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Course : IT 314 Software Engineering

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Lab : Program Inspection, Debugging and Static Analysis

Armstrong Number

Given code :

```
//Armstrong Number
class Armstrong{
        public static void main(String args[]){
                int num = Integer.parseInt(args[0]);
                int n = num; //use to check at last time
                int check=0,remainder;
                while(num > 0){
                        remainder = num / 10;
                        check = check + (int)Math.pow(remainder,3);
                        num = num % 10;
                }
                if(check == n)
                        System.out.println(n+" is an Armstrong Number");
                else
                        System.out.println(n+" is not a Armstrong Number");
        }
```

Input: 153

Output: 153 is an armstrong Number.

Program Inspection for Armstrong numbers

1. **How many errors are there in the program? Mention the errors you have identified.**

- **Errors Identified: 3**
  - **Incorrect Calculation of Remainder:** In the loop, the calculation of remainder should be done using num % 10 instead of num / 10. The current implementation incorrectly computes the next digit and does not correctly extract the digits of the number.
  - **Updating the Number Incorrectly:** The line num = num % 10; should be replaced with num = num / 10; to reduce the number correctly for the next iteration of the loop.
  - **Inconsistent Output Format:** The output statement should use "an" instead of "a" before "Armstrong Number" when referring to "Armstrong Number" because it starts with a vowel.

2. **Which category of program inspection would you find more effective?**

- **Effective Category:**
  - **Logic Errors:** This category is essential here since the Armstrong number check involves mathematical calculations and correctly iterating through the digits of a number. Identifying logical flaws is critical to ensure the correct behavior of the program.

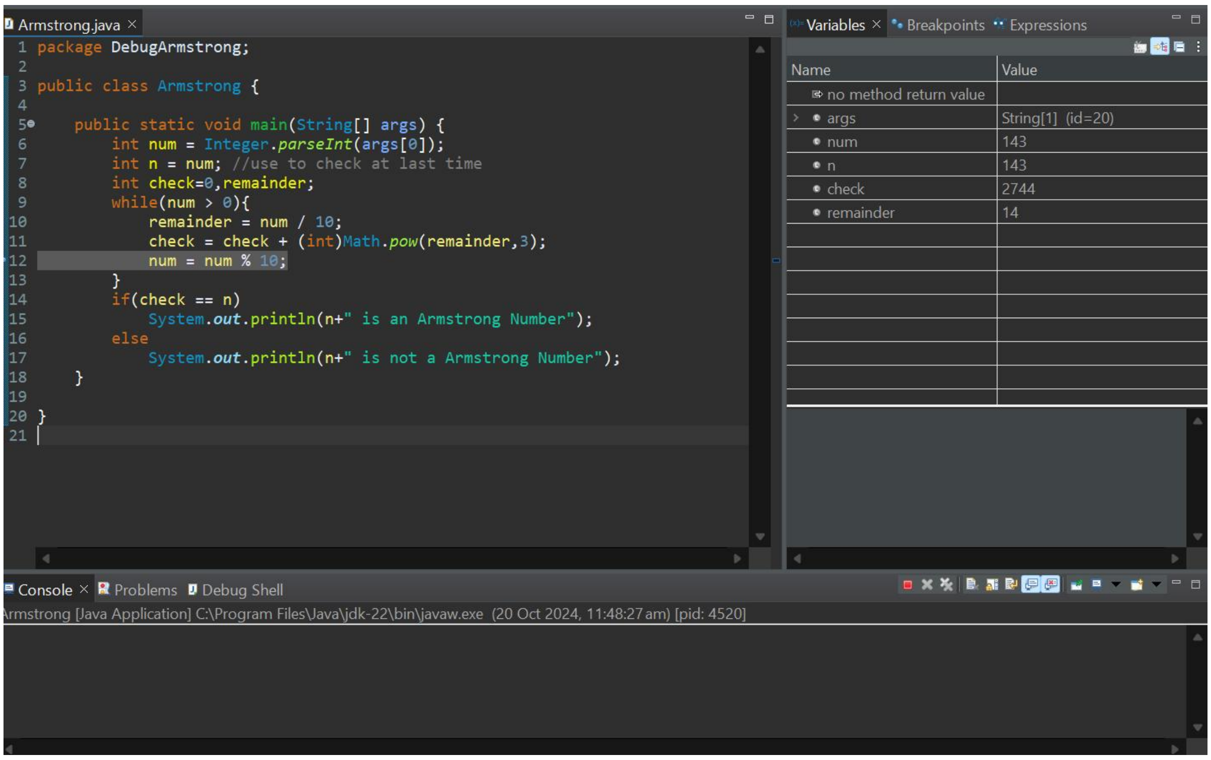
3. **Which type of error you are not able to identify using the program inspection?**

