Crawling the Web

Web Crawling

❖Retrieve (for indexing, storage, …) Web pages by using the links found on a page to locate more pages.

Must have some starting point

Type of crawl

- Web crawl versus

  crawl of more limited network – web
  - cs.princeton.edu
  - internal co. network
- complete crawl versus

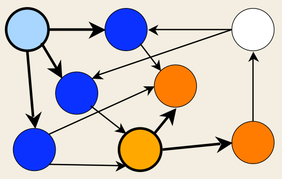
  focused crawl by some criteria
  - pages on one topic
- Type of crawl will affect necessity/usability of various techniques

Main Issues I

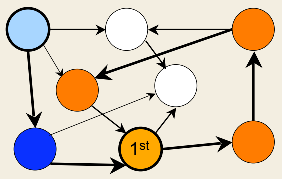
- starting set of pages?
- can visit whole of Web (or web)?
- how determine order to visit links?
  - graph model:

    breadth first vs depth first
    - what are pros and cons of each?
    - "black holes"
  - other aspects /considerations
    - how deep want to go?
    - associate priority with links

- Breadth-first:



- Depth-first:



Main Issues II

- Web is dynamic
  - time to crawl "once"
  - how mix crawl and re-crawl
    - priority of pages
- Social behavior
  - robot exclusion protocol
  - not flood servers

Technical issues

- maintain one or **more** queues of URLs to be visited
  - order of URLs in queues?
    - FIFO = breadth first
    - LIFO = depth first
    - priority queues
- bottleneck: resolve hostname in URLs to get actual IP addresses – Domain Name Service servers (DNS lookup)
- To do large crawls must have multiple crawlers with multiple network connections (sockets) open and probably multiple queues

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DNS lookup

- don't want temporal locality of reference
  - be nice to servers (or else)
- cache DNS map
  - large, local, in memory
  - hold most recently used mappings
- prefetch DNS resolution for URLs on page when it parsed
  - put in cache
  - use when URL gets to head of queue
  - resolution stale?
- How "large" ?
  - Problems?

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Duplicate URL removal

Has URL been visited already?

- Use:
  - canonical, fully specified URLs
  - canonical hostname provided by DNS
- *Visited?* hash table
  - hash canonical URL to entry
- *Visited?* table may be too large for MM

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Caching *Visited?* table

- not temporal but "spatial" locality:
  - most popular URLs
  - most popular sites
    - *some* temporal locality within
- to exploit site-level locality need hash that brings pages on same site together:
  - two-level hash:
    - hash hostname and port
    - hash path
- can use B+ tree, sorted on i then ii
  - if no entry for URL in tree, not visited

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(Near) Duplicate page removal

Has page been indexed already?

- mirror sites – different URLs, same page
  - bad: duplicate page in search results
  - worse?: add links from duplicate pages to queues
    - also mirrors?
  - mirrored pages my have slight differences
    - e.g. indicate which mirror they on
- other sources duplicates & near duplicates
- table of fingerprints or sketches of pages
  - fit in main memory?
  - if not, costs disk access per page crawler retrieves
    - cache?

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When apply duplicate removal?

- while crawling versus for search results
  - crawling larger problem
  - search results demand faster results
- duplicates versus near duplicates
  - same policy?

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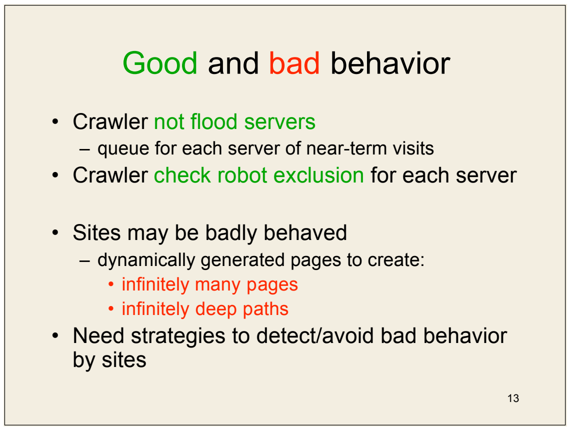

Good and bad behavior

- Crawler not flood servers
  - queue for each server of near-term visits
- Crawler check robot exclusion for each server

- Sites may be badly behaved
  - dynamically generated pages to create:
    - infinitely many pages
    - infinitely deep paths
- Need strategies to detect/avoid bad behavior by sites

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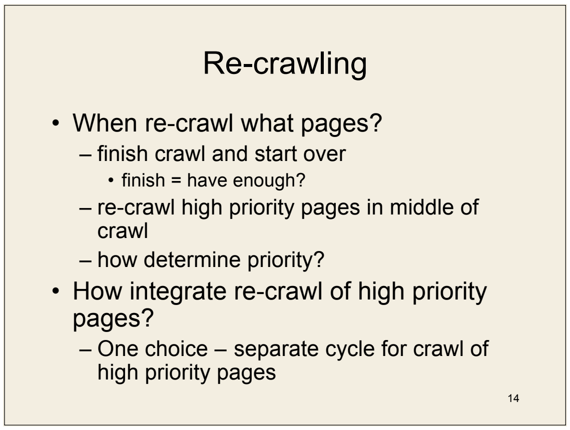

Re-crawling

- When re-crawl what pages?
  - finish crawl and start over
    - finish = have enough?
  - re-crawl high priority pages in middle of crawl
  - how determine priority?
- How integrate re-crawl of high priority pages?
  - One choice – separate cycle for crawl of high priority pages

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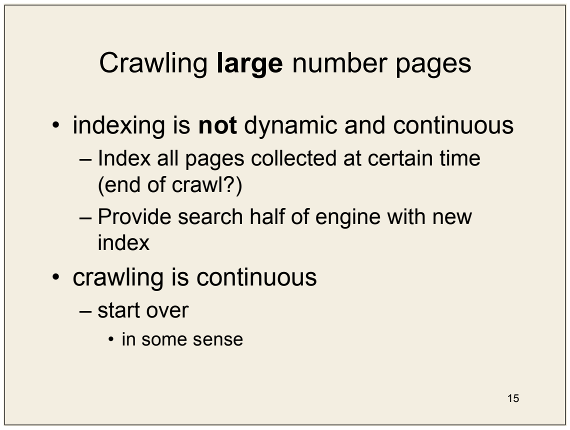

Crawling **large** number pages

- indexing is **not** dynamic and continuous
  - Index all pages collected at certain time (end of crawl?)
  - Provide search half of engine with new index
- crawling is continuous
  - start over
    - in some sense

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