TEACHING HPC IN DEVELOPING COUNTRIES: A CASE STUDY IN MEXICAN UNIVERSITIES

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Motivation
Motivation

- Most of students in Mexican Universities
Motivation

Most of students in Mexican Universities
Related work

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HPC in undergraduate

Curricula

Infrastructure

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Our case study
Challenges of teaching HPC in our case study

- HPC infrastructure
- Parallel programming (with no infrastructure)
- Domain specific problems
- COVID-19
Strategies to incorporate HPC into the universities of the case study

- Design of an effective infrastructure
- Development of parallel/distributed programs
- Domain specific problems
- Teaching HPC in the COVID-19 era
Design of an effective infrastructure

- Design of a Beowulf cluster
Design of an effective infrastructure

- Students of Universidad del Caribe use a set of computers with Nvidia GeForce in specialized laboratories.
Design of an effective infrastructure

- Students of UADY, and ITM- Mérida use two servers with multi-core and GPU capabilities at CIMAT-Merida
  - *Intel Xeon Gold 5222*
    - 16 hyper-threading cores
    - NVIDIA Quadro RTX 8000 with 48GB RAM
  - *Intel(R) Core(TM) i9-9920X CPU*
    - 24 hyper-threading cores
    - NVIDIA TITAN RTX with 24GB RAM
Design of an effective infrastructure

■ Students of UADY, Universidad de Guanajuato and ITM- Mérida use the insurgente cluster at CIMAT
  - 32 servers
    ■ One master node and 31 Slave nodes
  - One GPU server
  - Five PS3 consoles
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

Universidad del Caribe
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study
- Object oriented programming
- Operation Research
- Design of the course “parallel computing”
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

- Course Parallel Computing
  - Introduction to parallel algorithms
  - GPU programming
  - Introduction to CUDA
  - Introduction to OpenCL

UADY
Universidad Autónoma de Yucatán
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study
  - Advanced topics for programming
  - Client/server programming
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

- Advance Programming and Parallel Computing Techniques
- CUDA programming
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

Universidad de Guanajuato
Guanajuato
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

- Parallel Computing
Domain specific problems

- Numerical methods
  - Comparison of sequential versus parallel implementation

- Video Processing
  - Implementation using CUDA of some concepts in Video Processing

- Computational geometry
  - Implementation of Convex Hull in Parallel using CUDA
Teaching HPC in the COVID-19 era

- Video conference platforms
- Detailed information of the practices
- Use of remote servers to perform the practices
Discussions and results

- Involving of students in HPC research projects
- Extracurricular external interactions
- Design of a new course
Involving of students in HPC research projects

- In 2015 students from Universidad del Caribe implementing a Bewful cluster
- In 2016 students from Universidad del Caribe replicated a load balancing in a Bewful cluster.
Involving of students in HPC research projects

- Video processing
  - Video colorization
  - Object tracking
  - Change detection
  - Binarization of a huge number of document and images
  - Traffic flow estimation from aerial video captures
Involving of students in HPC research projects

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Involving of students in HPC research projects

- **Image processing**
  - *Image restoration using GPU*
  - *Fluid dynamics simulation*
Involving of students in HPC research projects

- Video processing in a server
  - Counting ellipses
  - Counting edges
Involving of students in HPC research projects

- **Publication of research papers**
Involving of students in HPC research projects

- **Extra-curricular activities related to HPC**
  - SPI 2017-2021
  - Internship at CICESE in 2014 and 2015
Involved of students in HPC research projects

- Design of the course “selected topics of parallel programming”
  - *Introduction to parallel computing*
  - *Numerical solutions to equations using parallelism*
  - *Parallel combinatorial optimization*
Involving of students in HPC research projects

- Design of the course “selected topics of parallel programming”
  - Introduction to parallel computing
  - Numerical solutions to equations using parallelism
  - Parallel combinatorial optimization

- 45 practical hours
- 30 theoretical hours
- This course is offered in UADY since 2017 to date
Conclusion

- We highlighted the difficulties to incorporate HPC in the universities of the case of study
- We presented a set of strategies to overcome such difficulties
- As a consequence we listed some of the most relevant results of incorporating such strategies
Any questions?

Thank you!!!

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