Comp 110/401
Collection Kinds

Instructor: Prasun Dewan

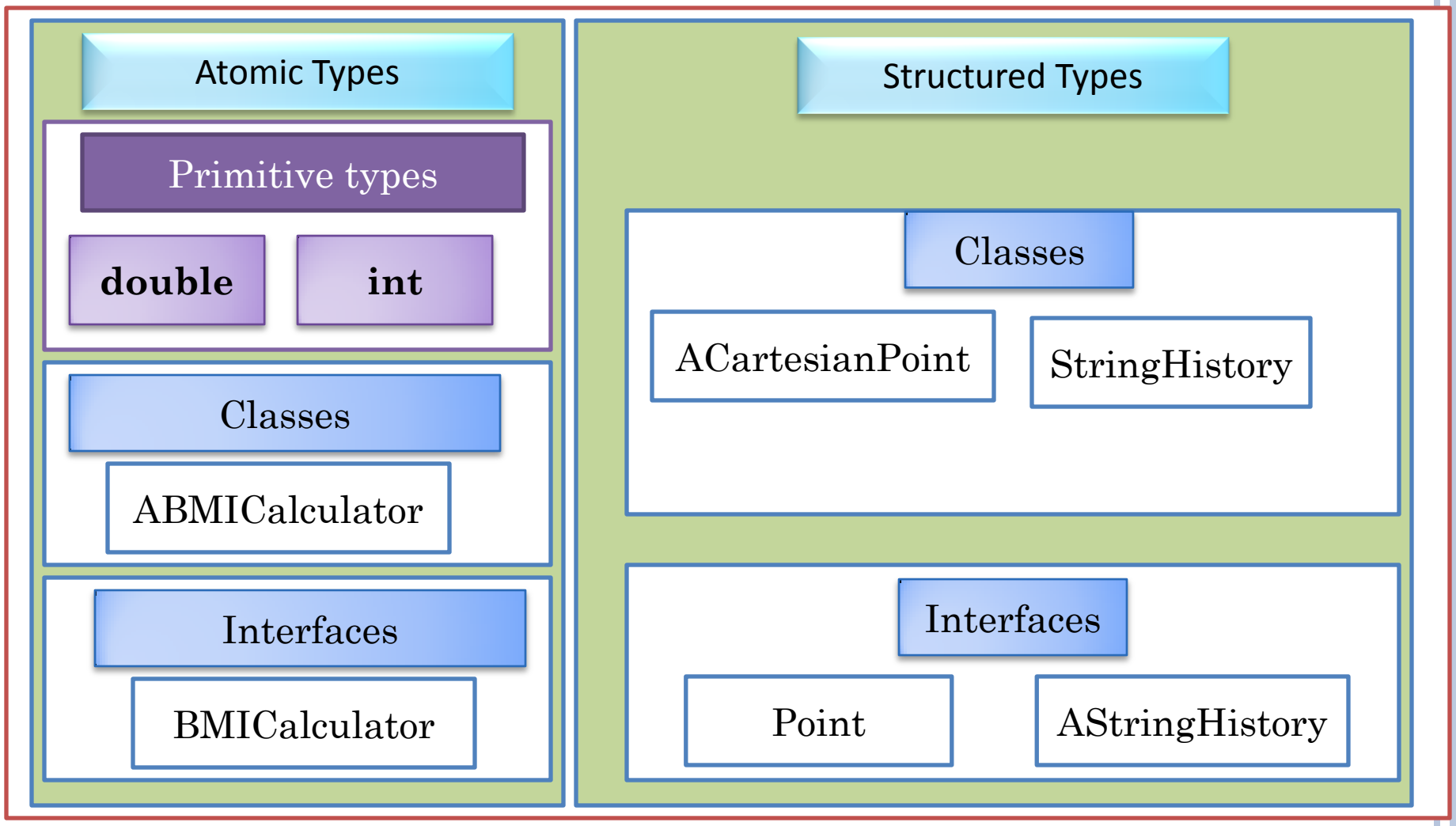
Prerequisite

- Arrays Collections Implementation

Collection Types

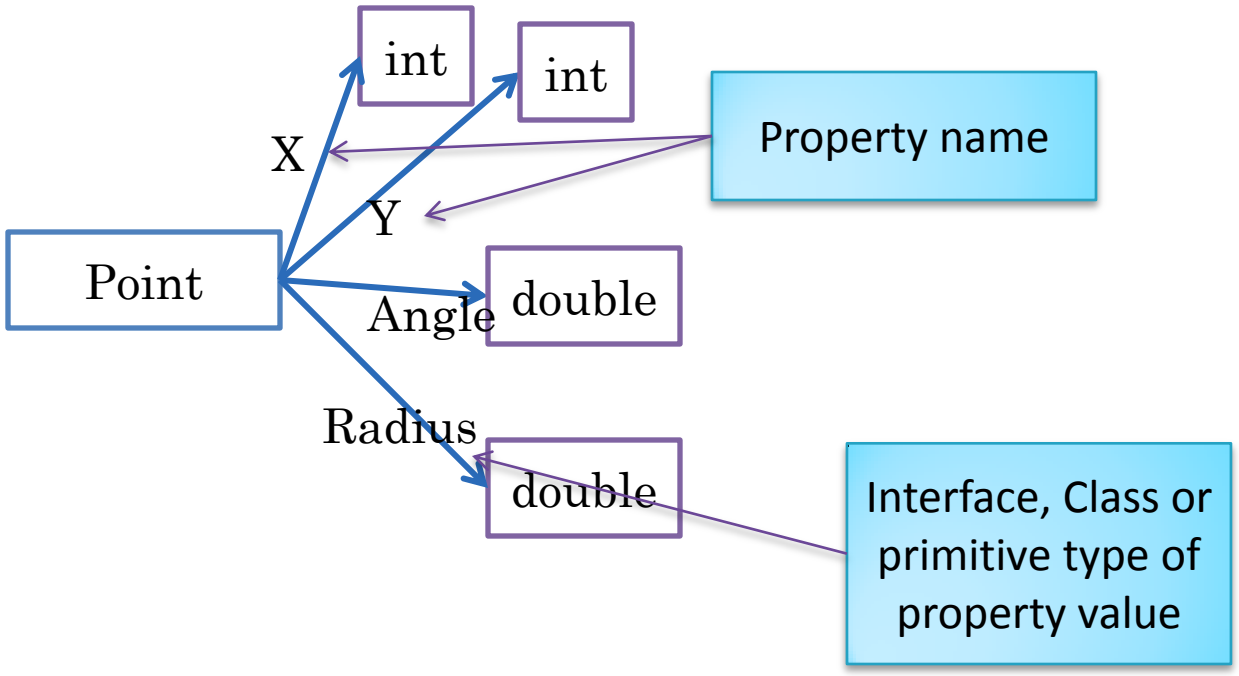
- StringHistory, StringDatabase, StringSet
- Array
- ArrayList, List
- Map
- Stack
- Queue

