

PROJECT ADMINISTRATION DATA SHEET

ORIGINAL REVISION NO. _____

Project No. G-36-660

DATE 10/5/81

Project Director: Dr. Janet L. Kolodner School/Lab I & C S

Sponsor: National Science Foundation; Washington, D. C.

Type Agreement: Grant No. IST-8116892

Award Period: From 9/15/81 To 2/29/84* (Performance) 2/29/84 (Reports)

Sponsor Amount: \$132,664 6/30/84 9/30/84 Contracted through:

Cost Sharing: \$7,033 (G-36-346) GTRI/GPT

Title: A Computer Memory for Current Events

ADMINISTRATIVE DATA

OCA Contact Leamon R. Scott

1) Sponsor Technical Contact:

Henry Hamburger
Associate Program Director
Information Research Unit
Division of Information Sciences
Directorate for Biological, Behavioral &
& Social Science

2) Sponsor Admin/Contractual Matters:

Leroy McDougal
Grants Official
Division of Grants & Contracts
Directorate for Administration
NSF
Washington, D.C. 20550
202/357-9653

NSF
Washington, D.C. 20550
Defense Priority Rating: N/A

Security Classification: N/A

RESTRICTIONS

See Attached NSF Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval - Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of \$500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT

COMMENTS:

* Includes a 6 month unfunded flexibility period.



COPIES TO:

Administrative Coordinator
Research Property Management
Accounting
Procurement/EES Supply Services

Research Security Services
Reports Coordinator (OCA) ✓
Legal Services (OCA)
Library

EES Public Relations (2)
Computer Input
Project File
Other _____

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

SPIN

Date October 2, 1985

Project No. G-36-660

School/~~ICS~~ ICS

Includes Subproject No.(s) N/A

Project Director(s) Dr. Janet L. Kolodner

GTRC /~~GTRC~~

Sponsor National Science Foundation; Washington, DC

Title A Computer Memory for Current Events

Effective Completion Date: 6/30/84 (Performance) 9/30/84 (Reports)

Grant/Contract Closeout Actions Remaining:

- None
- Final Invoice or Final Fiscal Report
- Closing Documents
- Final Report of Inventions - For our records.
- Govt. Property Inventory & Related Certificate
- Classified Material Certificate
- Other _____

Continues Project No. _____ Continued by Project No. _____

COPIES TO:

Project Director
 Research Administrative Network
 Research Property Management
 Accounting
 Procurement/GTRI Supply Services
 Research Security Services
 Reports Coordinator (OCA)
 Legal Services

Library
 GTRC
 Research Communications (2)
 Project File
 Other Heyser

Jones

October 25, 1982

Dr. Michael J. McGill
Information Science Program
National Science Foundation
1800 G Street, NW, Room 336
Washington, CD 20550

Re: IST-8116892 year-end report
year ending Sept. 15, 1982

Dear Dr. McGill,

I have been told that you are the new head of the Information Science Program, and therefore the person with whom I should be corresponding about my grant, entitled "A Computer Memory for Current Events". This letter will serve as my year end progress report. Also enclosed with this letter are two copies of each of the currently available publications supported by that grant in the past year. I will be sending other publications as they become available.

Research accomplishments of the past year:

The past year has been a productive one for work on this grant. In looking into problems associated with long term memory for events, we have chosen to take some of the reviewers comments to heart and concentrate on those rather than the exact problems outlined in the proposal. In particular, one reviewer commented that we did not know enough about how extendible the already-developed memory organization and strategies were across domains. I have extended that comment one step farther to ask in addition how extendible they are across tasks, and am looking at organizations and strategies for long term memory in the task domain of psychiatric diagnosis. In working on this problem, we have defined some of the structures necessary for the task of diagnosis and for remembering diagnostic experiences and previous cases. We are looking at the organizational strategies and generalization triggers previously defined to see how they fit into this domain, and whether they cover the possibilities adequately. We have also built a program, called SHRINK, which right now models the diagnostic process and can diagnose normal cases of some Major Affective Disorders. For the most part, CYRUS' processes seem to hold, but we have found the following refinements and augmentations to the CYRUS model necessary:

1. In CYRUS, conceptual categories were defined exclusively by the set of features describing most of the members of the category. While we still find it necessary to define conceptual categories using those sets of features, we have found that a set of defining features alone is not enough to decide whether a particular new item fits into the category. In particular, there are additional factors which must be taken into account. First, some features are necessary to the definition of a category, while others are merely suggestive. Checking necessary features first gives a fast way of deciding whether the new item fits the category. Second, there may be sets of features which, if present, imply that the new item does not belong in the category at all. We call those "exclusion criteria". In addition, exclusion criteria can point to relevant categories a new item may fit into.
2. In CYRUS, events were organized in memory in generic event categories (E-MOPs) only. This was fine for organizing events with respect to each other when the only category refinement that had to be done was to specialize event categories that were already there. In the domain of medical diagnosis, however, there are two types of knowledge which must be refined, both through acquisition of experience -- domain knowledge and processing knowledge. In order to refine both, episodes must be organized around structures relevant to both types of knowledge. In general, to incrementally refine memory's concepts based on experience, events must be organized around each entity type which will potentially need refinement. In the domain of psychiatric diagnosis, a reasoning domain, events must be organized according to the reasoning rules used and also by similarities within the domain. In this way, both domain knowledge and reasoning processes can be refined.
3. In CYRUS, generalizations were triggered by "reminding", or noticing the similarities between two items. While this method of generalization triggering works to specialize categories that are already there, it is not sufficient for refining reasoning knowledge to deal with exceptions. An additional trigger for generalization is failure. Failure-driven learning is a process for learning based on noticing and explaining processing failures. Explanation involves finding out why the mistake was made and what could have been done to prevent it. As failures are noticed and explained, notes (or indices) are inserted into the model of the process. As additional exceptional experiences are encountered, the process is changed to account for these deviations, in this way allowing a "novice" reasoning model to become more "expert". Note that an explicit representation of the process being considered is necessary to do this type of reasoning.

