

# Profiling In GoLang

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## Pre-Requisite

### Install Graphviz

Mac:

```
brew install graphviz
```

Linux:

```
sudo apt install graphviz
```

Windows:

See <https://graphviz.org/download/>

### Install Benchstat

```
cd ~  
go install golang.org/x/perf/cmd/benchstat@latest
```

## Benchmarks

We can add in a benchmark test which will allow us to profile a section of code.

```
func TestSolve(t *testing.T) {  
    c, _ := ioutil.ReadFile("1.txt")  
    res := solve(c)  
    expected := 398  
    if expected != res {  
        t.Fatalf("expected %d, got %d", expected, res)  
    }  
}  
  
func BenchmarkSolve(b *testing.B) {  
    c, _ := ioutil.ReadFile("1.txt")  
    for i := 0; i < b.N; i++ {  
        solve(c)  
    }  
}
```

## Creating Profiles from Benchmark Test

```
go test -bench=. -run=x -benchmem -memprofile mem.prof -cpuprofile cpu.prof -benchtime=10s > 0.bench
```

After running the benchmark we can use the outputted profiles with pprof.

## Adding Profiling to your Application

Add the following code:

```
import (
    echoprof "github.com/hiko1129/echo-pprof"
    "github.com/labstack/echo/v4"
)

func Start(){
    e := echo.New()
    echoprof.Wrap(e)
    e.Start(":8080")
}
```

Pull Metric from Endpoint

```
curl -sK -v http://localhost:8888/debug/pprof/heap > heap.out
```

Open heap.out in pprof

```
go tool pprof heap.out
```

## Profiling with Pprof

### CPU Profiling

```
$ go tool pprof cpu.prof
Type: cpu
Time: Jul 15, 2022 at 1:25pm (EDT)
Duration: 7.34s, Total samples = 7.45s (101.51%)
Entering interactive mode (type "help" for commands, "o" for options)
(pprof)
```

top 20

```

(pprof) top 20
Showing nodes accounting for 7.18s, 96.38% of 7.45s total
Dropped 81 nodes (cum <= 0.04s)
Showing top 20 nodes out of 134
      flat flat%   sum%        cum   cum%
  1.56s  20.94%  20.94%    1.56s  20.94% runtime.kevent
  1.45s  19.46%  40.40%    1.45s  19.46% runtime.madvise
  0.79s  10.60%  51.01%    1.18s  15.84% encoding/json.checkValid
  0.68s   9.13%  60.13%    0.68s   9.13% encoding/json.unquoteBytes
  0.48s   6.44%  66.58%    0.48s   6.44% encoding/json.(*decodeState).rescanLiteral
  0.37s   4.97%  71.54%    0.37s   4.97% encoding/json.stateInString
  0.37s   4.97%  76.51%    0.37s   4.97% runtime.pthread_cond_signal
  0.31s   4.16%  80.67%    0.31s   4.16% runtime.pthread_kill
  0.26s   3.49%  84.16%    0.27s   3.62% encoding/json.(*encodeState).string
  0.21s   2.82%  86.98%    0.21s   2.82% syscall.syscall
  0.20s   2.68%  89.66%    0.20s   2.68% runtime.usleep
  0.19s   2.55%  92.21%    0.19s   2.55% runtime.pthread_cond_wait
  0.13s   1.74%  93.96%    0.13s   1.74% unicode/utf8.RuneCountInString
  0.04s   0.54%  94.50%    0.04s   0.54% runtime.memmove
  0.04s   0.54%  95.03%    0.10s   1.34% runtime.scanobject
  0.03s   0.4%  95.44%    0.07s   0.94% kafka-azure-sink/src/internal/gateways/kafka/consumer.randomString
  0.03s   0.4%  95.84%    0.04s   0.54% runtime.findObject
  0.02s   0.27%  96.11%    0.44s   5.91% runtime.gcDrain
  0.01s   0.13%  96.24%    1.18s  15.84% encoding/json.(*decodeState).objectInterface
  0.01s   0.13%  96.38%    0.13s   1.74% runtime.gopreempt_m
(pprof)