- **Errors Not Identified:**
  - **Edge Cases:** While program inspection can reveal logical and syntactical errors, it may not fully capture potential issues with edge cases, such as negative numbers or non-integer inputs.

4. **Is the program inspection technique worth applicable?**

- **Applicability of Program Inspection:**
  - Yes, program inspection is valuable as it helps identify logical and syntactical errors before runtime. However, it should be used alongside unit tests to verify the program’s correctness across a variety of input scenarios.

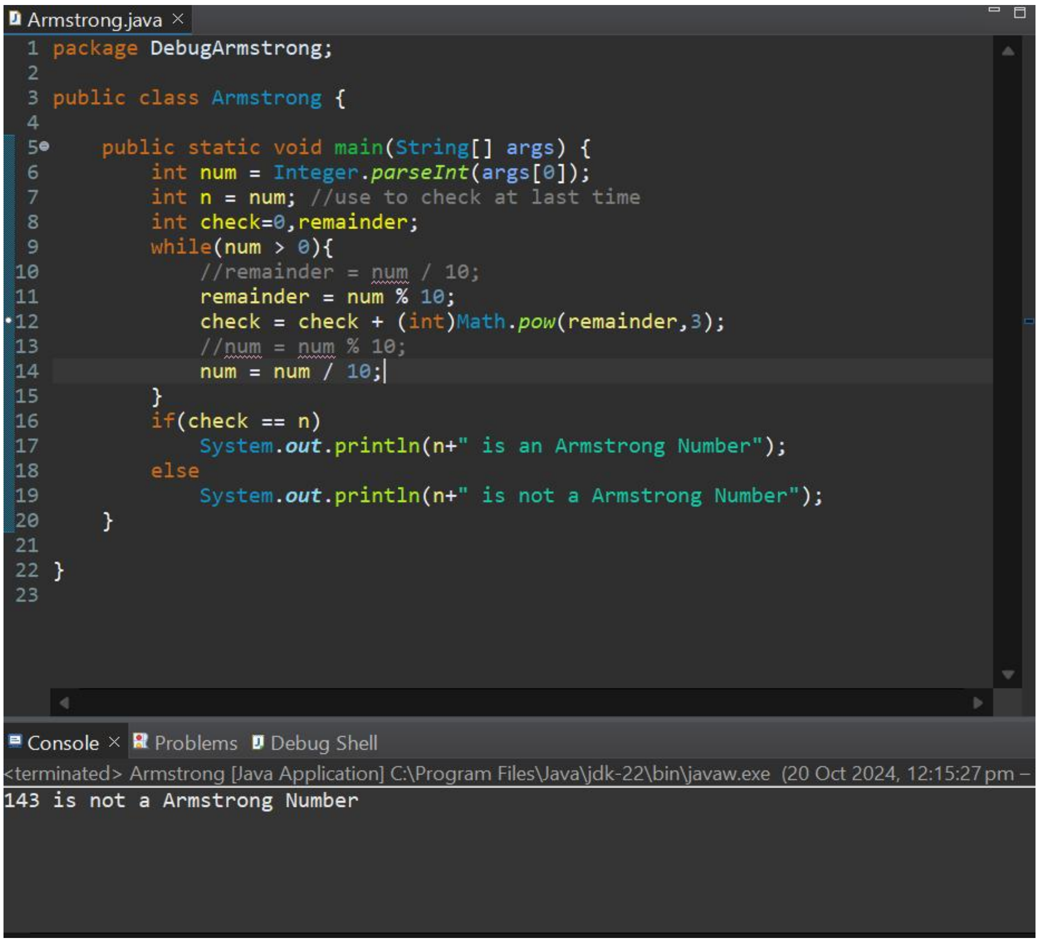
Code Debugging



```java
package DebugArmstrong;

public class Armstrong {

    public static void main(String[] args) {
        int num = Integer.parseInt(args[0]);
        int n = num; //use to check at last time
        int check=0,remainder;
        while(num > 0){
            remainder = num / 10;
            check = check + (int)Math.pow(remainder,3);
            num = num % 10;
        }
        if(check == n)
            System.out.println(n+" is an Armstrong Number");
        else
            System.out.println(n+" is not a Armstrong Number");
    }

}
```

