NOVA IMS Information Management School

Neural and Evolutionary Learning

Class 4 - Semantic Learning algorithm based on Inflate and Deflate Mutations (SLIM)

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SLIM-GSGP

	GA	Tree-based GP	GSGP
Genome	Constant length	Lisp-like tree	Lisp-like tree
Task type	Optimization	Many tasks, including ML	Many tasks, including ML
Population initialization	Random values	Random trees*	Random trees*
Crossover	“Blind" genotype variation**	“Blind" genotype variation**	Semantic (phenotype-based) genotype variation
Mutation	“Blind" genotype variation**	“Blind" genotype variation**	Semantic (phenotype-based) genotype variation

Important!

Remind that the neighbourhood of the fitness landscape is defined by the genetic operators. Therefore, the use of these Geometric Semantic operators enables the problem to be optimized in the error space, transforming any problem into a CONO one.

SLIM-GSGP

Three functions to produce [-ms, ms] perturbations

- SIG2 $ms \times (S(T_{R1}) - S(T_{R2}))$

as the traditional GSM

- SIG1 $ms \times (2 \times S(T_R) - 1)$

- ABS $ms \times \left(1 - \frac{2}{1 + |T_R|} \right)$

SLIM-GSGP

Two perturbation modes

- Addition (+): it adds or subtracts a near-zero value to gener- ate the small perturbation needed for ball mutation. Inflate GS mutation adds the SIG2, SIG1 or ABS output, while Deflate GS mutation subtracts one of the previously added terms.

- Multiplication (∗): it multiplies or divides by a factor close to one, to generate the small perturbation needed for ball mutation. Inflate GS mutation multiplies by $1 + \phi$, where ϕ is either SIG2, SIG1 or ABS, while Deflate GS mutation divides by one of the previosuly multiplied terms.

