High Performance Computing
„Vorbesprechung“: Planning, kick-off

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Sprechstunde: By email-appointment

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The takeaway

<table>
<thead>
<tr>
<th>Lecture:</th>
<th>Monday, 15:00-17:00, EI 1 Petritsch, old EI (now FAV 01A). Planned: Attendance mandatory. Reality: Online-distance</th>
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<td>Course HP+TUWEL (+TISS):</td>
<td><a href="http://www.par.tuwien.ac.at/teaching/2020w/184.725.html">http://www.par.tuwien.ac.at/teaching/2020w/184.725.html</a></td>
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What is this about: Efficient use of parallel computer systems

- What is High Performance Computing (HPC)?

- A topical overview of the “field”:
  - Systems
  - (Applications)
  - Measuring performance
  - Interfaces & Algorithms
  - Benchmarks, tools, libraries, algorithms
  - (File systems, parallel I/O)
  - (Linear algebra, solvers)
  - (Resilience, fault tolerance)
  - (Energy models)
  - (Machine learning, Analytics, “Big data”)
Content/outline this year:

1. Introduction, overview (what is?)
2. Measuring performance, data analysis
3. MPI Benchmarking
4. Interfaces and algorithms: Advanced MPI, implementing MPI, datatypes: 6-7 lectures
5. An MPI application: matrix-matrix multiplication
6. Research topics in MPI and related
7. Libraries, Benchmarks, Tools
8. MPI+X programming and models
Formalities

Lecture with two small projects (VU), in English

This year: Jesper Larsson Träff, Research Group Parallel Computing

4.5 ECTS = 112.5 hours of work

Breakdown:
• Lectures: 1.5 ECTS
• Projects: 2.0 ECTS
• Presentation&Exam: 1.0 ECTS

• Participation MANDATORY
• Credit/grade based on Projects + oral exam/presentation (2/3 and 1/3)
Detailed ECTS breakdown

- Planning, intro ("Vorbesprechung"): 1h
- Lectures: $15 \times 2h = 30h$
- Preparation: $15 \times 2.5h = 22.5h$
- Projects: $50h$
- Exam, including preparation: $9h$

Total: $112.5h = 4.5$ ECTS
Lectures (recordings):

Monday, 15:00 (s.t) - 17:00, EI 1, mandatory, active participation

Sign-up in TISS and TUWEL (deadline 2.11)

“Sprechstunde”: By appointment (there may be some real-time video-meetings, TBA)

Email:

traff@par.tuwien.ac.at
Detailed plan

05.10.2019: Preliminaries and Introduction
12.10: HPC Overview
19.10: HPC Overview
26.10: Advanced MPI 1/5
2.11: Measuring Performance and Data Analysis
9.11: MPI Benchmarking
16.11: Advanced MPI 2/5
23.11: Advanced MPI 3/5
30.11: Advanced MPI 4/5
7.12: Advanced MPI 5/5
14.12: Matrix-matrix multiplication with MPI

Christmas/New year break

11.1.2020: MPI Profiling and Tracing
18.1: Libraries and Benchmarks in HPC

25-29.1.20: Exam days

Project I (TBA)

Project II (TBA)
Projects

- Can be done in groups of ≤2
- Two projects (performance model, MPI)

Hand-in:
- Project 1: November-early December
- Project 2: Mid/End January 2019

LaTeX template will be available.
Follow instructions in TUWEL on how/what to hand in!!
Exam

- Oral exam based lecture material & project
- Individual
- Exam ca. $\frac{1}{2}$ hour
- Last January week, 25.-29.1.2021 (sign up from 11.1.2021, end 18.1.2021, sign off 16.1.21, see TISS)

Current situation: Oral or written exam, TBD
Credits/Grading

- Active participation
- Hand-in of projects
- Oral examination on lecture material/projects (ca. \(\frac{1}{2}\) hour)

Grade based on written hand-ins and exam

Doing project in group:

- Active collaboration, “2*100%”, NOT “2*50%”
- Both members get same grade (unless blatantly different)
- Both members must understand all aspects of solutions

Don’t forget to evaluate the course (TISS, after end of lecture)
NOTE:
• You only learn by doing project by yourself (in the group).
• Copying from somewhere ("plagiarism") will result in grade 5.
• Discussion with other groups encouraged, but hand in your own solution.

Grade weight: 2/3 projects, 1/3 oral exam

Both must be passed
New HPC server “hydra”

• 36 Compute nodes, dual-rail Intel Omnipath

• 2 48 Port H1048-OPF switches

Total 1152 cores/MPI processes

Intel Xeon 6130F (“skylake”), 2.1GHz, 2x16 cores, 96GByte main memory/node

Use with “slurm” from head node
System access

Get machine account via TUWEL (need 4K ssh-key, see instructions) exercise

**Deadline:** October 2020, TBA
Material, books

Slides and additional papers/material available from TUWEL and http://www.par.tuwien.ac.at/teaching/2020w/184.725.html

No good overview book of the field; most useful Hager&Wellein
General background

New:
TU Wien Introduction to Parallel Computing script
MPI, OpenMP usage, programming models, ...
Follow-up

- Projects (6.0 + 6.0 ECTS)
- Seminars in WS20, SS21, ...
- Seminar WS20, “Advanced constructs for shared-memory parallel programming”, Vorbesprechung October 2020, TBA
- Parallel Algorithms (WS20: VU, 3.0 ECTS)
- Advanced Multiprocessor Programming (SS21: VU, 4.5 ECTS)
- Master’s Thesis (30.0 ECTS)
- Talks in the group, everybody is welcome, see http://www.par.tuwien.ac.at/talks-guests.psp
Some HPC related Master’s thesis projects

• (MPI) datatype normalization (and performance)
• (MPI) datatypes as DAGs
• Efficient (MPI) datatype equivalence checking
• Dynamic programming for collective communication schedules

TI Research presentations, see https://ti.tuwien.ac.at/institute/teaching/ti-research-presentations/ti-research-presentation-dates

Vienna Scientific Cluster trainings (OpenMP, MPI, ...): http://typo3.vsc.ac.at/research/vsc-research-center/vsc-school-seminar/