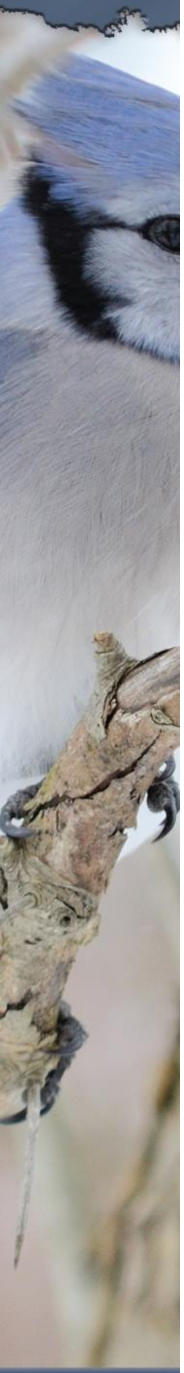
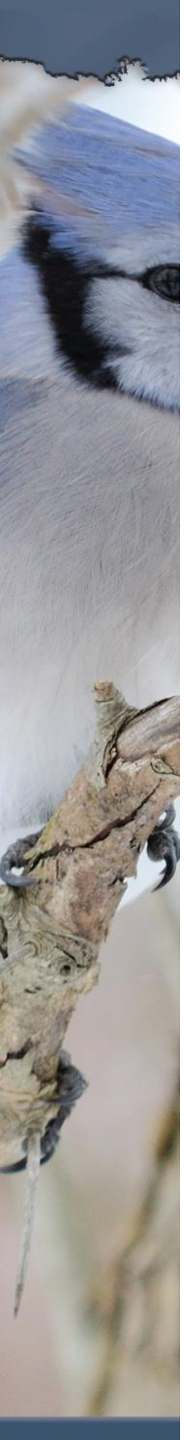


