

COMP 250

Assignment Project Exam Help

INTRODUCER SCIENCE

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Week 5-1: A
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Giulia Alberini, Fall 2020

WHAT ARE WE GOING TO DO IN THIS VIDEO?



- **Arraylist**

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ARRAYS IN JAVA

- Arrays whose elements have a primitive type

```
int[] myInts = new int[15];  
myInts[3] = -732;
```

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- Arrays whose elements have a reference

```
Shape[] myShapes = new Shape[428];  
shapes[293] = new Shape(▲);
```

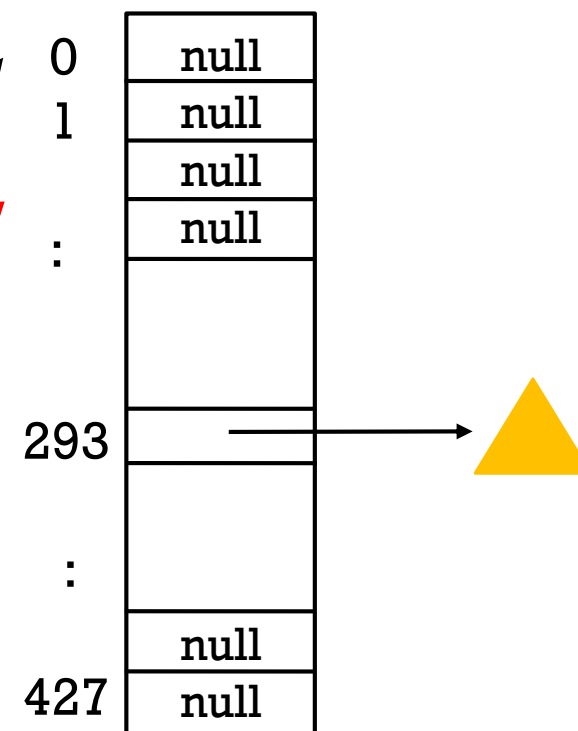
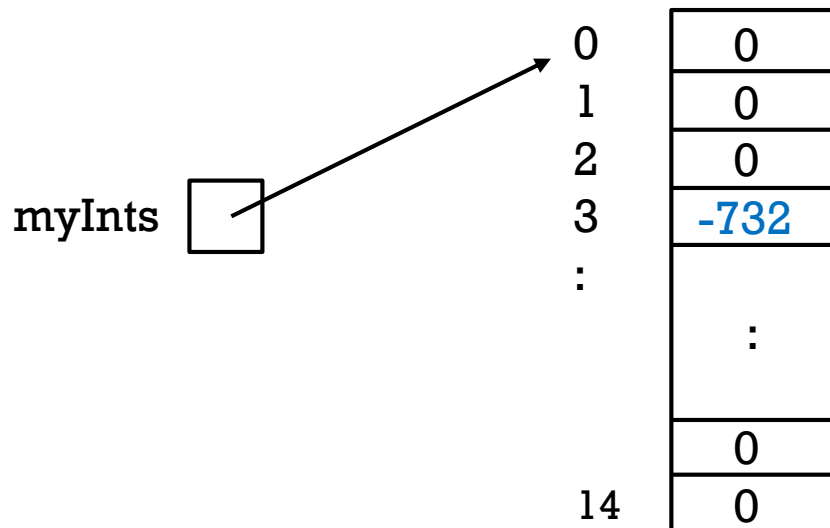
```
int[] myInts = new int[15];  
myInts[3] = -732;
```

```
Shape[] myShapes = new Shape[428];  
shapes[293] = new Shape(▲);
```

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You can think of an array as a block of consecutive slots in memory

ARRAYS HAVE CONSTANT TIME ACCESS

A computer accesses an element in an array in constant time

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i.e. constant, independent of the array.

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```
.... = a[k] ; // read
a[k] = .... ; // write
```

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You will learn more about how this works in COMP 206 and 273.

LIST

An ordered set of elements

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N is the number of elements in the list, often called the “size” of the list.

WHAT WOULD WE LIKE TO DO WITH A LIST?

`get(i)`

// Returns the i-th element (but doesn't remove it)

`set(i,e)`

// Replaces the i-th element with e

`add(e)`

// Adds element e to the end of the list

`add(i,e)`

// Inserts element e at the i-th position

`remove(i)`

// Removes the element at the i-th position

`remove(e)`

// Removes first occurrence of element e from the list (if it is there)

`clear()`

// Empties the list.

`isEmpty()`

// Returns true if empty, false if not empty.

`size()`

// Returns number of elements in the list

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IMPLEMENTATIONS

There are different implementations of a list:

- Array list Assignment Project Exam Help
- Singly linked list <https://eduassistpro.github.io/>
- Doubly linked list Add WeChat edu_assist_pro

IMPLEMENTATIONS

There are different implementations of a list:

- Array list → [Assignment Project Exam Help](#)
- Singly linked list <https://eduassistpro.github.io/>
- Doubly linked list [Add WeChat edu_assist_pro](#)

ARRAYLIST

Idea:

- Use an array to store the elements of the list
- Keep track of how many elements inserted in the list

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To decide:

- How big should the underlying array be when we first create an object of type ArrayList?
(this is referred to as the *initial capacity* of the list)

ArrayList.java

```
public class ArrayList {  
    private Shape[] arr;  
    private int size;  
  
}
```

ARRAYLIST

Idea:

- Use an array to store the elements of the list
- Keep track of how many elements inserted in the list

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To decide:

- How big should the underlying array be when we first create an object of type ArrayList?
→ Java's ArrayList creates an array of length 10.

ArrayList.java

```
public class ArrayList {  
    private Shape[] arr;  
    private int size;  
  
    public ArrayList() {  
        arr = new Shape[10];  
        size = 0;  
    }  
}
```

EXAMPLE

ArrayList.java

