CMSC 131
Object-Oriented Programming I

Privacy Leaks, Copying Objects

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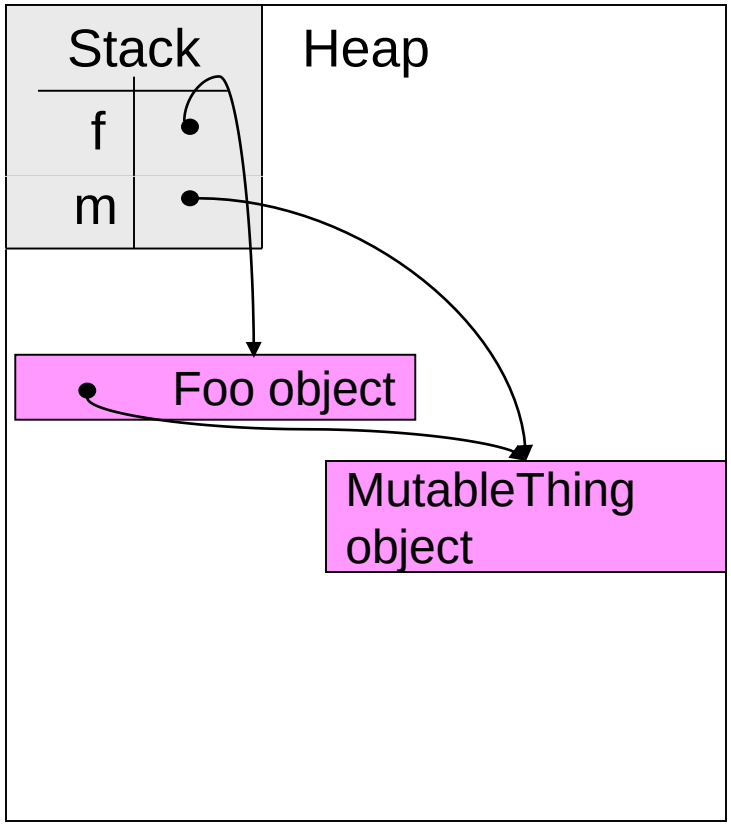
This material is based on material provided by Ben Bederson, Bonnie Dorr, Fawzi Emad, David Mount, Jan Plane

Privacy Leaks

```
public class MutableThing {
    …
    public void mutateMe() {…};
}
public class Foo {
    private MutableThing q
            = new MutableThing();
        …
    public MutableThing getQ(){
        return q;
    }
}
```



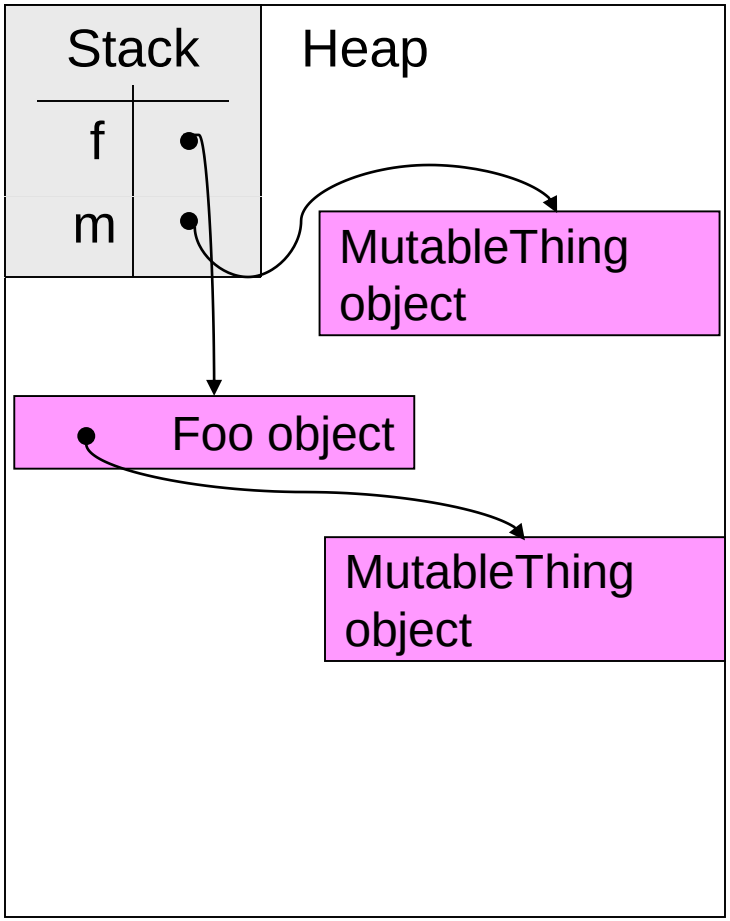
- Consider following code
  Foo f = new Foo ();
  MutableThing m = f.getQ();
  m.mutateMe();
- After this executes, what happens?
- This phenomenon is called a privacy leak
  - Private instance variables can be modified outside class
  - Behavior is due to aliasing
- **Example:** privacyLeak package

