CS 417-505
Design Patterns

Design patterns: Strategy cont., Factory, and Iterator

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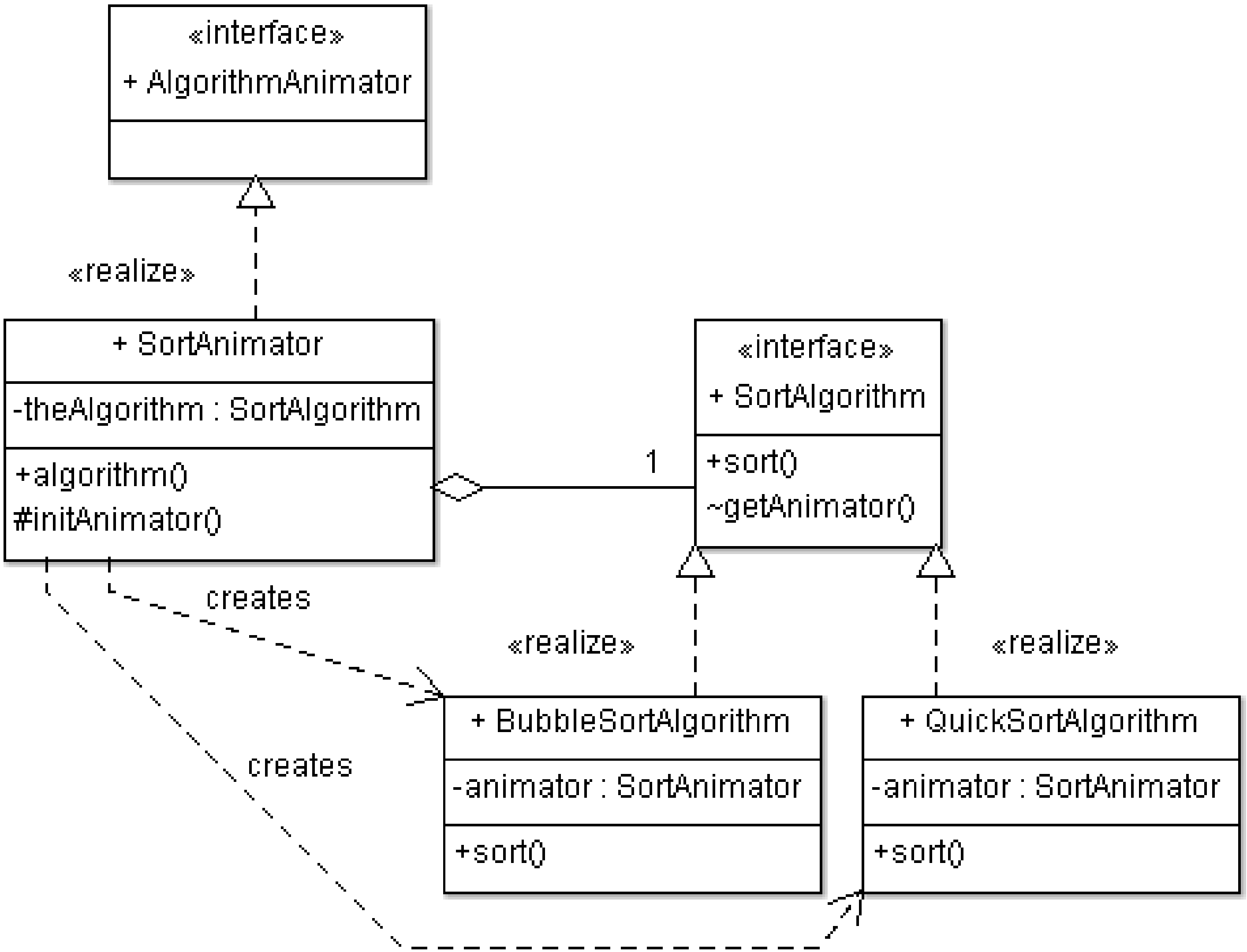
Agenda

- Design pattern: Strategy cont.
- Design pattern: Factory
- Design pattern: Iterator

