An Architecture for Selective Web Harvesting: The Use Case of Heritrix

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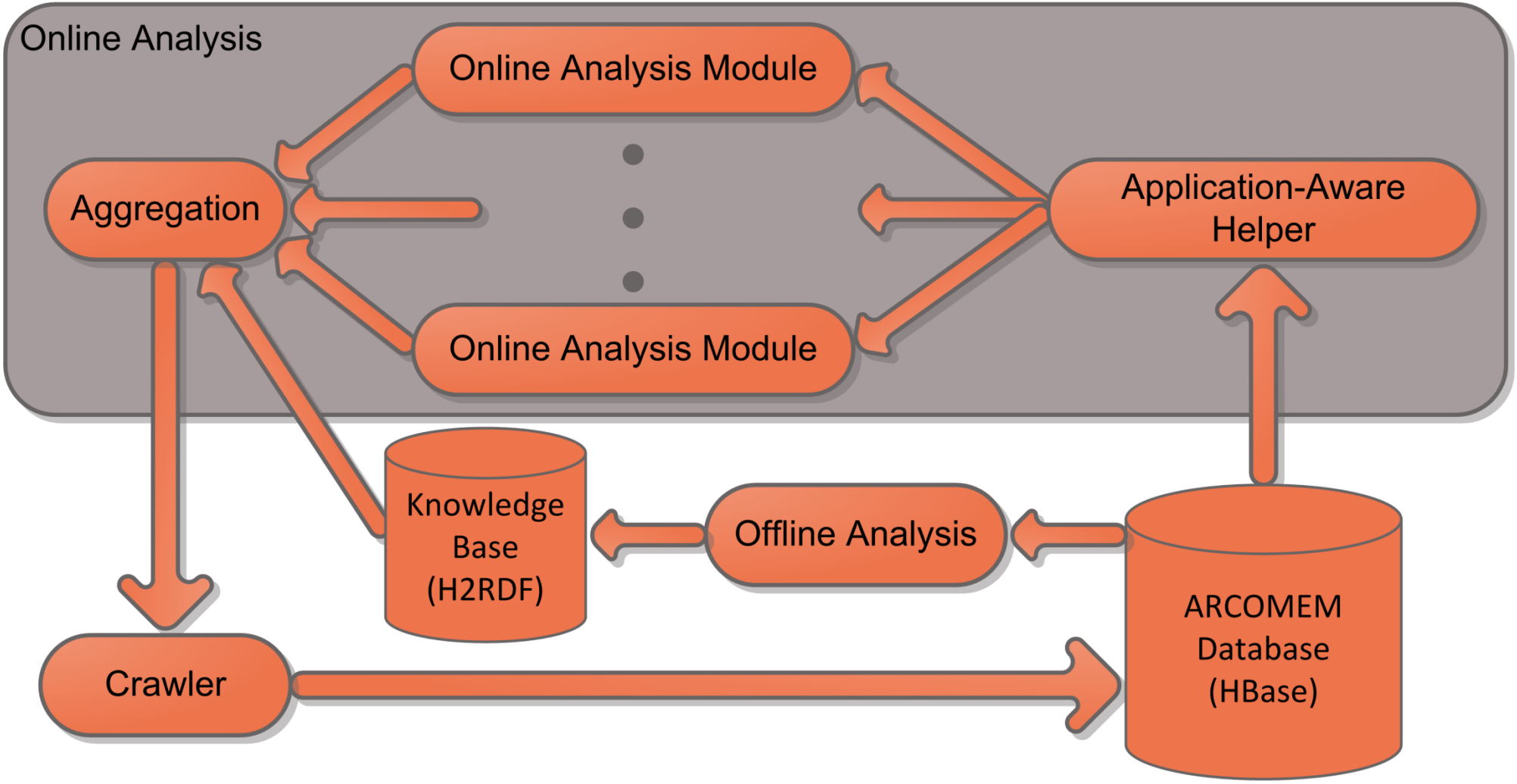
Motivation