Structured vs. Atomic Types

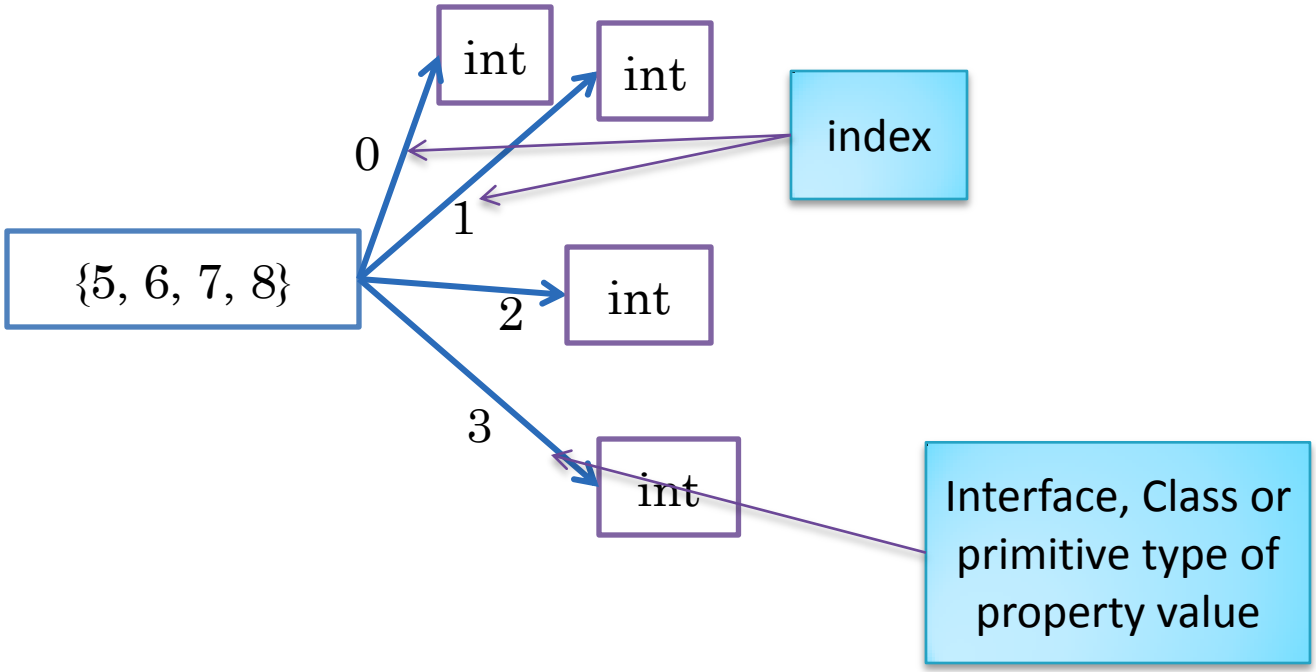


Instances of structure type decomposed into one or more smaller values

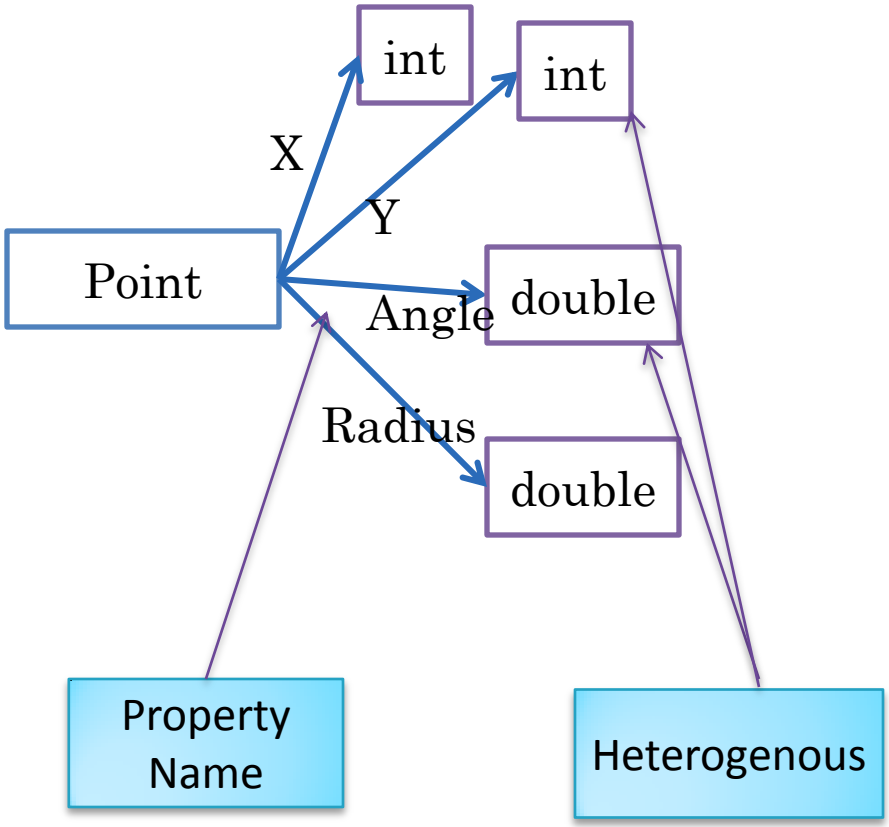
Logical Structure Point

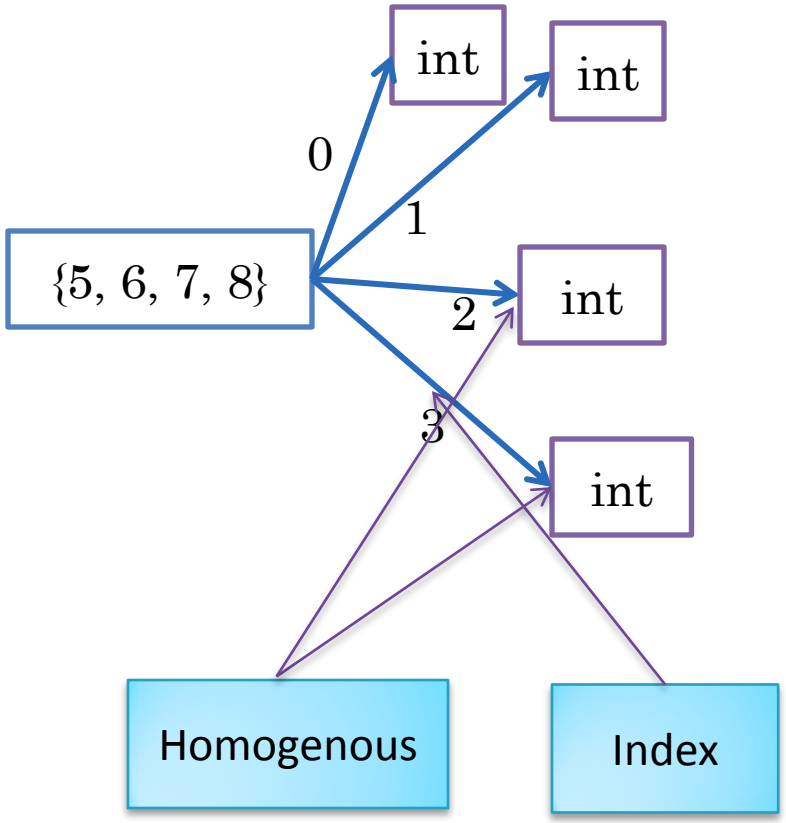


Logical Structure Array



Bean vs. Array



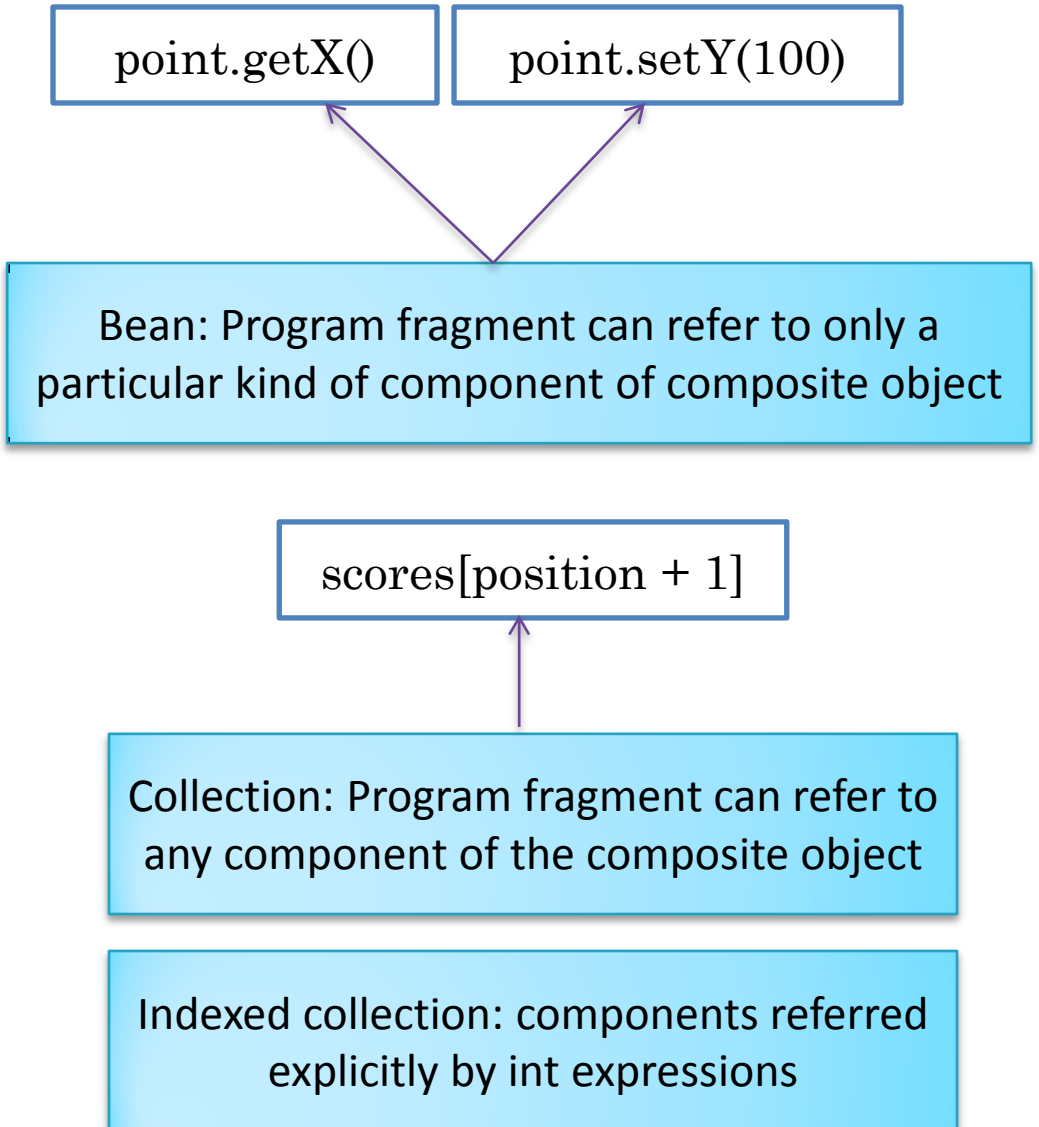


Components can be of different types and serve different functions

Components are of same type (which may be a super type of the specific types of the components) and are handles in the same way

