Week 4 – Errors in Java:

Day 1 - Compile Time/Syntax Errors:

Compiler Role:

- Translates Java code (human-readable) into Java bytecode (computer-readable).
- Analogous to a translator converting languages.

Error Cause:

- Compiler errors occur when the code breaks language rules (syntax).
- Equivalent to a translator unable to translate an unknown word.

Nature of Errors:

- Commonly due to forgotten semicolons, misspelled variables, or rule violations (e.g., using a non-static variable in a static function).

Example:

- Incomplete line causing a compile error (missing semicolon at the end).
- Understanding Java syntax is crucial to rectify such errors.

Identification:

- Many Java Integrated Development Environments (IDEs) detect compile errors during coding.
- Helps in easily recognizing and rectifying errors as you write code.

Runtime Errors:

Runtime Error Definition:

- Occurs during program execution, disrupting the normal flow and leading to abnormal termination.
- Reasons include invalid user input, inaccessible files, lost network connections, or JVM memory exhaustion.

Scenarios for Runtime Errors:

- Invalid user input, missing files, lost network connections, and resource failures can cause runtime errors.
- These errors stem from user, programmer, or physical resource issues.

Detection of Runtime Errors:

- Not detected by the compiler; they occur during program execution.

Example and Output Interpretation:

- Example error: **java.lang.ArrayIndexOutOfBoundsException: 5.**

Interpretation:

- Type of error **(ArrayIndexOutOfBoundsException).**
- Information about the error (attempting to access the 5th index of an array).
- Stack trace specifying the class, function, and line number where the error occurred.

Exception Handling:

- Aim: Prevent devastating effects of runtime errors and maintain the application's normal flow.
- Methods:

  Java try block:
  - Encloses code that might throw an exception.
  - Should be followed by catch or finally block.

  Java catch block:
  - Handles exceptions by declaring the type of exception within the parameter.
  - Multiple catch blocks can be used with a single try block.

  Java finally block:
  - Executes important code (e.g., closing connections or streams).
  - Always runs, whether an exception is handled or not.

Day 2 – Logic Errors:

Logic Errors:

- Logic errors occur when code compiles and runs without exceptions but fails to produce the expected output due to programmer assumptions, typos, or flawed logic.
- Identification is challenging during coding; testing by comparing expected versus actual results helps detect these errors.
- Logic errors might remain unnoticed, leading to flawed applications being deployed in production.
- Writing error-free code that compiles and runs doesn't guarantee the absence of logic errors; they are common occurrences in programming.

Debugging:

- Debugging is a systematic process of finding and fixing bugs or defects in a computer program.
- Bugs arise when something assumed to be right turned out to be wrong, making the process challenging.
- Vital in identifying and resolving errors, fundamental in a programmer's daily work.
- Helps maintain the quality and functionality of software applications.

Debugging Process:

1. **Localizing a Bug:**
   - Identifying the bug's origin is crucial before attempting to fix it.
   - Errors can be deceptive, making pinpointing them challenging.

2. **Classifying the Error:**
   - Categorizing errors (compile, runtime, or logic) aids in effective solutions.
   - Failure to classify correctly can hinder fixing the error.

3. **Understanding an Error:**
   - Complete understanding of the error is necessary before fixing it.
   - Avoids inadvertently causing more issues within the codebase.

4. **Repairing an Error:**
   - Fixing the error involves more than code modification.
   - Proper documentation of fixes is essential, aiding in future reference and learning.

Debugging Techniques:

1. **Exploiting Compiler Features:**
- Utilizing the Java compiler's static analysis capabilities to detect syntax or semantic issues before execution.

2. **The abused println() Debugging Technique:**
- Involves inserting print statements to track code execution flow and data values during runtime.
- Considered ad-hoc, time-consuming, and not reusable.

3. **Logging:**
- Recording information messages or events to monitor program status and diagnose issues.
- Implemented through tools like log4j, offering various logging levels.

4. **Defensive Programming and Assertions:**
- Using assertions to validate code assumptions at specific points; helpful in identifying code problems.

5. **ACI Debugging Technique:**
- Explaining code to someone else to rethink assumptions and solve problems effectively.

6. **Reading the Code Through:**
- Reviewing code away from the terminal to understand its logic and identify issues.

7. **The Debugger:**
- An interactive tool allowing line-by-line code execution inspection, variable inspection, and breakpoints setting.
- Useful when other methods fail to identify problems, providing detailed control over code execution.

Day 3 – Common Errors in Java:

“... Expected”

- Missing semicolon or closing parenthesis leads to this error.
- Ensure balanced parentheses and check the previous line.

“Unclosed String Literal”

- Occurs when a string literal lack closing quotation marks.
- Correct by adding the needed quote marks or breaking long literals.

“Illegal Start of an Expression”

- Less-helpful error message caused by syntax mismatch.
- Review statements where the error occurs.

