Victoria University
of Wellington, New Zealand
Te Whare Wananga o te
Upoko o te Ika a Maui
Aotearoa

SWEN221: Software Development

5: Inheritance I

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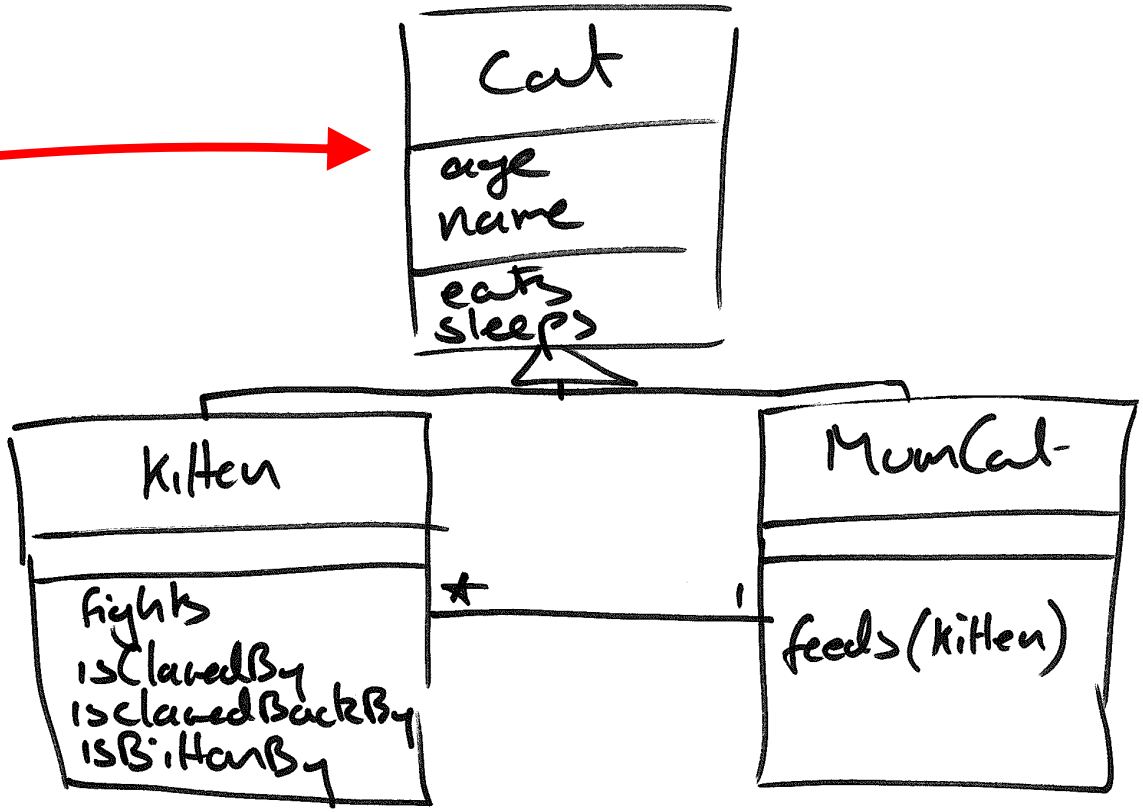
Inheritance basics

superclass
& baseclass

subclass



- Kitten & MumCat
  - Inherit attributes “age” and “name”
  - Inherit operations “eats” and “sleeps”

Inheritance basics

```
class Cat {
    int age;
    …
}
class Kitten extends Cat {
    void fights() {…}
    …
}
class MumCat extends Cat {…}
```

Inheritance

- What does it give us?

Subtyping

&

Code Reuse

What is Subtyping?

