For the given function, do the following:

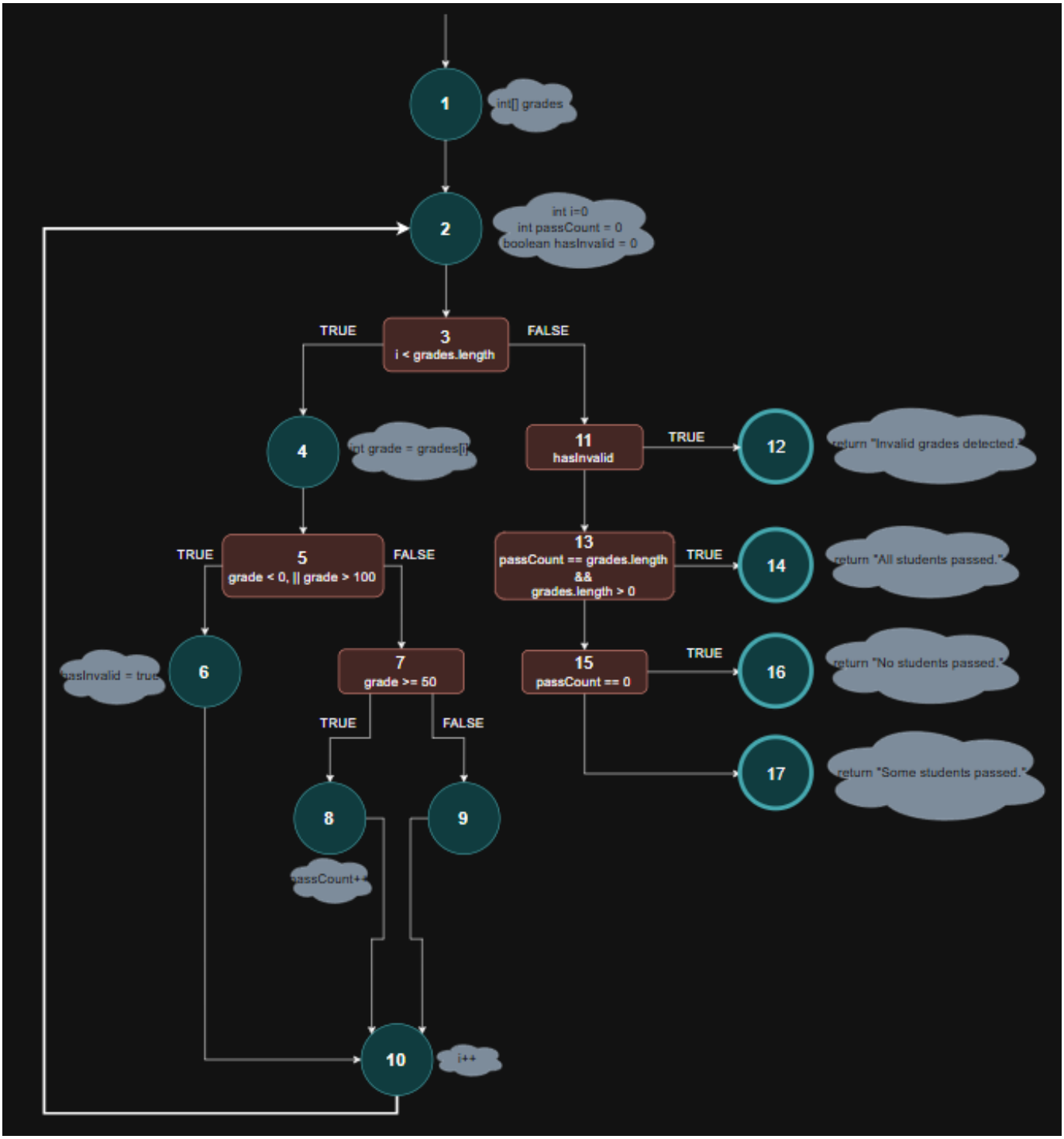
1. create a graph (full drawing)
2. find all du-paths that satisfy the criteria for All-Du-Paths Coverage
3. find the minimal test set that achieves Prime Path Coverage and create real Junit tests

```
 * Analyzes an array of student grades.
 * Returns a summary message based on:
 * - Number of passing grades (>= 50)
 * - If any grade is invalid (< 0 or > 100)
 * - If all students passed
 * @param grades an array of integers representing student grades
 * @return summary message
public static String analyzeGrades(int[] grades) {
    boolean hasInvalid = false;
    int passCount = 0;

    for (int i = 0; i < grades.length; i++) {
        int grade = grades[i];

        if (grade < 0 || grade > 100) {
            hasInvalid = true;
        } else if (grade >= 50) {
            passCount++;
        }
    }
    if (hasInvalid) {
        return "Invalid grades detected.";
    } else if (passCount == grades.length && grades.length > 0) {
        return "All students passed.";
    } else if (passCount == 0) {
        return "No students passed.";
    } else {
        return "Some students passed.";
    }
}
```

