Seminar course

Accelerated Computing Systems

(aka “acc-systems”)

Preliminary meeting

https://dse.in.tum.de/

Dr. Atsushi Koshiba, Prof. Pramod Bhatotia

Course instructors

Chair of Distributed Systems & Operating Systems

https://dse.in.tum.de/team/

Dr. Atsushi Koshiba

Research Group Leader

Prof. Pramod Bhatotia

Professor

acc-systems: Seminar info

https://github.com/**TUM-DSE/seminars/**

slack

Communication:

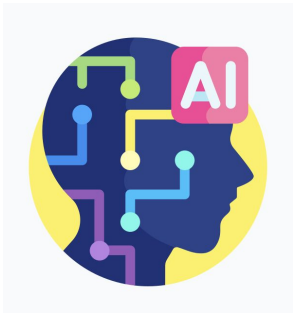
Join us with TUM email address (@tum.de)
ls1-courses-tum.slack.com
#ws-23-acc-systems

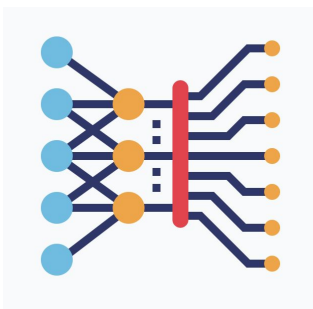
Context

The need for high performance computing

- The rise of AI is powered by **large-scale data-driven learning**
  - To meet the computational requirements of these modern workloads, we need **high-performance computing**

- ***Only* CPU-centric computing is still limiting**
  - We need large numbers of high performance cores!
  - Led to the rise of accelerators for compute-intensive, data-intensive tasks

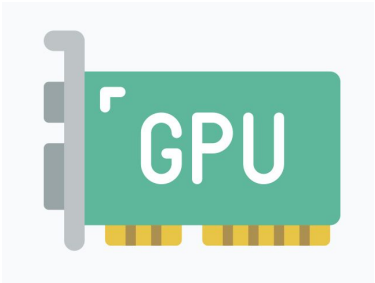




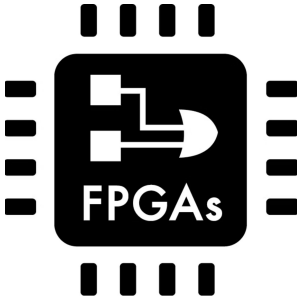
Hardware accelerators

- Optimized to accelerate a specific computation: 10x~100x faster than CPUs
  - Graphic processing units (GPUs)
  - Tensor processing units (TPUs) or specialized AI accelerators
  - Field processing gate arrays (FPGAs)

Question: how we can leverage accelerators in modern computer systems?



TPUs or
AI-specialized accelerators

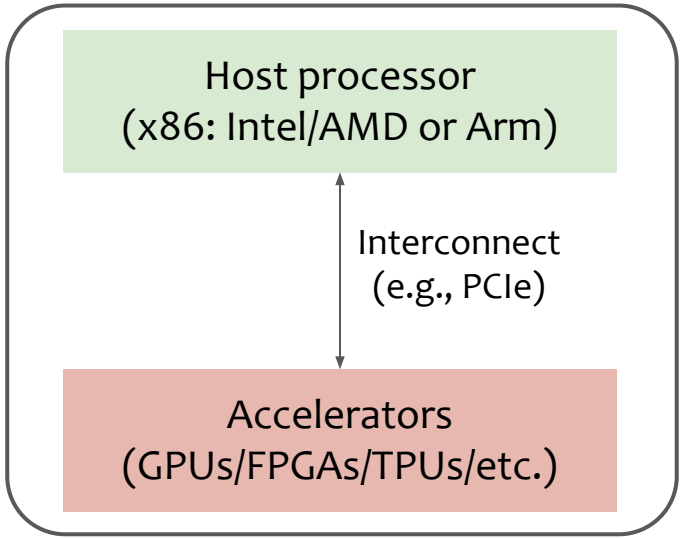


Accelerated computing systems

- **Accelerated computing** offloads compute-/data-intensive parts of a workload
  - Having separate types of accelerators is known as **heterogeneous computing**

- **Design challenges**
  - Programmability, portability
  - Performance
  - Security
  - Memory management
  - Synchronization
  - Resource isolation

Host code runs on a host processor (e.g.,filesystem, networking)

