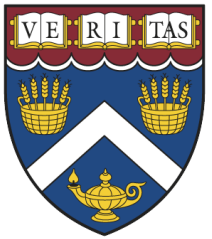
Since Last Week

- Lots of work on Assignment 1
  - Most people seem to be doing well
- A few bugs showing up in the VM
  - Windows compatibility
  - Java version
  - Off-by-one on stack frame check
- Lots of forum activity

Object Allocation



Object Layout

- Objects contain non-static field data
  - Values can be different for every instance
- Includes all fields defined by super classes
  - Remember that fields do not override
- Method data is not stored with the object
  - Loaded once per class

Field Layout

- Fields start at a fixed offset from the header
  - Remember that the header is a known size
- Object header can be at the end of the object
  - Fields laid out backwards
  - Pushes null pointer checks into hardware
- Same effect by guarding first few memory pages

Field Layout

- Layout strategy is implementation dependent
  - Ordered by defining class
  - Ordered by definition in the class file
  - Ordered by predicted access patterns
  - Ordered by type, keeping references together
- All have different cache characteristics

Object Creation

- Allocate heap space for the object
  - May trigger garbage collection
  - Could cause OutOfMemoryException
- Populate header or handle
- Initialize all fields to their default values
- Call the appropriate constructor

Header Creation

- Object type is known at allocation time
  - Dynamic type declared in `new` bytecode
  - May never be known afterwards
- Array length also known at allocation time
  - Arrays created using `newarray` and `anewarray`
- Other fields normally set to zero
  - We'll see exceptions when talking about GC

Default Values

- Every type has a default value
  - Zero for numerical types
  - False for boolean
  - Null for references
- Evaluates to zero in most implementations
  - False may not be represented by zero
  - Null is not required to be `0x0`
- Initialization can be done by a single `memset` call

Object Initialization

- Every class defines at least one constructor
  - Created automatically if not explicit
- Constructor must call superclass constructor
  - With one exception
- Recall that the object contains superclass fields
  - Design ensures encapsulation

```
class ClassA {

}
```

```
class ClassA {

  ClassA();
    0: aload_0
    1: invokespecial #8  // Method Object."<init>":()V
    4: return


}
```

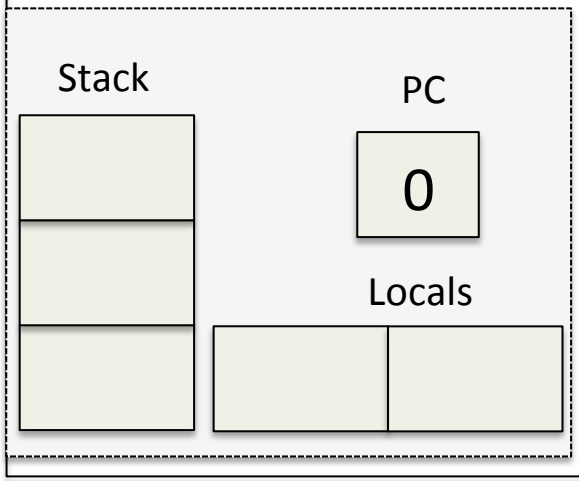
```
class ClassA {

  ClassA();
    0: aload_0
    1: invokespecial #8  // Method Object."<init>":()V
    4: return


}


class ClassB extends ClassA {

  private final int field;

  public ClassB(final int fld) {
    this.field = fld;
  }
}
```

```
class ClassA {

  ClassA();
    0: aload_0
    1: invokespecial #8  // Method Object."<init>":()V
    4: return


}

class ClassB extends ClassA {

  private final int field;

  ClassB(int);
    0: aload_0
    1: invokespecial #10  // Method ClassA."<init>":()V
    4: aload_0
    5: iload_1
    6: putfield      #13  // Field field:I
    9: return
}
```

```
public static ClassA getB() {
  final ClassA a = new ClassB(3);
  return a;
}
```

```
public static ClassA getB() {
  final ClassA a = new ClassB(3);
  return a;
}
```

```
public static ClassA getB();
  0: new           #16 // class ClassB
  3: dup
  4: iconst_3
  5: invokespecial #18 // Method ClassB."<init>":(I)V
  8: astore_1
  9: aload_1
 10: areturn
```

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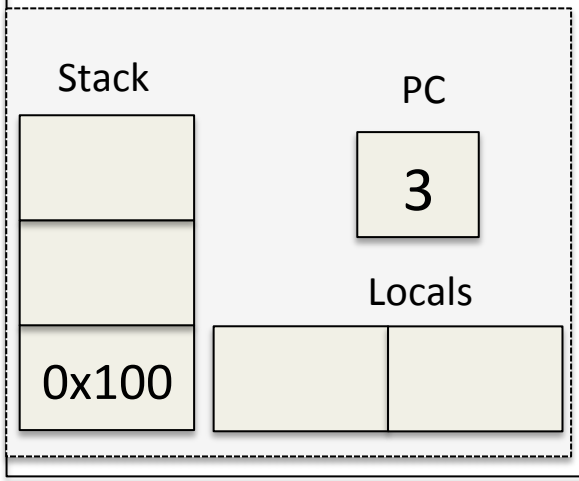


