

NIRMANI: A Multi-Agent Case-Based Collaborative Estimating and Design System

Benjamin Auffarth
Universitat de Barcelona
for the course “Aprentage i Raonament Basat en Casos”
at Universitat Politecnica de Catalunya

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Abstract

NIRMANI (written in capital letters, meaning “Creator“ or “Designer“ in Sinhalese) is a case-based design (CBD) and estimation system for the construction industry, developed by Srinath Perera and Ian Watson [1]. Retrieval of cases similar to given specifications proceeds by context-dependent recursion. It was presented as “a multi-agent case-based collaborative estimating and design system that implements a model of dynamical memory or episodic memory.“ We look at the peculiarities of this system’s framework and close with the conclusion that several of its claims are exaggerated.

1 Introduction

The paper is organized as follows. We will introduce NIRMANI as a framework integrating multiple perspectives and contexts, thereby making it suited to collaborative design. It aids in the adaption of past cases to the constraints of new design briefs and gives a cost estimate. We will present its basic elements, compare it briefly to other case-based reasoning systems and conclude with some thoughts about NIRMANI’s framework and architecture.

Perera and Watson argue the construction industry¹ is fragmented into stages of design, construction, and cost estimation, each having automated their individual process, while basically lacking unification. They cite the expert system ELSIE, developed at the University of Salford, as a noteworthy example of such an autom-

¹Construction is the “building or assembly of any infrastructure on a site or sites.“[2]

atization for the estimation of cost. While for “design to manufacture”² attempts had been made, in the construction industry, *design to construct* was faced with many difficulties, because e.g. prototyping is clearly not economical. Further, for simulation instead of prototyping, developed design choices are required, which may not be available at early stages, when most of the relevant decision have to be already made.

Perera and Watson present a framework that would integrate design, estimation, and construction processes and reduce the design cycle. What they propose is that, instead of beginning each design from scratch, previous cases of designs could guide new ones, with multi-media technology aiding in the visualization and simulation. Designs of the past would be stored in a library, organized in a fashion that accomodates the different expert groups involved, and would be retrieved and the costs of the proposed design estimated. The adaption process would have to eliminate potential problems and specify the design features.

The authors emphasize that architects also use some kind of reasoning based on earlier designs, and go on to argue that for a constraint satisfaction problem such as in design, case-based design could be adequate. They implement their system for use with light-industrial buildings in the ART*Enterprise language from BrightWare³ on Windows 95. ART* provides an object-oriented knowledge-based procedural programming environment with an existing implementation of case-based reasoning, together with a GUI builder. Warehouses were chosen as domain, because they are strictly functional buildings with less asthetical constraints, standardized components, for which the cost can be derived from the sum of its components.[4]

2 An integrated design and estimating system

NIRMANI starts from the *client brief*, which is weighted criteria such as number of occupants, total cost, shape, etc. and retrieves a set of cases that match together with images, videos, and text. The user then chooses a preferred case. NIRMANI maps the new design criteria to the design information of the previous case. In comparison with other systems, NIRMANI incorporates much more, e.g. it not only guides structural but also architectural design, comparable to SEED [5]⁴

Perera and Watson describe design as an ill-structured task, where an explicit

²Manufacturing is characterized in wikipedia as “the application of tools and a processing medium to the transformation of raw materials into finished goods for sale.”[3]

³the original site, given in [4] <http://www.brightware.com> is currently hosted by Oracle and seems to be no longer active for BrightWare Inc.

⁴<http://www.seedling.org/>

domain model does not exist or is not yet adequately understood. CASE-BASED DESIGN, as the process of adapting a new design solution by combining and/or adapting previous design solution(s)[6], as proposed in NIRMANI, could be ultimately suited as a means. They go further arguing that including the adoption of old cases, NIRMANI's memory organization would be in line of dynamic or episodic memory models (cf. e.g. [7]). In 6 they call it a multi-agent system, because of the involvement of several perspectives. [sic]

A session in NIRMANI proceeds through the following stages:

1. An initial client brief with weighted relevances of different criteria for the design process is given
2. A set of cases ranked according to their match is presented to the user
3. The user can visualize the matched cases by referring to multimedia documents
4. The user can evaluate the cases and confirm the choice that was made
5. NIRMANI then maps all the design information to the new case, creating a design specification
6. The designer can change these specifications.

It should be noted, that from step 5 on (adaptation), the steps appear not to be implemented. As for (5) it was argued that adaptation was too complicated.

3 Memory organization and retrieval

Perera and Watson stress the novelty of NIRMANI in that it can incorporate several perspectives. In fact, cases are organized into different perspectives, such as architectural, spatial, aesthetical, and other concerns. By narrowing down in nearest neighbor fashion on cases which match closely the given specifications both in context and perspective most cases can be filtered out, while some remain and can be ranked and scored, while at the same time increasing the accuracy.

Each case in the system consists of about 400 features, which complicates the task of retrieval immensely. [4] compare the accuracy in cost estimation of nearest neighbor case retrieval between flat feature representation and hierarchical representation and found that the context guided retrieval method using hierarchical case representation is significantly more accurate (t-test). They suggest that for big feature spaces, their approach would bring advantages. [4]

Adaption in NIRMANI is not automated, since, as the authors state, the complexity of design cases does not warrant automated adaption. [6] The user is presented a tabularized comparison of the original specifications and the retrieved cases. [4]

4 Conclusions

The model Perera and Watson outline sounds very sensible and well-founded. It seems furthermore a reasonable theoretical framework for collaborative design processes.

Since adaption not implemented, NIRMANI is more an aid in designing than a cross-domain automated solution. It could be speculated whether this fact leads Perera and Watson to emphasize the interactiveness of NIRMANI [6], in that the user has to adapt the old cases him- or herself. Furthermore any claims for cognitive or biological plausibility founded on perceived similarities to the episodic memory model should be made very cautiously, since the adaption process on which the claim is founded has not been implemented. We had some difficulties with the notion “multi-agent system“ with regard to NIRMANI, as we understand agents rather in the sense of software agents, which by means of goal-oriented behavior act in an environment. With respect to NIRMANI this notion is very loose.

We regret that we could not access the data base of cases on www.ai-cbr.org, which could have helped to get a closer understanding of the functioning of the system. The empirical evaluation in [4] showed the actual usefulness of their retrieval process as they implemented it. Not to belittle Ian Watson’s contributions to the field of case-based reasoning, we still feel that the papers on NIRMANI were very unsubstantial as to the explanations of the actual implementation and the small quantity of citations as evident in google scholar (3) and the complete lack in citeseer, leads to questioning the impact that this framework or system, as they presented it, eventually had.

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