Test-driven development in R

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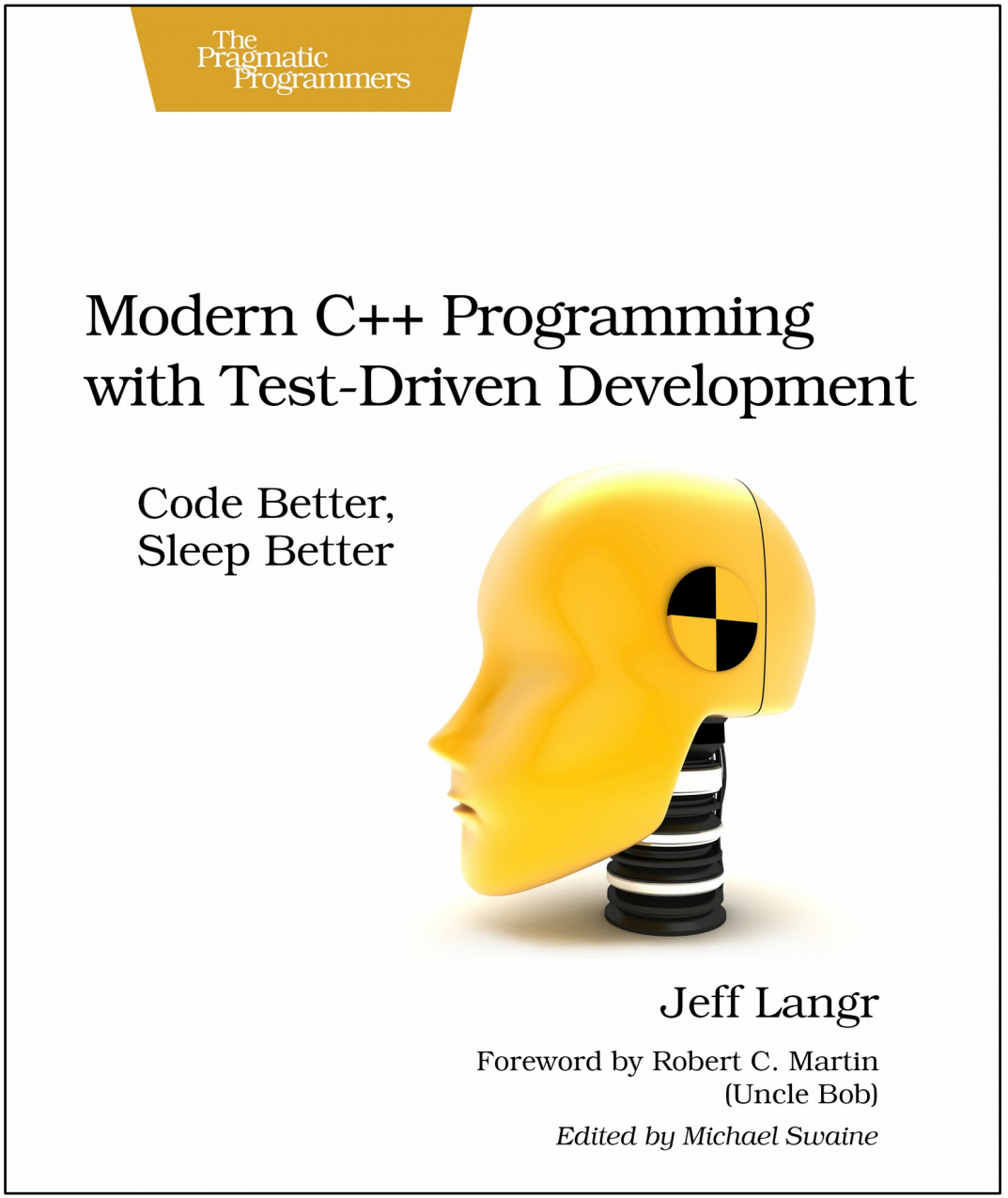
http://github.com/richelbilderbeek/PresentationsAboutR

