HPC EDUCATION: WIDENING PARTICIPATION AND INCREASING SKILLS THROUGH CONTESTS, CHALLENGES AND EXTRA CURRICULAR LEARNING
FORMAT

- SIGHPC Introduction
- Speaker Questions
- 5 minute talks
  - David Macleod
  - Matthew Curry
  - Maciej Szpindler
  - Victor Sande
- Discussion
- Closing
ORGANIZATION

- Maciej Cytowski
- Alexander Ditter
- Scott Lathrop
- Benson Muite
- Nitin Sukhija
SIGHPC EDUCATION CHAPTER

OVERVIEW OF CHAPTER ACTIVITIES AND COMMITTEES

SLIDES COURTESY OF STEVEN GORDON
CHAPTER PURPOSE

- Promotion of interest in and knowledge of applications of High Performance Computing (HPC)
  - Promote knowledge and interest in scientific applications of HPC and related education and training
  - Provide a conduit for communications across the community
  - Provide information on quality education and training materials
  - Provide guidance on the competencies required for effective application of computational modeling and data analysis
CURRENT ORGANIZATION

- Five elected officers
  - Chair
  - Vice-Chair
  - Secretary-treasuries
  - Two at large members
- Ex-officio members
  - Several active members actively contributing to chapter activities
REACHING A BROAD COMMUNITY

- Extremely broad and diverse community of stakeholders
  - Faculty and students from elementary/primary school to graduate school
  - HPC centers and staff from individual institutions to nationally funded projects across multiple nations
  - Research centers and government labs
  - Industries that provide and use HPC services
- Challenge to provide mechanisms for widespread participation and avoid duplication of efforts
IMPLEMENTING ACTIVITIES

• Began with a growing set of chapter activities
  ▪ Webinars
  ▪ Participation in conferences
  ▪ Communications channels (website, blog, social media)
• Recent effort to expand the scope and broaden the participation in chapter efforts by the formation of four working committees
• Committee participation open to all who are interested
FOUR COMMITTEES

• Education Content Committee
  ▪ Charged with curating and making available educational material relating to computational science and HPC

• Workshop Committee
  ▪ Coordinate and manage the development and implementation of in-person and virtual events

• Outreach Committee
  ▪ Arranging and promoting a variety of communications mechanisms

• Computational Science Education Committee
  ▪ Develop strategies to incorporate and/or enhance computational science education at all levels of education.
WOW – HOW DO I JOIN?

- Committees currently have two co-chairs and an initial set of members
- More members are welcome
  - Send an email to officers@sighpceducation.acm.org
  - Indicate your contact information and which committee(s) you are interested in joining
  - Also looking for student participation
- Join the chapter to stay informed
  - Annual dues $10 for professionals and $5 for students
  - https://sighpceducation.acm.org/membership.html
SPEAKER QUESTIONS

• Introduction to your program
  ▪ Who have been the main participants?
  ▪ How long has it been running?

• Key lessons learned
  ▪ What makes it successful?
  ▪ What would you not do again?

• Thoughts for the future
  ▪ How would you like it to grow further?
  ▪ How do you expect to adapt to future changes in the HPC ecosystem?
DAVID MACLEOD

- Center for High Performance Computing
  - https://www.chpc.ac.za/
- South African Student Cluster Competition
- dmacleod@csir.co.za
CHPC Student Cluster Competition
ISC BoF on HPC Education
June 2018

David Macleod
Programme Goals

1. Expose as many students as possible to HPC while they still have time to adjust their studies
   a. Target younger undergraduates
   b. Host multiple rounds
   c. Only allow students to participate at ISC once

2. Increase the participation of students from families from previously disadvantaged communities
   a. Fully fund the programme for all students
   b. Enforce team diversity

3. Increase the participation of women
   a. Enforce team diversity

4. Produce students who are competitive at the ISC SCC
   a. Multiple competition rounds
   b. Multiple training trips
   c. Strong support from sponsors and partners
CHPC SCC Programme