Strategy example

- Sorting algorithm animation
- Application displays an animation of how the elements within an array change as the algorithm runs
- Should be able to switch algorithms

Encapsulating sorting algorithm



Creating instances of concrete algorithms

```
public class SortAnimator implements
  AlgorithmAnimator{
  protected SortAlgorithm theAlgorithm;
  protected void initAnimator(){
    algName = “BubbleSort”;
    String at = getParameter(“alg”);
    if (at != null){
      algName = at;
    }
    if (“BubbleSort”.equals(algName)){
      theAlgorithm = new BubbleSortAlgorithm(this);
    }else if(“QuickSort”.equals(algName)){
      theAlgorithm = new QuickSortAlgorithm(this);
    }else{
      theAlgorithm = new BubbleSortAlgorithm(this);
    }
  }
}
```

Design analysis

- Algorithms can be switched without impacting animation code
- While majority of code abstracted, tightly coupled in creation of concrete algorithms
  - If new algorithms added, initAnimator code must be changed as well to be used
  - Goal be able to add sorting algorithms without changing code in SortAnimator

Separating creation

- Better alternative is to separate creation of concrete classes
- Factory pattern separates creation and encapsulates concrete classes from other code
- Decoupled code allows concrete classes to be added or changed with single point of code impact

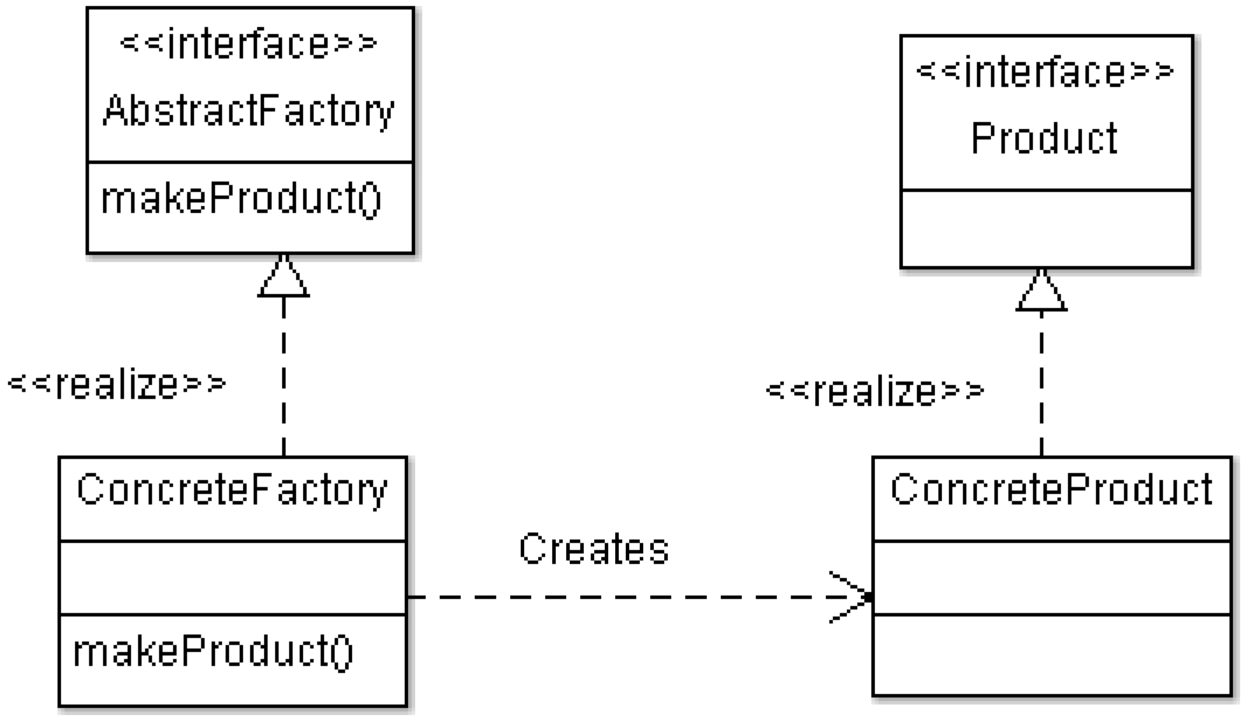
Factory pattern

- **Category**: Creational design pattern
- **Intent**: Define an interface for creating objects but let subclasses decide which class to instantiate and how
- **Applicability**: Should be used when a system should be independent of how its products are created

