Lecture 15 - Oct. 31

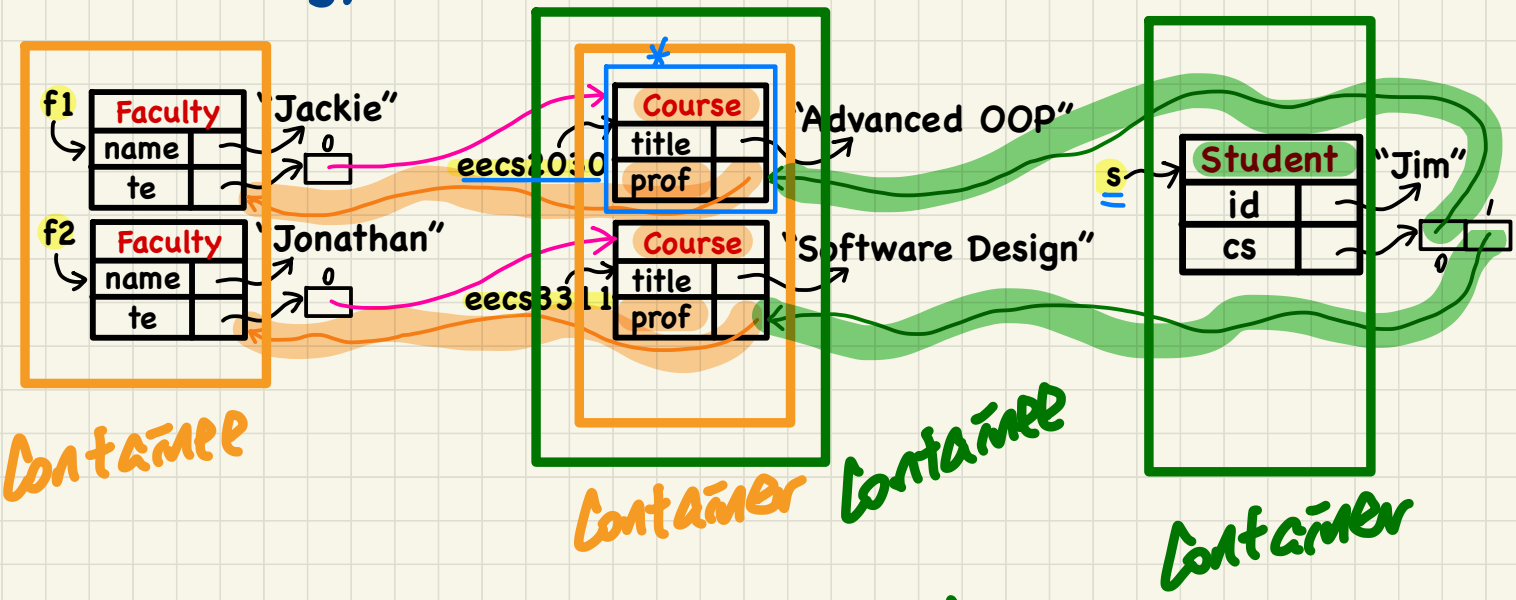
Aggregation and Composition

Modelling: Aggregation vs. Composition
Dot Notation Exercise
Copy Constructor, Shallow Copy

Announcements/Reminders

- Lab3 due tomororw at noon
- Lab4 to be released tomorrow
- ProgTest2 results & feedback tentatively Monday Nov 11

Terminology: Container vs. Containee



sharing : aliasing

* f1.te[0] sharing. (==) (T)
s.cs[0]

