Visitor [GoF]

Intent

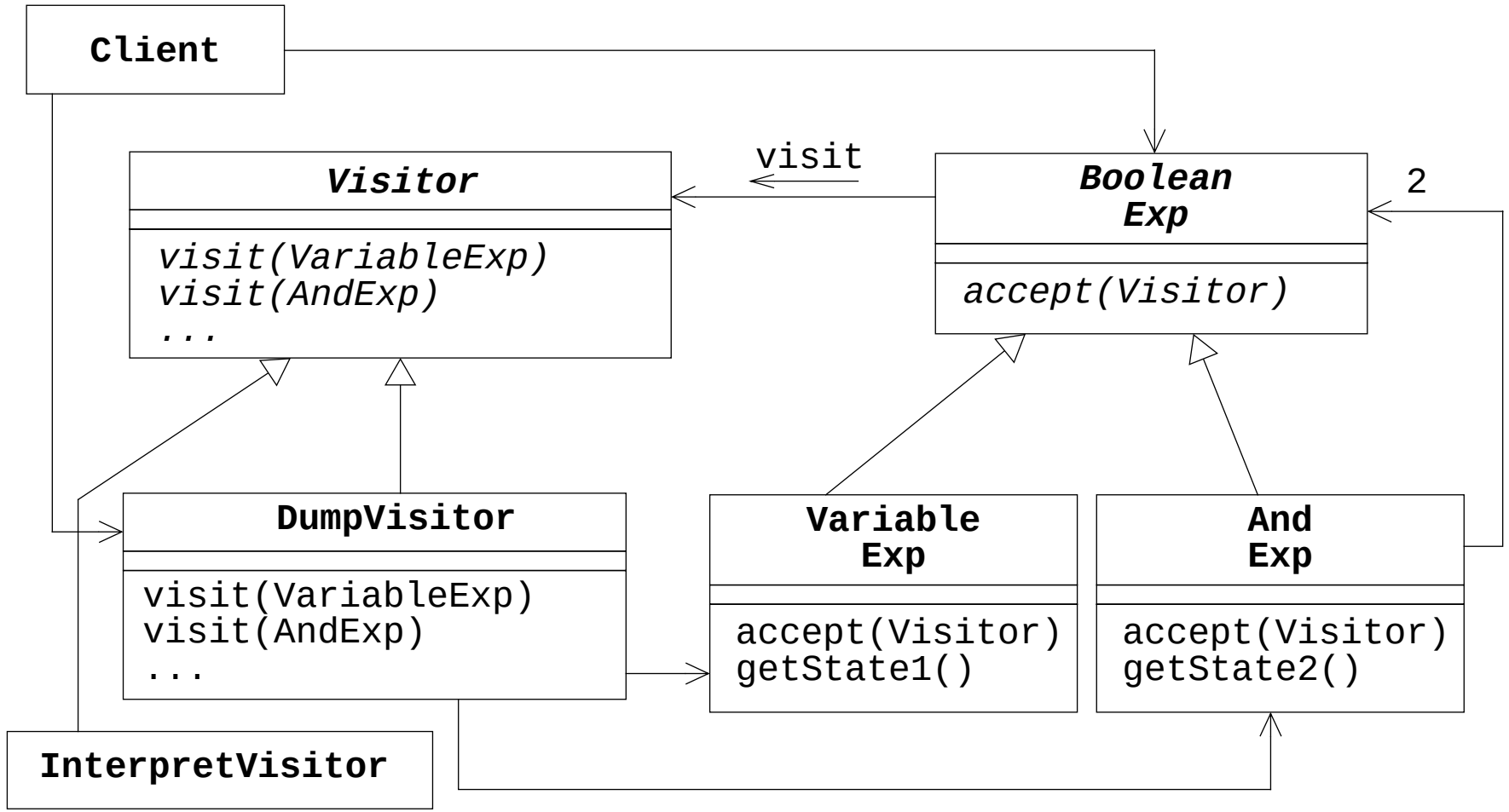
Parameterize behavior of elements of an object structure.

Motivation

Hard-coding the behavior of an object structure such as an abstract syntax tree requires re-writing the nodes' classes. Consider for example the binary node of a tree for Boolean expressions:

```
public class AndExp extends BooleanExp {
   public boolean interpret(Context ctx) { ... }
   public void dump(int level) { ... }
   // add new methods here when needed...
}
```

If the structure of your classes for your object structure is fairly stable, but behavior changes, then you might prefer to pull-out the behavior from the nodes of your structure. This is there the Visitor pattern comes in.


