High Performance Computing Systems (CMSC714)

Lecture 11: Measurement Tools

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Summary of last lecture

- Scalable networks: fat-tree, dragonfly
  - Use high-radix routers
  - Many nodes connected to each switch
- Low network diameter, high bisection bandwidth
- Dynamic routing

Performance analysis

- Parallel performance of a program might not be what we expect
- How do we find performance bottlenecks?
- Two parts to performance analysis: measurement and analysis/visualization
- Simplest tool: timers in the code and printf

Performance Tools

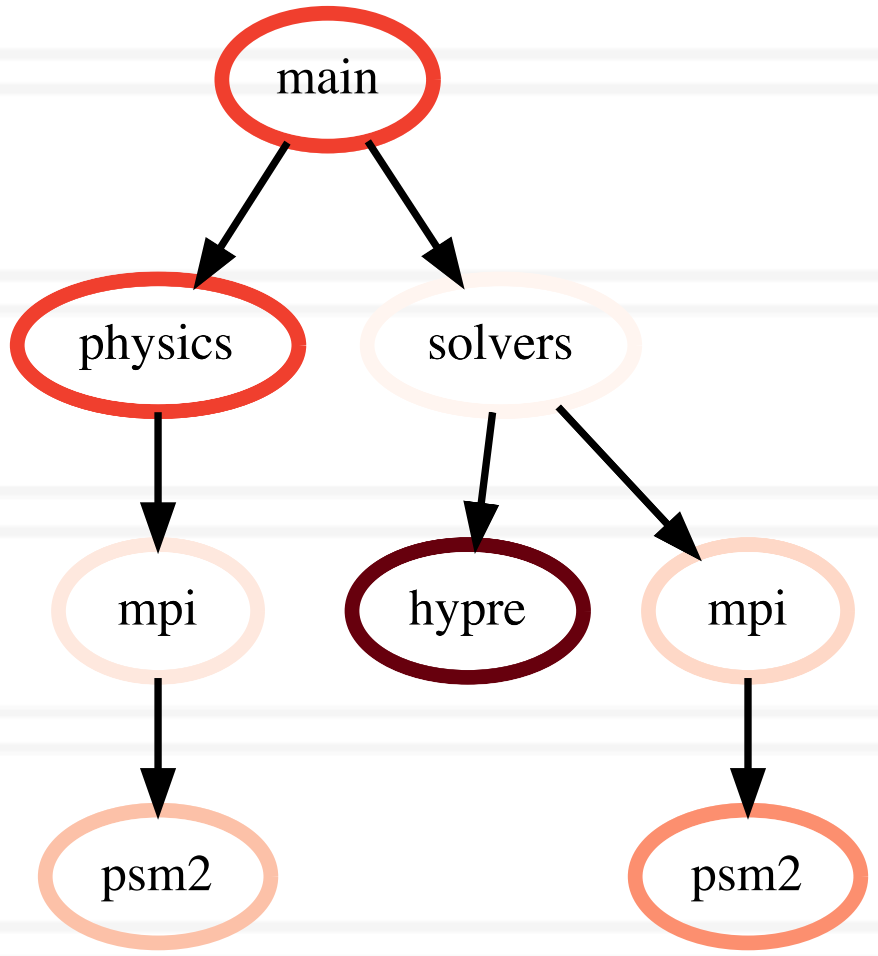
- Tracing tools
  - Capture entire execution trace
  - Vampir, Score-P
- Profiling tools
  - Typically use statistical sampling
  - Gprof
- Many tools can do both
  - TAU, HPCToolkit, Projections

Metrics recorded

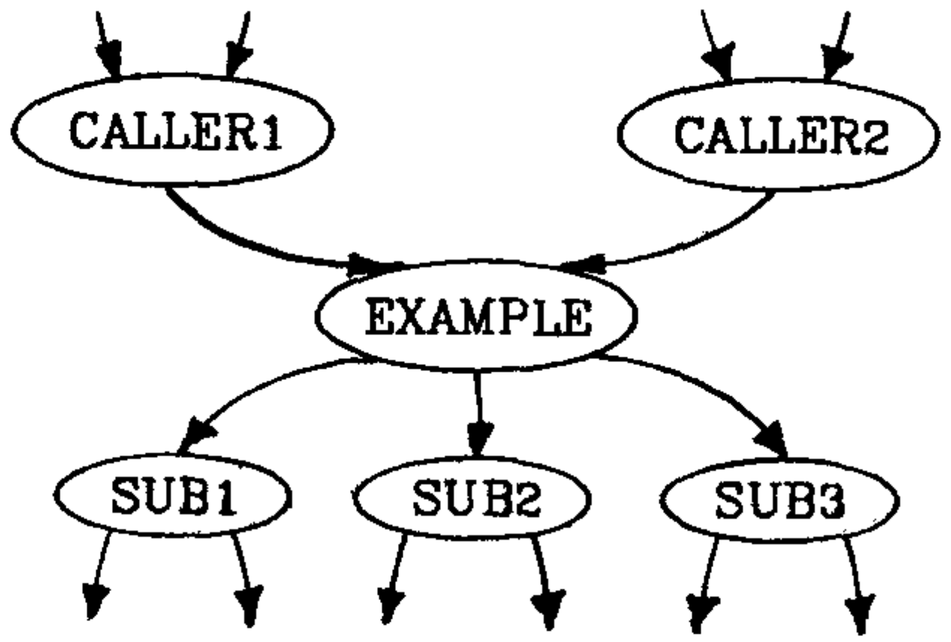
- Counts of function invocations
- Time spent in code
- Hardware counters

