AutoCWW: Automated Cognitive Walkthrough for the Web

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Abstract – **This paper describes a specification of AutoCWW which is an automated web usability evaluation tool based on the Cognitive Walkthrough for the Web (CWW)** [1]**. AutoCWW, running on a remote server, is used by a web site developer when a new site is being constructed or an existing site is redesigned. AutoCWW evaluates navigational pages in the site and informs the web developer of the content of the usability problems with suggestions how to repair them.**

Keywords : web usability, usability inspection method, Cognitive Walkthrough, cognitive model, automated usability evaluation

1. Introduction

The purpose of this paper is to describe a website usability inspection method, the Cognitive Walkthrough for the Web (CWW), and its automation (AutoCWW). The CWW [1],[4] is a transformation of the Cognitive Walkthrough (CW), a model-based usability inspection method that has proven useful in designing applications that support use by exploration. CW identifies usability problems by simulating step-by-step user behavior for a given task using a prototype interface, and by having the design team answer the questions at each simulated step.

The CWW is superior for evaluating how well websites support users' navigation and information search tasks, having the following features:

1) *Model-Based Usability Evaluation:* CWW simulates user's web navigation using a cognitive model, CoLiDeS.

2) *Realistic Goal:* CWW uses contextually rich descriptions of user goals (100-200 words long) incorporating more information about users' understanding of their tasks and underlying motivation.

3) *Objective Evaluation:* CWW uses psychologically valid user's semantic knowledge space, LSA (Latent Semantic Analysis) [8], to predict user's selections, and discovers problematic headings and links using a set of objective criteria.

4) *Coping with User Diversity:* CWW can consider user diversity by using respective semantic knowledge spaces when applying LSA.

5) *Fit with Web Site Development Process:* CWW supports incremental website design by having the analyst evaluate website page by page for a set of pre-specified goals. It examines a set of goals to confirm each goal is directed to the page that the developer intends.

We start by reviewing the cognitive model underlying the CWW. Then we introduce design questions that the web site developer has to answer during web site design. We show how these questions are answered with the help of CWW. Finally, we provide a set of specifications for an automated CWW.

2. Cognitive Model of Web Navigation

Like the Cognitive Walkthrough [6],[11], the CWW is derived from a theory of the cognitive processes that control goal driven exploration. The model underlying CWW, CoLiDeS [3],[7], an acronym for **Co**mprehension-based **Li**nked model of **De**liberate **S**earch, extends a series of earlier models of performing by exploration [6] based on Kintsch's construction-integration theory of text comprehension and problem solving processes [5]. CoLiDeS is part of a broad consensus among theorists and website usability experts [2],[7],[9],[10] that problem solving processes, guided by users' goals and information scent, drive users' information-seeking or search behaviors when exploring a new website or carrying out a novel task on a familiar website.

A web page is made up of a large collection of objects competing for users' attention (e.g., action graphic, hypertext link, navigation bar item, or paragraph), which are meaningful units and/or targets

Table 1   Evaluation questions.

Questions for CW	Questions for CWW
Q1) Will the correct action be made sufficiently evident to the user?	Q1) Same as CW
Q2) Will the user connect the correct action's description with what he or she is trying to do?	Q2a) Will the user connect the correct subregion of the page with the goal using heading information and her understanding of the sites page layout conventions? Q2b) Will the user connect the goal with the correct widget in the attended to subregion of the page using link labels and other kinds of descriptive information?
Q3) Will the user interpret the system's response to the chosen action correctly?	Q3) Same as CW

Table 2   Types of problems CWW can detect and their detection criteria.

