GENERALIZING EXPLANATIONS OF NARRATIVES INTO SCHEMATA

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ABSTRACT

This paper describes a natural language system which improves its performance through learning. The system processes short English narratives and from a single narrative acquires a new schema for a stereotypical set of actions. During the understanding process, the system constructs explanations for characters' actions in terms of the goals they were meant to achieve. If a character achieves a common goal in a novel way, it generalizes the set of actions used to achieve this goal into a new schema. The generalization process is a knowledge-based analysis of the narrative's causal structure which removes unnecessary details while maintaining the validity of the explanation. The resulting generalized set of actions is then stored as a new schema and used by the system to process narratives which were previously beyond its capabilities.

INTRODUCTION

AI systems for understanding natural language narratives have relied heavily on schemata for stereotypical sequences of actions [1-3]. Hand coding all the schemata a natural language processor would need to process a wide range of text would be an arduous if not impossible task. Consequently, we have been working on a natural language processing system called GENESIS (for GENeralizing Explanations of Stories Into Schemata) which acquires new schemata in the normal course of processing narratives. After acquiring new schemata, the system is able to correctly process narratives that were previously beyond its capabilities.

We call the learning process used by GENESIS *explanatory schema acquisition*. It is a form of *explanation-based learning* [4], which can be briefly defined as learning a new problem solving method by analyzing the causal structure of a problem solution. The system is fully implemented and an example sequence demonstrating the system's learning is given later in the paper. A longer description of GENESIS appears as [5].

GENERAL SYSTEM ORGANIZATION

First, English input is processed by a parser into a *conceptual representation*, a case-frame representation which uses some *conceptual dependency primitives* as well as predicates for complex schemata. Currently, we are using an adaptation of Dyer's McDYPAR [3] for this purpose.

The basic task of the *understander* is to construct a causally complete representation called the *model*. A model for a narrative has explicit representations for all the inputs as well as the many inferences that must be made to causally connect them together. Inferring causal relations necessarily employs a large amount of background knowledge which is stored in the *schema library*. The techniques and representations used in this process are similar to those used in past

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work in narrative understanding [1-3].

In order to demonstrate the abilities of the understander, a simple question answering system is used to inspect the model. The reason why an actor performed a certain action are easily retrieved by inspecting the causal links between assertions in the model. A simple natural language generator for translating replies into English is also included as part of the system.

If an actor in a narrative achieves an important goal through a novel combination of actions, the *explanation* for how the goal was achieved is generalized into a new schema. The combination of actions which supports the achieved goal is generalized as far as possible without breaking any of the connecting causal links or violating the well-formedness of individual actions and states. This generalized structure is then stored as a new schema and used to facilitate the processing of future narratives. The details of the generalization process are given in [5].

AN EXAMPLE

Currently, GENESIS has acquired two new schemata. In one example, the system learns a schema for kidnapping for ransom. In the other, it learns a schema for someone burning his own building to collect the insurance. Here we will show the performance of the system on the kidnapping example. Before processing the following narratives, GENESIS has information about bargaining, capturing, and many other concepts; however, it does not have a schema for kidnapping for ransom. First it receives the following "test" narrative:

INPUT: Ted is the husband of Alice. He won $ 100000 in the lottery. Bob imprisoned Alice in his basement. Bob got $75000 and released Alice.

Processing Story... Finished processing. Ready for questions:

? (Who gave Bob the money)
Answer unknown.

? (Why did Bob lock Alice in his basement)
Cannot find sufficient reason for his action.

? (Why did Bob release Alice)
Cannot find sufficient reason for his action.

Since the system does not have a schema for kidnapping, it cannot infer the missing information and construct a causally complete explanation of the narrative. Next, it is given the following narrative:

INPUT: Fred is the father of Mary and is a millionaire. John approached Mary. She was wearing blue jeans. John pointed a gun at her and told her he wanted her to get into his car. He drove her to his hotel and locked her in his room. John called Fred and told him John was holding Mary captive. John told Fred if Fred gave him $ 250000 at Trenos then John would release Mary. Fred gave him the money and John released Mary.

Processing Story... Finished processing. John achieved the thematic goal: John has $250000.
Generalizing... Building new schema: CAPTURE-BARGAIN. Ready for questions:

? (Why did John imprison Mary in his room)
So John and Fred could make a bargain in which John released Mary and Fred gave John 250000 dollars at Trenos restaurant.

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? (Why did Fred make the bargain with John)
Because Fred wanted Mary to be free more than he wanted to have 250000 dollars.

? (Why did Fred want Mary free)
Because Fred was Mary's father.

Unlike the first narrative, this one is detailed enough to allow GENESIS to causally connect the individual actions. The resulting causal structure is then generalized into a new schema for kidnapping for ransom. Next, the system is given the first narrative again, and using the schema it has just acquired, it is able to infer the missing information and causally connect the actions. Consequently, it is able to answer the questions which previously it could not answer.

INPUT: Ted is the husband of Alice. He won $ 100000 in the lottery. Bob imprisoned Alice in his basement. Bob got $75000 and released Alice.

Processing Story... Finished processing. Ready for questions:

? (Who gave Bob the money)
Ted gave Bob 75000 dollars.

? (Why did Bob lock Alice in his basement)
So Bob and Ted could make a bargain in which Bob released Alice and Ted gave Bob 75000 dollars.

? (Why did Bob release Alice)
Because Bob and Ted made a bargain in which Bob released Alice and Ted gave Bob 75000 dollars.

RELATION TO OTHER WORK

GENESIS uses background knowledge to generalize the causal structure or *explanation* of a single example. This approach differs dramatically from most approaches to learning in which generalization is accomplished by extracting features which are shared by a number of examples.

GENESIS' generalization process is most similar to the method used by STRIPS to generalize planning sequences into new MACROPs [6]. However, unlike STRIPS, GENESIS generalizes actions and states as well as objects and locations, and generalizes the order of independent actions.

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