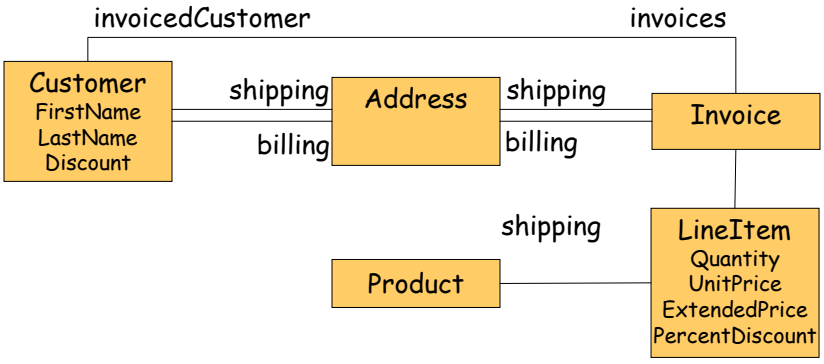
Example

- **Test addItemQuantity and removeLineItem methods of Invoice**



The Whole Test

```
public void testAddItemQuantity_severalQuantity() throws Exception {
  try {
     // Setup Fixture
     final int QUANTITY = 5;
     Address billingAddress = new Address("1222 1st St SW", "Calgary", "Alberta", "T2N 2V2", "Canada");
     Address shippingAddress = new Address("1333 1st St SW", "Calgary", "Alberta", "T2N 2V2", "Canada");
     Customer customer = new Customer(99, "John", "Doe", new BigDecimal("30"), billingAddress,
           shippingAddress);
     Product product = new Product(88, "SomeWidget", new BigDecimal("19.99"));
     Invoice invoice = new Invoice(customer);
     // Exercise SUT
     invoice.addItemQuantity(product, QUANTITY);
     // Verify Outcome
     List lineItems = invoice.getLineItems();
     if (lineItems.size() == 1) {
       LineItem actualLineItem = (LineItem)lineItems.get(0);
       assertEquals(invoice, actualLineItem.getInvoice());
       assertEquals(product, actualLineItem.getProduct());
       assertEquals(quantity, actualLineItem.getQuantity());
       assertEquals(new BigDecimal("30"), actualLineItem.getPercentDiscount());
       assertEquals(new BigDecimal("19.99"), actualLineItem.getUnitPrice());
       assertEquals(new BigDecimal("69.96"), actualLineItem.getExtendedPrice());
     } else {
       assertTrue("Invoice should have exactly one line item", false);
     }
  } finally {
     deleteObject(expectedLineItem);
     deleteObject(invoice);
     deleteObject(product);
     deleteObject(customer);
     deleteObject(billingAddress);
     deleteObject(shippingAddress);
  }
```

Verifying the Outcome

```
List lineItems = invoice.getLineItems();
if (lineItems.size() == 1) {
  LineItem actualLineItem = (LineItem)lineItems.get(0);
  assertEquals(invoice, actualLineItem.getInvoice());
  assertEquals(product, actualLineItem.getProduct());
  assertEquals(quantity, actualLineItem.getQuantity());
  assertEquals(new BigDecimal("30"),
       actualLineItem.getPercentDiscount());
  assertEquals(new BigDecimal("19.99"),
       actualLineItem.getUnitPrice());
  assertEquals(new BigDecimal("69.96"),
       actualLineItem.getExtendedPrice());
} else {
  assertTrue("Invoice should have exactly one line item",
                        false);
}
```

Obtuse Assertion

Refactoring

Use Better Assertion

```
List lineItems = invoice.getLineItems();
if (lineItems.size() == 1) {
  LineItem actualLineItem = (LineItem)lineItems.get(0);
  assertEquals(invoice, actualLineItem.getInvoice());
  assertEquals(product, actualLineItem.getProduct());
  assertEquals(quantity, actualLineItem.getQuantity());
  assertEquals(new BigDecimal("30"),
       actualLineItem.getPercentDiscount());
  assertEquals(new BigDecimal("19.99"),
       actualLineItem.getUnitPrice());
  assertEquals(new BigDecimal("69.96"),
       actualLineItem.getExtendedPrice());
} else {
  fail("invoice should have exactly one line item");
}}
```

