Tony Bai

一个程序员的心路历程

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Go程序调试、分析与优化

- 八月 25, 2015
- 17 条评论

Brad Fitzpatrick在YAPC Asia 2015（Yet Another Perl Conference）上做了一次技术分享，题为："Go Debugging, Profiling, and Optimization"。个人感觉这篇分享中价值最大的是BradFitz现场演示的一个有关如何对Go程序进行调试、分析和优化的 Demo，Brad将demo上传到了他个人在github.com的repo中，但不知为何，repo中的代码似乎与repo里talk.md中的说明不甚一致(btw，我并没有看video)。于 是打算在这里按照Brad的思路重新走一遍demo的演示流程(所有演示代码在这里可以下载到)。

一、实验环境

```
$uname -a
Linux pc-tony 3.13.0-61-generic #100~precise1-Ubuntu SMP Wed Jul 29
12:06:40 UTC 2015 x86_64 x86_64 x86_64 GNU/Linux
```

注意：在`Darwin`或`Windows`下，`profile`的结果可能与这里有很大不同（甚至完全不一样的输出和瓶颈热点）。

```
$go version
go version go1.5 linux/amd64

$ go env
GOARCH="amd64"
GOBIN="/home1/tonybai/.bin/go15/bin"
GOEXE=""
GOHOSTARCH="amd64"
GOHOSTOS="linux"
GOOS="linux"
GOPATH="/home1/tonybai/proj/GoProjects"
GORACE=""
GOROOT="/home1/tonybai/.bin/go15"
GOTOOLDIR="/home1/tonybai/.bin/go15/pkg/tool/linux_amd64"
GO15VENDOREXPERIMENT="1"
CC="gcc"
GOGCCFLAGS="-fPIC -m64 -pthread -fmessage-length=0"
CXX="g++"
```

```
CGO_ENABLED="1"
```

代码基于Brad的github.com/bradfitz/talk-yapc-asia-2015。

二、待优化程序(step0)

待优化程序，也就是原始程序，我们放在step0中：

```
//go-debug-profile-optimization/step0/demo.go

package main

import (
    "fmt"
    "log"
    "net/http"
    "regexp"
)

var visitors int

func handleHi(w http.ResponseWriter, r *http.Request) {
    if match, _ := regexp.MatchString(`^\w*$`, r.FormValue("color"));
!match {
        http.Error(w, "Optional color is invalid",
http.StatusBadRequest)
        return
    }
    visitors++
    w.Header().Set("Content-Type", "text/html; charset=utf-8")
    w.Write([]byte("<h1 style='color: " + r.FormValue("color") +
        "'>Welcome!</h1>You are visitor number " + fmt.Sprint(visitors)
+ "!"))
}

func main() {
    log.Printf("Starting on port 8080")
    http.HandleFunc("/hi", handleHi)
    log.Fatal(http.ListenAndServe("127.0.0.1:8080", nil))
}

$go run demo.go
2015/08/25 09:42:35 Starting on port 8080
```

在浏览器输入：http://localhost:8080/hi

一切顺利的话，页面会显示：

```
Welcome!
```

```
You are visitor number 1!
```

三、添加测试代码

按照talk.md中的说明，brad repo中demo中根本没有测试代码(commit 2427d0faa12ed1fb05f1e6a1e69307c11259c2b2)。

于是我根据作者的意图，新增了demo_test.go，采用TestHandleHi_Recorder和TestHandleHi_TestServer对HandleHi进行测试：

```
//go-debug-profile-optimization/step0/demo_test.go
package main

import (
    "bufio"
    "net/http"
    "net/http/httptest"
    "strings"
    "testing"
)

func TestHandleHi_Recorder(t *testing.T) {
    rw := httptest.NewRecorder()
    handleHi(rw, req(t, "GET / HTTP/1.0\r\n\r\n"))
    if !strings.Contains(rw.Body.String(), "visitor number") {
        t.Errorf("Unexpected output: %s", rw.Body)
    }
}

func req(t *testing.T, v string) *http.Request {
    req, err := http.ReadRequest(bufio.NewReader(strings.NewReader(v)))
    if err != nil {
        t.Fatal(err)
    }
    return req
}

func TestHandleHi_TestServer(t *testing.T) {
    ts := httptest.NewServer(http.HandlerFunc(handleHi))
    defer ts.Close()
    res, err := http.Get(ts.URL)
    if err != nil {
        t.Error(err)
        return
    }
    if g, w := res.Header.Get("Content-Type"), "text/html; charset=utf-
8"; g != w {
        t.Errorf("Content-Type = %q; want %q", g, w)
```

```
    }
    slurp, err := ioutil.ReadAll(res.Body)
    defer res.Body.Close()
    if err != nil {
        t.Error(err)
        return
    }
    t.Logf("Got: %s", slurp)
}

$ go test -v
=== RUN   TestHandleHi_Recorder
— PASS: TestHandleHi_Recorder (0.00s)
=== RUN   TestHandleHi_TestServer
— PASS: TestHandleHi_TestServer (0.00s)
    demo_test.go:45: Got: <h1 style='color: '>Welcome!</h1>You are
visitor number 2!
PASS
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step0    0.007s
```

测试通过！

至此，step0使命结束。

四、Race Detector(竞态分析)

并发设计使得程序可以更好更有效的利用现代处理器的多核心。但并发设计很容易引入竞态，导致严重bug。Go程序中竞态就是当多个goroutine并发 访问某共享数据且未使用同步机制时，且至少一个goroutine进行了写操作。不过go工具自带race分析功能。在分析优化step0中demo代码 前，我们先要保证demo代码中不存在竞态。

工具的使用方法就是在go test后加上-race标志，在step0目录下：

```
$ go test -v -race
=== RUN   TestHandleHi_Recorder
— PASS: TestHandleHi_Recorder (0.00s)
=== RUN   TestHandleHi_TestServer
— PASS: TestHandleHi_TestServer (0.00s)
    demo_test.go:45: Got: <h1 style='color: '>Welcome!</h1>You are
visitor number 2!
PASS
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step0    1.012s
```

-race通过做运行时分析做竞态分析，虽然不存在误报，但却存在实际有竞态，但工具没发现的情况。接下来我们改造一下测试代码，让test并发起来：

向step1(copy自step0)中demo_test.go中添加一个test method:

```
//go-debug-profile-optimization/step1/demo_test.go
… …
func TestHandleHi_TestServer_Parallel(t *testing.T) {
    ts := httptest.NewServer(http.HandlerFunc(handleHi))
    defer ts.Close()
    var wg sync.WaitGroup
    for i := 0; i < 2; i++ {
        wg.Add(1)
        go func() {
            defer wg.Done()
            res, err := http.Get(ts.URL)
            if err != nil {
                t.Error(err)
                return
            }
            if g, w := res.Header.Get("Content-Type"), "text/html;
charset=utf-8"; g != w {
                t.Errorf("Content-Type = %q; want %q", g, w)
            }
            slurp, err := ioutil.ReadAll(res.Body)
            defer res.Body.Close()
            if err != nil {
                t.Error(err)
                return
            }
            t.Logf("Got: %s", slurp)
        }()
    }
    wg.Wait()
}
… …
```

