Benchmarking: You're Doing It Wrong

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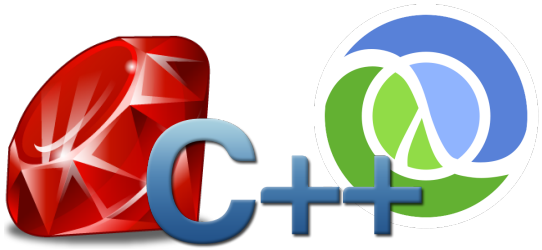
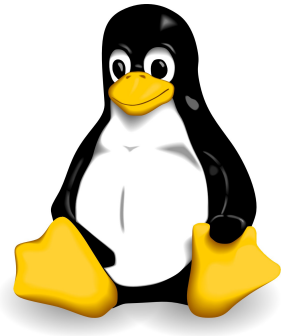
Google

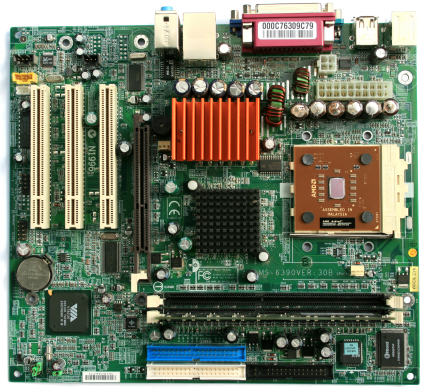
In Memes…

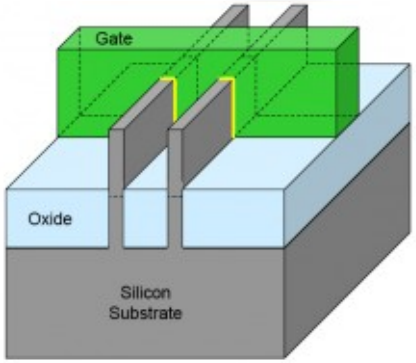
To Write Good Benchmarks…



Need to be Full Stack







What's a Benchmark

How fast?

Your process vs Goal

Your process vs Best Practices

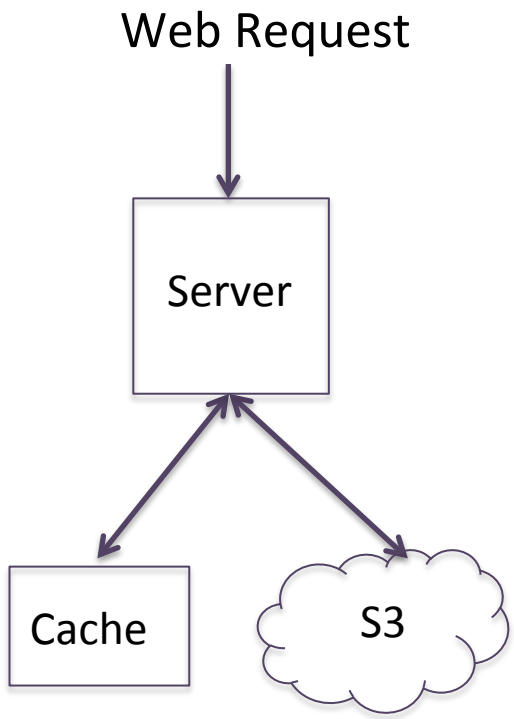
Today

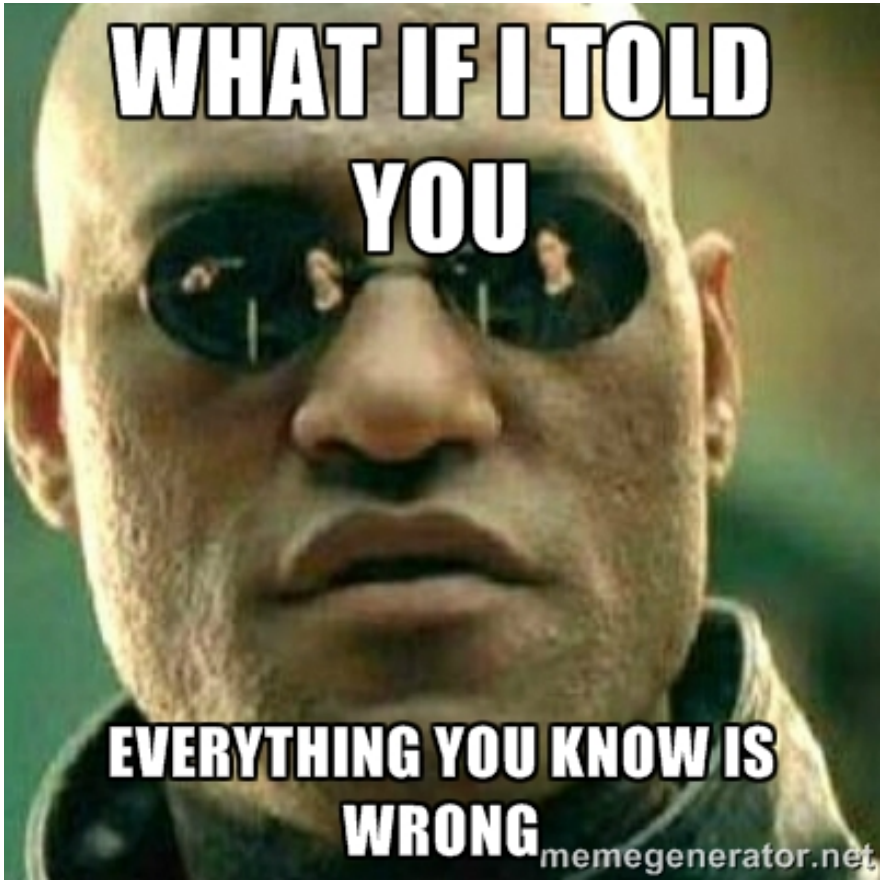
- How Not to Write Benchmarks
- Benchmark Setup & Results:
  - Wrong about the machine
  - Wrong about stats
  - Wrong about what matters
- Becoming Less Wrong

HOW NOT TO WRITE BENCHMARKS

Website Serving Images

- Access 1 image 1000 times
- Latency measured for each access
- Start measuring immediately
- 3 runs
- Find mean
- Dev machine





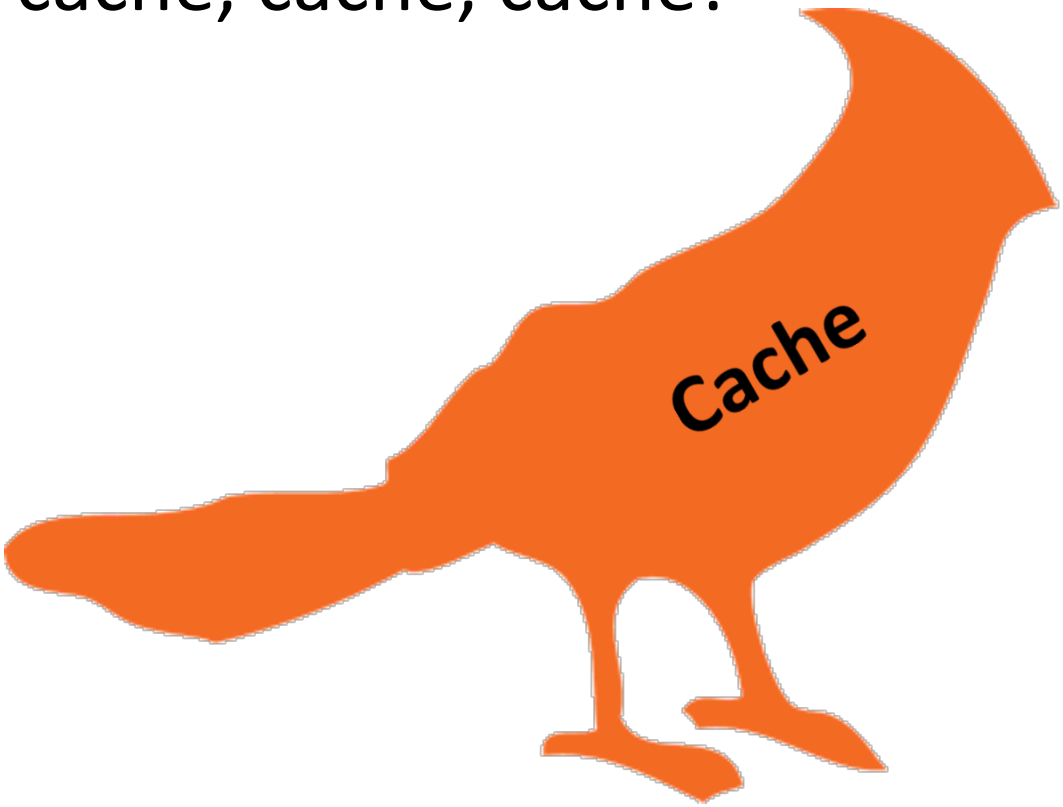
WHAT'S WRONG WITH THIS BENCHMARK?

