COMP90041

Programming and Software Development

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Lab 5

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Outline

- ❖ Static methods & variables
- ❖ Memory
- ❖ Stack & Heap
- ❖ Primitive vs. Class
- ❖ Pass by value
- ❖ Assignment 1 spec
- ❖ Exercises

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Static methods

- A method that belongs to the class, rather than an instance/object of that class
- Declared with:
  - <public | private> static <return type> <method name>(params) {…}
  - E.g. public static void main(String[] args) {…}

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Static methods

- Invoked using the class name, rather than the calling object – e.g.
  - returnedValue = MyClass.myStaticMethod(args);
  - Math.max(); Math.round();
  - Compared to non-static methods: keyboard.nextLine();
- Static methods cannot access non-static (instance) variables or non-static methods
- However, they can access other static variables and static methods

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Static variables

- ❖A variable that belongs to the class, rather than an instance/object of that class
- ❖There is only one copy of a static variable per class, compared to instance variables where each object has its own copy
- ❖All objects of the class can read and change a static variable
- ❖A static variable is declared like an instance variable, but with the modifier static:
  - ❖<public | private> static <return type> <var name>;
  - ❖E.g. private static int myStaticVariable;

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Memory

- ❖ A computer has two forms of memory: Secondary and Main
- ❖ Secondary memory is used to hold files for "permanent" storage – USB, Disk
- ❖ Main memory is used when running a program – e.g. a Java program :)
- ❖ Main memory consists of a long list of numbered locations called bytes, where each byte is 8 bits (e.g. 10100100)

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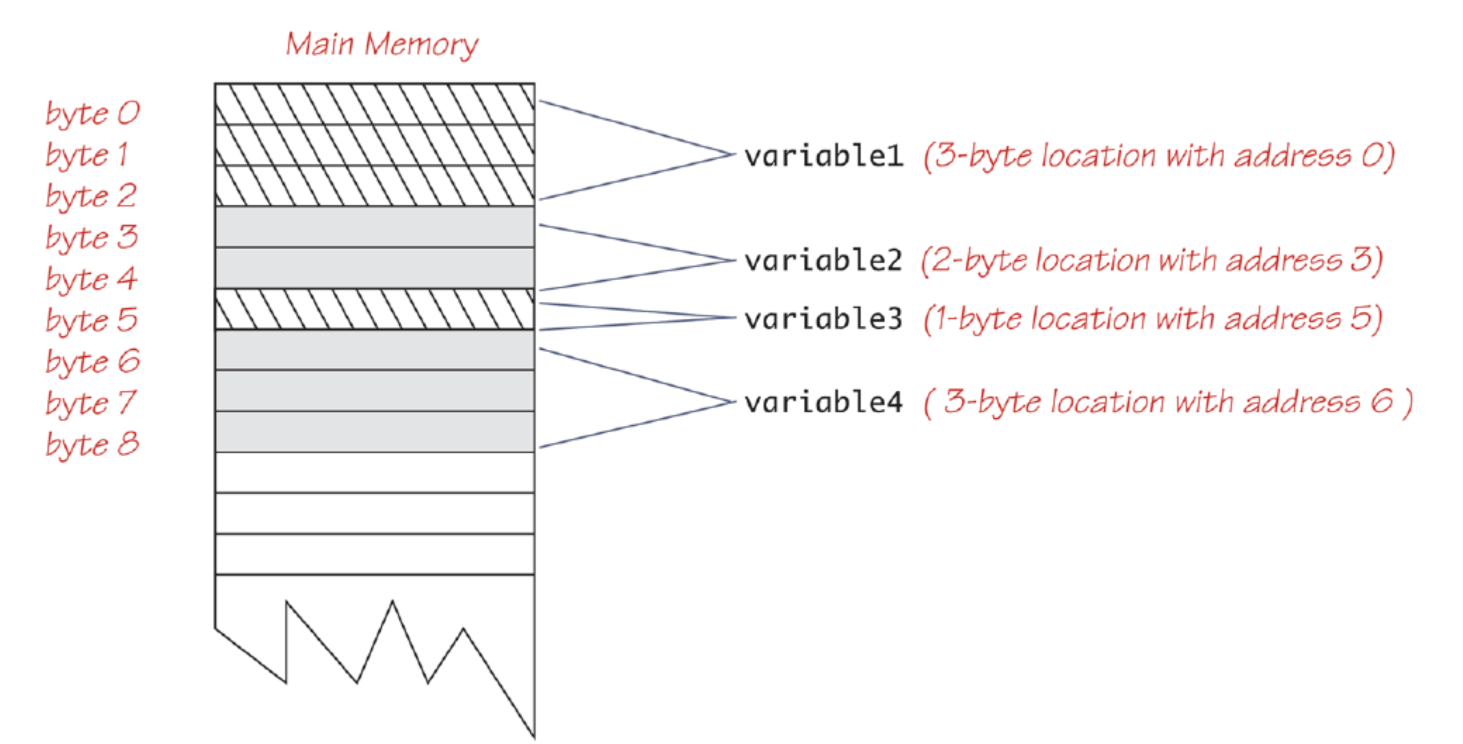
Main Memory

