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Artificial Intelligence Technical Paper Abstracts 1991

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ARTIFICIAL INTELLIGENCE TECHNICAL PAPER ABSTRACTS 1991

INTRODUCTION

The Navy Center for Applied Research in Artificial Intelligence (NCARAI) is part of the Information Technology Division within the Naval Research Laboratory (NRL). NCARAI is engaged in research and development efforts designed to address the application of artificial intelligence (AI) technology and techniques to critical Navy and national problems. The emphasis at NCARAI is the linkage of theory and application in demonstration projects that use a full spectrum of AI methods.

The technical papers and reports of NCARAI document the accomplishments of projects in machine learning, natural language understanding, intelligent decision aids, and intelligent systems for robotic sensing and control. Innovative basic and exploratory research in these areas is made possible by NCARAI's staff of 35 individuals comprising an extraordinary cross section of AI talent from the government civilian and military sectors, visiting scientists from universities, and consulting scientists from industry. An ongoing seminar series, featuring notable scientists from academic and industrial research communities, as well as the military services, provides an excellent opportunity to exchange information and maintain awareness of current developments.

Persons interested in acquiring additional information about the reported results are encouraged to contact the relevant technical personnel for whom e-mail addresses have been provided.

MACHINE LEARNING

Title: Is the Genetic Algorithm a Cooperative Learner?

Author(s): Helen G. Cobb

E-mail Address: cobb@aic.nrl.navy.mil

Citation: submitted to the Second Workshop on Foundations of Genetic Algorithms (FOGA-92)

Date: Forthcoming, 1992

AIC Report No.: AIC-91-001

Abstract

This paper begins to explore an analogy between usual competitive learning metaphor presented in the GA literature and the cooperative learning metaphor discussed by Clearwater, et al. Examining the GA in the cooperative learning framework provides additional insight into the power of the algorithm. The illustrative empirical study reported in this paper demonstrates the importance of GA parameter settings in viewing the GA as a cooperative learner. The study also points to some potential avenues of research in improving the performance of the GA.

Title: Learning the Persistence of Actions in Reactive Control Rules

Author(s): Helen G. Cobb and John J. Grefenstette

E-mail Address: cobb@aic.nrl.navy.mil, gref@aic.nrl.navy.mil

Citation: Proceedings of the Eighth International Workshop (ML91), edited by Lawrence A. Birnbaum and Gregg C. Collins, 293-297. Morgan Kaufmann.

Date: June 1991

AIC Report No.: AIC-91-002

Abstract

This paper explores the effect of explicitly searching for the persistence of each decision in a time-dependent sequential decision task. In prior studies, Grefenstette, et al., show the effectiveness of SAMUEL, a genetic algorithm-based system, in solving a simulation problem where an agent learns how to evade a predator that is in pursuit. In their work, an agent applies a control action at each time step. This paper examines a reformulation of the problem: the agent learns not only the level of response of a control action, but also how long to apply that control action. By examining this problem, the work shows that it is appropriate to choose a representation of the state space that compresses time information when solving a time-dependent sequential decision problem. By compressing time information, critical events in the decision sequence become apparent.

Title: Learning Concept Classification Rules Using Genetic Algorithms
Author(s): Kenneth A. DeJong and William M. Spears
E-mail Address: dejong@aic.nrl.navy.mil, spears@aic.nrl.navy.mil
Citation: 12th International Joint Conference on Artificial Intelligence (IJCAI-91), v2, 651-656. Morgan Kaufmann.
Date: 24-30 August 1991
AIC Report No.: AIC-91-003

Abstract

In this paper we explore the use of an adaptive search technique (genetic algorithms) to construct a system GABIL which continually learns and refines concept classification rules from its interaction with the environment. The performance of the system is measured on a set of concept learning problems and compared with the performance of two existing systems: ID5R and C4.5. Preliminary results support that, despite minimal system bias, GABIL is an effective concept learner and is quite competitive with ID5R and C4.5 as the target concept increases in complexity.

Title: An Analysis of the Interacting Roles of Population Size and Crossover in Genetic Algorithms
Author(s): Kenneth A. Dejong and William M. Spears
E-mail Address: dejong@aic.nrl.navy.mil, spears@aic.nrl.navy.mil
Citation: Parallel Problem Solving from Nature: 1st Workshop (PPSN 1), v496, edited by H.-P. Schwefel and R. Manner, 38-47, Springer-Verlag.
Date: October 1990
AIC Report No.: AIC-91-004

Abstract

In this paper we present some theoretical and empirical results on the interacting roles of population size and crossover in genetic algorithms. We summarize recent theoretical results on the disruptive effect of two forms of multi-point crossover: n-point crossover and uniform crossover. We then show empirically that disruption analysis alone is not sufficient for selecting appropriate forms of crossover. However, by taking into account the interacting effects of population size and crossover, a general picture begins to emerge. The implications of these results on implementation issues and performance are discussed, and several directions for further research are suggested.

