Is the Island Model Fault Tolerant?

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ABSTRACT

This paper presents a research about the Fault Tolerance nature of the Island Model when applied to Distributed-Parallel Genetic Algorithms (GAs). Parallel and distributed models have been extensively applied to GAs when researchers tackle hard problems. Nevertheless, there are few works dealing with the problem of failures that are usually present when a distributed infrastructure is employed. The main results from this research suggest that the GAs Island Models are fault tolerant by nature.

Categories and Subject Descriptors

Track [**Genetic Algorithms**]; I.2.8 [**Artificial Intelligence**]: Problem Solving, Control Methods and Search—*heuristic methods*

General Terms

Management, Measurement, Experimentation, Performance, Reliability

Keywords

Distributed GAs, Fault Tolerance

1. OVERVIEW OF THE WORK

During the last few years several researchers have extensively studied and applied parallel versions of Genetic Algorithms (GAs). The idea behind the parallelization of any Evolutionary Algorithm is to improve or at least keep the quality of solutions while reducing the computational time for obtaining them. But, if we are going to use this paradigm we will have to deal with resource failures (microprocessor errors, hangs, overflows, etc.). Failures are usually handled by means of libraries which implement a technique for solving them. Commonly used techniques are checkpointing, n-version, redundancy, epidemic algorithms, etc. Thus, by using these techniques inside our algorithms we can say that they are fault tolerant.

In this paper we test the Fault Tolerance nature of the Island Model on GAs when running them on a Distributed environment without using any library or technique for handling the above mentioned failures. We have analyzed the quality of the solutions with and without considering processor failures on a multiprocessor computer. Under these conditions we are trying to know if it will be necessary or not to use an error handling library on Parallel GAs.

Table 1: Differences between a failure and error free environment.

(a) Population Size 100, 2 and 8 Processors (Islands)

	Fmodal		
	Failures	Non-error	% Difference
Best Ind. Fitness	26.7	28.6	6.64
	27.3	27.3	0

(b) Population Size 200, 4 and 8 Processors (Islands)

	Shwefel		
	Failures	Non-error	% Difference
Best Ind. Fitness	4090	4130	0.96
	4030	4030	0

We have done the study with two different test problems: Fmodal and Schwefel's Function. PGAPack is the parallel framework that we have used. We chose a ring topology for the Island Model. Different rates of microprocessor failures are used for both test problems. The failures are simulated by closing the communications between the microprocessors (each time a microprocessor fails the ring topology is recalculated).

Table 1 shows some interesting results. These first results are on average of similar quality when faults are present than when we are on a error free environment. This study also found that is better to exchange more frequently individuals (so that the Island has time to distribute their genetic material before a failure can appear).

In conclusion, these first results suggest that the coarse grain parallel GA structured by means of the Island model achieves Fault Tolerance when applying to Multimodal functions. We have tested different failure rates with different number of processors having always a difference between the failures-free and faulty environment quite small (below 7%), being the average difference always below a 2%.

Summarizing, researchers can trust on the Island Model when running experiments on a non-reliable Parallel or Distributed infrastructure: despite processor failures the Island Model GA will still provide results of similar quality as when reliable infrastructures are used. In other words, we can say that the Island Model is fault-tolerant by nature.

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