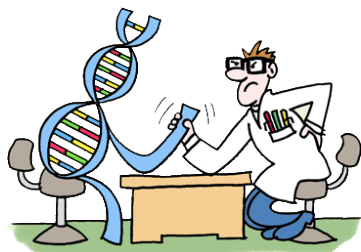# Genetic Improvement of Last Level Cache

W.B. Langdon

EuroGP2024

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A Field Guide to Genetic Programming

Riccardo Poli
William B. Langdon
Nicholas F. McPhee

with contributions by
John R. Koza

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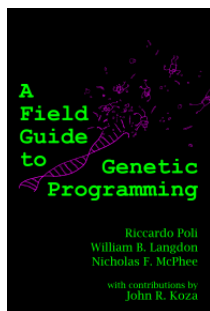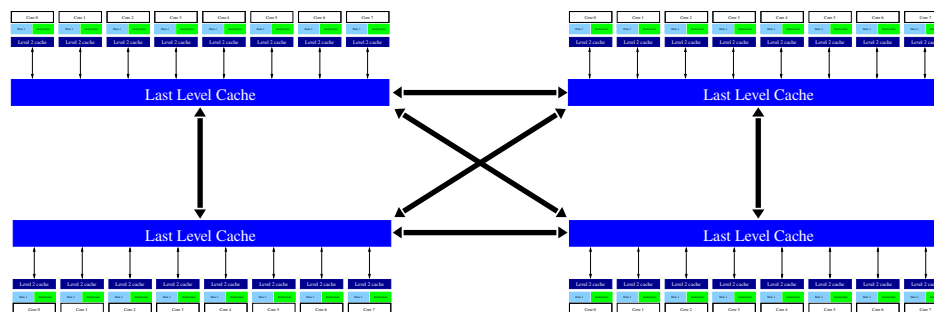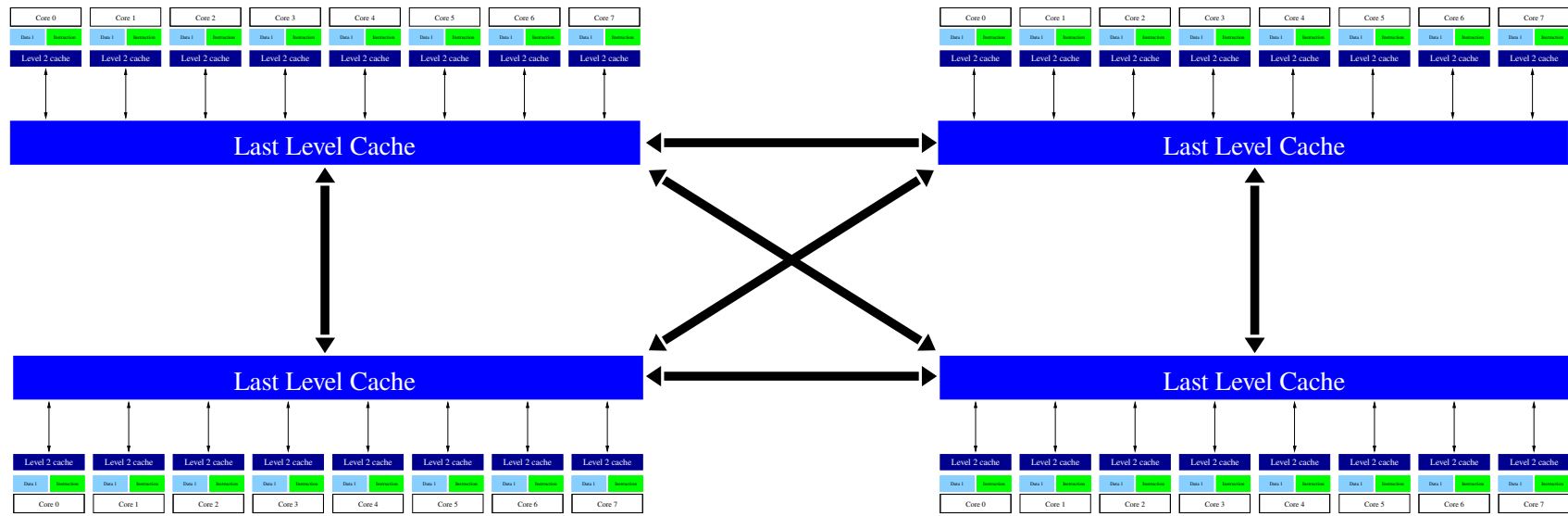GI workshop
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Genetic Improvement of Last Level Cache

- Cache hidden connection between CPUs and RAM. Vital for performance
- What is Last Level Cache (here Level 3)
- Why is last level cache important
- In practice impossible to program
- So evolve
- Magpie optimise parameters and code
- 4 fold reduction in last level cache

What is Last Level Cache

Communication between four chips linked via their LLC caches to appear as one cache

CPU cache hierarchy (Intel I7 has 3 levels)
  L1 Instruction and data cache, fast, both 32K bytes
  L2 256K bytes per core
  L3 8M bytes shared between cores. Link to RAM

Why is last level cache important

- Last level cache is by far largest cache
- Link between CPU and RAM
- Link between separate cores
- Increasingly link between CPU chips

Cannot program cache

- Cache is by definition hidden from programmer

- CPUs run far faster than RAM so cache performance vital to system performance

- Cache often proprietary "black box"

- Program can try to help: memory layout, order of access, but hard:

- Use Evolution on existing programs.