```
Object[] objects = { "Joe Doe", new AStringDatabase(), new AStringHistory()};
```

Bean vs. (Indexed) Collection



Indexed Collections

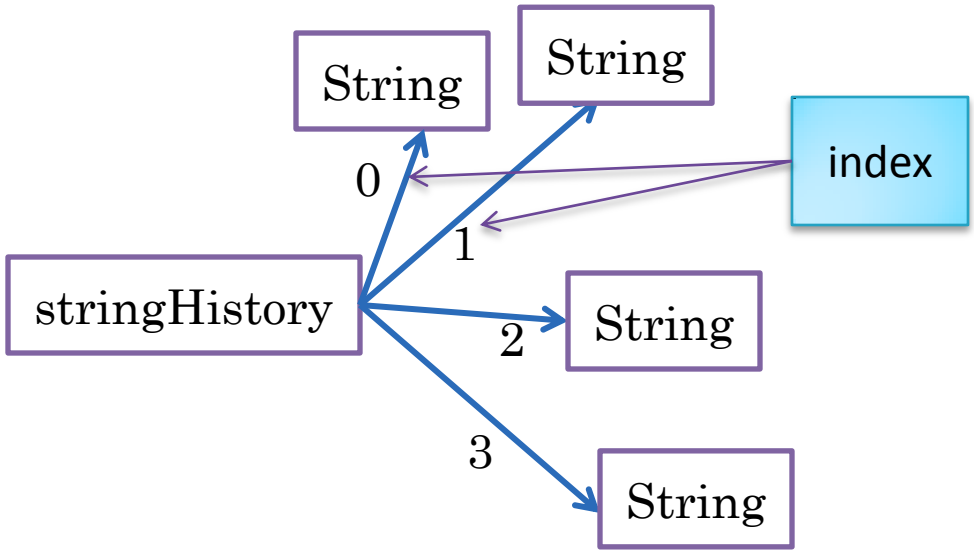
Each element identified by a unique index

Successive elements have consecutive indices

StringHistory?


```
<terminated> AHistoryDriver [Java Application]
James Dean
p
********************
James Dean
********************
Joe Doe
Jane Smith
p
********************
James Dean
Joe Doe
Jane Smith
********************
q
```

