**Kitten**: a tool for normalizing HTML and extracting its textual content

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Abstract

The web is composed of a gigantic amount of documents that can be very useful for information extraction systems. Most of them are written in HTML and have to be rendered by an HTML engine in order to display the data they contain on a screen. HTML files thus mix both informational and rendering content. Our goal is to design a tool for informational content extraction. A linear extraction with only a basic filtering of rendering content would not be enough as objects such as lists and tables are linearly coded but need to be read in a non-linear way to be well interpreted. Besides these HTML pages are often incorrectly coded from an HTML point of view and use a segmentation of blocks based on blank space that cannot be transposed in a text file without confusing syntactic parsers. For this purpose, we propose the **Kitten** tool that first normalizes HTML files into unicode XHTML files, then extracts the informational content into a text file with a special processing for sentences, lists and tables.

Keywords: HTML, content extraction, question-answering

1. Introduction

The motivation for coding the **Kitten** tool came during the question-answering system evaluation as part of the QUÆRO program as it showed that the data extracted from web pages were confusing the systems based on linguistic features (language model or dependancy grammar notably) (Quintard et al., 2010). The QUÆRO corpus is composed of 2 million HTML files (for French and for English) and only a subset is used for the evaluation campaigns: 499,736 files for French and 498,678 for English; from now these subsets will be referred to as the **QUÆRO corpus**. Participants were using textual files that had been linearly extracted without any kind of filtering or linguistic processing (Figure 1). It was inadequate mainly because HTML files contain visual blank spaces for segmenting blocks of text where systems expects punctuation marks.

![Figure 1: Example of a linear extraction.](http://htmlcleaner.sourceforge.net/)  
A correct extraction must focus on extracting textual content with respect to the limitations of a text file that is read from left to right, line by line and where sentences are delimited by punctuation marks; otherwise texts from different blocks would be merged. The Lynx software allows the dump of an HTML file faithfully to its rendering aspect (Figure 2) but a very difficult segmentational processing has to be done for syntactic parsers to work on correctly delimited sentences.

![Figure 2: HTML file dumped with Lynx.](http://jtidy.sourceforge.net/)

In this article, we present the **Kitten** (**K**itten Is a Te**x**tual **E**xtraction **F**or **A**ddition and **N**ormalization) tool that allows normalization of an HTML file and the extraction of its content into a basic text file. It focuses notably on tables and lists as they need particular attention for their extraction: a simple extraction would not be enough to obtain exploitable textual data for information extraction. **Kitten** is composed of two main steps (Figure 3): after a computational treatment aiming at normalizing the HTML code by combining existing tools (**HTMLCleaner** [1], **jTidy** [2] and **jChardet** [3]), a linguistic processing takes place for extraction

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1. **HTMLCleaner**: [http://htmlcleaner.sourceforge.net/](http://htmlcleaner.sourceforge.net/)
2. **jTidy**: [http://jtidy.sourceforge.net/](http://jtidy.sourceforge.net/)
3. **jChardet**: [http://jchardet.sourceforge.net/](http://jchardet.sourceforge.net/)
of the informational content into a basic text file. Producing a file at each step makes the use of these existing tools easier. We were not aiming at a spam detector, a removal of boilerplate text [Kobelschütter et al., 2010] or a web page cleaner [Baroni et al., 2008]. Our first objective of normalization is very close to the work of BeautifulSoup but the use of BeautifulSoup on the Quaero corpus showed too many losses of files at the time we tested it (19.11% were not completed with the 3.1.0.1 version in January 2010; no file was lost with the more recent version 3.2.0 of November 2010 but Kitten was already developed at that time).

We wanted to normalize the way an HTML file was coded to correctly extract its informational content (including for the moment SPAM and boiler plate content) and finally adapt it to a text file with sentence boundaries so that syntactic parsers can correctly process it.

Kitten processed both the English and French corpus: we provide here figures for the French one. The examples are written in English: some come from the English corpus and those from the French one have been translated.

Section 2 will present the HTML normalization processing and section 3 will focus on the statistical and linguistic processing during the extraction of informational content. Section 4 will present the evaluation of a question-answering system on the QUAERO corpus preprocessed by Kitten, thus giving an indirect evaluation of Kitten.

2. From crawled HTML to normalized XHTML

The main goal of the computational processing is to obtain a normalized and UTF-8 encoded XHTML source code. This normalized file must then be XHTML compliant according to the W3 consortium and thus have a valid tree structure for allowing HTML parsing.