```
public class ArrayList {  
    private Shape[] arr;  
    private int size;  
  
    public ArrayList() {  
        arr = new Shape[10];  
        size = 0;  
    }  
}
```

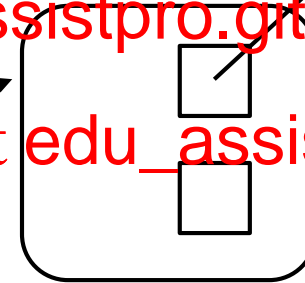
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```
ArrayList list = new ArrayList();
```

list



0

null

1

null

2

null

3

null

4

null

5

null

6

null

7

null

8

null

9

null

EXAMPLE – WHAT WE WANT WHEN ADDING ELEMENTS

ArrayList.java

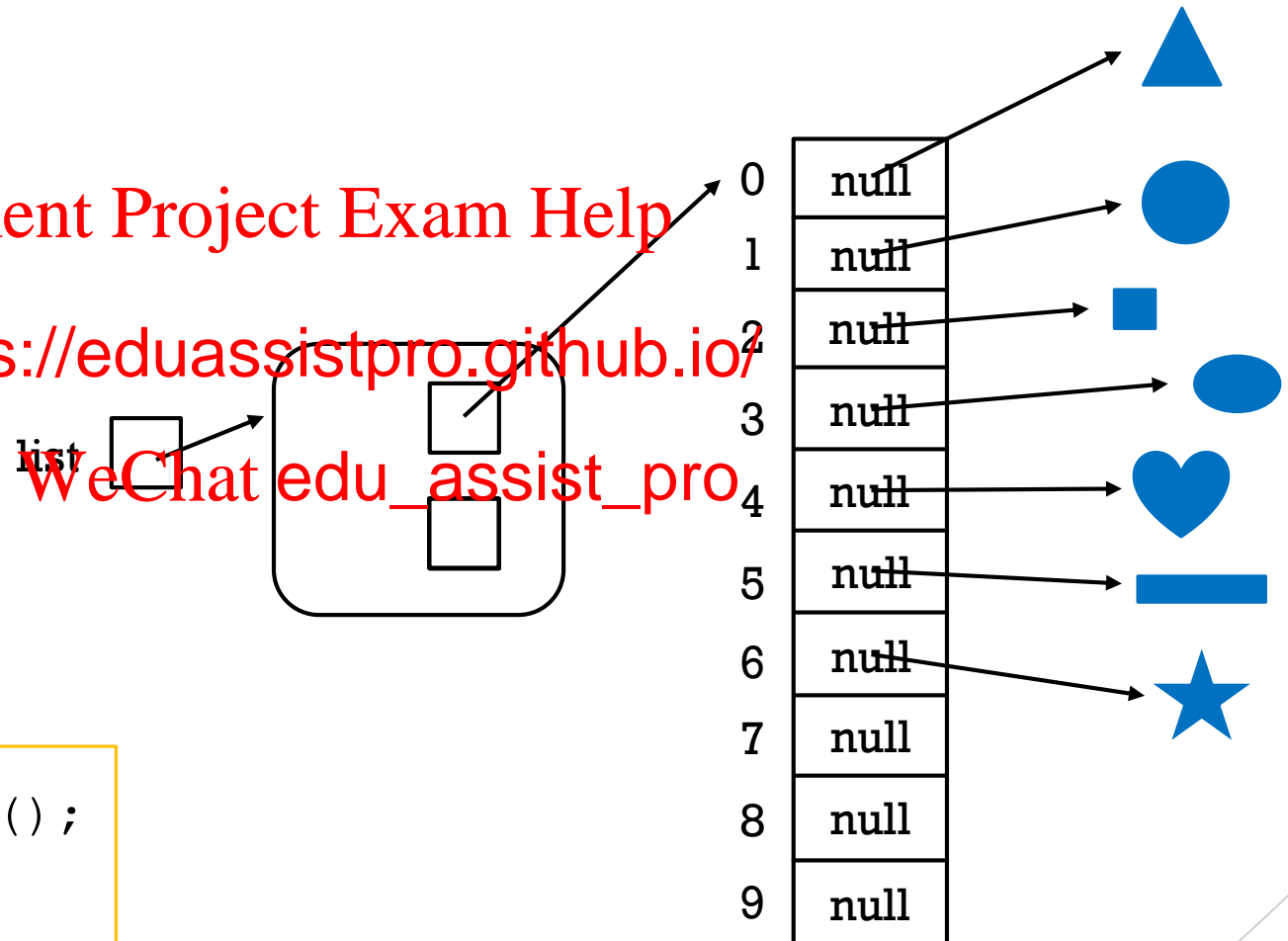
```
public class ArrayList {  
    private Shape[] arr;  
    private int size;  
  
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        arr = new Shape[10];  
        size = 0;  
    }  
}
```

