Web Crawling

Introduction to Information Retrieval

Informatics 141 / CS 121
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Content adapted from Hinrich Schütze
http://www.informationretrieval.org

Robots.txt - Exclusion

- Protocol for giving spiders ("robots") limited access to a website
  - Source: http://www.robotstxt.org/wc/norobots.html
- Website announces what is okay and not okay to crawl:
- Located at http://www.myurl.com/robots.txt
- This file holds the restrictions

Robots.txt Example

- http://www.ics.uci.edu/robots.txt

```
User-agent: MOMspider              # The Multi-Owner Maintenance Spider
Disallow: /cgi-bin/                #     Script files
Disallow: /Admin/MOM/              #     Local MOMspider output
Disallow: /~fielding/MOM/          #     Local MOMspider output
Disallow: /TR/                     #     Dienst Technical Report Server
Disallow: /Server/                 #     Dienst Technical Report Server
Disallow: /Document/               #     Dienst Technical Report Server
Disallow: /MetaServer/             #     Dienst Technical Report Server
Disallow: /~eppstein/pubs/cites/           #     Eppstein Database
Disallow: /~fiorello/pvt/          #     Private pages

User-agent: *                      # All other spiders should avoid
Disallow: /cgi-bin/                #     Script files
Disallow: /Test/                   #     The test area for web experimentation
Disallow: /Admin/                  #     Huge server statistic logs
Disallow: /TR/                     #     Dienst Technical Report Server
Disallow: /Server/                 #     Dienst Technical Report Server
Disallow: /Document/               #     Dienst Technical Report Server
Disallow: /MetaServer/             #     Dienst Technical Report Server
Disallow: /~fielding/MOM/          #     Local MOMspider output
Disallow: /~kanderso/hidden        #     Ken Anderson's stuff
Disallow: /~eppstein/pubs/cites/           #     Eppstein Database
Disallow: /~fiorello/pvt/          #     Private pages
Disallow: /~dean/
Disallow: /~wwwoffic/
Disallow: /~ucounsel/
Disallow: /~sao/
Disallow: /~support/
Disallow: /~icsdb/
Disallow: /bin/
```

Sitemaps - Inclusion

- https://www.google.com/webmasters/tools/docs/en/protocol.html#sitemapXMLExample

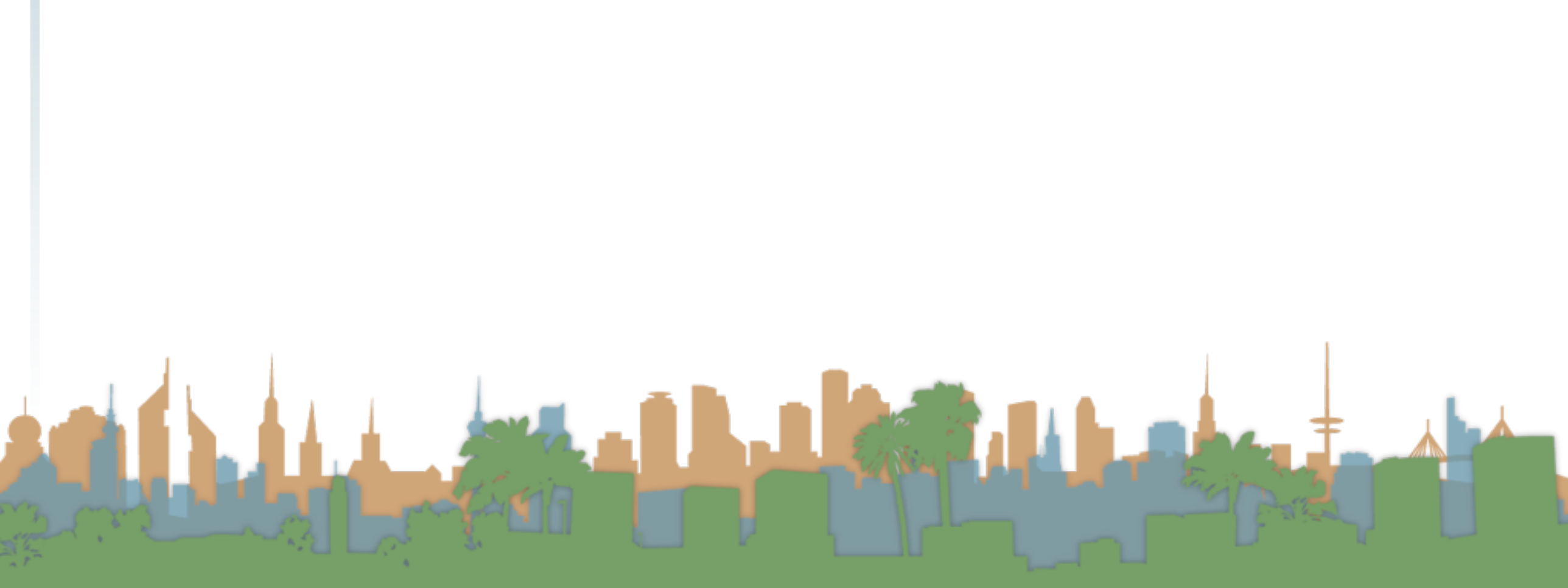
```
<?xml version="1.0" encoding="UTF-8"?>
<urlset xmlns="http://www.sitemaps.org/schemas/sitemap/0.9">

   <url>
      <loc>http://www.example.com/</loc>
      <lastmod>2005-01-01</lastmod>
      <changefreq>monthly</changefreq>
      <priority>0.8</priority>
   </url>
   <url>
      <loc>http://www.example.com/catalog?item=12&amp;desc=vacation_hawaii</loc>
      <changefreq>weekly</changefreq>
   </url>
   <url>
      <loc>http://www.example.com/catalog?item=73&amp;desc=vacation_new_zealand</loc>
      <lastmod>2004-12-23</lastmod>
      <changefreq>weekly</changefreq>
   </url>
   <url>
      <loc>http://www.example.com/catalog?item=74&amp;desc=vacation_newfoundland</loc>
      <lastmod>2004-12-23T18:00:15+00:00</lastmod>
      <priority>0.3</priority>
   </url>
   <url>
      <loc>http://www.example.com/catalog?item=83&amp;desc=vacation_usa</loc>
      <lastmod>2004-11-23</lastmod>
   </url>
</urlset>
```

