Using GAs to Deal with Dynamic Environments: A Comparative Study of Several Approaches Based on Promoting Diversity

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Extended Abstract

Most approaches used in EAs for problems in which the environment changes from time to time, try to preserve the diversity of the population. One of those approaches applies a new biologically inspired genetic operator called transformation (Simões & Costa, 2001). We tested two EAs using transformation (**TGA** and **ETGA**) and two other classical approaches: random immigrants (**RIGA**) and hypermutation (**HMGA**). The comparative study was made using the dynamic 0/1 Knapsack optimization problem.

Transformation is a process that modify certain bacteria (and occasionally other cells as well) which, when grow in the presence of killed cells, take up foreign DNA from that cells and acquire characters encoded by it. We incorporate transformation into the standard genetic algorithm as a new genetic operator that replaces crossover, and call the new algorithm **TGA**. The foreign DNA fragments, consisting of binary strings of different lengths, will form a gene segment pool and will be used to transform the individuals of the population. **ETGA**, is a enhanced version of TGA, where the parameters for transformation were optimized.

The **0/1 knapsack problem** is defined as follows: given a set of n items, each with a weight $W[i]$ and a profit $P[i]$, with $i = 1, ..., n$, the goal is to determine which items to include in the knapsack so that the total weight is less than some given limit (C) and the total profit is as large as possible. When the weight limit can change over time, we have the **dynamic** version. We used three types of changes in the capacity of the knapsack: periodic changes between two values (C1=104 and C2=60) and between three values (C1=60, C2=104 and C3=80) and non-periodic changes between 3 different capacities (C1=60, C2=80 and C3=104).

To evaluate the performance of the algorithms we used two measures: **accuracy**, the difference between the value of the current best individual in the population of "just before change" generation and the optimum value averaged over the entire cycle; **adaptability**, the difference between the value of the current best individual of each generation and the optimum value averaged over the entire cycle. The tables bellow show the results obtained with periodic changes among three values.

Accuracy	**TGA**	**ETGA**	**HMGA**	**RIGA**
Cycle = 30	5.27	1.45	**0.70**	1.08
Cycle = 100	2.53	**0.18**	0.36	0.22
Cycle = 200	1.27	**0.02**	0.42	0.15
Cycle = 300	0.78	**0.01**	0.49	0.22

Adaptability	**TGA**	**ETGA**	**HMGA**	**RIGA**
Cycle=30	7.63	3.53	**1.84**	2.74
Cycle=100	4.59	**1.30**	2.18	1.16
Cycle=200	3.10	**0.61**	1.39	0.65
Cycle=300	2.40	**0.42**	1.35	0.58

We can conclude that, in general, the approach based on transformation is a good candidate to be used in situations where the environment is dynamic, particularly in cases where the cycle length is greater than 30.

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References

A. Simões and E. Costa (2001). *On Biologically Inspired Genetic Operators: Transformation in the Standard Genetic Algorithm*. Proceedings of the Genetic and Evolutionary Computation Conference (GECCO'2001), San Francisco, USA, July 2001.