LORENZO CARPENTIERI

Curriculum Vitae - 19th March 2023

PERSONAL INFORMATION

Name: Lorenzo Carpentieri
Date of Birth: 17th February 1999
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EDUCATION

University of Salerno Fisciano, SA
PhD student in Computer Science 2022 - currently
Supervisor: *Biagio Cosenza*
Research Area: Approximate Computing applied to High-Performance Computing (HPC)

University of Salerno Fisciano, SA
Master's degree (M.SC.) in Computer Science 2020 - 2022
Graduation thesis in High Performance Computing
Thesis: A Performance Portability Study of SYCL Programs: from Micro-Benchmarks to a Drug-Discovery Industrial Application
***grade* 110/110 cum laude**
Academic advisor: *Biagio Cosenza*

University of Salerno Fisciano, SA
Bachelor's degree in Computer Science 2017 - 2020
***grade* 110/110 cum laude**
Academic advisor: *Amelia Giuseppina Nobile*
Thesis: Reti tandem e analisi delle loro misure prestazionali

RESEARCH ACTIVITY AND WORK EXPERIENCE

Scholarship for carrying out research activities February 2021 - October 2022
University of Salerno - Fisciano (SA), Italy
Acceleration of drug discovery codes for high-performance and heterogeneous compute clusters within C++ and SYCL.

PhD student at University of Salerno November 2022 - currently
Main research topics: High-Performance Computing, Approximate computing, Programming Models and Compilers.
Academic advisor: Prof. Biagio Cosenza

ACADEMIC AND/OR PROFESSIONAL QUALIFICATION

Academic Tutor February 2021 - September 2022
University of Salerno - Fisciano (SA), Italy
I completed the 120-hour assignment as a Tutor for students with disabilities by teaching Programming and Data Structures, Database, and Distributed Programming.

RELEVANT PUBLICATIONS

Paper: SYprox: Combining Host and Device Perforation with Mixed Precision Approximation on Heterogeneous Architectures
Authors: Lorenzo Carpentieri, Biagio Cosenza;
Internetional Conference on Supercomputing (ICS25).

Paper: Phase-based Frequency Scaling for Energy-efficient Heterogeneous Computing
Authors: Lorenzo Carpentieri, Antonio De Caro, Majid Salimi Beni, Kaijie Fan, Biagio Cosenza;
International Parallel & Distributed Processing Symposium(IPDPS25).

Paper: SYnergy: Fine-grained Energy-Efficient Heterogeneous Computing for Scalable Energy Saving
Authors: Kaijie Fan, Marco D'Antonio, Lorenzo Carpentieri, Biagio Cosenza, Federico Ficarelli, Daniele Cesarini
Conference: Super Computing (SC).

Paper: Domain-Specific Energy Modeling for Drug Discovery and Magnetohydrodynamics Applications
Authors: Lorenzo Carpentieri et al.
Workshop: The 1st International Workshop on the Environmental Sustainability of High-Performance Software (SHiPS23).

Deliverable: *EuroHPC project LIGATE*
Deliverable D1.3 – Portability analysis and Continuous Validation of the Methodology
Deliverable D2.3 – Intermediate run-time and auto-tuning framework

PERSONAL SKILLS

Organisational / Managerial Skills

Management and Scheduling Thanks to the PhD work activities and the exams carried out, I could improve my ability to organize work to meet deadlines. Both in preparation for exams and in work, I have shown good ability organization, always accomplishing the assigned tasks as well as possible. Especially during the Scholarship project and PhD research activity.

Communication Skills

Communication During my studies and research activity, I've had the opportunity to develop good communication and interpersonal skills that have allowed me to participate in the realization of numerous projects thanks to which I have developed a constructive attitude, an excellent ability to adapt, and considerable ability in job management.

