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13. ABSTRACT *(Maximum 200 words)*

The research project explores specific meta-dialogue behaviors in terms of both how a system could be made to perform them, and to what extent they can increase overall system performance. We focus on two types of metadialog1le capabilities: ability to detect and recover from anomalous dialogue patterns in simple exchanges, and on-line extensions or changes to working vocabulary.

Our main method involves detailed representation of the dialogue context, separating domain, language, and dialogue specific aspects, and significant amounts of meta-reasoning about the system's processing of these representations. An existing logical inference system, ALMA/CARNE, developed as part of a pilot study, is being used in an implementation phase of this work. We are also engaged in a study of existing dialogue corpora to investigate the range and frequency of meta-dialogue expressions in different task domains.

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FINAL REPORT

GRANT NUMBER: F496200010336
TITLE: Metareasoning for More Effective Human-Computer Dialogue
PRINCIPAL INVESTIGATORS:
    Don Perlis and Mike Anderson
    University of Maryland
    College Park, MD 20742

OBJECTIVES:

This study will foster new understanding of error-repair in
intelligent systems, of very broad applicability. Such repair is
necessary where there is complex and noisy data, as is prevalent in
military settings.

STATUS OF EFFORT:

See Accomplishments, below. The grant period ended December, 2002.

SUMMARY:

The research project explores specific meta-dialogue behaviors in
terms of both how a system could be made to perform them, and to what
extent they can increase overall system performance. We focus on
two types of metadialogue capabilities: ability to detect and recover
from anomalous dialogue patterns in simple exchanges, and on-line
extensions or changes to working vocabulary.

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processing of these representations. An existing logical inference
system, ALMA/CARNE, developed as part of a pilot study, is being used
in an implementation phase of this work. We are also engaged in a
study of existing dialogue corpora to investigate the range and
frequency of meta-dialogue expressions in different task domains.

ACCOMPLISHMENTS:

1. We designed and implemented extensions of the existing active logic
engine and dialogue manager, to be able to engage in a variety of
action directive subdialogues, which include:
(a) a request for action performance by the user
(b) performance of an action by the system
(c) feedback ("followup") from the user (which might be positive
    indicating acceptance of the action, or negative, possibly
    coupled with a replacement action).

2. We also designed a more powerful architecture that will allow us to
process new words and phrases and implicit and explicit quotation,
in order to adapt to a variety of users and contexts. As a
result, users will be able to instruct the system in exchanges
such as:
(d) I use "transportation" to refer to any vehicle, not just a car.
(e) Peking is the old name for Beijing.

3. Our most recent work has allowed us to implement a system (ALFRED:
Active Logic for Reason Enhanced Dialog) that can, in simple cases,
(i) recognize the need to for meaning clarification, (ii) generate a
request for such clarification, and (iii) process a direct supplying
of that clarification, as in:

(f) A: Shoot the Chicago train to Boston.
    B: What does "shoot" mean?
    A: Shoot means send.
    B: OK [and sends the Chicago train to Boston]

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This system was demonstrated at the University of Maryland Research Review Day (March 2003). A more advanced version is slated for demonstration at IJCAI 2003.

Implementing the more powerful architecture above involved integrating a new parser into the system, as well as recoding several other modules. We are now begining to extend the system, allowing it not only to learn new words and phrases as in (d-e-f) above, but also learn novel concepts.

In addition, isolating the metareasoning components involved in understanding language from the other parts of the system allows the dialog system to be easily oriented to different domains.

4. These capabilities advance the state of the art for current natural language dialogue systems, and represent a major step toward our long-term goal of "conversational adequacy" as described in our earlier papers.

5. We have also recently begun a corpus study of different kinds of meta-language, their form, frequency, and effect. Results from this study will help to implement more sophisticated reasoning mechanisms for dealing with the various kinds of misunderstanding in dialog.

6. Summary of Dissertation.
Khemdut Purang, ''Systems that Detect and Repair their own Mistakes'',
University of Maryland 2001.

