Lecture 15 - July 3

Object Equality, Inheritance

equals: Person vs. PersonCollector
Design: Cohesion, Single-Choice Principle
SMS: 1st Design Attempt

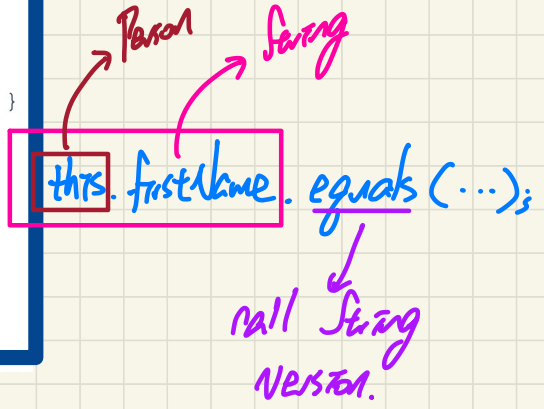
Announcements/Reminders

- Today's class: notes template posted
- On-demand extra TA help hours
- WrittenTest1 released
- ProgTest1 result to be released
- ProgTest2 (July 11) be released
  + Guide: Friday (July 4)
  + PracticeTest: Monday (July 7)
  + Review Session: Wednesday (July 9)
- Lab4 to be released next Monday
- Priorities:
  + Lab3 solution

PT3

Exercise: Two Persons are equal if their names and measures are equal

```
1  public class Person {
2    private String firstName; private String lastName;
3    private double weight; private double height;
4    public boolean equals(Object obj) {
5      if(this == obj) { return true; }
6      if(obj == null || this.getClass() != obj.getClass()) { return false; }
7      Person other = (Person) obj;
8      return
9          this.weight == other.weight
10       && this.height == other.height
11       && this.firstName.equals(other.firstName)
12       && this.lastName.equals(other.lastName);
13   }
14 }
```



exercises

Q1: At Line 6, will there be a **NullPointerException** if obj == **null**?

Q2: At Line 6, what if we change it to:

if(**this**.*getClass*() != obj.*getClass*() || obj == **null**)

Q3: At Lines 11 & 12 which version of the **equals** method is called?

Exercise: PersonCollectors are equal if their arrays of persons are equal

```
class PersonCollector {
  private Person[] persons;
  private int nop; /* number of persons */
  public PersonCollector() { ... }
  public void addPerson(Person p) { ... }
  public int getNop() { return this.nop; }
  public Person[] getPersons() { ... }
}
```

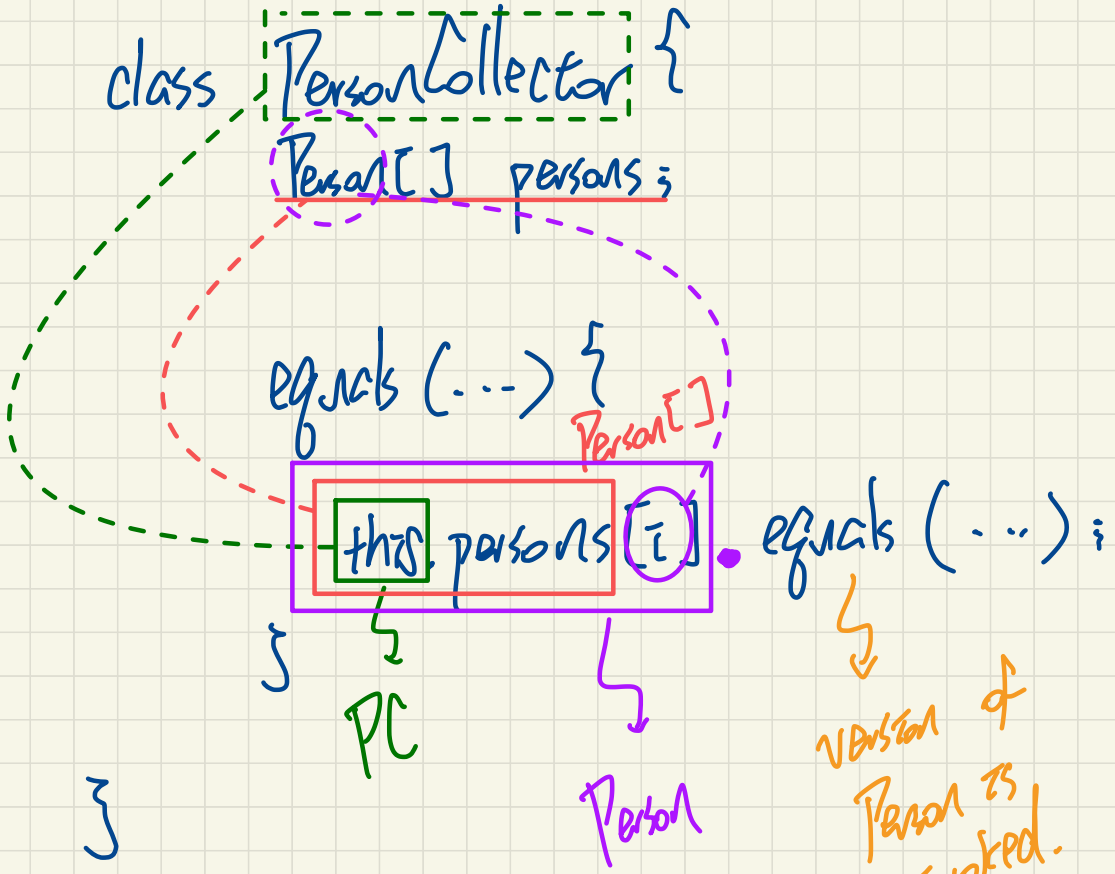
```
1  public boolean equals(Object obj) {
2    if(this == obj) { return true; }
3    if(obj == null || this.getClass() != obj.getClass()) { return false; }
4    PersonCollector other = (PersonCollector) obj;
5    boolean equal = false;
6    if(this.nop == other.nop) {
7      equal = true;
8      for(int i = 0; equal && i < this.nop; i ++) {
9        equal = this.persons[i].equals(other.persons[i]);
10     }
11   }
12   return equal;
13 }
```