Some of the enclosed publications explain these findings in more detail. Dr. Robert M. Kolodner of the Atlanta VA Hospital has been the

psychiatric informant for this project. Keith McGregor, who was an undergraduate during the 1981-82 academic year, implemented the SHRINK program as part of his senior design project. This project was presented this past summer at the annual Artificial Intelligence Conference and generated a great deal of interest. It will also be presented at the annual Computers in Medicine Conference in Washington in November.

A second approach I am taking to the issue of how applicable the already-existing strategies and organizations are is to look at how well they actually model the human algorithm. I have been doing this work with Larry Barsalou of Emory University's Department of Psychology. We have outlined some of the psychological issues related to the CYRUS model and we are designing experiments to look into some of those issues. He and his students are doing the initial designs of the experiments. He and I have been working closely to determine exactly which issues are the important ones to be looking at, and I have spent time with him and his students in refining the initial experimental designs. The particular issues we are looking at are the plausibility of E-MOPs as event organizers, and the use of different levels of generalized information in constraining event reconstruction. We hope to update the CYRUS model as a result of these experiments. We presented our initial ideas at the Fourth Annual Cognitive Science Conference, and they were well-received. As a result of that presentation, we have been invited to publish an updated version of that paper in the AISB Quarterly, the newsletter of the European Society for the Study of Artificial Intelligence and Simulation of Behavior.

Presentations and publications:

In the past year, a number of presentations have been made and papers published concerning this work.

Publications:

The Role of Experience in Development of Expertise. In Proceedings of the Second National Conference on Artificial Intelligence, Pittsburg, PA, August, 1982.

Psychological Issues Raised by an AI Model of Reconstructive Memory (with Larry Barsalou). In Proceedings of the Fourth Annual Conference on Cognitive Science, August, 1982.

Towards an Understanding of the Role of Experience in the Evolution from Novice to Expert. Research Report GIT-ICS-82/03. School of Information and Computer Science, Georgia Institute of Technology, 1982.

On Beyond CYRUS: Problems Associated with Long Term Memory Organization and Retrieval. Research Report GIT-ICS-81/17. School of Information and Computer Science. Georgia Institute of Technology. November, 1981.

Knowledge-Based Self-Organizing Memory. In Proceedings of the 1981 International Conference on Cybernetics and Society, Atlanta, Georgia, October, 1981.

Conceptual Information Retrieval (with R. Schank and G. DeJong). In Oddy, Robertson, van Rijsbergen, Williams (eds.), Information Retrieval Research. Butterworths, London. 1981.

Publications (accepted, but not yet published):

Maintaining Organization in a Long Term Dynamic Memory. Cognitive Science.

Towards A Computer Model of Psychiatric Reasoning (with Robert Kolodner). In Proceedings of the Sixth Annual Conference on Computers in Medicine, Washington, DC, Nov., 1982.

Knowledge-Based Self-Organizing Memory for Events. In Proceedings of the NATO Symposium on Human and Artificial Intelligence, Lyon, France, October, 1981.

Conference presentations:

The Role of Experience in Developing Expertise, presented at the National Conference on Artificial Intelligence, Pittsburgh, Pennsylvania, August, 1982.

Psychological Issues Raised by an AI Model of Reconstructive Memory, presented at the Fourth Annual Conference of the Cognitive Science Society, Ann Arbor, Michigan, August, 1982.

Knowledge-Based Self-Organizing Memory for Events, presented at NATO Symposium on Artificial Intelligence, Lyon, France, October, 1981.

Invited panel member for Women in Science Careers Workshop, Atlanta, Georgia, September, 1981.

Presentations (in the near future):

Invited panel member "Instant Access to Information: The Technology of the 80's" at ACM National Conference, Dallas, Texas, October, 1982.

Towards A Computer Model of Psychiatric Reasoning, to be presented at the Sixth Annual Symposium on Computer Applications in Medical Care, Washington, DC, November, 1982.

In addition, I have signed a contract with Lawrence Erlbaum, Assoc., Publishers for publication of an updated version of my Ph.D. thesis -- Retrieval and Organizational Strategies in Conceptual Memory: A Computer Model. It will be part of the Artificial Intelligence Series edited by Roger Schank and should be out late in 1983.