StringHistory

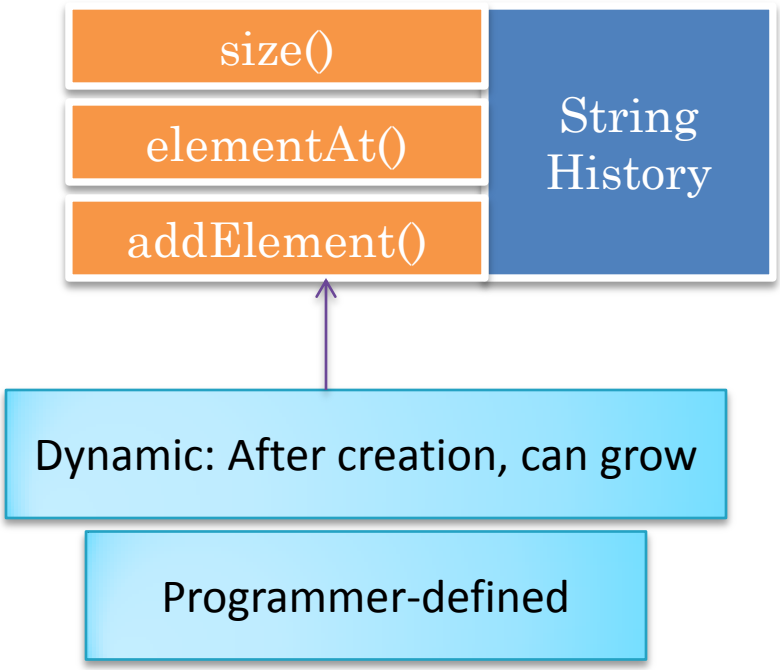


stringHistory.elementAt(position + 1)

Collection: Program fragment can refer to any component of the composite object

Indexed collection: components referred explicitly by int expressions

StringHistory vs. Array




```
<terminated> AHistoryDriver [Java Application]
James Dean
p
********************
James Dean
********************
Joe Doe
Jane Smith
p
********************
James Dean
Joe Doe
Jane Smith
********************
q
```

String[] strings= { “James Dean”, “Joe Doe”, “Jane Smith”)};

Static and Language-defined

Static vs. Dynamic Structures

Static
Beans have fixed number of properties
Arrays have fixed number of elements
Though an array variable can be assigned arrays of different sizes

Dynamic
Can create new edges in logical structure

History

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

Database

```
public interface  StringDatabase {
        //from history
        public int size();
        public void addElement(String element);
        public String elementAt(int index);

        //additional methods
         public void removeElement(String element);
         public boolean member(String element);
         public void clear();
}
```

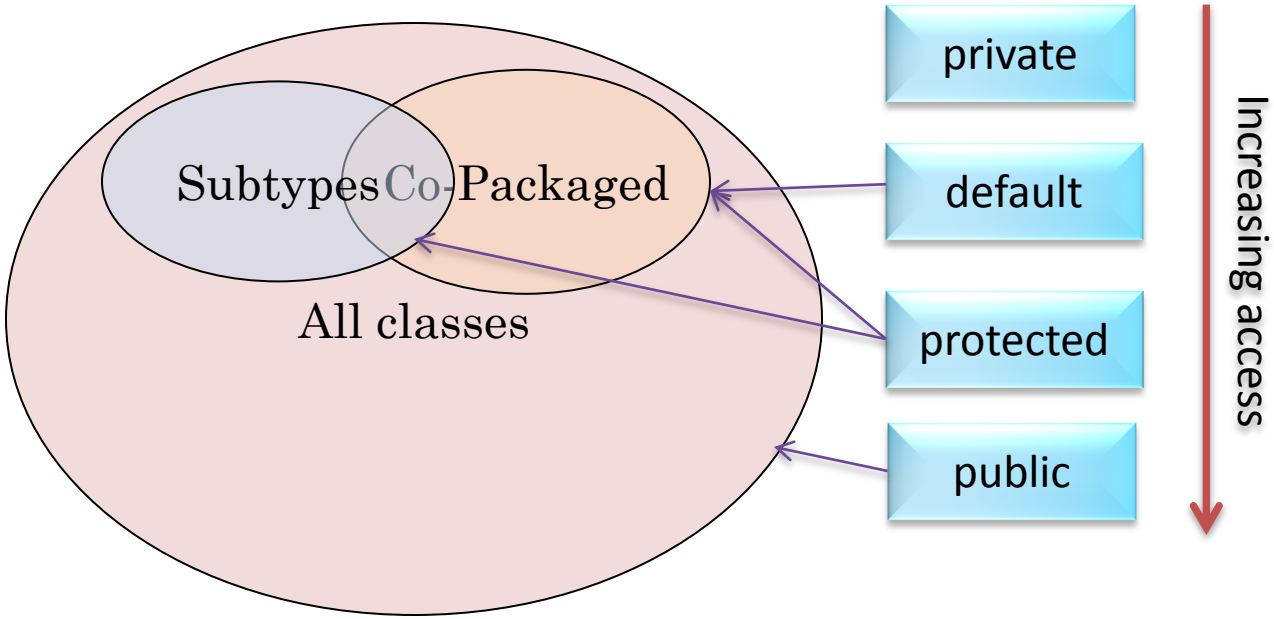
Do we need a history if we have a database?

Yes, principle of least privilege

Principle of Least Privilege/ Need to Know

- Do not give a user of some code more rights than it needs
  - Code is easier to change
  - Need to learn less to use code
  - Less likelihood of accidental or malicious damage to program
- Like hiding engine details from car driver

Visibility of A Type and its Members: Some Type are More Equal than Others



Co-packaged a la co-workers, amplifier + speakers

Subtype a la family, deluxe amplifier

Encapsulation Rule: Do not make variables of a class public

Using Database as History

```
public interface  StringDatabase {
        //from history
        public int size();
        public void addElement(String element);
        public String elementAt(int index);

        //additional methods
         public void removeElement(String element);
         public boolean member(String element);
         public void clear();
}
```

Programmer would be able to perform inappropriate operations on a logical history implemented physically as a database

Co-Existence

```
public interface  StringDatabase  extends StringHistory {
            //additional methods
             public void removeElement(String element);
             public boolean member(String element);
             public void clear();
}
```

Programmer would be able to perform inappropriate operations on a logical history implemented physically as a database

Vector: General Object Collection

```
public final int size();
public final Object elementAt(int index);
public final void addElement(Object obj) ;
public final void setElementAt(Object obj, int index);
public final void insertElementAt(Object obj,  int index);
public final boolean removeElement(Object obj);
public final void removeElementAt(int index);
public final int indexOf(Object obj);
…
```

Do we need other collections if we have Vector

Yes, principle of least privilege

Yes, implementation considerations

Class ArrayList And Vector (List)

```
public final int size();
public final Object get(int index);
public final void add(Object obj) ;
public final void set(int index, Object obj);
public final void insert(int index,  Object obj);
public final boolean remove(Object obj);
public final void remove(int index);
public final int indexOf(Object obj);
...
```

Vector has ArrayList (List) methods plus the additional original methods in the previous slides

Can add arbitrary objects to these collections

Array List and Vector User

```
import java.util.ArrayList;
import java.util.List;
import java.util.Vector;
public class VectorArrayListUser {
  public static void main (String[] args) {
    List names = new Vector();
    List grandSlams = new ArrayList();
    names.add("Nadal");
    grandSlams.add(13);
    names.add("Federer");
    grandSlams.add(17);
    names.add(“Borg");
    grandSlams.add(11);
    names.add(“Sampras");
    grandSlams.add(14);
  }
}
```

What kind of dynamic structure is being simulated?

