The Java class hierarchy

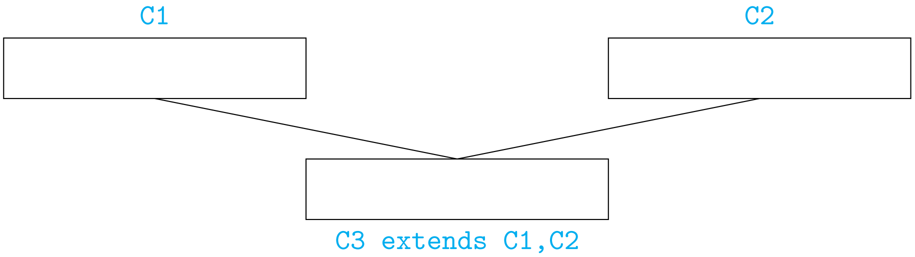
Madhavan Mukund

https://www.cmi.ac.in/~madhavan

Programming Concepts using Java

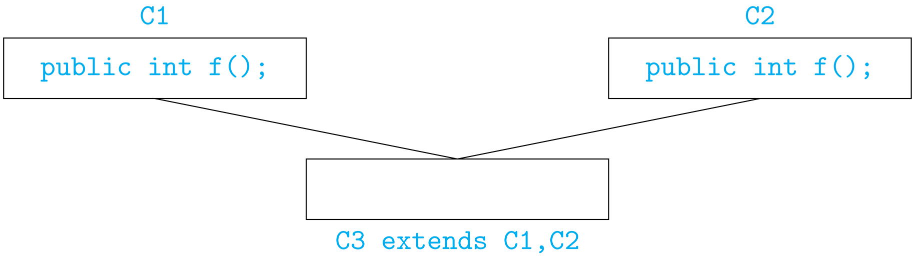
Week 3

Multiple inheritance



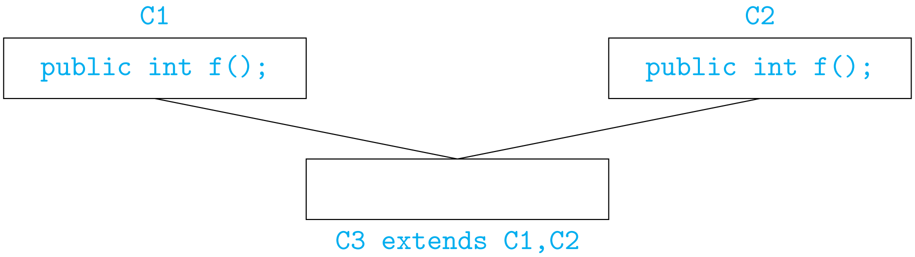
- Can a subclass extend multiple parent classes?

Multiple inheritance



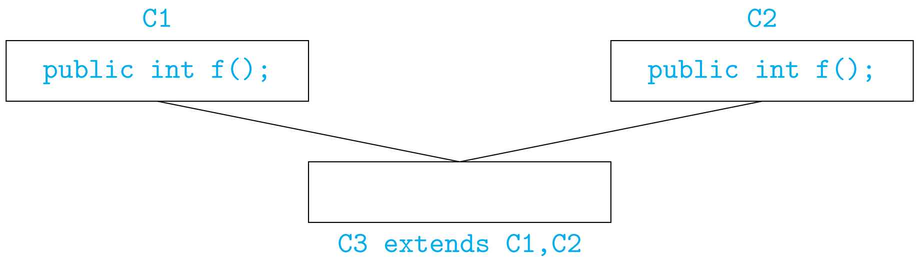
- Can a subclass extend multiple parent classes?
- If `f()` is not overridden, which `f()` do we use in `C3`?

Multiple inheritance



- Can a subclass extend multiple parent classes?
- If `f()` is not overridden, which `f()` do we use in `C3`?
- Java does not allow multiple inheritance

Multiple inheritance



- Can a subclass extend multiple parent classes?
- If `f()` is not overridden, which `f()` do we use in `C3`?
- Java does not allow multiple inheritance
- C++ allows this if `C1` and `C2` have no conflict

Java class hierarchy

- No multiple inheritance — tree-like

Java class hierarchy

- No multiple inheritance — tree-like
- In fact, there is a universal superclass `Object`

Java class hierarchy

- No multiple inheritance — tree-like
- In fact, there is a universal superclass `Object`
- Useful methods defined in `Object`

```
public boolean equals(Object o)  // defaults to pointer equality

public String toString()         // converts the values of the
                                 // instance variables to String
```

Java class hierarchy

- No multiple inheritance — tree-like
- In fact, there is a universal superclass `Object`
- Useful methods defined in `Object`

```
public boolean equals(Object o)  // defaults to pointer equality

public String toString()         // converts the values of the
                                 // instance variables to String
```