www.dilbert.com

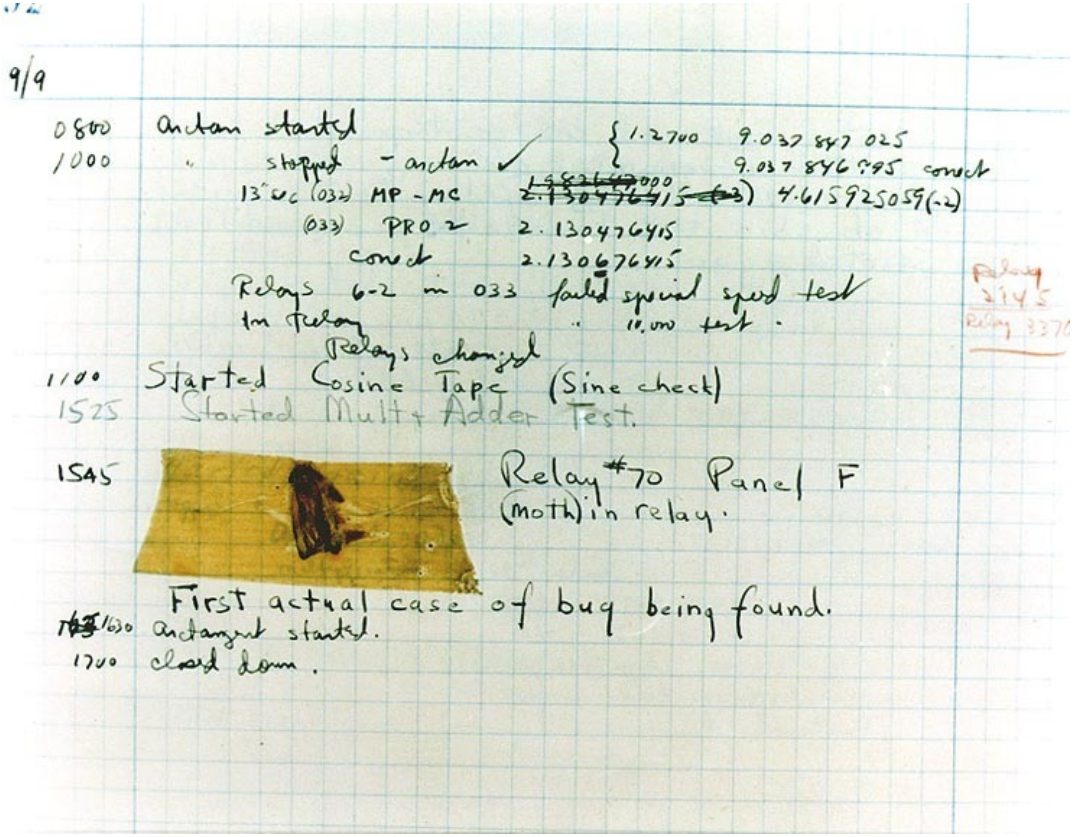
What is test-driven development?

- Letting tests being the guide in developing new code
- A workflow for growing high-quality code



Why tests?

- High-quality code
- Increase productivity
- Improves software architecture
- Documentation
- Collaboration

