

# 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/hikol129/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%   runtime.kevent
1.56s 20.94% 20.94%    1.56s 20.94%   runtime.madvise
1.45s 19.46% 40.40%    1.45s 19.46%   encoding/json.checkValid
0.79s 10.60% 51.01%    1.18s 15.84%   encoding/json.unquoteBytes
0.68s  9.13% 60.13%    0.68s  9.13%   encoding/json.(*decodeState).rescanLiteral
0.48s  6.44% 66.58%    0.48s  6.44%   encoding/json.stateInString
0.37s  4.97% 71.54%    0.37s  4.97%   runtime.pthread_cond_signal
0.37s  4.97% 76.51%    0.37s  4.97%   runtime.pthread_kill
0.31s  4.16% 80.67%    0.31s  4.16%   encoding/json.(*encodeState).string
0.26s  3.49% 84.16%    0.27s  3.62%   syscall.syscall
0.21s  2.82% 86.98%    0.21s  2.82%   runtime.usleep
0.20s  2.68% 89.66%    0.20s  2.68%   runtime.pthread_cond_wait
0.19s  2.55% 92.21%    0.19s  2.55%   unicode/utf8.RuneCountInString
0.13s  1.74% 93.96%    0.13s  1.74%   runtime.memmove
0.04s  0.54% 94.50%    0.04s  0.54%   runtime.scanobject
0.04s  0.54% 95.03%    0.10s  1.34%   kafka-azure-sink/src/internal/gateways/kafka/consumer.randomString
0.03s  0.4% 95.44%    0.07s  0.94%   runtime.findObject
0.03s  0.4% 95.84%    0.04s  0.54%   runtime.gcDrain
0.02s  0.27% 96.11%    0.44s  5.91%   encoding/json.(*decodeState).objectInterface
0.01s  0.13% 96.24%    1.18s 15.84%   runtime.gopreempt_m
0.01s  0.13% 96.38%    0.13s  1.74%
(pprof)

```

#### Using List to output annotated source

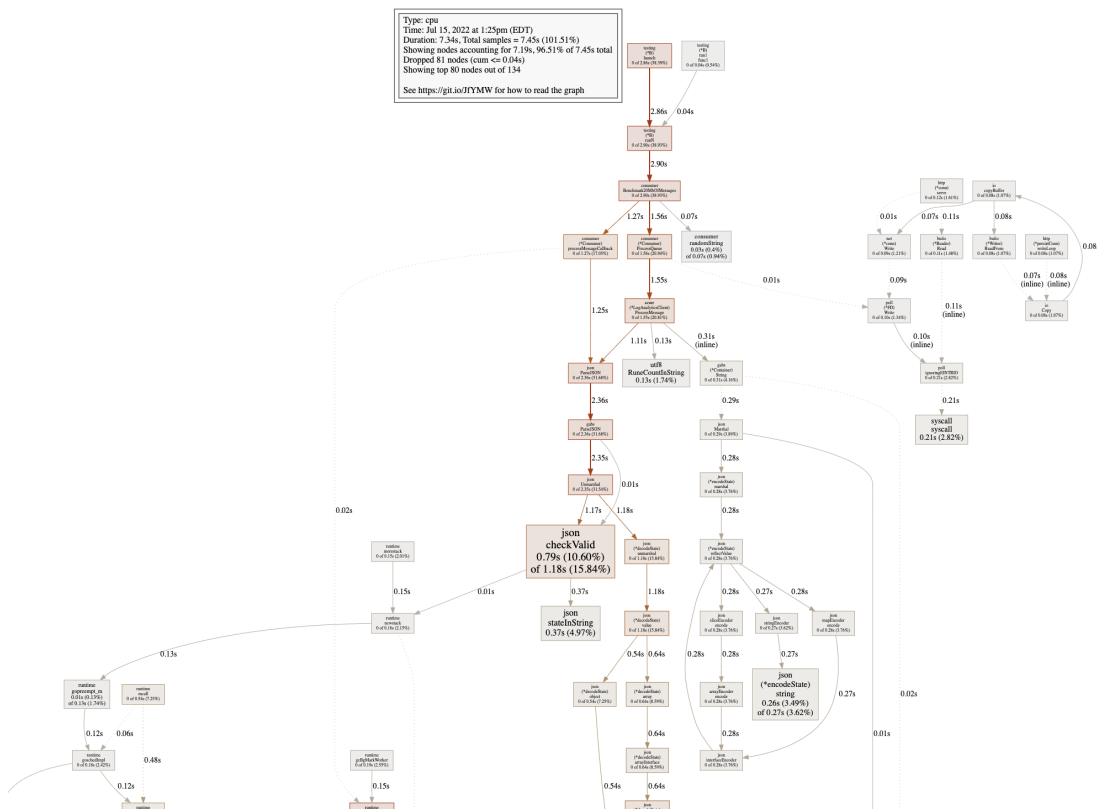
```

(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
```

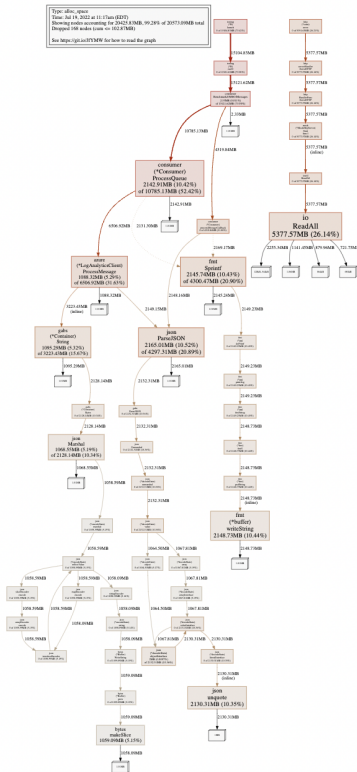
flat	flat%	sum%	cum	cum%	
5.25GB	26.14%	26.14%	5.25GB	26.14%	io.ReadAll
2.11GB	10.52%	36.66%	4.20GB	20.89%	kafka-azure-sink/src/internal/util/json.ParseJSON
2.10GB	10.44%	47.11%	2.10GB	10.44%	fmt.(*buffer).writeString (inline)
2.10GB	10.43%	57.54%	4.20GB	20.90%	fmt.Sprintf
2.09GB	10.42%	67.95%	10.53GB	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>