Usability Problem	Detection Criteria
Unfamiliar Heading/Link	A heading/link with an LSA term vector length of less than .8 (for two most meaningful words) is likely to be unfamiliar.
Confusable Heading/Link Pair	Any heading/link pair yielding a cosine of .6 or more in the LSA analysis is likely to be confusable.
Goal-Specific Competing Heading	1. The competing heading label must have a cosine greater than the similarity to the goal that the correct heading label has. 2. Not be judged by the analyst as a false alarm, a heading that real users would probably not select.
Goal-Specific Competing Link	1. The competing link label must be under the same heading as the correct link. 2. The competing link label must have a cosine indicating at least 80% of the similarity to the goal that the correct link label has. 3. Not be judged by the analyst as a false alarm, a link that real users would probably not select.

for action. The core process underlying web navigation is comprehension of texts and images. Comprehension processes build, elaborate and compare the mental representations of screen objects on a web page in preparation for selecting and clicking one particular hyperlink or image. Users act on the hyperlink, image, or other screen object that they perceive as being most semantically similar to the description of their current goal.

CoLiDeS assumes that selecting a next action on a page is a two-phase process:

Attention Phase: The user segments/parses the page into a collection of subregions and generates a brief description of each subregion from his/her knowledge of page layout conventions, and titles and headings on the page. The user attends to the subregion whose description is perceived as being most similar to the user's current goal.

Action Selection Phase: The user generates descriptions of all of the widgets in the subregion and acts on the one whose description is most similar to their goal.

The user's behaviors in the attention and the action selection phases are determined by the perceptions of similarity between the user's goals and the descriptions of alternative regions or actions. These similarities are calculated by LSA (Latent Semantic Analysis) [8]. LSA is a mathematical technique that estimates the semantic relatedness of texts, based on a statistical analysis of a large corpus.

3.   Usability Evaluation with CWW

3.1   Evaluation Questions

Table 1 shows the evaluation questions defined in the original CW and CWW. The CWW retains Q1 and Q3 in the original CW. However, Q2 in CW is transformed into Q2a and Q2b, which correspond to the attention and action selection phases respectively in the CoLiDeS model.

3.2   How CWW Answers the Questions

For answering Q2a and Q2b, CWW examines semantic similarities between heading labels, link labels, and goals. Table 2 summarizes three types of problems (i.e., unfamiliar, confusable, and goal-specific problems) in web page designs that the CWW identifies, and their detection criteria. According to CoLiDeS, a user first focuses on a subregion of a page based on its heading. A heading will cause trouble either because it is unfamiliar (the user does not know what the heading means), or because it is easily confusable with another heading. This is the same for links. These problems listed in the first and second rows in Table 2 are not dependent on the description of goals. However, some problems emerge only for some goals. For example, two head-

ings may not be very similar to one another, but may both be equally similar to a possible goal (third and fourth rows).

As can be seen in the right column of the table, detection criteria for goal independent problems (first and second rows) are objectively defined in terms of the results of LSA. However, goal specific problems (third and fourth rows) require analyst's intervention for checking false alarm. This is due to a bias in LSA's similarity estimates with respect to actual user judgment. LSA is more likely to overestimate than underestimate the similarity of items, in that a human judge may recognize that phrases that use similar terms are in fact sharply different in meaning. Allowing the analyst to reduce LSA's similarity estimate, and reject a proposed competing link label, is an approximate response to this problem.

Fig. 1 CWW Steps

4. CWW Procedure

Figure 1 outlines the entire CWW procedure:

1) Step 1 is for preparation that includes designing web pages to evaluate, compiling user goals, identifying intended correct links, and selecting appropriate semantic space that corresponds to each of the user goal.

2) Step 2 is to obtain distances between goals, headings, and links in a semantic space and term vector lengths by feeding these elements in LSA at http://lsa.colorad.edu.

3) Step 3 and 4 are for detecting usability problems by applying the criteria shown in Table 2.

5. Specification of AutoCWW

Currently, the steps shown in Figure 1 have neither been automated nor integrated well in the website development process. However, we are at the stage of exploring design for an automated CWW (AutoCWW). This section describes AutoCWW by specifying its definition, input from the user (web site developer), and feedback.

