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The Go Language: Principles and Practices for Oracle Database

DEV5047

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Data Access Development
Oracle Database
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About Me

Anthony Tuininga

- Creator and maintainer of cx_Oracle

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Oracle Database for the Developer

LANGUAGE	API
C	OCI, ODBC, ODPI-C
C++	OCCI
Java	JDBC
.NET	ODP.NET
Node.js	node-oracledb
Python	cx_Oracle
PHP	OCI8, PDO_OCI
R	ROracle
Erlang	erloci
Perl	DBD::Oracle
Ruby	ruby-oci8, ruby-odpi
Rust	mimir, rust-oracle
Go	goracle, rana, mattn

- Oracle Proprietary Drivers
- Oracle Open Source Drivers
- Third Party Open Source Drivers

... and Pro*C, OLE DB, Pro*COBOL, Pro*Fortran, SQLJ, OLE DB

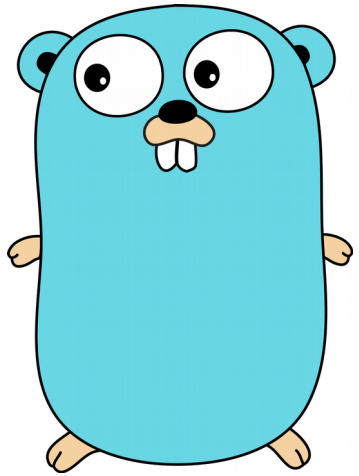
Program Agenda

1. Introduction
2. Types in Go
3. General Database Support
4. Oracle Database Support

Introduction

What is Go?

- General purpose, cross platform, open source programming language
- In the tradition of C but with many changes to make code shorter, simpler and safer
- Started at Google in 2007
  - Goal: “Fast, statically typed, compiled language that feels like a dynamically typed, interpreted language”
  - Open source in 2009
  - Version 1.0 released 2012, now at version 1.11
  - Consideration of version 2 features underway



Popularity

- Increased in popularity rapidly in last three years
  - Stack Overflow put Go in #16 earlier this year
  - TIOBE index for October 2018 puts Go in #12
  - GitHub puts Go as 7th fastest growing language (14,000+ repositories)
- Docker container system and Kubernetes container management system written in Go

What Does Go Have

- Fast compilation times
- Built-in concurrency primitives
- Built-in support for Unicode
- Automatic memory management
- Binaries are standalone and have no dependencies
- Simple cross compilation
- Easily extensible via packages
- Type inference
- Can integrate with C code

What Does Go Not Have

- No forward declarations or header files
- No exception handling (explicit error checking)
- No type hierarchy/inheritance (interfaces inferred by compiler)
- No overloading of methods/operators
- No implicit conversions
- No declaration of public/private (uses case of first letter of identifiers)

Simple Example

```
package main

import (
    "fmt"
)

func main() {
    fmt.Println("Hello, world!")
}
```

```
go run hello.go

go build hello.go
./hello

GOOS=windows go build hello.go
```

Types in Go

Basic Types

- Integer types (int, int8, int16, int32, int64, uint, etc.)
- Floating point types (float32, float64)
- Complex types (complex64, complex128)
- String
- Bool

Derived Types

- Pointers, functions
- Arrays, slices, maps
- Structures, interfaces
- Channels

Arrays/Slices

```go
var arr [5]int
fmt.Println("1 array:", arr)
for i := range arr {
    arr[i] = i * i
}
fmt.Println("2 array:", arr)

slice := arr[1:3]
fmt.Println("3 slice:", slice)
slice[1] = 15
fmt.Println("4 array:", arr)
fmt.Println("5 slice:", slice)
```

```
1 array: [0 0 0 0 0]
2 array: [0 1 4 9 16]
3 slice: [1 4]
4 array: [0 1 15 9 16]
5 slice: [1 15]
```

Structures/Interfaces

```
type TwoDShape interface {
    Area() float64
    Description() string
}

type Circle struct {
    Radius float64
}

func (circle *Circle) Area() float64 {
    return math.Pi * circle.Radius * circle.Radius
}

func (circle *Circle) Description() string {
    return fmt.Sprintf("Circle of radius %v", circle.Radius)
}
```

Structures/Interfaces (continued)

```
type Triangle struct {
    Base, Height float64
}

func (triangle *Triangle) Area() float64 {
    return 0.5 * triangle.Base * triangle.Height
}

func (triangle *Triangle) Description() string {
    return fmt.Sprintf("Triangle of base %v and height %v", triangle.Base,
            triangle.Height)
}
```

Structures/Interfaces (continued)

```
func ShowAreas(shapes ...TwoDShape) {
    for _, s := range shapes {
        fmt.Printf("%s has area %.2f\n", s.Description(), s.Area())
    }
}

func main() {
    ShowAreas(&Circle{5}, &Triangle{4, 6}, &Circle{3},
            &Circle{2.5}, &Triangle{Base: 2, Height: 7.5})
}
```

```
Circle of radius 5 has area 78.54
Triangle of base 4 and height 6 has area 12.00
Circle of radius 3 has area 28.27
Circle of radius 2.5 has area 19.63
Triangle of base 2 and height 7.5 has area 7.50
```

