The University of Nottingham

School of Computer Science

Intelligent Decision Support Systems

Invesitgation of Approximations in Fitness Function and its Effects

Introduction

•An optimisation problem is a NP-Hard problem that requires to find the maximum or minimum of a given continuous and bounded function.

•Recent empirical studies show that the smoothness of the continuous function affects the convergence speed and reduce the chance of converging on local optimal, e.g smoother function converge faster, chance to converge on true global optimal is higher.

Background Study

•There are many techniques in solving optimisation problem, from traditional numerical analysis to computation method such as Simulated Annealing, Local Search, Neural Network,and Evolutionary Algorithm.

•Evolutionary Algorithm receives attention because of its stochastic property that makes it capable of escaping the local optimal

•However, it still requires several iterations in order to escape the local optimal, which slows down the convergence.

Literature Review

•There exists many smoothing techniques to reduce noise in signal processing, and has been implemented in optimisation.

•Ko-Hsin Liang et al proposed quadratic approximation by sampling several evaluation and construct a quadratic function from samples. Quadratic function has only one optimal, and then is used as seed in local search.

•Dekun Yang and Stuart J. Flockton proposed a Gaussian smoothing kernel to smoothen the function

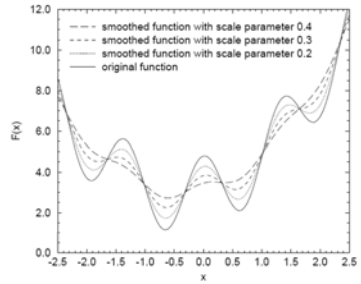
Problem Associate with Approximation

•If a fitness function is plotted against the parameter, the graph shows the landscape of the problem

•As we observe the approximation, we realise the smoothing techniques suppress the local optima in landscape, but also may remove the global optimal, which is the solution we want.

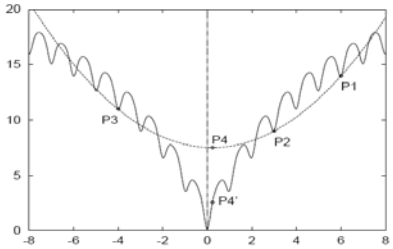
•We need to understand the level of smoothness to apply to the optimisation landscape before we applying approximation.

Gaussian Kernel Smoothing



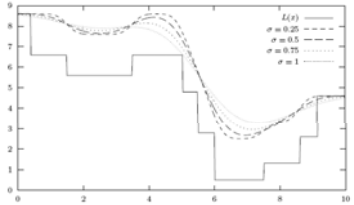
D. Yang, S.J. Flockton, Evolution Algorithms with Coarse-to-Fine Function Smoothing

Quadratic Approximation



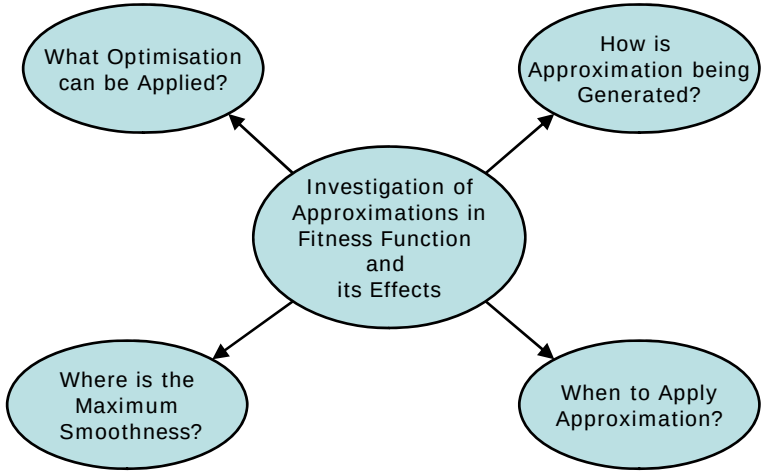
K-H Liang, X Yao, C Newton, Evolutionary Search of Approximated N-Dimension Landscape

Gaussian Filtering on Local Search



B. Addis, M. Locatelli, F. Schoen, Local Optima Smoothing for Global Optimization

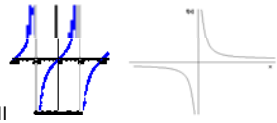
Question of Study



Suggestions

▪What kind of optimisation problem can we apply appoximation? A discontinuous, indifferentiable or unbounded fitness function is definitely not suitable for approximation. Example: Tangent/Unbounded, Discontinuous

▪How to generate the approximation? Most smoothing technique in Image Processing such as Gaussian Kernel, Fourier, Kriging are suitable.



▪Where is the maximum smoothness? This is still an open question, we need a measurement mechanism to measure the smoothness and the remaining characteristic of the original landscape in the approximation.

▪When to apply approximation? As for quadratic approximation, we can directly calculate the new approximated function, area of effect calculation like Gaussian may be calculated throughout the searching process.

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