Learn the Go Programming Language

For experienced developers or
those of an adventurous nature

gotutorial.net
@GoTutorialNet

Matt Nunogawa
@amattn

Lesson 09

JSON, JSON, JSON

v0.2 draft

Prelude

- encoding/json wasn't very useful in go1.0
- became the package we know in go1.1
- Much thought went into bridging the JSON and Go world view.

The Basics

Reads

- In-depth blog post:
  - http://blog.golang.org/json-and-go
- Package Documentation:
  - http://golang.org/pkg/encoding/json/

Two Flavors

```
// serializing
func Marshal(v interface{}) ([]byte, error)
func (enc *Encoder) Encode(v interface{}) error

// deserializing
func Unmarshal(data []byte, v interface{}) error
func (dec *Decoder) Decode(v interface{}) error
```

Two Flavors

- Marshall serializes to a byte slice
- Unmarshall deserializes a byte slice
- Encode serializes and writes bytes to an io.Writer
- Decoder deserialized bytes read from an io.Reader

Three Scenarios

```
// serializing
interface{} -> JSONBytes

// deserializing
JSONBytes -> struct
JSONBytes -> interface{}
```

Serialization

Three Scenarios: Serializing

- Serializing is relatively straight forward. Pass in an interface{} and get out some bytes.
- Normally, you pass in structs or maps or slices/arrays.

Serializing: Maps

- maps keys must be string
- map values must:
  - be a type supported by the json package
    - bools, floats, ints, numbers
    - strings
  - or structs that implement the Marshaller interface

Serializing: Maps

```
// http://play.golang.org/p/sUYgLd6WRq

jsonBytes, err := json.Marshal(map[string][]string{"1":
[]string{"x","y"}})
fmt.Println(string(jsonBytes))
fmt.Println(err)

_, err = json.Marshal(map[int][]string{1:
[]string{"x","y"}})
fmt.Println(err)

// outputs:
// {"1":["x","y"]}
// <nil>
// json: unsupported type: map[int][]string
```

SERIALIZING: SLICES & ARRAYS

- slices or arrays must also be a type supported by the json package or structs that implement the Marshaller interface

```
// http://play.golang.org/p/sOghfITGJF
jsonBytes, err := json.Marshal([]string{"a","b","c"})
fmt.Println(string(jsonBytes))
fmt.Println(err)

jsonBytes, err = json.Marshal([]complex128{complex128(1)})
fmt.Println(string(jsonBytes))
fmt.Println(err)

// outputs
// ["a","b","c"]
//  <nil>
//
// json: unsupported type: complex128
```

SERIALIZING: SCALARS

- Passing in scalars works, but isn't very useful

- http://play.golang.org/p/xeqNcILQTj

```
jsonBytes, err := json.Marshal(1.1)
fmt.Println(string(jsonBytes))
fmt.Println(err)
jsonBytes, err = json.Marshal("why?")
fmt.Println(string(jsonBytes))
fmt.Println(err)

1.1
<nil>
"why?"
<nil>
```

SERIALIZING: STRUCTS

- Only Exported fields are serialized.
- http://play.golang.org/p/sS3wL60X7v

```
type Shape struct {
     Name  string
     sides int
}
func main() {
    jsonBytes, err := json.Marshal(Shape{"square", 4})
    fmt.Println(string(jsonBytes))
    fmt.Println(err)
}

// outputs
// {"Name":"square"}
// <nil>
```

Serializing Structs: Tags

From the encoding/json documentation:

```
// Field is ignored by this package.
Field int `json:"-"`

// Field appears in JSON as key "myName".
Field int `json:"myName"`

// Field appears in JSON as key "myName" and
// the field is omitted from the object if its value is empty,
// as defined above.
Field int `json:"myName,omitempty"`

// Field appears in JSON as key "Field" (the default), but
// the field is skipped if empty.
// Note the leading comma.
Field int `json:",omitempty"`
```

Serializing Structs: Tags

```
// http://play.golang.org/p/6IzFngGX8k

type thing struct {
IgnoreMe int    `json:"-"`
Name     string `json:"name"`
Age      int    `json:"age_of_thing,omitempty"`
Comment  string `json:",omitempty"`
}

func main() {
// please don't ignore errors.
jsonBytes, _ := json.Marshal(thing{1, "Bob", 0, ""})
fmt.Println(string(jsonBytes))
jsonBytes, _ = json.Marshal(thing{1, "Bill", 1, ""})
fmt.Println(string(jsonBytes))
jsonBytes, _ = json.Marshal(thing{1, "Waldo", 1, "Where?"})
fmt.Println(string(jsonBytes))
}

// {"name":"Bob"}
// {“name”:"Bill","age_of_thing":1}
// {“name”:"Waldo","age_of_thing":1,"Comment":"Where?"}
```