Title: A Formal Analysis of the Role of Multi-Point Crossover in Genetic Algorithms
Author(s): Kenneth A. Dejong and William M. Spears
E-mail Address: dejong@aic.nrl.navy.mil, spears@aic.nrl.navy.mil
Citation: To appear in Annals of Mathematics and Artificial Intelligence. J.C. Baltzer AG Scientific Publishing Co.
Date: Forthcoming, 1992
AIC Report No.: AIC-91-005

Abstract

Traditionally, genetic algorithms have relied upon 1 and 2-point crossover operators as the standard mechanisms for implementing recombination. Many recent empirical studies, however, have shown the benefits of higher numbers of crossover points. Some of the most intriguing recent work has focused on uniform crossover, which involves on the average $L/2$ crossover points for strings of length L . In this paper we extend the early theoretical disruption results of Holland and DeJong to include two general forms of multi-point crossover: n -point crossover and uniform crossover. We also consider two other aspects of multi-point crossover operators, namely, their recombination potential and exploratory power. The results of this analysis provide a much clearer view of the role of multi-point crossover in genetic algorithms. The implications of these results on implementation issues and performance are discussed, and several directions for further research are suggested.

Title: Active Learning and Bias Adjustment
Author(s): Diana F. Gordon
E-mail Address: gordon@aic.nrl.navy.mil
Citation: 1991 NRL Review, 135-137, Naval Research Laboratory: Washington DC.
Date: May 1991
AIC Report No.: AIC-91-006

Abstract

Bias is important in concept learning because a strong, correct bias can dramatically reduce the number of hypotheses to consider. We have developed a new approach that involves making explicit, tentative assumptions about appropriate bias, actively testing these assumptions, and adjusting the bias based on the test results. Experiments with our system, PREDICTOR, demonstrate that this method can lead to a significant reduction in the number of examples needed to learn concepts.

Title: An Enhancer for Reactive Plans

Author(s): Diana F. Gordon

E-mail Address: gordon@aic.nrl.navy.mil

Citation: Proceedings of the Eighth International Workshop (ML91), edited by Lawrence A. Birnbaum and Gregg C. Collins, 505-508, Morgan Kaufmann.

Date: June 1991

AIC Report No.: AIC-91-007

Abstract

This paper describes our method for improving comprehensibility, accuracy, and generality of reactive plans. A reactive plan is a set of reactive rules. Our method involves two phases: (1) formulate explanations of execution traces, and then (2) generate new reactive rules from the explanations. Since the explanation phase has been previously described, the primary focus of this paper is the rule generation phase. This latter phase consists of taking a subset of the explanations and using these explanations to generate a set of new reactive rules to add to the original set. The particular subset of the explanations that is chosen yields rules that provide new domain knowledge for handling knowledge gaps in the original rule set. The original rule set, in a complimentary manner, provides expertise to fill the gaps where the domain knowledge provided by the new rules is incomplete.

Title: Active Bias Testing and Adjustment for Concept Learning
Author(s): Diana F. Gordon
E-mail Address: gordon@aic.nrl.navy.mil
Citation: 12th International Joint Conference on Artificial Intelligence (IJCAI-91),
Workshop W.8, "Evaluating and Changing Representation in Machine Learning", Sydney
Australia, Morgan Kaufmann.
Date: 24-30 August 1991
AIC Report No.: AIC-91-008

Abstract

Bias is a fundamental aspect of supervised concept learning. Nevertheless, selecting a good bias prior to learning is difficult. In response to this difficulty, systems have recently been developed that dynamically adjust the bias during incremental learning. These systems, however, are limited in their ability to identify erroneous assumptions about the relationship between the bias and the target concept. Without proper diagnosis, it is difficult to identify and then remedy faulty assumptions. We have developed a new approach that, unlike previous approaches, makes these assumptions explicit, actively tests them, and adjusts the bias based on the test results. When bias adjustment is appropriate for learning target concept, our approach can produce a 10-fold improvement in the rate of convergence to the target concept over a baseline performance.

Title: Machine Learning Systems: Part I - Concept Learning from Examples with AQ15 and Related Systems
Author(s): Diana F. Gordon and William M. Spears
E-mail Address: gordon@aic.nrl.navy.mil, spears@aic.nrl.navy.mil
Citation: NRL Report 9330, Naval Research Laboratory, Washington DC.
Date: September 30, 1991
AIC Report No.: AIC-91-009

Abstract

This is the first in a series of reports designed to acquaint Navy and other military personnel with current software available for machine learning. By acquainting personnel with the available software, we encourage the applicability of learning systems. AQ15 is a concept learning system that has the advantages of user-definable parameters and easily readable output.