aggregation : sharing/aliasing

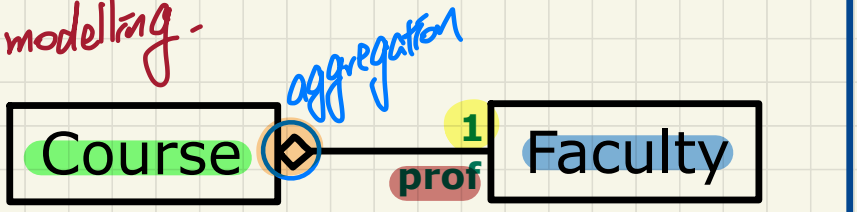
composition : little/none sharing

Aggregation: Design

composition

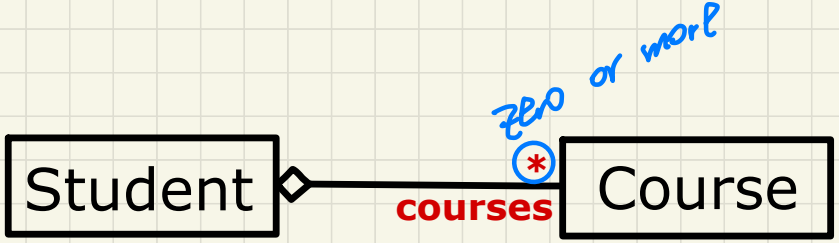
Design 1: Single Containee

modelling.



A course has, by aggregation, a single faculty as its prof.

Design 2: Multiple Containees



Java Implementation

programming

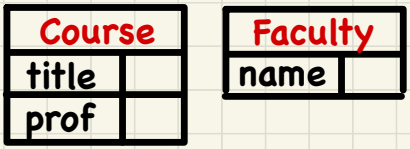
```
class Course {
   Faculty prof;
   ...
}
```

```
class Faculty {
   ...
}
```

```
class Student {
   Course[] courses;
   ...
}
```

```
class Course {
   ...
}
```

Aggregation (1)




```java
class Course {
  String title;
  Faculty prof;
  Course(String title) {
    this.title = title;
  }
  void setProf(Faculty prof) {
    this.prof = prof;
  }
  Faculty getProf() {
    return this.prof;
  }
}
```

```java
class Faculty {
  String name;
  Faculty(String name) {
    this.name = name;
  }
  void setName(String name) {
    this.name = name;
  }
  String getName() {
    return this.name;
  }
}
```

```java
@Test
public void testAggregation1() {
  Course eecs2030 = new Course("Advanced OOP");
  Course eecs3311 = new Course("Software Design");
  Faculty prof = new Faculty("Jackie");
  eecs2030.setProf(prof);
  eecs3311.setProf(prof);
  assertTrue(eecs2030.getProf() == eecs3311.getProf());
  /* aliasing */
  prof.setName("Jeff");
  assertTrue(eecs2030.getProf() == eecs3311.getProf());
  assertTrue(eecs2030.getProf().getName().equals("Jeff"));

  Faculty prof2 = new Faculty("Jonathan");
  eecs3311.setProf(prof2);
  assertTrue(eecs2030.getProf() != eecs3311.getProf());
  assertTrue(eecs2030.getProf().getName().equals("Jeff"));
  assertTrue(eecs3311.getProf().getName().equals("Jonathan"));
}
```

Aggregation (2)


```java
public class Student {
  private String id; Course[] cs; int noc; /* # of courses */
  public Student(String id) { ... }
  public void addCourse(Course c) { ... }
  public Course[] getCS() { ... }
}
```

```java
public class Course { private String title; private Faculty prof; }
```

```java
public class Faculty {
  private String name; Course[] te; int not; /* # of teaching */
  public Faculty(String name) { ... }
  public void addTeaching(Course c) { ... }
  public Course[] getTE() { ... }
}
```

```java
@Test
public void testAggregation2() {
  Faculty p = new Faculty("Jackie");
  Student s = new Student("Jim");
  Course eecs2030 = new Course("Advanced OOP");
  Course eecs3311 = new Course("Software Design");
  eecs2030.setProf(p);
  eecs3311.setProf(p);
  p.addTeaching(eecs2030);
  p.addTeaching(eecs3311);
  s.addCourse(eecs2030);
  s.addCourse(eecs3311);

  assertTrue(eecs2030.getProf() == s.getCS()[0].getProf());
  assertTrue(s.getCS()[0].getProf()
             == s.getCS()[1].getProf());
  assertTrue(eecs3311 == s.getCS()[1]);
  assertTrue(s.getCS()[1] == p.getTE()[1]);
}
```

Dot Notation: Private Attributes/Fields

Principle: **Private** attribute is accessible if the **context object**'s type matches the **context class** (where the method is defined).

```
class X {
  ...
  exp.privateAtt
  ...
}
```