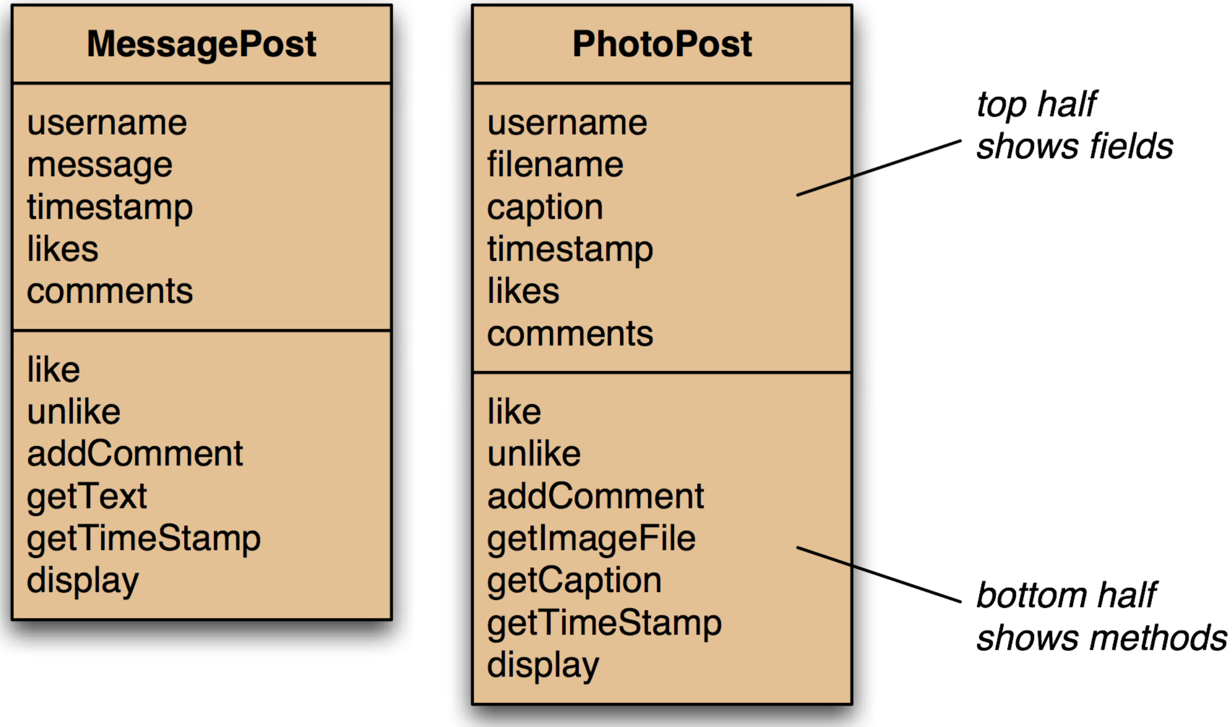
Improving structure with inheritance



The Network example

- A small, prototype social network
- Supports a news feed with posts
- Stores *text posts* and *photo posts*
  - **`MessagePost`**: multi-line text message
  - **`PhotoPost`**: photo and caption
- Allows operations on the posts:
  - e.g. search, display and remove

Network classes



MessagePost

username
message
timestamp
likes
comments

like
unlike
addComment
getText
getTimeStamp
display

PhotoPost

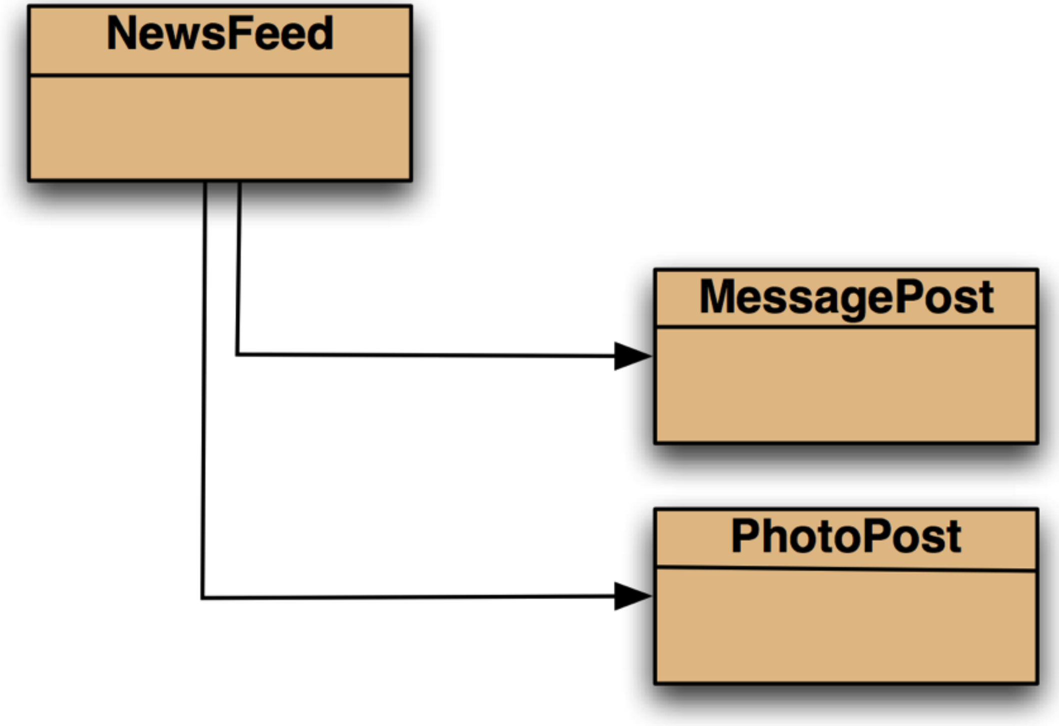
username
filename
caption
timestamp
likes
comments

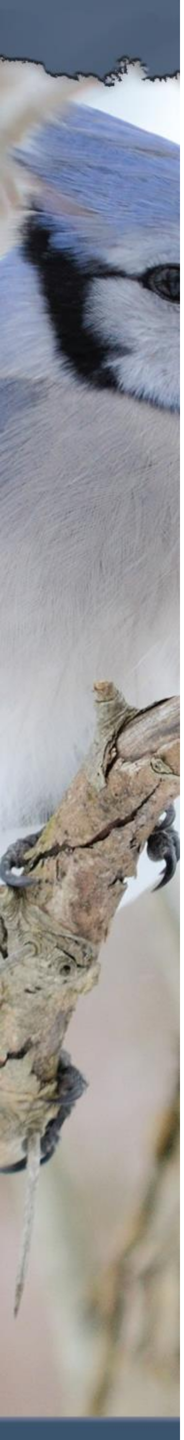
like
unlike
addComment
getImageFile
getCaption
getTimeStamp
display

