

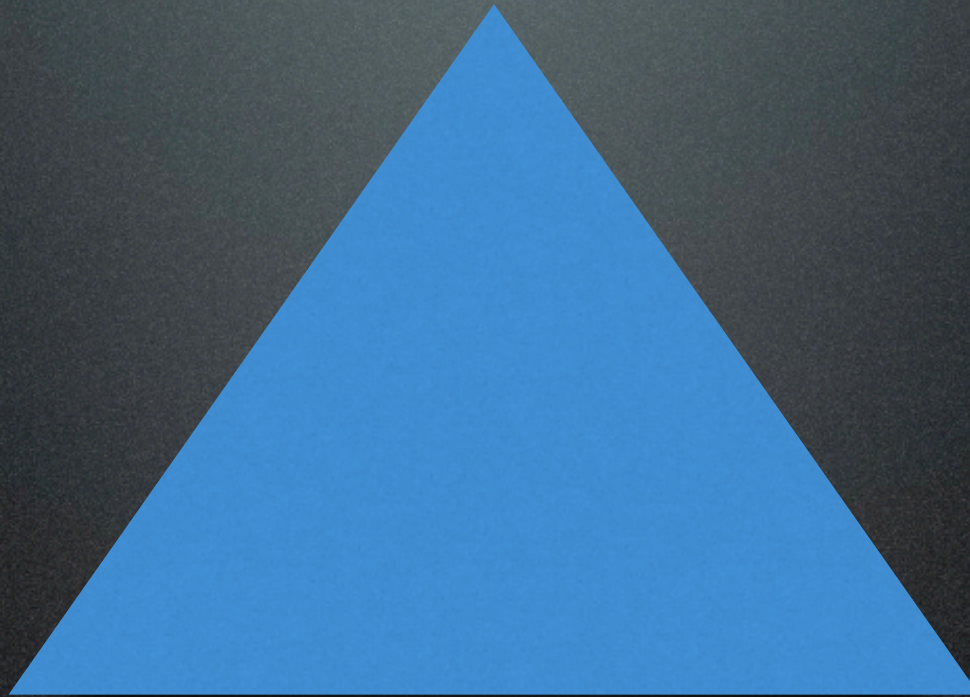
# Test Driven Development

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# The problem

Good



Cheap

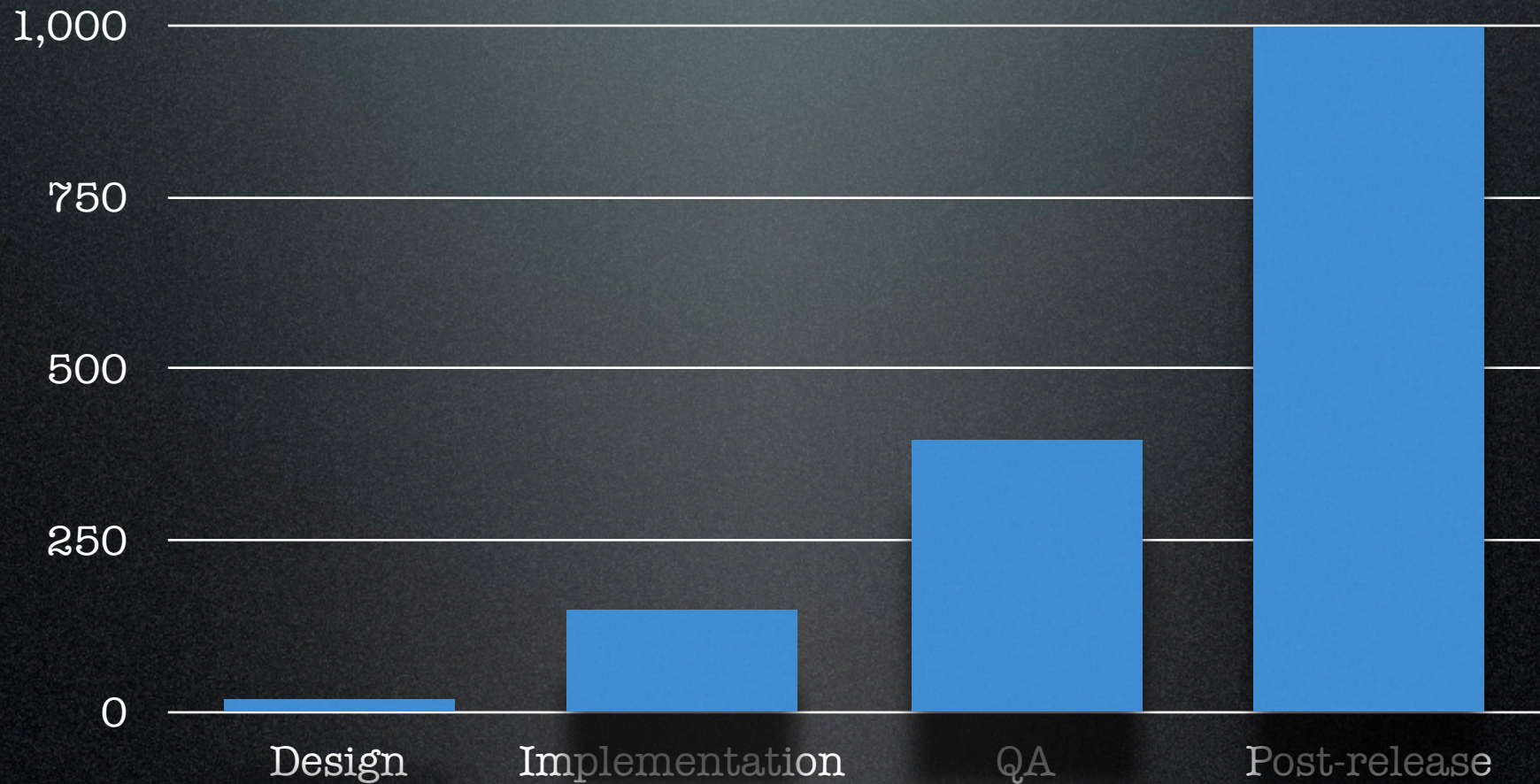
Fast



No silver bullet



# Time taken to fix bugs





# Cheap programmers

- Best programmers 10x as effective
- Testing can close the gap (somewhat)