Serializing: Others

- complex, channels and functions will panic
- cyclic structs will likely infinitely recurse
- pointer values usually dereference
- interface values usually unbox

Deserialization

Three Scenarios

```
// serializing
interface{} -> JSONBytes

// deserializing
JSONBytes -> struct
JSONBytes -> interface{}
```

Three Scenarios: Deserializing

- deserializing to a struct:
  - encoding/json will attempt to populate a struct with any fields it finds in a JSON object.
- deserializing to interface{}
  - encoding/json will create a new type based on maps, slices & scalars
    - map[string]interface{},
    - []interface{}

Three Scenarios: Deserializing

```
type Shape struct {
Names []string
Sides int
}
```

Three Scenarios: Deserializing

```
// http://play.golang.org/p/iC8a0VMDbq

jsonBytes := []byte(`{"Names":["square","rectangle","trapezoid"],"Sides":4}
`)
shapePtr := new(Shape)
_ = json.Unmarshal(jsonBytes, shapePtr)
fmt.Println("deserialized:", *shapePtr)
fmt.Printf("type: %T\n", shapePtr)

var v interface{}
_ = json.Unmarshal(jsonBytes, &v)
fmt.Println("deserialized:", v)
fmt.Printf("type: %T\n", v)
fmt.Printf("type: %T\n", v.(map[string]interface{})["Names"])

// deserialized: {[square rectangle trapezoid] 4}
// type: *main.Shape
// deserialized: map[Names:[square rectangle trapezoid] Sides:4]
// type: map[string]interface {}
// type: []interface {}
```

DESERIALIZING: MIXED TYPE MAPS

```
// http://play.golang.org/p/ALOCggwBmB

jsonBytes := []byte(`{"Names":["square","rectangle",1],"Sides":4}`)
shapePtr := new(Shape)
_ = json.Unmarshal(jsonBytes, shapePtr)
fmt.Println("deserialized:", *shapePtr)
fmt.Println("len(shapePtr.Names):", len(shapePtr.N

var v interface{}
_ = json.Unmarshal(jsonBytes, &v)
fmt.Println("deserialized:", v)


// deserialized: {[square rectangle ] 4}
// len(shapePtr.Names): 3
// deserialized: map[Names:[square rectangle 1] Sides:4]
// type: map[string]interface {}
```

mixed types ok in JSON!

third Name is the empty string

Deserializing: Extra Fields

```
// http://play.golang.org/p/WHxRB-Kg_4

jsonBytes := []byte(`{"Names":["square","rectangle",1],"Sides":
4, "Color":"red"}`)
shapePtr := new(Shape)
_ = json.Unmarshal(jsonBytes, shapePtr)
fmt.Println("deserialized:", *shapePtr)

var v interface{}
_ = json.Unmarshal(jsonBytes, &v)
fmt.Println("deserialized:", v)

// deserialized: {[square rectangle ] 4}
// len(shapePtr.Names): 3
// deserialized: map[Names:[square rectangle 1] Sides:4
Color:red]
```

extra fields…

… are ignored when unmarshalling into structs

Deserializing Structs: Tags

```
// http://play.golang.org/p/I-yadK-CLy

type thing struct {
IgnoreMe int    `json:"-"`
Name     string `json:"name"`
Age      int    `json:"age_of_thing,omitempty"`
Comment  string `json:",omitempty"`
}

var t1, t2, t3 thing
_ = json.Unmarshal([]byte(`{"name":"Bill","Age":2}`), &t1)
fmt.Println(t1)
_ = json.Unmarshal([]byte(`{"Name":"Bill","Age_of_thing":1, "Age":2}`), &t2)
fmt.Println(t2)
_ = json.Unmarshal([]byte(`{"IgnoreMe":1,"name":"Waldo","age_of_thing":
1,"Comment":"Where?"}`), &t3)
fmt.Println(t3)

// {0 Bill 0 }
// {0 Bill 1 }
// {0 Waldo 1 Where?}
```