top half shows fields

bottom half shows methods

Class diagram





Message-Post source code

Just an outline

```
public class MessagePost
{
   private String username;
   private String message;
   private long timestamp;
   private int likes;
   private ArrayList<String> comments;

   public MessagePost(String author, String text)
   {
        username = author;
        message = text;
        timestamp = System.currentTimeMillis();
        likes = 0;
        comments = new ArrayList<>();
   }

   public void addComment(String text) ...

   public void like() ...

   public void display() ...

   ...
}
```

Photo-Post source code

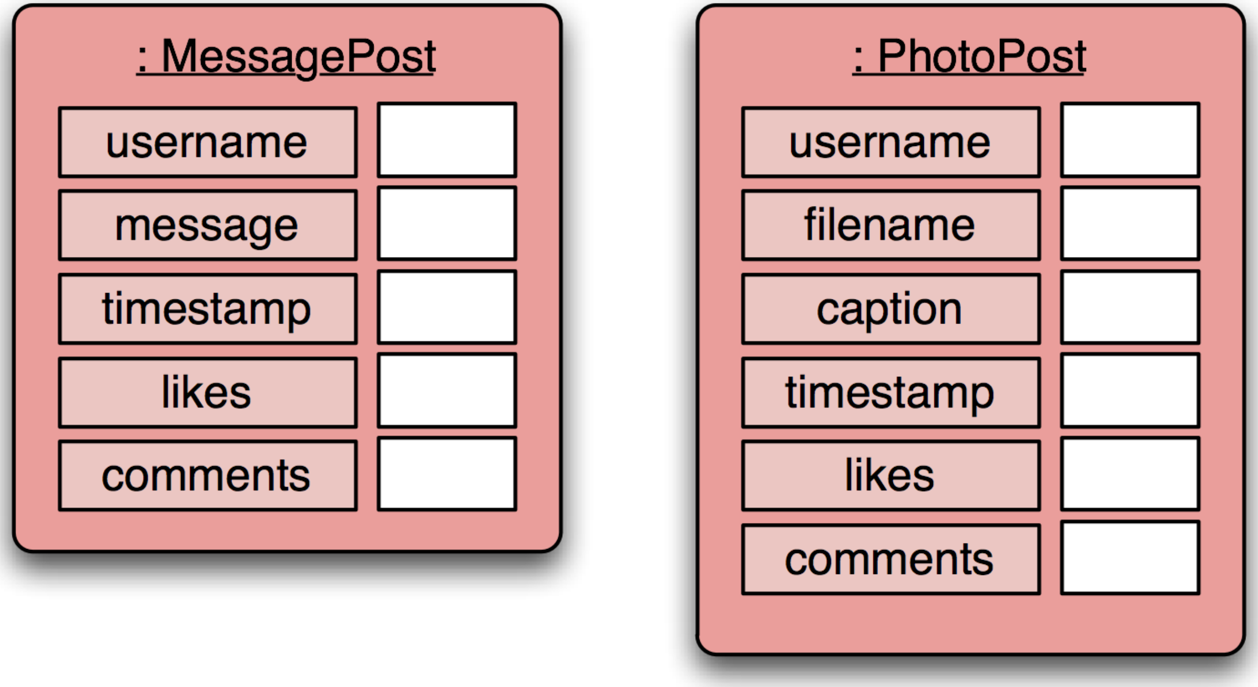
Just an outline

```
public class PhotoPost
{
   private String username;
   private String filename;
   private String caption;
   private long timestamp;
   private int likes;
   private ArrayList<String> comments;

   public PhotoPost(String author, String filename,
                    String caption)
   {
        username = author;
        this.filename = filename;
        this.caption = caption;
        timestamp = System.currentTimeMillis();
        likes = 0;
        comments = new ArrayList<>();
   }

   public void addComment(String text) ...
   public void like() …
   public void display() …
   ...
}
```

