Information Retrievel with PostgreSQL

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Outline

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Information Retrieval System (IRS)

Information Retrieval (IR)

- Information retrieval is the science of searching for information in a document
- An IR system is a software system that provides access to books, journals and other documents; stores and manages those documents.
- Web search engines are the most visible IR applications.

Full-Text-Search

The activity of searching through a collection of natural-language documents to locate those that best match a query

Objectives

- How does an IRS look made of a relational database
- Finding different database models
- Python api for the database creation and communication
- Crawl Wikipages to gather text data
- Use special type in PostgreSQL named tsvector

Support search querys with the boolean operator AND

Tsvector and Tsquery

- PostgreSQL provides **two** data types that are designed to support full text search
- The **tsvector** type represents a document in a form optimized for text search
- The **tsquery** type similarly represents a text query

Example Tsvector

SELECT to_tsvector('english', 'The Fat Rats');
{'fat':2 'rat':3}

Example Tsquery

SELECT to_tsquery('Fat:ab & Cats');
{'fat':AB & 'cat'}

Outline

Realization

Wiki crawler

- Based on package wikipedia version 1.4.0
- Takes number of pages and category as input
- Also searches in subcategories
- Variable level of subcategories

Database pipeline

- Used package psycopg2 version 2.8.5
- Custom converter for tsvector

Text Data Statistics

Wikipedia Category "Sports"

- Number of Wiki pages: 2000
- Number of sections (captions also count as section): 45756
- Total number of words: 17587832
- Total number of lexemes: 1969427

- Max number of words of a page: 124136
- Max number of lexemes of a page: 17787

- Max number of words of a section: 24163
- Max number of lexemes of a section: 2785
- Average number of words per section: 734.7

Text Data Statistics 2

Top 10 Frequent Terms

(1)	"game"	TF: 14044	DocF: 5370
(2)	"world"	TF: 13568	DocF: 6144
(3)	"championship"	TF: 12106	DocF: 5475
(4)	"team"	TF: 11955	DocF: 4362
(5)	"sport"	TF: 10658	DocF: 5014
(6)	"1"	TF: 10237	DocF: 4029
(7)	"first"	TF: 10199	DocF: 5073
(8)	"player"	TF: 9577	DocF: 3243
(9)	"2"	TF: 9090	DocF: 3821
(10)	"play"	TF: 9082	DocF: 3827

TF = term frequency DocF = document frequency

Three Database Model Approaches

Tsvector

- full text search with tsvector
- ranking function of tsvector
- weighting of tsvector
- tokenization and lemmatization
- tsquery

