Fall-11: A Spiral Curriculum Teaching PDC in a Small College Environment

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Abstract

Since receiving the early adopter status in July 2011, we have started implementing our proposed plan to integrate TCPP core curriculum topics in our existing courses; additionally, we have created a dedicated course on Parallel and Distributed Computing (PDC). Since the last report, we have taught the PDC course, adapted a unit of instruction at the freshmen level on PDC topics, and refined a four-year spiral curriculum including the most foundational topics in PDC. In this report, we evaluate our current adoption effort, present our experience, and outline future plans.

Progress Report

To implement our proposed plan to integrate TCPP core curriculum the Computer and Information Sciences Department has made the following changes to the computer science curriculum offered at Southwest Baptist University.

- The faculty designed a spiral 4-year PDC curriculum for the computer science degree program. The curriculum would be reasonably easy to duplicate at other small-college computer science departments.
- The faculty created and offered a dedicated PDC course, CIS2953 Parallel and Distributed Computing. This course was taught for the first time in a special intersession term in January of 2013.
- The faculty adopted a unit of instruction on multi-threading designed to introduce freshmen computer science majors to PDC topics. This unit will be pilot-tested late in the spring semester of 2013.

A Four-Year Spiral PDC Curriculum

Figure 1 depicts the four-year degree program in computer science at Southwest Baptist University. Highlighted in yellow are five courses which together comprise a foundational preparation in PDC for computer science students at SBU. The five courses highlighted, and the content each course contains is described below:

CIS1154 Computer Science II: This course as taught at SBU is a fairly traditional computer science II course with the addition of a unit on parallel computing based largely on Libby Shoop's work at Macalaster College. The purpose of the unit is to introduce the basic concepts of parallelism and provide a lab experience to undergird the introduction. The version of this course which includes the unit on parallel computing will be taught for the first time in the Spring of 2013.

CIS2233 Machine Organization: CIS2233, taught in the first semester of the second year for computer science majors, revisits (spirals back to) the idea of parallelism from the machine organization/computer architecture perspective. Topics introduced or revisited include pipelining, memory organization/hierarchy, latency & bandwidth, and SIMD/MPI programming. The revised course will be taught for the first time in the fall semester of 2013.

CIS2953 Parallel & Distributed Computing: This course seeks to integrate all of the most critical topics necessary for understanding and applying PDC concepts to a wide variety of problem domains. Included in the course are an introduction to cluster/grid/cloud computing, MPI programming on a PC cluster (LittleFe),

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Course syllabi, examples, assignments, and labs can be found at http://tinyurl.com/cy9jg59
Related topic-wise slides will be added soon.

openMP with Intel ManyCore testing lab, CUDA on GPGPU, hadoop MapReduce, shared memory vs distributed memory, power and locality, and performance modeling. This course was taught in Winterfest intercession of 2013.

Year 1	B.S. Computer Science				
CIS1144	Computer Science I	4	**CIS1154**	**Computer Science II**	**4**
MAT1143	College Algebra	3	CIS1001	Computer Science Seminar	1
UNI 1111	University Seminar	1	MAT1195	Calculus I	5
CIS1033	Foundations of Computer Science	3	MAT1173	Discrete Mathematics	3
	Gen Ed or Grad Req	3	UNI 1121	Critical Thinking	1
	Gen Ed or Grad Req (HPE/SOC/SPF)	2		Gen Ed or Grad Req (HPE/SOC/SPF)	2
Year 2					
CIS2233	**Machine Organization**	**3**	CIS2213	Systems Analysis & Design	3
ECO2023	Microeconomics	3	MAT2263	Calculus III	3
MAT2255	Calculus II	5		Gen Ed or Grad Req	3
	Gen Ed or Grad Req	3		Gen Ed or Grad Req	3
	Gen Ed or Grad Req (HPE/SOC/SPF)	2		Gen Ed or Grad Req (BIO)	4
Year 3	**January Winterfest**		**CIS2953**	**Parallel & Dist. Processing**	**3**
CIS3333	Algorithms & Data Structures	2	CIS3323	Database Management	3
CIS4433	Adv. Dis. Math & Num. Methods	3	CIS ---3	CIS Elective	3
PHY2214	University Physics	4	**CIS3353**	**Programming Languages & AI**	**3**
	Gen Ed or Grad Req	3	MAT3323	Linear Algebra	3
	Gen Ed or Grad Req	3		Gen Ed or Grad Req	3
				Free Elective	2
Year 4					
CIS4462	Applied Software Eng I	2	CIS4472	App Software Eng II	2
MAT3343	Probability and Statistics	3	CIS4443	Networks	3
PHY2214	University Physics	4	**CIS4423**	**Operating Systems**	**3**
	Gen Ed or Grad Req	3	LDR4043	Ethics & Prof. Dev.	3
	Gen Ed or Grad Req	3		Gen Ed or Grad Req	3

Figure 1: A four-year spiral PDC curriculum

CIS3353 Programming Languages and Artificial Intelligence: In year three, students take CIS3353, a course which spirals back to PDC topics by reteaching tasks and thread synchronization using openMP with Intel ManyCore testing lab. This time, however, these topics are taught from a language design viewpoint—languages which provide constructs for parallelism are treated as one of the categories of languages studied in the course. The revised course will be taught for the first time in the spring semester of 2013.

CIS4423 Operating Systems: The last spiral of the curriculum occurs in the fourth year when the students examine PDC topics from an operating systems perspective. In this course students examine concurrency defects, scheduling, and revisit for a final time the challenges faced in tasks/threads synchronization. Platforms include MPI on a cluster, CUDA on GPGPU, and data and task parallelism with hadoop MapReduce. The revised course will be taught for the first time in the spring semester of 2014.

As noted earlier, the curriculum has been partially implemented with CIS2953 being taught in January of 2013 and the pilot-test of the unit in CIS1154 occurring in the spring of 2013. This curriculum was first shared at the Parallel Programming and Cluster Computing Workshop at University of Oklahoma, July 29 - August 4, 2012, and was revised again in January of 2013. Our course curriculum, teaching modules, and the learning outcomes of our students will be shared with other educators again at the IPDPS-13 conference should we be fortunate enough to attend.

Course syllabi, examples, assignments, and labs can be found at http://tinyurl.com/cy9jg59
Related topic-wise slides will be added soon.

To address the faculty development challenge identified in the last report, our faculty members have been attending PDC related conferences/workshops. Two faculty members attended a week-long introduction to Parallel Programming and Cluster Computing workshop in August 2012. In November, two faculty members participated in SC12 educator's program, which includes the LittleFe buildout event. This March (2013) all faculty members will attend SIGCSE to share our experience and learn from others.

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