“Cannot Find Symbol”

- Arises due to undeclared identifiers or incorrect usage.
- Verify variable declaration, usage scope, and imported classes.

“Public Class Should Be in File”

- Class and Java file names mismatch.
- Name both consistently and ensure case consistency.

“Incompatible Types”

- Error occurs when types don't match during assignment.
- Convert types or redefine code logic.

“Invalid Method Declaration”

- Missing return type in the method signature.
- Specify the method's return type or use "void" for non-return methods.

“Missing Return Statement”

- A method returning a value lacks a return statement.
- Ensure all paths of value-returning methods have a return statement.

“Possible Loss of Precision”

- Occurs during type conversion causing data loss.
- Explicitly define variable types or perform type conversions.

“Reached End of File While Parsing”

- Missing closing curly brace leads to this error.
- Check code indentation and balance braces.

Runtime Errors:

“ArrayIndexOutOfBoundsException”

- Accessing an array index out of its range.
- Correct index definitions and loops.

“StringIndexOutOfBoundsException”

- Accessing parts of a string beyond its length.
- Check string indexing and lengths.

“NullPointerException”

- Attempting to use a null object reference.
- Ensure object references are valid before using them.

“NoClassDefFoundError”

- Unable to find a class file with the main method.
- Check file location, naming, and case sensitivity.

“NoSuchMethodFoundError”

- Trying to call an undefined method.
- Review method declarations for typos or missing methods.

“NoSuchProviderException”

- Requesting an unavailable security provider.
- Check JRE configuration and environment settings.

“AccessControlException”

- Denied access to system resources.
- Review permissions and resource access.

“ArrayStoreException”

- Violating rules of object casting in arrays.
- Ensure consistent object types in arrays.

“UnsupportedEncodingException”

- Unsupported character encoding used.
- Verify encoding support in the Java Virtual Machine.

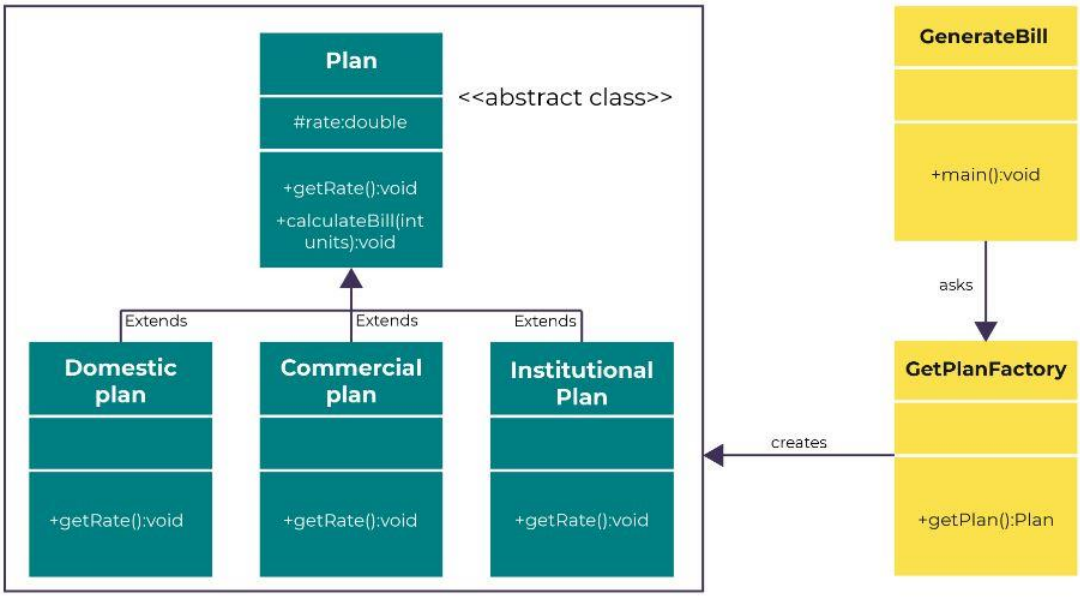
“TimeoutException”

- Blocking operation times out.
- Review the code and handling of blocking operations for timeout scenarios.

Factory Method Patterns:

- The factory method pattern involves defining an interface or abstract class for creating objects, allowing subclasses to determine the class used for object creation.
  This pattern is useful when:
  1. A class is unaware of which subclasses need to be created.
  2. Subclasses specify the objects to be created.
  3. Parent classes determine object creation for subclasses.

Example of Unified Modelling Language (UML)



Day 4 – Code Refactoring:

What is refactoring?

- Refactoring is a vital technique used in software development to enhance existing code without altering its observable behaviour.
- The primary aim of refactoring is to improve code quality, making it more maintainable, readable, and efficient.
- It's a fundamental Agile practice that allows developers to:
    1. Improve code maintainability, reducing costs associated with software maintenance.
    2. Enable efficient introduction of new requirements without introducing bugs.
    3. Restructure code to align with design patterns or best practices.