执行竞态test:

```
$ go test -v -race
=== RUN   TestHandleHi_Recorder
— PASS: TestHandleHi_Recorder (0.00s)
=== RUN   TestHandleHi_TestServer
— PASS: TestHandleHi_TestServer (0.00s)
    demo_test.go:46: Got: <h1 style='color: '>Welcome!</h1>You are
visitor number 2!
=== RUN   TestHandleHi_TestServer_Parallel
==================
WARNING: DATA RACE
Read by goroutine 22:
  _/home1/tonybai/proj/opensource/github/experiments/go-debug-profile-
```

```
optimization/step1.handleHi()
      /home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step1/demo.go:17 +0xf5
  net/http.HandlerFunc.ServeHTTP()
      /tmp/workdir/go/src/net/http/server.go:1422 +0×47
  net/http/httptest.(*waitGroupHandler).ServeHTTP()
      /tmp/workdir/go/src/net/http/httptest/server.go:200 +0xfe
  net/http.serverHandler.ServeHTTP()
      /tmp/workdir/go/src/net/http/server.go:1862 +0×206
  net/http.(*conn).serve()
      /tmp/workdir/go/src/net/http/server.go:1361 +0x117c

Previous write by goroutine 25:
  _/home1/tonybai/proj/opensource/github/experiments/go-debug-profile-
optimization/step1.handleHi()
      /home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step1/demo.go:17 +0×111
  net/http.HandlerFunc.ServeHTTP()
      /tmp/workdir/go/src/net/http/server.go:1422 +0×47
  net/http/httptest.(*waitGroupHandler).ServeHTTP()
      /tmp/workdir/go/src/net/http/httptest/server.go:200 +0xfe
  net/http.serverHandler.ServeHTTP()
      /tmp/workdir/go/src/net/http/server.go:1862 +0×206
  net/http.(*conn).serve()
      /tmp/workdir/go/src/net/http/server.go:1361 +0x117c

Goroutine 22 (running) created at:
  net/http.(*Server).Serve()
      /tmp/workdir/go/src/net/http/server.go:1910 +0×464

Goroutine 25 (running) created at:
  net/http.(*Server).Serve()
      /tmp/workdir/go/src/net/http/server.go:1910 +0×464
==================
— PASS: TestHandleHi_TestServer_Parallel (0.00s)
    demo_test.go:71: Got: <h1 style='color: '>Welcome!</h1>You are
visitor number 3!
    demo_test.go:71: Got: <h1 style='color: '>Welcome!</h1>You are
visitor number 4!
PASS
Found 1 data race(s)
exit status 66
FAIL    _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step1    1.023s
```

工具发现demo.go第17行：

```
   visitors++
```

是一处潜在的竞态条件。

visitors被多个goroutine访问但未采用同步机制。

既然发现了竞态条件，我们就需要fix it。有多种fix方法可选：

1、使用channel
2、使用Mutex
3、使用atomic

Brad使用了atomic：

```
//go-debug-profile-optimization/step1/demo.go
… …
var visitors int64 // must be accessed atomically

func handleHi(w http.ResponseWriter, r *http.Request) {
    if match, _ := regexp.MatchString(`^\w*$`, r.FormValue("color"));
!match {
        http.Error(w, "Optional color is invalid",
http.StatusBadRequest)
        return
    }
    visitNum := atomic.AddInt64(&visitors, 1)
    w.Header().Set("Content-Type", "text/html; charset=utf-8")
    w.Write([]byte("<h1 style='color: " + r.FormValue("color") +
        "'>Welcome!</h1>You are visitor number " + fmt.Sprint(visitNum)
+ "!"))
}
… …
```

再做一次测试：

```
$ go test -v -race
=== RUN   TestHandleHi_Recorder
— PASS: TestHandleHi_Recorder (0.00s)
=== RUN   TestHandleHi_TestServer
— PASS: TestHandleHi_TestServer (0.00s)
    demo_test.go:46: Got: <h1 style='color: '>Welcome!</h1>You are
visitor number 2!
=== RUN   TestHandleHi_TestServer_Parallel
— PASS: TestHandleHi_TestServer_Parallel (0.00s)
    demo_test.go:71: Got: <h1 style='color: '>Welcome!</h1>You are
visitor number 3!
    demo_test.go:71: Got: <h1 style='color: '>Welcome!</h1>You are
visitor number 4!
PASS
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step1    1.020s
```

竞态条件被消除了！

至此，step1结束了使命！

五、CPU Profiling

要做CPU Profilling，我们需要benchmark数据，Go test提供benchmark test功能，我们只要写对应的Benchmark测试方法即可：

```
//go-debug-profile-optimization/step2/demo_test.go
… …
func BenchmarkHi(b *testing.B) {
    b.ReportAllocs()

    req, err := http.ReadRequest(bufio.NewReader(strings.NewReader("GET
/ HTTP/1.0\r\n\r\n")))
    if err != nil {
        b.Fatal(err)
    }

    for i := 0; i < b.N; i++ {
        rw := httptest.NewRecorder()
        handleHi(rw, req)
    }
}
… …

$ go test -v -run=^$ -bench=.
PASS
BenchmarkHi-4      100000         14808 ns/op        4961 B/op
81 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step2    1.648s
```

开始CPU Profiling：

```
$ go test -v -run=^$ -bench=^BenchmarkHi$ -benchtime=2s -
cpuprofile=prof.cpu
PASS
BenchmarkHi-4      200000         14679 ns/op        4961 B/op
81 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step2    3.096s
```

执行完benchmark test后，step2目录下出现两个新文件prof.cpu和step2.test，这两个文件将作为后续go tool pprof的输入：

```
$ls
demo.go        demo_test.go    prof.cpu    step2.test*
```

