More on Strings

String methods and equality

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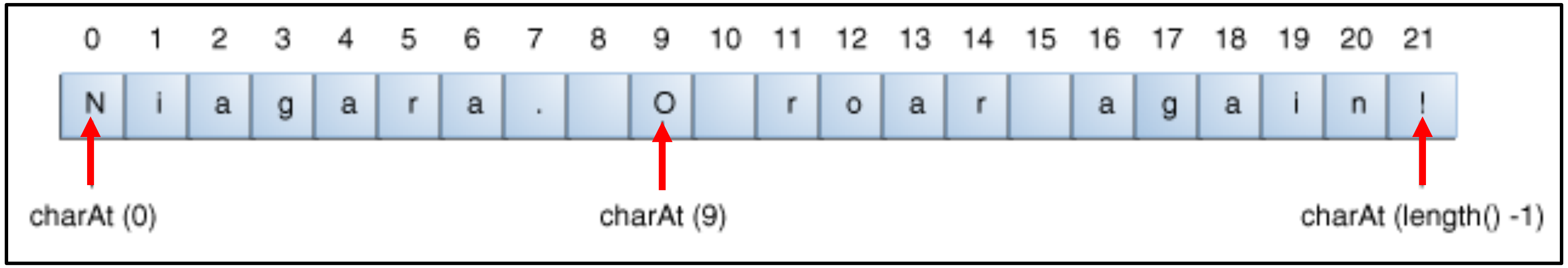
Topics list

1. Strings: index of characters
2. **String methods**:
   - **charAt**(int index)
   - **substring** (int beginIndex, int endIndex)
   - **compareTo** (String anotherString)
3. Recap: Primitive vs Object
4. **String identity** vs **equality**
5. Common **Errors** with Strings
6. **null**
7. **Escape Sequences**

Strings: index of characters

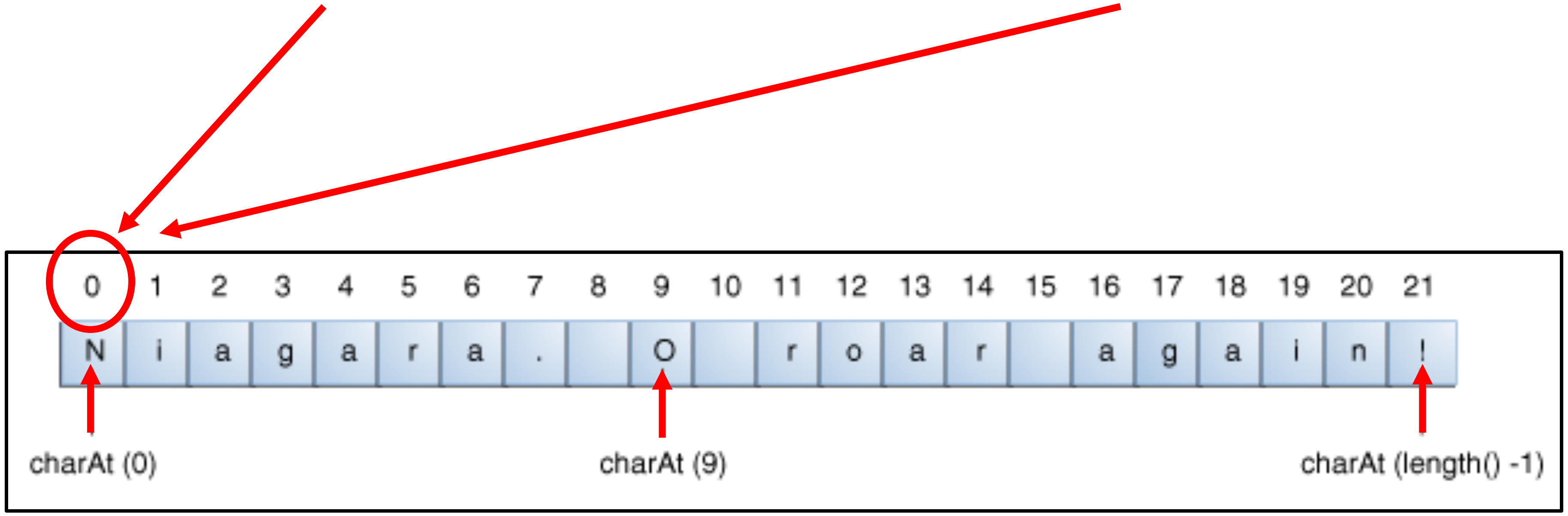
- A String holds a sequence of characters



https://docs.oracle.com/javase/tutorial/java/data/manipstrings.html

Strings: index of characters

- A String holds a sequence of characters.
- **first character** in a String has an **index 0**



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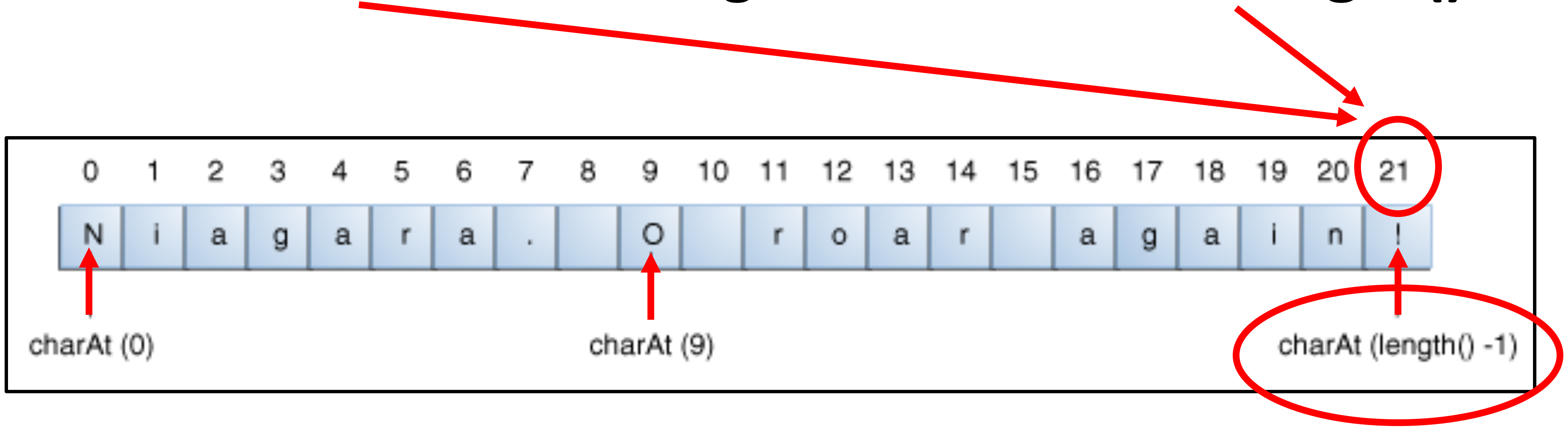
Strings: index of characters

- A String holds a sequence of characters
- **first character** in a String has an **index** of **0**
- **last character** in a String has an **index** of **length()-1**



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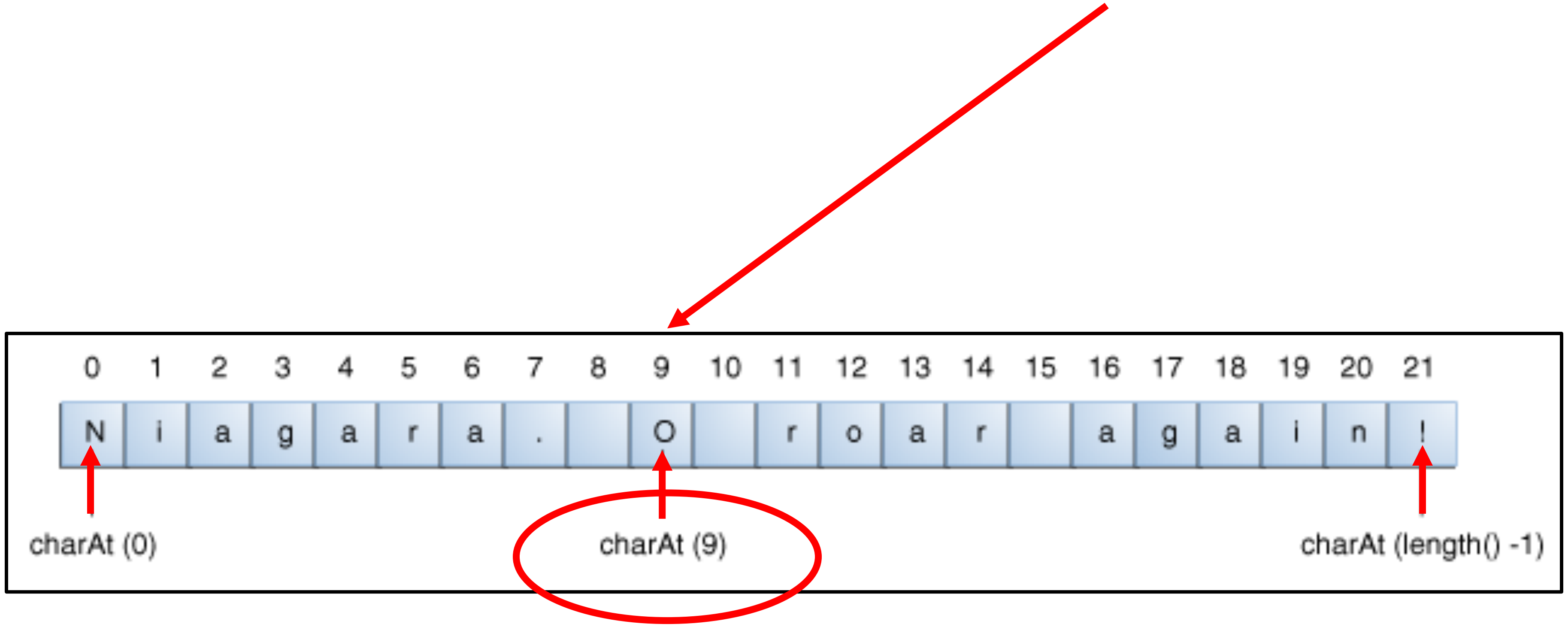
String methods: **charAt** (int index)