as soon as the first persons in "this" and "other" are found "not equal"

1. Person
2. PersonCollector
3. Object
4. String

Q: At Line 9 of PersonCollector's equals method which version of the equals method is called?

```
1  public class Person {
2    private String firstName; private String lastName;
3    private double weight; private double height;
4    public boolean equals(Object obj) {
5      if(this == obj) { return true; }
6      if(obj == null || this.getClass() != obj.getClass()) { return false; }
7      Person other = (Person) obj;
8      return
9          this.weight == other.weight
10       && this.height == other.height
11       && this.firstName.equals(other.firstName)
12       && this.lastName.equals(other.lastName);
13   }
14 }
```


class PersonCollector {
Person[] persons;
equals(...) {
Person[]
this.persons[i].equals(...);
}
PC
Person
version of
Person is
invoked.
}

Testing Equality of Person/PersonCollector in JUnit (1)

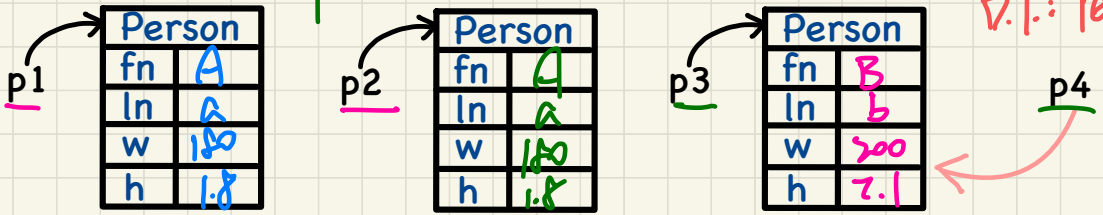
```
@Test
public void testPersonCollector() {
  Person p1 = new Person("A", "a", 180, 1.8);
  Person p2 = new Person("A", "a", 180, 1.8);
  Person p3 = new Person("B", "b", 200, 2.1);
  Person p4 = p3;
  assertFalse(p1 == p2); assertTrue(p1.equals(p2));
  assertTrue(p3 == p4); assertTrue(p3.equals(p4));
```