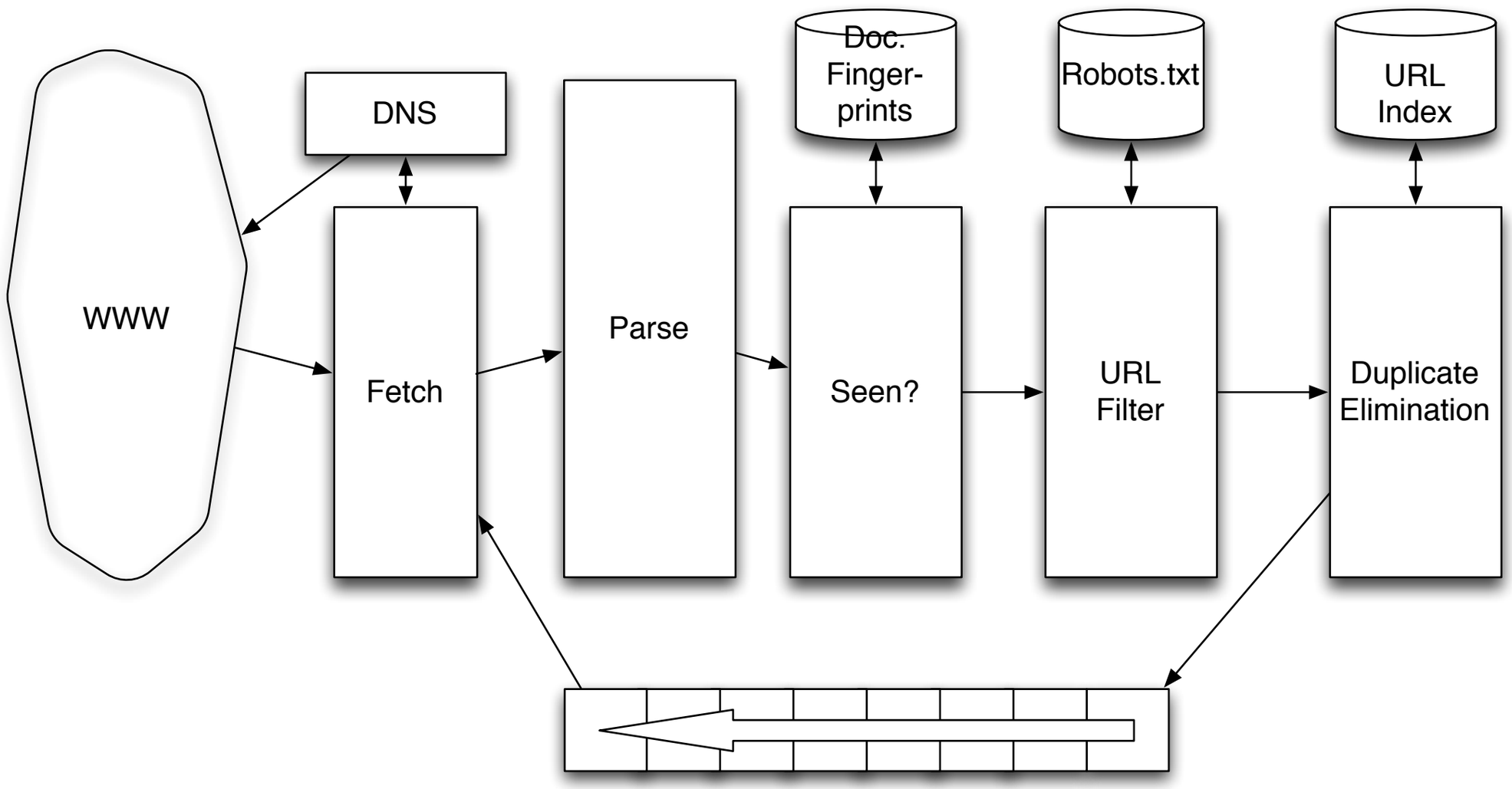
Web Crawling Outline

Overview

- Introduction
- URL Frontier
- Robust Crawling
  - DNS



A Robust Crawl Architecture



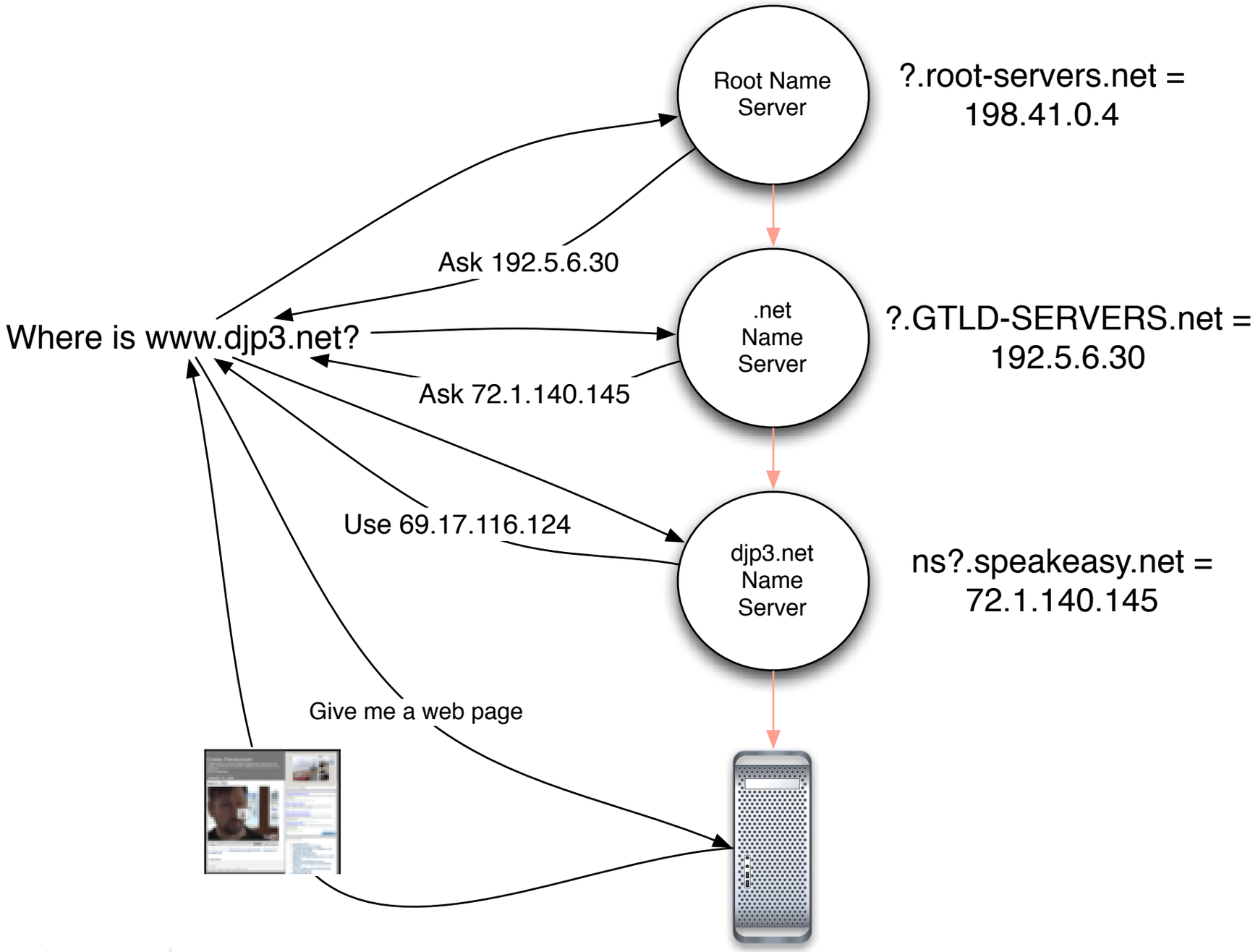
Processing Steps in Crawling

- Pick a URL from the frontier (how to prioritize?)
- Fetch the document (DNS lookup)
- Parse the URL
  - Extract Links
  - Check for duplicate content
    - If not add to index
- For each extracted link
  - Make sure it passes filter (robots.txt)
  - Make sure it isn’t in the URL frontier

