Intelligent and Adaptive Crawling of Web Applications for Web Archiving

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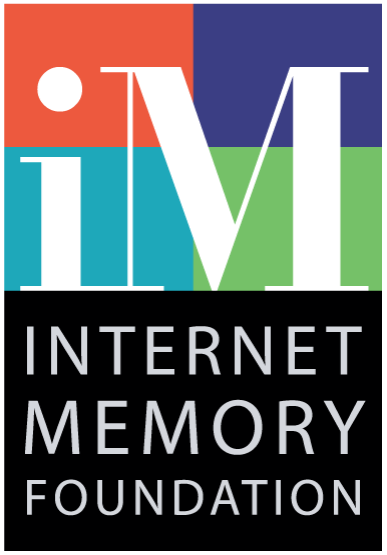
Web Archiving



Archiving the Social Web

Archiving the Social Web

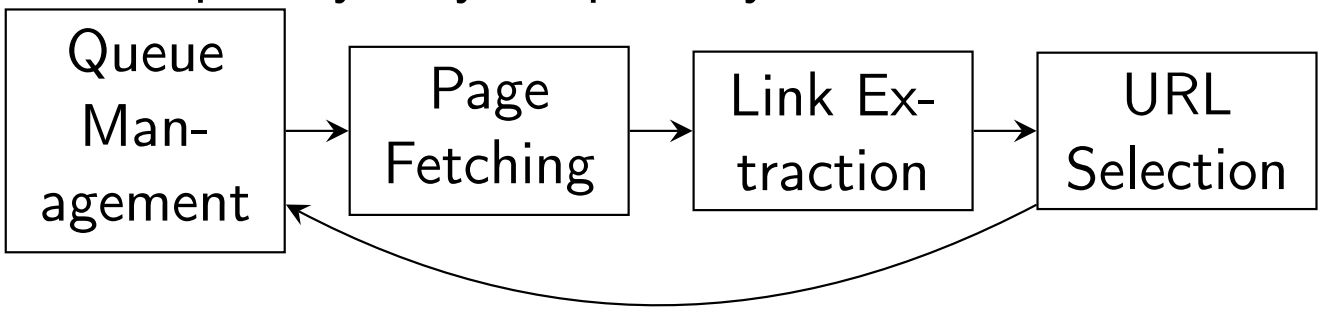
- Traditional crawling approach crawls the web sites independently of the nature of the sites and their content management system.
- Goal: Smart archiving of the Social Web;

  Intelligent Crawling
  Indexing Web objects

Agenda

Traditional Crawling Approach

- A traditional Web crawler (such as Heritrix) crawls the Web in a conceptually very simple way.



- This approach does not take into account the nature of the Web application.

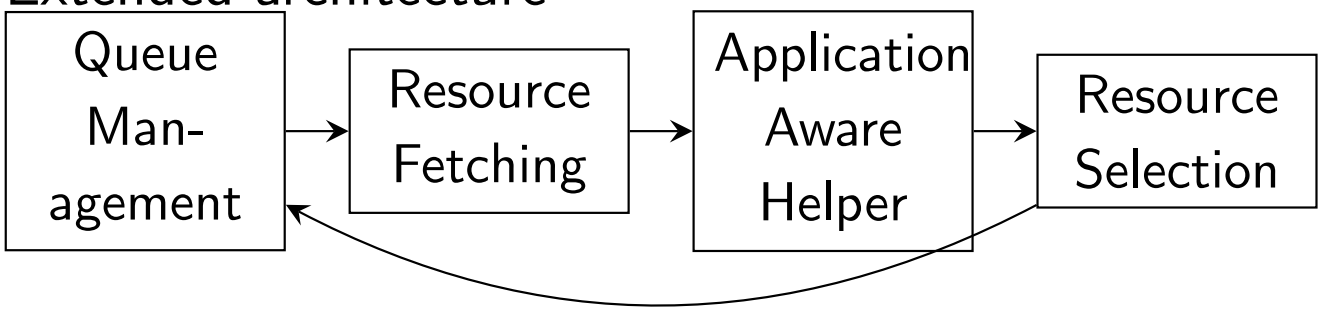
Introduction to Application-Aware Helper

- Different crawling techniques for different social Web sites.
- Detect the type of Web application, kind of Web pages inside this Web application, and decide crawling actions accordingly.
- Our approach does not have the same purpose as *focused* crawling.

