Rethinking Genetic Improvement Programming

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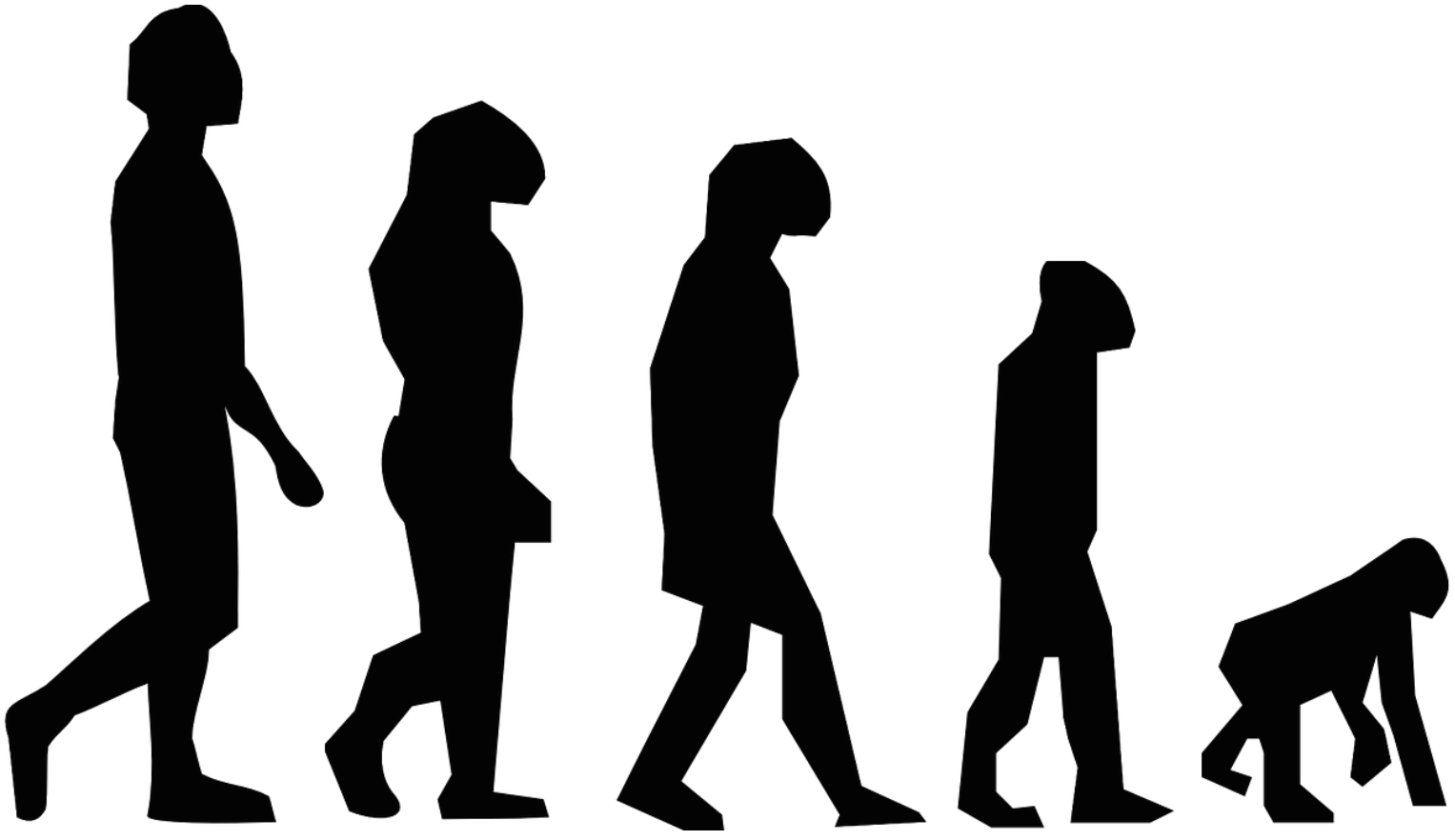
GI 2015, GECCO

Genetic Programming

has gone backwards.

http://www.davidrwhite.co.uk/2014/11/27/genetic-programming-has-gone-backwards/

Starting at the End



An Early Paper (2011)

Evolutionary Improvement of Programs

David R White, Andrea Arcuri, John A Clark.

