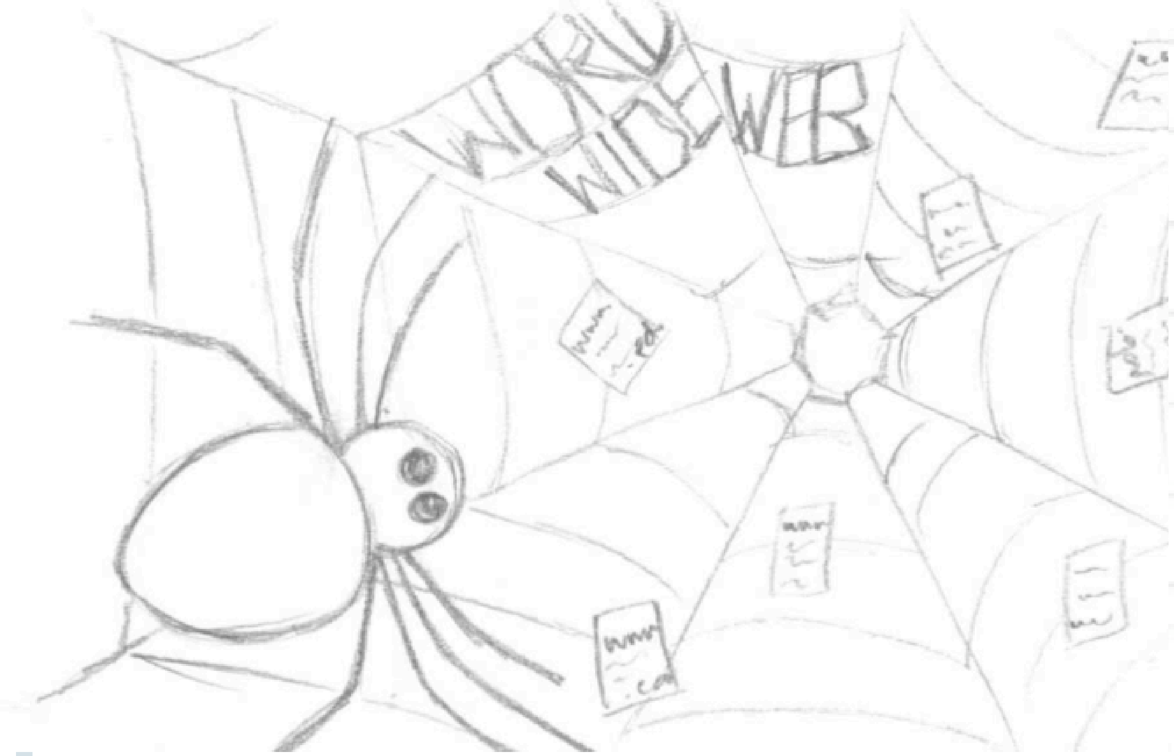
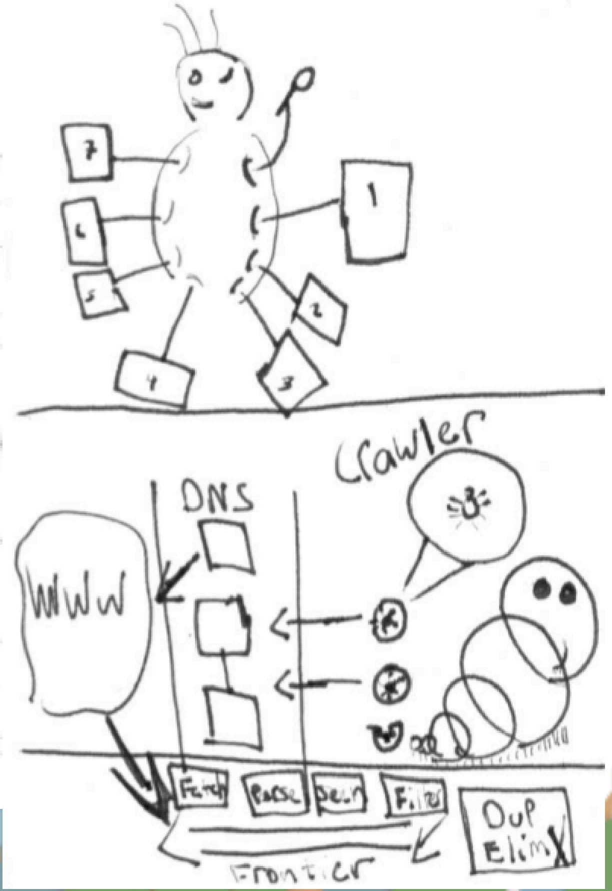
Web Crawling

Introduction to Information Retrieval
INF 141
Donald J. Patterson

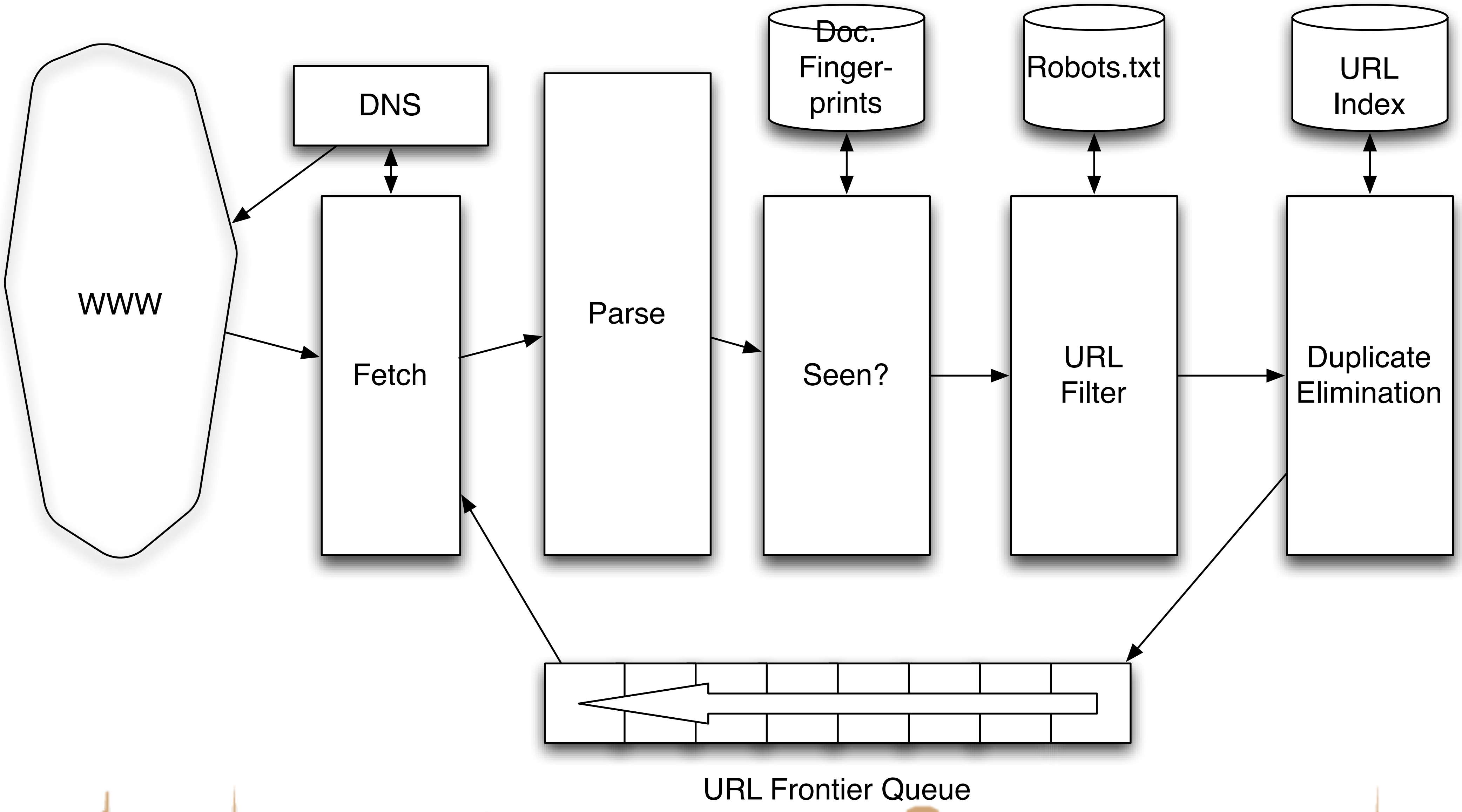
Content adapted from Hinrich Schütze
http://www.informationretrieval.org

