On detecting the novelties in metaphor-based algorithms

Iztok Fister Jr., Iztok Fister, Andres Iglesias, Akemi Galvez
University of Maribor & University of Cantabria
iztok.fister@um.si

Introduction

- New metaphor-based nature-inspired algorithms are coming to scientific literature on daily basis.
- Contribution of metaphor-based concepts do not bring too much to the scientific community.
- In contrast, many contemporary papers are searching for the conceptual similarities among these algorithms.
- Most of the studies are focused on comparison at the conceptual level, where similarities among definitions of variation operators are searched for.
- In this contribution, we search for similarities of algorithms on an operational level, where the population structures are observed on an internal level by transition over the generations.

Research question

- How to identify if two different runs of the stochastic population-based nature-inspired algorithms are equivalent?

Proposed method

- **Problem**: Two NI-algorithms are similar, if the angle between regression lines α is less than $5°$.
- **Method**: Calculate the correlation coefficient ρ between objective and population diversity and determine the regression angle α.

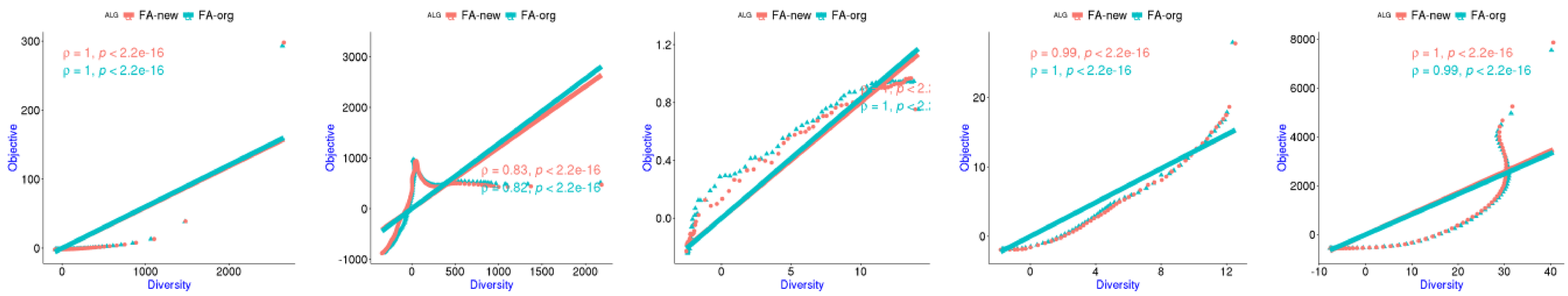
Genotype	Phenotype	Typical run	Spearman coeficient ρ	Regression angle α
$T : P_N^{(g)} \mapsto P_N^{(g+1)}$, measured by population diversity $I\left(P_N^{(g)}\right)$	$F : \overline{f}^{(g)} \mapsto \overline{f}^{(g+1)}$, problem dependent	$R : P_N^{(0)} \overset{\overline{f}^{(0)}}{\longrightarrow} P_N^{(1)} \overset{\overline{f}^{(1)}}{\longrightarrow} \ldots \overset{\overline{f}^{(G-1)}}{\longrightarrow} P_N^{(G)} \overset{\overline{f}^{(G)}}{\rightleftharpoons}$, where: R - run the evolutionary algorithm	$\rho = \frac{\mathrm{cov}(rg_X, rg_Y)}{\sigma_{rg_X} \cdot \sigma_{rg_Y}}$, X - pop. diversity Y - objective	$\tanh \alpha = \frac{1-\rho^2}{\rho} \cdot \frac{\sigma_X \cdot \sigma_Y}{\sigma_X^2 + \sigma_Y^2}$, X - algorithm 1 Y - algorithm 2

- **Task**: Find the regression angle between two algorithms $\alpha \leq 5°$.

Experiments

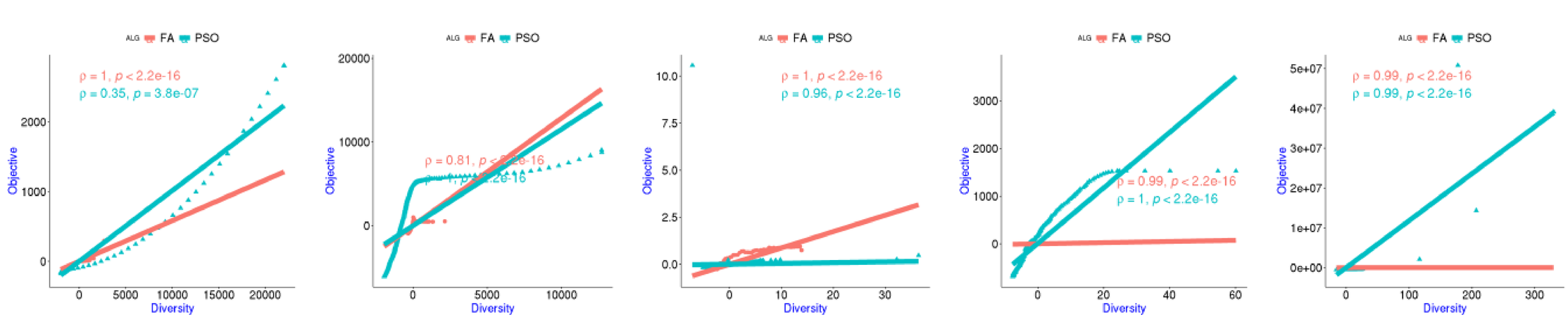
- Algorithms used in experiments: Firefly Algorithm (FA) and Particle Swarm Optimization (PSO)
- Control parameters of both algorithms: $N = 50$, and $G = 200$ (the other parameter settings were taken from corresponding literature)
- Number of independent runs: 51 independent runs
- Test functions included in experiments: Griewank, Schwefel, Michalewicz, Quartic, Zakharov

Results



(a) Function f_1 ($\alpha = 0°$). (b) Function f_2 ($\alpha = 2°$). (c) Function f_3 ($\alpha = 1°$). (d) Function f_4 ($\alpha = 0°$). (e) Function f_5 ($\alpha = 1°$).

Figure 1: Influence of the stochasticity by two instances of the FA using different seeds.



(a) Function f_1 ($\alpha = 14°$). (b) Function f_2 ($\alpha = 3°$). (c) Function f_3 ($\alpha = 17°$). (d) Function f_4 ($\alpha = 39°$). (e) Function f_5 ($\alpha = 37°$).

Conclusions and Future Work

- Our paper defines a measure for assessing if two algorithms are similar on the conceptual, as well as operational levels.
- If two algorithms are similar, the angle between regression lines constructed from Spearman correlation coefficients between objective and population diversity of two algorithms must be $\alpha \leq 5°$,
- In the future, stronger criteria about this measure need to be determined.