Analyzing Student Debugging Practices and Project Outcomes
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Identifying Debugging Behaviors in Intermediate Programmers

- Intermediate programmers often spend a lot of time debugging
- In a post-CS2 Data Structures and Algorithms course, we used IDE clickstream data to analyze detailed debugging behavior
- We hypothesize that there are differing debugging behaviors exhibited, and that differing behaviors lead to differing project outcomes

Research Questions

- To what extent is a particular debugging technique being used?
- Does it matter when in the project lifecycle that debugging takes place?
- Can a particular type of debugging technique lead to better project score?

Different Debugging Techniques

- Tracing Techniques [1]
  - Diagnostic Print Statement
  - System.out.print(...);
  - System.out.print("success!");

- Source-level Debugger
  - Code Comprehension
  - Tracing w/ Pen & paper

- Eclipse (IDE) Debugger

Diagnostic Print Statement (DPS) Classifier

We want to identify those print statements that the students use for debugging purposes i.e. DPS; this is not a trivial process.

1. Exclude Commented Print Statements
2. Exclude Trivial (Delimiter) Print Statements
3. Exclude Project Specific (Required) Statements

DPS Examples

- System.out.print(tempValue);
- System.out.print("success!");

Extracting Debugging Behavior

1. Extracting DPS from Code Snapshots
   - Snapshot History → Single Snapshot → All Print Statements

   Diagnostic Print Statement Classifier
   - Diagnostic Print Statements (for debugging purposes)
   - Non-Diagnostic Print Statements (for non-debugging purposes)

2. Extracting Eclipse Debugger Events via DevEventTracker* [2]

   * Eclipse-based click-stream data collector

   - DevEventTracker Plugin [2]
   - Breakpoints
   - Launch Debugger
   - Step into
   - Step over

   

Findings

Distribution of Different Debugging Techniques

- 87.21% of students used the DPS
- 75% of students used the Eclipse Debugger.
- Most students use both the DPS and the Eclipse Debugger.
- Debugging early and often showed a weak positive correlation with project performance.

\[
\text{corr coeff} = 0.19 \quad p - value < 0.001
\]

Preliminary Evaluation using DPS Classifier

- 12 sample projects (3 samples from 4 different Projects)
- Print Statements: Total 1467* (μ = 122, σ = 89 )
- DPS: Total 611* (μ = 51, σ = 54)

Accuracy: 100%

Therefore, this classifier works well on this dataset.

Relationship with Project Score

1. Project Score vs DPS
   - Project Score vs DPS
     \[
     p - value = 0.0347
     \]
   - Therefore, there is significant evidence that project scores correlate to DPS count.
   - \( R^2 = 0.0456 \)

2. Project Score vs Debugger Events

   * More Debugger Events (step over, step into) → lower Project Score
   * Step over: \( p = 0.039 \) and Step into: \( p = 0.005 \)

   Therefore, students tend to get lower Project Scores when they spend too much time on the same bug.

Key Results

- Students tend to perform better on the project when debugging takes place earlier in the overall project life-cycle.
- There is weak yet statistically significant evidence that both DPS and Debugger Events correlate to overall Project Score.
- Only 4.56% variability in Project Score can be explained by overall DPS count

Future Work

- We plan to focus on individual debugging sessions to find if one type of debugging technique is more effective than another.
- We plan to find out how the students verify that the bug is fixed, such as manual checking, writing new test-cases, and/or by submitting the project for evaluation.

References


This work is funded in part by NSF grants DUE-1245334 and DUE-1432008