NewsFeed

```
public class NewsFeed
{
   private ArrayList<MessagePost> messages;
   private ArrayList<PhotoPost> photos;
   ...
   public void show()
   {
       for(MessagePost message : messages) {
          message.display();
          System.out.println();  // empty line between posts
       }

       for(PhotoPost photo : photos) {
          photo.display();
          System.out.println();  // empty line between posts
       }
   }
}
```

Network objects



: MessagePost

username

message

timestamp

likes

comments

: PhotoPost

username

filename

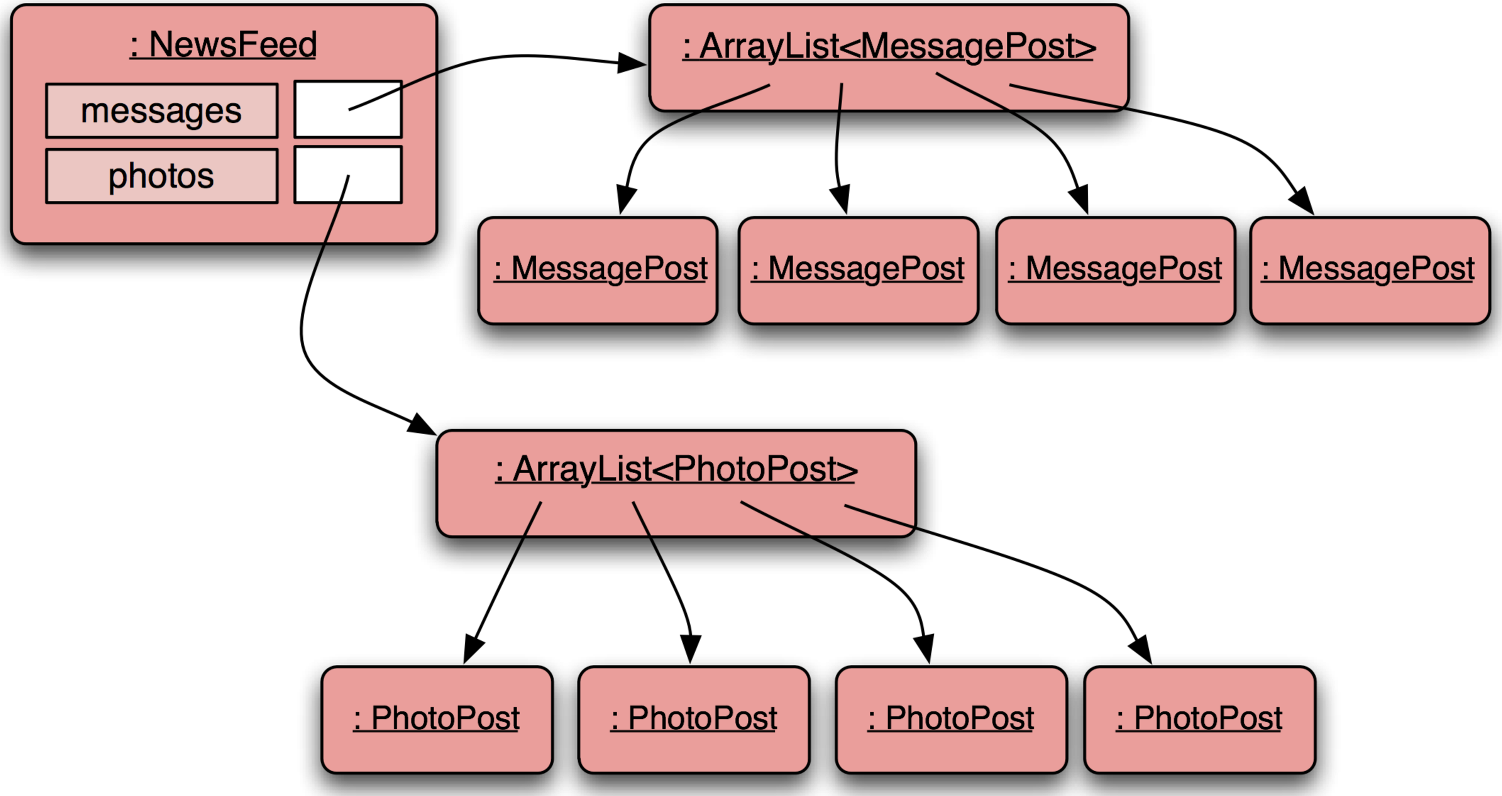
caption

timestamp

likes

comments

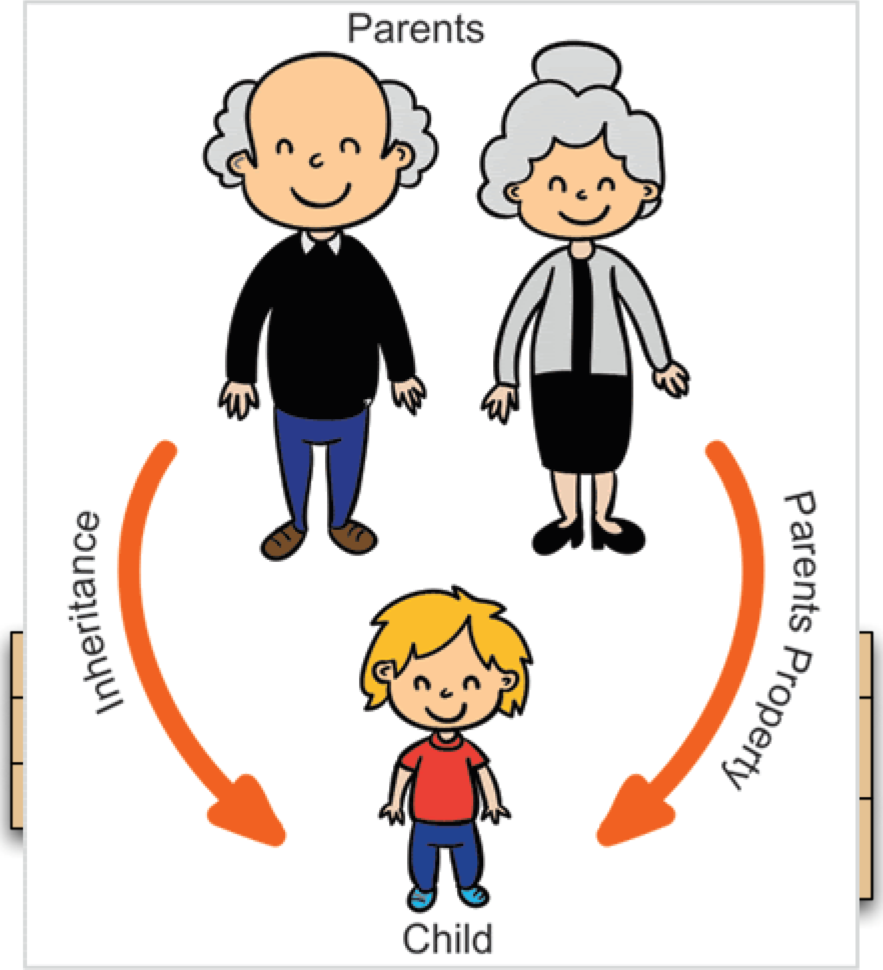
Network object model



Critique of Network

- Code duplication:
  - `MessagePost` and `PhotoPost` classes very similar (large parts are identical)
  - makes maintenance difficult/more work
  - introduces danger of bugs through incorrect maintenance
- Code duplication in `NewsFeed` class as well