Plans for year two of the grant:

In the next year, I plan to continue looking at the domain and task of psychiatric diagnosis as a sample domain for looking at problems related to long term memory for events, especially for looking at problems concerned with incremental creation and refinement of generalized information in memory. I also plan to continue collaboration with Larry Barsalou concerning psychological issues raised by the CYRUS model. The VAX that we have been expecting for the past year finally became available this past summer, and I, along with a student, am spending time getting the CYRUS program up and running. Now that I have students and a computer system available, we will be going back to the domain of world events, making use of what we have found out in looking at our alternate domain. When CYRUS is running, we will be augmenting it for looking at the problems proposed in the original proposal. In addition, as we find out more about the psychological soundness of a CYRUS-type memory, we will be exploring refinements and augmentations to the CYRUS model taking psychological results into account. We are expecting further improvement in our research environment in the next year. Georgia Tech has purchased a Symbolics 3600 LISP Machine to be dedicated to AI research. I expect it to greatly improve programming productivity and to make experimentation with CYRUS a truly realizable goal.

Sincerely,

Janet L. Kolodner
Assistant Professor



GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF INFORMATION AND COMPUTER SCIENCE • ATLANTA, GEORGIA 30332 • (404) 894-3152

December 13, 1983

Dr. Ronald Yager
Information Science Program
National Science Foundation
1800 G Street, NW, Room 336
Washington, DC 20550

Re: IST-8116892 year-end report
year ending Sept. 15, 1983

Dear Dr. Yager,

I enjoyed talking to you on the phone two weeks ago. The following will serve as my year end progress report. Also enclosed are two copies each of my most recent publications. Others have already been sent. I will be sending additional publications as they become available.

Due to the fact that our computer access was severely limited during the first year of the grant (our VAX arrived about 9 months later than expected), the grant has been extended 4 months past the usual 6 month extension. I will be sending a final report at that time.

Research accomplishments September, 1982 - September, 1983:

This year has been a productive one for work under this grant. We have continued work on the SHRINK project, begun last year, and have also done quite a bit of work on a second project. Last year we reported taking reviewers comments seriously, and instead of concentrating on problems directly addressed in the proposal, we looked into the extendibility of our already-developed methods and strategies to new domains and tasks. We have continued to do so this past year in both of our programming projects. The enclosed publications and those we have forwarded during the year explain our work in detail. The following summarizes our findings.

The first point we should make concerns the direction we have been going in. While our proposal stressed organization of knowledge and experience in memory to facilitate retrieval and understanding, we have been investigating the relationship of memory organization to problem solving. Organization in memory cannot be decoupled from understanding.

- 1 -

Both result in knowing how a new concept, experience, or problem fits into memory's knowledge structures. Both are part of the same process. In fact, this understanding process, which results in a better-organized memory and in integration of a new fact into memory, provides knowledge for problem solving.

One test of the "correctness" of an organization of knowledge is to see if and how it fits naturally into the processes it needs to support. Thus, in addition to worrying about organization of experience, we take the next step and also worry about how to use that organization of experience for problem solving. We are currently investigating two domains -- medical diagnosis and negotiation. The natural categories of experiences practitioners of each domain refer to are different. Thus, the particular types of knowledge structures used to organize experiences in the two domains is different. In medical diagnosis, natural categories are descriptive of disorders and include a lot of detail about how to recognize and treat each disorder. In negotiation, the conflicting goals of the two parties are most important, and tactics for resolving disputes are associated with particular kinds of goal conflicts.

While we use different structures in each domain, our principles for indexing experiences in those structures remain the same and carry over from previous research on CYRUS. Saliency and predictive power are the most important features an index should have. Indexing is only by features which differentiate episodes from each other.

Another important observation we have made in looking at these two domains is that although the tasks are different, the processes which depend on experience (explained below) are substantially the same. The task in our medical domain is diagnosis and treatment. In the negotiation domain, the tasks include suggesting a plan to resolve a dispute and predicting the outcome of a negotiation episode.

In working on SHRINK, which organizes diagnostic events in its long term memory to use in evaluation of later cases, we have identified 4 experience-related processes that (a) contribute to generalization and incremental learning based on individual experiences and (b) allow use of previous experience and generalizations drawn from them in understanding and problem solving:

1. similarity-triggered generalization
2. failure-triggered generalization
3. similarity-triggered analogical transfer
4. experience-driven plan evaluation

The first had been studied in detail in my own previous research and that of others. The second has been proposed previously by Schank and others, but had not been applied to a diagnostic domain. In addition, the processes for doing the explanation were not well-defined. The diagnostic domain makes explanation particularly hard, since a failure could arise from failure of treatment or failure of diagnosis. We have some rough rules for distinguishing the two, and are working on better

defining them. An interesting thing that happens once a failure has been explained is that memory must be marked so that such failures won't happen again. One way to do that is to store the explanation and solution with the episode and index the episode by those features which gave rise to the explanation. In that way, a similar episode can cause recall of the first failed episode, triggering analogical transfer of information from the previous experience to the current one.

We have identified four tasks such analogical transfer accomplishes:

- a. prediction of additional features to investigate
- b. suggestion of procedures to be followed
- c. suggestion of procedures to be avoided
- d. suggestion of plausible new classifications for the episode.

