CSE 3421

Software Testing

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Why This Lesson?

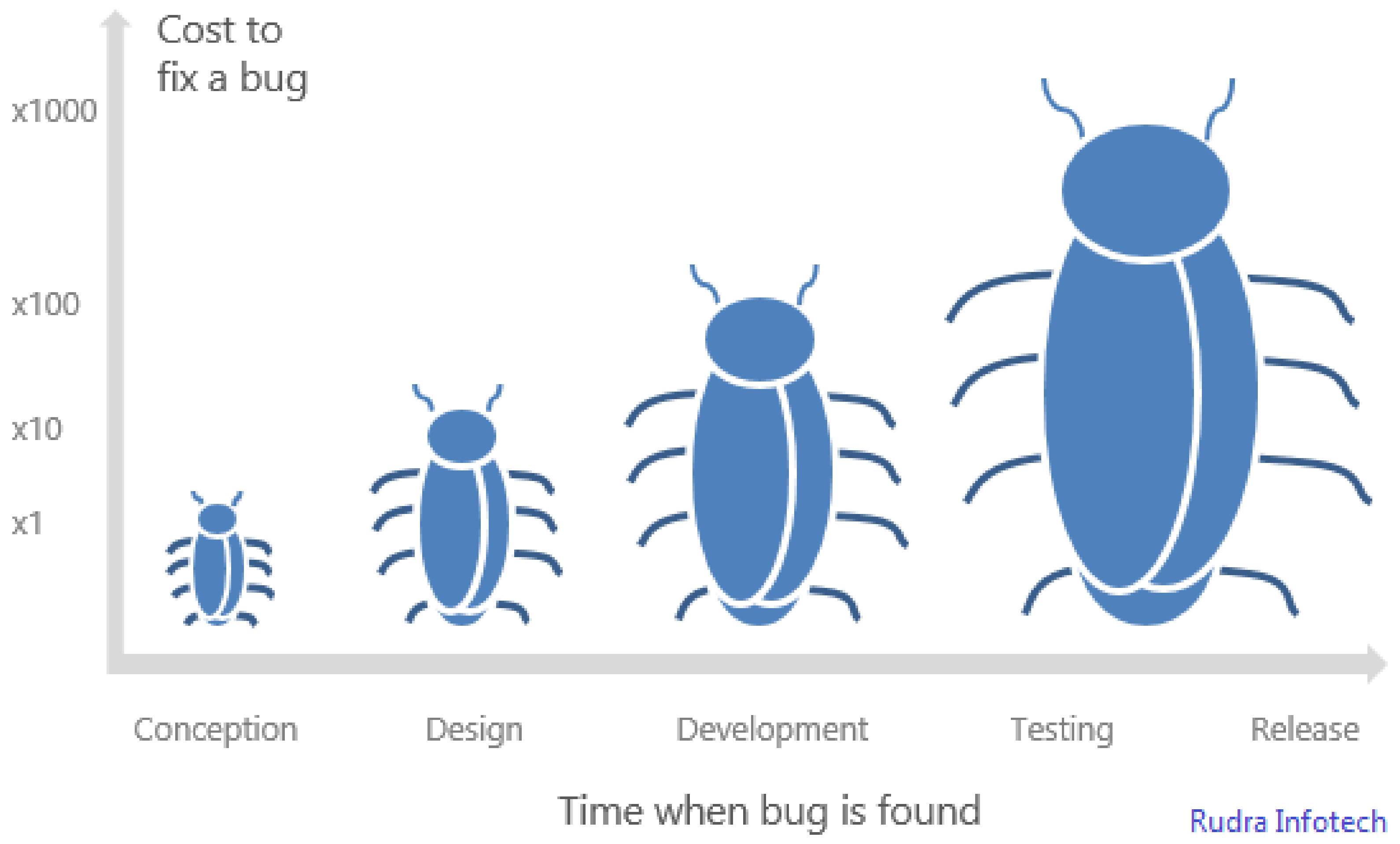
No customer likes to buy faulty products. Same goes for the software industry

What is software testing?

