Text Search and Similarity Search

PG 12.1–12.2, F.31

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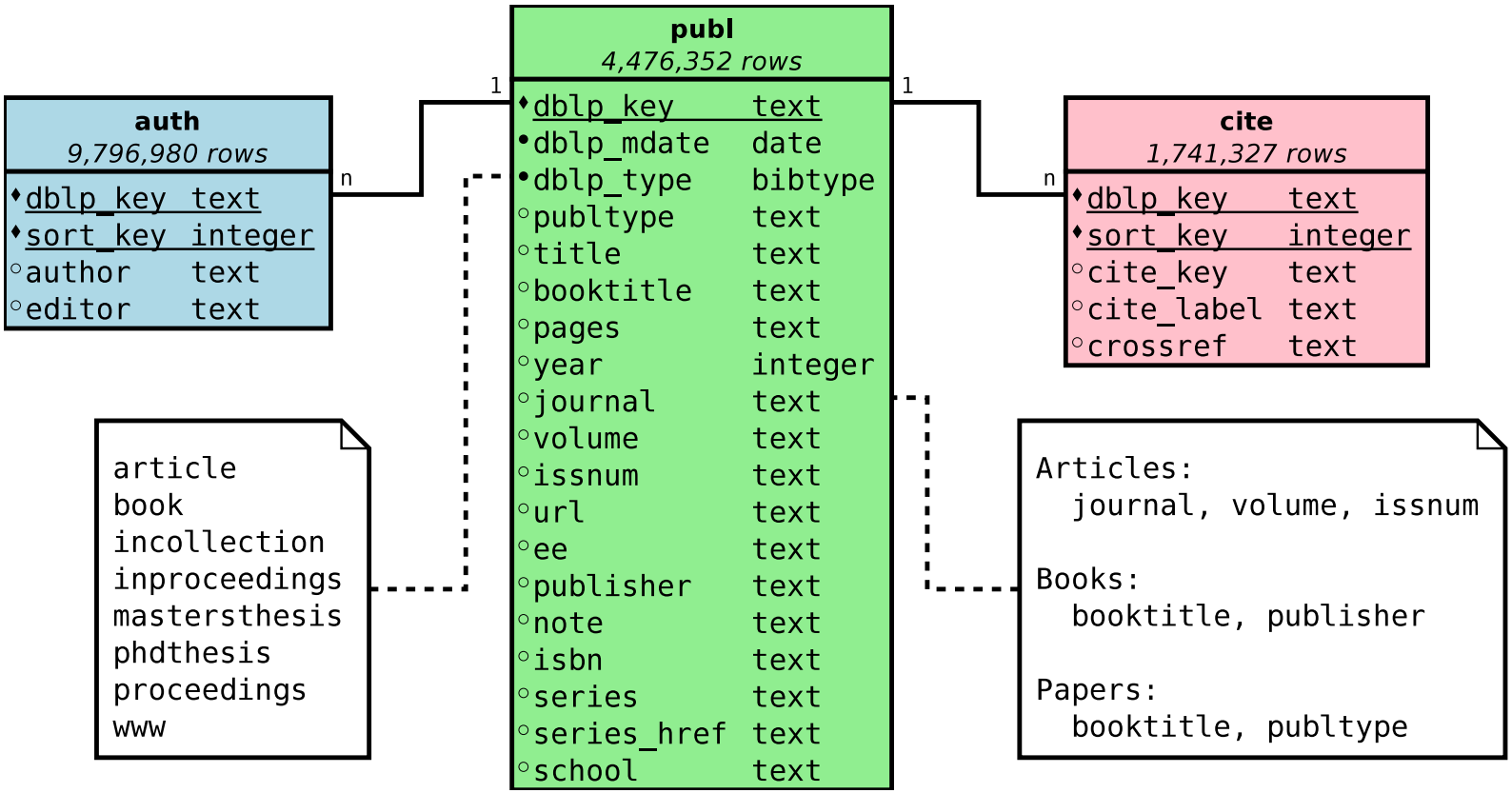
Hello DBLP