- Say we want the character at **index 9** in a String:



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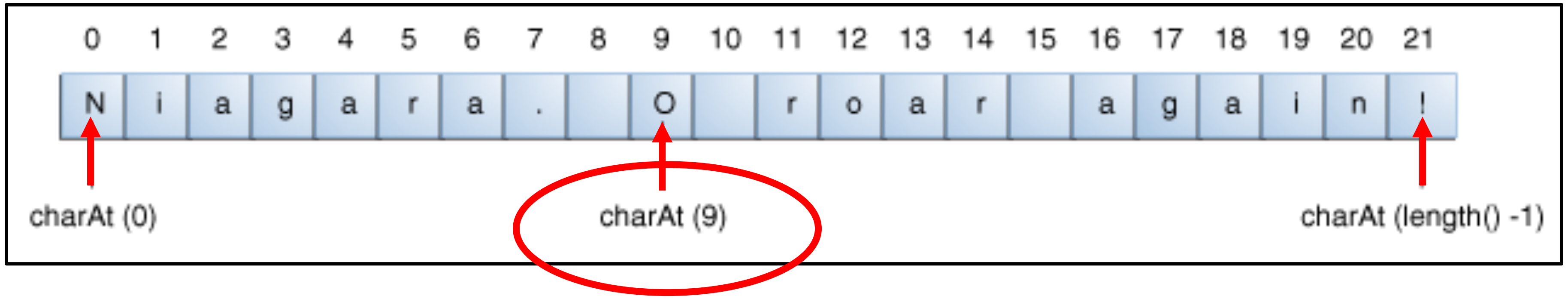
String methods: charAt(int index)

- Say we want the character at index 9 in a String:

```
String anotherPalindrome = "Niagara. O roar again!";
char aChar = anotherPalindrome.charAt(9);
```



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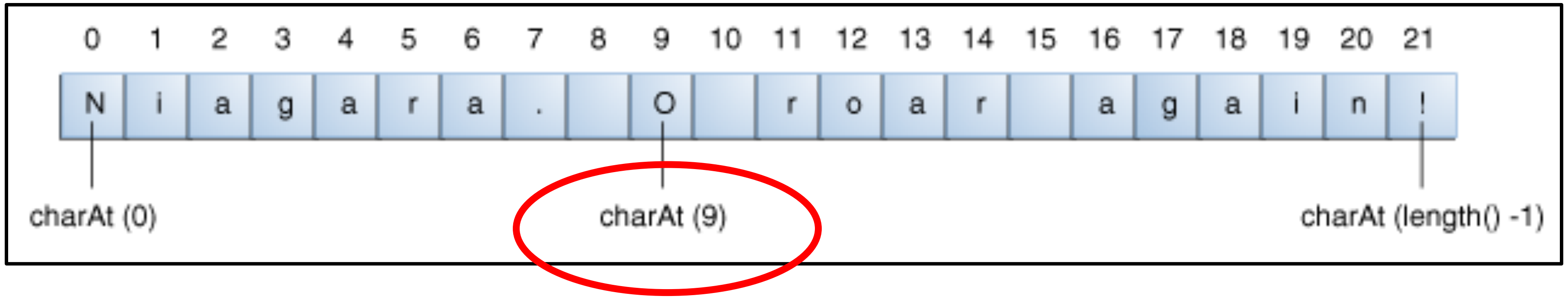
String methods: charAt(int index)

- Say we want the character at index 9 in a String:

```
String anotherPalindrome = "Niagara. O roar again!";
char aChar = anotherPalindrome.charAt(9);
```

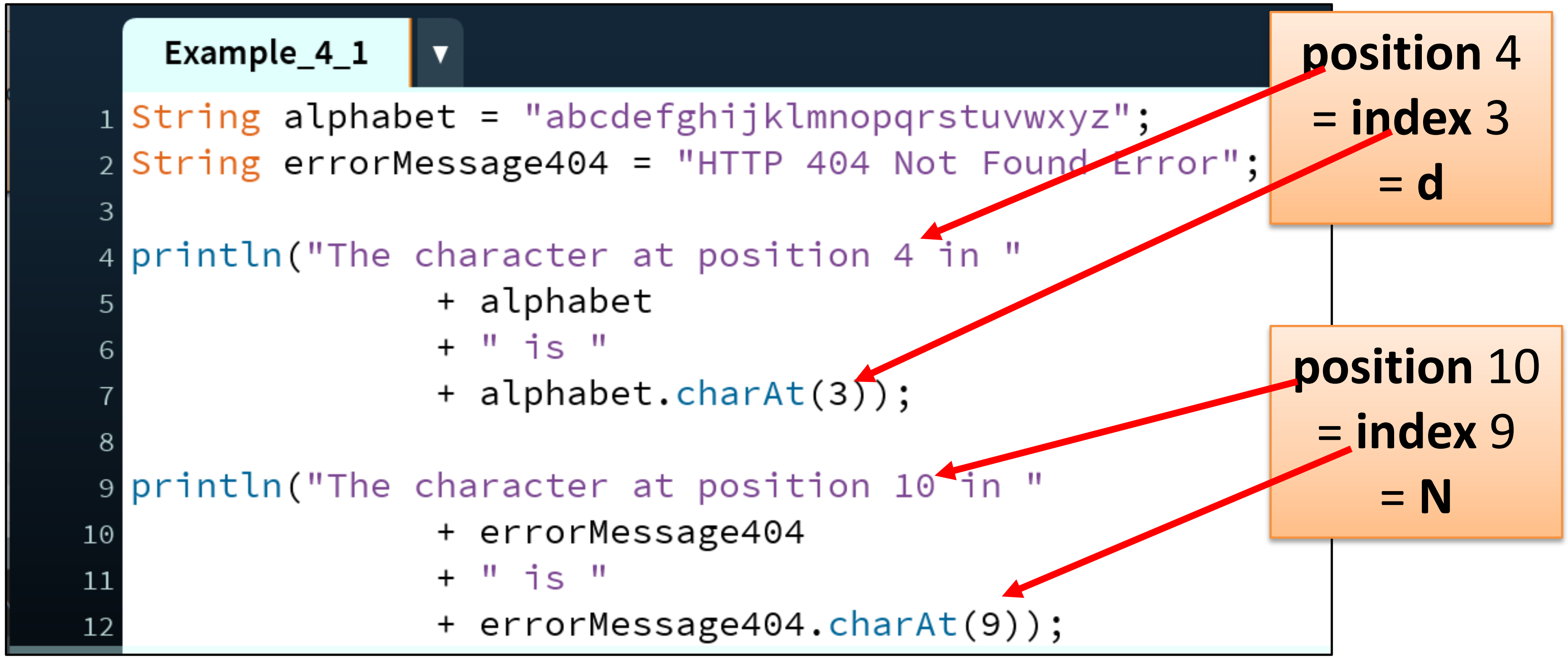


Indices begin at 0, so the character at **index 9** is 'O' i.e. **the 10th character**

https://docs.oracle.com/javase/tutorial/java/data/manipstrings.html

Example 4.1

Finding the character located at specific **position** in a String.



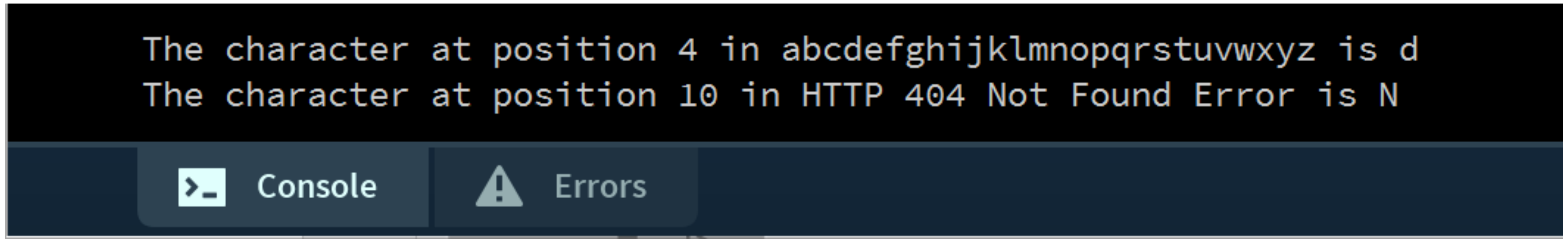
```
String alphabet = "abcdefghijklmnopqrstuvwxyz";
String errorMessage404 = "HTTP 404 Not Found Error";

println("The character at position 4 in "
              + alphabet
              + " is "
              + alphabet.charAt(3));

println("The character at position 10 in "
              + errorMessage404
              + " is "
              + errorMessage404.charAt(9));
```