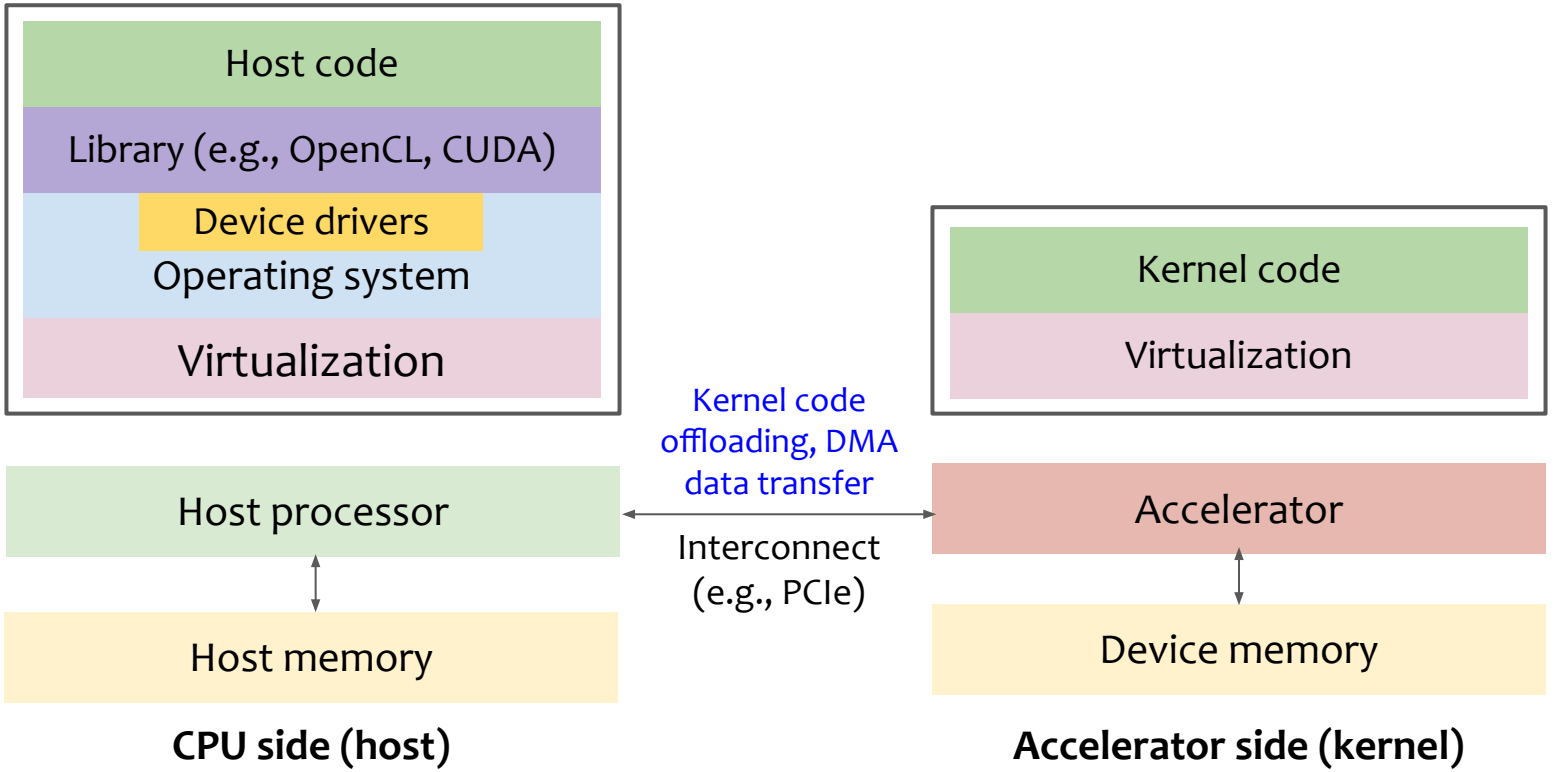


A server architecture w/ accelerators

Compute-intensive **"kernel" code** runs on the accelerators (e.g., training an AI model)

System stack

Accelerated computing systems comprises various SW/HW components



Tentative topics

Papers from top systems conferences: ASPLOS, OSDI, USENIX ATC, EuroSys, ISCA, and MICRO

Tentative topics
Virtualization for accelerators
Security for accelerators
Heterogeneous task scheduling
SmartNICs
Software-hardware co-design for accelerators
Hardware/OS support for heterogeneous computing
Near-data processing
Resource disaggregation
…

Format

Bird’s eyes view

Team
(2 students per team)

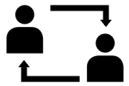
Research papers
(Top systems conferences)

Understand

Research ideas

1 presentation

1 short report



Peer-reviewing

Overview

Phase I

Kick-off

Phase II: Understand & explore

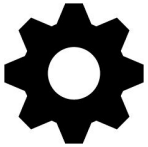
Understand

Presentation

Phase III: Research

Design

Implement (Bonus)



Phase IV: Report & review

Report

Peer-review

Phase I: Kick-off meeting

Format and motivation
(all participants meeting)