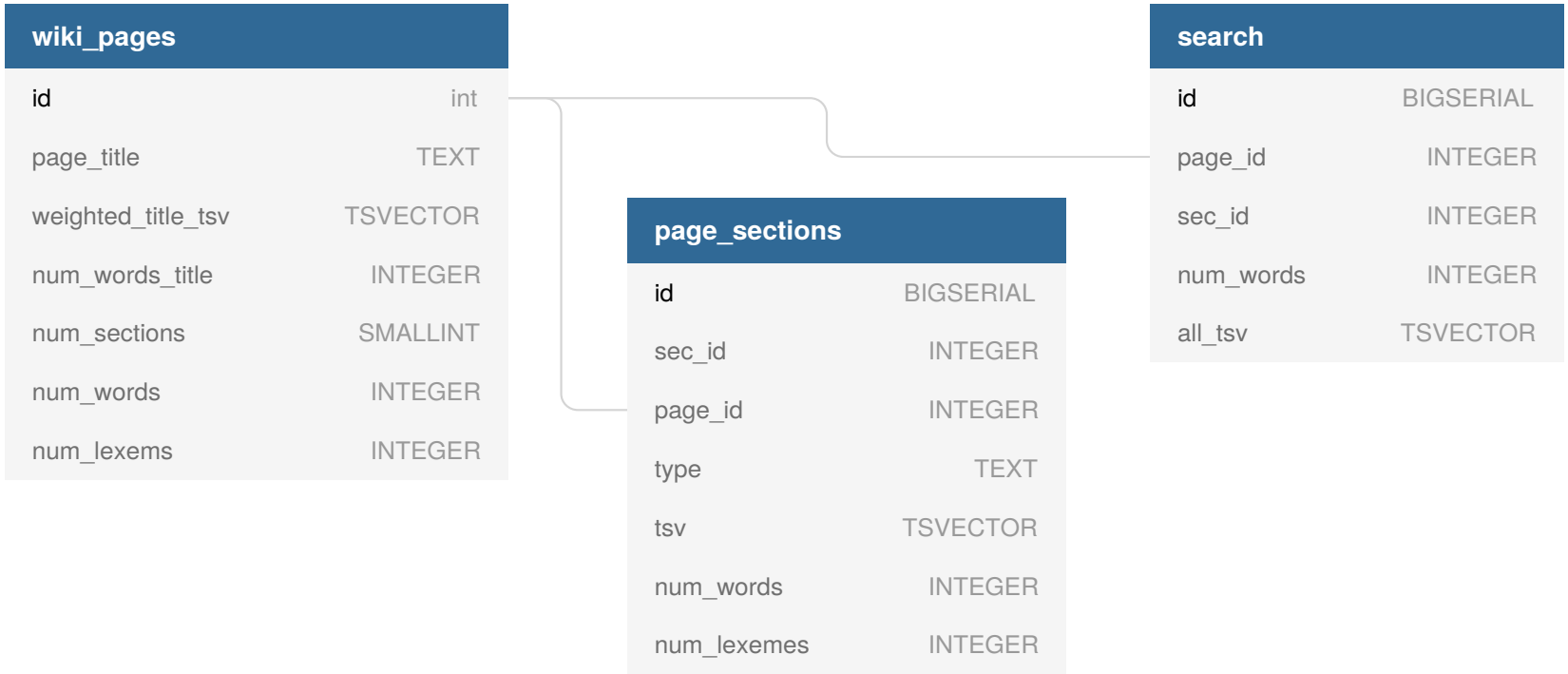
Mix

- raw tsvector + word-matrix for each doc
- needs a lot of memory
- customizable

Word-matrix

- one big word-matrix
- probably slow

Database model



Tsvector

Possibilities

- Full text search
- GIN-Index
- Automatic tokenization and lemmatization
- Adding weights
- Predefined ranking function

Limitations

- The number of lexemes must be less than 2^{64}
- Max position value: 16383
- No more than 256 positions per lexeme
- Relative small set of manipulation methods
- Ranking function must be customized

Outline

Reason to Extend PostgreSQL

Only a few manipulation methods for tsvectors exist

For example it is not possible to:

- count number of **all** lexemes in a tsvector
- create a tsvector with an offset for the position index
- get the max index of a tsvector
- concatenate two tsvecotrs without changing the position values

Solution

Write your own function either in plpgsql language or in C

Custom C-Functions in PostgreSQL

Prerequisites

- Developer version of PostgreSQL
- Installation of make
- Root privilege on database

Folder structure

```
Extension
├── function.c
├── Makefile
├── function.control
├── function--1.0.sql
└── README.function
```

Steps

(1) make install

(2) CREATE EXTENSION "extension"

