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An intelligent task analysis approach for special education based on MIRA

Bama Srinivasan *, Ranjani Parthasarathi

Department of Information Science and Technology, CEG Campus, Anna University, Chennai, India

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ABSTRACT

This paper describes a novel approach for generating a logical sequence of tasks in the task analysis process of special education. This approach is based on the formalism MIRA (Mīmāṁsā Inspired Representation of Actions), which has the feature of expressing an action as *reason*, *instruction* and *goal*. MIRA also prescribes a set of deduction rules, which helps in the reasoning process of actions. These features are incorporated in this approach and a software tool, namely MIRATaskGen is designed, which facilitates the task analysis process of special education. The software receives various action related inputs along with the *start* and *finish* stages and generates a sequence of tasks from the *start* to the *finish*. This tool also informs the user, whether the desired goal can be achieved. If the desired goal cannot be achieved, then the sequence of actions from the start to a point of discontinuity is detected.

1. Introduction

Individuals with behavioral disabilities have difficulties in learning and performing even mundane tasks such as brushing the teeth or washing hands, which consists of a series of discrete simple tasks such as *picking up the tooth brush*, *wetting it with water*, etc. In order to help the individuals master these kinds of tasks, the procedure of task analysis is used. In this procedure, a task is split into a list of small simple steps and connected in a logical sequence from the *start* to the *goal*.

To generate these tasks, the special educator lists down the subtasks manually. This is a laborious process, since it not only involves an in-depth understanding of the tasks, but also the links of the generated subtasks should be well preserved.

To ease this difficulty, an intelligent task analysis tool to assist special educators is proposed in this paper. This approach is based on the logical formalism proposed for representing and evaluating actions through imperatives, namely MIRA [9].

MIRA has the feature of representing an action as $\langle r, i, p\rangle$ (*reason*, *instruction*, *goal*), which provides the facility for the special educator to include all possible actions. For example, the statement "*Since grandmother is weak* (r)*, take this piece of cake* (i)*, to strengthen her* (p)" can be represented as $(r \rightarrow_r i) \rightarrow_p p$. MIRA provides a set of deduction rules, which helps in the reasoning process. The representation in $\langle r, i, p\rangle$ along with the application of deduction rules, help to identify the achievement of goal.

Once actions along with the *start* and *goal* are represented using this formalism and the deduction rules are applied, the sequence of actions from the *start* to the *goal* can be generated. MIRATaskGen [11] makes use of these features in generating the tasks sequentially from the *start* to the *goal*, even if the input tasks happen to be jumbled. Using this tool, the educator can verify whether the generated tasks lead to the *goal*. If the *goal* cannot be achieved, the tool detects the sequence from the *start* to the discontinuity in the link between the other tasks. Hence, the purpose served by MIRATaskGen is two-fold. These are:

* Corresponding author.
E-mail addresses: bama@annauniv.edu (B. Srinivasan), rp@annauniv.edu (R. Parthasarathi).

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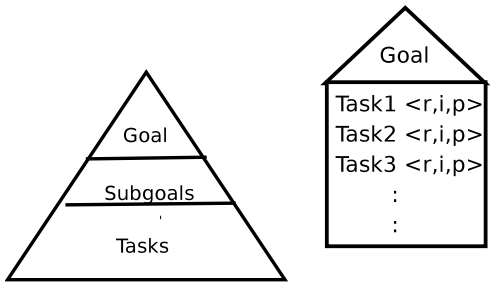

(a) Special Education (b) Using MIRA

Fig. 1. Task analysis.

1. It generates a logical sequence of tasks, which includes the categorization of independent activities and
2. It acts as a verification tool.

This paper is organized as follows: Section 2 gives an account of the task analysis procedure in special education. Section 3 describes a few difficulties in the manual generation of tasks and Section 4 elaborates the working of the tool with the help of an algorithm. Section 5 demonstrates the proposed methodology using a practical example and Section 6 summarizes the work.

2. Task analysis in special education

Task analysis is the process of breaking down complex tasks into subtasks such that these subtasks are easily understandable and manageable. The resulting subtasks, which when carried out in sequence, lead to the desired goal. Task analysis has been used widely in special eduction to master the activities independently [2,5,7].

In the task analysis procedure, the educator manually writes down the subtasks using the process shown in Fig. 1(a). The educator first divides the overall goal into subgoals. These subgoals are again divided into elementary tasks, which are essential for achieving the goal. For example, in the task analysis of preparing the sandwich, the overall goal is to prepare the sandwich with butter and jam. This goal is divided into subgoals like the completion of the task of spreading butter on bread and completion of the task of spreading the jam on bread through the tasks, taking the knife, opening the jam bottle, etc. The educator then uses an appropriate chaining method to link one task to another. Three methods of chaining are provided in the literature of task analysis. These are forward chaining, backward chaining and total chaining which are described below [8,1].

1. In the forward chaining approach, the tasks are designed to be trained from the start to the end. The educator guides the participant to perform the first task, master it completely with a reinforcement and then move on to the next task. The process is repeated until the participant masters the entire list of tasks in the discrete manner.
2. In the backward chaining approach, the educator guides the participant to master the task from the last step to the first with some reinforcement.
3. In the total chaining approach, the educator trains the participant from the first task. In the subsequent step, the educator trains the participant to perform first task as well as the next task. This process is repeated until the participant masters the entire task sequence.

In all these three approaches, the order of the performance of task is essential. Tom McIntyre lists a few methods in generating the sequence of tasks [6]. These are:

1. Imagination: The educator imagines the required steps and generates those manually.
2. Participation: The educator participates in the performance of the task and records those.
3. Brainstorming sessions: The educator brainstorms with colleagues and experts and generates a sequence of tasks.

While manually generating the tasks, the links between one task to another should be well defined. The difficulties in defining these links manually and hence the need for automating the process are described in the next section.

3. Need for the automatic task generator

Presently, the sequence of tasks is generated manually by the special educator. These might be cumbersome and may lead to errors. A few hiccups in the manual process of generating a sequence of tasks are listed below.