Reading Code, Debug

Problem Solving using Python - Week 6

Week 6 - Learning Objectives

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1. ... read code in a methodical and thoughtful manner.

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You will be able to

1. ... read code in a methodical and thoughtful manner.
2. ... *debug* code well.

Motivation - Reading Code and Debug?

How will we Learn to Read Code and to Debug?

How will we Learn to Read Code and to Debug?

Étude

How will we Learn to Read Code and to Debug?

Étude

> "An instrumental musical composition, usually short, of considerable difficulty, and designed to provide practice material for perfecting a particular musical skill." - Wikipeida

Reading Code

Why do we Read Code?

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2. Modifying a Program

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1. **Debugging a Program** - Étude!
2. Modifying a Program
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Let's Extract the Structure of a Natural Language Text

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> "(1) People say that a dog ”knows” its name (2) because it comes when it is called, and (3) that it ”remembers” its master, (4) because it looks sad in his absence, but (5) wags its tail and barks when he returns." - Bertrand Russell, The Analysis of Mind, Lecture I.

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> "(1) The fact is that, as a rule, a specific protein is produced by a cell in very small quantities, sometimes a mere one or two molecules per cell. (2) As a result, the production of proteins needed for particular research becomes an arduous and costly undertaking. (3) One has to process dozens of kilograms, nay tons, of biomass to obtain milligrams of protein. (4) Despite such meager quantities, it is still not possible to ensure the necessary purity of the protein. (5) Hence, the costs of many protein preparations are exorbitant and their purity is substandard." - Maxim D. Frank-Kamenetskii, Unraveling DNA, trans. Lev Liapin (New York: VCH Publishers, 1993), 61.

Reading Code - What is it all about?

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- Program's Code = A Solution to a Programming Problem

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- The goal is to extract the design and its implementation details, in some sense, performing **reverse engineering** of the code

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> "When you do this exercise, think of yourself as an anthropologist, trucking through a new land with just barely enough of the local language to get around and survive. Except, of course, that you will actually get out alive because the internet isn't a jungle." - Zed Shaw in "Learn Python the Hard Way".

The Two Questions to Answer

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1. **What** is the *problem* that the program solves?

2. **How** does the problem solve the problem? What is the *design* of the code?

Reading Code Steps

The process of reading code echoes

the "Programming Problem Solving Model"

Reading Code Steps

1. Apply the *Reinterpret the Problem* Phase
2. Split the Code into Sections with Goals
3. Identify the Meaning of Each Variable
4. Generate Test Cases
5. Walk Through each Section

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5. Walk Through each Section

1. Identify sections in the code
   - Spaces, flow controls (loops, conditions), functions
2. Identify goals for each section
3. Use the Comments

Reading Code Steps

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5. Walk Through each Section

1. Variable Names
2. Look at the **Usage** of Each Variable
    1. Where the variable is **used**?
    2. Is the variable **modified**? **Where** is the variable modified (also defined)?
    3. *How* the variable is **used**?

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1. Follow Execution
2. Track Variables
    1. Think-aloud
    2. Written
3. Note to Indentation
4. Pay Attention in Conditions and Loops

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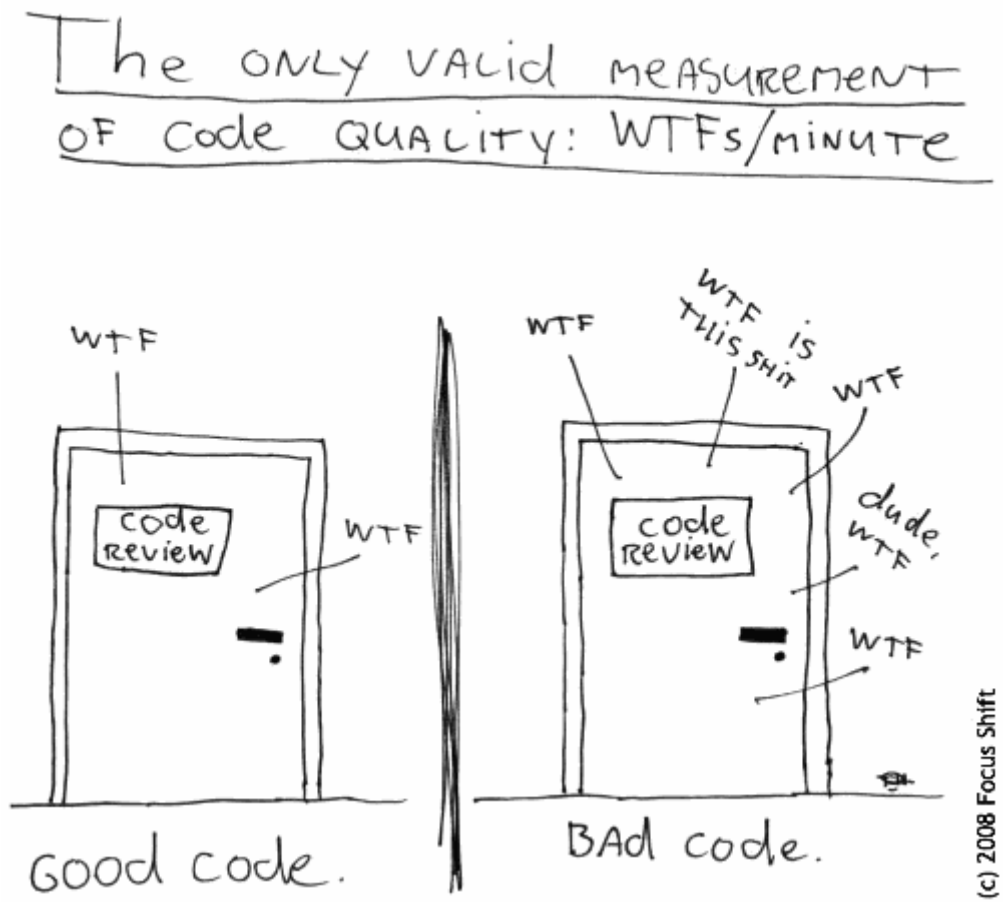
Reading Code
Wrap-up + Q&A

