Democratizing AI Accelerators for HPC Applications: Challenges, Success, and Support

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Collaboration between

BDAI Team (Big Data Artificial Intelligence)
    Nicolay Hammer, Juan Durillo, Jophin John, Michael Hoffmann

FC Team (Future Computing)
    Josef Weidendorfer, Amir Raoofy, Arjun Parab

Context: HPC at LRZ

- Part of German GCS
  (Gauss Centre for Supercomputing)
  - Compute proposals to be granted
  - German / European
- Academics in Munich area

~ 2.000
Researchers

100s of projects
- Astrophysics, Particle Physics
- Chemistry / Material Science
- Comp. Fluid Dynamics / Eng.
- Environmental / Life Sciences

LRZ user base is diverse
- **codes often developed by users**
- **porting/tuning is not contributing to science, so often not in focus**

SuperMUC-NG
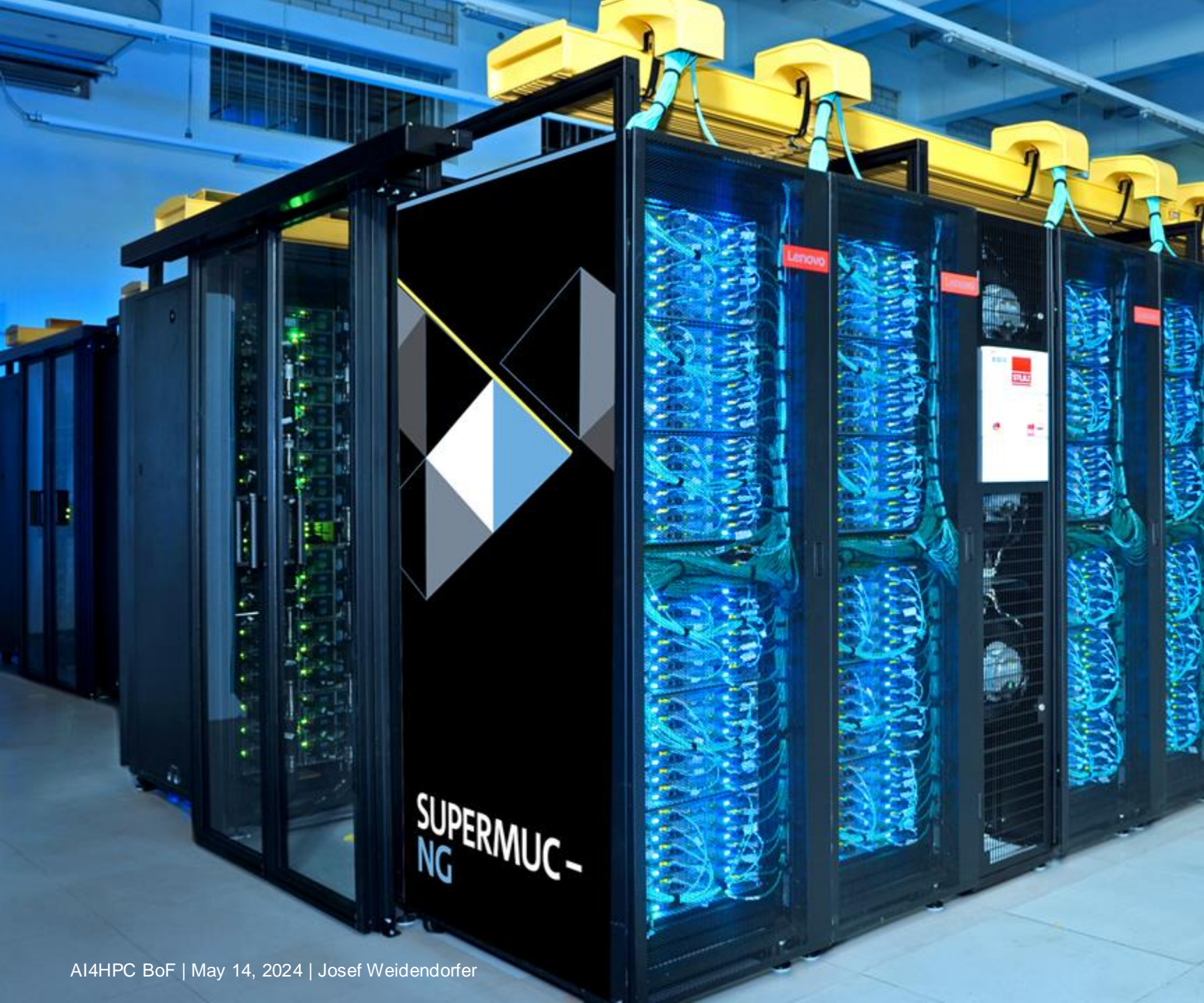Top500 - Nov 2018: #8
(Nov 2021: #23)

