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Extracting Product Data from E-Shops

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Abstract: We present a method for extracting product data from e-shops based on annotation tool embedded within web browser. This tool simplifies automatic detection of data presented in tabular and list form. The annotations serve as a basis for extraction rules for a particular web page, which are subsequently used in the product data extraction method.

1 Introduction and Motivation

Since the beginnings, web pages have served for presentation of information to human readers. Unfortunately, not even advent of the semantic web, which has been with us for more than ten years, was able to successfully solve the problem of structured web data extraction from web pages. Currently, there are various approaches to web extraction methods for information that was not indented for machine processing.

The scope of *Kapsa.sk* project is to retrieve information contained within e-shop products by crawling and extracting data and presenting it in a unified form which simplifies the user's decision of preferred products.

The result of crawling is a set of web pages that contain product details. As a subproblem, the crawler identifies pages that positively contain product details, and ignores other kind of pages.

A typical e-shop contains various kinds of products. Our goal is to retrieve as much structured data about product as possible. More specifically, this means retrieving their properties or attributes including their values. We have observed that each kind of product, called *domain* has a different set of attributes. For example, a domain of *television set* has such attributes as display size, or refresh rate. On the other hand, these attributes will not appear in the domains of *washing machines* or *bicycles*. However, we can see that there are certain attributes which are common to all domains, such as *product name*, *price* or *quantity in stock*. We will call such attributes to be *domain independent*. Often, the names of domain independent attributes are implicit or omitted in the HTML code of a web page (*price* being the most notorious example).

Since the number of product domains can be fairly large (tens, even hundreds), we have developed an extraction system, in which it is not necessary to annotate each product domain separately. In this paper, we present a method which extracts product data from a particular e-shop and requires annotation of just single page. Furthermore, many annotation aspects are automatized within this process. The whole annotation proceeds within a web browser.

2 State of the Art

The area of web extraction systems is well-researched. There are many surveys and comparisons of the existing systems [1, 2, 3, 4]. The actual code that extracts relevant data from a web page and outputs it in a structured form is traditionally called *wrapper* [1]. Wrappers can be classified according to the process of creation and method of use into the following categories:

- manually constructed systems of web information extraction
- automatically constructed systems requiring user assistance
- automatically constructed systems with a partial user assistance
- fully automatized systems without user assistance

2.1 Manually Constructed Web Information Extraction Systems

Manually constructed systems generally require the use of a programming language or define a domain-specific language (DSL). Wrapper construction is then equivalent to wrapper programming. The main advantage lies in the easy customization for different domains, while the obvious drawback is the required programming skill (which may be made ease by lesser complexity of a particular DSL). The well-known systems are MINERVA [5], TSIMMIS [6] and WEBOQL [7]. The OXPATH [20] language is a more recent extension of the XPath language specifically targeted to information extraction, crawling and web browser automation. It is possible to fill the forms, follow the hyperlinks and create iterative rules.

2.2 Automatically Constructed Web Extraction Systems Requiring User Assistance

These systems are based on various methods for automatic wrapper generation (also known as wrapper induction), mostly using machine learning. This approach usually requires an input set of manually annotated examples (i. e. web pages), where additional annotated pages are automatically induced. A wrapper is created according to the presented pages. Such approaches do not require any programming skills. Very often, the actual annotation is realized within the GUI. On the other hand, the annotation process can be heavily domain-dependent and web page depended and may be very demanding. Tools in this category include WIEN [8], SOFTMEALY [9] and STALKER [9].

2.3 Automatically Constructed Web Extraction Systems With Partial User Assistance

These tools use automated wrapper generation methods. They tend to be more automated, and do not require users to fully annotate sample web pages. Instead, they work well with partial or incomplete pages. One approach is to induce wrappers from these samples. User assistance is required only during the actual extraction rule creation process. The most well-known tools are IEPAD [11], OLERA [12] and THRESHER [13].

2.4 Fully Automatized Systems Without User Assistance

A typical tool in this group aims to fully automate the extraction process with no or minimal user assistance. It searches for repeating patterns and structures within a web page or data records. Such structures are then used as a basis for a wrapper. Usually, they are designed for web pages with a fixed template format. This means that extracted information needs to be refined or further processed. Example tools in this category are ROADRUNNER [14], EXALG [15] or approach used by Maruščák et al. [16].

