Comp 401
Generics and Adapters

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Prerequisite

- Inheritance
- Collections

Topics

- Generics
  - Code that works for a multiple types.
  - Not related by IS-A relationships.
  - Not code working on Object, specific type information is not lost, requires no cast
  - Array IS-A relation
- Adapter:
  - Converter class sitting between two other classes.
  - Special case of delegator

Duplication of Code in Collections

- Collection interfaces and classes had so much similarity.
- How to get rid of code duplication?

History Collections

```
public interface  StringHistory  {
        public void addElement(String element);
        public int size();
        public String elementAt(int index);
}
```

How to get rid of duplication in interface definitions?

```
public interface PointHistory {
        public void addElement (Point p );
        public Point elementAt (int index);
        public int size();
}
```

ObjectHistory?

```
public interface  ObjectHistory  {
        public void addElement(Object element);
        public int size();
        public Object elementAt(int index);
}
```

Can add both objects and points to history!

History Collections

```
public interface  StringHistory  {
        public void addElement(String element);
        public int size();
        public String elementAt(int index);
}
```

How to get rid of duplication in interface definitions?

```
public interface PointHistory {
        public void addElement (Point p );
        public Point elementAt (int index);
        public int size();
}
```

Methods Analogy

```
public double calculateMyCurrentBMI() {
        return 75/(1.77*1.77);
}
```

How to get rid of duplication in method definitions?

```
public double calculateMyFutureBMI() {
        return 77/(1.77*1.77);
}
```

```
public double calculateBMI(double weight, double height) {
        return weight/(height*height);
}
```

```
calculateBMI(75, 1.77);
```

```
calculateBMI(77, 1.77);
```

Relace int constant with int parameter/placeholder

Only one implementation exists

Duplication in Type Definitions

```
public interface  StringHistory  {
        public void addElement(String element);
        public int size();
        public String elementAt(int index);
}
```

```
public interface PointHistory {
        public void addElement (Point p );
        public Point elementAt (int index);
        public int size();
}
```

Need to replace type constants with type parameter

History Collections

```
public interface  StringHistory  {
        public void addElement(String element);
        public int size();
        public String elementAt(int index);
}
```

How to get rid of duplication in interface definitions?

```
public interface PointHistory {
        public void addElement (Point p );
        public Point elementAt (int index);
        public int size();
}
```

Java Generic Types with Type Parameters

```
public interface History {
        public void addElement (<T> t);
        public <T> elementAt (int index);
        public int size();
    }
```

Can accidentally call say <t> or <aT> and Java will not catch error

Need a way to declare type parameter like we declare a variable

Java Generic Types with Type Parameters

How to indicate a string or point history?

How many versions of History at runtime?

A scope name (class, interface, method) can be succeeded by a series of type parameters within angle brackets <A, B, C, …> that have the same value in all places

```
public interface History<T> {
        public void addElement (T t);
        public T elementAt (int index);
        public int size();
    }
```

A method, class, interface with type parameter is called a generic.

Create an elaboration of generic by giving actual value to type parameter

A single version in which T == Object is shared by all of its elaborations.

```
History<String>  stringHistory;
History<Point> pointHistory;
```

Assigning values to type parameters is a compile time activity for type checking only. The value assigned are “erased” at runtime

Java Generic Types with Type Parameters (Review)

How to indicate a string or point history?

How many versions of History at runtime?

A scope name (class, interface, method) can be succeeded by a series of type parameters within angle brackets <A, B, C, …> that have the same value in all places

```
public interface History<T> {
        public void addElement (T t);
        public T elementAt (int index);
        ; size();
```

When is parameter assigned?

A method, class, interface with type parameter is called a generic.

Create an elaboration of generic by giving actual value to type parameter

A single version in which T == Object is shared by all of its elaborations.

```
History<String>  stringHistory;
History<Point> pointHistory;
```

Assigning values to type parameters is a compile time activity for type checking only. The value assigned are "erased" at runtime

Arrays vs. Generics

```
public interface History<T> {
        public void addElement (T t);
        public T elementAt (int index);
        public int size();
    }
```

Are arrays generic with special syntax?

A single version in which T == Object is shared by all of its elaborations.

