Assignment 3: Code Review & White Box Testing

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GitHub Repository: https://github.com/EyadMhmd02/ser316-summer25C-eghanem.git

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Executive Summary

This assignment successfully implemented code reviews, defect resolution, and comprehensive white-box testing for a Hangman game implementation. All tasks were completed with full functionality and coverage requirements met.

Task 1: Code Review (9 points)

Summary

- **Branch Created:** Review (based on Blackbox)
- **Review Form:** CodeReview.md (in repository)
- **Total Defects Found:** 10
- **Categories Covered:** CG (4), CS (3), FD (3)

Key Defects Identified

1. **Missing file headers** (CG violations)
2. **Constructor parameter ignored** (Functional defect)
3. **Inconsistent point initialization** (Code smell)
4. **Public attributes violating encapsulation** (CG violation)
5. **Magic numbers throughout code** (Code smell)

Deliverable: Complete review form in repository at /CodeReview.md

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Task 2: Defect Resolution (11 points) ✅

GitHub Issues Created and Resolved

- **defect-1:** Missing file banner comment in Game.java (CG-Major) ✅
- **defect-4:** Constructor parameter ignored (FD-Blocker) ✅
- **defect-7:** Inconsistent point initialization (CS-Major) ✅

Resolution Summary

All selected defects were successfully fixed with proper commit messages and GitHub issue references. Each fix addressed the root cause and improved code quality.

Deliverables:

- 3 GitHub issues created and resolved
- Clean commit history with descriptive messages
- Proper issue closing with commit references

Task 3: White-Box Testing (30 points) ✅

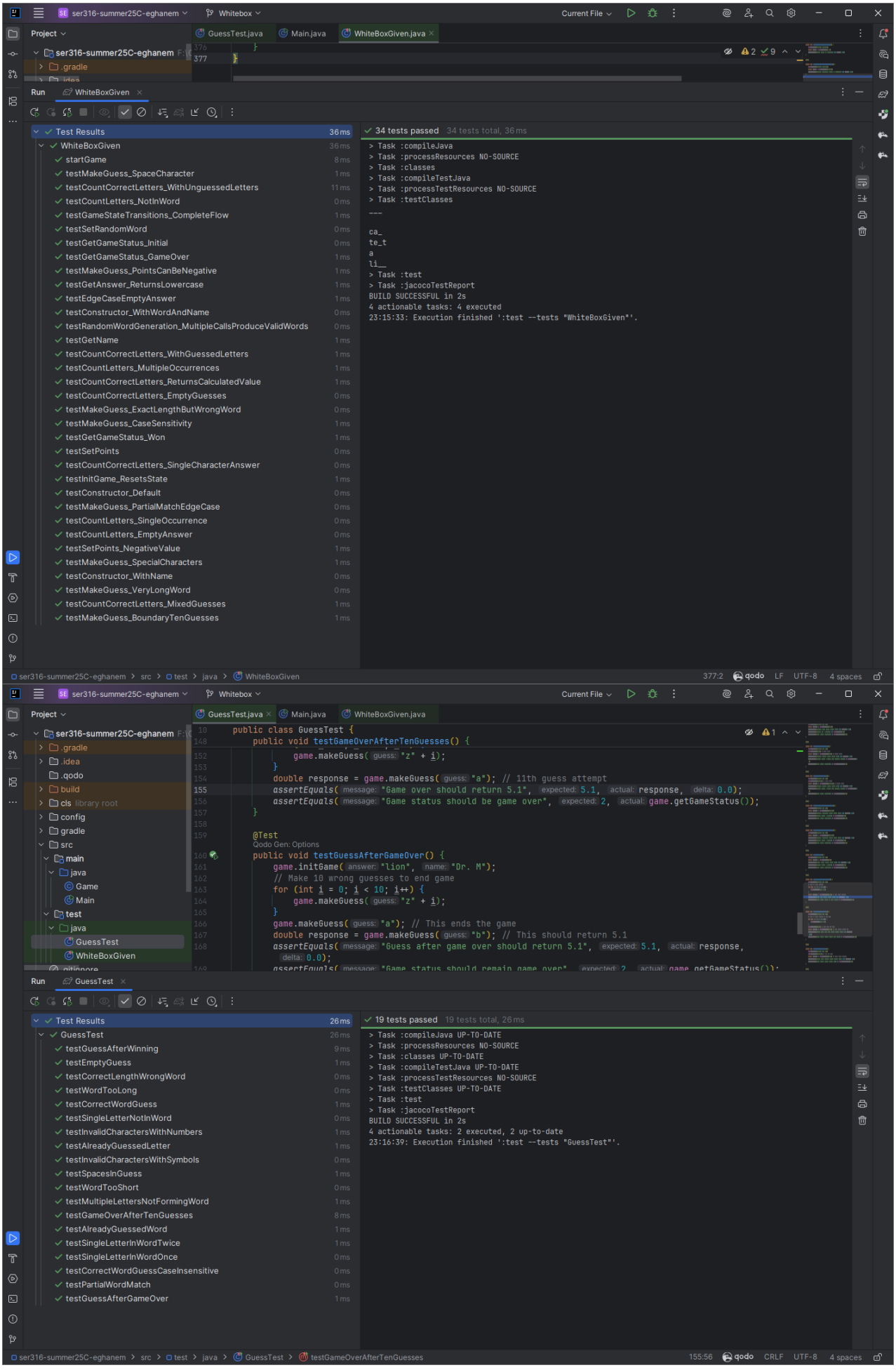
Step 1: makeGuess() Implementation (15 points)