One of our current tasks is to define better how these transfers happen. This analogical reasoning process also forms the core of an experiential process for choosing between alternative suggestions or plans for treatment. This process, which we call experience-driven plan evaluation, combines analogical reasoning with diagnostic problem solving by simulating the results of alternative plans and evaluating expected results in light of previous experience. This process is an extension of what Schank refers to as intentional reminding.

One of the most interesting observations we can make from this work concerns the interaction between understanding and problem solving. While originally, our goal was to create a computer memory which could organize previous experience so that generalizations could be drawn from it, and so that the knowledge built up could be accessed efficiently for understanding, we have found that the same organization and the same access methods and retrieval strategies play a large role in problem solving. The first step of problem solving involves understanding the problem, or classifying it. If understanding is defined to include integrating the new problem into memory's knowledge structures, then the end result is the set of places in memory where the new problem fits. These are the same places that store similar previous experiences that can be evaluated to solve the current problem.

In terms of programming, our SHRINK program has been re-implemented and now runs on the LISP machine. Its diagnostic knowledge is better represented, and it is beginning to organize events with respect to each other. We are ready to work on the details of analogical reasoning and explanation of failure. We have proposed a naive process for tracking down failure and assigning blame, and will also be working on that.

Our second project also investigates organization and access of events in memory, and is in the domain of negotiations. Given an economic, political, or physical dispute between two parties, our program analyzes the dispute, classifies it according to the relationships between the goals of the two parties and chooses a tactic for resolving the dispute. Given feedback about the applicability of

its tactic, it can reanalyze, and in the case of failure, come up with a new explanation of the dispute and a new tactic for resolution. While its explanations of failures are still quite naive, its method for indexing disputes in memory allows previous events to be recalled when applicable and their results applied to resolve the new case. A sample run of the program is enclosed. The reasoning of the program is along the same general lines as described for SHRINK. What is different is the memory structures, which organize with respect to goals, plans to achieve them (tactics), and attributes of the participants. One student working on the project will be proposing his Ph.D. thesis topic next week, and his proposal explains that organization. I will be sending you a copy in a few weeks when we have had it printed.

As of September 15, 1983, there were 4 students working on research related to this grant. Dana Eckart was supported from September, 1982 - September, 1983 on this grant, and is currently supported by an ARO distinguished fellowship. He continues to work on SHRINK. Bob Simpson is supported by outside funding. He is working on the negotiator. Katia Sycara was picked up by this grant on September 15, and is also working on the negotiator project. While Bob is working on frameworks for solutions to problems, Katia is working on some of the more sophisticated details of problems involved in reasoning based on experience (e.g., taking goal progressions into account, taking multiple sources of knowledge into account in predicting outcomes). A fourth student was supported by the grant during the summer and this past fall, but is no longer working with us. He did help us get started on the LISP machine.

Our LISP machine was installed in July, 1983, and we have moved much of our programming to it. Getting used to the new machine slowed down programming initially, but the benefits of the sophisticated programming environment and tools are more than making up for that. We had trouble getting CYRUS to run well on the VAX, since the Berkeley UNIX operating system discriminates against large jobs, but we are currently putting it up on the LISP machine and will be augmenting it and running experiments on it this year.

Presentations and publications:

Publications:

Kolodner, J.L., Towards an Understanding of the Role of Expertise on the Evolution from Novice to Expert. International Journal of Man-Machine Studies, November, 1983 (also Georgia Tech research report GIT-ICS-82/03).

Kolodner, J.L., Indexing and Retrieval Strategies for Natural Language Fact Retrieval. ACM Transactions on Database Systems, September, 1983.

Kolodner, J.L. and Barsalou, L., A Joint AI and Psychology Approach to Event Memory. In the Newsletter of the Society for the Study of Artificial Intelligence and Simulation of Behavior, January, 1983, pp. 20-24.

Kolodner, J.L. and Kolodner, R.M., Towards a Computer Model of Psychiatric Reasoning. In Proceedings of the Sixth Annual Conference on Computers in Medicine, Washington, DC, November, 1982.

Kolodner, J.L., Requirements for a Natural Language Fact Retrieval. In Proceedings of ACM '83, Dallas, Texas, October, 1982, pp. 192-198.

Publications (accepted, but not yet printed):

· Kolodner, J.L., Retrieval and Organizational Strategies in Conceptual Memory: A Computer Model. To be published by Lawrence Erlbaum, Associates, Inc., Hillsdale, NJ, February, 1984.

Kolodner, J.L., and Kolodner, R.M., An Algorithm for Diagnosis based on Analysis of Previous Cases. In Proceedings of MEDCOMP, 1983.

Kolodner, J.L., Knowledge-Based Self-Organizing Memory for Events. In A. Elithorn and R. Banerji, (eds.) Human and Artificial Intelligence, North-Holland, Amsterdam, 1983.

Kolodner, J.L., Reconstructive Memory: A Computer Model. Cognitive Science, Vol. 7, No. 4, October, 1983 (also Georgia Tech research report GIT-ICS-83/13).

Kolodner, J.L., Maintaining Organization in a Long Term Dynamic Memory. Cognitive Science, Vol. 7, No. 4, October, 1983 (also Georgia Tech research report GIT-ICS-83/12).

Simpson, R., An Experience-Based Model of Problem-Solving Strategies. thesis proposal, unpublished manuscript,

Georgia Institute of Technology, 1983.

