as a language-independent task.

- Usually when we say ‘stemming’ we mean cutting words (removing suffixes, prefixes, etc.) so that only the common part of all forms of the target word remains

- More widely spread and well-known is this one
  C.J. van Rijsbergen, S.E. Robertson and M.F. Porter, 1980. *New models in probabilistic information retrieval. London: British Library. (British Library Research and Development Report, no. 5587)*

The ‘condition’ part may also contain the following:

*S - the stem ends with S (and similarly for the other letters).
v - the stem contains a vowel.
*d - the stem ends with a double consonant (e.g. -TT, -SS).
*o - the stem ends cvc, where the second c is not W, X or Y (e.g. -WIL, -HOP).

The *rules* for removing a suffix will be given in the form

(condition) S1 -> S2

Step 1a

SSES -> SS	caresses -> caress
IES -> I	ponies -> poni

Data preparation: lemmatisation

- Preparing documents: lemmatisation
  - conversion to infinitive forms of words
- Usually: dictionary-based approach + morphological tricks!
- Russian: **mystem 3.0 / pymorphy2**
- Stemming: yandex myStem/nltk/spacy/ pattern (python) / apache lucene (Java)

By stages:

1. Collect data
2. Prepare documents
3. Process query
4. Retrieve by query
5. Rank documents
6. Prepare results
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8. Suggest query
9. Add wizard

Indexing (for boolean search)

So one does not simply scan the web

The minimal entity in search are **terms** -- so let us first learn how to retrieve documents containing certain terms and term combinations, that is, “boolean retrieval”

Information need = “would love to read wiki page on manul or maine coon”

Boolean query = “wiki” AND (“maine coon” OR “manul”)

Indexing

«wiki» and («manul» OF «maine coon»)

Long bit vectors + bitmasking for search!

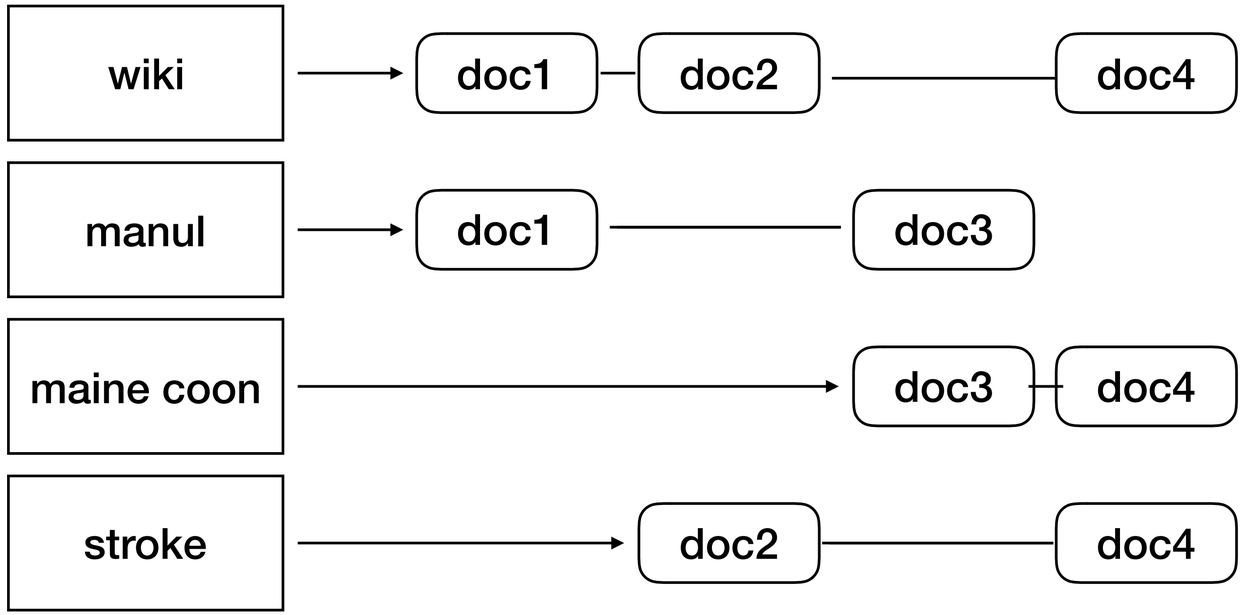
Is this an acceptable solution?