X ✓
Y ✗

```
public class A {
    private B ob;
    private int ai;
    public B getB() { return this.ob; }
    public int getAi() { return this.ai; }
    public int am() {
        int result;
        result = this.ai;
        result = this.getAi();
        result = this.ob.bi;
        result = this.getB().bi;
        result = this.ob.getBi();
        result = this.getB().getBi();
        result = this.ob.getA().ai;
        result = this.ob.getA().getAi();
        result = this.ob.oa.ai;
        result = this.ob.oa.getAi();
        return result;
    }
}
```

① this.ob.bi
② this.ob.getA().ai

Context: A
X
B

① ✓ this.ob.bi
Context path
ob declared in A

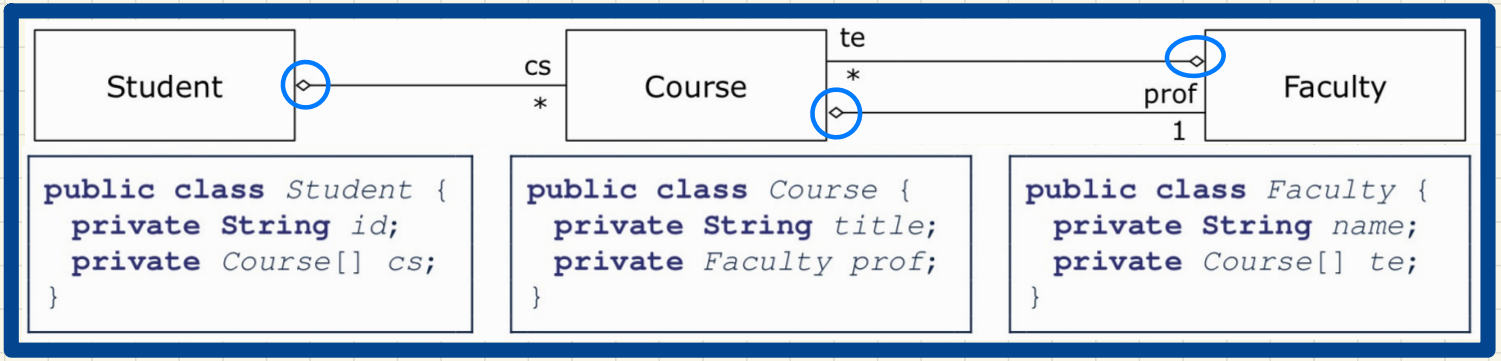
② this.ob.getA().ai
B
A
private

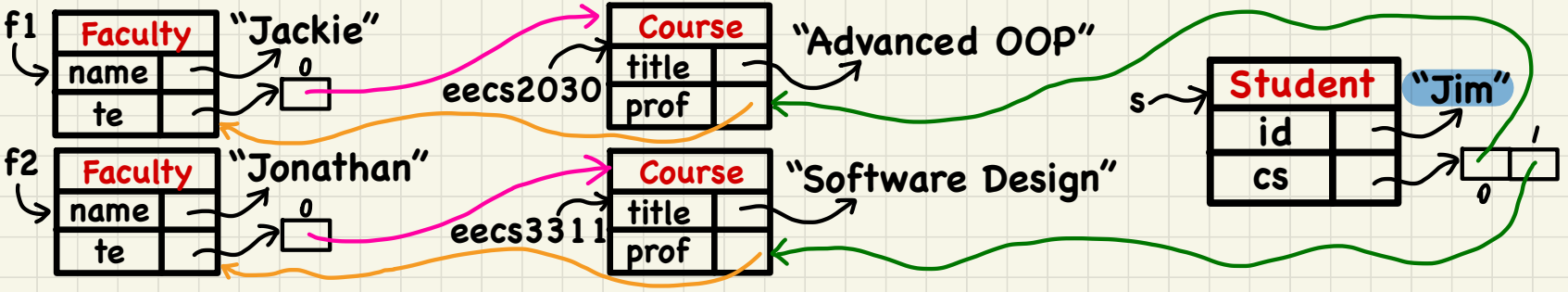
```
public class B {
    private A oa;
    private int bi;

    public A getA() {
        return this.oa;
    }

    public int getBi() {
        return this.bi;
    }
}
```