Job related Skills

C/C++	●●●●●	Java	●●●●○
JavaScript	●●●◐○	R	●●○○○
SQL	●●●○○	Python	●●●○○

Programming Models: SYCL, OpenCL, CUDA, OpenMP, MPI.
Technologies: Relational Databases, NoSQL Databases (MongoDB and Neo4J), Docker, SLURM, Git.
Security tools: Penetration testing tools offered by Kali Linux. Forensics tools such as DC3DD for data acquisition; Foremost, Scalpel for data carving; Autopsy, TSK, and Volatility Framework for analysis.

OTHER INFORMATION

Languages

Italian
Mother tongue

English
Listening — B2
Reading — B2
Spoken interaction — B2
Spoken production — B2
Writing — B2

Università degli Studi di Salerno
Centro Linguistico di Ateneo
June 2021

ACADEMIC PROJECTS

A Performance Portability Study of SYCL Programs from Micro-Benchmarks to a Drug-Discovery Industrial Application

My Master's thesis work focused on analyzing the performance portability of SYCL applications and investigates the challenges of porting an application from CUDA to SYCL. For this purpose, I have implemented a micro-benchmark and performed the CUDA-to-SYCL porting of the LiGen application, which is a real-world drug discovery application. Through the performance portability evaluation of the developed micro-benchmark, I highlighted the differences between the two SYCL implementations hipSYCL and Intel DPC++. The final step of the thesis has been focused on a performance portability study on LiGen a large-scale industrial application for drug discovery. This step includes also the porting from CUDA to SYCL of LiGen. Preliminary performance portability evaluation shows that LiGen v4.0 achieves a performance portability value of 56.17% and a loss of 48% compared to the CUDA manually-tuned version.

Approaching the Reduction Operation Using NVIDIA Cooperative Groups

My colleagues and I investigated the CUDA toolkit features during the High-Performance Computing course, focusing on applying the Cooperative Groups feature to the commutative reduction operation, a fundamental step in many algorithms. We assessed the influence of this feature on performance by creating several implementations and comparing them to state-of-the-art solutions. The benchmark's final result revealed that adopting Cooperative Groups features had no significant influence on performance.

SYprox: a SYCL API for Approximate Computing

SYprox is a SYCL-based API supporting a broad set of approximation techniques in modern C++. SYprox introduces a set of semantics that extend SYCL's buffers and accessors to provide a high-level easy-to-use programming API. It supports data perforation and elision patterns for efficient approximation, as well as signal reconstruction algorithms for error mitigation.

SYnergy: a SYCL API for Energy Profiling and Frequency Scaling
SYnergy provides a common interface that allows energy profiling and frequency scaling on different vendor devices, that would otherwise require the developer to deal with vendor-specific libraries. The API is released as a header-only library that can be integrated into an existing C++ building environment using cmake. The API has been implemented for NVIDIA and AMD GPU devices, thus respectively wrapping the NVML and ROCm SMI libraries used for managing the available devices on a node.

LiGen: Ligand Generator
LiGen is a suite of programs for drug discovery with the aim of finding a set of ligands that have a strong interaction with the protein. During my research scholarship, I ported the CUDA "LiGen" code to SYCL by providing performance portability and energy analysis evaluation.

Sycl-bench
SYCL-Bench is a versatile benchmark suite written in SYCL. The main goal of SYCL-Bench is to evaluate the performance of both devices and different SYCL implementations. I contributed to the integration of the SYnergy library in sycl-bench in order to have not only an evaluation of the performance but also of the energy consumption of the applications. In addition, I have updated existing applications to SYCL 2020 and expanded the suite with new applications.

Toy compiler:
My colleagues and I developed a source-to-source toy compiler addressing the stages of compiler development from lexical analysis to intermediate code generation.

MyTutor
MyTutor was developed for the Software Engineering course to digitalize and speed up the procedure for requesting the Help Teaching activities at the Computer Science Department of the University of Salerno.

PRIVACY TREATMENT & SIGNATURE

I give consent to process my data with the purpose of the recruitment process, in accordance to the Regulation of the European Parliament 679/2016, regarding the protection of natural persons and free movement of such data.

Fisciano, 19/03/2023
Signature