

Analysis of Ancestry in Genetic Programming with a Graph Database

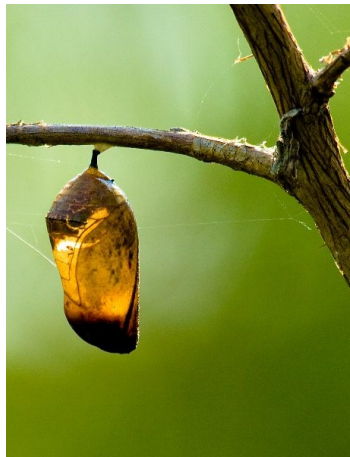
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The Big Picture

- The power of graph databases: analyzing internal data of GP
- ????????????
- Even fewer allow for plasticity during development????
- N-gram GP has natural developmental phase?????
- Can we find useful information about runs?



Bluedrakon

<http://tr.im/pWUi>

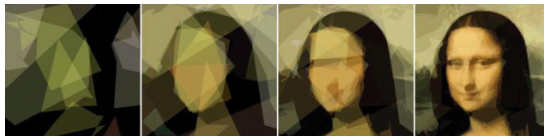
Outline

- 1 Genetic Programming
- 2 Graph Database
- 3 Experimental Setup
- 4 Results
- 5 Conclusions

Outline

- 1 Genetic Programming
 - GP Overview
 - Symbolic Regression and Fitness
- 2 Graph Database
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Genetic Programming Overview



Roger Alsing

<http://io9.com/5106124/a-computer-program-that-taught-itself-to-draw-the-mona-lisa>

- Genetic Programmings is based upon biological principles.
- Individuals form a population.
- Transformations
 - Crossover (XO)
 - Mutation
 - Reproduction
 - Elitism
- Transformations occur over a specified amount of generations.
- Individuals are rated by their fitness.

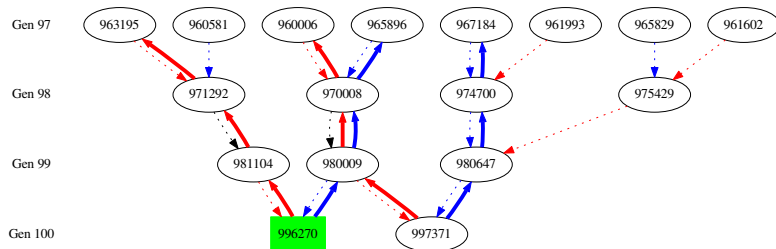
Transformations

(XO) sexual reproduction (root and non-root)

mutation subtrees altered

reproduction asexual reproduction

elitism reproduction based on fitness



Symbolic Regression and Fitness

We are focusing on symbolic regression problems.

- Measured data fitted to mathematical formula.
- Collection of test points to evolve individuals.

Fitness determines individual's distance from target function.

- Lower the fitness, the better the individual.
- A zero fitness would exactly match test data.
- Anything else to add??????????

The goal of GP is to evolve an individual with a fitness as low as possible.

Outline

1 Genetic Programming

2 Graph Database

- Neo4j
- Cypher

3 Experimental Setup

4 Results

5 Conclusions

Neo4j

Neo4j is a graph database.

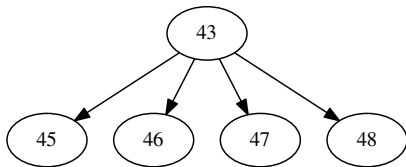
- Relatively new tool (initial release 2007 popularized in 2010).
- Information is stored like a graph.
- Nodes and relationships.
- Efficient recursive queries.

Cypher

Neo4j's query language is Cypher.

