Umetanje zavisnosti - *Dependency Injection*

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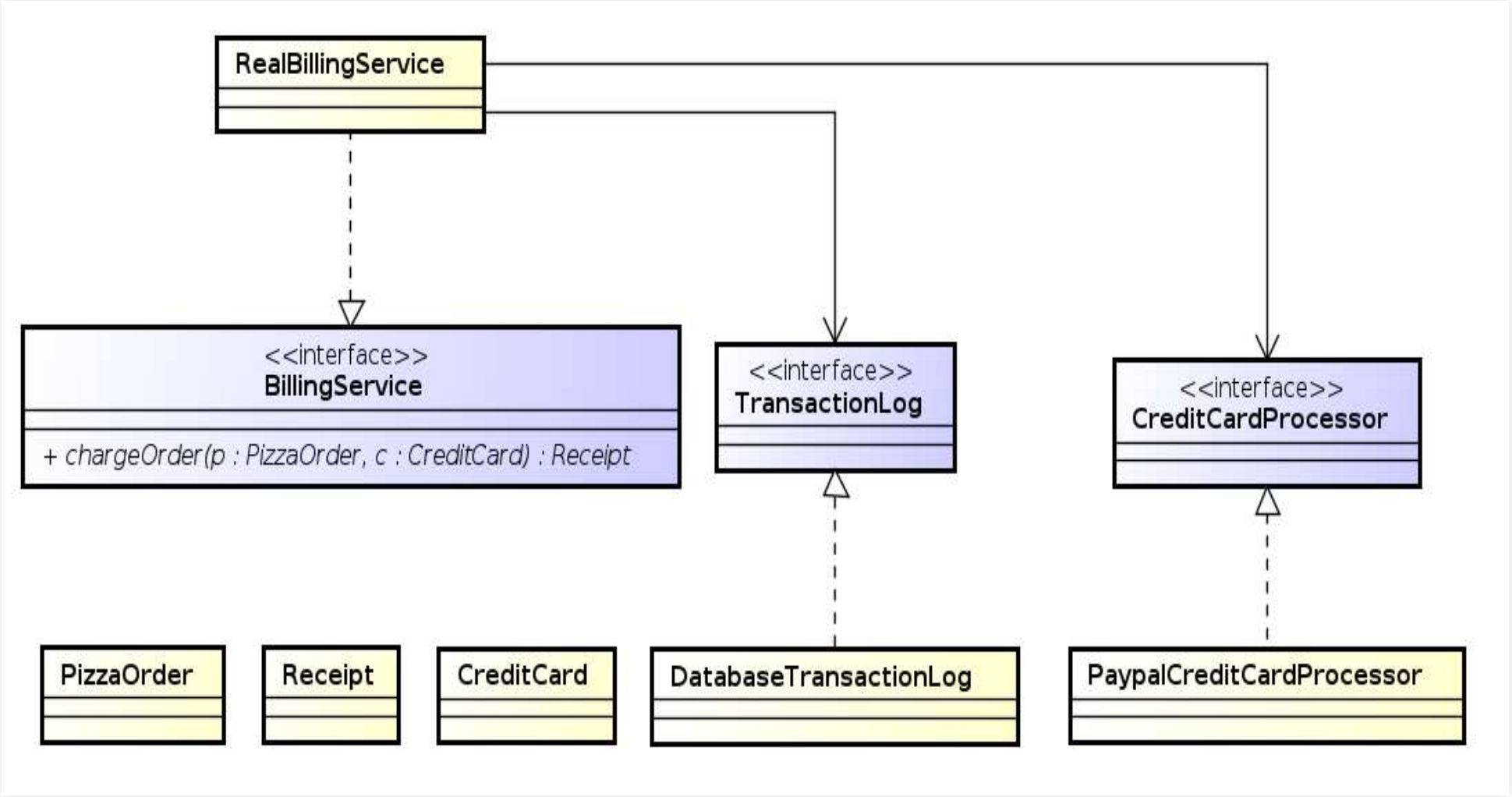
Sadržaj

Motivacija

Motivacija

- Objekti iole složenijih aplikacija formiraju složene grafove zavisnosti.
- Kako objekat "dobija" reference na zavisne objekte?

