

mal form (CNF) that is based on the effects and preconditions of actions in an n -step plan. In the second step, the aforementioned research results are used to convert the CNF representation into a decomposable negation normal form (DNNF) representation. It turns

out that the computation time needed to evaluate a DNNF expression to compute an optimal n -step plan increases only linearly with the DNNF representation size.

This work was done by Anthony Barrett of Caltech for NASA's Jet Propulsion Labo-

ratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-40296.

Semantic Metrics for Analysis of Software

These metrics represent a more human-oriented view of software.

Goddard Space Flight Center, Greenbelt, Maryland

A recently conceived suite of object-oriented software metrics focus is on semantic aspects of software, in contradistinction to traditional software metrics, which focus on syntactic aspects of software. Semantic metrics represent a more human-oriented view of software than do syntactic metrics. The semantic metrics of a given computer program are calculated by use of the output of a knowledge-based analysis of the program, and are substantially more representative of software quality and more readily comprehensible from a human perspective than are the syntactic metrics.

Semantic metrics have the potential to help software engineers identify fragile, low-quality sections of code much earlier in the development process than is possible by use of syntactic metrics. By enabling earlier and better detection of faults, semantic metrics are expected to make maintenance of software less time-consuming and

expensive and to make software more reusable. Because it is less costly to correct faults found earlier than to correct faults found later in the software-development process, it is expected that the overall cost of developing software will be reduced. Moreover, because semantic metrics provide better measures of internal documentation descriptiveness (descriptiveness of the comments and identifiers in software), all aspects of development of software can be expected to benefit from improved understanding of the software.

Prototype software called "SemMet" for computing semantic metrics is undergoing development. In SemMet, semantic metrics are described within the context of knowledge-based systems that consist of semantic networks formed from conceptual graphs. Conceptual graphs are often used for semantic networks for natural language processing; however, the use of conceptual graphs is also a general and fairly common

knowledge-representation technique. In the computation of semantic metrics, concepts and conceptual relations from conceptual graphs inside a knowledge base are used as input. The output semantic metrics are presented in a report.

This work was done by Letha H. Etkorn, Glenn W. Cox, Phil Farrington, Dawn R. Utley, Sampson Ghalston, and Cara Stein of the University of Alabama at Huntsville for Goddard Space Flight Center. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Letha Hughes Etkorn, Ph.D., P.E.

Assistant Professor

Computer Science Department

University of Alabama in Huntsville

Huntsville, AL 35899

Refer to GSC-14752-1, volume and number of this NASA Tech Briefs issue, and the page number.

Simulation of Laser Cooling and Trapping in Engineering Applications

This design instrument shows good agreement with experimental measurements.

NASA's Jet Propulsion Laboratory, Pasadena, California

An advanced computer code is undergoing development for numerically simulating laser cooling and trapping of large numbers of atoms. The code is expected to be useful in practical engineering applications and to contribute to understanding of the roles that light, atomic collisions, background pressure, and numbers of particles play in experiments using laser-cooled and -trapped atoms. The code is based on semiclassical theories of the forces exerted on atoms by magnetic and optical fields.

Whereas computer codes developed previously for the same purpose account for only a few physical mechanisms, this code incorporates many more physical mechanisms (including atomic collisions, sub-Doppler cooling mechanisms, Stark and Zeeman energy shifts, gravitation, and evanescent-wave phenomena) that affect laser-matter interactions and the cooling of atoms to submillikelvin temperatures. Moreover, whereas the prior codes can simulate the interactions of at most a few atoms with a reso-

nant light field, the number of atoms that can be included in a simulation by the present code is limited only by computer memory. Hence, the present code represents more nearly completely the complex physics involved when using laser-cooled and -trapped atoms in engineering applications.

Another advantage that the code incorporates is the possibility to analyze the interaction between cold atoms of different atomic number. Some properties that cold atoms of different atomic