- ❖ The number that identifies a byte is called its address
- ❖ A data item can be stored in one or more of these bytes
- ❖ The address of the byte is used to find the data item
- ❖ Most data types require more than one byte of storage:
  - ❖ In this case, several adjacent bytes are used. The entire chunk of memory is its memory location.
  - ❖ The address of the first byte of this memory is used as the address for the data item

Main Memory

- ❖ A computer's main memory can be thought of as a long list of memory locations of varying sizes

Display 5.10 **Variables in Memory**



Main Memory
byte 0
byte 1
byte 2
byte 3
byte 4
byte 5
byte 6
byte 7
byte 8
variable1 (3-byte location with address 0)
variable2 (2-byte location with address 3)
variable3 (1-byte location with address 5)
variable4 (3-byte location with address 6)

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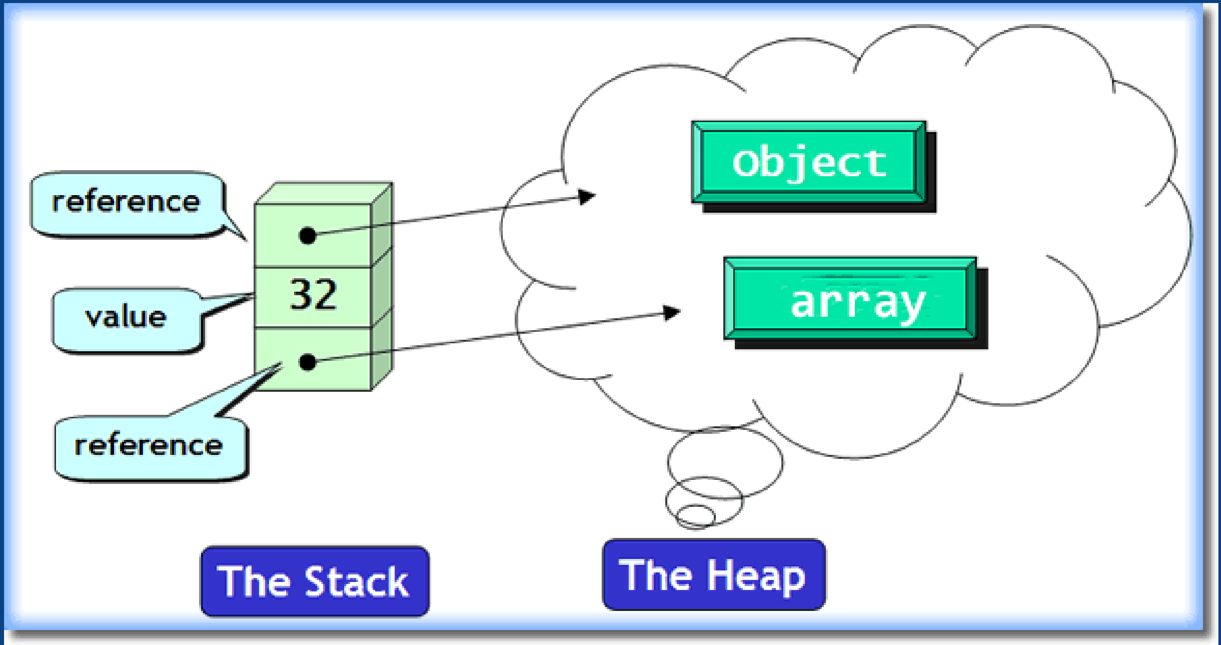
Stack & Heap

