Test Driven Development

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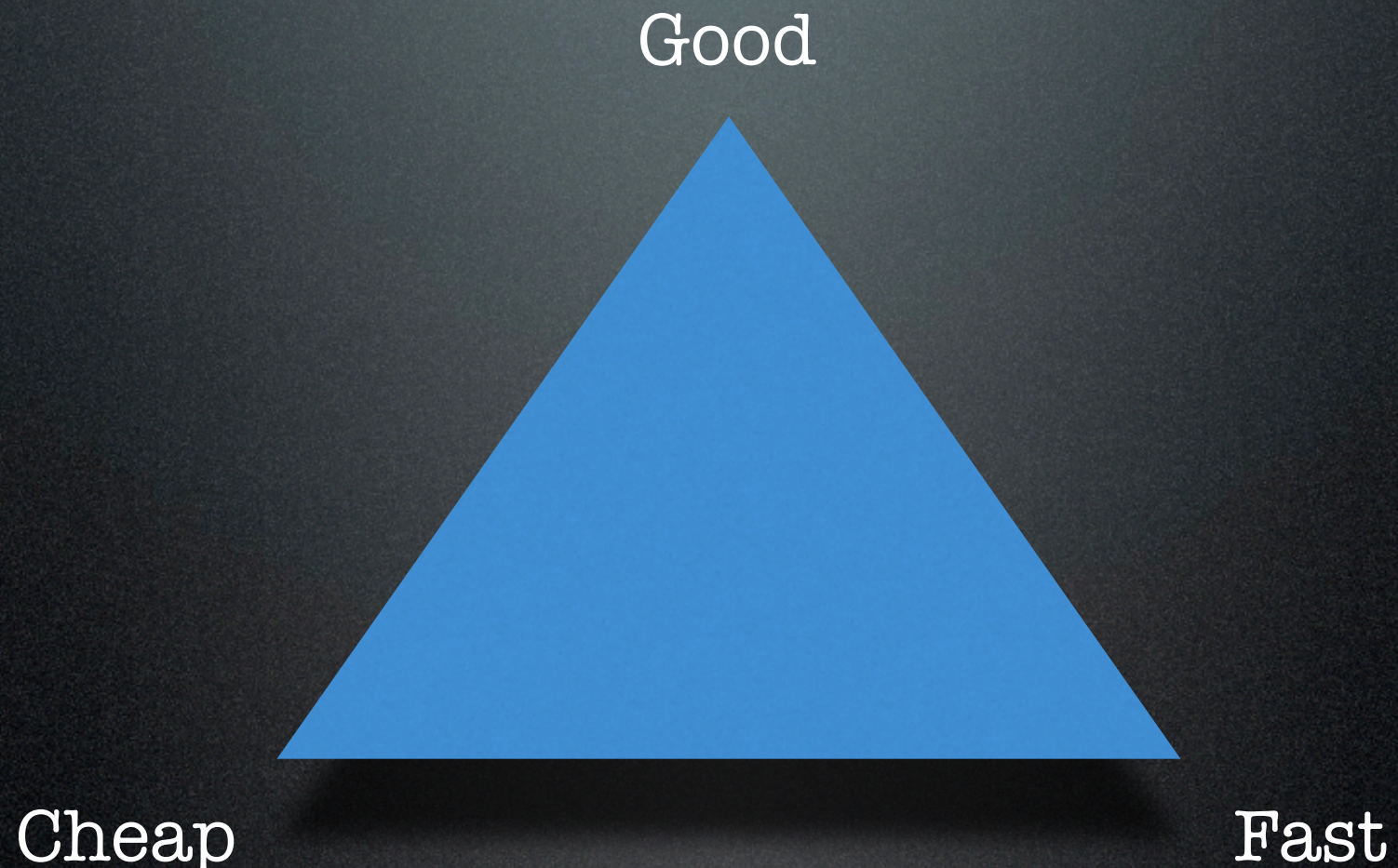
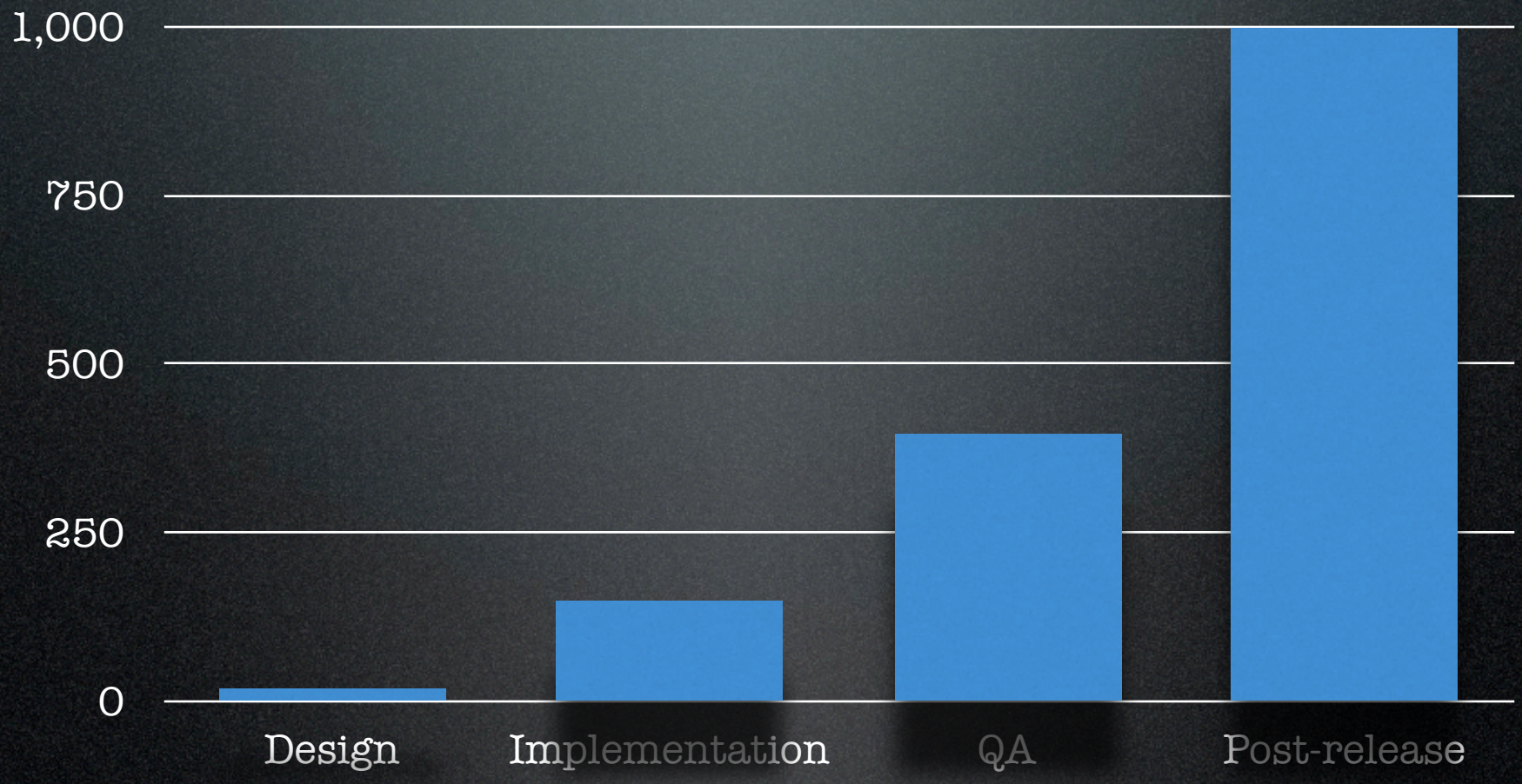
The problem



