TSE(3) 上自主机动星群在小天体悬停任务中的几乎全局稳定方案及其离散化

雷 锋

哈尔滨工业大学 航天学院

某某技术研究所

2023 年 2 月 31 日

前言

- Developmental plasticity: a powerful source of flexibility in biology
- Most EC & GP systems don't have a developmental phase
- Even fewer allow for plasticity during development
- N-gram GP has natural developmental phase
- Can we add plasticity?

Bluedrakon
http://tr.im/pWUi

目录

1 帝皇的崛起

2 Results

3 Conclusions

Outline

1. 帝皇的崛起
   - 贯穿银河的大远征
   - 荷鲁斯之乱
2. Results
3. Conclusions

贯穿银河的大远征

让人类再次伟大！

我来！我见！我征服！

何为忠诚？何为背叛？大叛乱的萌芽

普罗斯佩罗之焚

考斯之战与暗影远征

Sam Fraser-Smith
http://tr.im/pq7l

荷鲁斯之乱

Most EC systems have no (or trivial) developmental processes.

- Therefore can't have developmental plasticity

There are important exceptions. In GP, e.g.:

- Cellular encoding
- Many grammar-based systems
- DTAG3P

These remain, however, the exception rather than the rule.

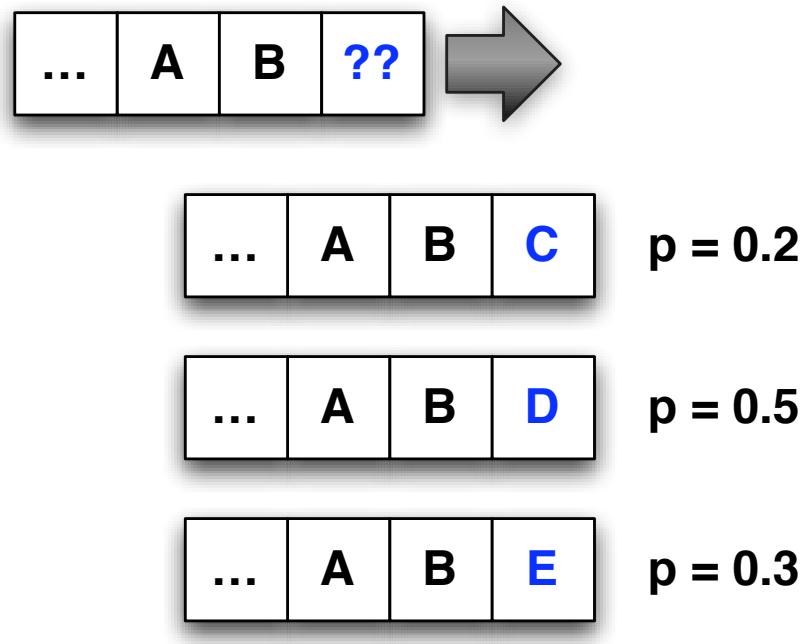
N-gram GP has natural developmental process, so a good candidate for adding developmental plasticity.

极限战士与考斯之战

N-gram GP uses a *probability table* to store likelihood of a triple of instructions appearing in a program:

$$Pr\{x_i \rightarrow x_{i+1} \rightarrow x_{i+2}\}.$$

Given pair of instructions (x_i, x_{i+1}), this table gives us the probability distribution for the subsequent instruction x_{i+2}.



Outline

1 帝皇的崛起

2 Results
- Empirical comparison of IFD, N-gram GP, and standard GP
- Modularity and repeated structures in IFD

3 Conclusions

Empirical comparison of IFD, N-gram GP, & TinyGP

Compare IFD, regular N-gram GP, and standard sub-tree XO GP (TinyGP)

- 11 different symbolic regression problems
- 100 independent runs for each system + problem + parameter set
- Various parameter settings (e.g., different block sizes)

2 register machine with $+, -, \times$, protected division, and swap

Normalize the clock:

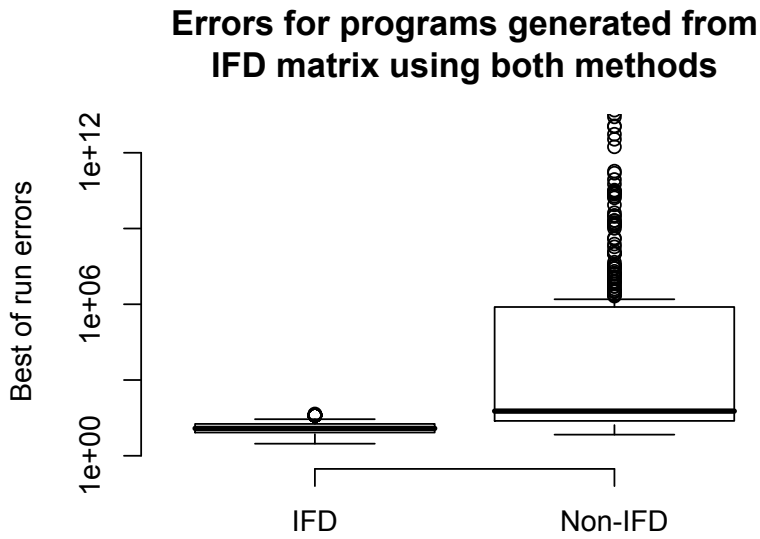
- Count instruction executions
- Allow 50M instruction evaluations per run
- Store machine state so only new block has to be executed in IFD

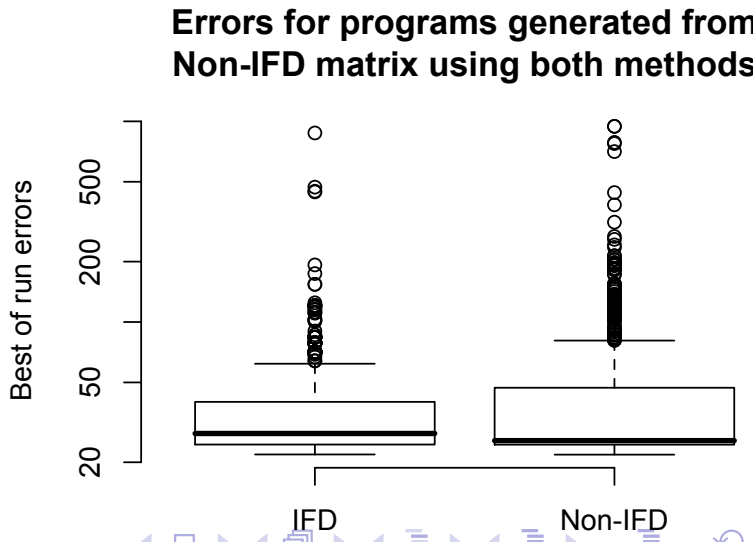
Success rates on 11 test problems

		Successes out of 100 runs		
Label	**Function**	**TinyGP**	**N-gram**	**IFD**
P1	$x + x^2 + x^3 + x^4 + x^5$	100	100	100
P2	$-x - 2x^2 + x^3$	100	100	100
P3	$1.009 + 1.419x + x^2$	100	61	100
P4	$6 + x^2 + 3x^3 + 8x^5$	0	0	0
P5	6	100	100	100
P6	$6 + x^2$	100	10	94
P7	$6 + x^2 + 3x^3$	85	0	1
P8	$8x^5$	100	100	100
P9	$3x^3 + 8x^5$	22	55	100
P10	$x^2 + 3x^3 + 8x^5$	100	7	80
Sine	$sin(x)$	0	1	63