# Software quality

- “Instinctive”
- Hard to measure

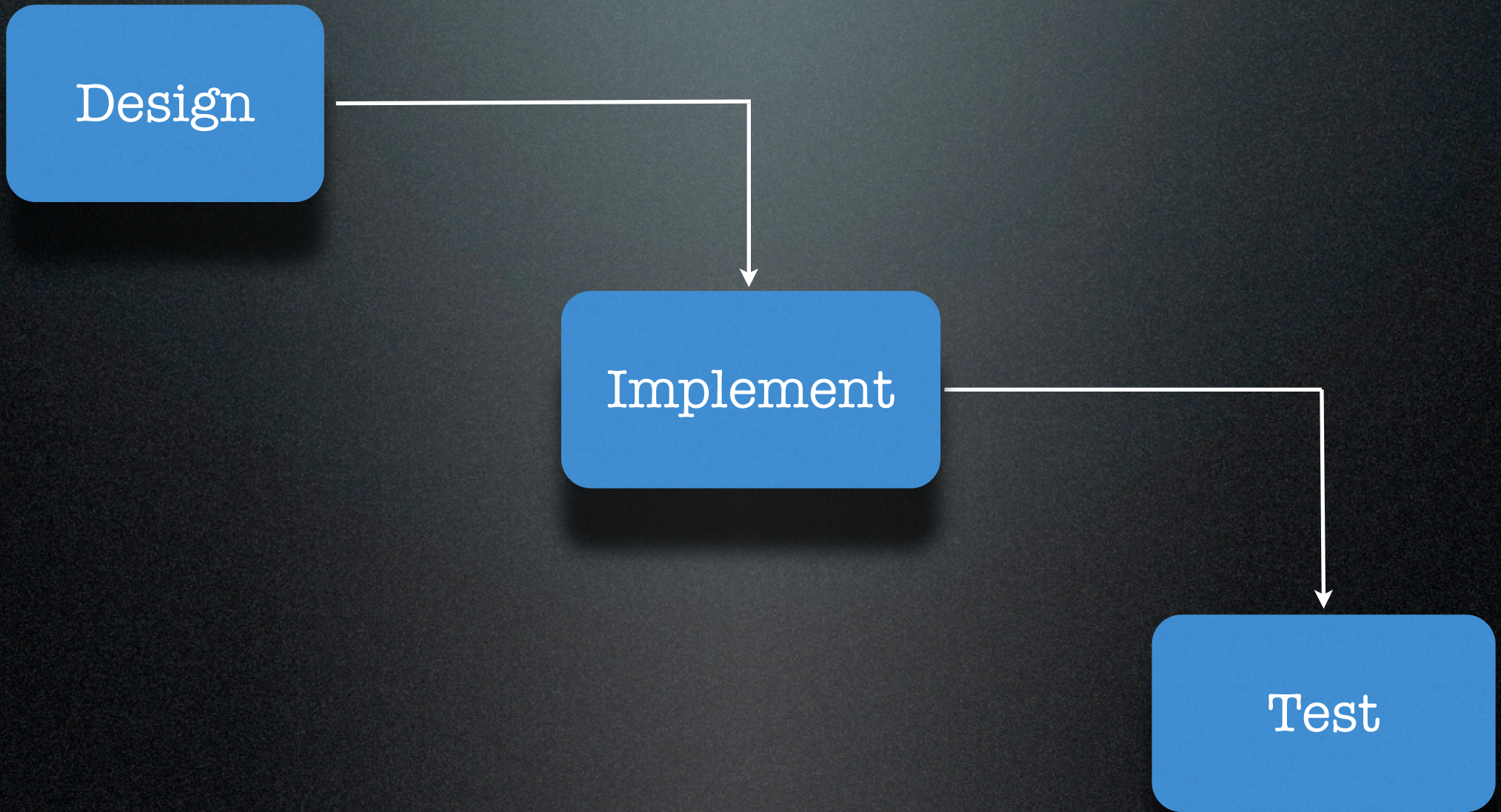


# The solution

- Testing
- Test Driven Development

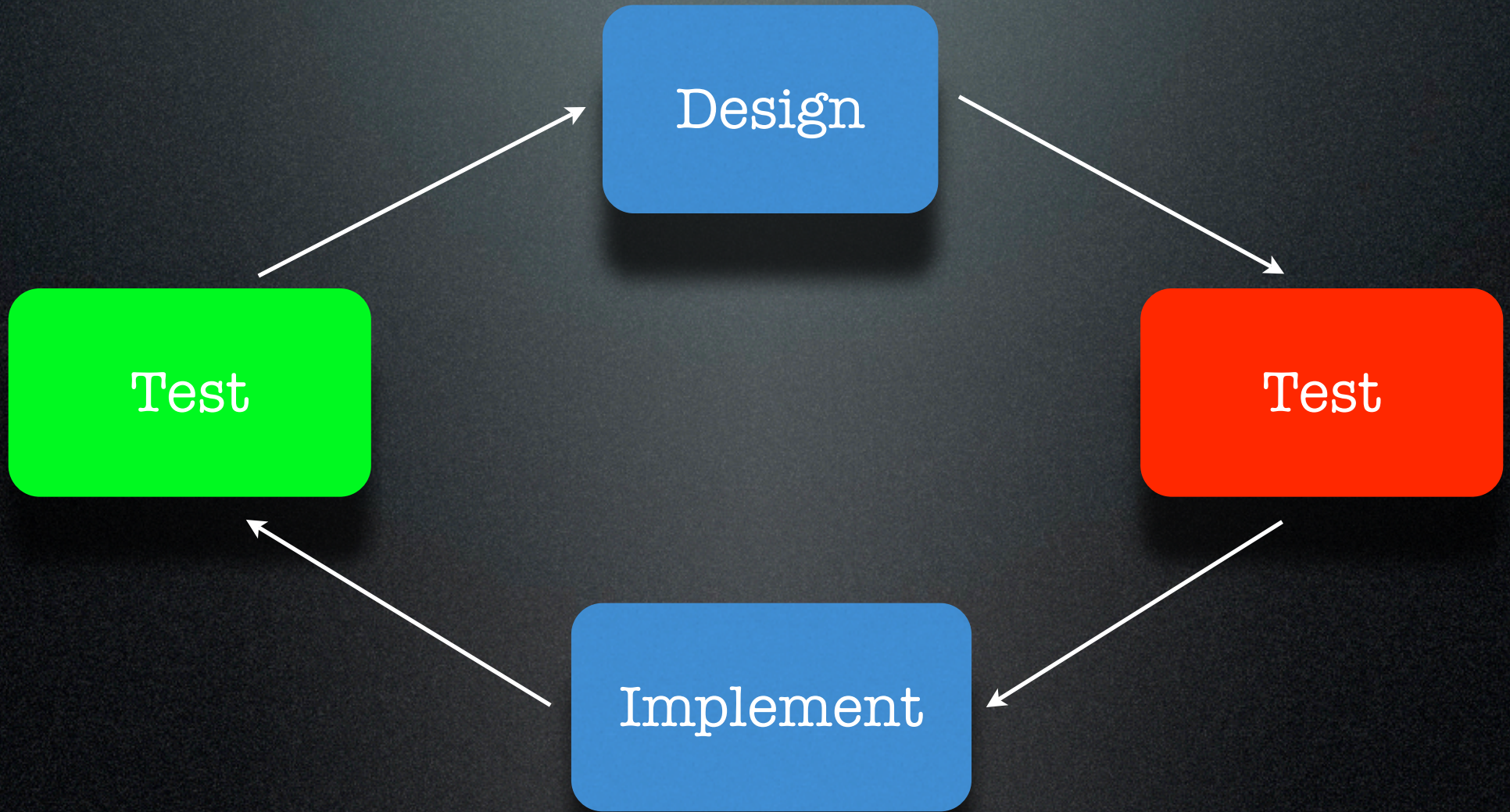


# Testing





# TDD





# How to do it

- Design: figure out what you want to do
- Test: write a test to express the design
  - It should **FAIL**
- Implement: write the code
- Test again
  - It should **PASS**



# Design

The subroutine `add()` takes two arguments and adds them together. The result is returned.



# Test

```
use Test::More tests => 1;
```

```
is(add(2,2), 4, "Two and two is four");
```



# FAIL

```
$ prove -v add.t
add...Undefined subroutine &main::add called at add.t line 3.
# Looks like your test died before it could output anything.
1..1
dubious
    Test returned status 255 (wstat 65280, 0xff00)
DIED. FAILED test 1
    Failed 1/1 tests, 0.00% okay
Failed Test Stat Wstat Total Fail  List of Failed
-----
add.t          255 65280      1     2  1
Failed 1/1 test scripts. 1/1 subtests failed.
Files=1, Tests=1,  0 wallclock secs ( 0.02 cusr +  0.01 csys =  0.03 CPU)
Failed 1/1 test programs. 1/1 subtests failed.
```



# Implement

```
sub add {  
  my ($first, $second) = @_;  
  return $first + $second;  
}
```



# Test

```
$ prove -v add.t
```

```
add....1..1
```

```
ok 1 - Two and two is four
```

```
ok
```

```
All tests successful.
```

```
Files=1, Tests=1, 0 wallclock secs ( 0.02 cusr + 0.01 csys = 0.03 CPU)
```