position 4
= **index** 3
= **d**

position 10
= **index** 9
= **N**



```
The character at position 4 in abcdefghijklmnopqrstuvwxyz is d
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```
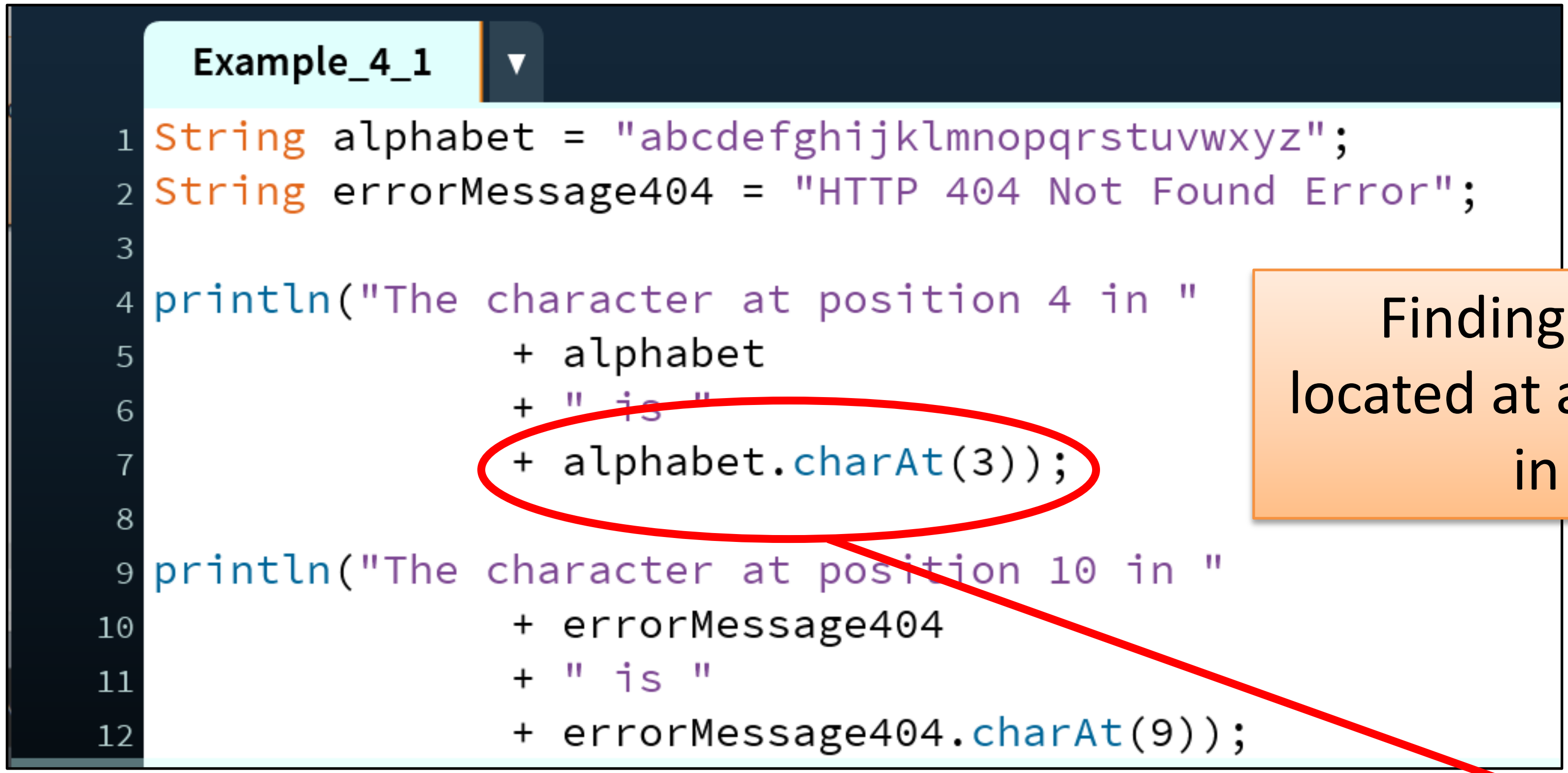

Example 4.1



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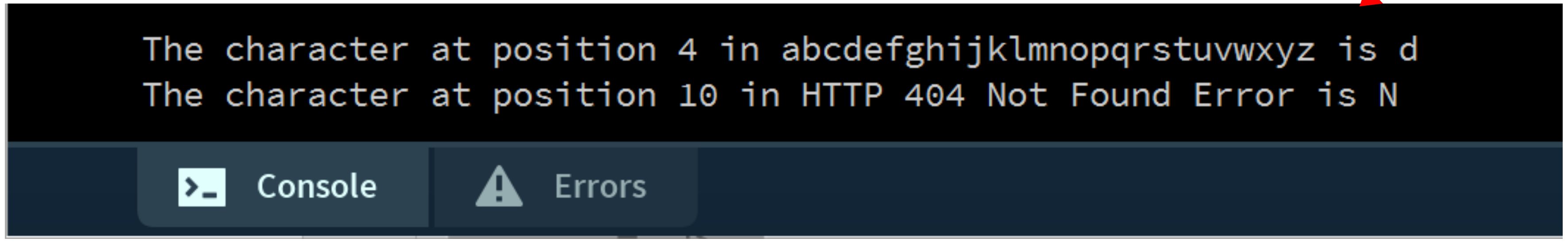
Finding the character located at a specific position in a **String**.



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The character at position 4 in abcdefghijklmnopqrstuvwxyz is d
The character at position 10 in HTTP 404 Not Found Error is N
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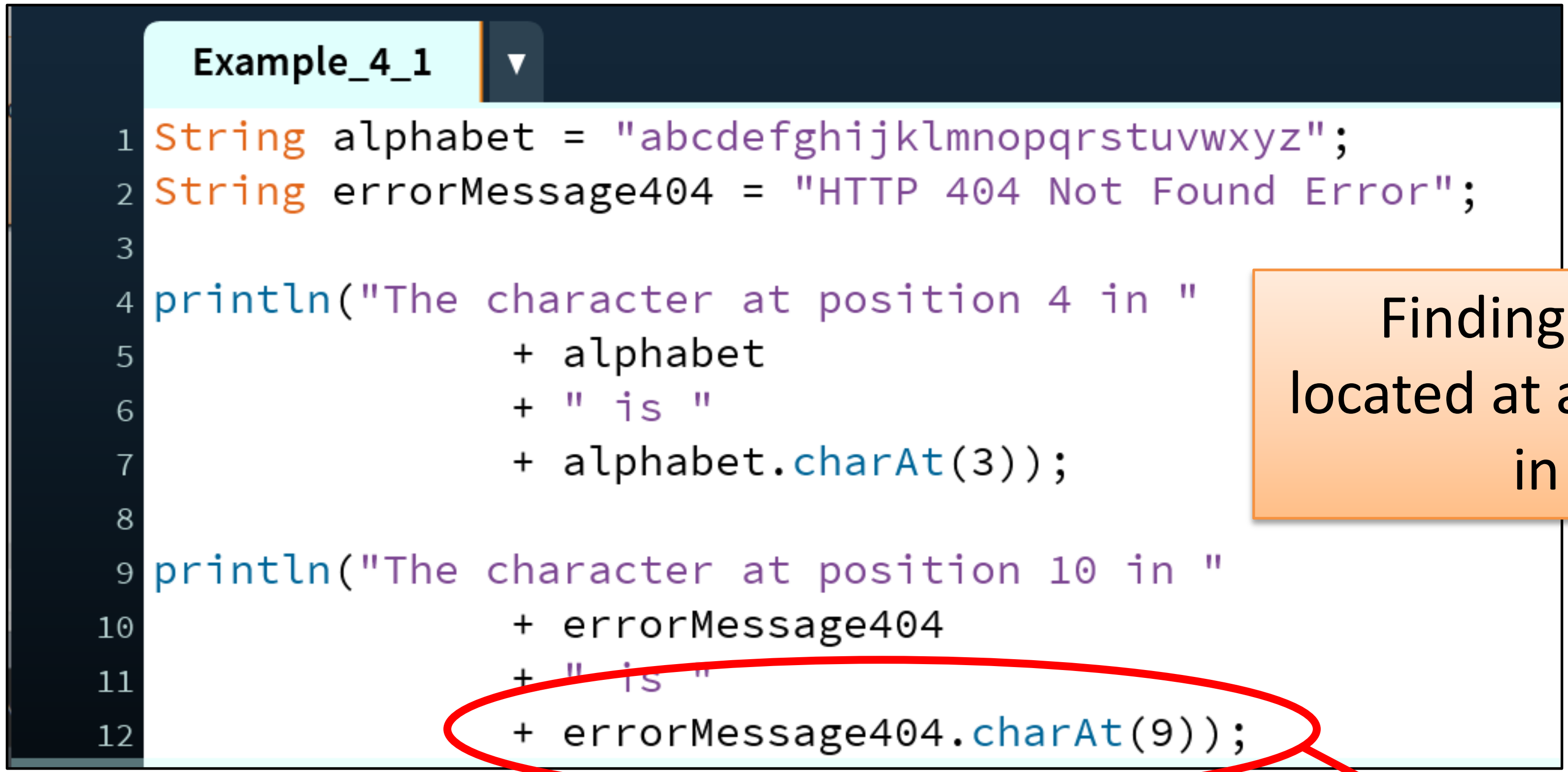
Example 4.1



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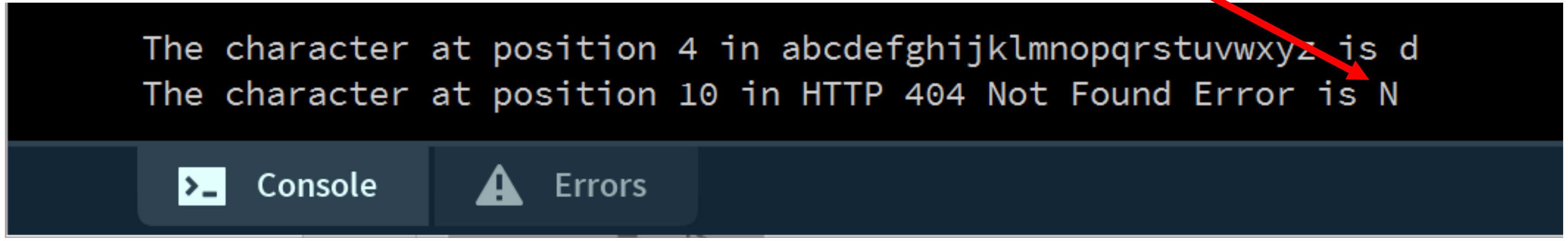
Finding the character located at a specific position in a **String**.