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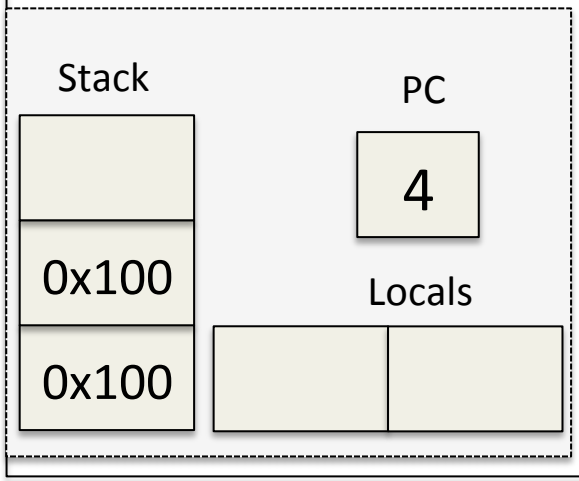


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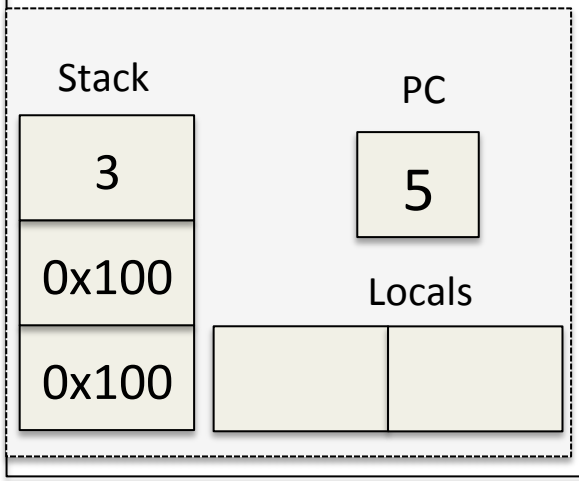


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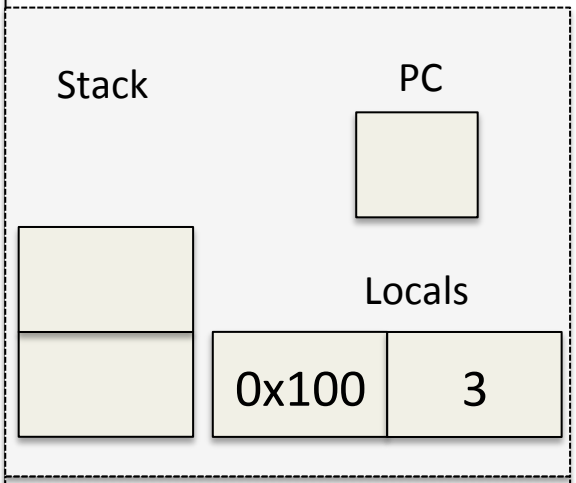


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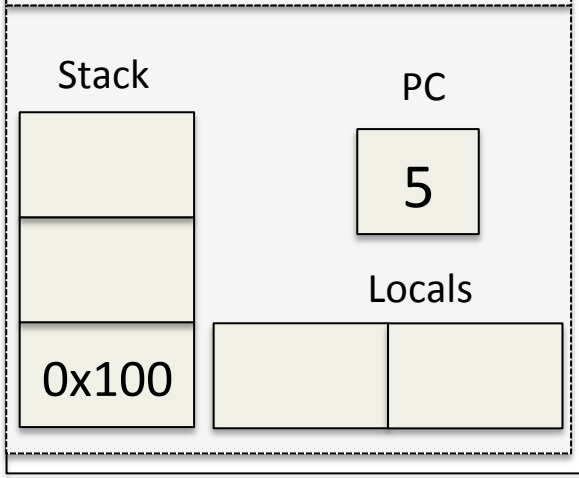


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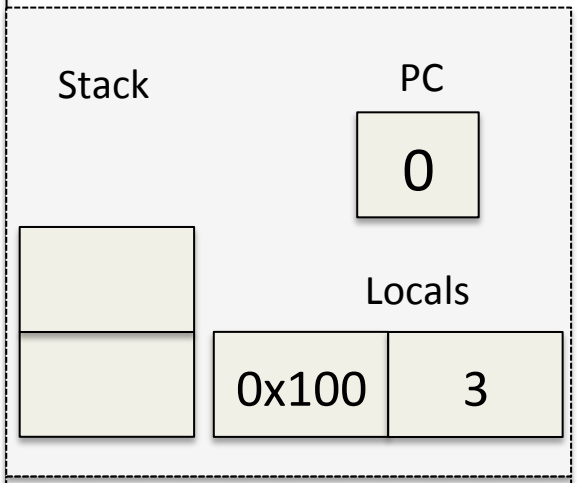


