

# Distributed Case-based Support for the Architectural Conceptualization Phase

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## 1 Introduction

When an architect conceptualizes a new building she is very likely in need of new ideas, solutions and inspiration to create a new design. *Metis* [3] is a basic case-based design research project of the German Research Center for Artificial Intelligence (DFKI) and the KSD Research Group of the TU Munich that aims to help architects during the early design concept stage and corresponding building plans creation by providing them with similar building designs to a created one. One of the main aspects of the project is the creation of new cases (building designs) by transforming floorplan sketches with image processing techniques into graph representations which are based on the *Semantic Fingerprint* [4] model. Another one is the retrieval process that uses a multi-agent system with case-based agents that are able to apply either subgraph matching or CBR-framework-based retrieval to find similar building designs. An architect can search for them by using a web browser-based graphical interface. As usual, the project also includes participation of experts, who discuss and explain the details and aspects of the CAAD, CBR and Multi-agent systems research tasks.

In my master thesis I extended the previously existing initial concept of the retrieval system to provide the core functionality for the project's retrieval tasks. This system uses the retrieval container structure where each container acts as a separate multi-agent system that is only responsible for resolving a single user query. The retrieval process is coordinated by a corresponding agent. The case base consists of extracted and imported graph representations of the building designs. The gateway supports the connection between the core systems and the user interface.

## 2 PhD Research Focus

In my PhD thesis research I am going to concentrate on the research fields named in Section 1 and continue to study the case-based architectural design support questions. The implemented retrieval system from the master thesis will be taken as a base and extended for the further research. In detail, the currently planned research goals are described in the following sections.

## 2.1 Case Representation

This research part will answer the question which model is the most preferable one for representing architectural design cases in CBD applications – graphs or *attribute-value* concepts. The comparison of those models will include the study on how both of them perform under the same conditions when conducting retrieval and inserting of new cases. Currently cases consist of graph-based, GraphML-based [1], myCBR-based [2] and ontologically applied multi-agent communication language FIPA-SL-based floorplan representations that include room representations and room connections with corresponding attributes and values. The knowledge for creating those cases is acquired and maintained by the specific maintainer system agent that obtains, transforms, separates and inserts building design graphs into the corresponding case bases.

## 2.2 Retrieval Performance

The cross-validation of both retrieval approaches – *subgraph matching* and *CBR-framework-based* – is another part of the planned research. Here both approaches will be validated by applying the cross-comparison between those two types. The aim of this process is to answer the question which of both approaches provides the highest quality of the retrieval results. Both retrieval models will be confronted with different user scenarios to find the best suitable method for a given situation or context.

## 2.3 Retrieval Coordination

Two currently available retrieval coordination approaches – *rule-based* and *case-based* – are going to be extended to a full functionality and provide a complete pool of features needed for the relevant query. In addition a cross-comparison of them as a part of the retrieval performance measurement could be performed as well. Architectural experts' help and users' feedback can be taken into account and used for the evaluation of the result quality.

## 2.4 CBR Domain Modelling

The myCBR part of the retrieval system contains the CBR domain that is based on the structure of the *Semantic Fingerprint* model. The underlying model of the domain is going to be improved (with the experts' help inter alia) and adapted to the results of the studies named in the previous research goals.

This aim is also valid for the CBR agents, the retrieval system entities that are responsible for the last step of the retrieval of the similar building designs. The case-based learning feature of those agents implements an own CBR domain component. This component is unique for each of the currently existing CBR agent types. It provides the corresponding agent with the reasoning functionality in order to support its decision when it comes to select the proper retrieval strategy and similarity measures.

## 2.5 Applying the Generic Framework Beyond Architectural Design

From the above described multi-agent-system-supported CBR-based retrieval a generic framework will be developed and applied to other domains than architecture. One specific focus will be under which constraints the generic framework can help to overcome the inherent complexity of searching for optimal subgraphs. Based on the results an according domain and task characterization will be developed. Other research focus will be dealing with the generalization of the learning agents approach for CBR-based information retrieval for design ideas generating process. The goal is to formalize and optimize the agents' experience and knowledge obtaining, teamwork and communication process in order to provide an efficient distributed case-based IR approach that is able to find information with high precision and recall rates in one or more case bases with differently (e.g. only partly) structured knowledge representation types and domain models. Consideration of applying similarity or diversity as the best suitable case comparison base will also be taken into account and a part of agents' reasoning process.

## 3 Current Progress

The current progress state is now in the initial phase. The research group of *Metis* is currently evaluating the user interface for creating the user queries in AGraphML (*Architectural* GraphML) format. The next steps are the integration of the interface into the retrieval system and the implementation of subgraph matching algorithms to be able to use them as second possible retrieval approach.

In the following research phase it is planned to find an explicit research direction of the PhD thesis, that can be either one of the described research foci or a combination of some of them with or without adding some new aspects that can appear during the ongoing *Metis* project discussions.

## References

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