Magpie optimise parameters and code

- Linux perf measure cache loads.
  - Noise, eg cache shared by whole computer, 100s of active processes
- Magpie simultaneously optimise:
  - C++ code
  - gcc compiler switches
  - program command line options

github.com/bloa/magpie

- L3 cache loads from RAM and stores to RAM reduced by factor of four.
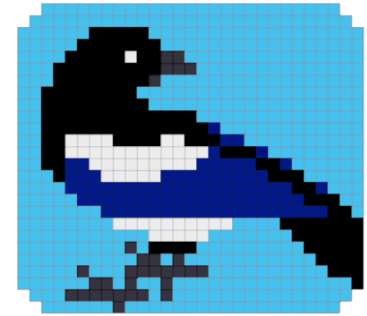
Conclusions

- Genetic Improvement has been applied to industrial code
- GI code has been adopted and is in use world wide
  - Eg used when designing covid tests
- GI code is under traditional human maintenance
- Cache vital to performance.
  - Last level cache critical to parallel multi-core computing.
  - Increasing number of parallel cores means last level cache importance will increase
  - But hard to optimise by hand.
- VIPS C++ image processing reduction by factor of four in sum of last level cache loads and stores.

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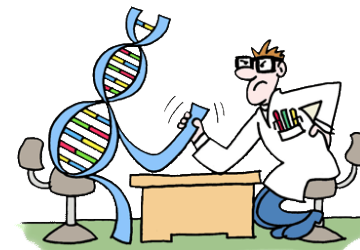
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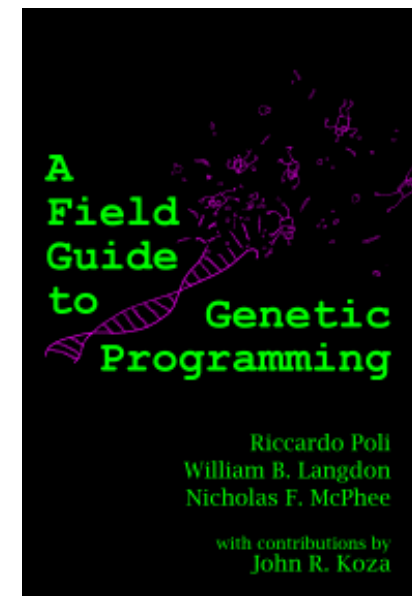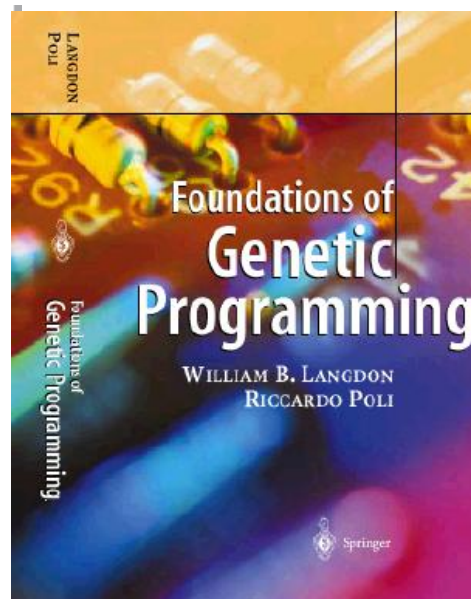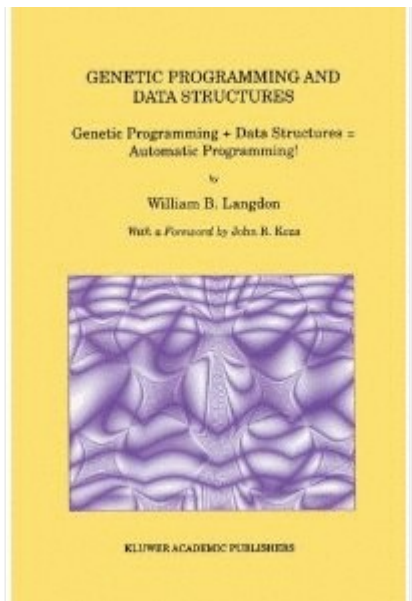https://geneticimprovementofsoftware.com/events/ase2024

Genetic Programming

W. B. Langdon

The Genetic Programming Bibliography

16710 references, [16000 authors](#)

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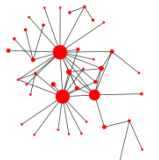E.g. email W.Langdon@cs.ucl.ac.uk   or   use | [Add to It](#) | web link

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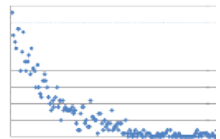
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