Title: Improving the Comprehensibility, Accuracy, and Generality of Reactive Plans
Author(s): Diana F. Gordon
E-mail Address: gordon@aic.nrl.navy.mil
Citation: 6th International Symposium, ISMIS '91, Charlotte, N.C., Methodologies for Intelligent Systems, v542, edited by Z.W. Ras and M. Zemankova, 358-367. Springer-Verlag.
Date: October 1991
AIC Report No.: AIC-91-010

Abstract

This paper describes a method for improving the comprehensibility, accuracy, and generality of reactive plans. A reactive plan is a set of reactive rules. Our method involves two phases: (1) formulate explanations of execution traces, and (2) generate new reactive rules from the explanations. The explanation phase involves translating the execution trace of a reactive planner into an abstract language, and then using Explanation Based Learning to identify general strategies within the abstract trace. The rule generation phase consists of taking a subset of the explanations and using these explanations to generate a set of new reactive rules to add to the original set for the purpose of performance improvement.

Title: Actively Testing and Minimally Weakening the Inductive Bias
Author(s): Diana F. Gordon
E-mail Address: gordon@aic.nrl.navy.mil
Citation: submitted to Machine Learning
Date: Forthcoming, 1992
AIC Report No.: AIC-91-011

Abstract

This paper describes a novel approach to bias adjustment that involves testing assumptions about the bias to identify and then to remedy the faulty assumptions. This diagnosis, which consists of queries to an oracle, enables minimal weakening of the bias to undo the results of faulty assumptions. A strong correct bias is usually desirable for learning concepts. Minimal bias weakening corrects the bias and preserves a strong bias. In this paper, we describe and analyze the results of experiments designed to characterize those situations for which our method is most appropriate. When it is appropriate, our method can produce an order of magnitude improvement in the rate of convergence to the target concept over baseline performance.

Title: Conditions for Implicit Parallelism

Author(s): John J. Grefenstette

E-mail Address: gref@aic.nrl.navy.mil

Citation: Foundations of Genetic Algorithms, edited by Gregory J.E. Rawlins, 252-261, Morgan Kaufmann.

Date: c1991

AIC Report No.: AIC-91-012

Abstract

Many interesting varieties of genetic algorithms have been designed and implemented in the last fifteen years. One way to improve our understanding of genetic algorithms is to identify properties that are invariant across these seemingly different versions. This paper focuses on invariants across these genetic algorithms that differ along two dimensions: (1) the way user-defined objective function is mapped to a fitness measure, and (2) the way the fitness measure is used to assign offspring to parents. A genetic algorithm is called *admissible* if it meets what seem to be the weakest reasonable requirements along these dimensions. It is shown that any admissible genetic algorithm exhibits a form of implicit parallelism.

Title: Strategy Acquisition with Genetic Algorithms
Author(s): John J. Grefenstette
E-mail Address: gref@aic.nrl.navy.mil
Citation: Handbook of Genetic Algorithms, edited by Lawrence Davis, Chapter 14, 186-201, Van Nostrand Reinhold.
Date: c1991
AIC Report No.: AIC-91-013

Abstract

The growing interest in genetic algorithms can largely be attributed to the generality of the approach. Genetic algorithms can be used for both numerical parameters optimization (Fitzpatrick and Grefenstette, 1988; Grefenstette, 1986) and combinatorial search (Grefenstette, 1987). This chapter shows an application to a rather different sort of problem: the optimization of policies for sequential decision tasks. In this approach, each policy, or *strategy*, is represented as a set of condition/action rules. Each proposed strategy is evaluated on a simulation model of the sequential decision tasks, and a genetic algorithm is used to search for high-performance strategies. The approach has been implemented in a system called SAMUEL. (SAMUEL stands for Strategy Acquisition Method Using Empirical Learning. The name also honors Art Samuel, one of the pioneers in machine learning).

Title: Lamarckian Learning in Multi-agent Environments
Author(s): John J. Grefenstette
E-mail Address: gref@aic.nrl.navy.mil
Citation: Proceedings of the Fourth International Conference on Genetic Algorithms, San Diego, 303-310, Morgan Kaufmann.
Date: July 13-16, 1991
AIC Report No.: AIC-91-014

Abstract

Genetic algorithms gain much of their power from mechanisms derived from the field of population genetics. However, it is possible, and in some cases desirable, to augment the standard mechanisms with additional features not available in biological systems. In this paper, we examine the use of Lamarckian learning operators in the SAMUEL architecture. The use of the operators is illustrated on three tasks in multi-agent environments.

