Balancing Volume, Quality and Freshness in Web Crawling

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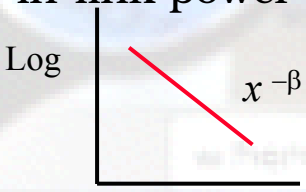
Agenda

- Motivation
- Search Engines
- Web Crawlers
- Crawling
- Crawling problems
- Software architecture
- Implementation details
- Concluding Remarks

Introduction 1/3

The Web

- Web: Largest public repository of *data* (more than 3 billion static pages)
- Today, there are more than 40 million Web servers
- Well connected graph with out-link and in-link power law distributions



Self-similar &
Self-organizing

Introduction 2/3

Web Retrieval

- Challenge: find information in this data
- Problems:
  - volume
  - fast rate of change and growth
  - dynamic content
  - redundancy
  - organization and data quality
  - diversity, etc...

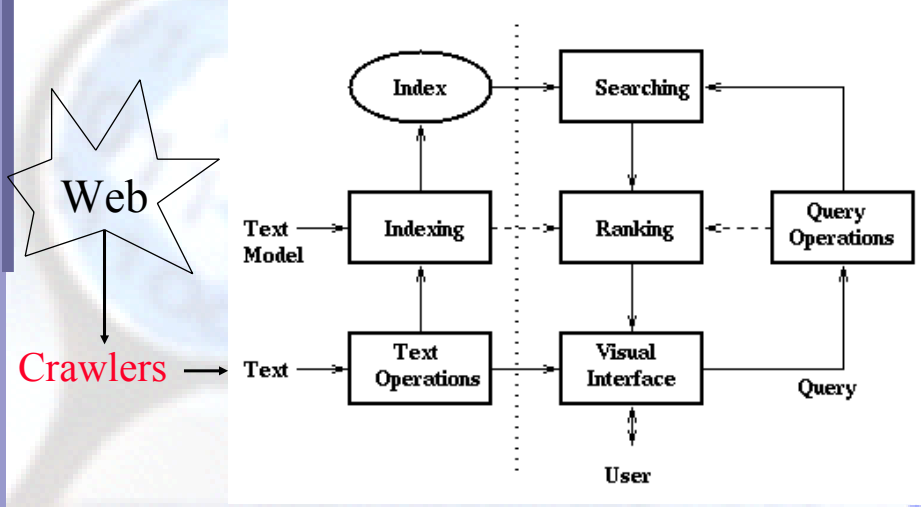
Introduction 3/3

Motivation

- Main problem of the Web: scalability
- Search engines are one of the most important tools
- Crawling the Web is the current resource bottleneck
- Our main motivation: WIRE project (Web IR Environment)
- Can we do it better?

Search Engines 1/2

Centralized Architectures



Search Engines 2/2

Crawling

- Crawlers: page recollection and parsing
- Crawlers do not crawl! They are static
- Bottlenecks: available bandwidth and CPU
- They use the wrong paradigm: pulling
- Pulling vs. pushing

Web crawlers 1/3

First Generation

- RBSE Spider
  - Web of 100,000 pages
- Crawler of the Internet Archive
- Web Crawler
- Common aspects:
  - Avoid rejection from webmasters
  - Try to discover new pages, pages are scarce

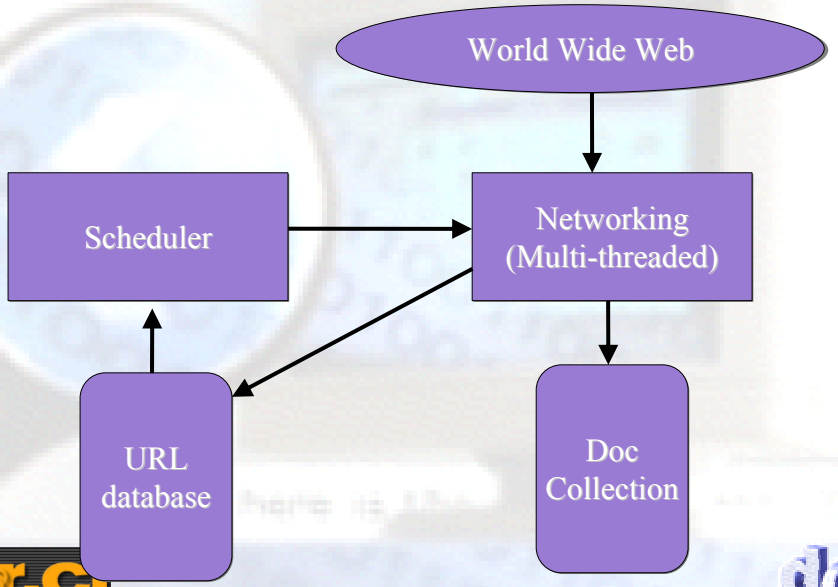
Web crawlers 2/3

Second Generation

- Mercator, Sphinx
  - Extensible architectures
  - Multi-protocol, multi-purpose
- Lycos, Excite, Google
  - Distributed (farm) crawlers
- Parallel crawlers

