EA Poster: Experience of Applying NSF/IEEE TCPP Curriculum Initiative on Parallel and Distributed Computing at College of Staten Island

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Abstract

Department of Computer Science at College of Staten Island (CSI) has been offering three different level of parallel and distributed computing (PDC) courses, mainly covering parallel programming and parallel algorithm analysis and design in addition to the basic concepts of parallel architectures. We applied early adopter award to improve the teaching of PDC by adapting the current core course of data structures and adding additional topics into existing two undergraduate PDC courses. In addition, a new course of shared memory programming has been proposed to enhance the PDC curriculum.

Background

College of Staten Island is one of twenty-three institutions of The City University of New York (CUNY). The Department of Computer Science offers B.S. program, M.S. program, and Ph.D. program in computer science. The B.S. program is accredited by the Computing Accreditation Commission of ABET, and the Ph.D. program is jointly offered with CUNY Graduate Center. The CUNY High Performance Computing Center (http://www.csi.cuny.edu/cunyhpc) is housed on the campus of CSI, and financially supported by several NSF grants and from state and local funds. In addition to supporting research from CUNY's institutions, CUNY HPC hosts clusters for faculty and students to access for teaching and learning purpose. We use them for current PDC courses for the labs and class projects for all the current three PDC courses.

Proposed Adopted Courses

The related courses we planned to revise and develop include the following.

1. CSC 229 Introduction to High Performance Computing is a two-credit course, which includes 1 lecture hour and three laboratory hours. It covers the very basics of parallel computing, and is intended for someone who is just becoming acquainted with the subject. This is an elective course to early expose PDC topics to students. We encourage students to further learn the PDC subject in high level elective PDC course CSC 429 Advanced High Performance Computing. We added the topics of the peer-to-peer model, the client-server model, and consistency in distributed transactions.

2. CSC 429 Advanced High Performance Computing (a 4-credit course with 3 lecture hours and 2 laboratory hours) emphasizes on algorithms design and analysis. The course includes both a theoretical component and a programming component. To enhance CSC 429, we introduced BSP/CILK models, the inter-influence of various cost measures, benchmark software, cluster computing, cloud/grid computing, peer-to-peer computing, collaborative computing, and pervasive/mobile computing.

3. CSC 326 Data Structures. We exposed PDC course in core course of data structures. We introduced the parallel/distributed models and complexity, algorithmic paradigm and problem to give students a brief idea of parallel/distributed computing. In addition, parallel sum and even-odd transposition sorting algorithm are added as

the examples of parallel algorithms, and locality is the term used for introduction of the concept inter-processor communication. All major students have to take CSC 326, thus to achieve wide dissemination of PDC topics among undergraduates.

4. CSC 4XX Shared Memory Programming. To complement the current PDC courses, we proposed a new course of shared memory programming covering multithreading, OpenMP, and GPU programming. Currently, the course has been approved by the Department, and we hope to offer it in near future.

Activities and Results

We have been implementing the proposed activities to achieve the goal of this early adopter project. The main activities and results are below.

1. Course modifications and development. We have developed the teaching materials for the modification of the three courses, including CSC 229, CSC 429, and CSC 326. Dr. Feng Gu and Dr. Yumei Huo applied the materials into these three courses. We also developed the curriculum of the new course CSC 4XX as a higher level elective course. It has been approved by the department and will be sent to the curriculum committee for approval.

2. Faculty training. The participating faculty attended the training seminar of parallel programming and optimization with Intel Xeon Phi coprocessors by Intel on May 5 – 6, 2015 and the NVIDIA GPU Programming Workshop by NVIDIA on Sept 29 - 30 2015, respectively. These seminars/workshops will help faculty understand new PDC technologies for future possible adoption in PDC courses.

3. Students participation. In addition to improve teaching and learning in class, we encourage students to develop more interesting class projects and participate in internships and research. Two undergraduates from the classes were hired as interns by CUNY HPCC and one of them was admitted to the NSF REU program to conduct PDC research at University of Texas at Austin. Another student published a conference paper as a co-author in Summer Simulation Multi-Conference 2015.

Evaluation and Dissemination

We evaluate the project quantitatively and qualitatively. We revised the three courses and developed one course. The number of participating faculty members is 2 and around 65 undergraduate students participated. To evaluate students' performance, we focused on the added topics in their exams. In CSC 229, two problems were used to test the understanding of the new topics in the midterm exam, and 100% of the students correctly did them. In CSC 429, students implemented successfully projects of matrix multiplication and stock marketing. In addition, in the exams, 80% of students can write the correct pseudocode for parallel vector multiplication using BSP/PRAM model. In CSC 326, as the first tryout, we did not test the new topics on PDC, but we had one discussion on them. Students showed a lot of interest in these topics and 7 out of 20 students are taking the elective course CSC429 in fall 2015 to gain more knowledge in this field. The next step for the evaluation is to interview and survey the participated students to evaluate how well they grasp the PDC concepts and skills. We will further report the evaluation results and analyze them.

To widely disseminate the project, we submitted a poster to EduPar-15 and will submit posters to other conferences. In addition, we are preparing to submit a journal paper regarding the HPC curriculum at CSI.