- ❖Two types of Main Memory: Stack and Heap
- ❖For primitive typed variables, their values get stored in Stack Memory
- ❖For class-typed variables, their memory address (or reference) where its object is located gets stored in Stack Memory. The object itself is stored in Heap Memory.



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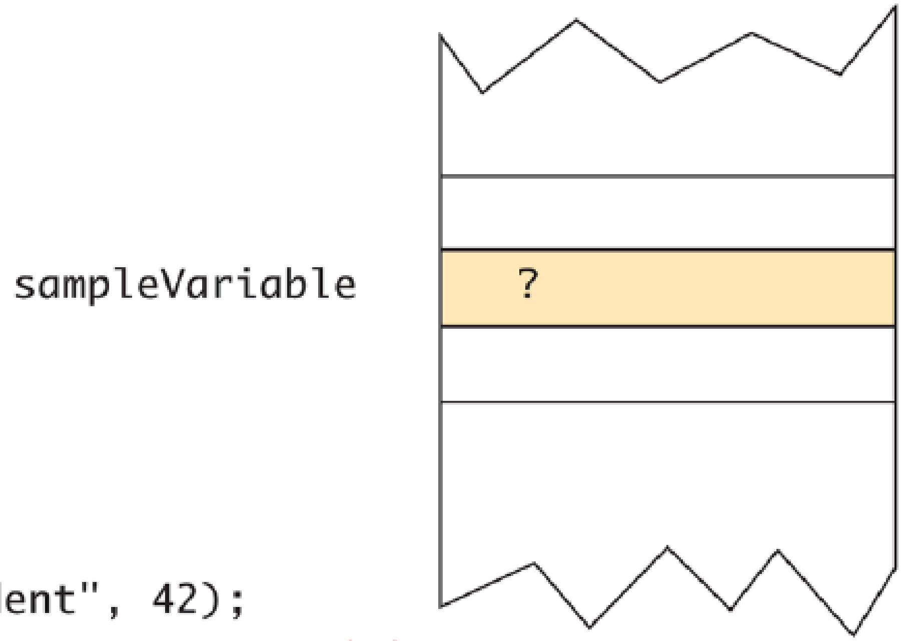
Display 5.12 Class Type Variables Store a Reference

```
public class ToyClass
{
    private String name;
    private int number;
```

The complete definition of the class `ToyClass` is given in Display 5.11.

```
ToyClass sampleVariable;
```

Creates the variable `sampleVariable` in memory but assigns it no value.

