Identifying and Expanding Titles in Web Texts

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ABSTRACT

In this paper, we present an analysis based on linguistic and typographic features that allows for the identification of titles in web documents. We focus in particular on procedural texts. Identifying titles is a difficult task because ways of encoding them are very diverse. A number of titles are also incomplete because of context, we propose therefore a way to retrieve the missing elements, in particular predicates, so that titles are fully intelligible.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous

General Terms

Human factors, Experimentation

Keywords

structure analysis, text semantics, text titles

1. INTRODUCTION

Recognizing and tagging titles in web documents is a difficult but necessary task. Indeed titles are realized in a large number of ways which do not follow in most cases the standards. Web texts produced by non-professionals do not have in general a very strict encoding in html. Titles found in Web texts may also have different roles: some are related to the page main contents, whereas others deal with external considerations such as advertising, links to blogs, hints and advices of various kinds, just to name a few. In this project, we are basically interested in identifying titles which are related to the document contents. For that purpose, we will consider both surface (e.g. typographical) and contents marks.

Titles in text play a large variety of roles. They obviously structure documents [6], outlining the main topics addressed. They can be viewed also as denoting goals, as in procedural texts, the area we are concerned with here. Question answering systems, for How-to questions need to refer to this latter type of title, whereas tutoring systems need to refer quite accurately to both types. We will not address here the complex roles titles may play, but this would certainly be a very useful investigation. To our knowledge, little work has been done on tagging titles, besides what has been elaborated in the Text Encoding Initiative. Titles have been studied in psycholinguistic circles, in linguistics [4, 6] and in didactics.

We conducted our investigations on procedural texts [1, 3] which include a large variety of domains and document types, including documents as diverse as teaching texts, medical notices, social behavior recommendations, directions for use, assembly notices, do-it-yourself notices, itinerary guides, advice texts, cooking recipes and video games solutions. In those documents we noted a large variety of titles: titles related to the text contents, but also a number of other elements encoded as titles such as adds, email addresses, hyperlinks, web navigation instructions, etc.

The next problem is that titles are often incomplete (in the basic form 'predicate + object argument' one of the two elements is missing), up to 65% in some procedural texts such as cooking recipes. It is obviously of much interest to be able to reconstruct those titles for an optimal use of those texts by users. Another illustration of this need is, for example, in a how-to question answering context, questions (How to change my mother card ?) that have to match with a comprehensive title, where the response is the procedure that follows. If we go further, in some areas, it may even be useful to add titles when sections are very long, however reconstructing (or inferring) missing titles is a different issue that may need techniques such as e.g. text tiling [7].

In this short document, we first address the issue of title identification and tagging in a large variety of types of procedural texts, next we show how titles can be reconstructed via a learning mechanism and how index can be added to titles to allow for question matching. Titles express goals. To answer questions, words in the title associated with a set of instructions must match words in questions. For example, to answer "How do I change my bike wheel?", we would look for a title like "Changing a bike wheel".

2. RECOGNIZING TITLES

The corpus we use was created for the TextCoop project. This project aims to build a question answering system. The goal is to answer *how-to* questions from procedural texts contents. This large corpus contains short procedural

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texts (texts that instruct how to do a particular activity), in French, collected without specific selection from general purpose websites such as *Castorama*[1] or *Mr Bricolage*[2]. The document format is html.

2.1 Cleaning Web texts

The input of our system is raw Web pages. To be able to correctly tag titles, it is necessary to eliminate useless information (advertising, summaries, links to blogs, comments, etc.). In our corpus, this useless information can represent up to 66% of the text. To carry this out, we need

1. to extract relevant text, that is, any kind of text that is not navigation help, advertisements or comments posted by cybernauts and
2. to select and to simplify the html tags in so as to keep the main typo-dispositional information (paragraph breaks, subdivisions of paragraphs into lines, lists and their subdivision into elements, emphasis).