You're wrong about the machine

BENCHMARK SETUP & RESULTS: COMMON PITFALLS

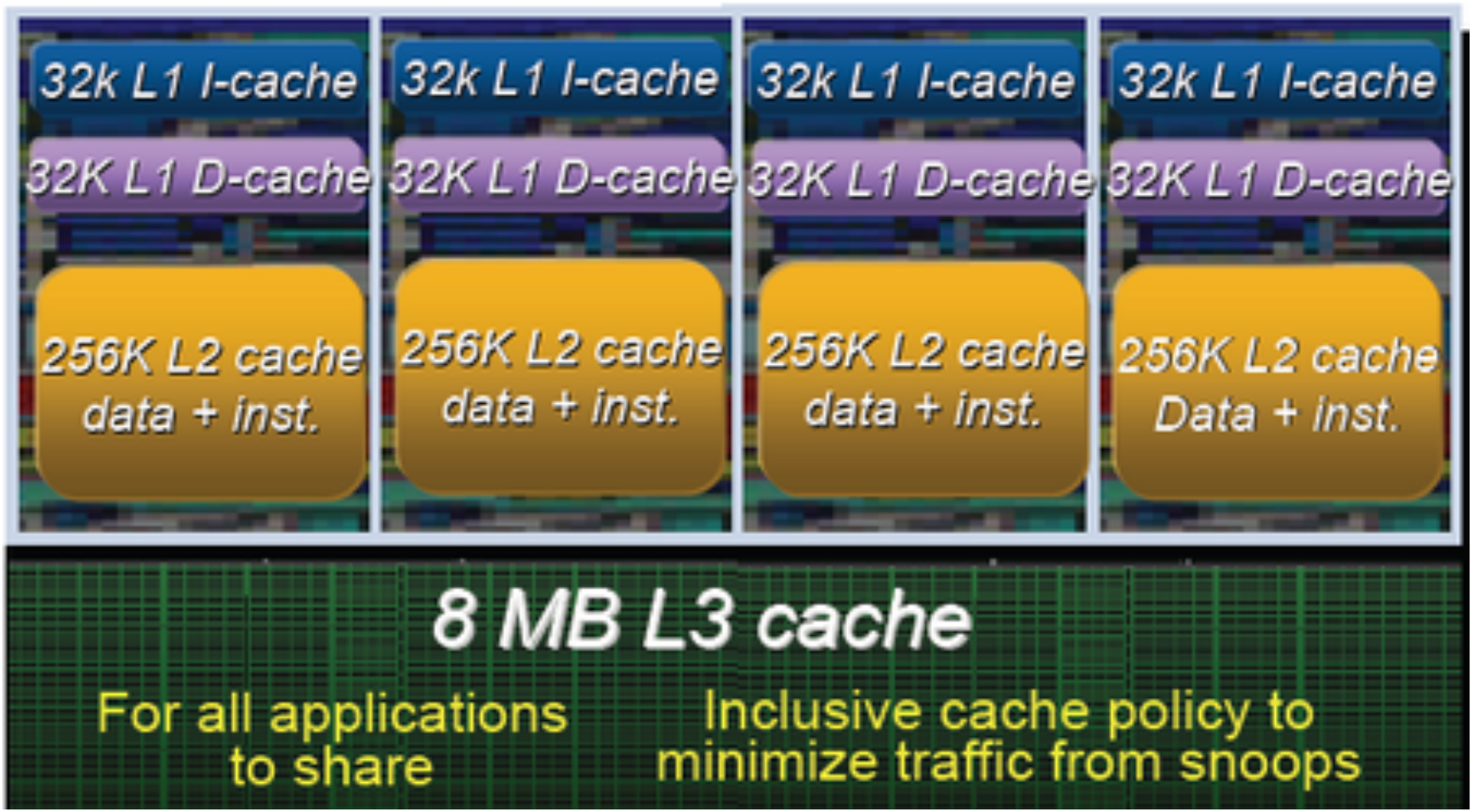
Wrong About the Machine

- Cache, cache, cache, cache!