Motivacija


RealBillingService
<<interface>>
BillingService
+ chargeOrder(p : PizzaOrder, c : CreditCard) : Receipt
<<interface>>
TransactionLog
<<interface>>
CreditCardProcessor
PizzaOrder
Receipt
CreditCard
DatabaseTransactionLog
PaypalCreditCardProcessor

Klasičan pristup dobavljanja referenci

```
public class RealBillingService implements BillingService {

  @Override
  public Receipt chargeOrder(PizzaOrder order, CreditCard creditCard) {
      CreditCardProcessor processor = new PaypalCreditCardProcessor();
      TransactionLog transactionLog = new DatabaseTransactionLog();

      try {
        ChargeResult result = processor.charge(creditCard, order.getAmount());
        transactionLog.logChargeResult(result);

        return result.wasSuccessful()
            ? Receipt.forSuccessfulCharge(order.getAmount())
            : Receipt.forDeclinedCharge(result.getDeclineMessage());
       } catch (UnreachableException e) {
        transactionLog.logConnectException(e);
        return Receipt.forSystemFailure(e.getMessage());
      }
  }
}
```

Upotreba *Singleton/Factory* obrasca

Objekat se sam brine o dobavljanju referenci ali to čini posredstvom globalne deljene reference.

```
public class RealBillingService implements BillingService {

  public Receipt chargeOrder(PizzaOrder order, CreditCard creditCard) {
    CreditCardProcessor processor = CreditCardProcessorFactory.getInstance();
    TransactionLog transactionLog = TransactionLogFactory.getInstance();

    try {
      ChargeResult result = processor.charge(creditCard, order.getAmount());
      transactionLog.logChargeResult(result);

      return result.wasSuccessful() ?
            Receipt.forSuccessfulCharge(order.getAmount()) :
            Receipt.forDeclinedCharge(result.getDeclineMessage());
    } catch (UnreachableException e) {
      transactionLog.logConnectException(e);
      return Receipt.forSystemFailure(e.getMessage());
    }
  }
}
```

Singleton/Factory - testiranje

```
public class RealBillingServiceTest extends TestCase {

  private final PizzaOrder order = new PizzaOrder(100);
  private final CreditCard creditCard = new CreditCard(5000);
  private final InMemoryTransactionLog transactionLog = new InMemoryTransactionLog();
  private final FakeCreditCardProcessor creditCardProcessor = new FakeCreditCardProcessor();

  @Override
  public void setUp() {
    TransactionLogFactory.setInstance(transactionLog);
    CreditCardProcessorFactory.setInstance(creditCardProcessor);
  }

  @Override
  public void tearDown() {
    TransactionLogFactory.setInstance(null);
    CreditCardProcessorFactory.setInstance(null);
  }

  public void testSuccessfulCharge() {
    RealBillingService billingService = new RealBillingService();
    Receipt receipt = billingService.chargeOrder(order, creditCard);

    assertTrue(receipt.hasSuccessfulCharge());
    assertEquals(100.0, receipt.getAmount(), 0.001);
    assertEquals(creditCard, creditCardProcessor.getCardOfOnlyCharge());
    assertEquals(100.0, creditCardProcessor.getAmountOfOnlyCharge(), 0.001);
    assertTrue(transactionLog.wasSuccessLogged());
  }
}
```

Upotreba *Singleton/Factory* obrasca - problemi

- Deljena referenca - moramo posebno da pazimo da je postavljamo na prave vrednosti.
- Nemoguće paralelizovati testove.