Title: Deception Considered Harmful
Author(s): John J. Grefenstette
E-mail Address: gref@aic.nrl.navy.mil
Citation: Submitted to the Second Workshop on Foundations of Genetic Algorithms (FOGA-92)
Date: Forthcoming, 1992
AIC Report No.: AIC-91-015

Abstract

A central problem in the theory of genetic algorithms is the characterization of problems that are difficult for GAs to optimize. Many attempts to characterize such problems focus on the notion of "deception", defined in terms of the static average fitness of competing schemas. This note argues this popular approach appears unlikely to yield a predictive theory for genetic algorithms. Instead, the characterization of hard problems must take into account the basic features of genetic algorithms, especially their dynamic, biased sampling strategy.

Title: User's Guide for SAMUEL, Version 1.3
Author(s): John J. Grefenstette and Helen G. Cobb
E-mail Address: gref@aic.nrl.navy.mil, cobb@aic.nrl.navy.mil
Citation: NRL Memorandum Report 6820, Naval Research Laboratory, Washington DC.
Date: May 6, 1991
AIC Report No.: AIC-91-016

Abstract

SAMUEL is a machine learning system designed to actively explore alternative behaviors in a simulated environment, and to construct high performance rules from this experience. The learning method relies on the notion of competition and employs genetic algorithms to search the space of decision policies. The rule language in SAMUEL also makes it easier to incorporate existing knowledge, whether acquired from experts or by symbolic learning programs. The system includes a competition based production system interpreter, incremental strength updating procedures to measure the utility of rules, and genetic algorithms to modify strategies based on past performance. The current version includes a more convenient language for the expression of tactical control rules, better interfaces, and a number of new heuristics for rule modification. We have experimented with SAMUEL on a task involving learning control rules that enable a simulated robotic aircraft to evade an approaching missile. SAMUEL has been able to learn high performance strategies for this task. This manual should help the user to experiment with SAMUEL on other problems.

Title: Adapting the Evaluation Space to Improve Global Learning
Author(s): Alan C. Schultz
E-mail Address: schultz@aic.nrl.navy.mil
Citation: Proceedings of the Fourth International Conference on Genetic Algorithms, San Diego, 158-164, Morgan Kaufmann.
Date: July 13-16, 1991,
AIC Report No.: AIC-91-017

Abstract

In domains where a stochastic process is involved in the evaluation of a candidate solution, multiple evaluations are necessary to obtain a good estimate of the performance of an individual. This work shows that biasing the sampling of that problem configuration space can lead to better performance of the structure being learned given the same amount of effort.

Title: Using a Genetic Algorithm to Learn Strategies for Collision Avoidance and Local Navigation

Author(s): Alan C. Schultz

E-mail Address: schultz@aic.nrl.navy.mil,

Citation: Proceedings of the Seventh International Symposium on Unmanned Untethered Submersible Technology, 213-225, University of New Hampshire, Marine Systems Engineering Laboratory

Date: September 23-25, 1991

AIC Report No.: AIC-91-018

Abstract

Navigation through obstacles such as mine fields is an important capability for autonomous underwater vehicles. One way to produce robust behavior is to perform projective planning. However, real-time performance is a critical requirement in navigation. What is needed for a truly autonomous vehicle are robust reactive rules that perform well in a wide variety of situations, and that also achieve real-time performance. In this work, SAMUEL, a learning system based on genetic algorithms, is used to learn high-performance reactive strategies for navigation and collision avoidance.

Title: Using Genetic Algorithms and Neural Networks as Heuristics for NP-Complete Decision Problems

Author(s): William M. Spears

E-mail Address: spears@aic.nrl.navy.mil

Citation: Submitted to the ORSA Journal on Computing

Date: Forthcoming, 1992

AIC Report No.: AIC-91-019

Abstract

Paradigms for using neural networks (NNs) and genetic algorithms (GAs) to heuristically solve boolean satisfiability (SAT) problems are presented. Both paradigms are important to the operations research community because of their implicit parallelism. Results are presented for some simple SAT problems. Since SAT is NP-Complete, any other NP-Complete problem can be transformed into an equivalent SAT problem in polynomial time, and solved via either paradigm. This technique is illustrated for hamiltonian circuit (HC) problems. Initial empirical results are presented which indicate that although both paradigms are effective for solving SAT problems, the GA paradigm may be superior for more complex boolean expressions.

Title: A Study of Crossover Operators in Genetic Programming

Author(s): William M. Spears and Vic Anand

E-mail Address: spears@aic.nrl.navy.mil

Citation: 6th International Symposium, ISMIS '91, Charlotte, N.C., Methodologies for Intelligent Systems, v542, edited by Z.W. Ras and M. Zemankova, 409-418, Springer-Verlag.