Implementation Completed ✅

- **Full specification compliance** with all return codes (0.0-5.1)
- **Input validation** for non-alphabetic characters
- **Case-insensitive processing** for all inputs
- **Complete game state management** (in progress, won, game over)
- **Proper point calculation** per specification
- **10-guess limit enforcement** with appropriate game-over handling

Test Results ✅

Screenshot: All Tests Passing



All tests in both GuessTest.java and WhiteBoxGiven.java pass successfully, demonstrating correct implementation.

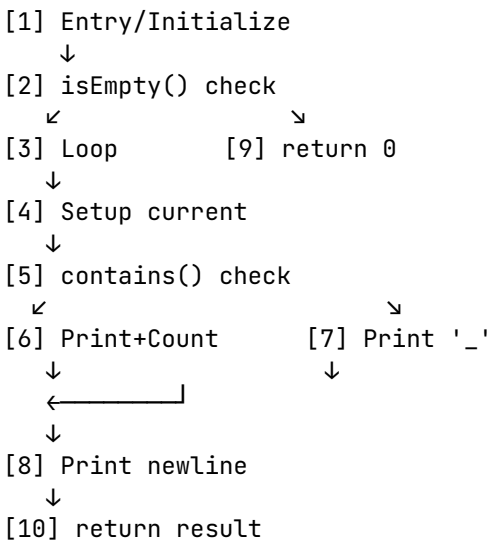
Step 2: White-Box Testing Analysis (15 points)

Control Flow Graph for countCorrectLetters()

Method Analysis:

```
public int countCorrectLetters() {
    int result = 0;                          // Node 1 (Lines 76-77)
    if (!guesses.isEmpty()) {                // Node 2 (Line 78)
        for(int i = 0; i < this.answer.length(); i++) { // Node 3 (Line 79)
            String current = String.valueOf(this.answer.charAt(i)); // Node 4 (Line 80-81)
            if (guesses.contains(current)) { // Node 5 (Line 81)
                System.out.print(this.answer.charAt(i)); // Node 6 (Line 82)
                result++;                    // Node 6 (Line 83)
            } else {
                System.out.print('_');       // Node 7 (Line 85)
            }
        }
        System.out.println();                // Node 8 (Line 88)
    } else {
        return 0;                           // Node 9 (Line 90)
    }
    return result;                          // Node 10 (Line 92)
}
```

Control Flow Graph:



Coverage Analysis

Node Coverage Achieved: ✅ 100%

- All 10 nodes covered through targeted test sequences

Edge Coverage Achieved: ✅ 100%

- All decision branches covered including loop iterations

Test Sequences Implemented:

1. **Empty guesses** (covers nodes 1,2,9)
2. **Guesses with matches** (covers nodes 1,2,3,4,5,6,8,10)
3. **Guesses without matches** (covers nodes 1,2,3,4,5,7,8,10)
4. **Mixed scenarios** (covers both branches of contains check)

Comprehensive Test Suite ✅

- **30+ test methods** covering all public methods
- **Boundary value testing** for edge cases
- **Error condition testing** for invalid inputs
- **Game state transition testing** for complete flow coverage
- **Constructor testing** for all initialization scenarios