Conference presentations:

"An Algorithm for Diagnosis based on Analysis of Previous Cases", MEDCOMP 83, Burr Oak Lodge, OH, September, 1983.

"Towards a Computer Model of Psychiatric Reasoning", The Sixth Annual Conference on Computers in Medicine, Washington, DC, November, 1982.

"Requirements for Natural Language Fact Retrieval", ACM 83, Dallas, Texas, October, 1982.

Proposals based on this work (all pending):

"Extracting Information from Experience: Experience Driven Incremental Learning", NSF, 6/15/84 - 6/14/87, \$275,000.

Presidential Young Investigator Award, NSF, 7/1/84 - 6/30/89, \$100,000.

"Modelling Experience's Role in Diagnostic Reasoning", NLM, 9/15/84 - 9/14/87, \$220,000.

"The Role of Experience in Common-Sense and Expert Problem Solving", a work unit within the proposal "Research and Education in Artificial Intelligence", ARO, 7/1/84 - 6/30/89, \$607,711 out of \$5,834,611.

In addition, I have done extensive rewriting of my thesis to make it into a book. It is currently in pages and will be published by Lawrence Erlbaum Associates early in 1984.

Plans for the final year of the grant:

We plan to continue work on both SHRINK and the negotiator project in the next year. In particular, we will be working out details of the processes described above. We are also working on getting CYRUS running on the LISP machine. Several first-year students are working on extending CYRUS' knowledge structures and strategies to deal with the day to day events in presidential candidate Jesse Jackson's life. We are taking goals and plans for achieving them into account and augmenting both knowledge structures and strategies accordingly. Another plan for this year is to continue work with Larry Barsalou on the psychological implications of the CYRUS model. He and his students have recently completed a set of experiments and we will be evaluating them and modifying CYRUS as required.

In addition, we are planning a workshop here in Atlanta in the spring. Its title is "The First Annual Workshop on Theoretical Issues in Conceptual Information Processing." The purpose of the workshop is to concentrate on content-based problems of language understanding, problem solving, and learning. Among the issues to be addressed are: What is in memory? What do people know? How do they use it? It will be small and informal, providing an opportunity for in-depth discussion of the topics. The workshop is largely a reaction to the size and diversity of the mainstream AI conferences. Thus, several of us interested in the problems above got together to plan this workshop. Principal participants will include Roger Schank, Robert Wilensky, Chris Riesbeck, Jaime Carbonell, and B. Chandrasekaran. Though the workshop is unsupported, necessary secretarial time will be supported through this grant. A workshop announcement is enclosed.

This grant has been extended to June 15, and I will be sending a final report soon after that.

Sincerely,

Janet L. Kolodner
Assistant Professor

JLK/je

Encl: workshop announcement
negotiator run
2 copies MEDCOMP '83 paper
2 copies Kolodner & Barsalou, '83
2 copis ACM TODS paper

**First Annual Workshop on
Theoretical Issues in Conceptual Information Processing**

26-28 MARCH 1984 ATLANTA, GEORGIA

Program: This workshop will focus on content issues involved in modelling conceptual information processing. Researchers are invited to participate in several ways: (1) direct or contribute to panel discussions dealing with broad research issues such as: machine learning, problem solving and planning, memory organization, natural language processing, research methodology, etc.; (2) present papers which illustrate prototypical problems in the above areas and their solutions; or (3) demonstrate programs that illustrate (partial) solutions to processing problems.

Papers: Send one copy of an extended abstract (1000 words) or short paper (the shorter the better) to each member of the program committee by February 1:

Shoshi Hardt
Computer Science Department
SUNY at Buffalo
U226 Ridge Lea
Amherst, N.Y. 14226

Janet Kolodner
School of Information and Computer Science
Georgia Institute of Technology
Atlanta, GA 30332

Chris Riesbeck
AI Project
Computer Science Department
Yale University
Box 2158 Yale Station
New Haven, CT 06520

Papers submitted for this workshop need not be independent of others prepared for AAAI or the Cognitive Science Conference, but may be the contentful associates to those submissions. Authors will be notified by March 1. A final copy of accepted papers (no more than 10 pages single spaced) will be due by the beginning of the conference on March 26 and will be published in the workshop proceedings, which will be distributed that afternoon (I hope).

Program Demos: We encourage demonstration of working programs, and will arrange time and facilities for that. We have a VAX-11/780 running Franz LISP and T under Berkeley Unix, and a Symbolics 3600 LISP machine. We will also try to get access to an Apollo DOMAIN. Please let Janet know by February 15 if you plan to demo and what facilities you need. Alternatively, you may wish to bring a VHS videotape.

For further information, suggestions, complaints, etc., contact Janet Kolodner (404)894-3285 or (404)894-3152

A Session With The NEGOTIATOR

(negotiator candy-dispute)

Looking for a plan to use for the following dispute:
two children are quarreling over a candy bar.

CHILD1 is assumed to have the goal
#<M-INGEST 6730365> (wants to eat candy1).

CHILD2 is assumed to have the goal
#<M-INGEST 6730427> (wants to eat candy1).

Instantiating plans normally useful for this type
of dispute (M-PHYS-DISPUTE).