使用go profile viewer工具：

```
$ go tool pprof step2.test prof.cpu
Entering interactive mode (type "help" for commands)
(pprof) top
1830ms of 3560ms total (51.40%)
Dropped 53 nodes (cum <= 17.80ms)
Showing top 10 nodes out of 133 (cum >= 1290ms)
      flat  flat%   sum%        cum   cum%
     480ms 13.48% 13.48%      980ms 27.53%  runtime.growslice
     360ms 10.11% 23.60%      700ms 19.66%  runtime.mallocgc
     170ms  4.78% 28.37%      170ms  4.78%  runtime.heapBitsSetType
     170ms  4.78% 33.15%      200ms  5.62%  runtime.scanblock
     120ms  3.37% 36.52%     1100ms 30.90%  regexp.makeOnePass.func2
     120ms  3.37% 39.89%      550ms 15.45%  runtime.newarray
     110ms  3.09% 42.98%      300ms  8.43%  runtime.makeslice
     110ms  3.09% 46.07%      220ms  6.18%  runtime.mapassign1
     100ms  2.81% 48.88%      100ms  2.81%  runtime.futex
      90ms  2.53% 51.40%     1290ms 36.24%  regexp.makeOnePass

(pprof) top -cum
0.18s of 3.56s total ( 5.06%)
Dropped 53 nodes (cum <= 0.02s)
Showing top 10 nodes out of 133 (cum >= 1.29s)
      flat  flat%   sum%        cum   cum%
         0     0%     0%      3.26s 91.57%  runtime.goexit
     0.02s  0.56%  0.56%      2.87s 80.62%  BenchmarkHi
         0     0%  0.56%      2.87s 80.62%  testing.(*B).launch
         0     0%  0.56%      2.87s 80.62%  testing.(*B).runN
     0.03s  0.84%  1.40%      2.80s 78.65%  step2.handleHi
     0.01s  0.28%  1.69%      2.46s 69.10%  regexp.MatchString
         0     0%  1.69%      2.24s 62.92%  regexp.Compile
         0     0%  1.69%      2.24s 62.92%  regexp.compile
     0.03s  0.84%  2.53%      1.56s 43.82%  regexp.compileOnePass
     0.09s  2.53%  5.06%      1.29s 36.24%  regexp.makeOnePass

(pprof) list handleHi
Total: 3.56s
ROUTINE ======================== handleHi in go-debug-profile-
optimization/step2/demo.go
      30ms      2.80s (flat, cum) 78.65% of Total
         .          .      9:)
         .          .     10:
         .          .     11:var visitors int64 // must be accessed
atomically
         .          .     12:
         .          .     13:func handleHi(w http.ResponseWriter, r
*http.Request) {
```

```
         .      2.47s     14:    if match, _ :=
regexp.MatchString(`^\w*$`, r.FormValue("color")); !match {
         .          .     15:        http.Error(w, "Optional color is
invalid", http.StatusBadRequest)
         .          .     16:        return
         .          .     17:    }
      10ms       20ms     18:    visitNum := atomic.AddInt64(&visitors,
1)
      10ms       90ms     19:    w.Header().Set("Content-Type",
"text/html; charset=utf-8")
      10ms       20ms     20:    w.Write([]byte("<h1 style='color: " +
r.FormValue("color") +
         .      200ms     21:        "'>Welcome!</h1>You are visitor
number " + fmt.Sprint(visitNum) + "!"))
         .          .     22:}
         .          .     23:
         .          .     24:func main() {
         .          .     25:    log.Printf("Starting on port 8080")
         .          .     26:    http.HandleFunc("/hi", handleHi)
(pprof)
```

从top -cum来看，handleHi消耗cpu较大，而handleHi中，又是MatchString耗时最长。

六、第一次优化

前面已经发现MatchString较为耗时，优化手段：让正则式仅编译一次(step3)：

```
// go-debug-profile-optimization/step3/demo.go

… …
var visitors int64 // must be accessed atomically

var rxOptionalID = regexp.MustCompile(`^\d*$`)

func handleHi(w http.ResponseWriter, r *http.Request) {
    if !rxOptionalID.MatchString(r.FormValue("color")) {
        http.Error(w, "Optional color is invalid",
http.StatusBadRequest)
        return
    }

    visitNum := atomic.AddInt64(&visitors, 1)
    w.Header().Set("Content-Type", "text/html; charset=utf-8")
    w.Write([]byte("<h1 style='color: " + r.FormValue("color") +
        "'>Welcome!</h1>You are visitor number " + fmt.Sprint(visitNum)
+ "!"))
}
… …
```

运行一下bench：

```
$ go test -bench=.
PASS
BenchmarkHi-4     1000000          1678 ns/op         720 B/op
       9 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step3    1.710s
```

对比之前在step2中运行的bench结果：

```
$ go test -v -run=^$ -bench=.
PASS
BenchmarkHi-4      100000         14808 ns/op        4961 B/op
81 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step2    1.648s
```

耗时相同，但优化后的bench运行了100w次，而之前的Bench运行10w次，相当于性能提高10倍。

再看看cpu prof结果：

```
$ go test -v -run=^$ -bench=^BenchmarkHi$ -benchtime=3s -
cpuprofile=prof.cpu
PASS
BenchmarkHi-4     3000000          1640 ns/op         720 B/op
       9 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step3    6.540s

$ go tool pprof step3.test prof.cpu
Entering interactive mode (type "help" for commands)
(pprof) top -cum 30
2.74s of 8.07s total (33.95%)
Dropped 72 nodes (cum <= 0.04s)
Showing top 30 nodes out of 103 (cum >= 0.56s)
      flat  flat%   sum%        cum   cum%
         0     0%     0%      7.17s 88.85%  runtime.goexit
     0.05s  0.62%  0.62%      6.21s 76.95%  step3.BenchmarkHi
         0     0%  0.62%      6.21s 76.95%  testing.(*B).launch
         0     0%  0.62%      6.21s 76.95%  testing.(*B).runN
     0.06s  0.74%  1.36%      4.96s 61.46%  step3.handleHi
     1.15s 14.25% 15.61%      2.35s 29.12%  runtime.mallocgc
     0.02s  0.25% 15.86%      1.63s 20.20%  runtime.systemstack
         0     0% 15.86%      1.53s 18.96%  net/http.Header.Set
     0.06s  0.74% 16.60%      1.53s 18.96%
net/textproto.MIMEHeader.Set
     0.09s  1.12% 17.72%      1.22s 15.12%  runtime.newobject
```

```
     0.05s  0.62% 18.34%      1.09s 13.51%  fmt.Sprint
     0.20s  2.48% 20.82%         1s 12.39%  runtime.mapassign1
         0     0% 20.82%      0.81s 10.04%  runtime.mcall
     0.01s  0.12% 20.94%      0.79s  9.79%  runtime.schedule
     0.05s  0.62% 21.56%      0.76s  9.42%  regexp.
(*Regexp).MatchString
     0.09s  1.12% 22.68%      0.71s  8.80%  regexp.(*Regexp).doExecute
     0.01s  0.12% 22.80%      0.71s  8.80%  runtime.concatstring5
     0.20s  2.48% 25.28%      0.70s  8.67%  runtime.concatstrings
         0     0% 25.28%      0.69s  8.55%  runtime.gosweepone
     0.05s  0.62% 25.90%      0.69s  8.55%  runtime.mSpan_Sweep
         0     0% 25.90%      0.68s  8.43%  runtime.bgsweep
     0.04s   0.5% 26.39%      0.68s  8.43%  runtime.newarray
     0.01s  0.12% 26.52%      0.67s  8.30%  runtime.goschedImpl
     0.01s  0.12% 26.64%      0.65s  8.05%  runtime.gosched_m
         0     0% 26.64%      0.65s  8.05%  runtime.gosweepone.func1
     0.01s  0.12% 26.77%      0.65s  8.05%  runtime.sweepone
     0.28s  3.47% 30.24%      0.62s  7.68%  runtime.makemap
     0.17s  2.11% 32.34%      0.59s  7.31%  runtime.heapBitsSweepSpan
     0.02s  0.25% 32.59%      0.58s  7.19%  fmt.(*pp).doPrint
     0.11s  1.36% 33.95%      0.56s  6.94%  fmt.(*pp).printArg
```