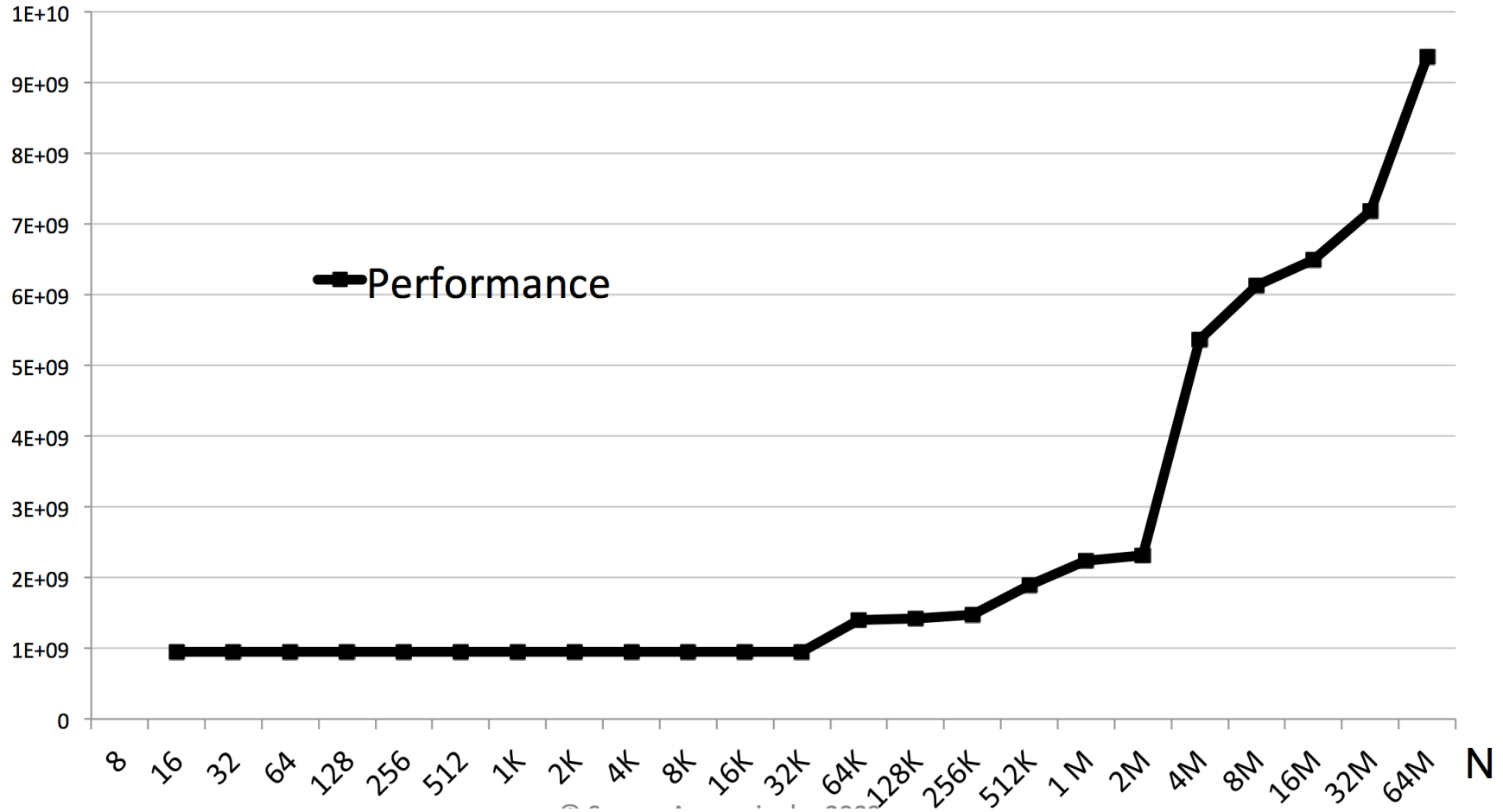
It’s Caches All The Way Down

It’s Caches All The Way Down



Caches in Benchmarks

Prof. Saman Amarasinghe, MIT 2009



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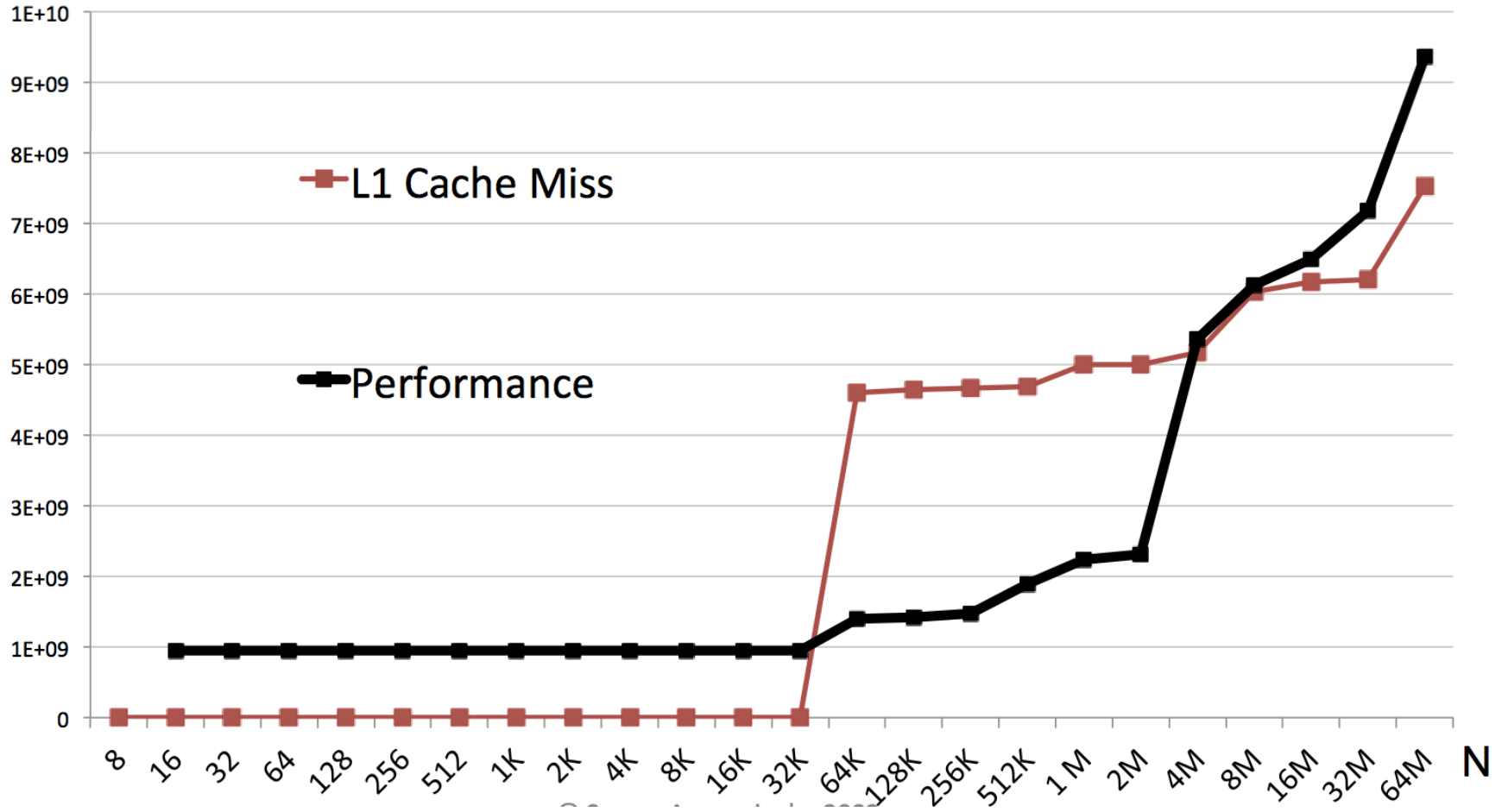

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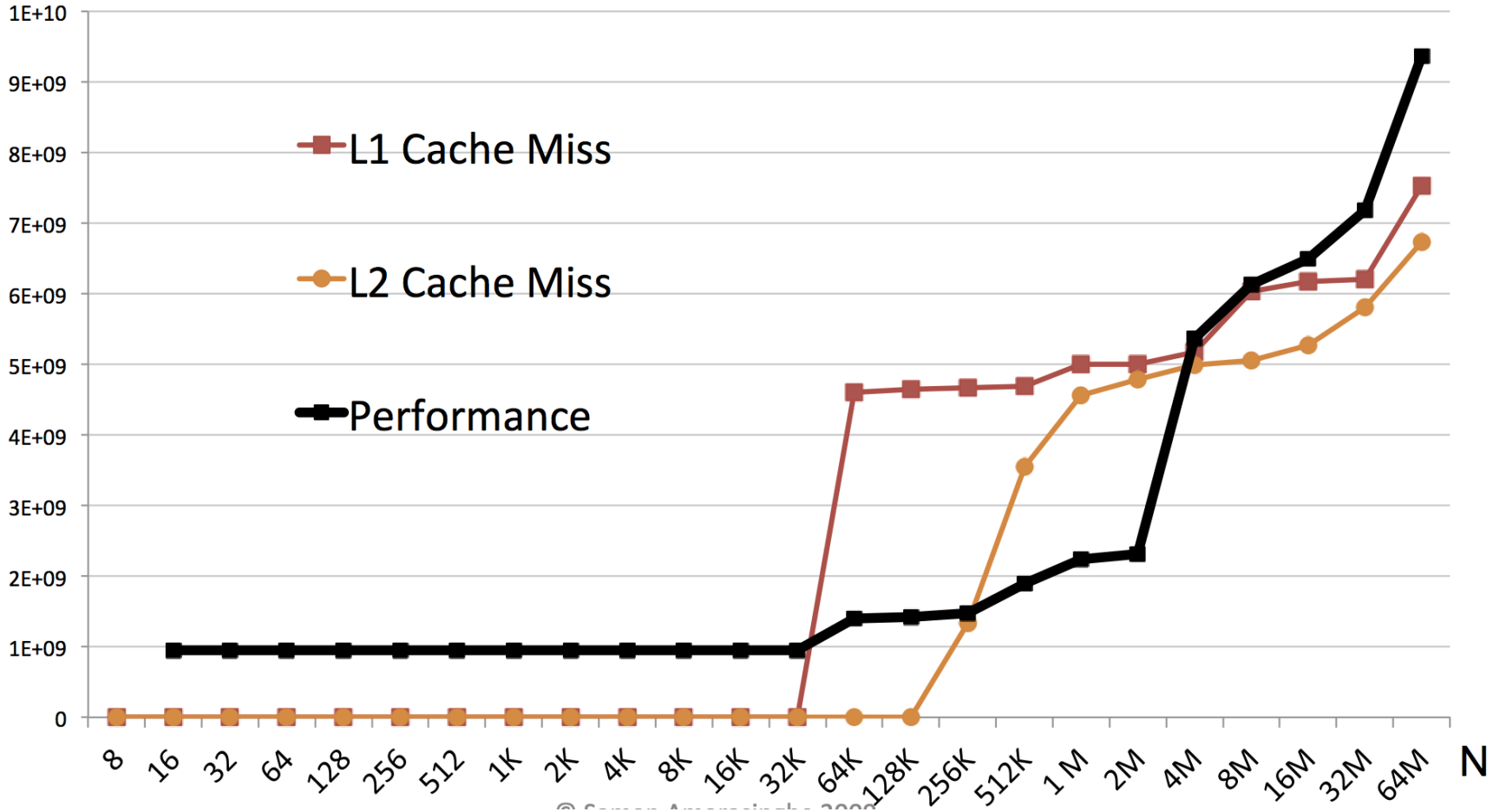