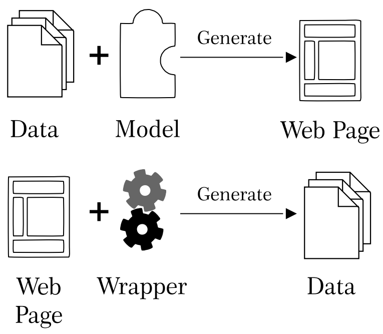

Figure 1: Extracting data from template-based pages

3 Web Extraction System within Kapsa.sk Project

Our design focuses on an automatically constructed web information extractor system with a partial user assistance. We have designed an annotation tool, which is used to annotate the relevant product attributes occurring on a sample page from a single e-shop. Each annotated product attribute corresponds to an element within the HTML tree structure of the product page, and can be uniquely addressed by an XPath expression optionally enriched with regular expressions.

Then, we have observed that many e-shops generate product pages from a server-side template engine. This means that in many cases, XPath expressions that address relevant product attributes remain the same. Generally, this allows us to annotate the data only once, on a suitable web page. (See Figure 1). To ease an effort of annotation, we discover the repeating data regions with the modified MDR algorithm [18] described in the section 5.1).

The result of the annotation process is an *extractor* (corresponding to the notion of a wrapper) represented as a set of extraction rules. In the implementation, we represent these rules in JSON, thus making them independent from the annotation tool. (see section 4 for more information).

This way, we are able to enrich the manual annotation approach with a certain degree of automation. Further improvements on ideas from other solutions are based on addressing HTML elements with product data not only with XPath (an approach used in OXPATH [20]), but also with regular expression. It is known that some product attributes may occur in a single HTML element in a semi-structured form (for example as a comma-delimited list). Since XPath expressions are unable to address such non-atomic values, we use the regular expressions to reach below this level of coarseness. Although a similar approach is used in the W4F [21], we have built upon similar ideas and we are presenting them in our web-browser-based annotation tool. Furthermore, we allow the use of the modified MDR algorithm to detect the repeating regions.

4 Extractors – The Fundament of Annotation

4.1 Extraction Rules

In the first step of annotation, an extractor is constructed. It is composed from one or multiple extraction rules, each corresponding to an object attribute. All extraction rules have two common properties:

1. They address a single HTML element on a web page that contains the extracted value. The addressing is represented by an XPath expression.
2. The default representation of the extraction rule in both annotation and extraction tools is JSON.

```
{
  "site": "http://www.kaktusbike.sk/terrano-lady-12097",
  "extractor": {
    "type": "complex",
    "items": [
      {
        /* -- Rule with fixed attribute name */
        "type": "label-and-manual-value",
        "xpath": "//*[contains(@class,\"name\")]/h1",
        "label": "Name"
      },
      {
         /* -- list (table rows) -- */
        "type": "list",
        "xpath": '//*[contains(@class,\"columns\")]/table/tbody/tr',
        "label": "N/A"
        "items": [
          {
            "type": "label-and-value",
            "labelXPath": "td[1]",
            "xpath": "td[2]"
          }]}]}}
```

Figure 2: Defining an extractor along with various extraction rules

4.2 Types of Extraction Rules

The value with fixed name rule is used to extract one (atomic) value along with a predefined attribute name. Usually, this attribute is specified via the graphic user interface of the annotation tool. Alternatively, this is specified as the name of well-known domain-independent attribute. See Figure 2, rule `label-and-manual-value` for an example.

The value with extracted name expands upon the previous rule. The name of the extracted attribute is defined by an additional XPath expression that corresponds to an HTML element that contains attribute name (e. g. string *Price*). The example in Figure 2 uses the `label-and-value` extraction rule.

The complex rule is a composition (nesting) of other rules. This allows to define extractor for multiple values, usually corresponding to attributes of the particular product. Whenever the complex rule contains an XPath expression (addressing a single element), all nested rules use this element as a context node. In other words, nested rules can specify their XPath expression relative to this element. The example uses the extraction rule declared as `complex`. Usually, a complex rule is a top-level rule in an extractor.

The list rule is used to extract multiple values with a common ancestor addressed by an XPath expression. This expression then corresponds to multiple HTML subtrees. This rule must contain one or more nested extraction rules. A typical use is to extract cells in table rows (by nesting a rule for extracted name). In the example, we use the extraction rule declared as a `list`.

An extractor defined by rule composition (i. e. with the *complex* rule) is specifically suited for data extraction not only from a particular web page (as implemented in the user interface, see section 6), but also for any other product pages of a particular e-shop. In this case, no additional cooperation with annotation tool is required.

