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TeMex: The Web Template Extractor

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ABSTRACT
This paper presents and describes TeMex, a site-level web template extractor. TeMex is fully automatic, and it can work with online webpages without any preprocessing stage (no information about the template or the associated webpages is needed) and, more importantly, it does not need a pre-defined set of webpages to perform the analysis. TeMex only needs a URL. Contrarily to previous approaches, it includes a mechanism to identify webpage candidates that share the same template. This mechanism increases both recall and precision, and it also reduces the amount of webpages loaded and processed. We describe the tool and its internal architecture, and we present the results of its empirical evaluation.

1. INTRODUCTION
This article presents TeMex, a tool able to automatically extract the template of a website. Template extraction is a hot topic with multiple applications, and thus, there exist several other approaches for template extraction (see, e.g., [4, 8, 10]). However, our new technique produces the best recall and precision in the state of the art with a remarkably improved performance. Moreover, thanks to a new algorithm, our tool needs to explore significantly less webpages to detect the template. TeMex is ready to be used by other systems, such as crawlers, and also by human users, because it is distributed as a (official) Firefox add-on.

1.1 Motivation
A web template (in the following just template) is a prepared HTML page where formatting is already implemented and visual components are ready to insert content into them.

Template extraction is needed) and, more importantly, it does not need a pre-defined set of webpages to perform the analysis. TeMex only needs a URL. Contrarily to previous approaches, it includes a mechanism to identify webpage candidates that share the same template. This mechanism increases both recall and precision, and it also reduces the amount of webpages loaded and processed. We describe the tool and its internal architecture, and we present the results of its empirical evaluation.

1.1 Motivation
A web template (in the following just template) is a prepared HTML page where formatting is already implemented and visual components are ready to insert content into them.

Templates are used as a basis for composing new webpages that share a common look and feel. This is good for web development because many tasks can be automated thanks to the reuse of components. In fact, many websites are maintained automatically by code generators that generate webpages using templates. Templates are also good for users, which can benefit from intuitive and uniform designs with a common vocabulary of colored and formatted visual elements.

Templates are also important for crawlers and indexers, because they usually judge the relevance of a webpage according to the frequency and distribution of terms and hyperlinks. Since templates contain a considerable number of common terms and hyperlinks that are replicated in a large number of webpages, relevance may turn out to be inaccurate, leading to incorrect results (see, e.g., [4, 12, 10]). Moreover, in general, templates do not contain relevant content, they usually contain one or more regions [4] where the main content must be inserted. Therefore, detecting templates helps indexers to identify the main content of the webpage. Gibson et al. [6] determined that templates represent between 40% and 50% of data on the Web and that around 30% of the visible terms and hyperlinks appear in templates. This justifies the importance of template removal [12, 10] for web mining and search.

2. CASE OF USE
In this section we show an example of usage of TeMex. TeMex is distributed as an official Firefox add-on, and it is extremely easy to download, install and use.

Download. TeMex can be downloaded from the Firefox add-ons repository. It can also be downloaded from: http://www.dsic.upv.es/~jsilva/retrieval/templates/

It comes as an XPI file that packages the whole add-on.

Installation. Just drag and drop the XPI file on the main Firefox window. It automatically adds a new button (the TeMex button: ) to the Firefox navigation toolbar.

Use. Navigate normally to a webpage, and press the TeMex button. The template is automatically shown.

EXAMPLE 2.1. Consider the WWW 2015 main webpage shown in Figure 1(a). This webpage shares a template with all webpages of the WWW 2015 website. By clicking the TeMex button, the tool automatically detects its template. Figure 1(b) shows the template extracted by TeMex.

Observe that the template produced by TeMex includes images, styles, HTML containers, and all web components that belong to the template. Therefore, it is ready to insert code, and can be reused by web engineers. Note also that TeMex identifies the texts “Welcome to the 24th...” and “published in Facebook and Twitter” as part of the template.
not an error. This is an indication of TeMex that the template contains a text in this position. Of course, this text can change between the different webpages, but the text appears in all of them, and thus, it is part of the template. The concrete text displayed by TeMex is the text appearing in the original webpage.

After extracting the template, the user can change the view swapping between the template and the webpage (and vice-versa) just pressing again the TeMex button.

3. INTERNAL ARCHITECTURE

3.1 The template extraction technique

TeMex implements various novel algorithms that make it more precise and efficient than other similar tools. Essentially, the internal template extraction technique works in three phases.

1. Detection of webpage candidates that share the template: The input of TeMex is a webpage (in the following key page) whose template is not necessarily shared with the other webpages in the website. Therefore, the first step is to explore the website searching for a set of webpages that share the template with the key page. To identify these webpages we use a novel technique [2] that detects the menu of the key page by calculating a complete sub-digraph (CS) in the website topology. The webpages pointed out by the menu are normally the homepage of different sections of the website; and these webpages often share the same template.

