Computational Science on Many-Core Architectures

360.252

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Zoom Channel 621 2711 2607
Wednesday, October 11, 2023

Introducing Myself

Current Positions

- Lecturer at IμE (former Postdoctoral Researcher)
- Co-Founder and Managing Director at BrickXter GmbH

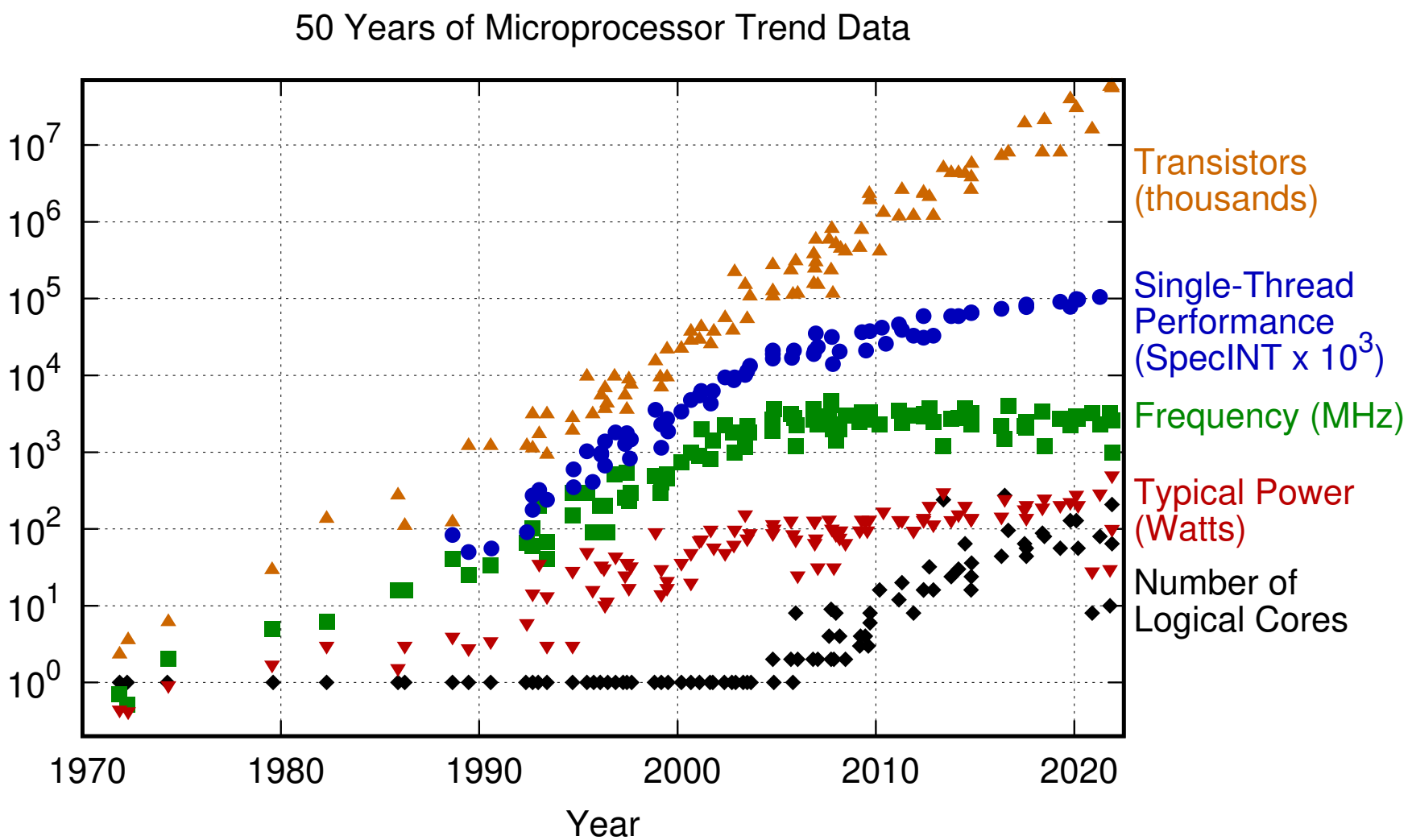
Professional Interests

- Efficient computation on modern hardware
- Semiconductor device simulation
- Industrial sensor applications (hardware + software)
- Making technology useful for “the average Joe”

Sideline Activities

- PETSc developer (`https://www.mcs.anl.gov/petsc/`)
- ViennaCL developer (`http://viennacl.sourceforge.net/`)

Introduction



Original data up to the year 2010 collected and plotted by M. Horowitz, F. Labonte, O. Shacham, K. Olukotun, L. Hammond, and C. Batten
New plot and data collected for 2010-2021 by K. Rupp

https://github.com/karlrupp/microprocessor-trend-data

Course Content

Subjects

- Ahmdal's Law
- FLOPs, Bandwidth, and Latency
- Performance Modeling
- Graphics Processing Units (SIMT processing, thread block sync)
- Programming Models (Annotation-driven as well as native)
- Field Programmable Gate Arrays
- Emerging Many-Core Architectures

Related CSE Courses

Term 1

- 360.242 - Numerical Simulation and Scientific Computing I
- 101.826 - Numerical Computation

Term 2

- 184.726 - Advanced Multiprocessor Programming
- 101.773 - Numerical Methods for PDEs

Course Objectives

Main Objective

Maximize students' useful knowledge
on using many-core architectures
within the available time

Modalities

- up to 13 sessions (45 minutes each), presence and virtual options
- up to 12 exercises (DIY-approach)
- Lecture and exercise material in TUWEL

Outcome

- Hands-on experience
- You will create some of the fastest GPU kernels in the world

Course Venue & Dates

Venue

- FH HS 7, Wednesdays, 17:00-18:00
- Video recordings (TUWEL)
- Zoom (meeting ID 621 2711 2607, passcode WS2023CSE)

Dates

- October 11 (introduction only), 18, 25
- November 8, 15, 22, 29
- December 6, 13, 20
- January 10, 17, 24 (backup)

Course Progression

Teach & Apply

- New subjects introduced via pre-recorded videos
- Clarify material and answer questions in course session
- Follow-up exercises to increase understanding

Timeline

- Week w: Material becomes available online (~ 2 blocks a 15 minutes)
- Week $w + 1$: Q&A in course session (Wednesday)
- Week $w + 2$: Exercises due (Tuesday night), discussion in course session
- Exception: $w = 0$

Inspiration

Tell me and I forget.
Teach me and I remember.
Involve me and I learn.

Benjamin Franklin

Grading

Part 1: Hands-On Exercises

- approx. 100 points over up to 12 exercises (excl. bonus points)
- approx. 40 percent of overall grade
- minimum of 50 percent of total points

Part 2: Oral exam

- oral exam (possibly virtual because of COVID-19)
- approx. 60 percent of overall grade
- “Fail” on oral exam means “Fail” on course

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Supplementary

Recordings

- Lectures will be recorded and posted in TUWEL
- Student questions will not be part of the recordings

Support Channels

- TISS forum (shared)
- Email me directly: `rupp@iue.tuwien.ac.at`

Office Hours

- *In Person* right after each lecture
- Monday, 18:00 - 19:00, Zoom Channel 621 2711 2607
- “ask me anything”

Exercises

Objective

- Apply and strengthen new skills
- Practice writing of technical reports
- Efficient communication of findings

Means

- Online programming environment (Exercise 2 and later)
- Explained in detail in next session

Deliverables

- PDF report, file name with student ID
- All relevant code (PDF appendix or zipped source files)

Feedback

- Individual feedback in text document for each student