Client
Visitor
visit(VariableExp)
visit(AndExp)
...
visit
Boolean Exp
accept(Visitor)
2
DumpVisitor
visit(VariableExp)
visit(AndExp)
...
Variable Exp
accept(Visitor)
getState1()
And Exp
accept(Visitor)
getState2()
InterpretVisitor

For visiting the “and” node of a tree of a Boolean expression, method `accept` of class `AndExp` looks like:

```
public class AndExp extends BooleanExp {
   ...
   public void accept(Visitor v) {
      v.visit(this);
   }
}
```

For example, an in-order traversal strategy of a tree can be programmed in a specific `DumpVisitor` class:

```
public class DumpVisitor extends Visitor {
   ...
   public void visit(AndExp exp) {
      exp.getLeftExp().accept(this);
      exp.getState();
      exp.getRightExp().accept(this);
   }
}
```

A post-order traversal strategy of a tree can be programmed in a specific `DumpVisitor` class:

```
public class DumpVisitorPO extends Visitor {
   ...
   public void visit(AndExp exp) {
      exp.getLeftExp().accept(this);
      exp.getRightExp().accept(this);
      exp.getState();
   }
}
```

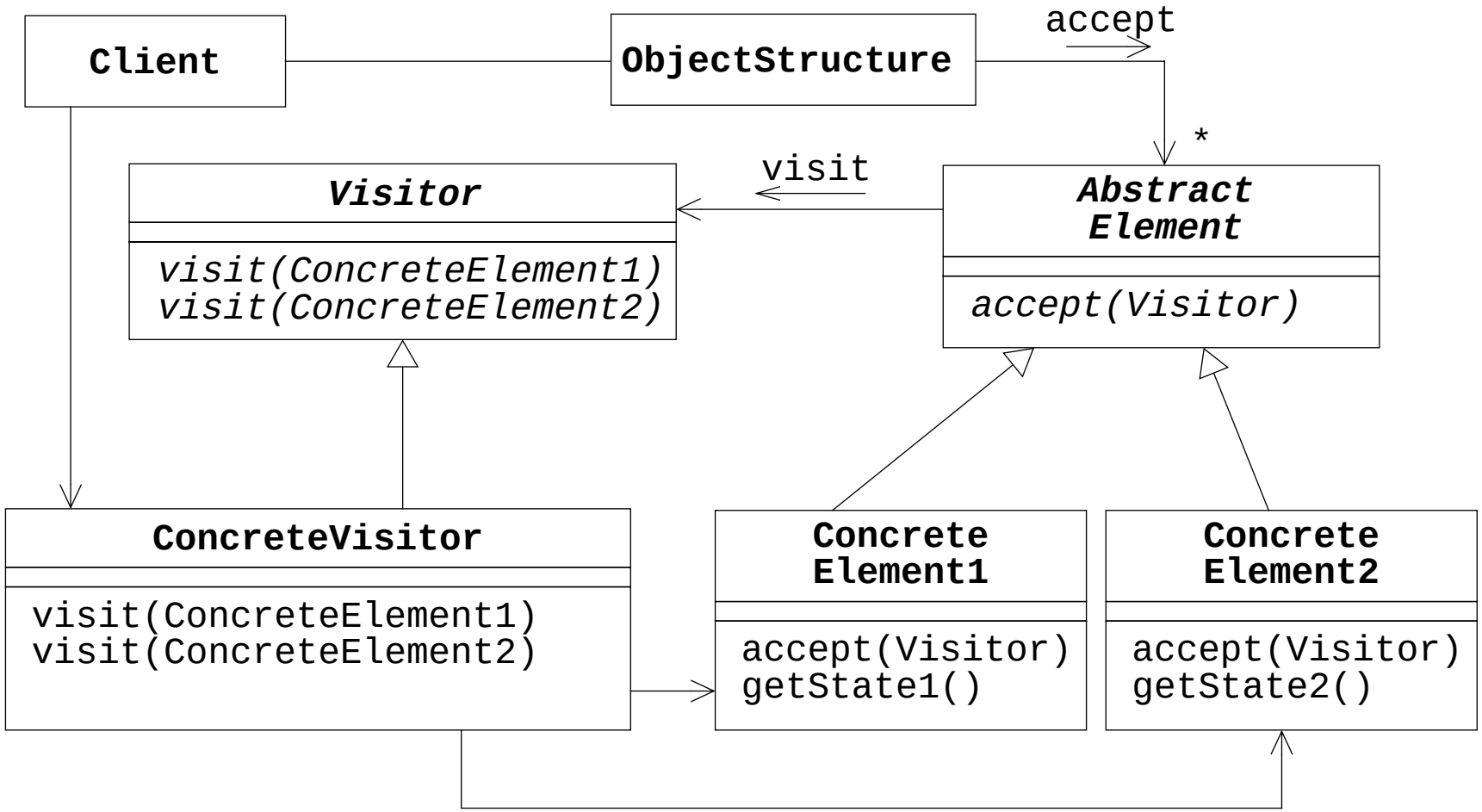
In the two variants above, the responsibility traversing the tree is in the visitors's `visit` methods.

