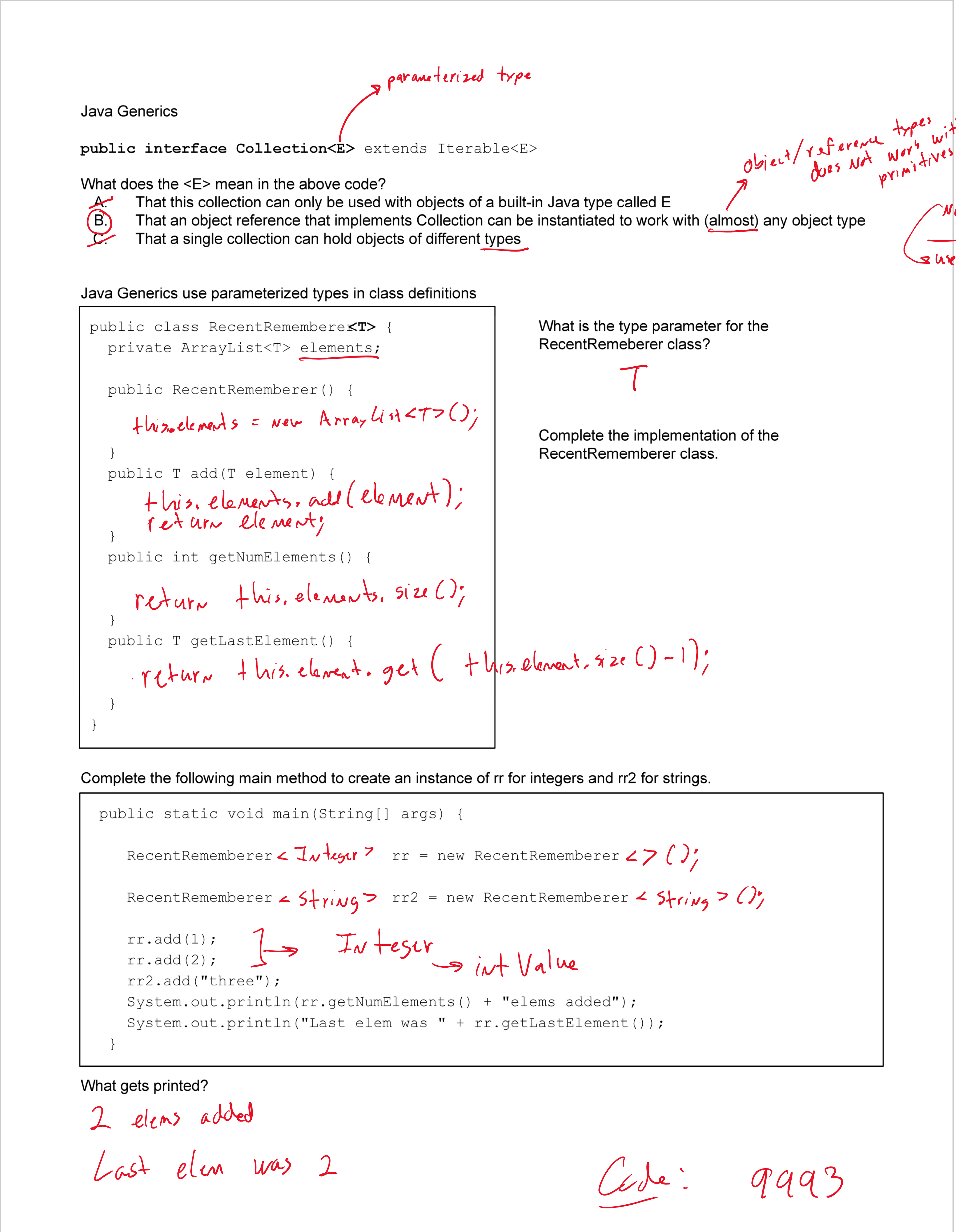
# CSE12 - Lecture 6

Friday, April 14, 2023 8:00 AM



parameterized type

Java Generics

```
public interface Collection<E> extends Iterable<E>
```

object/reference types does Not work with primitives

What does the <E> mean in the above code?