  Focused Crawling: crawling based on a Topic.
  Application-Aware Helper: crawling optimized for a particular Web Application.

Introduction to Application-Aware Helper

- Extended architecture



- To be implemented in 2 Web crawlers: Internet Memory Foundation crawler, and into Heritrix.

Knowledge base of Web applications

- Knowledge base of Web applications: describes how to crawl a Web site in an intelligent manner.
- Hierarchy: from general categorizations to specific instances (Web sites) of this Web application.

  categorizes the web applications.
  specifies the detection rules.
  describes the specific crawling actions.

Knowledge base of Web applications

- Different crawling actions for different kinds of Web pages under a specific Web application.
- Declarative, XML-based format.

Web application detection Module

- One main challenge in intelligent crawling and content extraction is to identify the Web application and then perform the best crawling strategy accordingly.
- Detecting Web application using:

  URL patterns,
  HTTP metadata,
  textual content,
  XPath patterns, etc.
- For instance the vBulletin Web forum content management system, that can be identified by searching for a reference to a `vbulletin_global.js` JavaScript script by using a simple `//script/@src` XPath expression.

Crawling and extraction

- **Next stage:** determining the corresponding crawling actions.
- **Crawling action:** not just a list of URLs; can be any action that uses REST API, complicated interaction with AJAX-based application, and extracts semantic Web objects.

Crawling and extraction

- More specifically, crawling actions are of two kinds:

  Navigation actions: to navigate to another Web page or Web resource.

  Extraction actions: to extract individual semantic objects from Web pages (e.g., timestamp, the blog post, the comments).

Adaptation to template change

- Two types of changes can occur in a Web page: Web content changes, and Web structure changes.
- It is complicated to adapt crawling action when a change occurs in a Web page structure.
- The AAH aims at determining when a change has occurred and adapting patterns and actions.
- The AAH deals with two different cases of adaptation: first, when a recrawl of Web application is carried out after template change; second, when a new Web application can be crawled with existing actions after slight adaptation.

Recrawl of a Web Application

- The structural changes are detected by looking for the content in the archive.
- In the presence of structural changes, the system first marks the failed crawling actions and then align them according to structural changes.

Crawl of new Web Application

- The WA type is detected but WA level or crawling actions do not work.
- For aligning WA level or crawling actions; the system collects all the candidate attributes, values, tag names from the knowledge base and then create all possible combinations of relaxed expressions.