Web Crawlers





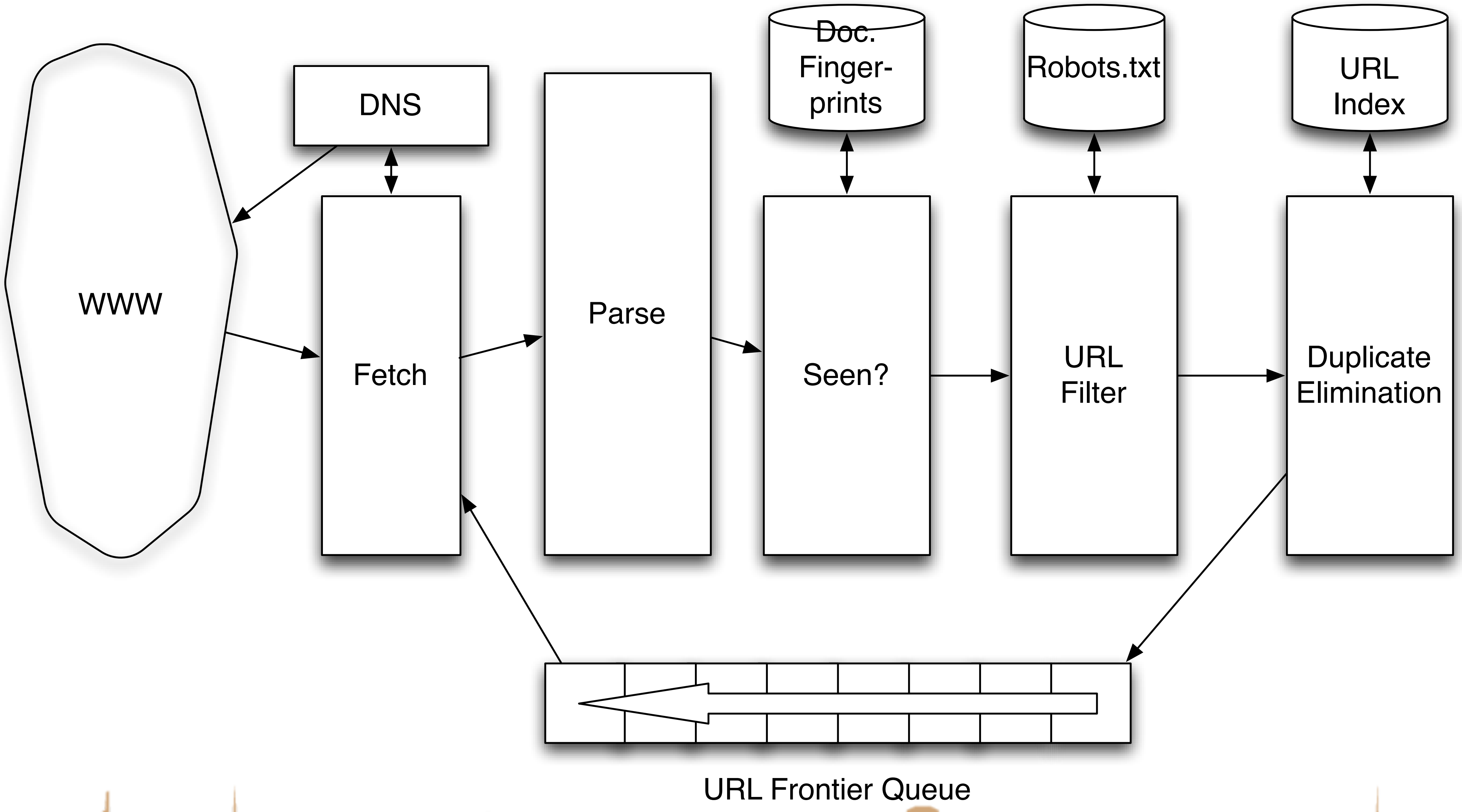
A Robust Crawl Architecture



Parsing: URL normalization

- When a fetched document is parsed
  - some outlink URLs are relative
    - For example:
      - http://en.wikipedia.org/wiki/Main_Page
      - has a link to “/wiki/Special:Statistics”
      - which is the same as
      - http://en.wikipedia.org/wiki/Special:Statistics
  - Parsing involves normalizing (expanding) relative URLs