```
The character at position 4 in abcdefghijklmnopqrstuvwxyz is d
The character at position 10 in HTTP 404 Not Found Error is N
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String methods:
substring (int beginIndex, int endIndex)

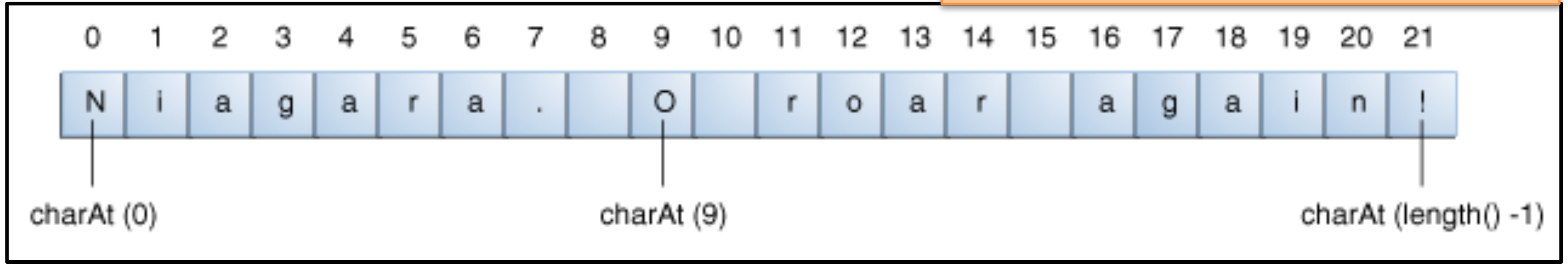
- This method returns a new String that is a **substring** of this String.

https://docs.oracle.com/javase/tutorial/java/data/manipstrings.html

String methods:
substring (int beginIndex, int endIndex)

- This method returns a new String that is a substring of this String.

Given this String…



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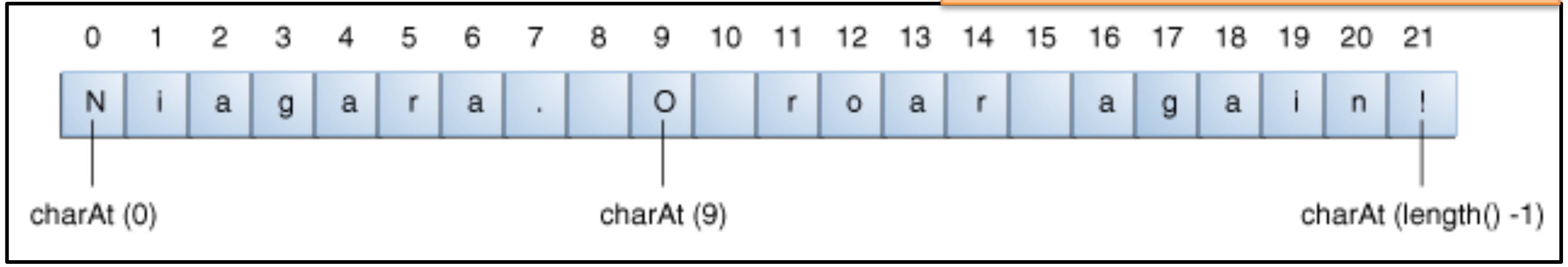
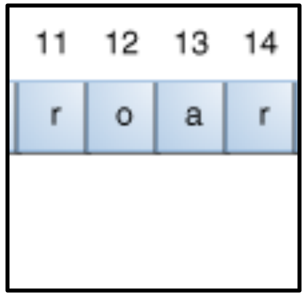


…this is a substring →



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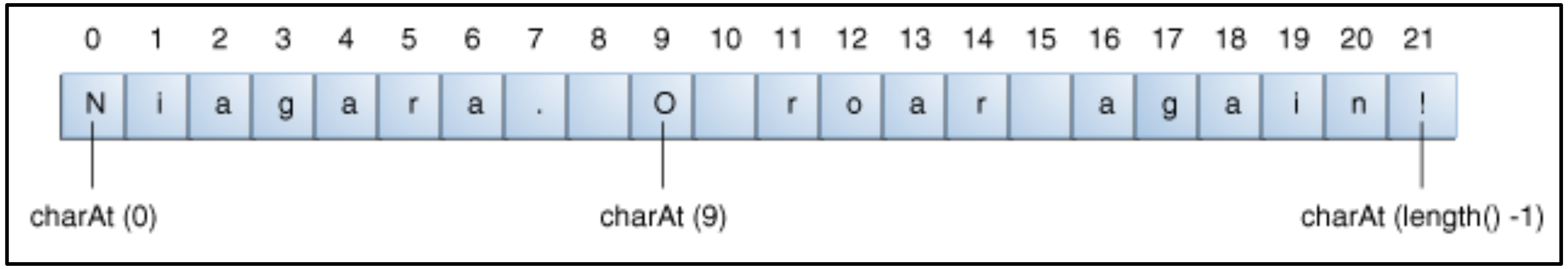
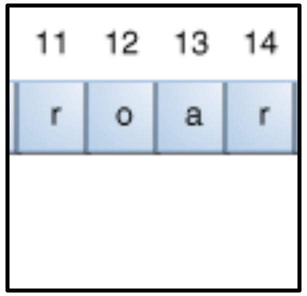
String methods:
substring (int beginIndex, int endIndex)

The substring begins at the specified **beginIndex…**

…and extends to the character at index **endIndex-1**



…this is a substring →



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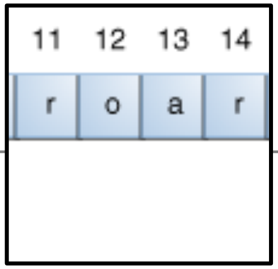
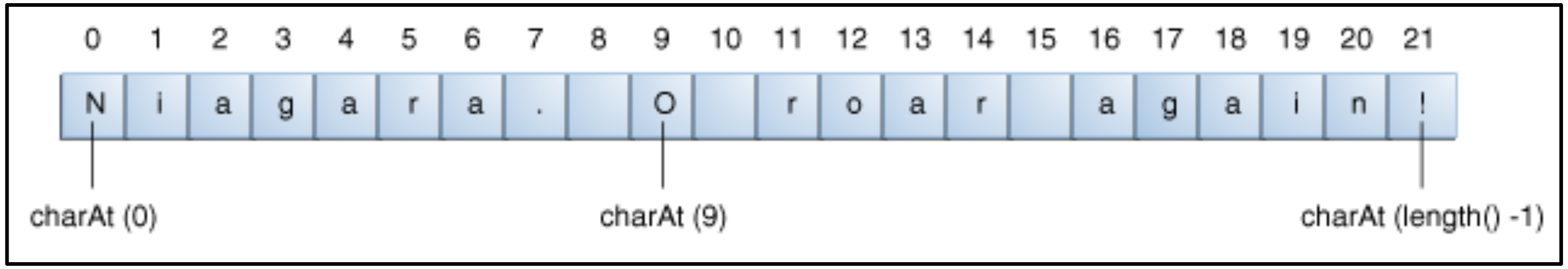
String methods:
substring (int beginIndex, int endIndex)



The substring begins at the specified **beginIndex…**

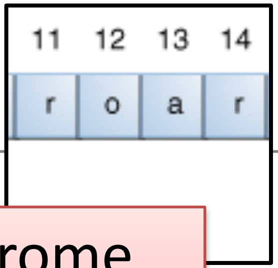
…and extends to the character at index **endIndex-1**



```
String anotherPalindrome = "Niagara. O roar again!";
String roar = anotherPalindrome.substring(11, 15);
```

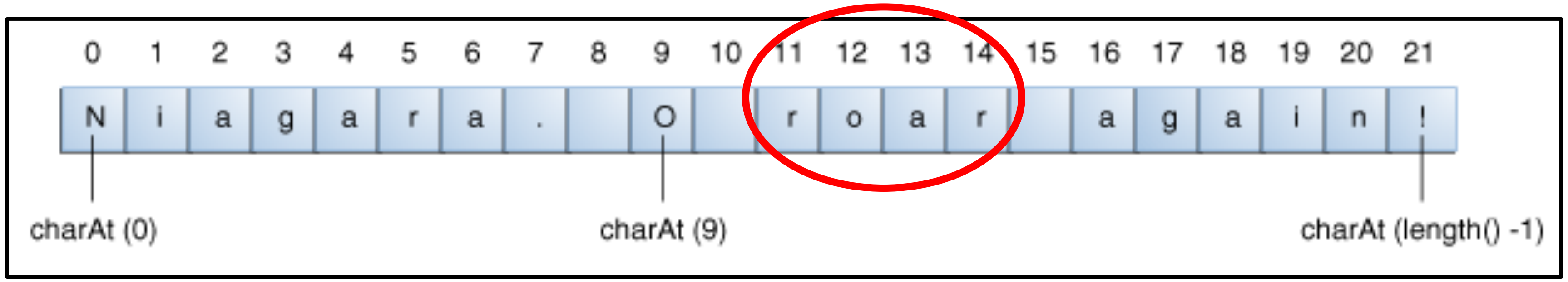
https://docs.oracle.com/javase/tutorial/java/data/manipstrings.html

String methods: **substring** (int beginIndex, int endIndex)



This code returns a substring ("roar") from anotherPalindrome.

It extends from index **11** up to **15 -1**, i.e. 11,12,13,14



```
String anotherPalindrome = "Niagara. O roar again!";
String roar = anotherPalindrome.substring(11, 15);
```

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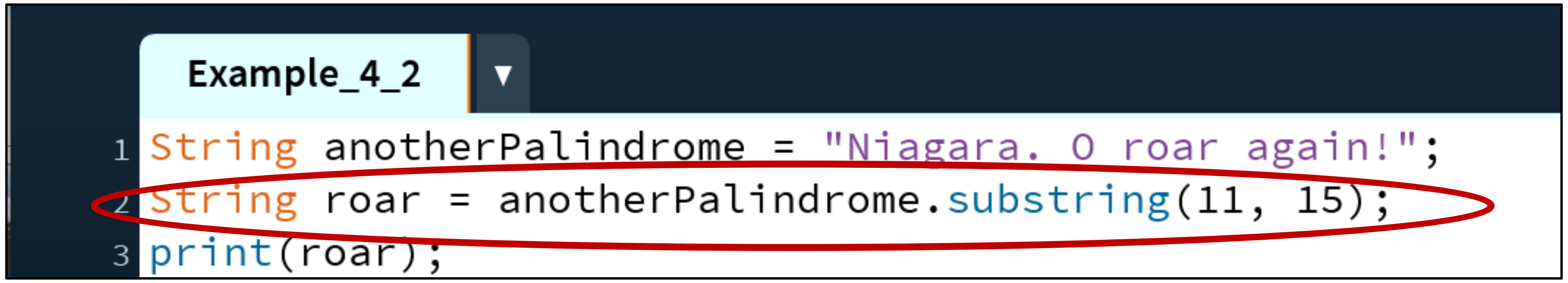
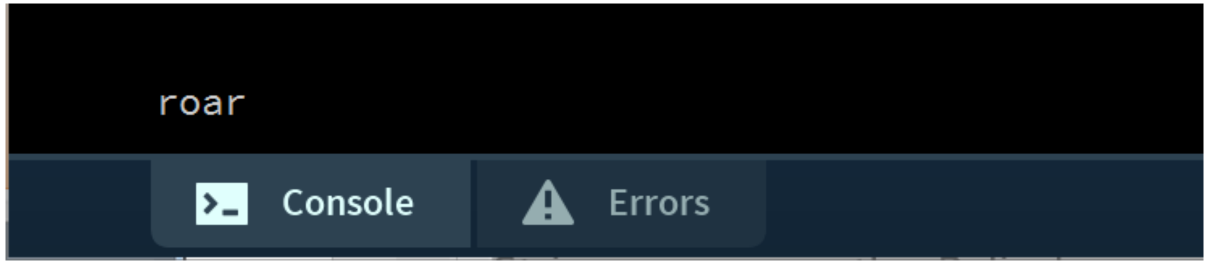
Example 4.2, **version 1**