Channels

```go
func calc_sum(c chan int, arr []int) {
    sum := 0
    for _, v := range arr {
        sum += v
    }
    c <- sum
}

func main() {
    c := make(chan int)
    go calc_sum(c, []int{1, 2, 3, 4, 5})
    go calc_sum(c, []int{8, -1, 0, 15, -25, 6, 2})
    go calc_sum(c, []int{1})
    for i := 0; i < 3; i++ {
        sum := <- c
        fmt.Printf("Calculated sum is %v\n", sum)
    }
}
```

```
Calculated sum is 15
Calculated sum is 5
Calculated sum is 1
```

General Database Support

Database Support Overview

- Package name is “database/sql”
- Intended to be generic database API for accessing any type of database
- Covers common cases but excludes database specific extensions
- Drivers implement the interfaces defined in package “database/sql/driver”
- Supports concurrent access by goroutines, context management (timeout, cancellation, etc.), connection pooling, statement caching, etc.

Database Type Support

- Only handles booleans, strings, numbers, dates
- Also has sql.NullInt64, sql.NullFloat64, sql.NullBool, sql.NullString
- Type conversion is permitted, but only if it can be done without data loss

Connecting to a Database

```
import (
    "database/sql"
    _ "gopkg.in/goracle.v2"
)

func main() {

    db, err := sql.Open("goracle", "godb/welcome@localhost/T183")
    if err != nil {
        panic(err)
    }
    defer db.Close()

    err = db.Ping()
    if err != nil {
        panic(err)
    }

}
```

Database Setup

```
create table TestQuery (
    IntCol          number(9) not null,
    StringCol       varchar2(30) not null
);

create table TestInsert (
    IntCol          number(9) not null,
    StringCol       varchar2(30) not null,
    DateCol         date not null
);

begin
    for i in 1..10 loop
        insert into TestQuery values (power(3, i), '3 ^ ' || to_char(i));
    end loop;
    commit;
end;
/
```

Multiple row query

```
rows, err := db.Query("select IntCol, StringCol from TestQuery where IntCol < 100")
if err != nil {
    panic(err);
}
defer rows.Close()

var intCol, strCol string
for rows.Next() {
    err := rows.Scan(&intCol, &strCol)
    if err != nil {
        panic(err)
    }
    fmt.Printf("IntCol=%s, StrCol=%s\n", intCol, strCol)
}
err = rows.Err()
if err != nil {
    panic(err)
}
```

```
IntCol=3, StrCol=3 ^ 1
IntCol=9, StrCol=3 ^ 2
IntCol=27, StrCol=3 ^ 3
IntCol=81, StrCol=3 ^ 4
```

Single row query

```
var intCol, strCol string
row := db.QueryRow("select IntCol, StringCol from TestQuery where IntCol = :1", 27)
err = row.Scan(&intCol, &strCol)
if err != nil {
    panic(err)
}
fmt.Printf("IntCol=%s, StrCol=%s\n", intCol, strCol)
```

```
IntCol=27, StrCol=3 ^ 3
```

DML Execution

```
var timeInserted time.Time
_, err = db.Exec("insert into TestInsert values (:IntCol, :StrCol, sysdate) " +
                 "returning DateCol into :TimeInserted",
        sql.Named("IntCol", 1),
        sql.Named("StrCol", "Test String 1"),
        sql.Named("TimeInserted", sql.Out{Dest: &timeInserted}))
if err != nil {
    panic(err);
}
fmt.Printf("Time inserted was %v\n", timeInserted)
```

```
Time inserted was 2018-10-15 13:41:41 +0000 UTC
```

Transactions

```
tx, err := db.Begin()
if err != nil {
    panic(err);
}

for i := 0; i < 5; i++ {
    _, err = tx.Exec("insert into TestInsert values (:1, :2, :3)",
           i + 1, "Test String " + strconv.Itoa(i + 1), time.Now())
    if err != nil {
        panic(err);
    }
}

err = tx.Commit()
if err != nil {
    panic(err);
}
```

Concurrent DML

```
 1 func Insert100(db *sql.DB, startingNum int, c chan int) {
 2     tx, err := db.Begin()
 3     if err != nil {
 4         panic(err)
 5     }
 6     for i := 0; i < 100; i++ {
 7         val := startingNum + i
 8         _, err := tx.Exec("insert into TestInsert values (:1, :2, :3)",
 9                 val, "Test String " + strconv.Itoa(val), time.Now())
10         if err != nil {
11             panic(err)
12         }
13     }
14     err = tx.Commit()
15     if err != nil {
16         panic(err)
17     }
18     c <- 1
19 }
```

