Assignment	1. Write a class named ArrayIterator that implements the Iterator interface and iterates over elements in an array, but skips null elements in the array. 2. Include a type parameter <T> in the class. 3. Use the package **`ku.util`** for your code.
What to Submit	1. Create an empty repository on Github Classroom using this link: **`https://classroom.github.com/a/g0EhuapO`** 2. Clone the repository. Add your own README.md and .gitignore. 3. Submit your source code in the "`src/ku/util`" directory. Push to Github.
Testing	You should test and review your own code! There will be a large penalty for dumb errors that you should have detected by testing your own code. There are some JUnit tests in assignments/ArrayIteratorTest.java, but they do not test everything!

Iterators

Many collections and data structures provide an *Iterator* so we can iterate over all the elements in the collection *without knowing the structure* of the collection.

In Java, an *Iterator* is any object that implements the java.util.Iterator interface. This interface has a type parameter that specifies the type of element the Iterator returns.

Iterator Interface in Java

The **`java.util.Iterator`** interface has 3 methods. The interface has a type parameter (usually shown as "T" or "E"). If you omit the type parameter, the default value is **`Object`**. Here are the 3 methods (shown with and without type parameter):

Type parameter T	No type parameter	Meaning
`T next( )`	**`Object next( )`**	Return the *next non-null* element in the array. If there are no more elements, it throws NoSuchElementException.
`boolean hasNext()`	**`boolean hasNext()`**	Returns true if **`next()`** can return another non-null array element, false if no more elements.
`void remove()`	**`void remove( )`**	(Optional) Not used in ArrayIterator

Example:

Scanner is a String Iterator. The Java API doc for Scanner states that Scanner implements `Iterator<String>`. This means that `next( )` will return a `String`. For example:

```
    Scanner input = new Scanner( "Iterating is       easy!" );
    while( input.hasNext() ) {
        String s = input.next();
        System.out.println( s );
    }
```

```
Iterating
is
easy!
```

Assignment

Arrays don't have an Iterator, but it would be useful to have one. Write an ArrayIterator class in the package **`ku.util`** that provides an *Iterator* for any array.

For *convenience*, we will design the Arrayiterator so it skips null elements in the array.

1. Write a class named ArrayIterator that implements java.util.Iterator.

2. Use a *type parameter* in the class declaration and next method. Declare the class like this:

```
public class ArrayIterator<T> implements Iterator<T>
```

T is a *type parameter*, which is a placeholder for the name of a class or Interface.

3. When we create an ArrayIterator object, the value of the type parameter should match the type of values in the array. For an array of Student objects we would write:
"new ArrayIterator<Student>(students)".

Define ArrayIterator like this. The "T" means the type of object that the next() method returns.

```
package ku.util;
//TODO write good Javadoc
public class ArrayIterator<T> implements Iterator<T>  {
    private T[] array;
    //TODO: define any other variables you need (a cursor)
    /**
     * Initialize a new array iterator with the array to process.
     * @param array is the array to iterate over
     */
    public ArrayIterator(T[] array) {
        this.array = array;
    }

    /**
     * @see java.util.Iterator#next()
     */
    @Override
    public T next() {

    }

   @Override
    public boolean hasNext() ...
}
```

4. The *constructor* has a parameter that is an array of type T. In Java, you can use a type parameter just like a class name (except that you cannot create "new" objects using a type parameter, e.g. "new T()").

5. ArrayIterator may *not* use any Java collections (like ArrayList). ArrayIterator needs only a reference to the **`array`** and a variable to keep track of the next element it should return..

6. The next( ) and hasNext( ) methods should *skip* **`null`** values (see example below).

7. Do not expect the user to always call hasNext() before next(). He may not call hasNext() at all, or call it many times consecutively.