Date: October 1991

AIC Report No.: AIC-91-020

Abstract

Holland's analysis of the sources of power of genetic algorithms has served as guidance for the applications of genetic algorithms for more than 15 years. The technique of applying a recombination operator (crossover) to a population of individuals is a key to that power. Nevertheless, there have been a number of contradictory results concerning crossover operators with respect to overall performance. Recently, for example, genetic algorithms were used to design neural networks modules and their control circuits. In these studies, a genetic algorithm without crossover outperformed a genetic algorithm with crossover. This report re-examines these studies, and concludes that the results were caused by a small population size. New results are presented that illustrate the effectiveness of crossover when the population size is larger. From a performance view, the results indicated that better neural networks can be evolved in a shorter time if the genetic algorithm uses crossover.

Title: An Analysis of Multi-point Crossover
Author(s): William M. Spears and Kenneth A. Dejong
E-mail Address: spears@aic.nrl.navy.mil, dejong@aic.nrl.navy.mil
Citation: Proceedings of the Foundations of Genetic Algorithms Workshop,
Bloomington, IN, 301-315, Morgan Kaufmann.
Date: July 1990, c1991
AIC Report No.: AIC-91-021

Abstract

In this paper we present some theoretical results on n-point and uniform crossover. This analysis extends the work from Dejong's thesis, which dealt with disruption of n-point crossover on 2nd order schemata. We present various extensions to this theory, including:

- 1) an analysis of the disruption of n-point crossover on kth order schemata;
- 2) the computation of tighter bounds on the disruption caused by n-point crossover, by handling cases where parents share critical allele values; and
- 3) an analysis of the disruption caused by uniform crossover on kth order schemata.

The implications of these results on implementation issues and performance are discussed, and several directions for further research are suggested.

Title: On the Virtues of Parameterized Uniform Crossover
Author(s): William M. Spears and Kenneth A. Dejong
E-mail Address: spears@aic.nrl.navy.mil, dejong@aic.nrl.navy.mil
Citation: Proceedings of the Fourth International Conference on Genetic Algorithms, San Diego, 230-336, Morgan Kaufmann.
Date: July 13-16, 1991
AIC Report No.: AIC-91-022

Abstract

Traditionally, genetic algorithms have relied upon 1 and 2-point crossover operators. Many recent empirical studies, however, have shown the benefits of higher numbers of crossover points. Some of the most intriguing recent work has focused on uniform crossover, which involves on the average $L/2$ crossover points for strings of length L . Theoretical results suggest that, from the view of hyperplane sampling disruption, uniform crossover has few redeeming features. However, a growing body of experimental evidence suggests otherwise. In this paper, we attempt to reconcile these opposing views of uniform crossover and present a framework for understanding its virtues.

Title: Adaptive Strategy Selection for Concept Learning
Author(s): William M. Spears and Diana F. Gordon
E-mail Address: spears@aic.nrl.navy.mil, gordon@aic.nrl.navy.mil
Citation: Multistrategy Learning (MSL-91) Workshop, Harpers Ferry MD, 231-246, published by George Mason University.
Date: November 1991
AIC Report No.: AIC-91-023

Abstract

In this paper, we explore the use of genetic algorithms (GAs) to construct a system called GABIL that continually learns and refines concept classification rules from its interaction with the environment. The performance of this system is compared with that of two other concept learners (NEWGEM and C4.5) on a suite of target concepts. From this comparison, we identify strategies responsible for the success of these concept learners. We then implement a subset of these strategies within GABIL to produce a multistrategy concept learner. Finally, this multistrategy concept learner is further enhanced by allowing the GAs to adaptively select the appropriate strategies.

INTELLIGENT DECISION AIDS

Title: CESA: A Case Study in the Application of Expert Systems Technology to Defense Research Contracting

Author(s): Laura C. Davis and Jay Liebowitz

E-mail Address: davis@aic.nrl.navy.mil, jayl@aic.nrl.navy.mil

Citation: Proceedings of the Twenty-Fourth Annual Hawaii International Conference on System Sciences, v3, 198-207, IEEE Computer Society Press.

Date: January 1991

AIC Report No.: AIC-91-024

Abstract

Because many Department of Defense research contracts require a level of technical guidance and oversight outside the knowledge of the Contracting Officer, it is necessary for research scientists or engineers, as Contracting Officer's Technical Representatives (COTRs), to provide this expertise in the administration of the contract. This paper presents a case study in the application of expert systems technology to Defense research contracting. It describes the life-cycle development of CESA, a COTR Expert System Aid built by the Navy Center for Applied Research in Artificial Intelligence (NCARAI) at the Naval Research Laboratory (NRL) to provide assistance to the COTR community in the pre-award phase of research contract administration. In particular, it discusses the selection of a specific contracting problem domain, describes the prototype development processes, discusses system testing and evaluation, and describes prototype maintenance during a projected period of extensive field testing. The paper also identifies factors contributing to the success of CESA, and concludes with a discussion of research issues relating to further CESA development.

