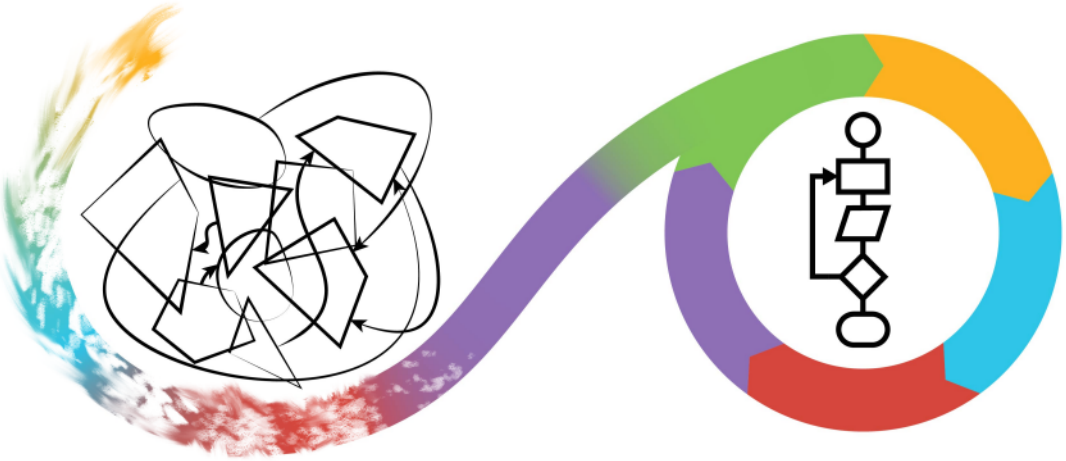
Test-Driven Development

Richèl Bilderbeek

1 The Big Picture

https://github.com/UPPMAX/programming_formalisms/blob/main/tdd/tdd_lecture/tdd_lecture.qmd



1.1 Breaks

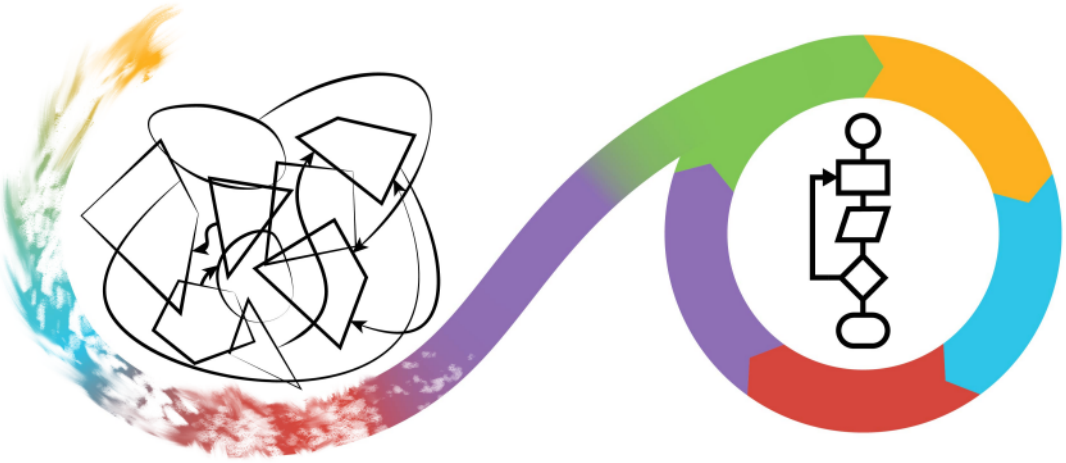
Please take breaks: these are important for learning. Ideally, do something boring (1)!