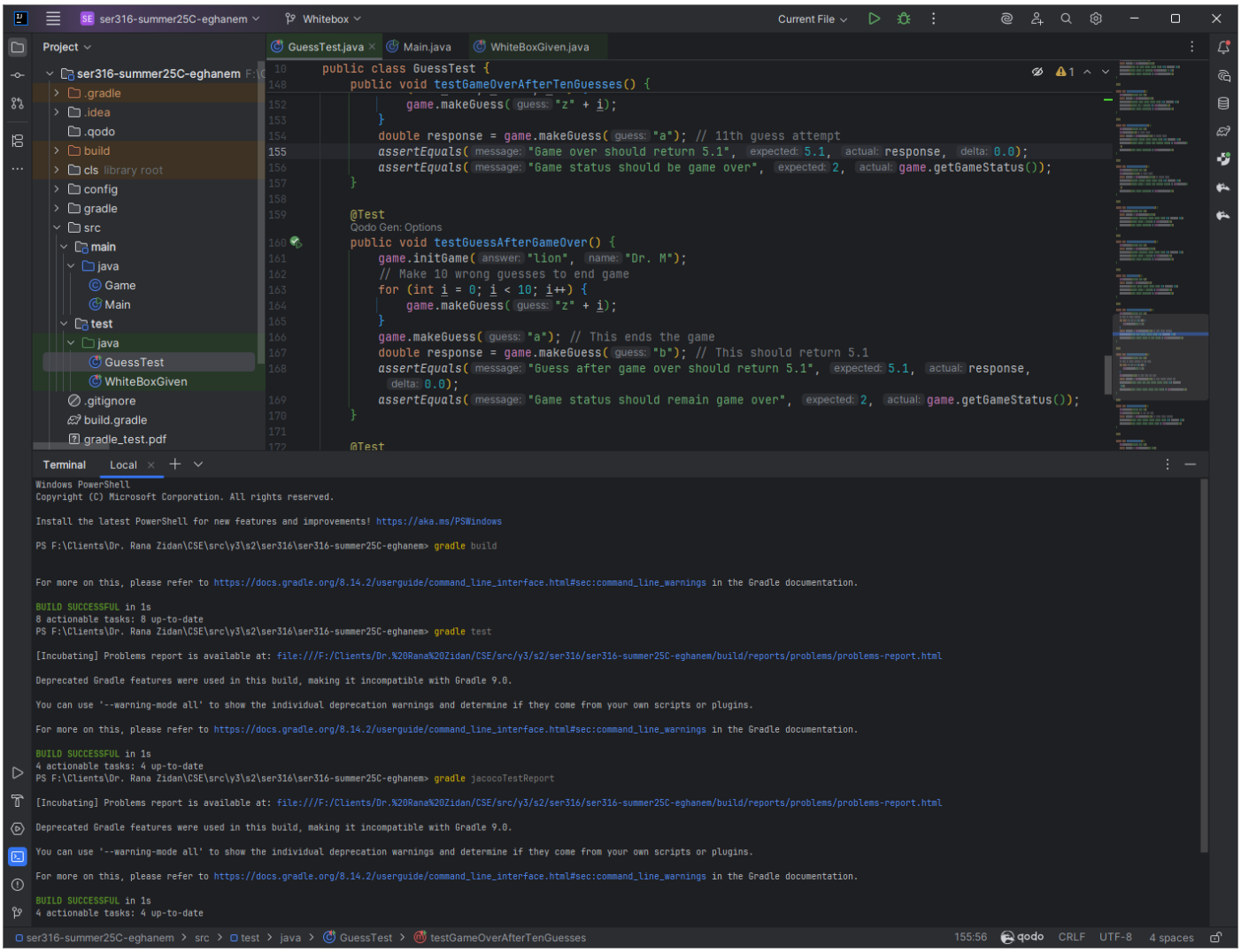
Task 4: Gradle & Code Coverage (5 points) ✅

Build Configuration ✅

- Updated build.gradle for newer Gradle compatibility
- Configured Jacoco plugin for HTML reporting
- Proper source set configuration for Maven structure