A Robust Crawl Architecture

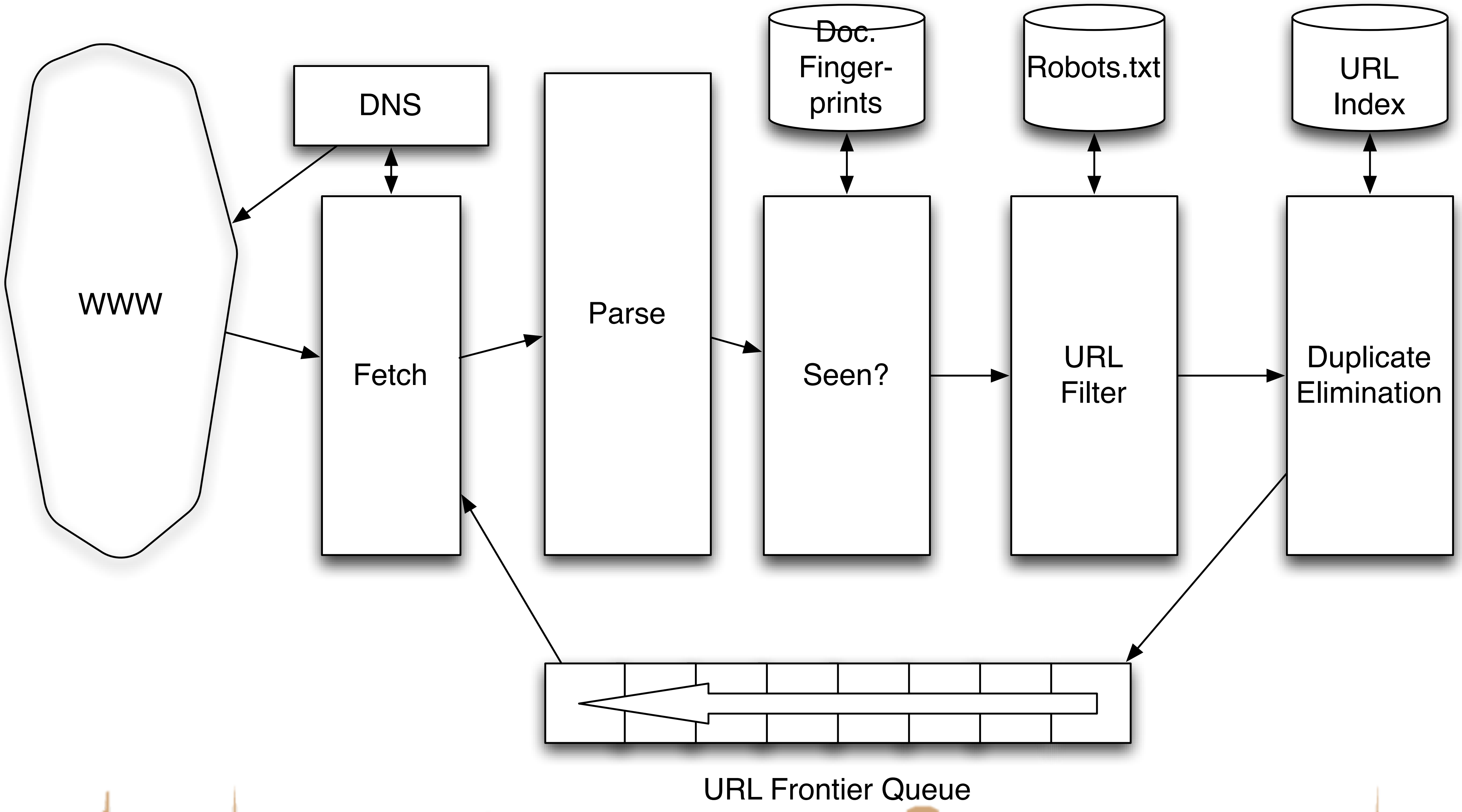


Duplication

Content Seen?

- Duplication is widespread on the web
- If a page just fetched is already in the index, don’t process it any further
- This can be done by using document fingerprints/shingles
    - A type of hashing scheme

A Robust Crawl Architecture

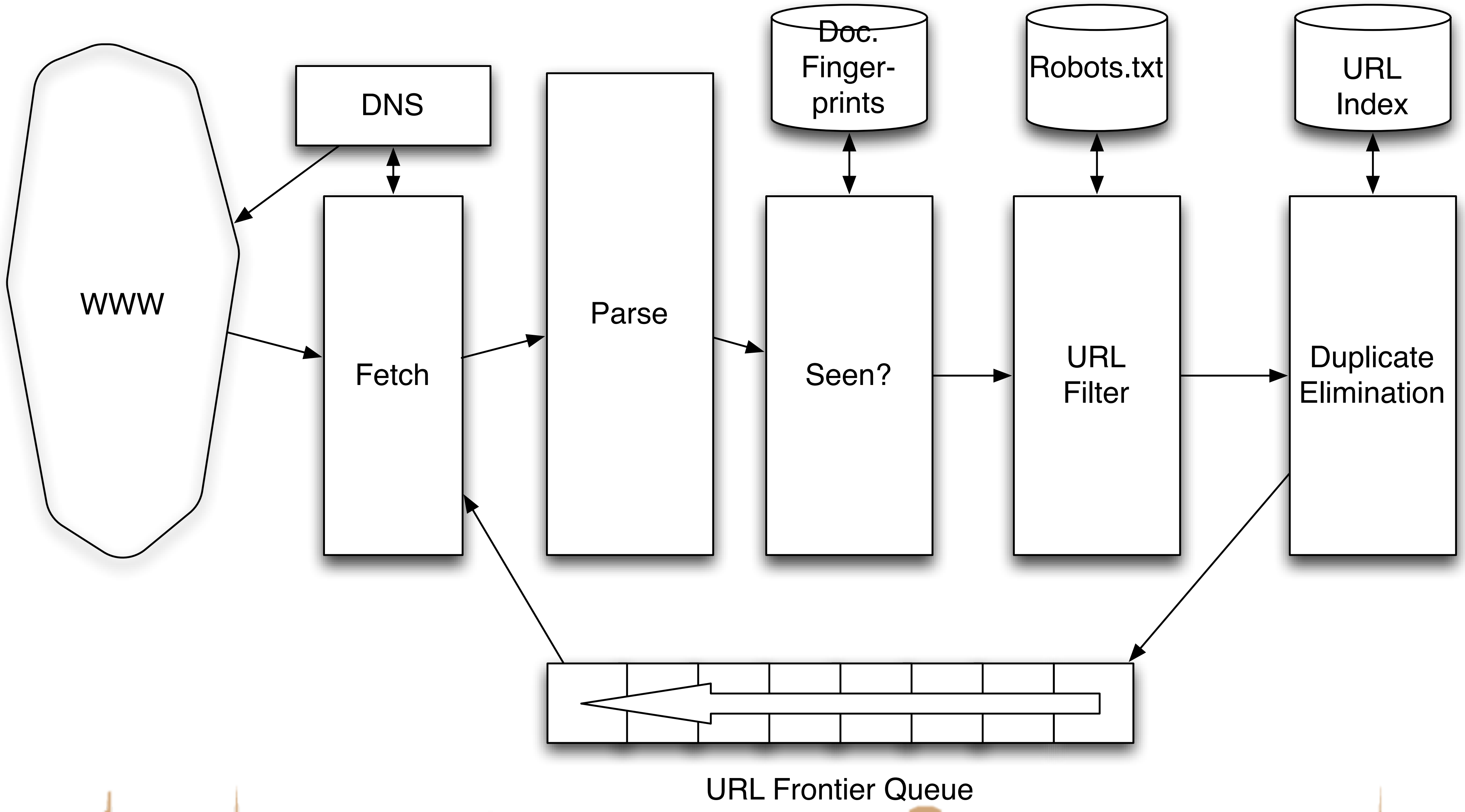


Filters

Compliance with webmasters wishes...

- Robots.txt
  - Filters is a regular expression for a URL to be excluded
  - How often do you check robots.txt?
    - Cache to avoid using bandwidth and loading web server
- Sitemaps
  - A mechanism to better manage the URL frontier