Factory pattern participants

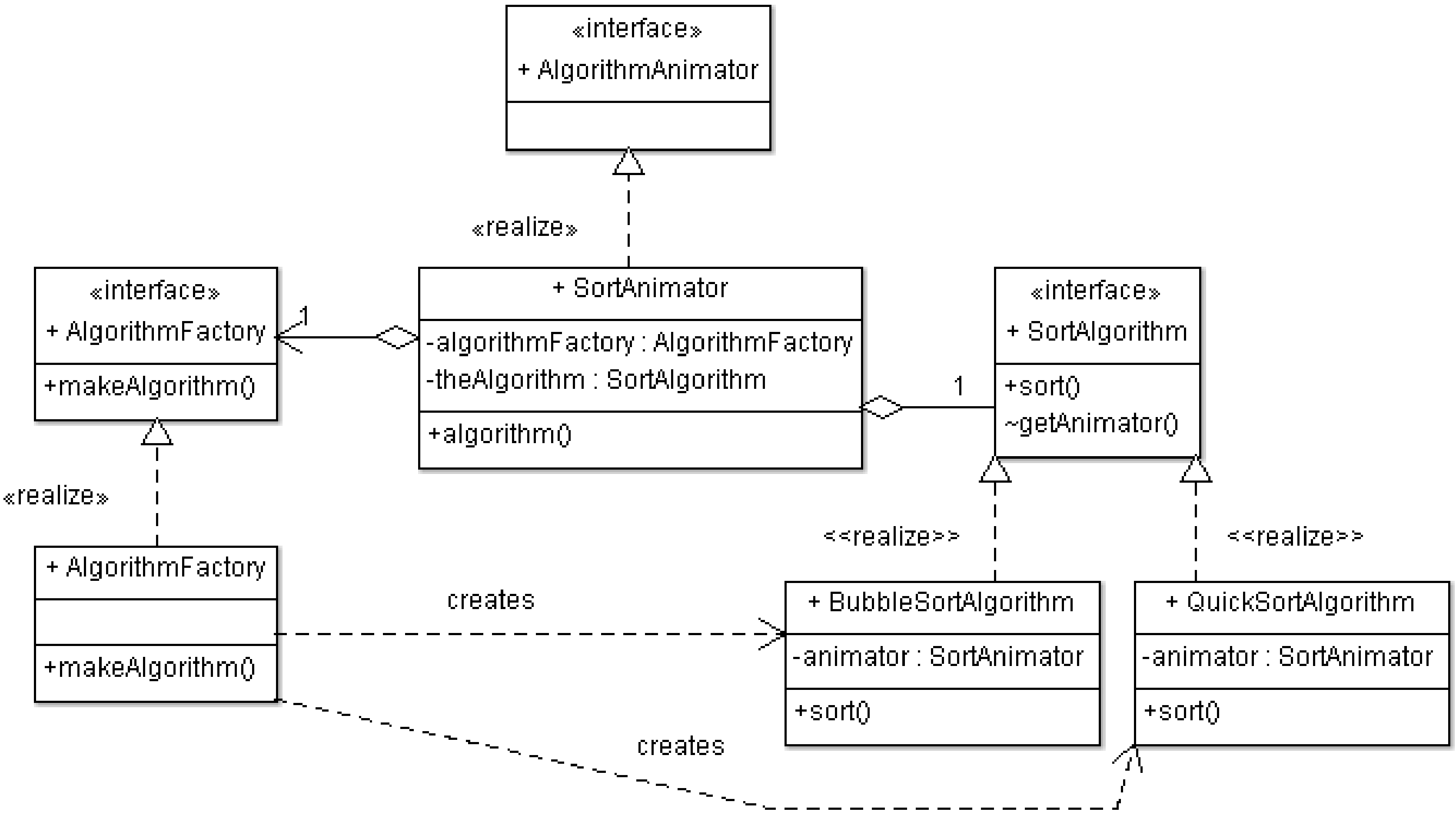
- **Product** – Defines an interface of objects the factory will create
- **ConcreteProduct** – Implements the Product interface
- **AbstractFactory** – Defines a factory method that returns an object of type Product
- **ConcreteFactory** – Overrides the factory method to return an instance of ConcreteProduct