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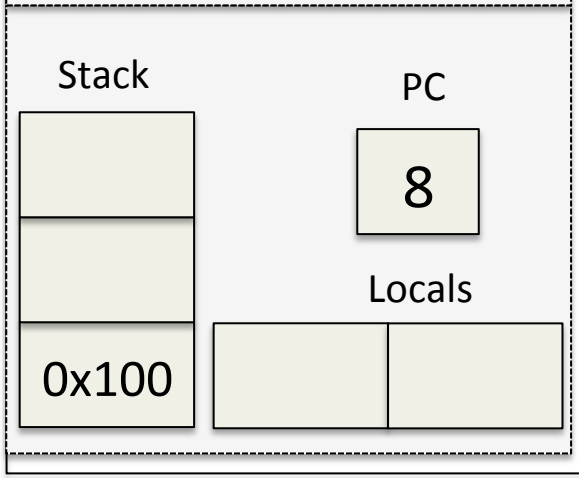


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 0: new           // class ClassB
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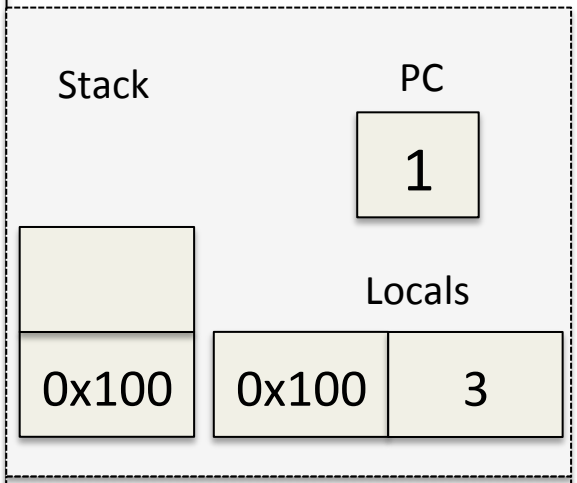


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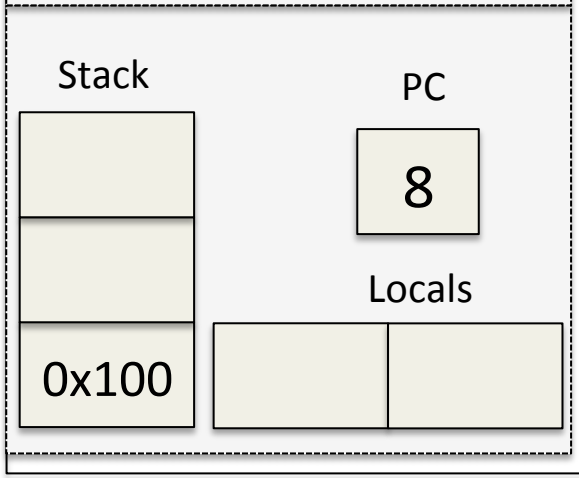


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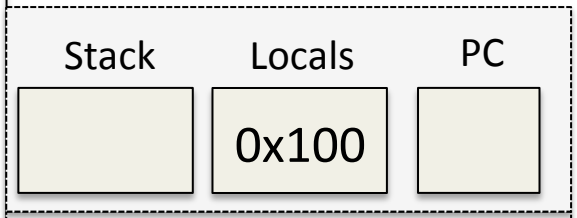

