

Introduction to Parallel Computing

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Sprechstunde: Monday, 13-15

Elements: Introduction to parallel computing

- Introduction: aims, basics, history (Amdahl's Law, Moore's „Law“, ...)
- Shared memory parallel computing
- Concrete language: OpenMP, pthreads
- Distributed memory parallel computing
- Concrete interface: MPI (Message-Passing Interface)
- New architectures, new languages (GPU, OpenCL)
- Other languages, paradigms

Project work:

- OpenMP
- MPI

Prerequisites

- C/C++, Fortran (Java) programming skills
- Operating systems
- Algorithms & Data structures
- ...

Lectures, exercises, projects

- Monday, 11:00-12:45 **MANDATORY** (note: changed)
- **Occasionally:** Thursday, 12:00-14:00 (also **MANDATORY**)

Seminarraum 121, Gußhausstraße 25-29

Project work: can start as soon as possible, discussion at end of lecture

BIG DISCLAIMER:

Parallel Computing is a **new group** at the TU Wien (since August 2011), and infrastructure (MPI cluster and OpenMP node) is **NOT (yet)** in place. Adjustments will be necessary!!!

Requirements, credit (4 hours/week, 6ECTS)

- Lecture attendance **MANDATORY**
- Discussion, questions during lecture
- Presentation of project work (last 1-2 dates) **MANDATORY**
- Hand-in of project work **MANDATORY**:
 1. Presentation slide and/or short write-up
 2. Program code
 3. Results

Practical project work: may be done in groups of 2

NOTE:

See me ("Sprechstunde") in case of problems with schedule
(unable to finish project in time)

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GRADE:

Based on project presentation and hand-in

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NOTE:

Solutions to project exercises can possibly be found somewhere.

Don't cheat yourself!!

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NOTE:

Solutions to project exercises can possibly be found somewhere.
Don't cheat me: be open about what you took from others, copying will automatically result in **grade 0!**

Litterature, course material

Slides in English - will be made available at

www.par.tuwien.ac.at/teach/WS11/ParComp.html

Look here and TISS for information (cancelled lectures, change of plans, ...)

No script this time; slides should be enough for doing the project work, additional material can be found easily

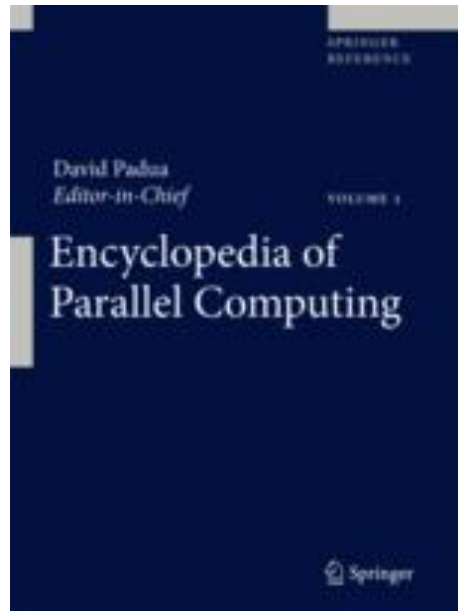
Litterature: general

- Thomas Rauber, Gudula Rünger: Parallel Programming for multicore and cluster systems. Springer, 2010
- Michael J. Quinn: Parallel Programming in C with MPI and OpenMP. McGraw-Hill, 2004
- Calvin Lin, Lawrence Snyder: Principles of parallel programming. Addison-Wesley, 2008
- Peter Pacheco: An introduction to parallel programming. Morgan Kaufmann, 2011

Randal E. Bryant, David R. O'Hallaron: Computer Systems. Prentice-Hall, 2011

Litterature: general

- NEW**: Encyclopedia of Parallel Computing. David Padua (eds).



Litterature: OpenMP, MPI

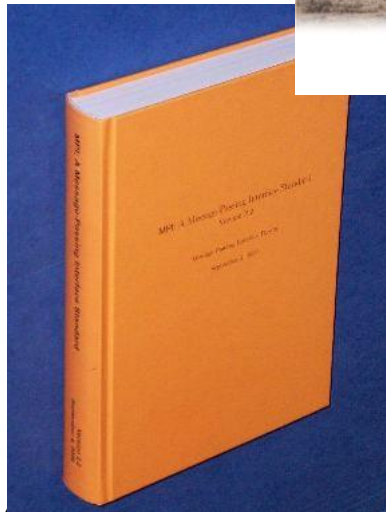
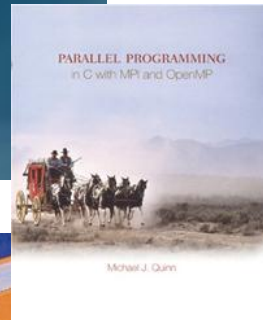
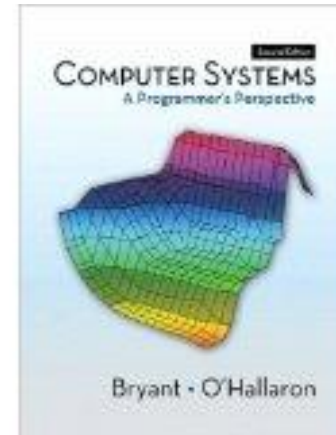
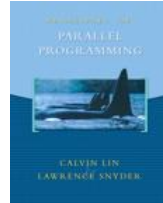
Chandra, Dagum et al.: Parallel Programming in OpenMP. Morgan Kaufmann, 2001

