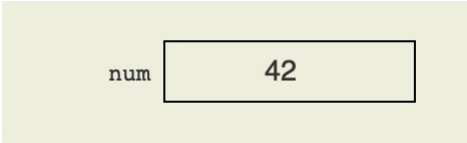
References (pointers) in Java

Data Types in Java

- Primitive Data Types
  - byte, short, int, long, float, double, boolean, char
  - Primitive types variable works like a box that can store a single value
  - Example: `int num = 42;`



Data Types in Java

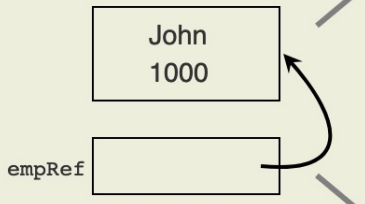
- References
  - Reference variable **does not store a simple value directly**
  - Reference variable **stores a *reference* to some *object***
  - The object that the reference refers to is known as its ***pointee***

Data Types in Java

- References
  - Example:

```
Employee empRef = new Employee("john", 1000);
```

```
public class Employee {
  private String name;
  private int salary;
  public Employee(String name,  int salary) {
    this.name = name;
    this.salary = salary;
  }
…
}
```



A simple `Employee` object. The current value is the string `John` for the name and 1000 for the salary. This object also plays the role of pointee for `empRef`.

A reference variable. The current value is a reference to the `Employee` object in the box above.

Dereferencing

- Dereferencing:
  - Accessing the value of the ***pointee*** for some ***reference*** variable
  - Is done with the **"dot" (.)** operator to access a field or method of an object

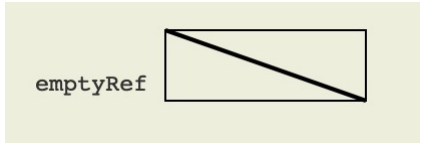
Dereferencing

- Dereferencing:
  - dereferencing **empRef** in the previous slide gives back its pointee, the Employee object
  - `String myName = empRef.getName();`

    dereferences `empRef` to call the `getName` method for that object

Referencing

- **A reference must be assigned a pointee** before dereference operations will work.
- Not assigning a pointee to a reference will cause a `NullPointerException`
- `null`: special reference value that encodes the idea of *"points to nothing".*
    - Initial value of references

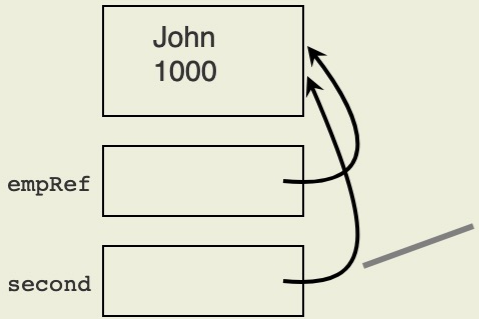


Reference Assignments

- An assignment (using equals) of one reference to another makes them point to the same pointee
  - Example:

```
Employee empRef = new Employee("john", 1000);

Employee second = empRef;
```

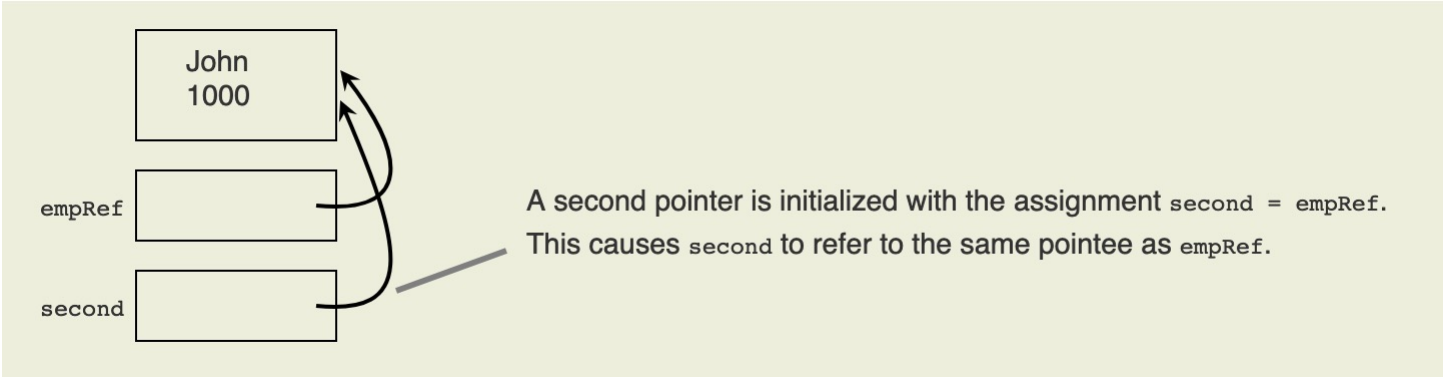


A second pointer is initialized with the assignment `second = empRef`.
This causes `second` to refer to the same pointee as `empRef`.

