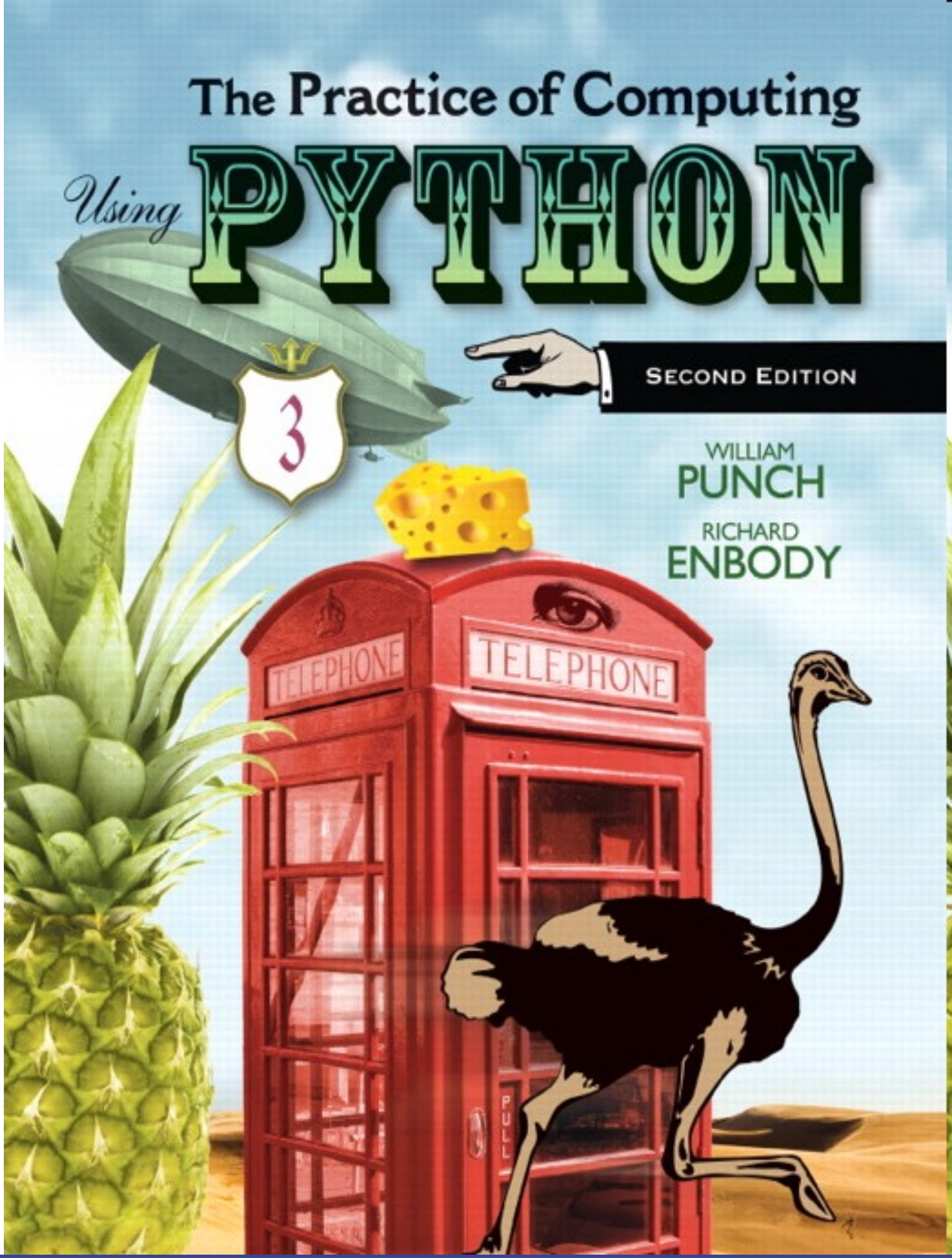
Chapter 3

Algorithms and Program Development



What is an algorithm

- process or a set of rules to be followed in calculations or other problem-solving operations

more informally

- a recipe for solving a problem

Example:Square Root Algorithm

1. Guess the square root of the number
2. Divide the working number by the guess
3. Average the quotient (from 2) and the guess
4. Make the new guess the average from step 3
5. If the new guess is "sufficiently different" from the old guess, go back to step 2, else halt.

Algorithm vs Program

- an ***algorithm*** is a description of how to solve a problem
- a ***program*** is an implementation of an algorithm in a particular language to run on a computer (usually a particular kind of computer)
- difference between ***what we want to do*** and ***what we actually did***

What’s the difference really?

