Brain Circulation Program Report from INRIA Lille

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My research is about evolutionary algorithms and their use on multi-objective problems. By using concepts form biology and applying them to mathematical optimization problems as a heuristic we can solve mathematical problems whose treatment is otherwise impossible.

In spite of being mathematical in nature, this branch of research cannot progress without a large number of experiments. The experiments (simulations) consist of running a randomized program on a computer and using statistic methods to evaluate results. The experiments need to be repeated many times and for many combinations of entry parameters. Without significant computing power, the possibilities of research in this direction are significantly restricted.

The Inria research institute in France has access to the Grid5000 distributed cluster computer with 5000 computing cores. During my stay at Inria, I have received tutoring by my colleagues on the complicated rules of conduct regarding this machine. With their help I was able to transform my source code to a platform-independent form, which could be compiled and executed on the Grid5000 cluster computer. They taught me how to use command line based access and booking system and helped me develop shell scripts to automate transportation of large amounts of data between my desktop station and the cluster computer.

With an unprecedented (for me) computing power and a team of people willing to assist me I was able to explore the performance of the Differential Evolution algorithm for many parameter combination. The Differential Evolution is a relatively new approach to evolutionary computation. It is an extremely useful tool for optimization in the continuous variable space. Its strengths are its outstanding simplicity and robustness. Unfortunately Differential Evolution has a few parameters which are not well understood and which have a significant influence on the performance of the algorithm. With the power of the cluster computer at hand I am able to analyze these parameters by brute force. By running the algorithm for each single combination of parameters I am able to construct so called performance surfaces. These surfaces are useful for understanding the problem theoretically as well as a practical guide to the engineer who merely wishes to use the Differential Evolution algorithm.

During my research my colleagues provide me with technical assistance, but what is even more important, they guide me in my research. Their knowledge on evolutionary computation is very broad, since all of them are practicing professionals in the field. We try to hold informal meetings and brainstorming sessions as often as possible, in order to evaluate progress and establish the direction the research should take.

I am just a student but I try my best not to be only on the receiving end of the deal. I try to understand the things my colleagues are working on and try to help them with my knowledge. For example the graduate student of Dr Brockhoff is performing intensive experimentation which takes too much time. I held a small session with him and showed him how to decrease the computational cost of his experiments using a general-purpose data structure which I implemented.

Also a lot of my time goes into the development of tools to analyze large amounts of data. In cooperation with Dr Bilel I hope to make my tools usable by the entire Inria community.

With the assistance of my colleagues I am working on publishing my research. I am currently working on two scientific papers. One (IEEE journal) related to data structures involved in evolutionary computation and the other (PPSN conference) dealing with performance surfaces of Differential Evolution.

In my stay at Inria I am finishing and closing my research on reducing the computational cost of nondominated sorting started in Japan. I am continuing research on the mathematical properties of Differential Evolution and my goal is to publish my results in international scientific journals.