Abstract—Most applications of Genetic Programming (GP) involve the creation of an entirely new function, program or expression to solve a specific problem. In this paper we propose a new approach that applies GP to improve existing software by optimising its non-functional properties such as execution time, memory usage or power consumption. In general, satisfying non-functional requirements

Readymades (Marcel Duchamp)

Image from the Walker Art Center

How does existing code help us?

Existing code provides:

1. An Oracle
2. A starting point
3. Raw material

Existing Software as an Oracle

The Oracle of Delphi

An Oracle

- Full (non-functional optimisation) or partial (bug-fixing)

We can effectively treat the Oracle as a specification for new versions:

- N-Version programming[1]
- Reverse Engineering[2]

[1] R. Feldt. Generating Multiple Diverse Software Versions with Genetic Programming. In *Euromicro Conference*, 1998

[2] M. Harman, W. B. Langdon, and W. Weimer. Genetic Programming for Reverse Engineering. In *Working Conference on Reverse Engineering*, 2013

Research Direction: Translating Software

Why not consider software translation in a very general sense?

- Porting to new languages.
- Target to new platforms and technologies.
  - Automated parallelisation?[3]
  - CUDA and GPGPU[4]
- Compressing and simplifying programs.
- A solution to the problem of *legacy software*?

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[3] C. Ryan. *Automatic Re-engineering of Software Using Genetic Programming*. Springer US, 2000

[4] W B Langdon and M Harman. Evolving a CUDA kernel from an nVidia template. In *CEC*, 2010

Existing Software as a Starting Point

https://www.flickr.com/photos/t_buchtele/3422507814

A Starting Point

The number of possible trees of depth d is given by:

$$c(d) = \begin{cases} n_0 & \text{for } d = 1 \\ \sum_{a=0}^{max} n_a \cdot c(d-1)^a & \text{for } d > 1 \end{cases} \quad (1)$$

n_a is the number of functions in N that have arity a. max is the maximum arity of functions in the function set.

Example Numbers for a Simple Function Set

Max Depth	Search Space Size
1	2
2	10
3	202
4	81610
5	$3.5x10^{20}$

David Robert White. *Genetic programming for low-resource systems*. PhD thesis, University of York, 2010

A Starting Point

- Reasonable assumption that the solution is close to the original program.
- Profiling the existing code reduces the size of the search space.
- Provides the basic units of manipulation, course-grained search.

Research Direction: Static and Dynamic Analysis

Plethora of techniques we have yet to exploit.

Simple example: profiling of memory usage to eliminate memory leaks or inefficiencies.