Factory UML



<<interface>>
AbstractFactory
makeProduct()
<<interface>>
Product
<<realize>>
<<realize>>
ConcreteFactory
makeProduct()
Creates
ConcreteProduct

Example UML


«interface»
+ AlgorithmAnimator
«realize»
«interface»
+ AlgorithmFactory
+makeAlgorithm()
1
+ SortAnimator
-algorithmFactory : AlgorithmFactory
-theAlgorithm : SortAlgorithm
+algorithm()
1
«interface»
+ SortAlgorithm
+sort()
~getAnimator()
«realize»
<<realize>>
<<realize>>
+ AlgorithmFactory
+makeAlgorithm()
creates
+ BubbleSortAlgorithm
-animator : SortAnimator
+sort()
+ QuickSortAlgorithm
-animator : SortAnimator
+sort()
creates

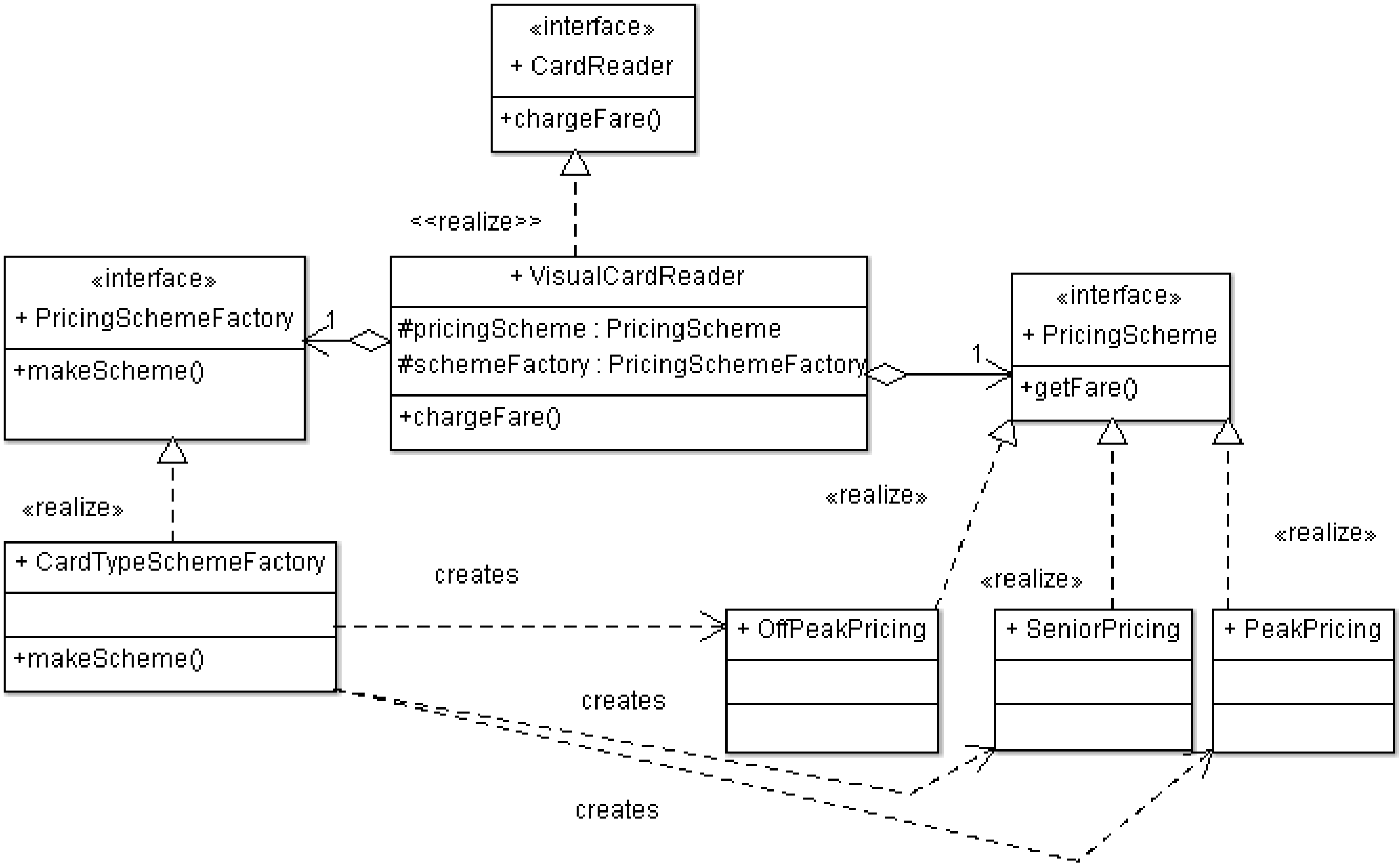
Revised SortAnimator

```
public class SortAnimator implements AlgorithmAnimator{
  private SortAlgorithm theAlgorithm;
  private SortAlgorithmFactory algorithmFactory;
  protected void initAnimator(){
    String at = getParameter(“alg”);
    algorithmFactory = new SortAlgorithmFactory();
    theAlgorithm = algorithmFactory.makeAlgorithm(at);
  }
}
```