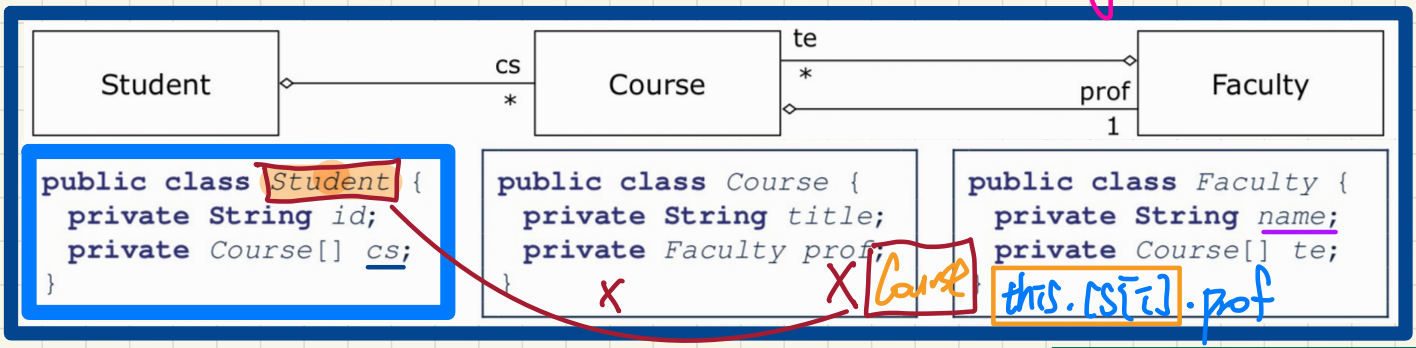
Runtime Object Structure: Student, Course, Faculty





Dot Notation for Navigating Classes (1)

*s.getName(1) → Jonathan.



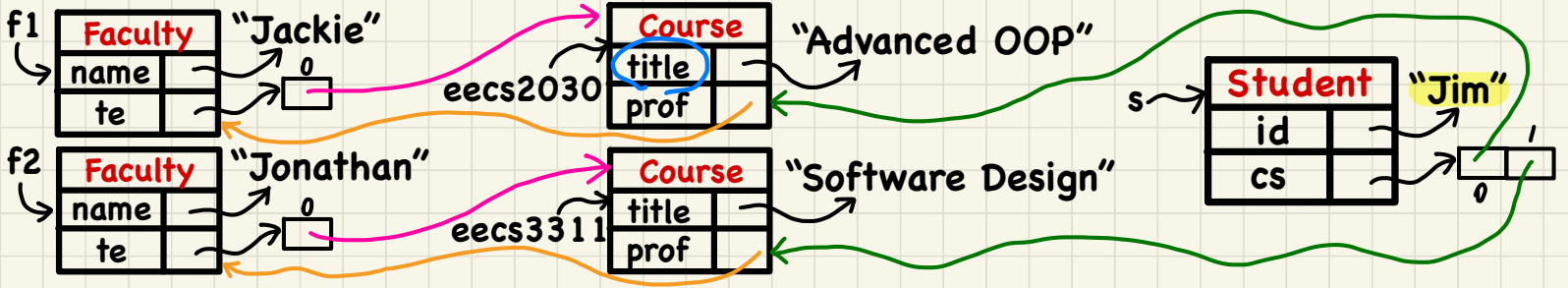

```
/* Get the student's id.
 */
String getID() {
    this.id        this.getId()
}
```

```
/* Title of ith course
 */
String getTitle(int i) {
    this.cs[i].title    this.getCourse(i).getTitle()
}
```