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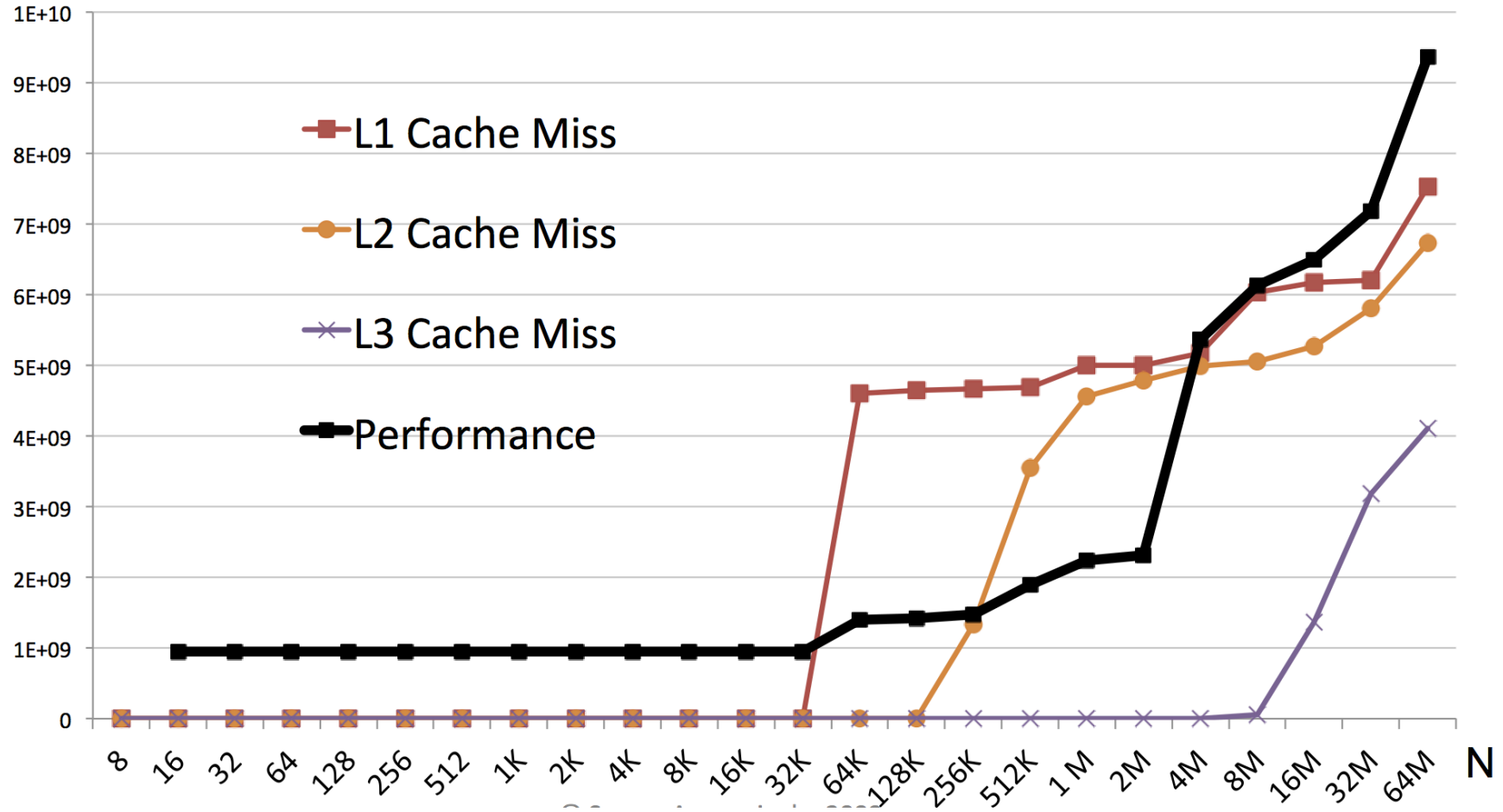

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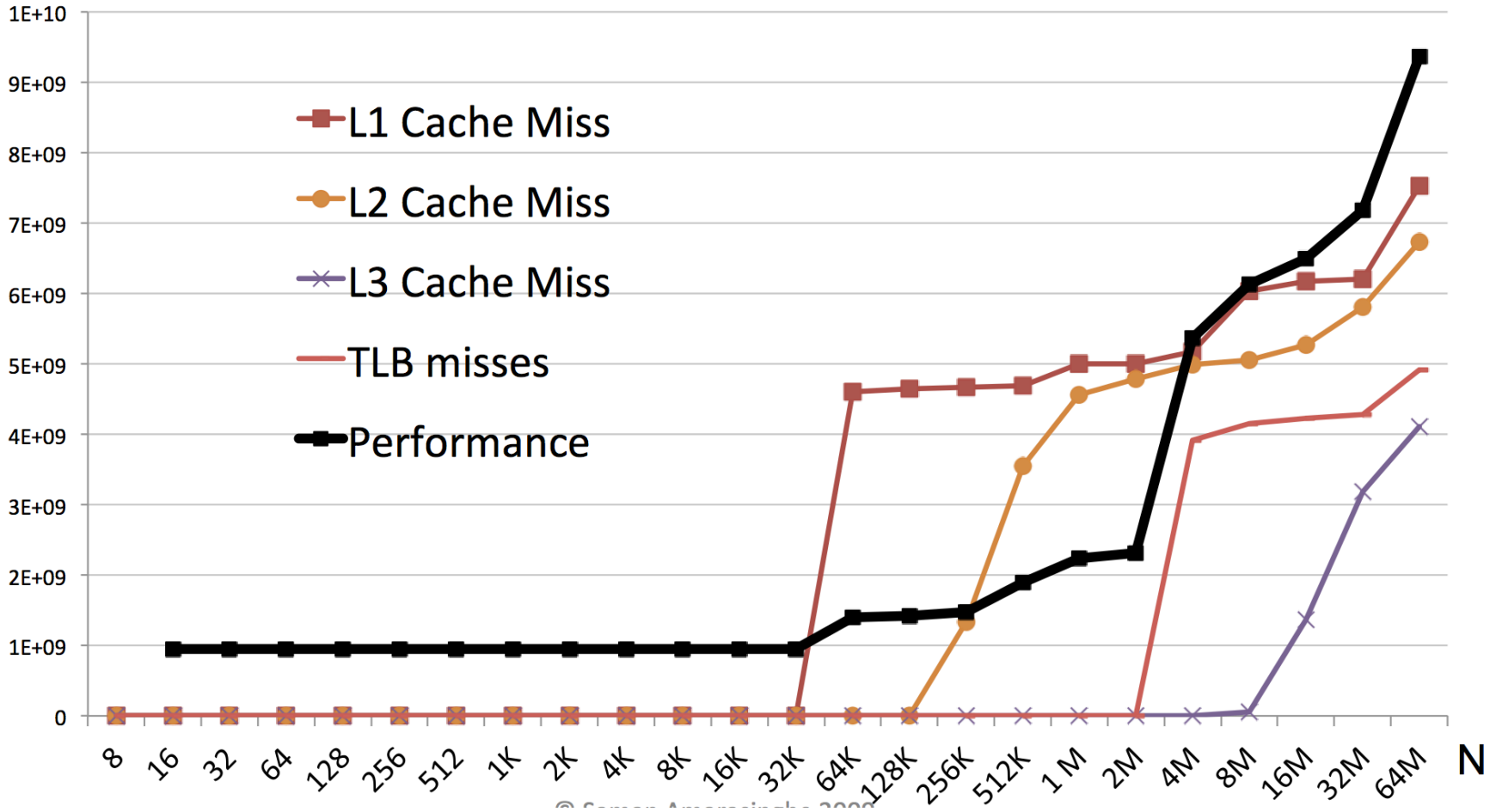

Website Serving Images

Access 1 image 1000 times

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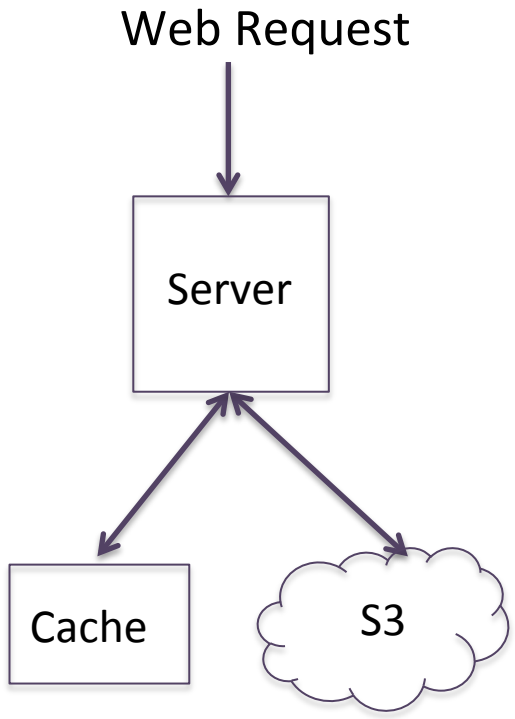

