Vacation Scholarship Report

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1 Introduction

My vacation scholarship consisted of being part of a team working on creating a Matlab Toolbox for the Cross Entropy method.

For those of you who are not familiar with the Cross Entropy method it

> was pioneered in 1997 by Reuven Rubinstein as an efficient method for the estimation of rare-event probabilities. The cross-entropy (CE) method has rapidly developed into a powerful and versatile technique for both rare-event simulation and combinatorial optimisation.[1]

2 Summary

Throughout my scholarship I have tried to enhance my programming skills through the use of programs such as Emacs and Matlab and develop my understanding of the Cross Entropy Method.

3 Body

The first part of my project was to familiarise myself with Latex and the typesetting program EMACS. It was the first time I had used a tool such as this and it has proved to be invaluable in developing documents with difficult mathematical formulae.
After becoming familiar with the workings of Latex and Emacs I read through the tutorial on the Cross Entropy Method (It can be found here:
http://iew3.technion.ac.il/CE/tutor.php) and in particular focused on the first two examples. I then attempted to create a Matlab program which implemented the combinatorial optimisation algorithm provided in the tutorial. After initial coding I experienced some errors but after some working through these problems I was able to reproduce the results obtained in the tutorial.

As part of the toolbox, we included graphic plots of a number of common test functions. Both Laurel Yu and I created separate plots in Matlab and cross checked the output of functions such as the Rosenbrock function

$$S(x) = \sum_{i=1}^{n-1} 100(x_{i+1} - x_i^2)^2 + (x_i - 1)^2$$

and Rastrigin's Function

$$n * 10 + \sum_{i=1}^{n} (x_i^2 - 10cos(2\pi x_i)), -5.12 \leq x_i \leq 5.12.$$

What is special about these functions is that they have many local maxima and minima and traditional optimisation search algorithms have difficulty in locating the true global maxima or minima.

The final part of my vacation scholarship was to develop a Graphical User Interface (or GUI as they are more commonly known) in Matlab to allow users who are not familiar with Matlab to use the CE Method to solve their problem. Zdravko Botev had already developed a Matlab function file which contained the mathematics behind the CE Method so my task was to create a friendly interface that people could use easily and efficiently.

This was the first time I had ever attempted to create a GUI, fortunately Matlab had a tool called the 'Guide' which made building interface components relatively easy. I used the 'learn by example' method extensively in developing the GUI. The coding of the GUI is largely based upon an extensive group of functions for each component on the interface. One of the problems I initially had was trying to store data input from the user which could be store and transferred on the callback of another operation. I overcame this by using the handle structure which stores instructions and allows the stored data to be called upon at anytime. Once I established how to do this I applied the same code to different components. The GUI allows the user to input there own function or choose from a number of test functions. The user can also set both function parameters (such as dimension) and CE parameters (smoothing constants, elite sample, injection size).

References

[1] The Cross Entropy Method, 2005, (Online), http://iew3.technion.ac.il/CE/about.php Faculty of Industrial Engineering and Management Technion - Israel Institute of Technology