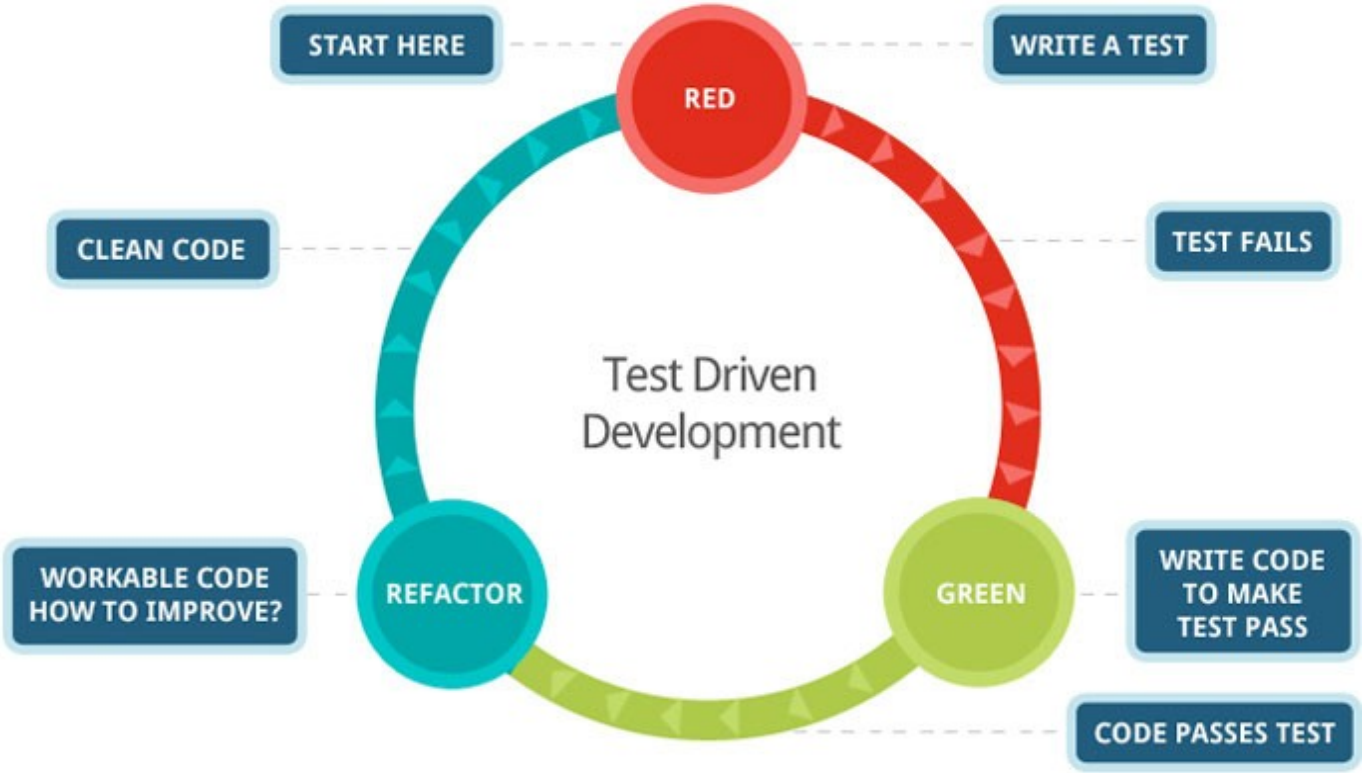


Example

```
is_prime <- function(x) {
  # check input arguments
  # calculation
  # return TRUE or FALSE
}
```

Developing is_prime

- Cycle test-driven development:
  - Red: write a test that fails
  - Green: pass the test
  - Refactor: improve the new code, clean up mess, check in code



Development is_prime

- As small steps as possible
- One step at a time

Red: write a test that fails

- Create the testing architecture, in console:

```
devtools::use_test(“is_prime”)
```

- Create a test that fails, in file 'test-is_prime.R':

```
context("is_prime")

test_that("is_prime works", {
  expect_equal(is_prime(2), TRUE)
})
```

Green: pass the test

```
#' Determines if the input is prime
#' @param x input
#' @return TRUE or FALSE
#' @export
is_prime <- function(x) {
  return (TRUE)
}
```

Refactor

- Checking in

```
git add --all :/
git commit -m
   “is_prime: 2 is prime”
```

Red: write a test that fails

```
test_that("is_prime works", {
  # Previous code
 expect_equal(is_prime(4), FALSE)
})
```

Green: pass the test

```
is_prime <- function(x) {
  if (x == 2) return(TRUE)
  for (i in seq(2, x - 1)) {
    if (x %% i == 0) {
      return(FALSE)
    }
  }
  return(TRUE)
}
```

Refactor

- Check in

```
git add --all :/
git commit -m
   “is_prime: 4 is not prime”
```

Red: write a test that fails

```
test_that("is_prime works", {
  # Previous code
 expect_equal(is_prime(1), FALSE)
})
```

Green: pass the test

```
is_prime <- function(x)
{
  if (x <= 1) return(FALSE)
  if (x == 2) return(TRUE)
  for (i in seq(2, x - 1)) {
    if (x %% i == 0) { return(FALSE) }
  }
  return(TRUE)
}
```

Refactor

- Check in

```
git add --all :/
git commit -m
   “is_prime: <←,1] is not prime”
```

Red: write a test that fails

```
test_that("is_prime works", {
  # Other test
  expect_error(
    is_prime(“Hello”),
    “testit: input must be numeric”
  )
})
```

Green: pass the test

```
is_prime <- function(x)
{
  if (!is.numeric(x)) {
    stop("is_prime: input should be numeric")
  }
  # Other code
}
```

Refactor

- Check in

```
git add --all :/
git commit -m
   “is_prime: input must be numeric”
```

Red: write a test that fails

```
test_that("is_prime works", {
  # Other tests
  expect_error(
    is_prime(c(1,2,3)),
    "is_prime: input should be one number"
  )
})
```

Green: pass the test

```
is_prime <- function(x)
{
  if (!is.numeric(x)) {
    stop("is_prime: input should be numeric")
  }
  if (length(x) != 1) {
    stop("is_prime: input should be one number")
  }
  # Other code
}
```