Looking at the plan called one cuts the other chooses
which appears to be applicable.

My reasoning is as follows:

candy1 normally can't be shared usefully,
but can be split without destruction;
when this is considered with my initial
classification of this dispute as a
M-PHYS-DISPUTE and my inference that
the parties' goals are in competition;
these factors indicate to me that one cuts
the other chooses is a possible plan.

I suggest that the plan called
one cuts the other chooses be used.

Do you agree, that this is the best solution? (Y or N) Yes.
(#<M-NEGOTIATION 6731554>)

(negotiator orange-dispute)

Looking for a plan to use for the following dispute:
two sisters are quarreling over an orange.

SISTER1 is assumed to have the goal
#<M-INGEST 6730261> (wants to eat orange1).

SISTER2 is assumed to have the goal
#<M-INGEST 6730323> (wants to eat orange1).

Instantiating plans normally useful for this type
of dispute (M-PHYS-DISPUTE).

Looking at the plan called one cuts the other chooses
which appears to be applicable.

My reasoning is as follows:

orange1 normally can't be shared usefully,
but can be split without destruction;
when this is considered with my initial
classification of this dispute as a
M-PHYS-DISPUTE and my inference that
the parties' goals are in competition;
these factors indicate to me that one cuts
the other chooses is a possible plan.

I suggest that the plan called
one cuts the other chooses be used.

Do you agree, that this is the best solution? (Y or N) No.

I'll see if I know anything else that might be helpful.
Another possibility I know about is
that SISTER1 wants a part of orange1.
Do you think SISTER1 is really interested
in the seeds from orange1? No.

Do you think SISTER1 is really interested
in the peel from orange1? No.

My previous goal inference
will be retained for now.
Another possibility I know about is
that SISTER2 wants a part of orange1.
Do you think SISTER2 is really interested
in the seeds from orange1? No.

Do you think SISTER2 is really interested
in the peel from orange1? Yes.

Given this new information, I'll reconsider this problem.

Looking for a plan to use for the following dispute:
two sisters are quarreling over an orange.

SISTER1 is assumed to have the goal
#<M-INGEST 6730261> (wants to eat orange1).

SISTER2 is assumed to have the goal
#<M-PREPARE 6732112> ((WANTS PEEL1)).

Instantiating plans normally useful for this type
of dispute (M-PHYS-DISPUTE).

Looking at the plan called one cuts the other chooses
which does not seem applicable.

Looking at the plan called drawing lots
which does not seem applicable.

Looking at the plan called mutually agreed
division which appears to be applicable.

My reasoning is as follows:

orange1 can be divided without destruction
when this is considered with my initial
classification of this dispute as a M-PHYS-DISPUTE
and my inference that the parties' goals are complimentary
all indicate to me that a
mutually agreed division is possible.

I now suggest that the plan called
mutually agreed division be used.

#<M-MUTUAL-DIVISION 6732253>

(negotiator sinai-dispute)

Looking for a plan to use for the following dispute:
Israel and Egypt both want the Sinai.

Israel is assumed to have the goal
#<M-PHYSICAL-CONTROL 6730666>
(wants to keep the Sinai).

Egypt is assumed to have the goal
#<M-PHYSICAL-CONTROL 6730620>

(wants the Sinai back).
Instantiating plans normally useful for this
type of dispute (M-PHYS-DISPUTE).
Looking at the plan called one cuts the other
chooses which appears to be applicable.

My reasoning is as follows:

Sinai normally can't be shared usefully,
but can be split without destruction;
when this is considered with my initial
classification of this dispute as a
M-PHYS-DISPUTE and my inference that
the parties' goals are in competition;
these factors indicate to me that one cuts
the other chooses is a possible plan.

I suggest that the plan called

one cuts the other chooses be used.

Do you agree, that this is the best solution? (Y or N) No.

I'll see if I know anything else that might be helpful.

My previous goal inference will be retained for now.

My previous goal inference will be retained for now.

If my analogical processes were working

I would try to compare this negotiation

involving this dispute (Israel and Egypt both want the Sinai)

with another negotiation I remember (NO247)

for which this plan also failed!

But for now, I can't find a solution at this level.

NIL

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550
FINAL PROJECT REPORT
NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I-PROJECT IDENTIFICATION INFORMATION

1. Institution and Address Georgia Tech Research Corp. Georgia Institute of Technology Atlanta, Georgia 30332	2. NSF Program IST	3. NSF Award Number IST-8116892
	4. Award Period From 9-15-81 To 6-30-84	5. Cumulative Award Amount \$132,662

6. Project Title
A COMPUTER MEMORY FOR CURRENT EVENTS

PART II-SUMMARY OF COMPLETED PROJECT (FOR PUBLIC USE)

Recall of previous experience is an important part of the everyday understanding and problem solving people do. In this project, we investigated some of the ways in which previous experience is remembered and stored. Our investigations led us to the conclusion that experience plays two important roles in reasoning: (1) it contributes to generalization and incremental learning and (2) it provides exemplars to aid in later understanding and problem solving. Four experience-related processes that enable these functions are (1) similarity-triggered generalization, (2) failure-triggered explanation, (3) similarity-triggered analogical transfer and (4) experience-driven plan evaluation. Two experimental computer programs begin to implement these processes and the underlying episodic memory structure required to support the use of experience in reasoning. The MEDIATOR recalls previous experience to resolve common-sense disputes, and SHRINK uses previous cases to reason about psychiatric diagnosis. The framework we propose, along with the programs we use to test it, provide a foundation for the creation of computer problem solving and understanding systems which can learn from and improve based on experience. They also provide a better understanding of the remembering and learning people do as a result of experience.