~~A.~~ That this collection can only be used with objects of a built-in Java type called E

[✓ B.] That an object reference that implements Collection can be instantiated to work with (almost) any object type

~~C.~~ That a single collection can hold objects of different types

no int double

use Integer Double

Java Generics use parameterized types in class definitions

```
public class RecentRememberer<T> {
  private ArrayList<T> elements;

  public RecentRememberer() {
     this.elements = new ArrayList<T>();
  }
  public T add(T element) {
     this.elements.add(element);
     return element;
  }
  public int getNumElements() {
     return this.elements.size();
  }
  public T getLastElement() {
     return this.element.get( this.element.size()-1);
  }
}
```

What is the type parameter for the RecentRemeberer class?

T

Complete the implementation of the RecentRememberer class.

Complete the following main method to create an instance of rr for integers and rr2 for strings.

```
public static void main(String[] args) {

   RecentRememberer<Integer> rr = new RecentRememberer<>();

   RecentRememberer<String> rr2 = new RecentRememberer<String>();

   rr.add(1);      1 → Integer → intValue
   rr.add(2);
   rr2.add("three");
   System.out.println(rr.getNumElements() + "elems added");
   System.out.println("Last elem was " + rr.getLastElement());
 }
```

What gets printed?

2 elems added

Last elem was 2

Code: 9993

The type parameter can be used to stand for a type (to be specified later anywhere in this class (and its inner classes!)

You are not allowed to use Generics as follows:

In creating an object of that type:

```
      new T() // error
```

In creating an array with elements of that type:

```
      new T[100] // error
```

→ E[] arr = (E[]) new Object[2];

As an argument to instanceof:

```
      someref instanceof T // error
```

Note: To ensure that certain methods can be called, we can constrain the generic type to be subclass of an interface or class

```
public class MyGenerics <E extends Comparable>{ ………}
```

→ compareTo()

Generics - https://docs.oracle.com/javase/tutorial/java/generics/erasure.html

Important for data structures in general

```
public class MyList<E>{
  //codes that use E
}
```

Pros of using generics

- Avoid type casting (i.e. limit runtime errors)

  Before Java 5

```
      ArrayList list = new ArrayList();// a list of objects
      list.add("greg")
      list.add(new Integer(12));

      Integer data = list.get(1);
```

Cons of using generics

- Type erasure

Type erasure during compile time

- Compiler checks if generic type is used properly. Then replace them with Object
- Runtime doesn't have different generic types

```
MyList<String>  ref1 = new MyList<String>();
MyList<Integer> ref2 = new MyList<Integer>();
```

Compile time:

```
MyList<String>  ref1 = new MyList<String>();
```

Runtime

```
MyList<Object>  ref1 = new MyList<Object>();
```

Name: ______________________________ PID: _________________________ Code: ______________

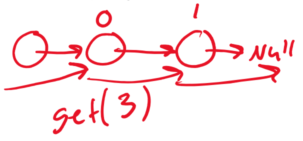
Convert Node and LinkedStringList to be a generic using List interface

```
public interface List<Element> {
  /* Add an element at the end of the list */
  void add(Element s);
  /* Get the element at the given index */
  Element get(int index);
  /* Get the number of elements in the list */
  int size();
}

class Node<E> {
  ~~String~~ E value;
  Node<E> next;
  public Node(~~String~~ E value, Node<E> next) {
    this.value = value;
    this.next = next;
  }
}

public class ~~LinkedStringList~~ LL<T> implements ~~StringList~~ List<T> {
  Node<T> front;
  int size;

  public ~~LinkedStringList~~ LL() {
      this.front = new Node<T>(null, null);
    this.size = 0;
  }
  public ~~String~~ T get(int index) {  0 -> size - 1
    Node<T> temp = this.front.next;
    for (int i = 0; i < index; i += 1) {
      temp = temp.next;
    }          ↳Null.Next
    return temp.value;
  }          ↳Null.value
  public int size() {
    return this.size;
  }
  public void add(~~String~~ T s) {
    Node<T> temp = this.front;
    while (temp.next != null) {
      temp = temp.next;
    }
    temp.next = new Node<T>(s, null);
    this.size += 1;
  }
}
```



Exceptions

What happens if an invalid index is passed to get()?

Null pointer exception

Modify get() to throw an exception if the index is invalid

```
public String get(int index) {
  Node temp = this.front.next;
  for (int i = 0; i < index; i += 1) {
    temp = temp.next;
  }
  return temp.value;
}
```

```
if (index<0 || index >= size) {
    throw new IndexOutOfBoundsException();
          new IllegalArgumentException(...);
}
```

jUnit - test that an exception is thrown

@Test(expected = IndexOutOfBoundsException.class)

Test fails if no IOOBE exception is thrown

Write a test to verify get() throws an exception with an invalid index