2013 Resource Allocation - Research Project Highlights

Régis Pomès
Senior Scientist,
The Hospital for Sick Children,
Associate Professor,
Department of Biochemistry
University of Toronto

Régis Pomès' group specializes in the development and application of computer simulation techniques to the study of biomolecular systems. Compute Canada infrastructure provides him with a computational microscope which can be used to examine biological processes at temporal and spatial resolutions that are inaccessible by any other method. Last year, in conjunction with experimental collaborators, our simulations lead to high-impact publications and our work was presented at multiple international conferences. The results of his research have the potential to impact Canadians by bridging the gap between microscopic and macroscopic scales of biological processes essential to life, providing meaningful insight into the molecular basis of human health and disease. Ultimately, these advances will lead to a better understanding of human susceptibility to highly-prevalent vascular diseases such as hypertension, atherosclerosis, and aneurysms. His work will also facilitate the development of biomimetic materials such as artificial skin and vascular grafts, as well as new therapeutic approaches for the treatment of numerous pathological ailments including pain, epilepsy, bacterial infections, and neurodegenerative diseases such as Alzheimer's and Huntington's diseases. This research would not be possible without Compute Canada infrastructure because of the immense amount of computational power and data storage that is required for our work. Very few laboratories that perform molecular simulations have such cutting-edge hardware and technical support at their fingertips.

Victoria Kaspi
Professor,
Department of Physics
McGill University

Victoria Kaspi's research is focused on the search for and discovery of Galactic radio pulsars, a form of rapidly rotating, highly magnetized neutron star. These objects are interesting for a wide variety of reasons, ranging from enabling the detection of gravitational waves as predicted by Einstein, to constraining the nature of matter at ultrahigh densities, to testing general relativity and alternative theories of gravity. Compute Canada infrastructure is used to process data obtained at the world's largest telescopes in search for periodic, dispersed radio signals. Thus far, Kaspi's research group has discovered 45 new radio pulsars using Compute Canada infrastructure, including 9 millisecond pulsars, some of the most rapidly rotating stars known. The latter represent a significant increase in the total known population. The results of this

research have the potential to constrain fundamental physics. They may further impact Canadians by developing novel time- and frequency-domain analysis techniques, which could be relevant to topics ranging from consumer marketing to stock market predictions. Moreover, extreme astrophysical discoveries like the ones her group is making have the potential to inspire young people toward careers in science. This research would not be possible without Compute Canada infrastructure because her project involves massive quantities of data and demands heavy computational power that is superior to what can be accessed elsewhere.

Ben Koop
Professor,
Department of Biology
University of Victoria

Ben Koop's research is focused on examining genomic forces in salmon. Apart from its economic importance to global fisheries and aquaculture, Koop's research is of particular biological interest because the common ancestor of salmon underwent a duplication of its entire genome, a rare poorly-understood event in evolution which is thought to produce novel molecular pathways and lead to the rapid formation of new species. The most fundamental step in analyzing salmonid genetic processes is the assembly of a robust reference genome sequence, a computationally demanding process which relies heavily on support from Compute Canada. Next-generation sequencing technology produces hundreds of millions of small DNA sequence fragments which must be pieced back together; this assembly is performed by complex programs which require high-powered, large-memory computer systems. Compute Canada critically provides both the infrastructure to use such assembly programs as well as assistance from extremely proficient staff who help with the configuration, modification and running of the software. Koop is addressing fundamental biological questions as well as practical problems related to the health and environmental interactions of an economically and culturally important species. An understanding of the key genomic forces guiding salmonid development and evolution have the potential to shape fisheries and environmental management while providing insight into universal biological processes.