

High-Performance Computing

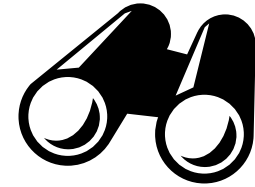
– Course Overview –

Christian Plessl

High-Performance IT Systems Group

Paderborn University

Course Synopsis



optional topics
marked in grey

■ Introduction

- Motivation
- Fundamentals of parallel hardware and software

■ Distributed-memory programming

- Message Passing Interface (MPI)
- Partitioned Global Address Space Languages (Chapel)

■ Shared-memory programming

- POSIX multi-threading (Pthreads)
- Open Multi-Processing (OpenMP)
- Shared-Memory Computing with Cilk (Work Stealing)

■ Performance optimization and measurements

- Profiling
- Cache-aware data structure layout, vectorization

■ Case studies and projects

■ Further Topics

- Heterogeneous, accelerated computing with GPUs and FPGAs using OpenCL
- Load balancing

Relation to other courses

■ Bachelor-level courses

- Foundations of Computer Architecture
- Concepts and Methods of System Software / Foundations of Programming

■ Master-level courses

- Advanced Computer Architecture
- Hardware/Software Codesign
- Architecture of Parallel Computer Systems
- Reconfigurable Computing

■ Emphasis of this course

- focus on programming of HPC systems
- significant part of practical assignments and projects
- access to HPC systems at Paderborn Center for Parallel Computing

Prerequisites

- **Fundamentals of parallel computer architectures**

- multi-core processors
- parallelism (data-level, instruction-level, thread-level)
- caches

- **Fundamentals of parallel computing**

- **Practical ability to program in C**

- required for understanding examples in the lecture and for participating in programming exercises

- **Familiarity with Linux environment**

- required for compiling, running and debugging examples on HPC clusters

- **Notebook for exercise sessions (Recommended)**

Course Organization

■ Lecture & exercises

- Tuesday, 9:15-10:45, room 02, (time slot primarily used for lectures)
- Fridays, 11:15–13:45, room 01.258 (time slot primarily use for exercises and labs)

■ Course materials

- We will use this textbook for the lecture

Peter S. Pacheco

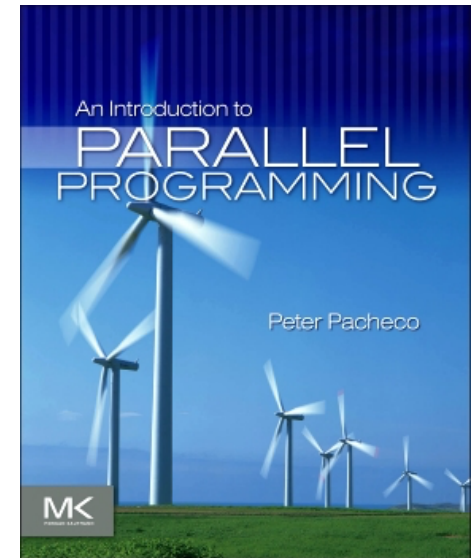
“An Introduction to Parallel Programming”

1st edition, Morgan Kaufmann, 2011, ISBN 978-0-12-374260-5

electronically available in UPB network:

<http://dx.doi.org/10.1016/B978-0-12-374260-5.00012-9>

- Lecture slides are provided
- For the majority of the lecture, theoretical and programming exercises will follow the book and the complete contents are exam relevant; hence the book should be considered as **required reading not optional**



Course Organization (2)

■ Course website

- Announcement of schedule, contents and news
- Download of slides and additional materials

<http://cs.uni-paderborn.de/hit/teaching/courses/ws-201718/high-performance-computing/>

■ Exam

- Oral module exam (30 minutes)
- Bonus for active participation in theoretical and programming exercises

■ Contact

- Christian Plessl
- Email: christian.plessl@uni-paderborn.de
- Office: 02.167, Phone: +49-5251-605399
- No fixed office hour, personal appointments on request by email

■ Feedback, questions and corrections are highly welcome

Change log

- **1.1.1 (2017-10-10)**
 - add link to online version of textbook
- **1.1.0 (2017-10-08)**
 - updated for winter term 2017/18
- **1.0.0 (2016-10-28)**
 - initial version of slides