Refactoring

Use Better Assertion

```
List lineItems = invoice.getLineItems();
if (lineItems.size() == 1) {
  LineItem actualLineItem = (LineItem)lineItems.get(0);
  assertEquals(invoice, actualLineItem.getInvoice());
  assertEquals(product, actualLineItem.getProduct());
  assertEquals(quantity, actualLineItem.getQuantity());
  assertEquals(new BigDecimal("30"),
       actualLineItem.getPercentDiscount());
  assertEquals(new BigDecimal("19.99"),
       actualLineItem.getUnitPrice());
  assertEquals(new BigDecimal("69.96"),
       actualLineItem.getExtendedPrice());
} else {
  fail("invoice should have exactly one line item");
}}
```

Hard-Wired Test Data

Fragile Tests

Pattern

Expected Object

```
List lineItems = invoice.getLineItems();
if (lineItems.size() == 1) {
  LineItem actualLineItem = (LineItem)lineItems.get(0);
  LineItem expectedLineItem =
           newLineItem(invoice, product, QUANTITY);
  assertEquals(expectedLineItem.getInvoice(),
          actualLineItem.getInvoice());
  assertEquals(expectedLineItem.getProduct(),
          actualLineItem.getProduct());
  assertEquals(expectedLineItem.getQuantity(),
          actualLineItem.getQuantity());
  assertEquals(expectedLineItem.getPercentDiscount(),
          actualLineItem.getPercentDiscount());
  assertEquals(expectedLineItem.getUnitPrice(),
          actualLineItem.getUnitPrice());
  assertEquals(expectedLineItem.getExtendedPrice(),
          actualLineItem.getExtendedPrice());
} else {
  fail("invoice should have exactly one line item");
}}
```

Pattern

Expected Object

```
List lineItems = invoice.getLineItems();
if (lineItems.size() == 1) {
  LineItem actualLineItem = (LineItem)lineItems.get(0);
  LineItem expectedLineItem =     newLineItem(invoice, product,
          QUANTITY, product.getPrice()*QUANTITY );
  assertEquals(expectedLineItem.getInvoice(),
          actualLineItem.getInvoice());
  assertEquals(expectedLineItem.getProduct(),
          actualLineItem.getProduct());
  assertEquals(expectedLineItem.getQuantity(),
          actualLineItem.getQuantity());
  assertEquals(expectedLineItem.getPercentDiscount(),
          actualLineItem.getPercentDiscount());
  assertEquals(expectedLineItem.getUnitPrice(),
          actualLineItem.getUnitPrice());
  assertEquals(expectedLineItem.getExtendedPrice(),
          actualLineItem.getExtendedPrice());
} else {
  fail("invoice should have exactly one line item");
}}
```

Verbose Test

Refactoring

Introduce Custom Assert

```
List lineItems = invoice.getLineItems();
if (lineItems.size() == 1) {
  LineItem actualLineItem = (LineItem)lineItems.get(0);
  LineItem expectedLineItem =     newLineItem(invoice, product,
          QUANTITY, product.getPrice()*QUANTITY );
  assertLineItemsEqual(expectedLineItem, actualLineItem);
} else {
  fail("invoice should have exactly one line item");
}
```

Refactoring

Introduce Custom Assert

```
List lineItems = invoice.getLineItems();
if (lineItems.size() == 1) {
  LineItem actualLineItem = (LineItem)lineItems.get(0);
  LineItem expectedLineItem =  newLineItem(invoice,
        product, QUANTITY, product.getPrice()*QUANTITY );
  assertLineItemsEqual(expectedLineItem, actualLineItem);
} else {
  fail("invoice should have exactly one line item");
}
```

