UNDERSTANDING ANALOGIES IN EDITORIALS

*Stephanie E. August **
Michael G. Dyer

Artificial Intelligence Laboratory
Computer Science Department, 3531 BH
University of California
LOR Angeles, California 90024
net address: AUGUSTOUCLA-LOCUS.ARPA

ABSTRACT

The widespread use of analogy in human communication underscores the need for a system which can recognize and understand analogies. This paper presents a theory of analogy recognition and comprehension, using as a domain letters to the editor of a weekly news magazine. Some of the issues facing a system which understands analogies in this domain are identified, initial work on this program is reviewed, and work in progress is discussed.

I Introduction

People often rely on analogy as a vehicle for conveying ideas. Researchers in linguistics, education, psychology and other academic disciplines have studied this use of analogy and metaphor in depth (LakofT and .Johnson, 1980) (Ortony, 1979) (Sternberg, 1977). Recent investigations by AI researchers into computational models of analogical reasoning include (Oarbonell, 1983), in which Carbonell outlines extensions to means-ends analysis which make use of past experience in solving new problems, thus integrating skill refinement and plan acquisition processes. There are few computational theories on the use of analogy in editorials, conversations, debates, narratives or other natural language text. Two examples of work in this area are Winston's work on learning by analogy (Winston, 1982) and Lebowitz[1] IPP (Lebowitz, 1980).

In Winston's system, a teacher supplied a precedent setting story to the system and then gave the system as an exercise a second story and a conclusion which was known to be true about the precedent. The system was able to reason why the conclusion was true for the precedent, and show how it was also true for the second story. While Winston's system was able to perform some analogical reasoning on the narratives, it did not recognize the narratives as being analogous without the assistance of the teacher.

IPP compared new wire service stories to similar events previously stored in memory. Lebowitz used in frame-like structures (Minsky, 1975) to index events in memory according to their similarities and differences. IPP was successful in finding events similar to the new one and was able to form generalizations allowing it to learn about its domain. However, IPP did not form specific analogical mappings and did not deal with disputes, arguments, or beliefs.

JULIP is a computer program which is part of the OpEd project (Alvarado, Dyer, and Flowers, 1985). The goal of OpEd is to develop a theory about the process of reasoning comprehension in the domain of editorials. The focus of JULIP is on the use of analogies in editorials. In contrast to the work by Winston and Lebowitz, the objective of JULIP is to implement a theory of analogy recognition, representation, and access for question answering. A completed JULIP system will accept as input a letter to the editor in English containing an analogy. Our challenge will be to recognize the presence of the analogy in the letter to the editor, map analogous elements together, and perform any transformations needed to complete the analogy. Our system will demonstrate that it understands the analogy via an English language question answer session with the user.

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* Also affiliated with the Software Engineering Division, Electro-Optical and Data Systems Group, Hughes Aircraft Company, El Segundo, CA 90245.

II The Issues Facing JULIP

Consider the following hypothetical letter to an editor:

HIGH-TECH-1

Some people are against computers because computers eliminate peoples jobs However, the automobile industry did the same thing to people in the horse carriage industry. Yet consumer demand for autos was strong enough that eventually more jobs were created in the auto industry than were lost in the horse carriage industry. In the end, the economy benefitted by the introduction of the new technology.

Informal protocols show that readers give the following answers when questioned on their understanding of this text:

QI: To what is the computer industry being compared?

AI: THE COMPUTER INDUSTRY IS BEING COMPARED TO THE AUTOMOBILE INDUSTRY.

Q2 What did the auto industry do to people in the horse carriage industry?

A2: PEOPLE IN THE HORSE CARRIAGE INDUSTRY LOST JOBS.

A3: Why is the computer industry being compared to the auto industry?

Q3: BOTH INDUSTRIES INITIALLY ELIMINATED JOBS BUT ULTIMATELY CREATED MORE JOBS THAN THEY ELIMINATED.

