🚀 fgprof

The Full Go Profiler

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Why is this program slow?

```
func main() {
    for {
        // Http request to a web service that might be slow.
        slowNetworkRequest()
        // Some heavy CPU computation.
        cpuIntensiveTask()
        // Poorly named function that you don't understand yet.
        weirdFunction()
    }
}
```

Wrap every call in a time tracking function

```
func main() {
    for {
        // Http request to a web service that might be slow.
        timeFn("slowNetworkRequest", slowNetworkRequest)
        // Some heavy CPU computation.
        timeFn("cpuIntensiveTask", cpuIntensiveTask)
        // Poorly named function that you don't understand yet.
        timeFn("weirdFunction", weirdFunction)
    }
}

func timeFn(name string, fn func()) {
    start := time.Now()
    fn()
    log.Printf("%s took %s", name, time.Since(start))
}
```

🎉 We just build a tracing profiler 😄

- But it's annoying that we had to explicitly instrument our code
- Some tracing profilers in e.g. Ruby or Python can wrap all your functions for you automatically, but they can slow your program by 2-3x.
- So if we're lazy people who want it all (no work, low overhead), what can we do?

How do sampling profilers work?

- For some duration, e.g. 10 seconds:
  - Stop program 100 times per second and record the current call stack(s)
- Afterwards
  - Count how many times each call stack was seen
  - At 100 Hz, each time a stack is seen is assumed to have lasted 10ms
  - Visualize or report the results

Using Go's builtin CPU profiler

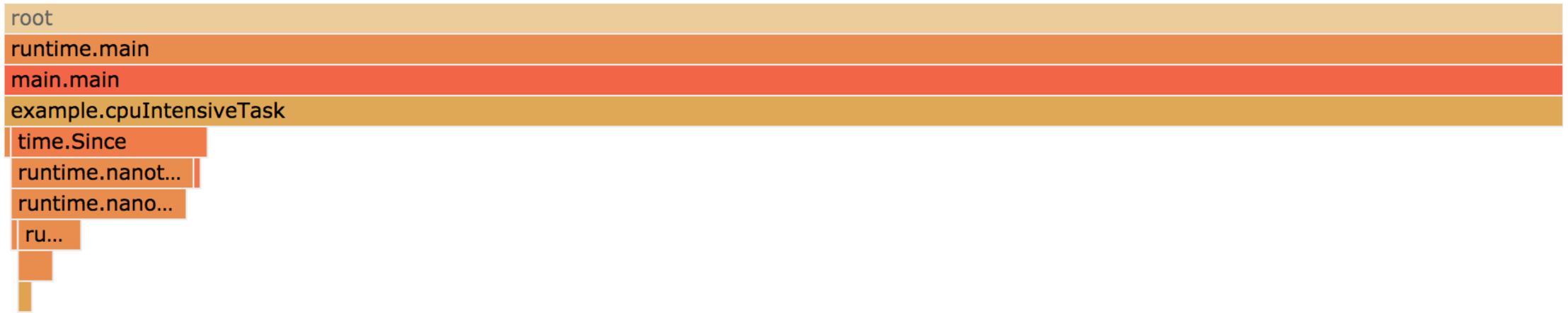
```
import _ "net/http/pprof"

func main() {
    go func() {
        log.Println(http.ListenAndServe(":6060", nil))
    }()

    // <code to profile>
}

$ go tool pprof -http=:6061 \
    http://localhost:6060/debug/pprof/profile?seconds=10
```

Go's profiler only shows *On-CPU* Time 😢



Using fgprof

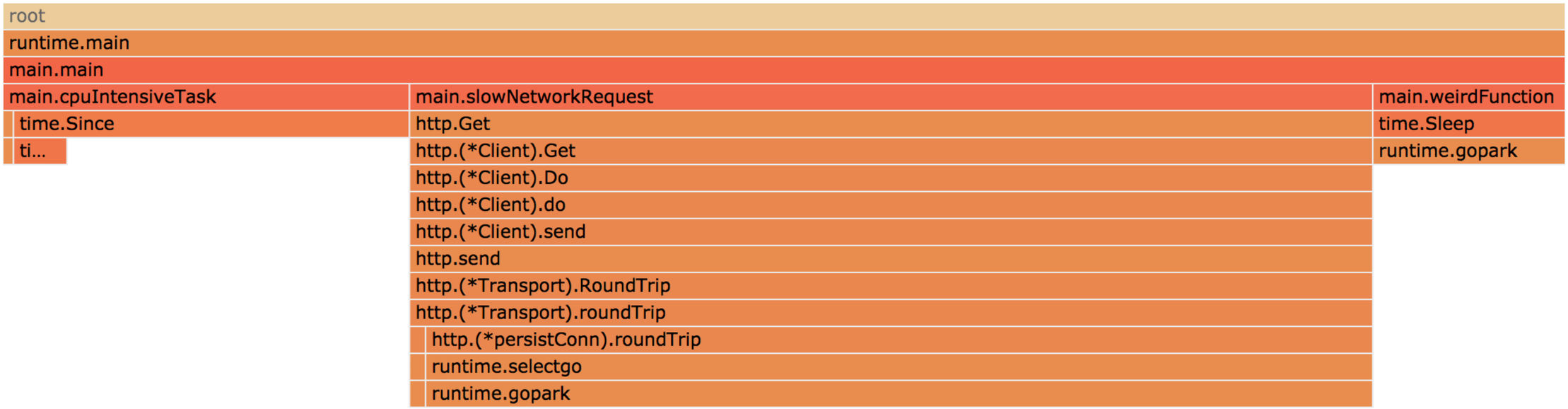
```
import _ "net/http/pprof"
import "github.com/felixge/fgprof"

func main() {
    http.DefaultServeMux.Handle("/debug/fgprof", fgprof.Handler())
    go func() {
        log.Println(http.ListenAndServe(":6060", nil))
    }()

    // <code to profile>
}
```

```
$ go tool pprof -http=:6061 \
    http://localhost:6060/debug/fgprof?seconds=10
```

🚀 fgprof shows *On-CPU* **and** *Off-CPU* Time



How Go's profiler works (on unixy systems)

- Uses `setitimer(2)` to ask the kernel to send SIGPROF signals to our program 100 times per second.
- These signals stop the program and are received by random OS threads used by the Go runtime.
- The signaled thread records it's current call stack for later aggregation and output.
- But since Go uses non-blocking I/O internally, OS threads are never blocked on e.g. read/write system calls. Goroutines waiting for I/O are "parked" until `epoll()` has new events for them. This makes them **invisible** to the builtin profiler.

How the fgprof profiler works

- Spawns a background goroutine that wakes up 99 times per second.
- On each wakeup it calls `runtime.GoroutineProfile()`, which briefly "stops the world", to provide a list of all goroutines and their stacks.
- The result is aggregated in an internal data structure for later output.
- `runtime.GoroutineProfile()` also includes Goroutines that are "parked" while waiting for I/O, so they are **visible** to fgprof.
- It's less than 100 lines of code, you should check it out :)

Not enough time for ... 😢

- fgprof Overhead (it's similar to Go's profiler)
- fgprof Accuracy (it's sometimes better than Go's profiler)
- Why nobody has done this before (probably lack of async preemption until Go 1.14)
- Related work on profiling Go code using Hardware Performance Monitoring Counters by Milind Chabbi

Thank you for your time!

Please ask Questions :)