Calling contexts, trees, and graphs

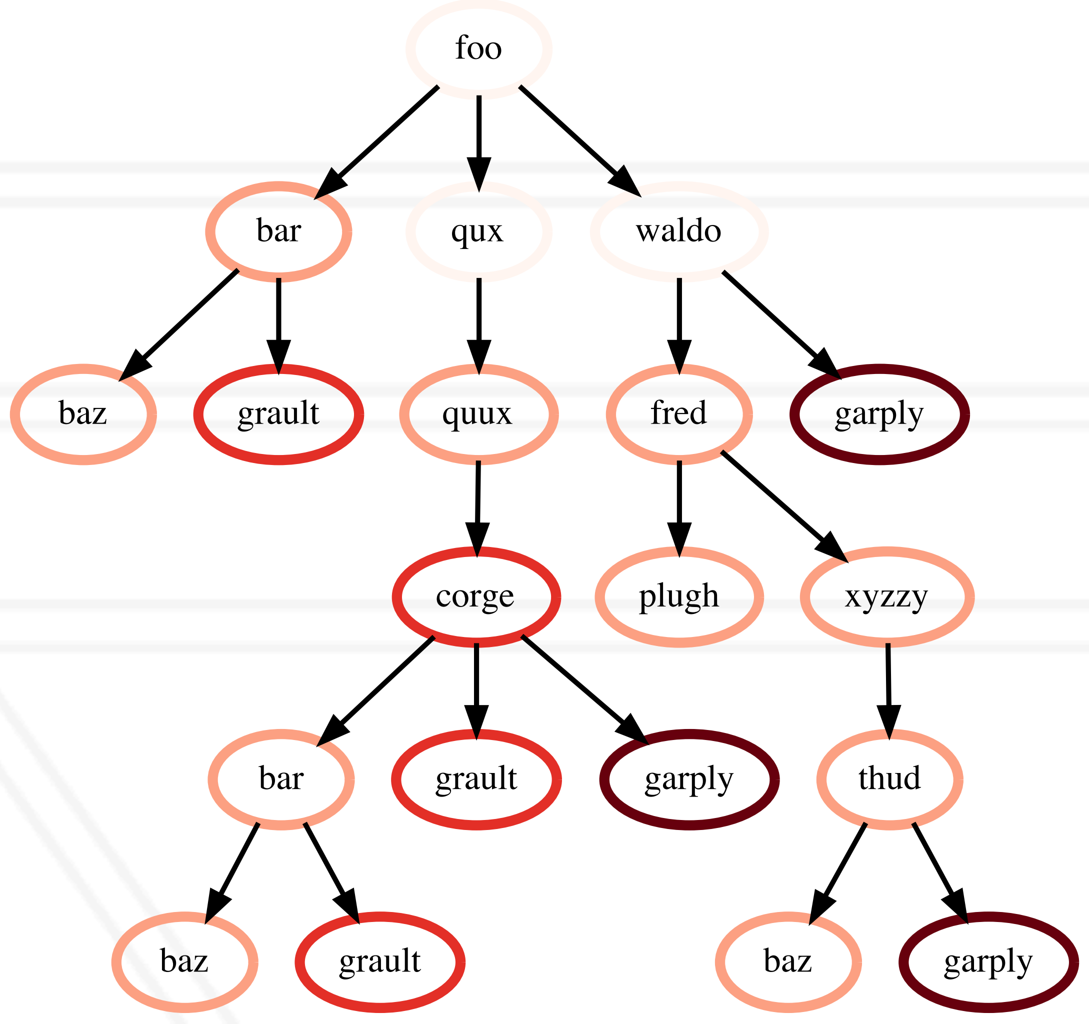
- Calling context or call path: Sequence of function invocations leading to the current sample
- Calling context tree: dynamic prefix tree of all call paths in an execution
- Call graph: keep caller-callee relationships as arcs



Output



- Flat profile: Listing of all functions with counts and execution times
- Call graph profile
- Calling context tree



Questions

gprof: A Call Graph Execution Profiler

- Execution count: It is highlighted to be two types of counts, which is either an actual count or a boolean. What's the benefit of introducing the second type?
- It seems that the call to monitoring routine is more informative but slower compared to the inline counter increment. Will the slow down actually affect the accuracy of the monitoring? Also is this trade-off generally worth it (in terms of profiling)?
- It is not immediately clear from the paper how they actually derive the timing approximation from the histogram. If possible I'd like to see if there's an illustrating example.
- Is there any principled way to extract static call graph from a generic program?
- What are the different types of call graphs? How is each type best used for understanding program performance?
- How much memory does profiling data require usually? Related: how does gprof balance various overheads?
- How does timeslicing work on timeshare machines?

Questions

Binary Analysis for Measurement and Attribution of Program Performance

- The paper states "dynamic instrumentation remains susceptible to systematic measurement error because of instrumentation overhead". Where do these overheads come from comparing to static and binary instrumentation?
- The loop optimization performed by compiler introduces semantic gap between source code and binary. Is there any effort on incorporating compiler into the profiling system to reduce such gap?
- It seems from the paper that the proposed HPCToolkit is better than gprof. How do they compare practically when used to profile a program?
- How does highly optimized code make it harder to accurately profile? How does binary analysis address these issues?
- What are the measurement techniques for instrumentation?

Questions?

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