The Integration of Goals and Actions in Text Understanding

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An important part of story understanding is the reader's ability to relate the actions of the characters to their goals. Often the reader is required to keep track of several of a character's goals at the same time. In this paper we investigate some of the processes involved in such tasks. We propose a model which assumes that the relationship between a goal and the various means of fulfilling that goal (e.g. through plans and actions) is represented as an associative network in memory. For our purposes, a goal such as seeking a girlfriend will be represented as a single node in the network (see Figure 1). This node will have links to associated general plan nodes (e.g. CONSULT PROFESSIONAL) and these in turn, to more specific action nodes (e.g. use dating service).

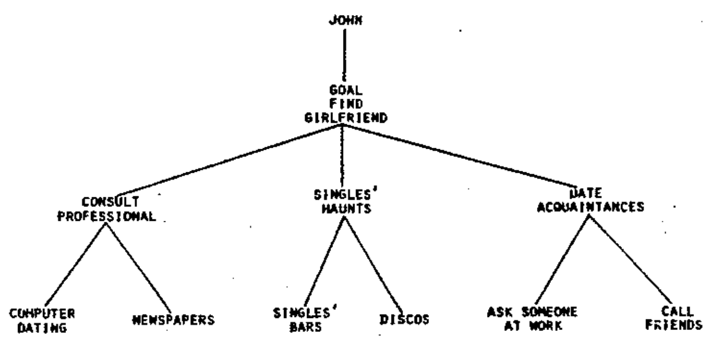

FIG. 1 PARTIAL NETWORK REPRESENTATION FOR A SINGLE GOAL

In these terms, we suppose that a reader comprehends an action by connecting it to an active goal for the actor. In the model, activation spreads out from the goal node to associated general plan nodes and thence throughout the network. At the same time, activation spreads out from the concepts in the stated action. If the goal and the action are related, their paths of activation will eventually intersect. When this occurs, a check is made to see if the stated action is an instantiation of one of the action nodes associated to the goals. This hypothesis predicts that the more goals currently active in memory, the longer it will take an action to be integrated with some one of them (except in special cases to be discussed later). This prediction follows from two assumptions. First, activation will be divided approximately equally among the K active goals for a given character; thus a character node with activation A will send activation A/K down each goal link. Second, we assume that the time required to check whether a stated action instantiates a candidate action node is shorter the greater the activation on that node.

This "goal-fan" effect was reported in a preliminary study by Bower (1982). He found that the more independent goals readers had to keep in mind, the longer it took them to decide whether an action fulfilled one of those goals. We used a similar experimental method which is described briefly below.

Subjects read a large number of brief vignettes in each of which a series of goals were ascribed to an actor. The goals were presented on a CRT screen, always in the form "<Character-name> wanted: X" (e.g. John wanted: to eat a hamburger.). Each goal was studied for three seconds and, after a one second pause, was replaced by another goal. During the pause the frame "Character-name wanted:" remained on the screen. At the end of each discrete trial (4 goal maximum) a prompt of the form "And so <character-name>" appeared for one second and was then followed by an action statement (e.g. And so John went to MacDonalds). During each vignette the same character preceded each goal. The subject's task was to press a 'yes' button if the action fulfilled some one of the goals which had just been presented and a 'no' button if it did not. This time to respond was the dependent measure in the studies.

We varied the number of goals that subjects had to monitor and the relationship between these goals. In Experiment 1, subjects were presented with either one or three goals on each trial. In the three goal conditions the goals were either independent of one another or they each could be satisfied by the same action. We call the latter condition Goal-Overlap (c.f. Wilensky, 1983). For example, the goals of wanting to live an outdoor life, to work in a forest, and to develop his physical strength can all be fulfilled by the action of becoming a lumberjack. As before, we expect the Three-Independent-Goals condition to take a longer time to verify due to greater dispersion of activation. In the Goal-Overlap condition the total activation divides equally among the three goals. However, as shown in Figure 2, the activation from the three goals re-converges on the overlapping action node. This node will then have approximately the same amount of activation as it would in the presence of a single goal. From this reasoning we expect no response time difference between the One-Goal and the Goal-Overlap conditions but both conditions should produce faster responses than the Three-Independent-Goal condition.

