Web Crawling

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...about 80% of users make use of a search engine to try to look for information

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- a front end

Usually, the end user only knows the latter component, that is, the part of a search engine that actually answers users' queries.

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- Failure to respect standards (HTTP, HTML, etc.)
- Spider traps!

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- Produce suitable (inverted) indices, and compute information needed in the last phase for selection and ranking purposes

Front end

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- Automatic clustering and classification

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The crawl is performed starting from one (or more) page(s), called *crawl seed*.

Structure of a crawler (II)

A visit:

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$\mathrm{visit}()$: **Perform a visit cycle**
while $F \neq \emptyset$ **do**
  $x \leftarrow F.\mathrm{pick}()$
  $\mathrm{visit}(x)$ i.e.: fetch the page with URL x!
  $St[x] \leftarrow \mathrm{black}$
  for $y \in N^+(x)$ **do**
    if $S[y] = \mathrm{white}$ **then**
      $St[y] \leftarrow \mathrm{grey}$
      $F.\mathrm{add}(y)$
    end if
  end for
end while

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- There is a (ever growing) portion of the web that is not reachable simply through links: this is the so called "dark matter" (automatic form-filling? fake user registration?)
- Many think that the "visible" part is by now only a minor portion (16-20%) of the entire web.

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- Choosing the pages on the basis of their (supposed) content (header content-type)
- Only text/html? Or also other formats? (P.es., application/ms-word, application/postscript, . . .)
- You need tools to parse other hypertextual formats (like PDF) different from HTML (to extract links, words etc.)

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- Note: a compressed page, with headers, may occupy on the average about 4KB (the whole web would occupy about 16 TeraBytes)

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- You must decide some criterion (what is the Italian web, after all? .it? any page that appears to be written in Italian? and how can you decide this? and even then, how can you reach all such pages?)
- The criteria that can be implemented more easily decide which links should be followed on the basis of some (purely synctactic) condition

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- While crawling, provide information (`user-agent`) that allow WebMasters to know who they should blame

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- From this choice depends how fast you reach “important” (high-quality) pages
- Under many quality metrics, for general-purpose (non-focused) crawls, breadth-first visits seem to be the most efficient (but. . .)

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- A crawler should be robust enough to tolerate anomalies (servers that don't respect the HTTP protocol; pages whose HTML syntax is not correct; etc.)
- Often, this need requires the usage of heuristics (e.g., if a server says it is going to serve a text/html page, should we trust it? how can we check if this is true?)

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- One should respect the politeness policies while guaranteeing the maximal possible freshness

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A distributed crawler features all the problems seen above, and some more. . .

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- You might have a central coordinator, that keeps track of the way the crawl is going on, or the agents may be losely coupled (in such case we speak of a *fully distributed crawler*).

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- Every agent, after fetching a page, must communicate the outlinks to the central coordinator.
- **Pro's:** No overlap; (potentially) optimal load-balancing; the number of agent may change during the crawl.
- **Con's:** It requires an enormous amount of information exchange; the central coordinator is both a communication bottleneck and a single point of failure.

Fully distributed crawlers with dynamic assignment

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  - all agents agree on their decisions;
  - if a new agent is added, it will take some of the responsibilities of the existing agents, but this will happen without causing conflicts in the responsibilities of the agents themselves.

More precisely. . .

Let A be the set of *potential agents*, and U be the set of URLs. In every moment, there will be a set $X \subseteq A$ of *alive agents*; given this set, you must decide, for each URL, who (among the alive agent) is responsible for that URL.

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- Suppose $y \notin X$: if $r(X \cup \{y\}, u) = x \in X$ then $r(X, u) = x$ (*covariance*); in other words: adding a new agent y cannot change the responsibilities of existing agents, except for the fact that some responsibilities will of course be given to y.

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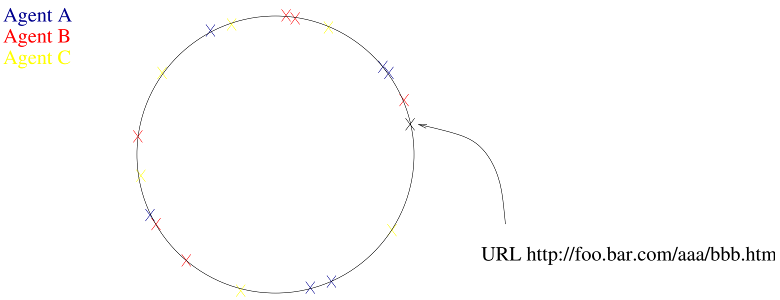
- you similarly map every URL $u \in U$ to a random point (seeded on the URL, or the URL's host part)
- $r(X, u)$ is found by determining the replica of an alive agent that is closest to the point assigned to u.

Consistent hashing



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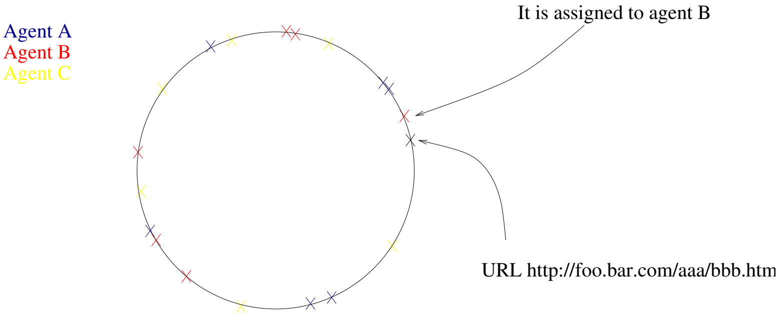

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