Fixing Privacy Leaks

- Return copies of objects referenced by instance variables
- To fix getQ method in Foo:

```
MutableThing getQ(){
   return new MutableThing(q);
}
```

- This returns a copy of q
- Changes made to this copy will not affect original

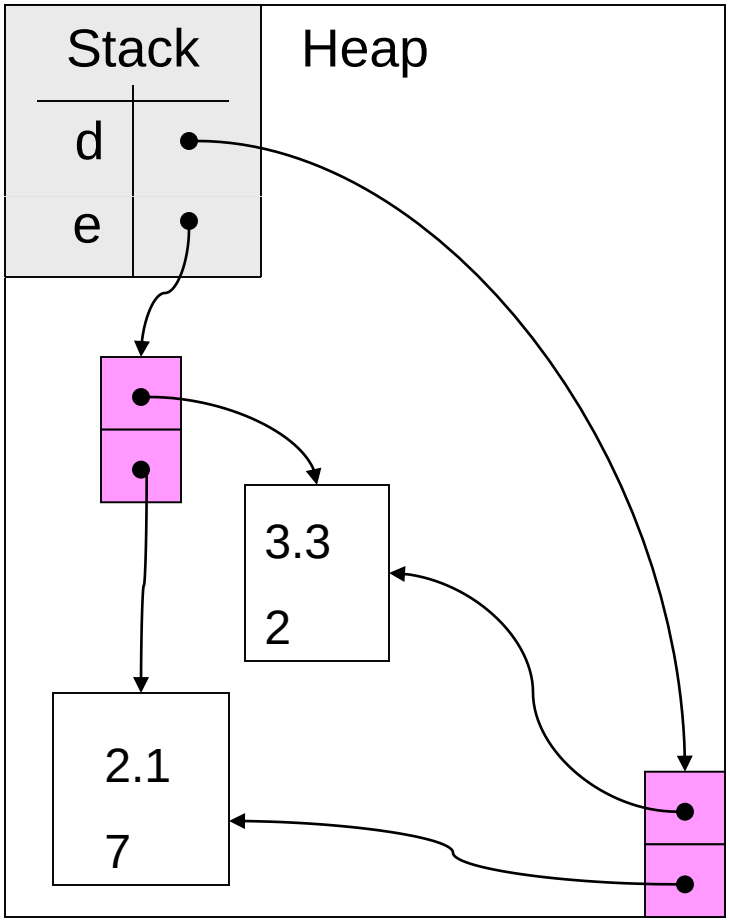


Copying Objects

- We can define three ways to copy objects
  - Shallow Copying
  - Reference Copying
  - Deep Copying
- Let's see examples in the context of arrays

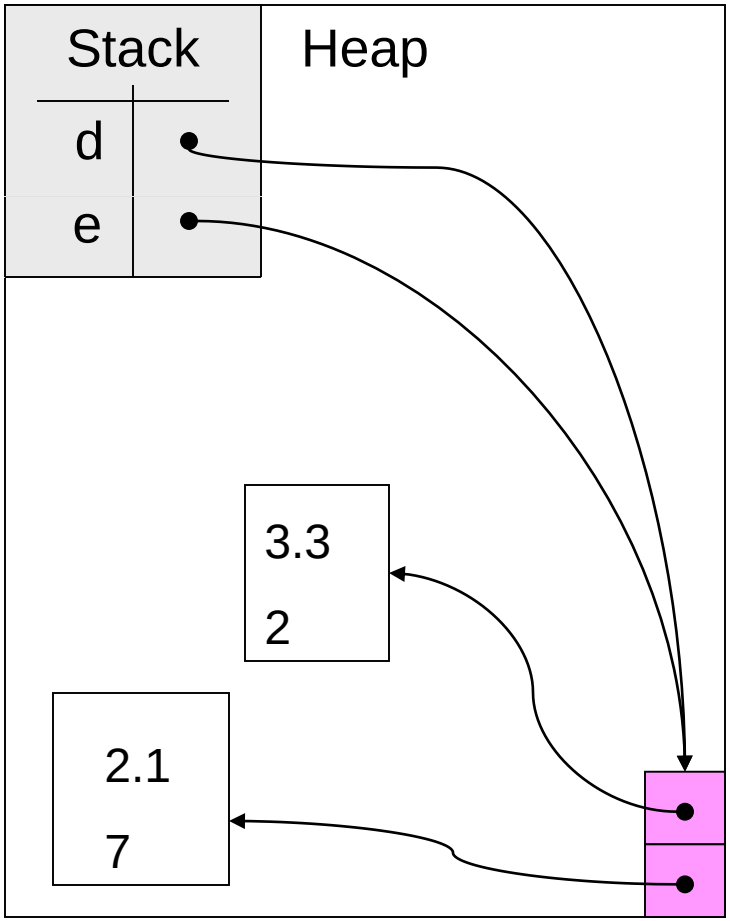
Shallow Copying

```
Person[] d = {
    new Person(2.1,7, …),
    new Person(3.3,2, …)
};

Person[] e = new Person[d.length];
for (int i = 0; i < d.length; i++){
    e[i] = d[i];
}
```