F T

* p1.equals(p2) T

** p3.equals(p4) T

D.T.: Person



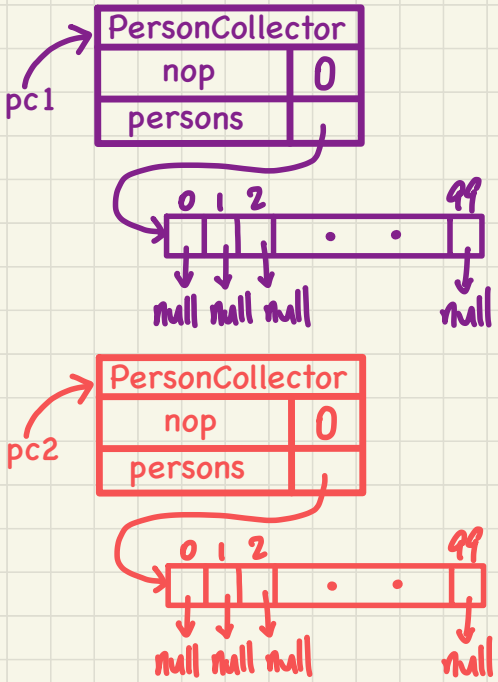

```
public class Person {
  private String firstName; private String lastName;
  private double weight; private double height;
  public boolean equals(Object obj) {
    if(this == obj) { return true; }
    if(obj == null || this.getClass() != obj.getClass()) { return false; }
    Person other = (Person) obj;
    return
        this.weight == other.weight
     && this.height == other.height
     && this.firstName.equals(other.firstName)
     && this.lastName.equals(other.lastName);
  }
}
```

** returns true.

* returns true.

Testing Equality of Person/PersonCollector in JUnit (2) (continued from testPersonCollector)

```
PersonCollector pc1 = new PersonCollector();
PersonCollector pc2 = new PersonCollector();
assertFalse(pc1 == pc2); assertTrue(pc1.equals(pc2));
```



Q: How about **assertTrue**(pc2.**equals**(pc1))?

```
class PersonCollector {
  private Person[] persons;
  private int nop; /* number of persons */
  public PersonCollector() { ... }
  public void addPerson(Person p) { ... }
  public int getNop() { return this.nop; }
  public Person[] getPersons() { ... }
}
```

```
public boolean equals(Object obj) {
  if(this == obj) { return true; }
  if(obj == null || this.getClass() != obj.getClass()) { return false; }
  PersonCollector other = (PersonCollector) obj;
  boolean equal = false;
  if(this.nop == other.nop) {
    equal = true;
    for(int i = 0; equal && i < this.nop; i ++) {
      equal = this.persons[i].equals(other.persons[i]);
    }
  }
  return equal;
}
```

Testing Equality of Person/PersonCollector in JUnit (3)

(continued from testPersonCollector)

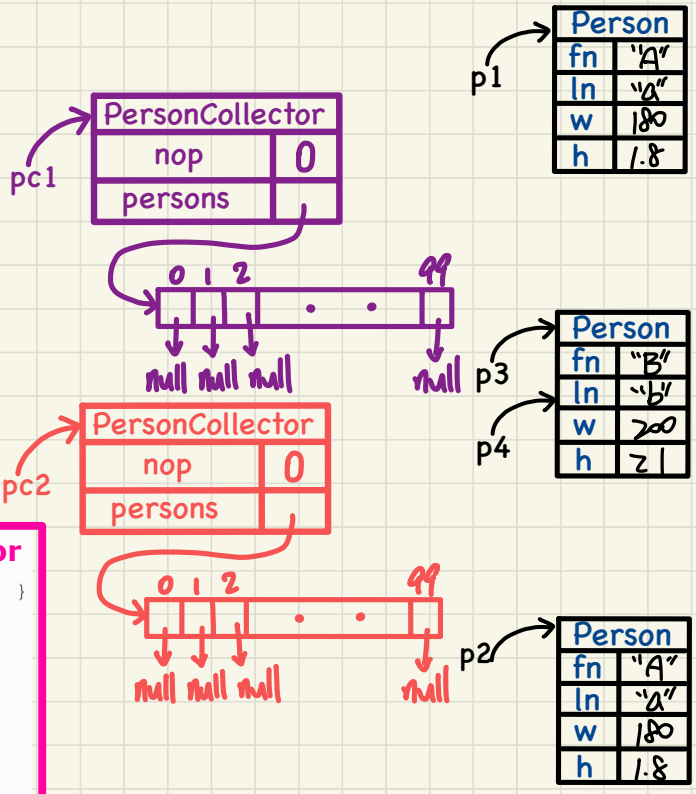
```
pc1.addPerson(p1);
assertFalse(pc1.equals(pc2));
pc2.addPerson(p2);
assertFalse(pc1.getPersons()[0] == pc2.getPersons()[0]);
assertTrue(pc1.getPersons()[0].equals(pc2.getPersons()[0]));
assertTrue(pc1.equals(pc2));
pc1.addPerson(p3);
pc2.addPerson(p4);
assertTrue(pc1.getPersons()[1] == pc2.getPersons()[1]);
assertTrue(pc1.getPersons()[1].equals(pc2.getPersons()[1]));
assertTrue(pc1.equals(pc2));
```