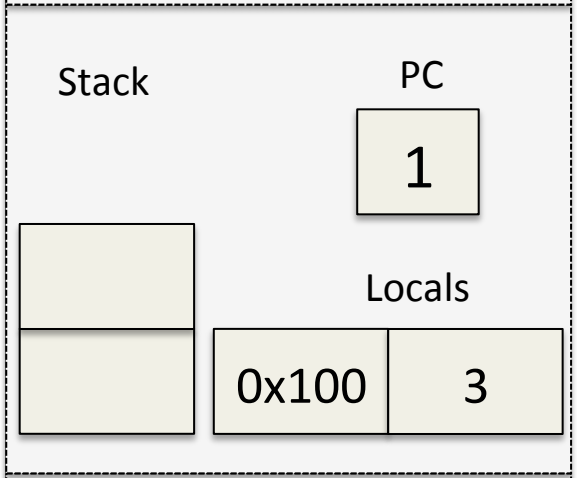

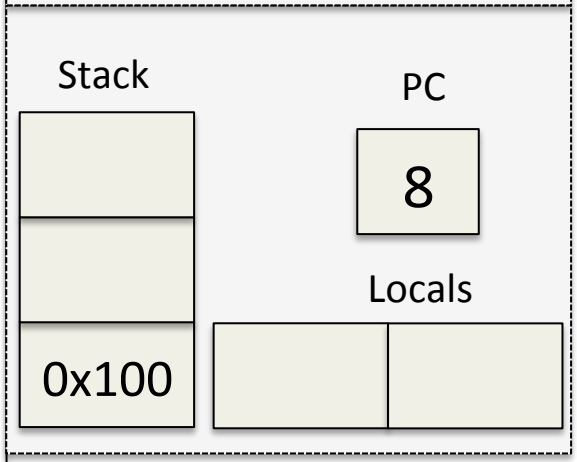


```
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 0: aload_0
 1: invokespecial // Method Object."<init>":()V
 4: return

public ClassB(int);
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 1: invokespecial // Method ClassA."<init>":()V
 4: aload_0
 5: iload_1
 6: putfield      // Field field:I
 9: return

public static ClassA getB();
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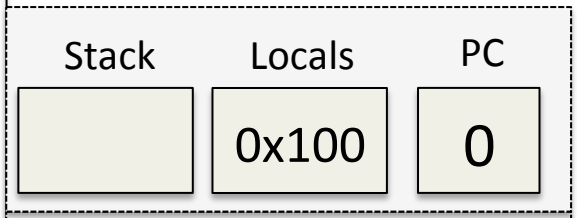

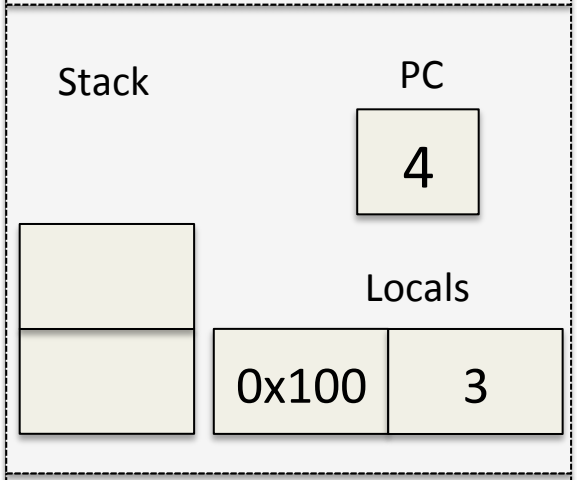

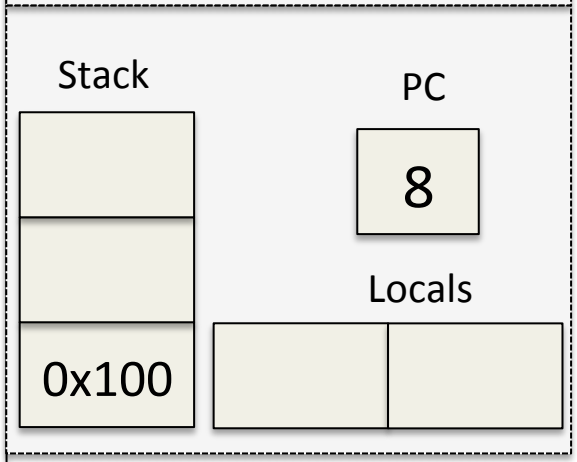


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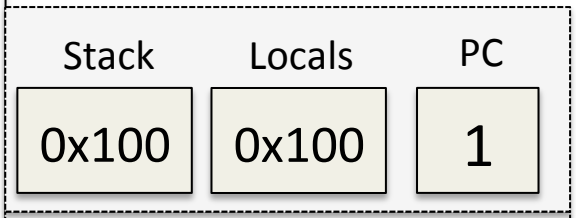


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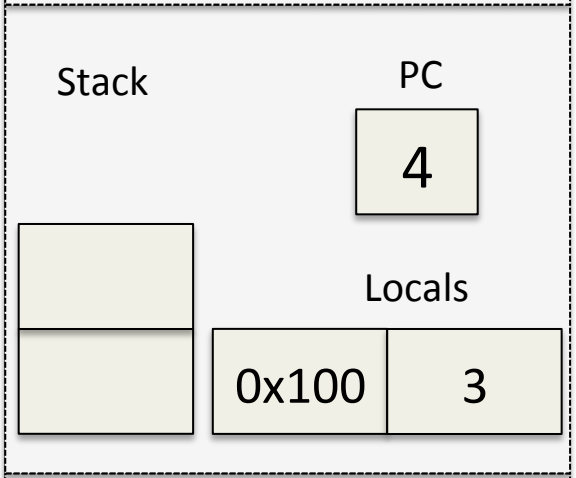


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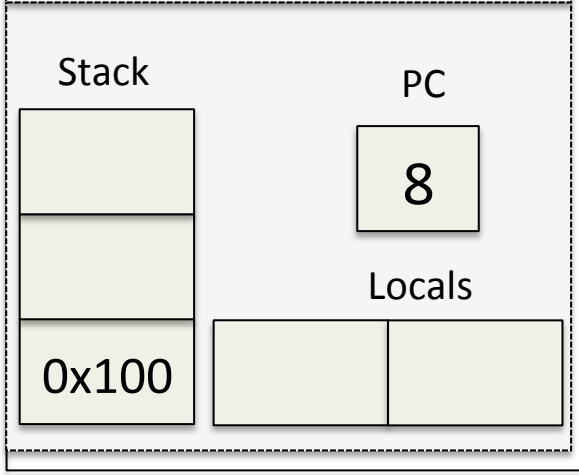


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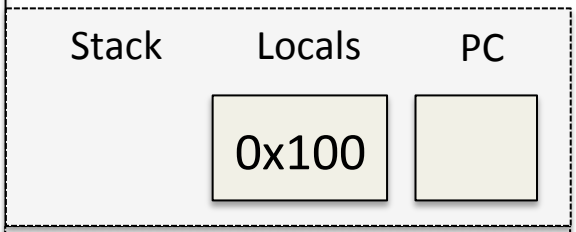
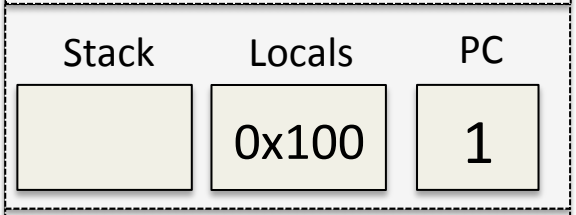