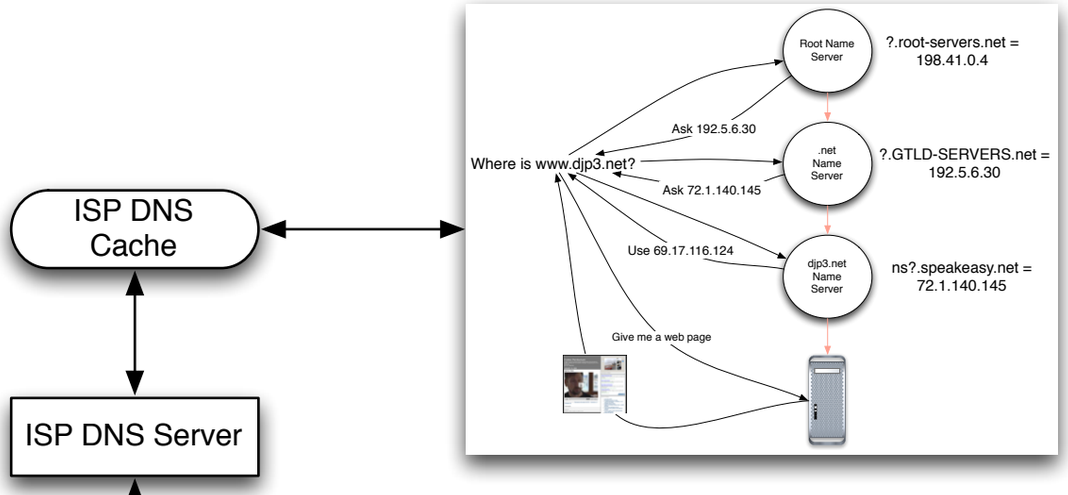
Domain Name Server

- A lookup service on the internet
  - Given a URL, retrieve its IP address
    - www.djp3.net -> 69.17.116.124
- This service is provided by a distributed set of servers
  - Latency can be high
    - Even seconds
- Common OS implementations of DNS lookup are blocking
  - One request at a time
- Solution:
  - Caching
  - Batch requests

