Practical guide to testing Go services

Conf42 Golang

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Nikolay Kuznetsov

@nikolayk812

About me

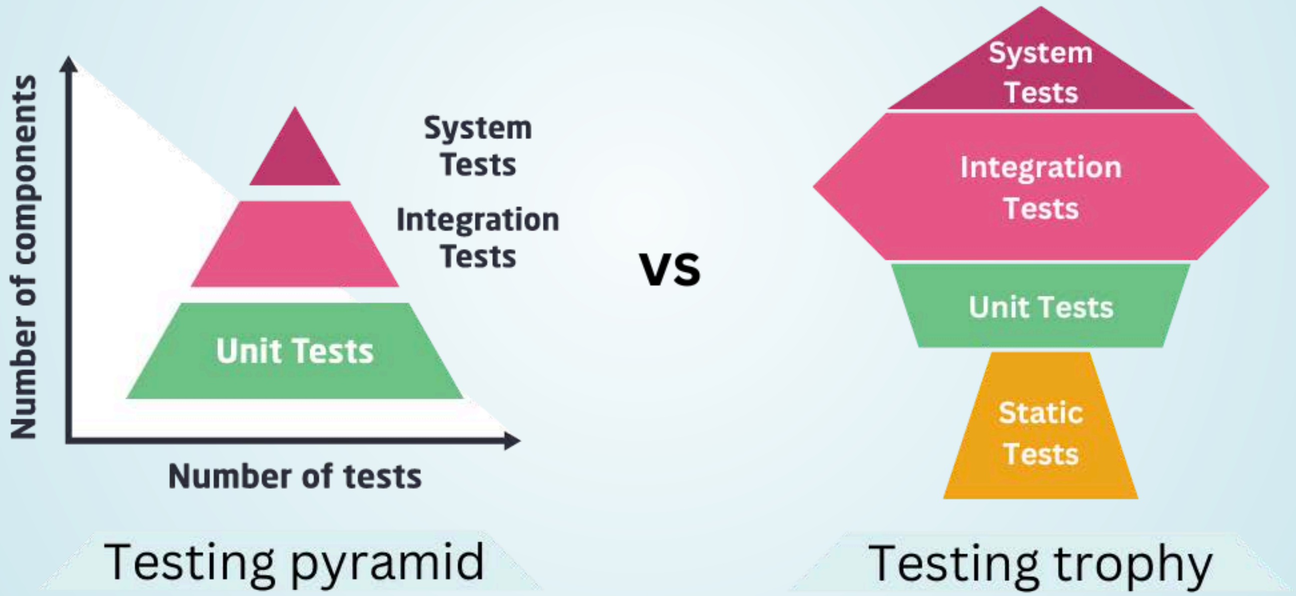
Senior software engineer

Pre-owned project at Zalando Helsinki

C → Java → Kotlin → Go

Author of pgx-outbox library

Pyramid vs trophy



https://symflower.com/en/company/blog/2023/what-is-the-testing-trophy/

Principles

Layer-by-layer testing

Table tests everywhere

Comprehensive comparison

Randomized test data

Service under test

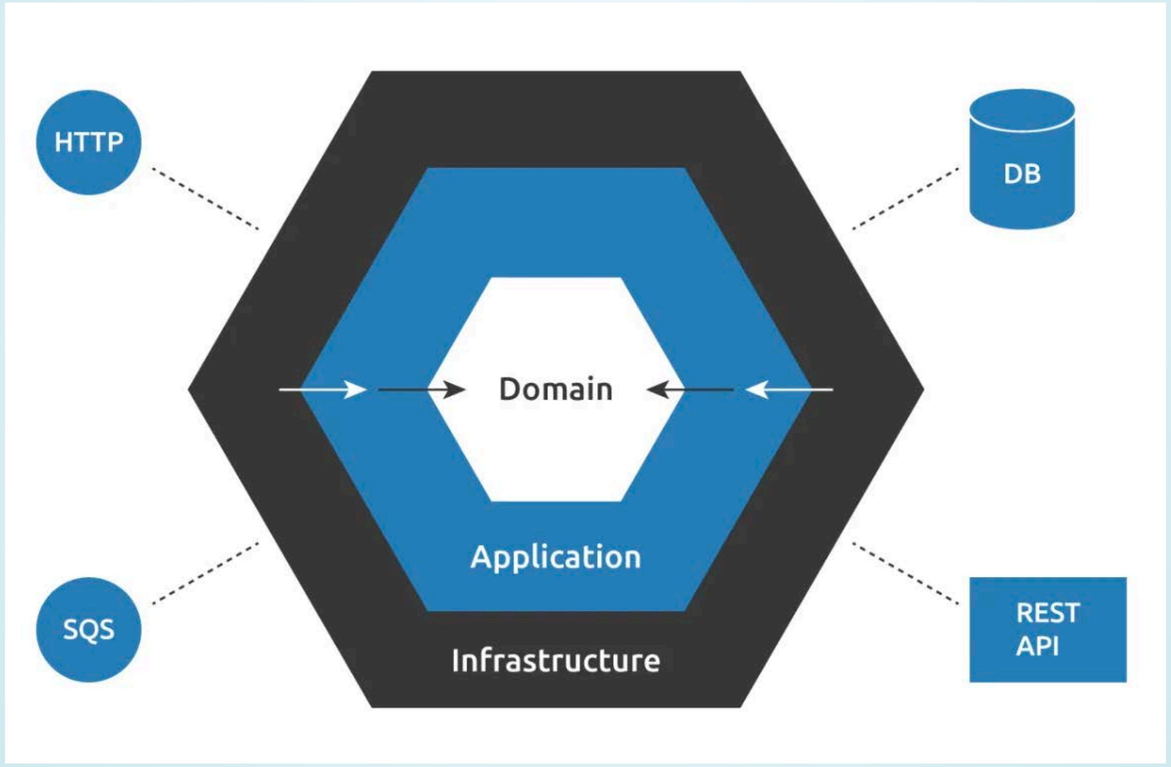
cart management of unique items

pgx driver for Postgres

gin framework for HTTP

hexagonal-like architecture

Hexagonal architecture



https://othercode.io/blog/hexagonal-architecture

Repository layer

test against a real database

production engine version

spin up containers from Go code:

testcontainers-go, *ory/dockertest*

Testcontainers modules

Postgres

Localstack

Kafka

Ollama

30+ more

Testcontainers

```go
import "github.com/testcontainers/testcontainers-go/modules/postgres"


pgContainer, err := postgres.Run(ctx, "postgres:17.4-alpine",
   postgres.BasicWaitStrategies(),
   postgres.WithInitScripts("migrations/01_cart_items.up.sql"),
)

//postgres://postgres:postgres@localhost:32847/postgres?sslmode=disable
connStr, err := pgContainer.ConnectionString(ctx, "sslmode=disable")
```

Containers lifecycle

Prefer ***stretchr/testify/suite*** over

- *TestMain*

- *sync.Once*

- per each test

Introduce suite

```go
import "github.com/stretchr/testify/suite"


type cartRepoSuite struct {
    suite.Suite

    container testcontainers.Container
}

// entry point to run all tests in the suite
func TestCartRepoSuite(t *testing.T) {
    suite.Run(t, new(cartRepoSuite))
}
```

Setup suite

```go
import "github.com/jackc/pgx/v5/pgxpool"


func (s *cartRepoSuite) SetupSuite() {
   s.container, connStr, err = startPostgres(ctx)
   suite.NoError(err)

   pool, err := pgxpool.New(ctx, connStr)
   repo := repository.New(pool)
}