Wrong About the Machine

- Cache, cache, cache, cache!
- Warmup & Timing

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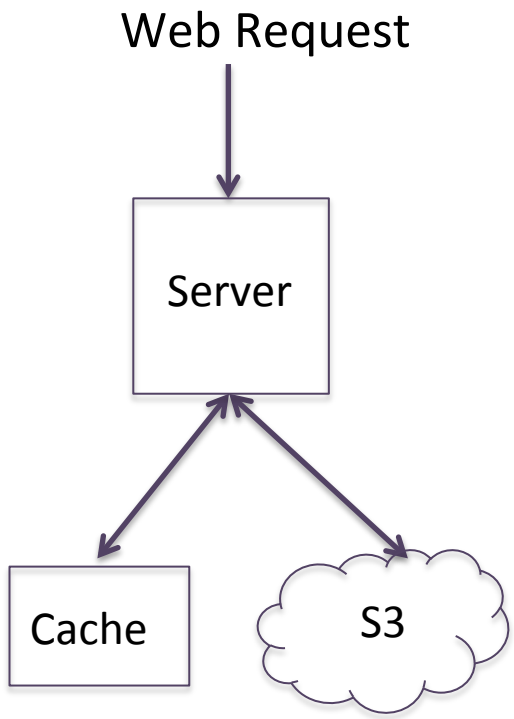
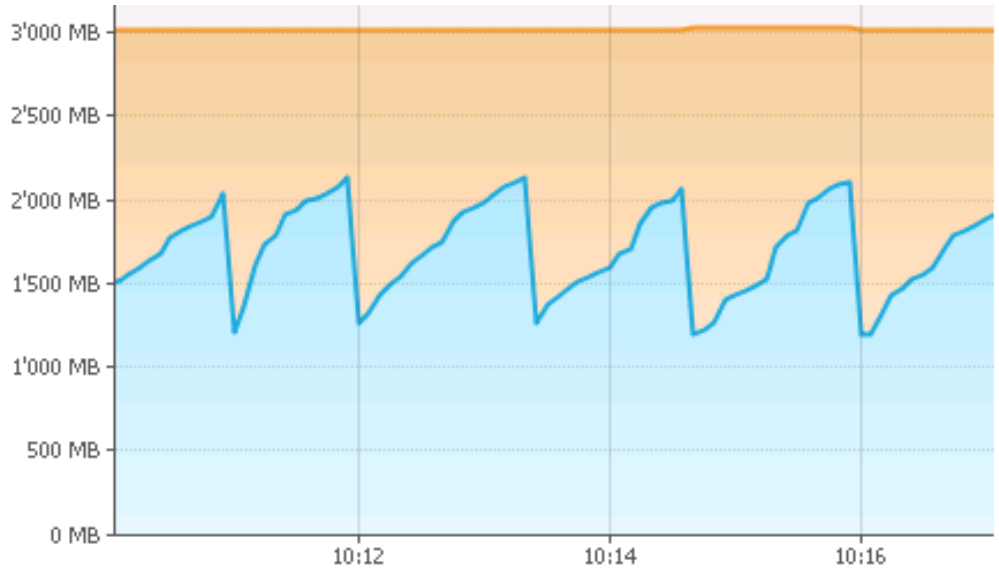


Wrong About the Machine

- Cache, cache, cache, cache!
- Warmup & Timing
- Periodic interference



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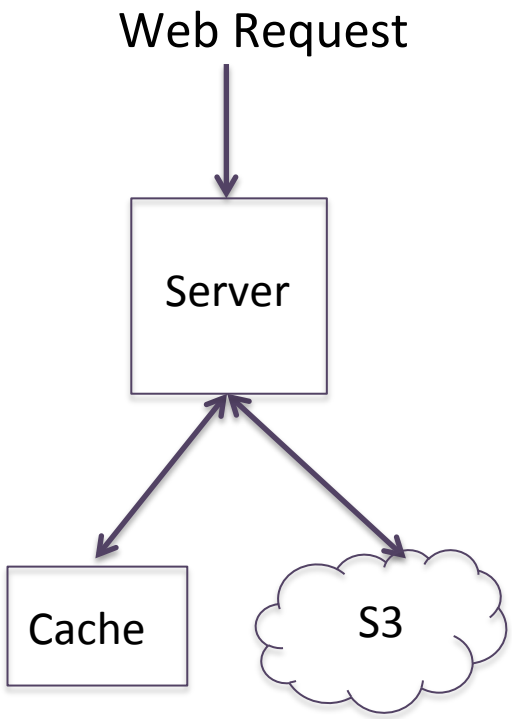

Wrong About the Machine

- Cache, cache, cache, cache!
- Warmup & Timing
- Periodic interference
- Different specs in test vs prod machines

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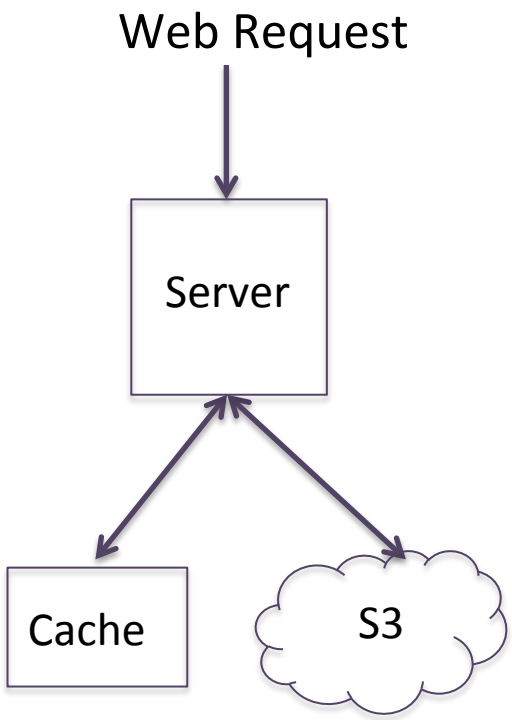
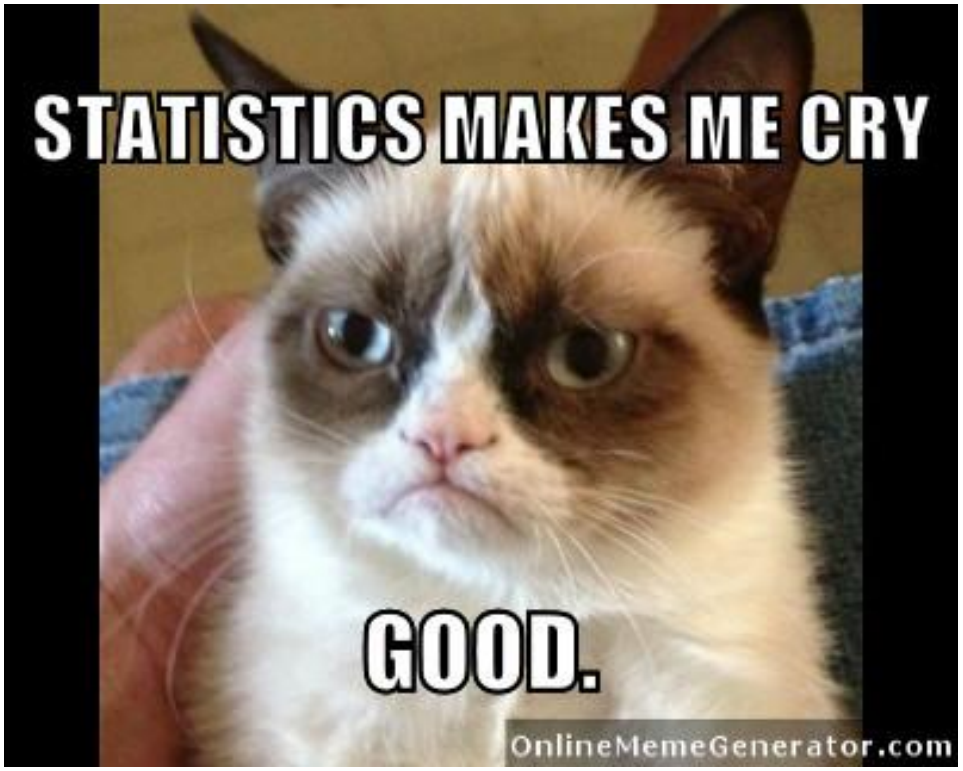
- ✗ Dev machine