Team Selection
- Identify potential mentors: February - March
- Application Period: Mid April to mid May
- Selection Round: Early July

National Competition
- Challenge Instructions Released: End August
- Cluster Designs Finalised: Mid October

International Competition
- Project Closing: Late July
- ISC Competition: Late June
- Local Training: March - June
- International Training: Late Jan early Feb
- National Competition: Early December
Participation & Interest

Students per Round
All Years Combined

Applicants: 801
Selection Round: 457
National Competition: 188
ISC Competition: 36
Participation by Universities

![Bar Chart showing participation by universities over years 2012 to 2018. Each year is represented with a series of bars indicating the proportion of participants from different universities. The universities are color-coded for easy identification.]
Team Diversity

Selection Round
Race Normalised

- Asian
- Indian
- Coloured
- White
- Black

Participants

Years

2012 2014 2016 2018

South Africa
Participation by Women

Selection Round
Sex Normalised

Years / Participants

75.00%

50.00%

25.00%

2013  2014  2015  2016  2017
ISC Student Cluster Competition

2013 - 1st Place

2014 - 1st Place

2015 - 2nd Place

2016 - 1st Place

2017 - 2nd Place

2018
Partners & Sponsors
Lessons Learned

The Obvious
1. Preparation is key
2. The more support at the university the better the team
3. It’s the small things that trip people up
4. Getting the equipment in advance of the competition makes competing much easier
5. Know what you want to achieve

Nice to Know
1. Driving transformation does not result in lower quality
2. Students will work extremely hard for a chance at a valuable experience
3. A team of young and inexperienced students does not make the team uncompetitive
4. Students want to give back to the programme

Stubborn Problems
1. Bridging the knowledge divide between students
2. Competitions move at the pace of the strongest team
3. The demand for the competition exceeds our capacity
4. What do you do with the students after the competition

How to Compete Successfully
1. Get committed support from academia, industry and government
2. Get the equipment you want
3. Do a quick and dirty first pass on all tasks then optimise
4. **READ THE INSTRUCTIONS**
Future Plans

1. Endorse and support SCC programmes at universities
2. Expand the competition to include students from other African countries
MATTHEW CURRY

• Sandia National Laboratory
  □ http://www.sandia.gov/
• New Mexico Supercomputing Challenge
• mlcurry@sandia.gov
About New Mexico

• Targeting New Mexico secondary school students
  • #45 in population density
    • 17.2 people sq. mi.
    • 6 people per sq. km
  • US News and World Report Rankings (out of 50)
    • #44 in median income
    • #50 in college readiness
    • #46 in economic strength
    • #44 in opportunity

• Home of multiple world-class government laboratories and universities
  • At least 9% of the Top500 FLOPS in the USA are located here

Image courtesy JimIrwin
https://commons.wikimedia.org/wiki/File:New_Mexico_population_map.png
The Supercomputing Challenge - Quick Facts

- Founded in 1990
- Project-based learning
  - Year-long program for completing computational science projects
  - Emphasis on modeling, simulation, technical writing, background research, and teamwork
- Rely on local research ecosystem
  - Los Alamos National Laboratory
  - Sandia National Laboratories
  - Regional universities, private businesses, and institutes
- 40% women, 53% minorities
- Holistic program - Involve teachers, students, and regional researchers
Key Lessons

• Volunteerism is extremely important
  • Hundreds of scientists volunteer at multiple events through the year

• ... but cannot solve all problems
  • Program management staff is invaluable

• Authentic assessment by domain experts is key

• Supporting teachers is necessary

• Recognize success in many dimensions

• Rigorously quantifying impact is challenging
  • Anecdotes abound, longitudinal data is rare
  • “The best time to plant a tree is twenty years ago. The second best time is now.”
Preparing for the Future

- Academically, focus on what’s timeless
  - Principles over technologies
  - Science over technology

- Strategically, keep moving forward
  - The Challenge has loyal sponsors, but no consistent funding stream
  - Need strategically minded board members
  - Need to constantly remind sponsors, legislators, and key decision makers of importance

