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System and Method for Identifying Maximal Independent Sets in Parallel

A fast partially randomized priority-assignment algorithm that has a high likelihood of returning large maximal independent sets to solve NP-hard optimization problems

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Field
Parallel Processing and High-Performance Computing (HPC)

Technology
Computational Optimization Algorithms

Key Features
- Enables the generation of maximal independent sets more efficiently
- Operates asynchronously for higher performance compared to other MIS algorithms
- Generates larger sets than other MIS algorithms
- Integrates advantages of random selection and random permutation
- Comparatively straightforward insertion into existing systems

Stage of Development
Extensive tests have been carried out using this algorithm in different environments

Status
Seeking commercial development and/or licensing partner

Patent Status
PCT Filed (**February 2017**)

Background

An independent set is a set of vertices in a graph, no two of which are adjacent. A maximal independent set (MIS) is an independent set in which no further vertices of the given graph can be included without breaking the independence. Identification of maximal independent sets is important in a variety of applications framed as graph theory problems. They are frequently used for solving problems in areas such as scheduling, computer vision, pattern recognition, map labeling, and molecular identification – where knowing the maximal independent set helps arrive at a solution in a shorter timeframe with fewer computational resources. For instance, in a parallel processing system, knowing the maximal independent set allows the parallelization of computations with arbitrary and dynamically changing conflicts. Finding the largest possible MIS of a graph is an NP (non-polynomial)-hard optimization problem.

Technology & Competitive Advantage

Researchers at Texas State University have developed a more effective algorithm to identify a maximal independent set. The algorithm can be used for resource conflict management in massively-parallel systems such as graphic processor units (GPUs) and wherever else MIS calculations are required. Its new heuristic consists of a partially randomized priority assignment function that has a higher likelihood of returning a larger maximal independent set than current approaches. Tests were performed using this approach on two different hardware platforms (Titan X and K40) with 16 datasets from different domains ranging from 65k to 23M vertices and 387k to 523M edges. The results obtained showed that the described algorithm produced larger sets (nearly three times closer to the optimum on average) and was consistently faster (10.7 times on average) than the best MIS codes from the literature.

Opportunity

A potential application of the technology is parallel graph processing libraries. Here, the algorithm would not only enhance the performance but also the result quality of MIS computations. A broader area of application would be in high-performance computing (HPC) environments used in fields such as weather forecasting, material modeling, social simulation and geology. Here, the algorithm may be able to more efficiently parallelize some of the most complex programs.