2.1. Specific preprocessing

The Kitten architecture (Figure 3) shows three steps: a file exclusion, a direct extraction and a preprocessing. The file exclusion rejects sitemap files as they only contain urls, are very time-consuming and seem to be relevant more for a document classification task [Qi and Davison, 2009] than for a question-answering system. The direct extraction handles already converted binary files (swf, doc, rtf): after having crawled the QUAERO corpus, Exalead converted the binary files into XML files using four tags (header, document, textfield, page); these XML files are thus ready to be extracted and do not need to be preprocessed. Almost all files of the QUAERO corpus are preprocessed (99.50%) while only 0.003% sitemap files are excluded and 0.5% XML files directly extracted.

2.2. Fixing HTML errors

HTMLCleaner and jTidy share a lot of common options for fixing HTML errors but we proceeded to several experiments that showed it was better to use them sequentially.

HTMLCleaner aims notably at:

- replacing the &apos; entity by its character ’ (simple quote): its use is valid in XML and XHTML but not in HTML,
- regarding the content of the tags <script> and <style> as plain text. It escapes entity like ”<” in javascript code that could be confused with an opening tag,
- replacing special HTML entities (i.e. &circ;, &permil;) with unicode characters they represent (ó, ÷),

jTidy also aims notably at:

- fixing incorrect tag sequence: for example, <b> <i> </b> <i> becomes <b> <i> <i> <b>,
- closing unclosed tags,
- setting the indentation length within the source file to zero (as it would otherwise insert new carriage-returns inside textual content that will cut sentences).

2.3. Normalizing the files

By fixing incorrectly ordered or non-closed tags, jTidy also allows the normalization of HTML files into XHTML. We use jChardet to detect the most likely encoding of the HTML file allowing thus jTidy to produce an XHTML file encoded in UTF-8.

5http://www.crummy.com/software/BeautifulSoup
6java port of the source from Mozilla automatic charset
Both HTMLCleaner and jTidy work on transformation of entities in order to return an unicode file. Non-ascii characters can be encoded on the web in three different ways: for example, the numeric entity &amp;#230;, the character entity &aelig; and the special character æ represent the same character. As we want to use only numeric entities after jTidy, a final conversion has to be done for the range of numeric entities from &amp;#128; to &amp;#159; as they are invalid in XHTML.

It was impossible to produce a normalized XHTML file for 5 files. In this situation, a textual dump of these files has been produced with the Lynx browser.

3. From normalized XHTML to exploitable text

The main goal during the extraction of textual content is to produce a text file that can be read directly by syntactic parsers. By doing so, we had to find a way to transform content using layout (once rendered by an HTML browser) such as tables, lists and blocks of textual content. The examples cited in this section come from needs of Question-Answering applications but all of these features can be set before launching Kitten.

3.1. HTML tables

A table often contains precious informational content and a linear extraction would be particularly inadequate as it is coded linearly in an HTML file, i.e. from left to right and row by row (Figure 4) but has to be read by linking semantically a data cell content with its header cell.

![Figure 4: A data leaf-table: source code and once rendered.](http://gsl.lab.asu.edu/doc/webtable.html)

| Dimensions | Comparison | DS Lite | Original DS | ESP |
|------------|------------|---------|-------------|-----|
| Length     | 133.0mm    | 148.7mm | 170.0mm     |     |
| Width      | 73.9mm     | 84.7mm  | 74.0mm      |     |
| Depth      | 21.5mm     | 28.8mm  | 23.0mm      |     |
| Weight     | 216g       | 275g    | 260g        |     |

Table 1: Categorization of 614 layout and 614 data leaf-tables.

The first pass with 10 cross-validations on the annotated corpus showed encouraging results (table 1).

3.1.2. Categorizing the cells of data tables

For all the data leaf-tables identified, a second decision tree was built in order to classify each cell among six categories (table 2):

- data and header are explicit and obligatory,
- neutral is an empty cell for rendering purposes (not for missing data),
- rate of empty cases for a line and a row,
- has a <form> tag,
- has a <caption> tag,
- number of <th> tags.

![Figure 5: Layout table.](http://gsl.lab.asu.edu/doc/webtable.html)
important acts like \textit{thema} but for information located at the bottom of the table (legend for example),

- \textit{finalNonImportant} is for duplicated header within the table.

This decision tree was also built with WEKA and also based on the features used by (Wang and Hu, 2002) and some others that we added:

- \textit{thema} is the caption of a table or information regarding all the cell data within the table,
- \textit{finalImportant} acts like \textit{thema} but for information located at the bottom of the table (legend for example),
- \textit{finalNonImportant} is for duplicated header within the table.

