

Scrap your Boilerplate with Object Algebras!

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Abstract. This is the abstract ...

1 Introduction

This is the Introduction.

2 Overview

We begin by reconsider the company structure problem raised by [1]. A company is divided into departments which in turn have a manager, and consists of a collection of sub-units. A unit is either a single employee or a department. Both managers and ordinary employees are persons receiving a salary. An common OOP programmer may organize the codes like:

```
public class Company {  
    private List<Department> depts;  
    public Company(List<Department> depts){this.depts = depts;}  
}  
public class Salary {  
    private float salary;  
    public Salary(float salary){this.salary = salary;}  
}
```

Similarly codes may be applied to Department, Employee, etc. Now consider adding two operations to our company structure: query the salary bill for the whole company and increase the salary for the each employee by 10%. One may decide adding two more functions to all the classes, which is:

```
public class Company {  
    public float salaryBill(){  
        float r = 0;  
        for (Department dept: depts) r+= dept.salaryBill();  
        return r;  
    }  
    public void increaseSalary(){  
        for (Department dept: depts) dept.increaseSalary();  
    }  
}
```

```

public interface SybAlg<Company, Dept, SubUnit, Employee, Person, Salary>{
    public Company C(List<Dept> depts);
    public Dept D(String name, Employee manager, List<SubUnit> subUnits);
    public SubUnit PU(Employee employee);
    public SubUnit DU(Dept dept);
    public Employee E(Person p, Salary s);
    public Person P(String name, String address);
    public Salary S(float salary);
}

```

Fig. 1. Company Structure represented by Object Algebra Interface

```

public class Salary {
    public float salaryBill(){return this.salary;}
    public void increaseSalary(){this.salary *= 1.1;}
}

```

This way of OOP style representation of tree structures can become cumbersome and inflexible due to the hard relationship between classes. For example, adding a new operation such as pretty printing of the company structure requires a lot of changes on the existing codes and violates the no modification rule. One can solve this problem by coding with object algebras as Figure 1:

Hence different operations can be realized by inheriting object algebras from object algebra interface. For query salary bill:

```

public class SalaryQuerySybAlg implements SybAlg<Float,Float,Float,Float,
    Float,Float> {
    public Float C(List<Float> depts){
        Float r = 0f;
        for (Float f: depts) r += f;
        return r;
    }
    public Float S(float salary){
        return salary;
    }
}

```

Increasing Salary is trickier:

```

public interface G_Company {
    <Company,Dept,SubUnit,Employee,Person,Salary> Company accept(SybAlg<
        Company,Dept,SubUnit,Employee,Person,Salary> alg);
}
public interface G_Salary {
    <Company,Dept,SubUnit,Employee,Person,Salary> Salary accept(SybAlg<
        Company,Dept,SubUnit,Employee,Person,Salary> alg);
}
public class IncreaseSalarySybAlg implements SybAlg<G_Company, G_Dept,
    G_SubUnit, G_Employee, G_Person, G_Salary>{
    @Override
    public G_Company C(List<G_Dept> p0) {
        return new G_Company() {
            public <Company,Dept,SubUnit,Employee,Person,Salary> Company accept(
                SybAlg<Company,Dept,SubUnit,Employee,Person,Salary> alg) {

```

```

        List<Dept> gp0 = new ArrayList<Dept>();
        for (G_Dept s: p0) {
            gp0.add(s.accept(alg));
        }
        return alg.C(gp0);
    }
};
}
public G_Salary S(float p0) {
    return new G_Salary() {
        @Override
        public <Company,Dept,SubUnit,Employee,Person,Salary> Salary accept(
            SybAlg<Company,Dept,SubUnit,Employee,Person,Salary> alg) {
            return alg.S(1.1f*p0);
        }
    };
}
}
}

```

However, although we solved the problem of extensibility with object algebra, these traversal codes become so long and most of the time we are writing boilerplate routine traversal codes. The only code we are really interested in is the Salary S(Float salary) function for salary. It will be great if those boilerplate codes can be generated automatically every time we want to traversal the tree structure.

Motivated by this problem of generating generic codes for tree structure traversals, more specifically, queries and transformations in object algebras, we designed an object algebra framework with great features. We introduce monoids in queries and generic visitable interfaces in transformations, and write generic query and transformation which can be easily inherited by real cases of queries and transformations. Furthermore, even the generic query and transformation codes can be generated automatically by adding an “@Algebra” annotation.