Indexed Collections

Each element identified by a unique index

Successive elements have consecutive indices

Tables

Each element identified by a unique object called a key

Usually strings are used as keys

HashMap (Implements Map)

```
// 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);
```

Final means method cannot be overridden

HashMap Use

```
public static void main (String[] args) {
  Map aMap = new HashMap();
  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"));
  System.out.println(aMap);
```

```
MapUser [Java Application] C:\Program Files\Java\jre6\bin\javaw.exe (Oct 2, 2012 10:58:49 AM
10
null
11
{Sampras=14, Federer=17, Nadal=11}
```

Explicit vs. Implicit Element Reference

Collection: Program fragment can refer to any component of the composite object

Indexed collection: components referred explicitly by int expressions

Table collection: components referred explicitly by Object expressions

Implicit reference to components?

Stack: Last in First Out

```
public interface StringStack {
  public boolean isEmpty();
  public String getTop();
  public void push(String element);
  public void pop();
}
```

```
StringStack stringStack = new AStringStack();
stringStack.push("James Dean");
stringStack.push("Joe Doe");
stringStack.push("Jane Smith");
stringStack.push("John Smith");
System.out.println(stringStack.getTop());
stringStack.pop();
System.out.println(stringStack.getTop());
```

```
John Smith
Jane Smith
```

Queue: First in First Out

```
public interface StringQueue {
  public boolean isEmpty();
  public String getHead();
  public void enqueue(String element);
  public void dequeue();
}
```

```
StringQueue stringQ = new AStringQueue();
stringQ.enqueue("James Dean");
stringQ.enqueue("Joe Doe");
stringQ.enqueue("Jane Smith");
stringQ.enqueue("John Smith");
System.out.println(stringStack.getHead());
stringQ.dequeue();
System.out.println(stringStack.getHead());
```

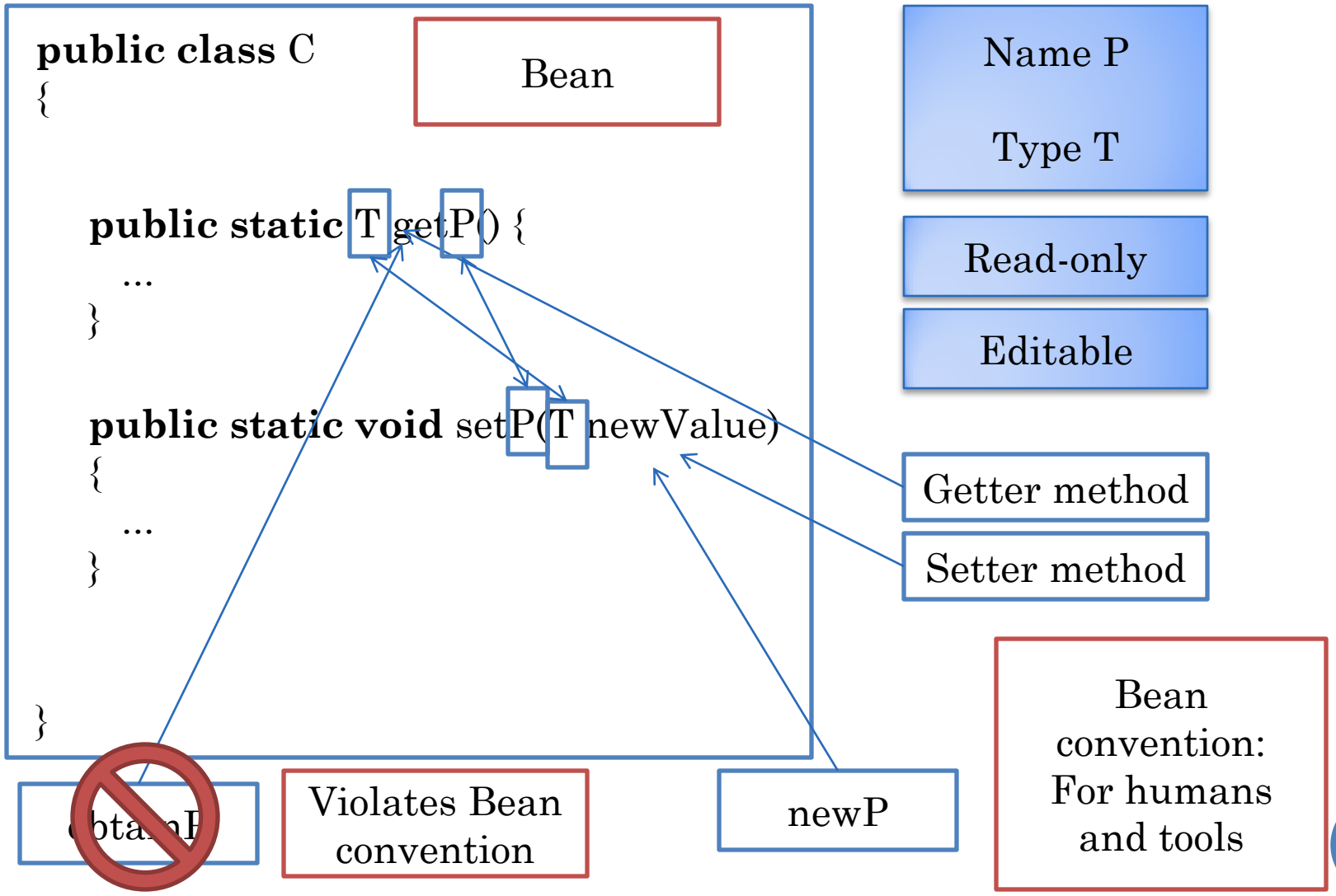
```
James Dean
Joe Doe
```

Structured Types

- Static named
- Static indexed
- Dynamic indexed
- (Static) Dynamic tables
- Stack (LIFO)
- Queue (FIFO)

Read-only and Editable Properties

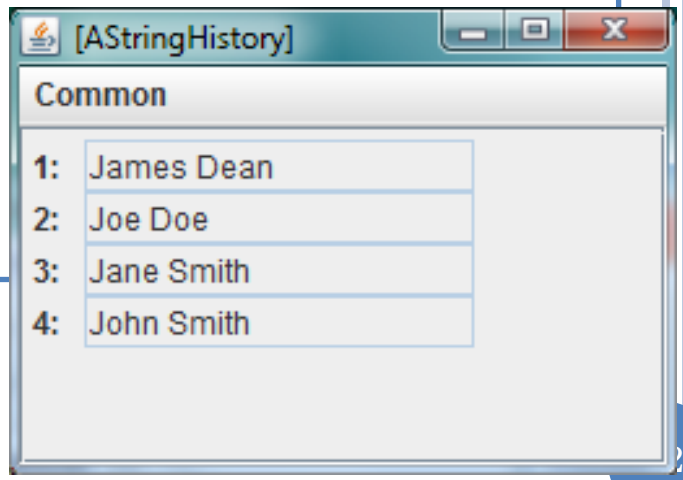
Typed, Named Unit of Exported Class State