IFD wins either way

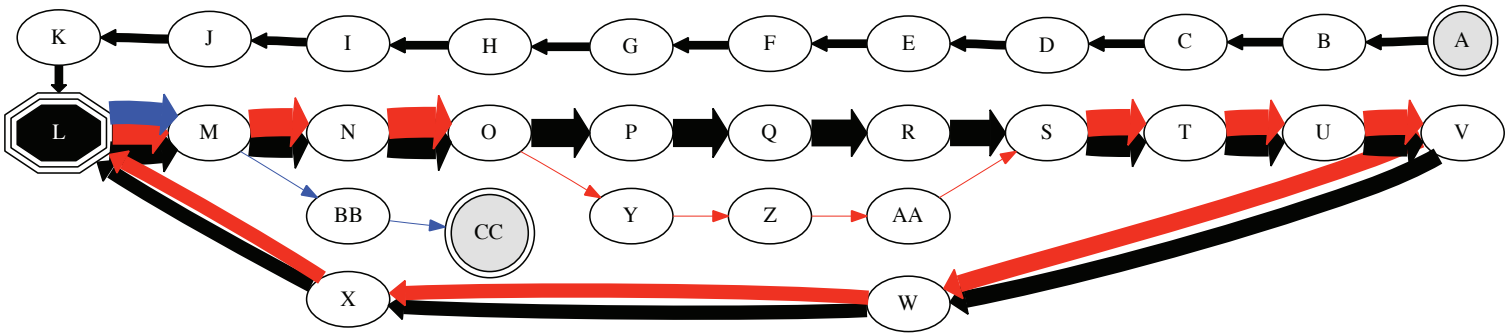
- IFD generates low-error individuals from tables evolved with IFD **and without IFD**.
- IFD's local search is valuable in all phases of the process, even if it wasn't used previously.
- N-gram GP isn't able to work effectively with the more complex probability tables that IFD generates.



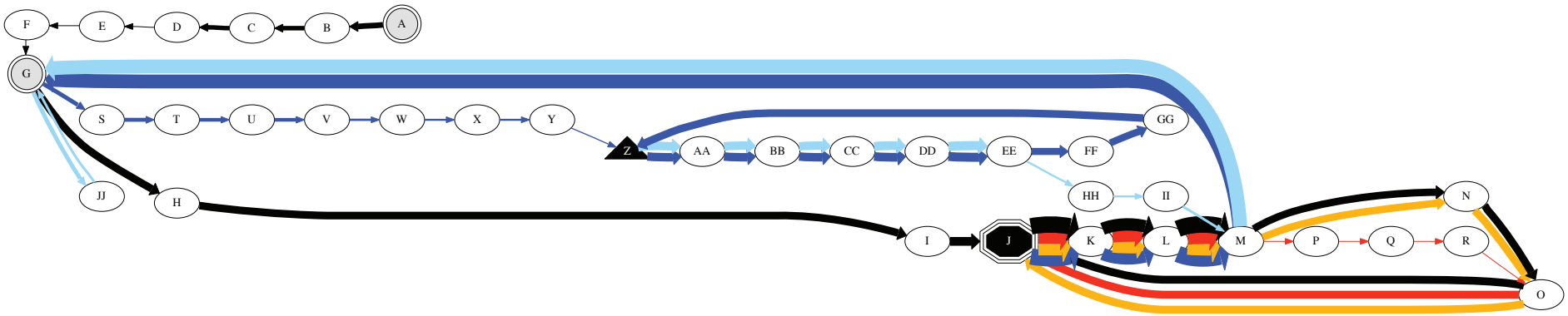


Structural differences and modularity

Standard N-gram GP tends to converge to a small set of loops with high probability edges.



With IFD there is less convergence, more variety and complexity in the modular structure, & greater use of low probability edges.



Outline

1 帝皇的崛起

2 Results

3 Conclusions

Conclusions

- Added developmental plasticity to N-gram GP using Incremental Fitness-based Development (IFD).
- IFD consistently improved N-gram GP performance on suite of test problems.
- “Knocking out” IFD shows it’s valuable in all phases, even if it wasn’t used earlier in a run.
- IFD generates more complex, less converged probability tables.
- IFD generates more modules/loops & uses more low-probability paths.
- Currently exploring applications to dynamic environments.

Thanks!

Contact:

- AK47@hit.edu.cn
- AK47@gmail.com
- AK47@outlook.com
- AK47@qq.com

幻灯片下载：

- https://github.com/HIT-CQ/Latex-Beamer-Template

References


N. F. McPhee, E. Crane, S. Lahr, and R. Poli.
Developmental Plasticity in Linear Genetic Programming.
In Günther Raidl, *et al*, editors, *GECCO '09*, pages 1019–1026, Montréal, Québec, Canada, 2009.


R. Poli and N. McPhee.
A linear estimation-of-distribution GP system.
In M. O'Neill, *et al*, editors, *EuroGP 2008*, volume 4971 of *LNCS*, pages 206–217, Naples, 26-28 Mar. 2008. Springer.

See the GECCO '09 paper for additional references.