- ARCOMEM Objectives
  - Selective preservation of Web content
  - Guided by social media

- Challenges for crawlers
  - Integration of computationally intensive content analysis
  - Accurate prioritization of links
  - Scalability

ARCOMEM Crawling Architecture



Large-scale distributed crawler

- Scalable crawling of Web pages and storing in HBase repository
  - Crawling at fast rate from start
  - Slowing down as little as possible after crawling billions of URLs
  - Observing politeness conventions
- Running multiple crawls concurrently
  - Each crawl job has own configuration and URL store
  - Single pool of fetchers for all crawl jobs
- Extensible configuration frameworks
  - Per-domain parameters
  - Updates are immediately usable

Developed by Internet Memory Foundation (IMF)

Application-Aware Helper

- Make the crawler aware of the particular kind of crawled Web applications
  - General classification of Web sites: Wiki, social network, blog, web forum, etc.
  - Technical implementation: Mediawiki, Wordpres, etc.
  - Specific instances: Twitter, CNN, etc.
- For each crawled document
  - Identify the corresponding Web application
  - If there's a match, identifies the kind of Web page
  - Extract Web objects
- Handling template changes

Related publication: M. Faheem, P. Senellart: Intelligent and Adaptive Crawling of Web Applications for Web Archiving. ICWE, 2013

Online Analysis

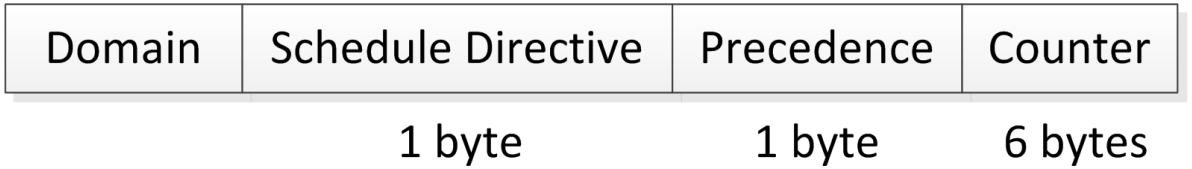
- Focus the crawler with respect to the crawl specification
- Integrate scores computed from different modules
  - Content written in a given language
  - URL matches regular expressions
  - URL corresponds to a known Web application identified by the AAH
  - URL contains keywords from crawl specification
  - …
- Aggregating scores
  - Linear combination based on a weight vector
  - Automatically adjusting weights

Adapting Heritrix to ARCOMEM Crawling Architecture

- Typical crawling process
  - URL priority is set at scheduling time
  - Centralized crawler
- Integrating Heritrix
  - Adaptive prioritization
  - Scheduling links by remote processes
- Other modifications
  - writing content directly to RDBMS, HBase
  - Timed-closing of WARC files
  - Extracting anchor text with URLs

Adaptive prioritization

- Default frontier employs Berkeley DB hash table for storing URLs to crawl
  - Key for a URL in the hash table



  - Method next() returns only the next URL to crawl from a domain
- Our solution
  - Maintain a mapping from URL to key in hash table
  - Update priority by recalculating key
  - Counter ensures that there are no collisions

Scheduling links

- Need to allow external processes, possibly on different servers, to schedule links
- Heritrix Action directory
  - Need for additional scripts to write files on Heritrix local filesystem
- Our solution
  - Implemented a Web service that accepts JSON formatted links and priorities