Although (2) was quite an easy task, we had some difficulties achieving (1). We designed an algorithm that returns, for each paragraph, if its contents can be considered as relevant or not. It mainly uses paragraph length and proportion of closed-class words criteria. We evaluated it on 100 Web pages, from 12 different web sites. The results compared to a manual treatment are quite good, we have 0,95 precision and 0,76 recall.

When the text is 'clean', we apply the TreeTagger on it to identify its morpho-syntactic categories. We also make some revisions since, in French, the imperative form, which is central to our system of extraction patterns, is often identified as present indicative tense.

2.2 Recognizing Titles

For answering How-to questions it is of much importance to recognize titles, which, in fact, mostly express goals of various levels. A second challenge is to possibly identify title hierarchies in complex or long texts. Automatically identifying titles is quite challenging and has been seldom addressed in the past. This task depends on the text format (pdf, word, html, etc.), the quality of the encoding, the type of text (procedural, roman, news, etc.) and the considered domain.

Let us focus here on procedural texts, encoded in html format, from various sources, styles and domains. As advocated above, a problem for us is that a number of titles in web pages are irrelevant with respect to the considered procedure, they are rather advertising, web services ('click here for more') or summaries, to cite just a few. Besides recognizing titles as such, our task is in fact to concentrate on titles related to a procedure, so that these can be used for answering questions.

Titles are short text sequences, highlighted (bold, color, underlined, large size or different type of font, etc.). A first observation is that html encodings are, by far, not homogeneous. Titles are coded with the tag $< h_n >$ in only 20% of the cases over the 600 titles observed. In most cases, the tag $< b >$ is used, possibly also $< emp >$, $< u >$ and a few others (macros...). Low level titles even have more unexpected encodings. Encodings may be quite homogeneous within a given web site, but heterogeneity prevails over different sites, even in the same domain.

To be more precise, we observed that, roughly:

- 80% of titles are encoded with $< b >$
- 57% of the total of $< b >$ used in texts encode titles
- 64% of the total of $< h >$ used in texts encode titles.

This means that we need to consider additional criteria, among which:

- typography (spacing w.r.t. paragraphs before and after),
- the contents (number of words, inflected verbs) in the segment assumed to be a title,
- the type of elements after the title (e.g. instructions, which are a good indicator of a procedural title).

Titles are identified in two steps. First, an algorithm traverses paragraphs of a text one by one, and assigns them one of the following tags: `title, text` or `ambiguous`. This first step is quite straightforward. From our investigations on procedural texts, a title is a paragraph composed of a sequence of words of less than 12 words long with typographical emphasis. The tag `text` will be assigned without any doubt if the paragaph is subdivided into smaller units or is longer than 12 words. Ambiguous parapraphs are mainly short sequences of words (12 words or less) with no emphasis.

The second step disambiguates the ambiguous paragraphs one by one, using the tags assigned by the first step to their surrounding paragraphs. For exemple, we have the following rules:
'an ambiguous paragraph between two titles is a text',
'an ambiguous paragraph followed by a title becomes a text'
'an ambigous paragraph becomes a title if it is the first paragraph of the text', etc.

This second step also makes some repairs on the tags yielded by the first step. For example, any sequence of more than two titles, i.e : "title title title", will be changed to "title title text".

The title hierarchy is very difficult to identify without content analysis. In fact, it is often largely pragmatic in nature. For example in 'The pizza Margarita .... the paste .... the topings .... the serving ...'. It is impossible a priori to hierarchically organize those subtitles if you do not know what pizzas look like.

However, standard procedural texts are not very long and tend to be relatively linear. This means that, besides the page title, we observed in 80% of our texts not more than 2 levels of titles (exluding the main title). We observed two regular types of titles that can be correlated to some form of hierarchy. Type 1 is a title separated from the paragraph that follows by a $< p >$ tag. Type 2 is a title separated from the paragraph that follows by a $< br >$ tag. Although we still have no means to tell the exact level for titles, we can quite confidently say that a type 2 title will be at a lower level than a type 1 title, whatever the website or the domain. This information may be useful for question-title matching: type 2 titles are expected to introduce paragraphs that deal with more specific aspects of a procedure than paragraphs introduced by a type 1 title. Type 2 titles could help answering specific questions.