No silver bullet

Time taken to fix bugs



Cheap programmers

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

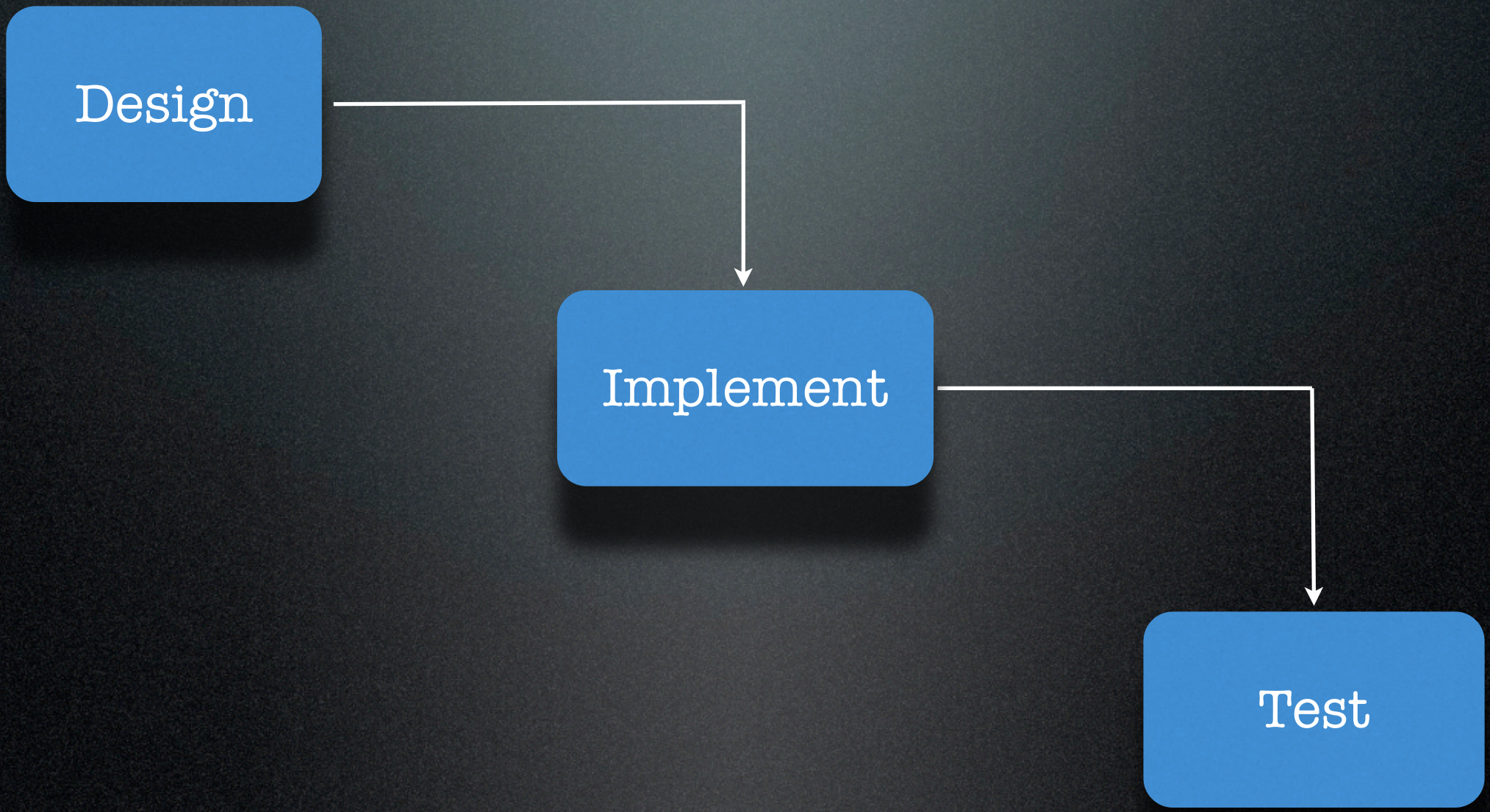