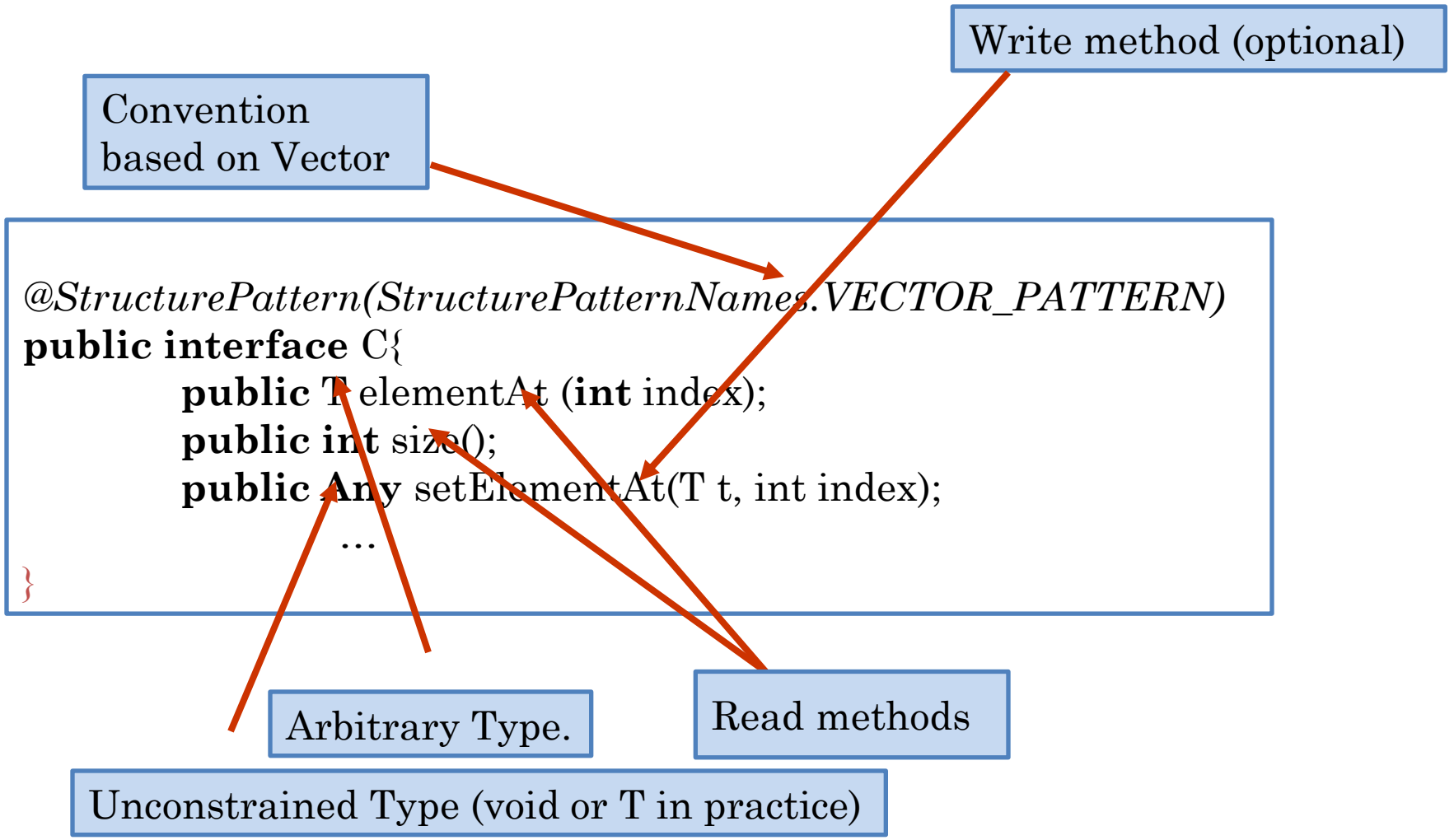
Visualizing Collections

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

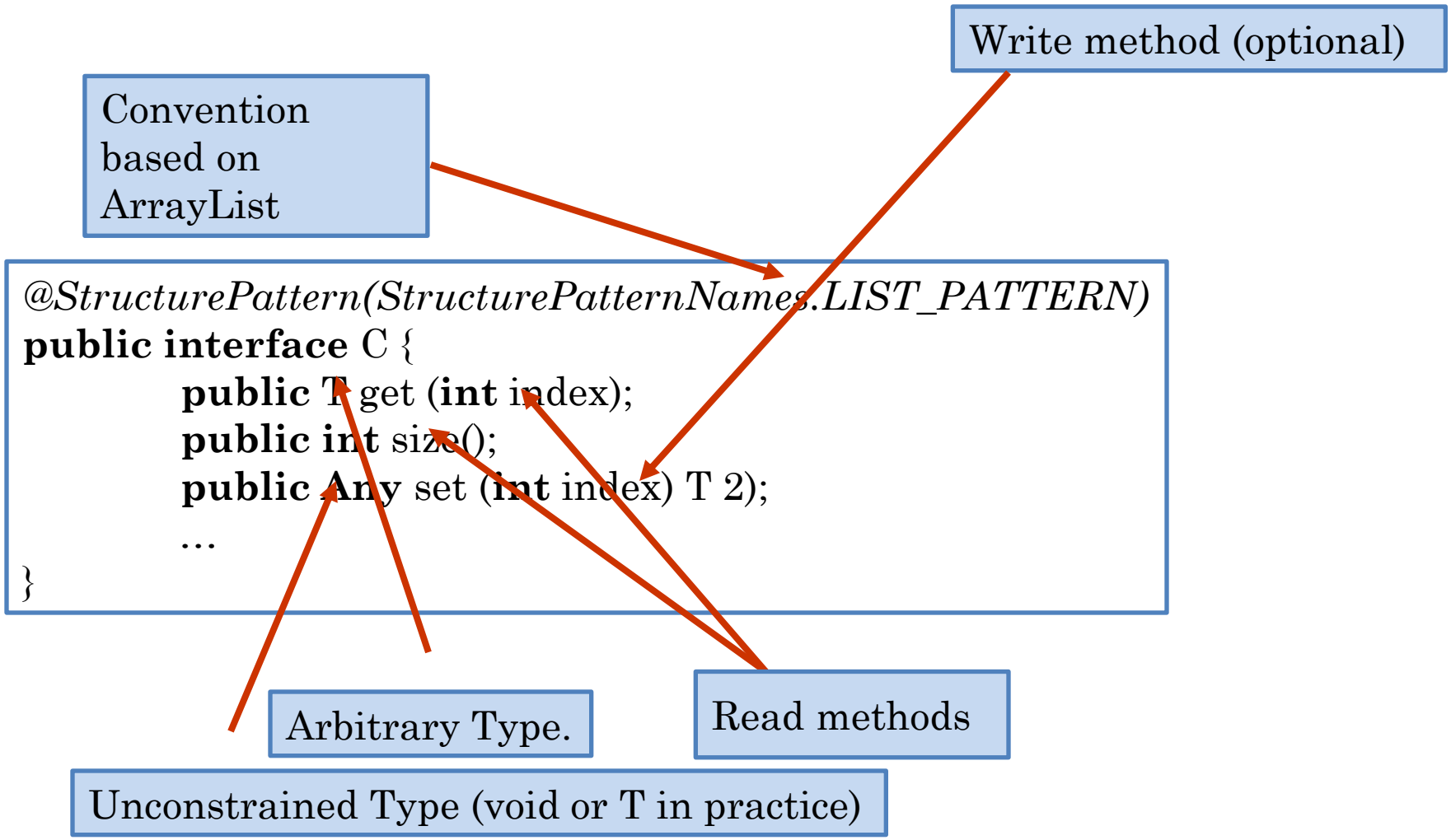
```
public static void main (String[] args) {
  StringHistory stringHistory = new AStringHistory();
  stringHistory.addElement("James Dean");
  stringHistory.addElement("Joe Doe");
  stringHistory.addElement("Jane Smith");
  stringHistory.addElement("John Smith");
  ObjectEditor.edit(stringHistory);
}
```