Deserializing Structs: Tags

```
// http://play.golang.org/p/I-yadK-CLy

type thing struct {
IgnoreMe int    `json:"-"`
Name     string `json:"name"`
Age      int    `json:"age_of_thing,omitempt
Comment  string `json:"omitempty"`
}

var t1, t2, t3 thing
_ = json.Unmarshal([]byte(`{"name":"Bill","Age":2}`), &t1)
fmt.Println(t1)
_ = json.Unmarshal([]byte(`{"Name":"Bill","Age_of_thing":1, "Age":2}`), &t2)
fmt.Println(t2)
_ = json.Unmarshal([]byte(`{"IgnoreMe":1,"name":"Waldo","age_of_thing":
1,"Comment":"Where?"}`), &t3)
fmt.Println(t3)

// {0 Bill 0 }
// {0 Bill 1 }
// {0 Waldo 1 Where?}
```

case-insensitive

respects the tagged name

"-" tagged is always ignored.

omitempty doesn't mean much for deserialization

Anonymous Fields

Anonymous Fields

- Review:

```
type Person struct {
    Name string
    Age  int
}
type Employee struct {
    Person
    StartDate time.Time
    Salary    int
}
type Manager struct {
    Employee
    Reports []Employee
}
```

Anonymous Fields

- Anonymous Fields are "flattened"

```
pointy := new(Manager)
pointy.Name = "Fred"
pointy.Age = 38
pointy.StartDate = time.Now()
rupert := new(Employee)
rupert.Name = "Rupert"
pointy.Reports = []Employee{rupert}

jsonBytes, err = json.Marshal(pointy)
```

Anonymous Fields

```
fmt.Println(jsonBytes)

// outputs (pretty printed for legibility)
{
    “Name":"name",
    “Age”:38,
    “StartDate":"2015-03-05T09:58:26.575833992-08:00",
    “Salary":0,
    “Reports”:[
        {
            “Name”:"Rupert",
            “Age":0,
            “StartDate":"0001-01-01T00:00:00Z",
            “Salary":0
        }
    ]
}
```

Anonymous Fields

- Deserialization works the similarly:

```
fmt.Println(jsonBytes)

jsonBytes = []byte(`{"Name":"Harry","Age":
38,"StartDate":"2015-03-05T09:58:26.575833992-08:00",
"Salary":0,"Reports":[{"Name":"Rupert","Age":
0,"StartDate":"0001-01-01T00:00:00Z","Salary":0}]}`)

hairy := new(Manager)
_ = json.Unmarshal(jsonBytes, hairy)
```

Anonymous Fields

- Deserialization will "drill down" and will best effort populate anonymous fields

```
fmt.Printf("%+v\n", hairy)

// outputs (pretty printed for legibility)
&{
  Employee: {
    Person:{Name:Harry Age:38}
    StartDate:2015-03-05 09:58:26.575833992 -0800 PST
    Salary:0
  }
  Reports:[{
      Person:{Name:Rupert Age:0}
      StartDate:0001-01-01 00:00:00 +0000 UTC Salary:0
    }
  ]
}
```

Overlapping Anonymous Fields

- Anonymous fields with overlap are a point of caution:

```
type Eye struct {
    Count int
    Color string
}
type Hair struct {
    Texture string
    Color   string
}
type Face struct {
    Eye
    Hair
}

face := new(Face)
face.Eye.Count = 2
face.Eye.Color = "Brown"
face.Hair.Color = "Blonde"
jsonBytes, _ = json.Marshal(face)
// outputs:
// {"Count":2,"Texture":""}
```