A Robust Crawl Architecture



Duplicate Elimination

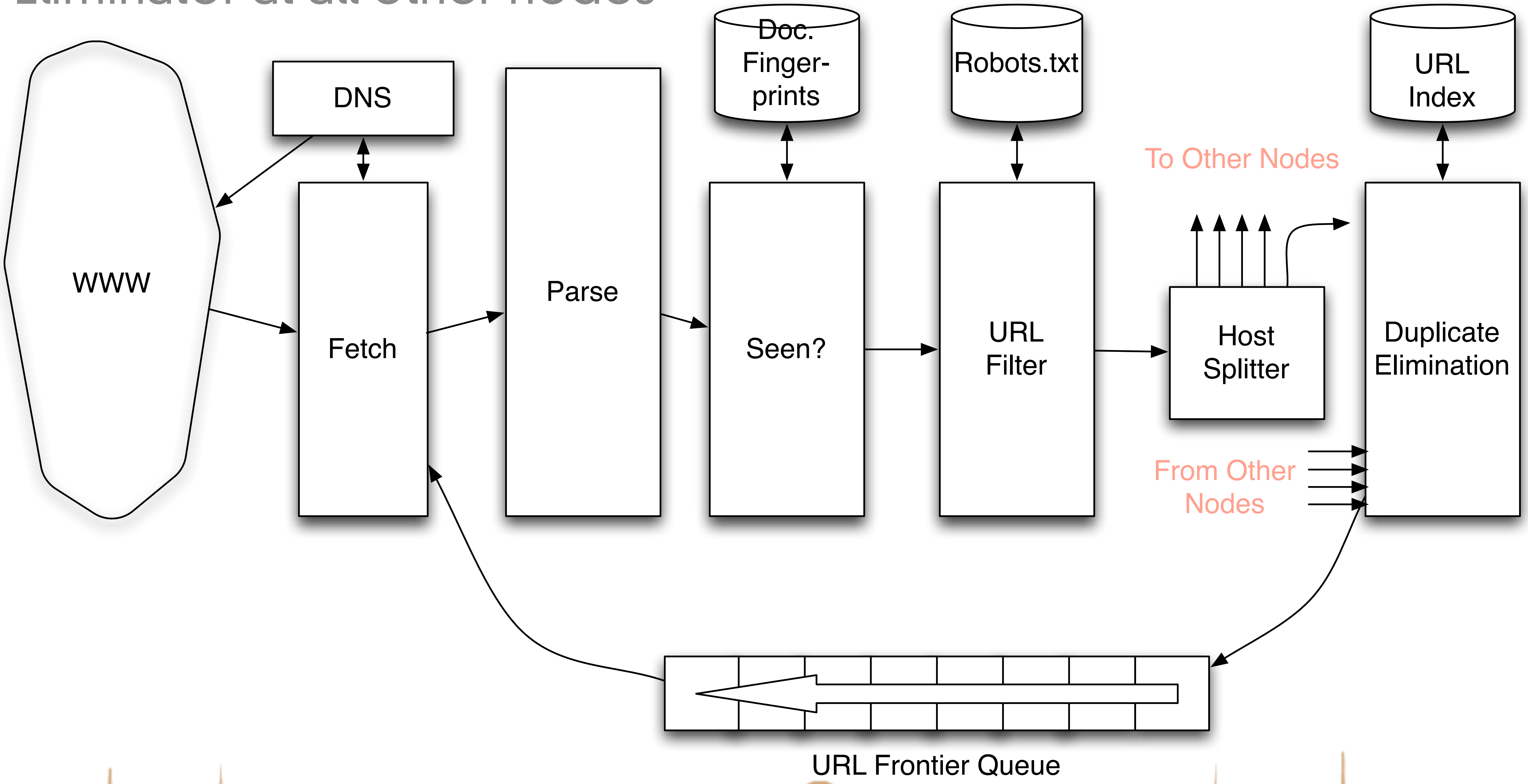
- For a one-time crawl
  - Test to see if an extracted,parsed, filtered URL
    - has already been sent to the frontier.
    - has already been indexed.
- For a continuous crawl
  - See full frontier implementation:
    - Update the URL’s priority
      - Based on staleness
      - Based on quality
      - Based on politeness

Distributing the crawl

- The key goal for the architecture of a distributed crawl is cache locality
- We want multiple crawl threads in multiple processes at multiple nodes for robustness
    - Geographically distributed for speed
- Partition the hosts being crawled across nodes
    - Hash typically used for partition
- How do the nodes communicate?

Robust Crawling

The output of the URL Filter at each node is sent to the Duplicate Eliminator at all other nodes



URL Frontier

- Freshness
  - Crawl some pages more often than others
    - Keep track of change rate of sites
    - Incorporate sitemap info
- Quality
  - High quality pages should be prioritized
  - Based on link-analysis, popularity, heuristics on content
- Politeness
  - When was the last time you hit a server?

URL Frontier

- Freshness, Quality and Politeness
  - These goals will conflict with each other
  - A simple priority queue will fail because links are bursty
    - Many sites have lots of links pointing to themselves creating bursty references
    - Time influences the priority
- Politeness Challenges
  - Even if only one thread is assigned to hit a particular host it can hit it repeatedly
  - Heuristic : insert a time gap between successive requests

Magnitude of the crawl

- To fetch 1,000,000,000 pages in one month...
  - a small fraction of the web
- we need to fetch 400 pages per second !
- Since many fetches will be duplicates, unfetchable, filtered, etc. 400 pages per second isn’t fast enough