1.2 Schedule

Day	From	To	What
Wed	9:00	10:00	TDD: `is_even`
Wed	10:00	10:15	Break
Wed	10:15	11:00	TDD: `is_odd`

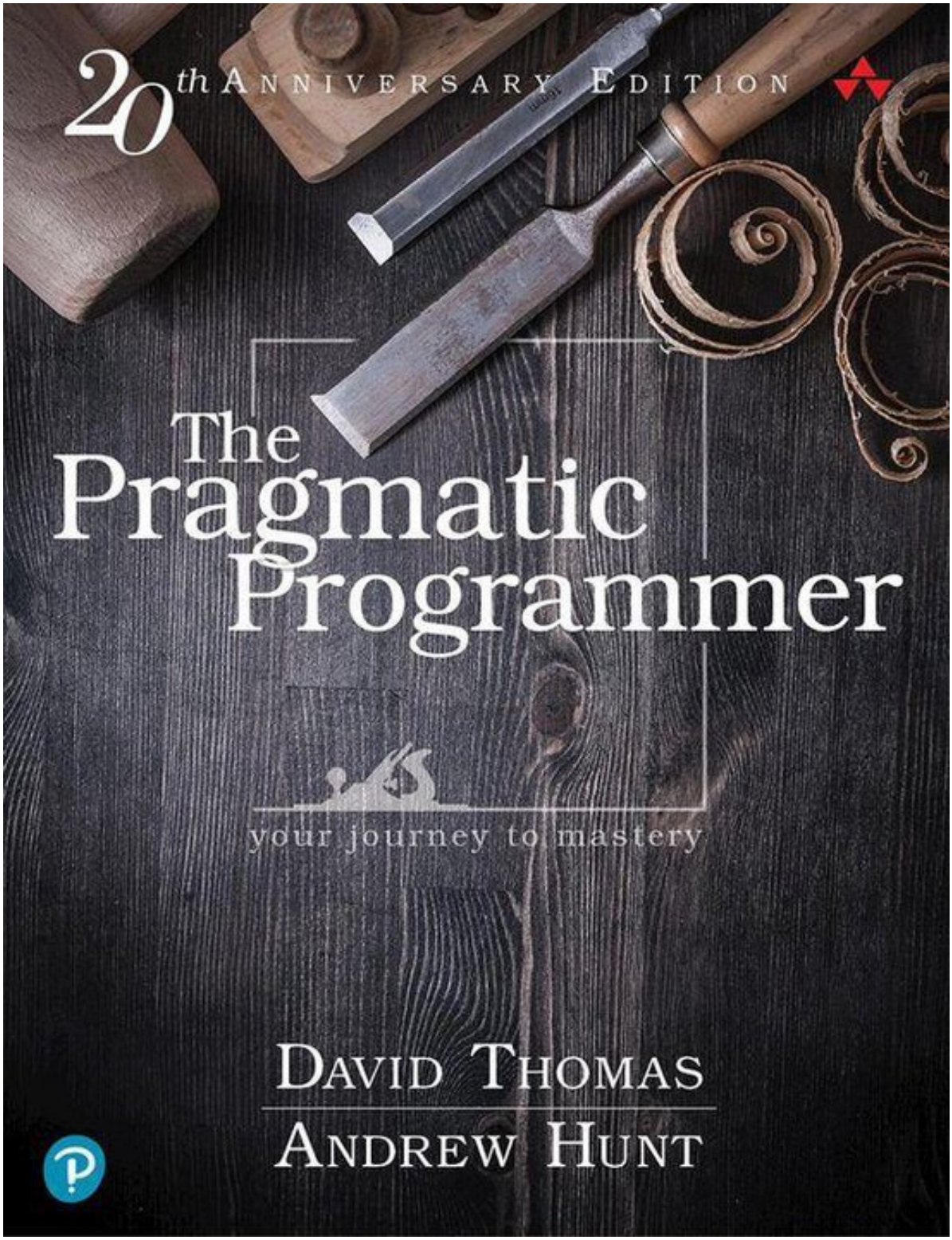
Day	From	To	What
Wed	11:00	11:15	Break
Wed	11:15	12:00	TDD: `is_probability`
Wed	12:00	13:00	Lunch

2 Growing code



2.1 Problem

How do you grow/develop your code?