Dependency Injection

Umetanje zavisnosti - *Dependency Injection*

- Izmeštanje nadležnosti za dobavljanje referenci van objekta - neko drugi će se brinuti da "umetne" reference pre njihove upotrebe.
- Prednosti:
  - Kod se pojednostavljuje. Zavisnost između klasa je bazirana na apstraktnim interfejsima što pozitivno utiče na održavanje (*maintability*), ponovnu iskoristljivost (*reusability*) i podelu posla i nadležnosti.
  - Objekat će do trenutka poziva njegovih servisnih metoda već biti na odgovarajući način inicijalizovan. Smanjuje se tzv. *boilerplate* kod.
  - Testiranje je daleko jednostavnije. Kreiranje "lažnih" objekata (*mockup*) je moguće i jednostavno se izvodi. Moguća paralelizacija testova.

Mehanizmi umetanja zavisnosti

- Putem parametara konstruktora.
- Putem mutator metoda (*setters*).
- Putem implementiranog interfejsa.

Injekcija putem parametara konstruktora

```
Client(Service service) {
    this.service = service;
}
```

- Wikipedia: Dependency Injection

Injekcija putem *setter* metoda

```
public void setService(Service service) {
    this.service = service;
}
```

- Wikipedia: Dependency Injection

Injekcija putem interfejsa

```
public interface ServiceSetter {
    public void setService(Service service);
}
public class client implements ServiceSetter {

    private Service service;

    @Override
    public void setService(Service service) {
        this.service = service;
    }
}
```

- Wikipedia: Dependency Injection

Upotreba DI

```
public class RealBillingService implements BillingService {
  private final CreditCardProcessor processor;
  private final TransactionLog transactionLog;

  public RealBillingService(CreditCardProcessor processor,
      TransactionLog transactionLog) {
    this.processor = processor;
    this.transactionLog = transactionLog;
  }

  public Receipt chargeOrder(PizzaOrder order, CreditCard creditCard) {
    try {
      ChargeResult result = processor.charge(creditCard, order.getAmount());
      transactionLog.logChargeResult(result);

      return result.wasSuccessful() ?
           Receipt.forSuccessfulCharge(order.getAmount()) :
           Receipt.forDeclinedCharge(result.getDeclineMessage());
    } catch (UnreachableException e) {
      transactionLog.logConnectException(e);
      return Receipt.forSystemFailure(e.getMessage());
    }
  }
}
```

Upotreba DI - testiranje

```
public class RealBillingServiceTest extends TestCase {

  private final PizzaOrder order = new PizzaOrder(100);
  private final CreditCard creditCard = new CreditCard(5000);

  private final InMemoryTransactionLog transactionLog =
                                          new InMemoryTransactionLog();
  private final FakeCreditCardProcessor creditCardProcessor =
                                          new FakeCreditCardProcessor();

  public void testSuccessfulCharge() {
    RealBillingService billingService = new RealBillingService(
        creditCardProcessor, transactionLog);
    Receipt receipt = billingService.chargeOrder(order, creditCard);

    assertTrue(receipt.hasSuccessfulCharge());
    assertEquals(100.0, receipt.getAmount(), 0.001);
    assertEquals(creditCard, creditCardProcessor.getCardOfOnlyCharge());
    assertEquals(100.0, creditCardProcessor.getAmountOfOnlyCharge(), 0.001);
    assertTrue(transactionLog.wasSuccessLogged());
  }
}
```

DI kontejneri

- DI se može implementirati i bez posebnog alata/okvira.
- DI kontejneri omogućavaju nametanje određenih konvencija za primenu ovog obrasca.
- Korišćenje DI kontejera donosi određene prednosti:
  - Upotreba najbolje prakse
  - Standardizacija

DI kontejneri za Javu

- Google Guice
- PicoContainer
- Spring
- …

Standardizacija za programski jezik Java

- JSR-330[1]
- Definiše skup standardnih Java anotacija za DI:
  - `Provider<T>` - Provides instances of T
  - `Inject` - Identifies injectable constructors, methods, and fields.
  - `Named` - String-based qualifier.
  - `Qualifier` - Identifies qualifier annotations.
  - `Scope` - Identifies scope annotations.
  - `Singleton` - Identifies a type that the injector only instantiates once.

1. https://code.google.com/p/atinject/

Google Guice

Google Guice

- *Lightweight* okvir za DI u Javi.
- Razvijen od strane Google-a.
- Konfiguracija bazirana na Java anotacijama.

