Model of Execution

Lecture Objective

No coding objective

Study this material for your interview and quiz

More Memory Examples

- Multiple frames on the stack

More Memory Examples

Multiple frames on the stack

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
<new stack frame>
name:n, value:3
<Used by another program>
<Used by another program>

- Call function
- Create new stack frame

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
<new stack frame>
name:n, value:3
<if block>
<new stack frame>
name:n, value:2
<Used by another program>
<Used by another program>

- Enter if block
- Call function again
- Create new stack frame

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
<new stack frame>
name:n, value:3
<if block>
<new stack frame>
name:n, value:2
<if block>
<new stack frame>
name:n, value:1
<Used by another program>
<Used by another program>

- In next function call, conditional true
- New if block
- New stack frame

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
<new stack frame>
name:n, value:3
<if block>
<new stack frame>
name:n, value:2
<if block>
<new stack frame>
name:n, value:1
<if block>
<new stack frame>
name:n, value:0
<Used by another program>
<Used by another program>

- Repeat, repeat
- Many variables named n on the stack
- Each is in different frame so it's ok

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
<new stack frame>
name:n, value:3
<if block>
<new stack frame>
name:n, value:2
<if block>
<new stack frame>
name:n, value:1
<if block>
<new stack frame>
name:n, value:0
<Used by another program>
<Used by another program>

- Conditional finally false
- return 0

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

- Assign return value to result

RAM
args
<new stack frame>
name:n, value:3
<if block>
<new stack frame>
name:n, value:2
<if block>
<new stack frame>
name:n, value:1
<if block>
name:result, value:0
<Used by another program>
<Used by another program>

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
<new stack frame>
name:n, value:3
<if block>
<new stack frame>
name:n, value:2
<if block>
<new stack frame>
name:n, value:1
<if block>
name:result, value:1
<Used by another program>
<Used by another program>

- Add value of the n in this stack frame to result
- result is the last expression and is returned

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
<new stack frame>
name:n, value:3
<if block>
<new stack frame>
name:n, value:2
<if block>
name:result, value:1
<Used by another program>
<Used by another program>

- Return to function call from previous frame
- Store return value in result

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

- Add value of n from this frame..
- Repeat

RAM
args
<new stack frame>
name:n, value:3
<if block>
<new stack frame>
name:n, value:2
<if block>
name:result, value:3
<Used by another program>
<Used by another program>

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

- Add value of n from this frame..
- Repeat

RAM
args
<new stack frame>
name:n, value:3
<if block>
name:result, value:3
<Used by another program>
<Used by another program>

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
<new stack frame>
name:n, value:3
<if block>
name:result, value:6
<Used by another program>
<Used by another program>

- And repeat..
- Imagine if the original input were 1000
  - This is why we use computers

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

- Value result in main method gets the last return value

RAM
args
name:result, value:6
<Used by another program>
<Used by another program>

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
name:result, value:6
<Used by another program>
<Used by another program>