20th Anniversary Edition
The Pragmatic Programmer
your journey to mastery
David Thomas
Andrew Hunt

2.2 Newbie developers

'Just start somewhere'

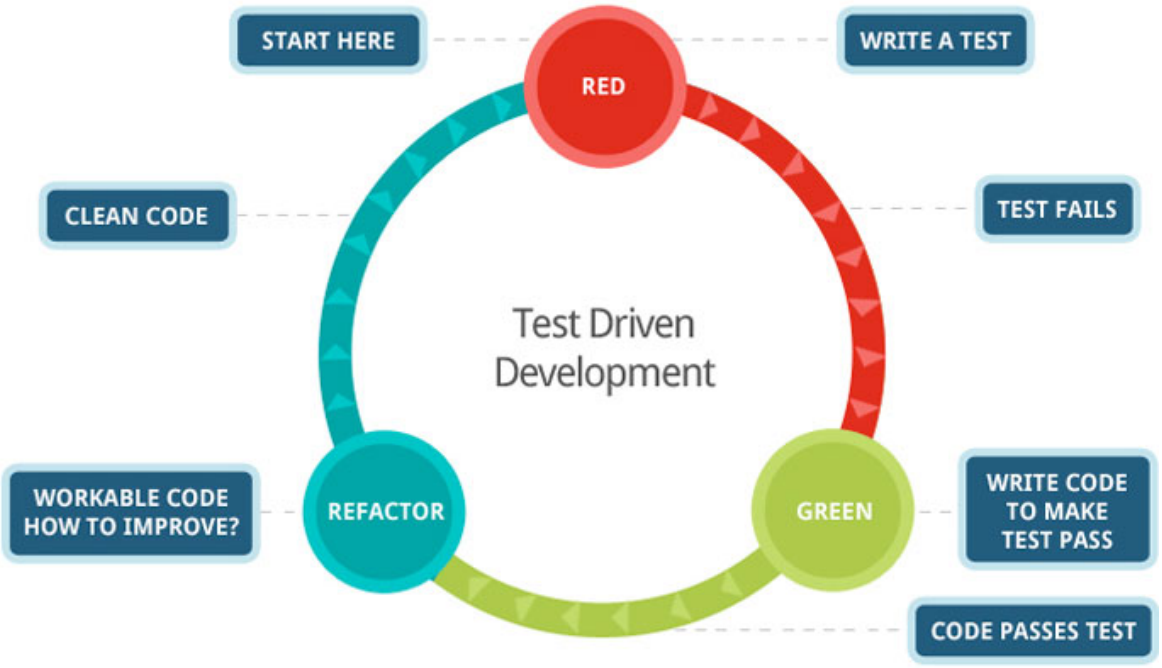
2.3 Experienced developers

Work systematically

2.4 TDD

Short for ‘Test-driven development’. A systematic way to grow code, used in academia and industry. It works (2)!

2.5 TDD cycle



3 Example exercise: `is_zero`

- Only observe, no type-along!
- Ask questions on the go! When in doubt: ask that question!
- Time: 15 minutes

3.1 Example exercise: `is_zero`

- Function name: `is_zero`
- Output:
  - Returns `True` if the input is zero
  - Returns `False` if the input is not zero
  - Gives an error when the input is not a number
- Zen Of Python: 'Errors should never pass silently'

3.2 Example exercise: `is_zero`, social

- Ping-Pong Pair programming
- Discuss how and when to switch roles first!
- Person with first name first in alphabet starts
- Try to be **an exemplary duo**

3.3 Example exercise: `is_zero` technical

- Use the GitHub repository for the learners of this course, https://github.com/programming-formalisms/programming_formalisms_project_autumn_2023
- Work on the main branch
- Work in a file called `learners/[your_name]/is_zero.py`, where `[your_name]` is the person with first name first in alphabet

3.4 Live demo (15 minutes)

- Only observe, no type-along!

