ON AUTOMATED LANDMARK IDENTIFICATION IN WRITTEN ROUTE DESCRIPTIONS BY VISUALLY IMPAIRED INDIVIDUALS

John Nicholson
Computer Science Assistive Technology Laboratory
Department of Computer Science
Utah State University
Logan, UT 84322-4205
john.nicholson@aggiemail.usu.edu

Vladimir Kulyukin
Computer Science Assistive Technology Laboratory
Department of Computer Science
Utah State University
Logan, UT 84322-4205
Vladimir.Kulyukin@usu.edu

Aliasgar Kutiyanawala
Computer Science Assistive Technology Laboratory
Department of Computer Science
Utah State University
Logan, UT 84322-4205
aliasgar.k@aggiemail.usu.edu

Abstract

An analysis of route descriptions written by blind individuals reveals several language patterns that can be used to automatically identify landmarks in the text.

Introduction

Route descriptions are used to describe how to complete a route from one location to another location. A key component of route descriptions is the set of landmarks that are mentioned in the description and will be encountered as the actions in the description are executed. People with visual impairments mention more landmarks than people with normal vision [1]. They also refer to landmarks experienced along non-turning segments of the route, not just at turns [3].

This paper describes an analysis of a set of route descriptions written by people with visual impairments. The analysis is centered on understanding the types of language patterns that people use in route descriptions and that can used to identify mentions of landmarks. The patterns can subsequently be used to build tools that can automatically extract landmarks from text.

One set of techniques used to automatically extract information from natural language text is Information Extraction (IE) [2]. When developing IE-based tools, natural language texts are analyzed and rules are created that can automatically extract the desired information from the text. We have been developing the Route Analysis Engine (RAE) [5], an IE-based tool that can automatically identify landmarks in route descriptions.

In 2007, an online web-based survey was used to collect real-world route descriptions from visually impaired individuals. Respondents were asked to submit two route descriptions, an outdoor route description for guiding travelers from one building to another building and an indoor route description for guiding travelers from one room to another room in the same building. We received 52 responses, providing 104 English route descriptions: 52 indoor route descriptions and 52 outdoor route descriptions. Two-thirds of the route descriptions were placed in the training set for the purpose of analysis and IE rule development. The remainder were placed in an evaluation set used to test the effectiveness of the IE rules .

Route Analysis

Identifying landmarks in the route descriptions began with identifying keywords and phrases that often appear in close proximity to the mention of a landmark. Keywords include verbs, terms for cardinal directions, and terms for distance measurements. Another set of keywords were the sets of spatial prepositions that had previously been identified in Jackendoff's language analysis [5].

Once the keywords were identified, phrase patterns consisting of the keywords and nouns were identified. Analysis showed that most landmarks were part of a phrase and were nouns in close proximity to the keywords. The following types of phrases were identified in the training set of route descriptions:

1. Spatial Simple Transitive Phrase – Phrases with nouns in close proximity to Jackendoff's simple transitives. For example, in the text "next to the stairs", the string "stairs" would be considered a landmark due to "next".

2. Spatial Compound Transitive Phrase – Phrases with nouns in close proximity to Jackendoff's compound transitives. For example, in the text "in front of the water fountain", the text "water fountain" would be considered a landmark due to "in front of".

3. Spatial Intransitive Phrase – Phrases with nouns in close proximity to Jackendoff's compound intransitives prepositions . For example, in the text "The stairs are afterward", the text "stairs" would be considered a landmark due to "afterward".

4. Spatial Angle Phrase – Phrases with nouns in close proximity to words denoting to angles. For example, in the text "The door at an angle to you," the string "door" would be

considered a landmark due to “angle”.

5. Spatial Distance Phrase – Phrases with nouns in close proximity to words denoting distance. For example, in the text “It is 10 feet to the door”, the string “door” would be considered a landmark due to “10 feet”.

6. Biased Part Phrase – Phrases with nouns in close proximity to keywords identifying part of the landmark. For example, in the text “Go to the top of the stairs”, the string “stairs” would be considered a landmark due to “top”.

7. Egocentric Reference Phrase – Phrases with nouns in close proximity to a reference to the traveler or the traveler's navigation tools. For example, in the text “Tell your guide dog to find the building entrance”, the string “building entrance” would be considered a landmark due to “your guide dog”.

8. Verb Phrase – Phrases with nouns in close proximity to an action verb. For example, in the sentence “Enter the room,” the text “room” would be considered a landmark due to “Enter”.

9. Phrase Secondary Landmark Phrase – Identifies landmarks mentioned in conjunction with another landmark but not yet identified by other patterns. For example, in the sentence “You will come right to the doors of the Front Office”, the text “door” would have been identified by Spatial Simple Transitive Phrase. The string “Front Office” would be extracted as the secondary landmark.

Results

On average, the outdoor routes contained twice as many sentences as the indoor route descriptions, 18.5 versus 9.9. The outdoor route descriptions contain almost twice as many words than as indoor route descriptions in the set, 277.3 versus 148.7. However, when looking at words counts on a per sentence basis, the average number of words per sentence remains consistent across all descriptions, 14.98 words per sentence for indoor descriptions and 14.99 words for outdoor descriptions. The number of landmarks follows similar patterns. The number of landmarks mentioned in outdoor route descriptions is approximately double the number mentioned in indoor route descriptions, 37.1 versus 19.5. The number of landmarks remains consistent on a per sentence basis with 1.96 landmarks per indoor description sentence and 2.00 landmarks per outdoor description sentence.

When analysis was complete, IE rules were written based on the phrase patterns. In order to test their effectiveness, all landmarks in each route description of the evaluation set were manually identified. The IE process was run, and the set of IE-extracted landmarks was compared against the manually identified set of landmarks. In order to evaluate the effectiveness of the rules, the standard information extraction evaluation metrics precision and recall were calculated.The results show that the majority of the extracted landmarks are relevant, with a precision of 0.8286 for all route descriptions. Likewise, it was found that the majority of the expected landmarks were extracted, with a recall of 0.8487 for all route descriptions. When the evaluation set is broken into inside and outside route directions, the measures are higher for inside descriptions than for outside descriptions. This may be because indoor environments tend to be more structured than

outdoor environments, leading to less variation in the language used to identify landmarks.

The two types of phrases that identified the most landmarks were the Spatial Simple Transitive Phrase and the Verb Phrase. Route directions are a series of instructions in which actions are committed at specific landmarks. Actions are communicated as verbs in the text. People typically do not usually write just "Enter" but will also explain what to enter, "Enter the main door", designating a landmark with which to commit or associate the action. Simple transitives, such as "in", "before", and "up", communicate spatial relationships that help explain the environment's layout.

Summary

Although this analysis is based on a relatively small number of routes, clear patterns that identify landmarks exist in the text. As additional route descriptions are collected, other patterns and keywords may be identified . It is hoped that this research can be used by those developing automatic route generation tools targeted towards people with visual impairments to enhance the quality of the generated route instructions so that the text is similar to that generated by people with visual impairments.

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