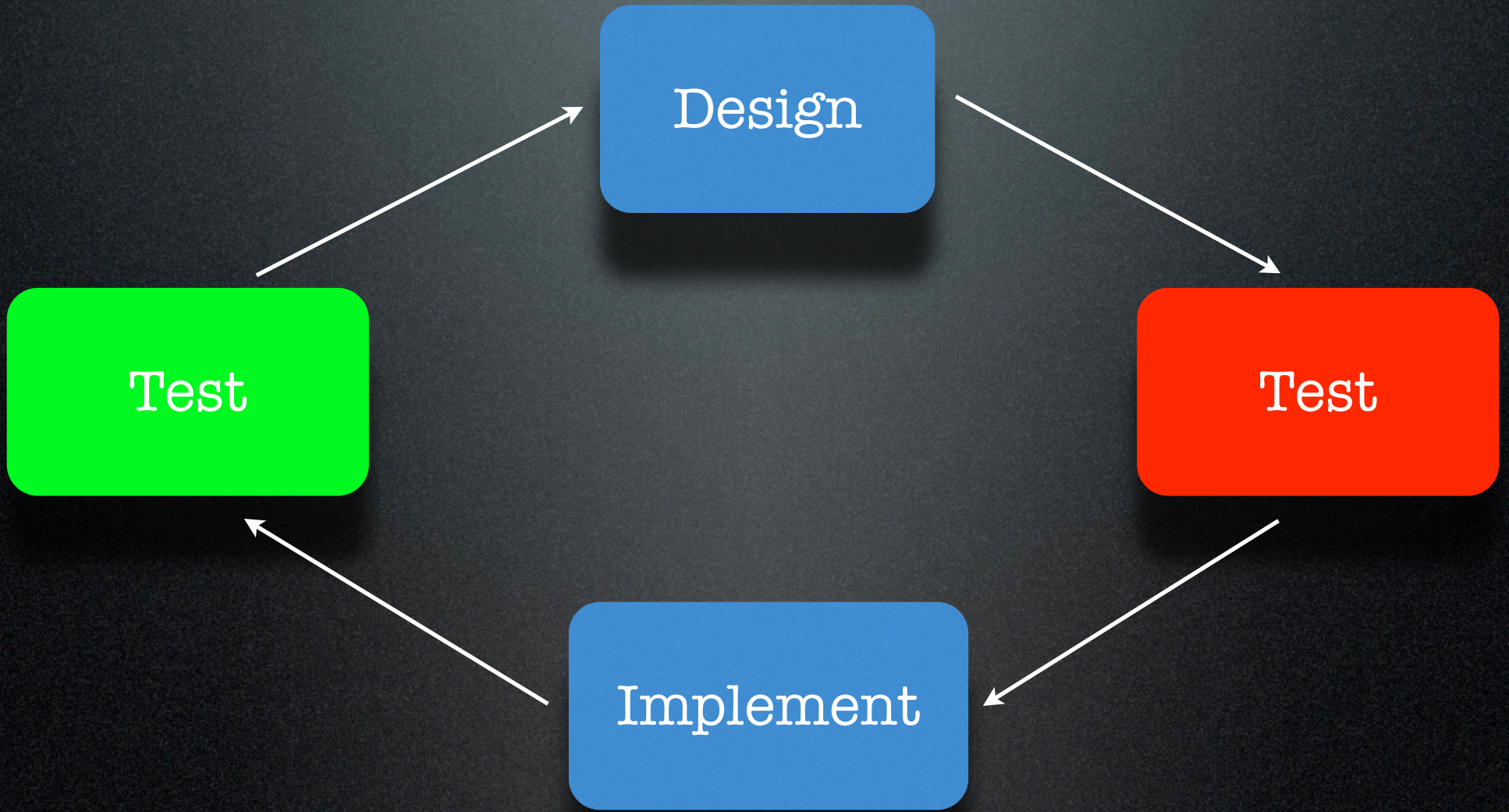


# Wait...

- What if there are fewer than two arguments?
- What if there are more than two arguments?
- What if the arguments aren't numeric?