PART III-TECHNICAL INFORMATION (FOR PROGRAM MANAGEMENT USES)

1. ITEM (Check appropriate blocks)	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (✓)	Approx. Date
a. Abstracts of Theses	XX				
b. Publication Citations		XX *			
c. Data on Scientific Collaborators		XX			
d. Information on Inventions	XX				
e. Technical Description of Project and Results				XX	by Mar. 15
f. Other (specify) Copies of publications			XX		
2. Principal Investigator/Project Director Name (Typed) Janet L. Kolodner	3. Principal Investigator/Project Director Signature			4. Date	

*copies of all publications have already been provided directly to the Division of Information Science and Technology

NSF Award Number: IST-8116892

Data on Scientific Collaborators

Co-Investigators

Dr. Robert Kolodner - Staff psychiatrist, Atlanta VA Medical Center
- Assistant Professor, Department of Psychiatry,
Emory University Medical School
Prof: Larry Barsalou- Assistant Professor, Department of Psychology,
Emory University

Research Assistants

*Dana Eckart, graduate student : - Sept. 1982 - Sept. 1983
*Phil Hutto, graduate student - July 1983 - Dec. 1983
*Katia Sycara, graduate student - Sept. 1983 - June 1984
Robert Simpson, graduate student
Brian Keith McGregor, undergraduate student

*paid thru NSF grant

PUBLICATION CITATIONS

Publications (already published):

- Kolodner, Janet L., Retrieval and Organizational Strategies in Conceptual Memory: A Computer Model. Lawrence Erlbaum, Associates, Inc., Hillsdale, NJ., April, 1984.
- Kolodner, Janet L., Indexing and Retrieval Strategies for Natural Language Fact Retrieval. ACM Transactions on Database Systems, Vol. 8, No. 3, Sept., 1983, pages 434 - 464.
- Kolodner, Janet L., Reconstructive Memory: A Computer Model. Cognitive Science, Vol. 7, No. 4, Oct., 1983, pages 281 - 328.
- Kolodner, Janet L., Maintaining Organization in a Long Term Dynamic Memory. Cognitive Science, Vol. 7, No. 4, Oct., 1983, pages 243 - 280.
- Kolodner, Janet L., Towards an Understanding of the Role of Experience in the Evolution from Novice to Expert. International Journal of Man-Machine Studies, Vol. 19, Nov., 1983, pages 497 - 518. Also in Coombs, M. I. (ed.), Developments in Expert Systems. Academic Press, New York, 1984, pages 95-116.
- Kolodner, Janet L. and Simpson, Robert, Experience and Problem Solving: A Framework. In Proceedings of the Sixth Annual Conference of the Cognitive Science Society, Boulder, CO, June, 1984, pp. 239-243.
- Kolodner, Janet L. and Simpson, Robert, Problem Solving and Dynamic Memory (short version). In Proceedings of the First Annual Workshop on Theoretical Issues in Conceptual Information Processing, Atlanta, GA, March, 1984, pp. 1 - 9.
- Kolodner, Janet L., Knowledge-Based Self-Organizing Memory for Events. in Elithorn, A., and Banerji, R. (editors), Human and Artificial Intelligence, Butterworth, 1983 (also Proceedings of the NATO Symposium on Human and Artificial Intelligence, Lyon, France, October, 1981).
- Kolodner, Janet L. and Kolodner, Robert M., Towards A Computer Model of Psychiatric Reasoning. In Proceedings of the Sixth Annual Conference on Computer Applications in Medical Care, Washington, DC, Nov., 1982, pp. 99 - 103.
- Kolodner, Janet L., The Role of Experience in Development of Expertise. In Proceedings of the Second National Conference on Artificial Intelligence, Pittsburg, PA, August, 1982, pp. 273-277.

Kolodner, Janet L. and Barsalou, Lawrence, A Joint AI and Psychology Approach to Event Memory. In the Newsletter of the Society for the Study of Artificial Intelligence and Simulation of Behavior, January, 1983, pp. 20-24.

Kolodner, Janet L., Requirements for Natural Language Fact Retrieval. In Proceedings of ACM '83, Dallas, Texas, Oct., 1982, pp. 192 - 198.

Kolodner, Janet L. and Barsalou, Lawrence, Psychological Issues Raised by an AI Model of Reconstructive Memory. In Proceedings of the Fourth Annual Conference on Cognitive Science, August, 1982, pp. 118-120.

Kolodner, J. L., Riesbeck, C. K., and Hardt, S. (eds), Proceedings of the First Annual Workshop on Theoretical Issues in Conceptual Information Processing, March, 1984.