Title: Twofold Continuity in Immersive Language Learning
Author(s): Henry Hamburger and Tucker Maney
E-mail Address: henryh@aic.nrl.navy.mil, maney@aic.nrl.navy.mil
Citation: CALL, 4(2), 81-92, Intellect Publishing Co.
Date: April 1991
AIC Report No.: AIC-91-025

Abstract

An immersive language learning environment undertakes to engage the student in a two-medium communication process: a conversation supplemented by graphical interaction in an ordinary scene on the computer screen. The fundamental rationale for such a system is that it promotes language learning by enabling the student to use the new language, not analyze or translate it. In this paper, we examine two constellations of issues that arise in trying to provide computer-based language immersion, issues concerning discourse and issues of tutorial strategy, and consider how to deal with their apparently conflicting demands.

Title: VIS/ACT: An Intelligent, Video-Oriented Instructional System for Aircrew Coordination Training
Author(s): Henry Hamburger and Tucker Maney
E-mail Address: henryh@aic.nrl.navy.mil, maney@aic.nrl.navy.mil
Citation: submitted to Conference on Intelligent Computer-Aided Training (ICAT-91),
Date: November 20-22, 1991
AIC Report No.: AIC-91-026

Abstract

An intelligent, video-oriented instructional system for aircrew coordination training (ACT), is being devised and implemented as a generalization of exercises for ACT instructors, developed by our colleagues at the Naval Training Systems Center. Work on this VIS/ACT system currently has two foci. One is an interface for knowledge capture from an expert and a simplified version of it for accepting instructor trainee (IT) responses to videos of flight simulation episodes. These latter responses take roughly the same form as the ones the IT would be expected to make in actual practice as a real instructor. The second thrust is the diagnostic component of the delivered system. It uses rules and computations, expressing both episodic and general knowledge acquired from the expert, to evaluate various aspects of the IT's performance. The resulting critique will then permit the pedagogical component to guide the IT in further study of the video episode. Some possible choices of what to do are to report the most serious performance flaws, give explanations for the expert's choices, and present or review relevant portions of the current and other episodes. To broaden the potential applicability of the system, we have attempted from the outset to generalize the problem.

Title: BaRT Manual Version 3.0
Author(s): Naveen Hota, Connie L. Ramsey, Liwu Chang, and Lashon Booker
E-mail Address: ramsey@aic.nrl.navy.mil, liwu@aic.nrl.navy.mil
Citation: NRL Memorandum Report 6778, Naval Research Laboratory, Washington DC.
Date: February 14, 1991
AIC Report No.: AIC-91-027

Abstract

BaRT is an inference engine which has been developed to aid in classification problem solving. This inference engine uses Bayesian reasoning and can handle problems associated with incomplete and uncertain evidence. It has successfully been used to perform ship classification. This manual describes how to load the BaRT program and how to use all of the available commands. This manual also provides some theoretical background and some implementation details concerning BaRT.

Title: Expert Systems Technology Development and Distribution Experience at the Naval Research Laboratory
Author(s): Randall P. Shumaker
E-mail Address: shumaker@itd.nrl.navy.mil
Citation: Proceedings of the 1991 World Congress on Expert Systems, v1, 93-100, Orlando, FL, Pergamon Press.
Date: December 16-19, 1991
AIC Report No.: AIC-91-028

Abstract

The Navy Center for Applied Research in Artificial Intelligence (NCARAI) at the Naval Research Laboratory conducts applied research in artificial intelligence (AI) aimed at demonstrating the applicability and effectiveness of AI methods to practical problems. Several systems developed at NCARAI have gone through the research phase, reached maturity, and are available for distribution to universities, industry and government laboratories. A surprisingly large fraction of these efforts was required to address means to transition artificial intelligence technology into service. The experiences gained during domain selection, system development, packaging, testing and distribution may serve to provide insights for others contemplating similar packages.

NATURAL LANGUAGE

Title: Towards Friendlier User Interfaces for Expert Systems

Author(s): Elaine Marsh

E-mail Address: marsh@aic.nrl.navy.mil

Citation: Proceedings of the 1991 World Congress on Expert Systems, v2, 1068-1076, Orlando, FL, Pergamon Press.