After the assignment, testing for `second == empRef` would return `true`

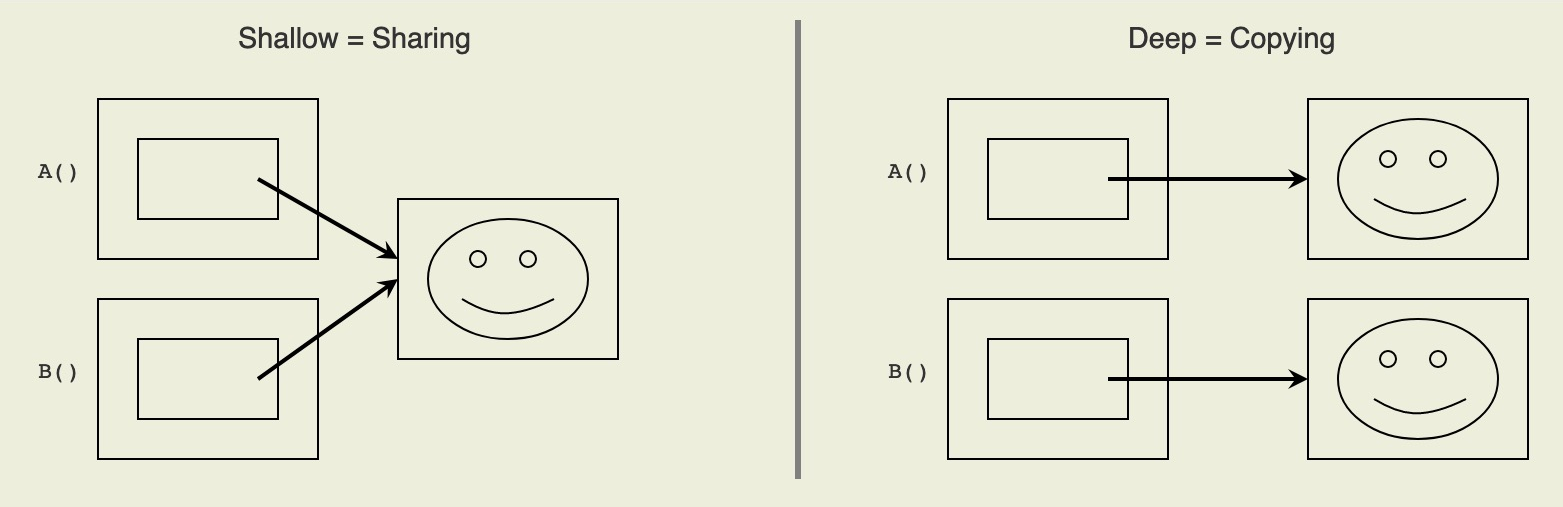
Sharing

- Two references which both refer to a single pointee are said to be **sharing**
- Each (shared reference) is an **alias** for the other



Shallow and Deep Copying

- Shallow copy (of a reference) is achieved through sharing
- Deep copy creates a new copy of the pointee



Shallow and Deep Copying Example

```
Employee firstEmployee = new Employee("Sam");
Employee shallowCopyEmployee = firstEmployee;
shallowCopyEmployee.setName("John");
System.out.println(firstEmployee.getName());
Employee secondEmployee = new Employee("Patrice");
Employee deepCopyEmployee = new Employee();
deepCopyEmployee.setName(secondEmployee.getName());
deepCopyEmployee.setName("John");
System.out.println(secondEmployee.getName());
```

alias

update alias

// John

deep copy

update deep copy

// Patrice

Shallow and Deep Comparing

- Double equals (==) checks **if two reference variables are referencing the same object**
  - Returns `true` for shallow copies
    - `firstEmployee == shallowCopyEmployee`
  - Returns `false` for deep copies
    - `secondEmployee == deepCopyEmployee`
- The **equals** method checks **if the values (data fields) of the two objects are the same**
  - Returns `true` for shallow copies
    - `firstEmployee.equals(shallowCopyEmployee)`
  - Returns `true` for deep copies
    - `secondEmployee.equals(deepCopyEmployee)`

```
public class Employee {
  private String name;
  private int salary;
  public Employee(String name,  int salary) {
    this.name = name;
    this.salary = salary;
  }
…
}
```

```
public boolean equals(Employee emp) {
    if(this == emp)
       return true;
    else{
       return this.name == emp.name &&
            this.salary == emp.salary;
    }
…
}
```