CHAPTER 3

# *Money Example*

We'll start with the object Ward created at WyCash, multi-currency money. Suppose we have a report like this:

| *Instrument* | *Shares* | *Price* | *Total* |
|---|---|---|---|
| IBM | 1000 | 25 | 25000 |
| GE | 400 | 100 | 40000 |
| | | Total: | 65000 |

To make a multi-currency report, we need to add currencies:

| *Instrument* | *Shares* | *Price* | *Total* |
|---|---|---|---|
| IBM | 1000 | 25 USD | 25000 USD |
| Novartis | 400 | 150 CHF | 60000 CHF |
| | | Total: | 65000 USD |

We also need to specify exchange rates:

| *From* | *To* | *Rate* |
|---|---|---|
| CHF | USD | 1.5 |

What behavior will we need to produce the revised report? Put another way, what is the set of tests which, when passed, will demonstrate the presence of code we are confident will compute the report correctly?

- We need to be able to add amounts in two different currencies and convert the result given a set of exchange rates.
- We need to be able to multiply an amount (price per share) by a number (number of shares) and receive an amount.

$5 + 10 CHF = $10 if rate is 2:1
$5 * 2 = $10

We'll make a to-do list to remind us what all we need to do, keep us focused, and tell us when we are finished. When we start working on an item, we'll make it bold, like this. When we finish an item we'll cross it off, ~~like this~~. When we think of another test to write, we'll add it to the list.

As you can see from the list, we'll work on multiplication first. So, what object do we need first? Trick question. We don't start with objects, we start with tests (I keep having to remind myself of this, so I will pretend you are as dense as I am).

Try again. What test do we need first? Looking at the list, that first test looks complicated. Start small or not at all. Multiplication, how hard could that be? We'll work on that first.

When we write a test, we imagine the perfect interface for our operation. We are telling ourselves a story about how the operation will look from the outside. Our story won't always come true, but better to start from the best possible API and work backwards than to make things complicated, ugly, and "realistic" from the get go.

Here's a simple example of multiplication:

```
public void testMultiplication() {
    Dollar five= new Dollar(5);
    five.times(2);
    assertEquals(10, five.amount);
}
```

$5 + 10 CHF = $10 if rate is 2:1
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Make "amount" private
Dollar side-effects?
Money rounding?

(I know, I know, public fields, side-effects, integers for monetary amounts and all that. Small steps. We'll make a note of the stinkiness and move on. We have a failing test and we want it to go green as quickly as possible.)

The test we just typed in (I'll explain where and how we type it in later, when we talk more about JUnit) doesn't even compile. That's easy enough to fix. What's the least we can do to get it to compile, even if it doesn't run? We have four compile errors:

- No class "Dollar"
- No constructor
- No method "times(int)"
- No field "amount"

Let's take them one at a time (I always search for some numerical measure of progress). We can get rid of one error by defining the class Dollar:

```
Dollar
class Dollar
```

3 errors. Now we need the constructor, but it doesn't have to do anything just to get the test to compile:

```
Dollar
Dollar(int amount) {
}
```

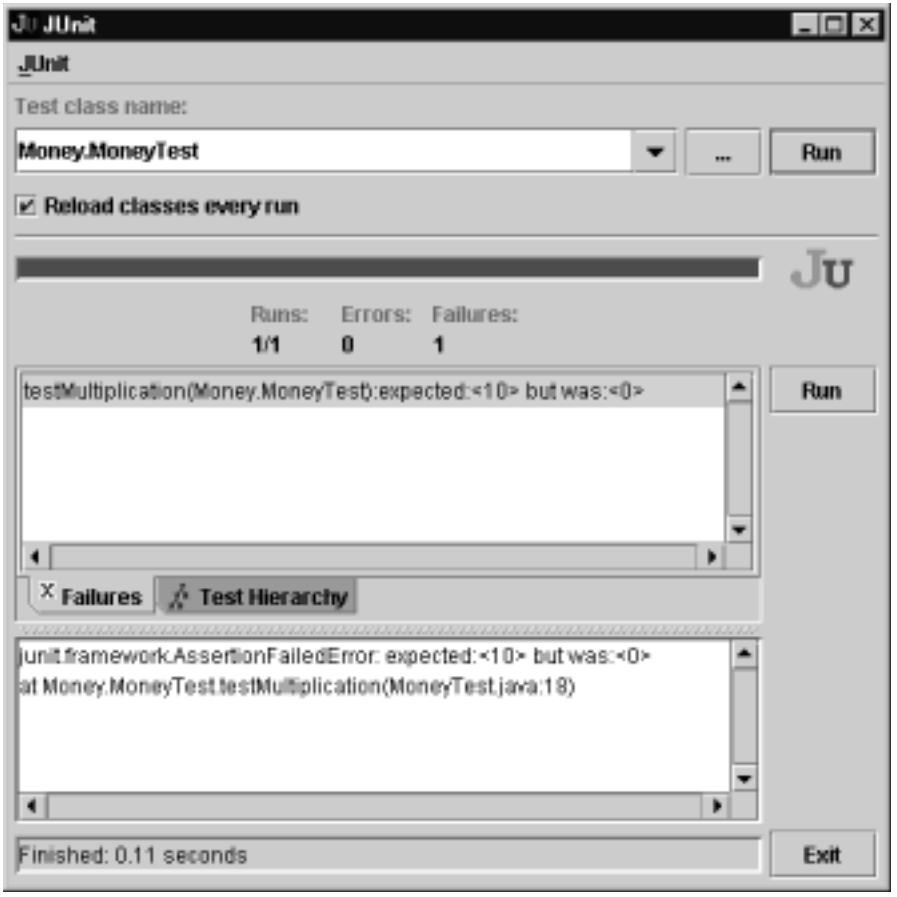
2 errors. We need a stub implementation of times(). Again we'll do the least work possible just to get the test to compile:

```
Dollar
void times(int multiplier) {
}
```

1 error. Finally, we need an amount field:

```
Dollar
int amount;
```

Bingo! Now we can run the test and watch it fail.




