Material and some slide content from:
- Krzysztof Czarnecki
- Ian Sommerville
- Head First Design Patterns

Dependency Injection & Design Principles Recap

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SOLID (Dependency Inversion)

Program to **interfaces** not to **implementations**.

Dependency Inversion

(also called inversion of control)

- Common problem: ‘how can we wire these interfaces together without creating a dependency on their concrete implementations?’
  - This often challenges the ‘program to interfaces, not implementations ’ design principle
    - Would like to reduce (eliminate) coupling between concrete classes
  - Would like to be able to substitute different implementations without recompiling
    - e.g., be able to test and deploy the same binary even though some objects may vary
  - Solution: separate objects from their assemblers

Example Overview

Simple Pizza BillingService API

```
public interface IBillingService {

  /**
   * Attempts to charge the order to the credit card. Both successful and
   * failed transactions will be recorded.
   *
   * @return a receipt of the transaction. If the charge was successful, the
   *      receipt will be successful. Otherwise, the receipt will contain a
   *      decline note describing why the charge failed.
   */
  Receipt chargeOrder(PizzaOrder order, CreditCard creditCard);
}
```

[Example from: https://code.google.com/p/google-guice/wiki/Motivation]

Example Overview

Charging orders requires a CCProcessor and a TransactionLog

```
public class RealBillingService implements IBillingService {
  public Receipt chargeOrder(PizzaOrder order, CreditCard creditCard) {

    ICreditCardProcessor processor = new PaypalCreditCardProcessor();
    ITransactionLog transactionLog = new DatabaseTransactionLog();

    …
    }
  }
}
```

BillingService is dependent on the concrete implementations of the processor/log classes rather than their interfaces

Example Overview

Can't test without actually processing the CC data

```
public class RealBillingServiceTest extends TestCase {

  private final PizzaOrder order = new PizzaOrder(100);
  private final CreditCard creditCard = new CreditCard("1234", 11, 2010);


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

    assertTrue(…);
 }
}
```

Could test with invalid data, but that would not test the success case.

Factory Fix

```
public class CreditCardProcessorFactory {

  private static ICreditCardProcessor instance;

  public static void setInstance(ICreditCardProcessor creditCardProcessor) {
    instance = creditCardProcessor;
  }

  public static CreditCardProcessor getInstance() {
    if (instance == null) {
      return new SquareCreditCardProcessor();
    }

    return instance;
  }
}
```

Factories provide one way to encapsulate object instantiation

Factory Fix

```
public class RealBillingService implements IBillingService {
  public Receipt chargeOrder(PizzaOrder order, CreditCard creditCard) {

    ICreditCardProcessor processor = CreditCardProcessorFactory.getInstance();
    ITransactionLog transactionLog = TransactionLogFactory.getInstance();

    …
  }
}
```

Instead of depending on the concrete classes, BillingService relies on the factory to instantiate them.

Factory Fix

This enables mock implementations to be returned for testing.

```
public class RealBillingServiceTest extends TestCase {

  private final PizzaOrder order = new PizzaOrder(100);
  private final CreditCard creditCard = new CreditCard("1234", 11, 2010);

  private final MemoryTransactionLog transactionLog = new MemoryTransactionLog();
  private final FakeCCPro creditCardProcessor = new FakeCCPro();

  @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(…);
 }
}
```

Factories work, but from the BillingService APIs alone, it is impossible to see the CC/Log dependencies.

DI Goal

- Eliminate initialization statements. e.g.,
  - Foo f = new ConcreteFoo();
- In dependency injection a third party (an injector)
- At a high level dependency injection:
  - **Takes** a set of components (classes + interfaces)
  - **Adds** a set of configuration metadata
  - **Provides** the metadata to an injection framework
  - **Bootstraps** object creation with a configured injector

Dependency Injection

```
public class RealBillingService implements IBillingService {
  private final ICreditCardProcessor processor;
  private final ITransactionLog transactionLog;

  public RealBillingService(ICreditCardProcessor processor,
      ITransactionLog transactionLog) {
    this.processor = processor;
    this.transactionLog = transactionLog;
  }

  public Receipt chargeOrder(PizzaOrder order, CreditCard creditCard) {
  …
 }
}
```

We can hoist the dependencies into the API to make them transparent.