func (s *cartRepoSuite) TearDownSuite() {
   suite.NoError(s.container.Terminate(ctx)) // helping Ryuk
}
```

Attach tests

```go
func (s *cartRepoSuite) TestAddItem() {
   // configure test cases
   for _, tt := range tests {
       suite.Run(tc.name, func() {
           t := suite.T()

           err := s.repo.AddItem(ctx, tt.ownerID, tt.item)
           require.NoError(t, err)

           // get actual cart

           assertCart(t, tt.expectedCart, actualCart) // using go-cmp
       })
   }}
```

go-cmp

semantic equality

more powerful than *reflect.DeepEqual*

customizable using options

not official Google product

Use *go-cmp*

```go
func assertCart(t *testing.T, expected, actual Cart) {
   // custom comparer for golang.org/x/text/currency
   comparer := cmp.Comparer(func(x, y currency.Unit) bool {
       return x.String() == y.String()
   })

   opts := cmp.Options{
       cmpopts.IgnoreFields(CartItem{}, "CreatedAt"),
       cmpopts.EquateEmpty(), // treat empty and nil slices equally
   }

   diff := cmp.Diff(expected, actual, comparer, opts)
   assert.Empty(t, diff)
}
```

Without comparer

```
=== RUN   TestCartRepositorySuite/TestAddItem/single_item:_ok
    options.go:256: test panicked: cannot handle unexported field at
    {Cart}.Items[0].Price.Currency.index:
    "golang.org/x/text/currency".Unit
    consider using cmpopts.EquateComparable
    to compare comparable Go types
```

Service layer

pure unit tests (if possible)

mock dependencies:

repository and other ports

Mocks in Go

vektra/mockery

uber-go/mock

matryer/moq

*golang/mock**

manual mocks

Mockery

mock generation from interfaces

testify/mock conventions, simple API

the most popular

Generate mocks

```go
//go:generate mockery --name=CartRepo --output=. --outpkg=repo
//      --structname=MockCartRepo --filename=cart_repo_mock.go
type CartRepo interface {
   GetCart(ctx, ownerID string) (Cart, error)
   AddItem(ctx, ownerID string, item CartItem) error
}
```

```
> go install github.com/vektra/mockery/v2@latest

> go generate ./...
```