Injekcija putem konstruktora

```
public class RealBillingService implements BillingService {
  private final CreditCardProcessor processor;
  private final TransactionLog transactionLog;

  @Inject
  public RealBillingService(CreditCardProcessor processor,
      TransactionLog transactionLog) {
    this.processor = processor;
    this.transactionLog = transactionLog;
  }

  public Receipt chargeOrder(PizzaOrder order, CreditCard creditCard) {
    try {
      ChargeResult result = processor.charge(creditCard, order.getAmount());
      transactionLog.logChargeResult(result);

      return result.wasSuccessful()
          ? Receipt.forSuccessfulCharge(order.getAmount())
          : Receipt.forDeclinedCharge(result.getDeclineMessage());
     } catch (UnreachableException e) {
      transactionLog.logConnectException(e);
      return Receipt.forSystemFailure(e.getMessage());
    }
  }
}
```

Konfiguracija za povezivanje - *binding/wiring*

```
public class BillingModule extends AbstractModule {
  @Override
  protected void configure() {
    bind(TransactionLog.class).to(DatabaseTransactionLog.class);
    bind(CreditCardProcessor.class).to(PaypalCreditCardProcessor.class);
    bind(BillingService.class).to(RealBillingService.class);
  }
}
```

Upotreba kontejnera

```
public static void main(String[] args) {
  Injector injector = Guice.createInjector(new BillingModule());
  BillingService billingService = injector.getInstance(BillingService.class);
  Receipt result = billingService.chargeOrder(new PizzaOrder(100),
                                              new CreditCard(500));
  System.out.println(result.hasSuccessfulCharge());
}
```

Linked Bindings

```
public class BillingModule extends AbstractModule {
  @Override
  protected void configure() {
    bind(TransactionLog.class).to(DatabaseTransactionLog.class);
    bind(DatabaseTransactionLog.class).to(MySqlDatabaseTransactionLog.class);
  }
}
```

Custom Bindings Annotations

```
package example.pizza;
import com.google.inject.BindingAnnotation;
import java.lang.annotation.Target;
import java.lang.annotation.Retention;
import static java.lang.annotation.RetentionPolicy.RUNTIME;
import static java.lang.annotation.ElementType.PARAMETER;
import static java.lang.annotation.ElementType.FIELD;
import static java.lang.annotation.ElementType.METHOD;

@BindingAnnotation @Target({ FIELD, PARAMETER, METHOD }) @Retention(RUNTIME)
public @interface PayPal {}
...
public class RealBillingService implements BillingService {

  @Inject
  public RealBillingService(@PayPal CreditCardProcessor processor,
      TransactionLog transactionLog) {
    ...
  }
...
    bind(CreditCardProcessor.class)
        .annotatedWith(PayPal.class)
        .to(PayPalCreditCardProcessor.class);
```

@Named Binding Annotation

```
public class RealBillingService implements BillingService {

  @Inject
  public RealBillingService(@Named("Checkout") CreditCardProcessor processor,
      TransactionLog transactionLog) {
    ...
  }
 ...
 ...
    bind(CreditCardProcessor.class)
        .annotatedWith(Names.named("Checkout"))
        .to(CheckoutCreditCardProcessor.class);
```

Instance Bindings

```
bind(String.class)
    .annotatedWith(Names.named("JDBC URL"))
    .toInstance("jdbc:mysql://localhost/pizza");
bind(Integer.class)
    .annotatedWith(Names.named("login timeout seconds"))
    .toInstance(10);
```

@Provides Methods

```
public class BillingModule extends AbstractModule {
  @Override
  protected void configure() {
    ...
  }

  @Provides
  TransactionLog provideTransactionLog() {
    DatabaseTransactionLog transactionLog = new DatabaseTransactionLog();
    transactionLog.setJdbcUrl("jdbc:mysql://localhost/pizza");
    transactionLog.setThreadPoolSize(30);
    return transactionLog;
  }
}
...
  @Provides @PayPal
  CreditCardProcessor providePayPalCreditCardProcessor(
      @Named("PayPal API key") String apiKey) {
    PayPalCreditCardProcessor processor = new PayPalCreditCardProcessor();
    processor.setApiKey(apiKey);
    return processor;
  }
```