Outline

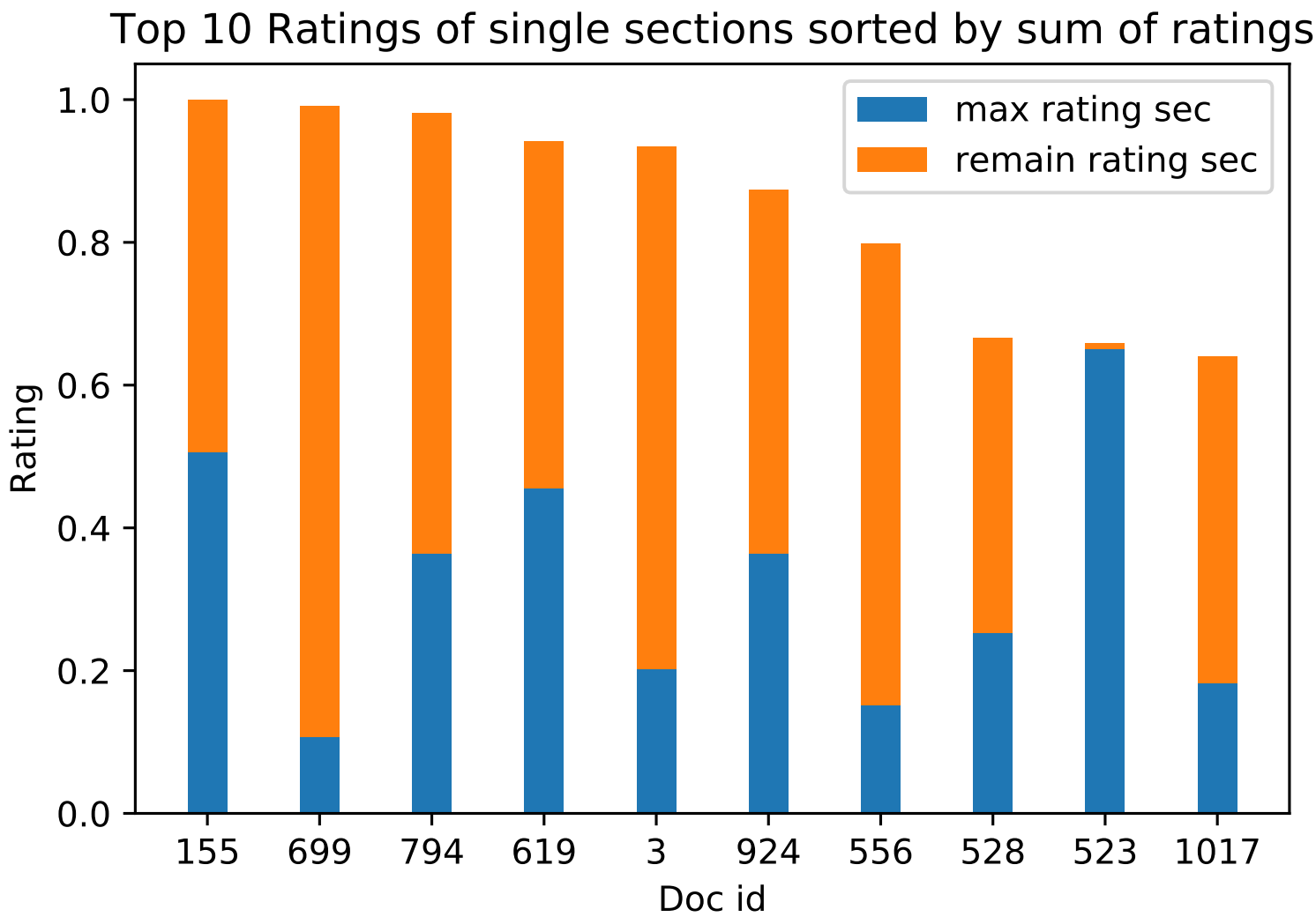
Idea

- Thought the task is to rank whole wiki pages
- User wants the most relevant section and not the "best" document
- So how is the relationship between page and section ranking