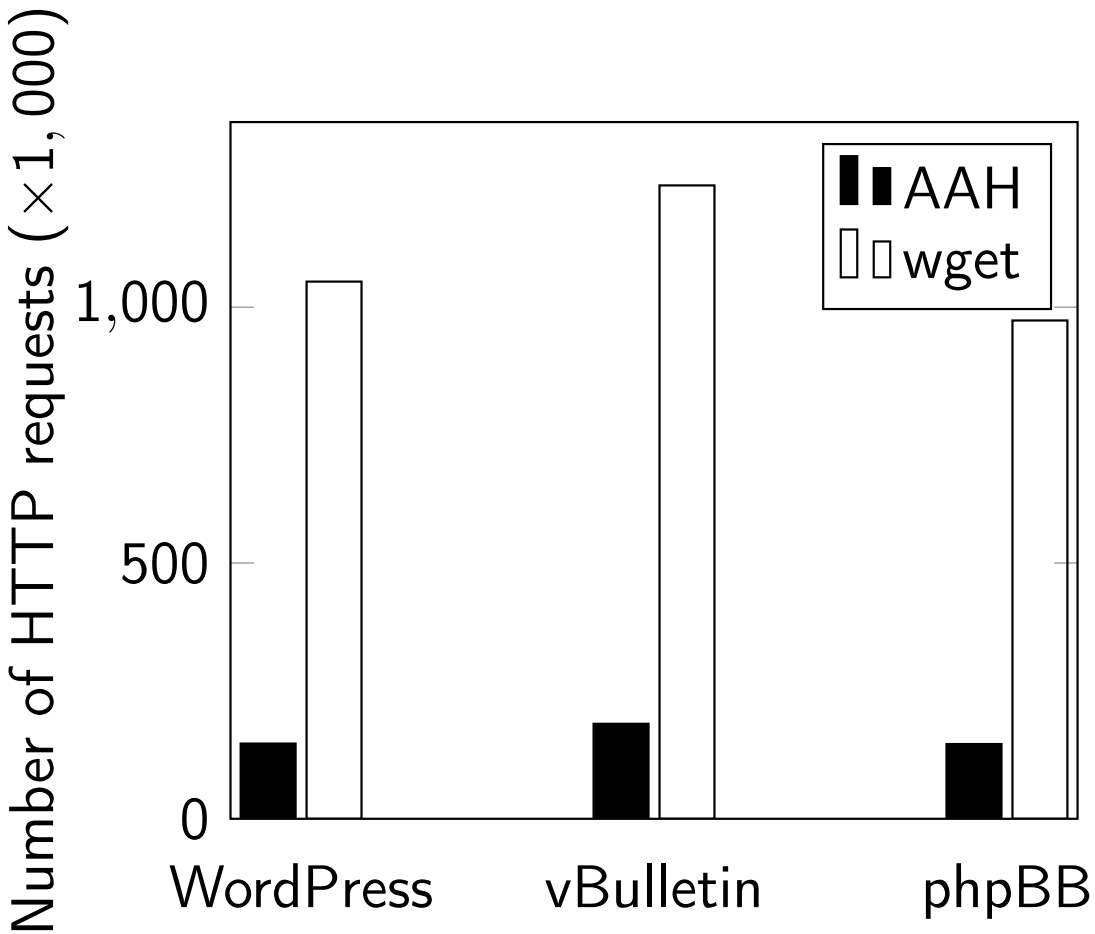
Experiment setup

- The experiments are performed with both AAH and GNU wget.
- Crawled 100 WAs (totaling nearly 3.3 million Web pages) of two types of social Web sites (Web forum and blog), for three CMSs (vBulletin, phpBB, WordPress).
- The WA were randomly selected from three different sources:
  - http://rankings.big-boards.com/, a database of popular Web forums.
  - A dataset related to the European financial crisis.
  - A dataset related to the Rock am Ring music festival in Germany.