8. If the user calls next( ) when there are no more elements, next throws a NoSuchElementException. Here is how to throw an exception:

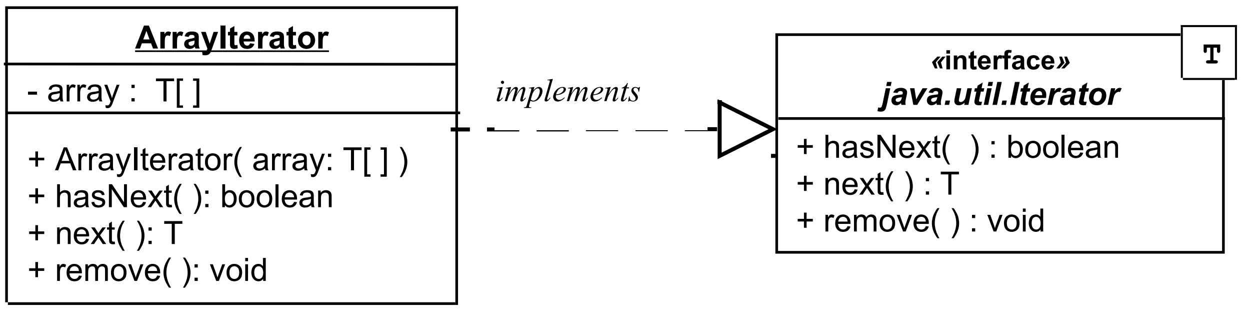
```
throw new NoSuchElementException("No more elements");
```

The code immediately exits when you throw an exception, so there is no "return" after you throw an exception.

remove( ) method

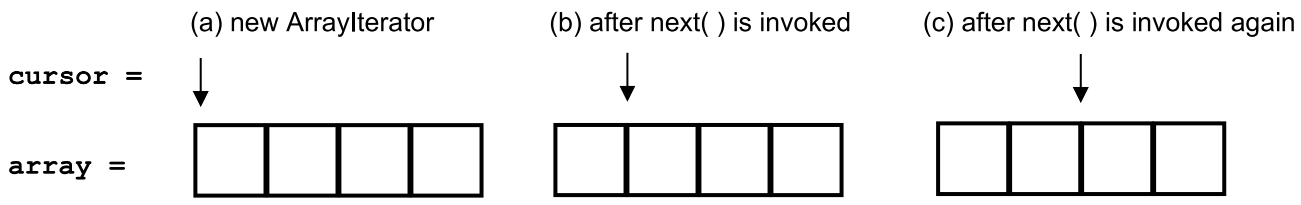
This method is optional. You can leave the remove() method empty or omit it.

Class Diagram for ArrayIterator



Programming Notes

1. An Iterator needs a variable (often called the **cursor**) to remember its position. Initially the cursor points to the first element. hasNext() checks if the cursor points to a valid element. If it is not valid, hasNext should advance the cursor to a valid element. Each time **next** is called, the Iterator returns the current element and increments the cursor by 1.


(a) new ArrayIterator
(b) after next( ) is invoked
(c) after next( ) is invoked again
cursor =
array =

2. The **hasNext** method ***does most of the work!*** It is the job of hasNext to decide if there is another element available and *move the cursor* to the location of the next non-null element.

3. **Don't write duplicate logic**! The next method should ask hasNext if there is another element, and let hasNext do the work of moving the cursor. Don't copy the hasNext logic into the next method.

4. It is legal for the user to call hasNext( ) *many times* consecutively without calling next. The iterator must not skip any elements if the user does this!

```
iterator.hasNext();
iterator.hasNext(); // no change. Duplicate calls to hasNext do not change the iterator.
iterator.hasNext(); // no change, again.
```

5. It is also legal for the user to call next *without* calling hasNext. Therefore, you must not *assume* the user will always call hasNext before calling next.

6. To throw an Exception, simply write: `throw new NoSuchElementException("message")`. Throwing an exception causes an immediate return from the method. Don't write return after throw. For example:

```
if (no more elements) {
    throw new NoSuchElementException("No more elements");
}
```

Example using BlueJ Interactive Mode

```
> String [] array = { "apple", "banana", null, "carrot", null };
> ArrayIterator<String> iter = new ArrayIterator( array );
> iter.next( )     // User not required to call hasNext() before next()
"apple"
> iter.hasNext( )
true
> iter.hasNext( )       // User can call hasNext many times
true
> iter.next( )
"banana"
> iter.next( )
"carrot"                // iterator skips the null element in array
> iter.hasNext()
false                   // iterator skips the null element in array
iter.next( )            // no more elements, so an exception is thrown
java.util.NoSuchElementException at ArrayIterator:xx
```

Example using an empty array:

```
> Object [ ] array = new Object[1];  // array containing null
> ArrayIterator it = new ArrayIterator( array );
> it.hasNext( )
false
> it.next()
java.util.NoSuchElementException at ArrayIterator:xx
```