```
public Object();
 0: return
```

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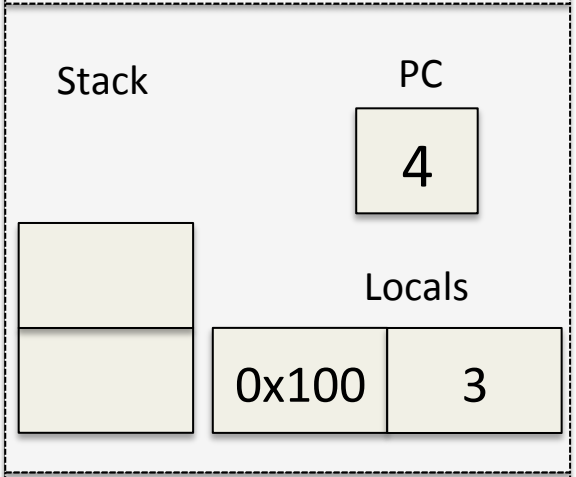


```
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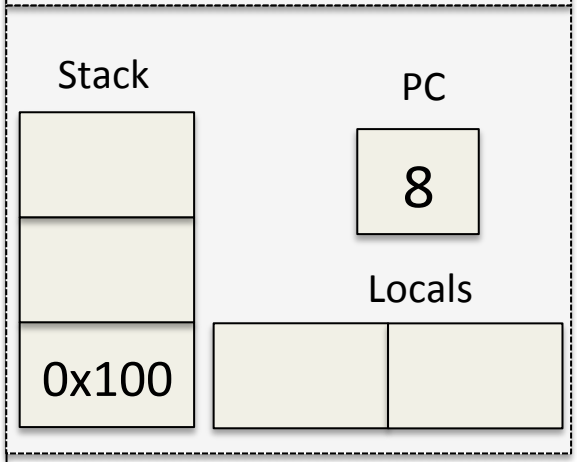


```
public static ClassA getB();
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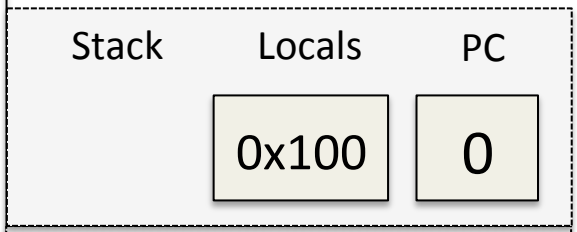


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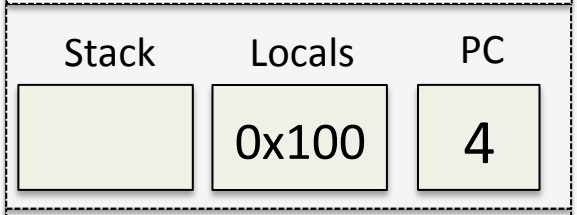


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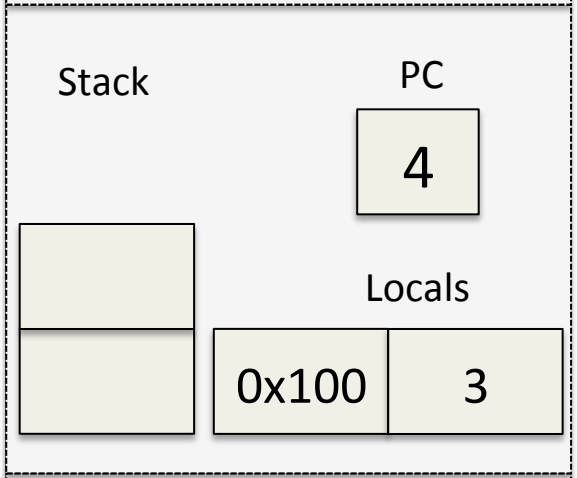


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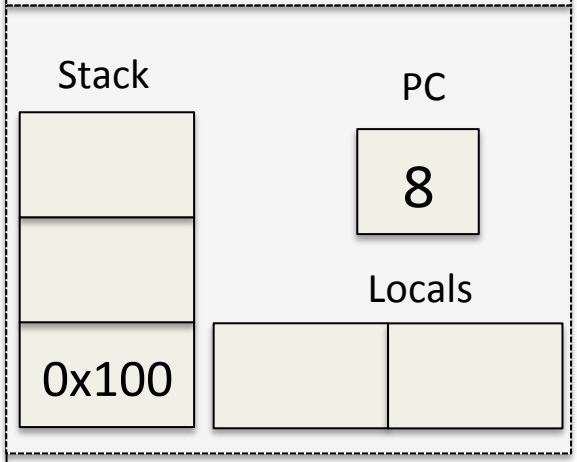


