IEEE-TCPP Parallel and Distributed Computing Curriculum for Computer Science and Engineering Undergraduates - Revision Update

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CDER Center

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EduHPC-19, Denver, Nov 17, 2019

TCPP Curriculum Initiative:
http://www.cs.gsu.edu/~tcpp/curriculum/
Outline

• IEEE-TCPP Curriculum – 5 mins
  – History, Opportunities
  – Key Activities and Milestones
    • ACM/IEEE 2013 CS Curriculum Taskforce
      – provided direct link to us for rigorous coverage
      – How formulated? Getting evaluated? Resources?

• Curriculum Revisions => Version 2 – 15 mins
  – Revision Aspects: Big Data, Energy, Distributed Computing, Cross-cutting topics
  – Areas:
    • Algorithms
    • Programming
    • Architecture
Curriculum Planning Workshops at DC (Feb-10) and at Atlanta (April-10)

- **Goals**
  - setup mechanism and processes which would provide periodic curricular guidelines
  - employ the mechanism to develop sample curriculums

- **Agenda:**
  - Review and Scope
  - Formulate Mechanism and Processes
  - Preliminary Curriculum Planning
    - Core Curriculum
    - Introductory and advanced courses
  - Impact Assessment and Evaluation Plan

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**Main Outcomes**

- **Priority:** Core curriculum revision at undergraduate level

- Preliminary Core Curriculum Topics

- Sample Intro and Advanced Course Curriculums
Some Participants at the Planning Workshop, Washington DC, Feb 5-6, 2010
<table>
<thead>
<tr>
<th>Algorithms Topics</th>
<th>Bloom#</th>
<th>Course</th>
<th>Learning Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algorithmic problems</td>
<td></td>
<td></td>
<td>The important thing here is to emphasize the parallel/distributed aspects of the topic</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>broadcast</td>
<td>C/A</td>
<td>Data Struc/Algo</td>
<td>represents method of exchanging information - one-to-all broadcast (by recursive doubling)</td>
</tr>
<tr>
<td>multicast</td>
<td>K/C</td>
<td>Data Struc/Algo</td>
<td>Illustrate macro-communications on rings, 2D-grids and trees</td>
</tr>
<tr>
<td>scatter/gather</td>
<td>C/A</td>
<td>Data Struc/Algo</td>
<td></td>
</tr>
<tr>
<td>gossip</td>
<td>N</td>
<td></td>
<td>Not in core</td>
</tr>
<tr>
<td>Asynchrony</td>
<td>K</td>
<td>CS2</td>
<td>asynchrony as exhibited on a distributed platform, existence of race conditions</td>
</tr>
<tr>
<td>Synchronization</td>
<td>K</td>
<td>CS2, Data Struc/Algo</td>
<td>aware of methods of controlling race condition,</td>
</tr>
<tr>
<td>Sorting</td>
<td>C</td>
<td>CS2, Data Struc/Algo</td>
<td>parallel merge sort,</td>
</tr>
<tr>
<td>Selection</td>
<td>K</td>
<td>CS2, Data Struc/Algo</td>
<td>min/max, know that selection can be accomplished by sorting</td>
</tr>
</tbody>
</table>
Early Adopter and Training Programs

- Over 100 institutions worldwide
  - Spring-11: 16 institutions; Fall’11: 18;
  - Spring-12: 21; Fall-12: 25 institutions, Fall-13: 25 institutions, Fall-14: 25, Fall-15: 13
  - Most from US (4 year to research institutions, one high school)
  - Some from South America, a few from Europe, fewer from Asia (India, China, Indonesia, Singapore), Middle East

- NSF CyberTraining Training Workshops - Summer 2018-19
  - UMass/Maryland; Tennessee Tech
  - NSF/Intel funded Stipend up to $1500-5000/proposal
  - Instructor training + adoption plans
Edu* Workshop Series

