Effects of Noise on multi-objective optimiser performance

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***Index Terms*—Multi-objective Evolutionary Algorithm, Noise, Rolling Tide Evolutionary Algorithm, Inverse Generational Distance, Hypervolume measure**

I. Introduction

Evolutionary Algorithms (EAs), particularly, genetic algorithms (GA), are known to be robust in the presence of noise [**?**]. Multi-objective Evolutionary Algorithms (MOEAs) obtain a Pareto set of non-dominated solutions, offering decision-makers more options from which to choose the best solution according to some preference information. MOEAs can be broadly classified into two categories - elitism and non-elitism. With the elitism approach, EMOs employ an external set to store the best solutions in each generation. This set will then be a part of next generation. With this method, the best individuals in each generation are always preserved, and this helps the algorithm to get as close as possible to the Pareto front. In contrast, the non elitism approach has no concept of elitism when it selects individuals for reproduction. In this study, we consider algorithms with an elitism approach [**?**]. A factor of interest in this study is the existence of noise in optimisation problems, which is inevitable are prevalent in sources such as sensors, actuators, or because of the stochasticity pertaining in some problems such as multi-agent simulations [**?**].

II. Background

A. MOEAs

1) NSGA-II:

2) SPEA2:

3) RTEA:

B. Noise

In a real-world black-box problem, noise takes various forms and can be stochastic in nature. In such cases, the effect of noise could lead to misleading non-dominating solutions which might actually be dominated for a true noiseless problem.

In modelling noise as a factor, various researchers have adopted different approaches. Bui *et al.* [**?**] use an additive factor which are randomly added or subtracted from the real fitness value, such that $F_{noise} = F + noise$, where F_{noise} is fitness function with presence of noise and F is the true fitness function. Fieldsend *et al.* [**?**] consider a gaussian function of noise to be added with $\mathcal{N} \sim (0, \sigma^2)$, i.e., a zero-mean isotropic Gaussian noise with standard deviation (σ) of a constant real number. They consider multiple standard deviation inputs of {0.00, 0.01, 0.10, 1.00}, where $\sigma = 0.00$ is the true, noiseless fitness function.

C. Performance metrics

III. Research methodology

A. Problem

B. Algorithms

The three MOEAs selected in this study are NSGA-II, SPEA2, and RTEA.

C. Noise magnitude

The noise magnitude considered in this study is a zero-mean isotropic gaussian noise with standard deviation magnitudes of $\sigma = \{0.00, 0.01, 0.05, 0.1, 1.00\}$ are considered, with reference to papers written by Bui *et al.* [**?**] and Fieldsend *et al.* [**?**]. This is because the additive nature of noise as described in the former paper has a similar effect to the true pareto front as by gaussian approach of the latter paper.

D. Performance metrics

IV. Results

V. Conclusion

Acknowledgment

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks . . .”. Instead, try “R. B. G. thanks. . .”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

References

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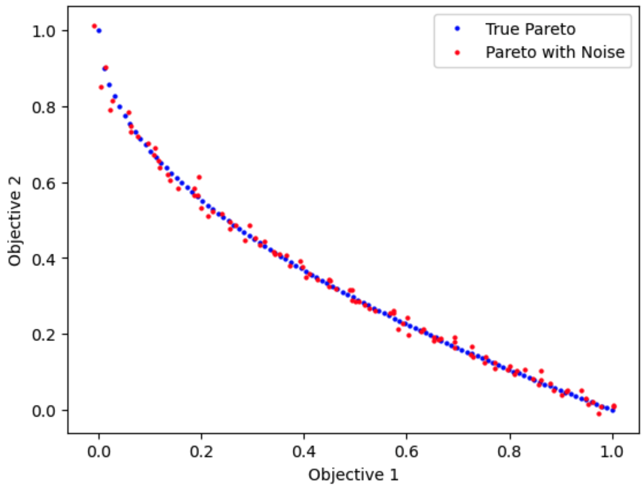

Fig. 1. Example of effect of gaussian noise of magnitude $\sigma = 0.01$ on true Pareto front

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