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Improving PolyBench: Heroes Wanted

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Easy fixes & low hanging fruit

- Bugs:
  - ADI
  - $A^T AX$ (already fixed but not released)
  - …
- No test inputs/outputs provided
- Parameters are static (#define) so compilers can optimize away
  - even "dynamic" parameters use #define
  - must be passed as arguments to functions

Low Hanging Fruit

- Some benchmarks are really microkernels
  - Vector add, 1D Jacobi stencil, …
- Some are terribly naïve
  - in memory – fdtd_apml is single assignment
  - in work and memory – dynprog and reg_detect are $O(N^4)$ with $O(N^3)$ memory
    - can be done in $O(N^3)$ work with $O(N^2)$ memory.
    - What is the goal? Do we expect compilers to reduce space/work complexity? If so, mark them as “challenges”

Some Higher Fruit

- Not very readable – heavy use of C macros
  - Motivation – need different “kinds of benchmarks” – e.g., linearized vs truly multidimensional arrays
  - Cleaner way: generate with a script – don’t use C macro processor as a scripting language.
- Relatively few truly difficult codes

Higher Fruit (complete apps)

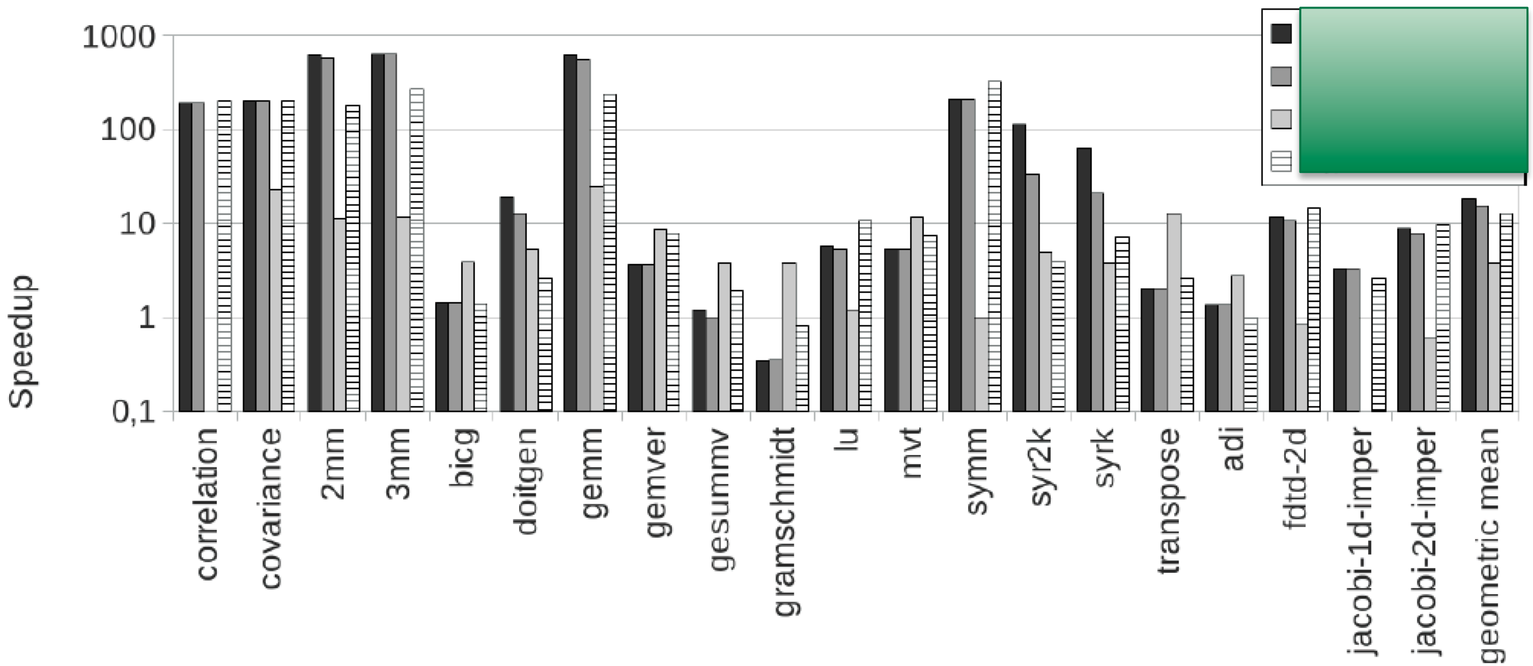
- HMMER (Hidden Markov Model – Viterbi)
  - hmmer.janelia.org
- Back-propagation NN training
- UAV tracking using POMDP
- Nupack (nucleic acid structure)
  - www.nupack.org
- Mfold/Unafold (RNA secondary structure)
  - mfold.rna.albany.edu
- Smith Waterman/BLAST/…
- FDTD apps
- …

Serious Benchmarking

- Q: What’s wrong with this?

-

Overall Results: The Same One Produced By Others



Serious Benchmarking

- Q: What's wrong with this?

- Answer
  - No absolute performance data
  - No information about GLFOP/sec attained
  - No comparison with the best possible (by hand)

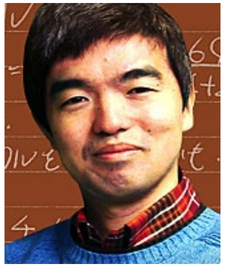
Towards a solution

- Need to know best achievable performance
  - on a given target
  - for a given set of size parameters
  - for all the benchmarks
- Separate compiler optimizations from "algorithmic innovations"
  - Dynamic programming
  - Floyd-Warshall
- Calls for heroes

Cédric's heroes

Outstanding Optimization Heroes

- John Carmack
  Game developer, id Software
  innovations in 3D Graphics, fast inverse square root



- Kazushige Goto
  Engineer, Intel
  hand-tuned programs for supercomputers
  "Goto BLAS"

- Vasily Volkov
  PhD student, Berkeley
  3x faster FFT than nVidia's proprietary implementation

Students are our heroes

- Set up a competition
- Like DARPA’s HPC Challenge benchmarks

- Reward successful students with
  - Fame
  - Travel to next IMPACT
  - Riches – ipad, laptop, …