The annotation of domain-independent values is usually realized with the *value with fixed name* rule, since the attribute name is not explicitly available within a HTML source of the web page.

Domain-dependent attributes (which are more frequent than the domain-independent ones) usually occur in a visually structured "tabular" form. The *annotation automatization process* described in the next section, allows us to infer a list rule along with a nested *value-with-extracted-name* rule. This combination of rules is sufficient to extract product data from multiple detail on web pages. Furthermore, this particular combination supports attribute permutation or variation. Therefore, we can successfully identify and extract attributes that are swapped, or even omitted on some web pages. This feature allows us to create wrappers that are suitable for all product domains of an e-shop.

Moreover, this set of extraction rules may be further expanded. We may specify additional rules that support regular expressions along with the XPath or we may possibly support the extraction of attribute values from web page metadata, e. g. the product identifier specified within an URL of the web page.

5 Automatizing Annotation Process

As we have mentioned in the previous section, we aim to make the annotation process easier and quicker. A product page often uses either tabular or list forms, which visually clarify complex information about many product properties (see Figure 4). We will call such form a *data record* denoting a regularly structured object within a web page, containing product attributes, user comments etc.

Within the annotation tool, we need to nest a *value-with-extracted-name* within a list-based rule. Unfortunately, it is quite difficult to address an element which contains list items by a mouse click. Although it is possible to directly create an XPath expression, this requires advanced skills in this language and knowledge of the HTML tree structure of the annotated web page. Therefore, we identify such list elements automatically by using the modified MDR algorithm. To recall, the classic MDR algorithm [17] is based on the Levenshtein string distance and on two observations on HTML element relationships within a web page.

1. Data records occur next to each other or in the close vicinity of each other. Moreover, they are presented with similar or identical formatting represented within HTML elements. Such data records constitute a *data region* (see Figure 3). Since HTML elements can be transformed into string representations, we can easily use the Levenshtein string distance.
2. HTML elements are naturally tree-based. Therefore, two similar data records have similar levels of nesting and share the same parent HTML element.

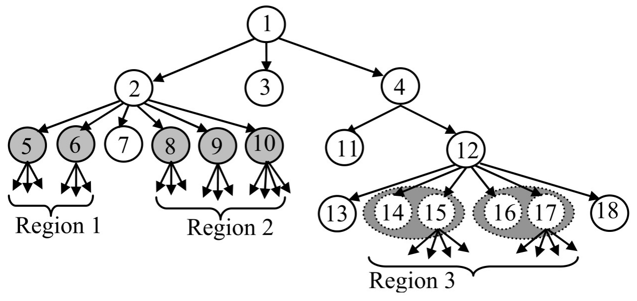

Figure 3: Data Regions

5.1 Modifying the MDR algorithm: attribute discovery

Bottom-up approach. The classical MDR algorithm traverses the HTML tree in the top-down direction and searches the data regions in the whole HTML document. Our modification uses the bottom-up approach: we start with an element annotated by the user and move upwards to the root element. This user annotation denotes the starting point for further comparisons, which removes the need for many computation steps.

Supporting shallow trees. The MDR algorithm has a limited use for shallow tree data regions. (The original authors state minimal limit of four layers.) However, attributes or user comments very often occur in such shallow trees. For example, a user comment occurring in element `<div id="comment3787" class="hbox comment"` in the classical MDR is transformed into the string `div`. It is obvious that such a string is too frequent in the HTML page, and therefore the Levenshtein distance cannot be used. We improve the string transformation by considering not only the name of the element, but also some of its attributes. In our example, the element is transformed into the string `div.hbox.comment`. This vastly improves the efficiency of the comparison in shallow trees.

Slicing tree by levels. The classical MDR algorithm transforms elements into strings by the depth-first traversal. This means, that a subtree of an element is represented as a string, which is used in the Levenshtein distance. In our approach, we slice the subtree into levels, transform them into strings and subsequently calculate the distance for each of these strings. The total distance is calculated from the partial distances for each layer.

Example 1. *Consider the example in Figure 3. The classical MDR algorithm transforms the HTML tree into the following strings:* `[2, 5, 6, 7, 8, 9, 10]` *and* `[4, 11, 12, 13, 14, 15, 16, 17, 18]`*, which are then compared.*

In our modification, we slice the tree by levels and create the following strings: first layer transforms to `[2]` *and* `[4]`*, the second layer transforms to* `[5, 6, 7, 8, 9, 10]` *and* `[11, 12]`*, and final layer maps to* `[]` *and* `[13, 14, 15, 16, 17, 18]`*. Then, each pair is compared according to Algorithm 1.*

The slicing approach has a positive effect on time and space complexity. This method needs not to compare elements in different layers (which usually are not related at all), and simultaneously does not decrease the distance between subtrees.