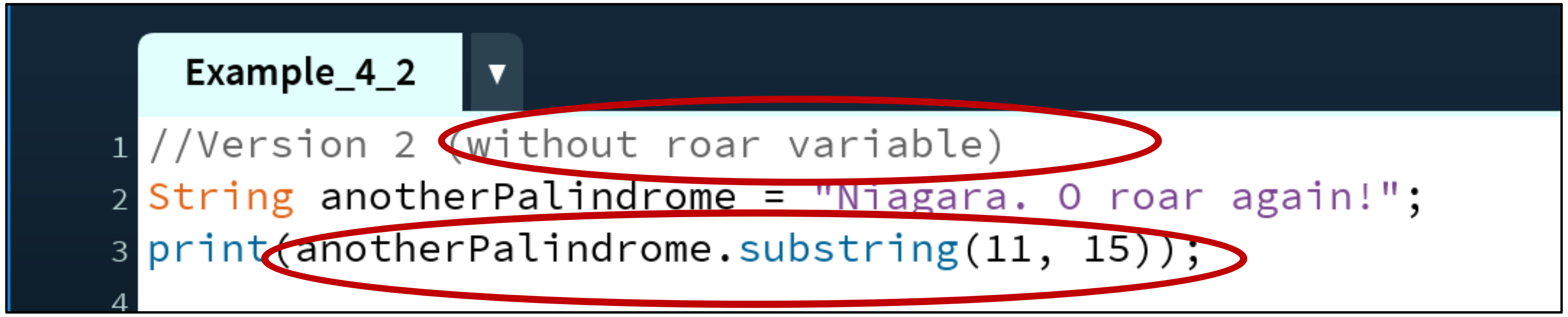
```
String anotherPalindrome = "Niagara. O roar again!";
String roar = anotherPalindrome.substring(11, 15);
print(roar);
```

Printing out a substring of a String to the console.



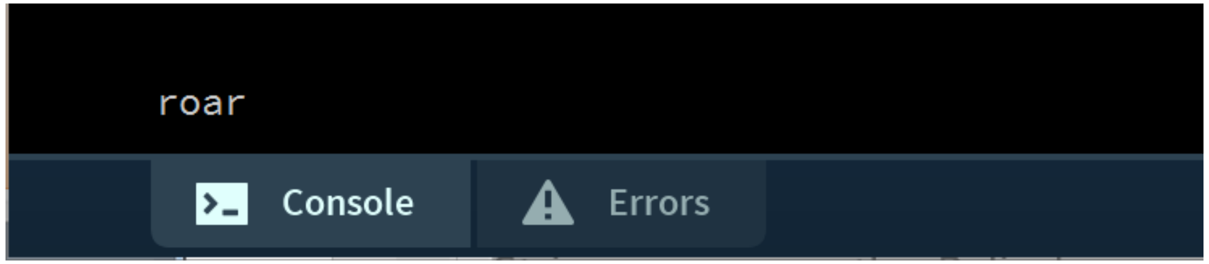
```
roar
```

Example 4.2, **version 2**



```
//Version 2 (without roar variable)
String anotherPalindrome = "Niagara. O roar again!";
print(anotherPalindrome.substring(11, 15));
```

Printing out a substring of a String to the console.



```
roar
```

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String methods: **compareTo**

int **compareTo** (String anotherString)

- This method compares two strings **lexicographically**
  - i.e.
    based on the Unicode value of the characters in the String.

- It returns an integer indicating whether this string is:
  - greater than (result is **> 0**)
  - equal to (result is **= 0**) or
  - less than (result is **< 0**)

  the argument, anotherString.

https://docs.oracle.com/javase/tutorial/java/data/comparestrings.html

Examples 4.3 - 4.6

- In the next 4 examples we compare 2 strings str1**.compareTo**(str2)
- where
  - str2 = "Cat”
  - str1 =
    - "Dog"
    - then "cat"
    - then "Animal"
    - then "Cat"

Example **4.3 – Dog**

Q: What will be printed to the console?

Q: Which boolean expression evaluates to true?

```
String str1 = "Dog";
String str2 = "Cat";

if (str1.compareTo(str2) < 0)          { // before
    println(str1+" comes before "+ str2 +" in the alphabet");
}
else if (str1.compareTo(str2) > 0)     { // after
    println (str1 +" comes after "+ str2  +" in the alphabet");
}
else{
   println ("The strings are identical");
}
```

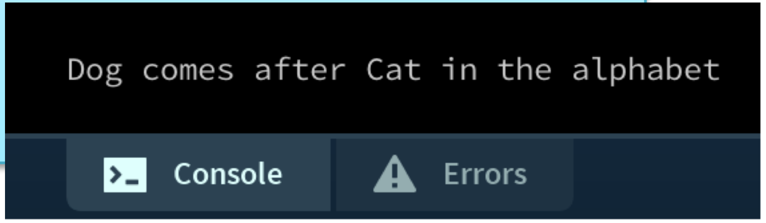
Example 4.3

A: str1.**compareTo** (str2)

returns a positive integer
as “Dog” (str1) comes **after** “Cat” (str2).

```
String str1 = "Dog";
String str2 = "Cat";

if (str1.compareTo(str2) < 0)          { // before
    println(str1+" comes before "+ str2 +" in the alphabet");
}
else if (str1.compareTo(str2) > 0)     { // after
    println (str1 +" comes after "+ str2  +" in the alphabet");
}
else{
   println ("The strings are identical");
}
```



```
Dog comes after Cat in the alphabet
```

Example **4.4 - cat**

Q: What will be printed to the console?

Q: Which boolean expression evaluates to true?

```
String str1 = "cat";
String str2 = "Cat";

if (str1.compareTo(str2) < 0)          { // before
    println(str1+" comes before "+ str2 +" in the alphabet");
}
else if (str1.compareTo(str2) > 0)    { // after
    println (str1 +" comes after "+ str2  +" in the alphabet");
}
else{
   println ("The strings are identical");
}
```

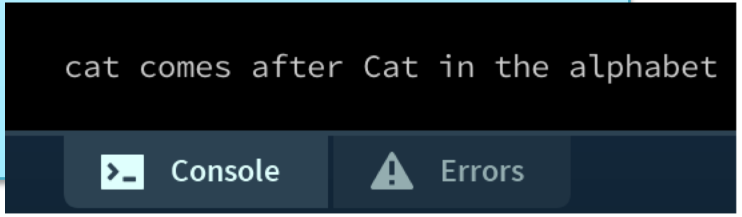
Example 4.4

```
String str1 = "cat";
String str2 = "Cat";

if (str1.compareTo(str2) < 0)           { // before
    println(str1+" comes before "+ str2 +" in the alphabet");
}
else if (str1.compareTo(str2) > 0)    { // after
    println (str1 +" comes after "+ str2  +" in the alphabet");
}
else{
   println ("The strings are identical");
}
```

A: str1.compareTo(str2)

returns a positive integer
as “cat” (str1) comes after “Cat” (str2)
in the Unicode character map.



```
cat comes after Cat in the alphabet
```

Example **4.5 - Animal**

Q: What will be printed to the console?

Q: Which boolean expression evaluates to true?

```
String str1 = "Animal";
String str2 = "Cat";

if (str1.compareTo(str2) < 0)           { // before
    println(str1+" comes before "+ str2 +" in the alphabet");
}
else if (str1.compareTo(str2) > 0)    { // after
    println (str1 +" comes after "+ str2  +" in the alphabet");
}
else{
   println ("The strings are identical");
}
```

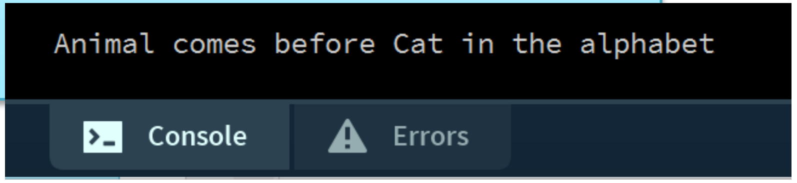
Example 4.5

A: str1.compareTo(str2)

returns a negative integer
as Animal(str1) comes before Cat (str2)
in the Unicode character map.

```
String str1 = "Animal";
String str2 = "Cat";

if (str1.compareTo(str2) < 0)          { // before
    println(str1+" comes before "+ str2 +" in the alphabet");
}
else if (str1.compareTo(str2) > 0)    { // after
    println (str1 +" comes after "+ str2  +" in the alphabet");
}
else{
   println ("The strings are identical");
}
```



```
Animal comes before Cat in the alphabet
```

Example **4.6 - Cat**

Q: What will be printed to the console?