With these ideas, and using an hyperlink analysis, to select the best CS, and the best components of the CS, the technique can select the best candidates with very few webpage loads (a mean of 5.3).

2. Comparison of the key page with the set of webpage candidates: The template is extracted by comparing the key page with the collected webpages. This comparison is done at the level of DOM, i.e., the template is a subset of the DOM nodes of the key page (those shared with a majority of the other webpages).

The comparison is done using a graph theory formalism called Equal Top-Down Mapping (ETDM) that establishes a relation between two given DOM trees. Roughly, the algorithm that compares DOM trees uses a voting system that determines that a node belongs to the template if it appears in more DOM trees than a precomputed threshold.

3. Filtering of the key page: The template is reconstructed using a DOM tree copy of the key page. An algorithm processes it removing those parts that do not belong to the template. In this way the technique can output a well-formed webpage as the template.

3.2 Integration into Firefox

TeMex is distributed as a Firefox add-on. Firefox is one of the most powerful and widely used browsers, and it is free and open source. This allows us to access and manipulate the internal data structures used to handle webpages as DOM trees. Moreover, Firefox offers important architectural advantages because add-ons have direct access to the internal Firefox API, and also because the design of the add-ons layer clearly separates functionality and GUI with specific languages and facilities for them. In particular, Firefox toolbars use XUL, an XML based language, to design the GUI. And they use Javascript, to implement the behavior and event-handling. The current version of TeMex (TeMex 1.5) contains 2594 LOC.

Between the multiple kinds of firefox extensions, TeMex is an overlay extension [1]. Therefore, it uses XUL overlays to specify the interface, and APIs available to privileged code such as tabbrowser and Javascript modules to interact with the application and content.

Figure 2 shows our Firefox add-on architecture. It uses four main modules to implement two functionalities: “Extract Template” (executed the first time that the TeMex button is pressed) and “Toggle View” (executed the second and successive times that the TeMex button is pressed). “Extract Template” (1) uses a module to analyze the key page and explore its links to obtain the topology of the website. (2) This topology is used by another module to identify a CS in the domain graph. Then, (3) TeMex compares the DOM trees of the CS webpages with the key page’s DOM tree to finally obtain the website template. “Toggle View” uses a single module to swap the webpage displayed (original ↔ template) by loading the appropriate DOM tree.

3.3 Interfaces with other systems

TeMex can be used by human users and by other systems that need to extract the template of a webpage (e.g., as a preprocessing stage). The later case is common in crawlers, which enhance searching and indexing processes thanks to the identification of the template. The interface and output produced by TeMex is different in each case:

- **Human users**: For human users TeMex implements a GUI. In this case, the template is displayed as a reusable webpage where containers are ready to insert content.
and styles are kept. In order to keep the same structure of the key page, the template is displayed by changing the visibility property of those non-template DOM nodes to hidden, i.e., `node.style.visibility = "hidden"`; (see Figure 1(b)).

- **Non-human users:** In this case, other systems can use TeMex with an interface to detect webpage candidates, to extract the template, etc. The template is returned in different formats, including HTML. It is also possible to output the HTML of the key page where those components that belong to the template have been included into an HTML class (`node.className += "template_node"`). In this way, it is possible to post-analyze the key page with explicit information about what parts belong to the template.

4. **EMPIRICAL EVALUATION**

We conducted several experiments with real, online webpages to provide a measure of the average performance regarding recall, precision and the F1 measure (see, e.g., [7] for a discussion on these metrics). Initially, we wanted to use a public standard collection of benchmarks, but we did not find any public dataset for template extraction. In particular, we could not use the standard CleanEval suite [5] of content extraction benchmarks, because it contains a gold standard prepared for content extraction (each part of the webpages is labelled as `main-content`, `template`, `notContent`, and/or `notTemplate` class. Therefore, the suite is useful for both content and template extraction. With TECO, researchers can evaluate or compare their technique very easily thanks to the labeling and also because the suite also includes scripts to automatize the analysis of webpages. TECO is open and free, and it is available at: http://www.dsic.upv.es/~jsilva/retrieval/teco/

A detailed description of the suite can be found in [3].

4.2 **Experiments**

Table 1 summarizes the results of the performed experiments. The first column contains the key pages’ URL of the evaluated websites (we used 40 benchmarks for training and 30 benchmarks for evaluation). For each benchmark, column DOM nodes shows the number of nodes of the key page’s DOM tree; column Template nodes shows the number of nodes of the gold standard template; column Total Retrieved shows the number of nodes that were identified by the tool as the template; column Template Retrieved shows the number of nodes retrieved that belong to the gold standard template; column Recall shows the number of correctly retrieved nodes divided by the number of nodes in the gold standard; column Precision shows the number of correctly retrieved nodes divided by the number of retrieved nodes; finally, column F1 shows the F1 metric that is computed as \( (2 \times P \times R) / (P + R) \) being \( P \) the precision and \( R \) the recall.