Refactor

- Check in

```
git add --all :/
git commit -m
   “is_prime: input one number”
```

Red: write a test that fails

```
test_that("is_prime works", {
  # Other tests
  expect_equal(
    is_prime(c(1,2,3)),
    c(FALSE, TRUE, TRUE)
  )
})
```

Green: pass the test

```
#' Calculates if the input is prime
#' @param x input values
#' @return vector of TRUEs and/or FALSEs
#' @export
is_prime <- function(x) {
  r <- rep(TRUE, times = length(x))
  for (i in seq(1, length(x))) {
    r[i] <- is_prime_single(x[i])
  }
  r
}
```

```
is_prime_single <- function(x) {
  # What used to be is_prime
}
```

Refactor

- Check in

```
git add --all :/
git commit -m
   “is_prime: allow multiple inputs”
```

Final is_prime

```
#' Calculates if the input is prime
#' @param x input values
#' @return vector of TRUEs and/or FALSEs
#' @export
is_prime <- function(x) {
  r <- rep(TRUE, times = length(x))
  for (i in seq(1, length(x))) {
    r[i] <- is_prime_single(x[i])
  }
  r
}

#' Calculates if the input is prime
#' @param x input value
#' @return TRUE or FALSE
#' @export
is_prime_single <- function(x) {
  if (!is.numeric(x)) {
    stop("is_prime: input must be integer")
  }
  if (length(x) != 1) {
    stop("is_prime_single: input must be a single value")
  }
  if (x == 2) return(TRUE)
  for (i in seq(2, x - 1)) {
    if (x %% i == 0) return(FALSE)
  }
  return(TRUE)
}
```

Complete test suite

```
context("is_prime")

test_that("is_prime works", {
  expect_equal(is_prime(2), TRUE)
  expect_equal(is_prime(4), FALSE)
  expect_equal(is_prime(1), FALSE)
  expect_equal(is_prime(0), FALSE)
  expect_equal(is_prime(-1), FALSE)
  expect_error(is_prime("hello"), "is_prime: input must be integer")
  expect_equal(is_prime(c(1,2,3)), c(FALSE, TRUE, TRUE))
})
```

Too complex to write a test for?

- Do test simple cases as usual
- Use vignettes to convince the reader it works for more complex input

```
devtools::use_vignette(“demo”)
```

Vignette

```
---
title: "is_prime demonstration"
author: "Richel Bilderbeek"
date: "`r Sys.Date()`"
output: rmarkdown::html_vignette
vignette: >
  %\VignetteIndexEntry{Richel Bilderbeek}
  %\VignetteEngine{knitr::rmarkdown}
  %\VignetteEncoding{UTF-8}
---

Density of primes should decrease:

```{r}
library(my_is_prime)
xs <- seq(1,100)
ys <- is_prime(xs)
plot(xs, ys)
```
```

