CS 4350: Fundamentals of Software Engineering
CS 5500: Foundations of Software Engineering

Lesson 5.4 Testing Systems

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Outline of this lesson

1. How can we test complex systems?
2. What are some ways to substitute out parts of the system?

Learning Objectives for this Lesson

- By the end of this lesson, you should be able to:
  - Contrast “mocks” and “spies” in testing;
  - Describe the limitations of automated testing;
  - Give some useful examples of nondeterministic testing.

Large Systems are Hard to Test

- Database component
  - Contents may need to reflect/simulate real-world;
  - Data may be expensive/proprietary/confidential.
- Network connections
  - ”Real” connections may be slow/flaky/disrupted;
  - Resources may have changed since test was written.
- Environment
  - Interactions with OS, locale or other software.
- Human actors
  - Ultimately unpredictable.

Testing(!) framework “jest” didn’t install because of Turkish locale (Piazza @108 sp21)

Two Ways to Handle Difficulties

Pay the cost, do the test

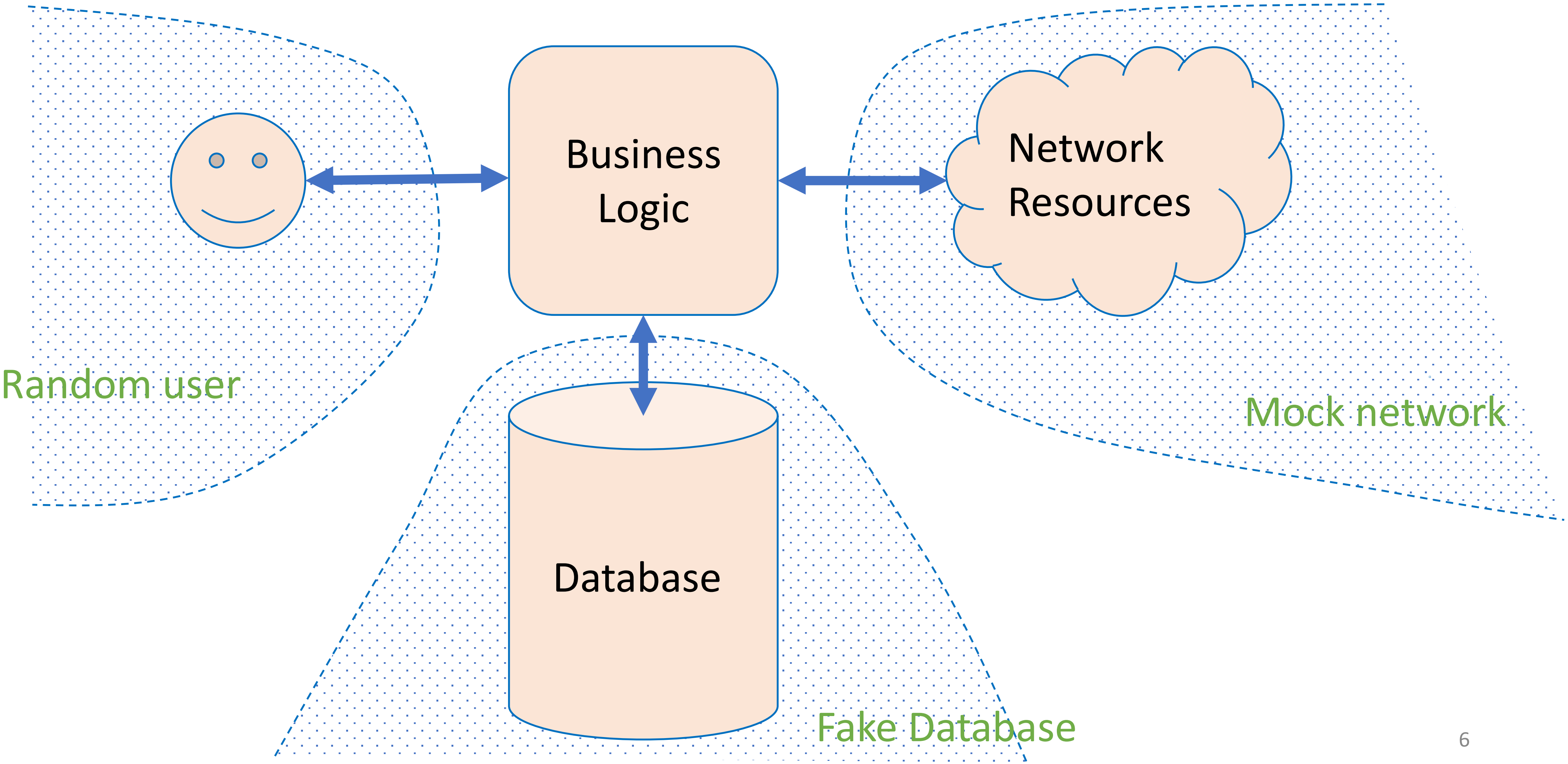
- A large test can reveal problems that smaller tests can't.
- Choose particular times (rare!) to do particular large tests.
- An "enormous" test at Google simulated an earthquake in Mountain View, CA.
- See Chapter 14 of SE@Google

Automate with tools:

- Use "Test Doubles"
  1. Stubs
  2. Mocks / Spies
  3. Fakes
- Random testing
  - "Fuzzing"
  - Against a reference implementation.