Software testing is the process of analyzing a software item to detect the differences between existing and expected conditions (i.e., bugs)

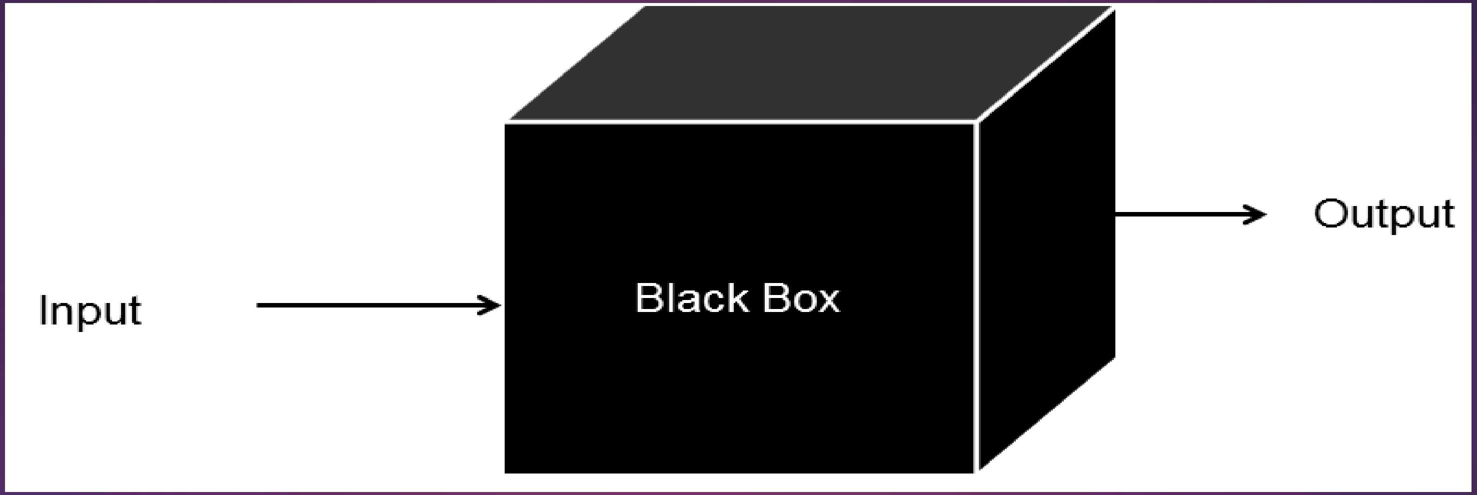
When should we test software?

Answer: Throughout the whole development process



Testing Models

Black box testing



Ignores the internal mechanism of a system or component and focuses solely on the outputs generated in response to selected inputs and execution conditions.

Black box testing

- Interface visible, internals unknown

- From the outside, you are testing its functionality against the specs

- For software this is testing the interface
  - What is input to the system?
  - What you can do from the outside to change the system?
  - What is output from the system?