Videos:

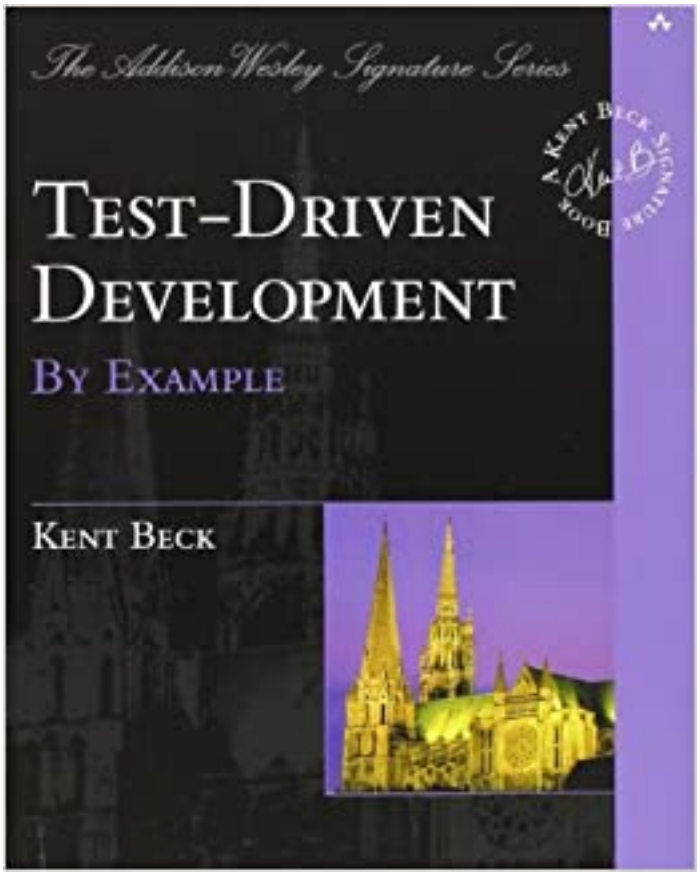
- **Python video for 'is_zero'**, from 3:02
- R video for 'is_one'
- Or see also slides beyond end

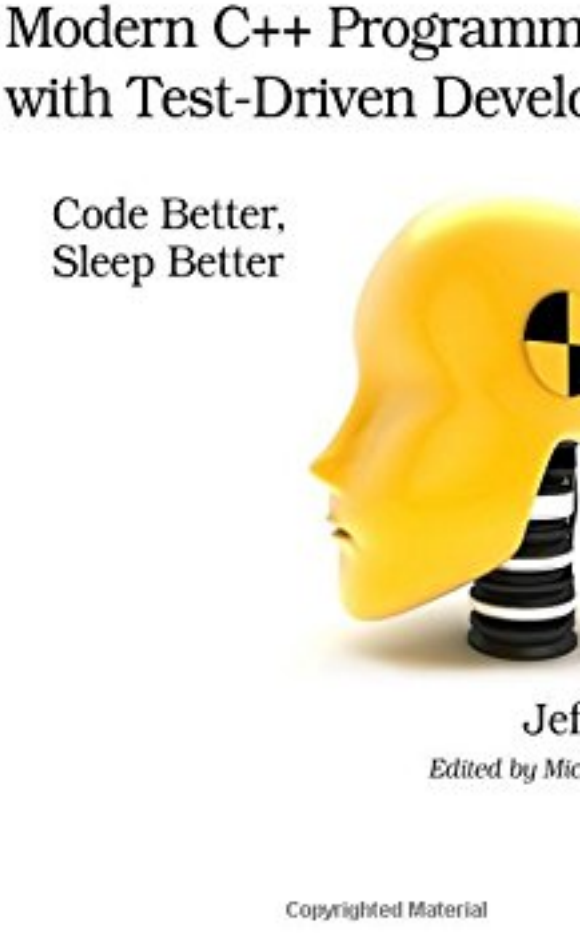
3.5 Reflection

Q: Do developers really do this?

. . .

A: Yes (3)(4)





4 Exercise 1: `is_even`

- Time: 30 mins

4.1 Exercise 1: `is_even` (30 mins)

- Develop a function called `is_even`
- Output:
  - Returns `True` if the input is even
  - Returns `False` if the input is not even
  - Gives an error when the input is not a number
- Try to be **exemplary**
- We'll discuss a random commit history

4.2 Exercise 1: `is_even` social (30 mins)

- Ping-Pong Pair programming
- Discuss how and when to switch roles first!
- Person with first name first in alphabet starts
- Try to be **an exemplary duo**

4.3 Exercise 1: `is_even` technical (30 mins)

- Use the GitHub repository for the learners of this course
- Work on the main branch
- Create a file called `learners/[your_name]/is_even.py`

Done? Write `is_odd`, then `is_probility`.