Database of CS journal articles and conference proceedings



Home page: https://dblp.org/

See also https://dl.acm.org/ and https://citeseerx.ist.psu.edu/

Example queries

```sql
-- find publications for an author
SELECT
  dblp_type, title, booktitle,
  journal, pages, ee, year
FROM publ
  NATURAL JOIN auth
WHERE author = 'Chris Mayfield'
  AND dblp_type <> 'www'
ORDER BY year DESC;

-- list proceedings of SIGMOD 2010
SELECT
  dblp_key, title, pages, ee
FROM publ
  NATURAL JOIN cite
WHERE crossref = 'conf/sigmod/2010'
ORDER BY split_part(pages, '-', 1)::integer;
```

Full Text Search

Using `tsvector` and `tsquery`

Motivation

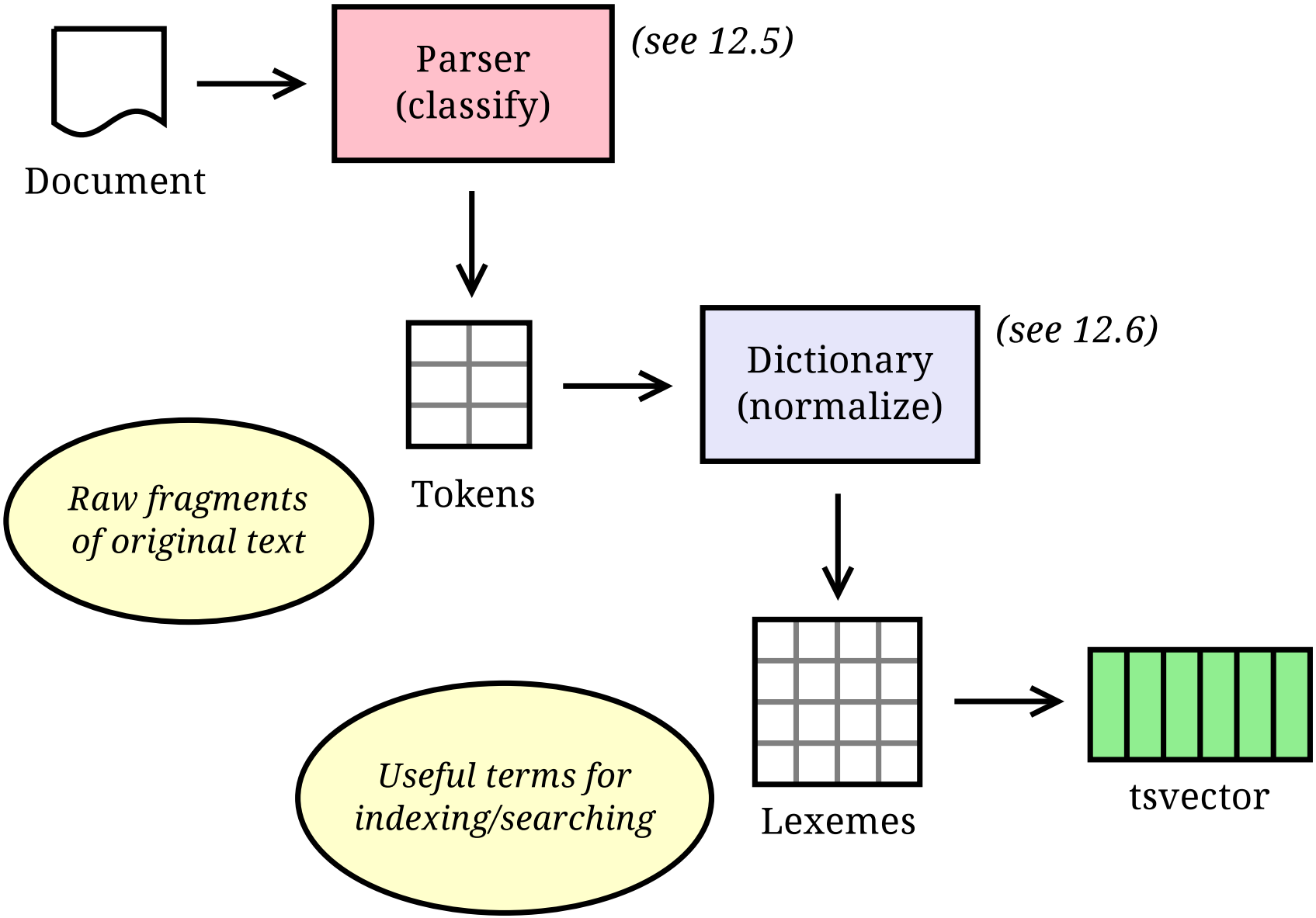
Write a query to select this paper: "ERACER: A Database Approach for Statistical Inference and Data Cleaning"

```
WHERE title = '...'

WHERE title LIKE '%Approach%'

WHERE title LIKE '%Approach%Cleaning%'
```