Date: December 16-19, 1991

AIC Report No.: AIC-91-029

Abstract

Much research in computational linguistics and artificial intelligence has gone into characterizing natural language discourse structures, developing discourse models, and using these to develop more useful natural language interfaces to databases and expert systems. However, this knowledge about the nature of discourse has not been used to any advantage in graphical expert system interfaces. This paper proposes that discourse elements and discourse models used in the world of natural language understanding can be extended to graphical expert system interfaces, promoting continuity of interactions and allowing relationships among interactions to be exploited, redundancy reduced, operations tracked, and higher-level operations recognized.

Title: InterFIS: A Natural Language Interface to an Expert System Shell
Author(s): Dennis Perzanowski and Brian Potter
E-mail Address: dennisp@aic.nrl.navy.mil
Citation: Proceedings of the 1991 World Congress on Expert Systems, v2, 1086-1094, Orlando, FL, Pergamon Press.
Date: December 16-19, 1991
AIC Report No.: AIC-91-030

Abstract

InterFIS: is a syntactically based natural language interface to a model-based expert system shell, FIS (Fault Isolation Shell). FIS diagnoses probable cause of failure of avionics equipment in an interactive troubleshooting session, assigning blame using probabilistic reasoning. InterFIS provides the FIS user with a non-tool-specific interface, allowing linguistically complex interactions. The expert system responds in graphics and text modes. We extended the mnemonic commands of a menu interface to FIS, allowing English commands and queries as input without changing any of the functionality of the shell.

We discuss the linguistic motivations for developing a syntactically based grammar for the interface, and the design issues for selecting a particular representation and structure for the semantic network. We conclude with implications and questions for future research in natural language interfacing to expert systems and shells.

Title: Preparing a Sublanguage Grammar
Author(s): Dennis Perzanowski and Elaine Marsh
E-mail Address: dennisp@aic.nrl.navy.mil, marsh@aic.nrl.navy.mil
Citation: NRL Report 9351, Naval Research Laboratory, Washington DC.
Date: October 31, 1991
AIC Report No.: AIC-91-031

Abstract

In this report we discuss the methods used in the preparation of a sublanguage grammar for processing particular sets of Navy messages. We used a set of Casualty Reports or "CASREPS" dealing with the failure of Starting Air Compressors. We also discuss our computational solution for processing a particular grammatical problem in several of the messages, namely so-called "garden-path" sentences. We offer our linguistic motivations for successfully parsing such constructions.

SENSOR BASED SYSTEMS

Title: Experiments with the Subsumption Architecture

Author(s): Ralph Hartley and Frank Pipitone

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Citation: Proceedings 1991 IEEE International Conference on Robotics and Automation, v2, 1652-1658, IEEE Computer Society Press.

Date: April 9-11, 1991

AIC Report No.: AIC-91-032

Abstract

The Subsumption Architecture is a special case of behavior based control for robotics. Behavioral modules are added as "layers" with each layer performing a complete behavior. Higher level behaviors override lower level ones by taking control of their effectors or manipulating their internal states. The control layers are built up out of finite state machines connected by links that act essentially like wires. To test this architecture on a reasonably complex problem, a prototype airplane controller was developed. This controller flies a simulated aircraft from take-off to landing and was run on a "C" based implementation of the subsumption architecture. Several lessons were learned from this effort. The subsumption architecture as currently defined is not sufficiently modular. A clean interface between different behaviors would be desirable. And finally, a more general relationship than strict hierarchy between high level and low level modules is required. None of these problems is insoluble within the behavior based approach but all must be solved if realistic problems are to be dealt with. Some candidate solutions are given.

Title: Registration of Multiple Overlapping Range Images: Scenes without Distinctive Features

Author(s): Behrooz Kamgar-Parsi, Jeffrey L. Jones, and Azriel Rosenfeld

E-mail Address: kamgar@aic.nrl.navy.mil

Citation: IEEE Transactions on Pattern Analysis and Machine Intelligence, 13(9), 857-871, IEEE Computer Society Press.

Date: September 1991

AIC Report No.: AIC-91-033

Abstract

The recent increase in the use of range images may suggest the revision of some of the techniques developed for intensity images so that they adapt to range images more effectively. An important topic is image registration. A scheme is developed to register range images in an environment where distinctive features are scarce. When each image overlaps with several other images, the registration must also be performed at the global level. This is particularly challenging because of the possibility of bending and compression in some forms of range images (i.e., the relative position of data points on the image reference surface may be inaccurate). The "primitives" used for local registration are contours of constant range, which are extracted from data and are represented by means of a modified chain code method. All "best" matches of pairs of contours are considered tentative until their "geometrical" implications are evaluated and a consistent majority has emerged. To do global registration, a cost function is constructed and minimized. Terms contributing to the cost include violation of local matches as well as compression and bending in range images. In cases where there is no appreciable compression and bending in the images, the proposed global scheme could improve the quality of local registration by enforcing consistency among them. In particular, we have implemented this scheme to map the floor of the ocean, where the range data is obtained by a multibeam echosounder system installed aboard a sailing ship producing multiple overlapping range images. The system that we have developed is the first automated system for correctly registered mapping of the ocean floor; it is efficient and robust.