Dependency Injection

```
public class RealBillingServiceTest extends TestCase {

  private final PizzaOrder order = new PizzaOrder(100);
  private final CreditCard creditCard = new CreditCard("1234", 11, 2010);

  private final MemoryTransactionLog transactionLog = new MemoryTransactionLog();
  private final FakeCCProcessor creditCardProcessor = new FakeCCProcessor();

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

    assertTrue(...);
  }
}
```

This also enables unit test mocking, but as in the initial example, pushes the object instantiations throughout the code.

Guice Injection

Google Guice is a common IoC framework for alleviating some of the boiler plate code associated with this pattern.

```
public class BillingModule extends AbstractModule {
  @Override
  protected void configure() {
    bind(ITransactionLog.class).to(DatabaseTransactionLog.class);
    bind(ICreditCardProcessor.class).to(PaypalCreditCardProcessor.class);
    bind(IBillingService.class).to(RealBillingService.class);
  }
}
```

Here, the types of classes to their concrete implementations. Guice automatically instantiates the objects as required.

Guice Injection

Deployment Module:

```
public class BillingModule extends AbstractModule {
  @Override
  protected void configure() {
    bind(ITransactionLog.class).to(DatabaseTransactionLog.class);
    bind(ICreditCardProcessor.class).to(PaypalCreditCardProcessor.class);
    bind(IBillingService.class).to(RealBillingService.class);
  }
}
```

Testing Module:

```
public class MockBillingModule extends AbstractModule {
  @Override
  protected void configure() {
    bind(ITransactionLog.class).to(MockTransactionLog.class);
    bind(ICreditCardProcessor.class).to(MockCreditCardProcessor.class);
    bind(IBillingService.class).to(RealBillingService.class);
  }
}
```

Guice Injection

```
public class RealBillingService implements IBillingService {
  private final ICreditCardProcessor processor;
  private final ITransactionLog transactionLog;

  @Inject
  public RealBillingService(ICreditCardProcessor processor,
      ITransactionLog transactionLog) {
    this.processor = processor;
    this.transactionLog = transactionLog;
  }

  public Receipt chargeOrder(PizzaOrder order, CreditCard creditCard) {
    …
 }
}
```

@Inject tells Guice to automatically instantiate the correct CC/Log objects. The module will determine what gets injected.

Guice Injection

Guice modules need to be configured with the configuration of the system they are injecting for.

Deployment:

```
public static void main(String[] args) {
    Injector injector = Guice.createInjector(new BillingModule());
    IBillingService billingService = injector.getInstance(IBillingService.class);
    ...
  }
```

Test:

```
public class RealBillingServiceTest extends TestCase {

  private final PizzaOrder order = new PizzaOrder(100);
  private final CreditCard creditCard = new CreditCard("1234", 11, 2010);

  @BeforeClass
  public final void guiceSetup() {
      Guice.createInjector( new MockBillingModule()).injectMembers(this);
  }

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

    assertTrue(...);
  }
}
```

SOLID
review

SOLID (Single Responsibility)

Classes should do one thing and do it well.

SOLID (Single Responsibility)

- Strategy (small, targeted, algorithms)
- Command (invokers should be oblivious to actions)
- Visitor (usually accomplish specific tasks)
- State XXX (centralize 3rd party complexity)
- Proxy (Enable RealSubject to focus on functionality)

SOLID (Open/Close)

Classes should be open to **extension** and closed to **modification**.

SOLID (Open/Close)

Which design patterns support the open/close principle?

(These patterns are a subset of those patterns that help with *encapsulating what varies*. E.g., the ‘extension’ part is often expected to change.)

SOLID (Open/Close)

- Observer (extend set of observers)
  - w/o changing subject behaviour
- Strategy (extend algorithm suite)
  - w/o changing context or other algorithms
- State (specialize runtime behaviour)
  - w/o changing context or other behaviours
- Command (extend command suite)
  - w/o changing invoker
- Visitor (extend model analysis)
  - w/o changing data structure, traversal code, other visitors
- Decorator (extend object through composition)
  - w/o changing base classes
- Composite (extend component)
  - w/o changing clients / composites using any component

SOLID (Liskov substitution)

Most design patterns break down if LSP is violated.