Removing non-structure elements. In the transformation process, we intentionally ignore elements which do not define a document structure. We omit purely formatting elements, such as `b`, `i`, `tt`, `abbr` etc.

The algorithm for searching similar elements (see Algorithm 1) retrieves a set of elements A. Each element of this set is compared to an element E and return a set of similar elements, while using the similarity threshold P. For each element Y from set A, the algorithm computes the similarity of a subtree of element Y with a subtree of element E, level-by-level. This level-wise slicing computes two sets of elements denoted as Z_x and Z_y. A similarity score is computed as a ratio of edit distance to number of elements that were compared.

The resulting score is a value between 0 and 1, ranging from identical subtress to completely different subtrees. This value is compared with the pre-set threshold P.

Algorithm 1 Searching similar elements

Let A be an element set in which we search a similar element.
Let E be an element for which we search a similar element.
Let P be a similarity threshold.

```
function SEARCH_SIMILAR_ELEMENTS(A, E, P)
    similar ← []
    for $Y$ in $A$ do
        $i \leftarrow 0$
        score ← 0
        $c \leftarrow 0$        ▷ number of elements for comparison
        while exists $i$-th level in $E$ or in $Y$ do
            $Z_x \leftarrow$ elements_in_level(i, E)
            $Z_y \leftarrow$ elements_in_level(i, Y)
            score ← score + Levenshtein($Z_x, Z_y$)
            $c \leftarrow c + \max(\text{length}(Z_x), \text{length}(Z_y))$
            $i \leftarrow i + 1$
            score = score/$c$
        end while
        if score $\leq P$ then
            add element $Y$ to result
        end if
    end for
    return result
end function
```

5.2 Annotation in the Annotation Tool

The process of annotation of tabular or list-based attributes is initiated by marking a single attribute value (by clicking on the particular highlighted element in the annotation tool). Then, the similar subtrees are discovered in the surroundings of this element. We start with the parent and run the algorithm for similar elements. If no similar elements are found on this level, we emerge at the parent level. Then, we rerun the algorithm for similar elements, until we find a level in which there exist elements that define all product attributes.

If we find similar elements on an incorrect level (for example, it is necessary to create a list rule based on the parent or ancestor of discovered elements, or it is desired to dive one level deeper), we have a possibility to manually move above or below the discovered elements. Effectively, this allows for increasing or decreasing the level of the discovered element, for which we create the list rule.

Beside the element with a product value, we need to annotate an element with an attribute name. Whenever any of subtrees generated by the list-based rule contains exactly two text elements, and one of these elements is annotated as an attribute name, the remaining element is considered as the attribute name element. Otherwise, a manual annotation assisted by the user is required.

6 User Interface for Annotations

Extraction rules defined in section 4 and attribute discovery can be achieved in the annotation tool implemented as the add-on EXAGO suitable for Mozilla Firefox browser (see Figure 4). This open-source and multiplatform tool (in comparison with commercial tools like MOZENDA, VISUAL WEB RIPPER, DEIXTO) represents a simple and practical user interface. We support a preview of the extractors based on the attribute discovery or manual annotations in the JSON representation.

The usual workflow includes visiting a web page of a particular product and annotating product attributes, thus declaring an extractor structure in the background (see example on Figure 2).

The declared extractor can be used in two ways: it can be immediately executed within the browser context, thus extracting product values from the web page. This data can be consequently sent to the server-side database for further processing. Otherwise, the JSON representation of the extractor can be sent to the server middleware. The extraction process can be performed independently on the server by one of the more advanced extraction techniques [19].

7 Conclusion and Future Work

We have presented a tool for annotating attributes of product in e-shops. We have defined a language of extraction rules, which are created either with the assistance of the user or are automatically inferred by the modified MDR algorithm. Extraction rules along with the algorithm were implemented as an add-on for Mozilla Firefox web browser.

The future research will be focused on further extension of the modified MDR algorithm, which will search for data regions in web pages. Besides, we will aim to implement the product page identification on the server-side and extend the extraction methods in order to support the pagination and tabs within a single web page.

