Artificial Intelligence Applications

3.64 Problem-Solving

See also: 32,446 [Cat. 3.62]; 32,496 [Cat. 5.21].

NOVAK, GORDON S., JR. 32,448
Computer understanding of physics problems stated in natural language.
Am. J. Comput. Linguist., Microfiche 53 (1976).

This paper describes a computer program called ISSAC, which can read, understand, solve, and draw pictures of physics problems stated in English. The program has solved twenty problems, most of which were taken unedited from high school and college physics texts. . . . An example of the class of problems solved is the following: *The foot of the ladder rests against a vertical wall and on a horizontal floor. The top of the ladder is supported from the wall by a horizontal rope 30 ft long. The ladder is 50 ft long, weighs 100 lb with its center of gravity 20 ft from the foot, and a 150 lb man is 10 ft from the top. Determine the tension in the rope.*

Thus begins the summary of this solid piece of work. The author has used ideas from Wood's ATN Parser, Simmon's semantic nets, Minsky's frames and some standard ideas from symbol algebraic computation to create ISSAC. The work differs sharply from previous word problem solvers such as Bobrow's STUDENT and Charniak's CARPS in that the English text is parsed and considerable semantic knowledge of the universe of physics statics problems is used to determine the correct parse and meaning in this context.

Once the internal model of the paragraph has been constructed, ISSAC uses frame ideas to construct the equations necessary to solve the problem. The frame paradigm works well here to semantically disambiguate and classify objects in the problem statement into the objects of the equation setup space. For example, "A person . . . might be modelled as a weight when sitting on a pole, or as a pivot when carrying it."

Once a frame has been selected, the program is capable of making and displaying a geometric model of the problem. Indeed, with the information in the frame, this appears easy. Finally, problem-solving programs write the necessary equations from the frame and a small symbolic manipulation package produces the answer.

There are a few questions of methodology. While the twenty problems were selected "before the major version of the program was written," ISSAC is not capable of solving new problems unaided. Five additional questions were independently selected by a colleague after the program was completed. The author states: "In order to solve all five of these problems, it would be necessary to extend the capabilities of the program in the areas of vocabulary, grammar, world knowledge, and algebraic manipulation. We do not feel that these modifications would be too difficult, and we believe that they could be made within the existing framework of the program." Despite the usual 'quota' of work for a PhD, it would have been better to make the necessary additions and report on the result. Further, I believe a superior methodology would have been to have the first twenty problems independently selected and perhaps presented to the author in blocks of five at various stages of the program development. Nonetheless, the methodology used here is a definite improvement over that used only five years ago, in which only successes were reported, and on far fewer than twenty samples.

In conclusion, I am impressed by this work. There is a distinct feeling that progress has been made in computational linguistics and artificial intelligence when such a nicely integrated program, well reported, can be accomplished in the usual time available for doctoral research.

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