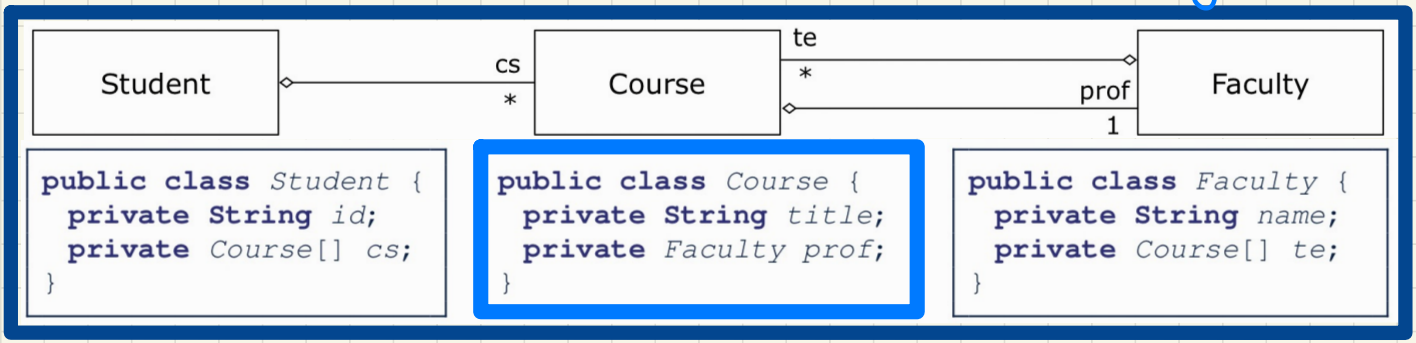
s.getTitle(0)

```
/* Name of
 * ith course's instructor
 */
String getName(int i) {
    this.cs[i].getProf().getName()
}
```

prof? name ?



Dot Notation for Navigating Classes (2) eecs3311.getTitle(0)



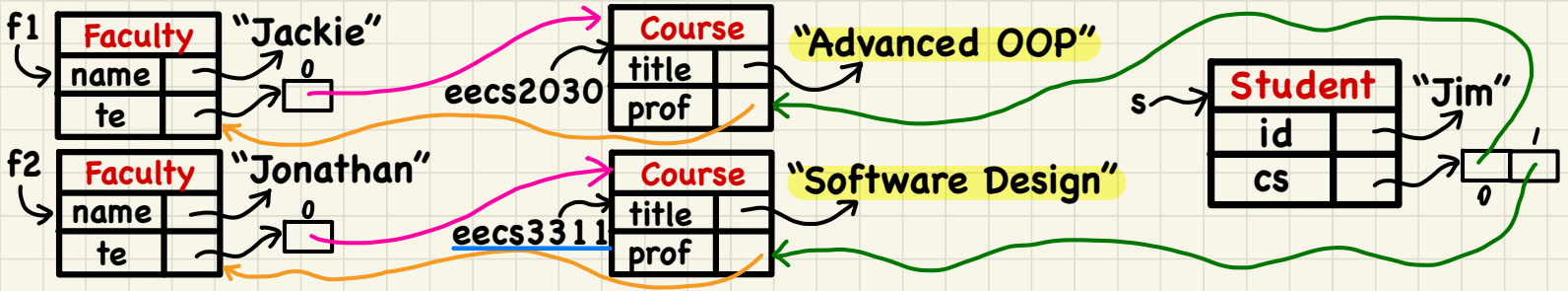

```
/* Get course's title.
 */
String getTitle() {


}
```

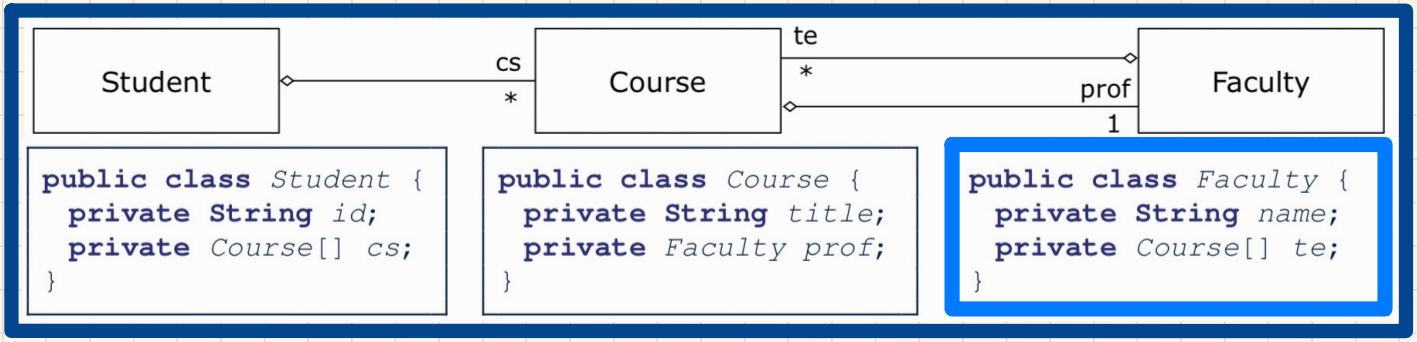
```
/* Name of instructor
 */
String getName() {


}
```

```
/* Title of instructor's
 * ith teaching course
 */*
String getTitle(int i) {
this.prof.getTe()[i].title
}
```