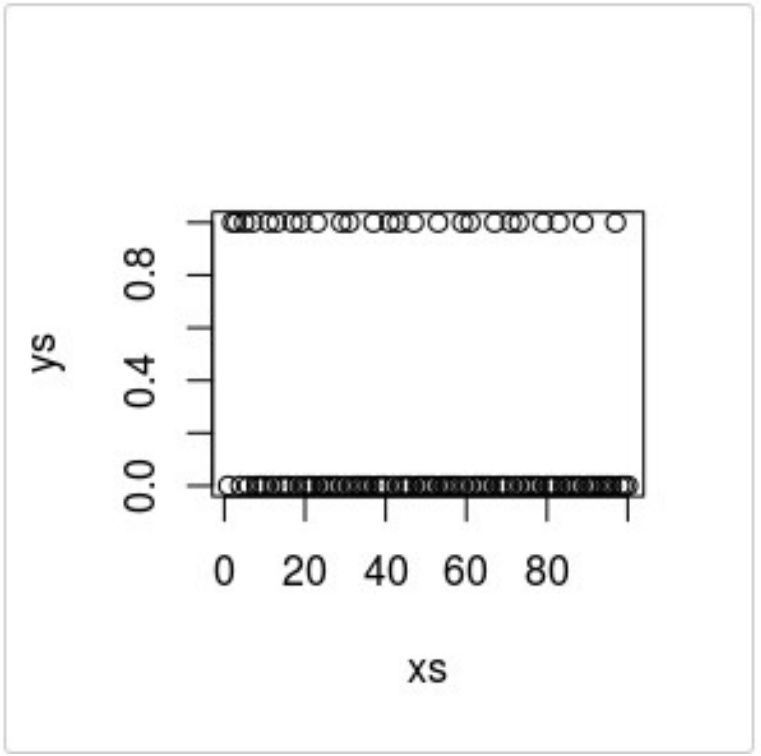
is_prime demonstration

Richel Bilderbeek

2016-04-17

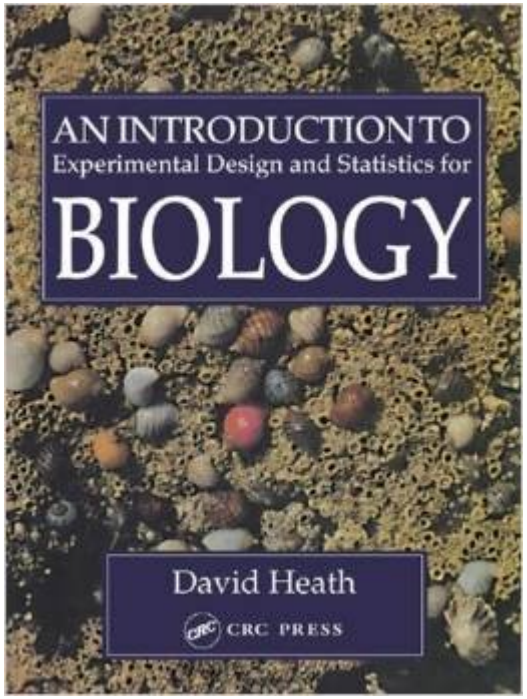
Density of primes should decrease:

```
library(testr)
xs <- seq(1,100)
ys <- xs
for (i in seq(1,length(ys))) { ys[i] <- is_prime(ys[i]) }
plot(xs, ys)
```



Collaboration

- Tests can be used as a mean to let others contribute
- Example:
  - I implemented a Wilcoxon's signed rank test, especially a function to get the rank of each value, following Heath
  - Later, Senbong G contacted me and helped us fix my function
- In this example, syntax is not important



C++ tests

```
values   = { 10.0, 20.0, 30.0 };
expected = {  1.0,  2.0,  3.0 };
results = GetRanks(values);
assert(expected == results);
```

```
values   = { 30.0, 10.0, 20.0 };
expected = {  3.0,  1.0,  2.0 };
results = GetRanks(values);
assert(expected == results);
```

C++ tests

```
//From Heath, page 263
values   = { 0.6, 1.4, 4.0, 13.0, 14.5, 9.4, 11.4, 12.6, 4.0 };
expected = { 1.0, 2.0, 3.5,  8.0,  9.0, 5.0,  6.0,  7.0, 3.5 };
results = GetRanks(values);
// Heath, page 263, no zero value
assert(expected == results);
```

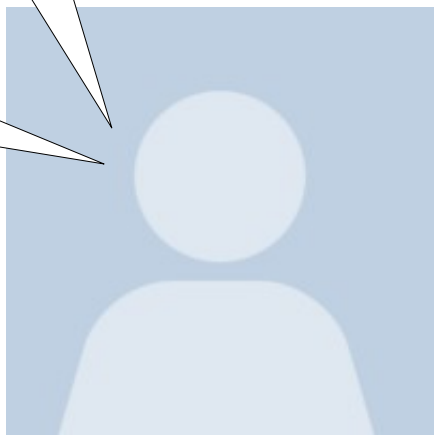
```
//From Heath, page 263, now with zero added
values   = { 0.6, 1.4, 0.0,  4.0, 13.0, 14.5, 9.4, 11.4, 12.6, 4.0 };
expected = { 1.0, 2.0, 0.0,  3.5,  8.0,  9.0, 5.0,  6.0,  7.0, 3.5 };
results = GetRanks(values);
// Heath, page 263, with zero value
assert(expected == results);
```

Email from Senbong G

I think I found a bug

How can that be?
Can you convince me with a test?