Barbara Chapman, Gabriele Jost, Ruud van der Pas: Using OpenMP. MIT, 2008

MPI: A message-passing interface standard. Version 2.2
Message Passing Interface Forum, September 4, 2009.
www.mpi-forum.org/docs/docs.html

William Gropp, Ewing Lusk, Anthony Skjellum: Using MPI. MIT, 1999

David B. Kirk, Wen-mei Hwu: Programming massively parallel processors. Morgan Kaufmann, 2010



Systems, hardware - **under installation**

OpenMP

48-core AMD-based shared-memory cluster

MPI

36-node InfiniBand AMD-based 2x8 core cluster = 576 processor cores

Idea: access via ssh (instructions to follow), program at home/TU

Is lab access needed?

Schedule - **VERY TENTATIVE**

10.10: Intro, planning

13.10: Concepts, motivation

17.10: An example (merging), concepts

24.10: Shared-memory parallel programming

31.10: OpenMP

7.11: OpenMP

14.11: OpenMP

21.11: Distributed memory parallel programming

28.11: No lecture

5.12: MPI

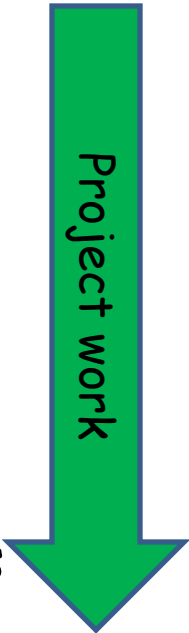