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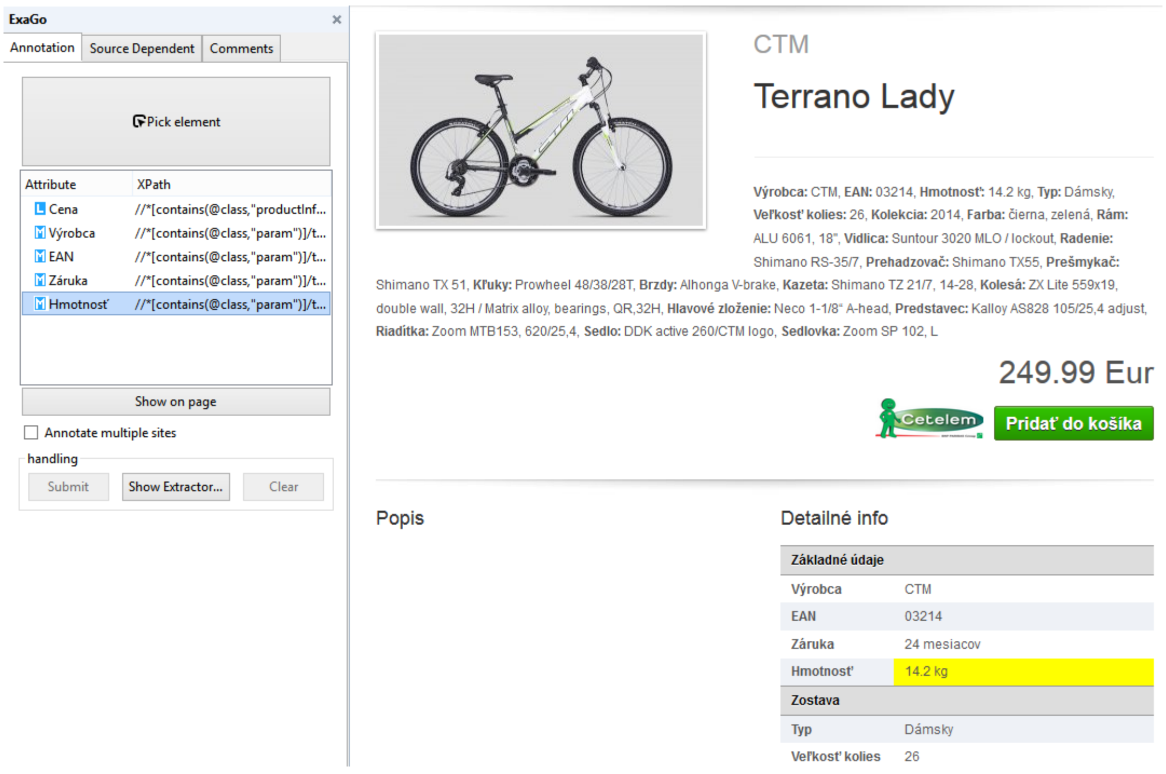

Attribute	XPath
Cena	//*[contains(@class,"productInf...
Výrobca	//*[contains(@class,"param")]/t...
EAN	//*[contains(@class,"param")]/t...
Záruka	//*[contains(@class,"param")]/t...
Hmotnosť	//*[contains(@class,"param")]/t...

CTM

Terrano Lady

Výrobca: CTM, **EAN:** 03214, **Hmotnosť:** 14.2 kg, **Typ:** Dámsky, **Veľkosť kolies:** 26, **Kolekcia:** 2014, **Farba:** čierna, zelená, **Rám:** ALU 6061, 18", **Vidlica:** Suntour 3020 MLO / lockout, **Radenie:** Shimano RS-35/7, **Prehadzovač:** Shimano TX55, **Prešmykač:** Shimano TX 51, **Kľuky:** Prowheel 48/38/28T, **Brzdy:** Alhonga V-brake, **Kazeta:** Shimano TZ 21/7, 14-28, **Kolesá:** ZX Lite 559x19, double wall, 32H / Matrix alloy, bearings, QR,32H, **Hlavové zloženie:** Neco 1-1/8" A-head, **Predstavec:** Kalloy AS828 105/25,4 adjust, **Riadítka:** Zoom MTB153, 620/25,4, **Sedlo:** DDK active 260/CTM logo, **Sedlovka:** Zoom SP 102, L

249.99 Eur

Základné údaje	
Výrobca	CTM
EAN	03214
Záruka	24 mesiacov
Hmotnosť	14.2 kg
Zostava	
Typ	Dámsky
Veľkosť kolies	26

Figure 4: Extracting data from template-based pages

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