

Research in Progress

AI Research at Bolt Beranek & Newman, Inc.

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Bolt Beranek & Newman, Inc.

Natural Language Research

BBN's project in knowledge representation for natural language understanding is developing techniques for computer assistance to a decision maker who is collecting information about and making choices in a complex situation. In particular, we are designing a system for natural language control of an intelligent graphics display. This system is intended for use in situation assessment and information management.

Our work is concentrated in the development of fundamental techniques for knowledge representation and language understanding. Specifically, we are working on advanced parsing techniques, syntactic/semantic interaction, recognition of speaker intent, anaphora and deixis, fundamental knowledge representation techniques, and parallel algorithms and techniques for knowledge-based inference. (*Contact person:* Bill Woods)

One major accomplishment so far is the development of the knowledge representation system KL-ONE. Another is a prototype display system that understands requests, assertions, and questions about display manipulation. This prototype is based upon several general tools, including the RUS parser, a lexical acquisition system, the PSI-KLONE interface, and a model of a speaker-meaning recognizer. We have also pursued research on an abstract parallel machine for marker passing, and implementations of knowledge-based

inference algorithms.

The RUS parsing system provides a practical framework for natural language processing that is as flexible and extensible as a modular syntactic/semantic processor and as efficient as a semantic grammar. RUS combines a large ATN grammar for English with an interface that permits semantic interpretation to be performed efficiently during the parsing process. The interaction between the parser and the interpreter takes the form of a cascade in which the interpreter receives information about syntactic constituents incrementally during the parsing process and provides immediate feedback to the parser about the semantic acceptability of the proposed syntactic structures. Because the grammar and semantic interpreter are two separate modules, we have been able to use the RUS grammar in a number of natural language systems which are in use at BBN, ISI, Sperry-Univac, General Motors, the National Library of Medicine, and the University of Delaware. (*Contact person:* Rusty Bobrow)

We are also working on natural language generation as exemplified by the ILIAD system, a computer-assisted instruction system designed to help deaf people improve their understanding of the English language. ILIAD is based on a transformational grammar that is capable of generating such structures as transitive and intransitive sentences, indirect objects, passives, predicate adjectives, predicate nominals, predicate adverbs, comparative and superlative structures, complex verb auxiliaries, modals, yes-no ques-

tions, wh-questions, indirect questions, relative clauses of all types, sentential complements, negatives, extraposed noun phrases, simple conjunctions, quantifiers, pronouns, and any grammatical combination of these forms. (*Contact person: Madeleine Bates*)

Speech Processing

Our research in speech signal processing includes signal modeling, analysis, spectral estimation, speech data compression, speech synthesis, speech recognition, speaker identification and verification, and objective methods of speech quality evaluation.

The overall goal of the speech processing group at BBN is to develop a total text/speech communication system in which text or speech can be used for either input or output. Intermediate results of processing text or speech can be stored or transmitted at different data rates. We have done extensive work in the data compression of speech for purposes of digital speech transmission and for storage/playback applications such as voice message systems. Our algorithms provide good speech quality in the data range of 1,000–16,000 bits/second. More recently we have begun research into a speech compression system that will transmit speech at a data rate of only 100 bits/second. This work depends heavily on our experience with the design of speech recognition and synthesis systems. We have recently designed a diphone synthesizer that produces natural-sounding speech at that low data rate. We have also developed a speech enhancement algorithm that performs noise stripping effectively; that is, it removes background noise. (*Contact person: Dr. John Makhouli*)

Advanced Information Presentation System (AIPS)

Interactive graphics is an indispensable technique for putting people in touch with a large knowledge base or knowledge-based system. It can play an important role in such systems, not only at the interface to the end user, but also at the interface to the implementor or maintainer. Unfortunately, interactive graphic interfaces built in low-level graphics languages can provide only limited flexibility to end users, and are costly to build and maintain.

The Advanced Information Presentation System (AIPS) is intended to be an intelligent, interactive graphic interface between a user and one or more other knowledge-based tools. Its purpose is to free the implementors of those tools from having to program all desired displays in great detail, and to free the user from having to select from among a limited set of possible displays provided by the implementors.