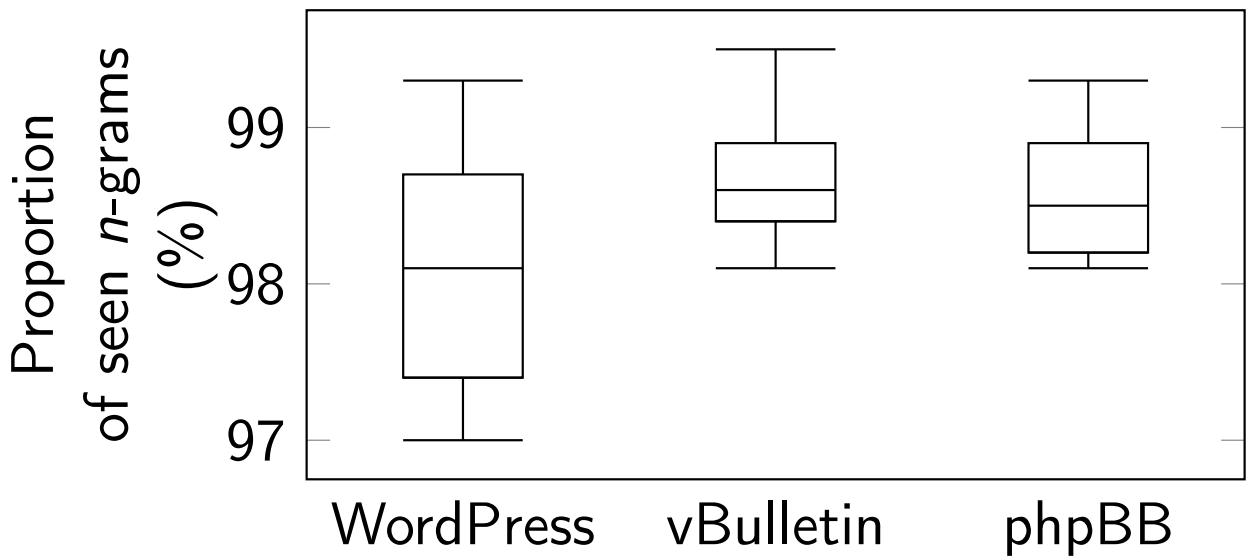
Performance metrics

- The number of HTTP requests made by both systems vs the amount of *useful* content retrieved.
- Coverage of useful content is calculated by comparing the proportion of 2-grams in the crawl result of both systems for every WA and by counting the number of external links.

