# Inheritance

## Exploring Polymorphism

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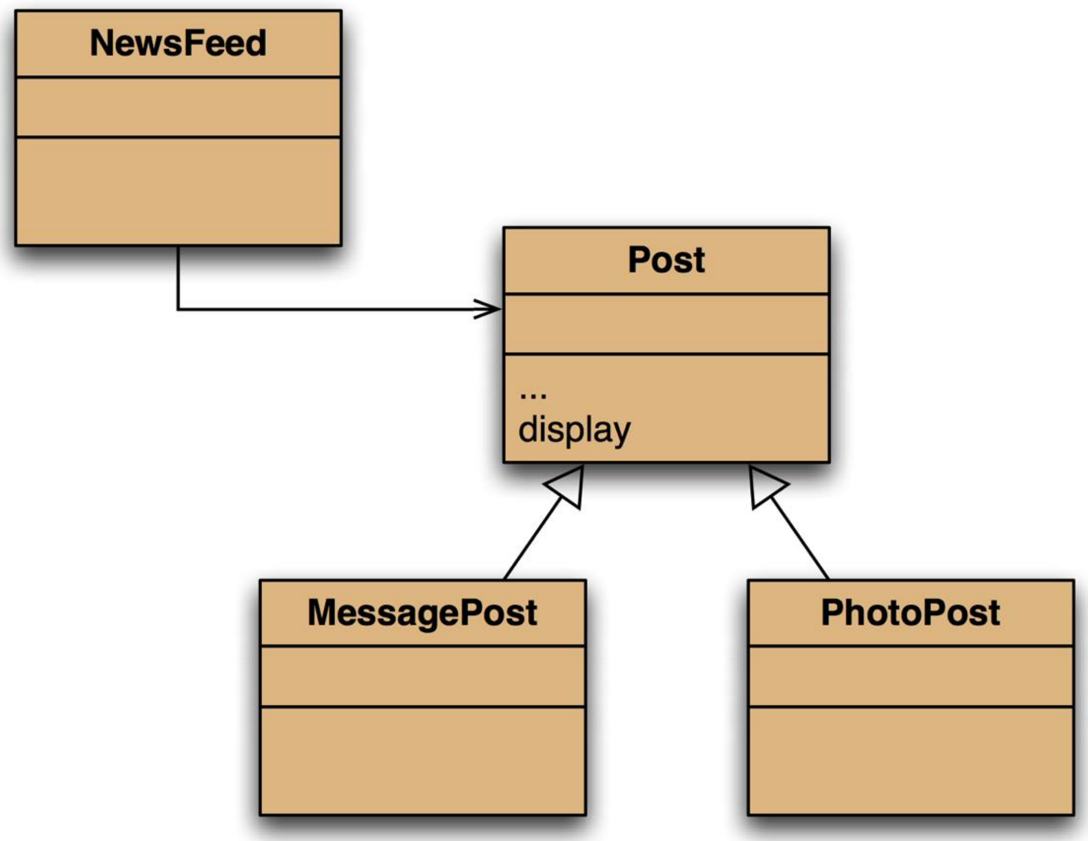
## Topic List

- Method polymorphism
- Static and dynamic type
- Overriding
- Dynamic method lookup
- Protected access

# NetworkV2 – Inheritance Hierarchy



# Testing the display method…

**Create this MessagePost**

```
Leonardo da Vinci
Had a great idea this morning.
But now I forgot what it was. Something to do
with flying ...
40 seconds ago - 2 people like this.
   No comments.
```

**Create this PhotoPost**

```
Alexander Graham Bell
[experiment.jpg]
I think I might call this thing 'telephone'.
12 minutes ago  -  4 people like this.
   No comments.
```

# Testing the display method…

```
Leonardo da Vinci
Had a great idea this morning.
But now I forgot what it was. Something to do with flying ...
40 seconds ago - 2 people like this.
  No comments.

Alexander Graham Bell
[experiment.jpg]
I think I might call this thing 'telephone'.
12 minutes ago  -  4 people like this.
  No comments.
```

