Advanced Systems Lab

Spring 2024

Lecture: Benchmarking

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Overview

Measuring performance & benchmarking

References:

- *Whaley and Castaldo: Achieving accurate and context-sensitive timing for code optimization, Software: Practice and Experience 2008*
- *Hoefler and Belli: Scientific Benchmarking of Parallel Computing Systems, Supercomputing 2015*
- *Section 3.2 in: Chellappa, Franchetti, Püschel: How To Write Fast Numerical Code: A Small Introduction, GTTSE 2008*

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Benchmarking

First: Test your code!

Measure runtime (in [s] or [cycles]) for a set of relevant input sizes

- *seconds: actual runtime*
- *cycles: abstracts from CPU frequency*

Usually: Compute and show performance (in [flop/s] or [flop/cycle])

Careful: Better performance ≠ better runtime (why?)

- *Op count could differ*
- *Never show in one plot performance of two algorithms with substantially different op count*

Make sure to measure under the conditions of real use (e.g., cache state)

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How to Measure Runtime?

C clock()

- *process specific, low resolution, very portable*

gettimeofday

- *measures wall clock time, higher resolution, somewhat portable*

Performance counter (e.g., TSC on Intel)

- *measures cycles (i.e., also wall clock time), highest resolution, not portable*
- *problematic with frequency scaling*

Careful:

- *measure only what you want to measure*
- *ensure proper machine state*
  (e.g., cold or warm cache = input data is or is not in cache)
- *measure enough repetitions*
- *check how reproducible; if not reproducible: fix it*

Getting proper measurements is not easy at all!

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Problems with Timing

Too few iterations: inaccurate non-reproducible timing

Too many iterations: system events interfere

Machine is under load: produces side effects

Multiple timings performed on the same machine

Bad data alignment of input/output vectors:

- *align to multiples of cache line (on Core: address is divisible by 64)*
- *sometimes aligning to page boundaries (address divisible by 4096) makes sense*

Machine was not rebooted for a long time: state of operating system causes problems

Computation is input data dependent: choose representative input data

Computation is inplace and data grows until an exception is triggered
(computation is done with NaNs)

You work on a computer that has dynamic frequency scaling (e.g., turbo boost)

Always check whether timings make sense and are reproducible

Benchmarks in Writing

Specify experimental setup for reproducability

- *platform*
- *compiler and version*
- *compiler flags used*

Plot: Very readable

- *Title, x-label, y-label should be there*
- *Fonts large enough*
- *Enough contrast (e.g., no yellow on white please)*
- *Proper number format that also matches measurement accuracy*
  - ***No:** 13.254687; **yes:** 13.25*
  - ***No:** 2.0345e-05 s; **yes:** 20.3 µs*
  - ***No:** 100000 B; **maybe:** 100,000 B; **yes:** 100 KB*

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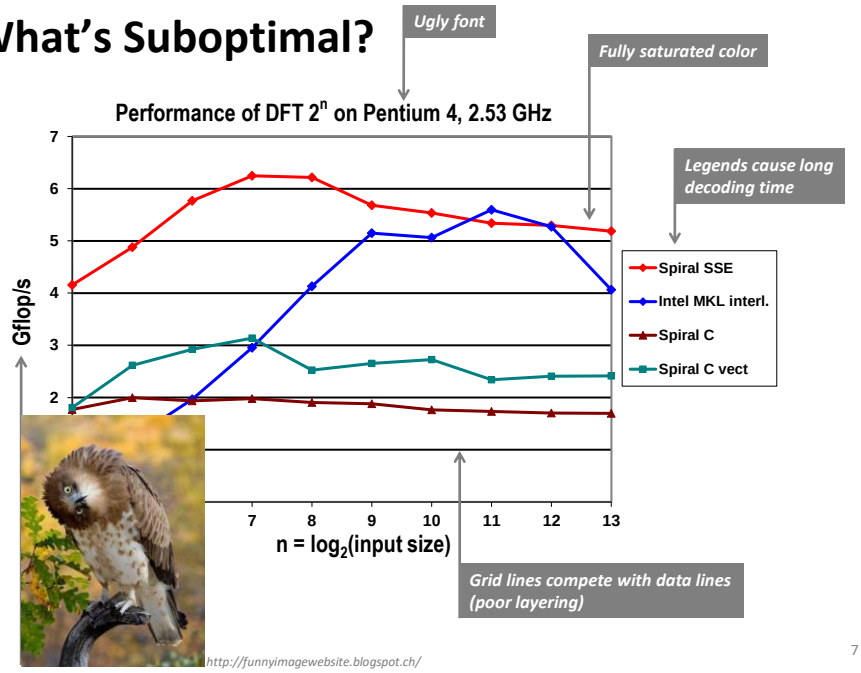
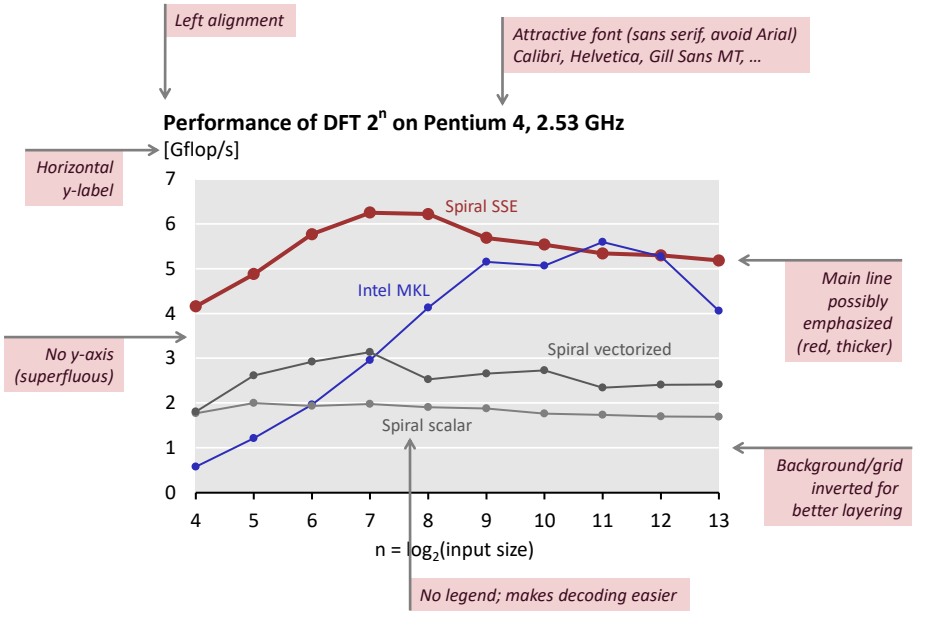
What's Suboptimal?



http://funnyimagewebsite.blogspot.ch/



Of course, this is only one of several ways to make a good viewgraph