12.12: MPI

19.12: New architectures

9.1: Other parallel programming paradigms and interfaces

16.1: Project discussion

23.1: Project discussion



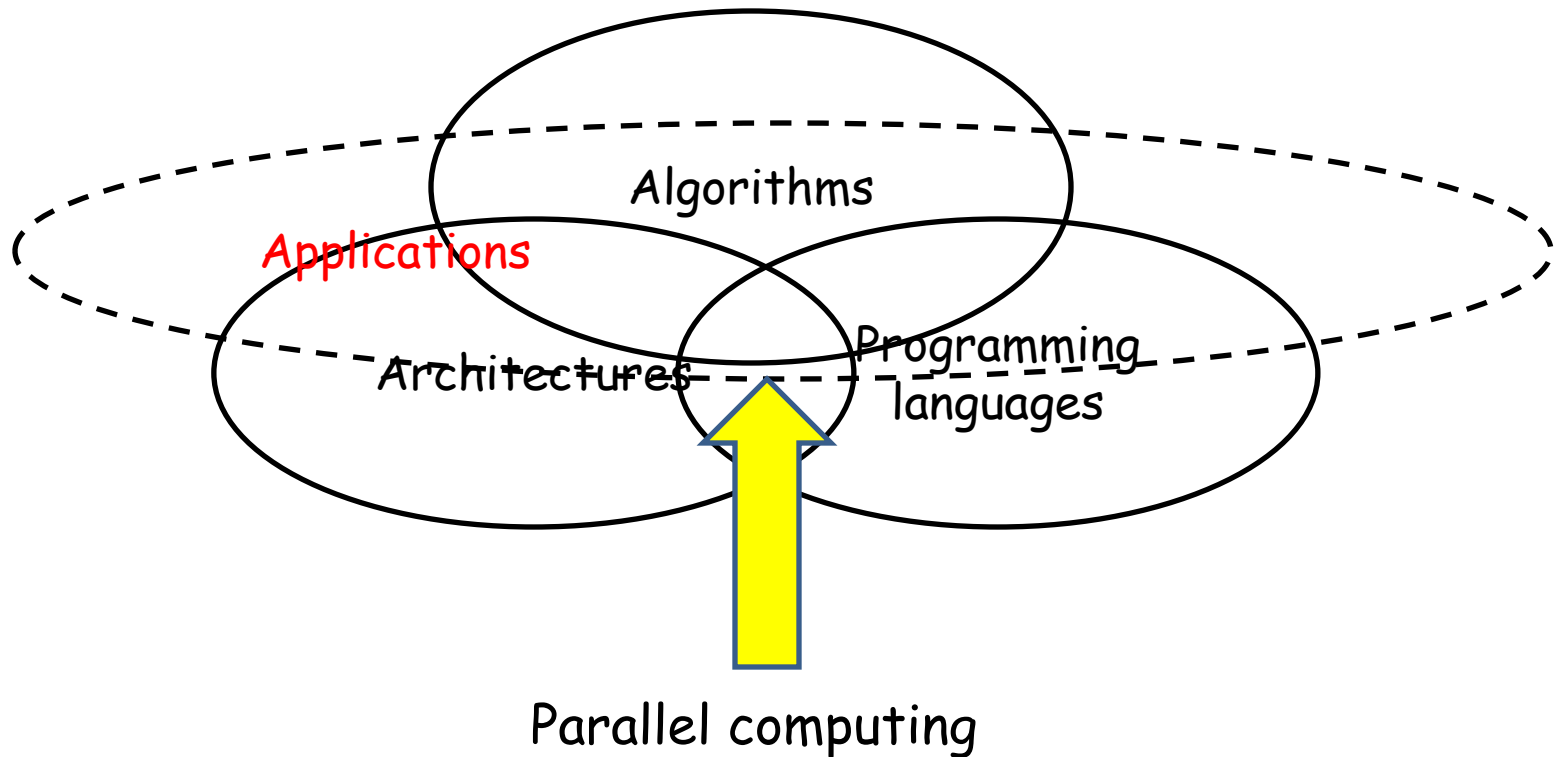
Project work

TU Wien Research Group Parallel Computing

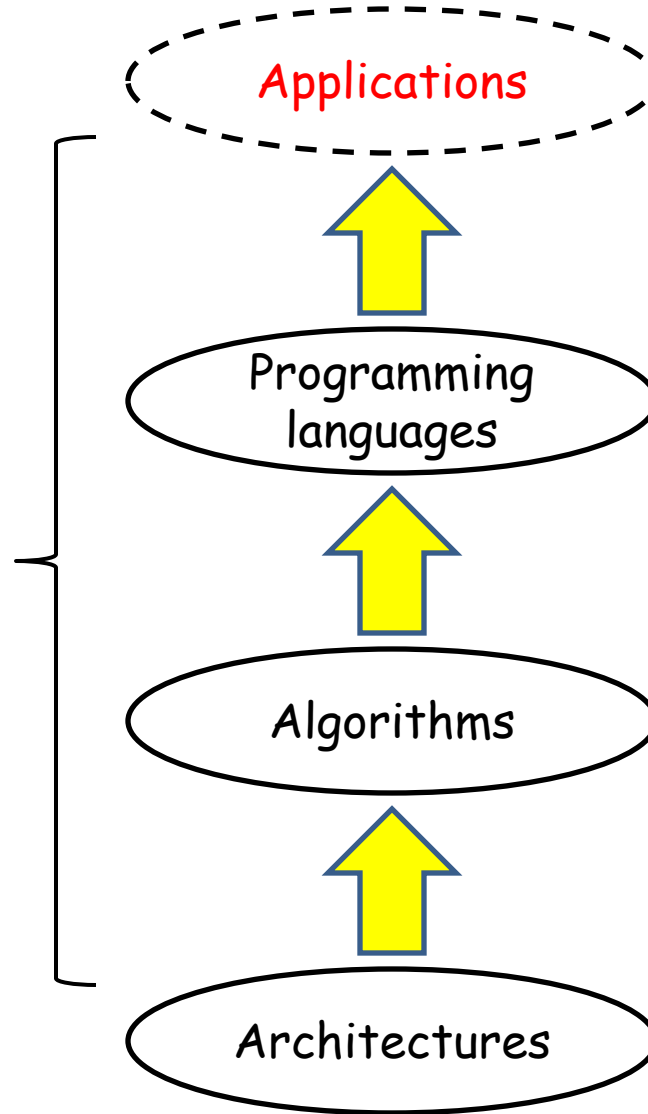
Themes

1. HPC languages, interfaces - algorithmic support and implementation
2. Interfaces for multi-core parallel computing - algorithmic support and implementation
3. Heterogeneous parallel computing: interfaces, autotuning, scheduling
4. Parallel algorithms

TU Wien Research Group Parallel Computing



TU Wien parallel
computing



Bachelor:

Bachelor thesis

VU Parallel Computing

Master:

Master's thesis
Project

VL Parallel Algorithms

- PRAM
- Network algorithms

VL Advanced Multiprocessor Programming

- Programming models, lock-free algorithms and data structures

VL High Performance Computing

SE Topics in Parallel Programming Models, Algorithms,
Architectures