An analysis of scholarly citations in Wikipedia

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March 24, 2016

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Wikipedia

- Free-access, free-content Internet encyclopedia
- One of the most popular web sites
- Started in 2001
- Studied by many
  - Quality of citations [4]
  - Illness prediction [2]
  - Stock market moves strategy [3]

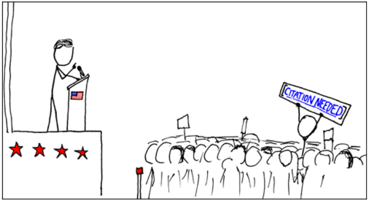


Figure: Wikipedian protester (xkcd.com/285)

Purpose of this work

- Analyze the quality of papers in Wikipedia, in term of:
    - Freshness of citations
    - Popularity of cited papers
    - Rank of cited journals
    - Lifetime of citations

Available datasets

- Microsoft Academic Graph: a dataset containing data about papers, authors, references, journals, conferences, etc.
- Wikipedia dumps: text of all page revisions since the beginning
- Wikimedia hourly page view statistics

Microsoft Academic Graph

- Dataset powering the Microsoft Academic Search engine
- Size: 96 GB
- Contains over 120M papers (1800 – 2016)
- Information about papers, authors, references, journals, conferences, keywords, etc.
- Papers identified by a Digital Object Identifier (DOI)
- Problems
  - Only *computer science* conferences
  - Some of papers' publication dates are incomplete
  - Not all the papers have a DOI (32% of them)

The missing pieces — Contributions

- History of papers appearing in Wikipedia (where and when)
- Page views dataset for large-scale article analysis

Extracting citations from Wikipedia

Problems

- Citations can be structured: *wikimarkup* templates
  - Many different variants
  - Anybody can use custom macros
  - Different templates for each language
- or unstructured: plain text
  - Recognize substrings that appear to be citations
- Entity disambiguation
- Dataset size: 13,3 TB as of September 1st, 2015

Solution

- Focus on publication identifiers (*DOI*, *PMID*, *arXiv*, *ISBN*)
- The **wikidump** framework

Wikidump

- Facility framework to extract **features** from Wikipedia XML dumps
  - Publication identifiers
  - Wikilinks
  - Page statistics
- Based on libraries by Aaron Halfaker
- Low memory consumption
- Highly parallelizable
- Written in Python
- Processed 445M page revisions (13,3 TB) in 21 hours

Type	Count
ISBN	1 153 330
DOI	651 199
PMID	372 939
arXiv	18 832

Table: Number of identifiers extracted

Wikimedia page views

Contains information about page visualization for all the Wikimedia projects, for all the languages.

Problems

- Dataset size: 23 TB (4,7 TB for the 2014)
- Aggregated and ordered by hour (8670 files per year)
- They need to be cleaned
- They need to be **reordered**
- Unfeasible on a single machine

Solution

- Clean and sort the dataset exploiting the UniTN Cisca Cluster
- 2014 dataset already published [1]

The Spark job

- Apache Spark: framework for large-scale data processing
- UniTN Cisca Cluster:
  - 125 workstations
  - 500 CPU cores in total
  - Available only at night and in the weekend
- Steps:
  - Normalize the content
  - Repartition the keyspace
  - Sort each partition locally

- Took one night to analyze and recreate the 2014 dataset
- Took many nights to get it to work