Web crawlers 3/3

Standard Architecture



Crawling 1/4

Main Goals

They depend on the index of a search engine:

- The index should contain a large number of objects that are interesting for the users
- The index should accurately represent a real object on the Web
- Generate a representation that captures the most significant aspects of the object using the minimum amount of resources

Crawling 2/4

Main Issues

Interesting object?

- Quality: intrinsic semantic value of the object. Possible estimators:
  - content analysis (e.g. vector model)
  - link analysis (e.g. Pagerank)
  - similarity to a driven query (focused crawlers, searching agents)
  - usage popularity
  - location based (depth, geography, etc.)

Crawling 3/4

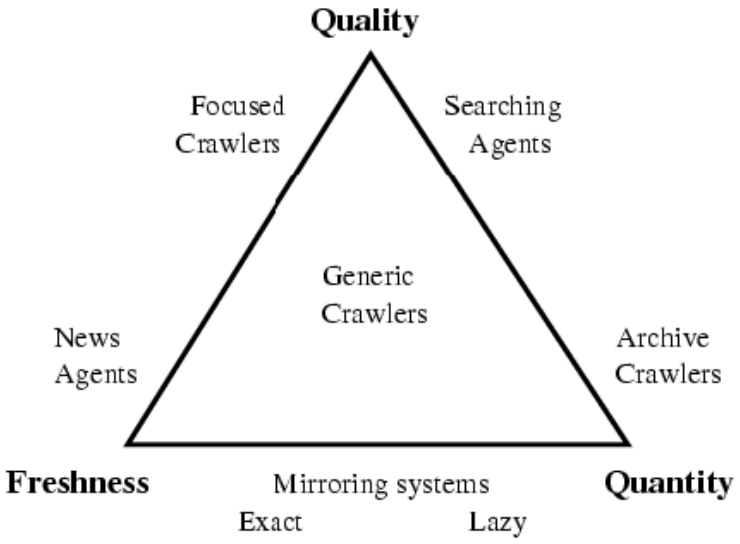
Main Issues

Accurate content of the objects?

- Quantity: as many objects as possible
  - Accurate content depends on the size and format of the representation
  - Accurate object through time?
- Freshness: how recent is the object
  - Web updates are common, half of the Web is less than 6 months old
  - Freshness can be estimated for most Web servers

Crawling 4/4

Taxonomy



Crawling Problems 1/3

Conflicting Goal

- Refreshing a page or bringing a new page?
  - However new pages are only found in updated or new pages
  - Trade-off between quantity (more objects) and quality-freshness (interesting and up-to-date objects)
- Secondary Goals
  - Resource usage and politeness

Crawling problems 2/3

Scheduling

- Keep collection fresh
  - More important pages must be kept fresher
- Use the network to the maximum extent
- Do not overload servers (robot politeness)
- Discover new pages (updated pages first)
- All this depends on the type of crawler

Crawling problems 3/3

Technical Problems

- DNS is a bottleneck
- Duplicates, slow servers
- Crawler traps
- Dynamic pages and session-ids in URLs
- Threads implementations
  - For example, for constant $C = p\ k\ t$ which is the optimal number of processors p running k processes with t threads each?
  - Simulation is difficult, experimenting too