handleHi耗时有一定下降。

七、Mem Profiling

在step3目录下执行bench，获取mem分配数据：

```
$ go test -v -run=^$ -bench=^BenchmarkHi$ -benchtime=2s -
memprofile=prof.mem
PASS
BenchmarkHi-4     2000000          1657 ns/op         720 B/op
       9 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step3    5.002s
```

使用pprof工具分析mem：

```
$ go tool pprof -alloc_space step3.test prof.mem
Entering interactive mode (type "help" for commands)
(pprof) top
2065.91MB of 2067.41MB total (99.93%)
Dropped 14 nodes (cum <= 10.34MB)
      flat  flat%   sum%        cum   cum%
 1076.35MB 52.06% 52.06%  1076.35MB 52.06%
net/textproto.MIMEHeader.Set
  535.54MB 25.90% 77.97%  2066.91MB   100%  step3.BenchmarkHi
  406.52MB 19.66% 97.63%  1531.37MB 74.07%  step3.handleHi
```

```
   47.50MB  2.30% 99.93%    48.50MB  2.35%  fmt.Sprint
         0     0% 99.93%  1076.35MB 52.06%  net/http.Header.Set
         0     0% 99.93%  2066.91MB   100%  runtime.goexit
         0     0% 99.93%  2066.91MB   100%  testing.(*B).launch
         0     0% 99.93%  2066.91MB   100%  testing.(*B).runN

(pprof) top -cum
2065.91MB of 2067.41MB total (99.93%)
Dropped 14 nodes (cum <= 10.34MB)
      flat  flat%   sum%        cum   cum%
  535.54MB 25.90% 25.90%  2066.91MB   100%  step3.BenchmarkHi
         0     0% 25.90%  2066.91MB   100%  runtime.goexit
         0     0% 25.90%  2066.91MB   100%  testing.(*B).launch
         0     0% 25.90%  2066.91MB   100%  testing.(*B).runN
  406.52MB 19.66% 45.57%  1531.37MB 74.07%  step3.handleHi
         0     0% 45.57%  1076.35MB 52.06%  net/http.Header.Set
 1076.35MB 52.06% 97.63%  1076.35MB 52.06%
net/textproto.MIMEHeader.Set
   47.50MB  2.30% 99.93%    48.50MB  2.35%  fmt.Sprint

(pprof) list handleHi
Total: 2.02GB
     ROUTINE =========step3.handleHi in step3/demo.go
  406.52MB     1.50GB (flat, cum) 74.07% of Total
         .          .     17:        http.Error(w, "Optional color is
invalid", http.StatusBadRequest)
         .          .     18:        return
         .          .     19:    }
         .          .     20:
         .          .     21:    visitNum := atomic.AddInt64(&visitors,
1)
         .     1.05GB     22:    w.Header().Set("Content-Type",
"text/html; charset=utf-8")
         .          .     23:    w.Write([]byte("<h1 style='color: " +
r.FormValue("color") +
  406.52MB   455.02MB     24:        "'>Welcome!</h1>You are visitor
number " + fmt.Sprint(visitNum) + "!"))
         .          .     25:}
         .          .     26:
         .          .     27:func main() {
         .          .     28:    log.Printf("Starting on port 8080")
         .          .     29:    http.HandleFunc("/hi", handleHi)
(pprof)
```

可以看到handleHi22、23两行占用了较多内存。

八、第二次优化

第二次优化的方法:
1、删除w.Header().Set这行
2、用fmt.Fprintf替代w.Write

第二次优化的代码在step4目录中:

```
// go-debug-profile-optimization/step4/demo.go
… …
func handleHi(w http.ResponseWriter, r *http.Request) {
    if !rxOptionalID.MatchString(r.FormValue("color")) {
        http.Error(w, "Optional color is invalid",
http.StatusBadRequest)
        return
    }

    visitNum := atomic.AddInt64(&visitors, 1)
    fmt.Fprintf(w, "<html><h1 stype='color: \"%s\"'>Welcome!</h1>You
are visitor number %d!", r.FormValue("color"), visitNum)
}
… …
```