The Spark job — Workflow

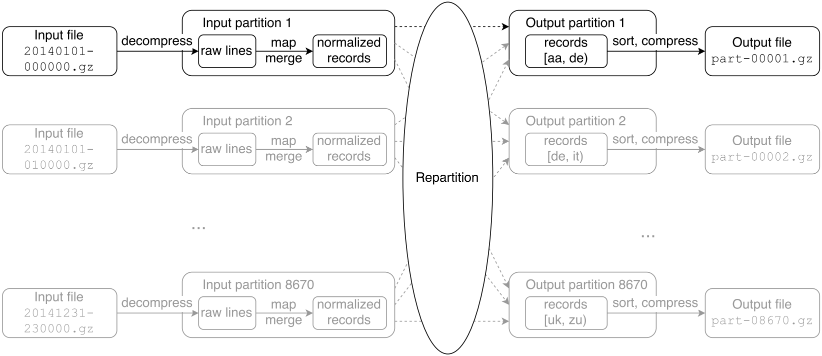
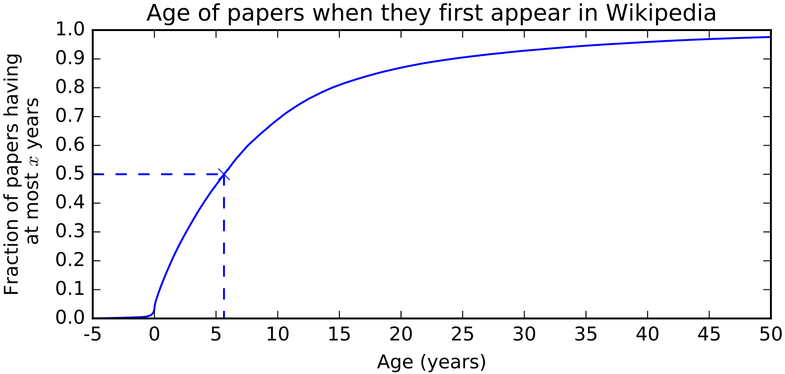


Figure: Workflow showing the processing of Wikimedia page views

Age of papers when inserted

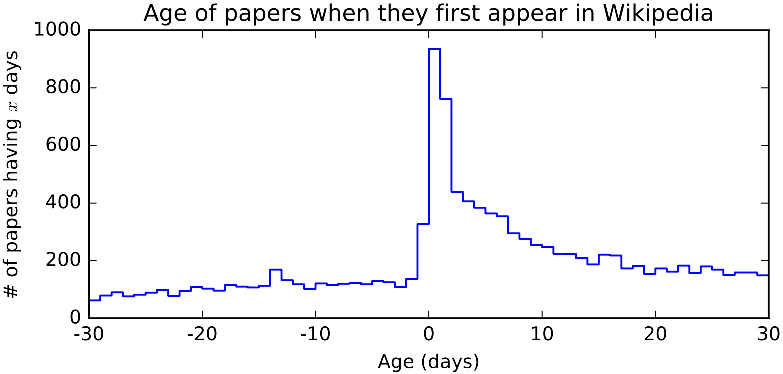
- How old is a paper when it is inserted in Wikipedia for the first time?
- Exploit the DOI mapping with the Microsoft dataset
- Interesting behavior of papers having few days

Age of papers when inserted



- Half of the papers cited are less than 5.5 years old

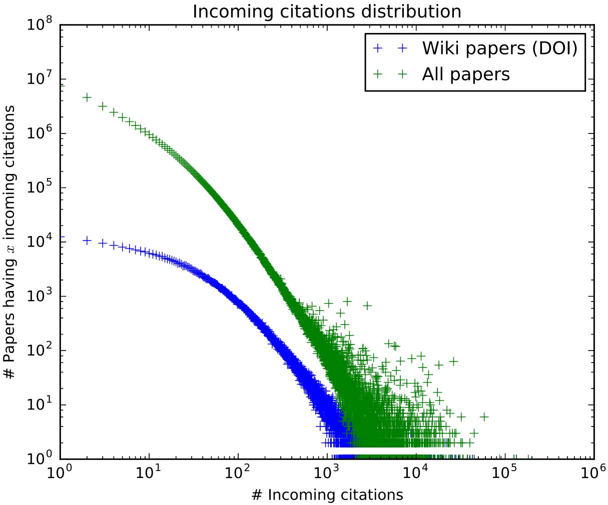
Age of papers when inserted — Detail



- 1.3% of papers are inserted within 7 days after the publication

Incoming citations distribution

- Arguably follows a power law [5]: $N(x) \sim x^{-\alpha}$
- How well papers in Wikipedia perform?



Incoming citations distribution

- Papers in Wikipedia behave like *Genome Research* and *PNAS*
- They outclass *Nature* and *Science*
- 74% of papers in Wikipedia have more than 10 incoming citations

