Convergence sextic polynomial. Grey % child's != parent's fitness. After gen 800 most children have identical fitness to mum, and on average (purple dotted line) incremental evaluation evaluates subtrees of depth 87.34. Saving up to 100 fold in evaluations of GP operations (blue v. top red). Note log scale.

Fitness first
Fitness is evaluated using only parents, i.e., before the child is created by crossover. Subtree to be inserted (black) is evaluated on all test cases and values transferred to evaluation of mum at the location of the subtree to be removed (white). Use EuroGP [3] incremental evaluation, so differences between original code (white subtree) and new are propagated up mum until either all differences are zero or we reach the root node.

Fitness first and Fatherless Crossover
W. B. Langdon  Department of Computer Science, University College London

Fitness First and Fatherless Crossover
W. B. Langdon  Department of Computer Science, University College London

Left: Conventional top-down recursive evaluation of (SUB 0.026 (DIV(SUB (MUL -0.826 -0.718) X) X)). X=10. Blue integers indicate evaluation order, red floats are node return values. Right: Bottom Up Evaluation: starting with leaf -0.826 and working to root node. Both return exactly the same answer.

250x SPEEDUP
Equivalent of 692 billion GP operations per second on 16core 3.8Ghz 17 desktop with AVX-512

C++ code
http://www.cs.ucl.ac.uk/staff/W.Langdon/ftp/gp-code/GPinc.tar.gz

w.langdon@cs.ucl.ac.uk

INFORMATION THEORY OF GP CONVERGENCE
All functions lose information. Without side effects, lost information cannot be restored. Disruption passes up tree but once lost on a test case cannot be restored. In deep trees impact does not reach root. Hence child behaves identically to its mother and therefore has the same fitness. Deep trees give GP a smooth landscape. Relatively insensitive, order log n, to number of test cases.

Incremental evaluation of first member of generation 1000. Number of test cases where evaluation in the root donating parent (mum) and its offspring are identical never falls.

1. GECCO 2021, doi:10.1145/3449726.3459437
2. GPTP 2021, Fitness First