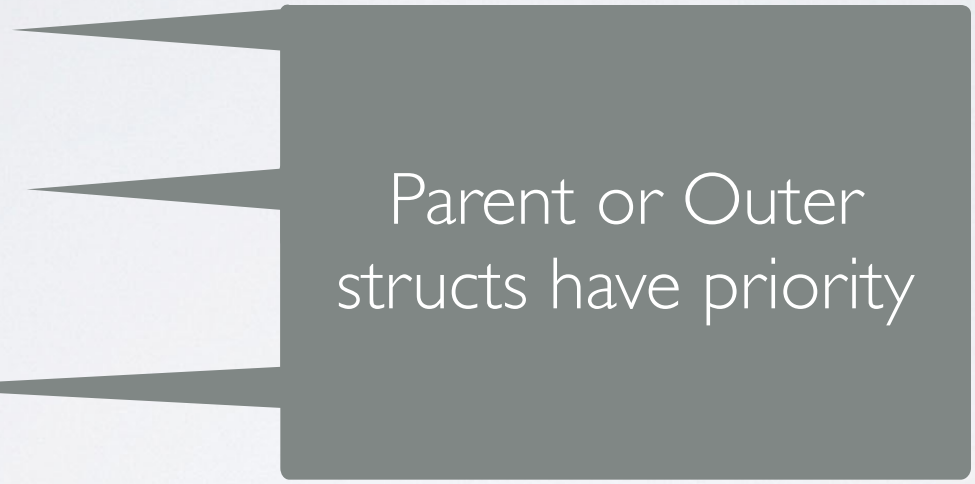
Ambiguous fields are just skipped

Overlapping Anonymous Fields

- Anonymous fields with overlap are a point of caution:

```
type Eye struct {
    Count int
    Color string
}
type Hair struct {
    Texture string
    Color   string
}
type Face struct {
    Eye
    Hair
    Color string
}

face := new(Face)
face.Color = "Fair"
face.Eye.Count = 2
face.Eye.Color = "Brown"
face.Hair.Color = "Blonde"
jsonBytes, _ = json.Marshal(face)
// outputs:
// {"Count":2,"Texture":"","Color":"Fair"}
```



Overlapping Anonymous Fields

- Anonymous fields with overlap are a point of caution:

```
type Eye struct {
    Count int
    Color string
}
type Hair struct {
    Texture string
    Color   string
}
type Face struct {
    MyEye Eye
    MyHair Hair
}

face := new(Face)
face.Eye.Count = 2
face.Eye.Color = "Brown"
face.Hair.Color = "Blonde"
jsonBytes, _ = json.Marshal(face)
// outputs:
```

Marshaler/Unmarshaler Interface

The Interfaces

```
type Marshaler interface {
        MarshalJSON() ([]byte, error)
}

type Unmarshaler interface {
        UnmarshalJSON([]byte) error
}
```

Why?

- implemented by some StdLib types:
  - RawMessage, Time, big.Int
- Design so YOU can use them
  - your own custom structs
  - customize the serialization
    - example: you want UUIDs to be in the readable form:
      - de305d54-75b4-431b-adb2-eb6b9e546013
      - instead of [1 2 3 4 5 …]

Example: time.Time

```
// MarshalJSON implements the json.Marshaler interface.
// The time is a quoted string in RFC 3339 format,
// with sub-second precision added if present.
func (t Time) MarshalJSON() ([]byte, error) {
    if y := t.Year(); y < 0 || y >= 10000 {
        // RFC 3339 is clear that years are 4 digits exactly.
        // See golang.org/issue/4556#c15 for more discussion.
        return nil, errors.New("Time.MarshalJSON: year out<snip>”)
    }
    return []byte(t.Format(`"` + RFC3339Nano + `"`)), nil
}

// UnmarshalJSON implements the json.Unmarshaler interface.
// The time is expected to be a quoted string in RFC 3339 format.
func (t *Time) UnmarshalJSON(data []byte) (err error) {
    // Fractional seconds are handled implicitly by Parse.
    *t, err = Parse(`"`+RFC3339+`"`, string(data))
    return
}
```

EXAMPLE: TIME.TIME

```
type Meal struct {
    Food string
    Timestamp time.Time
}
lunch := Meal{“sushi”, time.Now()}
jsonBytes, _ = json.Marshal(lunch)
fmt.Println(string(jsonBytes))

// outputs:
{"Food":"Sushi","Timestamp":"2015-03-05T10:54:58.6384
73751-08:00"}
```

Quotes manually inserted by MarshalJSON() implementation

Example: HUID

```
type HUID [8]byte

func (huid HUID) String() string {
  return fmt.Sprintf(
    "%s-%s",
    hex.EncodeToString(huid[0:4]),
    hex.EncodeToString(huid[4:8]),
  )
}

type Clown struct {
    Huid      HUID
    Name      string
    NoseColor string
}

huid := HUID{1, 2, 3, 4, 10, 11, 12, 13}
fmt.Println(huid)
// outputs
010203040-a0b0c0d
```