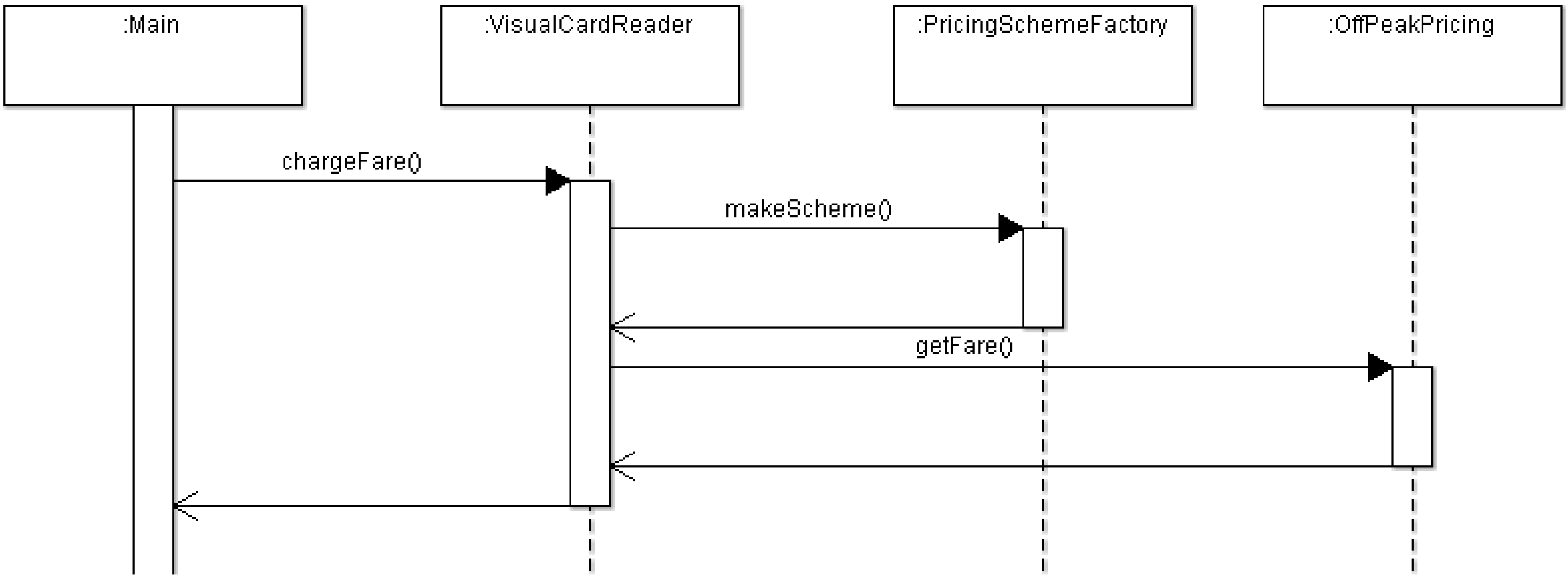
Card reader problem

Chicago is creating a new mass transit fare system. The system requires users to have an fare card that can be **read by multiple types of systems** (such as swiped, visual, etc). For one of these types, **visual,** they want the system to provide visual traits of the card and **determine the fare pricing scheme (Off peak, peak, senior)** that should be used for that card for the specified request. Note they want the **flexibility to have the look of fare cards to change and add additional pricing schemes** in the future. Draw the **class diagram** and sample **sequence** from a class Main.

Card reader solution



Card reader sequence



Group work

For a new ATM that can use **either** a specific **fingerprint** (i.e. each finger specifies a different account) or old fashion enter an **account number.** Once they have provided their **info to specify the account** and an instance of the **Account** of type **Checking** or **Credit** is returned where the type of account is determined based on the account number/fingerprint. Design for future flexibility in account selection method and account types. **Draw the class diagram and a sample sequence assuming the ATM class has chosen fingerprint access.**

Design guideline

- Program to an interface, not an implementation
  - Separate interface from implementation
  - Clients access functionalities via interface not directly on class
  - Implementation hidden from clients
- Programming to a class → context-specific, inflexible solutions
- Programming to an interface → general, extensible, reusable solutions

Enumerating elements

- Scenario – Given a group of Objects
- Operation - Loop through elements
- Common operation common to many different data structures

➢ Multiple implementations possible, used in multiple contexts making it a prime candidate for generalization

Solution 1 – direct access

```
LinkedList list;
for (LinkedList.Node cur = list.head;