dig +trace www.djp3.net

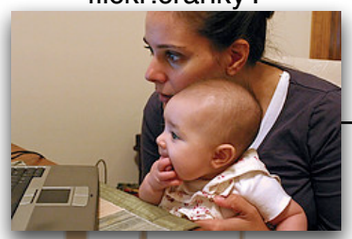


What really happens



The User

flickr:crankyT



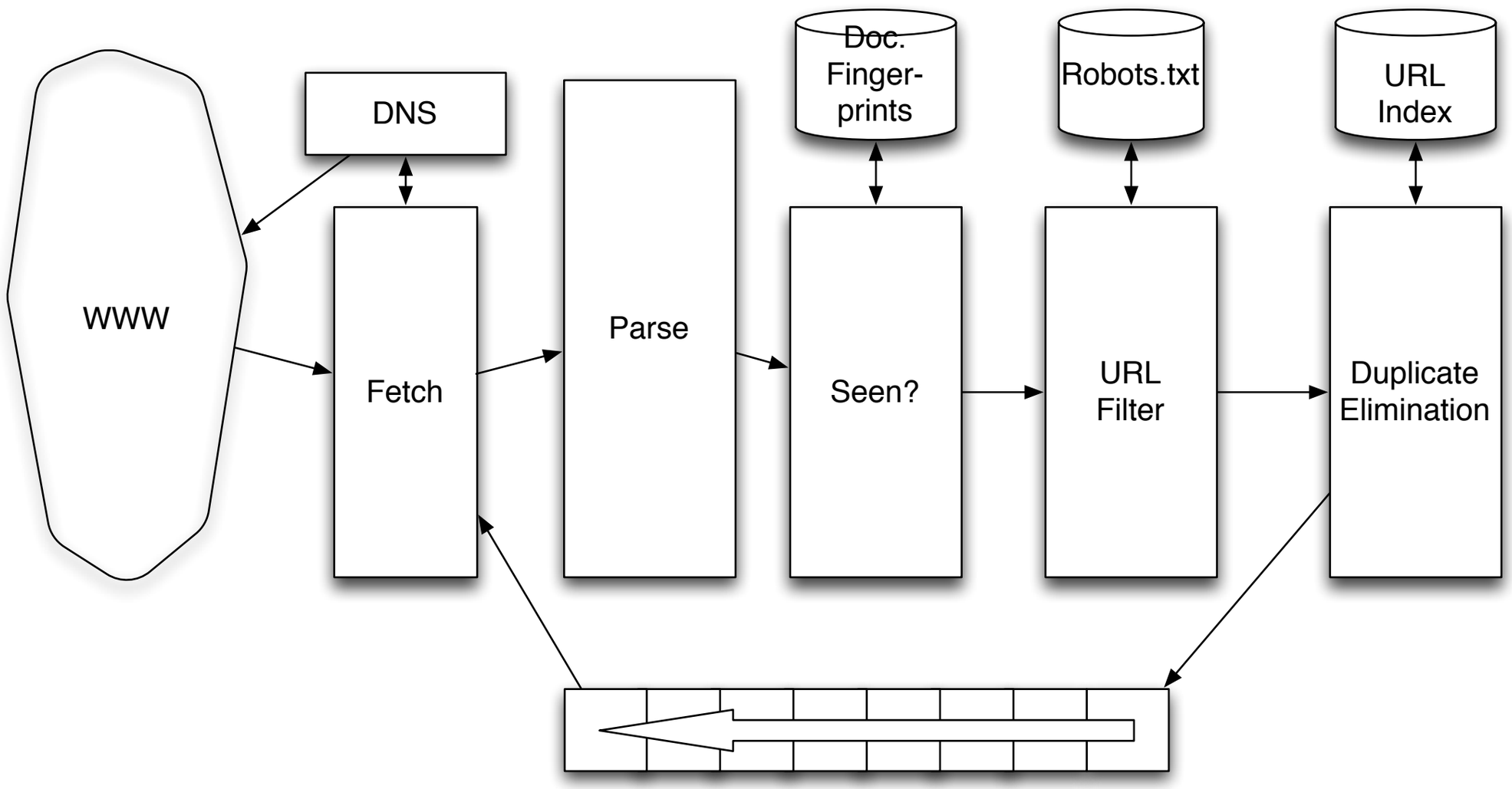
Give me a web page

Class Exercise

- Calculate how long it would take to completely fill a DNS cache.
  - How many active hosts are there?
  - What is an average lookup time?
  - Do the math.