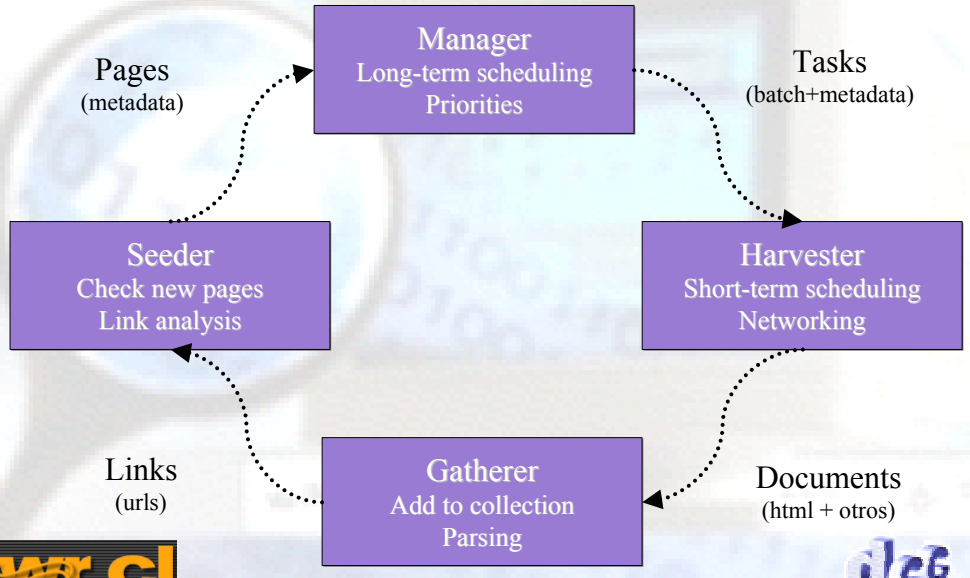
Software Architecture 1/3

Our Approach

- Goals depend on the index knowledge
  → crawlers should be tightly integrated with the index
- Page scheduling:
  - Long-term: quality-freshness vs. quantity
  - Short-term: resource usage and politeness
- Approach that we use in WIRE