Crawl efficiency



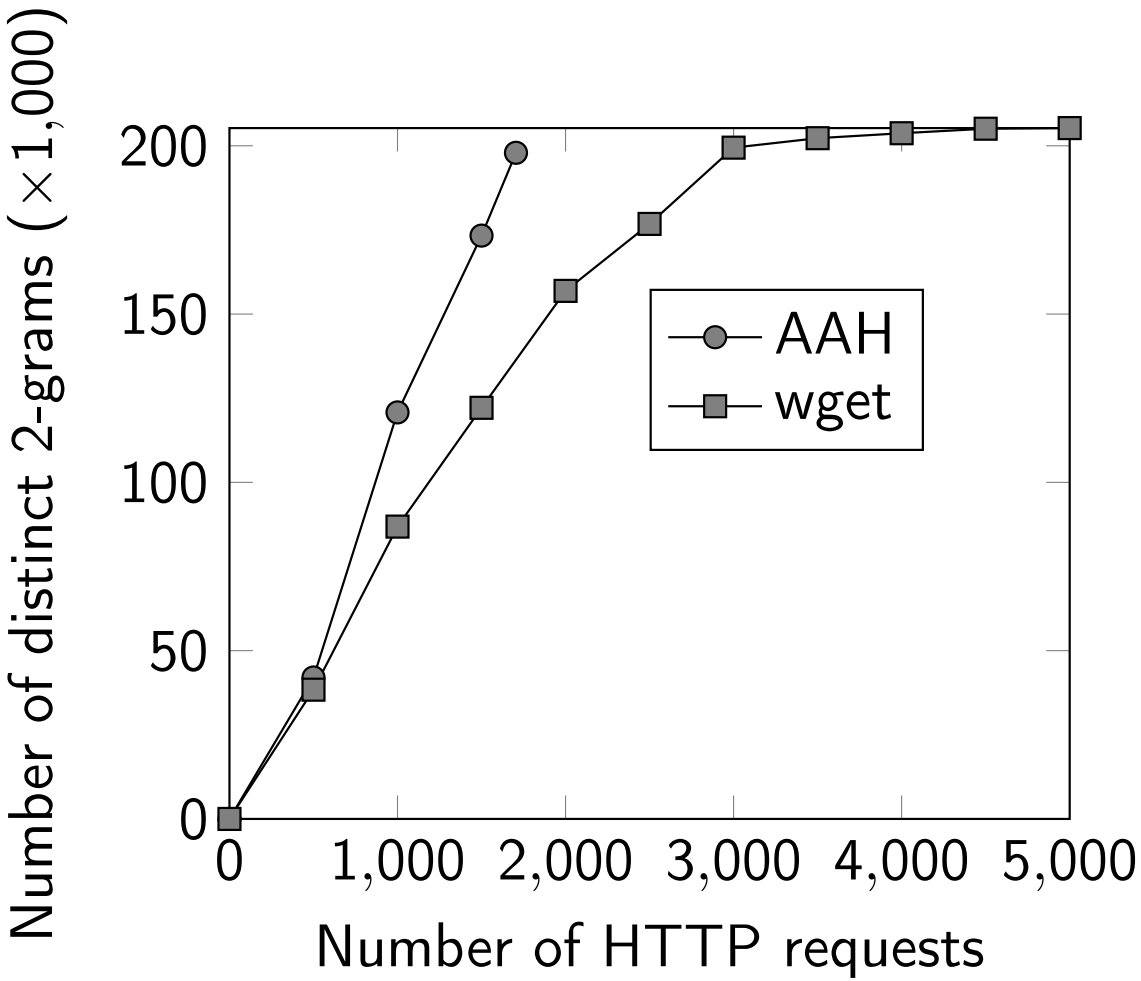
Crawl effectiveness



Crawl effectiveness

CMS	External links	External links (w/o boilerplate)
WordPress	92.7%	99.8%
vBulletin	90.5%	99.5%
phpBB	92.1%	99.6%

Crawl effectiveness



Adaptation performance

- Among the 100 WAs, the 77 did not require any adaptation.
- Remaining 23 had a structure that did not match the crawling actions in knowledge base.
- Most of the adaptation consisted in relaxing class or id attribute rather than replacing the tag name of an element.
- When there was tag name change then it was mostly div to span to article or vice versa.

Future Work

- Automatic, possibly unsupervised, learning of new Web applications, either by involving human interactions, or using semi supervised machine learning techniques.
- Integrating the OXPath to crawl complex Web applications by making use of AJAX or Web forms.

Merci

Grammar for AAH

$$
\begin{array}{lll}
\langle \text{expr} \rangle & ::= & \langle \text{step} \rangle \mid \langle \text{step} \rangle \text{ "/" } \langle \text{expr} \rangle \\
 & & \langle \text{step} \rangle \text{ "//" } \langle \text{expr} \rangle \\
\langle \text{step} \rangle & ::= & \langle \text{nodetest} \rangle \mid \langle \text{step} \rangle \text{ "[" } \langle \text{predicate} \rangle \text{ "]"} \\
\langle \text{nodetest} \rangle & ::= & \textit{tag} \mid \text{"@" } \textit{tag} \mid \text{"*" } \mid \text{"@*" } \mid \text{"text()"} \\
\langle \text{predicate} \rangle & ::= & \text{"contains(" } \langle \text{value} \rangle \text{ "," } \textit{string} \text{ ")" } \mid \\
 & & \langle \text{value} \rangle \text{ "=" } \textit{string} \mid \textit{integer} \mid \text{"last()"} \\
\langle \text{value} \rangle & ::= & \textit{tag} \mid \text{"@" } \textit{tag}
\end{array}
$$

Example of the knowledge base

```
<knowledgebase>
  <cms  name="vBulletin" type="webforum">
   <detection-rules>
     <xpath-expression>
      //script/@src[contains(.,'vbulletin_global.js')]
     </xpath-expression>
   </detection-rules>
   <page-level-cat>
     <list-of-forum>
        <detection-rules>
           <xpath-expression type="1">
            //a[@class="forum"]/@href
           </xpath-expression>
           <xpath-expression type="2">
             //h2[@class="forumtitle"]/a/@href
           </xpath-expression>
        </detection-rules>
```