Once cells are typed, we use manual heuristics to fix some incorrect identification like, for example, a cell identified as \textit{data} while all the others on the same line were identified as \textit{header}.

| Class (nb of instances) | Prec. | Rec. | F-score |
|-------------------------|-------|------|---------|
| header (8,542)          | 0.975 | 0.967| 0.971   |
| data (60,648)           | 0.995 | 0.997| 0.996   |
| neutral (4,468)         | 0.975 | 0.966| 0.971   |
| finalImportant (140)    | 0.897 | 0.732| 0.806   |
| finalNonImportant (34)  | 0.889 | 1    | 0.941   |
| thema (254)             | 0.874 | 0.867| 0.871   |

Table 2: Precision, recall and F-score for the identification of cells for the 614 data tables (10-fold cross validation).

**Dimensions comparison**

| Dimensions Comparison | DS Lite | Original DS | PSP |
|-----------------------|---------|-------------|-----|
| Length                | 133.0mm | 148.7mm     | 170.0mm |
| Width                 | 21.5mm  | 28.8mm      | 23.0mm |
| Depth                 | 73.9mm  | 84.7mm      | 74.0mm |
| Weight                | 218g    | 275g        | 260g  |

Figure 6: Table example with correctly identified cells: header, data, thema (top case), neutral (empty).

Our goal is to extract the table content in order to build a clause which can be parsed by information extraction systems. We combine each data cell content on the same row with its header cell(s) in the same sentence by using the following pattern (the pattern uses regexp symbols): thema? ::? finalImportant? ::? (header? ::? header ; data /?) + . Figure 6 shows the data leaf-table correctly identified and its extraction is the following:

- Dimensions comparison :: DS Lite : Length: 133.0mm / Original DS : Length: 148.7mm / PSP : Length: 170.0mm.

3.2. Lists

List objects can also confuse syntactic parsers as the items can be clauses syntactically related to the introductory clause (Gala, 2003), (Ait-Mokhtar et al., 2003). To that purpose, a typology of lists was created and extraction is guided according to rules specific to each type:

- conditional removal of hyperlinks in a hyperlink list,
- conditional removal of item bullets,
- list flattening,
- list flattening and introductory clause duplication for each item.

We only consider lists coded using the expected tag such as \texttt{<ul>}, \texttt{<ol>}, \texttt{<dl>} (ordered list) and \texttt{<dl>} (definition list); hardcoded lists using layout tags such as \texttt{<br>}, \texttt{</p>} are too difficult to identify for the moment. For the flattening operation, we only focus on the lists that are not embedded (only one level) and that have an explicit introductory clause (i.e ending by a colon).

3.2.1. Hyperlinks in a hyperlink list

First we removed particular items from hyperlink lists which are lists composed solely of hyperlinks. They can begin or not by an introductory clause. If an hyperlink item is composed of less than five words, it is removed as it is not likely to contain an answer. Each removal is archived and log exploration showed that on the nearly three million removed items, only 481,115 were different and the top-4 occurrences illustrates the purpose of this removal:

- empty words from menu or forum such as \texttt{Home} (30,847 occurrences), \texttt{Cite (21,638)},
- empty item used for layout (21,468),
- blog item from a calendar such as \texttt{september 2007} (8,442).

3.2.2. Hardwritten bullet removal

Inside a list, bullets are sometimes hardwritten by developers and need to be removed for not confusing the parser. A couple of regular expressions is used on the most common such as \texttt{*}, \texttt{-}, \texttt{1}, \texttt{a}).

3.2.3. List flattening

List flattening removes the carriage-return layout by putting each item in the same sentence than the introductory clause in two ways:
The following list contains a general guideline of different body styles and wedding dress styles to consider:

- Hourglass-shaped brides
- Pear-shaped brides
- Petite brides
- Plus-size brides
- Tall brides

Figure 7: Example of a list where a linear extraction would move away the item from the introductory clause.

Additionally to list flattening, introductory clauses can be repeated with each item (each pair forming a unique sentence) when a trigger word is ending the introductory clause. This happens when a syntactic dependency links each beginning of the item to the end of the introductory clause. If this clause is not repeated, parsers can be confused as the sentence would not be syntactically correct. The trigger words are thus composed of prepositions (in, to, ...), auxiliary verbs (may, can, ...) and the adverb not.

For example, the list on Figure 8 is flattened into the following sentence, improving the probability to answer a question about the terminology of wedding dress style: "The following list contains a general guideline of different body styles and wedding dress styles to consider: Hourglass-shaped brides, Pear-shaped brides, Petite brides, Plus-size brides, Tall brides."  

Figure 8: Example of syntactically related items.

Before selecting a college, parents need to:

1. Determine how much funding can be available from conventional sources such as savings, income from the family budget, trusts, and part-time jobs, if more money is needed.
2. Explore the availability of scholarships, low-interest student and parent loans, second mortgages, and conventional loans.
3. Examine their own life insurance policies and retirement programs to ensure that college funds will be available in the event of their death.