Applicability

Use the Visitor when

- the object structure contains many classes, and the operations you perform depends on their concrete classes;
- you have many distinct and unrelated operations such as `interpret` and `dump`.

Structure


Client
ObjectStructure
accept
*
Visitor
visit(ConcreteElement1)
visit(ConcreteElement2)
visit
Abstract Element
accept(Visitor)
ConcreteVisitor
visit(ConcreteElement1)
visit(ConcreteElement2)
Concrete Element1
accept(Visitor)
getState1()
Concrete Element2
accept(Visitor)
getState2()

Participants

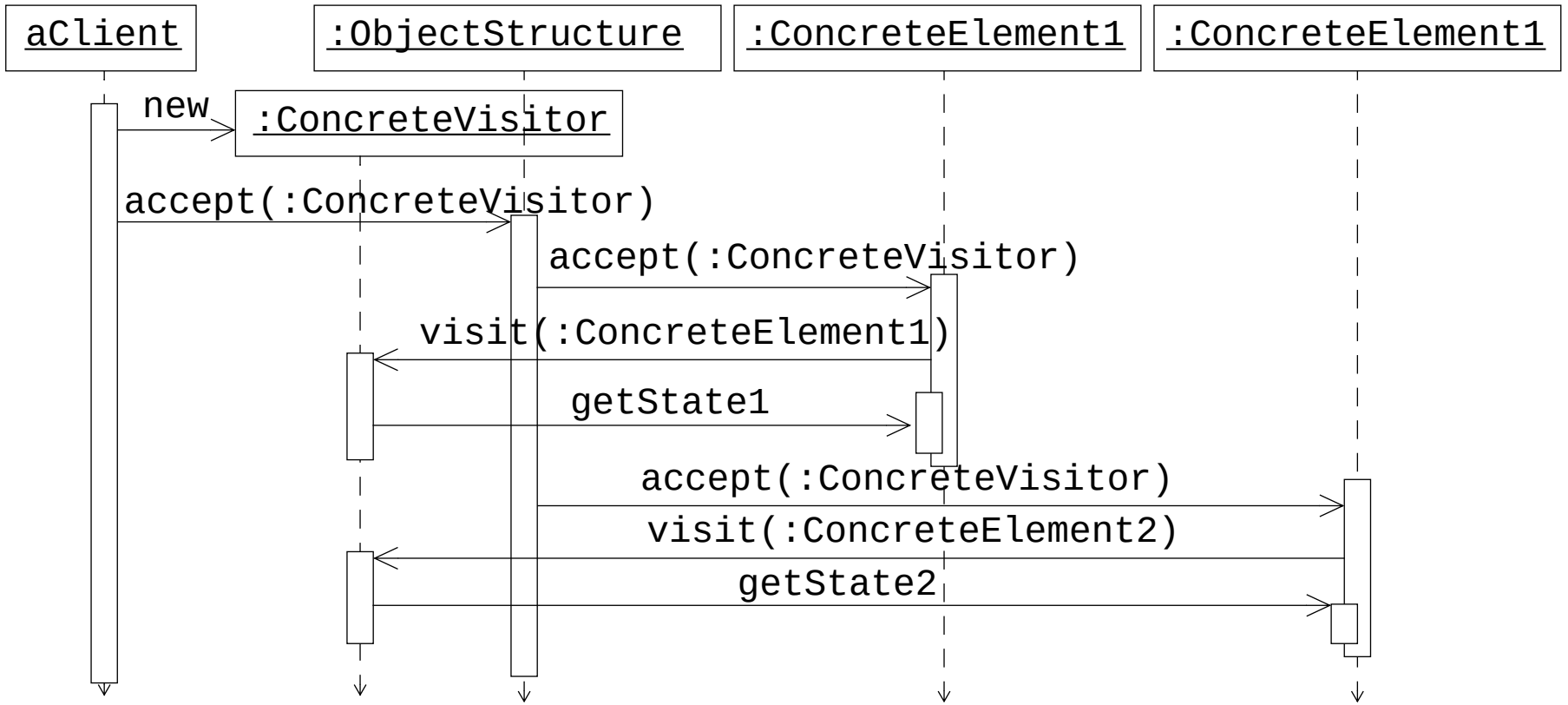
- **`Visitor`**:
  - declares abstract, overloaded `visit` methods for each concrete element
- **`ConcreteVisitor`**:
  - implements the overloaded `visit` methods
  - a concrete class is required for each terminal symbol of the grammar
- **`AbstractElement`**:
  - defines an abstract `accpet` method that takes `Visitor` as an argument
- **`ConcreteElement`**:
  - implement the `accept` method that takes `Visitor` as an argument
- **`ObjectStructure`**:
  - enumerates its elements
  - collection or a Composite

