SWEN221: Software Development

8: Polymorphism II

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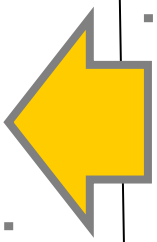
Inheritance + Constructors

- Constructors are **not** inherited
- Constructors use **super** in first line to forward construction to super class
- If the programmer does not explicitly write the super call, this call is **added by the compiler**.

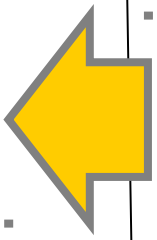
Sneaky code inserted by Java

```
class A { }
class B extends A {
  B(){
    System.out.println("B constr");
}}
```



How you code looks like

```
class A extends Object { A(){super();} }
class B extends A {
  B(){
    super();
    System.out.println("B constr");
}}
```

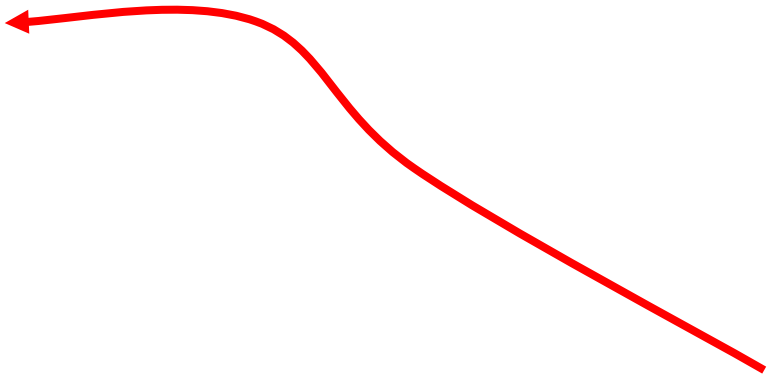


What is added by Java

Java code-Quiz: it compiles?

```
class A {
  int f;
  A(int f){
    this.f=f;
  }
}

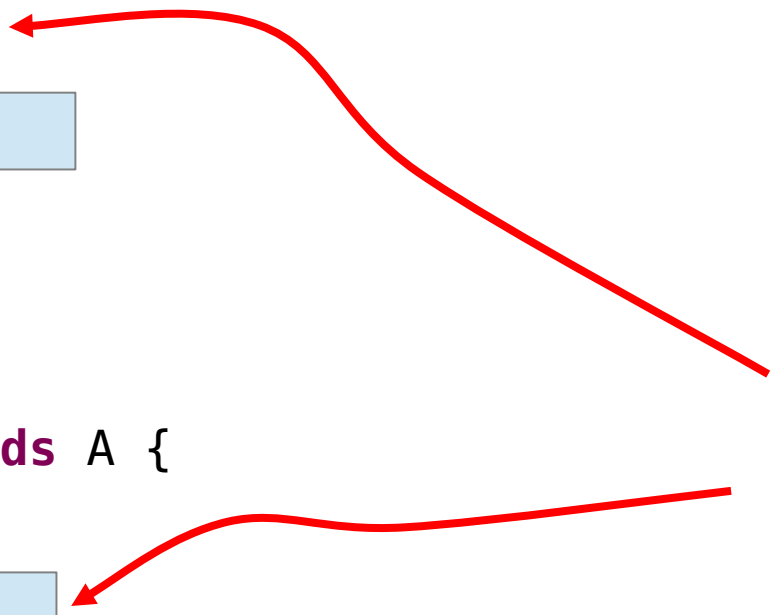
class B extends A {
  B(){
    System.out.println("B constr");
  }
}
```



Constructor of A takes 1 parameter

Java code-Quiz: it compiles? NO

```
class A extends Object {
  int f;
  A(int f){
    super();
    this.f=f;
  }
}
class B extends A {
  B(){
    super();
    System.out.println("B constr");
  }
}
```

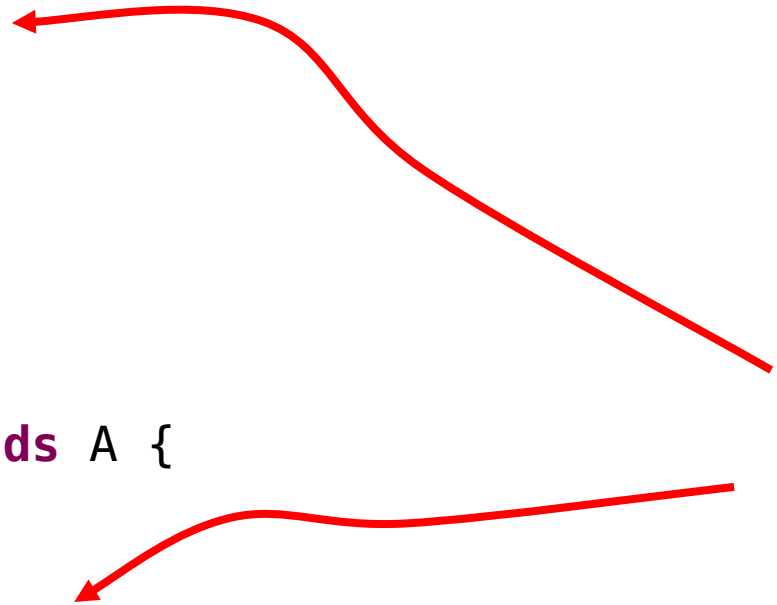


Constructor of A
takes 1 parameter

Java code-Quiz: Possible fix

```
class A {
  int f;
  A(int f){
    this.f=f;
  }
}

class B extends A {
  B(){
    super(0);
    System.out.println("B constr");
  }
}
```



Constructor of A
takes 1 parameter

Why inheritance?