What's wrong with = and `LIKE`?

1. No linguistic support (cleaning vs cleansing)
2. No ranking of results (order by relevance)
3. Limited index support (must be left anchored)
4. Difficult to search for multiple words / phrases

How FTS works



Text search vectors

The `to_tsvector` function runs the whole process:

```
SELECT to_tsvector('Thanks for giving your BEST TRY!');
```

```
'best':5 'give':3 'thank':1 'tri':6
```

"A `tsvector` value is a sorted list of distinct lexemes, which are words that have been normalized to merge different variants of the same word."

(https://www.postgresql.org/docs/11/datatype-textsearch.html)

Text search queries

The `plainto_tsquery` function is similar:

```
SELECT plainto_tsquery('Try your best');
```

```
'tri' & 'best'
```

"A `tsquery` value stores lexemes that are to be searched for, and combines them honoring the Boolean operators `&`, `|`, and `!`."

(https://www.postgresql.org/docs/11/datatype-textsearch.html)

FTS example in SQL

Use the @@ operator to run full text search

```
tsvector @@ tsquery
tsquery  @@ tsvector
text @@ tsquery
text @@ text      -- to_tsvector(x) @@ plainto_tsquery(y)
```

For example:

```
SELECT * FROM publ
WHERE title @@ 'clean data';
```

- Sequential scan takes forever (i.e., 80 seconds)

Indexing tsvectors

1. Create new table/column of text search vectors

```
CREATE TABLE publ_fts AS
  SELECT dblp_key, to_tsvector(title) AS title_tsv
  FROM publ;
```

2. Create a *Generalized Inverted Index*

```
CREATE INDEX ON publ_fts USING gin (title_tsv);
```

3. Search the index and join the results

```
SELECT * FROM publ NATURAL JOIN publ_fts
WHERE title_tsv @@ plainto_tsquery('clean data');
```

- Bitmap index scan + Index join (about 100 ms)

https://www.postgresql.org/docs/11/textsearch-indexes.html

Debugging and statistics

See what parser/dictionary are doing:

```
SELECT * FROM ts_debug('Now this is clean data!');
```

Calculate document statistics:

```
SELECT *
FROM ts_stat('SELECT title_tsv FROM publ_fts')
ORDER BY nentry DESC, ndoc DESC, word
LIMIT 100;
```

DBLP `title` statistics

- Unique words: 496,644 / Total words: 26,426,910
- Most frequent word: *base* 337,533 docs / 343,480 entries

https://www.postgresql.org/docs/11/functions-textsearch.html

How dictionaries work

A dictionary is a function that accepts a token and returns:

- An array of lexemes, if token is known
- An empty array, if token is a stop word
- New version of the lexeme (if filtering)
- `NULL` if the token is not recognized

Example dictionaries:

- `simple` - remove the stop words (the, and, a, . . .)
- `snowball` - canonical form using *Snowball* stemmer
- `ispell` - use spell checker for word variations
- `synonym` - map related words to a single word
- `thesaurus` - map phrases to a single word