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```
ArrayList list = new ArrayList();  
// add 7 elements...
```



HOW TO IMPLEMENT VARIOUS OPERATIONS? – get ()

Returns the element at the specified position in this list.

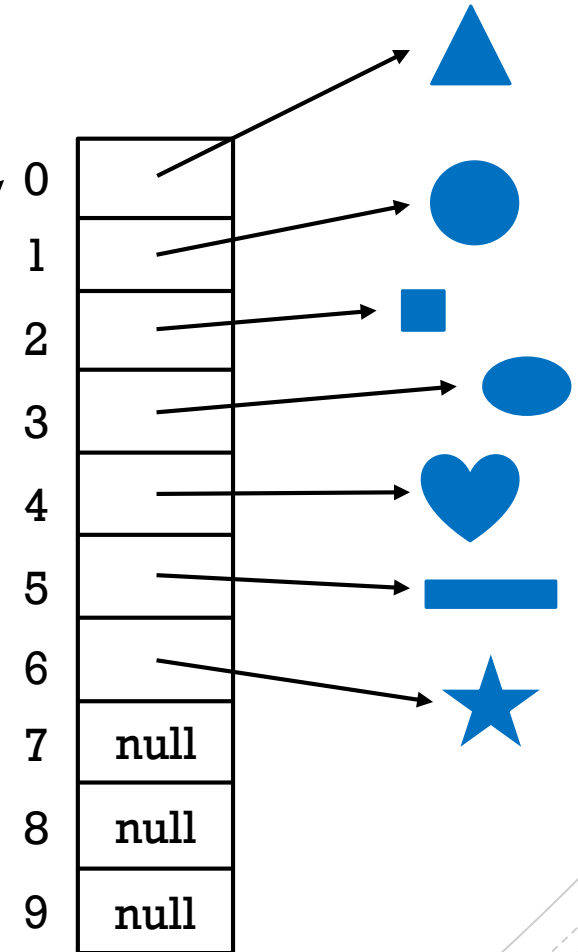
```
public class ArrayList {  
    private Shape[] arr;  
    private int size;  
  
    :  
  
    public Shape get(int i) {  
        if(  
            )  
            return arr[i];  
        // otherwise?  
    }  
}
```

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list



HOW TO IMPLEMENT VARIOUS OPERATIONS? – get ()

Returns the element at the specified position in this list.

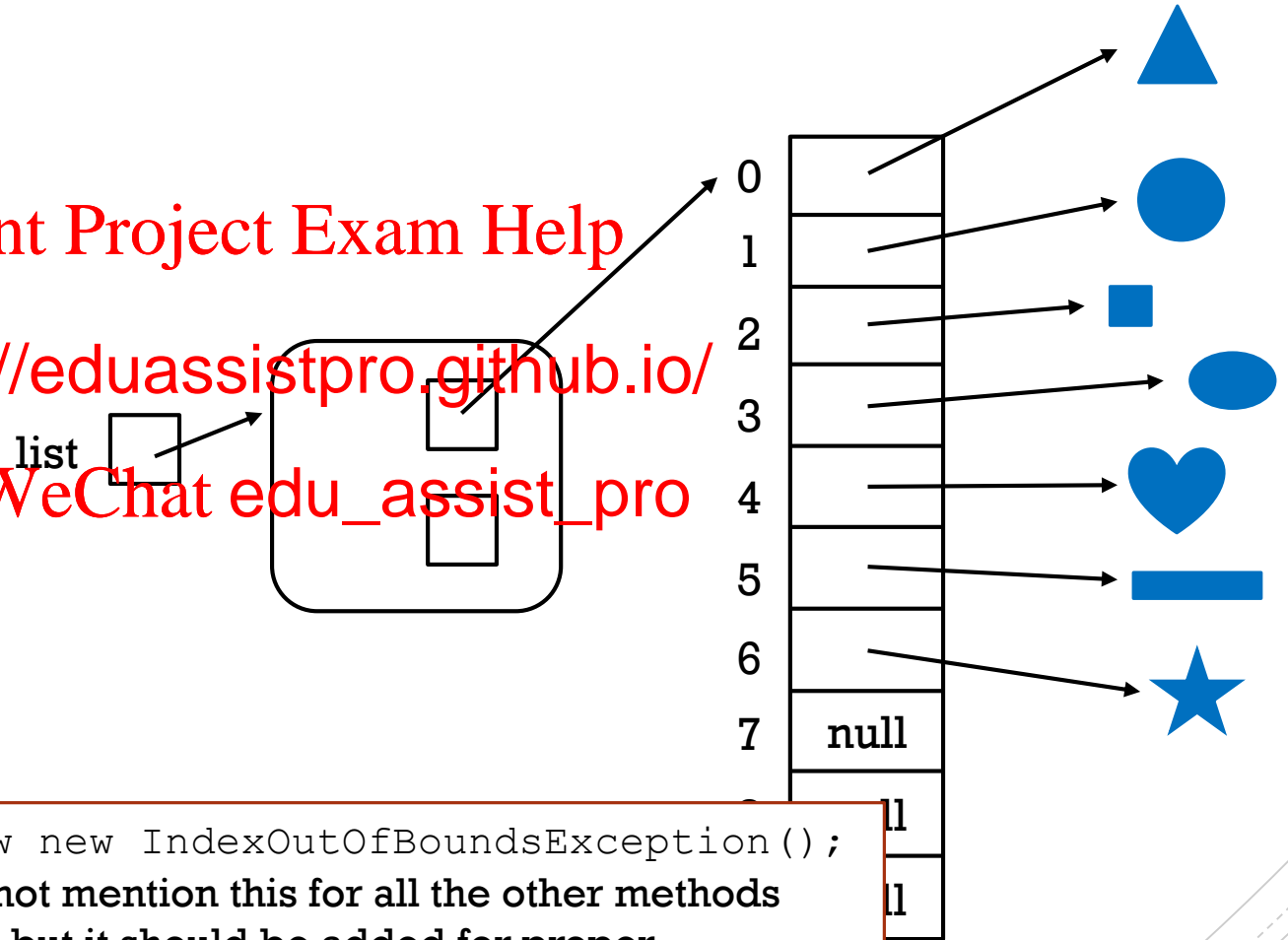
```
public class ArrayList {  
    private Shape[] arr;  
    private int size;  
  
    :  
  
    public Shape get(int i) {  
        if( i >= 0 && i < size )  
            return arr[i];  
        // otherwise?  
    }  
}
```

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throw new IndexOutOfBoundsException();
I will not mention this for all the other methods today, but it should be added for proper implementations.



HOW TO IMPLEMENT VARIOUS OPERATIONS? – set ()

Replaces the element at the specified position in this list with the specified element.

