

703308/703309 VO+PS High-Performance Computing

Where are the slides?

https://github.com/philippgs/uibk_hpc_25

or

<https://tinyurl.com/UIBKHPC25>






703308/703309 VO+PS High-Performance Computing Introduction & Administrative Stuff

Philipp Gschwandtner

Organizational stuff

▶ VO instructor information

- ▶ philipp.gschwandtner@uibk.ac.at
- ▶  philgs or room 2W05, ICT building
- ▶ no fixed office hours
(send an e-mail, I'm quite responsive...usually)
- ▶ Adhere to my communication rules!

▶ PS instructor information

- ▶ Abolfazl Younesi and myself
- ▶ abolfazl.younesi@uibk.ac.at

▶ dates and location

- ▶ see Ifu:online ([VO](#), [PS](#)) for exact dates
- ▶ generally:
 - ▶ lecture every Wednesday
10:45-12:30 in RR 15
 - ▶ proseminar every Wednesday
08:45-10:30 in RR 15

▶ Note the exceptions for November 19th – January 14th!

Communication rules

- ▶ Philipp (Gschwandtner (PhD))
- ▶ Use of LLMs (ChatGPT & Co)
 - ▶ “I hope this e-mail finds you well”
 - ▶ overly polite
 - ▶ very generic & lengthy
 - ▶ eloquent, over-the-top phrases
 - ▶ **wastes my time and yours**



<https://www.theatlantic.com/ideas/archive/2025/09/job-market-hell/684133/>

Communication rules cont'd

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<https://xkcd.com/1838/>

More organizational stuff

▶ prerequisites

- ▶ interest in parallel hardware, parallel programming and high-performance computing
- ▶ lecture: very little beyond that
- ▶ proseminar: + programming in C/C++

▶ language

- ▶ English

▶ content

- ▶ general concepts of parallel programming and its intricacies
 - ▶ concepts apply to almost all parallel programming models
 - ▶ as an example, we will mainly discuss MPI
 - ▶ there are countless others (OpenMP, Kokkos, CUDA, SYCL, TBB, Cilk, Pthreads, C++ STL, Charm++, X10, ...)
 - ▶ also bits and pieces of hardware every now and then
- ▶ guided tour
- ▶ Feel free to request topics!

Grading: Lecture

- ▶ no mandatory attendance
 - ▶ Note: not everything I say will be on the slides...
- ▶ single, written exam on January 28th 2026
 - ▶ multiple exercises with multiple points
 - ▶ standard grading scheme, $\geq 50\%$ for positive grade, 12.5% intervals between grades
 - ▶ Don't memorize the slides, understand the content!

Grading: Proseminar

- ▶ weekly assignments, published on GitHub
 - ▶ https://github.com/philippgs/uibk_hpc_25
- ▶ teamwork is permitted and encouraged
 - ▶ 3 people max. per team
 - ▶ **every** team member must be able to present and discuss solution
- ▶ solutions must be handed in via OLAT until Tuesday 17:00!
 - ▶ solutions **must work** on the LCC3 cluster
 - ▶ copying/generating solutions (e.g. off the Internet/LLMs) is acceptable **if properly cited and understood**
 - ▶ grade is 50 % solutions, 50 % presentations/discussion – both must be $\geq 50\%$!

Interaction & feedback

- ▶ platform for interaction outside of the PS/VO
 - ▶ <https://discord.gg/U53WkUbZKb>
- ▶ anonymous feedback possible via Google Form linked in OLAT

Literature

- ▶ **www.internet.com**

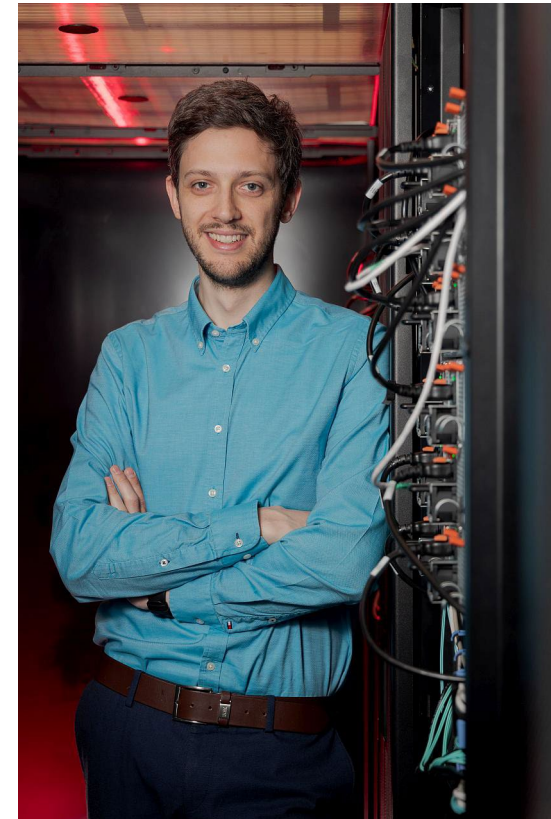
- ▶ MPI: A Message-Passing Interface Standard 5.0
(PDF available via <https://www.mpi-forum.org/>, hardcover of v3.1 available)
- ▶ <https://theartofhpc.com/>
- ▶ Stackoverflow
- ▶ Google
- ▶ ...

- ▶ **old school: Printed books**

- ▶ Let me know and I will look up some references...

Who is this speaker, what does he do besides teaching?

- ▶ Head of Research Center HPC (Forschungszentrum Hochleistungsrechnen), University of Innsbruck (<https://dps.uibk.ac.at/~philipp>, <https://uibk.ac.at/fz-hpc>)
 - ▶ Studied computer science @ UIBK, focus on parallel programming, benchmarking and tuning
- ▶ Research interests in and around HPC
 - ▶ Measurement/optimization/modeling of performance, energy, efficiency, ...
 - ▶ APIs, programming models, runtime systems, compilers, ...
- ▶ Aid researchers at UIBK in developing and optimizing parallel applications
 - ▶ (Co-)Writing HPC-focused project proposals
 - ▶ Making stuff go faster
 - ▶ Giving training course on how to make stuff go faster (OpenMP, MPI, etc.)
- ▶ **Supervising very exciting master theses!**



Extremely professional-looking
photo of Philipp Gschwandtner
(© Andreas Friedle)

What are we all doing here?

- ▶ discuss key concepts of parallel computing
 - ▶ hardware **and** software aspects
 - ▶ multiple non-functional aspects – there's more than just speed
 - ▶ portability, usability, maintainability, sustainability
- ▶ we still need to actually do some concrete work
 - ▶ (mostly) MPI for implementing and evaluating distributed-memory parallelism concepts
 - ▶ we'll use LCC3 for running experiments



What are we going to discuss?

- ▶ crash course on hardware and programming models
- ▶ introduction to MPI (and a bit of other APIs/models such as OpenMP?)
- ▶ tons of generic concepts at the example of MPI (and others) programs
 - ▶ metrics: performance, efficiency, scalability
 - ▶ problem partitioning, scheduling and load balancing
 - ▶ parallel program classification and characteristics
 - ▶ programmer productivity, debugging, profiling
 - ▶ ...

Hints (not only) for this course

- ▶ choose a suitable source code editor / IDE and choose it wisely!
- ▶ get acquainted with your toolchain
 - ▶ debuggers, version control (git), etc.
- ▶ use common sense and sanity checks!





Questions?

Image sources

- ▶ LCC3: <https://www.uibk.ac.at/zid/systeme/hpc-systeme/leo3/>
- ▶ Sandbox: <http://www.googblogs.com/open-sourcing-sandboxed-api/>