Wrong About the Machine

- Cache, cache, cache, cache!
- Warmup & Timing
- Periodic interference
- Different specs in test vs prod machines
- Power mode changes



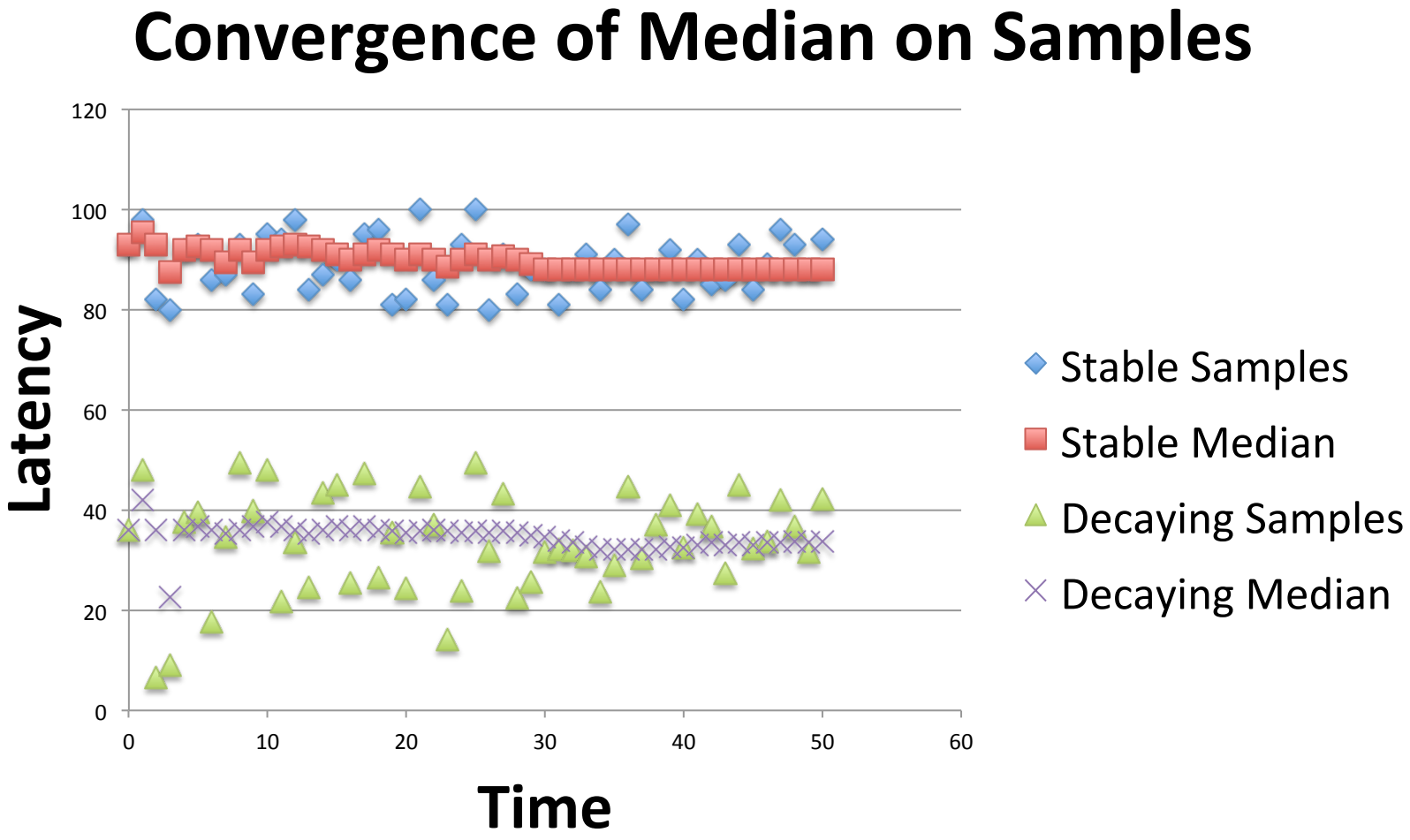
You're wrong about the stats

BENCHMARK SETUP & RESULTS: COMMON PITFALLS

Wrong About Stats

- Too few samples

Wrong About Stats



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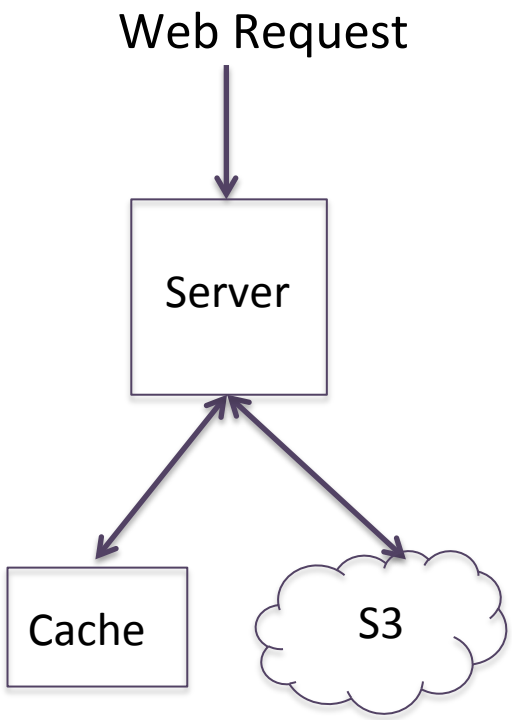