[1] http://www.castorama.fr
[2] http://www.mr-bricolage.fr

2.3 Evaluation

The evaluation corpus is composed of 78 Web pages over 5 domains: cooking recipes, do-it-yourself, video game solutions, social life, and medical recommendations. The total number of words is 61159, this not very large, but we feel sufficient for an indicative evaluation, giving us directions to improve the system. For each sequence, two annotators, doing the same task, had to decide whether it is a title or not. The corpus contains 4560 sequences, among which 511 titles and 1641 sentences containing at least one instruction.

The title recognition algorithm yields the following results over 5 different domains. Precision was given priority over recall to avoid errors as much as possible. We report here the recognition of titles related to text contents.

domain	recall	precision	certainty
cooking receipes	0.72	1	0.83
do it Yourself	0.8	0.96	0.87
social life	0.69	0.97	0.80
video games	0.61	0.93	0.74
medical notices	0.58	0.81	0.67

2.4 Filtering out non-relevant titles

The next step is to filter out as much as possible titles which are not relevant w.r.t. the contents of the page. The number of useless titles may vary quite largely depending on the domain. In general, we observed about 18 to 20% of irrelevant titles.

For that purpose, we consider two techniques that we are investigating at the moment:

- define a 'stop list' of typical terms found titles which are not relevant (e.g. click, see, consult, confirm, buy, advice, recommendation, etc.). So far, with a short stop list of 163 words, 59% of irrelevant titles are filtered out and only 4 titles out of 276 informative titles have been erroneously filtered out. This list may clearly be extended since so far the silence introduced is marginal.

- keep titles that have common contents with the paragraphs that follow. In particular, we are evaluating the fact that a relevant title must contain words, or related terms (synonyms, holonyms) [2], that appear frequently in the paragraphs that follows. A technique based on text tiling can be used.

3. RECONSTRUCTING TITLES

3.1 The problem and the situation

In our procedural texts, depending on the domains, we observed an average of 56% and up to 65% of the titles which are incomplete, i.e. w.r.t. the basic form: 'predicate + object argument' either the predicate or the argument is missing. For the reader, the reconstruction of the missing element is often straightforward due to context. Our goal is to identify the elements in the text that allow for the reconstruction of titles, and possibly, as a side effect, to index them for information retrieval or question answering purposes.

In general, elliptical situations do not really depend on the domain, there are however slightly more such titles in cooking recipes (references are probably more straightforward), and slightly less in the 'practical life' domain. Also, the deeper the titles are in the hierarchy, the more elliptical they are (from 31% for top titles to 86% in average for the lower level titles). Finally, texts which have a large number of titles have a slightly higher rate of elliptical titles (ranging from 40% to 60% in average for texts with more than 6 titles).

3.2 Missing argument

The case where subtitles have a missing object is relatively simple to resolve: in most cases, the object of the main title is inherited by the lower titles. In general, we observed that this form of inheritance only concerns those titles which are just one level below. It is also of interest to look, under a title composed only of an argument argument, if this argument is used with a verb in the text, then this verb may also be a good candidate for the title. The combination of these two simple strategies has 68% accuracy, which is quite satisfactory for our purpose.

3.3 Missing predicate

The case where the predicate is missing is the most frequent and the most complex to resolve. An approach is to deploy a learning mechanism, where we consider a sample of titles which are fully realized (predicate + argument). The principle is then to collect all the verbs (or deverbals, in what follows they will be both termed verbs) that appear in the instructions below this title. Learning consists then, roughly, in making a distributional analysis of the verbs that appear under a certain title verb. For that purpose, we considered a development corpus of 3000 web texts over various domains. Those texts were then annotated via the TextCoop text tagger [3].