Sure, the tests on the next slide all fail



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Senbong G

C++ tests

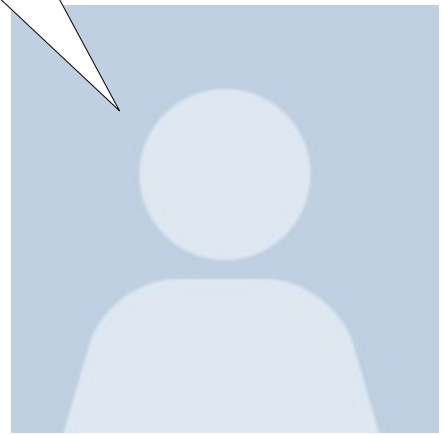
```
values   = { 1.0, 1.0, 1.0, 2.0, 2.0, 3.0, 3.0, 3.0};
expected = { 2.0, 2.0, 2.0, 4.5, 4.5, 7.0, 7.0, 7.0};
results = GetRanks(values);
assert(expected == results);
```

Email from Senbong G

Blimey, you're right!
I'll fix it within a week

No need to,
I already did,
here is the code

Thanks!



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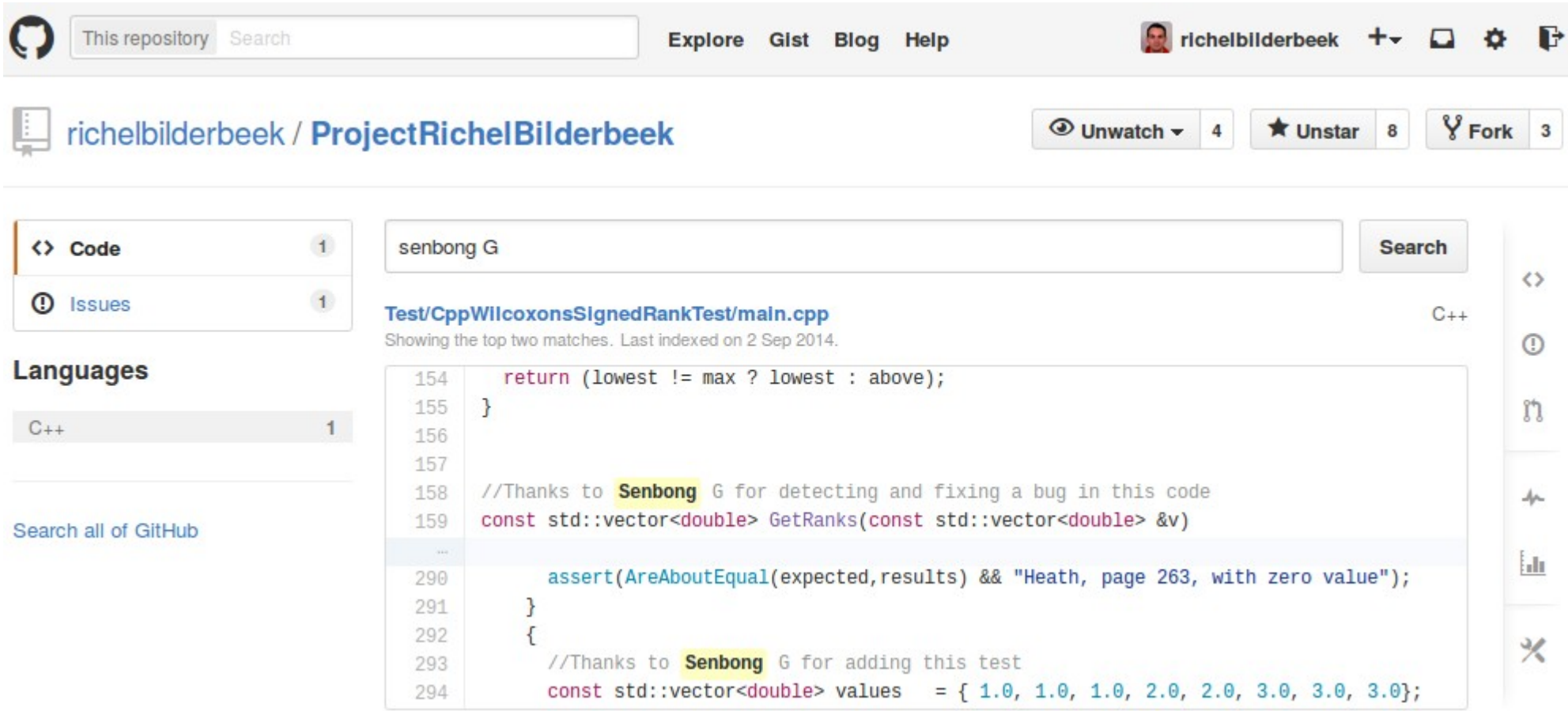
Senbong G

Eternal glory



Conclusion

- Test-driven development
  - uses a systematic approach
  - has guidelines for a lower and upper limit of tests
  - facilitates collaboration