Assigning values to type parameters is a compile time activity for type checking only. The value assigned are "erased" at runtime

```
History<String>  stringHistory;
History<Point> pointHistory;
Double<Point>  doubleHistory;
```

Generics and arrays are parameterized types

```
String[]  strings;
Point[] points;
double[]   doubles;
```

Different versions describe elements of different sizes.

Element type kept at runtime

AStringHistory

```
public class AStringHistory implements History<String> {
    public final int MAX_SIZE = 50;
    String[] contents = new String[MAX_SIZE];
    int size = 0;
    public int size() {return size;}
    public String elementAt (int index) {
      return  contents[index];
    }
    boolean isFull() {return size == MAX_SIZE;}
    public void addElement(String element) {
      if (isFull())
        System.out.println("Adding item to a full history");
      else {
        contents[size] = element;
        size++;
    }
}
```

APointHistory

```
public class APointHistory implements History<Point> {
    public final int MAX_SIZE = 50;
    Point[] contents = new Point[MAX_SIZE];
    int size = 0;
    public int size() {return size;}
    public Point elementAt (int index) {
      return  contents[index];
    }
    boolean isFull() {return size == MAX_SIZE;}
    public void addElement(Point element) {
      if (isFull())
        System.out.println("Adding item to a full history");
      else {
        contents[size] = element;
        size++;
    }
}
```

How to parameterize class definition?

AStringHistory

```
public class AStringHistory implements History<String> {
    public final int MAX_SIZE = 50;
    String[] contents = new String[MAX_SIZE];
    int size = 0;
    public int size() {return size;}
    public String elementAt (int index) {
      return  contents[index];
    }
    boolean isFull() {return size == MAX_SIZE;}
    public void addElement(String element) {
      if (isFull())
        System.out.println("Adding item to a full history");
      else {
        contents[size] = element;
        size++;
    }
}
```

Replace all occurrences of String with T?

AHistory

```
public class AHistory<T> implements History<T> {
    public final int MAX_SIZE = 50;
    Object[] contents = new Object[MAX_SIZE];
    int size = 0;
    public int size() {return size;}
    public T elementAt (int index) {
        return (T) contents[index];
    }
    boolean isFull() {return size ==
    public void addElement(T element)
      if (isFull())
        System.out.println("Adding it
      else {
        contents[size] = element;
        size++;
    }
}
```

A generic can pass its parameter to another generic

A single version where T = Object is shared by all of its elaborations.

Must tell Java which of the various possible array element types we want

Finally a type parameter T must reduce to object

Instantiating a History

```
History<String>  stringHistory = new AHistory<String>();
History<Point>   pointHistory  = new AHistory<Point>();
```

AHistory

```
public class AHistory<T> implements History<T> {
    public final int MAX_SIZE = 50;
    Object[] contents = new Object[MAX_SIZE];
    int size = 0;
    public int size() {return size;
    public T elementAt (int index)
        return (T) contents[index];
    }
    boolean isFull() {return size == MAX_SIZE;}
    public void addElement(T element) {
      System.out.println(element.charAt(0));
      System.out.println(element.getX());
      System.out.println(element.toString());
      if (isFull())
        System.out.println("Adding item to a full history");
      else {
        contents[size] = element;
        size++;
      }
}
```

Only object operations can be assumed because the only guarantee is that T will be elaborated with a subtype of Object

Understanding Passing Type Parameters

```
public class AHistory<T> implements History<T> {
    …
}
```

```
public interface History<T> {
    …
}
```

The parameter of AHistory is used as the parameter of History.

```
public double calculateMyBMI(double weight) {
        return calculateBMI(weight, 1.77);
}
```

The parameter of calculateMyBMI is used as the parameter of calculateBMI

```
public double calculateBMI(double weight, double height) {
        return weight/(height*height);
}
```

Declared vs. Passed Name

```
public class AHistory<AType> implements History<T> {
    …
}
```

```
public interface History<T> {
    …
}
```

Passed name must be the same as declared name

```
public double calculateMyBMI(double weight) {
        return calculateBMI(w, 1.77);
}
```

```
public double calculateBMI(double w, double height) {
        return w/(height*height);
}
```

Renaming Parameter

```
public class AHistory<AType> implements History<AType> {
    …
}
```

```
public interface History<T> {
    …
}
```