- **EduPar-11** at Alaska, IPDPS-2011
  - Receive feedback from the Adopters
  - Stimulate discussion of curricular and other educational issues.
- **EduPar-12** at Shanghai, IPDPS-2012
  - A regular satellite workshop of IPDPS
  - EduPar-15 @IPDPS, May, India; EduPar-16, Chicago, EduPar-17 in Orlando; EduPar-18 in Vancouver, **EduPar-19 @ IPDPS, Brazil**
- **EduHPC** Workshop at SC-13 + BOF at SIGCSE-14
  - EduHPC-14 @ SC-14, Nov – New Orleans; EduHPC-15 in Austin, EduHPC-16, EduHPC-17, EduHPC-18 in Dallas
  - **EduHPC-19 @ SC in Denver in Nov’19**
- **EduHiPC 2018 @ HiPC in Banglore** – for India and the region
  - **EduHiPC 2018 @ HiPC in Hyderabad in Dec’19**
Upload and Search Course Material

- **Type:**
  - Slides, Syllabus, Tutorial, Video
  - Animation, Article, Award, Blog, Book, Competition
  - Course Template, Course Module, Data
  - Hardware Access, Software/Tools
  - Proposal, Report

- **Courses:**
  - CS1, CS2, Systems, Data Structures and Algorithms, ...

- **NSF/TCPP Topic/Subtopic Classification:**
  - ALGORITHMS
    - Parallel and Distributed Models and Complexity
    - Algorithmic Paradigms
      - Divide & conquer (parallel aspects)
      - Algorithmic problems
  - ARCHITECTURE
  - PROGRAMMING
  - CROSS-CUTTING

- **Now open** - Work in Progress

Prasad/EduHPC-19
CDER Book Project

• Lack of suitable textbooks to integrate PDC topics into the core courses
  – CS1, CS2, Systems, and Data Structures and Algorithms
  – **Part I - For instructors:** Basic Concepts and References on what and how to teach
  – **Part 2: For students:** Supplemental teaching material for core courses
  – 9 chapters
    • over 27K chapter downloads – [free downloads](#)

• **2nd Volume** – Published Nov’18
  – **Vol 3** – Early Adopter course and topic exemplars and accompanying resources

Prasad/EduHPC-19
## Curriculum Version II Activities

<table>
<thead>
<tr>
<th>Areas</th>
<th>Architecture</th>
<th>Algorithms</th>
<th>Programming</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New Aspects</strong></td>
<td><strong>Area Lead/Aspect Lead</strong></td>
<td>Chip Weems</td>
<td>Alan Sussman</td>
</tr>
<tr>
<td><strong>Exemplars</strong></td>
<td>Sushil Prasad</td>
<td>Karen Karavanic, Eric Freudenthal</td>
<td>David Brown, Eric Freudenthal</td>
</tr>
<tr>
<td><strong>Distributed</strong></td>
<td>Vaidyanathan Ramachandran</td>
<td>Vaidyanathan Ramachandran, Manish Parashar</td>
<td>Alan Sussman, Chi Shen</td>
</tr>
<tr>
<td><strong>Big Data</strong></td>
<td>Trilce Estrada</td>
<td>Craig Stunkel</td>
<td>Debzani Deb</td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td>Krishna Kant, Craig Stunkel</td>
<td>Craig Stunkel, Karen Karavanic</td>
<td>John Dougherty</td>
</tr>
<tr>
<td><strong>Crosscutting</strong></td>
<td>Sheikh Ghafoor Arny Rosenberg, Anshul Gupta</td>
<td>Craig Stunkel, Eric Freudenthal</td>
<td>Sheikh Gafoor, Eric Freudenthal</td>
</tr>
</tbody>
</table>
NSF/TCPP Curriculum Initiative
What should every Computer Science and Engineering Student know about Parallel and Distributed Computing (PDC)?
http://www.cs.gsu.edu/~tcpp/curriculum/

• Aspects: Energy, Distributed, Big Data, Pervasive topics
• Timeline:
  • Beta Version-1.9 @ IPDPS’19
  • Ongoing revision based on expert reviews
  • Public review release Dec’19
• 2 pm: Session on Curriculum Update:
  • Feedback/Participation needed
• New: NSF Institute Planning Grant => 4 planning workshops
  • SC’19 (Mon - tomorrow) – by invitation
  • SIGCSE’20
  • IPDPS’20
  • NSF – Fall’20