Existing Software as Raw Material

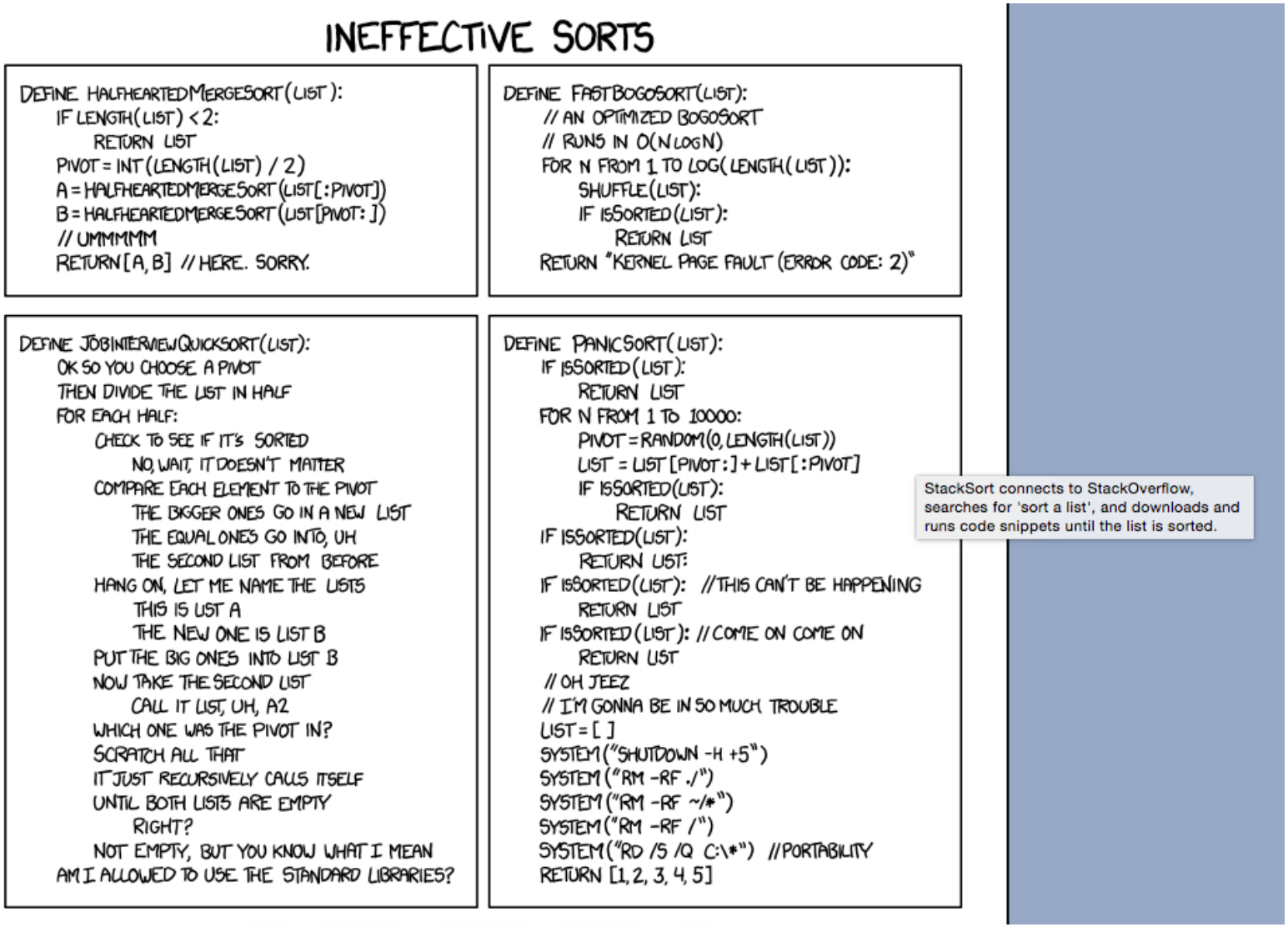
Raw Material

"In practice, a program that makes a mistake in one location often handles the situation correctly in another."

D. Engler, D. Y. Chen, S. Hallem, A. Chou, and B. Chelf. Bugs As Deviant Behavior: A General Approach to Inferring Errors in Systems Code. In *SOSP '01*, 2001

Prefabs

Research Direction: Code Scavenging



https://xkcd.com/1185/

Code Scavenging: Stacksort

stacksort

In a recent xkcd's alt text, Randall Munroe suggested **stacksort**, a sort that searches StackOverflow for sorting functions and runs them until it returns the correct answer. So, I made it. If you like running arbitrary code in your browser, try it out.

Like (or hate) it? Comment on HackerNews

stackoverflow_sort(
Try a list of numbers, a string, a list of words or json.

[8,6,7,5,3,0,9]

);

Sort

var output =
Output from the function.

;

output console

http://gkoberger.github.io/stacksort/

Summary

It's all about existing software.

1. As an Oracle.
2. As a starting point.
3. As readymades.

Image from the Walker Art Center