- Tests the functionality of the system by observing its external behavior

Advantages

- Robust with respect to changes in implementation

  - Test data need not be changed when code is changed

- Allows for independent testers

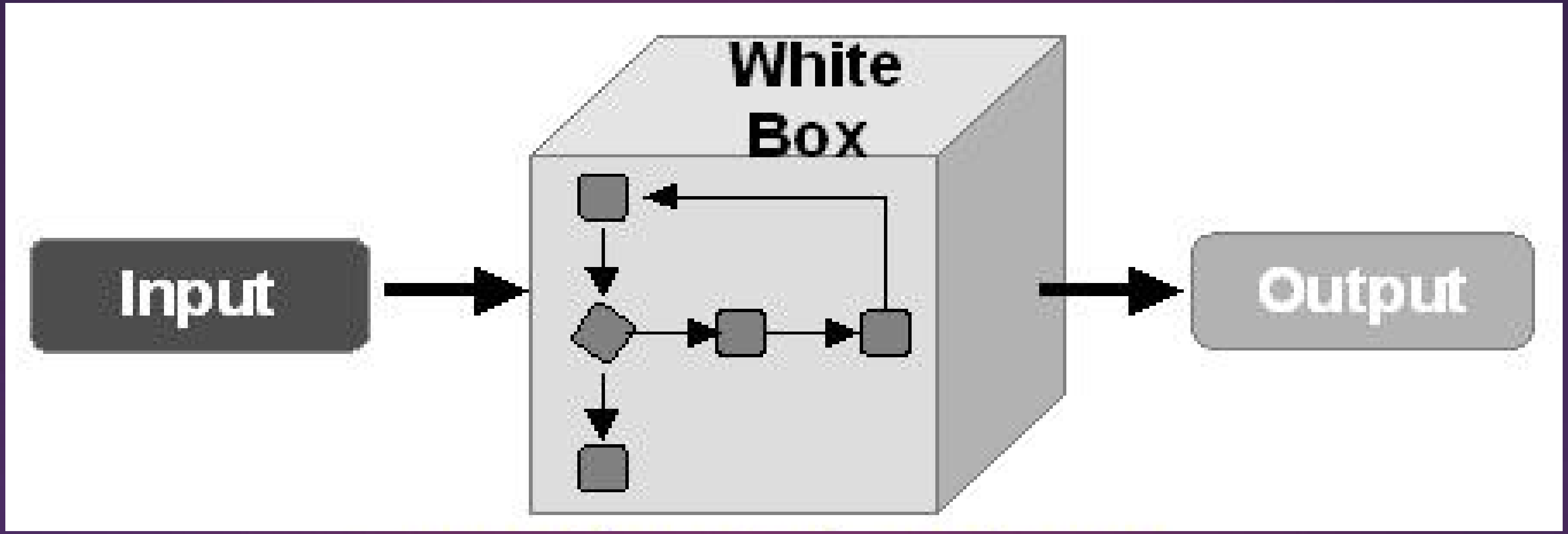
  - Testers need not be familiar with code

- Less time-consuming

Disadvantages

- It will miss bugs in the implementation that are not covered by the specification
- Does not allow performance optimization and alternate algorithms

White box testing



takes into account the internal mechanisms of a system or component.

White box testing

- Given knowledge of the internal workings, you thoroughly test what is happening on the inside

- Close examination of procedural level of detail

- Logical paths through code are tested
  - Conditionals
  - Loops
  - Branches

- Status is examined in terms of expected behaviors

Advantages

- Allows thorough testing of the software
- Helps finding hidden bugs & errors
- Yields useful test cases.
- Enables code optimization and experiment with alternate algorithms.

Disadvantages

- Impossible to thoroughly exercise all paths

  - Exhaustive testing grows without bound

- Requires Code Access

- Skilled tester required

  - Requires high level knowledge of internals of the software under test.

- More time-consuming

Functional testing

- **FUNCTIONAL TESTING** is a type of software testing whereby the system is tested against the functional requirements specifications (FRS).

- Functions (or features) are tested by feeding them input and examining the output.

- This type of testing is not concerned with how processing occurs, but rather, with the results of processing.

- During functional testing, Black Box Testing technique is used in which the internal logic of the system being tested is not known to the tester.

Non-Functional/ Technical testing

- **Technical TESTING** is a type of software to check non-functional aspects (performance, usability, reliability, security etc.) of a software.

- It is explicitly designed to test the readiness of a system as per nonfunctional parameters which are never addressed by functional testing

- It basically uses white-box testing, sometimes black box

Types of Testing

Unit testing

- Testing of individual software or hardware units or groups of related units
- Done by programmer(s)
- Generally white box
- Verify that code does what it is intended to do at a very low structural level
- Automation desirable for repeatability
- **Component Testing:** Almost identical to unit testing, except at a slightly larger scale

Integration testing

- Testing in which software components, hardware components, or both are combined and tested to evaluate the interaction between them
- Done by programmer as they integrate their code into code base
- Verifies that units work together when they are integrated into a larger code base
  - Just because the components work individually, that does not mean that they all work together when integrated
- Generally white box, maybe some black box
- Automation desirable for repeatability

System Testing

- **System testing** is testing conducted on a complete integrated system to evaluate the system's compliance with its specified requirements.
- System testing is performed on the entire system in the context of a Functional Requirement Specification(s) (FRS) and/or a Non-functional/Technical Requirement Specification that in combination generate Software Requirement Specification (SRS).
- So, it covers non-functional requirements as well.