Caller can rename the parameter

```
public double calculateMyBMI(double weight) {
        return calculateBMI(weight, 1.77);
}
```

```
public double calculateBMI(double w, double height) {
        return w/(height*height);
}
```

Renaming Type Variables

```
public interface I1 <T>{
        …
    }
```

```
public interface I2 <T>{
        …
    }
```

```
public class C<T1, T2> implements  I1 <T1>, I2<T2>{
        …
    }
```

PointHistory

```
public interface History<T> {
        public void addElement(T element);
        public T elementAt (int index);
        public int size();
}
```

```
public interface PointHistory extends History<String> {

}
```

```
public interface PointHistory {
        public void addElement (int x, int y);
        public Point elementAt (int index);
        public int size();
}
```

AHistory

```
public class AHistory<T> implements History<T> {
    public final int MAX_SIZE = 50;
    Object[] contents = new Object[MAX_SIZE];
    int size = 0;
    public int size() {return size;}
    public T elementAt (int index) {
        return (T) contents[index];
    }
    boolean isFull() {return size == MAX_SIZE;}
    public void addElement(T element) {
      if (isFull())
```

How to reuse this code in PointHistory implementation

```
public interface PointHistory {
        public void addElement (int x, int y);
        public Point elementAt (int index);
        public int size();
}
```

Adding to Generic?

```
public class AHistory<T> implements History<T> {
    public final int MAX_SIZE = 50;
    Object[] contents = new Object[MAX_SIZE];
    int size = 0;
    public int size() {return size;}
    public T elementAt (int index) {
        return (T) contents[index];
    }
    boolean isFull() {return size == MAX_SIZE;}
    public void addElement(T element) {
      if (isFull())
        System.out.println("Adding it
      else {
        contents[size] = element;
        size++;
    }
    public void addElement(int anX, int aY) {
        addElement(new ACartesianPoint(x,y));
    }
}
```

Method makes no sense for non point histories

Can only pass to addElement a T

Inheriting APointHistory?

```
public class APointHistory extends AHistory<Point>
implements PointHistory{
    public void addElement(int x, int y) {
        addElement(new ACartesianPoint(x,y));
    }
}
```

```
public interface History<T> {
        public void addElement(T element);
        public T elementAt (int index);
        public int size();
}
```

Has both addElement methods!

```
public interface PointHistory {
        public void addElement (int x, int y);
        public Point elementAt (int index);
        public int size();
}
```

Delegation

Delegator

Delegate

Adapter

Forwarding Proxy

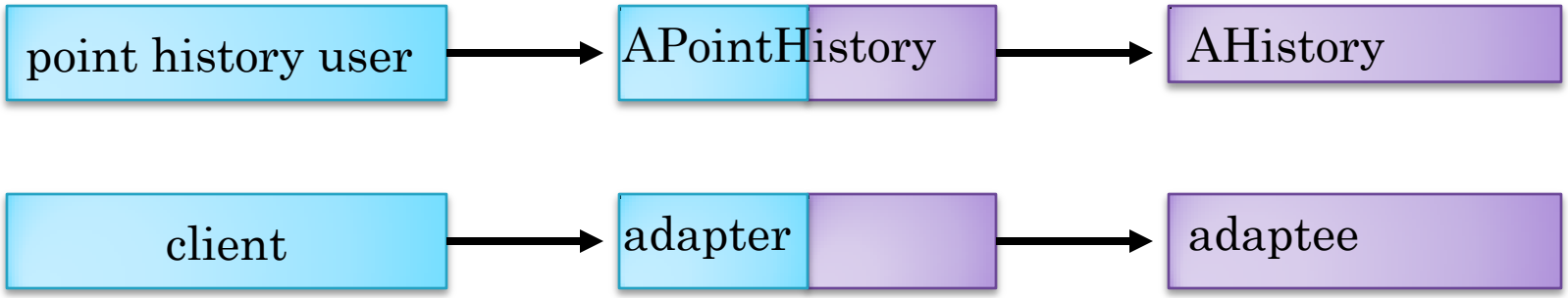
Forwarding Proxy

```
public class APointHistory implements PointHistory {
        History<Point> contents = new AHistory<Point>();
        public void addElement(int x, int y) {
                contents.addElement(new ACartesianPoint(x,y));
        }
        public Point elementAt(int index) {
                return contents.elementAt(index);
        }
        public int size() {
                return contents.size();
        }
}
```

In delegation, delegating class C1 has-a reference to reused delegate class C2, rather than C1 IS-A C2

What is this delegator doing?

