

# PDC Summer School 2024 Welcome & Introduction

Prof. Stefano Markidis KTH Royal Institute of Technology



# Welcome to the PDC Summer School!

### Welcome to the PDC Summer School 2024!

- Hosted by PDC The HPC Center at KTH
- PDC Summer School is the most prestigious Scandinavian from 1995
- **Organizers:** Dr. Alessandra Villa, Dr. Niclas Jansson, and Prof. Stefano Markidis
- This summer school brings together experts, students, and professionals passionate about HPC and how to solve problems that require HPC!
- Objective:
  - Enhance your knowledge and skills in HPC through lectures, hands-on sessions, and collaborative learning.
- Opportunities:
  - Engage with cutting-edge HPC technologies and methodologies.
  - Network with peers and instructors from diverse backgrounds.



Dr. Alessandra Villa Dr. Niclas Jansson



Prof. Stefano Markidis



## About PDC – The HPC Center at KTH

#### • What is PDC?

- Leading High-Performance Computing (HPC) center at KTH Royal Institute of Technology since 1990.
- Supports cutting-edge research and innovation with advanced computing resources.
- **Mission:** Provide world-class HPC resources and expertise to academia and industry.
  - Foster collaboration and innovation in computational science and engineering.

### • Key Facilities:

- Supercomputers:
  - State-of-the-art systems (e.g., Dardel) with massive computational power.
- Storage Systems:
  - High-capacity storage for managing vast datasets.
- Expert Support:
  - Access to HPC experts for guidance and optimization.
- Impact:
  - Enables groundbreaking research in various fields, including physics, biology, and climate science.
  - Plays a crucial role in national (NAISS) and international HPC initiatives (EuroHPC).





## **Overview of the Summer** School

#### • Duration:

One week

### • Target Audience:

 Researchers, Ph.D. students, and professionals interested in High-Performance Computing (HPC)

### • Format:

Combination of lectures and hands-on sessions

### • Goals:

- Equip participants with practical skills in HPC programming and software engineering
- Deepen understanding of HPC architecture and technologies
- Foster collaboration and knowledge sharing among participants

### Learning Outcomes:

- Master core concepts of HPC, including OpenMP, GPU programming, and MPI
- Gain experience with tools and techniques used in HPC environments
- Build a foundation for future research or career development in scientific computing and HPC





## **Topics We Will Cover**

HPC Architecture:	Overview of high-performance computing systems and their components
	Understanding processors, memory hierarchies, and interconnects
Research Software Engineering:	Best practices for developing and optimizing software for HPC environments
	Debugging and profiling HPC applications
	Introduction to parallel programming models and paradigms
OpenMP:	Introduction to shared-memory parallel programming
	Writing and optimizing parallel code with OpenMP
	Practical examples and exercises
GPU Programming:	Introduction to Graphics Processing Units (GPUs) for HPC
	Programming AMD GPUs on Dardel
	Techniques for optimizing GPU performance
MPI (Message Passing Interface): –	Fundamentals of distributed-memory parallel programming
	Writing MPI programs



# **Daily Schedule at a Glance**

### • Day 1:

- Morning: Introduction to Computer Architecture
- Afternoon: Research Software Engineering for HPC
- Day 2:
  - Morning: OpenMP-CPU / GPU Architecture and Programming Models Overview
  - Afternoon: OpenMP-GPU / Performance Analysis: Methodology, Tools, and Metrics
- Day 3:
  - Morning: Introductory Programming of AMD GPUs with HIP
  - Afternoon: Advanced GPU Programming, Debugging, and Profiling / Portability Across GPU Architectures and Programming Languages
- Day 4:
  - Morning: Distributed Memory Computing Introduction to MPI
  - Afternoon: Distributed Memory Computing Introduction to MPI
- Day 5:
  - Morning: Distributed Memory Computing Introduction to MPI
  - Afternoon: Distributed Memory Computing Introduction to MPI / Dardel MPI Tools
  - + Talks on HPC scientific use cases



## **Course Instructors**

- Prof. Ana Lucia Varbanescu. Focus: HPC Computer Architecture.
  - Affiliation: University of Twente
- Dr. Radovan Bast. Focus: Research Software Engineering.
  - Affiliation: University of Tromsø (UiT)
- Dr. Niclas Jansson. Focus: OpenMP and Tools on MPI
  - Affiliation: KTH
- Dr. Tim Dykes and Dr. Harvey Richardson Focus GPU Programming
  - Affiliation: HPE
- Dr. Joan Vinyals Ylla Català
  - Affiliation: Barcelona Supercomputing Center
- Prof. Erwin Laure. Focus: MPI.
  - Affiliation: MPG and TUM





Ana Lucia Varbanescu

**Erwin Laure** 





Radovan Bast

Joan Vinyals Ylla Català





# What to Expect from This Week

- Hands-On Learning:
  - Practical exercises and coding sessions to apply theoretical concepts
  - Access to HPC resources for real-world experience

### Interactive Sessions:

- Engaging lectures with opportunities for questions and discussions
- Group activities and collaborative problem-solving
- Networking Opportunities:
  - Meet and connect with peers, instructors, and experts
- Support and Resources:
  - Access to mentors and instructors for guidance and assistance
  - Materials, including slides, code examples, and reference documents
- Skill Development:
  - Enhance practical skills in HPC programming and software engineering
  - Gain insights into advanced HPC technologies and methodologies



## **Important Information**

#### • Venue:

- In-Person: E2, Osquars backe 2, KTH Main Campus
- Join PDC Summer School Slack: https://join.slack.com/t/pdcsummerschool2024/shared\_invite/zt-2p1iits41-IO9IQuFQ80PW05UyXSyq7A
- Schedule:
  - Start Date: August 19, End Date: August 23
- Daily Timings: 8.30 17.00
- Materials Provided:
  - Slides: Available for download or access online
  - Software: Instructions and access to necessary HPC tools
- Visit the Dardel Machine Room on Tue and Wed at 17:00.
- Wireless connection: eduroam (KTH Open available; ask PDC support)
- Contact Information:
  - For Questions: Slack Channel
  - PDC support at <a href="mailto:support@pdc.kth.se">support@pdc.kth.se</a>
- You will be provided with a certificate of attendance on Friday make sure to attend
  - PhD credits are only awarded to Ph.D. Students require the completion of course project see a close section at 11:30







# Welcome Once Again!

### • Engagement:

- Actively participate in all activities and share your experiences with others.
- Ask questions and seek support from instructors and peers.

## • Networking:

- Connect with fellow participants and build valuable professional relationships.
- Engage with speakers and mentors to gain additional insights and advice.
- Feedback:
  - Your feedback is important for improving future events. Be open to providing your thoughts throughout the week and on Friday with a survey .

Have a productive and enjoyable week of learning. Let's make the most of this experience together!