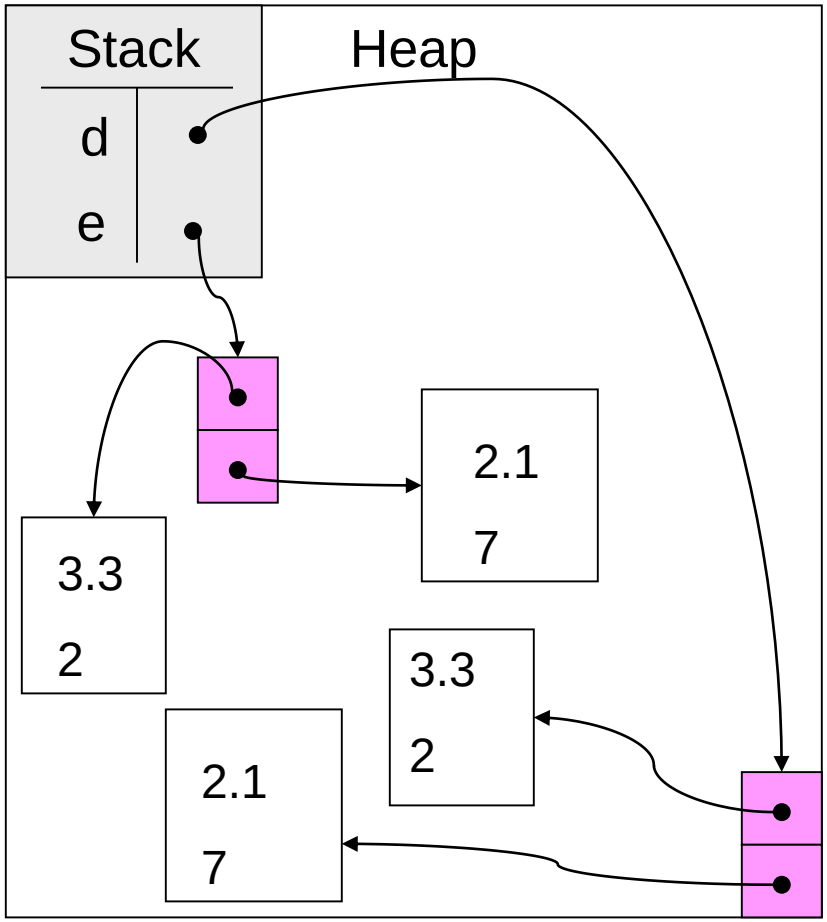
Reference Copying

```
Person[] d = {
    new Person(2.1,7, …),
     new Person(3.3,2, …)
};

Person[] e = d;
```



Deep Copying

```
Person[] d = {
    new Person(2.1,7,...),
    new Person(3.3,2,...)
};

Person[] e = new Person[d.length];
for (int i = 0; i < d.length; i++) {
    e[i] = new Person(d[i]);
}
```



Example

- **Example:** cdexample package

When to Use What kind of Copying?

- Deep copying provides maximal protection against aliasing (but takes a lot of time and space if it is not necessary)
- Storage space and time used
  - Reference → least
  - Shallow → middle
  - Deep → most
- If the class is mutable, aliasing is something to be avoided and you must have true copies to prevent privacy leaks and modifications outside
- If you know the class is immutable, aliasing doesn't hurt but neither does making true copies (except wasted space and time)
- If storage is an issue, aliasing problems may be worth copying with but must be well documented