Debugging

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Module Code: ELEE1147

Module Name: Programming for Engineers

Credits: 15

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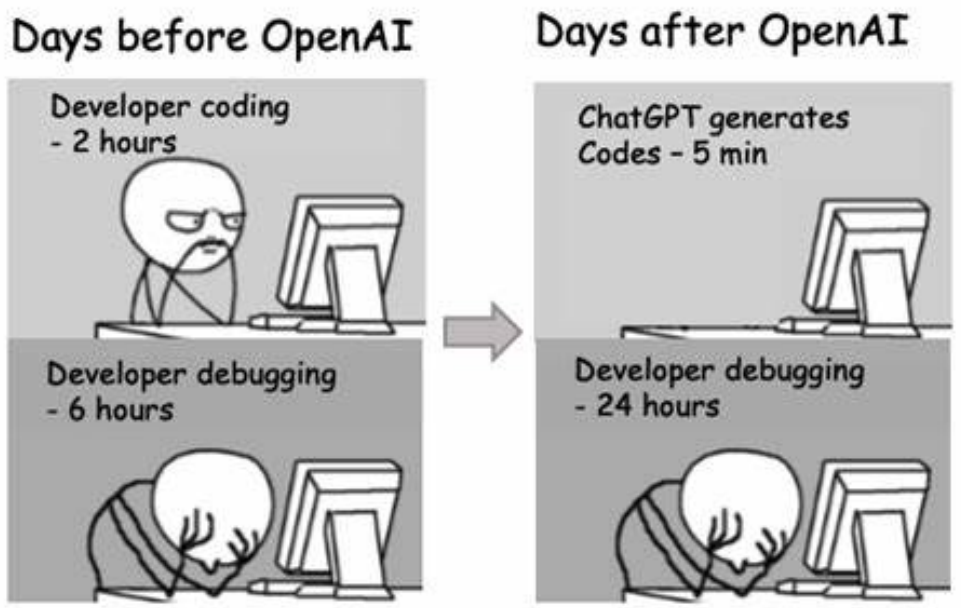
Introduction to Debugging

- Debugging is a crucial aspect of software development that involves identifying and fixing errors or defects (bugs) in computer programs.
- Regardless of programming language or development environment, all software developers encounter bugs during the development process.
- Debugging is the systematic process of locating and resolving these bugs to ensure that the software behaves as expected.



Origin of Debugging?

Name: Admiral Grace Hopper (USN)
When: 1947
How: Working on the Mark II computer in Harvard and discoved a moth stuck in one of the relays which was causing the errors in the computer... she remarked that she was "debugging" the computer.

*she created the first compiler and contributed to the programming language COBOL

Why Debugging Matters

- **Ensuring Software Quality**: Debugging helps improve the quality and reliability of software by identifying and fixing defects that could lead to unexpected behavior or system crashes.
- **Enhancing User Experience**: Software with fewer bugs provides a better user experience, leading to increased satisfaction and trust among users.
- **Reducing Development Costs**: Addressing bugs early in the development process helps reduce the time and resources required to fix them later, minimizing the overall cost of development.
- **Maintaining Developer Confidence**: Effective debugging techniques empower developers to tackle complex problems with confidence, enhancing their productivity and morale.

Common Types of Bugs

- **Syntax Errors**: These occur when the code violates the syntax rules of the programming language, leading to compilation errors.

```c
#include <stdio.h>

int main() {
    int x = 5
    printf("The value of x is: %d\n", x);
    return 0;
}
```

Common Types of Bugs

- **Logic Errors**: Logic errors occur when the program does not produce the expected output due to flaws in its logic or algorithm.

```c
#include <stdio.h>

int main() {
    int x = 5;
    int y = 3;
    int sum = x - y;  // Logic error: subtracting instead of adding
    printf("The sum of x and y is: %d\n", sum);
    return 0;
}
```