SLIM-GSGP

Six SLIM-GSGP variants

- SLIM+SIG2
- SLIM+SIG1
- SLIM+ABS

$$T + [SIG2, SIG1, ABS]$$

- SLIM*SIG2
- SLIM*SIG1
- SLIM*ABS

$$T \times (1 + [SIG2, SIG1, ABS])$$

SLIM-GSGP

Six SLIM-GSGP variants

Inflate Mutation

- SLIM+SIG2
- SLIM+SIG1
- SLIM+ABS

$$T + [SIG2, SIG1, ABS] \qquad + [SIG2, SIG1, ABS]$$

- SLIM*SIG2
- SLIM*SIG1
- SLIM*ABS

$$T \times (1 + [SIG2, SIG1, ABS]) \qquad \times (1 + [SIG2, SIG1, ABS])$$

SLIM-GSGP

Six SLIM-GSGP variants

- SLIM+SIG2
- SLIM+SIG1
- SLIM+ABS

$$T + [SIG2, SIG1, ABS]$$

Inflate Mutation

$$+ [SIG2, SIG1, ABS]$$

- SLIM*SIG2
- SLIM*SIG1
- SLIM*ABS

$$T \times (1 + [SIG2, SIG1, ABS])$$

Deflate Mutation

$$\times (1 + [SIG2, SIG1, ABS])$$

SLIM-GSGP

Six SLIM-GSGP variants

- SLIM+SIG2
- SLIM+SIG1
- SLIM+ABS

$$T + [SIG2, SIG1, ABS]$$

- SLIM*SIG2
- SLIM*SIG1
- SLIM*ABS

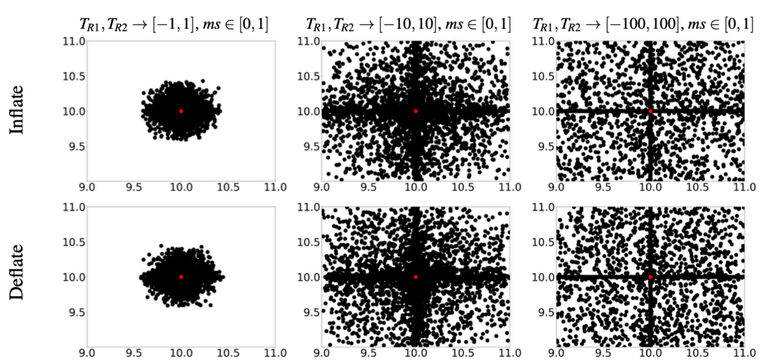
$$T \times (1 + [SIG2, SIG1, ABS])$$

Deflate Mutation

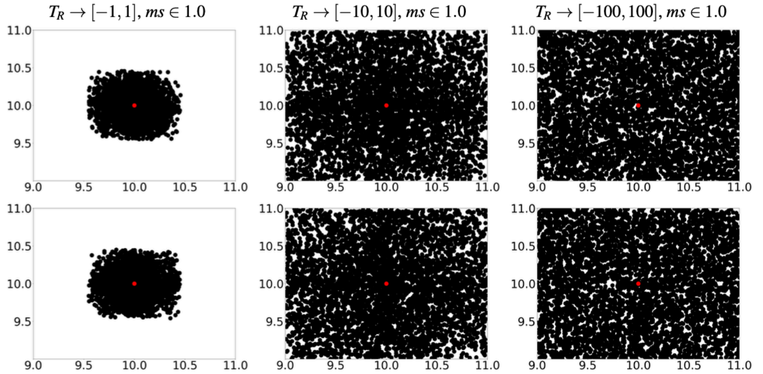
Formally, the addition deflate mutation subtracts a previously added mutation subtree, while the multiplication deflate divides by a previously multiplied mutation subtree. The effect is, in both cases, to remove a previously added mutation subtree.

SLIM-GSGP

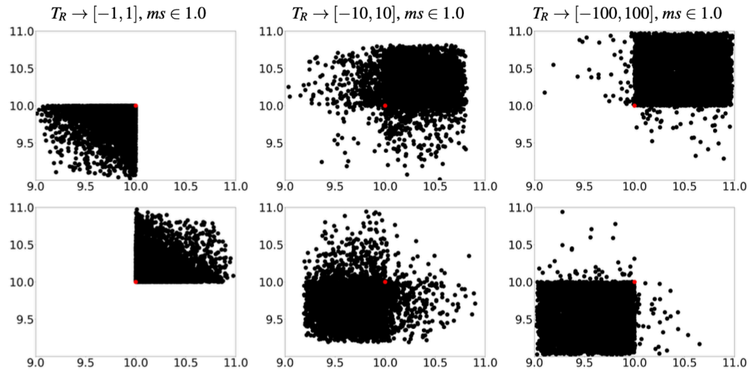
Geometry of SLIM-GSGP mutation variants



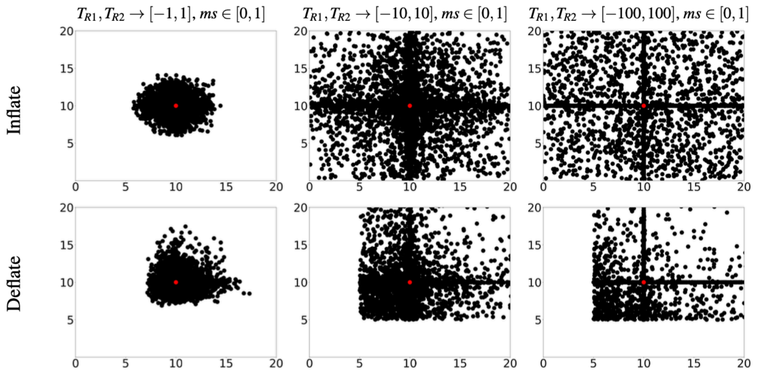
SLIM+SIG2



SLIM+SIG1



SLIM+ABS



SLIM*SIG2

Multiplication variants: greater variability in the mutation output.

Source: Vanneschi, et al. 2025 Exploring Non-bloating Geometric Semantic Genetic Programming. Genetic Programming Theory and Practice XXI. G https://doi.org/10.1007/978-981-96-0077-9_12

slim_gsgp NOVA IMS library

- Let's take a look at the codes.

Questions?

https://forms.gle/EV9VkExNtfNckMSM8

Register your feedback