http://www.flickr.com/photos/lurie/298967218/

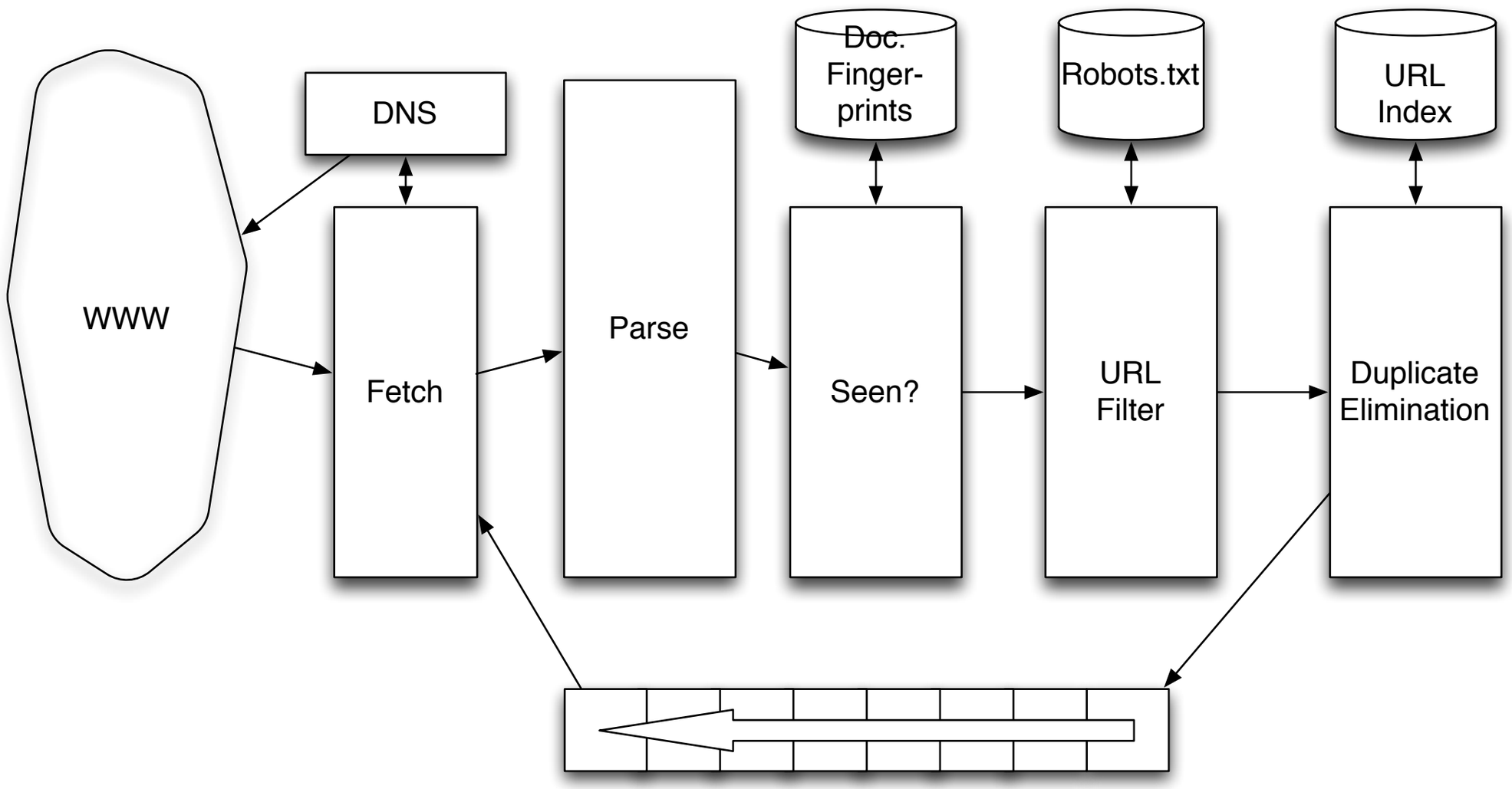
A Robust Crawl Architecture



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

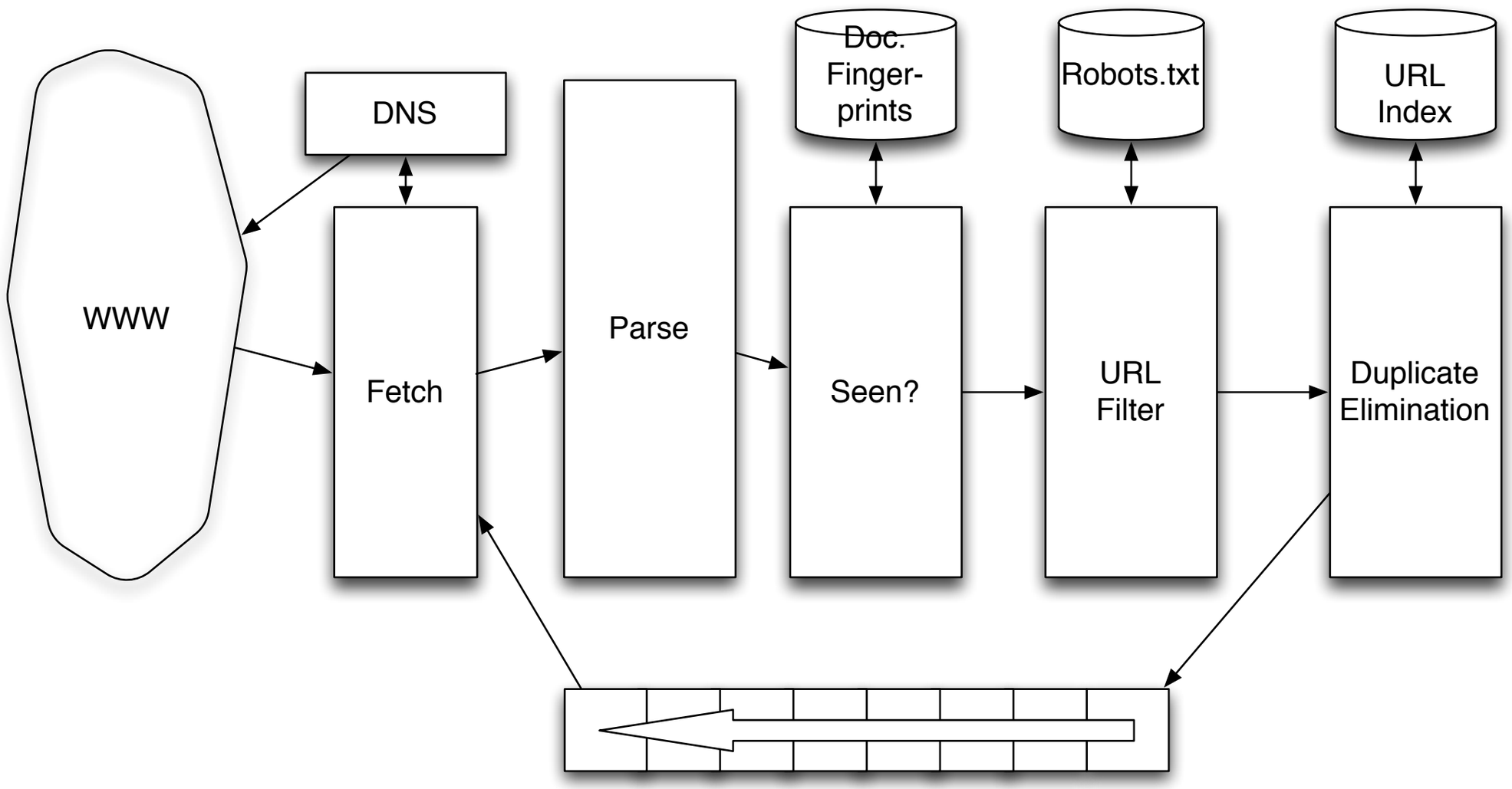
A Robust Crawl Architecture



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

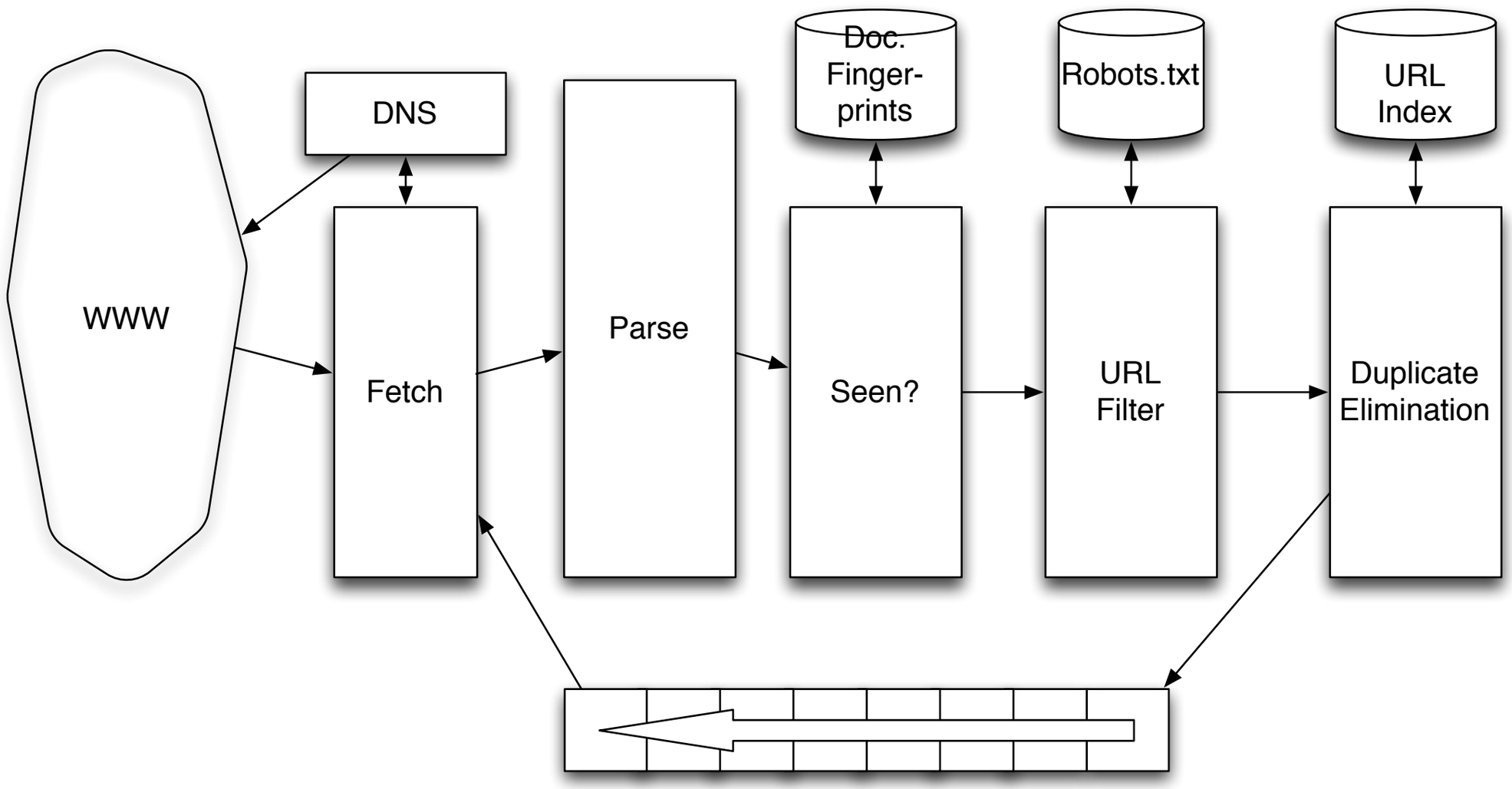