Common Types of Bugs

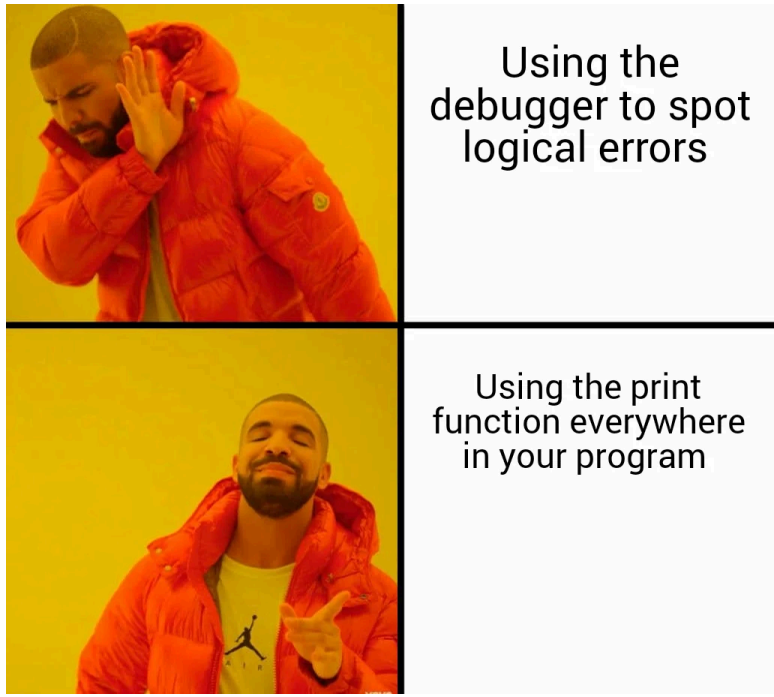
- **Runtime Errors**: Runtime errors occur during program execution and can result in crashes or unexpected behavior, often caused by issues such as null pointer dereferences or array out-of-bounds access.

```c
#include <stdio.h>

int main() {
    int x = 5;
    int y = 0;
    int result = x / y;  // Runtime error: division by zero
    printf("The result is: %d\n", result);
    return 0;
}
```

Debugging Techniques

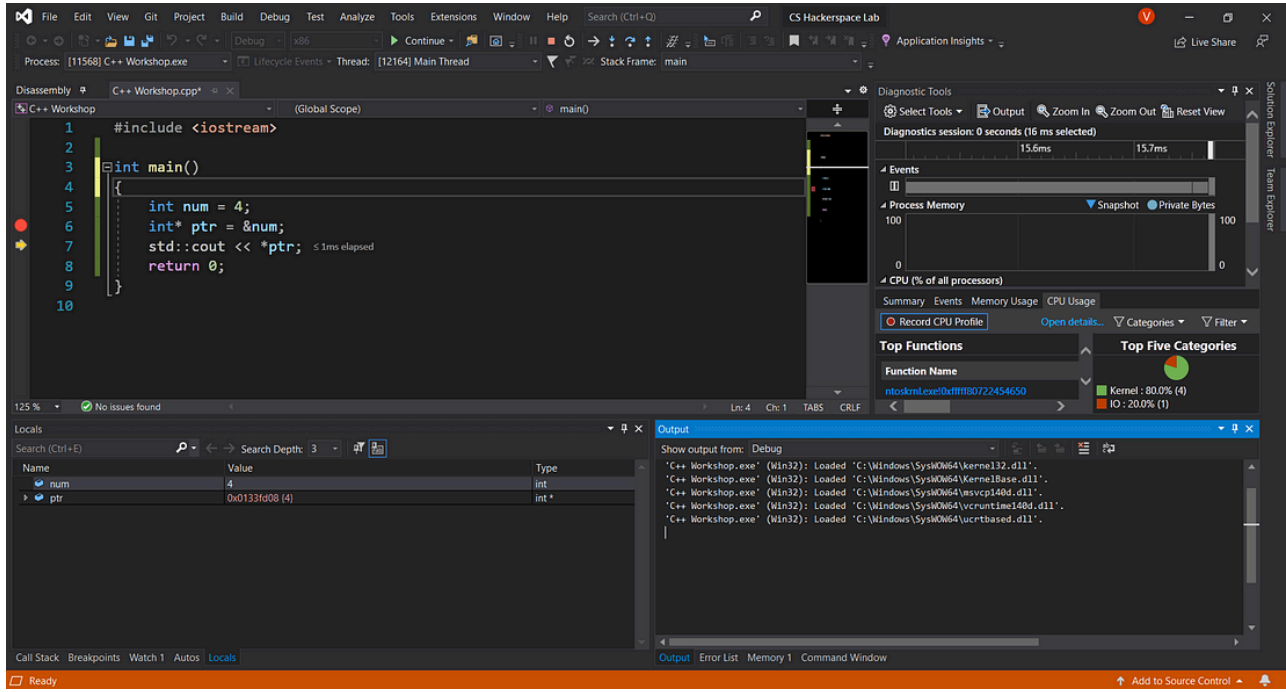
- **Print Statements:**

```c
int main() {
    int x = 5, y = 3;

    printf("Program start\n"); // Print statement to indicate the start of the program

    // Print statements to output variable values
    printf("Value of x: %d\n", x);
    printf("Value of y: %d\n", y);

    printf("Checkpoint reached\n"); // Print statement to indicate a checkpoint

    printf("Calculating sum\n"); // Print statement to perform a calculation

    int sum = x + y;

    printf("The sum of x and y is: %d\n", sum); // Print statement to output the result

    printf("Program end\n"); // Print statement to indicate the end of the program

    return 0;
}
```