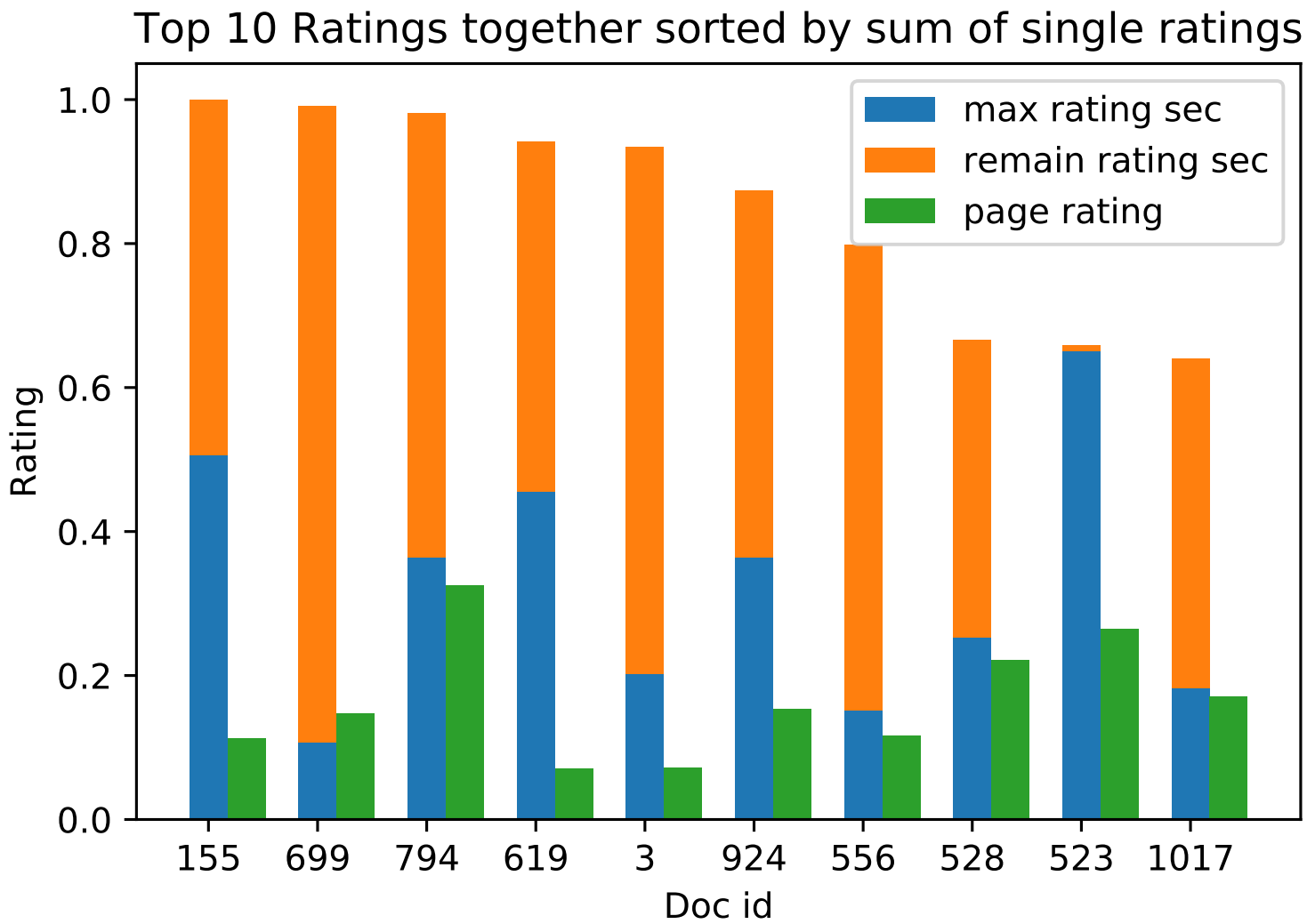
Calculation of Ranking

- **section**: ranking / num_words_of_section
- **page**: sum_of_rankings / num_words_of_page