What we want

```
Leonardo da Vinci
40 seconds ago  -  2 people like this.
  No comments.

Alexander Graham Bell
12 minutes ago  -  4 people like this.
  No comments.
```

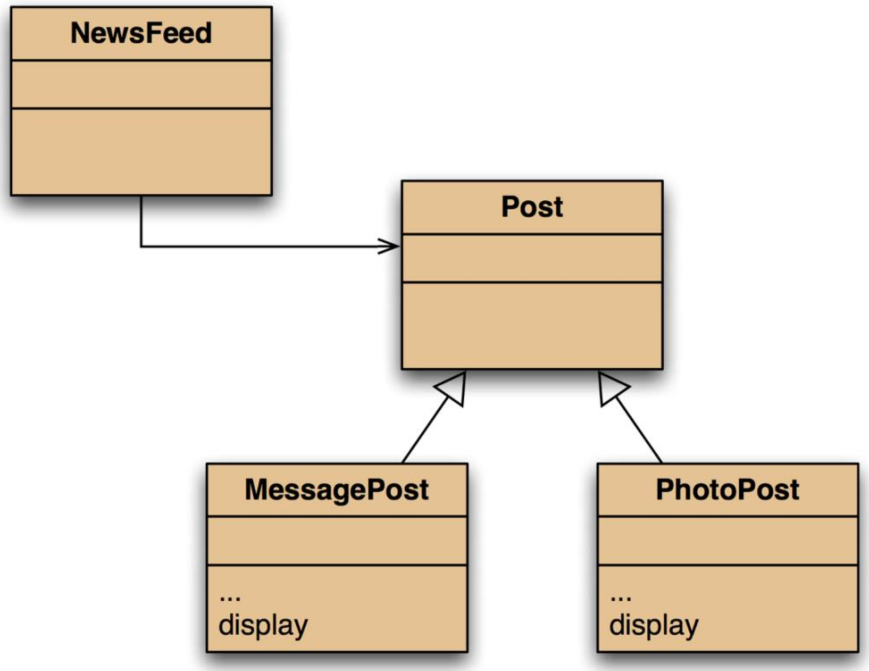
What we have

## The problem

- The **`display`** method in **`Post`** only prints the common fields.

- Inheritance is a one-way street:
  - A subclass inherits the superclass fields.
  - The superclass knows nothing about its subclass's fields.

## Attempting to solve the problem?



- Place **`display`** where it has access to the information it needs.
- Each subclass has its own version.

**<u>But</u>**:

- **`Post`**'s fields are private.
- **`NewsFeed`** cannot find a **`display`** method in **`Post`**.

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## Static type and dynamic type

- A more complex type hierarchy requires further concepts to describe it.
- Some new terminology:
  - static type
  - dynamic type
  - method dispatch/lookup

## Static and dynamic type

What is the type of c1?

```
Car c1 = new Car();
```

What is the type of v1?

```
Vehicle v1 = new Car();
```

## Static and dynamic type

- The declared type of a variable is its *static type*.
- The type of the object a variable refers to is its *dynamic type*.
- The compiler' s job is to check for static-type violations.

```
for(Post post : posts) {
    post.display();   // Compile-time error.
                     // display is not in
                // Post class.
}
```