Conventions for Variable-Sized Collection



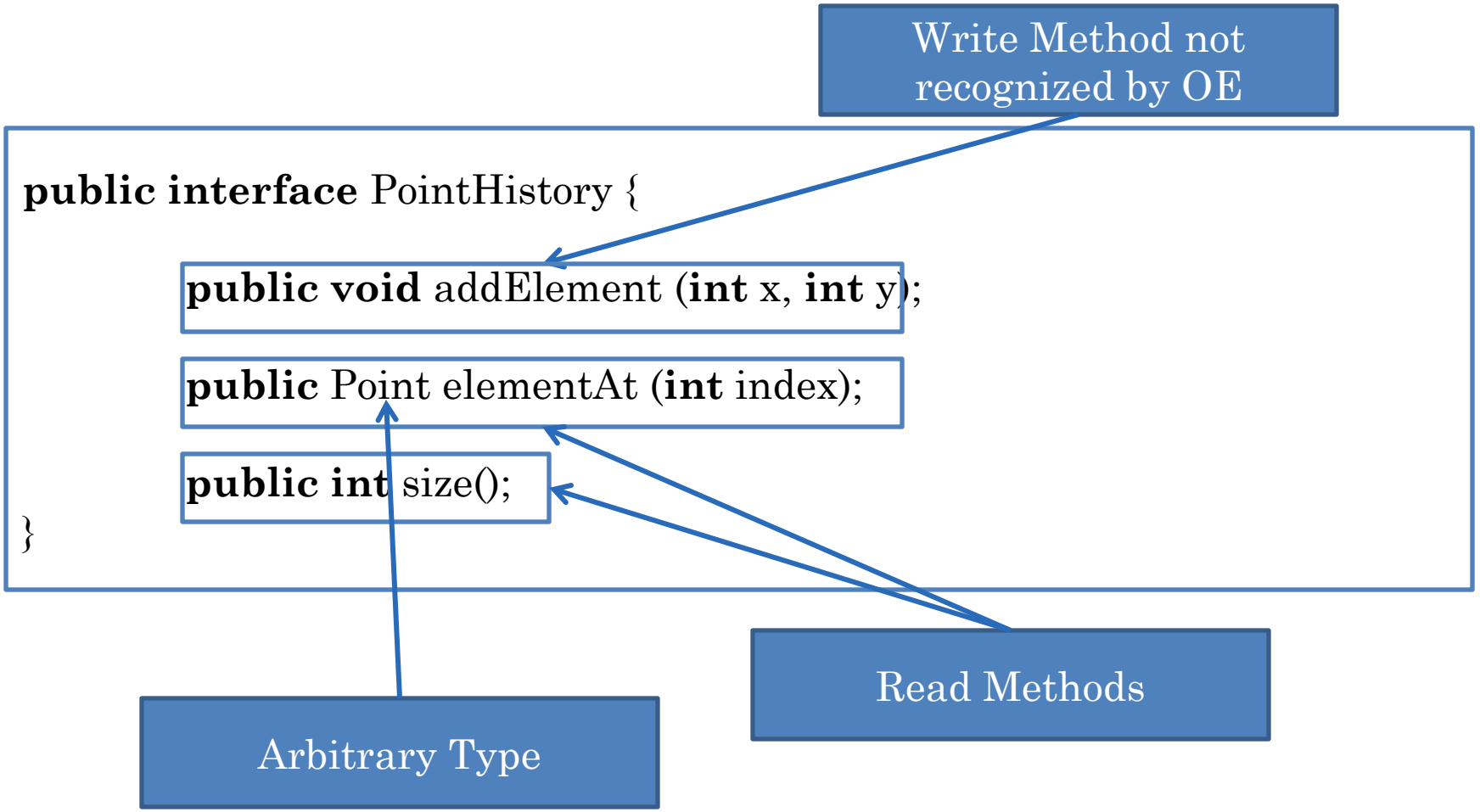
Alternative Conventions for Variable-Sized Collection