Software quality

- “Instinctive”
- Hard to measure

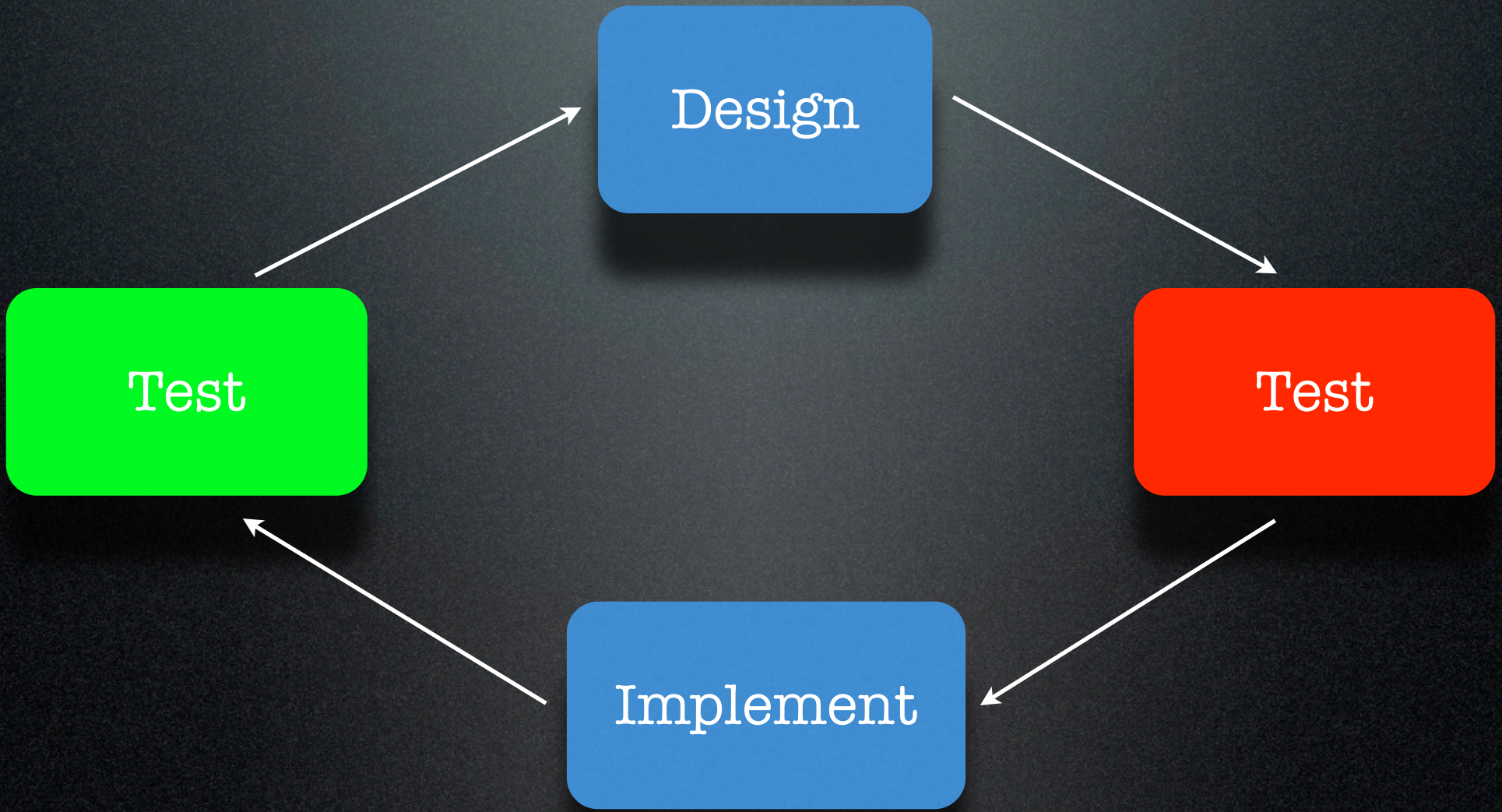
The solution

- 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