Collaborations

With using traversal responsibility at an `ObjectStructure` instance:

- First, a client creates a `ConcreteVisitor` object, and then traverses the object structure by first calling the `accept` method on the root object.
- When a `ConcreteElement` object is visited, it invokes `visit` on the `ConcreteVisitor` object that has been given as argument, and passes itself as argument (`this`).

Interaction between a `ConcreteVisitor` object, and `ObjectStructure`, and two `ConcreteElement` objects:



Consequences

- It is easy to add new operations on an object structure by adding a new `ConcreteVisitor` class.
- It is difficult to add new `ConcreteElement` classes. Each new class gives rise to a new abstract method `visit` on `Visitor`.
- Visitor can invoke `accept` on `ConcreteElement` object that to not necessarily have a common base class.
- Visitor can accumulate state. Without a Visitor, state would be passed as an extra argument.
- `ConcreteElement` classes need to offer accessor methods to allow inspection by the `ConcreteVisitor`.

Implementation

- Each object structure will have its associated `Visitor` class. This abstract class or interface declares *for each* `ConcreteElement` class the corresponding `visit` method.
- Instead using method overloading, you can also write methods with different names.
- Traversal responsibility: The responsibility for traversing the object structure can be placed in ay of three places: in the object structure, in the visitor, or in a separate iterator.

Sample Code

Given some the classes that form the AST of a boolean expression, object structure-controlled post-order traversal can be realized as follows:

```
public abstract class BoolenExp {
   public abstract void accept(Visitor v);
}

public class AndExp extends BooleanExp {
   private BooleanExp left, right;
   public void accept(Visitor v) {
      v.visit(this);
   }
   public BooleanExp getLeftExp() {...}
   public BooleanExp getRightExp() {...}
}
```

```
public class Variable extends BooleanExp {
   public void accept(Visitor v) {
      v.visit(this);
   }
   public String getName() { ... }
}
// other classes omitted...
```

The abstract `Visitor` class might look like:

```
public abstract class Visitor {
   public abstract void visit(OrExp exp);
   public abstract void visit(AndExp exp);
   public abstract void visit(NotExp exp);
   public abstract void visit(Variable exp);
   public abstract void visit(Constant exp);
}
```

Note above that an overloaded method exists for each node (`ConcreteElement`) in the AST. A concrete visitor class dumping the AST to the output in RPN form might look like:

```
public void class RPNVisitor extends Visitor {
   public void visit(AndExp exp) {
      exp.getLeft().accept(this);
      exp.getRight().accept(this);
      System.out.print(" *");
   }

   public void visit(OrExp exp) {
      // Left as an exercise
   }

   public void visit(NotExp exp) {
      // Left as an exercise
   }

   public void visit(Variable exp) {
      // Left as an exercise
   }
   public void visit(Constant exp) {
      // Left as an exercise
   }
}
```

Related Patterns

- Composite: Visitors can be used to traverse the composition of the Composite pattern, e.g., an AST.
- Interpreter: Visitor may be used to perform the interpretation.