CSE 3421

Software Testing

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Why This Lesson?

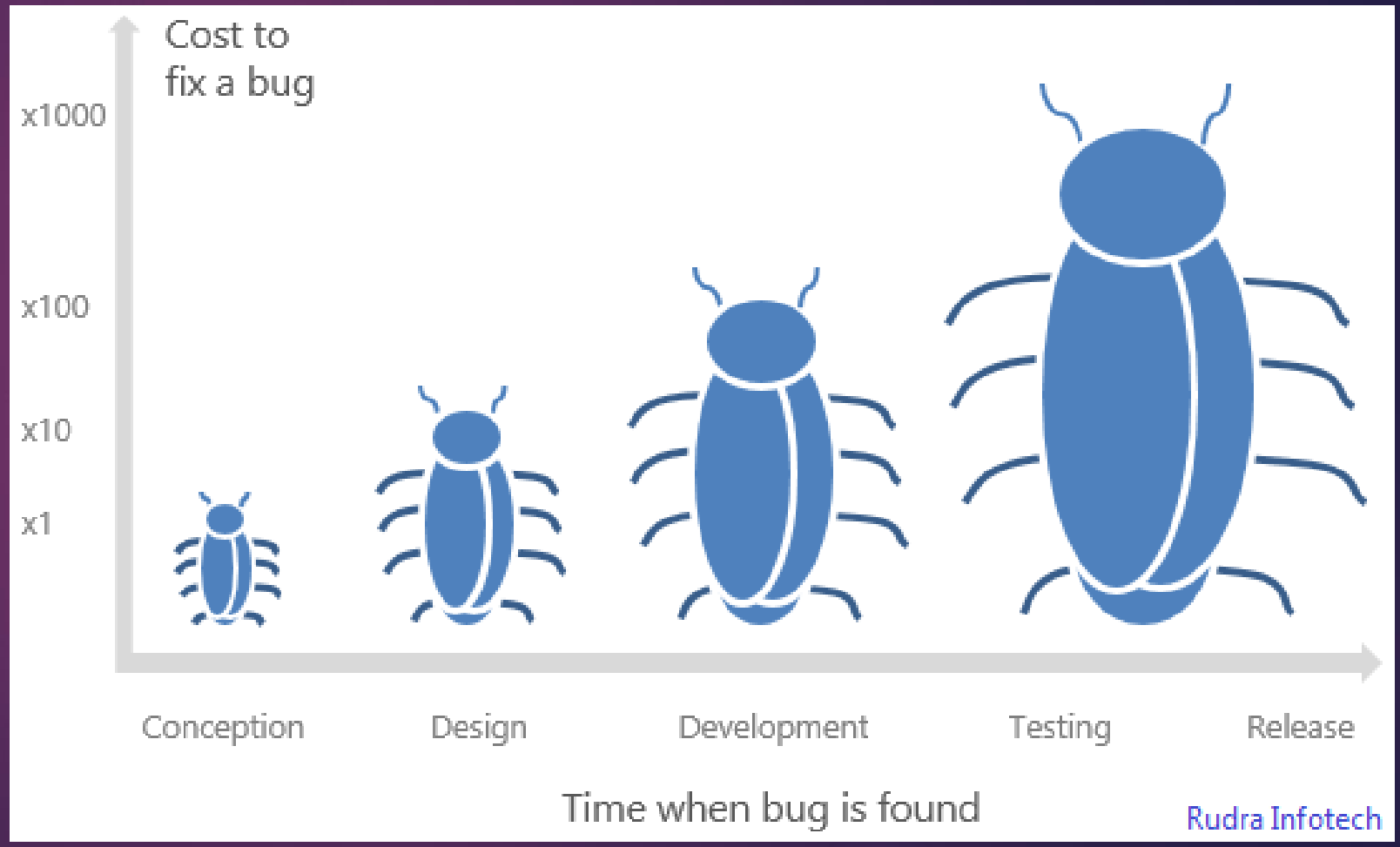
No customer likes to buy faulty products. Same goes for the software industry

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)