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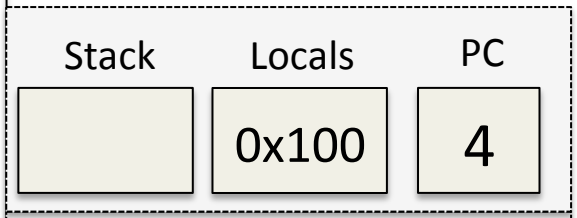


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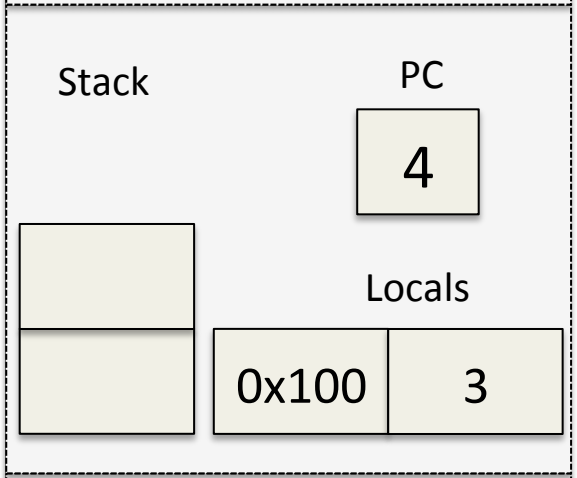


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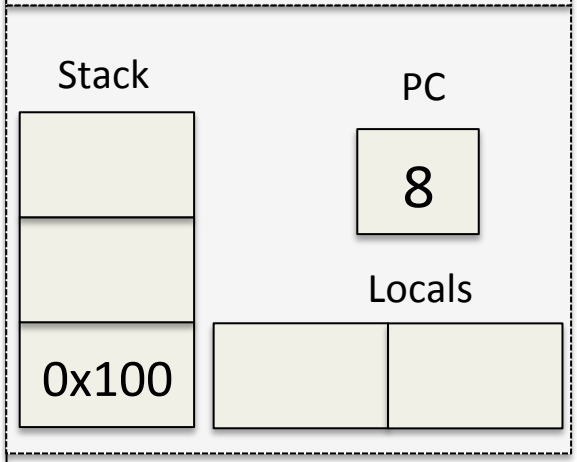


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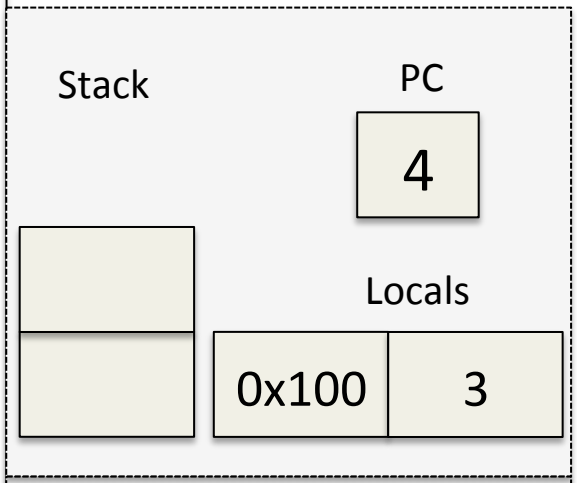


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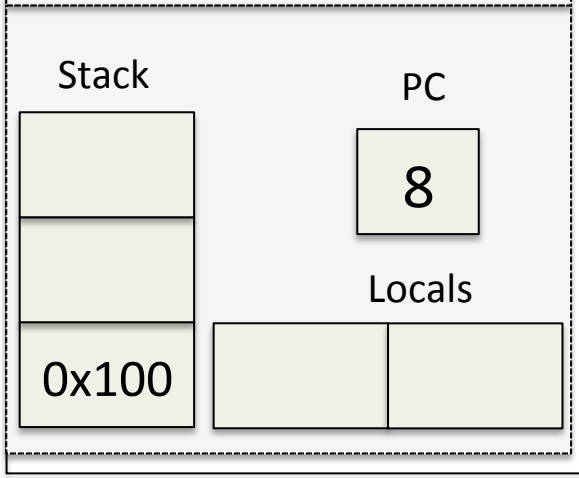


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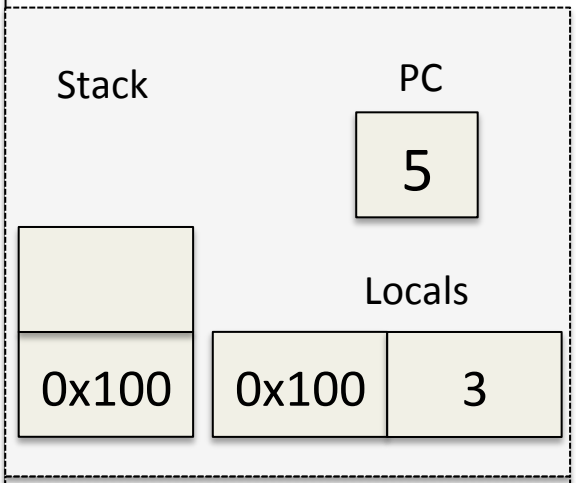


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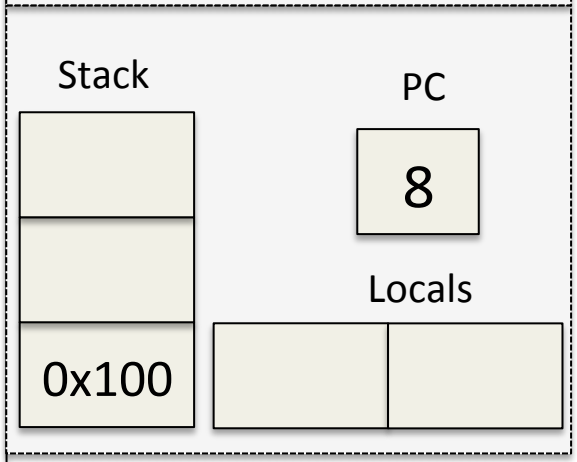