You are seeing the dreaded red bar. Our testing framework (JUnit, in this case) has run the little snippet of code we started with, and noticed that although we expected "10" as a result, we saw "0". Sadness.

No, no. Failure is progress. Now we have a concrete measure of failure. That's better than just vaguely knowing we are failing. Our programming problem has been transformed from "give me multi-currency" to "make this test work, and then make the rest of the tests work." Much simpler. Much smaller scope for fear. We can make this test work.

You probably aren't going to like the solution, but the goal right now is not to get the perfect answer, the goal is to pass the test. We'll make our sacrifice at the altar of truth and beauty later.

Here's the smallest change I could imagine that would cause our test to pass:

```
Dollar
int amount= 10;
```

Now we get the green bar, fabled in song and story.


Oh joy, oh rapture! Not so fast, hacker boy (or girl). The cycle isn't complete. There are very few inputs in the world that will cause such a limited, such a smelly,

such a naïve implementation to pass. We need to generalize before we move on. Remember, the cycle is:

1. Add a little test
2. Run all tests and fail
3. Make a little change
4. Run the tests and succeed
5. Refactor to remove duplication

Sidebar: Dependency and Duplication

Steve Freeman pointed out that the problem with the test and code as it sits is not duplication (which I have not yet pointed out to you, but I promise to as soon as this digression is over.) The problem is the dependency between the code and the test—you can't change one without changing the other. Our goal is to be able to write another test that "makes sense" to us, without having to change the code, something that is not possible with the current implementation.

Dependency is the key problem in software development at all scales. If you have details of one vendor's implementation of SQL scattered throughout the code and you decide to change to another vendor, you will discover that your code is dependent on the database vendor. You can't change the database without changing the code.

If dependency is the problem, duplication is the symptom. Duplication most often takes the form of duplicate logic—the same expression appearing in multiple places in the code. Objects are excellent for abstracting away the duplication of logic.

Unlike most problems in life, where eliminating the symptoms only makes the problem pop up elsewhere in worse form, eliminating duplication in programs eliminates dependency. That's why the second rule appears in TDD. By eliminating duplication before we go on to the next test, we maximize our chance of being able to get the next test running with one and only one change.

Now back to your regularly scheduled puzzling example.

We have run items 1-4. Now we are ready to remove duplication. But where is the duplication? Usually you see duplication between two pieces of code. Here the duplication is between the data in the test and the data in the code. Don't see it? How about if we write?

```
Dollar
int amount= 5 * 2;
```

That “10” had to come from somewhere. We did the multiplication in our heads so fast we didn’t even notice. The “5” and “2” are now in two places, and we must ruthlessly eliminate duplication before moving on. The rules say so.

There isn’t a single step that will eliminate the 5 and 2. However, what if we move the setting of the amount from object initialization to the times() method?

```
Dollar
int amount;

void times(int multiplier) {
    amount= 5 * 2;
}
```

The test still passes, the bar stays green. Happiness is still ours.

Do these steps seem too small to you? Remember, TDD is not about taking teensy tiny steps, it’s about being able to take teensy tiny steps. Would I code day-to-day with steps this small? No. But when things get the least bit weird, I’m glad I can. Try teensy tiny steps with an example of your own choosing. If you can make steps too small, you can certainly make steps the right size. If you only take larger steps, you’ll never know if smaller steps are appropriate.

Defensiveness aside, where were we? Ah, yes, we were getting rid of duplication between the test code and the working code. Where can we get a 5? That was the value passed to the constructor, so if we save it in the amount variable:

```
Dollar
Dollar(int amount) {
    this.amount= amount;
}
```

we can use it in times():

```
Dollar
void times(int multiplier) {
    amount= amount * 2;
}
```

The value of the parameter “multiplier” is 2, so we can substitute the parameter for the constant:

```
Dollar
void times(int multiplier) {
    amount= amount * multiplier;
}
```

To demonstrate our thorough-going knowledge of Java syntax, we will want to use the “*=” operator (which does, it must be said, reduce duplication):

```
Dollar
void times(int multiplier) {
    amount *= multiplier;
}
```

We can now mark off the first test as done. Next we’ll take care of those strange side effects. First, though, let’s review. We:

- Made a list of the tests we knew we needed to have working
- Told a story with a snippet of code about how we wanted to view one operation
- Ignored the details of JUnit for the moment
- Made the test compile with stubs
- Made the test run by committing horrible sins
- Gradually generalized the working code, replacing constants with variables
- Added items to our to-do list rather than addressing them all at once

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~~$5 * 2 = $10~~
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