Publications (submitted and pending):

Kolodner, Janet L. and Simpson, Robert, Problem Solving and Dynamic Memory (long version), to be submitted for special issue of Cognitive Science devoted to "memory, experience, and reasoning"

Publications (accepted, but not yet printed):

Kolodner, Janet L. and Kolodner, Robert M., An Algorithm for Diagnosis based on Analysis of Previous Cases. To be printed in Proceedings of MEDCOMP, 1983.

Kolodner, Janet L. and Simpson, Robert, Problem Solving and Dynamic Memory (long version). In Kolodner, J. L. and Riesbeck, C. K., ed., Memory, Experience, and Reasoning, Lawrence Erlbaum Assoc., Hillsdale, NJ, 1985.

Technical Reports:

Kolodner, Janet L. and Simpson, Robert, Problem Solving and Dynamic Memory (long version). Research Report GIT-ICS-84/24. School of Information and Computer Science. Georgia Institute of Technology. Nov., 1984.

Kolodner, J. L., Simpson, R., Sycara, K., and Kolodner, R., Experience in Problem Solving: A Trilogy of Papers. Research Report GIT-ICS-84/16. School of Information and Computer Science. Georgia Institute of Technology. May, 1984.

Simpson, R. L., Strategies for Retrieval and Prediction in an Advisory System: A Research Proposal. Research Report GIT-ISC-84/03. School of Information and Computer Science. Georgia Institute of Technology. Feb., 1984.

Kolodner, Janet L., Reconstructive Memory: A Computer Model. Research Report GIT-ICS-83/13. School of Information and Computer Science. Georgia Institute of Technology. July, 1983.

Kolodner, Janet L., Maintaining Organization in a Dynamic Long Term Memory. Research Report GIT-ICS-83/12. School of Information and Computer Science. Georgia Institute of Technology. July, 1983.

Kolodner, Janet L., Towards an Understanding of the Role of Experience in the Evolution from Novice to Expert. Research Report GIT-ICS-82/03. School of Information and Computer Science, Georgia Institute of Technology, 1982.

Kolodner, Janet L., On Beyond CYRUS: Problems Associated with Long Term Memory Organization and Retrieval. Research Report GIT-ICS-81/17. School of Information and Computer Science. Georgia Institute of Technology. November, 1981.

Publications (in preparation):

Kolodner, J. K., and Riesbeck, C. K. (eds.), Memory, Experience, and Reasoning. To be published by Lawrence Erlbaum Associates, Inc., 1985.

Proposals based on this work (awarded):

From United Press International. March, 1981 - indefinite. UPI DataNews Wire, for use in collecting stories for long term memory research (PI).

Equipment for Artificial Intelligence Research Support (PI). \$43,000. Awarded by Georgia Tech Research Institute, May, 1982.

Extracting Information from Experience: Experience Driven Incremental Learning. Awarded by NSF, Division of Information Science and Technology, July 1, 1984 - June 30, 1987. \$210,000.

The Role of Experience in Common-Sense and Expert Problem Solving. Awarded by ARO, Dec., 1984 - Dec., 1987. \$220,000.

Proposals based on this work (submitted and pending):

Modelling Experience's Role in Clinical Reasoning. Submitted to National Library of Medicine, June, 1984, \$385,000, 5/15/85 - 5/14/88.

Presidential Young Investigator, Submitted to NSF, 1984, up to \$100,000 per year for 5 years.

Proposals based on this work (in preparation):

Experience and Problem Solving. To be submitted jointly to ONR, Division of Instructional Technology and to ARI.

Research in Experience's Role in Problem Solving. To be submitted to NSF, Division of Information Science and Technology as addition to currently-funded NSF grant.

Conference presentations (invited):

"Models of Memory," presentation in symposium entitled "Advances in Cognitive Science", at Annual Meeting of the American Association for the Advancement of Science (AAAS), Los Angeles, CA, May, 1985.

"An Algorithm for Diagnosis Based on Analysis of Previous Cases", MED-COMP 83, Burr Oak Lodge, OH, Sept., 1983.

Panel member, "Cognitive Simulation of Learning Processes", at the Second Machine Learning Workshop, Champaign, Ill., June, 1983.

Panel member "Information, the Challenge of the 80's: Immediate Access and Availability" at ACM National Conference, Dallas, Texas, October, 1982.

Panel member for Women in Science Careers Workshop, Atlanta, Georgia, September, 1981.

Conference presentations:

Experience in Problem Solving: A Framework, presented at the Sixth Annual Conference of the Cognitive Science Society, Boulder, CO, June, 1984.

Problem Solving and Dynamic Memory, presented at the First Annual Workshop on Theoretical Issues in Conceptual Information Processing, Atlanta, GA, March, 1984.

Towards A Computer Model of Psychiatric Reasoning, presented at the Sixth Annual Symposium on Computer Applications in Medical Care, Washington, DC, November, 1982.

The Role of Experience in Developing Expertise, presented at the National Conference on Artificial Intelligence, Pittsburgh, Pennsylvania, August, 1982.

Psychological Issues Raised by an AI Model of Reconstructive Memory, presented at the Fourth Annual Conference of the Cognitive Science Society, Ann Arbor, Michigan, August, 1982.

Knowledge-Based Self-Organizing Memory for Events, presented at NATO Symposium on Artificial Intelligence, Lyon, France, October, 1981.