Pattern?



- Adapter is a class that sits between a client and adaptee class much like an adapter sits between two objects that need to interact with each other.
- Methods called in adaptee through adapter.
- Degree of adaptation undefined.
  - Assumed no extra functionality offered but some may be removed.
- Methods offered to client
  - Adapted name
  - Adapted parameters.

Generic Java Collection Types

```
import java.util.ArrayList;
public class AStringHistory implements History<String> {
    List<String> contents = new ArrayList<String>();
    public void addElement (String s) {contents.add (s);}
    public String elementAt (int index) {return  contents.get(index);  }
    public int size() {return contents.size();}
}
```

```
import java.util.ArrayList;
public class AStringHistory extends ArrayList<String>
                                 implements History<String>
{   }
```

Exposing only history methods

remove() not visible.

Adapter pattern often used with ArrayList and Vector

Object Table

```
public interface Table {
 // associates key with value, returning last value associated with key
 public final Object put (Object key, Object value);
 // returns last value associated with key, or null if no association
 public final Object get (Object key);
}
```

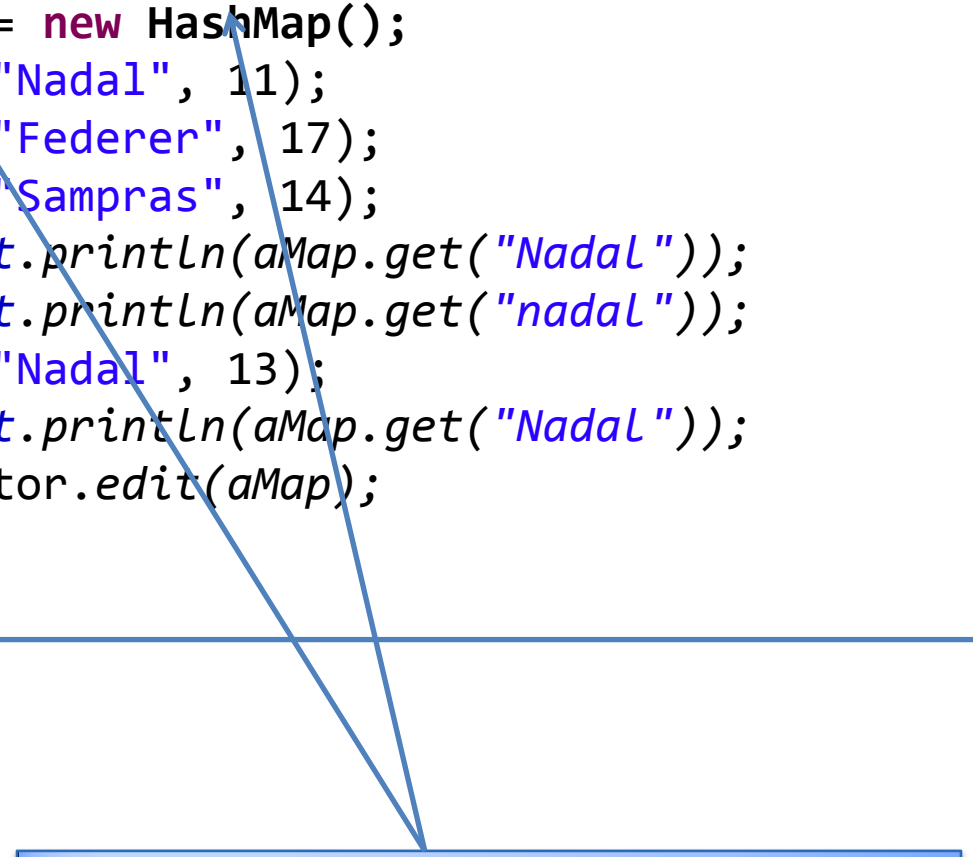
How to convert to generic?