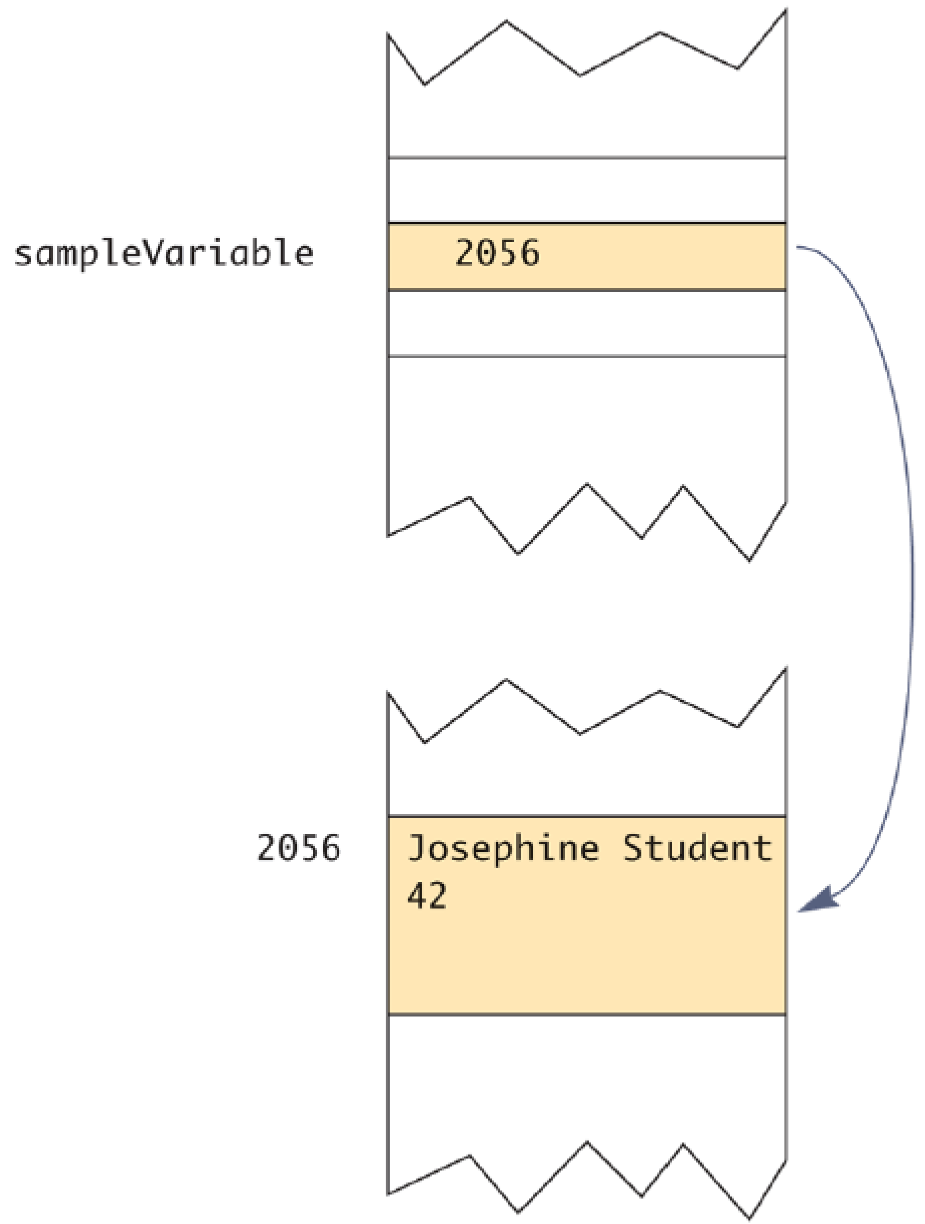


```
sampleVariable =
new ToyClass("Josephine Student", 42);
```

Creates an object, places the object someplace in memory, and then places the address of the object in the variable `sampleVariable`. We do not know what the address of the object is, but let's assume it is `2056`. The exact number does not matter.

(continued)

Display 5.12 Class Type Variables Store a Reference



For emphasis, we made the arrow point to the memory location referenced.

