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Web Search Basics

(Search and Data Mining)

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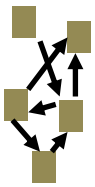
Characteristics of Web Data



- **The size of Web data is huge.**
  - Surface: static pages
  - Deep: dynamically generated pages
- **Frequent updates**
- **Variances in quality**
  - Web Spams
- **Graph-based data**

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General Challenges in Web Search

- Scalability — **Parallel query processing (MapReduce)**
  - How to handle the size of the Web?
- Addressing the dynamics of the Web — **Crawling/ Redundancy check**
  - Some pages may be updated very quickly
  - New pages are constantly created
- Dealing with low quality information — **Spam detection**
- Utilizing the additional information (such as links) to improve search quality — **Link analysis / multi-feature ranking**

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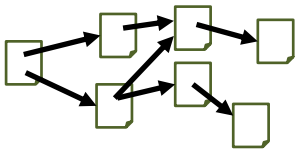
Component I: Crawler

- Basic steps of crawling
  - Start with a set of seed pages
  - Fetch pages from the Web
  - Parse the fetched pages and add the hyperlink to the list to be crawled
  - Repeat the previous steps until the list to be crawled is empty.



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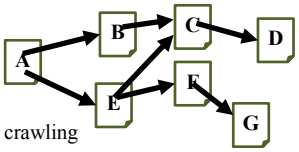
More Details about Crawling

- Breath-First



- Parallel crawling
- Focused crawling
- Incremental/repeated crawling

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Component II: Indexing

- Standard IR techniques are the basis, but insufficient
  - Scalability
  - Efficiency
- Google's innovations on Web-scale data processing
  - Google File System
    - Storing the indexes on multiple machines
  - MapReduce
    - Creating the indexes in parallel
  - BigTable

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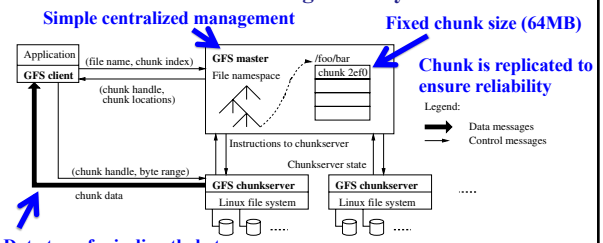
Illustration of Google File System



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MapReduce: A Framework for Parallel Computing

- It minimizes the effort to create an application that can be run on large cluster in parallel
- Advantages
  - Hide many low-level details
  - Built-in fault tolerance

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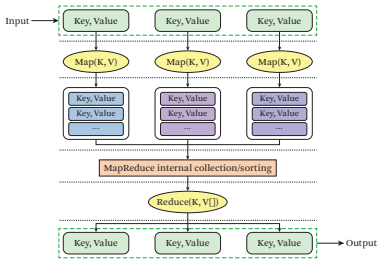
Computation Flow of MapReduce



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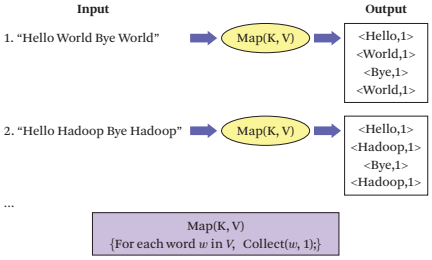
The map Function for word counting



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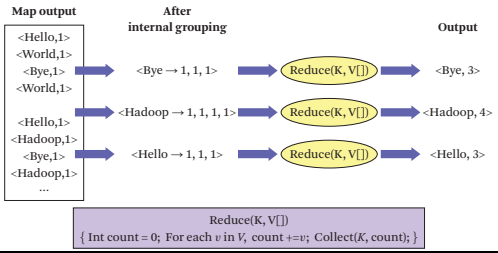
The reduce Function for word counting



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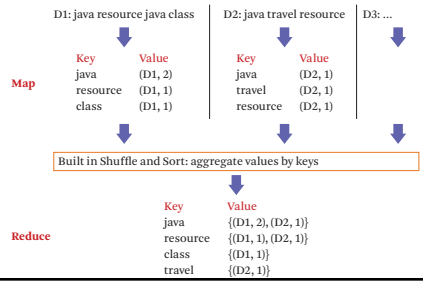
Using MapReduce to create an inverted index



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Pseudocode for Inverted Index Construction

```
function MAP(docid n, doc d)
    H ← new ASSOCIATIVEARRAY
    for term t ∈ d do
        H[t] ← H[t] + 1
    end for
    for t ∈ H do
        EMIT(t, [n, H[t]])
    end for
end function

function REDUCE(term t, postings [(a1, f1), (a2, f2), ...])
    P ← new LIST
    for all (a, f) do
        APPEND(P, (a, f))
    end for
    SORT(P)
    EMIT(t, P)
end function
```

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Component III: Retriever

- Traditional IR models are not enough
  - Information needs are different: navigational vs. informational
  - Documents have additional information
  - Information quality varies a lot
- Specific techniques for Web search
  - Exploiting links
  - Spelling correction
  - Spam detection
  - Leveraging more features such as clickthrough data
- In general, rely on machine learning to combine all kinds of features.

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