Fundamental elements of
Cypher queries:

- START
- RETURN
- MATCH
- WHERE



```
START parent=node(43)  
MATCH (parent)-[:PARENTOF]->(child)  
RETURN parent, child;
```

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1 Genetic Programming

2 Graph Database

3 Experimental Setup

- Configurations
- Methods

4 Results

5 Conclusions

Run Configurations

Function $\sin(x)$

Variables x (range from 0.0 to 6.2, incremented by steps of 0.1)

Constants range between -5.0 and 5.0

Operations addition (+), subtraction (-), multiplication (*), protected division (/)

Number 100

Iteration 1000 (6 runs) and 10000 (1 run)

Stages Crossover (90%), Mutation (1%), Reproduction (9%)

Elitism best 1%

Methods

- fitness** Absolute error between target function and individual function.
- PTC2** Randomly adds operators to array of specified length (empty slots for arguments where appropriate). Empty slots divided between variables (63%) and constants (37%).
- Type** Subtree Mutation

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- 1 Genetic Programming
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- 4 Results**
 - Questions Asked
 - Improved Transformations
 - Fitness Over Time
 - Common Ancestor
- 5 Conclusions

Questions Asked

- 1 *How often do mutations improve fitness? Also, how often do crossovers improve fitness, where the root parent is more fit than the non-root parent, and vice versa?*
- 2 *What does the fitness of the “winning” root parent ancestry line look like over time?*
- 3 *Do a group of individuals have a common root parent ancestor and what is the latest generation where such an ancestor occurs?*
- 4 *How many individuals in the initial generation have any root parent descendants in the final generation?*

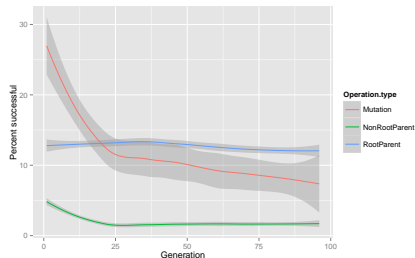
Percentage of Improved Transformations

How often do mutations and crossovers improve fitness?

Results for 10000 Individual Run

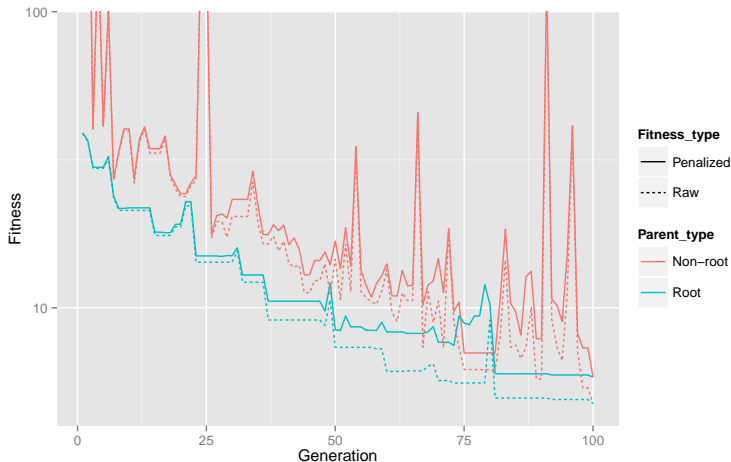


Results for Three 1000 Individual Runs



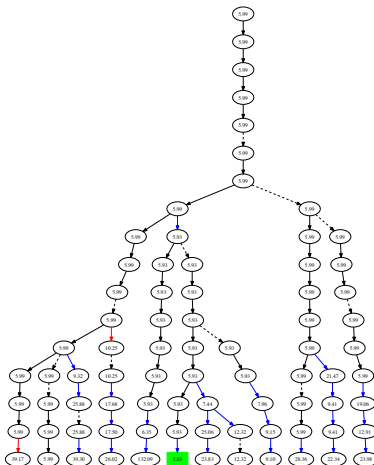
Fitness Over Time

What does the fitness of the “winning” root parent ancestry line look like over time?



Common Ancestor

Do a group of individuals have a common root parent ancestor and what is the latest generation where such an ancestor occurs?



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Conclusions

- We can gather internal data!
- Provides more in depth information than statistical summaries.
- Support for hypotheses.

Future work

- Trying different setup configurations.
- Enforcing the root parent to have better fitness in XO.
- Dynamically change parameters.

Thanks!

Thank you for your time and attention!

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Questions?

References



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In Günther Raidl, *et al*, editors, *GECCO '09*, pages 1019–1026, Montréal, Québec, Canada, 2009.



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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.