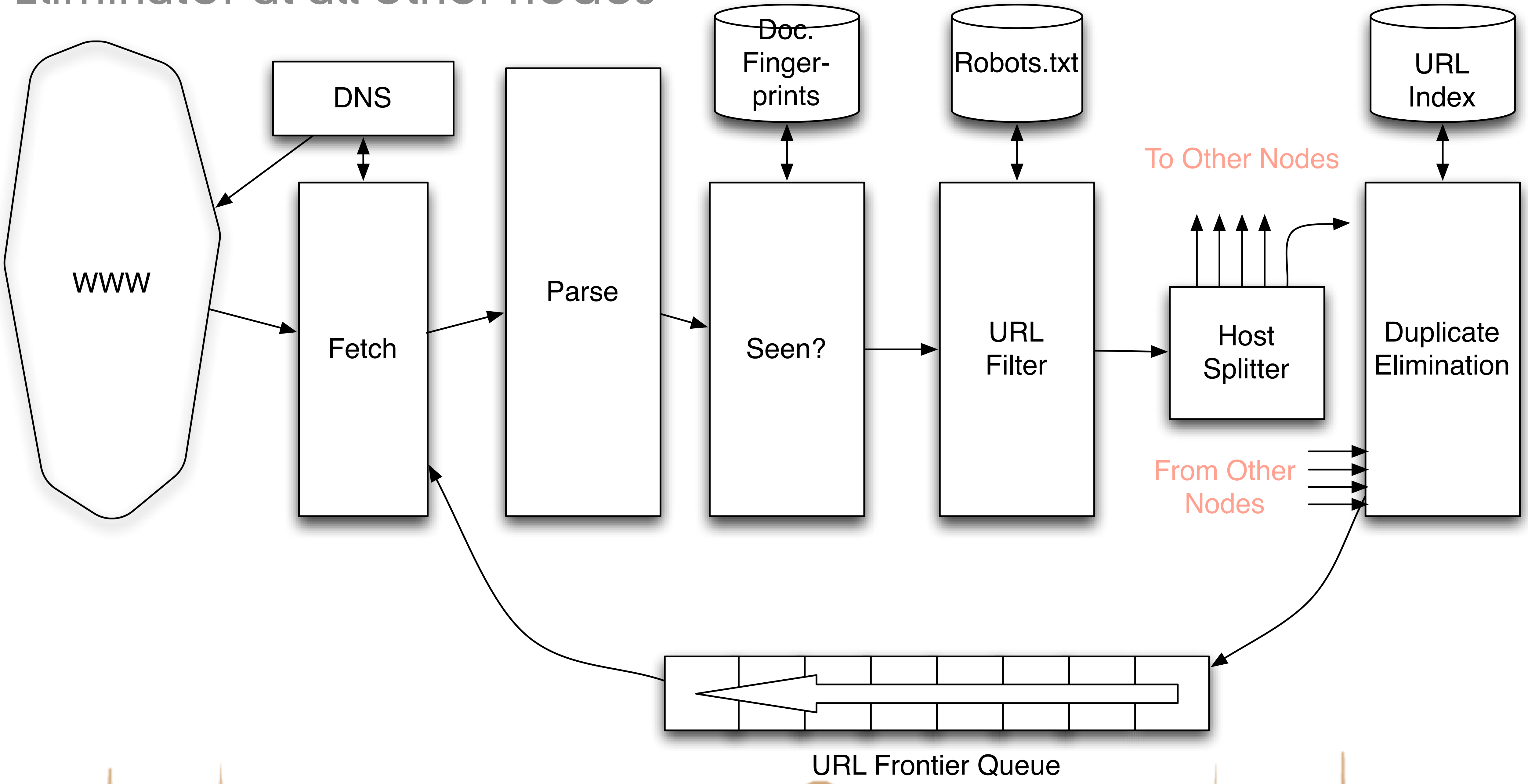
Web Crawling Outline

Overview

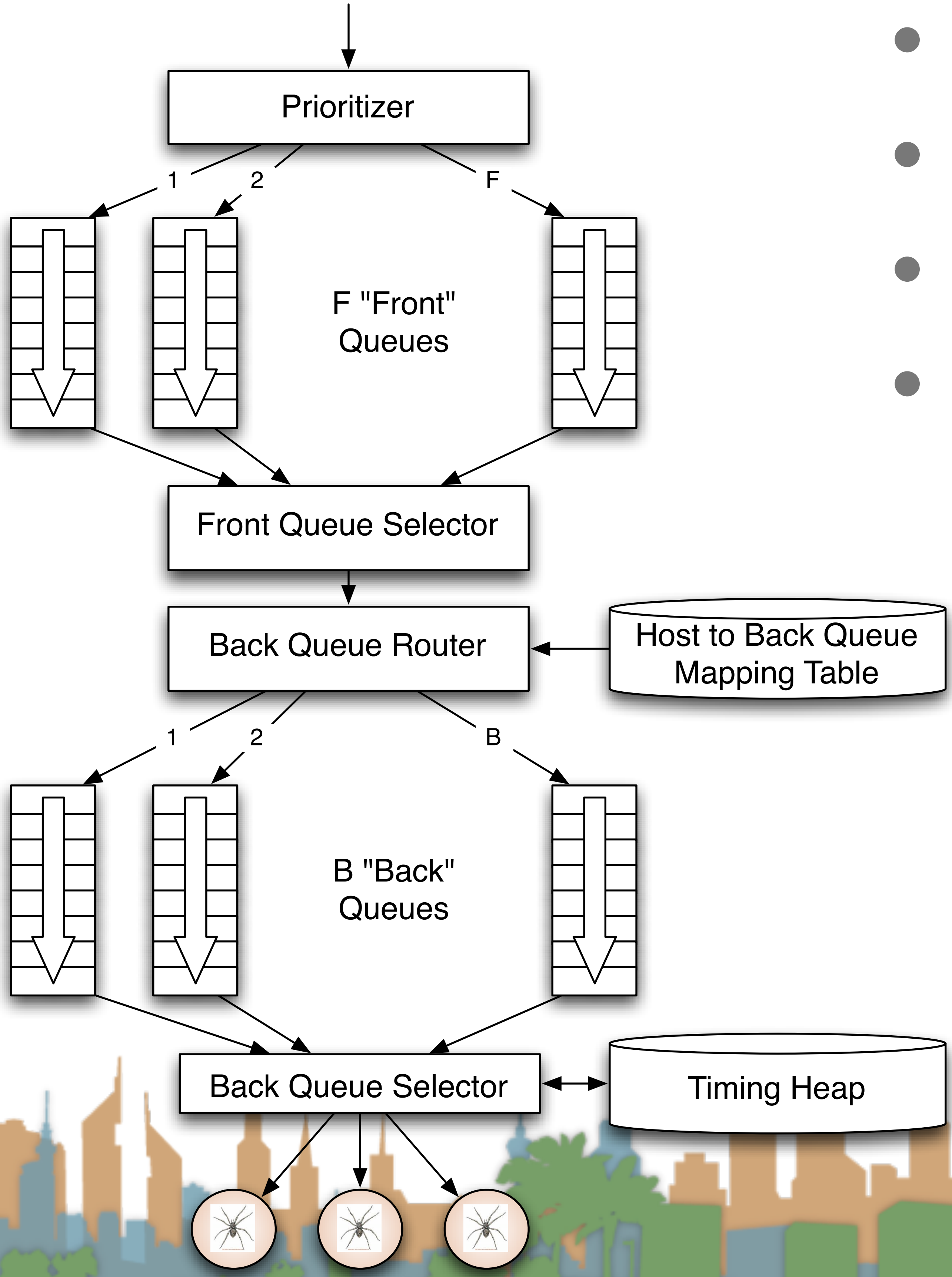
- Introduction
- URL Frontier
- Robust Crawling
    - DNS
    - Various parts of architecture
    - URL Frontier
- Index
    - Distributed Indices
    - Connectivity Servers

Robust Crawling

The output of the URL Filter at each node is sent to the Duplicate Eliminator at all other nodes



URL Frontier Implementation - Mercator

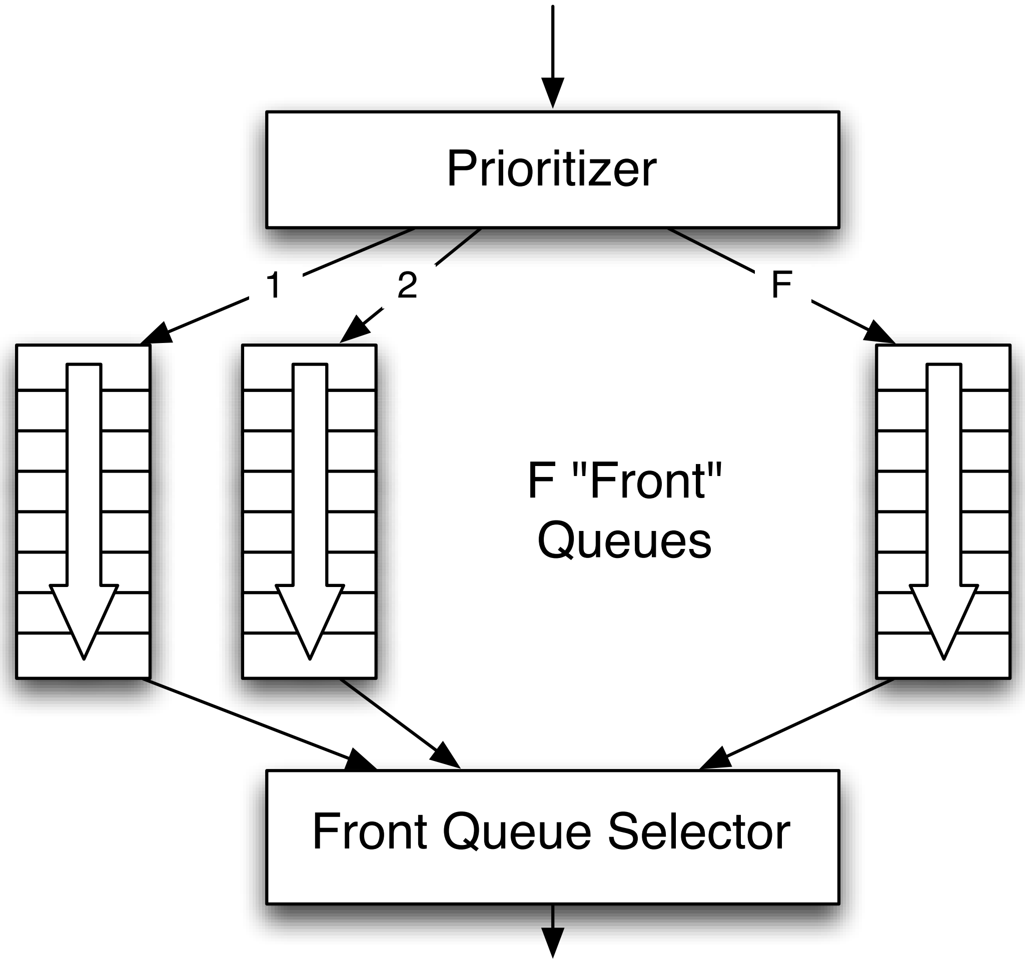


- URLs flow from top to bottom
- Front queues manage priority
- Back queue manage politeness
- Each queue is FIFO