执行一遍pprof:

```
$ go test -v -run=^$ -bench=^BenchmarkHi$ -benchtime=2s -
memprofile=prof.mem
PASS
BenchmarkHi-4     2000000          1428 ns/op         304 B/op
       6 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step4    4.343s

$ go tool pprof -alloc_space step4.test prof.mem
Entering interactive mode (type "help" for commands)
(pprof) top
868.06MB of 868.56MB total (99.94%)
Dropped 5 nodes (cum <= 4.34MB)
      flat  flat%   sum%        cum   cum%
  559.54MB 64.42% 64.42%   868.06MB 99.94%  step4.BenchmarkHi
  219.52MB 25.27% 89.70%   219.52MB 25.27%  bytes.makeSlice
      89MB 10.25% 99.94%   308.52MB 35.52%  step4.handleHi
         0     0% 99.94%   219.52MB 25.27%  bytes.(*Buffer).Write
         0     0% 99.94%   219.52MB 25.27%  bytes.(*Buffer).grow
         0     0% 99.94%   219.52MB 25.27%  fmt.Fprintf
         0     0% 99.94%   219.52MB 25.27%  net/http/httptest.
(*ResponseRecorder).Write
         0     0% 99.94%   868.06MB 99.94%  runtime.goexit
         0     0% 99.94%   868.06MB 99.94%  testing.(*B).launch
         0     0% 99.94%   868.06MB 99.94%  testing.(*B).runN
```

```
(pprof) top -cum
868.06MB of 868.56MB total (99.94%)
Dropped 5 nodes (cum <= 4.34MB)
      flat  flat%   sum%        cum   cum%
  559.54MB 64.42% 64.42%   868.06MB 99.94%  step4.BenchmarkHi
         0     0% 64.42%   868.06MB 99.94%  runtime.goexit
         0     0% 64.42%   868.06MB 99.94%  testing.(*B).launch
         0     0% 64.42%   868.06MB 99.94%  testing.(*B).runN
      89MB 10.25% 74.67%   308.52MB 35.52%  step4.handleHi
         0     0% 74.67%   219.52MB 25.27%  bytes.(*Buffer).Write
         0     0% 74.67%   219.52MB 25.27%  bytes.(*Buffer).grow
  219.52MB 25.27% 99.94%   219.52MB 25.27%  bytes.makeSlice
         0     0% 99.94%   219.52MB 25.27%  fmt.Fprintf
         0     0% 99.94%   219.52MB 25.27%  net/http/httptest.
(*ResponseRecorder).Write
(pprof) list handleHi
Total: 868.56MB
ROUTINE ============ step4.handleHi in step4/demo.go
      89MB   308.52MB (flat, cum) 35.52% of Total
         .          .     17:        http.Error(w, "Optional color is
invalid", http.StatusBadRequest)
         .          .     18:        return
         .          .     19:    }
         .          .     20:
         .          .     21:    visitNum := atomic.AddInt64(&visitors,
1)
      89MB   308.52MB     22:    fmt.Fprintf(w, "<html><h1
stype='color: \"%s\"'>Welcome!</h1>You are visitor number %d!",
r.FormValue("color"), visitNum)
         .          .     23:}
         .          .     24:
         .          .     25:func main() {
         .          .     26:    log.Printf("Starting on port 8080")
         .          .     27:    http.HandleFunc("/hi", handleHi)
(pprof)
```

可以看出内存占用大幅减少。

九、Benchcmp

golang.org/x/tools中有一个工具：benchcmp，可以给出两次bench的结果对比。

github.com/golang/tools是golang.org/x/tools的一个镜像。安装benchcmp步骤：

```
1、go get -u github.com/golang/tools
2、mkdir -p $GOPATH/src/golang.org/x
3、mv $GOPATH/src/github.com/golang/tools $GOPATH/src/golang.org/x
```

```
4、go install golang.org/x/tools/cmd/benchcmp
```

我们分别在step2、step3和step4下执行如下命令：

```
$ go-debug-profile-optimization/step2$ go test -bench=. -
memprofile=prof.mem | tee mem.2
PASS
BenchmarkHi-4      100000         14786 ns/op        4961 B/op
81 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step2    1.644s

go-debug-profile-optimization/step3$ go test -bench=. -
memprofile=prof.mem | tee mem.3
PASS
BenchmarkHi-4     1000000          1662 ns/op         720 B/op
       9 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step3    1.694s

go-debug-profile-optimization/step4$ go test -bench=. -
memprofile=prof.mem | tee mem.4
PASS
BenchmarkHi-4     1000000          1428 ns/op         304 B/op
       6 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step4    1.456s
```

利用benchcmp工具对比结果（benchcmp old new）：

```
$ benchcmp step3/mem.3 step4/mem.4
benchmark         old ns/op     new ns/op     delta
BenchmarkHi-4     1662          1428          -14.08%

benchmark         old allocs     new allocs     delta
BenchmarkHi-4     9              6              -33.33%

benchmark         old bytes     new bytes     delta
BenchmarkHi-4     720           304           -57.78%

$ benchcmp step2/mem.2 step4/mem.4
benchmark         old ns/op     new ns/op     delta
BenchmarkHi-4     14786         1428          -90.34%

benchmark         old allocs     new allocs     delta
BenchmarkHi-4     81             6              -92.59%

benchmark         old bytes     new bytes     delta
BenchmarkHi-4     4961          304           -93.87%
```

可以看出优化后，内存分配大幅减少，gc的时间也随之减少。

十、内存来自哪

我们在BenchmarkHi中清理每次handleHi执行后的内存：

```
//step5/demo_test.go
… …
func BenchmarkHi(b *testing.B) {
    b.ReportAllocs()

    req, err := http.ReadRequest(bufio.NewReader(strings.NewReader("GET
/ HTTP/1.0\r\n\r\n")))
    if err != nil {
        b.Fatal(err)
    }

    for i := 0; i < b.N; i++ {
        rw := httptest.NewRecorder()
        handleHi(rw, req)
        reset(rw)
    }
}

func reset(rw *httptest.ResponseRecorder) {
    m := rw.HeaderMap
    for k := range m {
        delete(m, k)
    }
    body := rw.Body
    body.Reset()
    *rw = httptest.ResponseRecorder{
        Body:      body,
        HeaderMap: m,
    }
}

… …
$ go test -v -run=^$ -bench=^BenchmarkHi$ -benchtime=2s -
memprofile=prof.mem
PASS
BenchmarkHi-4     2000000          1518 ns/op         304 B/op
       6 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step5    4.577s

$ go tool pprof -alloc_space step5.test prof.mem
Entering interactive mode (type "help" for commands)
(pprof) top -cum 10
```

```
290.52MB of 291.52MB total (99.66%)
Dropped 14 nodes (cum <= 1.46MB)
      flat  flat%   sum%        cum   cum%
         0     0%     0%   291.02MB 99.83%  runtime.goexit
  179.01MB 61.41% 61.41%   290.52MB 99.66%  step5.BenchmarkHi
         0     0% 61.41%   290.52MB 99.66%  testing.(*B).launch
         0     0% 61.41%   290.52MB 99.66%  testing.(*B).runN
   26.50MB  9.09% 70.50%   111.51MB 38.25%  step5.handleHi
         0     0% 70.50%    85.01MB 29.16%  bytes.(*Buffer).Write
         0     0% 70.50%    85.01MB 29.16%  bytes.(*Buffer).grow
   85.01MB 29.16% 99.66%    85.01MB 29.16%  bytes.makeSlice
         0     0% 99.66%    85.01MB 29.16%  fmt.Fprintf
         0     0% 99.66%    85.01MB 29.16%  net/http/httptest.
(*ResponseRecorder).Write
(pprof) list handleHi
Total: 291.52MB
ROUTINE ========================
_/home1/tonybai/proj/opensource/github/experiments/go-debug-profile-
optimization/step5.handleHi in
/home1/tonybai/proj/opensource/github/experiments/go-debug-profile-
optimization/step5/demo.go
   26.50MB   111.51MB (flat, cum) 38.25% of Total
         .          .     17:        http.Error(w, "Optional color is
invalid", http.StatusBadRequest)
         .          .     18:        return
         .          .     19:    }
         .          .     20:
         .          .     21:    visitNum := atomic.AddInt64(&visitors,
1)
   26.50MB   111.51MB     22:    fmt.Fprintf(w, "<html><h1
stype='color: \"%s\"'>Welcome!</h1>You are visitor number %d!",
r.FormValue("color"), visitNum)
         .          .     23:}
         .          .     24:
         .          .     25:func main() {
         .          .     26:    log.Printf("Starting on port 8080")
         .          .     27:    http.HandleFunc("/hi", handleHi)
(pprof)
```

