Towards Interactive Object-Oriented Programming

Keehang KWON††, Kyunghwan PARK††, Nonmembers, and Mi-Young PARK†, Member

SUMMARY To represent interactive objects, we propose a choice-disjunctive declaration statement of the form $S \sqcup R$ where $S, R$ are the (procedure or field) declaration statements within a class. This statement has the following semantics: request the user to choose one between $S$ and $R$ when an object of this class is created. This statement is useful for representing interactive objects that require interactions with the user.

key words: interactions, object-oriented, computability logic.

1. Introduction

Interactive programming [4], [5] is an important modern trend in information technology. Despite much popularity, object-oriented languages [6]–[8] have traditionally lacked mechanisms for representing interactive objects. For example, an object like a lottery ticket is in a superposition state of several possible values and require further interactions with the environment to determine their final value.

To represent interactive objects, we propose to adopt a choice-disjunctive operator in computability logic [1], [2]. To be specific, we allow, within a class definition, a choice-disjunctive declaration statement of the form $S \sqcup R$. This statement has the following semantics: request the user to choose one between $S$ and $R$ when an object is created. This statement is useful for representing interactive objects. For example, a lottery ticket, declared as $S \sqcup R$ when an object is created. This statement is useful for representing interactive objects. For example, an object like a lottery ticket is in a superposition state of several possible values and require further interactions with the environment to determine their final value.

The remainder of this paper is structured as follows. We describe the new language Java† in the next section. In Section 3, we present some examples. Section 4 concludes the paper.

2. The Language

The language is a subset of the core (untyped) Java with some extensions. It is described by $G$- and $D$-formulas given by the syntax rules below:

$$G ::= A \mid x = E \mid G; G \mid o = new D$$

$$D ::= A ::= G \mid x = E \mid \forall x D \mid D \land D \mid D \lor D$$

In the rules above, $o$ is an object name, $x$ is a field name, $E$ is an expression, and $A$ represents a procedure (or a method) of the form $p(t_1, \ldots, t_n)$. The notation $x = E$ in $G$ denotes an assignment statement.

A $D$-formula is called a class definition. The notation $x = E$ in $D$ denotes a field $x$ with an initial value $E$. The notation $A ::= G$ in $D$ denotes a procedure declaration where $G$ is called a procedure body. The notation $D \land D$ denotes a conjunction of two $D$-formulas.

In the transition system to be considered, $G$-formulas will function as the main program (or procedure bodies), and a set of tuples $(o, D)$ where $o$ is an object name and $D$ is a $D$-formula will constitute a program.

We will present an operational semantics for this language via a proof theory. The rules are formalized by means of what it means to execute the main task $G$ from a program $P$. These rules in fact depend on the top-level constructor in the expression, a property known as uniform provability [3]. Below the notation $(o, D); P$ denotes $(\{o, D\}) \cup P$ but with the $(o, D)$ tuple being distinguished (marked for backchaining). Note that execution alternates between two phases: the goal-reduction phase (one without a distinguished tuple) and the backchaining phase (one with a distinguished tuple). The notation $S$ and $R$ denotes the following: execute $S$ and execute $R$ sequentially. It is considered a success if both executions succeed. The notation $o.G$ represent an association of $o$ with every field or procedure name appearing in $G$. For example, if $G$ is $p(t_1, \ldots, t_n)$, then $o.G$ represents $o.p(t_1, \ldots, t_n)$.

Definition 1. Let $o$ be an object name, let $G$ be a main task and let $P$ be a program. Then the notion of executing $(P, o.G)$ successfully and producing a new program $P'$ – $ex(P, o.G, P')$ – is defined as follows:

1. $ex(o, (A ::= G), P, A, P')$ if $ex(P, o.G, P')$. % matching procedure for $A$ is found

2. $ex(o, \forall x D), P, A, P')$ if $ex(o, [t/x]D), P, A, P')$. % argument passing

3. $ex(o, D_1 \land D_2), P, A, P')$ if $ex(o, D_1), P, A, P')$. % looking for the procedure $A$ in $D_1$. 

††The authors are with Computer Eng., DongA Univ., Korea. {khkwon,openmp}@dau.ac.kr
†The author is with Computer Eng., DongA Univ. khpark@dau.ac.kr. The corresponding author.
4. Examples

Imagine Temple University charges $5,000 as its tuition for nonemployees and $3,000 for employees. An example of this class is provided by the following program:

```java
class TempleU {
    tuition = 0 ∧
    (employee = true ⊔ employee = false) ∧
    (comp_tuition() := if employee then tuition = $3000 else tuition = $5000)
}

void main()
    TempleU p = new TempleU;
    comp_tuition();
    print(p.tuition)
```

In the above, creating a TempleU object via the `new` construct basically proceeds as follows: the machine asks the user “are you an employee?”. If the user answers yes by choosing the left disjunct, `employee` will be initialized to `true` and the machine will eventually print $3000 for its tuition. If the user answers no by choosing the right disjunct, `employee` will be initialized to `false` and the machine will eventually print $5000 for its tuition. Our language thus makes it possible to customize the amount for tuition via interaction with the user.

4. Conclusion

In this paper, we have considered an extension to the core Java with disjunctive statements within a class definition. This extension allows statements of the form \( S ⊔ R \) where \( S, R \) are statements. These statements are particularly useful for representing interactive objects.