Generic Table

```
public interface Table <KeyType, ValueType> {
 // associates key with value, returning last value associated with key
 public final ValueType put (KeyType key, ValueType value);
 // returns last value associated with key, or null if no association
 public final ValueType get (Object key);
}
```

HashMap Without Assigning Parameters Explicitly

```
public static void main (String[] args) {
  Map aMap = new HashMap();
  aMap.put("Nadal", 11);
  aMap.put("Federer", 17);
  aMap.put("Sampras", 14);
  System.out.println(aMap.get("Nadal"));
  System.out.println(aMap.get("nadal"));
  aMap.put("Nadal", 13);
  System.out.println(aMap.get("Nadal"));
  ObjectEditor.edit(aMap);
}
```



Not mentioning type value == type is Object

HashMap with Explicit Elaboration

```
public static void main (String[] args) {
  Map aMap<String, Integer> = new HashMap<String, Integer>();
  aMap.put("Nadal", 10);
  aMap.put("Federer", 17);
  aMap.put("Sampras", 14);
  System.out.println(aMap.get("Nadal"));
  System.out.println(aMap.get("nadal"));
  aMap.put("Nadal", 11);
  System.out.println(aMap.get("Nadal"));
  ObjectEditor.edit(aMap);
}
```

Generics → Collections?

Observer Interfaces

```
public interface CounterObserver {
  public void update(Counter aCounter);
}
```

```
public interface BMISpreadsheetObserver {
  public void update(BMISpreadsheet aBMISpreadsheet);
}
```

```
public interface GenerictObserver<Observable> {
  public void update(Observable anObservable);
}
```

Elaborating Generic Observer

```
public class ACounterObserver implements GenericObserver<Counter> {
  public void update(Counter aCounter) {
    System.out.println(aCounter.getValue());
  }
}
```

```
public class ABMISpreadsheetObserver
             implements GenericObserver<BMISpreadsheet> {
  public void update(BMISpreadsheet aBMISpreadsheet) {
    System.out.println(aBMISpreadsheet.getBMI());
  }
}
```

Multiple Implementations

```
public class ABMISpreadsheetAndCounterObserver
                implements GenericObserver<BMISpre
                           GenericObserver<Counter
  public void update(BMISpreadsheet aBMISpreadsh
    System.out.println(aBMISpreadsheet.getBMI());
  }
  public void update(Counter aCounter) {
    System.out.println(aCounter.getValue());
  }
}
```

Cannot implement the same generic twice with different parameters

A single interface method exists at run time

An interface method is mapped to a class method at runtime (dynamic dispatch)