Using inheritance



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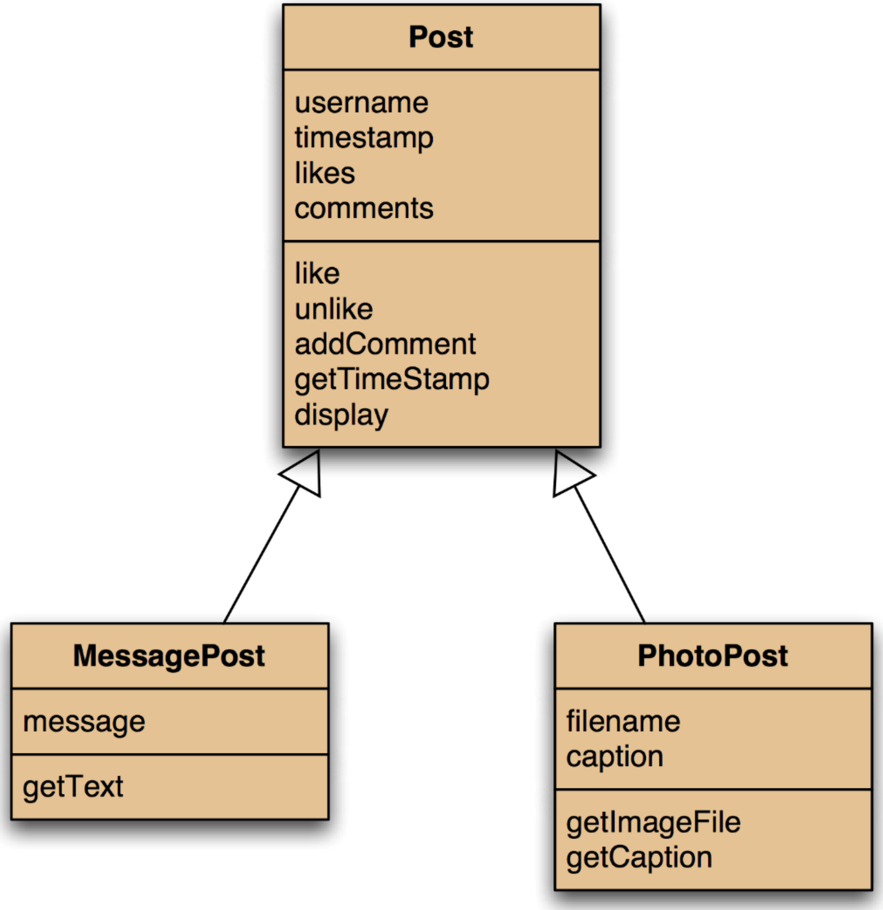
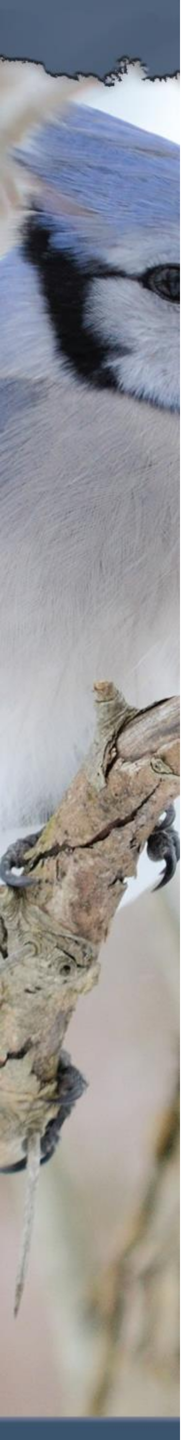
Using inheritance