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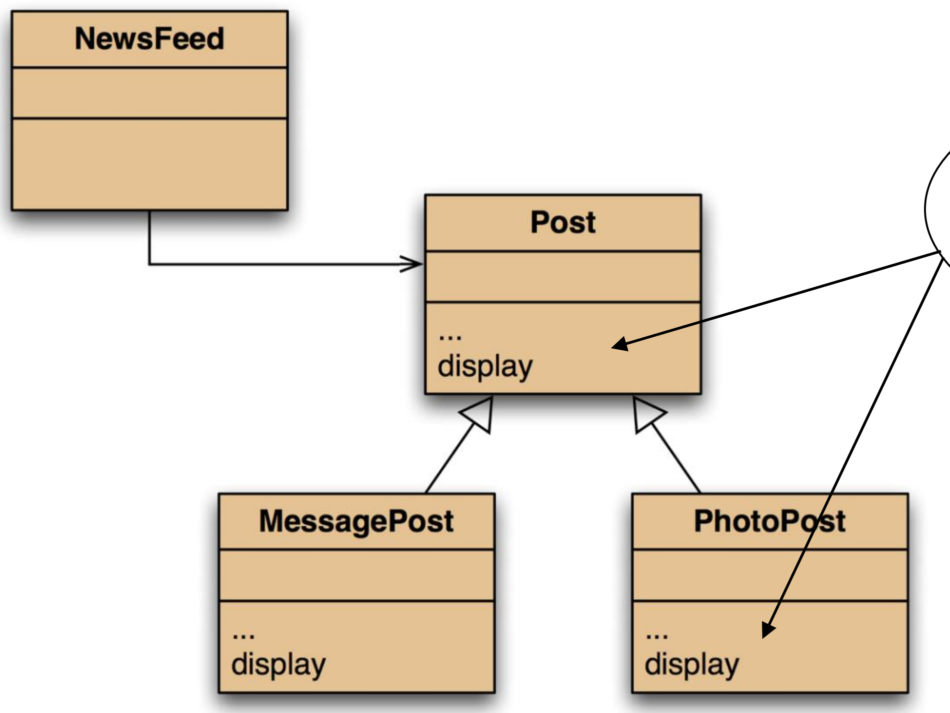
# Overriding: the solution



`display` method in *both* super- and subclasses.

Satisfies both static and dynamic type checking.

## Overriding

- Superclass and subclass define methods with the same signature.
- Each has access to the fields of its class.
- Superclass satisfies static type check.
- Subclass method is called at runtime – it *overrides* the superclass version.
- What becomes of the superclass version?

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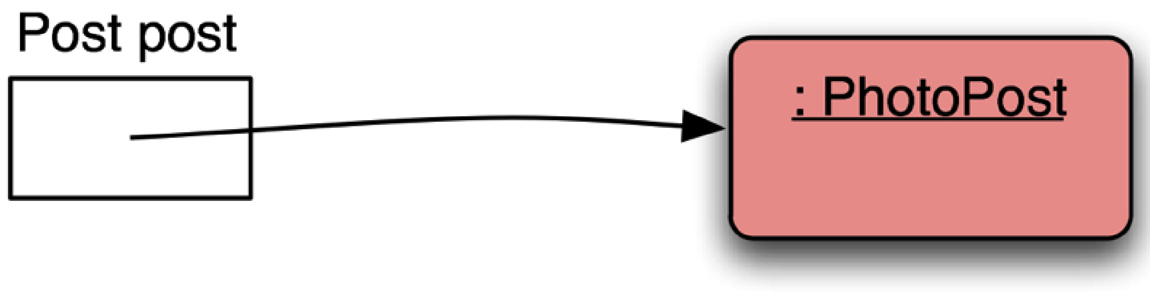
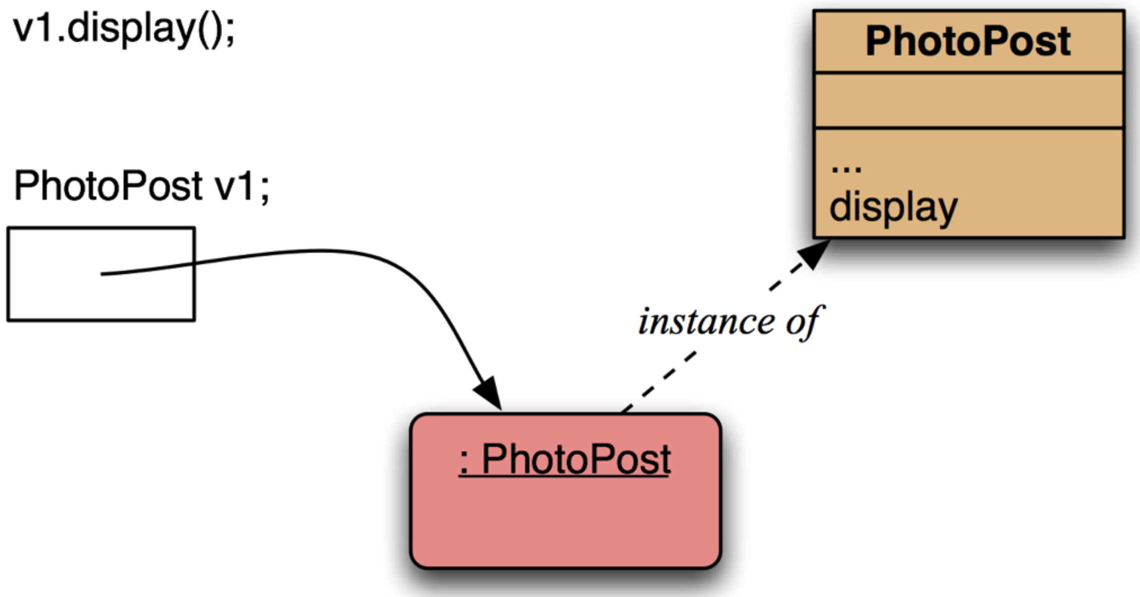
# Distinct static and dynamic types