Example: HUID

```
huid := HUID{1, 2, 3, 4, 10, 11, 12, 13}
wally := Clown{huid, "Wally", "Red"}
jsonBytes, _ = json.Marshal(wally)
fmt.Println(string(jsonBytes))

// outputs (pretty printed for legibility)
{
    “Huid":[1,2,3,4,10,11,12,13],
    “Name":"Wally",
    “NoseColor":"Red"
}
```

HUID: MarshalJSON()

```
func (huid HUID) MarshalJSON() ([]byte, error) {
    return []byte(huid.String()), nil
}

huid := HUID{1, 2, 3, 4, 10, 11, 12, 13}
wally := Clown{huid, "Wally", "Red"}
_, err = json.Marshal(wally)
fmt.Println(err)

// outputs
json: error calling MarshalJSON for type main.HUID: invalid
character '1' after top-level value

// This code is attempting to generate:
// {“Huid”:01020304-0a0b0c0d,”Name”:"Wally","NoseColor":"Red"}
// which is not valid json
```

HUID: MarshalJSON()

```
func (huid HUID) MarshalJSON() ([]byte, error) {
    return []byte(`"` + huid.String() + `"`), nil
}

huid := HUID{1, 2, 3, 4, 10, 11, 12, 13}
wally := Clown{huid, "Wally", "Red"}
jsonBytes, _ = json.Marshal(wally)
fmt.Println(jsonBytes)

// outputs
{“Huid":"01020304-0a0b0c0d","Name":"Wally","NoseColor
":"Red"}
```

HUID: UnmarshalJSON()

```
func (huid *HUID) UnmarshalJSON(data []byte) (err error) {
    // not a truly robust solution...
    // in practice check err, len, etc.
    unquoted := strings.Trim(string(data), `"`)
    first_half, _ := hex.DecodeString(unquoted[0:8])
    second_half, _ := hex.DecodeString(unquoted[9:17])
    for i := 0; i < 4; i++ {
        huid[i] = first_half[i]
        huid[i+4] = second_half[i]
    }
    return nil
}

jsonBytes = []byte(`{"Huid":"11223344-
aabbccdd","Name":"Squally","NoseColor":"Blue"}`)
squally := new(Clown)
json.Unmarshal(jsonBytes, squally)
fmt.Println(squally)
// outputs
&{11223344-aabbccdd Squally Blue}
```

When?

- Custom types (MyInt, etc)
- Enums (iota) or fixed sets
  - Especially when the internal representation is a number, but the logical representation is a word.
- When you want more human readable representation (eg. time.Time instead of a unix timestamp)
- When you have existing parsers/formaters or encoders/decoders

RawMessage

JSON.RawMessage

- Sometimes you don't want to deserialize the whole thing.

```
// hypothetical json pattern:
{"type":"shape","raw":{"sides":4}}
{"type":"person","raw":{"name":"lucy"}}
{"type":"list","raw":[1,2,"abc"]}

type Generic struct {
    Type string
    Raw  *json.RawMessage
}
```

JSON.RawMessage Internals

- It's just bytes

```
// RawMessage is a raw encoded JSON object.
// It implements Marshaler and Unmarshaler and can
// be used to delay JSON decoding or precompute a JSON encoding.
type RawMessage []byte

// MarshalJSON returns *m as the JSON encoding of m.
func (m *RawMessage) MarshalJSON() ([]byte, error) {
    return *m, nil
}

// UnmarshalJSON sets *m to a copy of data.
func (m *RawMessage) UnmarshalJSON(data []byte) error {
    if m == nil {
        return errors.New("json.RawMessage: UnmarshalJSON on nil pointer")
    }
    *m = append((*m)[0:0], data...)
    return nil
}
```

JSON.RawMessage Deserialize

```
type Shape struct {
    Sides int
}

func decode(g Generic) interface{} {
    jsonBytes, _ := g.Raw.MarshalJSON()
    switch g.Type {
    case "shape":
       var s Shape
        _ = json.Unmarshal(jsonBytes, &s)
        return s
    case "list":
        var l interface{}
        _ = json.Unmarshal(jsonBytes, &l)
        return l
    default:
        return nil
    }
}
```