1. Control Flow Graph



Variables:

- grades
- i
- passCount
- hasInvalid
- grade

2. Find all du-paths that satisfy the criteria for All-Du-Paths Coverage (Data Flow Graph Coverage)

DU-Paths => grades

- def: 1
- use: (4), (3, 4), (3, 11), (13, 14), (13, 15)
    - DU-Paths
        - [1, 2, 3, 4]
        - [1, 2, 3, 11]
        - [1, 2, 3, 11, 13, 14]
        - [1, 2, 3, 11, 13, 15]
    - All DU-Path Coverage
        - [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 12]
        - [1, 2, 3, 11, 12]
        - [1, 2, 3, 11, 13, 14]
        - [1, 2, 3, 11, 13, 15, 16]

DU-Paths => i

- def: 2, 10
- use: (10), (3, 4), (3, 11)
    - DU-Paths
        - [2, 3, 4, 5, 6, 10]
        - [2, 3, 4, 5, 7, 8, 10]
        - [2, 3, 4, 5, 7, 9, 10]
        - [2, 3, 4]
        - [2, 3, 11]
        - нема потреба:
        - [10, 2, 3, 4, 5, 6, 10]
        - [10, 2, 3, 4, 5, 7, 8, 10]
        - [10, 2, 3, 4, 5, 7, 9, 10]
        - [10, 3, 4]
        - [10, 3, 11]
    - All DU-Path Coverage
        - [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 12] => покриено од 4-тото по ред
        - [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 12]
        - [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 12]
        - [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 12]
        - [1, 2, 3, 11, 12]

DU-Paths => passCount

- def: 2, 8
- use: (8), (13, 14), (13, 15), (15, 16), (15, 17)
    - DU-Paths
        - [2, 3, 4, 5, 7, 8]
        - [2, 3, 11, 13, 14]
        - [2, 3, 11, 13, 15]
        - [2, 3, 11, 13, 15, 16]
        - [2, 3, 11, 13, 15]
    - All DU-Path Coverage

        - [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 12]
        - [1, 2, 3, 11, 13, 14]
        - [1, 2, 3, 11, 13, 15, 16] => покриено од 4-тото по ред
        - [1, 2, 3, 11, 13, 15, 16]
        - [1, 2, 3, 11, 13, 15, 17]

DU-Paths => hasInvalid

- def: 2, 6
- use: (11, 12), (11, 13)
    - DU-Paths
        - [2, 3, 11, 12]
        - [2, 3, 11, 13]
        - [6, 10, 2, 3, 11, 12]
        - [6, 10, 2, 3, 11, 13]
    - All DU-Path Coverage
        - [1, 2, 3, 11, 12]
        - [1, 2, 3, 11, 13, 14]
        - [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 12]
        - [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 13]

DU-Paths => grade

- def: 4
- use: (5, 6), (5, 7), (7, 8), (7, 9)
    - DU-Paths
        - [4, 5, 6]
        - [4, 5, 7]
        - [4, 5, 7, 8]
        - [4, 5, 7, 9]
    - All DU-Path Coverage
        - [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 12]
        - [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 12] => покриено од 3-тото по ред
        - [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 12]
        - [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 12]

3. Find the minimal test set that achieves Prime Path Coverage and create real JUnit tests (Graph Coverage)

Invalid grades detected.

- [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 12]
- [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 12]
- [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 12]
- [1, 2, 3, 11, 12]

All students passed.

- [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 13, 14]
- [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 13, 14]
- [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 13, 14]
- [1, 2, 3, 11, 13, 14]

No students passed.

- [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 13, 15, 16]
- [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 13, 15, 16]
- [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 13, 15, 16]
- [1, 2, 3, 11, 13, 15, 16]

Some students passed.