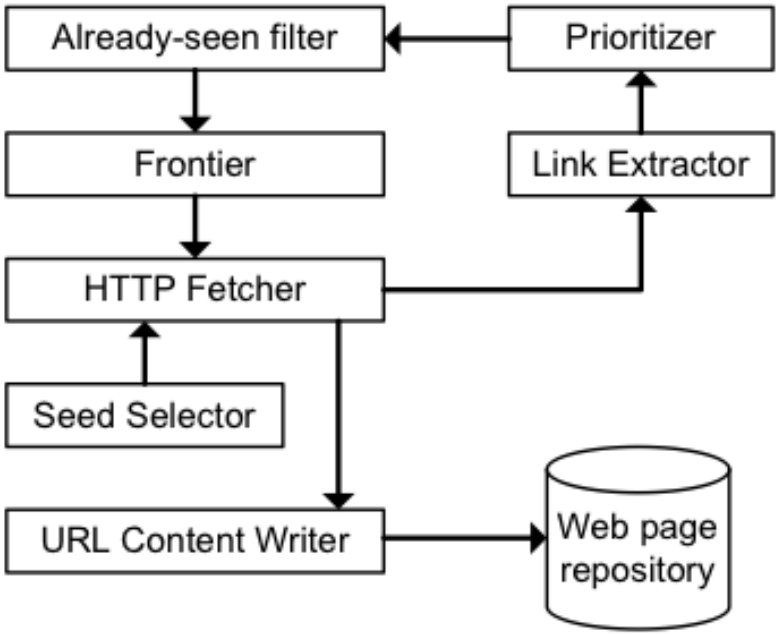
Assessing the impact of decoupled URL fetching and prioritization

- Simulations to evaluate how adaptive and asynchronous/batch prioritization affects performance of a focused crawler

- Compare the effectiveness of a best-first crawler to
  - Adaptive prioritization
  - Asynchronous and batch URI prioritization

Baseline crawler

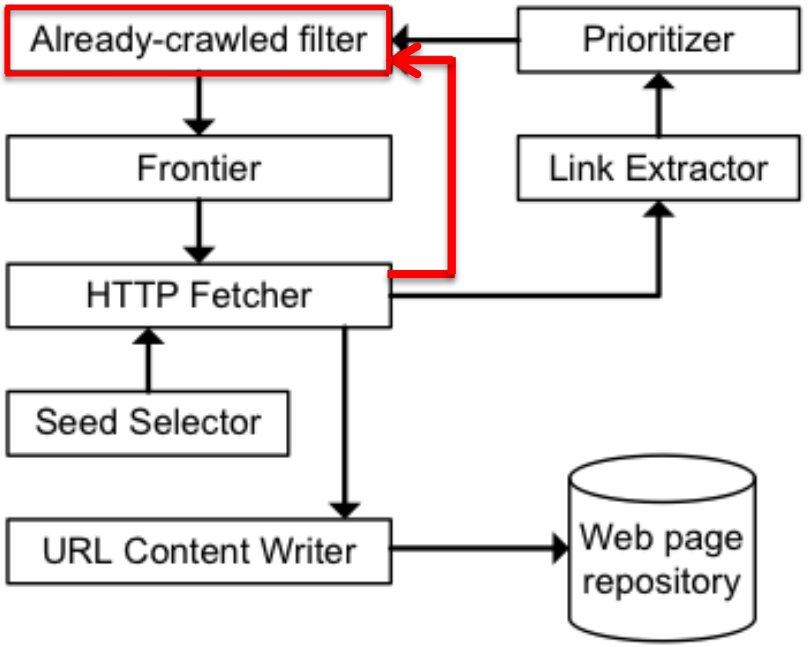
- For link $s \rightarrow d$, the score of destination URL d:
  - (1-aw)*cosine(topic, w_s)
  - aw*cosine(topic, $a_{s \rightarrow d}$) (1)
- where
  - w_s is the term vector of Web page s
  - $a_{s \rightarrow d}$ is the term vector of the link's anchor text
  - topic is the term vector of the crawl's seeds
  - aw = 0.5 is the weight of anchor text
- Balance per queue
  - Crawl k pages from the site with the highest priority