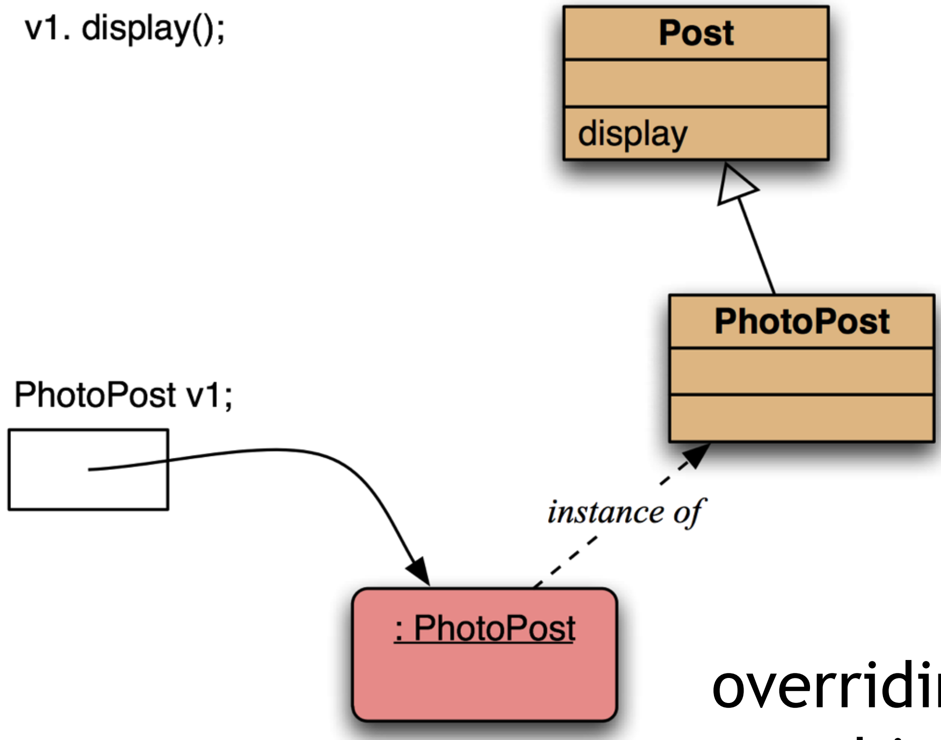


# Method lookup



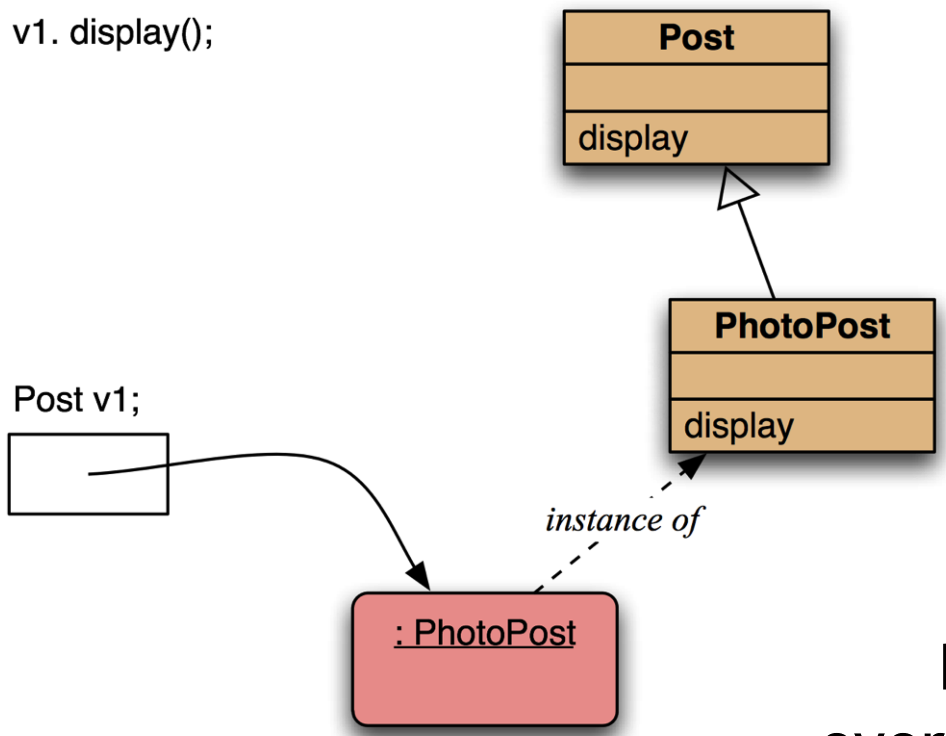
No inheritance or polymorphism.
The obvious method is selected.

## Method lookup



Inheritance but no overriding. The inheritance hierarchy is ascended, searching for a match.

# Method lookup



Polymorphism and overriding. The 'first' version found is used.

## Method lookup summary

- The variable is accessed.
- The object stored in the variable is found.
- The class of the object is found.
- The class is searched for a method match.
- If no match is found, the superclass is searched.
- This is repeated until a match is found, or the class hierarchy is exhausted.
- Overriding methods take precedence.

## Super call in methods

- Overridden methods are hidden ...
- ... but we often still want to be able to call them.
- An overridden method *can* be called from the method that overrides it.
  - **`super.method(...)`**
  - Compare with the use of **`super`** in constructors.

## Calling an overridden method

```
public void display()
{
    super.display();
    System.out.println("  [" +
                           filename +
                           "]");
    System.out.println("  " + caption);
}
```

## Method polymorphism

- We have been discussing *polymorphic method dispatch*.
- A polymorphic variable can store objects of varying types.
- Method calls are polymorphic.
  - The actual method called depends on the dynamic object type.

## The `instanceof` operator

- Used to determine the dynamic type.
- Recovers ‘lost’ type information.
- Usually precedes assignment with a cast to the dynamic type:

-
  ```
  if(post instanceof MessagePost) {
      MessagePost msg =
          (MessagePost) post;
      … access MessagePost methods via msg …
  }
  ```

## The Object class's methods

- Methods in **`Object`** are inherited by all classes.
- Any of these may be overridden.
- The **`toString`** method is commonly overridden:
  - **`public String toString()`**
  - Returns a string representation of the object.

## Overriding `toString` in `Post`

```
public String toString()
{
    String text = username + "\n" +
                  timeString(timestamp);
    if(likes > 0) {
        text += " - " + likes + " people like this.\n";
    }
    else {
        text += "\n";
    }
    if(comments.isEmpty()) {
        return text + " No comments.\n";
    }
    else {
        return text + " " + comments.size() +
               " comment(s). Click here to view.\n";
    }
}
```

## Overriding toString

- Explicit print methods can often be omitted from a class:

```
System.out.println(post.toString());
```

- Calls to **`println`** with just an object automatically result in **`toString`** being called:

```
System.out.println(post);
```