- In Java, can write the following:

```
void g(long y) { … }
void f(int x) { g(x); }
```

  - This is OK because an **`int`** is always a valid **`long`**
  - But, this **does not** compile:

```
void g(int y) { … }
void f(long x) { g(x); }
```

  - Because a **`long`** is not always a valid **`int`**
    - E.g. 8589934592 is valid long, but is greater than 2^{32}

- We say **`int` is a subtype of `long`**
  - denoted by **`int <: long`**
  - A subtype can be used whenever its supertype(s) are expected

Inheritance and Subtyping

- For two classes/interfaces A and B:
  - if A **extends** B, or A **implements** B, then A **<:** B

```
class Point { int xpos; int ypos; … }
class ColouredPoint extends Point { int colour; }

void move(Point p, int dx, int dy) {
 p.xpos += dx;
 p.ypos += dy;
}
ColouredPoint cp = new ColouredPoint(…);
move(cp,1,1);
System.out.println("cp.xpos = " + cp.xpos);
```

Through p we cannot see "colour" but it is there!

  - Therefore, in this case, ColouredPoint **<:** Point
  - Meaning we can use a ColouredPoint instead of a Point!

Static vs Dynamic Typing

- **What is it?**
  - **Static Type** – the declared type of a variable
  - **Dynamic Type** – the actual type of an object

```
class Point { int xpos; int ypos; … }
class ColouredPoint extends Point { int colour; }

void move(Point p, int dx, int dy) {
 p.xpos += dx;
 p.ypos += dy;
}
move(new ColouredPoint(…),1,1);
System.out.println("cp.xpos = " + cp.xpos);
```

  - Here, parameter p has **static type** Point
  - But, p refers to object with **dynamic type** ColouredPoint
  - Can only access fields/methods through static type of p

Properties of Subtyping

- Subtyping properties:
  - Transitive
    - If X **<:** Y and Y **<:** Z then X **<:** Z
  - Reflexive
    - X **<:** X always holds!

```
class Point { int xpos; int ypos; … }
class ColouredPoint extends Point { int colour; }
class Coloured3DPoint extends ColouredPoint { int z; }
```

- So, does Coloured3DPoint **<:** Point hold?

Exercise – which ones work?

```
class Point { int xpos; int ypos; … }
class 3DPoint extends Point { int z; }
class ColouredPoint extends Point { int colour; }
class Coloured3DPoint extends ColouredPoint { int z; }

void move(Point p, …) { … }
void paint(ColouredPoint cp, … ) { … }

Coloured3DPoint c3p = new Coloured3DPoint(…);
3DPoint 3p = new 3DPoint(…);
```

A) `move(c3p);` B) `move(3p);` C) `paint(3p);`

Inheritance + Method overriding

- Can **override** methods of superclass:

```
class A {
 void aMethod() {
  System.out.println("A called");
}}
class B extends A {
 void aMethod() {
  System.out.println("B called");
}}
A x = new A();
A y = new B();
x.aMethod();
y.aMethod();
```

B.aMethod()

overrides

A.aMethod()

Static vs Dynamic Typing (again)

```
…

A x = new A();  // static type of x is A
A y = new B();  // Static type of y is A
x.aMethod();
y.aMethod();
```

- Static Type
  - Types written in the **program source**
  - Every variable or field has a **static type**

Static vs Dynamic Typing (cont'd)

```
…

A x = new A();  // dynamic type of x is A
A y = new B();  // dynamic type of y is B
x.aMethod();
y.aMethod();
```

- Dynamic Type
  - **Actual type** of an object
  - May be **different** from static type
  - Determined when object **created** using new
  - Dynamic type of variable always **subtype** of static type

Quiz – what gets printed?

```
class Person { … }

class Car {
 void shutDoor(Person p) {
  System.out.println("Door shuts");
}}
class BigCar extends Car {
 void shutDoor(Person p) {
  System.out.println("Door SLAMS!");
}}

Car c = new Car();
BigCar b = new BigCar();
Person jim = new Person();
c.shutDoor(jim);
b.shutDoor(jim);
```

A)
"Door shuts"
"Door shuts"

B)
"Door SLAMS!"
"Door SLAMS!"

C)
"Door shuts"
"Door SLAMS!"