



Defining Inductive Data in Java

Corky Cartwright

Stephen Wong

Department of Computer Science

Rice University



Partial Hoisting

- In a union hierarchy, the same code may be repeated in *some proper subset* of the variants.
- We can eliminate this code duplication by introducing a new abstract class that is a *superclass only of the variants that repeat the same code*.
- Partial hoisting modifies the form of the class diagram because it introduces a new abstract class below the *root* abstract class of the union.



Revised Code for CityEntry

```
abstract class CityEntry {
    /* common fields */
    String name, address, phone;

    /** Returns true if key is a prefix of name. */
    boolean nameStartsWith(String key) { return name.startsWith(key); }
}

class ResidentialEntry extends CityEntry { }

abstract class NonResidentialEntry extends CityEntry {
    String city, state;
}

class BusinessEntry extends NonResidentialEntry { }

class GovernmentEntry extends NonResidentialEntry {
    String government;
}
```



Defining DeptDirectory Data

A **DeptDirectory** is either:

- **Empty()**, the empty **DeptDirectory**, or
- **NonEmpty(first, rest)**, a non-empty **DeptDirectory**, where **first** is an **Entry** and **rest** is a **DeptDirectory**

Examples:

Empty()

**NonEmpty(Entry("Stephen", "DH 3103", "x
3846"), Empty())**



DeptDirectory

```
abstract class DeptDirectory {}  
  
class Empty extends DeptDirectory {}  
  
class NonEmpty extends DeptDirectory {  
    Entry first;  
    DeptDirectory rest;  
}
```



The Composite Pattern

The **DeptDirectory** class hierarchy is a special form of union called a *composite*. A union is composite when one or more variants contain fields of the root class type. In other words, variants in the union contain references to objects of union type. In the **DeptDirectory** example, the **NonEmpty** variant contains a field **rest** of type **DeptDirectory**.



Searching a DeptDirectory

Given the name of a person, we want to find that person's phone number in our **DeptDirectory**. In other words, we want to define a method in the **DeptDirectory** class

findPhone(String key)

that searches "this" **DeptDirectory** for an **Entry** that matches the argument **key**.



The Interpreter Pattern

- To define a method **m** on a composite class like **DeptDirectory**, we follow the same process as we would in defining a method on a union class, with one new wrinkle. In the variants that refer to the composite class (have fields of composite class type), computing **m** for embedded self references will usually involve delegating the task of computing **m** to the (abstract) composite class. (Exactly as in Scheme!)
- In our **DeptDirectory** example, the only embedded reference to **DeptDirectory** in variant subclasses is the **rest** field in **NonEmpty**.



Template for coding findPhone

```
abstract class DeptDirectory {  
    abstract String findPhone(String key);  
}
```

```
class Empty extends DeptDirectory {  
    String findPhone(String key) { ... }  
}
```

Fill in this method body

```
class NonEmpty extends DeptDirectory {  
    Entry first;  
    DeptDirectory rest;  
  
    String findPhone(String key) {  
        ... rest.findPhone(key) ...  
    }  
}
```

Fill in this method body



findPhone

```
abstract class DeptDirectory {
    abstract String findPhone(String key);
}

class Empty extends DeptDirectory {
    String findPhone(String key) { return null; }
}

class NonEmpty extends DeptDirectory {
    Entry first;
    DeptDirectory rest;

    String findPhone(String key) {
        if (key.equals(first.getName())) return first.getPhone();
        else return rest.findPhone(key);
    }
}
```



Another Composite Example: Lists

An `IntList` is either:

- `EmptyIntList()`, the empty list, or
- `NonEmptyIntList(first, rest)`, a non-empty list, where `first` is an `int` and `rest` is an `IntList`.

Some examples include:

```
EmptyIntList()
```

```
NonEmptyIntList(7, EmptyIntList())
```

```
NonEmptyIntList(12, NonEmptyIntList(7, EmptyIntList()))
```



IntList

```
abstract class IntList { }
```

```
class EmptyIntList extends IntList { }
```

```
class NonEmptyIntList extends IntList {  
    int first;  
    IntList rest;  
}
```



Defining Methods on `IntList`

Sort example:

```
abstract class IntList {  
    abstract IntList sort() { }  
}  
class EmptyIntList extends IntList {  
    IntList sort() { ... }  
}  
class NonEmptyIntList extends IntList {  
    int first;  
    IntList rest;  
    IntList sort() { ... }  
}
```



IntList sort cont.

```
abstract class IntList {
    abstract NonEmptyIntList add(int i);
    abstract IntList sort() { }
    abstract IntList insert(int i) { }

}

class EmptyIntList extends IntList {
    IntList sort() { return this; }
    IntList insert(int i) { return add(i); }
}

class NonEmptyIntList extends IntList {
    int first;
    IntList rest;
    IntList sort() { return rest.insert(first); }
    IntList insert(int i) {
        if (i <= first) return add(i);
        else return rest.insert(i).add(i);
    }
}
```



For Next Class

- HW6 (extra credit) Due Monday 11:59pm.
- HW7 due next Friday
- Reading: OO Design Notes, 1.5.