        cur != null; cur = cur.next){
   System.out.println(cur.element);
}
```

- Solution works for LinkedList but tightly coupled to implementation breaking encapsulation
- Also would have to completely recode if a different data structure was wanted

Solution 2 – Iterate via Method invocation

```
public class IterList extends LinkedList{
  public void reset(){ cur = head; }
  public Object next(){
    Object obj = null;
    if (cur != null){
      obj = cur.element;
      cur = cur.next;
    }
    return obj;
  }
  public boolean hasNext(){
    return (cur != null);
  }
  protected Node cur;
}
```

- Encapsulates implementation but still strongly tied to context of implementation (ex. Looping within a loop)

Solution 3 – Separate iterator from List

```
public class LinkedListIterator{
  public LinkedListIterator(LinkedList list){
    this.list = list;
    cur = list.head;
  }
  public Object next(){
    Object obj = null;
    if (cur != null){
      obj = cur.element;
      cur = cur.next;
    }
    return obj;
  }
  public boolean hasNext(){
    return (cur != null);
  }
  protected LinkedList.Node cur;
  protected LinkedList list;
}
```

- Fixes the multiple iterator problem but iterator is still tightly coupled with LinkedList

Solution 4: Generalization through abstract coupling

```
interface Iterator{
  Object next();
  boolean hasNext();
  void remove();
}
```

- Now concrete iterators such as a LinkedListIterator or a TreeIterator can implement the Iterator interface and the client doesn't have to change its code despite change in implementation

Solution 4 cont.

```
public interface List{
  public Iterator iterator();
  …
}
public class LinkedList implements List{
  public Iterator iterator(){
    return new LinkedListIterator();
  }
  private class LinkedListIterator implements
  Iterator{
  }
}
```

- Now any number of structures that support List interface can also return a way to iterate through them without clients being able to access internals at all

