Non-stationary Function Optimization using Polygenic Inheritance

J.J. Collins and Conor Ryan
Dept. of Computer Science and Information Systems
University of Limerick, Limerick, Ireland

Non-stationary function optimization has proved to be a difficult subject for genetic algorithms (GAs). Standard haploid GAs find it difficult to track a moving target and tend to converge to a local optimum that appears early in a run. We have surveyed a number of diploid GAs which use classic dominant recessive expressions, and outline some possible reasons why they have failed to gain wide acceptance [3]. A new haploid system, Shades, is then described which uses polygenic inheritance, in which several genes contribute to each phenotypic trait. The first instance of this in natural biology was discovered in 1909 by Nilsson-Ehle when he showed that the kernel color in wheat, an additive trait, was in fact managed by two pairs of genes. Inheritance of genes of this type is known as polygenic inheritance, and the more loci involved in the calculation of a trait, the smoother the phenotypic space.

Using polygenic inheritance in a haploid GA can effectively be the same as using a diploid GA. Using two genes to control each trait, we get a range of values as in table 1. We say that each trait is a *shade* of 1. Thus, a phenotype of 0 is a lighter shade of 1. and the darker the shade of 1, the more likely the phenotype is to be 1. We compare the Shades system to the well known constrained 17-Object 0-1 knapsack problem, taken from Goldberg & Smith [1]. Fig.1 shows that when the system is applied to a genuine non-stationary function, it can successfully track changes in the environment.

Recently, Lewis et al. reported conflicting results [2] in which only diploidy representations which supported DCMs were capable of reacting to changes in their environment. The problem they examined was similar to the knapsack problem used here, except that the oscillatory period was changed to 1500 from 15. The conclusions reached in that paper are controversial. Firstly, the oscillatory period of 1500 generations is considerably longer than that the norm, and it might be suggested that it is unreasonable to describe a problem with such a large period of constancy as non-stationary. A second difficulty is the reliance on the 20% change in fitness. This may render the system ineffectual on problems with small changes, as evidenced by our initial results on DCM [3].

Table 1: Dominance map for the Shades scheme.

	A	B	C
A	0	0	
B	0		1
C		1	1

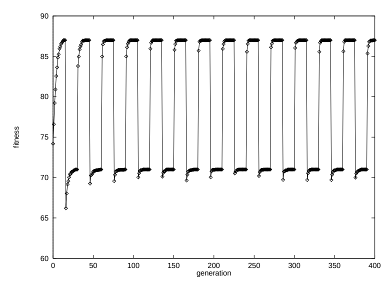

Figure 1: Knapsack problem using Shades.

References

[1] Goldberg, D. (1987). Nonstationary function optimisation with dominance and diploidy. In *Procs. of the Second Int. Conf. on Genetic Algorithms*, pp. 59–68.

[2] Lewis, J., Hart, E. and Ritchie, G. (1998). A Comparison of Dominance Mechanisms and Simple Mutation on Non-stationary Problems. In *Proc. of Parallel Problem Solving from Nature - PPSN V*, pp. 139-148. Springer LNCS 1498.

[3] Ryan, C. and Collins, J.J. (1998). Polygenic Inheritance - A Haploid Scheme that Can Outperform Diploidy. In *Proc. of Parallel Problem Solving from Nature - PPSN V.* pp. 178-187. Springer LNCS 1498.