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CS47300: Web Information Search and Management

Web Crawling

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Some slides courtesy Croft et al.

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Web Crawling

- Web crawlers spend a lot of time waiting for responses to requests
- To reduce this inefficiency, web crawlers use threads and fetch hundreds of pages at once
- Crawlers could potentially flood sites with requests for pages
- To avoid this problem, web crawlers use *politeness policies*
  - e.g., delay between requests to same web server

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URL frontier: two main considerations

- Politeness: do not hit a web server too frequently
- Freshness: crawl some pages more often than others
  - E.g., pages (such as News sites) whose content changes often

These goals may conflict with each other.

(E.g., simple priority queue fails – many links out of a page go to its own site, creating a burst of accesses to that site.)

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Explicit and implicit politeness

- Explicit politeness: specifications from webmasters on what portions of site can be crawled
  - robots.txt
- Implicit politeness: even with no specification, avoid hitting any site too often

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Controlling Crawling

- Even crawling a site slowly will anger some web server administrators, who object to any copying of their data
- Robots.txt file can be used to control crawlers

```
User-agent: *
Disallow: /private/
Disallow: /confidential/
Disallow: /other/
Allow: /other/public/

User-agent: FavoredCrawler
Disallow:

Sitemap: http://mysite.com/sitemap.xml.gz
```

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Robots.txt example

- No robot should visit any URL starting with "/yoursite/temp/", except the robot called “searchengine":

```
User-agent: *
Disallow: /yoursite/temp/

User-agent: searchengine
Disallow:
```

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Politeness – challenges

- Even if we restrict only one thread to fetch from a host, can hit it repeatedly
- Common heuristic: insert time gap between successive requests to a host that is >> time for most recent fetch from that host

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Freshness

- Web pages are constantly being added, deleted, and modified
- Web crawler must continually revisit pages it has already crawled to see if they have changed in order to maintain the *freshness* of the document collection
  - *stale* copies no longer reflect the real contents of the web pages

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Freshness

- HTTP protocol has a special request type called HEAD that makes it easy to check for page changes
  - returns information about page, not page itself

Client request:
```
HEAD /csinfo/people.html HTTP/1.1
Host: www.cs.umass.edu
```

Server response:
```
HTTP/1.1 200 OK
Date: Thu, 03 Apr 2008 05:17:54 GMT
Server: Apache/2.0.52 (CentOS)
Last-Modified: Fri, 04 Jan 2008 15:28:39 GMT
ETag: "239c33-2576-2a2837c0"
Accept-Ranges: bytes
Content-Length: 9590
Connection: close
Content-Type: text/html; charset=ISO-8859-1
```

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Freshness

- Not possible to constantly check all pages
  - must check important pages and pages that change frequently
- Freshness is the proportion of pages that are fresh
- Optimizing for this metric can lead to bad decisions, such as not crawling popular sites
- *Age* is a better metric

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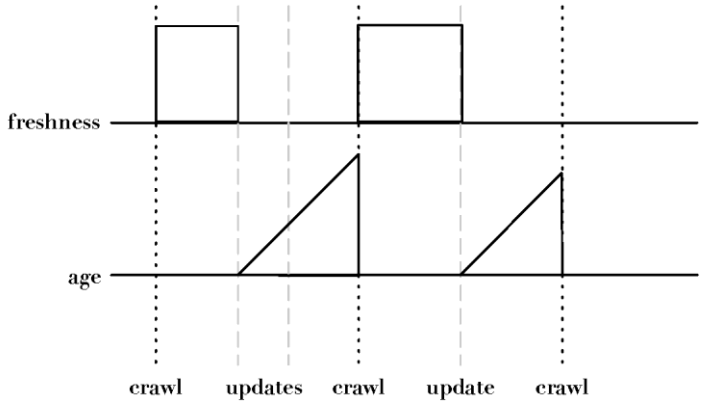
Freshness vs. Age



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Age

- Expected age of a page *t* days after it was last crawled:

$$\text{Age}(\lambda, t) = \int_0^t P(\text{page changed at time } x)(t-x)dx$$

- Web page updates follow the Poisson distribution on average
  - time until the next update is governed by an exponential distribution

$$\text{Age}(\lambda, t) = \int_0^t \lambda e^{-\lambda x}(t-x)dx$$

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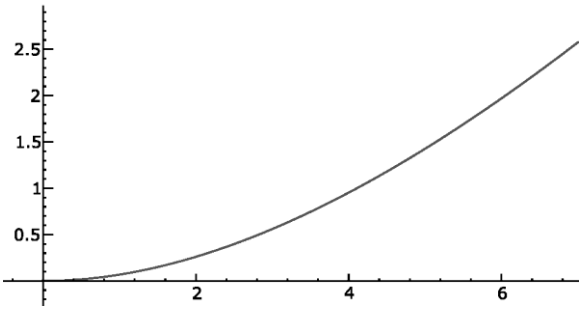
Age

- The older a page gets, the more it costs not to crawl it
  - e.g., expected age with mean change frequency $\lambda = 1/7$ (one change per week)