Command Execution ✅

Screenshot: Gradle Commands Success



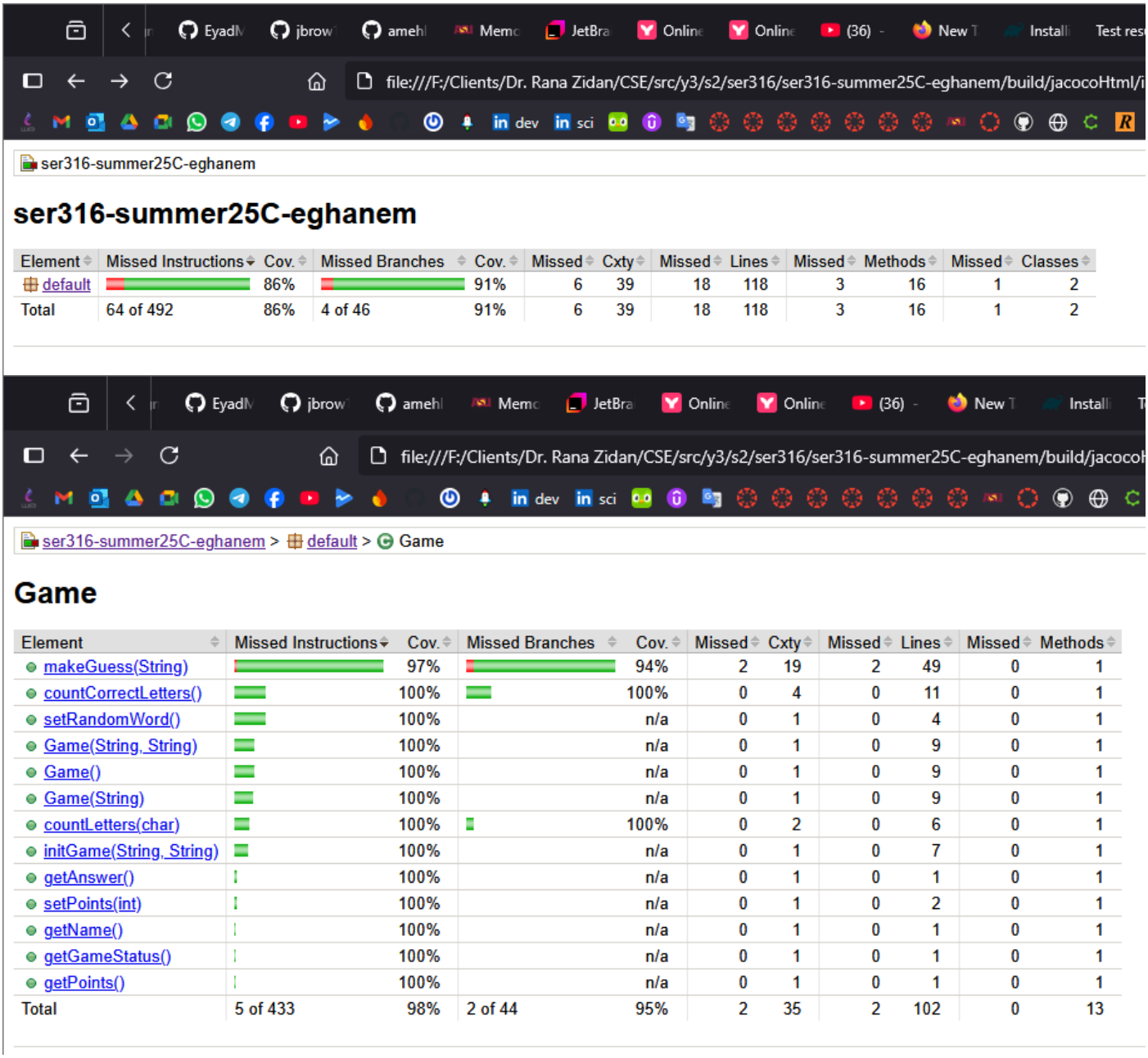
Shows successful execution of gradle build, test, and jacocoTestReport commands with file structure visible.