# Iterate





# Design

- The subroutine `add()` takes two arguments and adds them together. The result is returned.
- If fewer than two arguments are provided, `add()` will return `undef`.
- If more than two arguments are provided, `add()` will return the sum of the first two.
- If any argument is non-numeric, `add()` will return `undef`.



# Test

```
use Test::More tests => 4;
```

```
is(add(2,2), 4,  
  "Simple case: two and two is four");
```

```
is(add(3), undef,  
  "Return undef for < 2 args");
```

```
is(add(2,2,2), 4,  
  "Only add first 2 args");
```

```
is(add("foo", "bar"), undef,  
  "Return undef for non-numeric args");
```



# Test

```
prove -v add.t
```

```
add...1..4
```

```
ok 1 - Two and two is four
```

```
ok 2 - Return undef for < 2 args
```

```
ok 3 - Only add first 2 args
```

```
ok 4 - Return undef for non-numeric args
```

```
ok
```

```
All tests successful.
```



Effective tests must  
be automated



# Write once, run often

- Write tests once
- Keep them somewhere sensible
- Run frequently (one click)
- No human input
- Machine-parsable output



# Test coverage

- How much of the code is tested?
- What areas still need testing?
- Where are the greatest risks?



## TDD in summary

- A. First we write a test.
- B. Then we write code to make the test pass.
- C. Then we find the best possible design for what we have - refactoring (Relying on the existing tests to keep us from breaking things while we are at it)

## TDD goals

- **TDD** is a technique for improving the software's **internal** quality

### **Well-written code**

- Good design
- A balanced division of responsibilities
- Without duplication of responsibility
- Maintainability and smooth evolution



## ***Build it right: TDD***

- TDD: building up the system incrementally, knowing that we're never far from a working baseline.
  - A test is our way of taking that next small step.
- The term ***refactoring*** is used to better communicate that the last step is about transforming the current design toward a better design.

## ***First we write a test***

- We are writing a test. Also, we are making design decisions:
  - We are designing the API—the interface for accessing the functionality we're testing.
  - The test case that we design will be the first “**client**” of the functionality that we are going to implement.
  - One of the fundamental lessons in designing an interface is that we only evaluate a design effectively and objectively when we try to use it.



### ***Then we write just enough code***

- The second step of the TDD cycle is to write just enough code to make the test pass.
- You're satisfying an explicit, unambiguous requirement expressed by a test.

### ***And then we refactor***

- Take a step back, look at our design, and figure out ways of making it better.
- It is all about keeping your software in good health—at all times.
- Refactoring is about applying refactorings on code in a controlled manner



## ***Keeping code healthy with refactoring***

- *“a disciplined technique for restructuring an existing body of code, altering its internal structure without changing its external behavior” : Martin Fowler*

## ***Refactoring Example***

- Replace Inheritance with Delegation
  - Motivation: A subclass uses only part of a superclass interface or does not want to inherit data
  - Summary: *Create a field for the superclass, adjust methods to delegate to the superclass, and remove the subclassing.*



## ***Refactoring Example***

- Mechanics
  1. Create a field in the subclass that refers to an instance of the superclass. Initialize it to **this**.
  2. Change each method defined in the subclass to use the delegate field.
  3. Compile and test after changing each method.

## ***Refactoring Example***

- Mechanics
  4. Remove the subclass declaration and replace the delegate assignment with an assignment to a new object.
  5. For each superclass method used by a client, add a simple delegating method.
  6. Compile and test.



## ***Refactorings alter internal structure***

- Many of the refactorings are very low-level
  - *rename method*
  - *Rename variable*
- Low-level refactorings are the fundamental building blocks to achieving larger refactorings
  - Moving the responsibilities around in your code
  - Introducing or removing an inheritance hierarchy

## ***Refactorings preserve behavior***

- whatever transformations you apply to the existing code, those transformations should only affect the code's design and structure—not its externally visible behavior or functionality.
  - Renaming a method that is part of a class's public interface - ???
  - how can we be sure that our refactorings haven't changed the code's external behavior? - ???