5.1 Definition

AutoCWW is a web usability evaluation tool running on a remote server. It is used by a web site developer when a new site is being constructed or an existing site is redesigned. AutoCWW evaluates navigational pages in the site from top to bottom, page-by-page basis. It first evaluates the homepage, then the pages reachable from the links on the home-
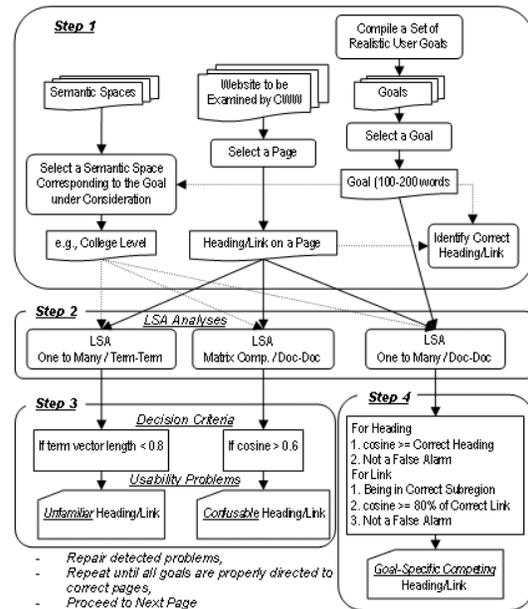
page, and continues until it reaches content pages where user's information needs are to be satisfied. AutoCWW checks the current design of site navigation if user goals are directed to correct terminal content pages. When it finds navigational problems, AutoCWW informs the web developer of the content of the problems and suggestions how to repair them.

5.2 Data required for doing AutoCWW

The following set of information defines input to AutoCWW, which has to be specified by the web site developer:

1) *Description of goals:* Detailed description of goals that the intended users will bring into the site have to be described in advance (100-200 words), including not only description of their immediate target information but also background of their information needs. The goals thus defined have to specify unambiguously the context of search as much as possible. Each terminal content page should be associated with at least one user goal.

2) *Description of headings of sub-regions of a page:* A web page is segmented into sub-regions by the web developer. Heading is the label associated with the sub-region.

3) *2-word description of headings of sub-regions of a page:* If the heading is longer than two words, the web developer has to select most representative two words from the heading words. These

words are used to evaluate the degree of familiarity of the heading.

4) *Description of links in the sub-region of a page:*

5) *2-word description of links in the sub-region of a page:*

6) *Elaboration of headings:* Explanatory texts accompanied with the headings.

7) *Elaboration of links:* Explanatory texts accompanied with the links.

8) *Correct link for each goal:*

5.3 Feedback from AutoCWW

The following feedback will be returned to the web site developer by AutoCWW:

1) *Unfamiliar heading:* AutoCWW indicates those heading labels that are estimated unfamiliar with a list of alternatives.

2) *Unfamiliar link:* AutoCWW indicates those link labels that are estimated unfamiliar with a list of alternatives.

3) *Confusable headings:* AutoCWW indicates pairs of heading labels that are confusable.

4) *Confusable link labels:* AutoCWW indicates pairs of link labels that are confusable.

5) *Competing headings:* For a given goal, AutoCWW indicates heading labels that compete with the correct heading.

6) *Competing links:* For a given goal, AutoCWW indicates link labels under the correct heading that compete with the correct link.

5.4 Support for Repair

The following information will be provided by AutoCWW to help repair process:

A) *Unfamiliar headings/links:* AutoCWW looks up terms similar to the problematic headings/links and provides them in the order of familiarity. Selection is up to the web site developer.

B) *Confusable headings/links:* For the repaired heading and links, the developer tries alternative descriptions for the problematic pair of headings/links. AutoCWW provides immediate feedback to the developer.

C) *Goal-specific competing headings:* The default repair strategy for this problem is to add the correct link under each of goal-specific competing heading. AutoCWW provides feedback if this action causes confusable link problem.

D) *Goal-specific competing links (no support required):* The default repair strategy for this problem is to establish paths from the goal-specific competing links to the correct linked-to page. Thus no repair is needed at the level of link labeling.

6.   Conclusion

The unique strength of AutoCWW is its potential for integration into the web site development process, and thus, ultimately, AutoCWW environment needs to be integrated into Web authoring tools, such as Adobe's GoLive, Macromedia's Dreamweaver, etc., allowing for the web developers to design web site without feeling any inconvenience caused by switching between designing and evaluation phases. Aiming at better support for web site development process, implementation of AutoCWW according to the specification described in this paper is under way.

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