Review Sheet 5b

CS 70: Data Structures and Program Development

Thursday, Feb 20, 2020

Learning Targets

1. I can explain what testing is.
2. I can explain why testing is useful.

Review

Testing: Philosophy of Science Point of View

"My proposal is based on an asymmetry between verifiability and falsifiability; an asymmetry which results from the logical form of universal statements. For these are never derivable from singular statements, but can be contradicted by singular statements.""

- Karl Popper: The Logic of Scientific Discovery 1959

Program testing can be used to show the presence of bugs, but never to show their absence!

- Edsger Dijkstra. Notes On Structured Programming 1970

What does that have to do with testing?

What is the purpose of testing?

- To show that the code has no bugs? A nice ideal.
- Is exhaustive testing possible?
- Consider an application with input fields:
  - First Name: up to 20 characters
  - Last Name: up to 20 characters
  - Phone Number: 10 digits

The goal of testing is to *find errors*.

Why test during development?

Depends on the project.

- Not necessary in ALL cases
- Designing an interface for many other users? definitely test.
- In projects where one makes big design choices or there are multiple strategies, testing is especially important.

Test first?

Test first gives you a hint as to whether your interface suffices.

- Is it enough to solve a problem?

Test first suggests that your interface is even testable.

- Does your code actually have the *potential* to work?

Test first increases your velocity in general.

- You get to your solution quicker
- Get to see how far you have gotten and how much more you have until you reach your goal

What is a test?

A test should have several components:

- The test input or scenario
- The expected result
- Documentation
  - What part of the requirements is being tested?
  - What is the reasoning behind the test?

How do we test?

- Find a framework to make testing easy
  - i.e. the lightweight testing-logger we provided
- Testing Domain Specific Languages (DSLs)
- C++: gtest (an open source project, stands for Google Test).
- Python: pytest
- Java: junit, Truth

Equivalence Partitioning

What are some good test values for this function?

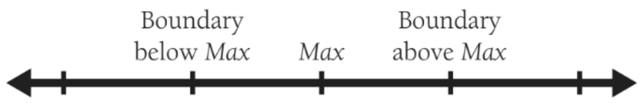
```
double compute(double x){
  double y = x + 1.0;
  if(y < 10.0){
    return y;
  }
  return 10;
```

Boundary Analysis

Extremely common mistakes:

- you write *num* when you meant *num - 1*
- you write >= when you meant >

Explicitly write tests to discover these types of errors.



```
double compute(double x){
  double y = x + 1.0;
  if(y < 10.0){
    return y;
  }
  return 10;
```

Explicitly test for bad data

Examples:

- Too little data: an empty vector
- Too much data: array of 1 million employees
- Invalid data: Negative student ID number
- Uninitialized data

Explicitly test for good data

Examples:

- Nominal data: middle of the road, expected data
  - e.g. 10 employees in database
- Minimum nominal configuration
  - e.g. 1 employee in database
- Maximum nominal configuration
  - e.g. 1,000 employees in database

Unit testing

Test individual units of code:

- typically, test every single function

How much testing is enough?

At a *minimum*

- Cover every statement
- Cover every branch

Integration testing

After individual units (e.g. functions) are tested, do they correctly work together?

Two main ways to combine units:

Output of one passed to the other

```
int x = function1(y);
int z = function2(x);
```

One function is called by another

```
int function3(int x){
  int y = function4(x)
  return y;
}
```

Integration testing with a Driver

For integration testing, a driver is a function or class whose sole purpose is to combine two or more units.

```
int driver(int y){
  x = function1(y);
  z = function2(x);
  return z;
}
```