```
public class ArrayList {  
    private Shape[] arr;  
    private int size;  
  
    :  
  
    public Shape set(int i, Shape e)  
    {  
        if(i >= 0 && i < size) {  
            Shape tmp = arr[i];  
            arr[i] = e;  
            return tmp;  
        }  
    }  
}
```

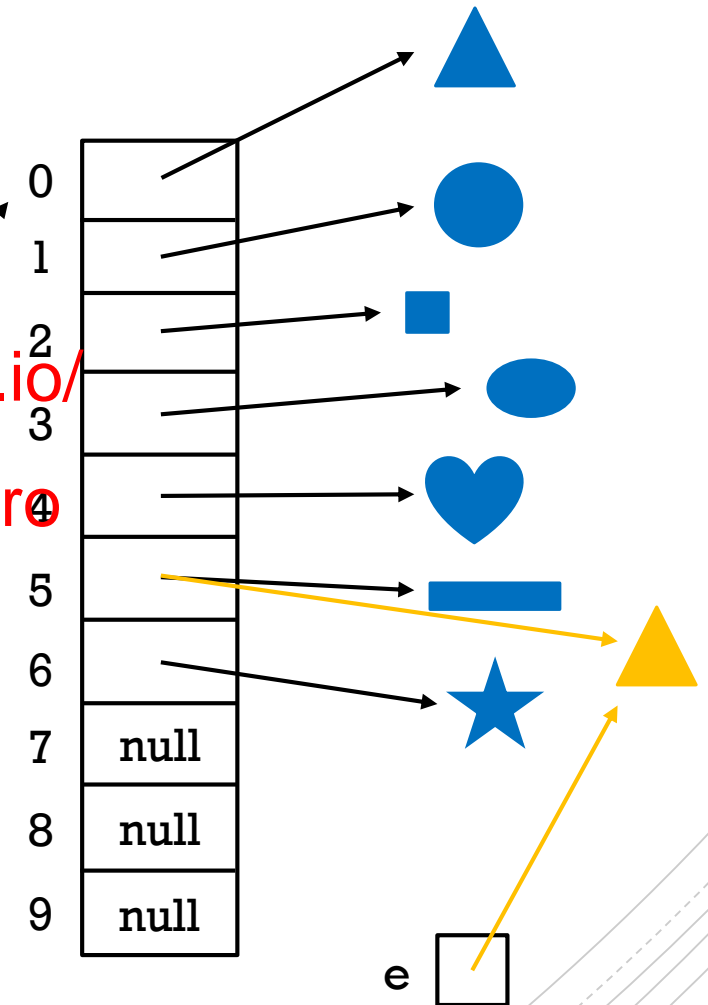
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For example:

`list.set(5, e);`



HOW TO IMPLEMENT VARIOUS OPERATIONS? – add ()

Appends the specified element to the end of this list.

```
public class ArrayList {  
    private Shape[] arr;  
    private int size;  
  
    :  
  
    public void add(Shape e)  
    {  
        arr[    ] = e;  
        size = size + 1;  
    }  
}
```

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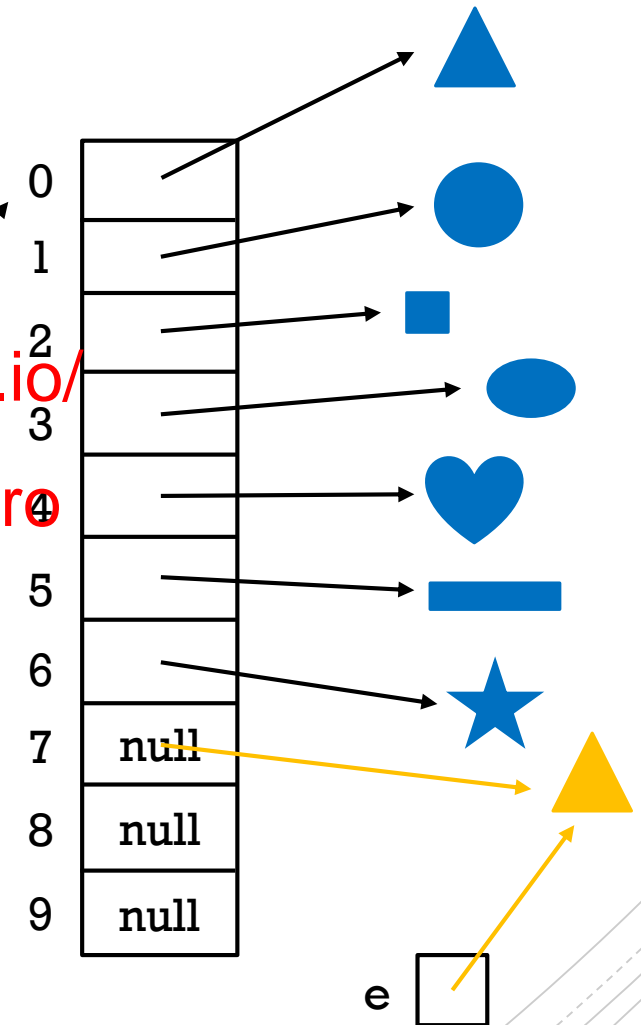
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list

For example:
`list.add(e);`

What if the array `arr` is full?



HOW TO IMPLEMENT VARIOUS OPERATIONS? – add ()

Appends the specified element to the end of this list.