- we can analyze the algorithm independent of its implementation. This is the science in Computer Science
- we can examine how easily, or with what difficulty, a language allows us to realize an algorithm
- we can examine how different computers impact the realization of an algorithm

Aspects of an algorithm

- ***Detailed***: Provide enough detail to be implementable. Can be tricky to define completely, relies on “common sense”
- ***Effective***: the algorithm should eventually halt, and halt in a “reasonable” amount of time. “reasonable” might change under different circumstances (faster computer, more computers, etc.)

Aspects of an Algorithm (2)

- ***Specify Behavior***: the algorithm should be specific about the information that goes in (quantity, type, etc.) and the information that comes out.
- ***General Purpose***: algorithms should be idealized and therefore general purpose. A sorting algorithm should be able to sort anything (numbers, letters, patient records, etc.)

A lot to do!

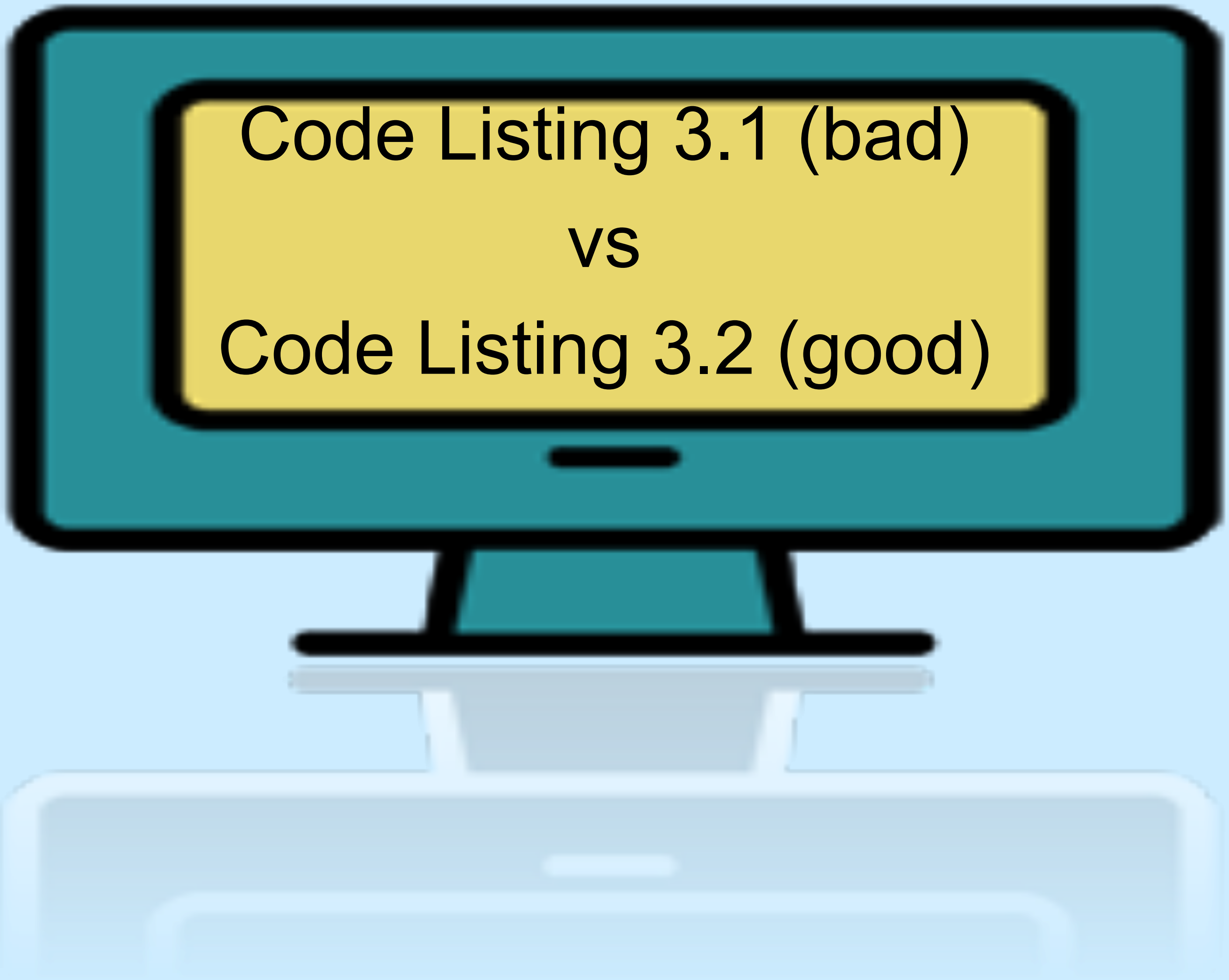
- That is a lot to do for the burgeoning programmer.
- Get better as we go along, but good to know what the standards are!

