Programming Languages – Functional Languages

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Functional Programming concepts

- Pure functions & side effects
- Referential transparency
- First class functions & higher order functions
- Immutability
- Recursion & tail-recursion
- Lambda functions
- Strict and lazy evaluation
- Pattern matching

Functional Programming concepts - Immutability

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  - variable/reference immutability vs object immutability.

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//Array is mutable object in Scala
val arr = Array(5, 6)
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2. More mathematical like.
3. Think about concurrent programming
   - Multi-threading? Immutable objects are more thread-safe.

Functional Programming concepts - Immutability

HOW do we write programs using only immutable objects?

Functional Programming concepts - Immutability

- Factorial function:

```
def fact(n: Int): Int = {
    var i = n //Can't change input
    var f = 1
    while (i > 1){
        f = f * i
        i = i - 1
    }
    f
}
```

Functional Programming concepts - Immutability

- Factorial function – use recursion:

```
def fact(n: Int): Int = {
    if (n < 1) 1
    else n * fact(n - 1)
}
```

For loops, we use recursion.

Functional Programming concepts - Immutability

What about other situations?

For example:

I have string “Hello, world”

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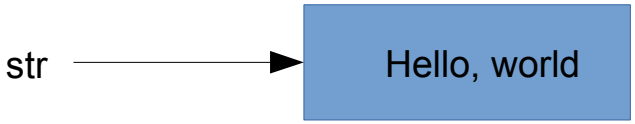
For each new state/change:

we create a new object

Functional Programming concepts - Immutability

val str = "Hello, world"



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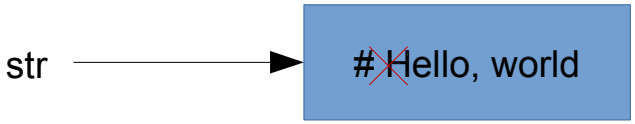

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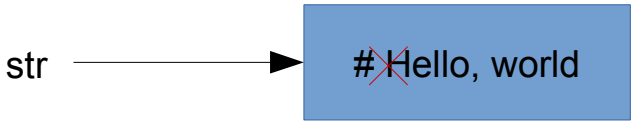
val str = "Hello, world"

//str(0) = '#' -> Error strings are immutable



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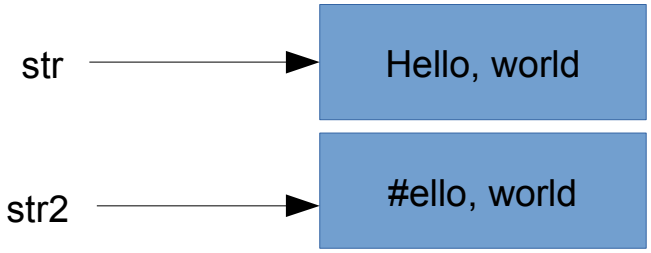
```
val str = "Hello, world"
//str(0) = '#' -> Error strings are immutable
val str2 = "#" + str.substring(1)
```



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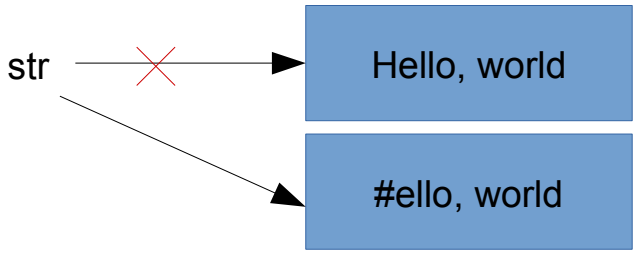

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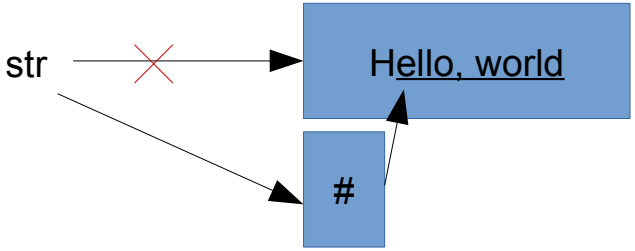
Sharing partial values



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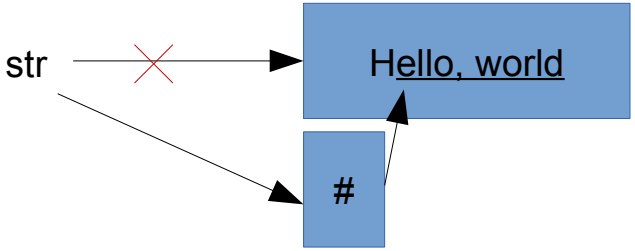
Sharing partial values & Persistent Data Structures



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- For example, sum of range from 1 to n:

```
def sum(n: Int): Int = {
    if (n == 1) 1
    else n + sum(n - 1)
}
```

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Solution? Tail recursion

Functional Programming concepts – Recursion & Tail Recursion

- Tail recursion:
  - Recursive call should be the last statement to be executed.
  - The compiler will substitute the recursive function by a loop.

Functional Programming concepts – Recursion & Tail Recursion

- Use tail recursion:

```
def sum(n: Int, res: Int): Int = {
    if (n == 1) res
    else sum(n - 1, res + n)
}
```

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