Q: Which boolean expression evaluates to true?

```
String str1 = "Cat";
String str2 = "Cat";

if (str1.compareTo(str2) < 0)          { // before
    println(str1+" comes before "+ str2 +" in the alphabet");
}
else if (str1.compareTo(str2) > 0)    { // after
    println (str1 +" comes after "+ str2  +" in the alphabet");
}
else{
   println ("The strings are identical");
}
```

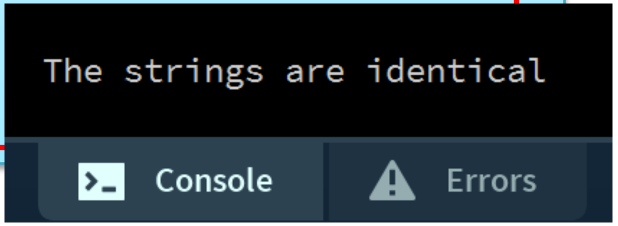
Example 4.6

A: str1.compareTo(str2)

returns 0
as Cat (str1) is identical to Cat (str2).

```
String str1 = "Cat";
String str2 = "Cat";

if (str1.compareTo(str2) < 0)          { // before
    println(str1+" comes before "+ str2 +" in the alphabet");
}
else if (str1.compareTo(str2) > 0)    { // after
    println (str1 +" comes after "+ str2  +" in the alphabet");
}
else{
   println ("The strings are identical");
}
```



```
The strings are identical
```

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Recap: **Object** types **e.g. String**

- Strings
  - are a sequence of characters enclosed by double quotes ")

- **String**
  - is an object type.

- The Java API
  - provides information about the String class
  - lists methods that can be used on Strings
    - (https://docs.oracle.com/javase/8/docs/api/java/lang/String.html).

- The most direct way to create a String is to write:

```
String greeting = "Hello world!";
```

http://www.tutorialspoint.com/java/pdf/java_strings.pdf

Primitive types vs. **Object** types

Primitive type

```
int i = 17;
```

Primitive types vs. Object types

Primitive type

```
int i = 17;
```

Directly stored in memory...

$\boxed{17}$

Primitive types vs. Object types

Primitive type

```
int i = 17;
```

Directly stored in memory…

$\boxed{17}$

Object type

```
String hi = “Hello”;
```

Primitive types vs. Object types

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```
int i = 17;
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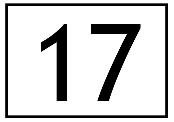
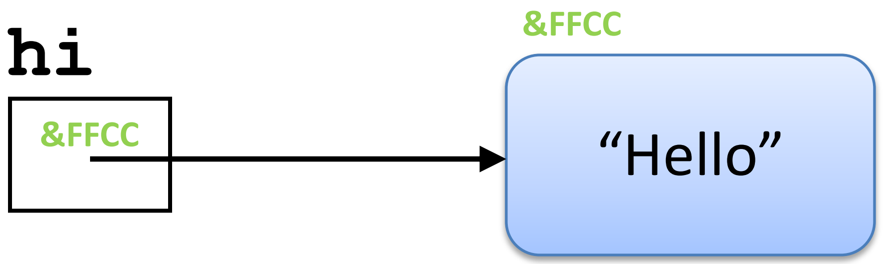
Directly stored in memory…



Object type

```
String hi = "Hello";
```

hi variable
contains a **reference** (*address*) to where the String is stored in memory



Primitive types vs. Object types

Primitive type

```
int i = 17;
```

Directly stored in memory...

$\boxed{17}$

With **primitive** type variables (e.g. int, float, char, etc)

the **value** of the variable is stored in the memory location assigned to the variable.

Primitive types vs. Object types

With **object** types,
the variable holds
the **memory address**
of where the object is located
– **not the values** inside the object.

This memory address is called
a **reference** to the object.

Object type

```
String hi = "Hello";
```

hi variable
contains a reference (*address*)
to where the String is stored in
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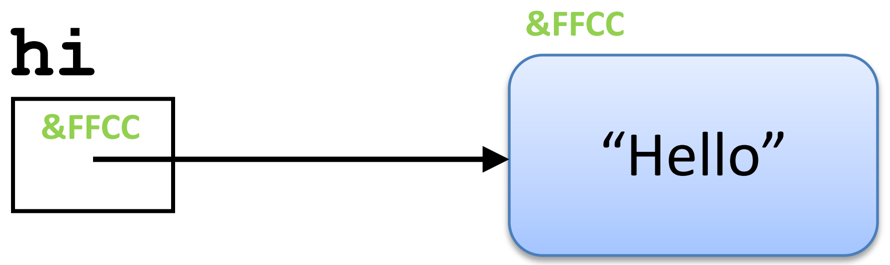


Primitive types vs. Object types

Now that we know how primitive types and object types store data,

we will look at this statement (b=a) in the context of primitive and object types.

```
b = a;
```

Primitive types vs. Object types

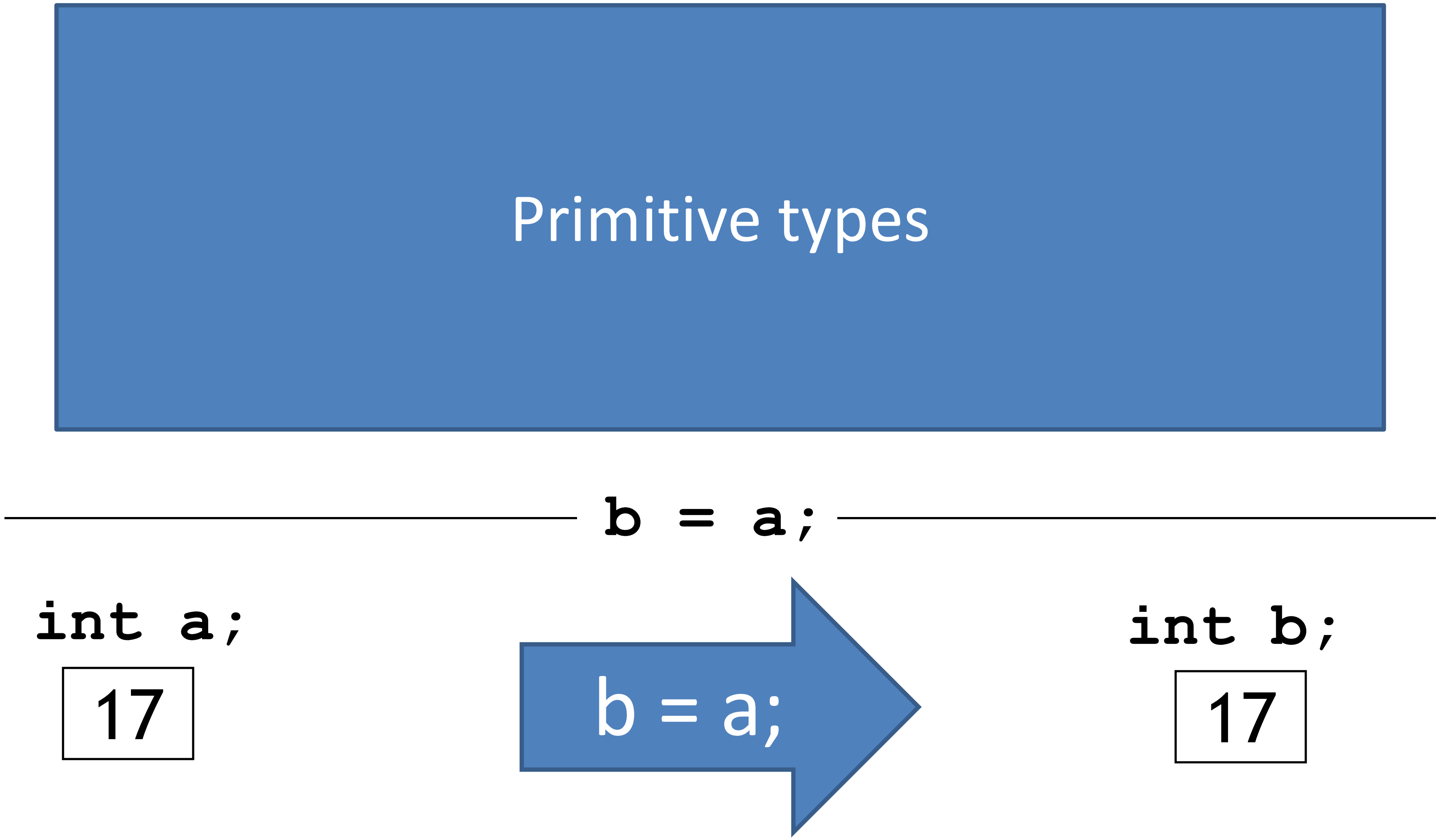
Primitive types

```
b = a;
```

```
int a;
```