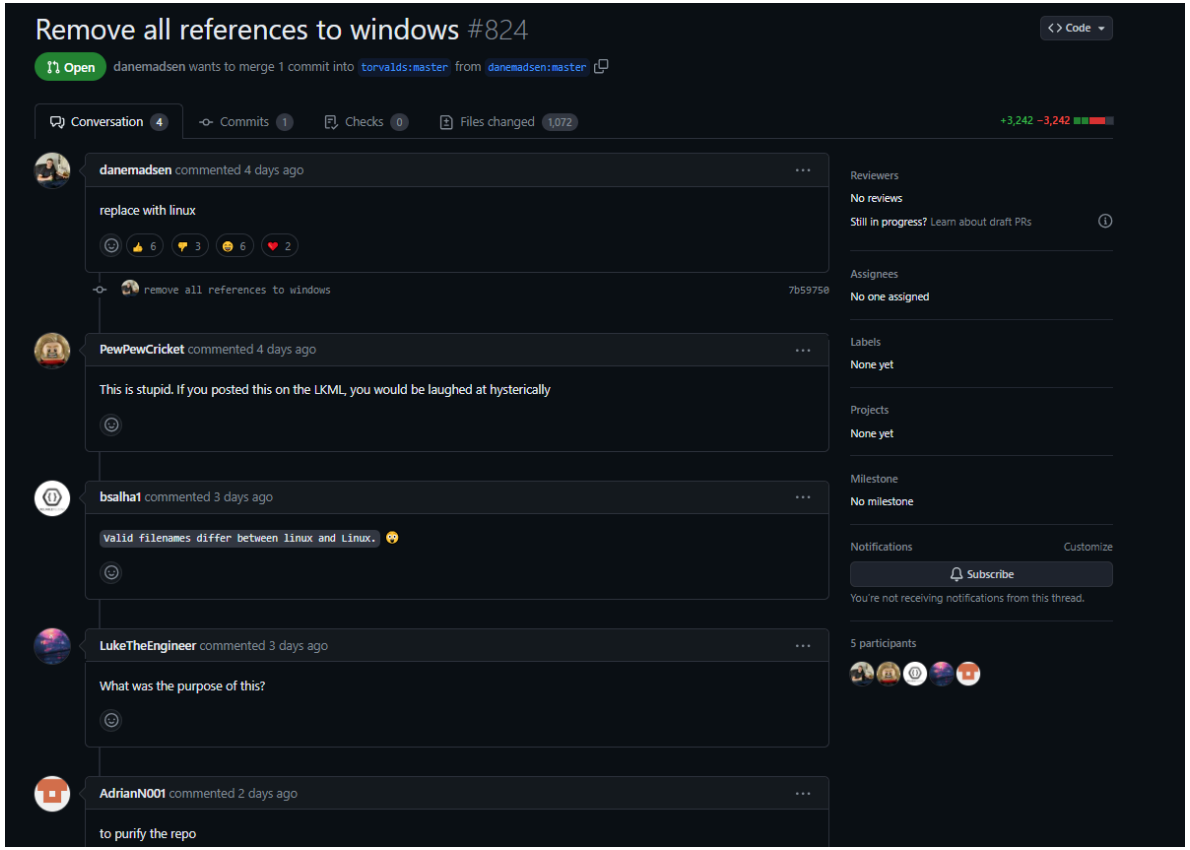
Debugging Techniques

- **Debugger Tools:** Integrated development environments (IDEs) and standalone debugger tools provide features such as breakpoints, stepping through code, and variable inspection, allowing developers to analyze program behavior in real-time.