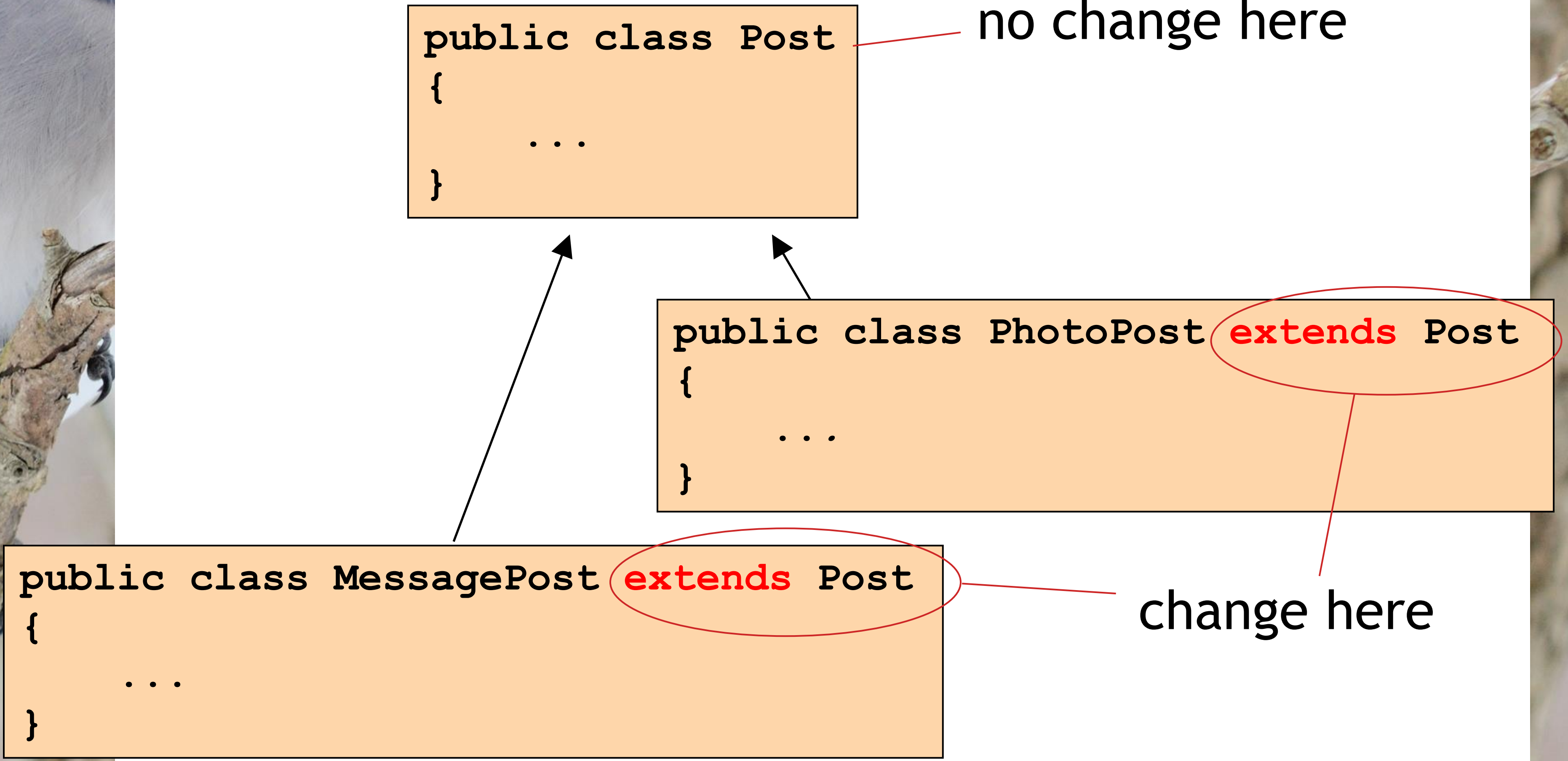




Using inheritance

- define one **superclass** : **`Post`**
- define **subclasses** for **`MessagePost`** and **`PhotoPost`**
- the superclass defines common attributes (via fields)
- the subclasses **inherit** the superclass characteristics
- the subclasses add other characteristics

Inheritance in Java



```
public class Post
{
      . . .
}
```

no change here

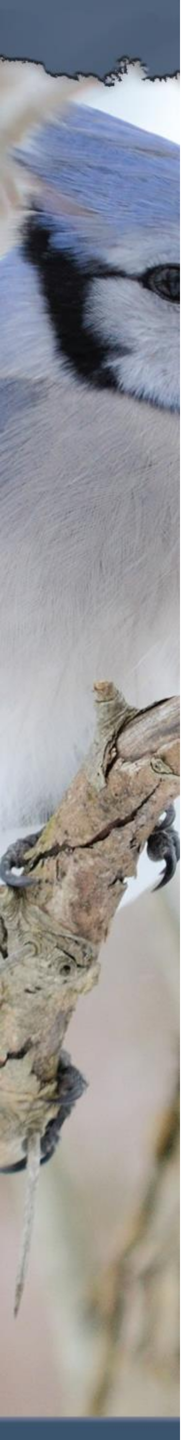
```
public class PhotoPost extends Post
{
      . . .
}
```

```
public class MessagePost extends Post
{
      . . .
}
```

change here

Superclass

```
public class Post
{
    private String username;
    private long timestamp;
    private int likes;
    private ArrayList<String> comments;

    // constructor and methods omitted.
}
```