Configure mocks

```go
tests := []struct {
   name      string
   mockSetup func(repo *MockCartRepo) // new field
}{
   {
      name: "happy case",
      mockSetup: func(repo *MockCartRepo) {
         repo.On("AddItem",
            mock.Anything, mock.AnythingOfType("string"), cartItem).
            Return(nil)
      },
   },
}
```

Use mocks

```go
t.Run(tt.name, func(t *testing.T) {
   mockRepo := new(MockCartRepo)

   if tt.mockSetup != nil {
       tt.mockSetup(mockRepo)
   }

   cartService, err := service.NewCart(mockRepo)
   require.NoError(t, err)

   // test cartService

   mockRepo.AssertExpectations(t)
}
```

Data for tests

brianvoe/gofakeit

jaswdr/faker

go-testfixtures

hardcoded

gofakeit

```go
import (
   "github.com/brianvoe/gofakeit"
   "github.com/google/uuid"
   "github.com/shopspring/decimal"
)

func fakeCartItem() CartItem {
   return CartItem{
       ProductID: uuid.MustParse(gofakeit.UUID()),
       Price: Money{
           Amount:   decimal.NewFromFloat(gofakeit.Price(1, 100)),
           Currency: currency.MustParseISO(gofakeit.CurrencyShort()),
       },
   }
}
```

HTTP layer

mock service layer

handler, router tests with *httptest*

also *gavv/httpexpect*, *steinfletcher/apitest*

Gin handler

```go
import "github.com/gin-gonic/gin"

type CartHandler struct {
   service service.CartService
}

func (h *CartHandler) GetCart(c *gin.Context) {
   c.JSON(http.StatusOK, cartDTO)
}


t.Run(tt.name, func(t *testing.T) {
   handler, err := rest.NewCart(mockService)
   require.NoError(t, err)
```

Invoke handler

```go
recorder := httptest.NewRecorder()

ginContext, _ := gin.CreateTestContext(recorder)
ginContext.Params = gin.Params{gin.Param{
                           Key: "owner_id", Value: tt.ownerID}}

req, err := http.NewRequest(http.MethodGet, "any_path", nil)
ginContext.Request = req

// func (h *cartHandler) GetCart(c *gin.Context)
handler.GetCart(c)
```

Assert from recorder

```go
handler.GetCart(c)

assert.Equal(t, tt.wantStatus, recorder.Code)

if tt.wantStatus == http.StatusOK {
   var actualCart dto.Cart
   err := json.Unmarshal(recorder.Body.Bytes(), &actualCart)
   require.NoError(t, err)

   assertEqualCart(t, tt.wantCart, actualCart)
}
```

Router vs handler tests

Characteristic	Handler	Router
Primary Focus	Handler logic	Routing mechanics
Key Validation	Input processing Service interactions Error handling Edge cases	Route matching Parameter extraction Middleware application Happy path
Test Depth	Deep, comprehensive	Shallow, broad coverage

Router test case

```
{
   name:    "GetCart",
   method: http.MethodGet,
   url:    "/carts/" + owner1,
   mockFunc: func() {
       mockService.On("GetCart", mock.Anything, owner1).
           Return(cart1, nil)
   },
   statusCode: http.StatusOK,
},
```

Router test

```go
t.Run(tt.name, func(t *testing.T) {
   w := httptest.NewRecorder()

   req, err := http.NewRequest(tt.method, tt.url, tt.bodyBytes)
   req.Header.Set("Content-Type", "application/json")

   router.ServeHTTP(w, req)

   assert.Equal(t, tt.statusCode, w.Code)
}
```

Coverage report

```
> go test ./... -v -coverprofile=coverage.out -race

> go tool cover -html=coverage.out -o coverage.html

> open coverage.html
```

```
- name: Upload coverage to Coveralls
  uses: coverallsapp/github-action@v2
  with:
    github-token: ${{ secrets.COVERALLS_TOKEN }}
    path-to-lcov: coverage.out
```

Misc

pact-go: contract testing

testifylint: linter for testify

smoke+ testing in test clusters

Takeaways

Layer	**Tools**
All	*testify/assert+require*, *go-cmp*, *brianvoe/gofakeit*
Repository	*testcontainers-go*, *testify/suite*, *uber-go/goleak*
Service	*vektra/mockery*, *testify/mock*
HTTP	*httptest+*, *vektra/mockery*, *testify/mock*

Thank you and happy testing!

github.com/nikolayk812/go-tests