http://research.microsoft.com/~najork/mercator.pdf

URL Frontier Implementation - Mercator

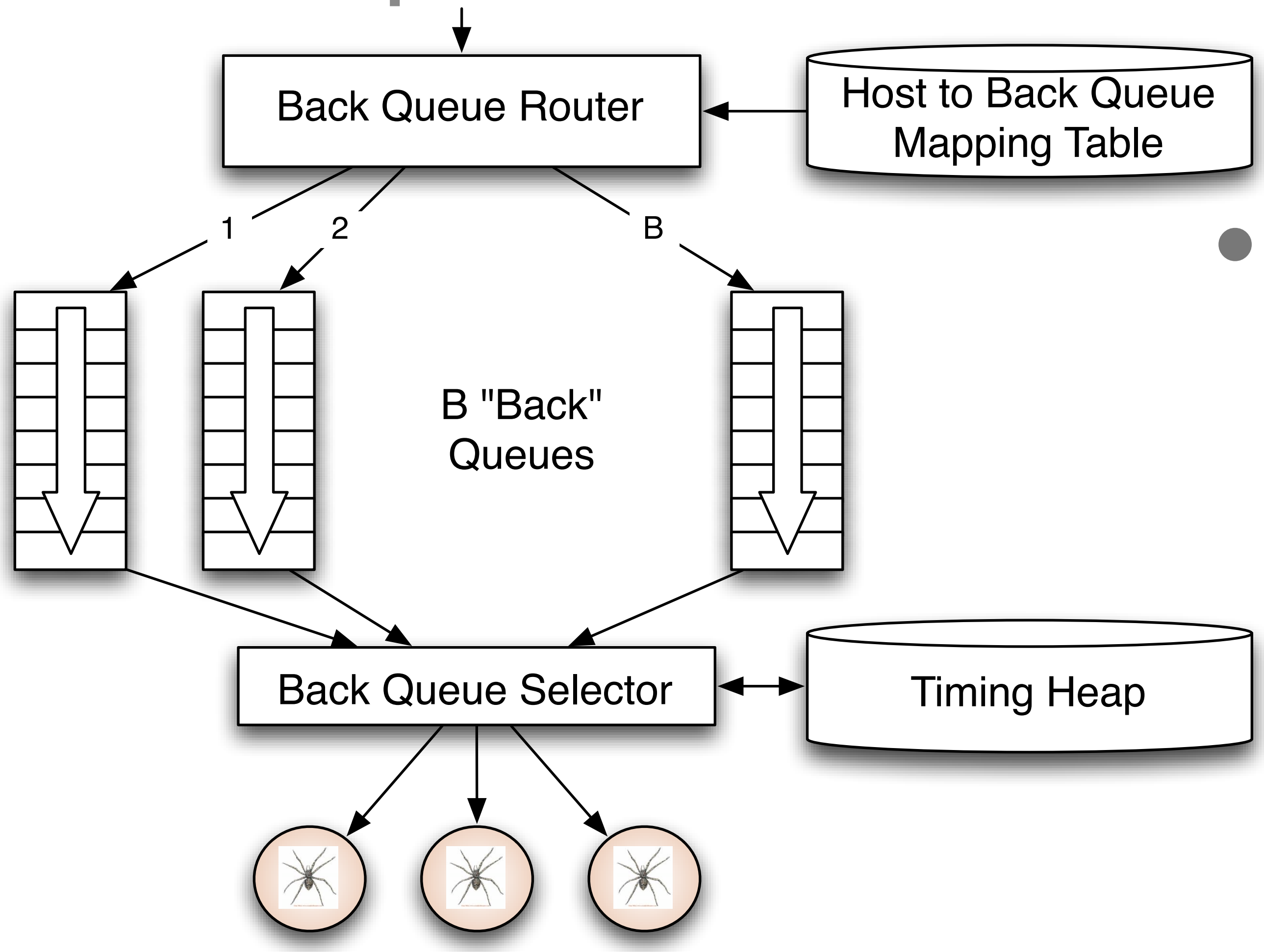
Front queues



- Prioritizer takes URLS and assigns a priority
  - Integer between 1 and F
  - Appends URL to appropriate queue
- Priority
  - Based on rate of change
  - Based on quality (spam)
  - Based on application

