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## Illinois Researchers Break Billion Variable Optimization Barrier

Urbana, IL, January 17, 2007. A paper published today in the journal *Complexity* describes how a team of researchers in the Illinois Genetic Algorithms Laboratory (IlliGAL) at the University of Illinois at Urbana-Champaign (UIUC) has achieved efficient, scalable solutions on difficult optimization problems containing over a billion variables. The team led by noted researcher and author David E. Goldberg used specially programmed *genetic algorithms* (GAs)—search procedures based on natural selection and genetics—to achieve the feat, together with theories of scalability and implementation techniques developed at Illinois. Optimization uses mathematics and computation to find efficient, effective solutions to problems in science, technology, and commerce, and it is widely used in scheduling, engineering design, and business management. Procedures in common use today are limited to thousands, sometimes millions, of variables because the most powerful methods become prohibitively expensive as the size of the problem increases. The Illinois result proves that billion-variable problems can be solved effectively and practically on existing computers with known procedures.

The calculations were performed on subsets of the 1536-processor Turing cluster housed in UIUC's Computational Science and Engineering (CSE) program. CSE director, Michael Heath, greeted the accomplishment. "This is exactly the kind of paradigm-breaking computational result that we hoped to enable in creating the Turing cluster." UIUC material scientist, Duane Johnson suggested that the result "is a milestone in the developing world of nanotechnology, enabling the analysis and design of new molecules in ways that were not previously possible," and John Deere emerging technology guru Bill Fulkerson sees the results as heralding a new day of complex

systems optimization more generally. “Gone are the days of using a toy GA to solve a toy problem. With petascale computing and solvers like this, complex systems optimization becomes possible.”

Other team members included Kumara Sastry, a PhD candidate in Industrial and Enterprise Systems Engineering and Xavier Llora, a machine learning researcher at the National Center for Supercomputing Applications (NCSA). Although the team is pleased with the billion-variable result, it is not resting on its laurels. Sastry put it this way: “One reason this result is so interesting is because it is so general. With most optimization procedures you are stuck solving a limited class of problems. This result is immediately useful to a broad array of problems, and existing theory and technique tells us how to speed results on larger, harder problems that would otherwise be prohibitively expensive or impossible.” Goldberg is excited by the array of existing application areas that can benefit from the result. “Genetic algorithms have been used regularly for two decades across the spectrum of human endeavor. Science, engineering, commerce, and even the humanities and the arts have already benefited from myriad applications of genetic algorithms. The billion-variable result can be put to use immediately across the panoply of existing and yet-to-be-imagined application domains.” *Complexity* editor-in-chief, Alfred Hübler welcomed the research as “spectacular.” “Goldberg’s team has achieved something special. This result advances complexity science and technology immediately and noticeably.”

The work was sponsored by the Air Force Office of Scientific Research and the NSF-sponsored Materials Computation Center (MCC) at the UIUC.

For additional information contact David E. Goldberg.

About the Illinois Genetic Algorithms Laboratory. The Illinois Genetic Algorithms Laboratory (IlliGAL) is among the foremost research centers for the study and advancement of genetic algorithms and evolutionary computation. The laboratory is housed in the Department of Industrial and Enterprise Systems Engineering (IESE) at the University of Illinois at Urbana-Champaign and is directed by David E. Goldberg, Jerry S. Dobrovolny Distinguished Professor. Goldberg is a 1985 recipient of the NSF Presidential Young Investigator Award, and his 1989 text *Genetic Algorithms in Search, Optimization, and Machine Learning* is one of the most highly cited books in computer science. His 2002 book, *The Design of Innovation,* explores the connections between genetic algorithms and human innovation.
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