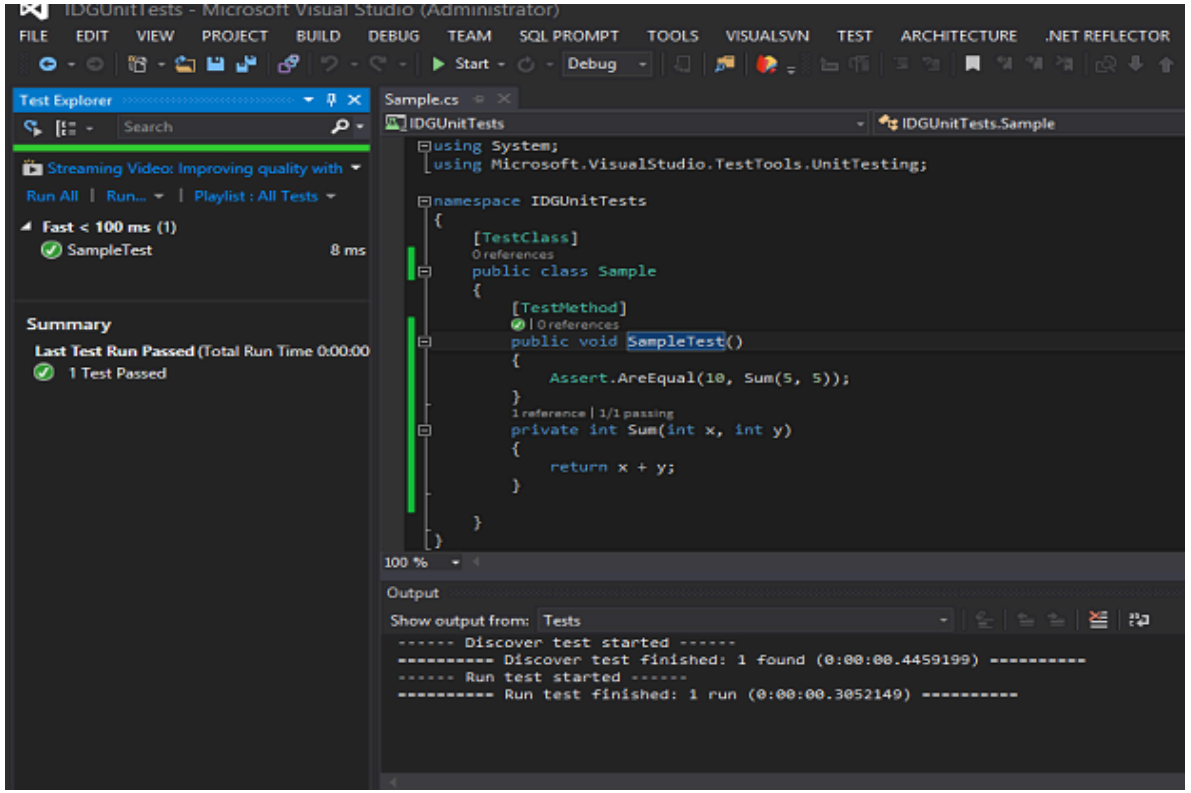
Debugging Techniques

- **Code Review:** Collaborating with peers to review code can help identify bugs and provide alternative perspectives on problem-solving.