Person

```
public boolean equals(Object obj) {
  if(this == obj) { return true; }
  if(obj == null || this.getClass() != obj.getClass()) { return false; }
  Person other = (Person) obj;
  return
      this.weight == other.weight
   && this.height == other.height
   && this.firstName.equals(other.firstName)
   && this.lastName.equals(other.lastName);
}
```

PersonCollector

```
public boolean equals(Object obj) {
  if(this == obj) { return true; }
  if(obj == null || this.getClass() != obj.getClass()) { return false; }
  PersonCollector other = (PersonCollector) obj;
  boolean equal = false;
  if(this.nop == other.nop) {
    equal = true;
    for(int i = 0; equal && i < this.nop; i ++) {
      equal = this.persons[i].equals(other.persons[i]);
    }
  }
  return equal;
}
```



Testing Equality of Person/PersonCollector in JUnit (4)

(continued from testPersonCollector)

```
pc1.addPerson(new Person("A", "a", 175, 1.75));
pc2.addPerson(new Person("A", "a", 165, 1.55));
assertFalse(pc1.getPersons()[2] == pc2.getPersons()[2]);
assertFalse(pc1.getPersons()[2].equals(pc2.getPersons()[2]));
assertFalse(pc1.equals(pc2));
```

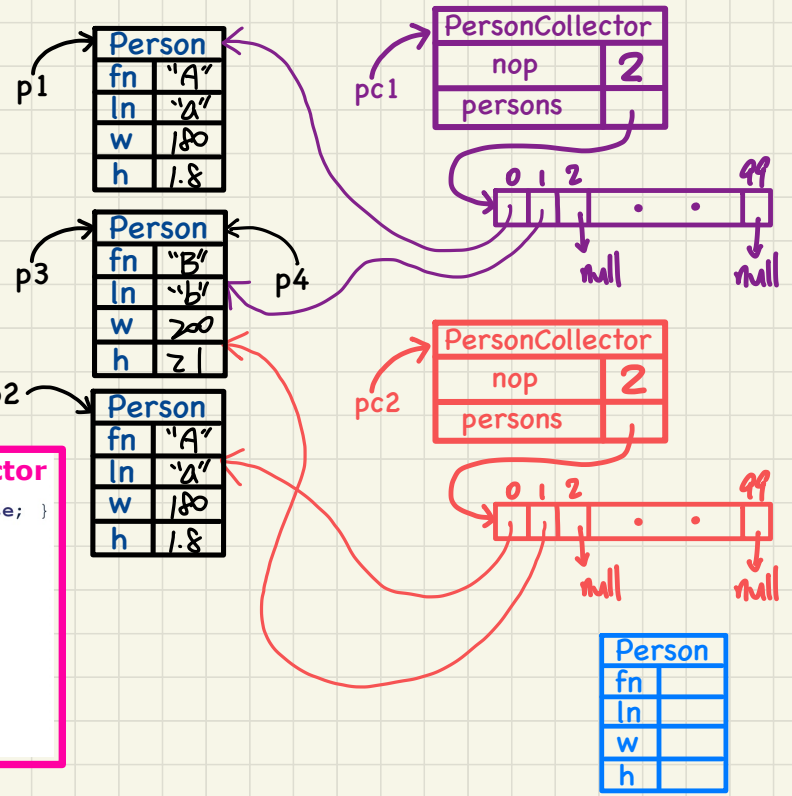
Person	
fn	
ln	
w	
h	

Person

```
public boolean equals(Object obj) {
  if(this == obj) { return true; }
  if(obj == null || this.getClass() != obj.getClass()) { return false; }
  Person other = (Person) obj;
  return
       this.weight == other.weight
    && this.height == other.height
    && this.firstName.equals(other.firstName)
    && this.lastName.equals(other.lastName);
}
```

PersonCollector

```
public boolean equals(Object obj) {
  if(this == obj) { return true; }
  if(obj == null || this.getClass() != obj.getClass()) { return false; }
  PersonCollector other = (PersonCollector) obj;
  boolean equal = false;
  if(this.nop == other.nop) {
    equal = true;
    for(int i = 0; equal && i < this.nop; i ++) {
      equal = this.persons[i].equals(other.persons[i]);
    }
  }
  return equal;
}
```