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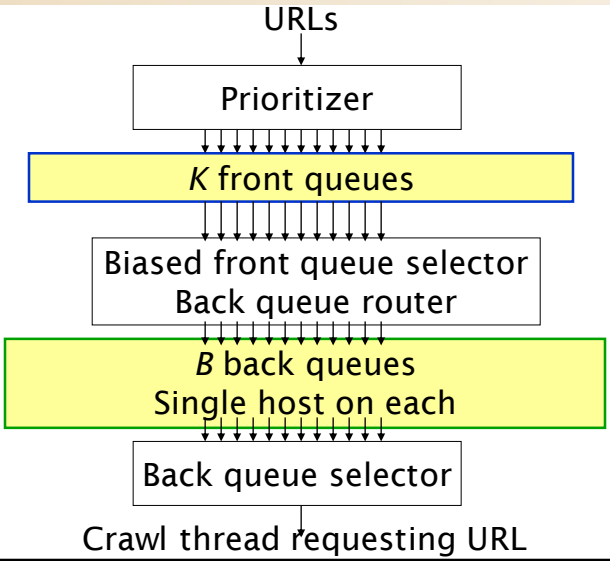
URL frontier: Mercator scheme



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Mercator URL frontier

- URLs flow in from the top into the frontier
- Front queues manage prioritization
- Back queues enforce politeness
- Each queue is FIFO

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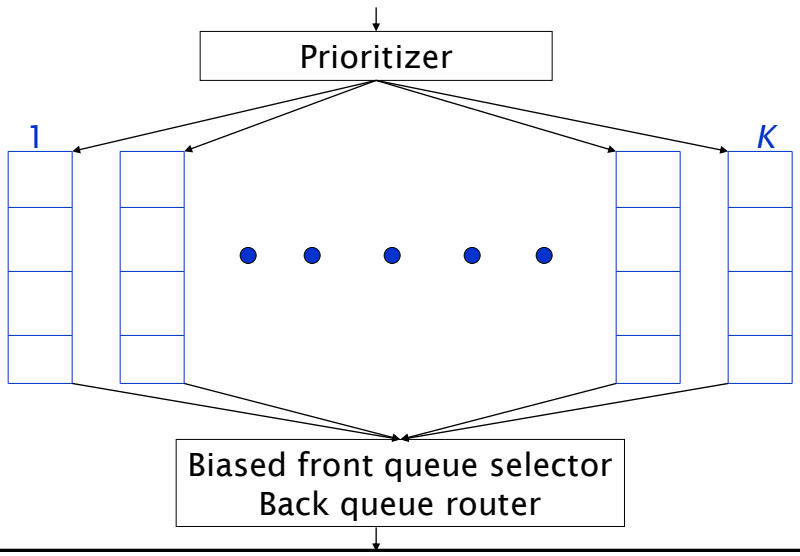
Front queues



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Front queues

- Prioritizer assigns to URL an integer priority between 1 and *K*
  - Appends URL to corresponding queue
- Heuristics for assigning priority
  - Refresh rate sampled from previous crawls
  - Application-specific (e.g., “crawl news sites more often”)

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Biased front queue selector

- When a back queue requests a URL (in a sequence to be described): picks a front queue from which to pull a URL
- This choice can be round robin biased to queues of higher priority, or some more sophisticated variant
  - Can be randomized

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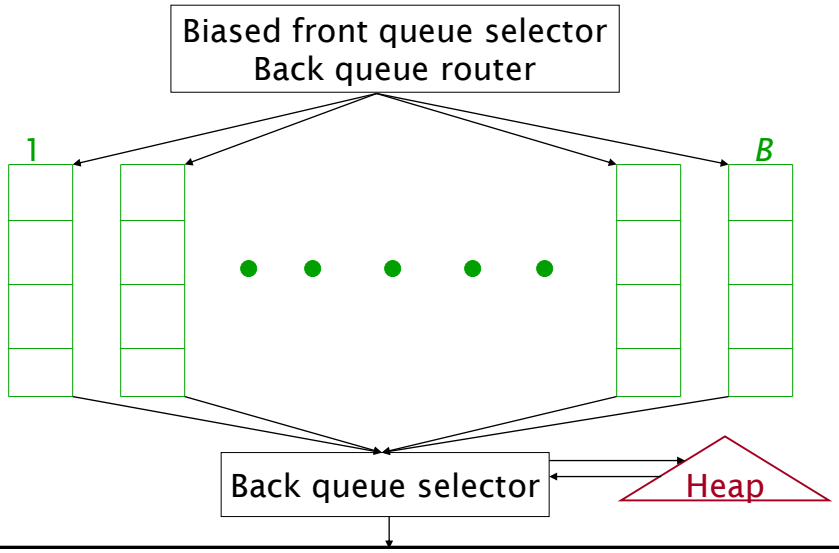
Back queues



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Back queue heap

- One entry for each back queue
- The entry is the earliest time t_e at which the host corresponding to the back queue can be hit again
- This earliest time is determined from
  - Last access to that host
  - Any time buffer heuristic we choose

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Back queue processing

- A crawler thread seeking a URL to crawl:
- Extracts the root of the heap
- Fetches URL at head of corresponding back queue *q* (look up from table)
- Checks if queue *q* is now empty – if so, pulls a URL *v* from front queues
  - If there's already a back queue for *v*'s host, append *v* to it and pull another URL from front queues, repeat
  - Else add *v* to *q*
- When *q* is non-empty, create heap entry for it

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Focused Crawling

- Attempts to download only those pages that are about a particular topic
  - used by *vertical search* applications
- Rely on the fact that pages about a topic tend to have links to other pages on the same topic
  - popular pages for a topic are typically used as seeds
- Crawler uses *text classifier* to decide whether a page is on topic