URL Frontier Implementation - Mercator

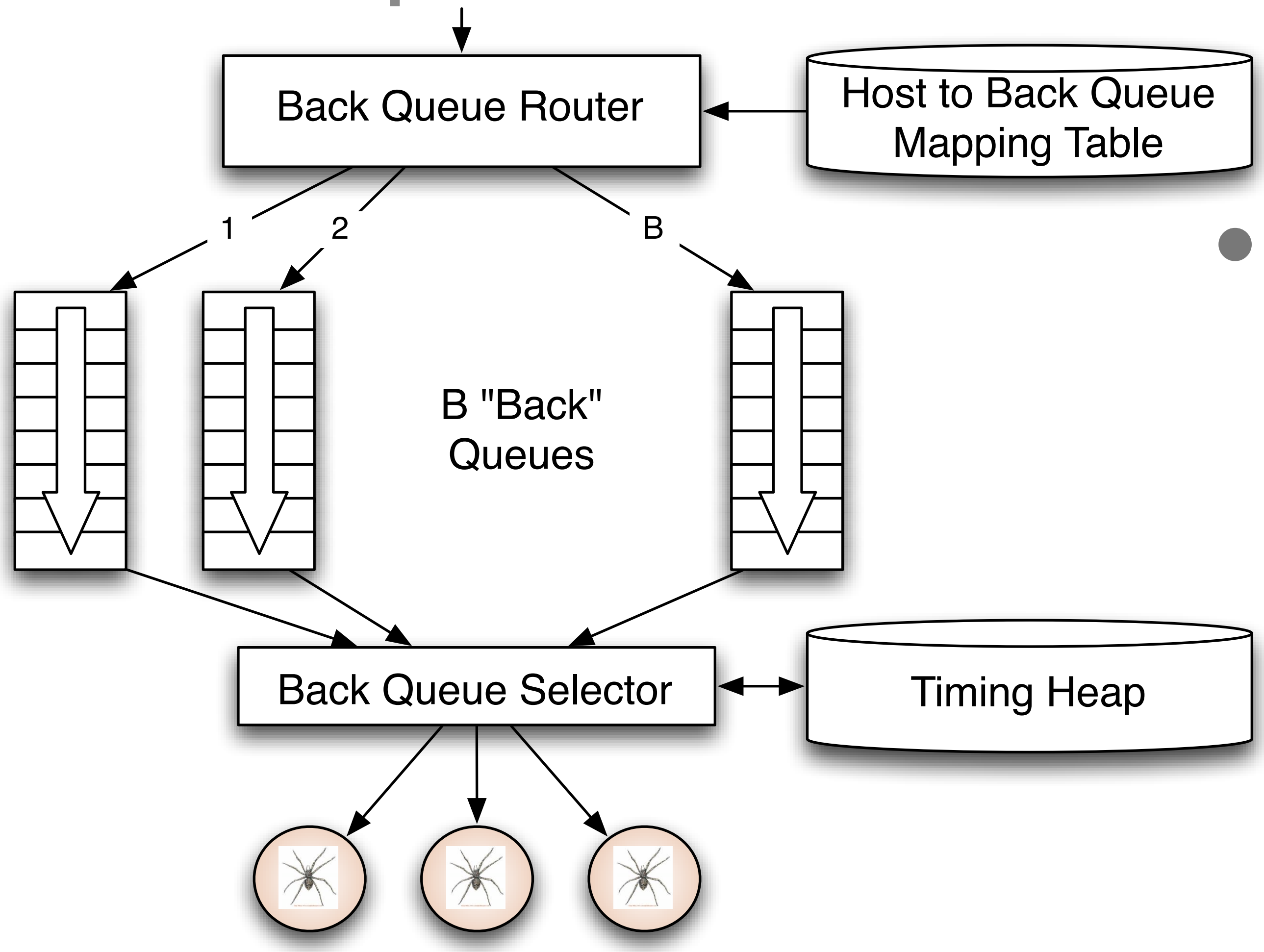
Back queues



- Selection from front queues is initiated from back queues
- Pick a front queue, how?
  - Round robin
  - Randomly
  - Monte Carlo
  - Biased toward high priority

URL Frontier Implementation - Mercator

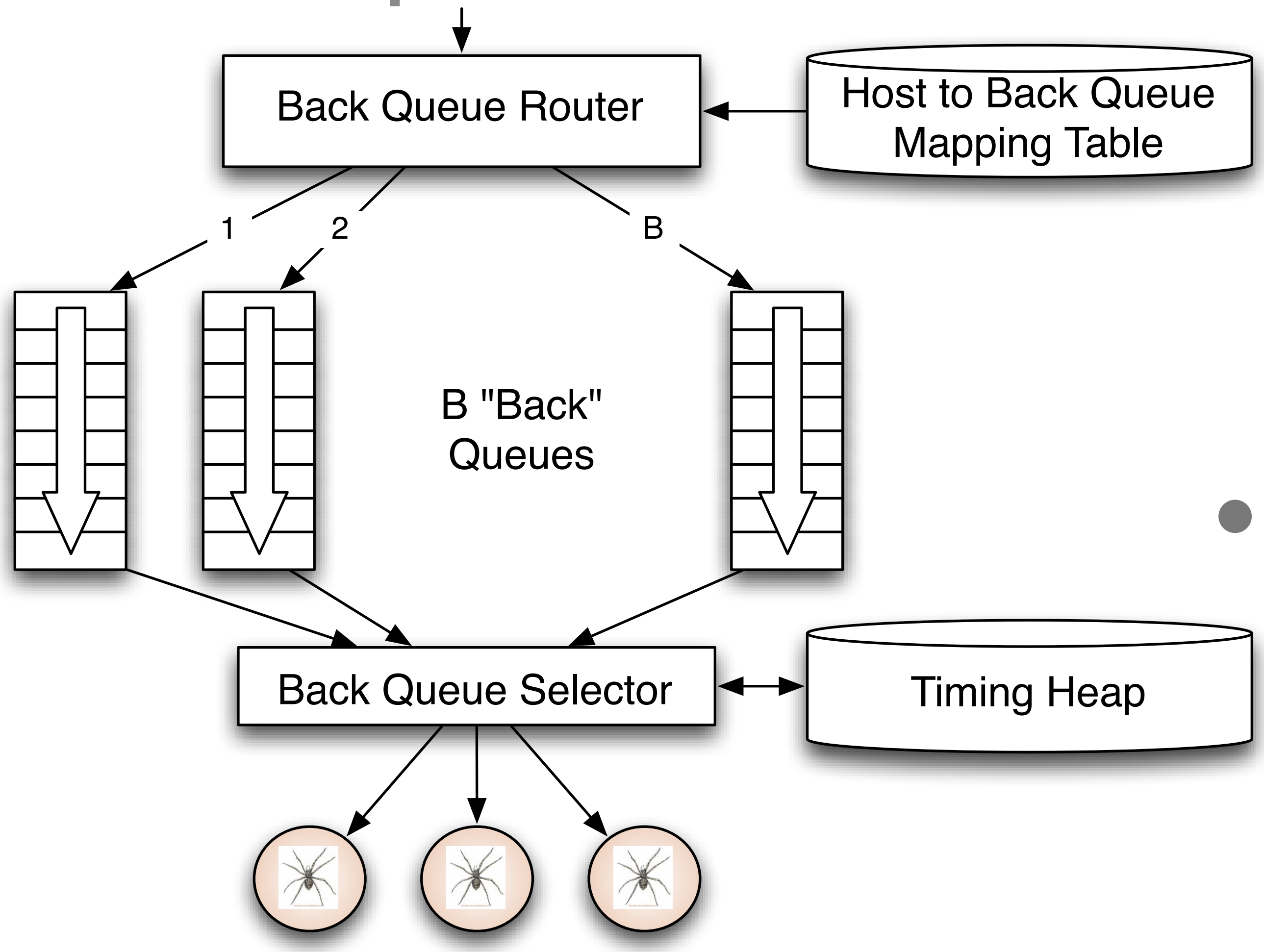
Back queues



- Each back queue is non-empty while crawling
- Each back queue has URLs from one host only
  - Maintain a table of URL to back queues (mapping) to help