/	Wiki	manul	Maine coon	Stroke
doc1	1	1	0	0
doc2	1	0	0	1
doc3	0	1	1	0
doc4	1	0	1	1

Indexing

- «wiki» and «manul» or «maine coon»

/	Wiki	manul	Maine coon	Stroke
doc1	1	1	0	0
doc2	1	0	0	1
doc3	0	1	1	0
doc4	1	0	1	1



A dictionary, with linked lists of document meta information records (position in text, true word form, frequency of the term in concern in the document etc.) **ordered by document IDs**

Inverted index

- Inverted indices
  - **AND**: **intersection** of sorted lists
  - **OR**: **union** of sorted lists
- Multiple natural tricks for performance and quality boost:
  - store lists compressed and unpack on the fly when reading
  - store IDs diffs, not IDs themselves
  - add forward-links once in a while (skip-lists)
  - store positions of terms in the doc (allows to use distances between terms from query)

Query preprocessing:

Preparing the query the way we did with the document -- and we have the boolean retrieval system all set and ready.

Also a good idea in practice:

- add extra similar and relevant terms (query expansion)
- classification of query intention to understand which index to use (there may be many specific ones)

However, there are many more tricks, which are out of scope of this course

Ranking - is hard

Why is that hard?

jaguar

jaguar напиток

jaguar

jaguar xf

Jaguar в Санкт-Петербурге - отзывы, фото, телефоны,...
maps.yandex.ru › jaguar
Jaguar в Санкт-Петербурге - отзывы, фото, телефоны, адреса с рейтингом, отзывами и фотографиями. Адреса, телефоны, часы работы, схема проезда.

Jaguar — смотрите картинки
yandex.ru/images › jaguar

Jaguar — подержанные и новые авто в **Санкт-Петербурге**
Запчасти Объявления Отзывы Каталог Дилеры
auto.ru › Jaguar
Большая база объявлений о продаже автомобилей **Jaguar**. Полная информация об автомобилях — фотографии, отзывы, характеристики и цены.

Why is that hard?

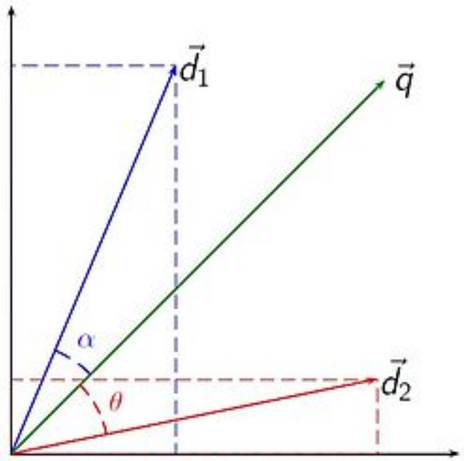
One have to solve multiple problems simultaneously:

1. Matching document and query
2. Document quality
3. Matching user’s interests and behavioral patterns*
4. Search results diversification (one of the “Jaguar case” solutions)
5. …

Classics: Vector Space Model (VSM)

Every text and every query is represented as a vector of the same fixed number of dimensions, then documents vector representations are sorted by the distance/closeness to the query vector

$$d_j = (w_{j1}, w_{j2} \ldots, w_{jn})$$
$$q = (w_{1q}, w_{2q}, \ldots, w_{nq})$$



$$cos\ \theta = \frac{d \cdot q}{||d|| \cdot ||q||}$$

$$sim(d_j, q) = \frac{d_j\ q}{||d_j||\ ||q||} = \frac{\sum_{i=1}^{N} w_{i,j} w_{i,q}}{\sqrt{\sum_{i=1}^{N} w_{i,j}^2} \sqrt{\sum_{i=1}^{N} w_{i,q}^2}}$$