Experiments reveal a high average precision and recall: more than 85% in both cases. This was computed by calculating a CS of size 3. We observed that other techniques such as [4, 10, 7, 9, 11] obtain good values of F1 in certain webpages, but they are manually feed with collections of webpages that share the same template. With this conditions, our tool produces an F1 close to 95% in most of the cases. For instance, in [10] the authors get an F1 between 85% and 95% with collections of 24 webpages where all of them implement the same template (e.g., all of them are product descriptions). In our experiments, in contrast, our tool inputs heterogeneous webpages that not necessarily implement the same template. Moreover, our tool only needs an average of 5.3 webpages loaded to get the results in Table 1.

The F1 measure reported in the bibliography is different for each paper. Some of them measure the number of words correctly retrieved [10, 9]. This can be rather imprecise, because it ignores the structure (e.g., div, table...) retrieved. In our experiments we measured DOM nodes, which is the smallest granularity measure, and it takes into account the text and structure retrieved. We wanted to compare all techniques with the same benchmarks and with the same measure, but we could not access to the implementation of the tools even if they were reported as free. It is surprising, and quite disappointing, to see how few systems are open-source, or even otherwise (freely) available. In many papers, it is stated that a prototype was developed but we were not able to find the tool. To solve this, we are currently reimplementing the main template extraction systems in literature with the same language. This will allow us to compare them with the same benchmarks, measures and criteria. Some of them are already available as open-source at: http://www.dsic.upv.es/~jsilva/retrieval/templates/

5. **CONCLUSIONS**

TeMex is a tool able to automatically extract the template of a given webpage. It implements new analyses and techniques to detect the menu of the website in an efficient way. The webpages pointed out by the menu are used to compare their
DOM trees in order to identify what parts form the template. Our experiments demonstrate that the tool only needs to load around 5 webpages from the website to extract the template, and it produces a 85.73% of F1.