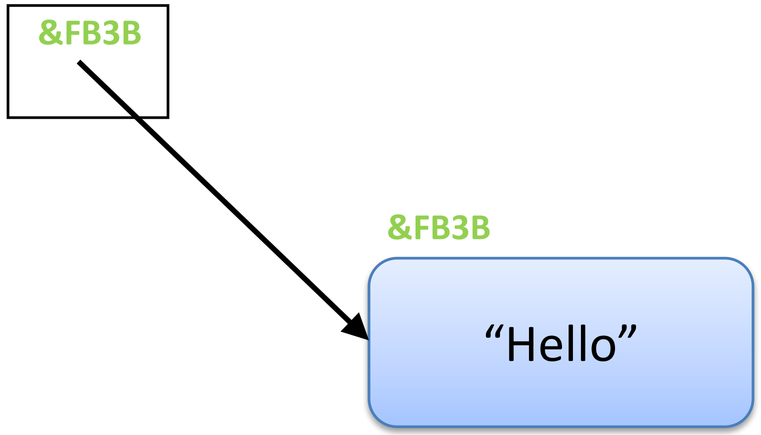
$\boxed{17}$

Primitive types vs. Object types



Primitive types vs. Object types

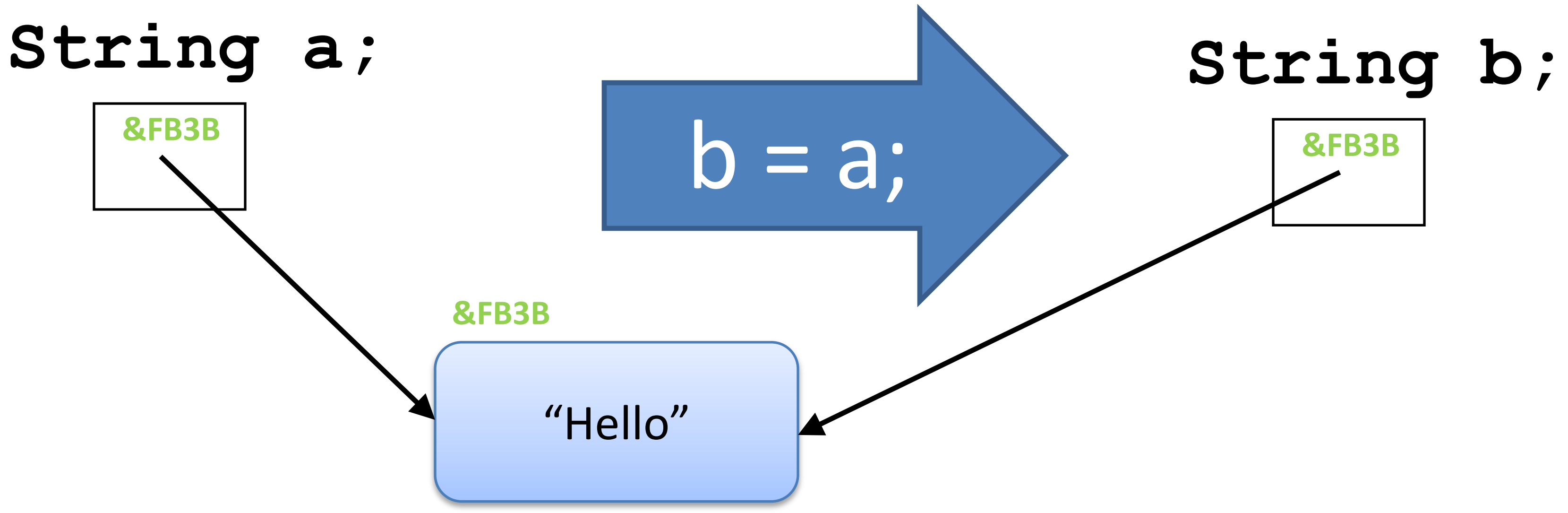
```
String a;
```



```
b = a;
```

Object types

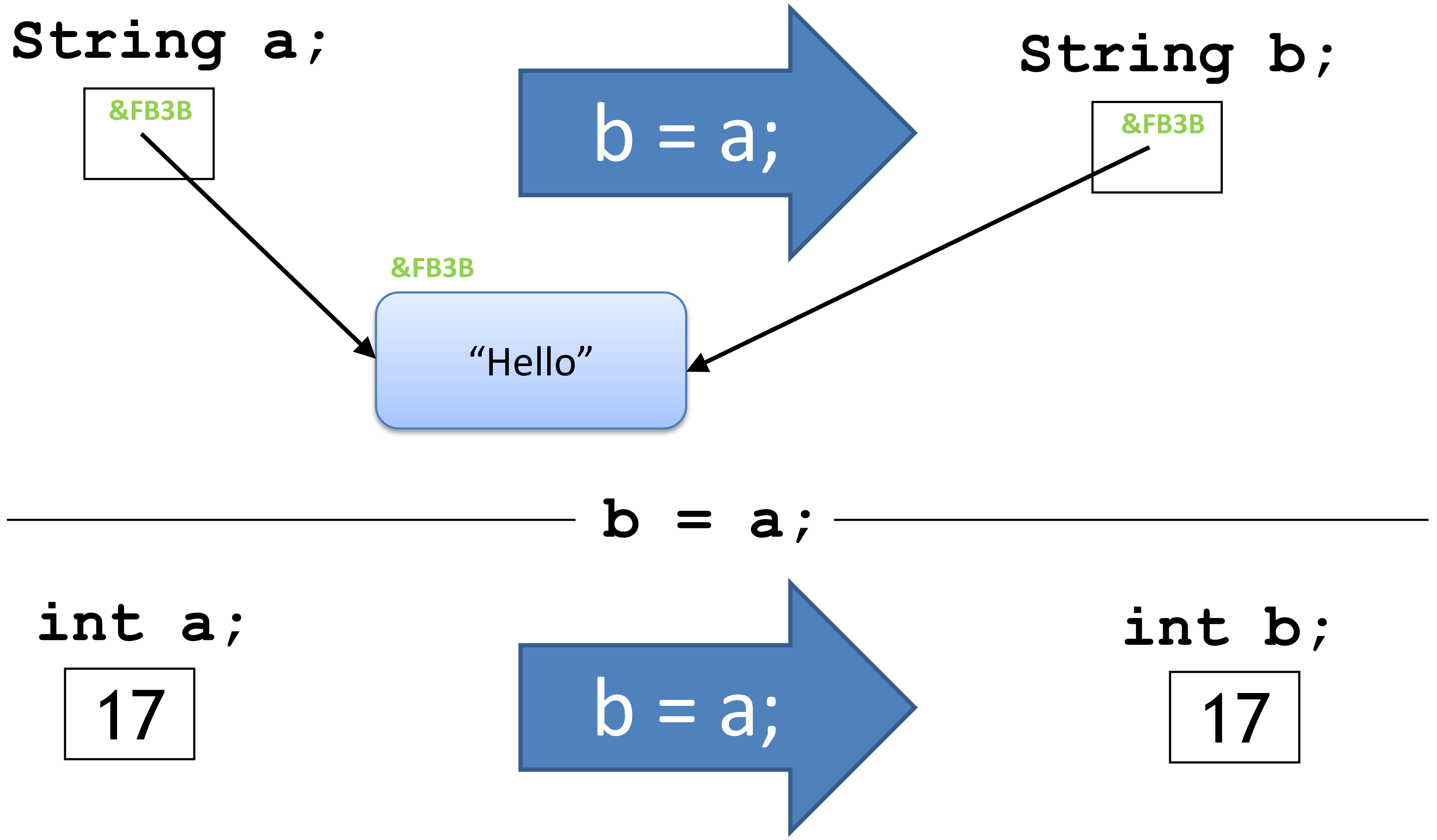
Primitive types vs. Object types



```
b = a;
```

Object types

Primitive types vs. Object types

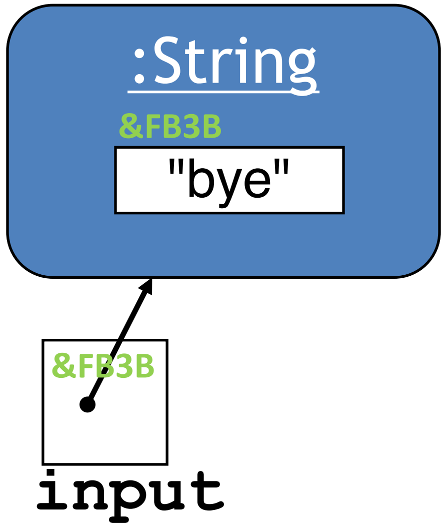


Topics list

1. Strings: index of characters
2. **String methods**:
   - **charAt**(int index)
   - **substring** (int beginIndex, int endIndex)
   - **compareTo** (String anotherString)
3. Recap: Primitive vs Object
4. **String identity** vs **equality**
5. Common **Errors** with Strings
6. **null**
7. **Escape Sequences**

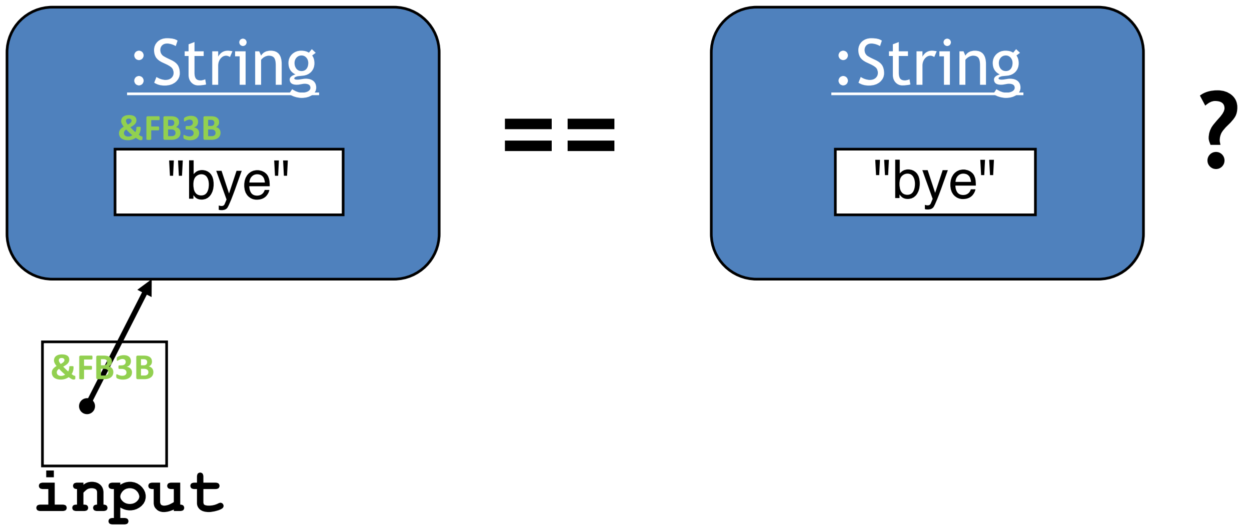
String: Identity vs Equality

```
String input = "bye";
```