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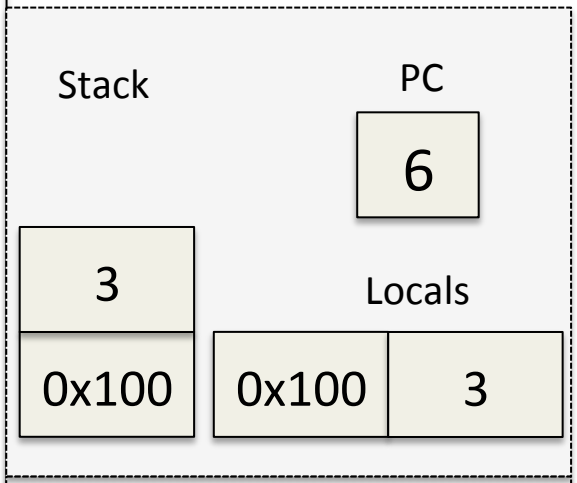


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 9: return
```
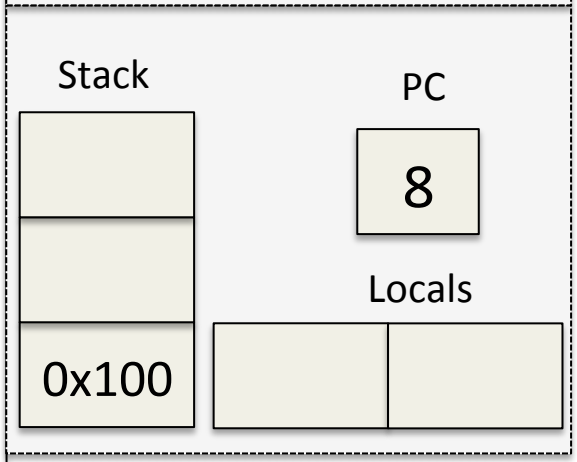
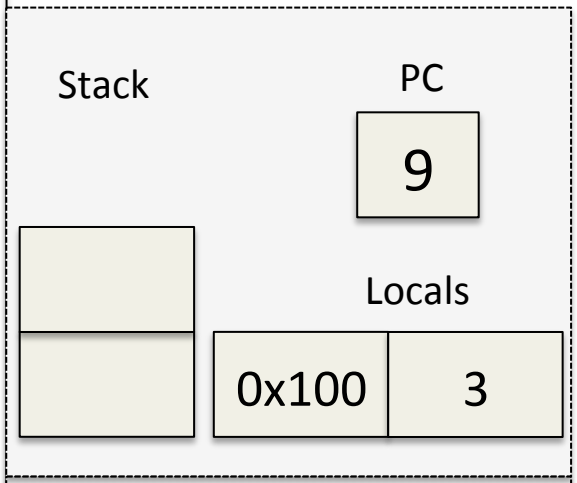
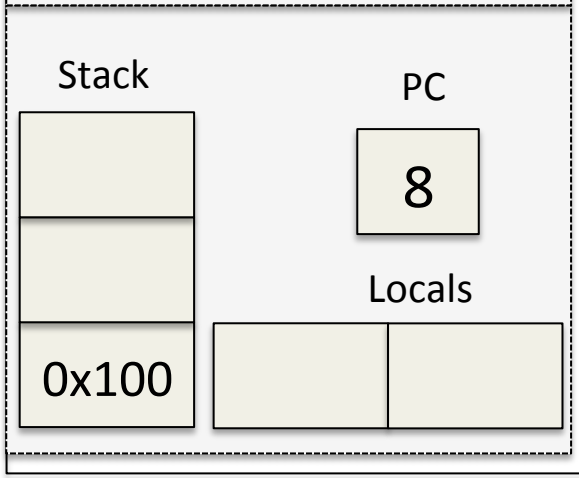




```
public static ClassA getB();
 0: new           // class ClassB
 3: dup
 4: iconst_3
 5: invokespecial // Method ClassB."<init>":(I)V
 8: astore_1
 9: aload_1
10: areturn
```




```
public ClassB(int);
 0: aload_0
 1: invokespecial // Method ClassA."<init>":()V
 4: aload_0
 5: iload_1
 6: putfield      // Field field:I
 9: return
```