4.4 Exercise 1 feedback

☐ Ask for a volunteer for feedback

- If none: pick a random folder

☐ Discuss history

4.5 Reflection

Q: Does this really save time?

. . .

A: No, it takes longer

Study	Extra time	Effect
(5)	16%	18% more black-box tests pass
(6)	15%	2x higher code quality
(7)	15-35%	40%-90% less defects

4.6 Reflection

Q: Why do TDD?

. . .

A:

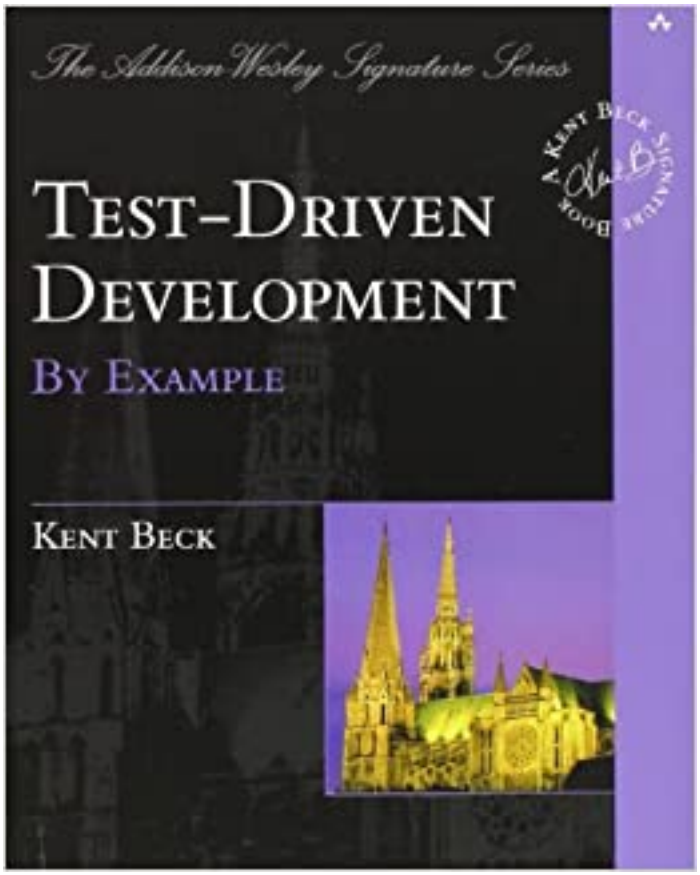
- TDD makes developers more productive (8)
- TDD increases quality of the code (8) (9) (10)
  - There are plenty of costly programming mistakes documented!
- TDD helps shape the project architecture (11)
- TDD helps better modularisation (12)
- TDD works great with Xtreme programming and CI

4.7 Reflection

Q: How many tests should I write?

. . .

A: Until you cannot break your function anymore (3)(4)



5 Exercise 2: `is_odd`

- Time: 30 mins

5.1 Exercise 2: `is_odd` (30 mins)

- Develop a function called `is_odd`
- Output:
  - Returns `True` if the input is odd
  - Returns `False` if the input is not odd
  - Gives an error when the input is not a number
- Try to be **exemplary**
- We'll discuss a commit history after the exercise

5.2 Exercise 2: `is_odd` social (30 mins)

- Ping-Pong Pair programming
- Discuss how and when to switch roles first!
- Person with first name first in alphabet starts
- Try to be **an exemplary duo**

5.3 Exercise 2: `is_odd`, technical (30 mins)

- Use the GitHub repository for the learners of this course, e.g. https://github.com/programming-formalisms/programming_formalisms_project_autumn_2023
- Work on the main branch
- Use a file called `learners/[your_name]/is_odd.py`

Done? Try exercise 3: `is_probability`.