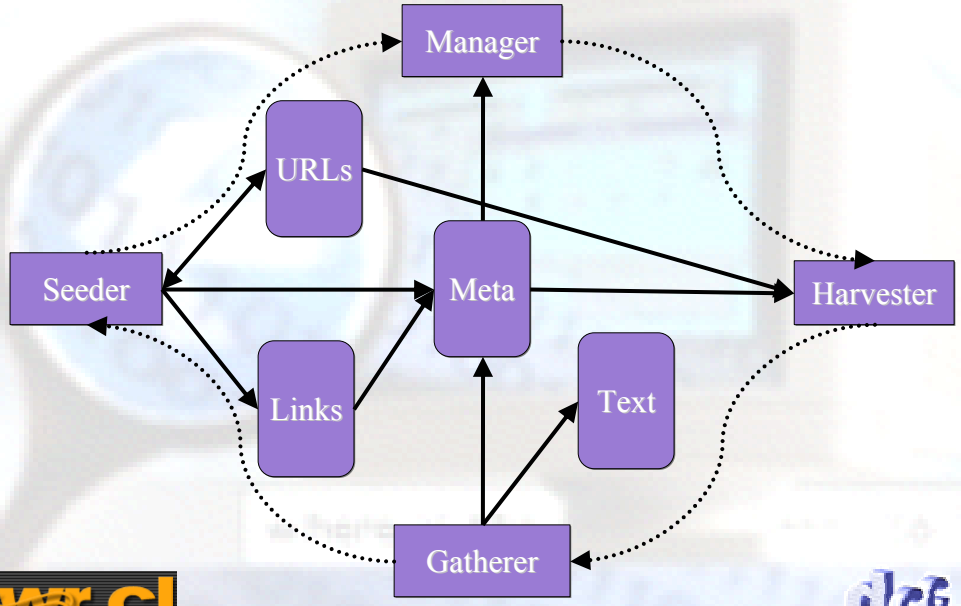
Software Architecture 2/3

High-Level Architecture



Software architecture 3/3

Indices



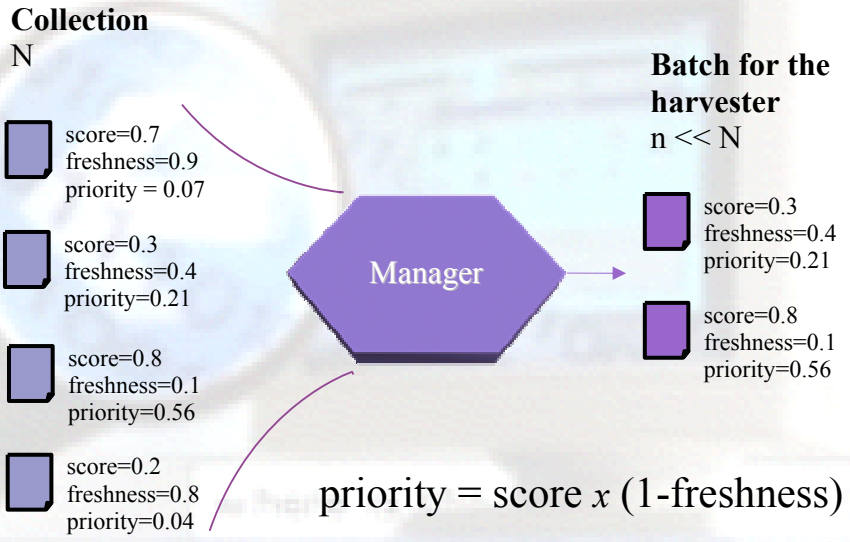
Implementation details 1/5

Non Trivial

- Share-nothing distributed architecture
- Performance: how good is the result, how fast is accomplished
- No benchmarks, no standard measures
  - Pages per processor cycles, bandwidth, and time?