- Expand impact
  - Interested in finding partners to expand/replicate program throughout USA
MACIEJ SZPINDLER

- University of Warsaw
  - http://icm.edu.pl/
- Activities
  - Hackathons
  - Polish Children's fund workshops
  - Student cluster competitions
- m.szpindler@icm.edu.pl
HPC EDUCATION AT THE UNIVERSITY OF WARSAW

University of Warsaw runs HPC centre for science (ICM UW). The centre serves regular academic course (Master course on computing engineering - not covered here).

Extra activities widening HPC knowledge:

- Workshop for the Polish Children’s Fund
- Hackathons "Programming Challenges"
- Student Cluster Competitions
WORKSHOPS FOR THE POLISH CHILDREN’S FUND

- The Fund gives scholarships for pre-university students skilled in the sciences, humanities, musics or ballet
- Instead of a financial aid, participants receive opportunity to participate in lectures, workshops and research projects in cooperation with scholars both from Poland and other countries
- Most of the scientific camps and workshops are devoted to a single discipline and have its further qualification, they are organized by various institutions including ICM UW, one workshops at ICM UW last about 5 days
- Participants: middle school and high school scholarship students, groups of 10-20
- Lead usually by the Fund's alumni (a number of them joined ICM UW staff)
- It is running for more than 10 years, one annual workshop at ICM UW
"PROGRAMMING CHALLENGES" HACKATHONS

- 24-hours hackathon on complex problem requiring substantial computational power to be solved. Parallel programming techniques are preferred. Proof-of-concept solution designed from scratch and demonstrated on HPC infrastructure.
- Problems attacked: “smart charge” - designing optimal EV charging stations locations over Poland; “map the gap” - designing fiber cable network for public internet access over Poland.
- Participants: university students, phd students and others (open formula); teams of 2-4.
- Lead by: Prof. Piotr Bała, bala@icm.edu.pl.
- Two annual editions completed.
“Warsaw Team” was formed to represent Polish students in Student Cluster Competitions.

- The team took part in SCC at ASC17 (China), SC17, ASC18 (not reaching the final), ISC18 and qualified for SC18.
- Received ministerial funding for 2017 competitions.
- Participants: college level university students, team composition evolves with 9 members.
- The team exists from late 2016.
- Lead by: Maciej Szpindler (originally Maciej Cytowski, now at Pawsey).
EXTRA EDUCATIONAL "PROGRAM"

• What is common for these activities:
  ▪ Target hard and inspiring problems using HPC techniques
  ▪ Ad-hoc approach, zero knowledge required
  ▪ Voluntary mentorship, individual or team based management
  ▪ Strengths development with competitive spirit

• What is different:
  ▪ Participants from early stage (Fund) to university and phd students (Hackathons)
  ▪ Scope of the activity
  ▪ Time frame: from 24-hours (Hackathon), couple of days (Fund's workshps) to months (SCC preparation)
  ▪ Project coordinators, their personalities
  ▪ Funding scheme
KEY LESSONS LEARNED

- Ambitious projects attract ambitious students
- Less control and guidance – surprising results
- Unconsciousness of the problem complexity sometimes leads to original and inspiring ideas
- Hermetic HPC methods and environments are often barrier at the beginning of the process
- It is essential to concentrate on problems not on hardware and tools
- Qualification/selection is necessary
- Care for team consistency
- Mentor or advisor need to be skilled or rely on experts to provide high quality knowledge
THOUGHTS FOR THE FUTURE

• Most inspiring result:
  ▪ **Julia** who participated once in the Children Fund workshop now returned to join SCC team (!)
• Close the circle having SCC advisor from the Fund alumnus
• Integrate the activities to achieve more synergy (not easy because of different coordinators and visions)
• Rely on more flexible environments (containers for example)
VICTOR SANDE