Adaptive prioritization

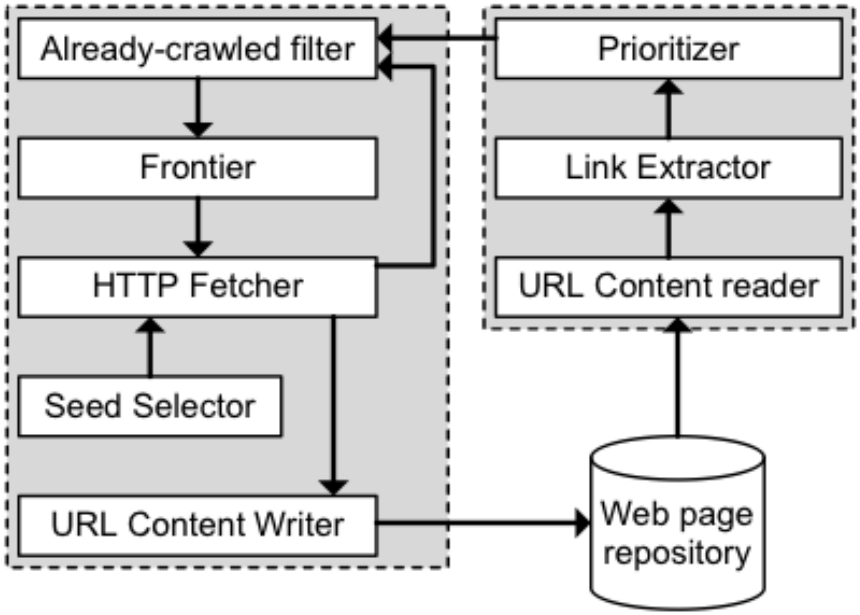
- Update priority of already scheduled URIs when new links are found

- Score for URL u_d is updated with one of the functions
  - **MAX**
  - **AVG**
  - **SUM**
  - **LAST** : keeps the most recent score
  - **FIRST** : equivalent to best-first crawler



Asynchronous & Batch Prioritization

- Fetch Web pages and write to the Web page repository
- Prioritize URLs in batches after crawling N pages
  - N = 100 pages
  - Link score computed from all anchors and source Web pages in which URL *d* is found
- Send batch of prioritized URLs back to the crawler



Simulation experiments

- Simulation on 3 DMOZ topics
  - Genetics, Recycling, Oceanography
- Running simulated crawl
  - Start from set of 20 randomly selected seeds (repeated 3 times)
  - Topic vector is the sum of the seed vectors
  - Crawl 10,000 web pages
- Evaluation measures
  - Harvest ratio: # of Web pages with cosine similarity to topic > 0.333
  - Average similarity of crawled pages
  - Fraction of DMOZ topics with at least one crawled page

Adaptive prioritization results

Using anchor text weight *aw* = 0.5

Update function	Harvest Ratio	Average Similarity	DMOZ topics
FIRST	0.3317	0.2945	0.4979
AVG	**0.3609**	0.3024	0.5779
MAX	0.3388	0.2967	0.5270
SUM	0.2679	0.2759	0.4650
LAST	0.3404	0.2961	**0.5985**

- AVG and LAST have highest harvest ratios and find most pages from DMOZ topics

Simulation results: asynchronous & batch priorities

Parameters: *aw* = 0.5 and balance per queue *bpq* = 1 and 5

Batch	Balance per queue	Update function	Harvest Ratio	Average Similarity	DMOZ topics
No	1	FIRST	0.3317	0.2945	0.4979
No	5	FIRST	0.2948	0.2819	0.4677
No	1	AVG	**0.3609**	0.3024	0.5779
No	5	AVG	0.3200	0.2897	0.5420
Yes	1	AVG	0.3556	0.3013	0.5260
Yes	5	AVG	0.3347	0.2952	0.5176

- Batch prioritization achieves similar harvest ratio to synchronous with adaptively averaging priorities (see rows 3 & 5)
- When increasing bpq from 1 to 5
  - synchronous crawler's harvest ratio reduces ~ 11% (see rows 1 & 2 and 3 & 4)
  - Batch crawler's harvest ratio reduces ~ 6%, more effective than synchronous (see rows 5 & 6 and 4 & 6)

Concluding remarks

- Effective architecture for selective crawling
  - Application-Aware Help
  - Online analysis
  - Large-scale distributed crawler
- Adapting Heritrix
  - Adaptive prioritization
  - Scheduling links from external processes

Thank you!

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