

Technological advances have resulted in increasing levels of on-chip functionality. Multi-core architectures pervade all levels of computing platforms, from smart phones to servers and high-performance computers. Extraction of parallelism from mainstream applications is thus even more imperative than in the past.

This seminar will examine new developments in the concurrency space - common (and new) programming platforms (languages and runtimes), scalable architectures that support concurrency, support for heterogeneous computing, energy and power-aware concurrency, and performance in the presence heterogeneity and imperfect reliability.

Prerequisites: CSC 2/458, CSC 254, and CSC 256, or equivalent, and/or instructor's permission. In other words, basic knowledge about parallel and distributed systems will be assumed.

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Office hours by appointment, but don't be afraid to stop by. If you want to be sure I'm in my office, use e-mail to contact me.

Web site: <http://www.cs.rochester.edu/sandhya/csc572.12> — I will make all material and links available here.

Class time: To be determined based on class participants' schedules. First meeting on Wednesday January 18th at 4.50 in CSB 703.

Workload: Class participation and presentation is required. Those officially taking the course will be required to do a term project, along with brief paper summaries.

Initial/tentative list of papers we will discuss in class (and that will be presented by class participants) -

Composability

- "Lithe: Enabling Efficient Composition of Parallel Libraries", Heidi Pan, Benjamin Hindman, and Krste Asanovic, in *Proceedings of HOTPAR 2010*, 2010.
- "Composing Parallel Software Efficiently with Lithe", Heidi Pan, Benjamin Hindman, and Krste Asanovic, in *Proceedings of PLDI*, 2010.

Thread pools and task parallelism

- "Apple's Grand Central Dispatch (GCD) Reference", Apple Inc., August 2009.
- "Intel Threading Building Blocks 4.0", Intel, September 2011.
- "CAFÉ: Scalable Task Pools with Adjustable Fairness and Contention", D. Basin, R. Fan, I. Keidar, O. Kiselov, and D. Perelman, in *Proceedings of the 25TH DISC*, Rome, Italy, September 2011.

Heterogeneity

- "Twin peaks: a software platform for heterogeneous computing on general-purpose and graphics processors", Jayanth Gummaraju, Laurent Morichetti, Michael Houston, Ben Sander, Benedict R Gaster, and Bixia Zheng, in *Proceedings of the 19th International Conference on Parallel Architectures and Compilation Techniques*, 2010.
- "CellSs: a Programming Model for the Cell BE Architecture", Piter Bellens, Josep Perez, Rosa Badia, and Jesus Labarta, SC 2006.

- “Programming Model for a Heterogeneous x86 Platform”, Saha et al., In *Proceedings of the International Conference on Programming Language Design and Implementation (PLDI)*, 2009.
- “Merge: A Programming Model for Heterogeneous Multi-Core Systems”, M. Linderman, J. Collins, H. Wang, and T. Meng, *ASPLOS*, 2008.
- “Enabling Legacy Applications on Heterogeneous Platforms”, Becchi et al., In *HotPar*, 2010.
- “An OpenCL Framework for Heterogeneous Multicores with Local Memory”, Lee et al., in *Proceedings of the International Conference on Parallel Architectures and Compilation Techniques (PACT)*, September 2010.

Synchronization

- “Fast and Scalable Rendezvousing”, Y. Afek, M. Hakimi, and A. Morrison, in *Proceedings of the 25TH DISC*, Rome, Italy, September 2011.
- “Flat Combining and the Synchronization-Parallelism Tradeoff”, Danny Hendler, Itai Incze, Nir Shavit, and Moran Tzafrir, in *Proceedings of the 22nd SPAA*, Santorini, Greece, June 2010.

Parallel Algorithms/Concurrent Data Structures

- “Internally Deterministic Parallel Algorithms Can Be Fast”, Guy E. Blelloch, Jeremy T. Fineman, Phillip B. Gibbons, and Julian Shun, *PPoPP* 2012.
- “Scalable Flat-Combining Based Synchronous Queues”, Danny Hendler, Itai Incze, Nir Shavit, and Moran Tzafrir, in *Proceedings of the 24TH DISC*, Cambridge, MA, September 2010.

Domain-Specific Languages

- “A Domain Specific Approach to Heterogeneous Parallelism”, Hassan Chafi, Arvind Sujeeth, Kevin Brown, HyoukJoong Lee, Anand Atreya, and Kunle Olukotun, in *Proceedings of PPoPP*, 2011.
- “S: a Scripting Language for High-Performance RESTful Web Services”, Daniele Bonetta, Achille Peternier, Cesare Pautasso, and Walter Binder, University of Lugano, *PPoPP*, 2012.

Architectural Support

- “Rigel: An Architecture and Scalable Programming Interface for a 1000-core Accelerator”, Kelm et al., in *Proceedings of the International Symposium on Computer Architecture (ISCA)*, 2010.
- “An OS-Based Alternative to Full Hardware Coherence on Tiled CMPs”, C. Fensch and M. Cintra, in *HPCA*, 2008.
- “Atomic Coherence: Leveraging Nanophotonics to Build Race-Free Cache Coherence Protocols”, Dana Vantrease (Wisconsin), Mikko H. Lipasti (Wisconsin), and Nathan Binkert (HP), *HPCA*, 2011.
- “HAQu: Hardware Accelerated Queueing For Fine-Grained Threading on a Chip Multiprocessor”, Sanghoon Lee (NCSU), Devesh Tiwari (NCSU), Yan Solihin (NCSU), and James Tuck (NCSU), *HPCA*, 2011.

Operating Systems Support

- “PTask: Operating System Abstractions to Manage GPUs as Compute Devices”, Christopher J. Rossbach, Jon Currey, Mark Silberstein, Baishakhi Ray, and Emmett Witchel, *SOSP*, 2011.