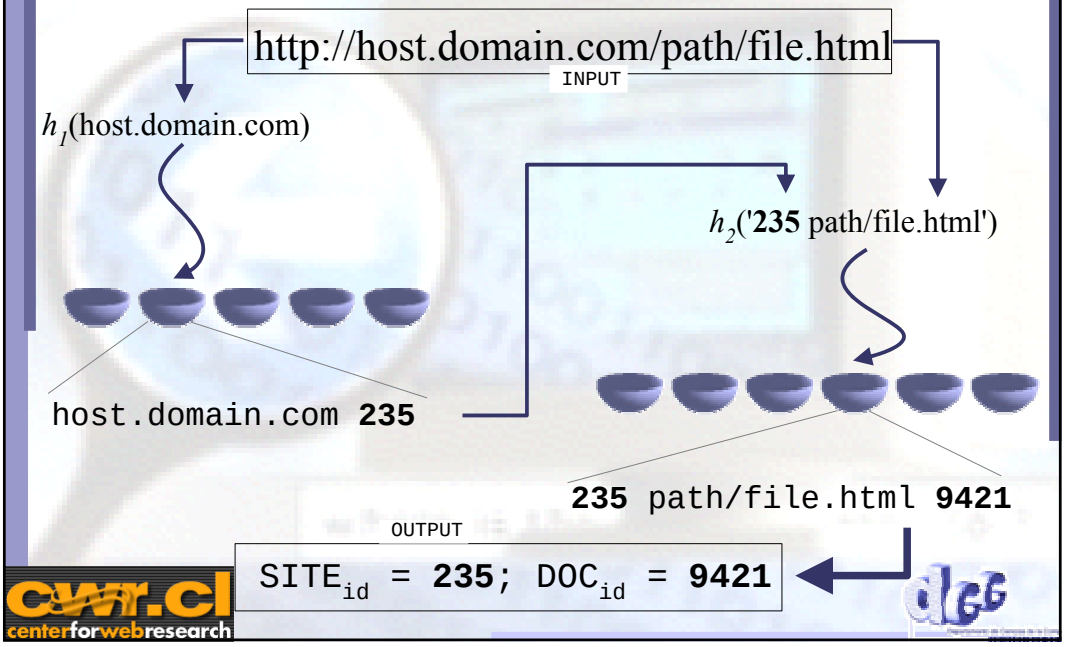
Implementation details 2/5

Manager



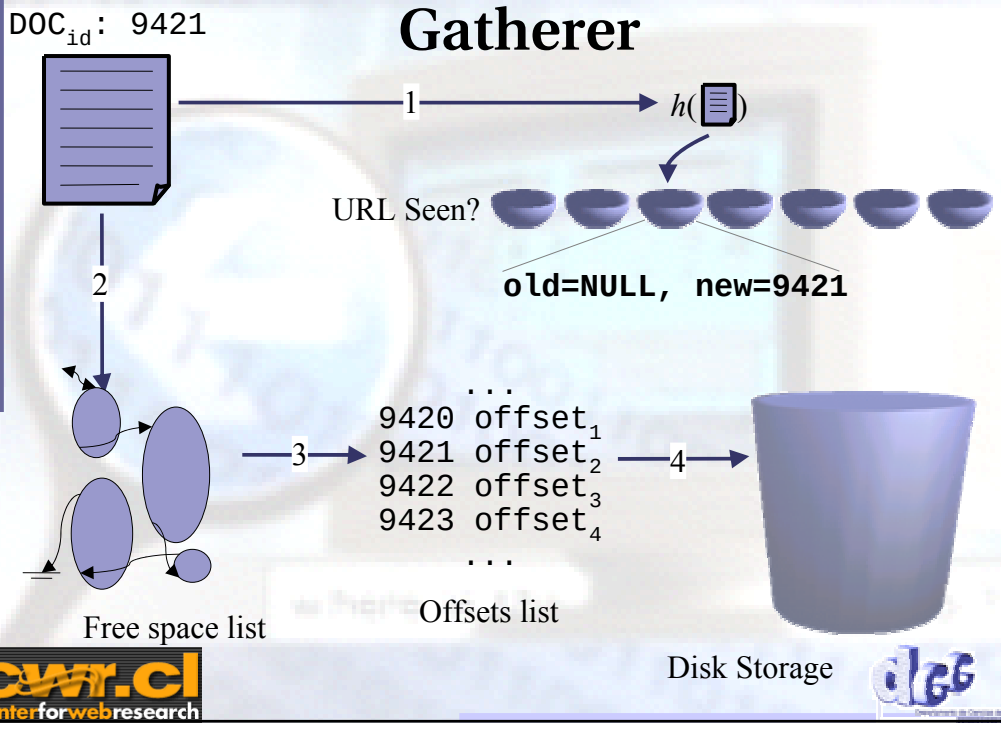
Implementation details 3/5

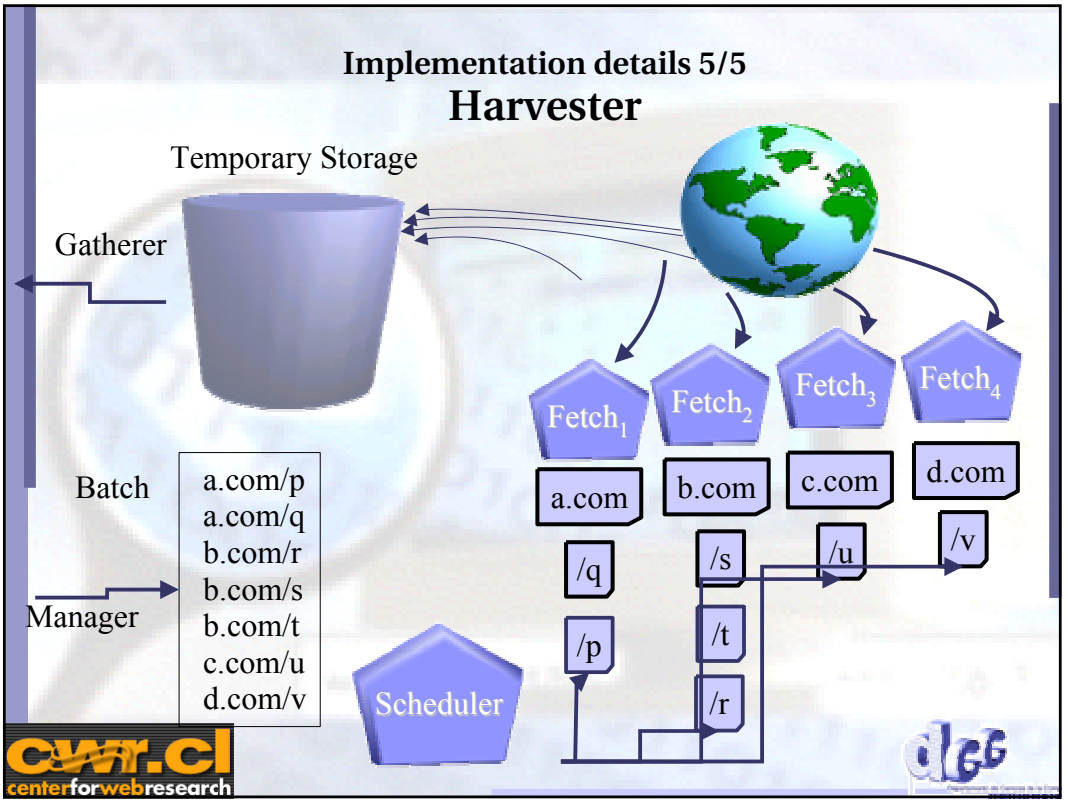
URL resolving (Seeder)



Implementation details 4/5

Gatherer





Concluding Remarks

- Prototype currently under evaluation
- Future: Agents and pushing?
- Real networks are dynamic
  - Crawlers do not care about network topology… but could (and should!)
  - Redundancy and fault tolerance is based on randomness
  - How to avoid changing the information market in the wrong (almost any!) direction?

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Questions, comments? ...