```
public class ArrayList {  
    private Shape[] arr;  
    private int size;  
  
    :  
  
    public void add(Shape e)  
    {  
        arr[size] = e;  
        size = size + 1;  
    }  
}
```

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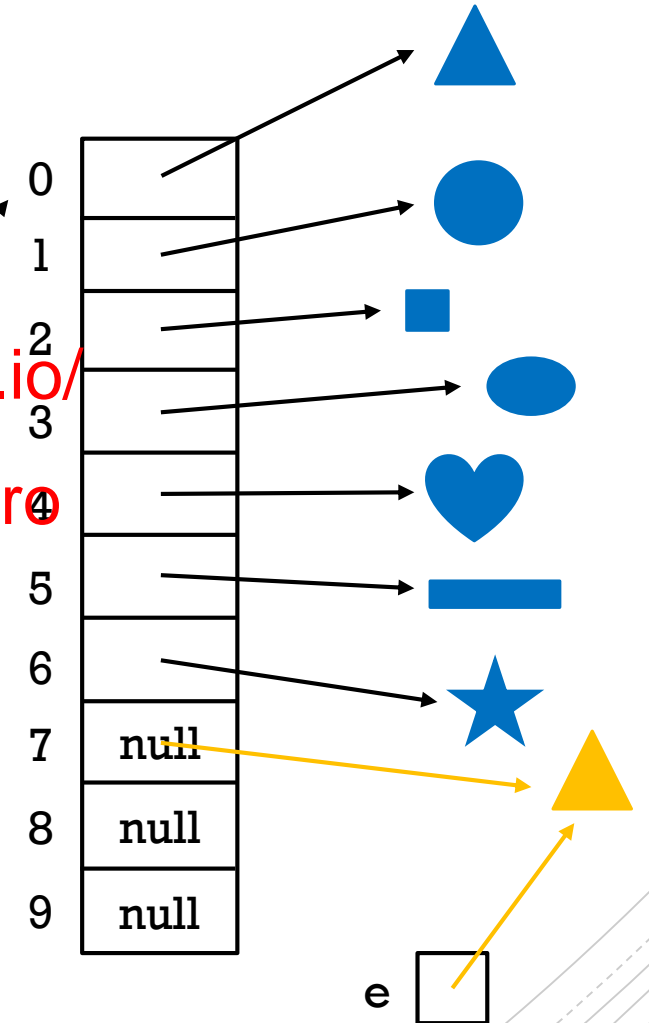
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list

For example:
`list.add(e);`

What if the array `arr` is full?



HOW TO IMPLEMENT VARIOUS OPERATIONS? – add ()

Appends the specified element to the end of this list.

What if the array arr is already full?

```
public void add(Shape e) {  
    if ( Assignment Project Exam Help  
        resize();  
    arr[size] = https://eduassistpro.github.io/  
    size = size  
}  
  
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private void resize() {  
    Shape[] bigger = new Shape[arr.length*2]; // example  
    for(int i=0; i < size; i++) {  
        bigger[i] = arr[i];  
    }  
    arr = bigger;  
}
```

HOW TO IMPLEMENT VARIOUS OPERATIONS? – add ()

Appends the specified element to the end of this list.

What if the array arr is already full?

```
public void add(Shape e) {  
    if (arr.length == size)  
        resize();  
    arr[size] = e;  
    size = size + 1;  
}  
  
private void resize() {  
    Shape[] bigger = new Shape[arr.length*2]; // example  
    for(int i=0; i < size; i++) {  
        bigger[i] = arr[i];  
    }  
    arr = bigger;  
}
```

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OVERLOADING

`add(e)` `// inserts element e at end of list`

`add(i ,e)` `// Inserts element e into the i-th position`

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`remove(i)` `// Removes the i-th element from list`

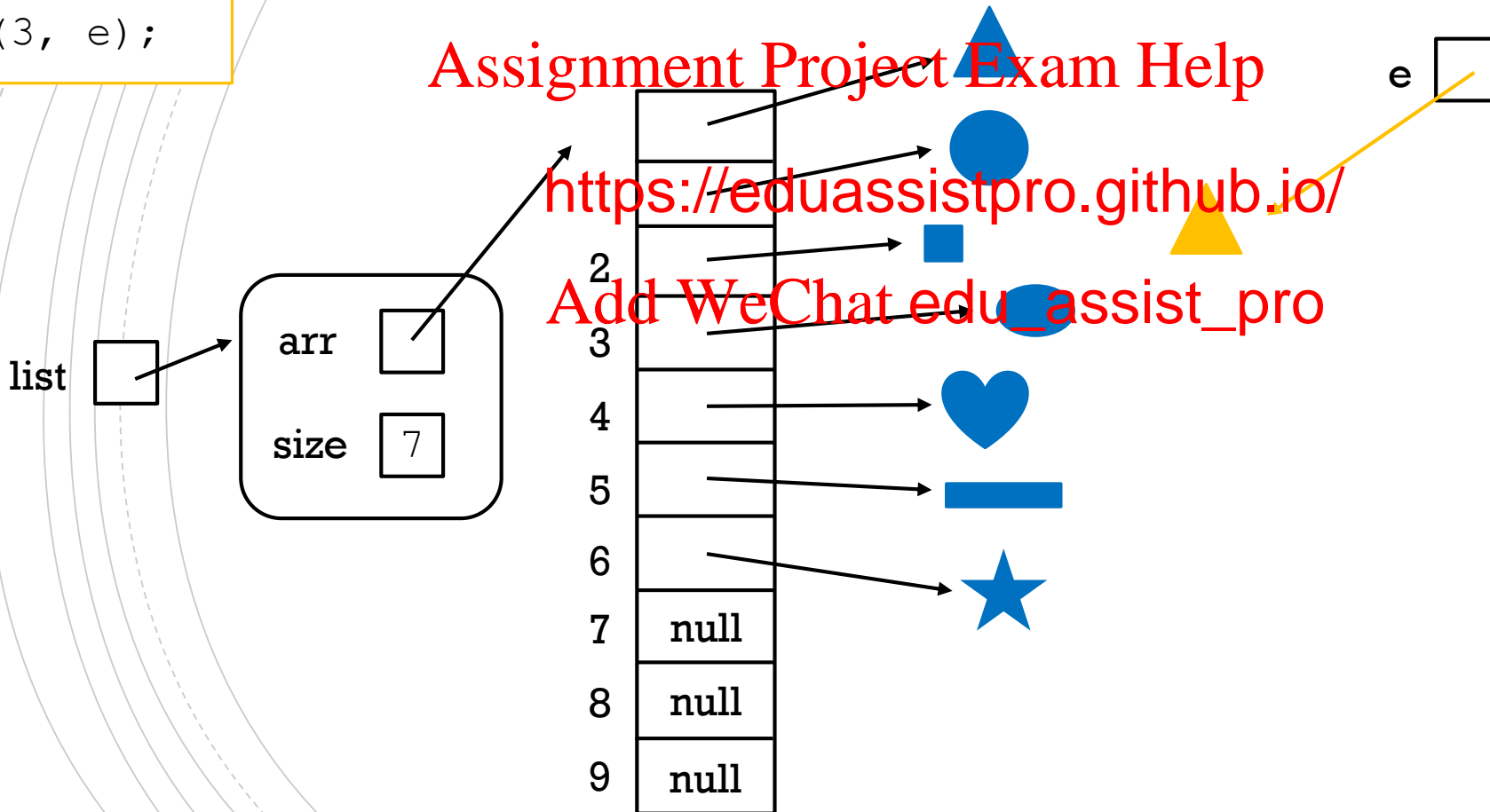
`remove(e)` `// Removes first occurrence of element e`
`// from the list (if it is there)`

HOW TO IMPLEMENT `add(i, e)`

Inserts the specified element at the specified position in the list.

For example:

```
list.add(3, e);
```



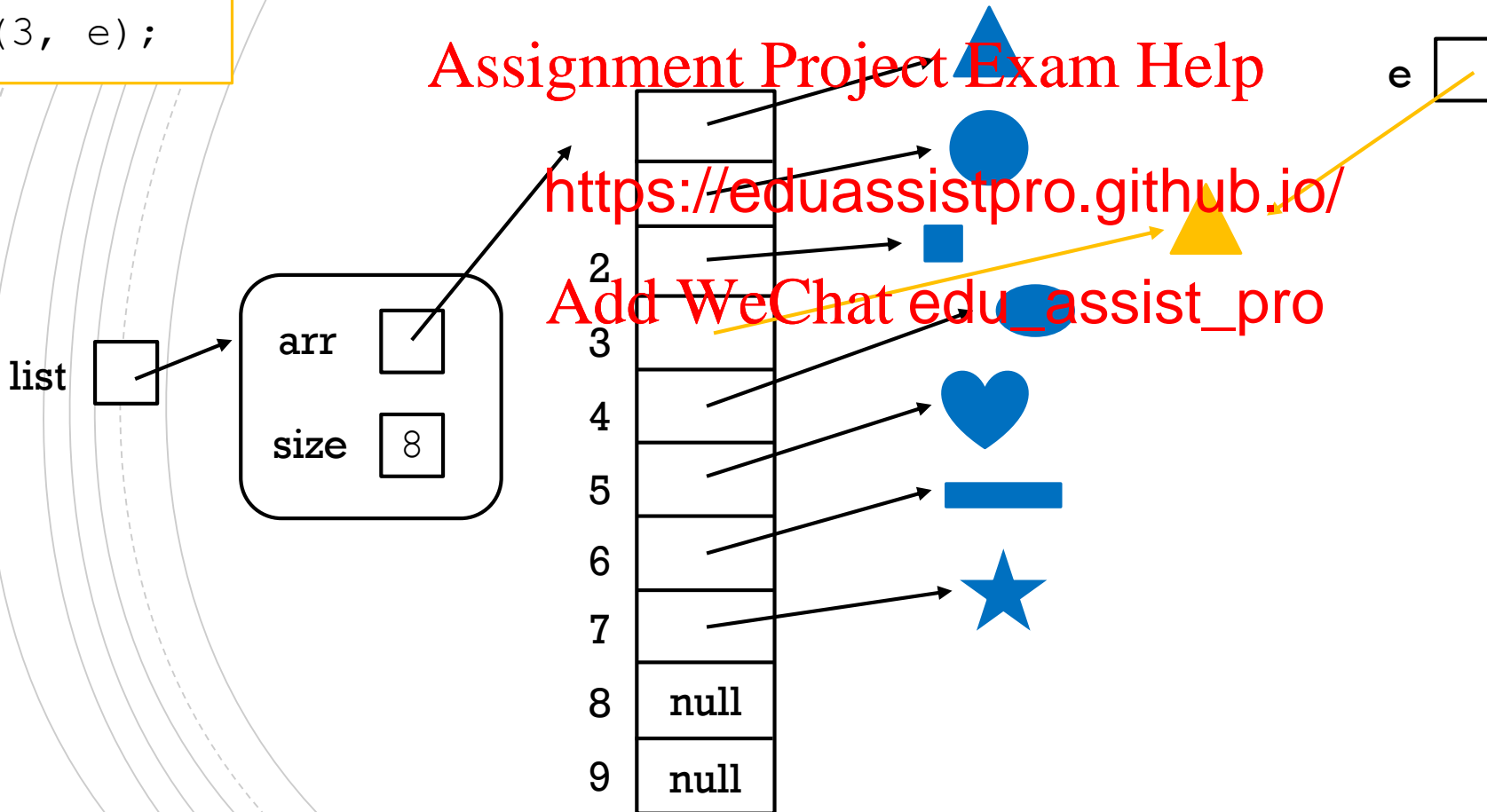
HOW TO IMPLEMENT `add(i, e)`

Inserts the specified element at the specified position in the list.

IDEA: make room by shifting the elements, then add `e`

For example:

```
list.add(3, e);
```



HOW TO IMPLEMENT `add(i,e)`

Inserts the specified element at the specified position in the list.