It can be mapped to a single class method at run time

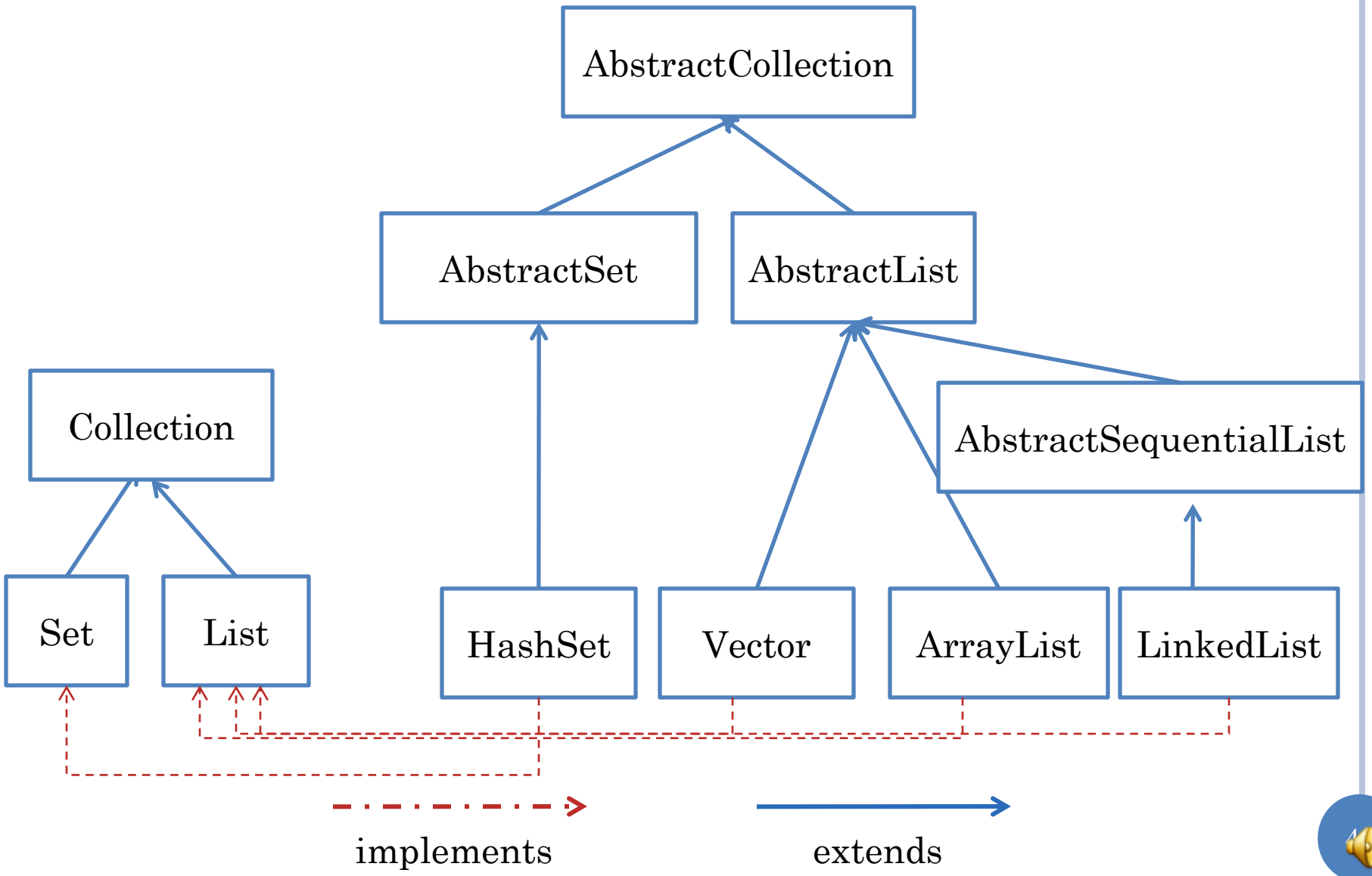
```
GenericObserver<Counter> counterObserver = new
ABMISpreadsheetAndCounterObserver();
counterObserver.update(counter);
```

Extra

Java Vectors, Array Lists, Enumerations

- Just like collections we defined
- Except they can store and iterate arbitrary objects

Java Collection Classes



PointHistory

```
public interface PointHistory {
        public void addElement (Point p );
        public Point elementAt (int index);
        public int size();
}
```

Java Generic Types (Review)

A scope name (class, interface, method) can be succeeded by a series of type parameters within angle brackets <A, B, C, …> that have the same value in all places

```
public interface I<T> {
        public void addElement (T t);
        public T elementAt (int index);
        public int size();
    }
```

A method, class, interface with type parameter is called a generic.

Create an elaboration of generic by giving actual value to type parameter

A single implementation is shared by all of its elaborations.

```
I<String>  stringI;
I<Point> pointI;
```

Assigning values to type parameters is a compile time activity for type checking only.

Generic with Type Parameter

```
public interface  History <T>  {
        public void addElement(T element);
        public int size();
        public  T elementAt(int index);
}
```

How to indicate a string or point history?

```
History<String> stringHistory;
History<Point> pointHistory;
```

Generic with Type Parameter

```
public interface  History <T>  {
        public void addElement(T element);
        public int size();
        public  T elementAt(int index);
}
```

How to indicate a string or point history?

```
History<String> stringHistory;
History<Point> pointHistory;
```

Delegating APointHistory (Review)

```
public class APointHistory implements PointHistory {
        History<Point> contents = new AHistory();
        public void addElement(int x, int y) {
                contents.addElement(new ACartesianPoint(x,y));
        }
        public Point elementAt(int index) {
                return contents.elementAt(index);
        }
        public int size() {
                return contents.size();
        }
}
```

In delegation, class C1 has-a reference to reused class C2, rather than C1 IS-A C2

Passing Type Parameters

```
public class AHistory<AType> implements History<AType> {
    …
}
```

```
public double calculateMyBMI(double w)  {
        return w/(1.77*1.77);
}
```

```
public double calculateBMI(double weight, double height)  {
        return weight/(height*height);
}
```