- For Java objects `x` and `y`, `x == y` invokes `x.equals(y)`

Java class hierarchy

- No multiple inheritance — tree-like
- In fact, there is a universal superclass `Object`
- Useful methods defined in `Object`

```
public boolean equals(Object o)  // defaults to pointer equality

public String toString()         // converts the values of the
                                 // instance variables to String
```

- For Java objects `x` and `y`, `x == y` invokes `x.equals(y)`
- To print `o`, use `System.out.println(o+"");`
  - Implicitly invokes `o.toString()`

Java class hierarchy

- Can exploit the tree structure to write generic functions
  - Example: search for an element in an array

```
public int find (Object[] objarr, Object o){
  int i;
  for (i = 0; i < objarr.length(); i++){
      if (objarr[i] == o) {return i};
  }
  return (-1);
}
```

Java class hierarchy

- Can exploit the tree structure to write generic functions
  - Example: search for an element in an array

```
public int find (Object[] objarr, Object o){
  int i;
  for (i = 0; i < objarr.length(); i++){
      if (objarr[i] == o) {return i};
  }
  return (-1);
}
```

- Recall that == is pointer equality, by default

Java class hierarchy

- Can exploit the tree structure to write generic functions
  - Example: search for an element in an array

```
public int find (Object[] objarr, Object o){
  int i;
  for (i = 0; i < objarr.length(); i++){
      if (objarr[i] == o) {return i};
  }
  return (-1);
}
```

- Recall that `==` is pointer equality, by default
- If a class overrides `equals()`, dynamic dispatch will use the redefined function instead of `Object.equals()` for `objarr[i] == o`

Overriding functions

- For instance, a class `Date` with instance variables `day`, `month` and `year`

Overriding functions

- For instance, a class `Date` with instance variables `day`, `month` and `year`
- May wish to override `equals()` to compare the object state, as follows

```
public boolean equals(Date d){
  return ((this.day == d.day) &&
          (this.month == d.month) &&
          (this.year == d.year));
}
```

Overriding functions

- For instance, a class `Date` with instance variables `day`, `month` and `year`
- May wish to override `equals()` to compare the object state, as follows

```
public boolean equals(Date d){
  return ((this.day == d.day) &&
          (this.month == d.month) &&
          (this.year == d.year));
}
```

- Unfortunately,
  `boolean equals(Date d)`
  does not override
  `boolean equals(Object o)`!

Overriding functions

- For instance, a class `Date` with instance variables `day`, `month` and `year`
- May wish to override `equals()` to compare the object state, as follows

```
public boolean equals(Date d){
  return ((this.day == d.day) &&
          (this.month == d.month) &&
          (this.year == d.year));
}
```

- Unfortunately,
  `boolean equals(Date d)`
  does not override
  `boolean equals(Object o)`!

- Should write, instead

```
public boolean equals(Object d){
  if (d instanceof Date){
    Date myd = (Date) d;
    return ((this.day == myd.day) &&
            (this.month == myd.month)
            (this.year == myd.year));
  }
  return(false);
}
```

  - Note the run-time type check and the cast

Overriding functions

- Overriding looks for “closest” match

Overriding functions

- Overriding looks for “closest” match
- Suppose we have `public boolean equals(Employee e)` but no `equals()` in `Manager`

Overriding functions

- Overriding looks for "closest" match
- Suppose we have `public boolean equals(Employee e)` but no `equals()` in `Manager`
- Consider

```
Manager m1 = new Manager(...);
Manager m2 = new Manager(...);
...
if (m1.equals(m2)){ ... }
```

Overriding functions

- Overriding looks for "closest" match
- Suppose we have `public boolean equals(Employee e)` but no `equals()` in `Manager`
- Consider

```
Manager m1 = new Manager(...);
Manager m2 = new Manager(...);
...
if (m1.equals(m2)){ ... }
```

- `public boolean equals(Manager m)` is compatible with both `boolean equals(Employee e)` and `boolean equals(Object o)`

Overriding functions

- Overriding looks for "closest" match
- Suppose we have `public boolean equals(Employee e)` but no `equals()` in `Manager`
- Consider

```
Manager m1 = new Manager(...);
Manager m2 = new Manager(...);
...
if (m1.equals(m2)){ ... }
```

- `public boolean equals(Manager m)` is compatible with both `boolean equals(Employee e)` and `boolean equals(Object o)`
- Use `boolean equals(Employee e)`

Summary

- Java does not allow multiple inheritance
  - A subclass can extend only one parent class
- The Java class hierarchy forms a tree
- The root of the hierarchy is a built-in class called `Object`
  - `Object` defines default functions like `equals()` and `toString()`
  - These are implicitly inherited by any class that we write
- When we override functions, we should be careful to check the signature