Read vs. Write Methods

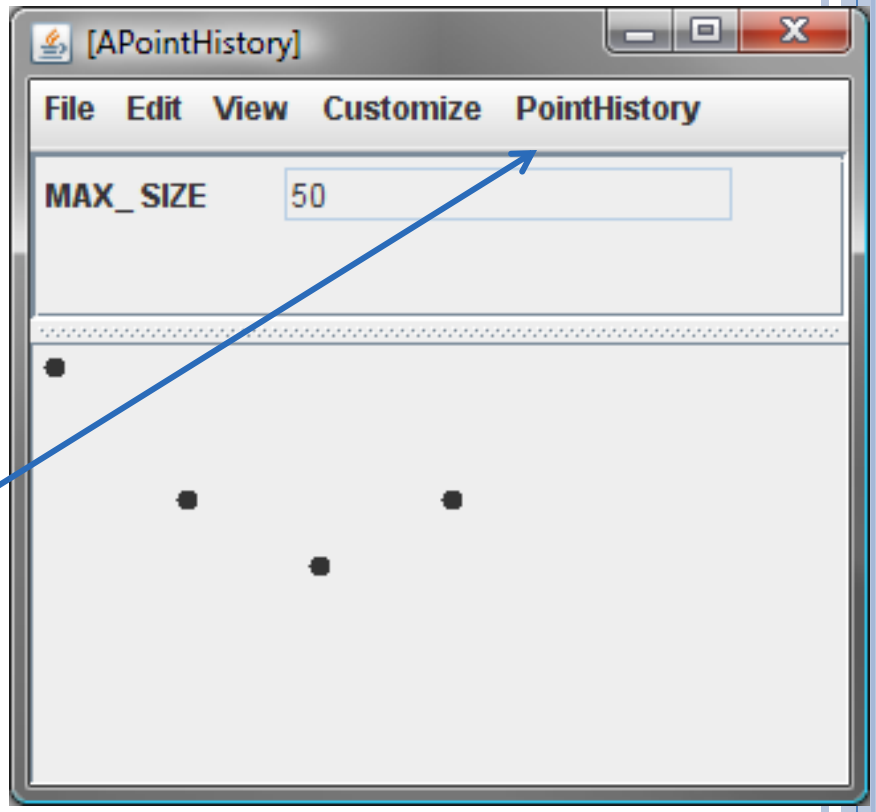
- Read Methods
  - Used to get components of object
  - Getter methods
  - size(), elementAt()
- Write Methods
  - Used to change components of object
  - Setter methods
  - addElement(), removeElement(), setElementAt()
  - some used by Object Editor
- Distinction independent of conventions and important for Model-View-Controller and other paradigms you will see later
- Conventions used in Object Editor

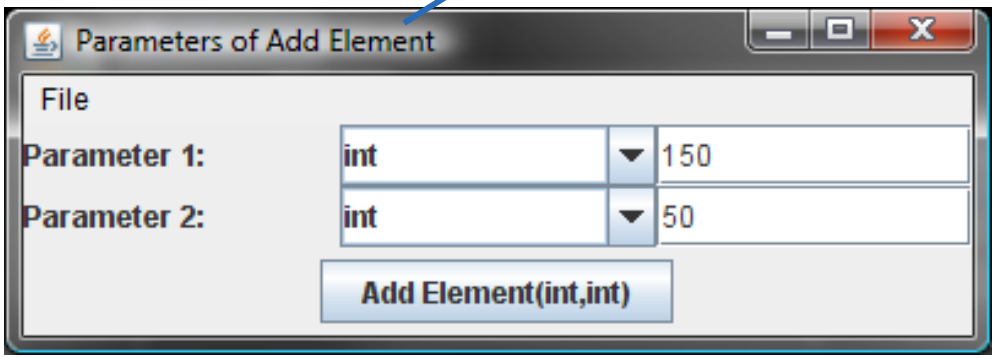
Conventions for Variable-Sized Collection



APointHistory

- Variable-sized Collection
- History
- Methods added to menu associated with class
- Graphic elements of dynamic collections added at their (X, Y) locations

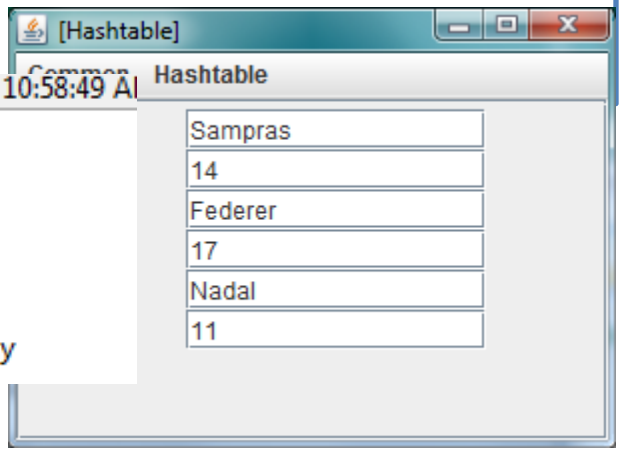




HashMap Use

```
public static void main (String[] args) {
  Map aMap = new HashMap();
  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"));
  System.out.println(aMap);
  ObjectEditor.edit(aMap);
}
```

```
MapUser [Java Application] C:\Program Files\Java\jre6\bin\javaw.exe (Oct 2, 2012 10:58:49 Al
10
null
11
{Sampras=14, Federer=17, Nadal=11}
oeall20 Copyright Prasun Dewan, 2011, All rights reserved
Object Editor Version: 20
Built On: Unknown time because of java version incompatibility
```



OE Conventions For Table

```
// associates key with value, returning last value associated with key
public <ValueType> put (<KeyType> key, <ValueType> value);
// returns last value associated with key, or null if no association
public <ValueType> get (<KeyType> key);
// optional, removes associated value, and returns it or null
public <ValueType> remove(<KeyType> key);
```

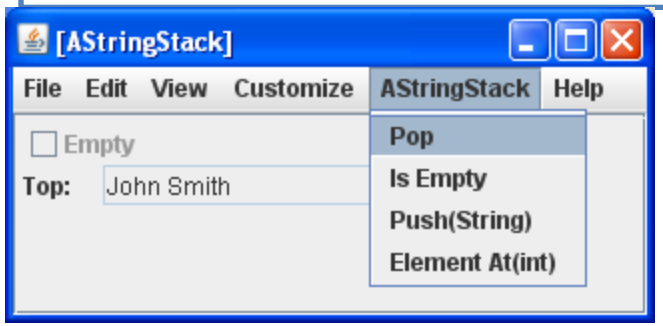
Necessary but not sufficient to displays all keys and elements

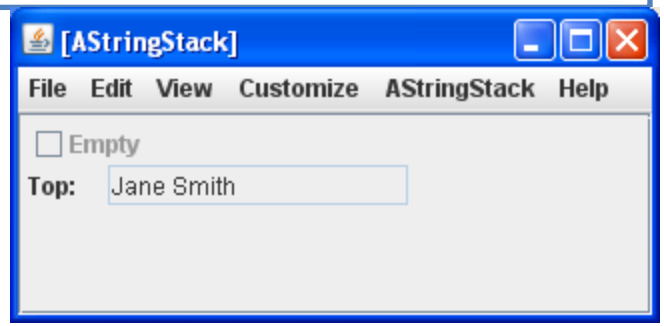
Displaying Stack (LIFO)

```
public interface StringStack {
  public boolean isEmpty();
  public String getTop();
  public void push(String eleme
  public void pop();
}
```

Does not provide read methods for reading all elements

```
StringStack stringStack = new AStringStack();
stringStack.push("James Dean");
stringStack.push("Joe Doe");
stringStack.push("Jane Smith");
stringStack.push("John Smith");
ObjectEditor.edit(stringStack);
```





Displaying Transparent Stack (LIFO)

```
public interface TransparentStringStack {
  public int size();
  public String get(int index);
  public void push(String element);
  public void pop();
}
```

Provides read methods following OE collection conventions

```
StringStack stringStack = new AS
stringStack.push("James Dean");
stringStack.push("Joe Doe");
stringStack.push("Jane Smith");
stringStack.push("John Smith");
```

Can provide additional method for top value