Aspects of a Program: Readability

- We will emphasize, over and over, that a program is an essay on problem solving intended to be read by other people, even if “other people” is you in the future!
- Write a program so that you can read it, because it is likely that sometime in the future ***you will*** have to read it!

Readability(2): Naming

- The easiest thing to do that affects readability is good naming
  - use names for the items you create that reflect their purpose
  - to help keep straight the types used, include that as part of the name. Python does not care about the type stored, but you do!
  - remember "lower with under"



Code Listing 3.1 (bad)
vs
Code Listing 3.2 (good)

```
a = input("give a number: ")
b,c=1,0
while b<=a:
    c = c + b
    b = b + 1
print(a,b,c)
print("Result: ", c/b-1)
```

versus

```
# Calculate the average of a sum of consecutive integers in a given range.

limit_str=input("Range is from 1 to your input:")

limit_int = int(limit_str)
count_int = 1
sum_int = 0
while count_int <= limit_int:
        sum_int = sum_int + count_int
        count_int = count_int + 1
average_float = sum_int/(count_int - 1)
print("Average of sum of integers from 1 to",limit_int,"is", average_float)
```

Readability(3): Comments

- info at the top, the goal of the code
- purpose of variables (if not obvious by the name)
- purpose of other functions being used
- anything ***tricky***. If it took you time to write, it probably is hard to read and needs a comment

Rule 6

If it was hard to write, it is probably hard to read. Add a comment.

Code Listing 3.3
Bad Comment Style

Code Listing 3.3

```
# Calculate the average of a sum of consecutive integers in a given range.

# input the value
limit_str=input("Range is from 1 to your input:")
#convert the input string to an input
limit_int = int(limit_str)
# assign 1 to the counting variable
count_int = 1
# assign 0 to the sum
sum_int = 0
# while loop runs while the counting variable is smaller than the input value

while count_int <= limit_int:
        # add the count and the sum, reassign to sum
        sum_int = sum_int + count_int
        # add one to the count
        count_int = count_int + 1
# calculate the average
average_float = sum_int/(count_int - 1)
# print the result
print("Average of sum of integers from 1 to",limit_int,"is", average_float)
```

Readability(4): Indenting

- indenting is a visual cue to say what code is “part of” other code.
- This is not always required as it is in Python, but Python forces you to indent.
- This aids readability greatly.

Aspects of Programming (2)

- ***Robust***: As much as possible, the program should account for inputs that are not what is expected. More on this with error handling in Chapter 14
- ***Correct***: Our programs should produce correct results. Much harder to ensure than it looks!

More on Problem Solving

The Problem is “Problem-Solving”

- Remember, two parts to our goal:
  - Understand the problems to be solved
  - Encode the solution
    in a programming language, e.g. Python

Mix of both

- The goal in each class is to do a little of both: problem solving and Python
- Terribly important that we impress on you *to try and understand how to solve the problem **first** before you try and code it.*

Steps to problem solving

- Engage/Commit
- Visualize/See
- Try it/Experiment
- Simplify
- Analyze/Think
- Relax

Engage

You need to commit yourself to addressing the problem.

- Don’t give up easily
- Try different approaches
- Set the “mood”

Just putting in time does not mean you put in a real effort!!!

Visualize/See the problem

Find a way that works for you,
some way to make the problem tangible.

- draw pictures
- layout tables
- literally “see” the problem somehow

Everyone has a different way, find yours!

Try it/Experiment

For some reason, people are afraid to just ***try*** some solution. Perhaps they fear failure, but experiments, done just for you, are the best way to figure out problems.

Be willing to try, and fail, to solve a problem. Get started, don't wait for enlightenment!

Simplify

Simplifying the problem so you can get a handle on it is one of the ***most powerful*** problem solving tools.

Given a hard problem, make is ***simplier*** (smaller, clearer, easier), figure that out, then ramp up to the harder problem.

Think it over/Analyze

If your solution isn't working:

- stop
- evaluate how you are doing
- analyze and keep going, or start over.

People can be amazingly "stiff", banging their heads against the same wall over and over again. Loosen up, find another way!

One more thing, relax

Take your time. Not getting an answer right away is not the end of the world. Put it away and come back to it.

You’d be surprised how easy it is to solve if you let it go for awhile. That’s why ***starting early*** is a luxury you should afford yourself.

Babylonian Square Root Example

Reminder, rules so far

1. Think before you program!
2. A program is a human-readable essay on problem solving that also happens to execute on a computer.
3. The best way to imporve your programming and problem solving skills is to practice!
4. A foolish consistency is the hobgoblin of little minds
5. Test your code, often and thoroughly
6. If it was hard to write, it is probably hard to read. Add a comment.