From each title which is complete, we created the structure: <verb of title> - [list + frequency of the verbs in the instructions under the scope of that title]. Then, summing over all texts and titles, we have a structure such as:
<verb of title + frequency> - [list of verbs + frequency],
where the frequency associated with the 'verb of title' is the number of times this verb has been found in titles and the 'list of verbs' is the union of all verbs encountered under the 'verb of title', with frequencies for each verb. This list is obviously dependent on the domains considered, or the group of domains, as in our case where closely related domains have been considered alltogether.

We then constructed the inverse list, where an entry is a verb from the 'list of verbs':
<verb in instructions, frequency> - [list of title verbs associated, with frequencies].
This inverse list is used to reconstruct missing verbs in titles.

Then, to reconstruct a verb in a title with no verb, we proceed as follows. Given a title with a missing verb, we construct the list of verbs in the instructions in the scope of that title. From the inverse list above, we select potential title verbs, construct the union + frequencies set and, finally, keep the three most prominent verbs. By prominent, we mean here those verbs which have the richest meronym set, i.e. the largest number of associated verbs in their associated list found in the instructions.

This simple approach gives the following results, via a manual analysis, considering again complete titles (but simulating lack of predicate), so that we have the solution accessible: in 46% of the cases, the correct verb has been proposed, and in 65% of the cases a good verb, closely related,

< *procedure* > < *title level* = "0" *index* = "*embellish, paint, decorate*" > How to embellish your balcony < /*title* >
< *Prerequisites* > 1 lattice, window boxes, etc.< /*prerequisites* >
....
< *title level* = "1" *index* = "*cleaning, sweep, wash*" *missing* − *arg* = "*balcony*" > Cleaning < /*title* >
..... (instructions).....
< *title level* = "1" *index* = "*adding, including, decorating with*" *missing* − *verb* = "*adding*" > plants < /*title* >
..... (instructions).....
< *title level* = "1" *index* = "*spreading, painting, choosing*" *missing* − *verb* = "*spreading*" > the paint < /*title* >
..... (instructions).....
.....
< /*procedure* >

Figure 1: Annotated titles in a procedure, (gloss from French)

has been proposed. These results are good and will allow for an adequate question-title match.

Now, we can pair this algorithm with an endogenous search: we search in the paragraphs below the title if the argument which is the title is used and combined with a verb. In 29% of the cases, the argument is associated with the correct verb, in 47% of the cases, a closely related verb is proposed. If we combine the two techniques, learning and endogenous search, then, the results are really satisfactory: the correct verb is proposed in the list in 62% of the cases and a closely related verb is proposed in 86% of the cases.

An interesting feature is that the verbs present in titles have a relatively rich distribution, while remaining generic: we have about 30 recurrent verbs covering only 50% of the titles. These are quite generic for the group of domains we considered: *choose, maintain, use, make, put, clean, paint, replace, prepare, manage, plant,* etc.

The validity of this resource turns out to be limited to its training domains. It can not directly be applied to other domains, like health or video games. This requires to apply the learning algorithm on a corpus of texts of these domains.

3.4 Indexing titles

Finally, we can, based on the list of proposed verbs and deverbals, index all titles (complete or not) by means of that list, for question answering purposes. Consequently, in our representation, any title receives a list of closely related verbs and deverbals used to index the title, which will be used when attempting to match the terms of an How-to question with a title. So, instead of searching quasi-synonyms [2] via a lexicon or an ontology as it is often the case in question matching procedures, resource which is not readily available for verbs in most domains, we have a list of terms which can be used directly as indexes with a good relevance score. This list is obviously much more accurate.

The representation of a title is as follows:
<title index="w1, w2, w3"> ... title .... < /title>
where w1, w2 and w3 are indexes, ranked by decreasing frequency. An example is given in Fig. 1.

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