Ranking query results

Many ways to define relevance

- Built-in `ts_rank` function takes into account: lexical, proximity, and structural information

```
SELECT
  dblp_key,
  ts_headline(title, tsq) AS body,
  ts_rank(title_tsv, tsq) AS rank
FROM publ NATURAL JOIN publ_fts,
  plainto_tsquery('approach for cleaning data') AS tsq
WHERE title_tsv @@ tsq
ORDER BY rank DESC;
```

- Tip: call functions in `FROM` clause to reuse them
- Comma means `CROSS JOIN`, but it's only one row

https://www.postgresql.org/docs/11/textsearch-controls.html

Similarity Search

Using the `pg_trgm` module

Problem with real data

Based on the original CSV files from VDOE's website

```
SELECT div_num, sch_num, count(DISTINCT sch_name)
FROM fall_membership
GROUP BY div_num, sch_num
HAVING count(DISTINCT sch_name) > 2
ORDER BY count DESC;
```

div=029 sch=1371

- Thomas Jefferson High
- Thomas Jefferson High School
- Thomas Jefferson High School for Science and Technology
- Thomas Jefferson High for Science and Technology

div=043 sch=0600

- John RandolphTucker High
- John Randolph Tucker High
- Tucker High
- John Randolphtucker High

Similarity queries

How do you join with other data sets?

- Names of cities and counties in VA
- Names of schools (past and present)

One solution: approximate string matching

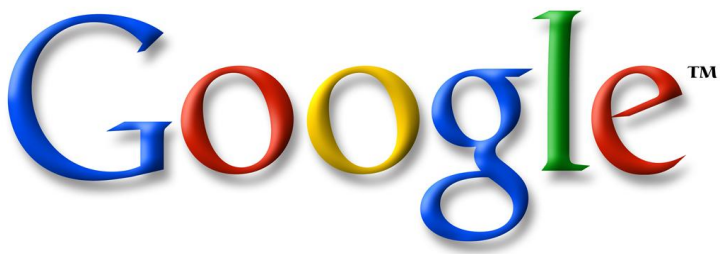
- Fuzzy string search
- Levenshtein distance
- Regular expressions
- Soundex / metaphone
- ...

Example: n-grams

"An n-gram is a contiguous sequence of n items from a given sequence of text or speech."

https://en.wikipedia.org/wiki/N-gram

https://books.google.com/ngrams/ (see About page)



Trigram (or trigraph)

https://www.postgresql.org/docs/11/pgtrgm.html

- A trigram is a group of three consecutive characters taken from a string.
- We can measure the similarity of two strings by counting the number of trigrams they share.
- Each word is considered to have two spaces prefixed and one space suffixed.
- For example, the set of trigrams in the string `'cat'` is:
  `'  c'`, `' ca'`, `'cat'`, `'at '`

Trigram module

To install in your database:

```
CREATE EXTENSION pg_trgm;  -- must be superuser
```

Example queries:

```
-- how similar are the two strings?
SELECT similarity('Rockingham County',
                  'County of Rockingham');


-- true if similarity > threshold (0.3 by default)
SELECT set_limit(0.75);
SELECT 'Rockingham County' % 'County of Rockingham';
```

- GiST and GIN index support for %, `LIKE`, and regex

Text search integration

Use `simple` TS config to analyze originial (unstemmed) words

```
CREATE TABLE stats AS
  SELECT * FROM ts_stat('
    SELECT to_tsvector(''simple'', title) FROM publ');
```

GIN is faster to search than GiST, but slower to build/update

```
  CREATE INDEX ON stats USING gin (word gin_trgm_ops);
--CREATE INDEX ON stats USING gist (word gist_trgm_ops);
```

Suggest corrections for misspelled words

```
SELECT * FROM stats
WHERE word % 'algorithum'
ORDER BY ndoc DESC
LIMIT 5;
```