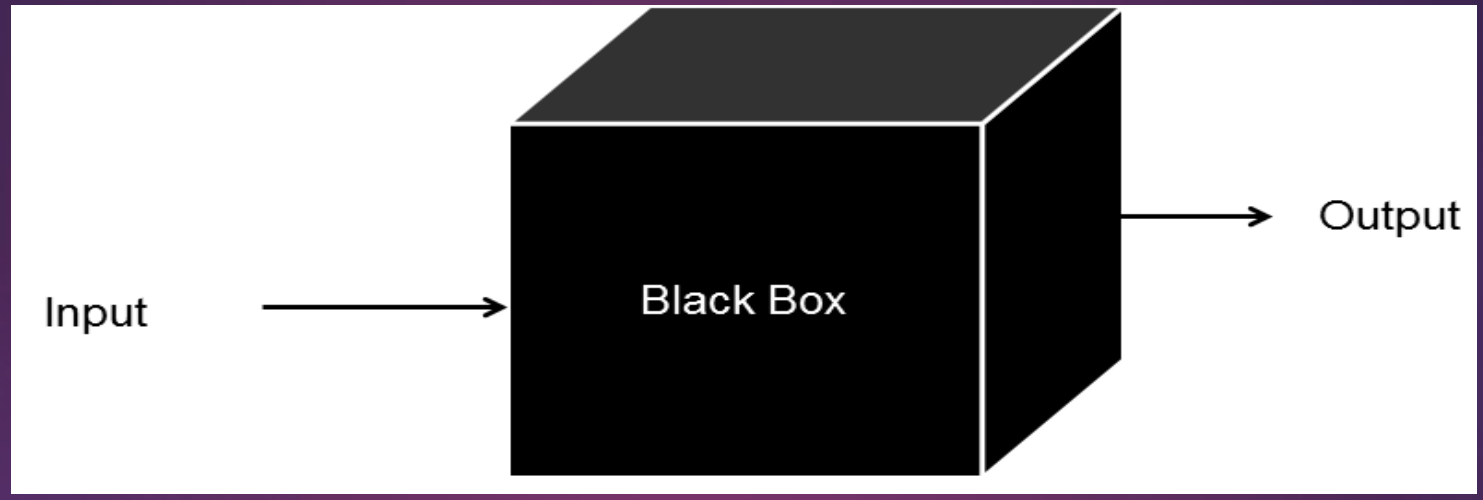
When should we test software?

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

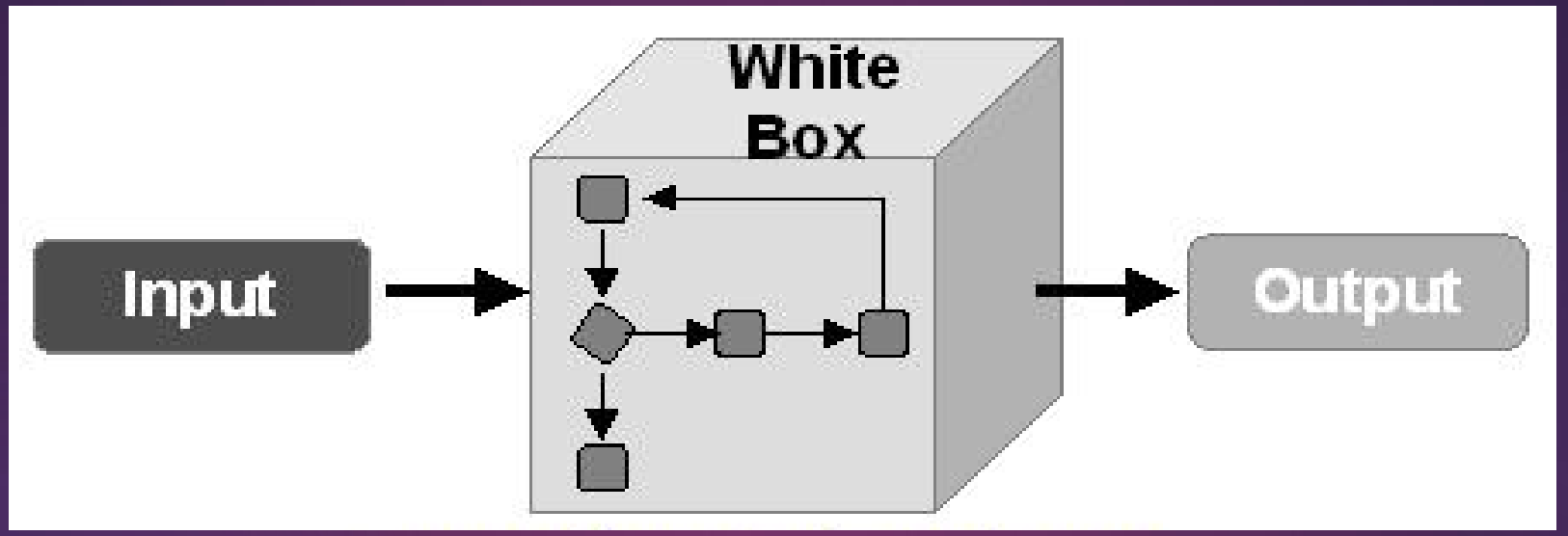
Advantages

- 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
  Unit usually represents a single function, method, procedure, or object within the code.
- 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
  deals with slightly larger components or modules within the software.