The ultimate goal of the AIPS project is a system that can present arbitrary information as graphic displays automatically synthesized in real time, in accordance with natural language direction from the user. The work is a

cooperative effort with the Natural Language Understanding Project, and is being sponsored by the DARPA Information Processing Technology Office as part of the Advanced Command and Control Architectural Testbed (ACCAT). The sponsor's interest lies in providing Navy Command and Control (C2) decision makers with a powerful graphics interface to a collection of C2 decision aids and information sources.

AIPS uses KL-ONE to raise the level of interaction between a program and its graphic display generation function. It allows displays to be specified in terms of declarative descriptions of their format and semantic content, rather than in terms of detailed procedures for their generation. This relieves applications programmers of a considerable burden and provides more flexibility to end users.

AIPS knows about a variety of basic display formats, and can select formats intelligently according to the type of information to be displayed. Because formats are internally described in AIPS using KL-ONE, it is relatively easy to specify new, application-tailored formats in terms of existing ones.

In systems which unite many sources of information, such as Command and Control (C2) or Office Information Systems, AIPS unifies the graphic interface function. This makes it possible to generate displays that combine information from different sources, and presents the end user with a uniform interface for controlling the graphic display of information.

The AIPS concept promises major improvements in the interactivity and economic feasibility of graphics interfaces to complex knowledge-based systems. It is particularly important to military Command and Control crisis management, where decision makers often need to see information displayed in unanticipated ways. However, information presentation pays off even in less volatile environments because it can economically satisfy graphic interface requirements for knowledge-based systems irrespective of their subject domain, and inexpensively track those requirements as such systems evolve.

AIPS was conceived as a display management tool suitable for work environments supported by fast personal machines with very large virtual memories. The current prototype is implemented in INTERLISP-Jericho and runs on the BBN Jericho symbolic processor. (*Contact person: Frank Zdybel*)

Computer-based Tutoring

The STEAMER project is a long term research and development effort to design, implement, and evaluate applications of advanced computer technology to the training problems associated with operating and maintaining complex physical devices. We have chosen Navy steam propulsion systems as a prototype domain (hence the name STEAMER).

A practical goal of the project is to build a computer-based tutor knowledgeable about propulsion plant construction and operation. Our current system includes a simula-

tion model of a ship's steam plant, animated color diagrams to monitor and control the simulation, a graphics editor to create and modify the diagrams, and an instructor (one can't really call it a tutor yet) to present and monitor operational procedures and provide some qualitative explanation of component function. We are working on MIT LISP Machines.

Color diagrams are constructed with an editor from a library of object prototypes and depict the information being computed by the simulation model. The graphic objects can display continuous parameters and discrete state information in a variety of ways, as well as accept user input which affects the simulation model. Communication with graphic objects is via message-passing.

The STEAMER system is designed to incorporate an intelligent tutorial component capable of providing students with guidance in plant operating procedures, instruction in basic operating principles, and explanation of component and subsystem operation. As a first step toward implementation of the tutor, we have developed a representation for the steam plant layout and construction, as well as the plant procedures and underlying principles that constrain their application.

The major scientific goals of STEAMER touch upon many current topics in computer science, cognitive psychology, and AI: object-based programming languages, complex user environments (incorporating color graphics, sound, and voice), knowledge representation, qualitative reasoning extended to incorporate a notion of process, truth maintenance in the context of rich structural descriptions, and alternate forms of explanation. (*Contact person*: Bruce Roberts)

ANNOUNCEMENT

INTERLISP for VAX is Available

The INTERLISP-VAX project at the USC/Information Sciences Institute is pleased to announce the availability of INTERLISP-VAX—a system functionally equivalent to INTERLISP-10 (see W. Teitelman, *INTERLISP Reference Manual*. Palo Alto, Calif.: Xerox Palo Alto Research Center, 1975). INTERLISP-VAX runs on a VAX 11/780 and VAX 11/750, currently under Berkeley UNIX and soon under VMS as well. INTERLISP-VAX was sponsored by DARPA under contract number MDA 903-81-C-0335; there is no charge for a copy of the system.

If you are interested in receiving a copy of the system, please send your name and address to:

USC/Information Sciences Institute
INTERLISP-VAX Project
4676 Admiralty Way
Marina del Rey, CA 90291

Alternatively, you may send an ARPANET message with your name and address to INTERLISP@ISIB. We will mail you an information letter and the necessary paperwork.

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