Q4: What will happen as computers eliminate jobs?

A4. AN EVEN GREATER NUMBER OF NEW JOBS WILL BE CREATED.

Both the textual clues and an understanding of the mechanics of editorials and arguments are used in recognizing and following an analogy. Since JULIP's domain is letters to the editor, work on JULIP also encompasses a theory of editorial comprehension and draws upon previous work on argument structures and rules (Flowers, McGuire, and Birnbaum, 1982).

How can all these elements - analogical reasoning, editorial comprehension, and argumentation — be combined with natural language understanding? Our approach is to base the natural language comprehension component on BORIS (Dyer83), an integrated natural language understanding system for narratives. The work by Flowers et al. on representation of beliefs and the structure of arguments is a key part of our representation of an editorial letter (Flowers, McGuire, and Birnbaum, 1982). Memory organization and causal rea-

soning components are based upon Schank's work (Schank, 1982) (Schank, 1977). Our implementation of JUMP'S question answer processing draws upon Lehnert's work in this area (Lchnert, J 978).

III How Do You Know the Analogy Is There?

Understanding an editorial requires that the reader identify the dispute being presented, and the technique being used to support or refute the author's arguments. Analogy is one of these techniques. There are two main indicators of the presence of an analogy: 1) textual clues, and 2) conceptual similarities. JUMP relies upon both of these indicators to identify the presence of an analogy.

A. Textual Clues

Use of textual clues provides the most direct technique for introducing an analogy into an editorial letter, lu this case, the author uses a phrase such as "the same thing" or "similar to" or "so it is" to link the source to the target. This technique is used in the following letter:

REVOLUTION

The Soviets are doing the same thing in Lebanon that they did in Viet Nam. By supplying the Syrians and the Druze with weapons, the USSR is fostering internal feuds and abetting the downfall of Lebanon. (Christison, 1983)

In REVOLUTION, the reader is explicitly called upon to map the Soviets' role in Viet Nam in the past to the Soviets' role in Lebanon today. It is assumed that the reader has prior knowledge of what the Soviets did in Viet Nam.

B. Conceptual Similarities

People can readily detect the presence of an analogy even in the absence of textual clues, as seen in the following example:

DESTRUCTION

The Soviets are bombing people in Afganistan. But the U.S. killed people in Vietnam. What does labelling the Soviet's actions as despicable say about our own action?

A reader identifies both events as instances of destruction. This indicates that the concepts representing the text are categorized in memory by type. To provide this capability in a computer program, conceptual representations must be categorized as they are built, and linked together in the order in which they are encountered. The contents of these groups must be checked as new elements are added to them. When similar conceptual representations are encountered, similarity measures and other heuristics must be employed to determine whether an analogy is intended.

IV Constructing a Representation of the Analogy in an Editorial Letter

HIGH-TECH-1 serves as a typical editorial letter containing an analogy. Here we present the analysis that JULIP is being designed to perform in building the representation of HIGH-TECH-1 in memory.

The author of HIGH-TECH-1 first brings up the issue (ARG-1) of introduction of computers into manufacturing, where robots are being used on the assembly lines. The author makes the point that this automation is causing people who would normally work on the assembly lines to lose their jobs. This is understood as a belief that computer aided manufacturing (CAM) is bad. This belief is justified by the fact that computers cause people to suffer job loss, and that losing a job is something bad.

Since this is a letter to an editor, JULIP must expect the author of the article to either defend or attack the original point. JULIP sees the author's argument begin to unfold in the second sentence, when the conjunction "however" provides a lexical clue that a dispute regarding the argument is about to be introduced.

lu sentence 2, JULIP is introduced to a new topic, the automobile industry and its relationship to the horse carriage industry. Encountering the phrase "did the same thing" must cause JULIP to search memory for the most recent causal structure (CAM leads to job loss) and try to make a mapping to it. JULIP must map the auto industry to CAM and infer that the auto industry caused people in the horse carriage industry to lose jobs. Comparison links between the first causal structure and the second, and between the antecedents of both and the consequents of both will be added to these structures to reflect the mapping. By analogy to ARG-1, JULIP must form the second argument, ARG-2, reflecting the belief that manufacturing of automobiles was bad.