5.4 Exercise 2 feedback

☐ Ask for a volunteer for feedback
  - If none: pick a random folder

☐ Discuss history

6 Exercise 3: `is_probability`

- Time: 30 mins

6.1 Exercise 3: `is_probability` (30 mins)

- Develop a function called `is_probability`
- Output:
  - Returns `True` if the input is in range [0.0, 1.0]
  - Returns `False` if the input is outside that range
  - Gives an error when the input is not a floating point number
- Try to be **exemplary**
- We'll discuss a commit history after the exercise

6.2 Exercise 3: `is_probability` social (30 mins)

- Ping-Pong Pair programming
- Discuss how and when to switch roles first!
- Person with first name first in alphabet starts
- Try to be **an exemplary duo**

6.3 Exercise 3: `is_probability`, technical (30 mins)

- Use the GitHub repository for the learners of this course
- Work on the main branch

- Use a file called `learners/[your_name]/is_probability.py`

6.4 Exercise 3 feedback

☐ Ask for a volunteer for feedback

  - If none: pick a random folder

☐ Discuss history

6.5 Extra exercises

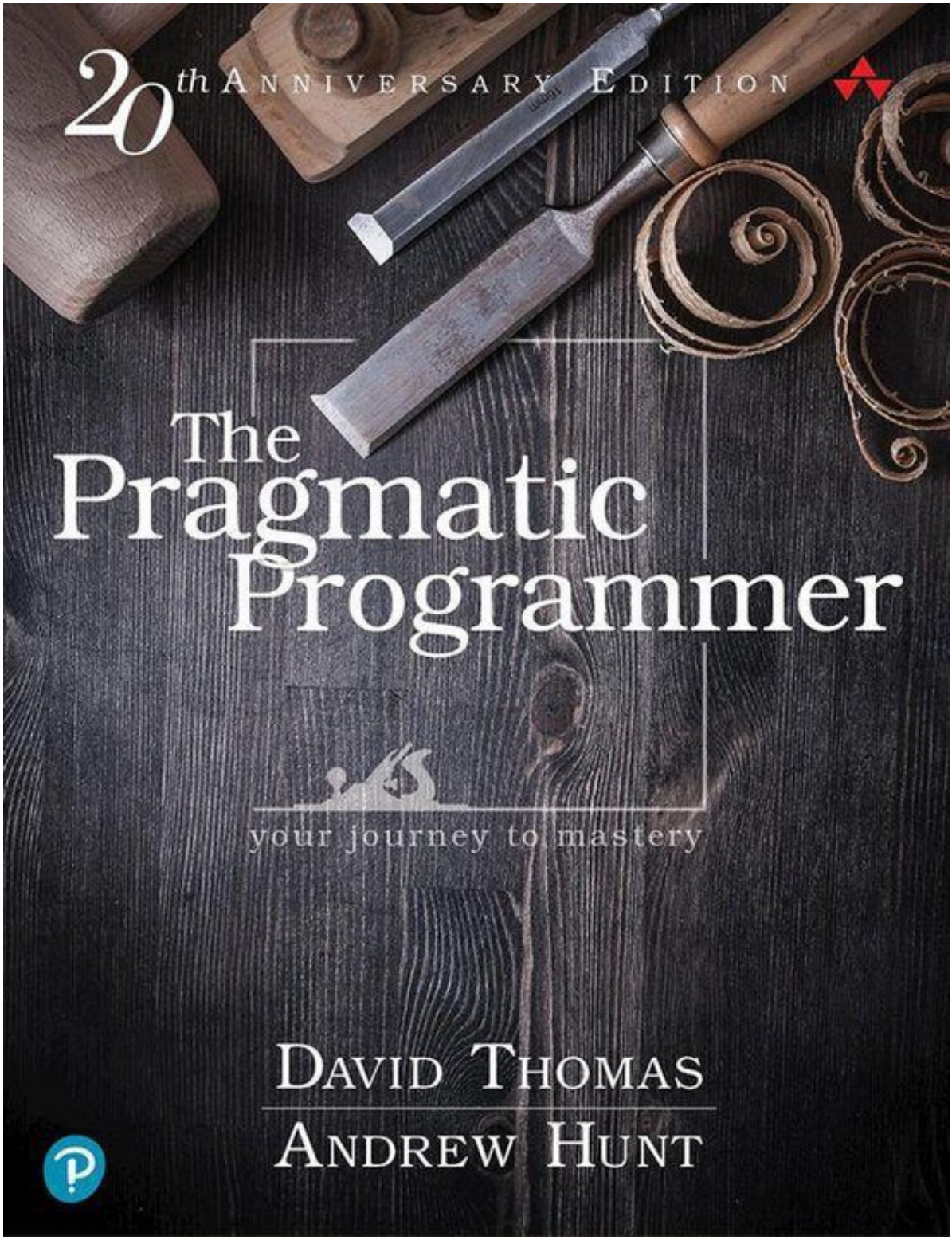
Done?