```

Using List to output annotated source

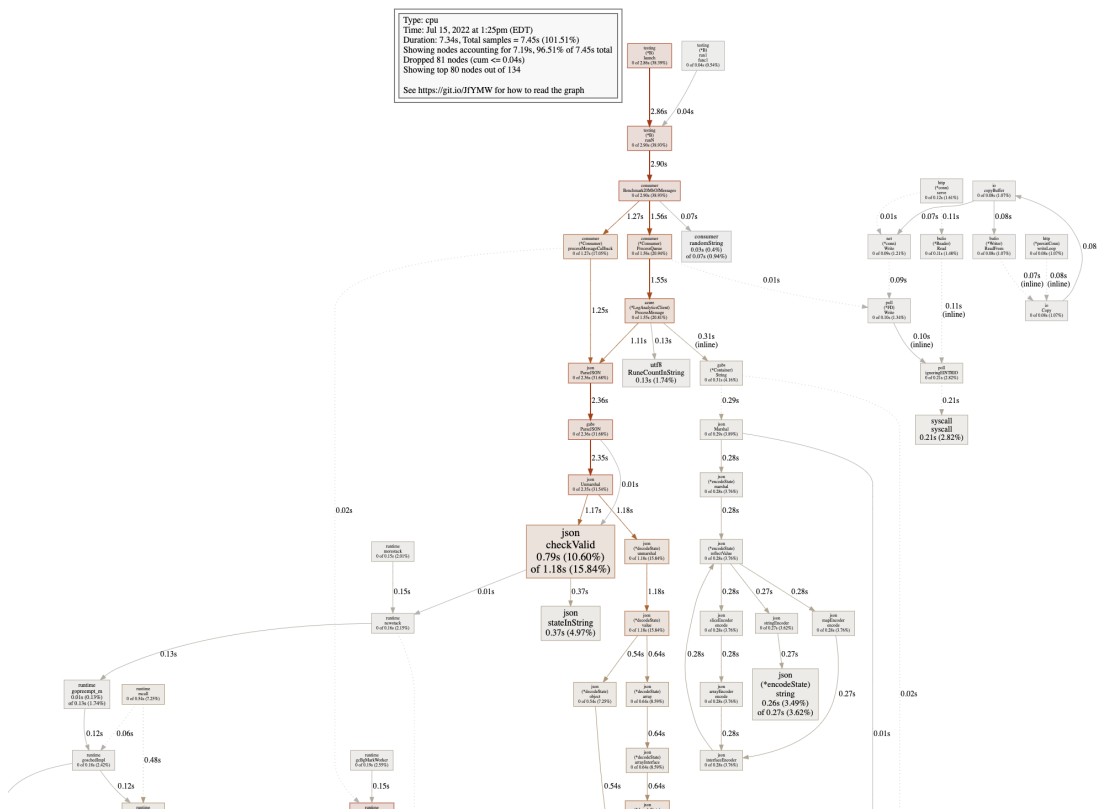
```

(pprof) list encoding/json.checkValid
Total: 12.96s
ROUTINE ===== encoding/json.checkValid in /usr/local/go/src/encoding/json/scanner.go
  690ms      1.17s (flat, cum) 9.03% of Total
    .          .      27:
    .          .      28:// checkValid verifies that data is valid JSON-encoded data.
    .          .      29:// scan is passed in for use by checkValid to avoid an allocation.
    .          .      30:func checkValid(data []byte, scan *scanner) error {
    .          .      31:    scan.reset()
  130ms      140ms  32:    for _, c := range data {
  120ms      120ms  33:        scan.bytes++
  440ms      910ms  34:        if scan.step(scan, c) == scanError {
    .          .      35:            return scan.err
    .          .      36:        }
    .          .      37:    }
    .          .      38:    if scan.eof() == scanError {
    .          .      39:        return scan.err

```

Visualize It

```
(pprof) web
```



## Memory Profiling

```
$ go tool pprof mem.prof
Type: alloc_space
Time: Jul 19, 2022 at 11:17am (EDT)
Entering interactive mode (type "help" for commands, "o" for options)
(pprof)
```

top 10

```
(pprof) top
Showing nodes accounting for 19.94GB, 99.26% of 20.09GB total
Dropped 168 nodes (cum <= 0.10GB)
Showing top 10 nodes out of 45
```