```
public void add(int i, Shape e) {  
    // Throw of bounds  
    // Resize if not enough  
    // Shift elements down  
    // Add the new element  
}
```

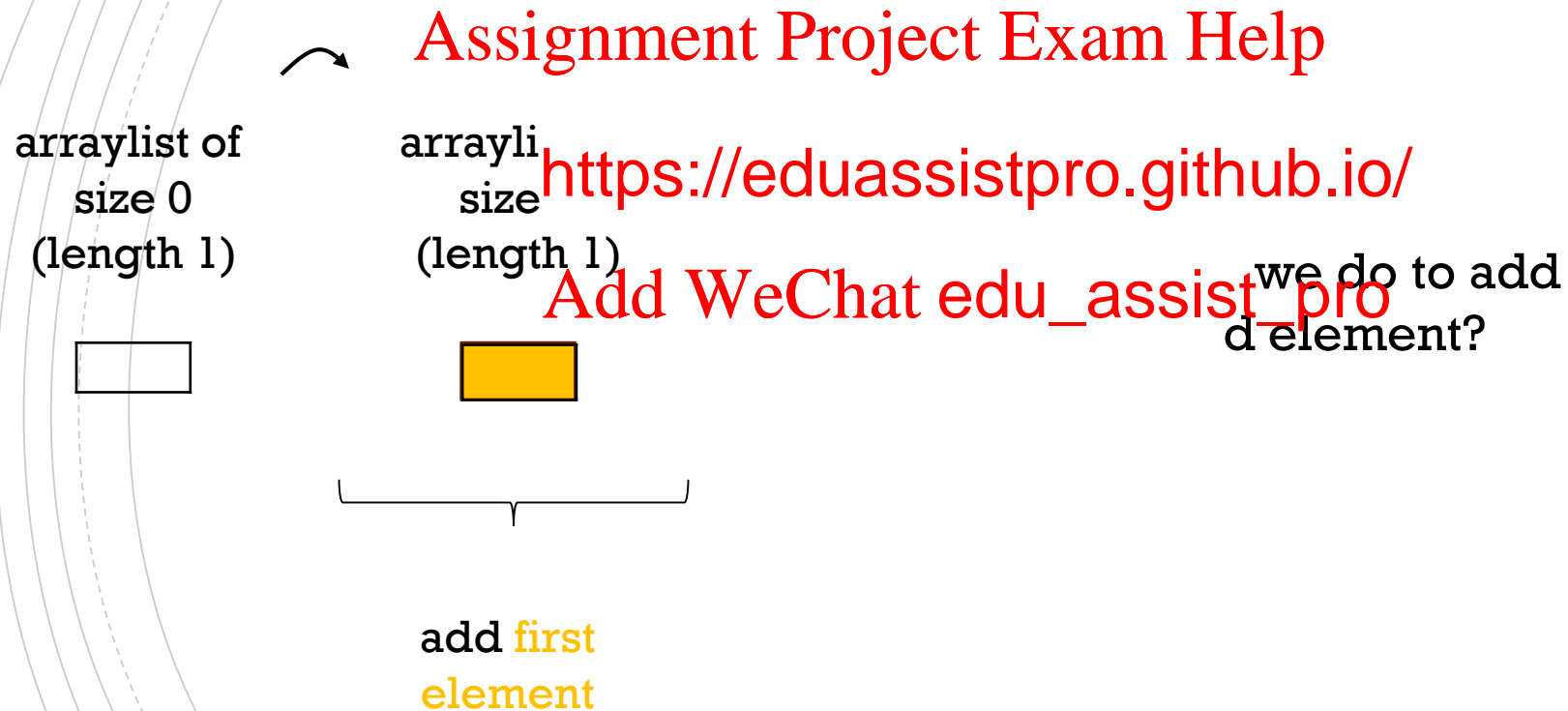
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ADDING N ELEMENTS TO AN ARRAY LIST

Suppose we initialize an array list with an empty array of length 1.
We then add an element.



ADDING N ELEMENTS TO AN ARRAY LIST

Suppose each time we add to a full array list, we double the length of the array.

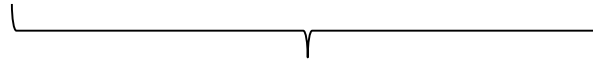
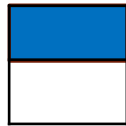
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arraylist of
size 1
(length 1)



of
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(length 2)

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add **second**
element

ADDING N ELEMENTS TO AN ARRAY LIST

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arraylist of
size 2
(length 2)



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(length



aylist of
size 4
th 4)



add third element

ADDING N ELEMENTS TO AN ARRAY LIST

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add fourth
element

ADDING N ELEMENTS TO AN ARRAY LIST

arraylist of
size 4
(length 4)



arraylist of
size 4
(length 8)



arraylist of
size 5
(length 8)



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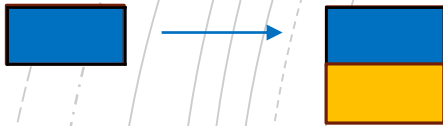
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add fifth element

ADDING N ELEMENTS TO AN ARRAY LIST

Double length and
copy one element

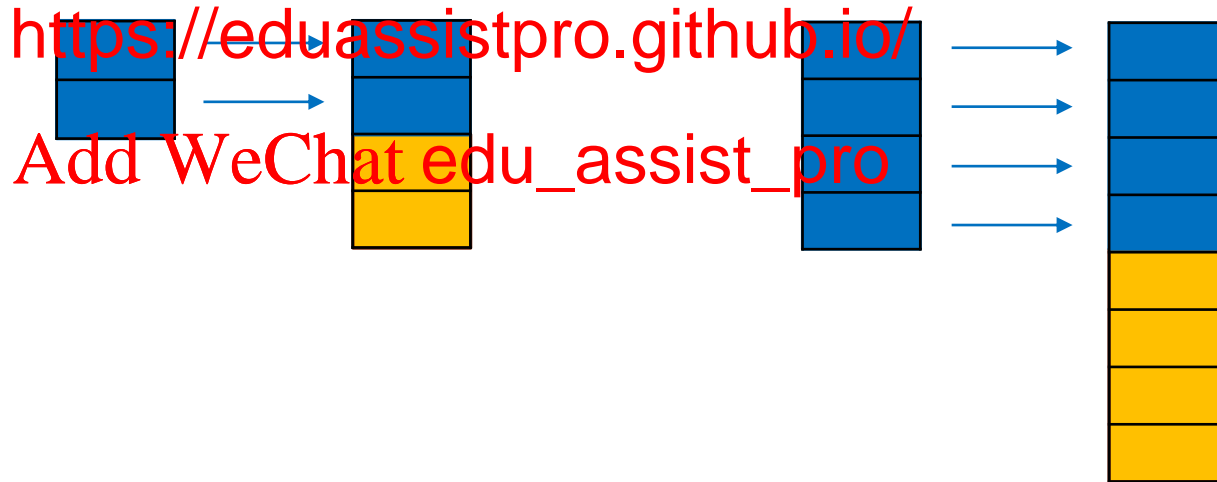


add two elements

Double length and
copy two elements

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Double length and
copy four elements



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add 3-4 elements

add 5-8 elements

Q: How many times k do we need to double the length of the array so that it is of length N ?

A:

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Q: How many **cop** <https://eduassistpro.github.io/> uired to add N elements to an empty array
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A:

Q: How many times k do we need to double the length of the array so that it is of length N ?

A: $2 \cdot 2 \cdots 2 = 2^k = N \rightarrow k = \log_2 N$
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Q: How many **cop** <https://eduassistpro.github.io/> uired to add N elements to an empty array
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A:

Q: How many times k do we need to double the length of the array so that it is of length N ?

A: $2 \cdot 2 \cdots 2 = 2^k = N \rightarrow k = \log_2 N$
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Q: How many **cop** <https://eduassistpro.github.io/> uired to add N elements to an empty array
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A: $1 + 2 + 4 + \dots + 2^{k-1}$

SERIES

- *Geometric series*

$$\sum_{i=0}^n x^i = 1 + x + x^2 + \cdots + x^n = \frac{1 - x^{n+1}}{1 - x}$$

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- *Arithmetic series*

$$\sum_{i=1}^n i = 1 + 2 + \cdots + n = \frac{1}{2}n(n + 1)$$

Q: How many times k do we need to double the length of the array so that it is of length N ?

A: $2 \cdot 2 \cdots 2 = 2^k = N \rightarrow k = \log_2 N$
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Q: How many **copies** required to add N elements to an empty array
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A: $1 + 2 + 4 + \dots + 2^{k-1} = \sum_{i=0}^{k-1} 2^i = \frac{1-2^k}{1-2} = 2^k - 1 = N - 1$

JAVA ARRAYLIST CLASS

<https://docs.oracle.com/javase/8/docs/api/java/util/ArrayList.html>

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- It uses an array as the underlying data structure.

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- It grows the array (by 50%, ~~not 100%~~) when it is full and a new element is added.
- As a client, we don't have access to the fields directly. We need to use the methods provided (get(), set(), ...) to manipulate the list.

JAVA ARRAYLIST – GENERIC CLASS

- ArrayList is a generic class with a type parameter.
- When you create an object of type ArrayList you specify the type of the element ArrayList a class name enclosed

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- Example:

```
// creates an arraylist of integers with initial capacity 10
ArrayList<Integer> words = new ArrayList<Integer>();

// creates an arraylist of shapes with initial capacity 23
ArrayList<Shape> myShapes = new ArrayList<Shape>(23);
```

If we write `int` instead we get a compile-time error!

WRAPPER CLASSES

- Integer, Double, and Character wrap a value of the primitive type `int`, `double`, and `char` (respectively) in an object. Thus, they turn primitive types into reference types.

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- The conversion between their wrappers is done automatically. For example, the following code will cause a compile-time error:

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```
Integer x = 5;
```

- Note that these classes have static methods/attributes that you might have already used. For example: `Integer.MAX_VALUE`, `Double.parseDouble()`

AUTOBOXING AND UNBOXING

- *Autoboxing* is the automatic conversion that the Java compiler makes between the primitive types and their corresponding object wrapper classes. For example converting an `int` to an `Integer`.

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- If the conversion goes the other way, this is called *unboxing*.

```
Integer x = new Integer(5);  
int y = x;
```

- <https://docs.oracle.com/javase/tutorial/java/data/autoboxing.html>

IMMUTABLE TYPES

- Note that `Integer`, `Double`, and `Character` are **immutable** (`String`).
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- As with `String`, you can append values, but you are never changing the actual Object. A new Object gets created each time we “change” a value.

WHY WRAPPER CLASSES?

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It is much simpler (in terms of code re-use) to have
ArrayList req <https://eduassistpro.github.io/> hject (a reference
type), instead of using primitiv

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For example, all reference types can be compared using
.equals(), while we have to use == for primitive types.

THE FOREACH LOOP

```
int[] numbers = {1, 2, 3, 4, 5};  
for (i  
    System.out.print  
}
```

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The foreach loop (also called enhanced for loop) can make your code more readable and can be convenient to use. It is not helpful when you need to refer to the index of an element.

An orange paint roller with a red handle, positioned horizontally. The roller is partially filled with orange paint, and there are orange paint splatters and drips around it. The text "Coming Soon" is written in white on the orange background of the roller.

Coming Soon

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In the next

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