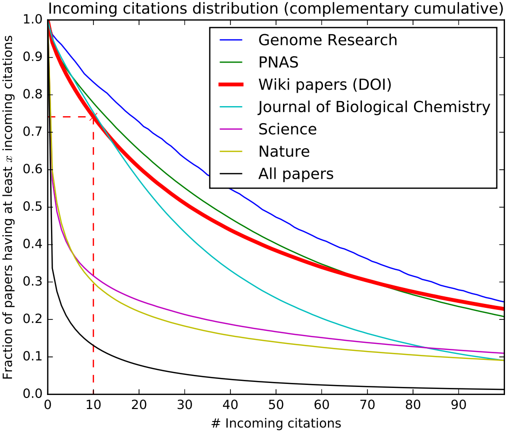


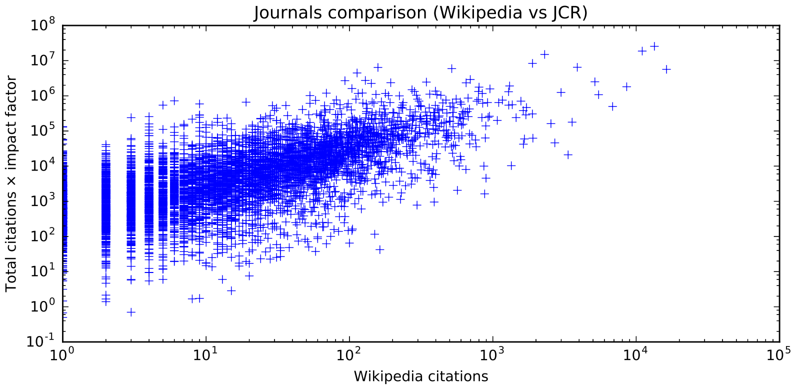
Figure: Papers cited in Wikipedia vs papers in top journals

Journals rank

- First proposed by Nielsen in 2007 [4]
- Most cited journals in Wikipedia are also the most important ones

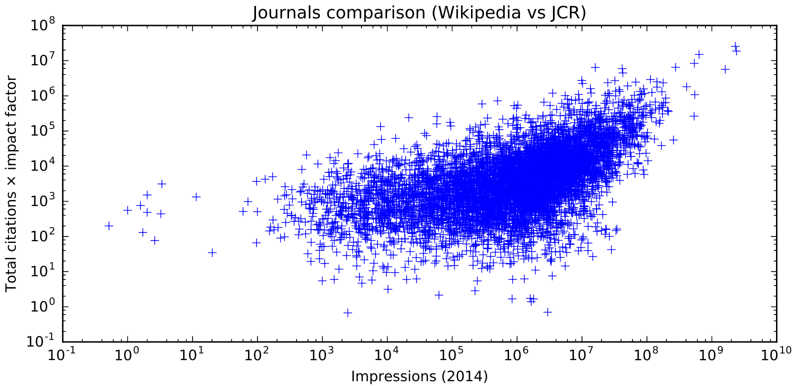
- Journals rank by impact factor (from JCR) versus:
  - citations in Wikipedia
  - visualizations in Wikipedia (in 2014)
- Measured in term of Kendall rank correlation coefficient ($-1 \leq \tau \leq 1$)

Journals impact factor vs Wikipedia citations



- Kendall rank correlation coefficient: 0.464

Journals impact factor vs Wikipedia impressions



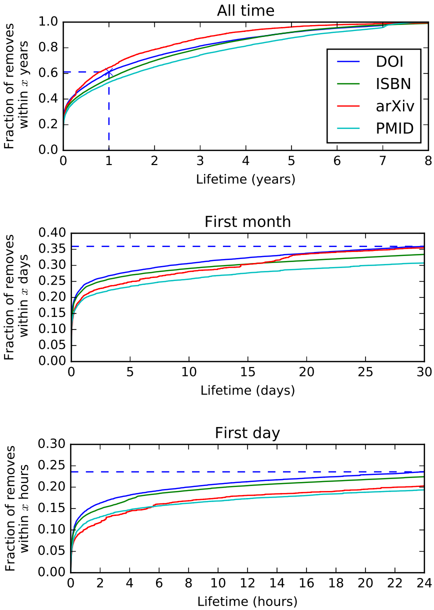
- Kendall rank correlation coefficient: 0.401

Lifetime of irrelevant citations

- How long does it take for a Wikipedia contributor to discover and remove an “irrelevant” paper from an article?
- A paper is “irrelevant” for an article if it appeared on that page and was then removed.

- Fraction of papers removed in time

- 61% of irrelevant DOI removed within one year
- 36% within one month
- 24% within one day



Further work

- Exploit the page views dataset and the framework
- Open questions:
  - If a paper appears in Wikipedia, will it become more popular in the scientific community?
  - In another way, do researcher use Wikipedia as their primary data source?
  - Predict whether a publication is going to stay on a page

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