Load, and Stress Testing

- **Load testing** is a kind of Performance Testing which determines a system's performance under real-life load conditions. **Load testing** usually identifies the maximum operating capacity of an application.
- **Load** can be the **expected concurrent number of users** on the application performing a specific number of transactions within the set duration. This test will give out the response times of all the important business critical transactions.
- **Stress testing** *implies* evaluating a system beyond the limits of its specification. In **Stress testing**, we measure the breakpoint of a system.

Difference between load and stress test

- The goal of a load test is to prove that a system can handle the expected volume with minimal to acceptable performance degradation.
- A stress test is a test designed to increase the number of simultaneous requests on a system past a point where performance is degraded, possibly even to the point of complete failure.
- **Difference in short:** If you are testing normal, expected load, this is *load testing*. But when you want to determine how the system behaves under extreme load (DoS) and when it breaks, this is *stress testing*.

Security testing

- **SECURITY TESTING** is a type of software testing that intends to uncover vulnerabilities of the system and determine that its data and resources are protected from possible intruders.
  - **Vulnerability Scanning**: This is done through automated software to scan a system against known vulnerability signatures.
  - **Ethical hacking:** It's hacking an Organization Software systems. Unlike malicious hackers ,who steal for their own gains , the intent is to expose security flaws in the system.
  - **Penetration testing**: This kind of testing simulates an attack from a malicious hacker. This testing involves analysis of a particular system to check for potential vulnerabilities to an external hacking attempt.

Regression testing

- Regression testing is selective retesting of a system or component to verify that modifications have not caused unintended effects and that the system or component still complies with its specified requirements
- Subset of the original set of test cases.
- Core group of tests re-run often after any significant changes
  - Choose a representative sample of tests that exercise all the existing functionalities
  - Chose additional test cases that are most likely to be affected by the change
- ***Smoke test:*** a subset of the regression test cases that establish that the system is stable and all major functionality is present and works under "normal" conditions

Beta testing

- Organization can offer an advance partial or full version of a software package free to one or more potential users.
- Users use the software as they wish, with the understanding that they will report any errors revealed during usage back to the organization.

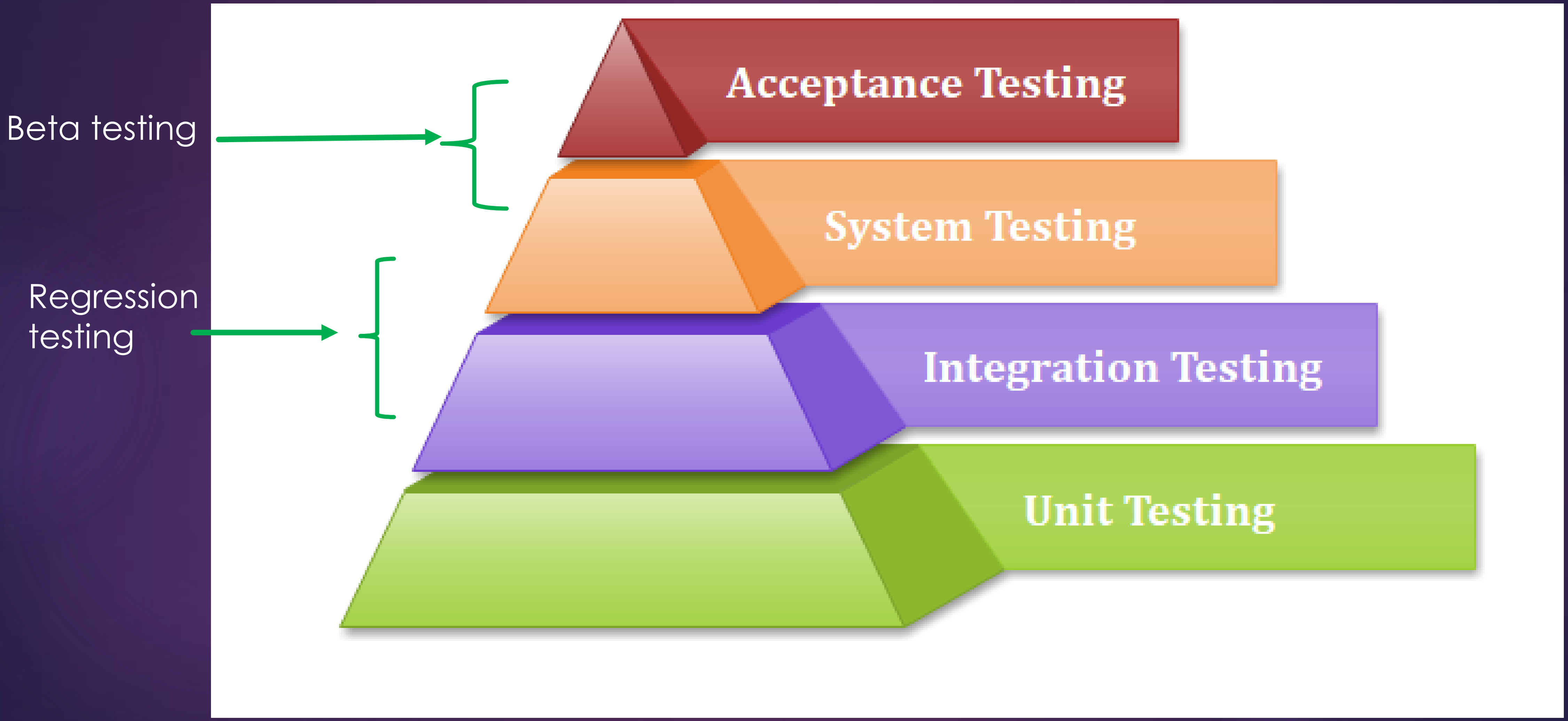
- Advantages
  - Identification of unexpected errors
  - Low costs
  - Wider population / environment