Rest of Lesson

Test Double Example



Test Stub

- Supply an object with the same interface:
  - Same methods;
  - Default result values.
- The stub gets the test to run:
  - If the client blindly uses the stub, it can proceed;
  - If the client expects something from the object, the test will likely fail.
- Need two more things:
  1. Remember how the stub was used;
  2. Tell the stub what to do when it is called.

Test Spies

- A test spy remembers how the object was called
  - Then the test harness can check what happened;
  - For example: a particular method should be called
    1. First with parameters “foo” and 42;
    2. Then with parameters “quux” and -88.
- A spy can be useful on the “real” object:
  - What was sent on the network?
  - How many times a problem was logged?
  - What was inserted in the database?
- But most often used with a “mock.”

Test Mocks

- A test mock has scripted results:
  - If such-and-such a method is called
    - return some particular value.
- A complex mock can have many scripts:
  - Multiple methods;
  - Different results for subsequent calls.
- Useful mocking assumes we know how mocked object will be used.
- If a “mock” has real logic, it becomes a “fake”.

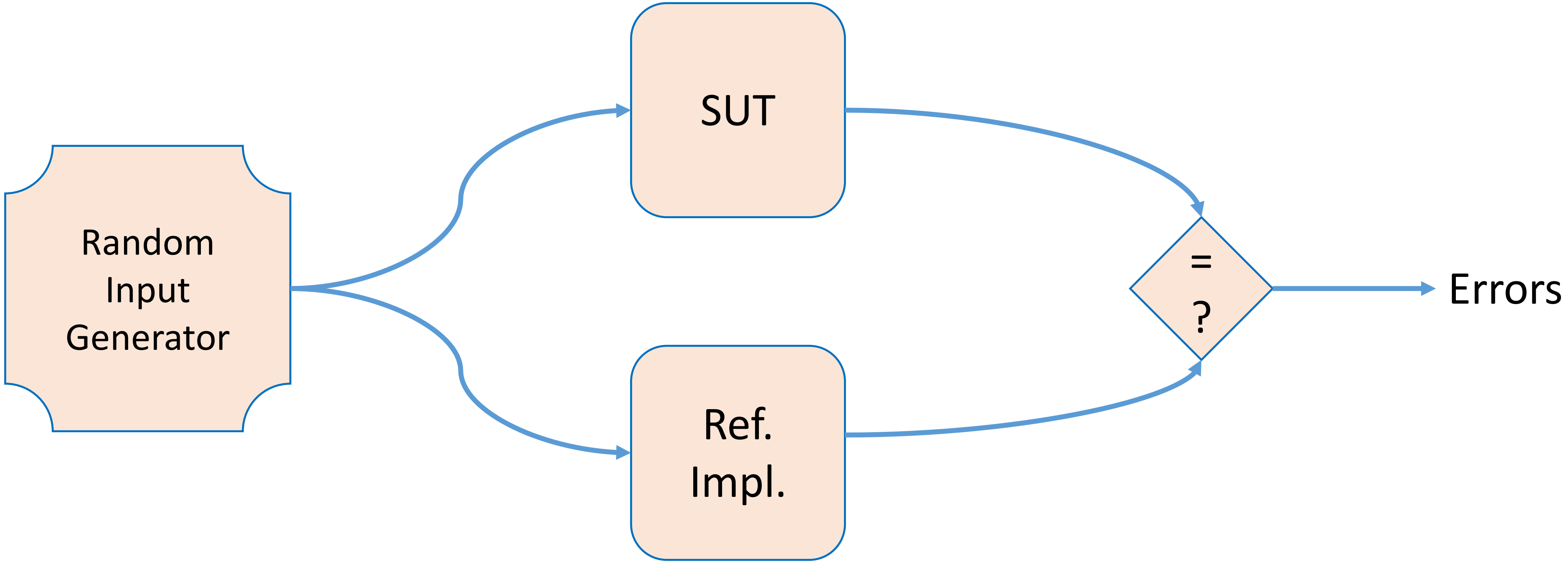
Test Fakes

- A *fake* has an implementation of the object being replaced
  - A *low-fidelity* fake implements things partially
    - Enough to work for the test.
  - A *high-fidelity* fake implements most aspects:
    - Usually all functional aspects;
    - Usually not as efficiently or as scalable.
- The purpose of the fake is to avoid processes/network/cost:
  - So the test can be cheap and deterministic.

Random Input

- To replace a user, we can program a “bot”
  - Randomly use mouse, press buttons;
  - Arbitrary text;
  - Fast or slow.
- Smarter (“Fuzzing”)
  - Capture real actions;
  - Then make targeted mutations.
  - (This applies also to programs taking text input.)
- Expected result can only be imprecise:
  - E.g., “not crash” or “not leak secrets”.

Related: Random Testing



Weaknesses of Test Doubles

- The Mock/Fake may not behave correctly
  - The test harness may assume wrong behavior;
  - Particularly an issue if original object changes
    - Mocks have to be maintained as well!
  - Solution: Test the mock/fake against a higher fidelity fake, or against the real thing.
- The SUT may use a different algorithm:
  - The Spies expect a particular usage of double;
  - The test is “brittle” because it depends on internal behavior of SUT;

Review: Learning Objectives for this Lesson

- You should now be able to:
    - Contrast “mocks” and “spies” in testing;
    - Describe limitations of automated testing;
    - Give some useful examples of nondeterministic testing.

Looking forward…

- In our next lesson, we'll discuss designing for the user experience.