URL Frontier Implementation - Mercator

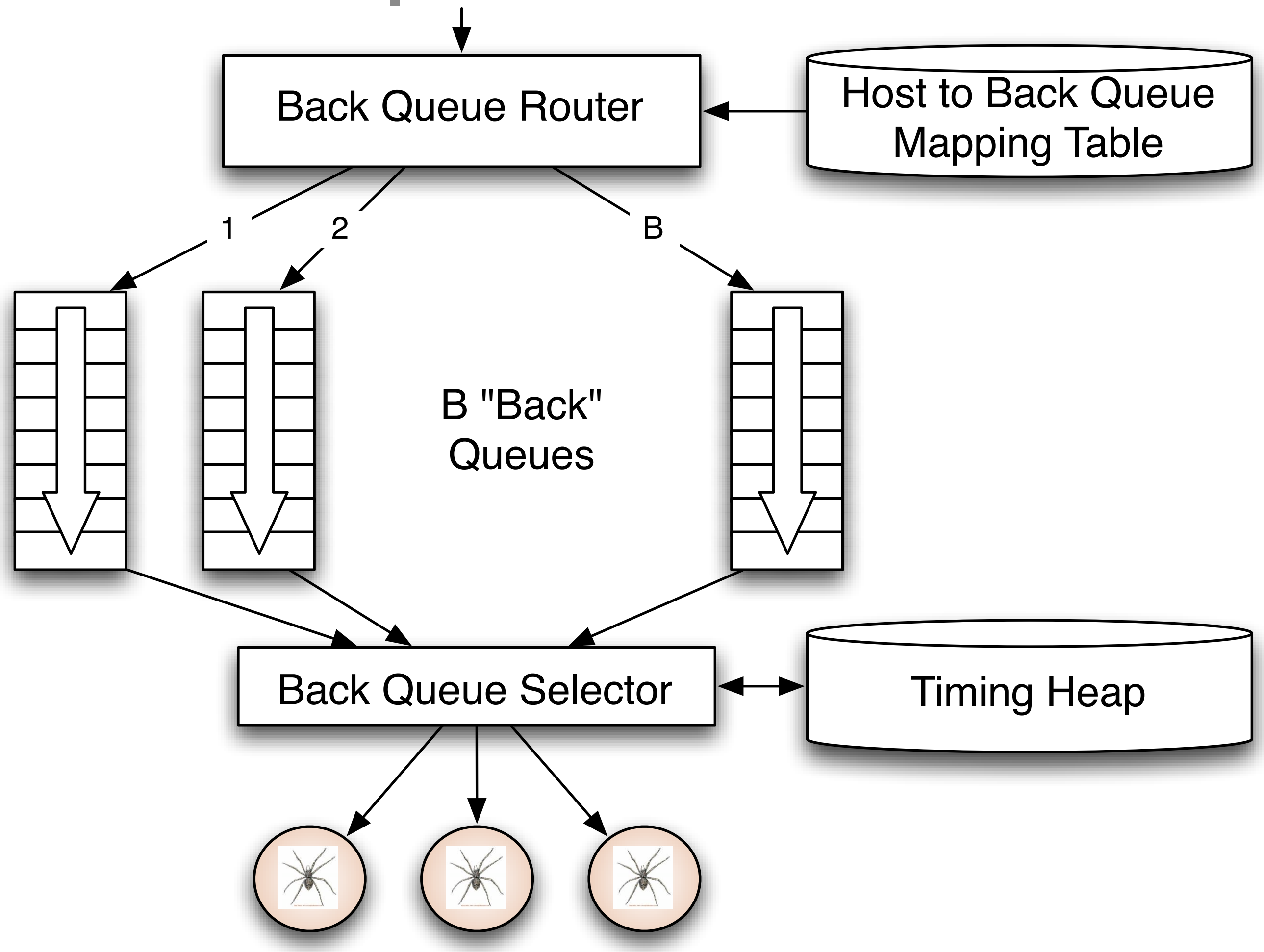
Back queues



- Timing Heap
  - One entry per queue
  - Has earliest time that a host can be hit again
- Earliest time based on
  - Last access to that host
  - Plus any appropriate heuristic

URL Frontier Implementation - Mercator

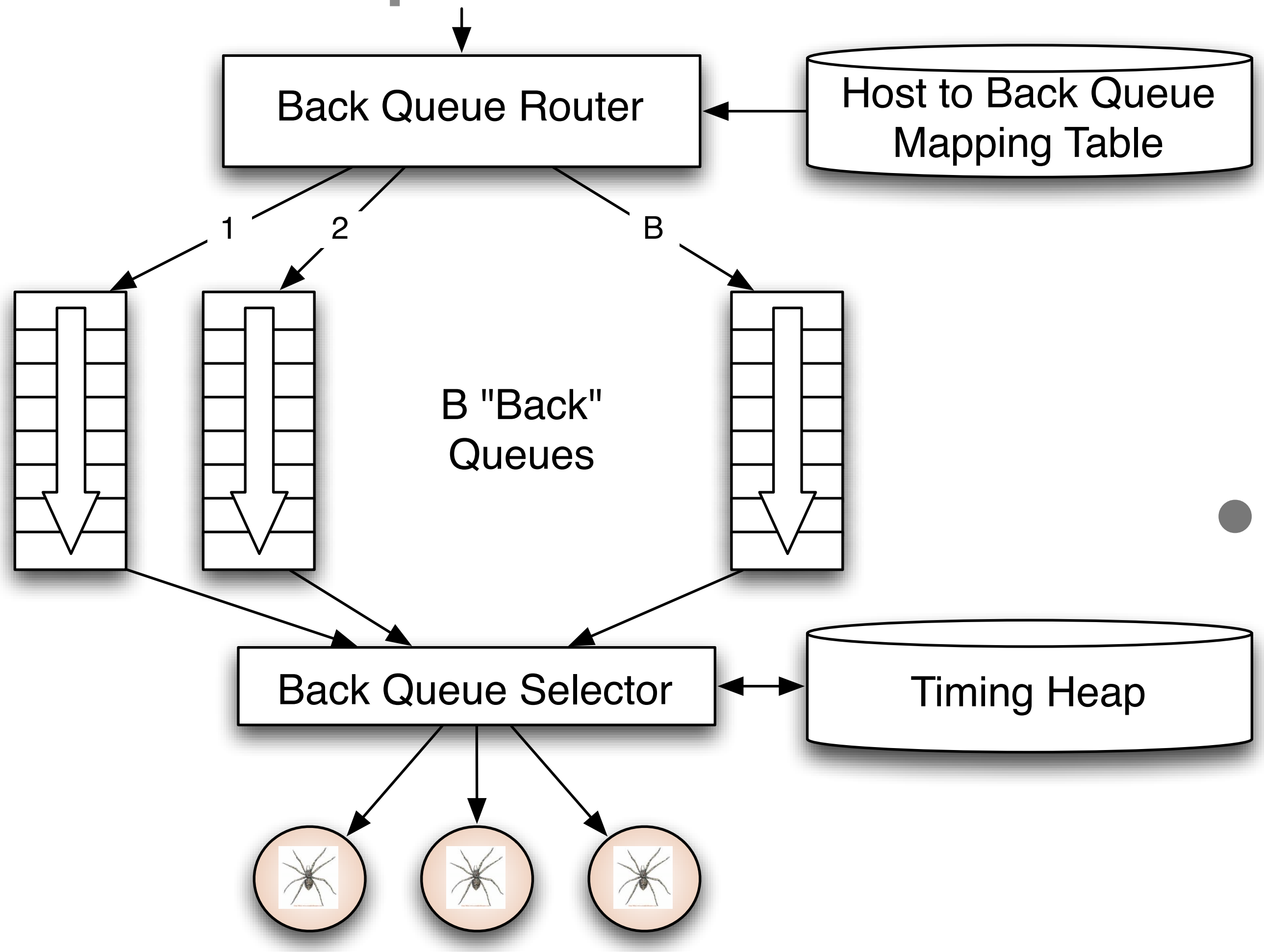
Back queues



- A crawler thread needs a URL
  - It gets the timing heap root
  - It gets the next eligible queue based on time, b.
  - It gets a URL from b
  - If b is empty
  - Pull a URL v from front queue
  - If back queue for v exists place it in that queue, repeat.
  - Else add v to b - update heap.

URL Frontier Implementation - Mercator

Back queues



- How many queues?
  - Keep all threads busy
  - ~3 times as many back queues as crawler threads
- Web-scale issues
  - This won't fit in memory
  - Solution
    - Keep queues on disk and keep a portion in memory.

LUCI