- Allows to create a hierarchy of classes/interfaces, and to model our problem domain.

- Dynamic dispatch (overriding) ensures subclass can change behaviour as needed

- For example, method toString()
  allows any possible object,
  of any possible class,
  included the one that still does not exist, to
  decide how to convert into a String

Why dynamic dispatch? (overriding)

```
class Log{
  static void print(Object o){
    System.out.println("Log: "+o.toString());
  }

 Point p=new Point(1,2);
 Log.print(p)
```

- Point: class created in 2015
- Log: class created in 2005
- Thanks to dynamic dispatch, the code of `print` can call `toString`, so code wrote in 2005 can call code wrote in 2015!
- Not trivial with conventional imperative programming.

Why dynamic dispatch?

```
class HashSet implements Collection { … }
class ArrayList implements Collection { … }
class Vector implements Collection { … }
class TreeSet implements Collection { … }
```

```
int sumElems(Collection<Integer> elems) {
   int sum=0;
   for(Integer i : elems) { sum += i; }
   // use elems.iterator()
   return sum;
   // for(int i=0;i<elems.size();i++){sum+=elems.get(i);}
   //use elems.get() and elems.size()
}
```

Dynamic dispatch + Subtyping

- Methods can operate on many different objects
- Behaviour depends upon types of objects
- Powerful mechanism for code reuse

Dispatch special cases

Access control: non all the methods are visible at any points, so while looking for method descriptors, look only for visible methods.

Static/private methods: while most methods can be overrided, static and private methods can not.

Remember, no dynamic dispatch for static and private methods. Dispatch decided at compile time.

Recompilation: adding-modifying overloaded versions can provide “interesting behaviour”, just recompile all often

(eclipse: project->clean)

Overloading/Overriding

- Overloading: just syntactic convenience
  - understanding how it behave in all the cases is very hard
- Overriding: the most important feature in OO!
  - understanding how it behave is easy, but design programs taking full advantage of it, requires a lifetime programming experience.

- Interaction between the two is hard to understand
- Just distinguishing between the two can be hard

Overloading is not Overriding

- **Overloading: multiple methods with the same name, but different parameters type.**
- **Overriding: redefinition of the same method in the same method in a subtype.**

```
class James{
  String sayHiTo(String name){...}
  String sayHiTo(String name,String surname){...}
  }
```

Is there overloading/overriding here?
A:Only Overloading, B:Only Overriding, C: both, D: none

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```
class James{
  String sayHiTo(String name){...}

  }

class JamesBond extends James{
  String sayHiTo(String name){...}

  }
```

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Overloading:: Quiz

- **Really simple: 1 parameter methods**

```
class Foo{
  String bar(int i){return "i";}                          (A)
  String bar(String s){return "s";}                       (B)
  String bar(Point p){return "p";}                        (C)
  String bar(ColoredPoint cp){return "cp";}               (D)
  void print(){
    System.out.println(bar(new Point()));
    System.out.println(bar("foo"));
    System.out.println(bar(1));
    System.out.println(bar(new ColoredPoint()));
    System.out.println(bar((Point)new ColoredPoint()));
    System.out.println(bar(null));}}
```

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    System.out.println(bar("foo"));                       //b
    System.out.println(bar(1));                           //a
    System.out.println(bar(new ColoredPoint()));          //
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Overloading:: Quiz

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    System.out.println(bar("foo"));                       //b
    System.out.println(bar(1));                           //a
    System.out.println(bar(new ColoredPoint()));          //d
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    System.out.println(bar(null));}}                      //
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Overloading:: Quiz

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    System.out.println(bar(1));                           //a
    System.out.println(bar(new ColoredPoint()));          //d
    System.out.println(bar((Point)new ColoredPoint()));   //c
    System.out.println(bar(null));}}                      //
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Overloading:: Quiz

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  String bar(ColoredPoint cp){return "cp";}               (D)
  void print(){
    System.out.println(bar(new Point()));                 //c
    System.out.println(bar("foo"));                       //b
    System.out.println(bar(1));                           //a
    System.out.println(bar(new ColoredPoint()));          //d
    System.out.println(bar((Point)new ColoredPoint()));   //c
    System.out.println(bar(null));}}                      //
```