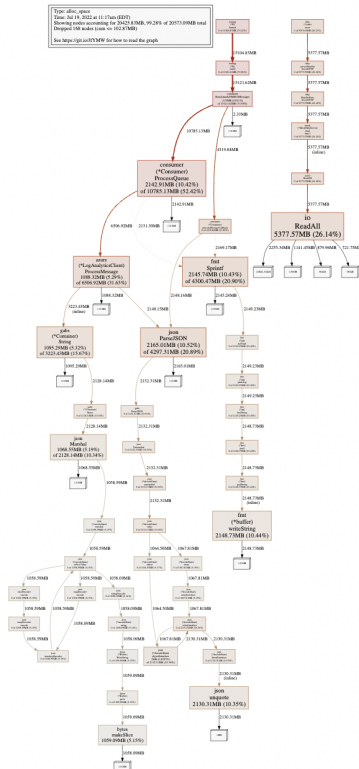
| flat           | flat%  | sum%   | cum     | cum%   |                                                                     |
|----------------|--------|--------|---------|--------|---------------------------------------------------------------------|
| 5.25GB         | 26.14% | 26.14% | 5.25GB  | 26.14% | io.ReadAll                                                          |
| 2.11GB         | 10.52% | 36.66% | 4.20GB  | 20.89% | kafka-azure-sink/src/internal/util/json.ParseJSON                   |
| 2.10GB         | 10.44% | 47.11% | 2.10GB  | 10.44% | fmt.(*buffer).writeString (inline)                                  |
| 2.10GB         | 10.43% | 57.54% | 4.20GB  | 20.90% | fmt.Sprintf                                                         |
| 2.09GB         | 10.42% | 67.95% | 10.53GB | 52.42% | kafka-azure-sink/src/internal/gateways/kafka/consumer.(*Consumer).  |
| ProcessQueue   |        |        |         |        |                                                                     |
| 2.08GB         | 10.35% | 78.31% | 2.08GB  | 10.35% | encoding/json.unquote (inline)                                      |
| 1.07GB         | 5.32%  | 83.63% | 3.15GB  | 15.67% | github.com/Jeffail/gabs/v2.(*Container).String (inline)             |
| 1.06GB         | 5.29%  | 88.92% | 6.35GB  | 31.63% | kafka-azure-sink/src/internal/gateways/azure.(*LogAnalyticsClient). |
| ProcessMessage |        |        |         |        |                                                                     |
| 1.04GB         | 5.19%  | 94.12% | 2.08GB  | 10.34% | encoding/json.Marshal                                               |
| 1.03GB         | 5.15%  | 99.26% | 1.03GB  | 5.15%  | bytes.makeSlice                                                     |

Using List to output annotated source

```
(pprof) list json.ParseJSON
Total: 20.09GB
ROUTINE ===== kafka-azure-sink/src/internal/util/json.ParseJSON in /Users/john/projects/netguard/cyberdome/services/kafka-azure-sink/src/internal/util/json/json_util.go
2.11GB 4.20GB (flat, cum) 20.89% of Total
.      .      8:)
.      .      9:
.      .      10:func ParseJSON(message string) (*gabs.Container, error) {
.      .      11:
.      .      12:         //parse message as JSON
2.11GB 4.20GB 13:         json, err := gabs.ParseJSON([]byte(message))
.      .      14:         if err != nil {
.      .      15:             logrus.Errorf("Failed to parse json message: %s", message)
.      .      16:             return nil, err
.      .      17:         }
.      .      18:         return json, nil
```

Visualize It

```
(pprof) web
```



## References

| Reference                                                             | URL                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Go (Golang) Profiling Tutorial                                        | <a href="https://www.youtube.com/watch?v=HEwSkhr_8_M">https://www.youtube.com/watch?v=HEwSkhr_8_M</a>                                                                                                                                                     |
| How I investigated memory leaks in Go using pprof on a large codebase | <a href="https://www.freecodecamp.org/news/how-i-investigated-memory-leaks-in-go-using-pprof-on-a-large-codebase-4bec4325e192/">https://www.freecodecamp.org/news/how-i-investigated-memory-leaks-in-go-using-pprof-on-a-large-codebase-4bec4325e192/</a> |