Wrong About Stats

- Too few samples
- Non-Gaussian

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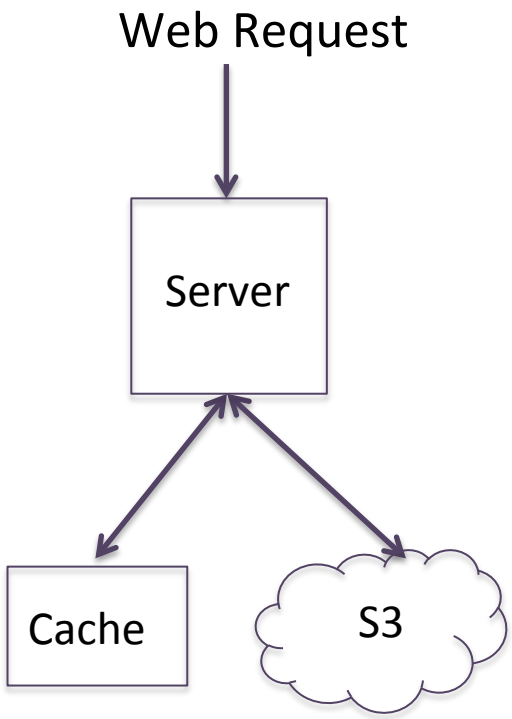
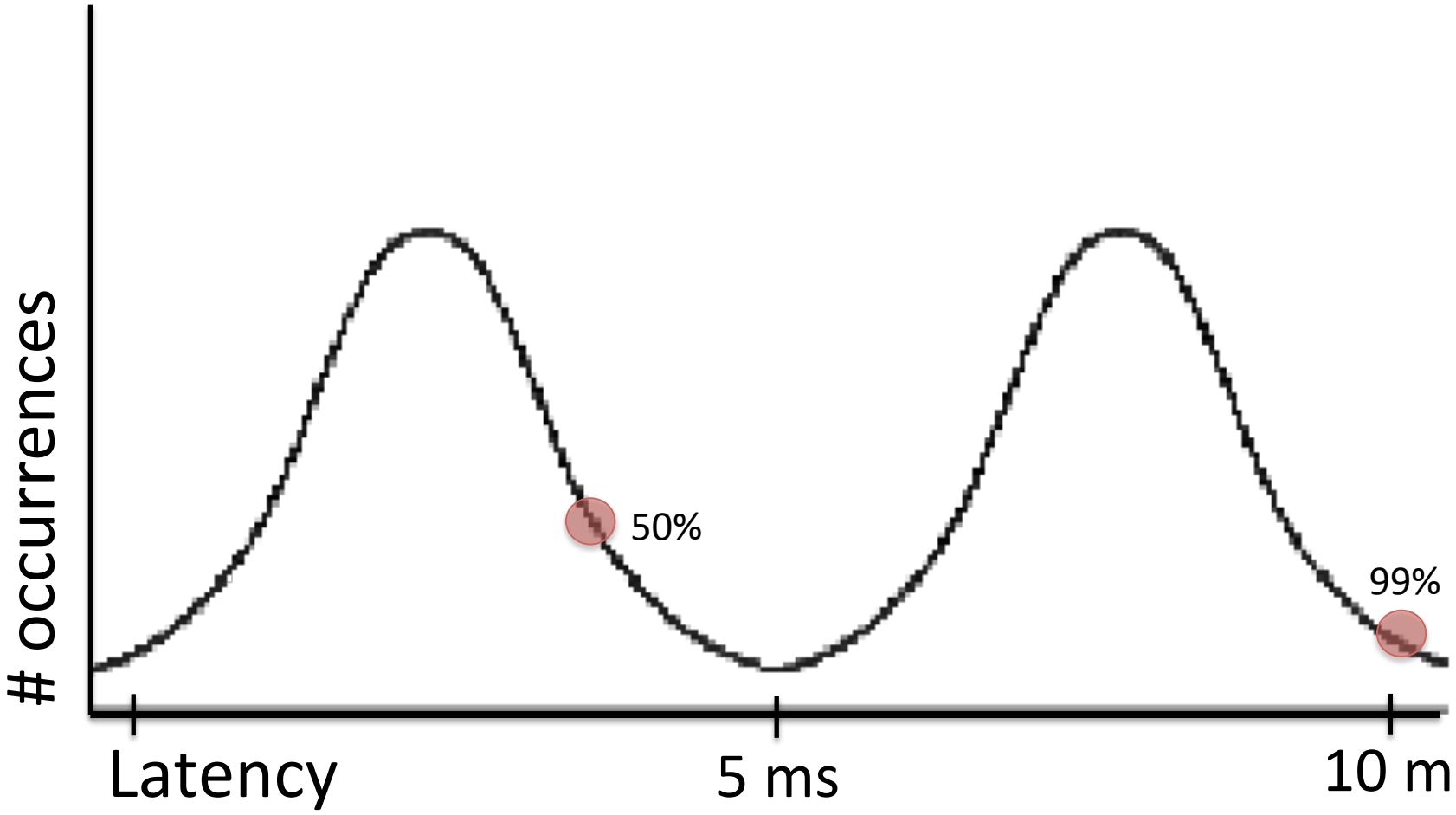


Wrong About Stats

- Too few samples
- Non-Gaussian
- Multimodal distribution

Multimodal Distribution



Wrong About Stats

- Too few samples
- Non-Gaussian
- Multimodal distribution
- Outliers

You're wrong about what matters

BENCHMARK SETUP & RESULTS: COMMON PITFALLS

Wrong About What Matters

- Premature optimization

“Programmers waste enormous amounts of time thinking about … the speed of noncritical parts of their programs … Forget about small efficiencies …97% of the time: **premature optimization is the root of all evil**. Yet we should not pass up our opportunities in that critical 3%.”

-- Donald Knuth

Wrong About What Matters

- Premature optimization
- Unrepresentative Workloads

Wrong About What Matters

- Premature optimization
- Unrepresentative Workloads
- Memory pressure

The How

BECOMING LESS WRONG

Becoming Less Wrong

User Actions Matter

X > Y for workload Z

with trade offs A, B, and C

- http://www.toomuchcode.org/

Becoming Less Wrong

Profiling

Code Instrumentation

Aggregate Over Logs

Traces

Microbenchmarking: Blessing & Curse

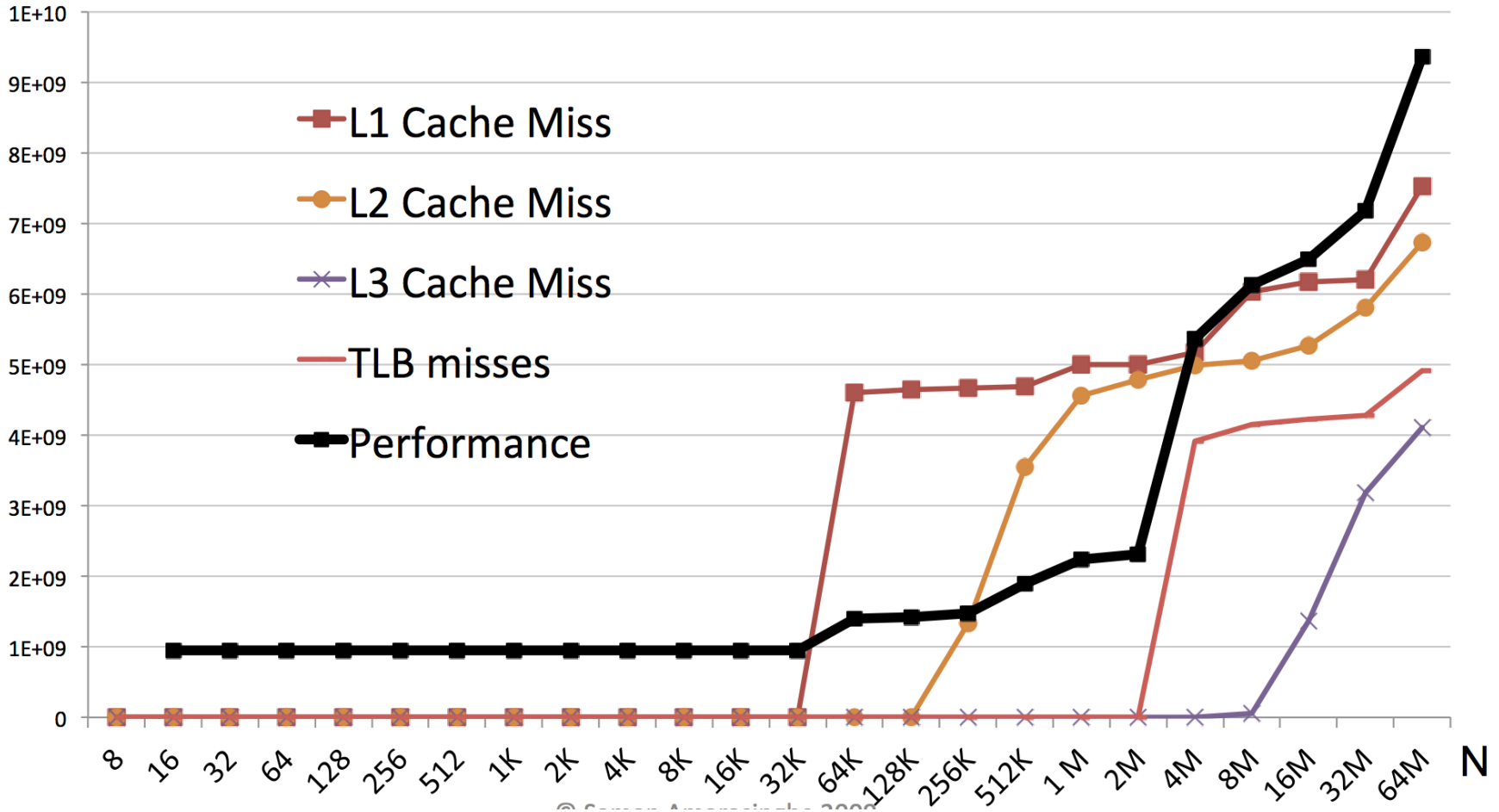
+ Quick & cheap
+ Answers narrow ?s well
– Often misleading results
– Not representative of the program