Overloading:: Quiz

- **Really simple: 1 parameter methods**

```
class Foo{
  String bar(int i){return "i";}                          (A)
  String bar(String s){return "s";}                       (B)
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  String bar(ColoredPoint cp){return "cp";}               (D)
  void print(){
    System.out.println(bar(new Point()));                 //c
    System.out.println(bar("foo"));                       //b
    System.out.println(bar(1));                           //a
    System.out.println(bar(new ColoredPoint()));          //d
    System.out.println(bar((Point)new ColoredPoint()));   //c
    System.out.println(bar(null));}}                      //X
```

Overloading:: Good uses of overloading

- **Different number of parameters**
  - **Quite simple, only one is "syntactically" applicable**

Overloading:: Good uses of overloading

- Really isomorphic behaviour.
  - **PrintStream.println** //as in System.out.println(1);
    - byte, short, int, long, float, double, boolean, char,
      - Just print it!
    - object
      - Just print the result of .toString()
    - object IF null
      - Just print “null”
  - **StringBuffer.append** is similar!

Questions

```
abstract class Parent {
  int x=100;
  Parent (int x) {this.x=x;}
  abstract int m(int x);
  static Parent k (Parent x) { return x;}
  int f (int x) { return m(x+1);}}

class Heir extends Parent {
  static int x=200;
  Heir (int x) { super (x+1);}
  Heir () {this(3);}
  int m(int x) { return x+2;}
  int n (int x) { return this.x + x; }}
```

```
public class Es1 {
public static void main(String[] argv){
  Parent p = new Heir();
  Heir h = new Heir();
  System.out.println(p.f(h.x));                    //a
  System.out.println((p.k(new Parent())).x);//b
  System.out.println((p.k(h)).x);                  //c
  System.out.println((p.n(5)).x);                  //d
  new Heir().x=5;                                  //e1
  System.out.println((h.n(p.x)));                  //e2
  }}
```

First point//step 0

```
abstract class Parent {
  int x=100;
  Parent (int x) {this.x=x;}
  abstract int m(int x);
  static Parent k (Parent x) { return x;}
  int f (int x) { return m(x+1);}}

class Heir extends Parent {
  static int x=200;
  Heir (int x) { super (x+1);}
  Heir () {this(3);}
  int m(int x) { return x+2;}
  int n (int x) { return this.x + x; }}
```

```
public class Es1 {
public static void main(String[] argv){
  Parent p = new Heir();
  Heir h = new Heir();
  System.out.println(p.f(h.x));                    //a
}}
```

First point//step 1

```
abstract class Parent {
  int x=100;
  Parent (int x) {this.x=x;}
  abstract int m(int x);
  static Parent k (Parent x) { return x;}
  int f (int x) { return m(x+1);}}

class Heir extends Parent {
  static int x=200;
  Heir (int x) { super (x+1);}
  Heir () {this(3);}
  int m(int x) { return x+2;}
  int n (int x) { return this.x + x; }}
```

```
public class Es1 {
public static void main(String[] argv){
  Parent p = //some Heir instance x=?
  Heir h =  // some Heir instance x=?
 System.out.println(p.f(h.x));                    //a
 }}
```

First point//step 2

```
abstract class Parent {
  int x=100;
  Parent (int x) {this.x=x;}
  abstract int m(int x);
  static Parent k (Parent x) { return x;}
  int f (int x) { return m(x+1);}}

class Heir extends Parent {
  static int x=200;
  Heir (int x) { super (x+1);}
  Heir () {this(3);}
  int m(int x) { return x+2;}
  int n (int x) { return this.x + x; }}
```

```
public class Es1 {
public static void main(String[] argv){
  Parent p = //some Heir instance x=?
  Heir h =  // some Heir instance x=?
 System.out.println(p.f(200));                    //a
 }}
```

First point//step 3

```
abstract class Parent {
  int x=100;
  Parent (int x) {this.x=x;}
  abstract int m(int x);
  static Parent k (Parent x) { return x;}
  int f (int x) { return m(x+1);}}

class Heir extends Parent {
  static int x=200;
  Heir (int x) { super (x+1);}
  Heir () {this(3);}
  int m(int x) { return x+2;}
  int n (int x) { return this.x + x; }}
```

```
public class Es1 {
public static void main(String[] argv){
  Parent p = //some Heir instance x=?
  Heir h =  // some Heir instance x=?
 System.out.println(p.m(200+1));
}}
```

First point//step 4

```
abstract class Parent {
  int x=100;
  Parent (int x) {this.x=x;}
  abstract int m(int x);
  static Parent k (Parent x) { return x;}
  int f (int x) { return m(x+1);}}

class Heir extends Parent {
  static int x=200;
  Heir (int x) { super (x+1);}
  Heir () {this(3);}
  int m(int x) { return x+2;}
  int n (int x) { return this.x + x; }}
```

```
public class Es1 {
public static void main(String[] argv){
  Parent p = //some Heir instance x=?
  Heir h =  // some Heir instance x=?
 System.out.println((200+1)+2);
}}
```