Towards a Framework for Software Design Defects Correction with Refactoring Plans

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Introduction

Software Design Defects

Definition

Design defects are “bad” solutions to recurring design problems in object-oriented systems. Design defects are problems resulting from bad design practices. They include problems ranging from high-level and design problems, such as antipatterns, to low-level or local problems, such as code smells. (Moha, 2008)

- Why is important to deal with design defects?

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Motivation

- Software evolution “happens”.
- Software design decays:
  - changes are applied hastily
  - “design debt” appears (Kerievsky, *Refactoring To Patterns*)
- Design decay can manifest through design defects, which affect software quality factors:
  - maintainability
  - reusability
  - comprehensibility
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Software Design Defect Management

- Techniques to **detect design defects** and to **suggest design changes** are maturing:
  - Structural patterns to find defects (Moha, DECOR project)
  - Metrics to detect “bad smells” (Marinescu, 2006; Crespo et al., 2005).
  - Formal/Relational Concept Analysis to propose reorganisation of OO entities (Moha et al., 2006; Prieto et al., 2003).
  - Software inconsistency management (Mens, 2006)
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Refactorings to Correct Design Defects

- **Refactorings** are structural transformations that can be applied to a software system to perform design changes without modifying its behaviour.
- **Current approaches** to improve a system design with refactorings focus in:
  - Individual refactoring steps.
  - Detecting refactoring opportunities.
  - Assisting the developer in executing the refactoring

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A **Refactoring Plan** will be a specification of a refactoring sequence which matches a system redesign proposal, so that it can be automatically executed to modify the system in order to obtain that desirable system redesign without changing the system's behaviour.

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Goals of a Framework for Refactoring Plans

1. **Support to automatic or assisted generation of refactoring plans**
2. **To provide very high level (big) refactorings** for design improvement, using refactoring plan generation altogether with the defect detection techniques that suggest redesign proposals.

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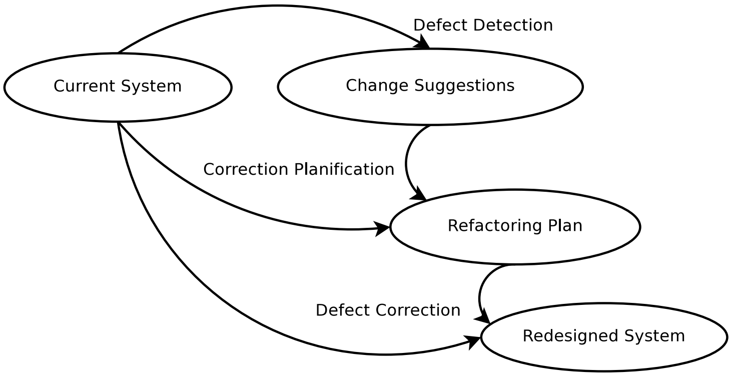
Design Defect Correction

General Defect Correction Process



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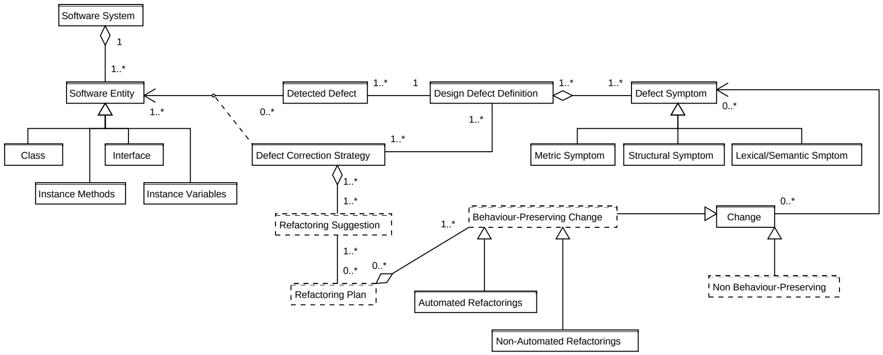
A Framework sketch



Generating Refactoring Plans

Refactoring Plan Questions

- Given **a software system** as the source of the transformation, **a redesign proposal**, and **a set of refactorings** that can be used as transformation operations:
  1. Does a refactoring plan, which transforms the source, according to the redesign proposal, using the provided refactorings, exist?
     - additional non-refactoring transformations could be needed
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Subproblems