Provider Bindings

```
public class DatabaseTransactionLogProvider
      implements Provider<TransactionLog> {
  private final Connection connection;

  @Inject
  public DatabaseTransactionLogProvider(Connection connection) {
    this.connection = connection;
  }

  public TransactionLog get() {
    DatabaseTransactionLog transactionLog = new DatabaseTransactionLog();
    transactionLog.setConnection(connection);
    return transactionLog;
  }
}
...
public class BillingModule extends AbstractModule {
  @Override
  protected void configure() {
    bind(TransactionLog.class)
        .toProvider(DatabaseTransactionLogProvider.class);
  }
}
```

Scopes

```
@Singleton
public class InMemoryTransactionLog implements TransactionLog {
  /* everything here should be threadsafe! */
}
...
bind(TransactionLog.class)
  .to(InMemoryTransactionLog.class).in(Singleton.class);
...
@Provides @Singleton
TransactionLog provideTransactionLog() {
  ...
}
...
bind(Bar.class).to(Applebees.class).in(Singleton.class);
bind(Grill.class).to(Applebees.class).in(Singleton.class);
```

Injector

Injector

- https://github.com/alecthomas/injector
- Python biblioteka za DI modelovana prema *Google Guice* ali sa *Pythonic API*.

Jednostavan primer

```
>>> from injector import Injector, inject
>>> class Inner(object):
...     def __init__(self):
...         self.forty_two = 42
...
>>> class Outer(object):
...     @inject
...     def __init__(self, inner: Inner):
...         self.inner = inner
...
>>> injector = Injector()
>>> outer = injector.get(Outer)
>>> outer.inner.forty_two
42
```

- Python type hints - https://docs.python.org/3/library/typing.html

Složeniji primer

```
from injector import Key
Name = Key('name')
Description = Key('description')
```

```
from injector import inject, provider, Module

class User(object):
    @inject
    def __init__(self, name: Name, description: Description):
        self.name = name
        self.description = description


class UserModule(Module):
    def configure(self, binder):
       binder.bind(User)


class UserAttributeModule(Module):
    def configure(self, binder):
        binder.bind(Name, to='Sherlock')

    @provider
    def describe(self, name: Name) -> Description:
        return '%s is a man of astounding insight' % name
```

http://injector.readthedocs.io/en/latest/terminology.html#injection

Složeniji primer

```
from injector import Injector
injector = Injector([UserModule(), UserAttributeModule()])
```

ili

```
injector = Injector([UserModule, UserAttributeModule])
```

Upotreba:

```
>>> injector.get(Name)
'Sherlock'
>>> injector.get(Description)
'Sherlock is a man of astounding insight'
```

```
>>> user = injector.get(User)
>>> isinstance(user, User)
True
>>> user.name
'Sherlock'
>>> user.description
'Sherlock is a man of astounding insight'
```

Flask injector

Flask injector

- Veza između `injector` biblioteke i `Flask` okvira za razvoj.

Primer upotrebe

```
import sqlite3
from flask import Flask, Config
from flask.views import View
from flask_injector import FlaskInjector
from injector import inject

app = Flask(__name__)

@app.route("/bar")
def bar():
    return render("bar.html")

@app.route("/foo")
@inject(db=sqlite3.Connection)
def foo(db):
    users = db.execute('SELECT * FROM users').all()
    return render("foo.html")

def configure(binder):
    binder.bind(
        sqlite3.Connection,
        to=sqlite3.Connection(':memory:'),
        scope=request,
    )

FlaskInjector(app=app, modules=[configure])

app.run()
```

Reference

- Dependency Injection on Wikipedia
- Martin Fowler, Inversion of Control Containers and the Dependency Injection pattern, January 2004.
- Google Guice Wiki
- `Injector` dokumentacija
- `Flask Injector` projekat