内存从300MB降到111MB。内存来自哪？看到list handleHi，fmt.Fprintf分配了111.51MB。

我们来看这一行代码：

```
fmt.Fprintf(w, "<h1 style='color: %s'>Welcome!</h1>You are visitor
number %d!",
               r.FormValue("color"), num)
```

fmt.Fprintf的manual：

```
$ go doc fmt.Fprintf
func Fprintf(w io.Writer, format string, a …interface{}) (n int, err
error)

    Fprintf formats according to a format specifier and writes to w. It
returns
    the number of bytes written and any write error encountered.
```

这里回顾一下Go type在runtime中的内存占用：

```
A Go interface is 2 words of memory: (type, pointer).
A Go string is 2 words of memory: (base pointer, length)
A Go slice is 3 words of memory: (base pointer, length, capacity)
```

每次调用fmt.Fprintf，参数以value值形式传入函数时，程序就要为每个变参分配一个占用16bytes的empty interface，然后用传入的类型初始化该interface value。这就是这块累计分配内存较多的原因。

十一、消除所有内存分配

下面的优化代码可能在实际中并不需要，但一旦真的成为瓶颈，可以这么做：

```
//go-debug-profile-optimization/step6/demo.go
……
var bufPool = sync.Pool{
    New: func() interface{} {
        return new(bytes.Buffer)
    },
}

func handleHi(w http.ResponseWriter, r *http.Request) {
    if !rxOptionalID.MatchString(r.FormValue("color")) {
        http.Error(w, "Optional color is invalid",
http.StatusBadRequest)
        return
    }

    visitNum := atomic.AddInt64(&visitors, 1)
    buf := bufPool.Get().(*bytes.Buffer)
    defer bufPool.Put(buf)
    buf.Reset()
    buf.WriteString("<h1 style='color: ")
    buf.WriteString(r.FormValue("color"))
    buf.WriteString("'>Welcome!</h1>You are visitor number ")
    b := strconv.AppendInt(buf.Bytes(), int64(visitNum), 10)
    b = append(b, '!')
    w.Write(b)
}
```

```
……

$  go test -v -run=^$ -bench=^BenchmarkHi$ -benchtime=2s -
memprofile=prof.mem
PASS
BenchmarkHi-4     5000000           780 ns/op         192 B/op
       3 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step6    4.709s

 go tool pprof -alloc_space step6.test prof.mem
Entering interactive mode (type "help" for commands)
(pprof) top -cum 10
1.07GB of 1.07GB total (  100%)
Dropped 5 nodes (cum <= 0.01GB)
      flat  flat%   sum%        cum   cum%
    1.07GB   100%   100%     1.07GB   100%  step6.BenchmarkHi
         0     0%   100%     1.07GB   100%  runtime.goexit
         0     0%   100%     1.07GB   100%  testing.(*B).launch
         0     0%   100%     1.07GB   100%  testing.(*B).runN

$ go test -bench=. -memprofile=prof.mem | tee mem.6
PASS
BenchmarkHi-4     2000000           790 ns/op         192 B/op
       3 allocs/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step6    2.401s

$ benchcmp step5/mem.5 step6/mem.6
benchmark         old ns/op     new ns/op     delta
BenchmarkHi-4     1513          790           -47.79%

benchmark         old allocs     new allocs     delta
BenchmarkHi-4     6               3              -50.00%

benchmark         old bytes     new bytes     delta
BenchmarkHi-4     304           192           -36.84%
```

可以看到handleHi已经不在top列表中了。benchcmp结果也显示内存分配又有大幅下降！

十二、竞争(Contention)优化

为handleHi编写一个Parallel benchmark test:

```
//go-debug-profile-optimization/step7/demo_test.go
… …
func BenchmarkHiParallel(b *testing.B) {
    r, err := http.ReadRequest(bufio.NewReader(strings.NewReader("GET /
HTTP/1.0\r\n\r\n")))
```

```
    if err != nil {
        b.Fatal(err)
    }

    b.RunParallel(func(pb *testing.PB) {
        rw := httptest.NewRecorder()
        for pb.Next() {
            handleHi(rw, r)
            reset(rw)
        }
    })
}
… …
```

执行测试，并分析结果:

```
$ go test -bench=Parallel -blockprofile=prof.block
PASS
BenchmarkHiParallel-4     5000000           305 ns/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step7    1.947s

$ go tool pprof step7.test  prof.block
Entering interactive mode (type "help" for commands)
(pprof) top -cum 10
3.68s of 3.72s total (98.82%)
Dropped 29 nodes (cum <= 0.02s)
Showing top 10 nodes out of 20 (cum >= 1.84s)
      flat  flat%   sum%        cum   cum%
         0     0%     0%      3.72s   100%  runtime.goexit
     1.84s 49.46% 49.46%      1.84s 49.46%  runtime.chanrecv1
         0     0% 49.46%      1.84s 49.46%  main.main
         0     0% 49.46%      1.84s 49.46%  runtime.main
         0     0% 49.46%      1.84s 49.46%  testing.(*M).Run
         0     0% 49.46%      1.84s 49.43%  testing.(*B).run
         0     0% 49.46%      1.84s 49.43%  testing.RunBenchmarks
         0     0% 49.46%      1.84s 49.36%  step7.BenchmarkHiParallel
     1.84s 49.36% 98.82%      1.84s 49.36%  sync.(*WaitGroup).Wait
         0     0% 98.82%      1.84s 49.36%  testing.(*B).RunParallel
(pprof) list BenchmarkHiParallel
Total: 3.72s
ROUTINE ====== step7.BenchmarkHiParallel in step7/demo_test.go
         0      1.84s (flat, cum) 49.36% of Total
         .          .    113:        rw := httptest.NewRecorder()
         .          .    114:        for pb.Next() {
         .          .    115:            handleHi(rw, r)
         .          .    116:            reset(rw)
         .          .    117:        }
```

```
         .      1.84s    118:    })
         .          .    119:}
ROUTINE ==== step7.BenchmarkHiParallel.func1 in step7/demo_test.go
         0    43.02ms (flat, cum)  1.16% of Total
         .          .    110:    }
         .          .    111:
         .          .    112:    b.RunParallel(func(pb *testing.PB) {
         .          .    113:        rw := httptest.NewRecorder()
         .          .    114:        for pb.Next() {
         .    43.02ms    115:            handleHi(rw, r)
         .          .    116:            reset(rw)
         .          .    117:        }
         .          .    118:    })
         .          .    119:}
(pprof) list handleHi
Total: 3.72s
ROUTINE =====step7.handleHi in step7/demo.go
         0    43.02ms (flat, cum)  1.16% of Total
         .          .     18:        return new(bytes.Buffer)
         .          .     19:    },
         .          .     20:}
         .          .     21:
         .          .     22:func handleHi(w http.ResponseWriter, r
*http.Request) {
         .    43.01ms     23:    if
!rxOptionalID.MatchString(r.FormValue("color")) {
         .          .     24:        http.Error(w, "Optional color is
invalid", http.StatusBadRequest)
         .          .     25:        return
         .          .     26:    }
         .          .     27:
         .          .     28:    visitNum := atomic.AddInt64(&visitors,
1)
         .     2.50us     29:    buf := bufPool.Get().(*bytes.Buffer)
         .          .     30:    defer bufPool.Put(buf)
         .          .     31:    buf.Reset()
         .          .     32:    buf.WriteString("<h1 style='color: ")
         .          .     33:    buf.WriteString(r.FormValue("color"))
         .          .     34:    buf.WriteString("'>Welcome!</h1>You
are visitor number ")
(pprof)
```