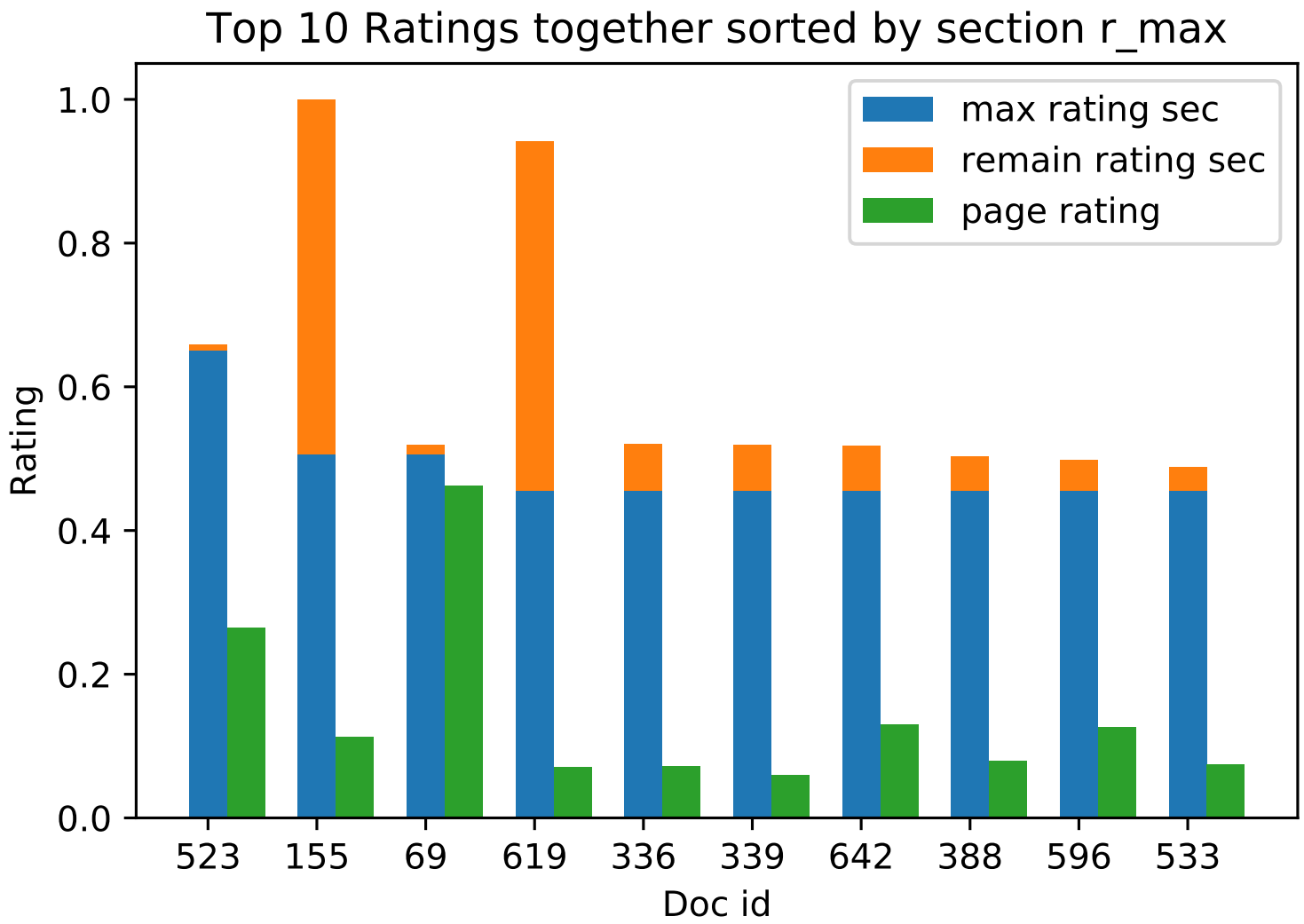
Query:"game", Sorted by Sum of Section Rankings