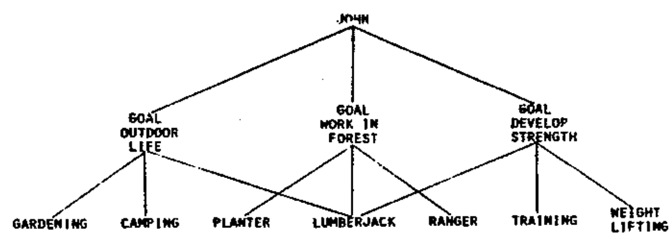

FIG. 2 PARTIAL NETWORK REPRESENTATION FOR THREE OVERLAPPING GOALS

The results accorded with these predictions. For both the 'yes' and 'no' responses verification times were as fast for an action satisfying three overlapping goals as for an action satisfying a single goal. Both were significantly faster than the time to verify an action satisfying a one of three independent goals. Effects were significant beyond the .001 level by MinF.

In a second experiment subjects were presented with either two or four goals. The goals were either independent or they conflicted with each other in pairs e.g. "John wanted hamburgers for dinner this evening. John wanted to eat chinese food this evening." So the four conditions studied were: 1 or 2 pairs of conflicting goals and 1 or 2 pairs of independent goals. In the network model the activation pattern for a goal conflict pair differs somewhat from that for independent goals. Figure 3 shows a pair of conflicting goals that share many thematically related concepts and high level plans (e.g. EAT FOOD). In Figure 3 we can see that activation initially gets divided between a pair of conflicting goals and then re-converges on the thematically related plan nodes. If the activation level on a goal node is a_g, then the activation on each of the plan nodes underneath it will be $a_p = (a_g/k_g).K$, where k_g = the total number of plan nodes, and K = the number of conflicting goals. Thus these plan nodes will receive approximately twice as much activation as equivalent nodes in the case of two independent goals. However, the specific instantiations of these plans are mutually exclusive and so activation will divide again at these nodes. In this way activation on the action nodes may be at an equivalent level in the case of conflicting and independent goals.

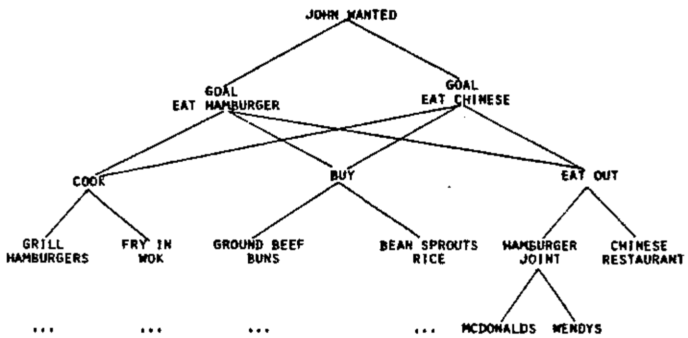

FIG. 3 PARTIAL NETWORK REPRESENTATION FOR TWO CONFLICTING GOALS

As in Experiment 1, we hypothesize that the time a person waits before rejecting a foil in the Goal-Conflict conditions should be governed by the activation levels at the thematically related nodes. Put simply, if an action doesn't fit the theme of a conflict, then it must be an unrelated foil. On this basis, foils should be rejected sooner when they are preceded by conflicting goals than by independent goals. Following similar reasoning, the intersection of activation for 'yes' decisions should be faster when the action probe is preceded by conflicting goals. However, given that actions associated with conflicting goals are mutually exclusive, we have good reason to believe that the evaluation of the intersection may be slowed.

The results came out as predicted. Subjects were faster to reject foils which were preceded by conflicting goals rather than independent goals. Decisions were always slower with 4 goals than with 2 goals, replicating earlier results. Goal type and goal number did not interact significantly. For 'yes' responses 4 goals caused slower times than 2 goals; conflicting goal pairs were slightly but not significantly faster than independent goal pairs. Although these results fit our predictions, further experimentation is needed to bolster our claims.

In summary, we proposed a spreading activation network model of how people relate actions to goals. The results from our Overlapping and Conflicting goal experiments provide some initial support for the model. We are currently pursuing follow-up experiments which use thematically related foils. Such foils should prevent subjects from simply using the activation level at the overlapping nodes to reject the foils. Thus we would expect conflict goal pairs to take as long to reject as independent goal pairs.

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References

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