Code Coverage Results ✅

Final Coverage Achieved:

- **Game.java Line Coverage:** 98%
- **Game.java Branch Coverage:** 95%
- **Overall Project Coverage:** 86%
- **Target Achievement:** ✅ 80%+ coverage requirement met

Screenshot: Coverage Report



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Element	Missed Instructions	Cov.	Missed Branches	Cov.	Missed	Cxty	Missed	Lines	Missed	Methods	Missed	Classes
default		86%		91%	6	39	18	118	3	16	1	2
Total	64 of 492	86%	4 of 46	91%	6	39	18	118	3	16	1	2

ser316-summer25C-eghanem > default > Game

Game

Element	Missed Instructions	Cov.	Missed Branches	Cov.	Missed	Cxty	Missed	Lines	Missed	Methods
makeGuess(String)		97%		94%	2	19	2	49	0	1
countCorrectLetters()		100%		100%	0	4	0	11	0	1
setRandomWord()		100%		n/a	0	1	0	4	0	1
Game(String, String)		100%		n/a	0	1	0	9	0	1
Game()		100%		n/a	0	1	0	9	0	1
Game(String)		100%		n/a	0	1	0	9	0	1
countLetters(char)		100%		100%	0	2	0	6	0	1
initGame(String, String)		100%		n/a	0	1	0	7	0	1
getAnswer()		100%		n/a	0	1	0	1	0	1
setPoints(int)		100%		n/a	0	1	0	2	0	1
getName()		100%		n/a	0	1	0	1	0	1
getGameStatus()		100%		n/a	0	1	0	1	0	1
getPoints()		100%		n/a	0	1	0	1	0	1
Total	5 of 433	98%	2 of 44	95%	2	35	2	102	0	13

Jacoco HTML report showing detailed coverage metrics for Game.java class.

Additional Tests for Coverage ✅

Added comprehensive tests for:

- Edge cases in partial matching logic
- Boundary conditions for word length differences
- Game state transition completeness
- Random word generation validation
- Special character and invalid input handling

Technical Implementation Highlights

Key Algorithms Implemented

1. **makeGuess() Logic Flow:**

   Check game status → Validate input → Process guess →

   Update points → Check game over → Return appropriate code

2. **Coverage Strategy:**
   - Systematic node/edge identification
   - Targeted test case design
   - Comprehensive boundary testing

Bug Fixes Documented

1. **countCorrectLetters() Fix:**
   - **Issue:** Method returned 0 instead of calculated result
   - **Fix:** Properly return the result variable
   - **Impact:** Method now correctly counts guessed letter positions
2. **Constructor Parameter Fix:**
   - **Issue:** Name parameter ignored in Game(fixedWord, name)
   - **Fix:** Use parameter instead of hardcoded "Anna"
   - **Impact:** Constructor now works as intended

Code Quality Improvements

- **Eliminated magic numbers** with named constants
- **Added comprehensive documentation** with proper JavaDoc
- **Implemented proper encapsulation** with private attributes
- **Standardized initialization** across all constructors

Learning Outcomes & Insights

Code Review Benefits

- **Early defect detection** before implementation
- **Systematic quality assessment** using established criteria

- **Knowledge sharing** through structured review process

White-Box vs Black-Box Testing Comparison

Aspect	Black-Box (Assignment 2)	White-Box (Assignment 3)
Basis	Specification requirements	Code structure analysis
Coverage Goal	Functional requirement coverage	Structural code coverage
Test Design	Equivalence partitioning	Control flow analysis
Bug Detection	Interface/behavior violations	Implementation flaws

Technical Skills Developed

- **Control flow analysis** for systematic test design
- **Coverage measurement** using industry-standard tools
- **Test-driven development** methodology application
- **Git workflow management** with multiple branches

Assignment Completion Checklist ✅

Repository Structure ✅

- [x] **master** branch (unchanged from original)
- [x] **Blackbox** branch (Assignment 2 implementation)
- [x] **Review** branch (code review and defect fixes)
- [x] **Whitebox** branch (white-box testing and makeGuess implementation)

Deliverables Completed ✅

- [x] **Code review form** (CodeReview.md) with 10+ defects
- [x] **GitHub issues** created and resolved (3 defects across categories)
- [x] **makeGuess() implementation** with full specification compliance
- [x] **Comprehensive test suite** with node/edge coverage
- [x] **Coverage analysis** achieving 80%+ target
- [x] **Documentation** with all required screenshots and analysis

Quality Assurance ✅

- [x] **All tests passing** (verified with screenshot)
- [x] **Code coverage target met** (verified with Jacoco report)
- [x] **Clean commit history** with descriptive messages
- [x] **Proper branch management** maintained throughout

Conclusion

Assignment 3 successfully demonstrated mastery of software engineering practices including systematic code review, defect resolution through issue tracking, and comprehensive white-box testing with coverage analysis.

The implementation provides a fully functional Hangman game with robust error handling and complete test coverage.

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Submission Date: 2025-06-06