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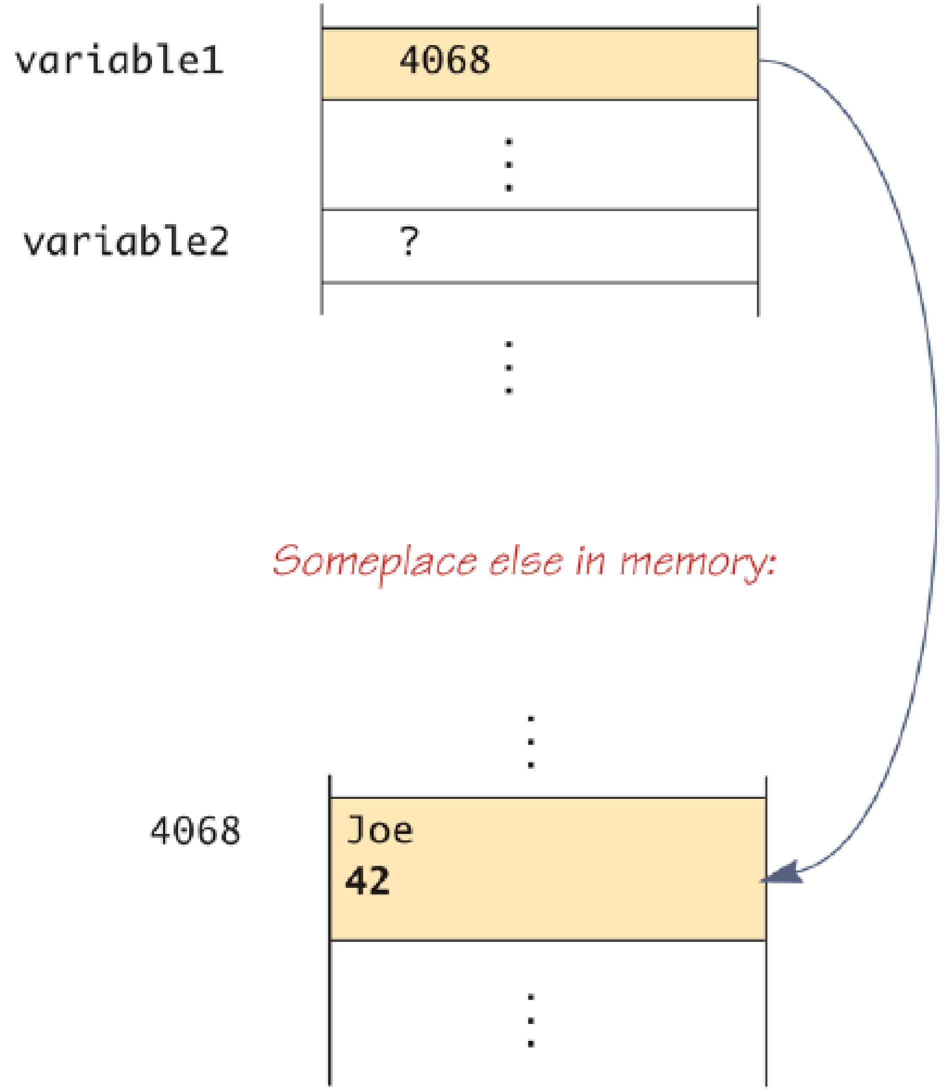
Display 5.13 Assignment Operator with Class Type Variables

```
ToyClass variable1 = new ToyClass("Joe", 42);
ToyClass variable2;
```



We do not know what memory address (reference) is stored in the variable `variable1`*. Let's say it is* `4068`*. The exact number does not matter.*

