Provenance Support for Rework

Xiang Zhao\textsuperscript{1}, Leon J. Osterweil\textsuperscript{1}, Barbara Staudt Lerner\textsuperscript{2}, Emery R. Boose\textsuperscript{3}, Aaron M. Ellison\textsuperscript{3}

\textsuperscript{1}University of Massachusetts Amherst  
\textsuperscript{2}Mount Holyoke College  
\textsuperscript{3}Harvard University

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The Problem: How to Support Rework

- Rework is quite common in software development processes
  - Inconsistencies between requirement and design specifications cause reconsideration of both
  - Inconsistencies between code and design too
  - Most software engineering books ignore the topic
- Process provenance support could help
  - People could review earlier decisions to facilitate rework
Refactoring as an Example of Rework

Refactoring is rework of design
- May or may not be triggered when code is recognized as being untidy
- There are many different design patterns [Fowler 1999]
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Separate Query from Modifier Refactoring

- Splits a method that was both a query and a modifier into two methods
  - Create a query method to return the same value
  - Change the return statement in original method to return the query
  - Add calls to the query before the calls to the original method
  - Change the original method to void and remove its return statements
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- Executing this rework process can entail carrying out a number of different kinds of rework
Exception instances are handled differently according to their types.

Each exception instance triggers rework.
Separate Query from Modifier Refactoring as an Example of Rework

- Change return statement
- Compile
- Run unit tests
- Modify Original Method
- Handle Compilation Failure
- Handle Unit Tests Failure
- UnitTestFailureException
- CompilationFailureException

- Exception instances are handled differently according to their types.
- Each exception instance triggers rework
Rework is modeled very accurately as recursive step invocations. Actual rework should be guided by context provided by provenance.

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Actual rework should be guided by *context* provided by provenance.
Typical Questions that Users Want Answers to during Rework

- Where am I?
- What am I doing here?
- How did I get here?
- What have I already tried?
- How did that work out?
- What alternatives do I have now?
- Which are likely to turn out best?
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Contextual information provided by provenance could help
Context Information that could Help

- Present process execution state
  - Current artifact values
  - Pointers to executing steps and their recursions
- A complete process execution history
  - Prior values of artifacts
  - Previous step execution sequences
- Information that could help to form a plan for completing rework successfully

**Data Derivation Graph** is the key artifact
Data Derivation Graph

Legend:
- Leaf Step
- Non-leaf Step
- Start/Finish
- Control Flow
- Data Flow
- Exception
- Data
- Execution
- Run unit tests
- Change return statement
- Unit Test Suite
- Handle Unit Tests Failure Start
- Handle Unit Tests Failure Finish
- Handle Unit Test Compilation Failure Start
- Handle Unit Test Compilation Failure Finish
- Handle Compilation Failure Finish
- Unit TestCompilationFailureException
- UnitTestFailureException
- sourcefilename
- sourcefilecontent
- Change return statement
- Create query method
- Compile
- Run unit tests
- Handle Unit Test Compilation Failure

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Provenance Support for Rework
Data Derivation Graph

Run unit tests
Change return statement
UnitTestSuite

Handle Unit Tests Failure Start
Handle Unit Tests Failure Finish

Handle Unit Test Compilation Failure Start
Handle Unit Test Compilation Failure Finish

Create query method
Compile

sourcefilename --> sourcefilecontent

Handle Unit Tests Failure
UnitTestFailureException
Handle Unit Test Compilation Failure
UnitTestCompilationFailureException

Change return statement
Create query method
Compile

Run unit tests

Xiang Zhao¹, Leon J. Osterweil¹, Barbara Staudt Lerner², Emery R. Boose³, Aaron M. Ellison³
Provenance Support for Rework
• Defined templates for translating Little-JIL step executions into DAG fragments
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- Basic Features
  - Represents how artifacts are derived from each other
  - Incorporates scoping, nesting, hierarchy information

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Provenance Support for Rework
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- Additional Features
  - Links to previous artifacts values
  - Detailed history is inferable

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Additional Features
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Can generate DDGs dynamically while the process is executing
Q: What did I do to (the same part of) the source code when I was trying to fix an issue caused by test case failure, which may possibly be the reason why the compilation fails right now?
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A: See the DDG
Q: What did I do to (the same part of) the source code when I was trying to fix an issue caused by test case failure, which may possibly be the reason why the compilation fails right now?
Check our paper and poster for details
Future Work

- How to present the “right” information?
  - How to support asking questions during rework?
  - How to make sure the answers are presented in a meaningful way?
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  - How to support asking questions during rework?
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- Ripple effects
  - Support for helping users decide the order in which to handle exceptions when many are thrown
    - Probably can use prospection for this

- Study more refactoring patterns
Related Work

- Rework Formalization
  - [Cass et al. EWSPT] proposed initial approaches of formalizing rework
  - A pattern for modeling rework [Cass et al. ICSP '09]

- Context Support
  - [Antunes et al. AITSE '10] proposed a context model in software development with multiple layers and perspectives.
  - Mylyn [12] is a tool integrating task management and task context [Kersten et al. AOSD '05]

- Workflow Provenance: VisTrails [Callahan et al. SIGMOD '06], Kepler [Altintas et al. SSDBM '04], and etc.
Conclusion

- Executable model of rework processes
- Provenance as a first class data
  - Available process wide
  - Directly supports the process where it comes from
- DDG facilitates provenance support
  - Scoping and nesting
  - Version edges and equivalence edges
  - Process introspection and retrospection
Thank You

Questions?