Title: Tripod Operators for the Interpretation of Range Images
Author(s): Frank Pipitone
E-mail Address: pipitone@aic.nrl.navy.mil
Citation: NRL Memorandum Report 6780, Naval Research Laboratory Washington DC.
Date: February 18, 1991
AIC Report No.: AIC-91-034

Abstract

A new kind of feature extraction operator for range images is introduced that facilitates object recognition in several ways. It consists of three points in 3-space fixed at the vertices of an equilateral triangle and one or more curves, called test curves, fixed in the reference frame of the triangle. This mathematical structure is then moved as a rigid body until the vertices all lie on the surface of some range image modeled object. The point(s) of intersection of the test curve(s) and the surface are used to define local shape features which are invariant under rigid motions. These features can be used to automatically find distinctive regions at which to begin recognition, to rapidly screen candidate modeled objects for a match, and to speed pruning in the generation of interpretation trees. Tripod operators are applicable to all 3-D shapes, and reduce the need for specialized feature detectors.

Title: Tripod Operators for Recognizing Objects in Range Images: Rejecting Library Objects Without Explicit Models

Author(s): Frank Pipitone and William Adams

E-mail Address: pipitone@aic.nrl.navy.mil

Citation: 1992 IEEE Proceedings Robotics and Automation Conference

Date: Forthcoming, 1992

AIC Report No.: AIC-91-035

Abstract

The tripod operator is a class of feature extraction operators for range images which facilitate the recognition and localization of objects. It consists of three points in 3-space fixed at the vertices of an equilateral triangle and several curves, called test curves, fixed in the reference frame of the triangle. This mathematical structure is then moved as a rigid body until the three vertices lie on the surface of some range image or modeled object. The point (s) of intersection of the test curve(s) and the surface are used to define local shape features which are invariant under rigid motions. These features can be used to automatically find distinctive regions at which to begin recognition, to rapidly screen candidate objects for a match, and to speed pruning in the generation of interpretation trees. Tripod operators are applicable to all 3-D shapes, and reduce the need for specialized feature detectors. A key property is that they can be moved on the surface of an object in only three DOF (like a surveyor's tripod on the ground). Consequently, only a 3-dimensional manifold of feature space points can be generated, for any number of test curves. Thus, objects can be represented compactly, and in a form allowing fast matching. They are used here to characterize objects by generating a cloud of points in feature space for each object by random placement of the operator. Then new feature measurements are made by operator placements in a range image containing one of those objects. Using a simple nearest-neighbor approach, we determine which objects are rejected and which remain as recognition candidates. Experiments were performed using this approach in order to measure the discriminating power of tripod operators.

Title: An Artificial Intelligence Approach to Analog Systems Diagnosis
Author(s): F. Pipitone, K.A. Dejong, and W. Spears
E-mail Address: pipitone@aic.nrl.navy.mil, dejong@aic.nrl.navy.mil,
spears@aic.nrl.navy.mil
Citation: Testing and Diagnosis of Analog Circuits and Systems, edited by Ruey-wen Liu
Chapter 7, 187-215, Van Nostrand-Reinhold, Co.
Date: c1991
AIC Report No.: AIC-91-036

Abstract

Techniques are described for the automatic diagnosis of primarily analog systems. These results arose from several years of work at NRL in this area, along with a fully implemented research prototype diagnosis system, FIS (Fault Isolation System). Key features are a local qualitative causal model of replaceable module behavior, the absence of the single fault assumption, a rigorous probabilistic treatment of fault probabilities, dynamic best test selection based on heuristics or entropy, and efficient algorithms for computing the probability and the entropy of Boolean expressions.

NEURAL NETWORKS

Title: Neural Networks: A Computer Science Perspective
Author(s): Dr. Alan L. Meyrowitz
E-mail Address: alanm@aic.nrl.navy.mil
Citation: Naval Research Reviews, Volume XLIII, 13-18
Date: Two/1991
AIC Report No.: AIC-91-037

Abstract

There is potential for important progress to be made in understanding the design and enhancing the computational power of artificial neural networks, but the approaches need not be biologically motivated. Moreover, as the basis for automating intelligent behavior, the manipulation of symbols remains a viable alternative to the neural paradigm. There remain grand challenges to achieving with neural networks the computational capabilities afforded by symbol manipulation. Hybrid approaches coupling symbolic and neural processing have the potential to overcome apparent deficiencies in the neural arena. Experimental evidence of computational inefficiency in artificial neural networks may reflect underlying theoretical limitations, as reported in the recent literature.

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