6. REFERENCES


Table 1: Results of the experimental evaluation

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>DOM nodes</th>
<th>Template nodes</th>
<th>Total retrieved</th>
<th>Template retrieved</th>
<th>Recall</th>
<th>Precision</th>
<th>F1</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.accountiler.com/eb/">www.accountiler.com/eb/</a></td>
<td>301 nodes</td>
<td>222 nodes</td>
<td>222 nodes</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td>parents.berkeley.edu/advice/</td>
<td>292 nodes</td>
<td>98 nodes</td>
<td>95 nodes</td>
<td>96.94 %</td>
<td>100 %</td>
<td>98.45 %</td>
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</tr>
<tr>
<td>switzerland.issuers.com/e/</td>
<td>116 nodes</td>
<td>561 nodes</td>
<td>519 nodes</td>
<td>91.86 %</td>
<td>100 %</td>
<td>95.76 %</td>
<td></td>
</tr>
<tr>
<td>today.java.net/pub/</td>
<td>955 nodes</td>
<td>332 nodes</td>
<td>332 nodes</td>
<td>99 %</td>
<td>96.20 %</td>
<td>99 %</td>
<td></td>
</tr>
<tr>
<td>en.proverbia.net/citastema.asp</td>
<td>372 nodes</td>
<td>126 nodes</td>
<td>131 nodes</td>
<td>100 %</td>
<td>98.18 %</td>
<td>98.05 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.brightband.com/news/">www.brightband.com/news/</a></td>
<td>1116 nodes</td>
<td>815 nodes</td>
<td>815 nodes</td>
<td>73.03 %</td>
<td>100 %</td>
<td>84.41 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.hazards.org/rehab/">www.hazards.org/rehab/</a></td>
<td>134 nodes</td>
<td>1116 nodes</td>
<td>1116 nodes</td>
<td>100 %</td>
<td>95.61 %</td>
<td>95.29 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.moderncreative.com/services/">www.moderncreative.com/services/</a></td>
<td>364 nodes</td>
<td>275 nodes</td>
<td>229 nodes</td>
<td>72.01 %</td>
<td>100 %</td>
<td>81.27 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.registry.com/irwintransl/">www.registry.com/irwintransl/</a></td>
<td>571 nodes</td>
<td>93 nodes</td>
<td>93 nodes</td>
<td>62.42 %</td>
<td>100 %</td>
<td>76.86 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.prc.org/resources_student.html">www.prc.org/resources_student.html</a></td>
<td>528 nodes</td>
<td>199 nodes</td>
<td>177 nodes</td>
<td>99 %</td>
<td>100 %</td>
<td>99.57 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.robyncarr.com/qa.html">www.robyncarr.com/qa.html</a></td>
<td>292 nodes</td>
<td>92 nodes</td>
<td>40 nodes</td>
<td>43.48 %</td>
<td>100 %</td>
<td>60.61 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.strangehorizons.com/2004/">www.strangehorizons.com/2004/</a></td>
<td>654 nodes</td>
<td>149 nodes</td>
<td>154 nodes</td>
<td>100 %</td>
<td>98.35 %</td>
<td>98.35 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.facts-about-japan.com/">www.facts-about-japan.com/</a></td>
<td>504 nodes</td>
<td>431 nodes</td>
<td>431 nodes</td>
<td>100 %</td>
<td>92.29 %</td>
<td>94.99 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.userfriendly.org/community/">www.userfriendly.org/community/</a></td>
<td>244 nodes</td>
<td>105 nodes</td>
<td>105 nodes</td>
<td>99 %</td>
<td>97.71 %</td>
<td>98.64 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.armscontrol.org/act/">www.armscontrol.org/act/</a></td>
<td>836 nodes</td>
<td>334 nodes</td>
<td>286 nodes</td>
<td>86.20 %</td>
<td>100 %</td>
<td>91.42 %</td>
<td></td>
</tr>
<tr>
<td>melizzard.typepad.com</td>
<td>565 nodes</td>
<td>265 nodes</td>
<td>265 nodes</td>
<td>100 %</td>
<td>94.31 %</td>
<td>97.07 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.uniteddesign.com/">www.uniteddesign.com/</a></td>
<td>232 nodes</td>
<td>99 nodes</td>
<td>99 nodes</td>
<td>100 %</td>
<td>94.68 %</td>
<td>97.27 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.rockits.com/91-1983.html">www.rockits.com/91-1983.html</a></td>
<td>765 nodes</td>
<td>533 nodes</td>
<td>533 nodes</td>
<td>100 %</td>
<td>91.42 %</td>
<td>95.52 %</td>
<td></td>
</tr>
<tr>
<td>pages.jb.edu/~jhmag/</td>
<td>993 nodes</td>
<td>89 nodes</td>
<td>89 nodes</td>
<td>100 %</td>
<td>98.38 %</td>
<td>99.39 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.intelligencecetest.com/minigames/">www.intelligencecetest.com/minigames/</a></td>
<td>366 nodes</td>
<td>284 nodes</td>
<td>281 nodes</td>
<td>100 %</td>
<td>98.94 %</td>
<td>99.47 %</td>
<td></td>
</tr>
<tr>
<td>doodle.com/online-calendars.html</td>
<td>572 nodes</td>
<td>496 nodes</td>
<td>496 nodes</td>
<td>100 %</td>
<td>98.79 %</td>
<td>99.39 %</td>
<td></td>
</tr>
<tr>
<td>worryfreelabs.com/jobs/index.html</td>
<td>424 nodes</td>
<td>321 nodes</td>
<td>321 nodes</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td>ernstfamily.ch/jonathan/</td>
<td>219 nodes</td>
<td>104 nodes</td>
<td>104 nodes</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td>golang.org/doc/snapshot/fgcgo.html</td>
<td>717 nodes</td>
<td>78 nodes</td>
<td>78 nodes</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td>wwww.epxprosoft.com/</td>
<td>832 nodes</td>
<td>151 nodes</td>
<td>148 nodes</td>
<td>100 %</td>
<td>98.01 %</td>
<td>99.00 %</td>
<td></td>
</tr>
<tr>
<td>wwww.folj.com/puzzles/</td>
<td>559 nodes</td>
<td>175 nodes</td>
<td>171 nodes</td>
<td>97.71 %</td>
<td>100 %</td>
<td>95.54 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.alt-codes.net/">www.alt-codes.net/</a></td>
<td>772 nodes</td>
<td>237 nodes</td>
<td>237 nodes</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td>cluster013.ovh.net/~polcapro/</td>
<td>491 nodes</td>
<td>238 nodes</td>
<td>238 nodes</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.coffeecake.com/">www.coffeecake.com/</a></td>
<td>610 nodes</td>
<td>345 nodes</td>
<td>345 nodes</td>
<td>100 %</td>
<td>99.14 %</td>
<td>99.57 %</td>
<td></td>
</tr>
<tr>
<td>uninnovistalist.com/</td>
<td>490 nodes</td>
<td>273 nodes</td>
<td>309 nodes</td>
<td>103.29 %</td>
<td>100 %</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>526 nodes</td>
<td>274.8 nodes</td>
<td>242.5 nodes</td>
<td>240.84 nodes</td>
<td>87.64 %</td>
<td>92.22 %</td>
<td>88.14 %</td>
</tr>
</tbody>
</table>