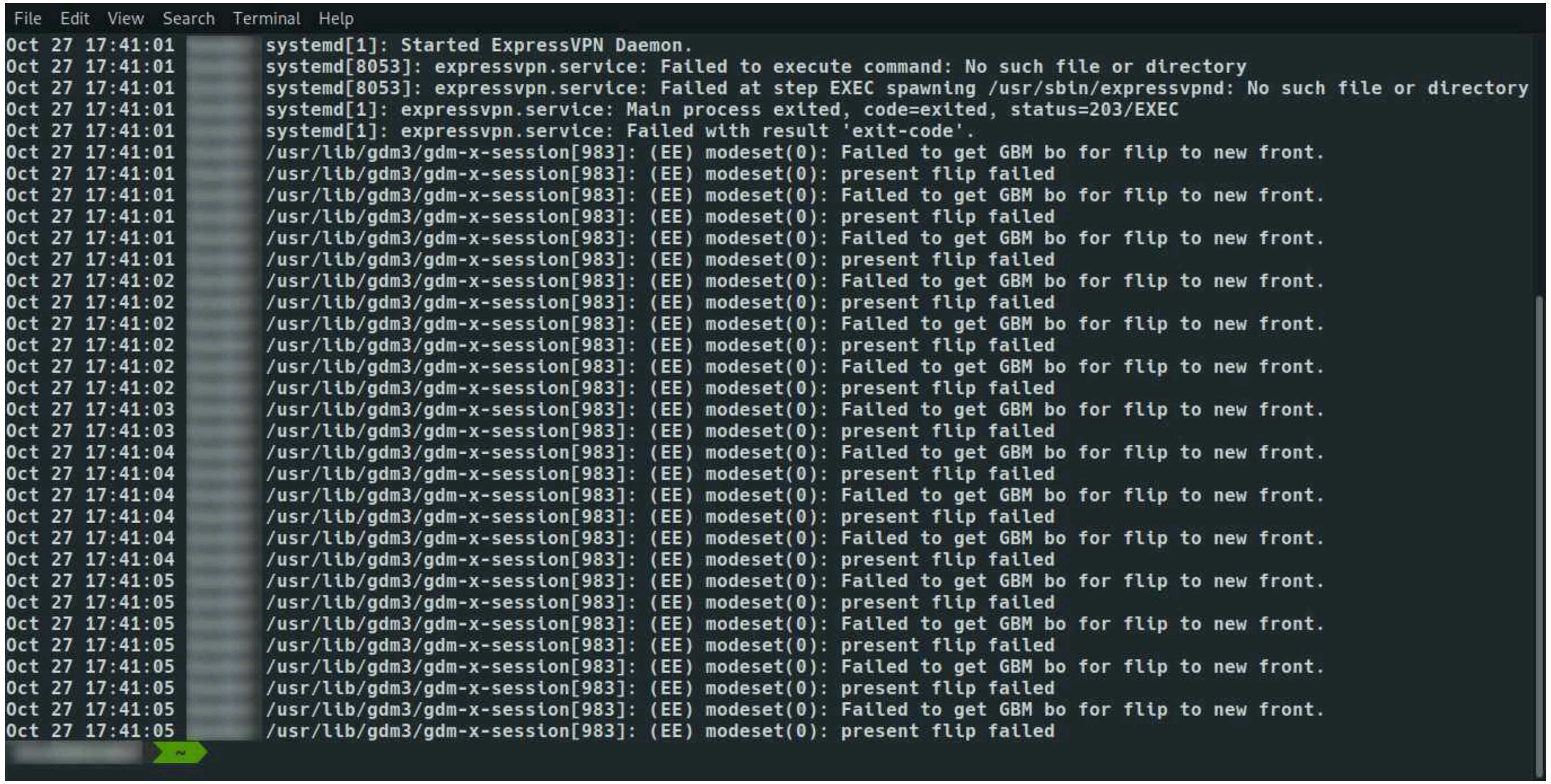
Debugging Techniques

- **Unit Testing:** Writing and executing unit tests to validate individual components of the software can help catch bugs early in the development process.



Debugging Techniques

- **Logging:** Incorporating logging mechanisms into the software to record relevant events and errors can aid in post-mortem analysis and troubleshooting.



Best Practices for Effective Debugging

- **Reproduce the Issue**: Attempt to reproduce the bug consistently to understand its scope and conditions.
- **Isolate the Problem**: Narrow down the search for the bug by identifying the specific sections of code or inputs that trigger the unexpected behavior.
- **Stay Organized:** Keep track of debugging progress, including any changes made to the code or observations during the process, to maintain clarity and focus.
- **Document Findings:** Documenting the debugging process, including the steps taken and the solutions attempted, can provide valuable insights for future reference.
- **Continuous Learning:** Stay updated on debugging techniques and tools, and learn from past debugging experiences to improve problem-solving skills.