Dot Notation for Navigating Classes (3)

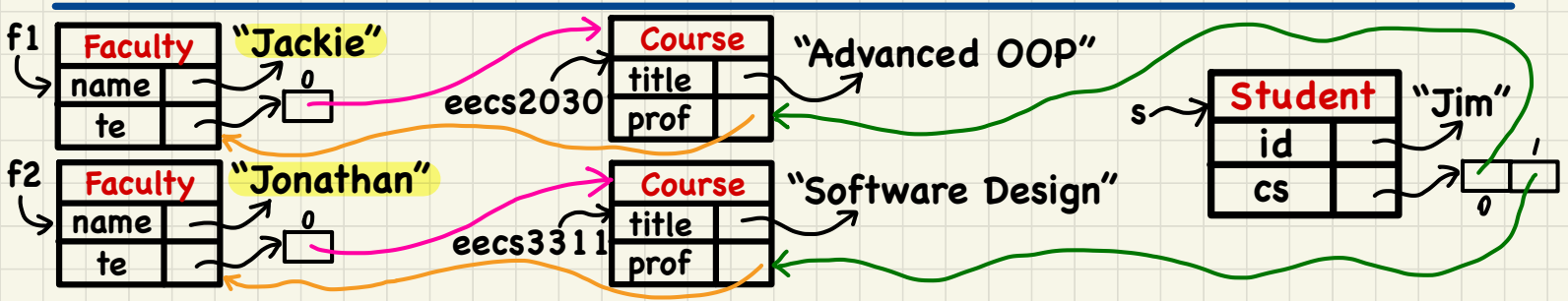



```
/* Name of instructor
 */
String getName() {


}
```

```
/* Title of instructor's
 * ith teaching course
 */
String getTitle(int i) {


}
```