- Disadvantages
  - Lack of systematic testing
  - Low quality error reports

Acceptance testing

- Formal testing conducted to determine whether or not a system satisfies its acceptance criteria (the criteria the system must satisfy to be accepted by a customer) and to enable the customer to determine whether or not to accept the system
- Generally done by customer/customer representative in their environment through the GUI
- Definitely black box

Testing Hierarchy



Beta testing

Regression testing

Acceptance Testing

System Testing

Integration Testing

Unit Testing

Static & Dynamic testing

- Static testing refers to testing something that’s not running.
- It is sort of examining and reviewing the work. E.g. code review, software inspection are some static testing methods.
- Dynamic Testing involves working with the software, giving input values and checking if the output is as expected.
- Unit Tests, Integration Tests, System Tests and Acceptance Tests are few of the Dynamic Testing methodologies.

Code Review

Code review

- **Code review** is the process of analyzing code written by another developer on the project to judge whether it is of sufficient quality to be integrated into the main project codebase.
- The formal variant of peer code review, which is better known as software inspection or Fagan-inspection, has been an effective quality improvement practice for a long time.
- Even with the benefits offered by software inspections, their relatively high cost and formal requirements have reduced the prevalence with which software teams adopt them.
- Hence, lightweight, informal, and tool-based code review practices are being popular.

