Case Library Reduction Applied to Pile Foundations

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Abstract. The case-based reasoning paradigm is applied in support of decision making processes related to pile foundations. Based on this paradigm, the system accumulates experience from previously realized pile foundations. This experience can be drawn when new situations with similar attributes of geotechnical situation of the site and geometric characteristics of the piles are encountered. Two case libraries were created based on previously realized sites. The representativeness of the case libraries and the efficiency of the search process are facilitated by the use of a genetic algorithm reduction.

1 Introduction

The Case-Based Reasoning (CBR) paradigm facilitates the effective reuse of previously accepted results [1], [2], [3], [4].

In the presented research, this paradigm is applied to support any decision concerning the structure of pile foundations of construction sites. Objectives of case library representativeness are discussed in the next paragraph, followed by discussion about weight-setting and reduction methods. The reduction method chosen for the application is based on Genetic Algorithms (GA) [5], [6], [7], [8], briefly discussed in a subsequent part of the paper. The application of this paradigm to pile foundations is studied afterwards, together with the results of the reduction.

2 Representativeness of Case Libraries

Case-based reasoning relies on past case history. For a new problem, case-based reasoning strives to locate a similar previous solution.

When solving a new problem, the most similar old case is retrieved from the case library. Retrieval methods are based mainly on some modification of the nearest neighbor algorithm [9], [10], [11], [12], [13]; or induction [14], [15], [16]. As the case
library gets larger in size, the retrieval process becomes more time-consuming, especially for nearest neighbor methods, where time complexity is generally linear.

A case-based reasoning system can only be as good as its case library [9], and the quality of case libraries can be judged in two aspects:

- **Representativeness of the library** – The quality of the decision, and especially its accuracy, can be improved by employing a more appropriate representation of the case and with a cautious selection of cases.
- **Effectiveness of the retrieval** – Effectiveness is mainly based on (i) the complexity of retrieval algorithms, and (ii) the size and organization of the library.

There is a mutual relationship between these two aspects: the case library size and organization are strongly related with its representativeness. Therefore, the majority of the approaches striving to improve case libraries affects both aspects.

### 2.1 Case authoring

With the progress of case-based reasoning, more complex case libraries have been constructed. Researches have begun addressing more practical problems assisting case authors [17], [18]. The former claims that case-based reasoning can eliminate the need for knowledge engineering, required for expert systems, have been questioned. Case authoring, sometimes referred as case engineering [19], has emerged, developing principles and guidelines for case library design. Authoring cases is a difficult process. It can be expensive in time (e.g. long learning curves) or money (e.g. for training fees, consulting fees, or for purchasing case libraries). Novice case authors tend to build rather poorly designed case libraries, causing problems and dissatisfaction to users, with possible commercial consequences for the case-based reasoning product market. Therefore, case-based reasoning product vendors provide library design guidelines for their products.

Supporting the case authoring process, such guidelines are usually essential for library design. However, working with an extensive list of rules – in a written form – can be tedious and not very effective. Aha [19] suggests a software tool revising the library according to the guidelines. He focuses on Conversational Case-based Reasoning engines conducting an interactive end-user conversation to incrementally extract a query. The CLIRE (Case Library REvisor) system, described in [17], is a realization of the software revising tool. The system assists case authors by revising case libraries, improving the conformance with the design guidelines.

### 2.2 Competence Model

McKenna and Smyth have proposed a Competence Model [20] to judge the coverage of a case-base. This model is based on the concepts of retrieval space and adaptation space of some target problem. The retrieval space for a certain target problem is the set of cases which is retrieved for solving that problem. The adaptation space is the set of cases in the library which can be adapted to solve a certain target problem.