Does My Profiler Tell The Truth?

Fabian Lange - codecentric AG

Profilers are Measurement Tools

“A fool with a tool is still a fool”

–Grady Booch

Available Tools

YourKit

Mission Control

NetBeans Profiler

VisualVM

AppDynamics

Honest Profiler

JProfiler

New Relic

Dynatrace

JProbe

Java Virtual Machine Tool Interface

JSR-163

- Java Platform Profiling Architecture
- defines following APIs
  - JVMTI (C API) as successor to JVMPI
  - java.lang.instrument
    - ClassFileTransformer
  - java.lang.management
    - MemoryMXBean
    - ThreadMXBean

How To Measure?

- Native Agent
  - written in C
  - Inserted into the JVM using -agentpath
- Java Agent
  - using java.lang.instrument package
  - loaded using -javaagent
- External
  - Logs, DTrace, JMX

Function Index

“One cannot measure Java code without interfering with the JVM.”

–Werner Heisenberg, 1927

Error Sources

Overhead

Overhead

- Runtime Delay
- CPU Consumption
- Thread Scheduling
- Memory Consumption
- Network Saturation
- Diskspace Usage

Accuracy

Accuracy

- System.currentTimeMillis()

```
/**
 * Returns the current time in milliseconds. Note that while the unit of time of the return value is a millisecond,
 * the granularity of the value depends on the underlying operating system and may be larger. For example, many
 * operating systems measure time in units of tens of milliseconds.
 *
 * See the description of the class <code>Date</code> for a discussion of slight discrepancies that may arise between
 * "computer time" and coordinated universal time (UTC).
 */
```

- System.nanoTime()

```
/**
 * Returns the current value of the running Java Virtual Machine's high-resolution time source, in nanoseconds.
 *
 * This method can only be used to measure elapsed time and is not related to any other notion of system or wall-clock
 * time. The value returned represents nanoseconds since some fixed but arbitrary <i>origin</i> time (perhaps in the
 * future, so values may be negative). The same origin is used by all invocations of this method in an instance of a
 * Java virtual machine; other virtual machine instances are likely to use a different origin.
 *
 * This method provides nanosecond precision, but not necessarily nanosecond resolution (that is, how frequently the
 * value changes) - no guarantees are made except that the resolution is at least as good as that of
 * {@link #currentTimeMillis()}.
 *
 * The values returned by this method become meaningful only when the difference between two such values, obtained
 * within the same instance of a Java virtual machine, is computed.
 */
```

Time

Time

- Wall-Clock Time
  - “real” Time which has passed since start.
  - Measurable with a clock on the wall.
- CPU Time
  - Time the CPU was busy.
  - Measurable but questionable.

