

**Lab Terminal**

**Name : Muhammad Wasiq**

**Reg. no . : fa21-bcs-039**

**Course : Compiler Construction**

**Q.5:**The semantic analysis phase ensures that the program logic and data types adhere to the language's rules. In the mini compiler, this is handled by the semanticAnalysis function.

### **Function Definition**

void semanticAnalysis(const std::vector<ASTNode> &ast) {

for (const auto &node : ast) {

if (node.type == "return" && !std::is\_integral<decltype(node.value)>::value) {

throw std::runtime\_error("Semantic Error: Return value must be an integer.");

}

}

}

### **Purpose**

The semanticAnalysis function checks for logical and type-related correctness in the Abstract Syntax Tree (AST). In this mini compiler:

* It validates that all return nodes in the AST return an integer value.

### **How It Works**

1. Iterate Through AST Nodes:
   * The function loops through each ASTNode in the ast vector.
2. Check Node Type:
   * It focuses on return nodes because they require a specific semantic check.
3. Validate Return Value Type:
   * For each return node, it uses std::is\_integral to ensure the value is an integer.
   * If the value is not an integer, the function throws a semantic error.
4. Error Reporting:
   * If a semantic rule is violated, the function provides a clear error message indicating the issue.

### **Example Workflow**

#### Input AST:

[{type: "return", value: 42}]

#### Execution:

* The function checks the node type (return).
* It verifies that value (42) is an integer.
* The analysis passes, and no error is thrown.

#### Input AST with Error:

[{type: "return", value: "Hello"}]

#### Execution:

* The function checks the node type (return).
* It verifies that value ("Hello") is not an integer.

An error is thrown:  
  
Semantic Error: Return value must be an integer.

### **Benefits**

1. Type Safety: Ensures the return statement always returns a value of the correct type.
2. Extensibility: Additional semantic checks (e.g., type compatibility or variable initialization) can be added as needed.
3. Error Clarity: Provides precise and actionable error messages.