Electrical & Computer Engineering

S E M I N A R

Louisiana State University

GPU Road Network Graph Contraction and SSSP Query

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Abstract—A *Single Source Shortest Path (SSSP)* query on a weighted graph computes the distance (sum of weights) from a given start node to all other nodes in the graph. SSSP queries on large *road-network* graphs are used in a variety of applications. Existing GPU accelerated SSSP queries work well on most graph types, but on road-network graphs they have failed to deliver any advantage over the common CPU algorithms such as Dijkstra's. Acceleration of SSSP has been effective when a graph can be pre-processed on a CPU. *PHAST* is to date one of the fastest algorithms for performing SSSP queries on pre-processed road-network graphs. PHAST operates on graphs pre-processed in part using Geisberger's *contraction hierarchy (CH)* algorithm. This pre-processing is time consuming, limiting PHAST's usefulness when graphs are not available in advance. CH iteratively assigns scores to nodes, contracts (removes) the highest-scoring node, and adds shortcut edges to preserve distances. Iteration stops when only one node remains. Scoring and contraction rely on a *witness path search (WPS)* of nearby nodes. Little work has been reported on parallel and especially GPU CH algorithms. This is perhaps due to issues such as the validity of simultaneous potentially overlapping searches, score staleness, and parallel graph updates.

In this talk a brief overview CH and the challenges associated with a GPU implementation will be discussed and a GPU contraction algorithm, *CUCH*, is presented which overcomes these difficulties. CUCH exposes parallelism by partitioning a graph into levels composed of independent sets of nodes (non-adjacent nodes) with similar scores. This allows contracting multiple nodes simultaneously with little coordination between threads. A GPU-efficient WPS is presented in which a small neighborhood is kept in shared memory and a hash table is used to detect path overlap. Low-parallelism regions of contraction and query are avoided by halting contraction early and computing APSP on the remaining graph. A PHAST-like query computes SSSP using this contracted graph. Contraction of some DIMACS road network graphs on an Nvidia P100 GPU achieves a speedup of 20 to 37 over Geisberger's serial code on a Xeon E5-2640 v4. Query times on CUCH- and CH-contracted graphs were comparable.

Bio—Roozbeh Karimi is a Ph.D. candidate in the division of Electrical and Computer Engineering at Louisiana State University. He received his B.Sc. in Electrical Engineering from Azad University Tehran, and his M.Sc. in Biomedical engineering from Amirkabir University of Technology (Tehran Polytechnic), Iran. He worked as part of the LA-SiGMA research program between 2013 and 2015 working on optimizations on the Intel Xeon Phi platform. His research interests are in applications of massively parallel architectures specifically GPGPUs and development of algorithms for such platforms.

When: Thursday, **25 April 2019,** 12:30 - 13:30
Where: Room 3285 Patrick F. Taylor Hall
Info: `https://www.lsu.edu/eng/ece/seminar`
Food: *Pizza will be served.*