Team formation
(2 students per team)

Paper selection
(Top systems conferences)

The first week

NOTE

1. A list of papers will be provided for FCFS bidding
2. Paper presentation guidelines will be provided for the next phase

Phase II: Understand & explore

Understand the paper(s)

Focus

1. **Understand** the paper and related work
2. Also **explore** a "laundry list" of research ideas/directions

Paper presentation

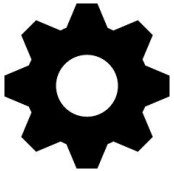
Focus

1. Explain the work/related work (**"why?"** and **"how?"**)
2. Explain and discuss all possible research directions
3. Pick a research direction

Phase III: Research

Research work

Focus:
Indepth research work to nail-down the problem and detailed approach to solve it!



Research prototype

Bonus:
(Optional)
"Build the system to solve it!" and show us the working idea and associated results

Phase IV: Report & review

Report

Focus

Prepare a single “short & sweet” report summarizing

(a) Paper

(b) Research work

Peer-review

Focus

Give constructive (positive and critical) feedback for

(a) Paper summary

(b) Research work

END.

Overall timeline

Phase I

Kick-off

Phase II: Understand & explore

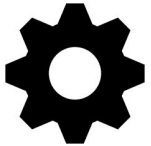
Understand

Presentation

Phase III: Research

Design

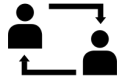
Implement (optional)



Phase IV: Report & review

Report

Peer-review



Milestone #1: Team formation & paper selection

Milestone #2: Paper presentations

Milestone #3: Research work complete

Milestone #4: Report submission

Milestone #5: Peer-reviewing

1 week | **3** weeks | **2** weeks | **3** weeks | **1** week | **2** weeks

Meeting **Meeting**

Organization

- Format
  - Team-based seminar course (2 students per team)
- Communication
  - Slack for announcements and information sharing
  - Hotcrp for report submission and peer-reviewing
- Meetings (**in-person, attendance is compulsory**)
  - **Meeting #1:** Kick-off
  - **Meeting #2:** Paper presentation

Learning goals

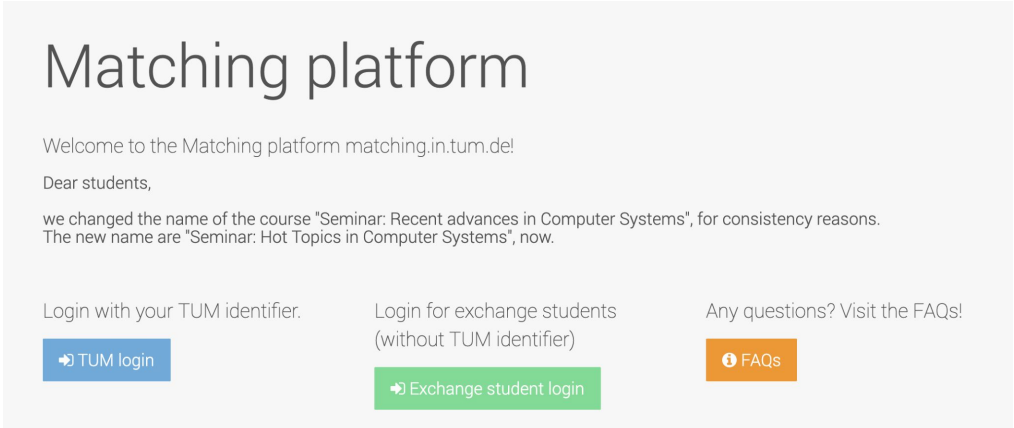
- Learn about the cutting-edge research in computer systems
- Promote critical thinking
- Cultivate an environment for innovation
  - To push the boundaries by advancing the state-of-the-art
- Improve scientific skills
  - Presentation
  - Writing
  - Communication: discussion and arguing
  - Mentorship: giving feedback and moderating discussion
- Encourage system building and evaluation
  - Learn by building, breaking, and benchmarking systems
- Importantly, to have fun!

Code of conduct

- University plagiarism policy
  - https://www.in.tum.de/en/current-students/administrative-matters/student-code-of-conduct/

- Decorum
  - Promote freedom of thoughts and open exchange of ideas
  - Cultivate dignity, understanding and mutual respect, and embrace diversity
  - Racism and bullying will not be tolerated

Interested?



Sign up on the TUM matching platform

Contacts

- Dr. Atsushi Koshiba
  - atsushi.koshiba@tum.de

- **All seminar-related info:** https://github.com/TUM-DSE/seminars

Workspace: http://ls1-courses-tum.slack.com/

Channel: #ss-25-acc-systems

Join us with TUM email address (@tum.de)