3 Queries

How to write generic queries by hand

Introduce Monoid

```

public interface Monoid<R> {
    R join(R x, R y);
    R empty();
    default R fold(List<R> lr){
        R res = empty();
        for (R r: lr){
            res = join(res, r);
        }
        return res;
    }
}

```

Free Variables Monoid

```

public class FreeVarsMonoid implements Monoid<String[]>{
    @Override
    public String[] empty() {
        return new String[]{};
    }
    @Override
    public String[] join(String[] e1, String[] e2) {
        int ellen = e1.length;
        int e2len = e2.length;
        String[] res = new String[ellen+e2len];
        System.arraycopy(e1, 0, res, 0, ellen);
        System.arraycopy(e2, 0, res, ellen, e2len);
        return res;
    }
}

```

Fig. 2. Free Variables Monoid

Generic Query by hand with Monoid
Free Vars Query

4 Transformations

Generic classes with accept methods

```

public interface G_Exp {
    <Exp> Exp accept(ExpAlg<Exp> alg);
}

```

Generic Transformation by hand with acceptor interface
Substitute Variables Transformation

5 Object Algebras Framework

Users still need to write generic queries and transformation by hand. It will be great if these boilerplate codes can be generated automatically. Solution: Object Algebra Framework Java annotation tool

```

@Algebra
public interface ExpAlg<Exp> {
    Exp Var(String s);
    Exp Lit(int i);
    Exp Add(Exp e1, Exp e2);
}

```

With the annotation "Algebra", the framework will generate the boilerplate codes for us automatically. Generic Query using monoid Generic Acceptors
Generic transformation with acceptor interfaces

Furthermore, the monoid interface is also included in the Object Algebras Framework

```

public class QueryExpAlg<Exp> implements ExpAlg<Exp> {
    private Monoid<Exp> m;
    public Monoid<Exp> m() { return m; }
    public QueryExpAlg(Monoid<Exp> m) {
        this.m = m;
    }
    public Exp Add(Exp p0,Exp p1) {
        Exp res = m.empty();
        res = m.join(res, p0);
        res = m.join(res, p1);
        return res;
    }
    public Exp Lit(int p0) {
        Exp res = m.empty();
        return res;
    }
    public Exp Var(String p0) {
        Exp res = m.empty();
        return res;
    }
}

```

Fig. 3. Generic Query by hand with Monoid

```

public class FreeVarsQueryExpAlg extends QueryExpAlg<String[]>{
    public FreeVarsQueryExpAlg(Monoid<String[]> m) {super(m);}
    public String[] Var(String s){return new String[] {s};}
}

```

Fig. 4. Free Vars Query

For query, only need to write interesting cases, for example, the return free variable names, and the specific monoid needed, which in Free Variables case will be A String List Monoid.

6 Other Features

One More section

7 Case Study

Case study section

8 Related Work

Finally related work.

```

public interface ExpAlgTransform extends ExpAlg<G_Exp> {
    @Override
    default G_Exp Add(G_Exp e1, G_Exp e2) {
        return new G_Exp() {
            @Override
            public <Exp> Exp accept(ExpAlg<Exp> alg) {
                return alg.Add(e1.accept(alg), e2.accept(alg));
            }
        };
    }
    @Override
    default G_Exp Lit(int i) {
        return new G_Exp() {
            @Override
            public <Exp> Exp accept(ExpAlg<Exp> alg) {
                return alg.Lit(i);
            }
        };
    }
    @Override
    default G_Exp Var(String s) {
        return new G_Exp() {
            @Override
            public <Exp> Exp accept(ExpAlg<Exp> alg) {
                return alg.Var(s);
            }
        };
    }
}

```

Fig. 5. Generic Transformation by hand with acceptor interface

9 Conclusion

And conclusion.

Acknowledgements We should thank someone!

References

1. ralf Lammel, S.P.J.: Scrap your boilerplate: A practical design pattern for generic programming. In: TLDI'03 (2003)

```

public class SubstVarsTransform implements ExpAlgTransform{
    private String s;
    private G_Exp gExp;
    public SubstVarsTransform(String s, G_Exp gExp){
        this.s = s;
        this.gExp = gExp;
    }
    @Override
    public G_Exp Var(String ss) {
        return new G_Exp() {
            @Override
            public <Exp> Exp accept(ExpAlg<Exp> alg) {
                if (ss.equals(s)) return gExp.accept(alg);
                else return alg.Var(ss);
            }
        };
    }
}

```

Fig. 6. Substitute Variables Transformation