Name	Value
no method return value	
args	String[1] (id=20)
num	143
n	143
check	2744
remainder	14

```
rmstrong [Java Application] C:\Program Files\Java\jdk-22\bin\javaw.exe  (20 Oct 2024, 11:48:27 am) [pid: 4520]
```



```java
package DebugArmstrong;

public class Armstrong {

    public static void main(String[] args) {
        int num = Integer.parseInt(args[0]);
        int n = num; //use to check at last time
        int check=0,remainder;
        while(num > 0){
            //remainder = num / 10;
            remainder = num % 10;
            check = check + (int)Math.pow(remainder,3);
            //num = num % 10;
            num = num / 10;
        }
        if(check == n)
            System.out.println(n+" is an Armstrong Number");
        else
            System.out.println(n+" is not a Armstrong Number");
    }

}
```

```
<terminated> Armstrong [Java Application] C:\Program Files\Java\jdk-22\bin\javaw.exe  (20 Oct 2024, 12:15:27 pm –
143 is not a Armstrong Number
```

Errors Identified

1. **Incorrect Calculation of Remainder:**
   - **Original Line:** remainder = num / 10;
   - **Correction:** remainder = num % 10; (This extracts the last digit of the number.)
2. **Incorrect Update of num:**
   - **Original Line:** num = num % 10;
   - **Correction:** num = num / 10; (This removes the last digit from the number.)
3. **Missing Closing Bracket:**
   - Ensure that the class and main method have matching closing brackets.

Breakpoints Needed

To effectively debug the code, consider setting breakpoints at the following locations:

- After int num = Integer.parseInt(args[0]); to check the initial value of num.
- After remainder = num % 10; to verify the value of remainder.
- After num = num / 10; to see how num changes after extracting the last digit.

Steps to Fix the Errors

1. Change the line for calculating the remainder to remainder = num % 10;.
2. Change the line for updating num to num = num / 10;.
3. Ensure the closing brackets for the class and the main method are properly placed.

Fixed Code

```
// Armstrong Number
class Armstrong {
  public static void main(String args[]) {
    int num = Integer.parseInt(args[0]);
    int n = num; // use to check at last time
    int check = 0, remainder;

    while (num > 0) {
      remainder = num % 10; // Extract the last digit
```

```
            check = check + (int) Math.pow(remainder, 3); // Sum of cubes of digits
            num = num / 10; // Remove the last digit
        }

        if (check == n)
            System.out.println(n + " is an Armstrong Number");
        else
            System.out.println(n + " is not an Armstrong Number");
    }
}
```

Input and Output

- **Input:** 153
- **Output:** 153 is an Armstrong Number

Static Analysis Tools

Choose a static analysis tool (in Java, Python, C, C++) in any programming language of your interest and identify the defects. You can also choose your own code fragment from GitHub (more than 2000 LOC) in any programming language to perform static analysis. Submit your results in the .xls or .jpg format only.

Link of the excel file(.xls):

https://docs.google.com/spreadsheets/d/1ETFxQdw1_RNXufBPwhlt7OumxA7lJCjh/edit?usp=sharing&ouid=117105520491645507929&rtpof=true&sd=true