A Robust Crawl Architecture



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

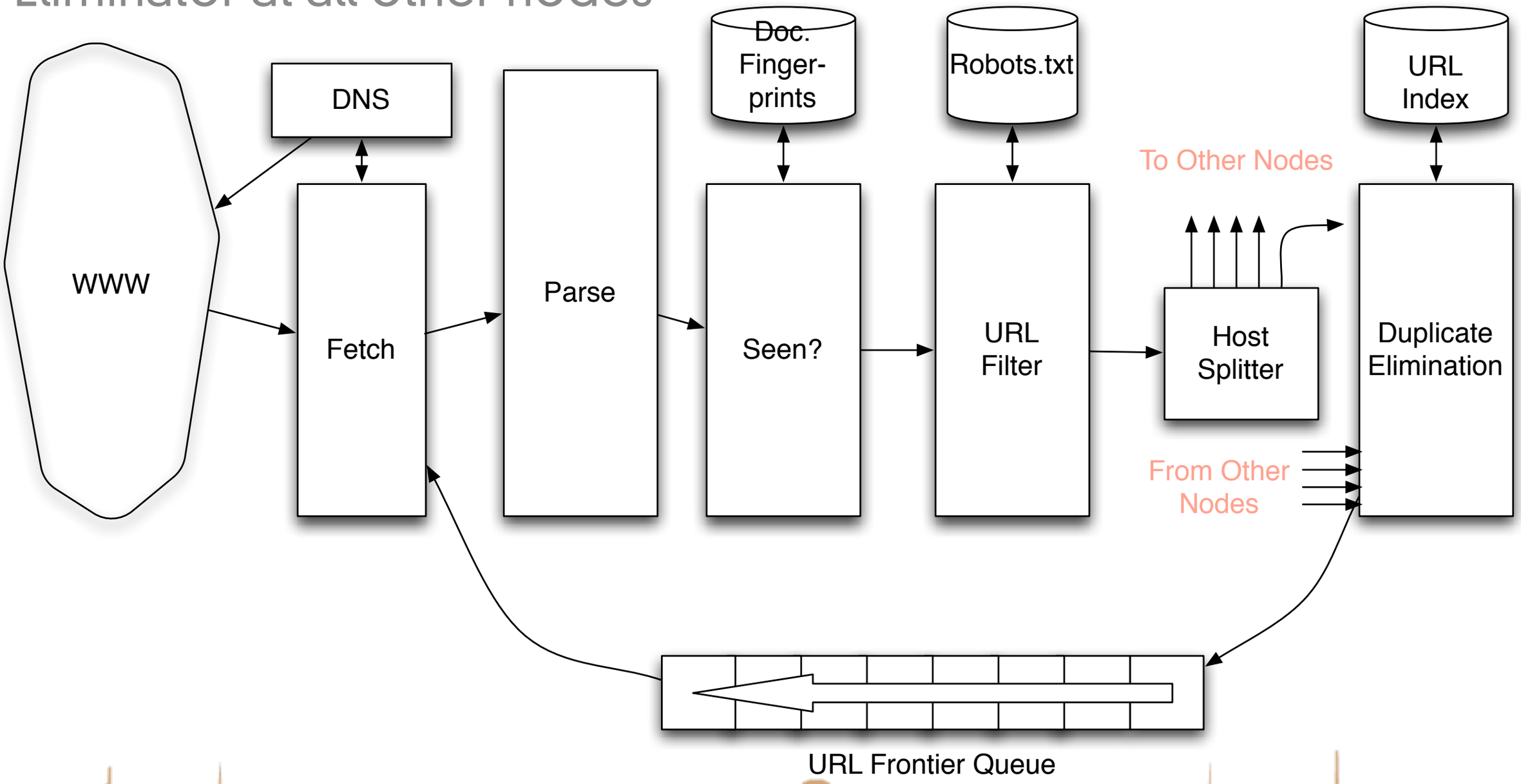
- For a one-time crawl
  - Test to see if an extracted,parsed, filtered URL
    - has already been sent to the frontier.
    - has already been indexed.
- For a continuous crawl
  - See full frontier implementation:
