Incorporating High Performance Computing in a Physics Curriculum

Chris Harris[1], Maciej Cytowski[1], Nigel Marks[2], Andrew Rohl[2], Paul Hancock[2], Paolo Raiteri[2] and Igor Bray[2]

[1]Pawsey Supercomputer Centre, Perth, Western Australia
[2]Curtin University, Perth, Western Australia

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Introduction

challenges

- Much of science and industry now has a substantial HPC component
  - Physics is now an experimental and a computational science
  - HPC is often a destination of Physics students
  - School students: if I study Physics what job will I get?
    - The world would be a better place if run by physics graduates 
- HPC is rarely taught to science and engineering students:
  - Who will teach it?
  - What to take out to make room for HPC?
  - How to start, and ensure a common background for interested students?

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Who will teach HPC?

- Presently, many students teach themselves using resources provided by HPC Centers
  - Online workshops
  - GPU Hackathons
  - SIGHPC Education resources a great place to start
  - Impressive collaboration of HPC Centers in education
- Access to HPC Centers may be problematic
  - On-line portals being developed, e.g. AMP Gateway
- In-house expertise rarely spans the full range of HPC
  - A mix of in-house champions with HPC access seems a necessary requirement
  - Physics culture ideal for HPC education

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What to take out to make room for HPC?

- We have to be driven by what is best for the students
  - Success metric: career diversity of physics graduates
  - Physics students: “Jacks of all trades and masters of one”
- Many students, one physics major; compromise (optimisation) inevitable
  - Statements like “You can’t have a physics major without X” have to be addressed.
- Allowing for an HPC option may work at larger universities

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How to start?

- Need to have some computing courses in the early years of a physics major
- Can incorporate computation into existing courses:
  - “Advanced Computational Quantum Mechanics”
  - Ask mathematicians to add numerical computation
- Only then can HPC education be considered

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Physics at Curtin University

Western Australia is home to ASKAP, MWA, and SKA, and hence the Pawsey Supercomputer Centre.

- Physics at Curtin University is multicultural:
  - Mathematics
  - Computing
  - Physics: theoretical, computational and experimental
- Physics students have the background for HPC
  - Object Oriented Program Design
  - Unix and C Programming
  - Data Structures and Algorithms
  - Mathematics: pure, applied and computational

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HPC at Curtin University

organisation

- HPC at Curtin University is a partnership
  - Infrastructure and staff of the Pawsey Supercomputer Centre
  - Staff from Physics and Chemistry
- Taught as an Honours subject over 12 weeks
  - 2 hours/week content delivery
  - 2 hours/week practical implementation
  - 4 assignments, no exam
- Taken by Computing, Mathematics, Physics and Engineering students

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  - Supercomputer architecture (one week)
  - Serial optimisation (one week)
  - MPI (four weeks)
  - OpenMP (one week)
  - GPU acceleration with CUDA, OpenAcc and OpenMP (two weeks)
  - Large-scale I/O and Python in HPC (one week)
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