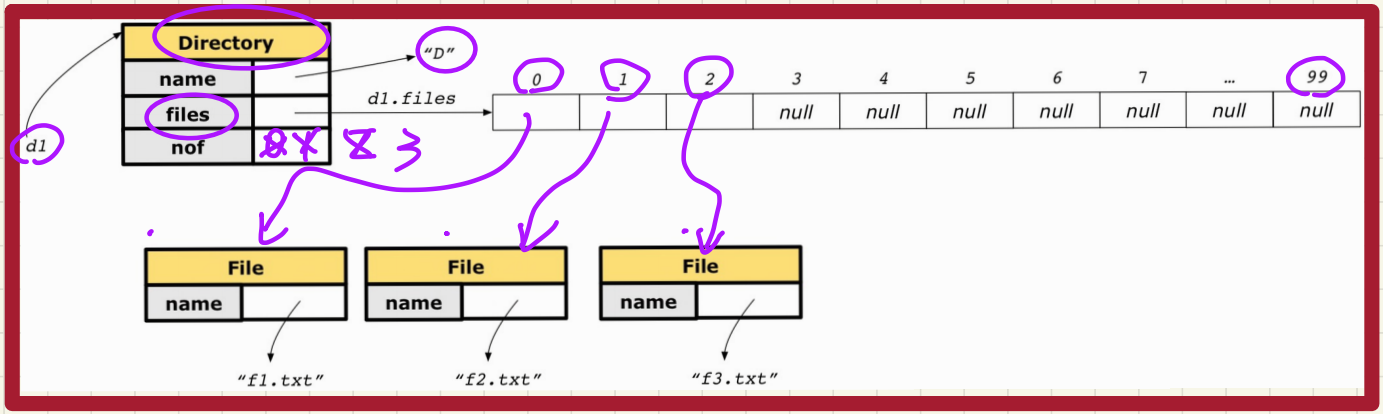
Composition: No Sharing

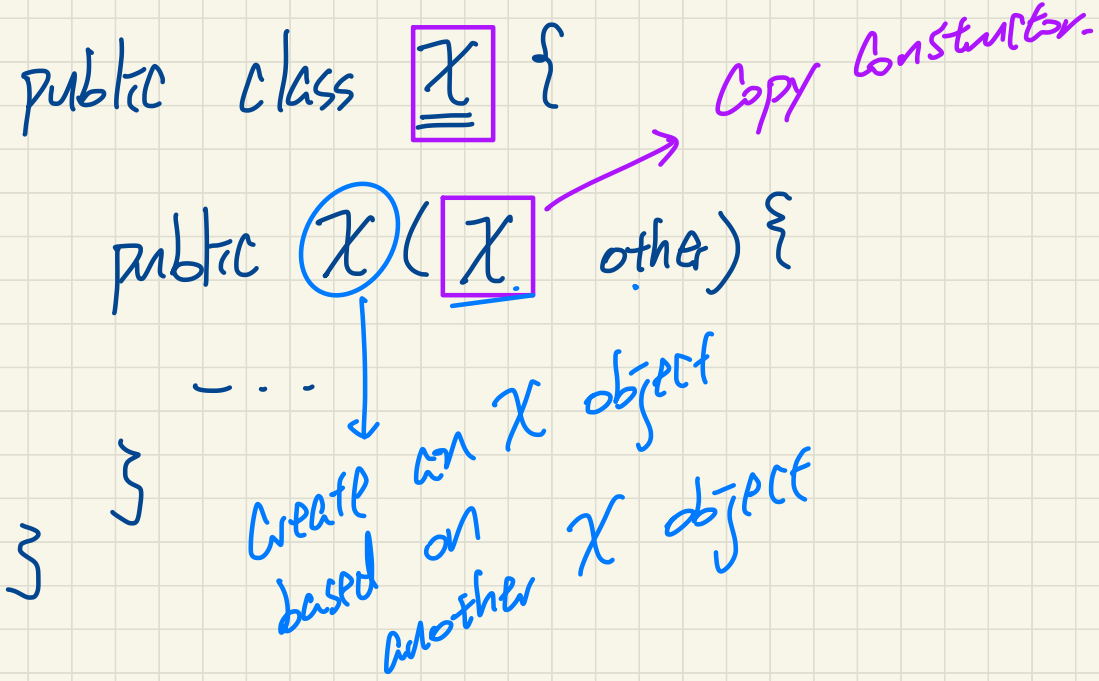
```
class Directory {
  String name;
  File[] files;
  int nof; /* num of files */
  Directory(String name) {
    this.name = name;
    files = new File[100];
  }
  void addFile(String fileName) {
    files[nof] = new File(fileName);
    nof ++;
  }
}
```

```
class File {
  String name;
  File(String name) {
    this.name = name;
  }
}
```

```
public File[] getFiles() {
  return this.files;
}
```

```
1  @Test
2  public void testComposition() {
3    Directory d1 = new Directory("D");
4    d1.addFile("f1.txt");
5    d1.addFile("f2.txt");
6    d1.addFile("f3.txt");
7    assertTrue(
8      d1.files[0].name.equals("f1.txt"))
9  }
```




public class X {
public X(X other) {
...
}
}
Copy constructor.
Create an X object based on another X object

Composition: Copy Constructor (Shallow Copy)

```java
@Test
public void testShallowCopyConstructor() {
  Directory d1 = new Directory("D");
  d1.addFile("f1.txt"); d1.addFile("f2.txt"); d1.addFile("f3.txt"
  Directory d2 = new Directory(d1);
  assertTrue(d1.files == d2.files);
  d2.files[0].changeName("f11.txt");
  assertFalse(d1.files[0].name.equals("f1.txt")); }
```

```java
class Directory {
  String name;
  File[] files;
  int nof; /* num of files */
  Directory(Directory other) {
    /* value copying for primitive type */
    nof = other.nof;
    /* address copying for reference type */
    name = other.name; files = other.files; }
```