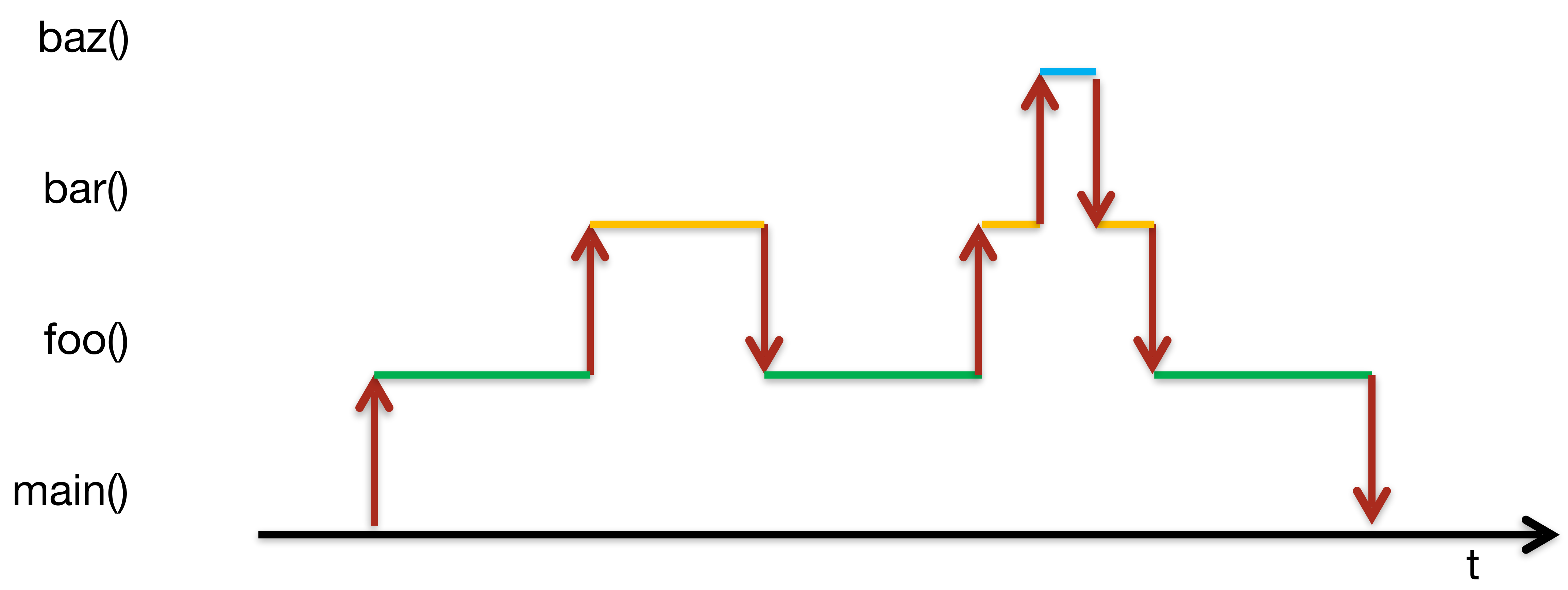
Lots of Data

Data Collection

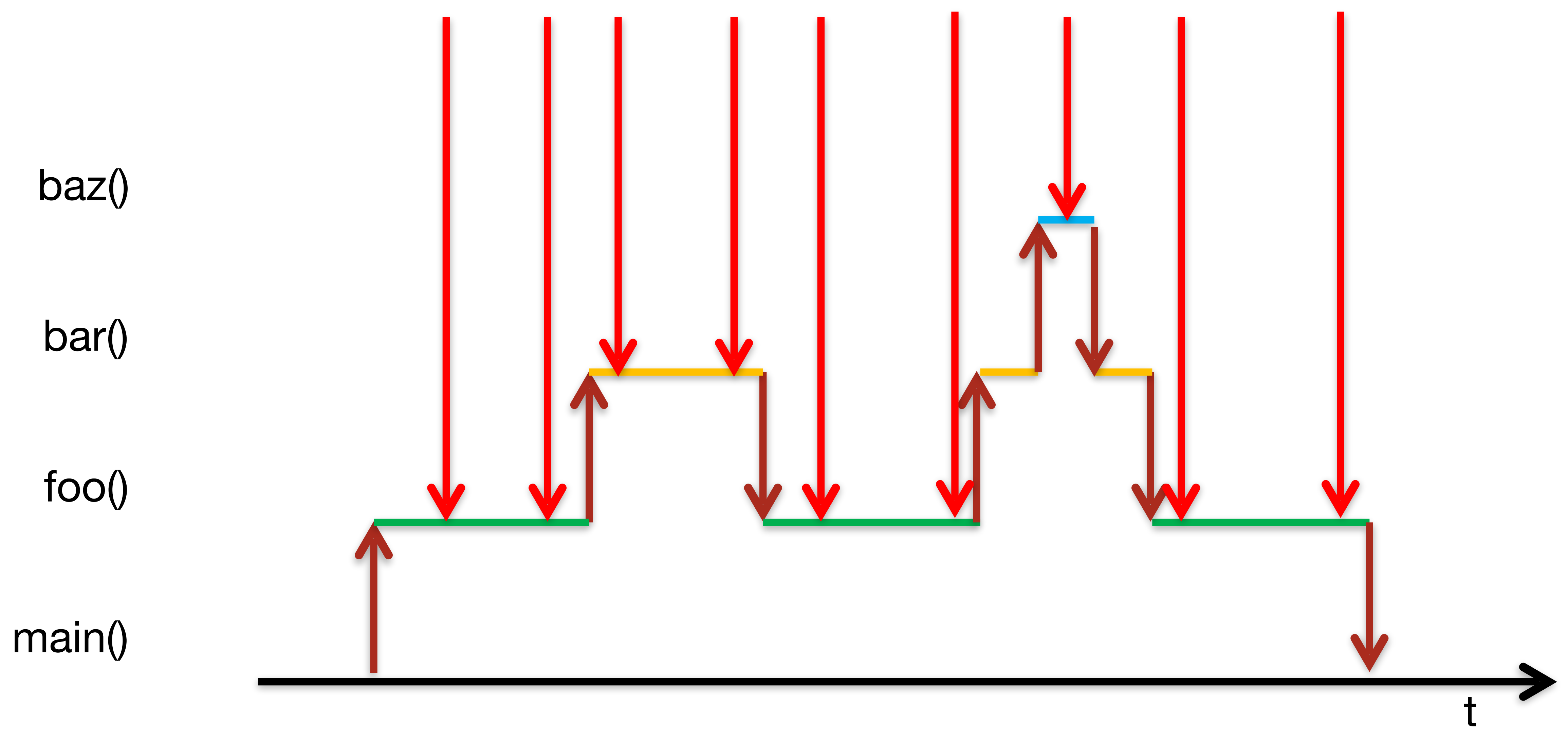
Data Collection

- (Stack) Sampling
    - Checking JVM activity in regular intervals.
- Instrumentation
    - Injection of measurement code.
- Sampling II
    - Reducing data by omission.