handleHi中MatchString这块是一个焦点，这里耗时较多。

优化方法（**step8**）：

```
//go-debug-profile-optimization/step8/demo.go
… …
```

```
var colorRxPool = sync.Pool{
    New: func() interface{} { return regexp.MustCompile(`\w*$`) },
}

func handleHi(w http.ResponseWriter, r *http.Request) {
    if !colorRxPool.Get().
(*regexp.Regexp).MatchString(r.FormValue("color")) {
        http.Error(w, "Optional color is invalid",
http.StatusBadRequest)
        return
    }

    visitNum := atomic.AddInt64(&visitors, 1)
    buf := bufPool.Get().(*bytes.Buffer)
    defer bufPool.Put(buf)
    buf.Reset()
    buf.WriteString("<h1 style='color: ")
    buf.WriteString(r.FormValue("color"))
    buf.WriteString("'>Welcome!</h1>You are visitor number ")
    b := strconv.AppendInt(buf.Bytes(), int64(visitNum), 10)
    b = append(b, '!')
    w.Write(b)
}
… …
```

测试执行与分析：

```
$ go test -bench=Parallel -blockprofile=prof.block
PASS
BenchmarkHiParallel-4      100000         19190 ns/op
ok      _/home1/tonybai/proj/opensource/github/experiments/go-debug-
profile-optimization/step8    2.219s

$ go tool pprof step8.test  prof.block
Entering interactive mode (type "help" for commands)
(pprof) top -cum 10
4.22s of 4.23s total (99.69%)
Dropped 28 nodes (cum <= 0.02s)
Showing top 10 nodes out of 12 (cum >= 2.11s)
      flat  flat%   sum%        cum   cum%
         0     0%     0%      4.23s   100%  runtime.goexit
     2.11s 49.90% 49.90%      2.11s 49.90%  runtime.chanrecv1
         0     0% 49.90%      2.11s 49.89%  main.main
         0     0% 49.90%      2.11s 49.89%  runtime.main
         0     0% 49.90%      2.11s 49.89%  testing.(*M).Run
         0     0% 49.90%      2.11s 49.86%  testing.(*B).run
         0     0% 49.90%      2.11s 49.86%  testing.RunBenchmarks
         0     0% 49.90%      2.11s 49.79%  step8.BenchmarkHiParallel
```

```
     2.11s 49.79% 99.69%      2.11s 49.79%  sync.(*WaitGroup).Wait
         0     0% 99.69%      2.11s 49.79%  testing.(*B).RunParallel
(pprof) list BenchmarkHiParallel
Total: 4.23s
ROUTINE ======step8.BenchmarkHiParallel in step8/demo_test.go
         0      2.11s (flat, cum) 49.79% of Total
         .          .    113:        rw := httptest.NewRecorder()
         .          .    114:        for pb.Next() {
         .          .    115:            handleHi(rw, r)
         .          .    116:            reset(rw)
         .          .    117:        }
         .      2.11s    118:    })
         .          .    119:}
ROUTINE ======step8.BenchmarkHiParallel.func1 in step8/demo_test.go
         0    11.68ms (flat, cum)  0.28% of Total
         .          .    110:    }
         .          .    111:
         .          .    112:    b.RunParallel(func(pb *testing.PB) {
         .          .    113:        rw := httptest.NewRecorder()
         .          .    114:        for pb.Next() {
         .    11.68ms    115:            handleHi(rw, r)
         .          .    116:            reset(rw)
         .          .    117:        }
         .          .    118:    })
         .          .    119:}
(pprof) list handleHi
Total: 4.23s
ROUTINE ======step8.handleHi in step8/demo.go
         0    11.68ms (flat, cum)  0.28% of Total
         .          .     21:var colorRxPool = sync.Pool{
         .          .     22:    New: func() interface{} { return
regexp.MustCompile(`\w*$`) },
         .          .     23:}
         .          .     24:
         .          .     25:func handleHi(w http.ResponseWriter, r
*http.Request) {
         .     5.66ms     26:    if !colorRxPool.Get().
(*regexp.Regexp).MatchString(r.FormValue("color")) {
         .          .     27:        http.Error(w, "Optional color is
invalid", http.StatusBadRequest)
         .          .     28:        return
         .          .     29:    }
         .          .     30:
         .          .     31:    visitNum := atomic.AddInt64(&visitors,
1)
         .     6.02ms     32:    buf := bufPool.Get().(*bytes.Buffer)
         .          .     33:    defer bufPool.Put(buf)
         .          .     34:    buf.Reset()
```

```
         .          .      35:     buf.WriteString("<h1 style='color: ")
         .          .      36:     buf.WriteString(r.FormValue("color"))
         .          .      37:     buf.WriteString("'>Welcome!</h1>You
are visitor number ")
(pprof)
```

优化后，MatchString从43ms降到5.66ms。

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1. *那抹湛蓝*
   2015/08/27

   在 CPU profiling 中，下面这个命令出错

   go test -v -run=^$ -bench=.

   提示 no matches found: -run=^$

   回复

2. *bigwhite*
   2015/08/27

   -run regexp Run only those tests and examples matching the regular expression.
   ^$是正则式，我在go 1.5 ubuntu amd64下执行没有问题啊。你的go版本和环境是?