(this is not the end yet)


The ONLY VALID MEASUREMENT OF CODE QUALITY: WTFs/MINUTE
WTF
code review
WTF
!
Good code.
WTF
WTF is this shit
WTF
code review
dude, WTF
WTF
!
BAd code.
(c) 2008 Focus Shift

Debug Phase

Programming Problem Solving Model

1. Reinterpret the Problem
2. Design a Solution
3. Code
4. Test
5. Debug
6. Evaluate & Reflect

How to Avoid Debugging?

"Everyone knows that debugging is twice as hard as writing a program in the first place.

So if you're as clever as you can be when you write it, how will you ever debug it?"

Brian Kernighan in "The Elements of Programming Style" (1974)

How to Avoid Debugging?

1. Write **tests** at the Problem phase (e.g. using `asserts`)
2. Use **incremental development** = Get something working and keep it working
    1. Start small
    2. Keep it working

Problem  **Solution**

`assert`

🎉 🎊

How do you Debug?

How Debugging should not Look Like?

Why is Debugging Hard?

Programmer

Program

Why is Debugging Hard?

Programer Mental Gap **Program**

How to Debug? - The Fundamental Mindset

How to Debug? - The Fundamental Mindset

The Scientific Method

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The Scientific Method

Think Like ...

Empirical Scientist | **Detective** | **Doctor**

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Debugging Systematically

How to Debug? - The Fundamental Mindset

The Scientific Method

Think Like ...

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Debugging Systematically

Everyone is a suspect (Except Python)

The Four Questions to Answer

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1. **What** is the bug?
2. **Why** does the bug happen? What is the cause of the bug? What is the **root cause**?
3. **Where** in the code is the cause of the bug?
4. **What-if** I change the code like that...?

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> "Hercule Poirot's methods are his own. Order and method, and 'the little grey cells'." - The Big Four, in Agatha Christie

`is_prime`

Find the Failure - Test Phase

And Say "Eureka!"

`is_prime` - Test

```
for number in range(10):
    print(number, is_prime(number))
```

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1 False
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5 True
6 False
7 True
8 False
9 False
```

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The Debugging Process

1. **Reproduce** (What?)
2. **Diagnose** (Why? Where?)
3. **Fix** (What-if?)
4. Repeat until you fix the bug
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Collect Clues

1. The Bug Itself
    1. Input/Output
    2. Error messages & Traceback
2. Reading the Code (with a critical eye)
3. Results from the Test phase
4. Debugging Toolbox (`print`, comment in/out)

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Model the Cause(s) of the Bug

1. Formulate Hypothesis
2. Manipulate / Check
3. Accept / Reject
4. Keep Records

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Use Binary Search

How to catch lion in the desert?

> "Once you eliminate the impossible, whatever remains, no matter how improbable, must be the truth." - Sherlock Holmes, in Doyle Arthur Conan

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Debug Yourself

The Debugging Process

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2. **Diagnose** (Why? Where?)
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4. Repeat until you fix the bug
5. **Reflect**

> "The most effective debugging tool is still careful thought, coupled with judiciously placed print statements." - Brian Kernighan in "Unix for Beginners" (1979)

`show_day`

Test & Debug Phases

Your Turn!

The Debugging Process

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Rubber Duck Debugging

Source: UNIshop Potsdam

Debug Phase

Wrap-up + Q&A

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Q&A

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