Exercise	Function name	Function purpose
4	`is_number`	Determines if an object is a number

Exercise	Function name	Function purpose
5	`are_numbers`	Determines if an object is a list of numbers
S1	`is_roman_number`	Determine if a string is a roman number
S2	`is_prime`	Determine if a number is a prime number

6.6 Bottom line

- This session, we wrote **unit tests**
- It is only those your boss may read
- The literature assumes a responsible programmer writes tests, in C++ (13), R (14) and Python (15)


20th Anniversary Edition
The Pragmatic Programmer
your journey to mastery
David Thomas
Andrew Hunt

6.7 Weaknesses

- We only test manually
- We only test on our own computer
- We are not sure if our functions are tested completely
- We do not test the code for style
- We should consider using a testing framework

These are addressed in the session called 'Testing' :-)

6.8 Questions?

Questions?

6.9 The End

6.10 TDD cycles in text

- In both Python and R

6.11 First example: `is_zero`

- Function name: `is_zero`
- Output:
  - Returns `True`/`TRUE` if the input is zero
  - Returns `False`/`FALSE` if the input is not zero
  - Gives an error when the input is not a number

6.12 Cycle 1, red: write a test that breaks

```
assert is_zero(0)
```

```
library(testthat)
expect_true(is_zero(0))
```

code that is not run, uses , as a worm cannot run.

6.13 Cycle 1, green: make the test pass

```
def is_zero(number):
  return True

assert is_zero(0)
```

```
library(testthat)

is_zero <- function(number) {
  TRUE
}

expect_true(is_zero(0))
```

6.14 Cycle 1, blue: refactor and commit

```
git add .
git commit -m "Add stub of 'is_zero'"
git push
```

6.15 Cycle 2, red: write a test that breaks

```
assert is_zero(0)
assert not is_zero(42)
```

```
expect_true(is_zero(0))
expect_false(is_zero(42))
```

6.16 Cycle 2, green: make the test pass

```
def is_zero(x):
  return x == 0

assert is_zero(0)
assert not is_zero(42)
```

indent of 2 is non-standard, see PEP 8

```
library(testthat)

is_zero <- function(number) {
  number == 0
}

expect_true(is_zero(0))
expect_false(is_zero(42))
```

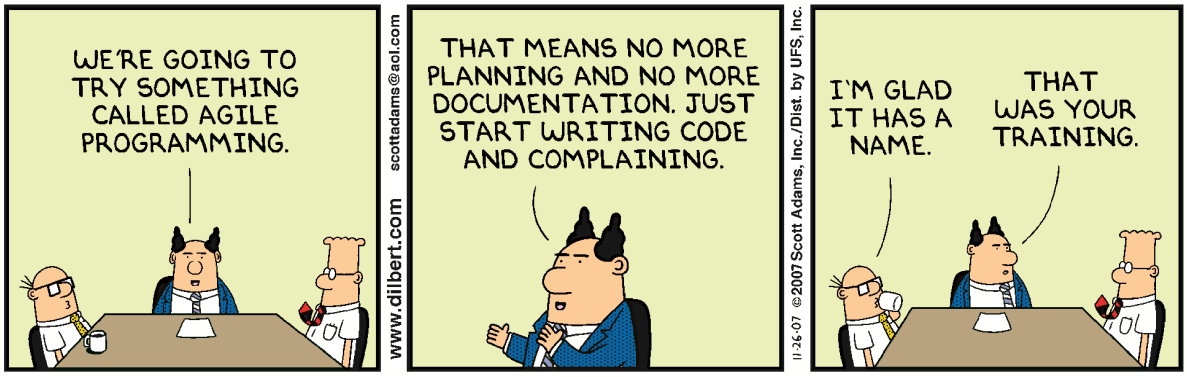
6.17 Cycle 2, blue: refactor and commit

```
git add .
git commit -m "'is_zero' responds correctly to numbers"
git push
```