   回复

   - *那抹湛蓝*
     2015/08/27

     $ uname -a
     Linux shhl2 3.16.0-30-generic #40~14.04.1-Ubuntu SMP Thu Jan 15 17:43:14 UTC 2015 x86_64 x86_64 x86_64 GNU/Linux
     $ go version
     go version go1.5 linux/amd64

我用的是 zsh

回复

3. bigwhite
2015/08/31

可以将-run去掉试试。

回复

4. 原来微博的昵称真的可以好长好长
2015/09/02

博客的模板比较差啊。。。 代码段看起来非常不舒服。。。 影响文章质量了都~ 不过，内容很精彩实用~ 赞~

回复

- bigwhite
2015/09/05

  有好模板，不妨推荐一个？

  回复

  - 原来微博的昵称真的可以好长好长
2015/09/23

    我也没啥好模板，只是你这个代码较多，格式化展示效果会好很多~

    回复

    - bigwhite
2015/09/23

      嗯，我也在逐渐切换到markdown，希望后续格式会好些。

      回复

5. Hessian海生
2015/10/10

找个代码高亮插件吧

回复

6. 8094731

2016/01/09

在windows 7中，为什么我执行后的没有*.test文件 其他的都好。

回复

- bigwhite
  2016/01/09

  我手头没有windows go开发环境，工作中也不用windows，您自己不妨摸索一下，有结论后，别忘了在这里的评论中补上一句。呵呵。

  回复

7. *Fred*
   2016/12/06

   写的很不错，其中有个问题指出，以免后看者在测试验证时浪费不必要的时间使用pprof工具分析mem：$ go tool pprof –alloc_space step3.test prof.memEntering interactive mode (type “help” for commands)—中划线大写了–alloc_space（错误）-alloc_space

   回复

8. small-pig
   2018/05/06

   //go-debug-profile-optimization/step0/demo.go
   package main

   import (
   “fmt”
   “log”
   “net/http”
   “regexp”
)

   // must be accessed atomically

   var add = make(chan struct{})
   var total = make(chan int)

   func getVistors() int {
   return <-total
   }

   func addVistors() {
   add <- struct{}{}
   }

   func teller() {

```
var visitors int
for {
select {
case <-add:
visitors += 1
case total <- visitors:
}
}
}

func handleHi(w http.ResponseWriter, r *http.Request) {
if match, _ := regexp.MatchString(`^\w*$`, r.FormValue("color")); !match {
http.Error(w, "Optional color is invalid", http.StatusBadRequest)
return
}
addVistors()
visitNum := getVistors()
w.Header().Set("Content-Type", "text/html; charset=utf-8")
w.Write([]byte("Welcome!You are visitor number ” + fmt.Sprint(visitNum) + “!”))
}
func main() {
log.Printf(“Starting on port 8080″)
go teller()
http.HandleFunc(“/hi”, handleHi)
log.Fatal(http.ListenAndServe(“127.0.0.1:8080″, nil))
}
```

请问big white大大,我使用了channel,为什么go test的时候会不成功?
现象是go test timeout。

回复

9. *small-pig*
2018/05/06

不好意思
var c = make(chan struct{}, 1)
func handleVistors() {
c <- struct{}{}
vistors++
<-c
}

我这样写,测试依旧不通过，依旧是timeout。不知道为什么。

回复

-  *bigwhite*
2018/05/07

无论是否是buffered channel，go test执行到TestHandleHi_Recorder时，只是直接调用了handleHi，而你在demo.go中写的teller() goroutine并没有启动啊。因此测试始终阻塞在那里了啊。应该是visitors这个channel上。

回复

10. *small-pig*
2018/05/06

你好，
不太理解step 8 为什么会优化之前的做法[让正则仅编译一次]。
我浅显的理解,sync.Pool不是会不定时被gc掉么,如果被gc了的话,又要重新编译正则了。

回复

- *bigwhite*
2018/05/07

regexp.Regexp内部是有一个mutex的，因此是goroutine-safe的，但mutex在并发时存在一定的性能损耗。step8目的就是建立一个regexp.Regexp pool，这样多个goroutine按需获取，这样不用每收到一个连接就创建一个Regexp，sync.Pool中的对象是暂时性的，在两个GC周期之间未被get出去的object会被gc掉，但pool的确增加对象重用的几率，减少gc的负担，因此一定程度上减少内存分配，提升整体性能。

回复

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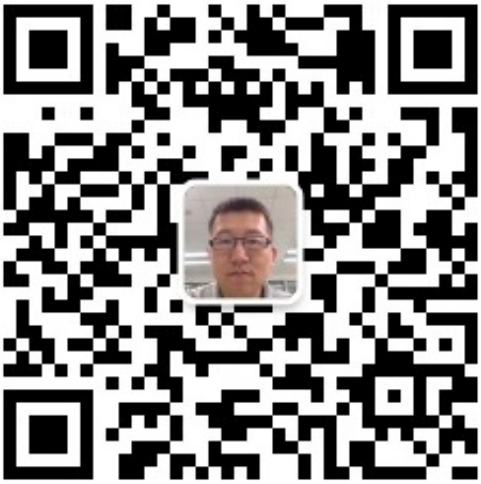

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- 写Go代码时遇到的那些问题[第2期]

评论

- bigwhite 在 Hello，Termux
  那个防止垃圾评论的plugin的确体验较差，不过我的wordpress版本较低，还懒得升级，好的防垃...
- Hugh 在 Hello，Termux
  如果是想获得管理员权限的话可以用tsu命令替换su命令,原来的命令都还能执行. pkg instal...
- bob 在 ngrok原理浅析
  受益匪浅，已订阅博文免费ngrok服务器铂金ngrok https://ngrok.bob.kim
- bigwhite 在 在Kubernetes集群上部署高可用Harbor镜像仓库
  我的邮箱，bigwhite.cn@aliyun.com，欢迎沟通。您要做的这个平台也不算小，兄台背后...
- bigwhite 在 在Kubernetes集群上部署高可用Harbor镜像仓库
  大大的赞。codefresh.io这个很不错。国内这方面的服务似乎多是绑定某个容器云平台了。没有独立...
- 今何安 在 在Kubernetes集群上部署高可用Harbor镜像仓库
  架构上目前还没有做HA，这个问题不大，目前就只有数据库mysql会存在单点问题，这个后续会切换到直接...
- 今何安 在 在Kubernetes集群上部署高可用Harbor镜像仓库
  经过年后这段时间的准备，我开发了一个精简版的docker镜像仓库产品：https://douwa.t...
- bigwhite 在 部署devstack
  以前没遇到过，现在也没有devstack环境了。不过 google了一下，找到了两个和你遇到相似问题...
- 洪城浪子 在 部署devstack
  请问如果出现g-api该如何解决+functions:wait_for_service:432 ...
- bigwhite 在 Go程序调试、分析与优化
  regexp.Regexp内部是有一个mutex的，因此是goroutine-safe的，但mute...
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