CMSC 131
Object-Oriented Programming I

PrivacyLeaks, 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

Consider the following code:

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

- Consider following code
  ```java
  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:

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

Person[] e = d;

Reference Copying
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