JULIP must interpret the concepts represented by sentence 3 as a contradiction to ARG-2. Flowers et al. note that an argument can be contradicted by an attack on the belief espoused, by attack on the justification given for that belief, or by attack on the claim that the justification supports the belief. Lack of a value judgement on manufacturing of autos, and lack of a contradiction to the claim that job loss is bad rule out the first and second attack strategies. JULIP's knowledge of the consumer demand/manufacturer supply cycle and its relationship to an increased job market must guide it to the realization that manufacturing automobiles actually led to the creation of additional new jobs. This contradiction of the justification given for ARG-2 must cause JULIP to recognize that ARG-2 is invalid. The comparison links indicate that ARG-2 is parallel to ARG-1, so justification for ARG-1 as well as ARG-1 itself must now be viewed as suspect.

After reading sentence 4, JULIP must to build ARG-2' as an alternate to ARG-2, reflecting the belief that manufacturing of automobiles is good, justified by the fact that the economy ended up actually improving as a result of the introduction of automobiles to the marketplace. By analogy, a representation for an alternate argument to ARG-1 must now be built, reflecting the belief that computer aided manufacturing is actually good, since it too will lead to new jobs and an improved economy. Thus the conceptual representation for this analogy has been completed in memory.

Figure 1 depicts the basic elements of the completed representation of HIGH-TECH-1.

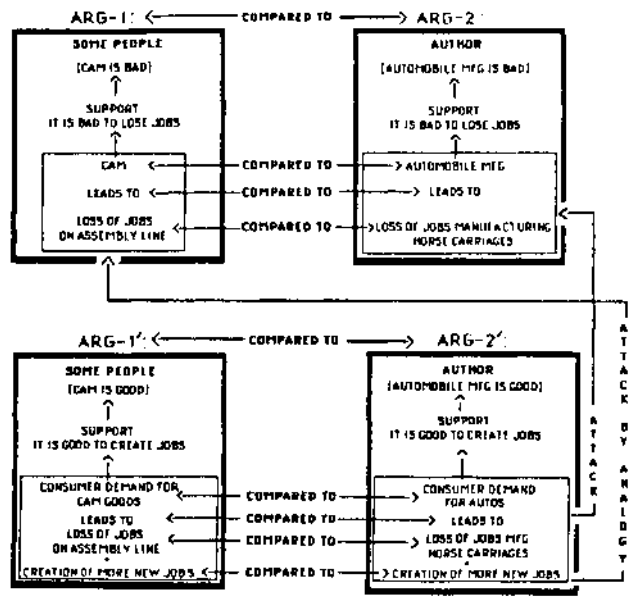

Figure 1. Argument Graph for HIGH-TECH-1.

V Answering Questions About the Analogy

JULIP is being designed to answer questions related to the mapping of source and target in the analogy, the transforms required to complete the analogy, and the basis of the analogy. Techniques for answering these types of questions draws upon LehncrUs theory of question answering (Lehnert, 1978), which is being augmented to handle questions peculiar to accessing the conceptual representation of an analogy. For example, questions regarding analogical mapping such as Q1 above, are basically concept completion questions that require traversing a new type of link; in this case, the comparison link.

VI Work in Progress

Work on JUMP up to this point has concentrated on developing a conceptual representation of the text of HIGH-TEOH-1. We examined the text of this letter in detail in an effort to identify the lexical items, demons, and domain knowledge that must be available to the parser in order to develop a plausible conceptual representation of HIGH-TECH-1 in memory. This approach enabled us to test the robustness of the representation, without being distracted by parser and coding implementing details.