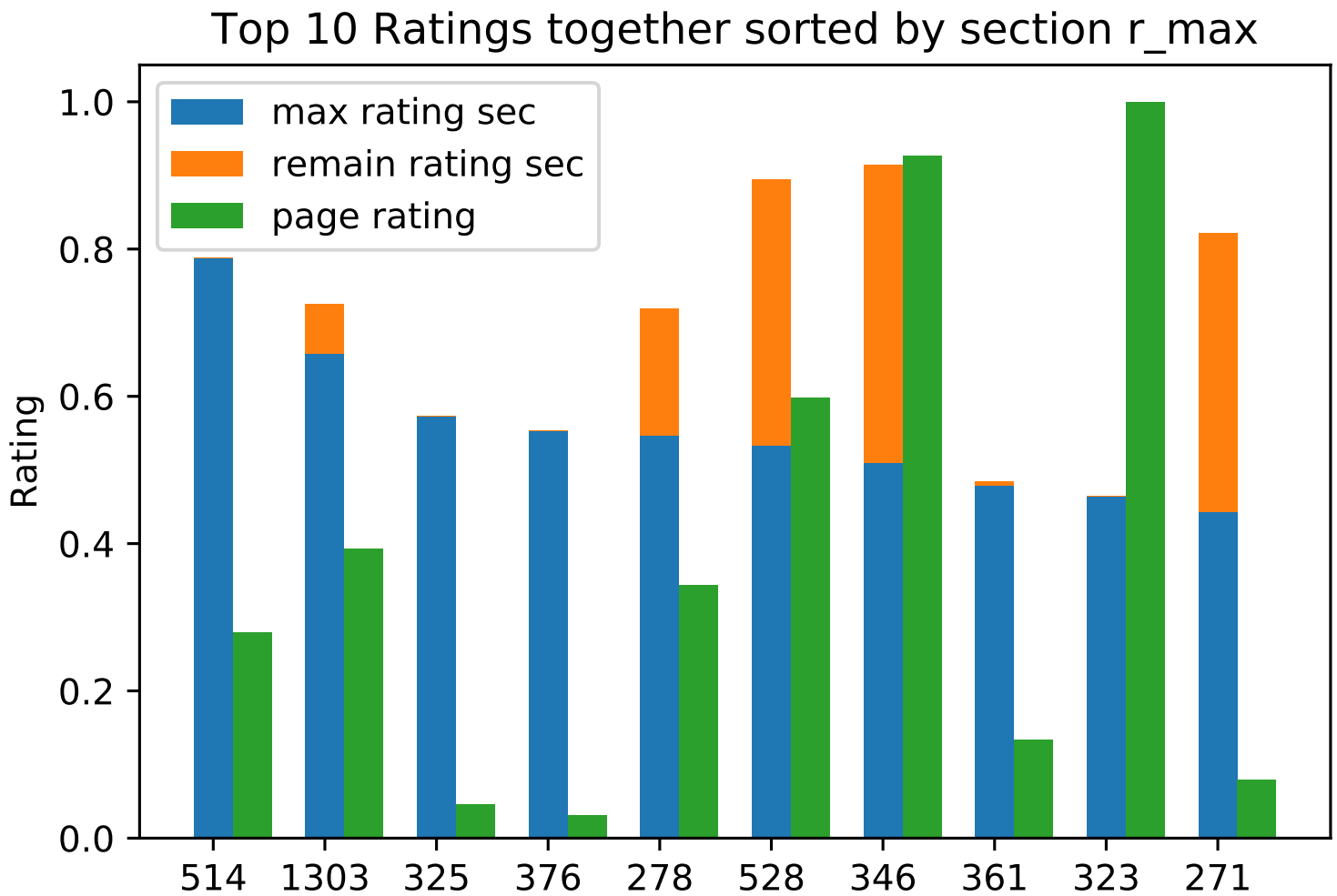
Query:"game", Adding The Rank for the Whole Page



Query:"game", Ordered by Max Section Ranking



Query:"game AND team AND ball", Ordered by Max Section Ranking



Distance Between Rankings

Calculating Distance

- To calculate the difference between pageranking and sectionranking
- Distance first of max section rank to first of max page rank, distance of second max section ranking to second of max page rank and so on...

Query "game"

- result pages: 1176
- Top 10 - 289.5 avg(dist)
- Top 20 - 250.9 avg(dist)
- Top 30 - 183.2 avg(dist)
- Top 40 - 155.5 avg(dist)

Query "game & team & ball"

- result pages: 274
- Top 10 - 36.0 avg(dist)
- Top 20 - 40.6 avg(dist)
- Top 30 - 36.6 avg(dist)
- Top 40 - 34.0 avg(dist)

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Conclusion and Future Work

Conclusion

- Rankings for sections and page return total different results
- Tsvector has a lot of potential
- PostgreSQL is easy customizable
- TODO comparing performance and ranking to solr

Future Work

- Improve the ranking algorithm with tf idf information (ts_stat)
- Tests on big datasets

Questions

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