Code Review Efforts

Avg. 6 hours / week

10%~15% of developer times

Microsoft : 50,000 developers X 6 hours/ week X $50 /hour

= $15,000,000 / Week

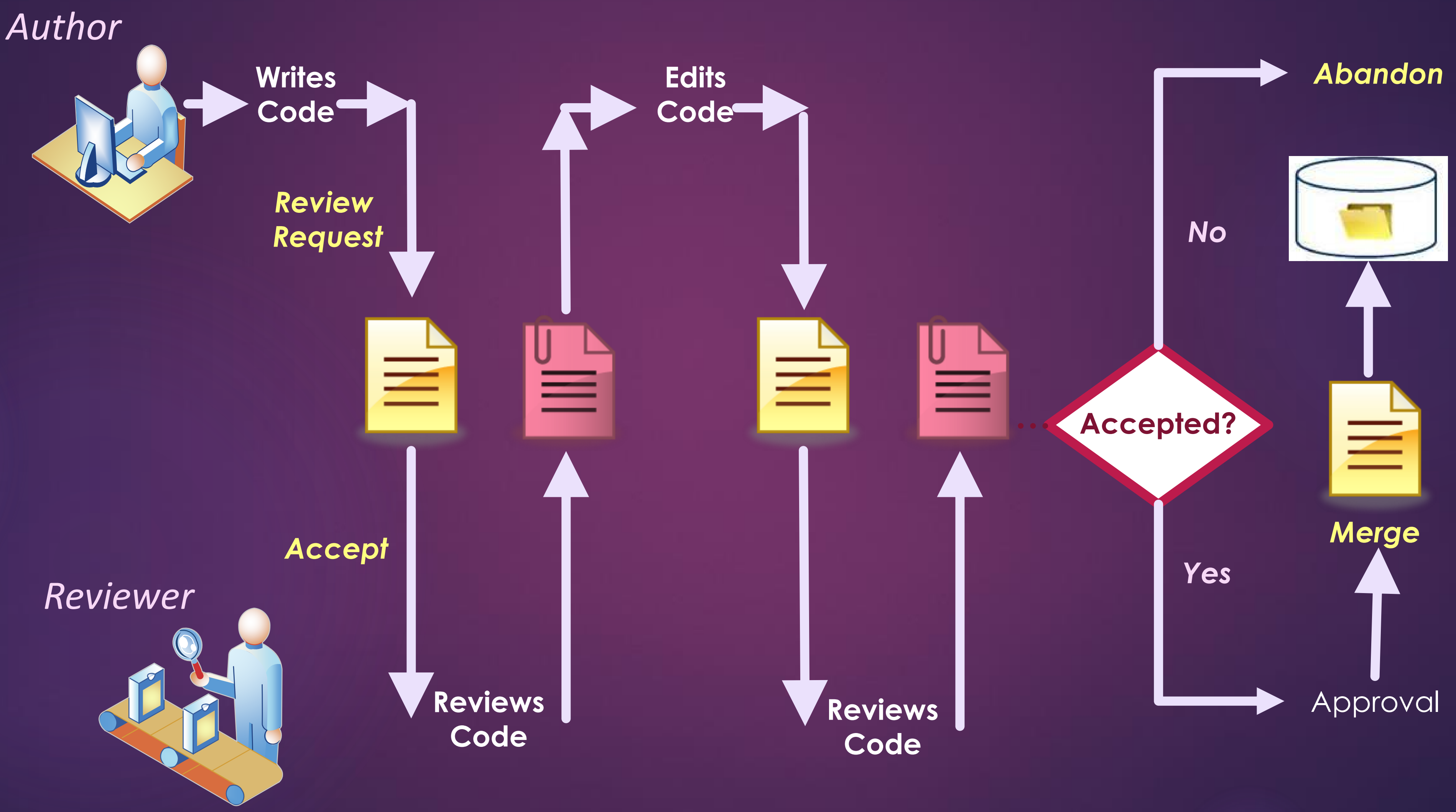
Code smell

- Code smell implies code components that are **absolute violations of the fundamentals** of developing software that decrease the quality of code.
- Has negative impact on readability and maintainability.
- Code smells are usually not bugs; they are not technically incorrect and do not prevent the program from functioning.
- Instead, they indicate weaknesses in design that may slow down development or increase the risk of bugs or failures in the future.
- For instance Long function, code duplication, mysterious names etc.
- Tools such as *CodeGrip*, *Checkstyle*, *PMD*, *FindBugs*, and *SonarQube* can automatically identify code smells.

Issues identified during code reviews

- ✓ Coding style
- ✓ Redundant checks
- ✓ Project design violation
- ✓ Misunderstood requirements
- ✓ Critical security defects
- ✓ Malicious code
- ✓ Inadequate input validation
- ✓ Unsafe methods
- ✓ Lack of exception handling

Code Review Workflow



Practical Impacts

- Peer review can put strain on interpersonal team relationships.
- It´s difficult to have every piece of work critiqued by peers and to have management evaluating and measuring defect density in your code.
- It´s extremely important that mangers create a culture of collaboration and learning in peer review.
- While it´s easy to see defects as purely negative, each bug is actually an opportunity for the team to improve code quality.

Other Benefits of Code review

- Project awareness
- Peer impression formation
- Consistent coding style
- Knowledge dissemination

Code Review Tools

DIFFY
The Kung Fu
Review Cuckoo

Gerrit: https://code.google.com/p/gerrit/

Review Board: https://www.reviewboard.org/

Phabricator: https://phabricator.org/

Crucible: https://www.atlassian.com/software/crucible

Thank You