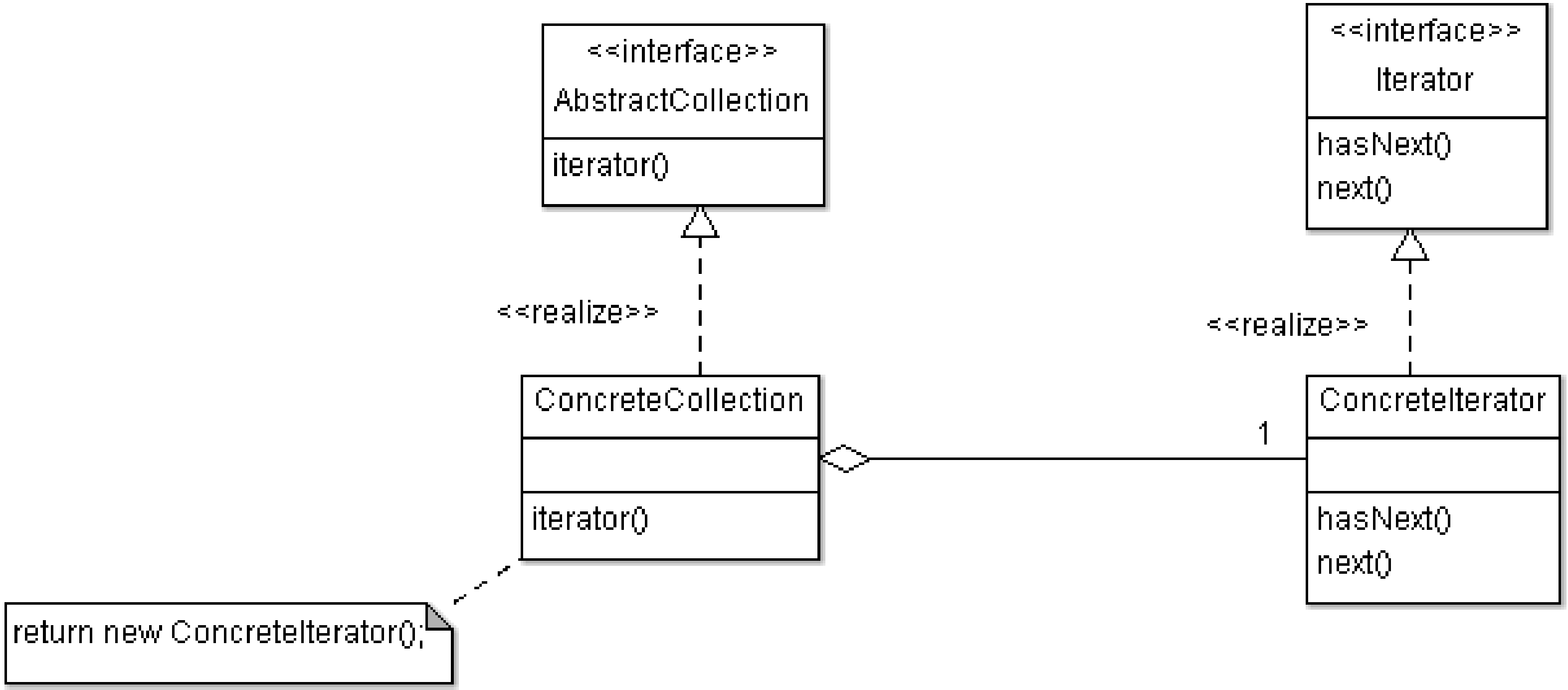
Design pattern: Iterator

- **Category –** Behavioral design pattern
- **Intent** – Provide a way to access the elements of a collection sequentially
- **Applicability –** Should be used if…
  - To access contents of a collection without exposing its internal representation
  - Support multiple traversals of a collection (with Trees preOrder(),postOrder())
  - Provide uniform interface for traversing different collections (polymorphic iteration)

Iterator participant descriptions

- **Iterator** – defines interface for accessing and traversing the elements
- **ConcreteIterator** – implements iterator interface and keeps track of current position in traversal
- **AbstractCollection** – defines interface for creating a concrete iterator
- **ConcreteIterator** – implements the iterator method and returns an instance of the proper ConcreteIterator

Iterator UML



Tree example

- Create UML class diagram extension for an tree data structure support of the iterator pattern.
- Write pseudo code to support iterator pattern for a tree data structure

Group work

- Create UML class diagram extension for an array data structure support of the iterator pattern.
- Write pseudo code to support iterator pattern for an array data structure