

Targeted Detection: Application to Error Detection in a Pedagogical System

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The software "Combien?" is a pedagogical system to help students learn combinatorics using mathematical language

Targeted detection

The context of our research is an interactive system in which the user edits a tree-like structured conceptual representation, in an incremental manner. We defined the targeted detection model in order to search for the instantiation of the variables of a tree-like pattern in a tree-like structure, certain variables satisfying a particular condition which binds them. We distinguish a particular node of the pattern, named target variable, and we restrict the pattern matching; the target variable matches with a particular element of the structure, named target element. The root of the pattern, named context variable, can be matched with an unspecified node. We call context element the node of the structure which matches the context variable.

Exercise E: With a 32-card pack, how many 5-card hands is it possible to form with the queen of hearts, exactly 2 other queens and exactly 1 heart which is not the queen.

The constructive method

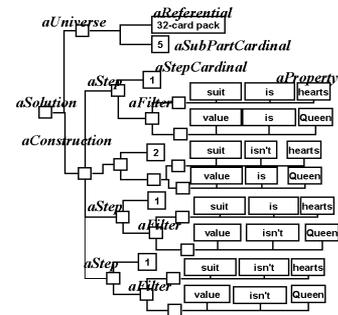
To solve an exercise, the student builds **one element of the set to be enumerated (solution)**, then he/she reasons about this construction in order to calculate the cardinal of the set to be enumerated.

The internal representation of this solution is a tree-like structure. Each node is valued by an object of the conceptual model of the domain and each edge is labelled.

For each exercise, a solution is composed of a *universe* and a *construction* composed of several steps.

Universe: Set of five-card hands
 Construction: Four steps

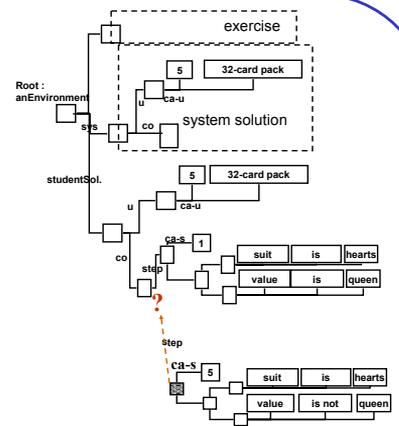
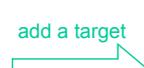
- choice of the queen of hearts
- choice of 2 queens that are not hearts
- choice of 1 card which is a heart and is not a queen
- choice of 1 card which is not a heart and not a queen



A solution of E

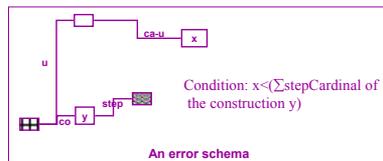
Class of problems → Interface

We classified the combinatorics problem and defined the solution schemata associated with the different classes. For each class, the student builds his/her solution through an interface dealing with this class. The input of the solution is interactive.



Error detection: Knowledge

The problem of the detection of students' errors arises in an incremental manner, at each input of information. We used the targeted detection mechanism for the incremental detection of errors in the building of the tree-like structure. The concept of target (new input element to be analysed) allows us to take into account the interactive aspect. In order to detect and explain the errors, the system needs specific knowledge. This knowledge is grouped in a data structure named **error schema**.



- There is an error when adding the target if:
- the pattern of an error schema matches with a sub-tree-structure in the new tree-structure
 - the condition of the error schema is verified

Process of construction

Error detection: Algorithm

The target ancestors are examined one by one beginning with the target itself. Each of them is a possible context of an error schema. For each context, each error schema is examined and only those whose context anchoring constraint and context type constraint are satisfied are selected. For these, we try to match the target element of the structure with the target variable of the pattern. The schemata for which such matches are possible are kept. For each kept schema, all the instantiations of variables verifying the error condition are sought.

This general principle can be improved by indexing the error schemata in the data base with the pair (context, target) as index key.

