POP: A Transversal HPC Centre of Excellence in Performance Optimisation and Productivity

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Performance Optimisation and Productivity

Introduction

The *Performance Optimisation and Productivity Centre of Excellence in Computing Applications* (POP) has received funding from the European Commission to uncover inefficiencies and their causes in HPC applications.

From its start date in October 2015, POP aims to analyse 150 HPC codes in its first 2.5 years and provide €3M worth of savings through improved performance.

This is achieved through **free of charge** performance investigations.

Methods Used

POP uses a defined methodology to fully understand issues affecting performance of parallel applications by calculating the following metrics:

- **Global Efficiency** - Overall performance
  - **Parallel Efficiency** - Efficiency of parallelisation strategy
    - **Load Balance Efficiency** - Distribution of work
    - **Communication Efficiency**
      - **Serialisation Efficiency** - Dependencies between processes
      - **Transfer Efficiency** - Effect of data transfer
  - **Computational Efficiency** - Scaling of computational load
    - **IPC Scaling** - Implicates resource contention
    - **Instruction Scaling** - Increase in computational work

Tools

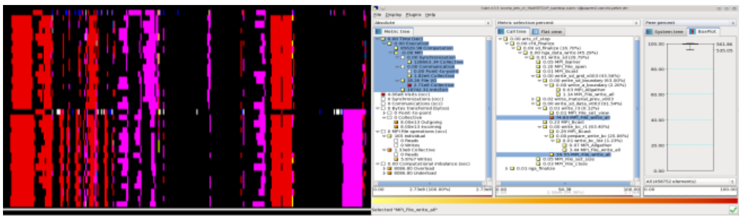
Integral to the POP project is the use of open source performance analysis tools developed by members of the POP consortium.

Barcelona tools

Include **Paraver**, a trace-based performance analyser with great flexibility to explore and extract information, including timelines that graphically display the evolution of the application over time.

Jülich tools

Include **Scalasca** which characterises parallel execution inefficiencies, such as wait states in communications and synchronisations, and detects the best candidates for optimisation.



Highlights: GraGLeS2D

The Institute of Physical Metallurgy and Metal Physics of RWTH Aachen University develops a microstructure materials simulation code called GraGLeS2D.

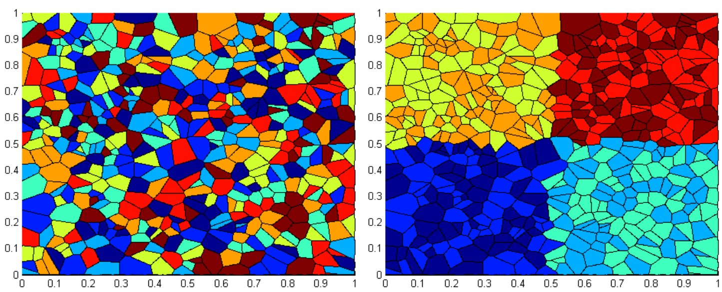
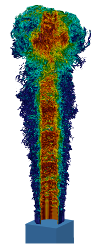


Figure 1: Initial (l) vs. optimised (r) work/data distribution.

We implemented several optimisations, including matching work distribution to data locality. The hotspot's runtime improved by more than 10X.

Highlights: Ateles



The Institute for Simulation Techniques and Scientific Computing of the University of Siegen develops a CFD code called Ateles. POP identified potential optimisations:

- Inlining of very short functions with high call rates
- Reduction of expensive CPU operations such as division

We measured a performance increase of nearly 50% on the provided test case and the user confirmed a substantial performance improvement for production runs.

Results

To date, POP has achieved 60 Audits completed or reporting to customer and 4 completed Proof-of-Concepts, and is working on a further 42 studies. A wide range of application areas and languages have been covered:

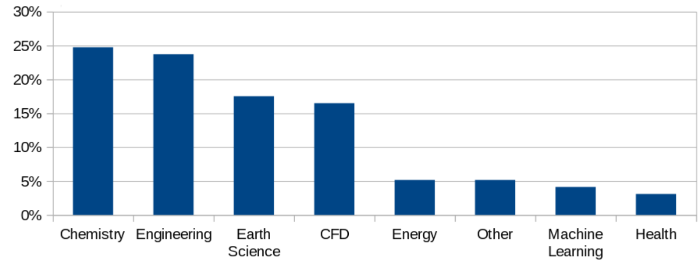


Figure 2: Application areas.

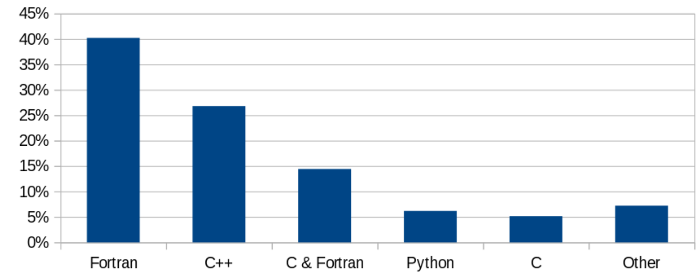


Figure 3: Application languages.

Figure 4 examines the main cause of inefficiency identified in the Audits conducted so far. We see that no single type of inefficiency is the most prevalent.

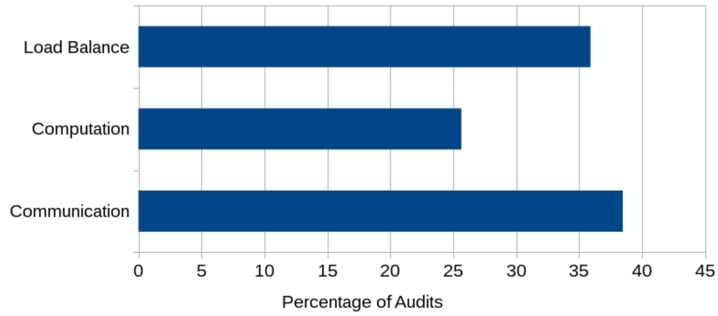


Figure 4: Leading cause of inefficiency found by Audits.

Conclusion and Impact

POP shows that there is great scope for gains in application performance. Such gains can lead to reduced simulation time, the ability to run larger problems, and an improved competitive advantage.

POP investigations are free of charge for EU based organisations.

https://pop-coe.eu

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