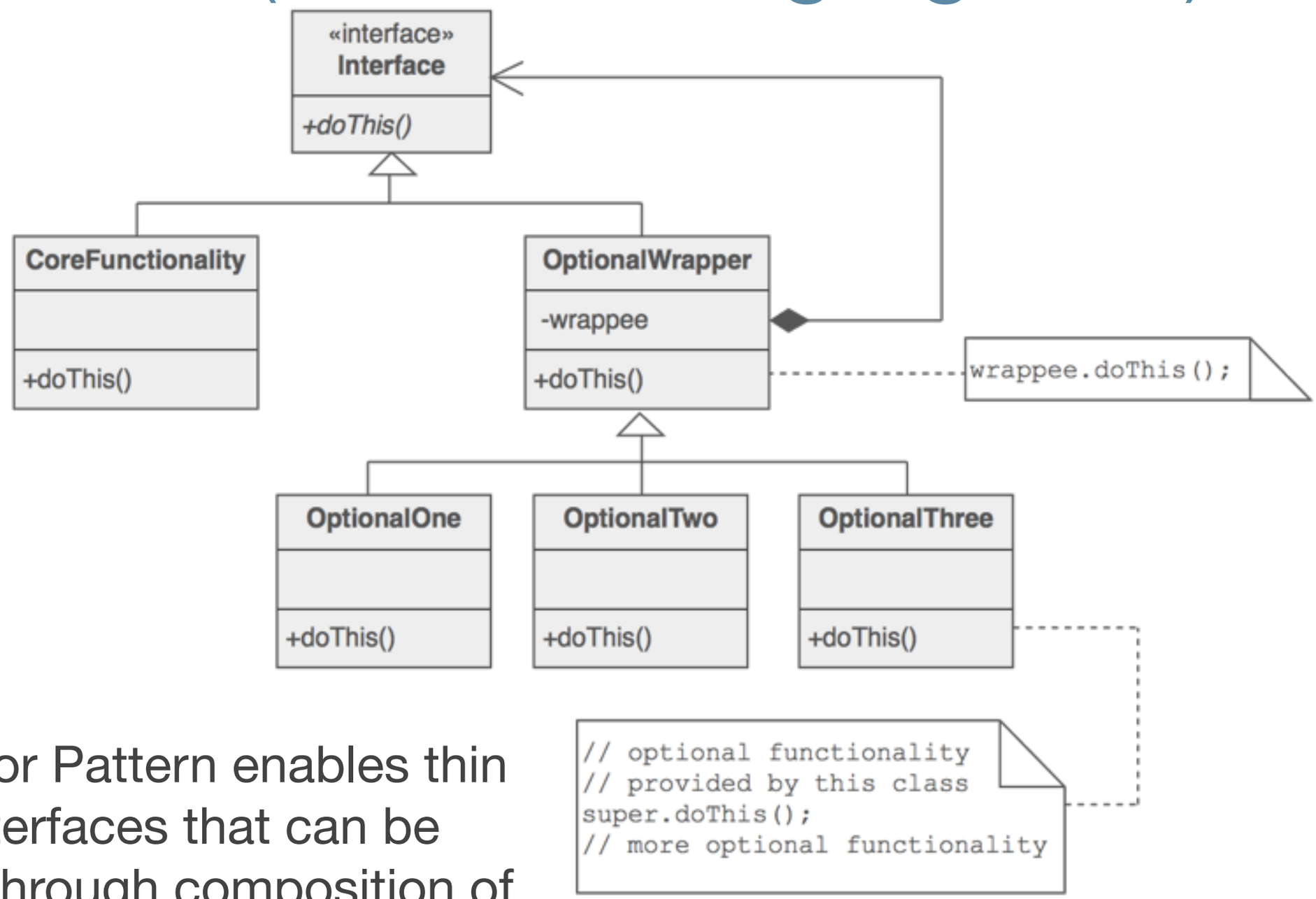
(Most design patterns are enabled through a layer of abstraction, typically provided through inheritance. When subtypes violate LSP inconsistencies can occur at runtime.)

SOLID (Interface segregation)

Clients should not be forced to **depend** on **interfaces** they do not use.

(Depending on irrelevant interfaces causes needless coupling. This causes classes to change even when interfaces they do not care about are modified.)

SOLID (Interface segregation)



The Decorator Pattern enables thin high-level interfaces that can be augmented through composition of concrete Decorators.