Concurrent DML (continued)

```
const numBatches = 5
c := make(chan int)
for i := 0; i < numBatches; i++ {
    go Insert100(db, i * 100 + 1, c)
}

for i := 0; i < numBatches; i++ {
    <- c
}
```

Oracle Database Support

Oracle Database Drivers

- https://github.com/rana/ora
  - Oldest driver (about four years old)
  - Development has mostly ceased
- https://github.com/mattn/go-oci8
  - Next oldest driver (about three years old)
  - Still active
- https://github.com/go-goracle/goracle
  - Youngest driver (about a year old)
  - Most active development

Bulk DML

```
const numRows = 500
intVals := make([]int, numRows)
strVals := make([]string, numRows)
dateVals := make([]time.Time, numRows)
for i := range intVals {
    intVals[i] = i + 1
    strVals[i] = "Test String " + strconv.Itoa(i + 1)
    dateVals[i] = time.Now()
}
_, err = db.Exec("insert into TestInsert values (:1, :2, :3)", intVals,
        strVals, dateVals)
if err != nil {
    panic(err);
}
```

PL/SQL Arrays (Package Header)

```
create or replace package pkg_TestArrays as

    type udt_NumberList is table of number index by binary_integer;
    type udt_StringList is table of varchar2(100) index by binary_integer;

    procedure TestArrays (
        a_NumElems              number,
        a_OutNums               out udt_NumberList,
        a_OutStrings            out udt_StringList
    );

end;
/
```

PL/SQL Arrays (Package Body)

```
create or replace package body pkg_TestArrays as

    procedure TestArrays (
        a_NumElems              number,
        a_OutNums               out udt_NumberList,
        a_OutStrings            out udt_StringList
    ) is
    begin
        for i in 1..a_NumElems loop
            a_OutNums(i) := i * i;
            a_OutStrings(i) := 'The square of ' || to_char(i);
        end loop;
    end;

end;
/
```

PL/SQL Arrays

```
import (
    "database/sql"
    goracle "gopkg.in/goracle.v2"
)

const numElems = 5
numArr := make([]int, numElems)
strArr := make([]string, numElems)
_, err = db.Exec("begin pkg_TestArrays.TestArrays(:1, :2, :3); end;",
        goracle.PlSQLArrays, numElems, sql.Out{Dest: &numArr},
        sql.Out{Dest: &strArr})
if err != nil {
    panic(err);
}
for i := range numArr {
    fmt.Printf("%v is %v\n", strArr[i], numArr[i])
}
```

```
The square of 1 is 1
The square of 2 is 4
The square of 3 is 9
The square of 4 is 16
The square of 5 is 25
```

LOBS

```
var intCol int
var clobCol interface{}
for rows.Next() {
    err := rows.Scan(&intCol, &clobCol)
    if err != nil {
        panic(err)
    }
    if clob, ok := clobCol.(*goracle.Lob); !ok {
        panic("Not a LOB!")
    } else {
        data, err := ioutil.ReadAll(clob)
        if err != nil {
            panic(err)
        }
        fmt.Printf("IntCol=%v, CLOBCol=%v bytes\n", intCol, len(data))
    }
}
```

Nested Cursors

```
ctx, _ := context.WithTimeout(context.Background(), 10 * time.Second)
rows, err := db.QueryContext(ctx, "select cursor(select * from TestQuery) from dual")
if err != nil {
    panic(err);
}
defer rows.Close()
for rows.Next() {
    var refCursor interface{}
    if err := rows.Scan(&refCursor); err != nil {
        panic(err);
    }
    cursor, err := goracle.WrapRows(ctx, db, refCursor.(driver.Rows))
    if err != nil {
        panic(err);
    }
    defer cursor.Close()
    for cursor.Next() {
        ...
```

Other Sessions: https://tinyurl.com/AppDevOOW18

- Getting Started with GraphQL APIs on Oracle Database with Node.js [DEV4879]
  - Tuesday, Oct 23, 11:30 am - 12:15 pm | Moscone West - Room 2012
- Python and Oracle Database on the Table [TIP4076]
  - Tuesday, Oct 23, 12:30 pm - 1:15 pm | Moscone West - Room 2007
- A Database Proxy for Transparent High Availability, Performance, Routing, and Security [TRN4070]
  - Wednesday, Oct 24, 11:15 am - 12:00 pm | Moscone West - Room 3009
- Meet the Experts: Node.js, Python, PHP, and Go with Oracle Database [MTE6765]
  - Wednesday, Oct 24, 3:00 pm - 3:50 pm | Moscone West - The Hub - Lounge B
- Performance and Scalability Techniques for Oracle Database Applications [TIP4075]
  - Thursday, Oct 25, 12:00 pm - 12:45 pm | Moscone West - Room 3009
- Demo Booth: APD-A03 Moscone South

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