Note that you can think of

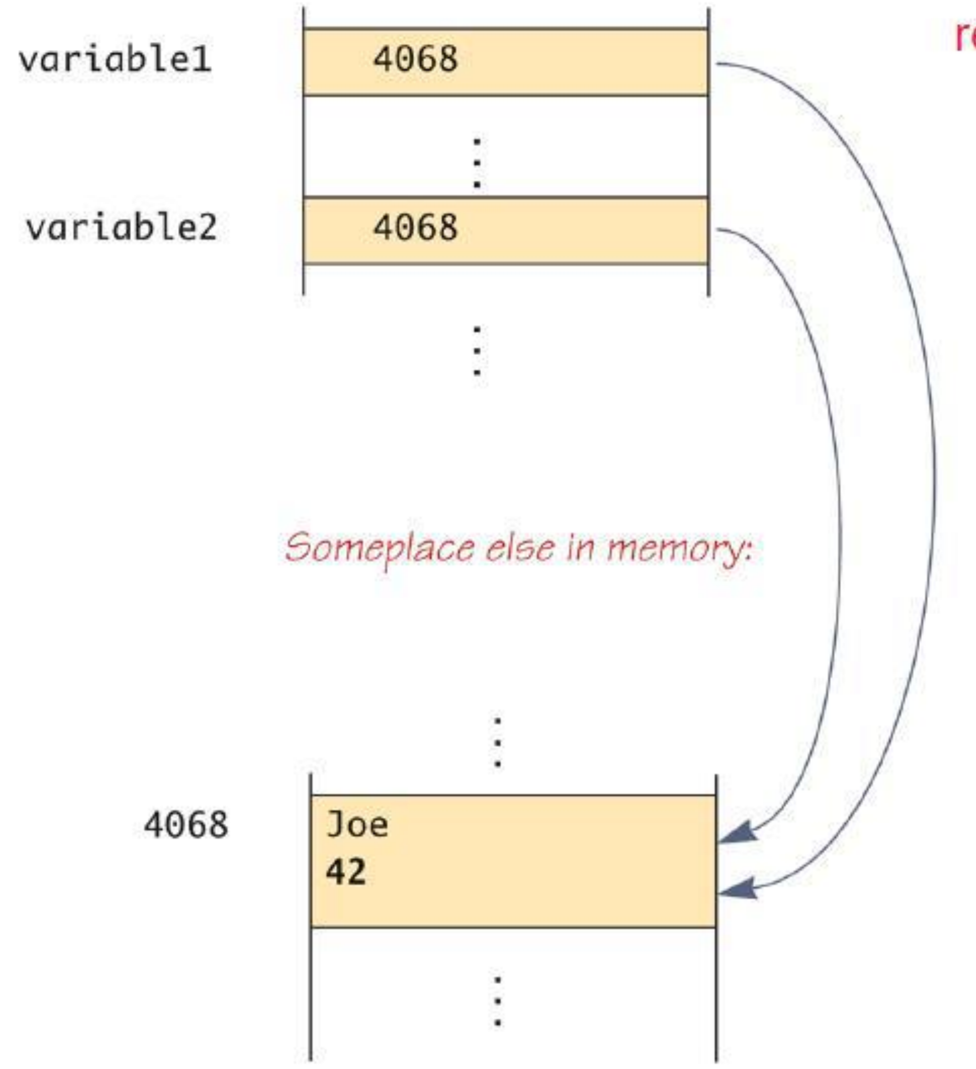
```
new ToyClass("Joe", 42)
```

as returning a reference.

(continued)

