Data Dependence Analysis Techniques for Multi-core Architectures

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Abstract
In multi-core architectures large scale scientific applications have to be redesigned to efficiently use the multiple cores and deliver higher performance. Optimizing compilers rely upon program analysis techniques to detect data dependences between program statements, perform optimizations, and identify code fragments that can be executed concurrently. However, most data dependence tests are only able to analyze linear expressions, even though non-linear expressions occur frequently in practice. Therefore, considerable amounts of potential parallelism remained unexploited. In order to handle such complex instances of the dependence problem and increase program parallelization we developed new program analysis techniques. Our methods are based on a set of polynomial time techniques that can prove or disprove dependences in source codes with non-linear and symbolic expressions, complex loop bounds, arrays with coupled subscripts, and if-statement constraints. We performed an experimental evaluation of several data dependence tests and we compared them in terms of data dependence accuracy, compilation efficiency, effectiveness in parallelization and program execution performance. We run various experiments using the Perfect Club Benchmarks, the SPEC benchmarks, and the scientific library Lapack. We measured the accuracy and efficiency of each data dependence test. We also determined the impact of each data dependence test on the total compilation time. Finally, we measured the number of loops parallelized by each test and we compared the execution performance of each benchmark on a multi-core architecture. The experimental results indicate that our dependence analysis tool is accurate, efficient and more effective in program parallelization than past data dependence analysis techniques. The improved parallelization resulted into higher speedups and better program execution performance in several benchmarks.

Biography
Kleanthis Psarris is Professor and Chair of the Department of Computer Science at the University of Texas at San Antonio. He received his B.S. degree in Mathematics from the National University of Athens, Greece in 1984. He received his M.S. degree in Computer Science in 1987, his M.Eng. Degree in Electrical Engineering in 1989 and his Ph.D. Degree in Computer Science in 1991, all from Stevens Institute of Technology in Hoboken, New Jersey. His research interests are in the areas of Parallel and Distributed Systems, Programming Languages and Compilers, and High Performance Computing. He has designed and implemented state of the art program analysis and compiler optimization techniques and he developed compiler tools to increase program parallelization and improve execution performance on advanced computer architectures. He has published extensively in top journals and conferences in the field and his research has been funded by the National Science Foundation and the Department of Defense. He is an Editor of the Parallel Computing journal. He has served on the Program Committees of several international conferences including the ACM International Conference on Supercomputing (ICS) in 1995, 2000, 2006 and 2008, the IEEE International Conference on High Performance Computing and Communications (HPCC) in 2008, 2009 and 2010, and the ACM Symposium on Applied Computing (SAC) in 2003, 2004, 2005 and 2006.
A Smart World: A Development Model for Intelligent Cities

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Abstract
The 21st century smart sustainable development suggests the wholly new principles, strategies, and elements of sustainable living: a new set of eco-intelligent world strategies, models, policies, and solutions. It’s when the sustainable world’s intelligent urbanism is synergistically driven by natural capital, social capital and digital capital, like as the Internet/Web of Things, Knowledge and Social Intelligence and Renewable Energy Sources.

A genuine sustainable community is consistently defined as digitally smart, socially intelligent, and ecologically sustainable.

At the global level, the Smart World is modeled as a Smart Eco Planet of intelligent sustainable communities: countries, regions, cities, towns, villages, districts, and neighborhoods. The Smart Eco Planet is then all as about intelligent communities, smart natural ecosystems, digital smart economy, intelligent people, digital smart governance, smart transport and intellectual ICTs, eco-environments, eco-smart living and creative working in intelligent eco-buildings, cities, regions, countries, and global knowledge ecosystems.

A true Smart Sustainable City is accordingly redefined as an urban entity or city pattern with three critical parts/layers/levels/spaces, all planned, developed and managed as its integrated elements:

- Digital / ICT / Hi-Tech / Ubiquitous / Cyber City (Digital / Information Capital; Multi-Play Telecom Network, ICT spaces / systems / applications, Ubiquitous Computation, Network-integrated Real Estate, Virtual Lifestyle);
- Sustainable / Ecological / Green / Zero-Carbon / Zero-Waste / Eco Friendly / Solar City (Natural Capital; Green Energy Network, Real Eco Estate, Green Lifestyle);
- Knowledge / Learning / Innovation / Intelligent / Science / Intellectual / LivingLab / Creative / Human City / Noopolis (Knowledge Capital; Knowledge Triangle / Square / Grid / Ecology, Intelligent/Smart Lifestyle).

Modeled as the fully sustainable city, the Smart/Intelligent Eco City’s concept, design, planning and implementation is moving further on the Europe 2020 strategic priorities of smart sustainable and inclusive growth.
**Biography**

From 1975 to 1981, Azamat Abdoullaev was a postgraduate and research associate at the USSR Academy of Sciences, the Institute of Physics (Moscow, USSR), one of the leading world research institutions. From 1983 to 1991, a research scientist at the Institute of Scientific and Technical Information at the USSR Academy of Sciences and the Government Committee in Scientific and Technical Information of the USSR Council of Ministers. In 1988, he received a scientific degree in physics and mathematics conferred by the USSR Academy of Sciences, the Lebedev’s Institute of Physics, Moscow.

In 1989, Dr Azamat Abdoullaev published ‘Introduction into Information World’. The book pioneered the role of global and unified ontology in building the Information World of advanced large-scale knowledge systems, as all-purpose encyclopedic intelligent systems, the engines of knowledge-based societies and innovation networks. Presently, core ontologies, as reference world/data models and fundamental form of knowledge and reasoning representation, are key concepts and tools in information sciences, computing, bioinformatics, artificial intelligence, software engineering, the semantic web, or strategic computing technologies. In 1990-1993, he received an academic funding from the USSR Academy of Sciences, initiating the Encyclopedic Knowledge Base in Physical Sciences.

From 1993 up to date, Dr A. Abdoullaev is Director and Chief Research Scientist of a Russian company, OOO “Entsiklopedicheskiye Intellectualniye Systemy” (Moscow). With its sister international company, EIS Encyclopedic Intelligent Systems Ltd, both entities aim to play a visible role in the emerging global market of intelligent/smart cities, contributing into building a Smart World of Sustainable Communities.

As ontologist, Azamat Abdoullaev introduced a common world schema, a standard ontology/semantics for human beings and computing machines, to be applied as a unified web ontology.

In all, he is originally involved in several innovative enterprises and frontier research programs, such as:

- Ontopaedia, Unified Standard Entity Classification System (USECS), a Global Web Ontology
- Integrated Model of Science, Arts and Technology
- Intelligent Eco Cities (Standard Development Framework)
- Smart World of Sustainable Communities
- Executive Education Programs in Smarter World and Sustainable Cities

As the latest international sustainable urban projects, he was instrumental to launch the first intelligent eco city ab novo in Europe, trademarked as “Neapolis Smart EcoCity”, within the framework of Smart Eco Pafos and Smart/Sustainable Cyprus, to be considered by the national and local governments as the Regional and National Development Plans, respectively.

In addition, Dr Azamat Abdoullaev is promoting the integrated models of “Intelligent Europe”, “Sustainable Russia”, and “Smart Sustainable World”.

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