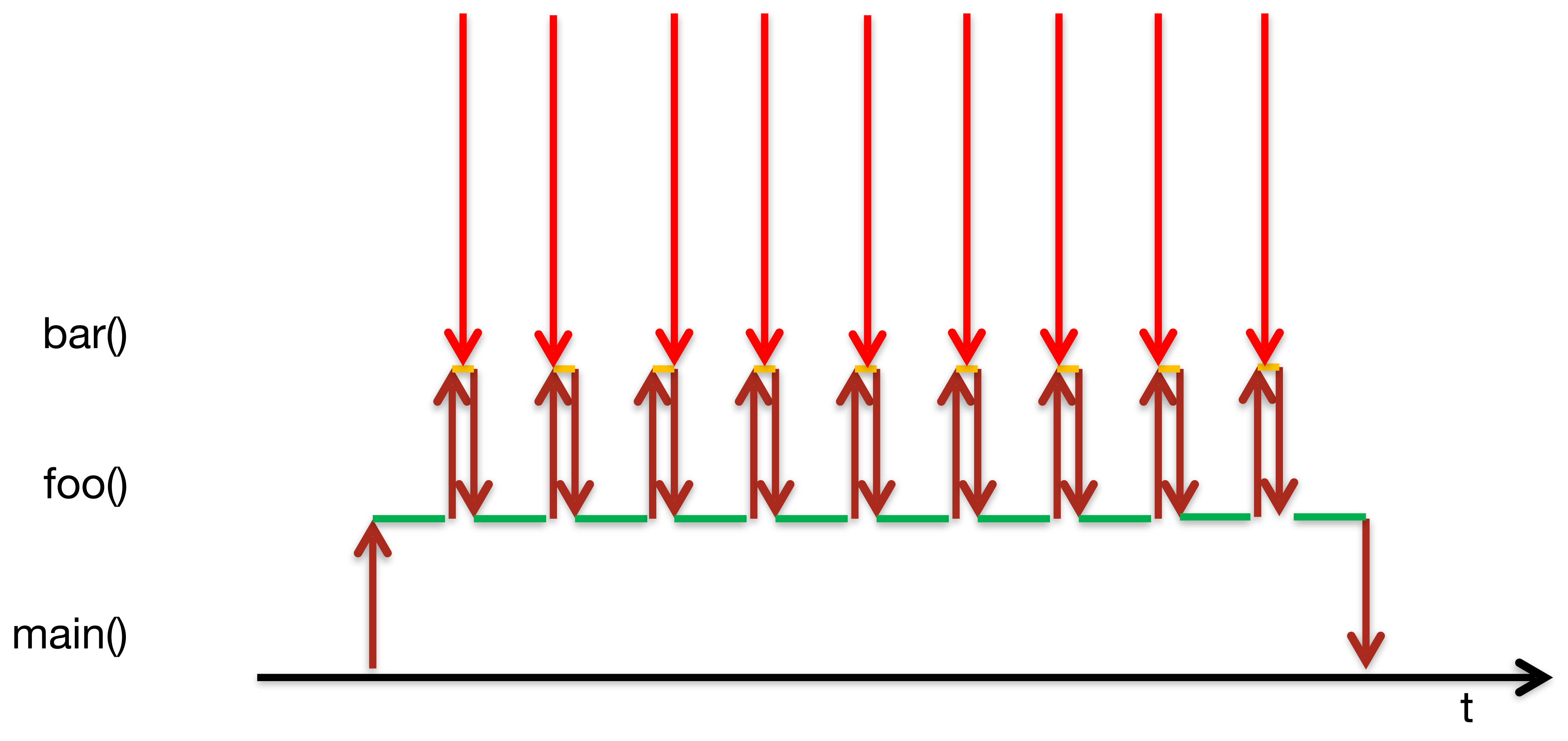
Sampling



Sampling - Great

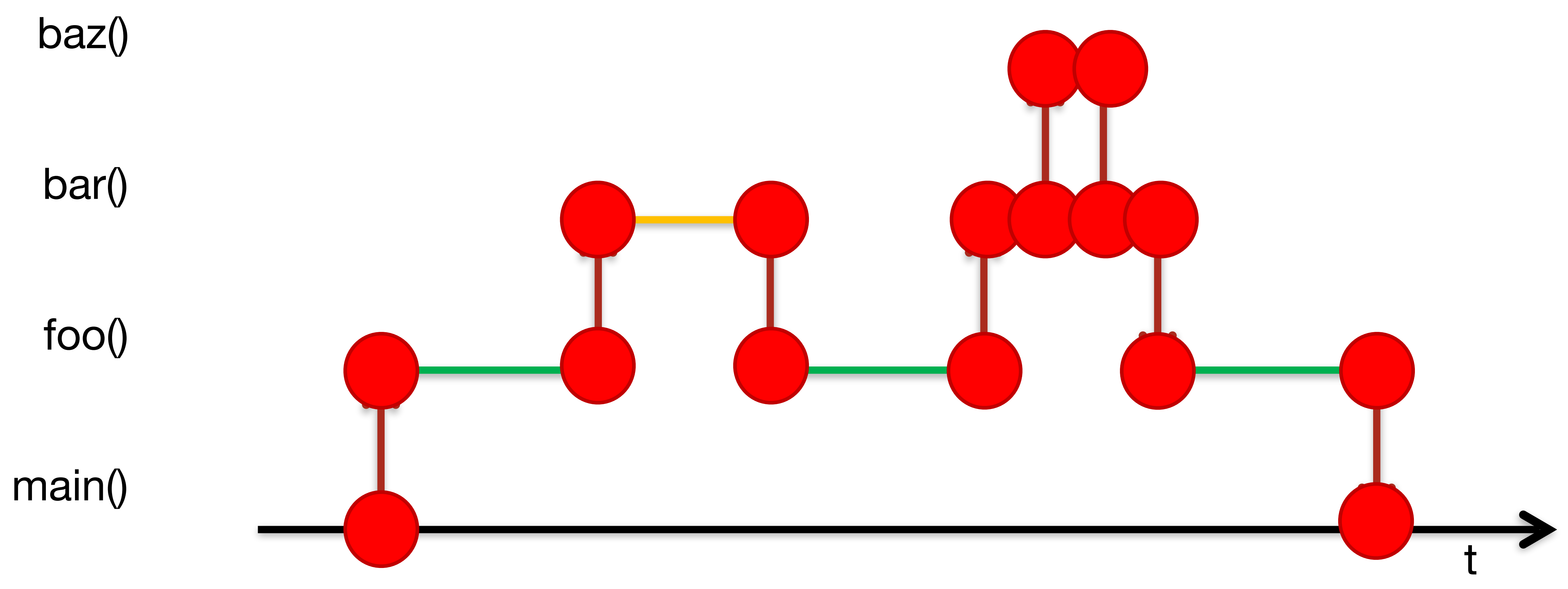


Sampling - Oh Well…



Instrumentation

Instrumentation



Sampling
vs
Instrumentation

DEMO

Code on Github

https://github.com/CodingFabian/SamplingVsInstrumentation

Using JProfiler

DEMO

Using HProf

DEMO

Using Honest Profiler

DEMO

Safepoints

Safepoints

- Sampling thread has to wait for steady state to interrogate other threads
- Safepoints are in-between code, so conceptually sampling never sees running code
- Honest Profiler uses JVMTI AsyncGetCallTrace which does not wait for safepoints
    - github.com/RichardWarburton/honest-profiler
    - jeremymanson.blogspot.co.uk/2013/07/lightweight-asynchronous-sampling.html

From My Daily Work

Performance Tuning Guide

- Start off with Sampling
- Do not take results to serious
- Look for bottlenecks
- < 10 ms is most of the time irrelevant when profiling
- Get better results from benchmarking
- Check code, bytecode, assembly

How Much Influence has Instrumentation Code?

DEMO

SEPA

DEMO

Does My Profiler Tell The Truth?

NO

Use JMH for Benchmarks

Further Reading

- Dapper, a Large-Scale Distributed Systems Tracing Infrastructure
  - static.googleusercontent.com/media/research.google.com/de//pubs/archive/36356.pdf
- Evaluating the Accuracy of Java Profilers
  - www-plan.cs.colorado.edu/klipto/mytkowicz-pldi10.pdf
- How to Measure Java Performance
  - blog.codecentric.de/en/2011/10/measure-java-performance-sampling-or-instrumentation/
- Java Microbenchmark Harness
  - openjdk.java.net/projects/code-tools/jmh/
- Richard Warbutons Honest Profiler
  - github.com/RichardWarburton/honest-profiler

Want to know more?

@CodingFabian

fabian.lange@codecentric.de

speakerdeck.com/CodingFabian

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Thanks :-)