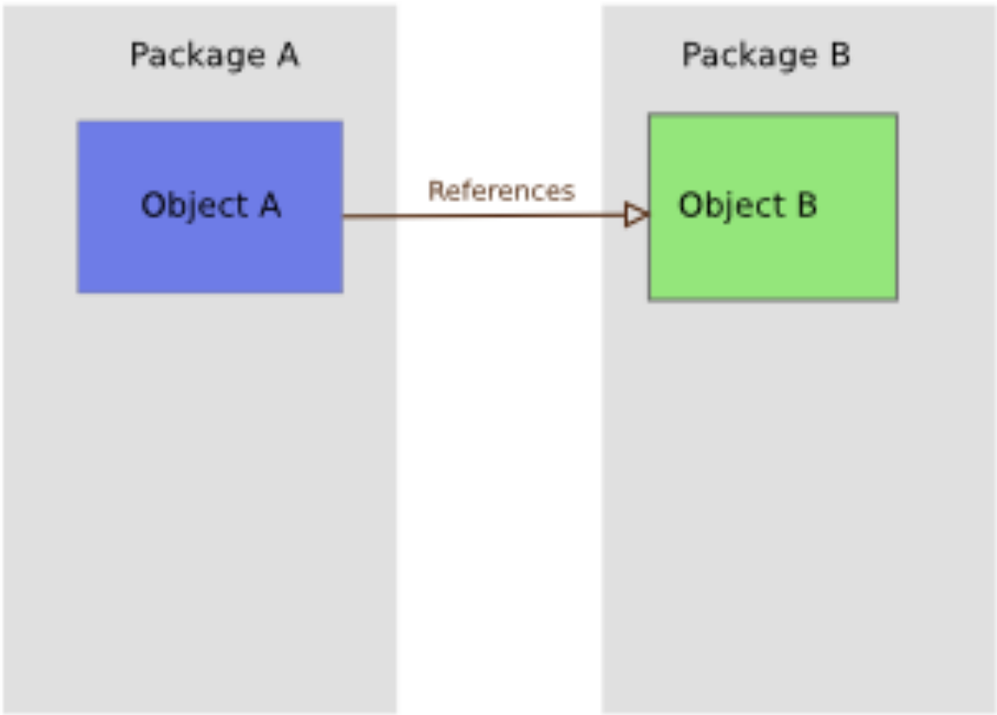
SOLI**D** (Dependency inversion)

Depend on **abstractions** not **implementations**.

(High-level modules should not depend on low-level modules; instead, they should depend on abstractions.)

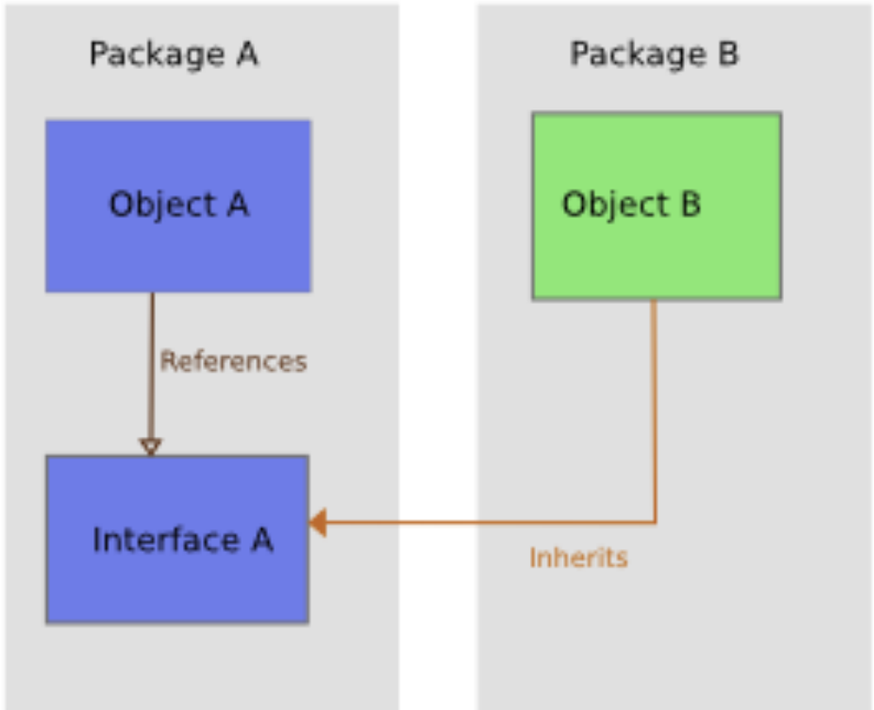
SOLID (Dependency inversion)

From this:



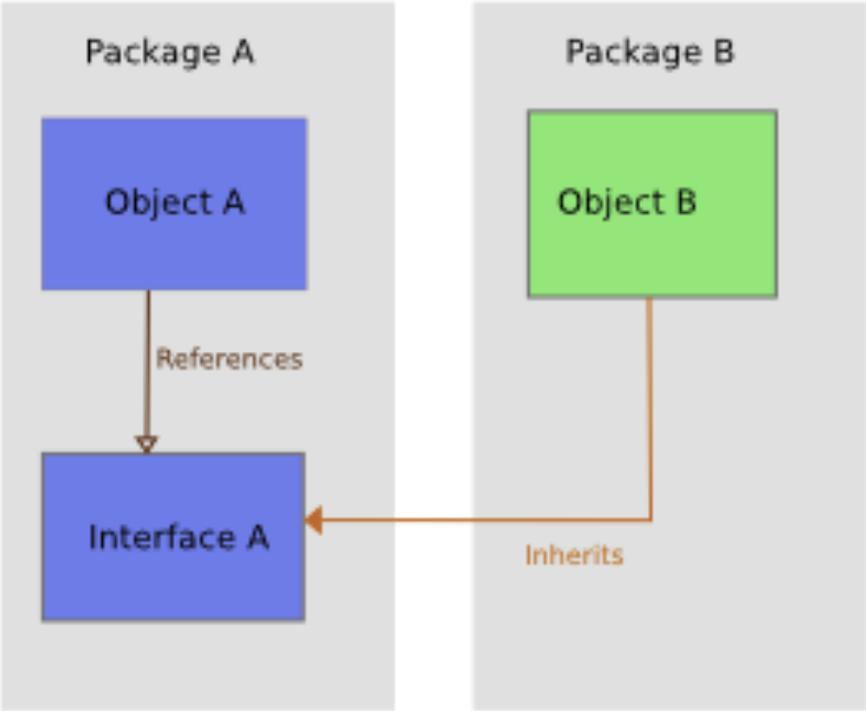
In the original version, reusing ObjectA requires reusing ObjectB. In the second, reusing A only requires an implementation of InterfaceA.

To this:

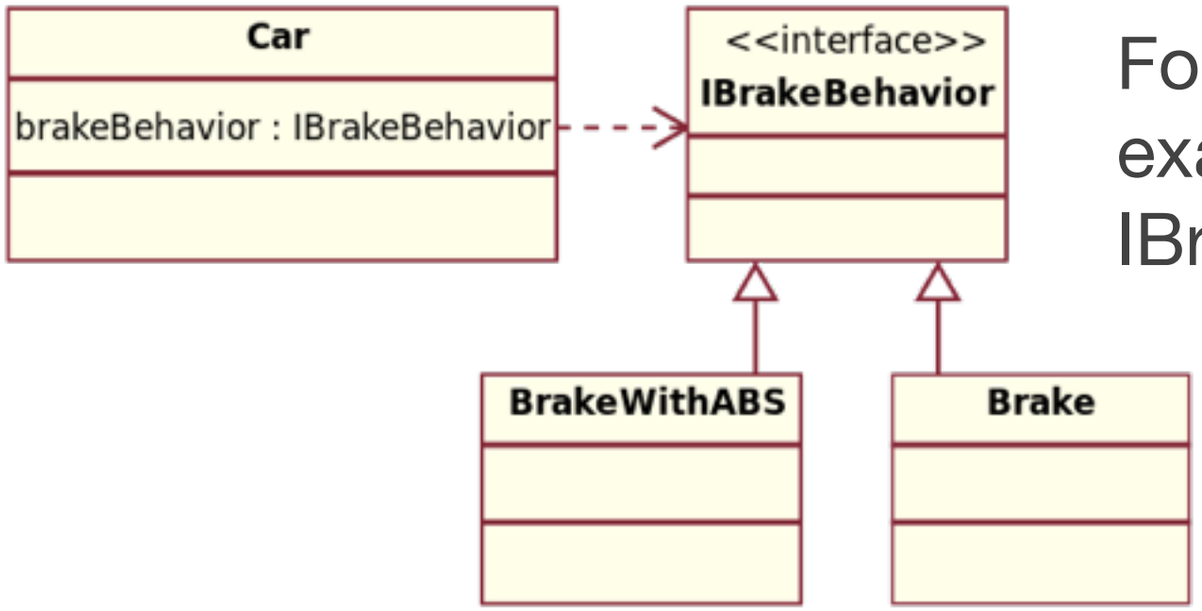


Instantiating instances of InterfaceA still ‘leaks’ details about concrete implementations; this is what Dependency Injection aims to solve.

SOLID (Dependency inversion)



Many of the patterns we have discussed in class look just like this (from the client's perspective).



For example, in this strategy example, Car only depends on IBrakeBehavior.