7 Breaks

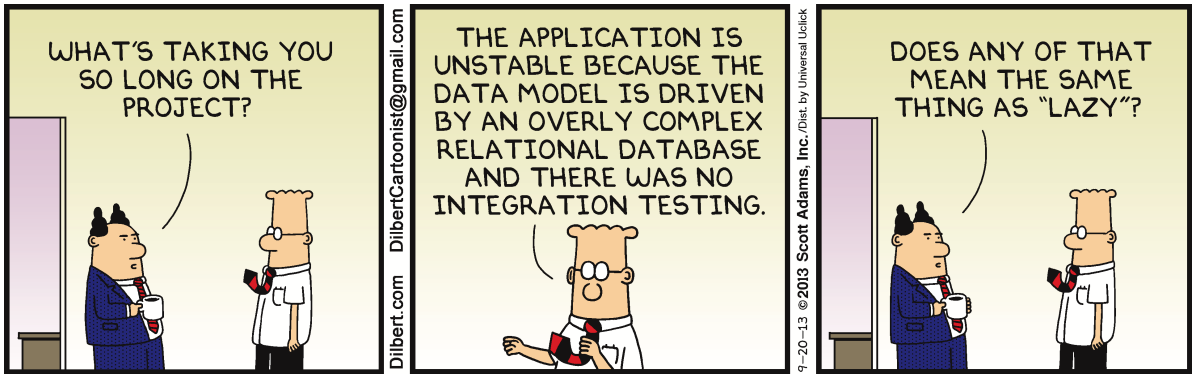
I put the break slides in the end

7.1 Break 1: 10:00-10:15



7.2 Break 2: 11:00-11:15

7.3 Lunch: 12:00-13:00



References

1. Newport C. Deep work: Rules for focused success in a distracted world. Hachette UK; 2016.
2. Martin RC. The clean coder: A code of conduct for professional programmers. Pearson Education; 2011.
3. Beck K. Test driven development: By example. Addison-Wesley Professional; 2022.
4. Langr J. Modern c++ programming with test-driven development: Code better, sleep better. Modern C++ Programming with Test-Driven Development. 2013;1–368.
5. George B, Williams L. A structured experiment of test-driven development. Information and software Technology. 2004;46(5):337–42.
6. Bhat T, Nagappan N. Evaluating the efficacy of test-driven development: Industrial case studies. In: Proceedings of the 2006 ACM/IEEE international symposium on empirical software engineering. 2006. p. 356–63.
7. Nagappan N, Maximilien EM, Bhat T, Williams L. Realizing quality improvement through test driven development: Results and experiences of four industrial teams. Empirical Software Engineering. 2008;13:289–302.
8. Erdogmus H, Morisio M, Torchiano M. On the effectiveness of the test-first approach to programming. IEEE Transactions on software Engineering. 2005;31(3):226–37.
9. Alkaoud H, Walcott KR. Quality metrics of test suites in test-driven designed applications. International Journal of Software Engineering Applications (IJSEA). 2018;2018.
10. Janzen DS, Saiedian H. Test-driven learning: Intrinsic integration of testing into the CS/SE curriculum. Acm Sigcse Bulletin. 2006;38(1):254–8.
11. Mayr H. Projekt engineering: Ingenieurmäßige softwareentwicklung in projektgruppen. Hanser Verlag; 2005.
12. Madeyski L, información G de sistemas de. Test-driven development: An empirical evaluation of agile practice. Springer; 2010.
13. Stroustrup B, Sutter H, et al. C++ core guidelines. Web Last accessed February. 2018;
14. Wickham H. Advanced R. CRC press; 2019.
15. Van Rossum G, Warsaw B, Coghlan N. PEP 8–style guide for Python code. Python org. 2001;1565.