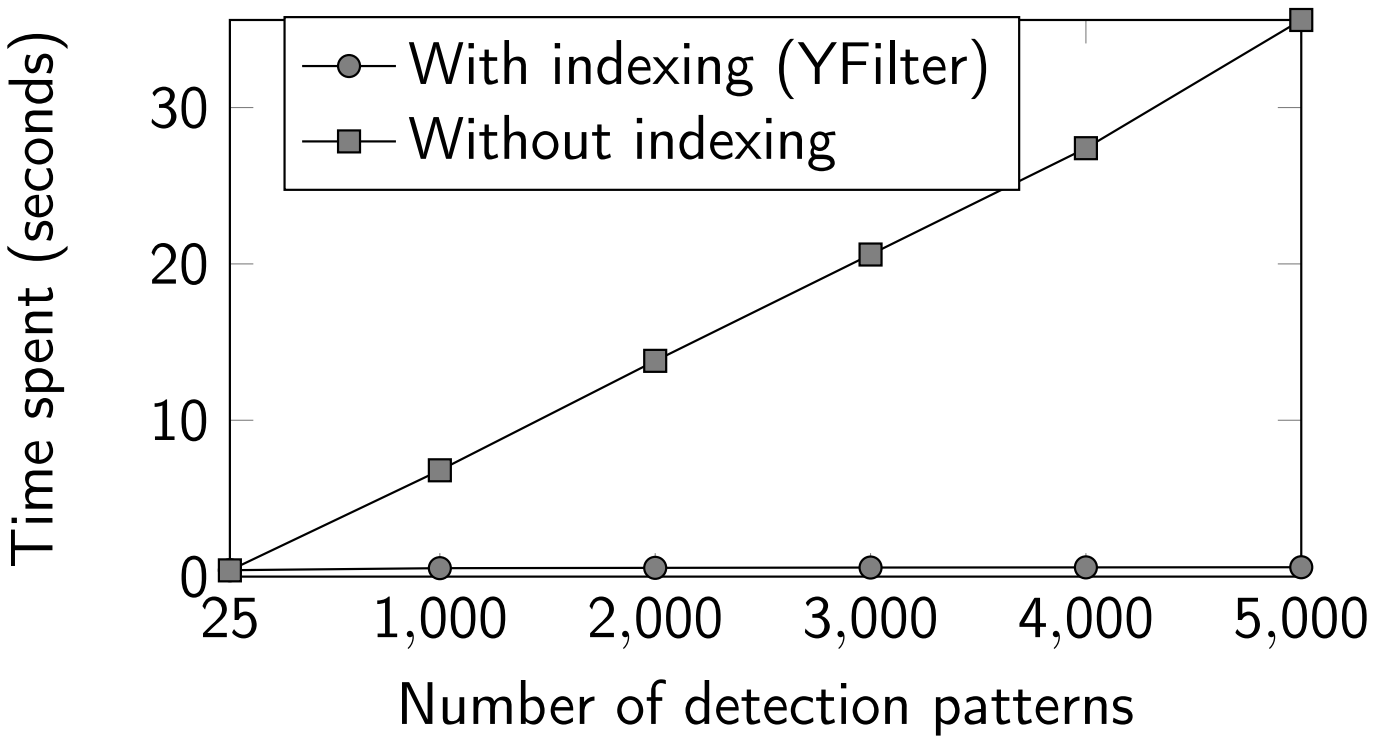
Example of the knowledge base

```
        <crawling-action>
            <action id="1">
                //a.forum/@href
             </action>
             <action id="2">
               //td.forumtitle/div/a/@href
             </action>
         </crawling-action>
    </list-of-forum>
    <list-of-thread>
            .
    </list-of-thread>
    <thread>
            .
    </thread>
</knowledgebase>
```

Indexing detection patterns

- The number of of detection patterns for detecting Web application type and level grows with the addition of knowledge about new Web Application.
- We integrated the AAH with the YFilter system (an NFA-based filtering system for XPath expressions) with some slight changes, for efficient indexing.
- In our integrated version of YFilter, the detection patterns will be submitted as queries. When a document satisfies a query, the system processing the document against all remaining queries (in contrast to standard behaviour of YFilter).

Efficiency of detection patterns



Comparison to iRobot

- The iRobot system assists the extraction process by providing the sitemap of the Web application being crawled.
- The iRobot system has considered 50,000 Web pages over 10 different Web forums.
- The completeness of content of the AAH is over 99 percent as compared to 93 percent of iRobot.
- The number of HTTP requests for iRobot is claimed to be 1.73 less than a regular crawler, whereas AAH makes 10 times fewer requests than wget.