.11 'LIP currently works with a hand coded conceptual representation of the HIGH-TECH-1 analogy built in memory using ARF (Edwards, 1984), a knowledge representation tool which supports both static and dynamic property inheritance. JULIP accepts queries in conceptual representation form. It searches the completed graph in memory and returns a conceptual representation of its findings to the user. The question answer session is implemented via ARF queries on the representation.

VII Future Work

We are now developing the parsing and generation components of JULIP to enable it to handle verbatim input.

The next step for JULIP is to translate our theory into the demons and lexical entries needed to support analogy recognition and comprehension in DYPAR, the parsing component of BORIS (Dyer, 1983). Our theory will continue to develop as we collect additional examples of letters to the editor containing analogies and human protocols for understanding them. JULIP's current objective is to demonstrate understanding of editorial analogies given to the program in English through a natural language question answer session with the user. Future objectives of the project will address the issues of incorporation of conclusions drawn from the analogies into long term memory, and generation of analogies.

VIII Conclusions

JULIP draws upon knowledge of editorial comprehension, argumentation, and integrated natural language understanding systems to develop a theory of analogy comprehension in the domain of letters to the editor. We have shown how both lexical cues and comparison of conceptual similarities trigger recognition of analogies in editorials letters. Our conceptual representation of an analogy in memory utilizes comparison links to map analogous elements to each other and to tie together parallel arguments. These links must be created and traversed during understanding as the representation of the completed analogy is built in memory. Question answer processing utilizes these links to demonstrate the system's understanding of the completed analogy.

REFERENCES

Alvarado, S.J., Dyer, M.G., Flowers, M. "Understanding Editorials: The Process of Reasoning Comprehension," Technical Report UCLA-AI-85-3, University of California, Los Angeles, 1985.

Carbonell, J.G. "Learning by Analogy: Formulating and Generalizing Plans from Past Experience", in *Machine Learning,* R.S. Michalski, J.G. Carbonell, and T.M. Mitchell, eds., Tioga, Palo Alto CA, 1983.

Dyer, Michael G. *In-Dcpth Understanding: A Computer Model of Integrated Processing for Narrative Comprehension.* MIT Press, Cambridge MA, 1983.

Edwards, Gary R. *A Rule and Frame System,* Version *2.2.* Hughes Artificial Intelligence Center, Calabasas CA, 1984.

Flowers, M., McGuire, R., and Birnbaum, L. "Adversary Arguments and the Logic of Personal Attacks", in *Strategies for Natural Language Processing,* Wendy G. lyehnert and Martin H. Ringlc, eds., Lawrence Erlbaum Associates, Hillsdale NJ, 1982.

Lakoff, G. and Johnson, M. *Metaphors We Live By.* Chicago University Press, 1980.

Lebowitz, Michael. "Generalization and Memory in an Integrated Understanding System", Research Report #18fl, Yale University Computer Science Department of Computer Science, November 1980.

Lehnert, W.G. *The Process of Question Answering.* Lawrence Erlbaum Associates, Hillsdale NJ, 1978.

Minsky, M. "A Framework for Representing Knowledge", in *The Psychology of (ompuler Vision,* P. Winston, ed., McGraw-Hill, NY, 1975.

Ortouy, A. (Ed.) *Metaphor and Thought.* Cambridge University Press, Cambridge, 1979.

Schank, R., and Abelson, R. *Scripts Plans Goals and Understanding.* Lawrence Erlbaum Associates, Hillsdale NJ, 1977.

Schank, R.O. *Dynamic Memory.* Cambridge University Press, Cambridge, 1982.

Sternberg, R.J. *Intelligence, Information Processing and Analogical Reasoning: the Componential Analysis of Human Abilities.* Lawrence Erlbaum Associates, Hillsdale NJ, 1977.

Christison, Robert. From "Letters", in TIME, 24 October 1983.

Winston, PH. "Learning new principles from precedents and examples", *Arttjictal Intelligence,* 19:3, November 1982, p.321.