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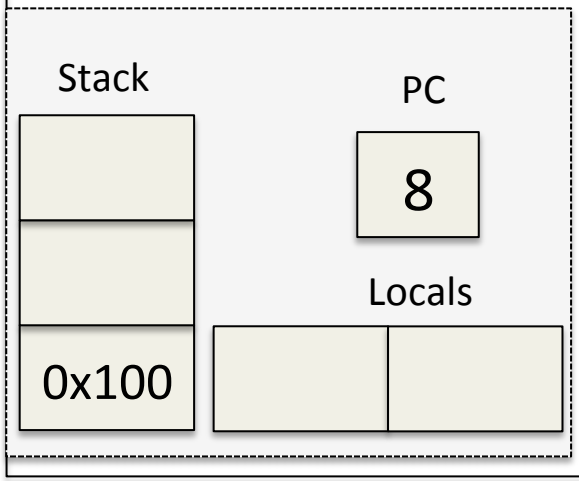


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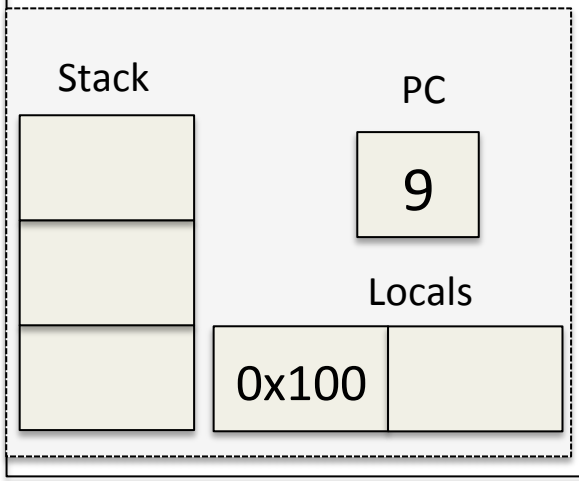


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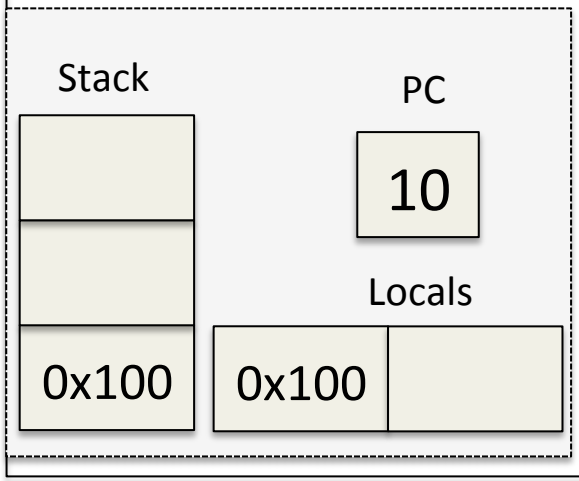


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