Ranking: the task

The goal is to sort search results so that the most relevant would be at the top of the list

We can treat it as machine learning task to learn relevance function: **Rel**(D, Q) -> R

Approaches:

- **Elementwise** approach:
  We have relevance scores defined in train set; fitting to them

- **Pairwise** approach:
  Rel(d, q) < Rel(d', q), fitting the function given pairs

- **Listwise** approach:
  Lists of documents **{d^i },** sorted by relevance for **q**

Results preparation

Google

ranking ml memes

Все | Картинки | Новости | Видео | Покупки | Ещё | Настройки | Инструменты

Результатов: примерно 5 520 000 (0,61 сек.)

Картинки по запросу ranking ml memes

→ Другие картинки по запросу "ranking ml memes"

Пожаловаться на картинки

Ranked Lists | Know Your Meme
https://knowyourmeme.com/memes/ranked-lists ▾ Перевести эту страницу
Ranked Lists is a phrasal template in which people use the format of a **ranked** list to express the pointlessness of the exercise. However, the number one slot ...
Не найдено: ~~ml~~

Best Memes of 2018: Most Popular Memes of Last Year - Thrillist
https://www.thrillist.com/entertainment/.../best-memes-2018 ▾ Перевести эту страницу
2018's **memes** had big shoes to fill -- it's tough to beat a year of blinking guy, Salt Bae, and disrespectful .... **MLB** Insider Dinger (@atf13atf) February 12, 2018 ...

The 15 best ranking memes, ranked - Mashable
https://mashable.com/article/ranked-memes-ranking/ ▾ Перевести эту страницу
26 июн. 2018 г. - A **ranked ranking** of the best **ranking memes**. **Rank rank rank rank rank**.
Не найдено: ~~ml~~

ranking ml memes

Web | Images | Video | News | More | Anytime

The Phenomena Behind Popular Memes: How Ranking Algorithms ...
www.analyticsindiamag.com/the-phenomena-behind...
The Phenomena Behind Popular **Memes**: How **Ranking** Algorithms Are Making Only Some Posts Richer. ... Tags algorithms **machine learning** popularity based **ranking ranking**.

The Week's Best Memes, Ranked - Digg
digg.com/2019/meme-ranking-really-choking-sasuke
The Official Josco™ 2019 **Meme** Power **Ranking** As the weeks go by, we'll keep **ranking memes**, and the 2019 Power **Ranking** will take shape. For now, we have this week's **memes**.

Ranking Ml Memes - Image Results

More Ranking Ml Memes images

This Week's Best Memes, Ranked - Digg
digg.com/2019/meme-ranking-mulaney-shaggy-thotiana
The Official Josco™ 2019 **Meme** Power **Ranking** As year goes on, we'll keep **ranking memes**, and the 2019 Power **Ranking** will take shape. For now, we have this week and last week's **memes**.

The ranking meme is the ultimate meme for superfans ...
www.someecards.com/life/lifestyle/ranking-memes
The **ranking meme** is the ultimate **meme** for superfans. Orli Matlow. Jun 27, 2018 @ 4:39 PM. Advertising. The latest hot **meme** since yesterday's hottest **meme** (shout out ...

How to build your own IR engine:

- **Python:**
  - Scrapy, requests/urllib + BeautifulSoup
  - Pylucene, Xapian
- **Java**:
  - Crawling: Nutch, StormCrawler, …
  - Retrieval: Lucene (Java library), ElasticSearch (incl. Lucene), Solr

Other tasks from IR:

- Query correction/augmentation
- Query expansion: morphology, semantics
- Search/suggestions personalization
- Dealing with queries semantic ambiguity
- Fact extraction

- Smart suggestions
- Queries classification
- Document clustering
- Duplicate detection
- Virus / spam detection
- Events detection

Remarks about IR + NLP

- It is mainly thanks to IR community's efforts that evaluation of data processing algorithms became a common practice (esp. in NLP)
- IR != NLP, but IR + NLP = <3
  interconnections & common tricks
- Web search is probably the most successful case of applying NLP in production (though the number grows)