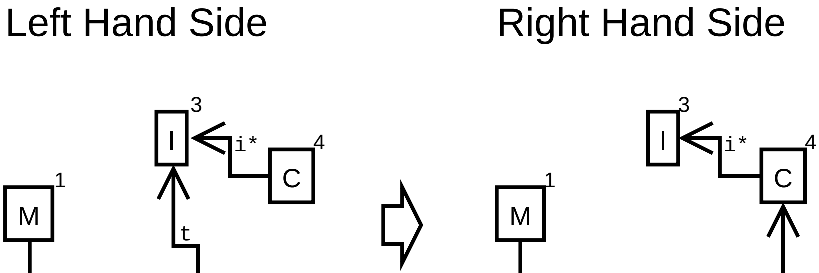
- We have divided the problem of **automatic generation of refactoring plans** in:
  - Definition and formalization of the “Refactoring Plan” concept
  - Representation of Software
  - Formalization of Refactorings
  - Elaboration of techniques to obtain refactoring plans

Formalising Refactorings

- Any refactoring formalization method must allow:
  - to deal with **system structure**.
  - to **check** behaviour preserving **conditions**.
- We will use **Graph Transformations** because:
  - Representing and managing structural information is straightforward with graphs.
  - This approach has already been validated (Mens et al., 2005).
- With Graph Transformation:
  - **Software** is represented as **graphs**.
  - **Refactorings** are represented as **graph transformation rules**.

Other refactoring formalization approaches:
  - First Order Logic (Kniessel, Köch, 2002).

Example of a Graph Transformation Rule



Software Representation: Program Graphs

- A graph representation for Object-Oriented Software is needed. We must represent:
  - elements of OO paradigm (classes, fields, methods, ...)
  - structural relationships
  - method bodies
- We have chosen the software representation part from the refactoring formalization of (Mens et al., 2005). This representation:
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  - is language independent, lacking specific language constructions.
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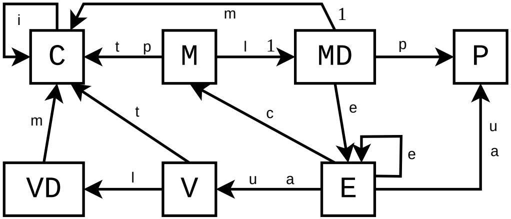

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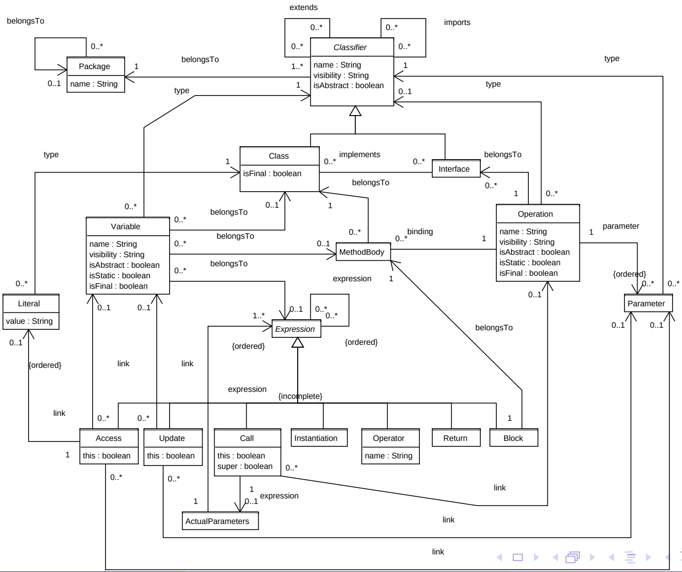

Possible Approaches to Obtain Refactoring Plans

- We are exploring two aproaches:
  - Searching forwards
  - Searching backwards

Searching forwards

- **approach**
  - Suggested changes are turned into a simplified version of the sstem's desirable design.
  - Available refactorings are applied in a state space search way.
  - Refactoring pre and postconditions guide the search.
- **Advantages**
  - Every possible path is being explored
  - Relatively easy to implement
- **Problems**
  - Size of the state space
  - Possible infinite process

Searching Backwards

- **approach**
  - Dependencies between refactorings are computed
  - Iteratively, refactorings which enable the application of the desired change are added to the plan.
- **Advantages**
  - More efficient than searching backwards
- **Problems**
  - More difficult to implement with current Graph Transformation tools

Open questions

- Can complex refactorings be represented and analysed with current GT tools?
- Can searching be reduced to finite process?

Conclusions and Future Work

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- Automatic generation of refactoring plans will provide very high level refactorings to improve the design of existing code.
- The Main subproblems and the research strategy have been introduced.
- Graph transformation can be used as the underlying formalism, specifically the programmed graph rewriting approach.
  - Representing Java programs with Java Program Graphs.
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Future Work

- Main future tasks will be directed to:
  - Further definition of the “Refactoring Plan” concept.
  - Explore the expressivenss of GT tools
  - Analyse termination and correctness conditions of the searching approaches.

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