- [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 13, 15, 17]
- [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 13, 15, 17]
- [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 13, 15,17]
- [1, 2, 3, 11, 13, 15, 17]

JUnit Tests

```
package com.example.laboratoryexercises.JUnit.LaboratoryExercies02;

import org.junit.Test;

import static org.junit.Assert.assertEquals;

public class GradeAnalyzerTest {

    // ---- "Invalid grades detected." paths ----

    @Test
    public void testSingleInvalidGrade() {
        // Path: [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 12]
        // A path where an invalid grade is found during iteration
        int[] grades = {-5};
        String result = GradeAnalyzer.analyzeGrades(grades);
        assertEquals("Invalid grades detected.", result);
    }

    @Test
    public void testPassingThenInvalid() {
        // Path: [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 12]
        // Path where we have valid passing grades before finding an invalid one
        int[] grades = {75, 101};
        String result = GradeAnalyzer.analyzeGrades(grades);
        assertEquals("Invalid grades detected.", result);
    }

    @Test
```

```
public void testFailingThenInvalid() {
    // Path: [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 12]
    // Path where we have valid failing grades before finding an invalid one
    int[] grades = {45, 101};
    String result = GradeAnalyzer.analyzeGrades(grades);
    assertEquals("Invalid grades detected.", result);
}

// Note: Path [1, 2, 3, 11, 12] with empty array actually leads to "No students passed"

// ---- "All students passed." paths ----

@Test
public void testAllStudentsPassed() {
    // Path: [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 13, 14]
    // Path where all grades are passing (≥50)
    int[] grades = {50, 75, 90};
    String result = GradeAnalyzer.analyzeGrades(grades);
    assertEquals("All students passed.", result);
}

@Test
public void testSingleStudentPassed() {
    // Similar to Path: [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 13, 14] but with one iteration
    // Single passing grade
    int[] grades = {75};
    String result = GradeAnalyzer.analyzeGrades(grades);
    assertEquals("All students passed.", result);
}

// Note: Paths [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 13, 14],
// [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 13, 14], and [1, 2, 3, 11, 13, 14]
// are logically impossible for "All students passed"

// ---- "No students passed." paths ----

@Test
public void testAllStudentsFailed() {
    // Path: [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 13, 15, 16]
    // Path where all grades are failing (<50)
    int[] grades = {30, 45, 49};
    String result = GradeAnalyzer.analyzeGrades(grades);
    assertEquals("No students passed.", result);
}

@Test
public void testEmptyArray() {
    // Path: [1, 2, 3, 11, 13, 15, 16]
    // Path for an empty array where no students passed
    int[] grades = {};
    String result = GradeAnalyzer.analyzeGrades(grades);
    assertEquals("No students passed.", result);
}

@Test
public void testSingleStudentFailed() {
    // Similar to Path: [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 13, 15, 16] but with one iteration
```

```
        // Single failing grade
        int[] grades = {45};
        String result = GradeAnalyzer.analyzeGrades(grades);
        assertEquals("No students passed.", result);
    }

    // Note: Paths [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 13, 15, 16] and
    // [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 13, 15, 16] are logically impossible for "No students passed"

    // ---- "Some students passed." paths ----

    @Test
    public void testSomeStudentsPassedPassingFirst() {
        // Path: [1, 2, 3, 4, 5, 7, 8, 10, 2, 3, 11, 13, 15, 17]
        // Path with mix of passing and failing grades (some passing)
        int[] grades = {75, 45};
        String result = GradeAnalyzer.analyzeGrades(grades);
        assertEquals("Some students passed.", result);
    }

    @Test
    public void testSomeStudentsPassedFailingFirst() {
        // Path: [1, 2, 3, 4, 5, 7, 9, 10, 2, 3, 11, 13, 15, 17]
        // Path with mix of passing and failing grades (first failing)
        int[] grades = {45, 75};
        String result = GradeAnalyzer.analyzeGrades(grades);
        assertEquals("Some students passed.", result);
    }

    @Test
    public void testMultipleMixedGrades() {
        // Combined path with multiple iterations through both passing and failing branches
        int[] grades = {45, 75, 30, 80, 49};
        String result = GradeAnalyzer.analyzeGrades(grades);
        assertEquals("Some students passed.", result);
    }

    // Note: Paths [1, 2, 3, 4, 5, 6, 10, 2, 3, 11, 13, 15, 17] and
    // [1, 2, 3, 11, 13, 15, 17] are logically impossible for "Some students passed"
}
```