Conditional Test Logic

Refactoring

Replace Conditional Logic with Guard Assertion

```
List lineItems = invoice.getLineItems();
assertEquals("number of items",lineItems.size(),1);
LineItem actualLineItem = (LineItem)lineItems.get(0);
LineItem expectedLineItem =  newLineItem(invoice,
   product, QUANTITY, product.getPrice()*QUANTITY );
assertLineItemsEqual(expectedLineItem, actualLineItem);
```

The Whole Test

```
public void testAddItemQuantity_severalQuantity () throws Exception {
  try {
     // Setup Fixture
     final int QUANTITY = 5;
     Address billingAddress = new Address("1222 1st St SW", "Calgary", "Alberta", "T2N
          2V2", "Canada");
     Address shippingAddress = new Address("1333 1st St SW", "Calgary", "Alberta", "T2N
          2V2", "Canada");
     Customer customer = new Customer(99, "John", "Doe", new BigDecimal("30"),
          billingAddress, shippingAddress);
     Product product = new Product(88, "SomeWidget", new BigDecimal("19.99"));
     Invoice invoice = new Invoice(customer);
     // Exercise SUT
     invoice.addItemQuantity(product, QUANTITY);
     // Verify Outcome
     List lineItems = invoice.getLineItems();
     assertEquals("number of items",lineItems.size(),1);
     LineItem actualLineItem = (LineItem)lineItems.get(0);
     LineItem expectedLineItem = newLineItem(invoice, product, QUANTITY);
     assertLineItemsEqual(expectedLineItem, actualLineItem);
  } finally {
     deleteObject(expectedLineItem);
     deleteObject(invoice);
     deleteObject(product);
     deleteObject(customer);
     deleteObject(billingAddress);
     deleteObject(shippingAddress);
```


The Smells Seen Thus Far (1)

- **Obscure Test**
  - Test is hard to understand.
- **Common Causes:**
  - Verbose Test
    - » So much test code that it obscures the test intent
  - Eager Test
    - » Several tests merged into one Test Method
  - General Fixture
    - » Fixture contains objects irrelevant for this test
  - Obtuse Assertion
    - » Using the wrong kind of assertion
  - Hard-Coded Test Data
    - » Lots of “Magic Numbers” or Strings used when creating objects.
    - » More likely to result in unrepeatable tests

The Patterns Used So Far

- **Expected Objects**
  - Use AssertEquals on whole objects rather than comparing individual fields
- **Guard Assertions**
  - Remove conditional logic associated with avoiding assertions when they would fail
- **Custom Asserts**
  - Remove Test Code Duplication by factoring out common code
  - Remove conditional logic associated with complex verification logic

Pattern

Expected Object

- **Replace a series of assertEquals on individual fields:**
  - assertEquals (expectedXvalue, actualPoint .getx());
  - assertEquals (expectedYvalue, actualPoint .getY());
- **with a single assertion of the whole object:**
  - assertEquals (expectedPoint, actualPoint);
- **Ways to construct the Expected Object:**
  - Point expectedPoint = new Point(17.0, 9.0)

  Or:
  - expectedPoint.setX(17.0);
  - expectedPoint.sety(9.0);

Pattern

Guard Assertion

Conditional Test Logic creates multiple execution paths thru test:

```
if (actualCollection == null)
    fail("collection is null");
else {
    assertTrue( actualCollection.includes(expectedElement) );
}
```

This makes tests hard to verify.

Better to replace with a Guard Assertion:

```
assertNotNull( "collection is null", actualCollection);
assertTrue( actualCollection.includes(expectedElement) );
```


Pattern

Custom Assertion

Remove duplicated assertion logic by creating your own Assertion Methods to:

- **Improve readability**
  - Intent-revealing methods that verify expected outcome
- **Simplify troubleshooting**
  - Make xUnit failure reports easier to understand
- **Define test-specific equality**
  - Ignore "don't care" fields when comparing objects
  - "Foreign Method" specific to testing
- **Can be defined using Extract Method refactoring.**