JSON.RawMessage Deserialize

```
func decode(g Generic) interface{} {
    switch g.Type {
    case "shape":
        jsonBytes, _ := g.Raw.MarshalJSON()
        var s Shape
        _ = json.Unmarshal(jsonBytes, &s)
        return s
    case "list":
        var l interface{}
        _ = json.Unmarshal(jsonBytes, &l)
        return l
    default:
        return nil
    }
}

_ = json.Unmarshal([]byte(`{"type":"shape","raw":{"sides":4}}`), &g1)
decoded_raw := decode(g1)
fmt.Println(“Generic struct: g1”, g1)
fmt.Printf(“decoded_raw type: %T, value: %+v\n", decoded_raw, decoded_raw)

// Generic struct: g1 {shape 0x20820e840}
// decoded_raw type: main.Shape, value: {Sides:4}
```

JSON.RawMessage Deserialize

```
func decode(g Generic) interface{} {
    jsonBytes, _ := g.Raw.MarshalJSON()
    switch g.Type {
    case "shape":
       var s Shape
        _ = json.Unmarshal(jsonBytes, &s)
        return s
    case "list":
        var l interface{}
        _ = json.Unmarshal(jsonBytes, &l)
        return l
    default:
        return nil
    }
}

_ = json.Unmarshal([]byte(`{"type":"list","raw":[1,2,"abc"]}`), &g3)
decoded_raw = decode(g3)
fmt.Println("Generic struct: g3", g3)
fmt.Printf(“decoded_raw type: %T, value: %+v\n", decoded_raw, decoded_raw)

// Generic struct: g3 {list 0x20820e940}
// decoded_raw type: []interface {}, value: [1 2 abc]
```

JSON.RawMessage Serialize

- If you have []byte that you want to turn into a RawMessage, you have to use RawMessage.UnmarshalJSON(data)

```
triangle := Shape{3}
g4 := new(Generic)
g4.Type = "shape"
jsonBytes, _ = json.Marshal(triangle)
raw_message := new(json.RawMessage)
raw_message.UnmarshalJSON(jsonBytes)
g4.Raw = raw_message

jsonBytes, _ = json.Marshal(g4)
fmt.Println(string(jsonBytes))
// output
{"Type":"shape","Raw":{"Sides":3}}
```

JSON.RawMessage Serialize

- Usually, you make a convenience method:

```
func (s Shape) Genericize() Generic {
    g := Generic{}
    g.Type = "shape"
    jsonBytes, _ := json.Marshal(s)
    raw_message := new(json.RawMessage)
    raw_message.UnmarshalJSON(jsonBytes)
    g.Raw = raw_message
    return g
}

pentagon := Shape{5}
jsonBytes, _ = json.Marshal(pentagon.Genericize())
fmt.Println(string(jsonBytes))
// output
{"Type":"shape","Raw":{"Sides":5}}
```

Misc

Quick REST API

```
http.HandleFunc("/api/shape/", func(w http.ResponseWriter, r *http.Request) {
    path_components := strings.Split(r.URL.Path, "/")
    last_path_component := path_components[len(path_components)-1]
    sides, err := strconv.ParseInt(last_path_component, 10, 64)
    if err != nil {
        w.WriteHeader(http.StatusBadRequest)
        w.Write([]byte("400 You messed up"))
    } else {
        shape := Shape{int(sides)}
        jsonBytes, _ := json.Marshal(shape)
        w.Header().Add("Content-Type", "application/json")
        w.Write(jsonBytes)
    }
})

log.Fatal(http.ListenAndServe(":8080", nil))
```

Pretty Printing

```
// http://play.golang.org/p/UZ4YyZg8Bd

jsonBytes := []byte(`{"Names":["square","rectangle",1],"Sides":4,
"Color":"red"}`)
var buf bytes.Buffer
json.Indent(&buf, jsonBytes, "", "\t")
pretty, _ := ioutil.ReadAll(&buf)
fmt.Println(string(pretty))

// Outputs:
{
    "Names": [
        "square",
        "rectangle",
        1
    ],
    "Sides": 4,
    "Color": "red"
}
```

Compacting

```
// http://play.golang.org/p/hIxM_nwqrq

jsonBytes := []byte(`{
    "Names": [
        "square",
        "rectangle",
        1
    ],
    "Sides": 4,
    "Color": "red"
}`)
var buf bytes.Buffer
json.Compact(&buf, jsonBytes)
pretty, _ := ioutil.ReadAll(&buf)
fmt.Println(string(pretty))

// Outputs
{"Names":["square","rectangle",1],"Sides":4,"Color":"red"}
```

Thank You, Credits & License

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Matt Nunogawa
@amattn

- I owe many many, thanks to the many authors of Go and to Rob Pike in particular.
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