Microbenchmarking: Blessing & Curse

- Choose your N wisely

Choose Your N Wisely

Prof. Saman Amarasinghe, MIT 2009



Microbenchmarking: Blessing & Curse

- Choose your N wisely
- Measure side effects

Microbenchmarking: Blessing & Curse

- Choose your N wisely
- Measure side effects
- Beware of clock resolution

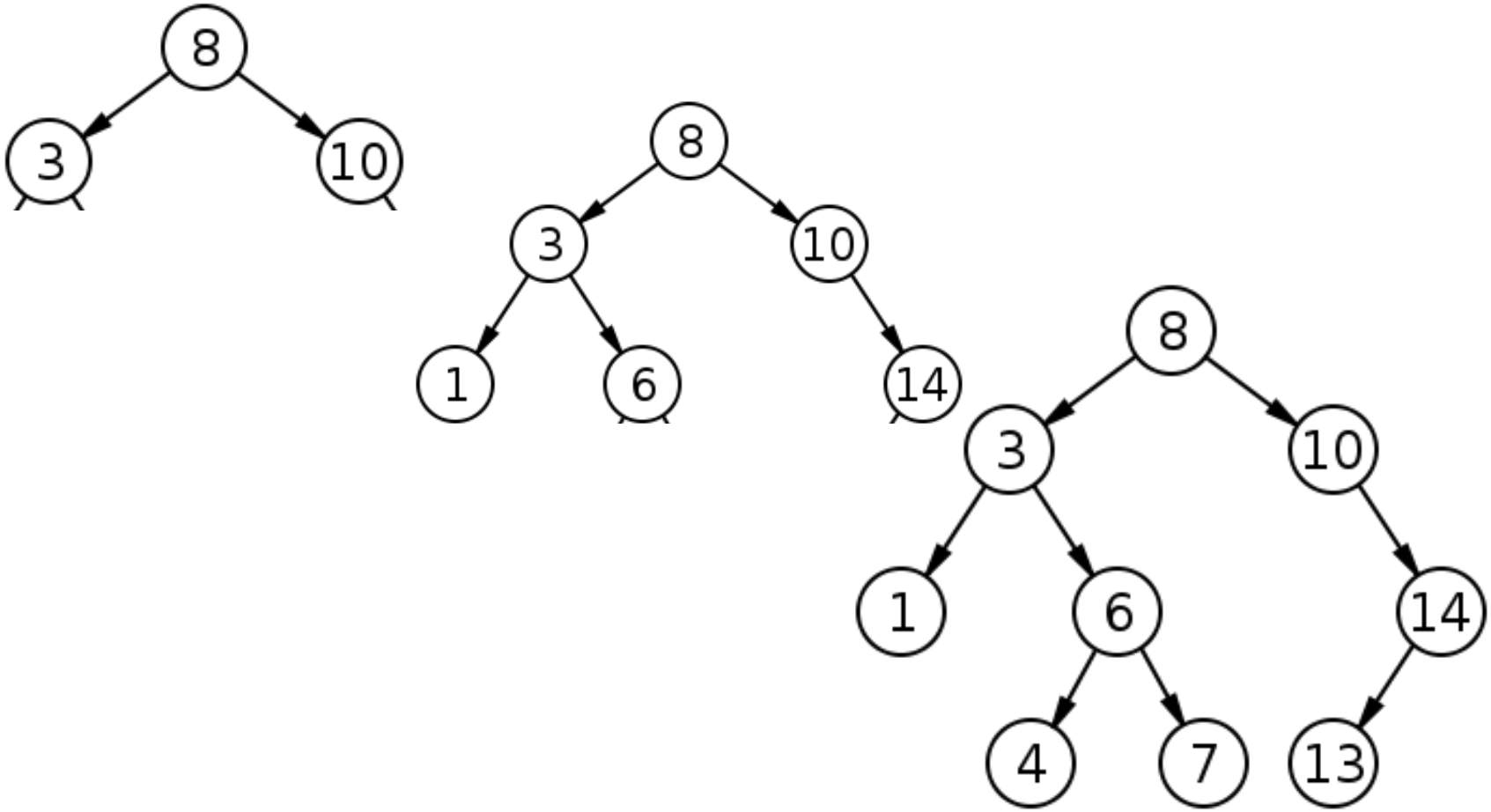
Microbenchmarking: Blessing & Curse

- Choose your N wisely
- Measure side effects
- Beware of clock resolution
- Dead Code Elimination

Microbenchmarking: Blessing & Curse

- Choose your N wisely
- Measure side effects
- Beware of clock resolution
- Dead Code Elimination
- Constant work per iteration

Non-Constant Work Per Iteration

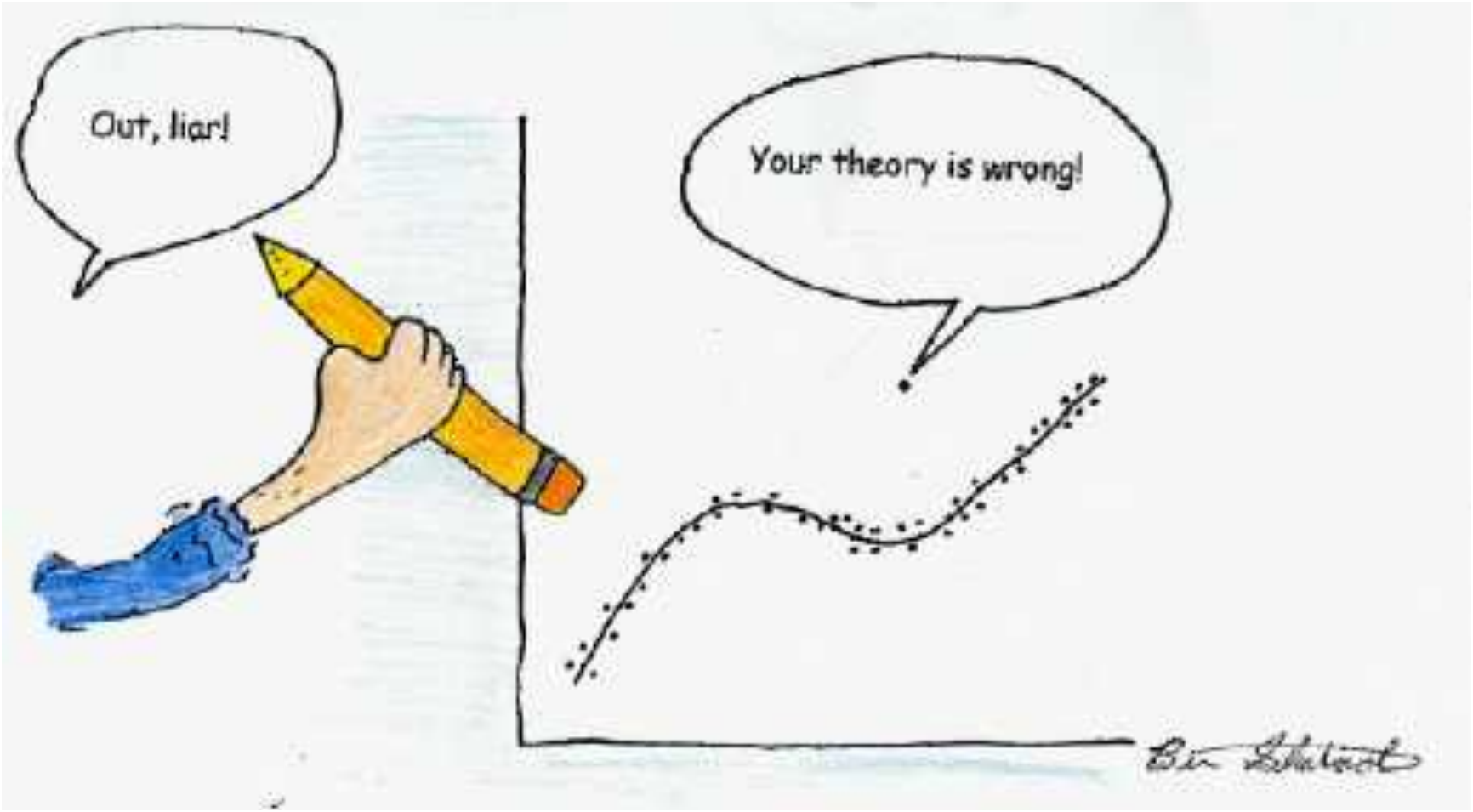


Follow-up Material

- *How NOT to Measure Latency* by Gil Tene
- *Taming the Long Latency Tail* on highscalability.com
- *Performance Analysis Methodology* by Brendan Gregg
- *Robust Java benchmarking* 1 & 2 by Brent Boyer
- Benchmarking articles by Aleksey Shipilëv

Takeaway #1: Cache

Takeaway #2: Outliers



Takeaway #3: Workload

Benchmarking: You're Doing It Wrong

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