;
}
```

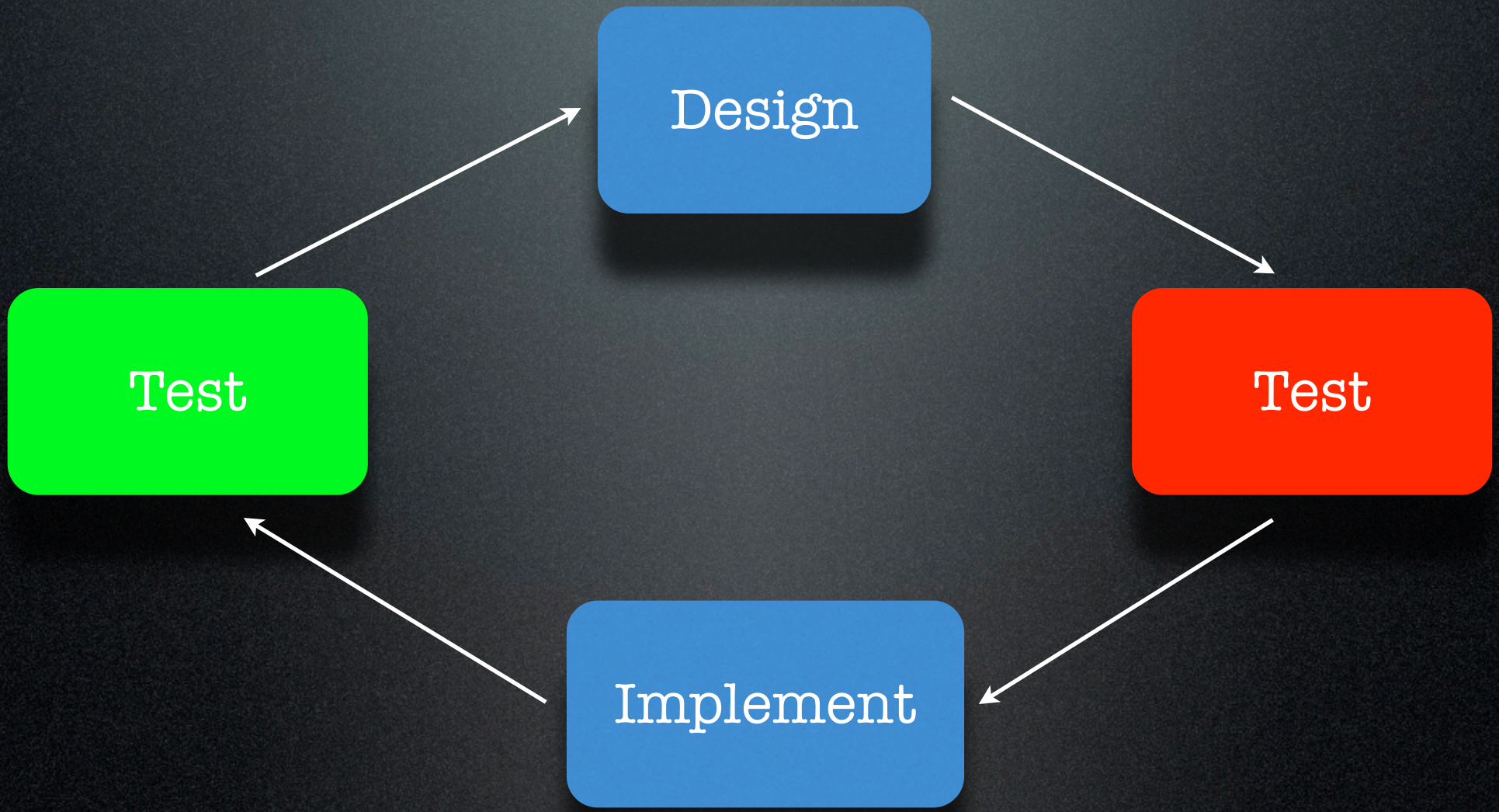
Test

```
$ 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? - ???