Inheritance: Motivating Problem

Nouns -> classes, attributes, accessors

Verbs -> mutators

Problem: A student management system stores data about students. There are two kinds of university students: resident students and non-resident students. Both kinds of students have a name and a list of registered courses. Both kinds of students are restricted to register for no more than 10 courses. When calculating the tuition for a student, a base amount is first determined from the list of courses they are currently registered (each course has an associated fee). For a non-resident student, there is a discount rate applied to the base amount to waive the fee for on-campus accommodation. For a resident student, there is a premium rate applied to the base amount to account for the fee for on-campus accommodation and meals.

Design Principles

1. **Cohesion** → Unix philosophy is cd ↳ each command should do one thing and do it well.

   ↳ Attributes and methods in a single class should serve the same purpose / be under a unifying theme

2. **Single Choice Principle**

   ↳ A change to be made should be on a minimum number of places → classes, methods

   not necessarily 1, but no more than necessary

   ← violation: duplicates

First Design Attempt

how to use a non-OO language (e.g. C) to simulate OO.

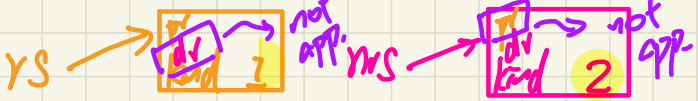
```
public class Student {
   private Course[] courses;
   private int noc;

   private int kind;
   private double premiumRate;
   private double discountRate;

   public Student (int kind){
      this.kind = kind;
   }
   ...
}
```

RS NRS RS

NRS

```
rs.getTuition();
nrs.getTuition();
```

```
Student rs = new Student(1);
Student nrs = new Student(2);
```




```
public double getTuition(){
   double tuition = 0;
   for(int i = 0; i < this.noc; i++){
      tuition += this.courses[i].fee;
   }
   if (this.kind == 1) {
      return tuition * this. premiumRate;
   }
   else if (this.kind == 2) {
      return tuition * this.discountRate;
   }
}
```

base cost

```
public void register(Course c){
   int MAX = -1;
   if (this.kind == 1) { MAX = 6; }
   else if (this.kind == 2) { MAX = 4; }
   if (this.noc == MAX) { /* Error */ }
   else {
      this.courses[this.noc] = c;
      this.noc ++;
   }
}
```

First Design Attempt

```
public class Student {
   private Course[] courses;
   private int noc;

   private int kind;
   private double premiumRate;
   private double discountRate;

   public Student (int kind){
      this.kind = kind;
   }
   ...
}
```

```
public double getTuition(){
   double tuition = 0;
   for(int i = 0; i < this.noc; i++){
      tuition += this.courses[i].fee;
   }
   if (this.kind == 1) {
      return tuition * this. premiumRate;
   }
   else if (this.kind == 2) {
      return tuition * this.discountRate;
   }
}
```

```
public void register(Course c){
   int MAX = -1;
   if (this.kind == 1) { MAX = 6; }
   else if (this.kind == 2) { MAX = 4; }
   if (this.noc == MAX) { /* Error */ }
   else {
      this.courses[this.noc] = c;
      this.noc ++;
   }
}
```

Good design?

Judge by **Cohesion**

violation! pr is only applicable to RS;

dr is only applicable to URS.

First Design Attempt

```
public class Student {
   private Course[] courses;
   private int noc;

   private int kind;
   private double premiumRate;
   private double discountRate;

   public Student (int kind){
      this.kind = kind;
   }
   ...
}
```

```
public double getTuition(){
   double tuition = 0;
   for(int i = 0; i < this.noc; i++){
      tuition += this.courses[i].fee;
   }
   if (this.kind == 1) {
      return tuition * this. premiumRate;
   }
   else if (this.kind == 2) {
      return tuition * this.discountRate;
   }
}
```

dup1

dup2.

```
public void register(Course c){
   int MAX = -1;
   if (this.kind == 1) { MAX = 6; }
   else if (this.kind == 2) { MAX = 4; }
   if (this.noc == MAX) { /* Error */ }
   else {
      this.courses[this.noc] = c;
      this.noc ++;
   }
}
```

Good design?

Judge by Single Choice Principle

- Repeated if-conditions
- A new kind is introduced?
- An existing kind is obselete?