Lenovo Intel

311,040 cores
Intel Xeon Skylake

26.9 PetaFlops Peak

19.5 PetaFlops Linpack*

719 TeraByte Main Memory

70 PetaByte Disk

SuperMUC-NG Phase 2

![lrz logo]

Accelerated node architecture
- 2x Intel® Xeon® Platinum 8480L, 56 cores
- 4x Intel® Data Center GPU Max 1550
- 512 GB DDR5 main memory
- Lenovo's SD650-I v3 platform

Distributed asynchronous object storage (DAOS)

- 1 PB capacity
- > 750 GB/s write bandwidth

High speed interconnect

- Mellanox HDR Infiniband
- fat tree topology
- two uplinks per node
- separated from Phase 1

Integration

- Phase 1 accounts and HOME directories
- Phase 1 WORK and SCRATCH filesystems
- DSS volumes available
- direct warm water cooling

Efforts on Future Technologies: BEAST Experimental Environment

BEAST (Bavarian Energy Architecture Software Testbed)

- Evaluate recent hardware technology options for HPC and AI
  - CPUs : x86 (Intel / AMD), ARM (Marvell, Fujitsu, Nvidia GH)
  - GPUs : Nvidia (A-100/H-100), AMD (MI-100/200), Intel (PVC)
  - Special Purpose Accelerators : NextSilicon DataFlow, Cerebras WSE-2
- Other research infrastructure (FPGAs, Smart Network, Quantum Computing)

Efforts on Future Technologies: BEAST Experimental Environment

BEAST (Bavarian Energy Architecture Software Testbed)

- Benchmarking of hardware located at LRZ allows to understand
  - Performance for different domains (vs. vendor claims)
  - Power/Energy efficiency measurements (using LRZ monitoring solution DCDB)
  - Stability of Software Stack
  - Experience from selected friendly users
  - Effectiveness of vendor-provided support on hardware failures

Evaluation of Cerebras WSE-2 as part of BEAST

In Contact with 13 "Friendly" User Groups

HPC
2 (CFD, Data Mining)

NLP
6 (LLMs, …)

