# Reading Code, Debug

## Problem Solving using Python - Week 6

# Week 6 - Learning Objectives

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2. ... *debug* code well.

# Motivation - Reading Code and Debug?

# How will we Learn to Read Code and to Debug?

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## Étude

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## 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

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1. **Debugging a Program** - Étude!
2. Modifying a Program
3. Using a Program (Code as Documentation)
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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.

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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".

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

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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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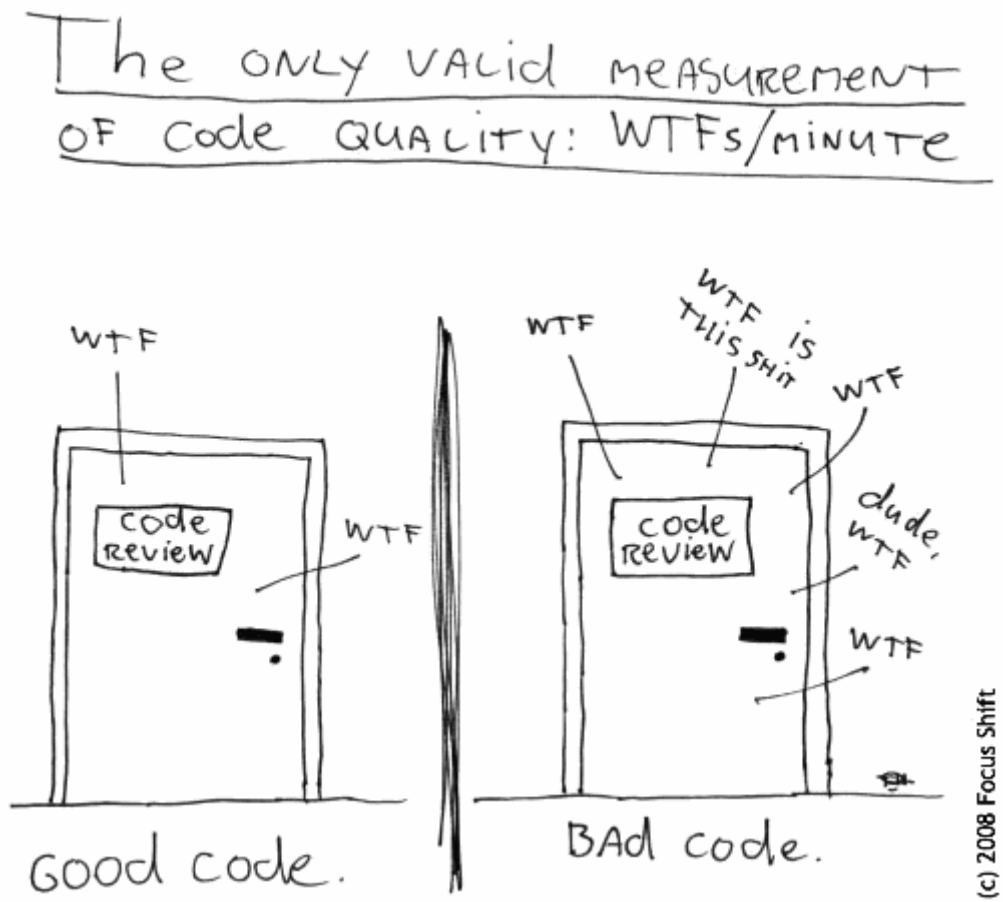
# Reading Code
# Wrap-up + Q&A

(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

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## The Scientific Method

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Think Like ...

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

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Debugging Systematically

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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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3 True
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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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> "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

> "Debugging is like being the detective in a crime movie where you are also the murderer." - Filipe Fortes

# Programming Problem Solving Model

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# Q&A

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