Importance of Refactoring:

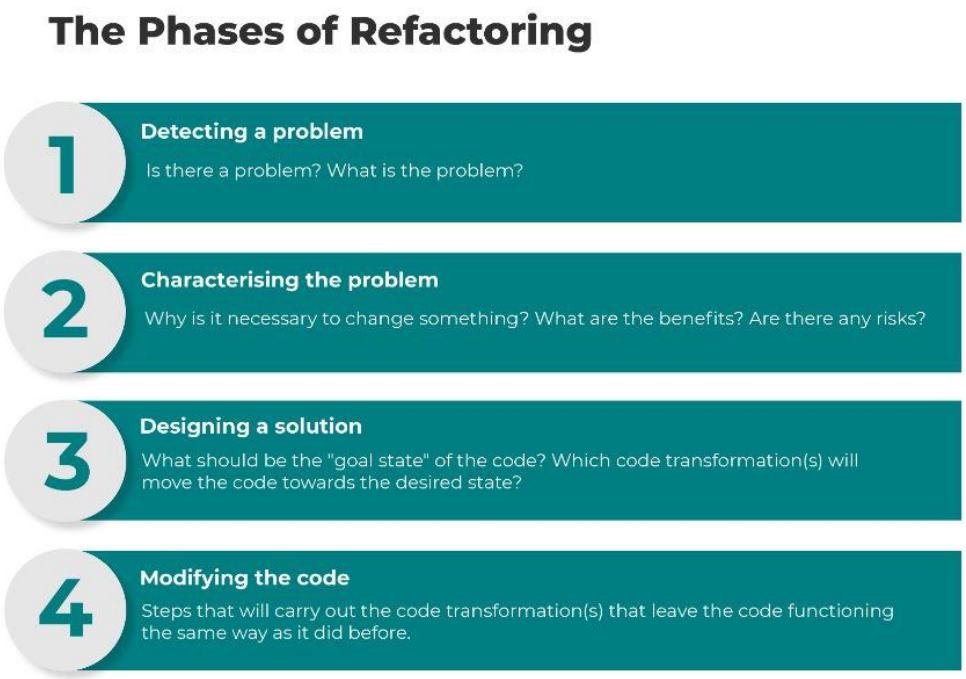
- As software grows and complexity, bugs often infiltrate the codebase, decreasing code reliability.
- Refactoring plays a pivotal role in addressing these issues by making the code more understandable and maintainable.
- This helps in reducing costs and freeing up development resources for other tasks.
- Additionally, well-structured code makes it easier to introduce new features seamlessly and with minimal issues.

The Refactoring Process:

- Refactoring involves making incremental, logical changes to code structure while ensuring its behaviour remains unchanged.
- By breaking down changes into small steps and running tests after each step, potential bugs introduced can be identified immediately, facilitating quick resolution.
- This incremental approach ensures better control over the code changes and minimizes the risk of introducing errors.

Phases of Refactoring:

1. **Detecting a Problem:** Identify issues or areas within the code that need improvement.
2. **Characterizing the Problem:** Understand the reasons behind the necessary changes, assessing the benefits and potential risks.
3. **Designing a Solution:** Define the desired state of the code and plan the transformations needed to achieve it.
4. **Modifying the Code:** Implement code transformations in incremental steps while ensuring the code functions as expected throughout the process.



When is Refactoring Used?

1. **Code Maintenance:** To address codebase issues, such as eliminating code smells or improving readability.
2. **Feature Enhancement:** When introducing new features that may conflict with existing code or design.
3. **Code Restructuring:** Aligning code with established design patterns or best practices.

Examples of Refactoring:

1. **Renaming:**
   - **Purpose:** Correct misleading or confusing names of methods, variables, classes, etc.
   - **Process:** Update all references to the renamed entity across the codebase.
   - **Impact:** Renaming may require adjustments in subclasses, clients, file locations, and directories, along with updates in the version control system.

2. **Moving a Class:**
   - **Purpose:** Relocate a class from one package to another where it fits more appropriately.
   - **Process:** Update all import statements and references to the class in its new package.
   - **Impact:** Involves moving the file to the new location and updating references in the source control system.

3. **Extract Method:**
   - **Purpose:** Break down lengthy methods to enhance code readability and maintainability.
   - **Process:** Identify a section of code performing a specific logical task and replace it with a call to a new method.
   - **Impact:** Improves readability by segregating logical units of work into separate methods, making the code more understandable.

4. Extracting a Superclass:

   - **Purpose:** Introduce an abstract class as a parent to an existing class to manage common functionality.
   - **Process:** Pull up common behaviour from the existing class into the new abstract parent class.
   - **Impact:** Clients of the original class are modified to reference the new parent class, enabling different implementations through polymorphism.