Figure 9: Example of cut clauses due to incorrect use of the <br> tag (source code above, linear extraction below).

3.3. Segmentation

The basic unit of syntactic parsers is the sentence delimited by punctuation marks. Without them, giant segments of text would be considered as a unique sentence. On the contrary, separated segments of the same sentence written on two consecutive lines would be considered as two sentences. To optimize the syntactic parsing of textual extracted data, we added a full period when missing: for example between a title and a paragraph or between two paragraphs.

We also need to join two parts of a sentence cut with the <br> tag for rendering result as showned in Figure 9. In a case of a linear extraction, each <br> tag would transform the current line (from the source code) into a unique sentence: the linear extraction would then produce six sentences whereas there are only three.

Figure 10: Example of the <acronym> tag that displays informational content on mouseover near NSW.

HTML code contains informational content that would be displayed only with a user interaction like the event "on
Accessible Arts is the peak arts organisation in NSW (New South Wales) promoting creative expression and participation in arts and cultural activities by people with disabilities. This site provides information on art and disability in NSW (New South Wales).

Around 89,000 abbreviations and 15,000 acronyms were extracted. Logs showed that abbreviation was massively used by a calendar widget of a blog generator: for example, we found 9,318 occurrences of mon (monday). Abbreviation tag also contains sometimes a very precious information for question-answering using temporal inference as a relative temporal expression is associated with an absolute date (e.g. 25 days ago (Wed, 07 May 2008 06:13:06 -0700)).

On the contrary, some informational content such as the option selected attribute from a <form> tag should not be extracted (from a question-answering point of view it should not be extracted as it would generate noise). With the same goal of removing link lists, the tag <div> can be set to be removed if the value of the attribute id contains the substring menu.

4. Evaluation

A global evaluation of normalization and textual extraction is quite difficult to obtain. We saw that the normalization part was effective but the evaluation depends on the purpose of the extraction. A global evaluation of the question-answering system QAVAL (using a machine learning approach for answer validation) was performed on the QUARERO corpus processed by Kitten and showed a significant improvement (Grappy et al., 2011). Since, Kitten was improved with list flattening and manual heuristics for table cell identification. We then decided to perform a fine-grained evaluation regarding the contribution on tables on one side and lists on the other. For that purpose, we used the FIDJI question-answering system based on syntactic dependencies (Moricau and Tannier, 2010) hoping a significative gain since FIDJI relies on its core on well formed sentences. FIDJI was evaluated on different processings made on the French Quaero corpus:

- the linear extraction of the corpus done by Exalead ("Baseline"),
- the cleaning of the corpus made by BoilerPipe (Kohlschütter et al., 2010) ("BoilerPipe"),
- a processing of the corpus by Kitten only for tables ("Kitten - Tab"), lists ("Kitten - List") and segmentation ("Kitten - Seg"),
- a complete processing of the corpus by Kitten ("Kitten-Full").

We used the 500 questions of Quaero 2010 evaluation without filtering the question categories which were boolean, definition, factual, list and complex (why, how). We wanted to evaluate the performance of FIDJI on supporting passage extraction (i.e. a passage containing the correct answer). For each question, FIDJI proposes 3 ranked answers with their supporting passage.

Results on table 3 show a gain on the corpora processed by Kitten regarding the baseline (around 24.64% for answers at first rank and 20.18 % for answers at the top-3 ranks) and the runs show that the most significative improvement is given by the segmentation processing.

| Corpus    | First rank | Top-3 ranks |
|-----------|------------|-------------|
| Baseline  | 69         | 109         |
| BoilerPipe| 75         | 116         |
| Kitten-Tab| 80         | 125         |
| Kitten-List| 80       | 123         |
| Kitten-Seg| 86         | 126         |
| Kitten-Full| 86        | 131         |

Table 3: FIDJI results for the 500 Quaero 2010 questions: number of questions correctly answered.

5. Conclusion

Kitten is a tool aiming at making exploitable HTML corpus for information extraction. To make HTML corpus exploitable, Kitten integrates:

- existing tools in order to normalize the HTML code and the encoding of the files,
- tools that we developed in order to extract its textual content with a focus on tables, lists, and sentence segmentation.

Textual corpus can thus be processed efficiently by syntactic parsers. Besides, by keeping informational content, Kitten allows web-based question-answering systems to produce better results. Future works on Kitten will include a module of detecting both SPAM and boilerplate text for removal if asked. It will also focus on improving table header detection (Tajima and Ohnishi, 2008) and multiple header-table extraction.

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