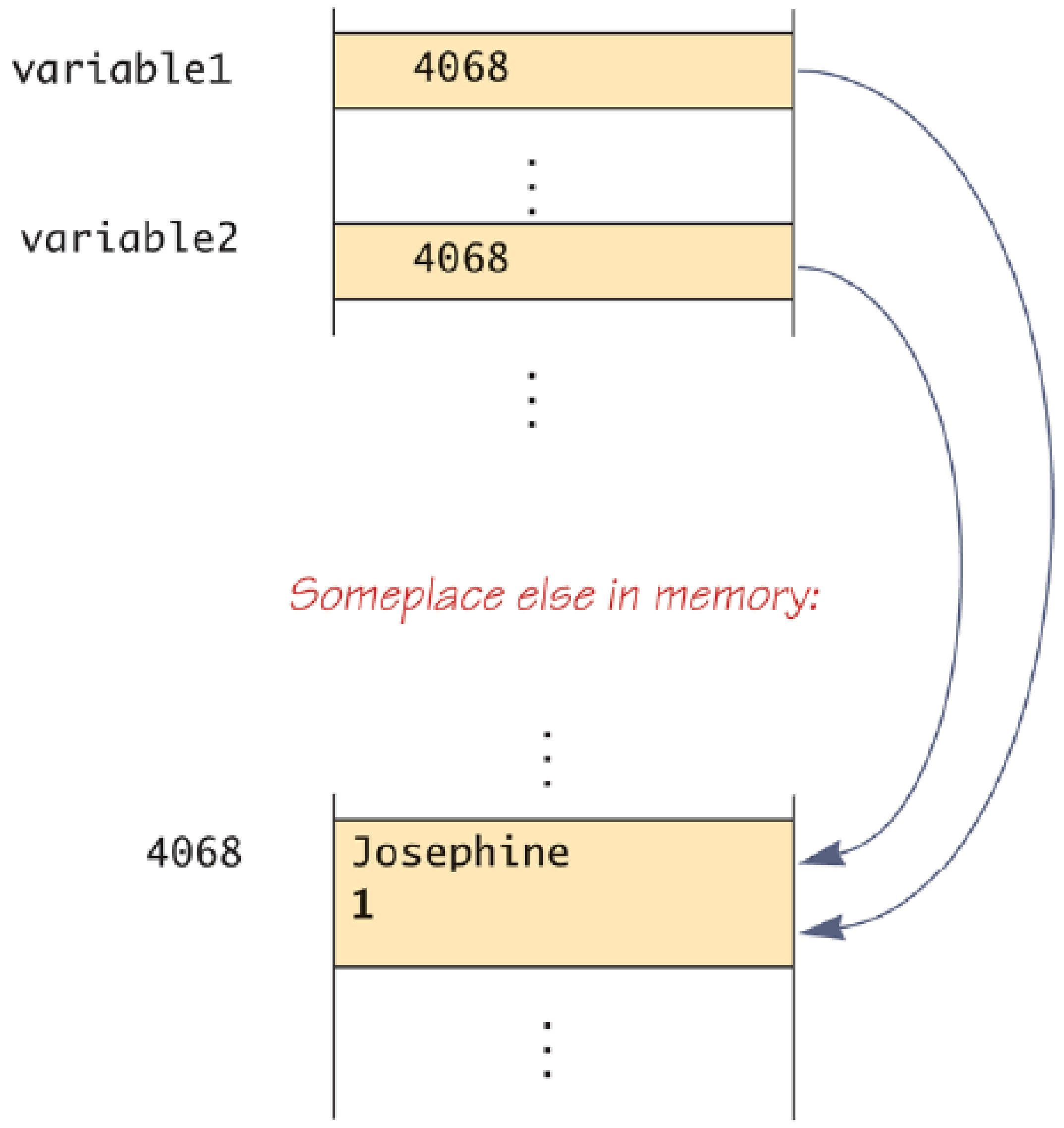
```
variable2 = variable1;
```

refer to the same memory address



(continued)

```
variable2.set("Josephine", 1);
```



the address not change
just the content

Java is Pass by Value

- ❖ Suppose I have an integer (primitive-type) variable num1, an instance of ToyClass toyObject, and a method myMethod
- ❖ int num1 = 10;
- ❖ ToyClass toyObject = new ToyClass();
- ❖ public void myMethod(int n1, ToyClass toy) {n1 = 20;}
- ❖ When I execute the method... myMethod(num1, toyObject);
- ❖ ...The value of num1 (i.e. 10) and the value of toyObject (i.e. the memory address 4068) will be passed to myMethod

Java is Pass by Value

- If we do not want to allow myMethod to change the original contents of our variable toyObject, we can pass a new variable with the copied contents of the object and whose value (memory address) will be different, e.g. using the copy constructor of ToyClass:
  - myMethod(num1, new ToyClass(toyObject);

Assignment 1

- Spec read-through
- Questions

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Exercises