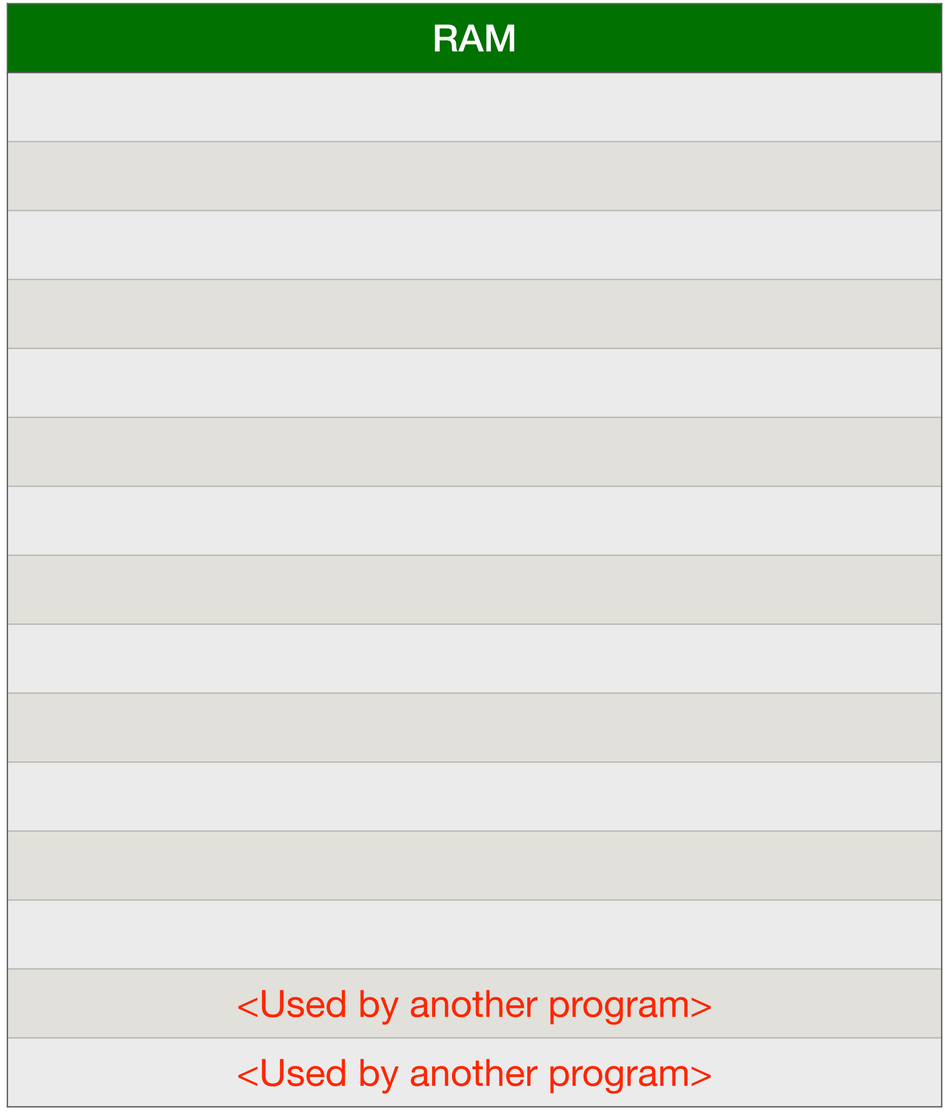
- print 6

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  if(n>0) {
    var result: Int = computeGeometricSum(n - 1)
    result += n
    result
  }else{
    0
  }
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

- Free memory



More Memory Examples

- We were close to the end of the stack on that example
  - In reality, the stack will be much larger than in this example
- What if this were our code?

```
def computeGeometricSum(n: Int): Int ={
  var result: Int = computeGeometricSum(n - 1)
  result += n
  result
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  var result: Int = computeGeometricSum(n - 1)
  result += n
  result
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
<new stack frame>
name:n, value:3
<if block>
<new stack frame>
name:n, value:2
<if block>
<new stack frame>
name:n, value:1
<if block>
<new stack frame>
name:n, value:0
<Used by another program>
<Used by another program>

- At this point the other program was going to return 0 and return back up the stack

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  var result: Int = computeGeometricSum(n - 1)
  result += n
  result
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

RAM
args
<new stack frame>
name:n, value:3
<new stack frame>
name:n, value:2
<new stack frame>
name:n, value:1
<new stack frame>
name:n, value:0
<new stack frame>
name:n, value:-1
<new stack frame>
name:n, value:-2
<Used by another program>
<Used by another program>

- This program keeps adding frames to the stack

Recursive Example

```
def computeGeometricSum(n: Int): Int ={
  var result: Int = computeGeometricSum(n - 1)
  result += n
  result
}

def main(args: Array[String]): Unit = {
  val result: Int = computeGeometricSum(3)
  println(result)
}
```

- STACK OVERFLOW
- Program crashes

RAM
args
<new stack frame>
name:n, value:3
<new stack frame>
name:n, value:2
<new stack frame>
name:n, value:1
<new stack frame>
name:n, value:0
<new stack frame>
name:n, value:-1
<new stack frame>
name:n, value:-2
<Used by another program> <new stack frame>
<Used by another program> name:n, value:-3

Lecture Objective

No coding objective

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