Evolving Inversion Methods in Geophysics with Cloud Computing

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Magnetotellurics is a geophysics technique for characterisation of geothermal reservoirs, mineral exploration, and other geoscience endeavours that need to sound deeply into the earth – many kilometres or tens of kilometres. Central to its data processing is an inversion problem which currently takes several weeks on a desk top machine. In our new eScience lab, enabled by cloud computing, we parallelised an existing FORTAN program and embedded the parallel version in a cloud-based web application to improve it usability. A factor-of-five speedup has taken the time for some inversions from weeks down to days and is in use in a pre-fracturing and post-fracturing study of a new geothermal site in South Australia, an area with a high occurrence of hot dry rocks. We report on our experience with Amazon Web Services cloud services and our migration to Microsoft Azure, the collaboration between computer scientists and geophysicists, and the foundation it has laid for future work exploiting cloud data-parallel programming models.

This seminar will also report on some new work by Brad Alexander using an evolutionary technique, an alternative approach to forming MT models.There are very many evolutionary frameworks that can be used to drive the inversion process but almost all have the advantage that they are easy to parallelise. We use an approach where models are expressed as combination of fuzzy volumetric functions. These functions are modelled on volumetric functions called metaballs or blobs in computer graphics. We model each blob as an ellipsoid defined by parameters defining the blobs, location, size in each dimension, orientation, central resistivity and how fast the blob's influence fades into the background. We have verified that reasonably good and convincing models of broad-scale structures can be modelled using a few blobs.

The results reported in this seminar come from a collaboration of geophysicists, namely Graham Heinson and Stephan Thiel, and computer scientists.

The university housing this collaboration supports an exciting geophysical precinct because the state of South Australia has some of the best hot rocks suitable for electricity generation from enhanced geothermal systems, has a vibrant minerals exploration industry, and is home to a massive new mine, Olympic Dam, owned by BHP Billiton, the world's largest mining company.

The speaker:
The University of Adelaide's Cloud Computing Lab (C3L) was established by Craig Mudge in 2010. It follows his Chairmanship of a Working Group on Cloud Computing in the Australian Academy of Technological Sciences and Engineering. Mudge returned to Australia in 2005 after ten years in Silicon Valley where he led the Xerox PARC computer science lab. He founded Austek Microsystems based on a breakthrough design technology developed at CSIRO. Its products included signal processing chips that formed the basis of Cochlear and radio astronomy breakthroughs and the world's first single-chip cache. He was an engineer (including VAX and multiprocessors) at DEC (now part of Hewlett Packard) and led micro-chip research at CSIRO . Mudge received his Ph.D. in computer science from the University of North Carolina at Chapel Hill and an undergraduate degree from the ANU. He co-authored "Computer Engineering" with Gordon Bell, published over sixty papers, holds six patents, and taught at Caltech and CMU.