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. identify weakness in security/
  - **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 a type of software testing that ensures changes or updates to the system do not introduce new problems.

- 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

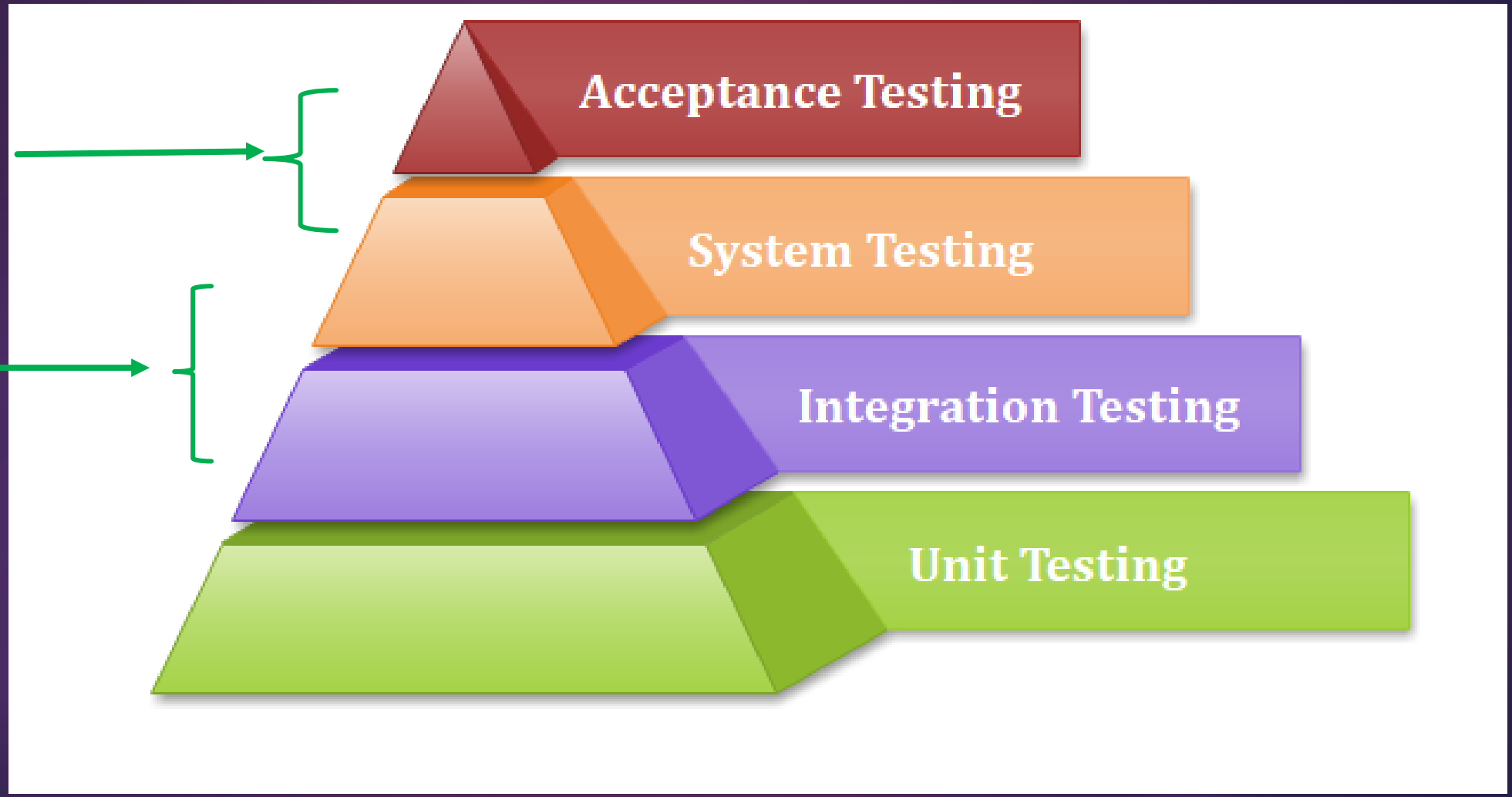
- Disadvantages
  - Lack of systematic testing
  - Low quality error reports

Acceptance testing

Acceptance testing is the final phase of software testing where the customer checks if the system meets their requirements and decides whether to accept it

- 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



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.