    - Update the URL's priority
      - Based on staleness
      - Based on quality
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

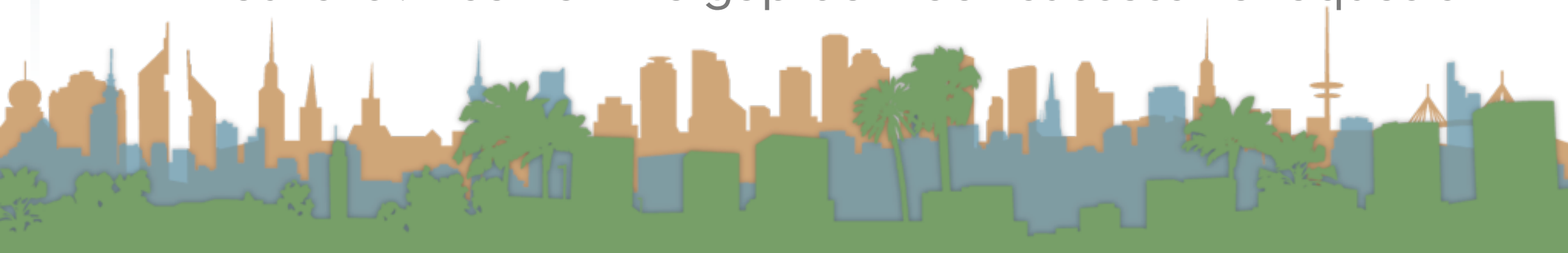


URL Frontier

- 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 eachother
  - 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