- CESGA
  - https://www.cesga.es/
- Spanish Parallel Programming Contest
- vsande@cesga.es
Spanish Parallel Programming Contest

Víctor Sande, ISC, Frankfurt, 2018
Spanish Parallel Programming Contest

- Parallel systems have gained popularity and have become the standard computer systems in many areas.
- The Spanish Parallel Programming Contest is organized to promote this type of programming among university students.
- The contest has an annual periodicity and is being performed since 2011.
- Problems, materials and platforms can be reused in other kind of educational activities (access luna.inf.um.es).
Spanish Parallel Programming Contest

Locations
# Spanish Parallel Programming Contest

## Past editions

(in the context of Jornadas Sarteco, Spanish meeting of parallelism groups)

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Spanish Parallel Programming Contest

- **Contest overview**
  - Start point
    - Several problems are provided to participants
    - A sequential solution per problem is also provided
  - Submission and evaluation
    - Automatic, adapted Mooshak system
    - Exclusive usage of resources
  - Scoring
    - Execution time measured (milliseconds)
    - Evaluation based on speed-up
    - No duplicated codes are admitted
    - More than 10 submits of the same problem decrease the score
Spanish Parallel Programming Contest

- **Stages**
  - Practice
    - In calisto.inf.um.es (quad core) OpenMP, MPI and MPI+OpenMP, the problems of all the editions
    - In mooshak.cesga.es (systems of CESGA, where the contest runs) OpenMP, MPI and CUDA, the problems of the last editions

- **Contest**
  - Overview
    - Solve a number of programming problems in a limited time
    - A sequential solution per problem is provided
    - Participants try to reduce the execution time
  - Modes
    - Exhibition
    - Competition
Spanish Parallel Programming Contest

Example of problems to be solved

- Characteristics
  - Simple problems with a well known algorithmic schema (pipe, synchronous, data parallelism...)
  - Participants work on parallelization and optimization for the computational system.

Examples of problems (2017)

- Displaced additions on a vector of floats
- Medians of each row in a matrix, for each median number of its multiples
- Multiplication of matrices with tails of zeros
- Maximum coincidence with a mask in 2D
- Maximum and subtraction in increasing blocks
- Iterations with rows falling
Spanish Parallel Programming Contest

- **Participants**
  - Practice
    - No restrictions
    - An account can be obtained for each contest by accessing mooshak.cesga.es or calisto.inf.um.es

- **Contest**
  - Exhibition
    - No restrictions
  - Competition
    - Spanish university students (Bsc, Msc, PHD)
    - Maximum of 28 years
    - Individual, classification test and final in-situ
Spanish Parallel Programming Contest

- **Technologies**
  - Compiler: GCC v6.1.0
  - OpenMP: v4.5
  - MPI: OpenMPI v2.0.0
  - CUDA: v7.5

- (Hybrid MPI+OpenMP not allowed)
Spanish Parallel Programming Contest

- **Hardware systems**
  - Practice (all the editions)
    - Quad Core in calisto.inf.um.es for OpenMP, MPI and MPI+OpenMP problems
  - Contest, in CESGA (also practice with contests of previous edition)
    - OpenMP
      - 2 Haswell 2680v3 nodes (24 cores/node)
    - MPI
      - 4 Haswell 2680v3 nodes (24 cores/node)
    - CUDA
      - NVIDIA Tesla K80
Spanish Parallel Programming Contest

- **Participants**
  - Warm-up and Qualification
    - Variable number per edition
    - Between 8 - 15 groups for classification
  - Contest
    - Variable number per edition
    - Between 5 - 10 groups for competition
## Spanish Parallel Programming Contest

- **Mooshak: Submissions**

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Page 1 of 9
# Spanish Parallel Programming Contest

- **Mooshak**: evaluation

## Table:

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DISCUSSION

POLL:
HTTPS://POLLEV.COM/SURVEYS/Z2QVATP25/WEB
CLOSING

• Join - http://sighpceducation.acm.org/
• Workshop at SC 18, submit a paper
• Thanks for your attendance