DF21500
Multicore Computing

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Staff 2013

- **Christoph Kessler**, IDA chrke (at) ida. liu. se
  - Organization, most lectures, examinator
- **Ingemar Ragnemalm**, ISY ingis (at) isy. liu. se
  - Guest lectures on GPU architecture and CUDA
- **Welf Löwe**, Linnaeus University, Växjö
  - Guest lectures, guest examinator
- **Nicolas Melot**, IDA nicolas.melot (at) liu. se
  - Course assistant, lesson, CPU labs
- **Usman Dastgeer,** IDA usman.dastgeer (at) liu. se
  - Guest lecture, Lab assistant GPU labs
- **Anne Moe**, IDA annes (at) ida. liu. se
  - Course secretary (registration, Fo-Ladok reporting / paper certificates)
- **Petru Eles**, IDA petel (at) ida. liu. se
  - Director of graduate studies

Course Moments

- Lectures
- Lessons
- Lab introductions (CPU, GPU)
- Lab sessions (assistant jour)
- Presentation day

- Credits: 7.5 hp in total
  - Written exam, 3 hp
  - Lab series attended and completed by deadlines, 3 hp
    - No guarantee for completing / correcting labs after the deadlines
  - Presentation, opposition and summary accepted, 1.5 hp

Lecture Topics (Week 1)

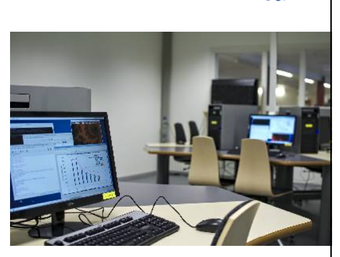
- Organization, Overview.
  Motivation, Multicore architectural concepts and trends.
  SIMD computing. (CK)
- Parallel programming with threads and tasks. (CK)
- Shared memory architecture concepts and performance issues. (CK)
- CPU lab introduction. (NM)
- Theory: Design and analysis of parallel algorithms (CK)
- Parallel sorting algorithms. (CK)
- Non-blocking synchronization. (CK)
- GPU architecture and trends (IR)
- Introduction to CUDA programming. (IR)

Lecture Topics (Week 2)

- Parallelization of sequential programs.
  Runtime parallelization. (CK)
- Algorithmic multithreading with Cilk (CK)
- Lesson: Solving selected theory exercises. (NM)
  Please prepare suggested theory exercises in advance
- On-chip pipelining (CK)
- OpenCL introduction. (UD)
- GPU lab introduction. (UD)
- Models: BSP, LogP, … . (WL)
- Scheduling tasks and malleable tasks. (WL)
- Parallel Design Patterns and Skeleton Programming. (CK)
- Components and optimized composition, autotuning, PEPPHER approach (CK)

Labs: Some Practical Details

- Labs:
  in the IDA Multicore Lab (”Konrad Zuse”)
  - Usually locked,
    use only at scheduled times



- Lab kick-off sessions are mandatory
- Limited supervision beyond the kick-off sessions
- If you intend to do the labs:
  You may need a **guest account** at IDA to get access to our hardware used in the labs
  - Sign up on account list, or contact Nicolas Melot
- Work in pairs or alone
- Submit to your lab assistant by **23/9/2013**

Course material and WWW homepage

- All information available on the course homepage: www.ida.liu.se/~chrke/courses/MULTI
- Some slide sets and other material require login/password
  - Handed out to registered participants only
  - Please keep it secret
- Lab assignments on the course homepage
- Literature recommendations on the course homepage. Some books:

Introductory Literature (Selection)

If you already attended TDDC78, you need no book on the general / CPU part.

Otherwise, one of the following introductory books might be useful (available in the TekNat library as refcopy and for loan):

- C. Lin, L. Snyder: *Principles of Parallel Programming*. Addison Wesley, 2008.
  (general introduction; Pthreads)
- B. Wilkinson, M. Allen: *Parallel Programming, 2e*. Prentice Hall, 2005.
  (general introduction; pthreads, OpenMP, MPI)

GPU Programming Literature

Focus on CUDA. One of the following books might be useful:

- J. Sanders, E. Kandrot: *CUDA by example*. Addison-Wesley, 2011.
- David B. Kirk and Wen-mei W. Hwu: *Programming Massively Parallel Processors: A Hands-on Approach.* Morgan Kaufmann, 2010.

Available in the TekNat library

Further Reading

- M. Herlihy, N. Shavit: *The Art of Multiprocessor Programming*. Morgan Kaufmann, 2008.
  (threads; nonblocking synchronization)
- A. Vajda: *Programming Many-Core Chips*. Springer, 2011.
  (recent overview)
- A. Grama, G. Karypis, V. Kumar, A. Gupta: *Introduction to Parallel Computing, 2nd Edition.* Addison-Wesley, 2003.
  (design and analysis of parallel algorithms)
- …

See the course homepage for further references

- Available in TekNat library

- On-line references on the course homepage

Related Courses (1)

TDDD56 Multicore and GPU Programming, 6hp

- Master-level
- HT2 (nov–jan) every year
- Quite large overlap with DF21500
  - Most lecture material is shared
  - More on GPU programming
  - No SIMD, no advanced BSP/LogP…, no scheduling
  - No presentations
  - Different lab series

Related Courses (2)

TDDC78 Programming of Parallel Computers, 6hp

- Master-level
- VT2 (march – may) every year
- Topics include:
  - Parallel computer architecture concepts, esp. clusters
  - Parallel algorithms for High-Performance Computing
  - Parallel thread programming with OpenMP **(Labs)**
  - Message passing programming of clusters with MPI **(Labs)**
  - Tools for performance analysis (**Labs**)
- A good complement of TDDD56 / DF21500