String: Identity vs Equality

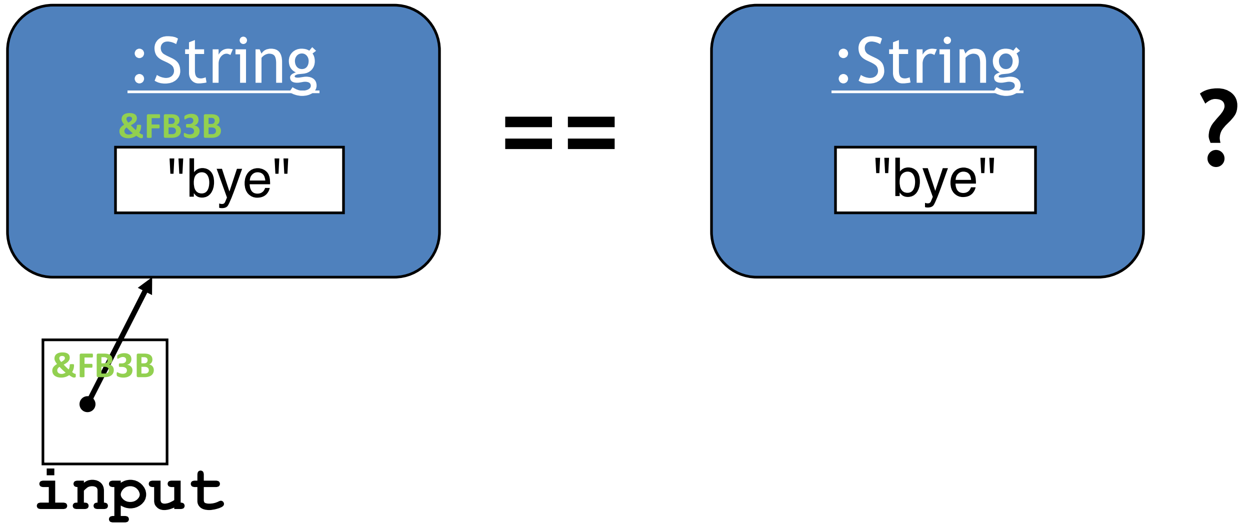
```
String input = "bye";
if(input == "bye") {
   //...
}
```



String: Identity vs Equality

```
String input = "bye";
if(input == "bye") {
   //...
}
```

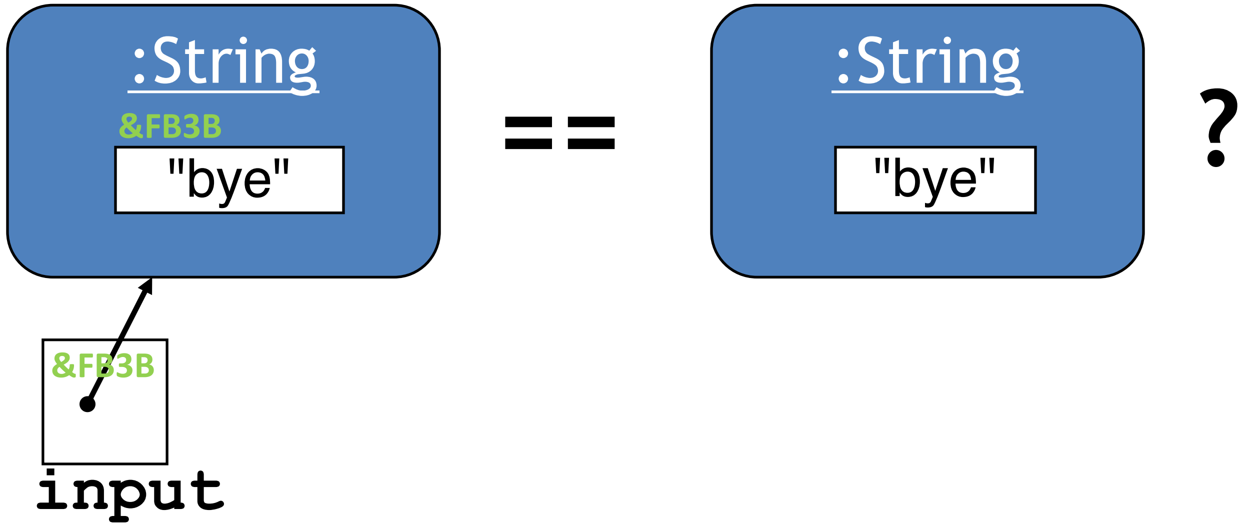
== tests identity



String: **Identity** vs Equality

```
String input = "bye";
if(input == "bye") {
   //...
}
```

== tests identity

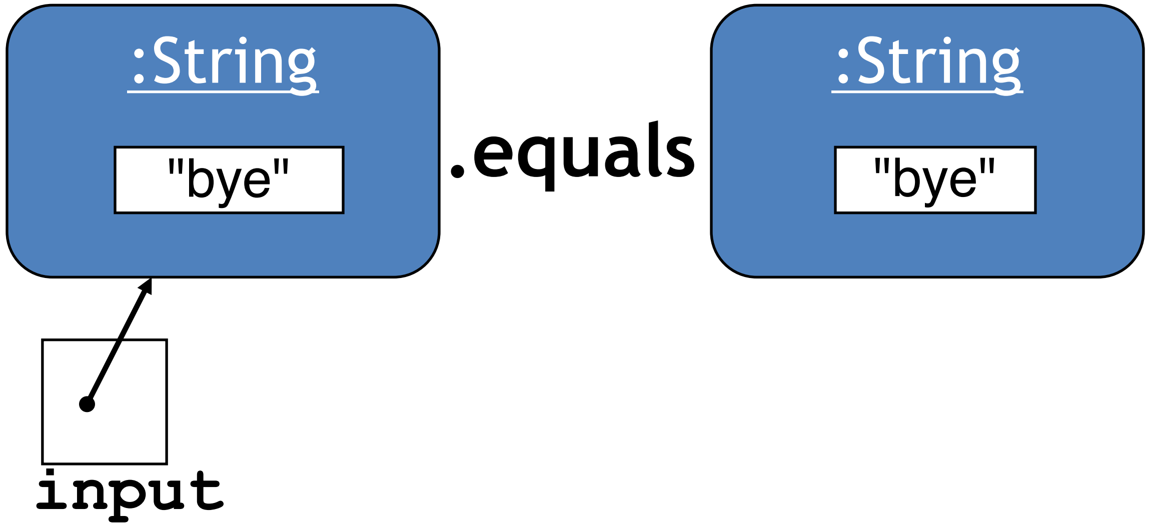


Answer: (maybe) false!

String: Identity vs **Equality**

```
String input = "bye";
if(input.equals("bye")) {
    ...
}
```

.equals tests equality



Answer: true

"bye" equals "bye"

String: **Identity vs Equality**

```
if(input == "bye") {
    ...
}


if(input.equals("bye")) {
    ...
}
```

tests **identity**
i.e. the reference

tests **equality**
i.e. string value

Strings should always be **compared** using the **`.equals`** method

Topics list

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Q1: What’s wrong here?

```
void anyMethod()
{
    String str1 = "a";
    String str2 = "b";

    if(str1 == str2)
    {
        println(str1+" is the same as "+ str2);
    }
    else
    {
        println(str1+" is NOT same as "+ str2);
    }
}
```

A1: Strings need to use the **.equals()** method

```
void anyMethod()
{
    String str1 = "a";
    String str2 = "b";

    if(str1 == str2)
    {
        println(str1+" is the same as "+ str2);
    }
    else
    {
        println(str1+" is NOT same as "+ str2);
    }
}
```

Q2: What’s wrong here?

```
public void anyMethod()
{
    int num1 = 1;
    int num2 = 2;

    if(num1 = num2)
        println(num1+" is the same as "+ num2);
    else
        println(num1+" is NOT same as "+ num2);
}
```

A: You need two equals for equality
Single equals means assignment

```
public void anyMethod()
{
    int num1 = 1;
    int num2 = 2;

    if(num1 = num2)
        println(num1+" is the same as "+ num2);
    else
        println(num1+" is NOT same as "+ num2);
}
```

Topics list

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null

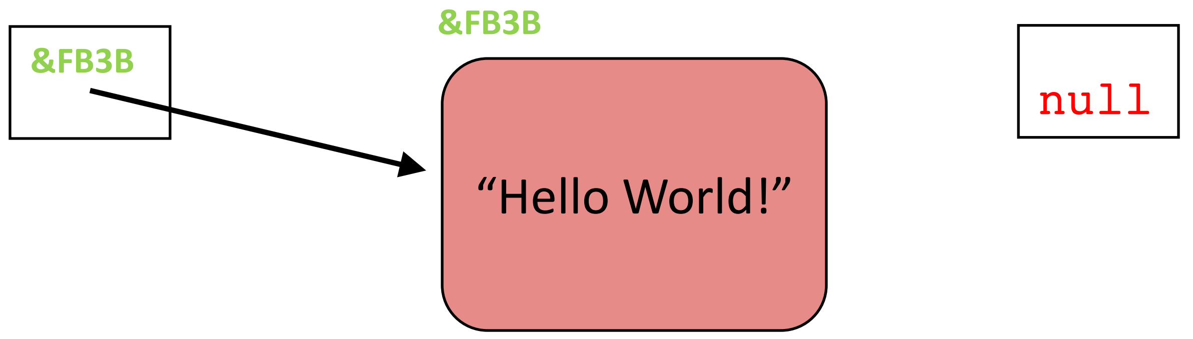
- `null` is a special value in Java.
- All object variables are initialised to `null`.

null

- null means that the object variable does not have a reference

  e.g.
  - str1 below has a reference to the string "hello World!"
  - str2 below does not have a reference. It is null.

```
String str1;                    String str2;
```



null

You can **test** for null:
You can **assign** null:

```
String hours;

if(hours == null)
{
      //...
}
hours = null;
```

test

assign

Topics list

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Escape sequences

When a String is printed,
certain **single characters that follow a backslash (\\)**
have special meaning…

…and the compiler interprets them accordingly.

http://docs.oracle.com/javase/tutorial/java/data/characters.html

Java escape sequences

Escape Sequence	Description
\t	Insert a **tab** in the text at this point.
\b	Insert a **backspace** in the text at this point.
\n	Insert a **newline** in the text at this point.
\r	Insert a **carriage return** in the text at this point.
\f	Insert a **formfeed** in the text at this point.
\'	Insert a **single quote** character in the text at this point.
\"	Insert a **double quote** character in the text at this point.
\\	Insert a **backslash** character in the text at this point.

http://docs.oracle.com/javase/tutorial/java/data/characters.html

Examples of escape sequences

```
print(“Java\n”);
```

is the exact same as:

```
println(“Java”);
```

```
println(“	Java”);
```

is similar to:

```
println(“\tJava”);
```

http://docs.oracle.com/javase/tutorial/java/data/characters.html

Summary

1. Strings: index of characters
2. **String methods**:
   - **charAt**(int index)
   - **substring** (int beginIndex, int endIndex)
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Questions?