A code smell is a sign that something might be wrong with your code, even if it technically works fine.

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.

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

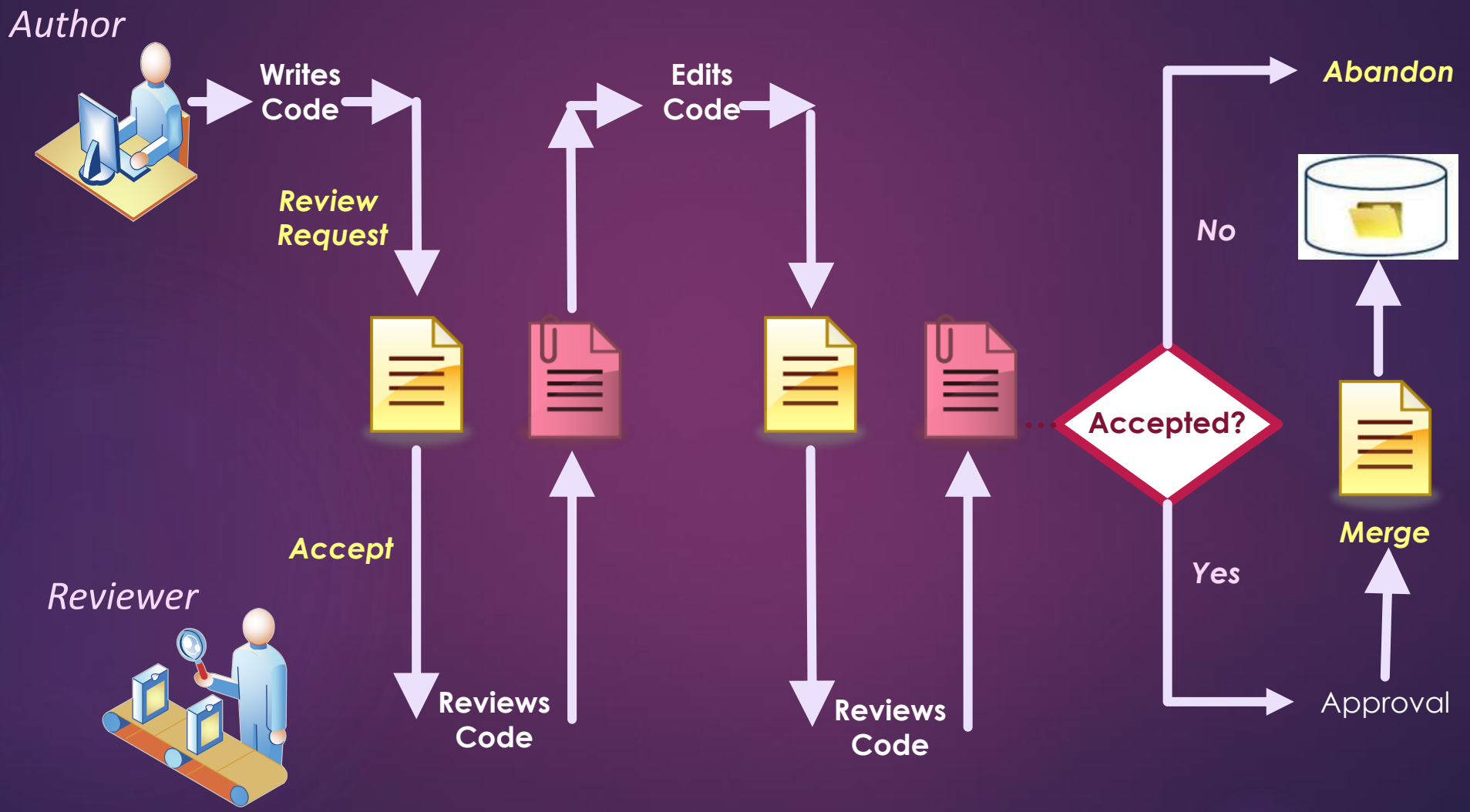
Avg. 6 hours / week

10%~15% of developer times

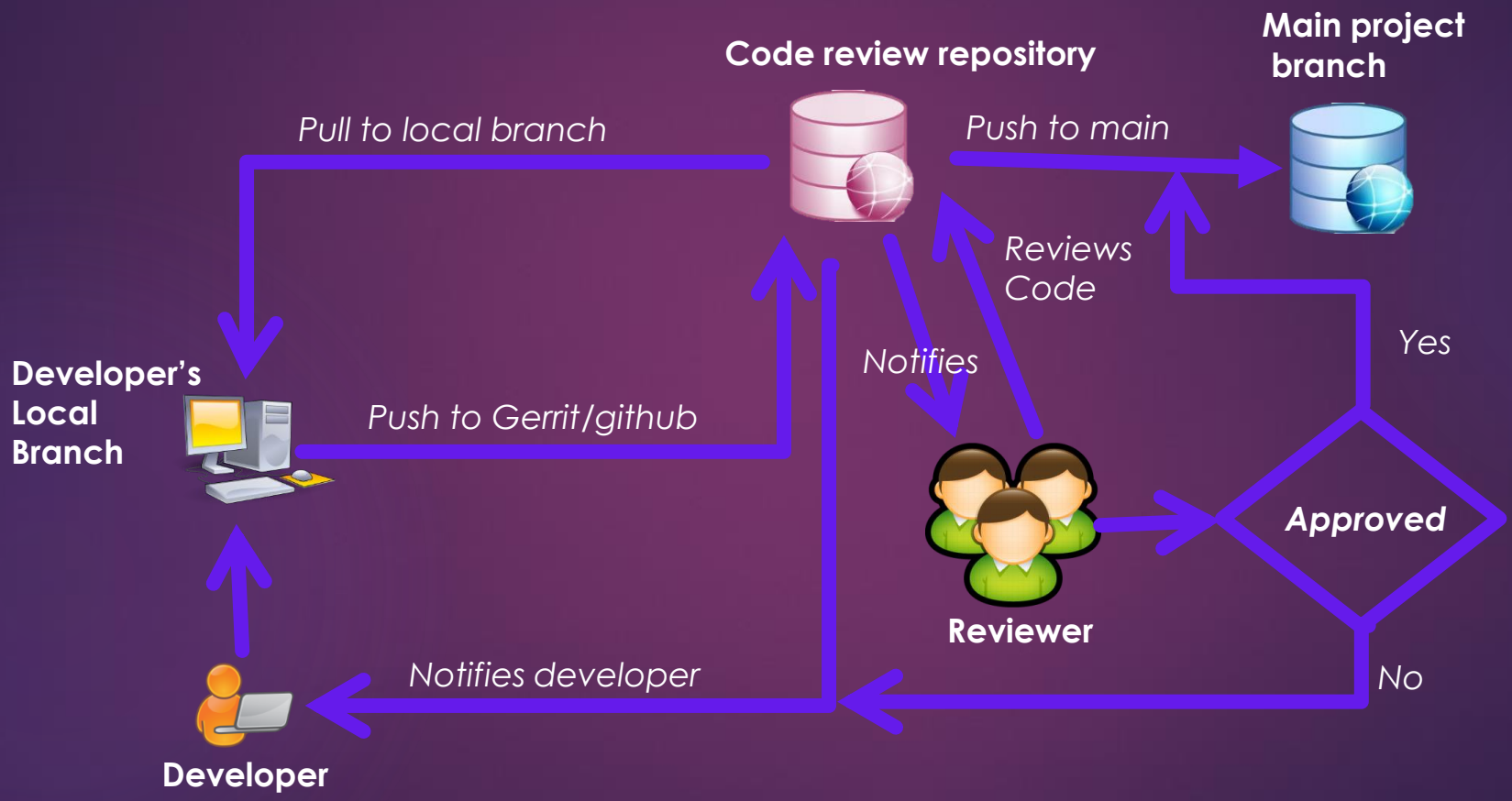
Microsoft : 50,000 developers X 6 hours/ week X $50 /hour

= $15,000,000 / Week

Code Review Workflow



Simplified code review workflow



Code Review Tools

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

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

Phabricator: https://phabricator.org/

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

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

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

Thank You