School of Computer Science
MS Thesis Defense
Xiaolei Yan

# REINFORCEMENT LEARNING SCHEDULER FOR HETEROGENEOUS MULTI-CORE PROCESSORS

**ABSTRACT**

Asymmetric multiprocessor systems provide opportunities for exploiting differences between programs' behavior to achieve power effciency and performance. Unfortunately, heterogeneity in multicore processor systems creates significant challenges in effectively mapping these programs to diverse type of cores. To avoid requiring a static assignment of an application to a particular core type by the programmer, various approaches have been proposed to dynamically schedule applications across cores with heterogeneous sets of capabilities. Typical scheduling approaches require either sampling through a permutation of thread schedules to find the optimal mapping or use rough heuristics for predicting the performance of an application on a particular core type. We instead introduce a new, systematic approach to automate thread assignment. We construct a reinforcement-learning-based scheduler to assign threads to the best performing core given the state of the program and the processor cores. We use tile coding/artificial neural networks(ANNs) to represent system features as states and explore linear/nonlinear relationships between states and performance estimation. We present results demonstrating the promise of this approach for single-ISA heterogeneous multicore processors using multiprogram workloads from SPEC CPU2006 benchmarks. Our initial tile coding based function approximation learning experiments are encouraging, and our reinforcement-learning-based scheduler with ANNs function approximator delivers 1.77%(ignoring the overhead of switching) and 4.1%(considering the overhead of sampling) better performance and 41.4% (ignoring the overhead of switching) and 41.7%(considering the overhead of switching) improvement towards an ideal performance estimation over heuristic-sampling-based scheduler and 6% better performance than the average of all possible static schedules for a four-core heterogeneous system. We also show the great potential of this approach using either online or o_ine learning. Finally, we discuss the implementation of our model its impact on results and propose future directions for improving the reinforcement-learning-based scheduling approach.

Date: Wednesday, **April 24**, 2013    Committee Members: Dr. McGovern

Time: **3:00 PM**    Dr. Fagg

Place: Devon Hall room **151**    Dr. Barnes