Computer Vision
5 (Medical, …)
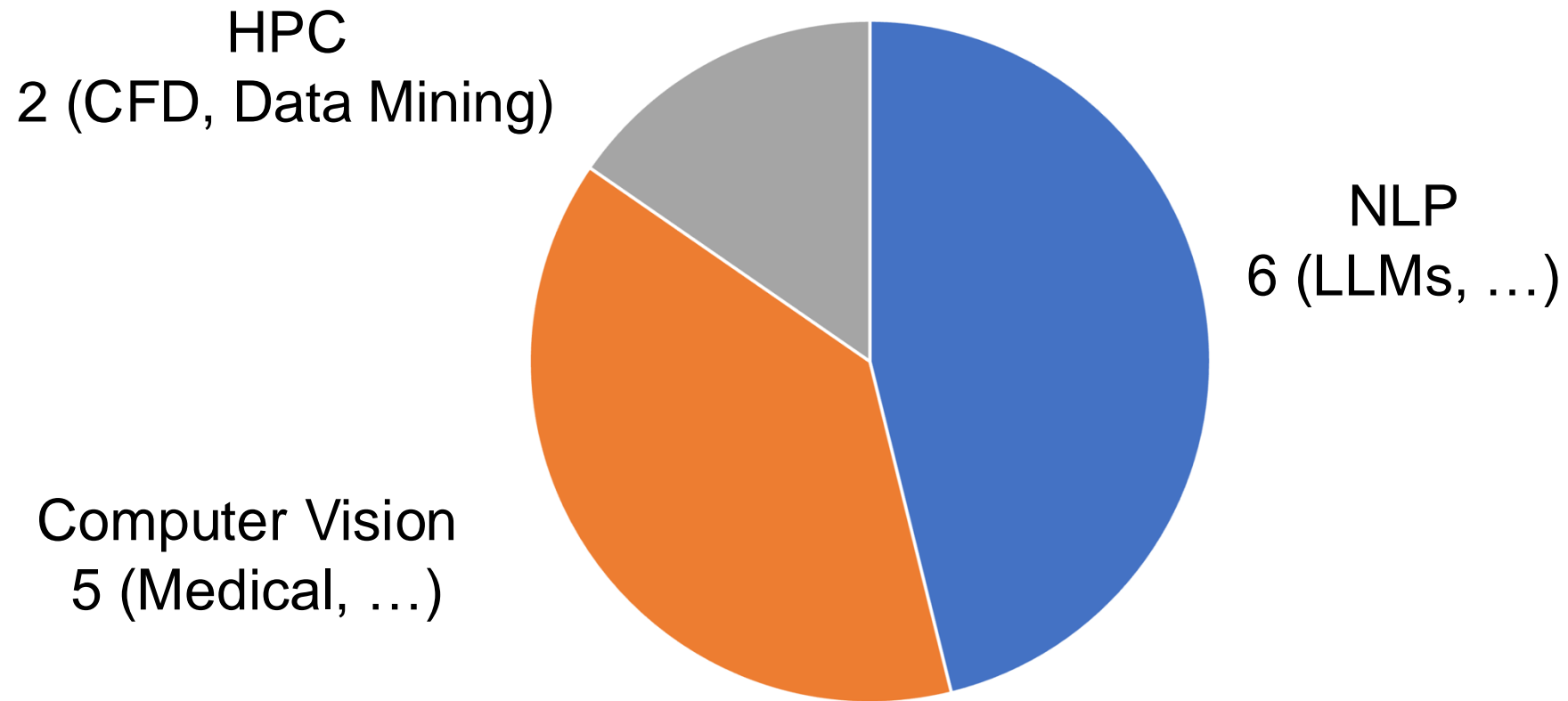
"Unconventional Usage" of Accelerators

Can we support HPC via AI Accelerators?

Why does anybody want to use an exotic AI HW for HPC?

- Exceptional On-Chip Memory Capability
  - Size
  - Bandwidth
- Huge number of cores on a single chip promise low-latency synchronization

- Unique architecture of WSE-2
  - 850000 cores
  - 40GBs on-chip SRAM
  - 20 PB/s memory bandwidth
  - Very high NoC bandwidth

Case Study (In Cooperation with TUM)

Master Thesis

- "Implementation and Evaluation of Matrix Profile Algorithms on the Cerebras Wafer-Scale Engine"
- Time Series Mining (Similarity Indexing)

- Matrix profile computations are usually performed on CPUs and GPUs using SCAMP library which is known to be fast
- Can we port SCAMP to CS-2 WSE?

- Experiments were conducted on the CS-2 of the EIDF (EPCC)

Case Study - Preliminary Take Away Lessons

- Cerebras's SDK and Documentation have matured over the study's time allowing to successfully port the SCAMP Kernel to CS-2

  - Functional port successful

  - No optimizations yet done about

    - on-chip data pipelining

    - data transfers to device

  - Challenge to make best use of on-chip per-core memory
    (both needed by code and data)

Is Cerebras WSE Usable for HPC?

Usecase Study

- First efforts promising

- More research required

- Default software stack may be difficult for HPC usage

General Perspective

- Ongoing evolution (CS-2 to CS-3)

- Expanded library and customer support enhances usability

- Continuous feature additions to the SDK