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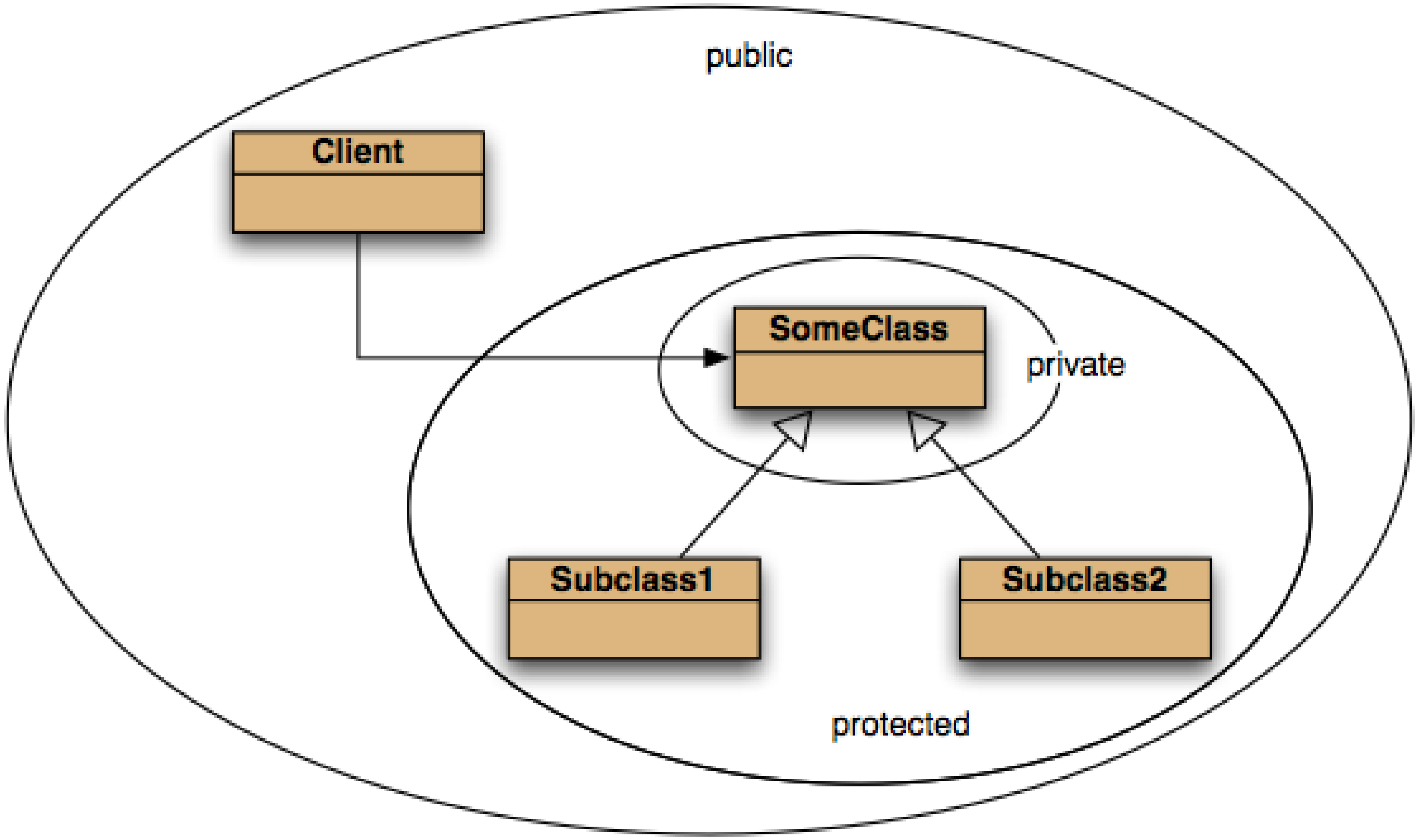
## Protected access

- Private access in the superclass may be too restrictive for a subclass.
- The closer inheritance relationship is supported by *protected access*.
- Protected access is more restricted than public access.
- We still recommend keeping fields private.
  - Define protected accessors and mutators.

# Access levels



## Review

- The declared type of a variable is its static type.
  - Compilers check static types.

- The type of an object is its dynamic type.
  - Dynamic types are used at runtime.

- Methods may be overridden in a subclass.
- Method lookup starts with the dynamic type.
- Protected access supports inheritance.

## Any Questions?