UNIVERSIDAD DEL BÍO-BÍO
FACULTAD DE CIENCIAS EMPRESARIALES

Heterogeneous Computing

Professor: Dr. Joel Fuentes - jfuentes@ubiobio.cl

Teaching Assistants:
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Course Website: http://www.face.ubiobio.cl/~jfuentes/classes/hc

About us

- Joel Fuentes
  - Ph.D. in Computer Science. (University of California, Irvine 2014-2019), Postdoc at Intel (2019-2020)
  - Research field: High-performance algorithms, compilers, and accelerators (GPUs, TPUs, multi-core CPUs, etc.)
- Daniel López
  - Civil Engineering in Computer Science student, 5th year.
  - Civil Engineering in Computer Science Master's Degree student, 1st year.
- Sebastián González
  - Civil Engineering in Computer Science student, 4th year.

About the course

- Originates thanks to a partnership with Intel
- The first course of its kind in Latin America
- Students from
  - Civil Engineering in Computer Science (Chillán and Concepción)
  - Computer Science and Computer Engineering (Concepción)
- A paper will be written about the contents and the experience of this course
- All the resources will be available in both english and spanish
  - http://www.face.ubiobio.cl/~jfuentes/classes/ch
  - http://www.face.ubiobio.cl/~jfuentes/classes/hc

About the course

- Contents in the context of
  - Modern processors and accelerators
  - Programming languages (Data Parallel C++, CUDA, OpenMP)
  - Optimization and performance
- Hands-on work with real-life accelerators and processors
  - DevCloud access
  - Servers with multi-core CPUs, GPUs, and FPGAs from different vendors
- We'll host talks featuring distinguished researchers and developers

About the course

- Elective theoretical-practical course for fifth-year students, where you'll learn concepts, design strategies, tools, and necessary APIs for the creation of algorithms in different types of heterogeneous architectures: CPUs, GPUs, and FPGAs.
- Contributes to the following competences to the graduate's profile:
  - GC.1
  - GC.2
  - GC.3
  - GC.4

Learning goals

Evaluate comparatively sequential and parallel algorithms for different types of heterogeneous architectures such as CPUs, GPUs, and FPGAs; differentiating characteristics from computational and energetic efficiency.

Learning goals:

- LG1. Analyzes advantages and disadvantages of developing algorithms for heterogeneous architectures such as CPUs, GPUs, and FPGAs.
- LG2. Determines the most effective parallelism technique for a given problem, based on its algorithmic nature, parallelism complexity, and computational architecture.
- LG3. Builds algorithms for heterogeneous architectures based on a determined methodology, measuring its computational efficiency.

Planning - Syllabus

- Contents split across four units:
  - Heterogeneous Architectures
  - Programming Models
  - Algorithms
  - Optimization and performance

Planning

- Heterogeneous Architectures
  - 2 weeks
  - Exam at the end of the unit
- Programming models
  - 6 weeks
  - 1 laboratory
  - Exam at the end of the unit
- Algorithms
  - 4 weeks
  - 1 laboratory
  - Exam at the end of the unit
- Optimization and Performance
  - 3 weeks
  - Exam at the end of the unit

Assessments

- Exams at the end of the unit(4) 40%
- Labs (2) 20%
- Final Project 40%

Important dates

- Exams at the end of the unit (4)
  - Exam 1 — 20/09/2021
  - Exam 2 — 09/11/2021
  - Exam 3 — 07/12/2021
  - Exam 4 — 03/01/2022
- Laboratories (2)
  - Lab 1 — 25/10/2021
  - Lab 2 — 29/11/2021
- Final Project
  - First review — 22/11/2021
  - Final review — 04/01/2022

Schedule and platforms

- Schedule
  - Mondays 10:20 AM - 12:30 PM.
  - Tuesdays 4:20 - 5:50 PM.
- Online platforms
  - M. Teams
  - Course Webpage
    - http://www.face.ubiobio.cl/~jfuentes/classes/ch
    - http://www.face.ubiobio.cl/~jfuentes/classes/hc

Bibliography and resources

- Almeida, F., Giménez, D., Mantas, J. M., & Vidal, A. M. (2008). Introducción a la programación paralela. Thompson Paraninfo.
- Silveira, A., Avila, R. B., Barreto, M. E., & Navaux, P. O. A. (2000). DPC++: Object-Oriented Programming Applied to Cluster Computing. In PDPTA.
- Reinders, J., Ashbaugh, B., Brodman, J., Kinsner, M., Pennycook, J., & Tian, X. (2021). Data Parallel C++: Mastering DPC++ for Programming of Heterogeneous Systems using C++ and SYCL (p. 548). Springer Nature.
- Fox, G. C., Williams, R. D., & Messina, G. C. (2014). Parallel computing works!. Elsevier.
- Padua, D. (Ed.). (2011). Encyclopedia of parallel computing. Springer Science & Business Media.
- Herlihy, M., Shavit, N., Luchangco, V., & Spear, M. (2020). The art of multiprocessor programming. Newnes.