Refactoring Techniques and Automated Approaches Through Tool Support

Seminar in Software Engineering

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ISSE

Outline

1. **Introduction**
   - Automated Refactoring in General
2. **Automated Refactoring Approaches**
   - Restructuring Legacy C Code into C++
   - Performance Impact of Polymorphism
   - Design Differencing
   - The Spartanizer: Massive Automatic Refactoring
3. **Evaluation**

Refactoring

- Restructuring code without change in semantics
  - Importance in software evolution is obvious
  - Tool support is important
- Topics:
  - Performance impact of refactoring
  - Modernizing code
  - Automated refactoring

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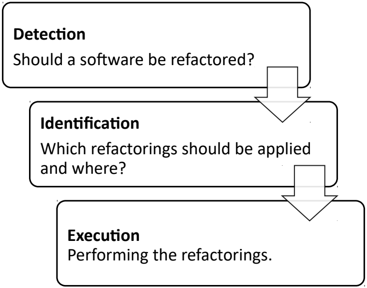
Automated Refactoring

- Goals
  - Understandability
  - Correctness
  - Ease of Maintenance and Evolution
- Automated Refactoring Steps
  - detection when an application should be refactored
  - identification which refactorings should be applied and where
  - performing the refactorings



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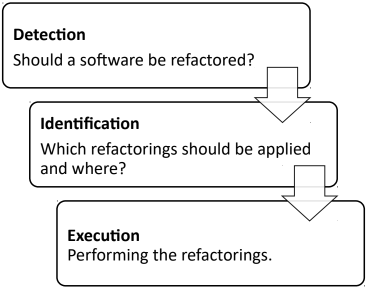

Restructuring Legacy C Code into C++

- Case study on Mosaic browser code
- Combination of refactorings to create classes
  - From C `structs`
  - From related variables

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Performance Impact of Polymorphism

- Case Study Paper
- Comparison of the performance of two programms
  - one which contains large conditionals
  - one where the conditionals are implemented using polymorphism

Performance Impact of Polymorphis

```
class ConditionalWidget {
  short mType;
  int mData;
public:
  ConditionalWidget(short type, int data)
    : mType(type), mData(data) { }
  int actionIf();
  int actionSwitch();
};

int ConditionalWidget::actionIf() {
  if(mType == 0) {
    return mData + 1;
  } else if(mType == 1) {
    return mData - 3;
  ...
  } else {
    return -1;
  }
}

int ConditionalWidget::actionSwitch() {
  switch(mType) {
    case 0: return mData + 1;
    case 1: return mData - 3;
    ...
    default: return -1;
  }
}
```

```
class PolymorphicWidget {
protected:
  int mData;
public:
  explicit PolymorphicWidget(int d)
    : mData(d) { }
  virtual ~PolymorphicWidget() = default;
  virtual int action() {
    return -1; // Default case
  }
};

class Widget0 : public PolymorphicWidget {
public:
  Widget0(int d) : PolymorphicWidget(d) {
  }
  int action() override {
    return mData + 1;
  }
}
class Widget1 : public PolymorphicWidget {
public:
  Widget1(int d) : PolymorphicWidget(d) {
  }
  int action() override {
    return mData - 3;
  }
}
...
```

Design Differencing

- Novel refactoring approach that refactors a program based on
  - desired design
  - source code
- Using desired design as target, based on
  - current software design and
  - understanding of how it may be required to evolve

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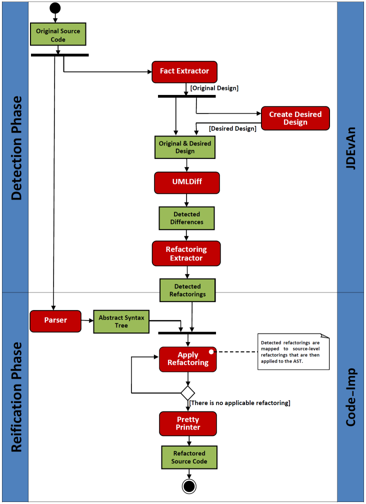

- JDEvAn
  - Item
  - Item
- Code-Imp
  - Item
  - Item

The Spartanizer: Massive Automatic Refactoring

Yossi Gil, Matteo Orrù (2017)

- Tool demo paper
- Eclipse plugin for automatic refactoring to make code more compact
- Shows that automatic refactoring can be used effectively

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The Spartanizer: Massive Automatic Refactoring

```java
public class C0<T> {
  private T inner;
  public C0(T inner) {
    super();
    this.inner = inner;
  }
  public int hashCode() {
    final int prime = 31;
    int result = 1;
    result = prime * result + ((inner==null)
      ? 0 : inner.hashCode());
    return result;
  }
  public boolean equals(Object obj) {
    if(this == obj)
      return true;
    if(obj == null)
      return false;
    if(getClass() != obj.getClass())
      return false;
    C0 other = (C0) obj;
    if(inner == null) {
      if(other.inner != null)
        return false;
    } else if(!inner.equals(other.inner))
      return false;
    return true;
  }
}
```

```java
public class C1<T> {
  private final T inner;
  public C1(T inner) {
    this.inner = inner;
  }
  public int hashCode() {
    return 31 + ((inner == null) ? 0 :
        inner.hashCode());
  }
  public boolean equals(Object c) {
    return c == this ||
        c != null && getClass() ==
        c.getClass() && equals((C1) c);
  }
  private boolean equals(C1 c) {
    return inner == null ?
        c.inner == null :
        inner.equals(c.inner);
  }
}
```

Evaluation

- Item
- Item
- Item

Evaluation

- Item
- Item
- Item

Evaluation

Table: Comparison with respect to achieved goals

	Understandability	Correctness	Maintainability
C to C++	+	+	+
Polymorphism	o	+	+
Design Diff.	o	+	+
JDEvAn	o	-	+
Code-Imp	o	-	+
The Spartanizer	+	o	+

Evaluation

Table: Comparison with respect to supported steps

	Detection	Identification	Execution
C to C++	o	o	o
Polymorphism	o	o	-
Design Diff.	-	o	+
JDEvAn	+	+	+
Code-Imp	+	+	+
The Spartanizer	o	+	+

Papers

Demeyer
Maintainability versus Performance: What's the Effect of Introducing Polymorphism?
Technical Report, Lab. on Reengineering, Universiteit Antwerpe, 2002

D'Hondt, De Volder, Mens, Wuyts
Co-evolution of Object-Oriented Software Design and Implementation
Software Architectures and Component Technology, 2002

Moghadam, Ó Cinnéide
Automated Refactoring using Design Differencing
16th European Conference on Software Maintenance and Reengineering (CSMR), 2012

Papers

Fanta, Rajlich
Restructuring Legacy C Code into C++
IEEE International Conference on Software Maintenance (ICSM), 1999

Gil, Orrù
The Spartanizer: Massive Automatic Refactoring
24th International Conference on Software Analysis, Evolution and Reengineering (SANER), 2017