Making mistakes is an inescapable aspect of everyday life. We constantly make mistakes, recognize them and try to correct them. Mistakes are inevitable because of the incompleteness of our knowledge of the world, its inherent uncertainty and its being in a constant state of change. We can never know for sure that what we know is true and the actions that we take based on these beliefs can therefore be misguided. Sooner or later we act based on some false belief or the world changes in an unexpected way and we fail to

achieve our goal. But the fact that we can recognize and repair these errors mitigates their effects. Software systems face the same problems. The difference is that they do not ususally have as robust a capability as we have to detect and respond to their mistakes. This is part of what makes them seem brittle and user-unfriendly. This problem is not likely to get any better as the systems exhibit more complex behaviors in more realistic domains. Our work begins to address that problem by focusing on the computational capabilities required of software systems for them to be able to autonomously recognize and respond to their own mistakes. We study in particular, mistaken beliefs, intentions and actions in agents that have some goals to achieve. Intuitively enough, the basic capabilities required are an ability to inspect their past behavior and computations and the past states of the world and to use that to determine their future behavior. These abilities are not typically available in software systems. We have implemented a general logical framework in which one can specify the behavior of an agent that supports this kind of representation and computation . We have implemented agents that detect and respond appropriately to their mistakes in some aspects of language processing. We have also implemented a system that handles its mistaken beliefs in any domain that can be described using the language of non-monotonic logic. This system was tested on a test suite that we compiled from examples of non-monotonic reasoning in the literature. We finally provide a design of the representations and algorithms for handling mistakes in an agent that acts in the world and has mistaken beliefs, intentions and actions. Implementing such an agent is the next step in this work.

PERSONNEL SUPPORTED

D Perlis (PI)
M Anderson (co-PI)
K Purang (GRA)
Y Chong (GRA)
Y Okamoto (GRA)
D Josyula (GRA)
A Rogriguez (GRA)
G Lapizco (GRA)

TRANSITIONS (to DoD, Government, Industry):

None.

PUBLICATIONS:

1. Representations of Dialogue State for Domain and Task Independent
    Meta-Dialogue. David Traum, Carl Andersen, Yuan Chong, Darsana Josyula,
    Yoshi Okamoto, Khemdut Purang, Michael O'Donovan-Anderson and Don Perlis.
    Electronic Transactions on AI 6, 2002.

2. The Use-Mention Distinction and its importance to HCI. Michael
    L. Anderson, Yoshi Okamoto, Darsana Josyula, and Don Perlis. Proceedings
    of the Sixth Workshop on the Semantics and Pragmatics of Dialog. 2002.

3. Meta-reasoning for Conversational Adequacy. Michael L. Anderson
    Invited talk, Deutsches Forschungszentrum fr Knstliche Intelligenz. 2002.

4. Seven Days in the Life of a Robotic Agent. Waiyian Chong, Mike
    O'Donovan-Anderson, Yoshi Okamoto and Don Perlis.
    First GSFC/JPL Workshop on Radical Agent Concepts,
    2001, NASA Goddard Space Flight Center, Greenbelt, MD, USA

5. Meta-reasoning for Intelligent Dialog Repair, Khemdut Purang, David Traum, Darsana V. Purushothaman, Waiyian Chong, Yoshi Okamoto and Don Perlis. November 2000.

6. Time-Situated Agency: Active Logic and Intention Formation. Cognitive Agents Workshop, 2002. With M. Anderson, D. Josyula, Y. Okamoto.

7. Handling Uncertainty with Active Logic, Manjit Bhatia, Paul Chi, Waiyian Chong, Darsana P. Josyula, Yoshi Okamoto, Don Perlis and Khemdut Purang. March 2001. To be presented at the 2001 AAAI Fall Symposium Series in North Falmouth, MA.

8. Zi at the Interface and Beyond, Yoshi Okamoto. Presented at the LOT-NWCL Summer School. Utrecht, the Netherlands: Universiteit Utrecht, 2001.

9. Feature Analysis of Zibun, Yoshi Okamoto. April 2000. Presented at 45th Annual Conference of the International Linguistic Association. Washington, DC: Georgetown University.

10. Split Antecedents <EO> la Movement, Yoshi Okamoto. July 2000. Snippets, Issue 2. Milano, Italy: LED - Edizioni Universitarie di Lettere Economia Diritto.

11. Agents that recognize and repair their own mistakes. PhD dissertation. Khemdut Purang. August 2001.

12. D. Perlis. What does it take to refer? (Invited paper.) J. of Consciousness Studies, 2000.

13. Symbol Systems. With Michael L. Anderson. Encyclopedia of Cognitive Science. 2002.

14. Invited one-hour talk and paper on self-reference, presented at PhiLog, Copenhagen, October 2002.

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INTERACTIONS:

1. invited talk at New Mexico University

2. contact and discussions with ARL (Dr. John Gurney)

3. invited talk at PhiLog (Logic Colloquium in Denmark)

4. invited talk at DFKI.

Inventions: none

Awards: none