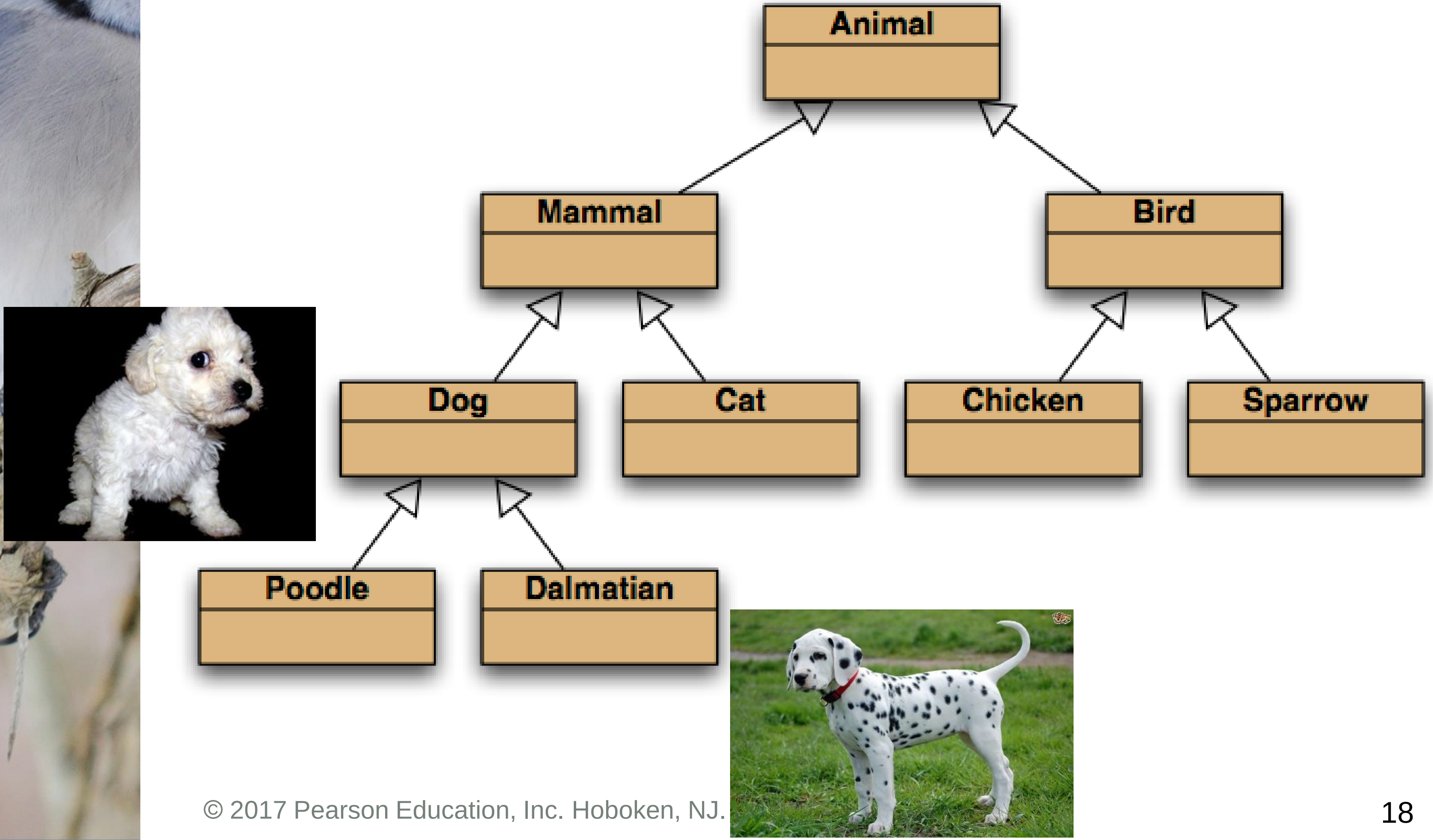


Subclasses

```
public class MessagePost extends Post
{
    private String message;

    // constructor and methods omitted.
}
```

```
public class PhotoPost extends Post
{
    private String filename;
    private String caption;

    // constructor and methods omitted.
}
```

Inheritance hierarchies



Inheritance and constructors

```
public class Post
{
    private String username;
    private long timestamp;
    private int likes;
    private ArrayList<String> comments;

    /**
     * Initialise the fields of the post.
     */
    public Post(String author)
    {
        username = author;
        timestamp = System.currentTimeMillis();
        likes = 0;
        comments = new ArrayList<String>();
    }

    // methods omitted
}
```

Inheritance and constructors

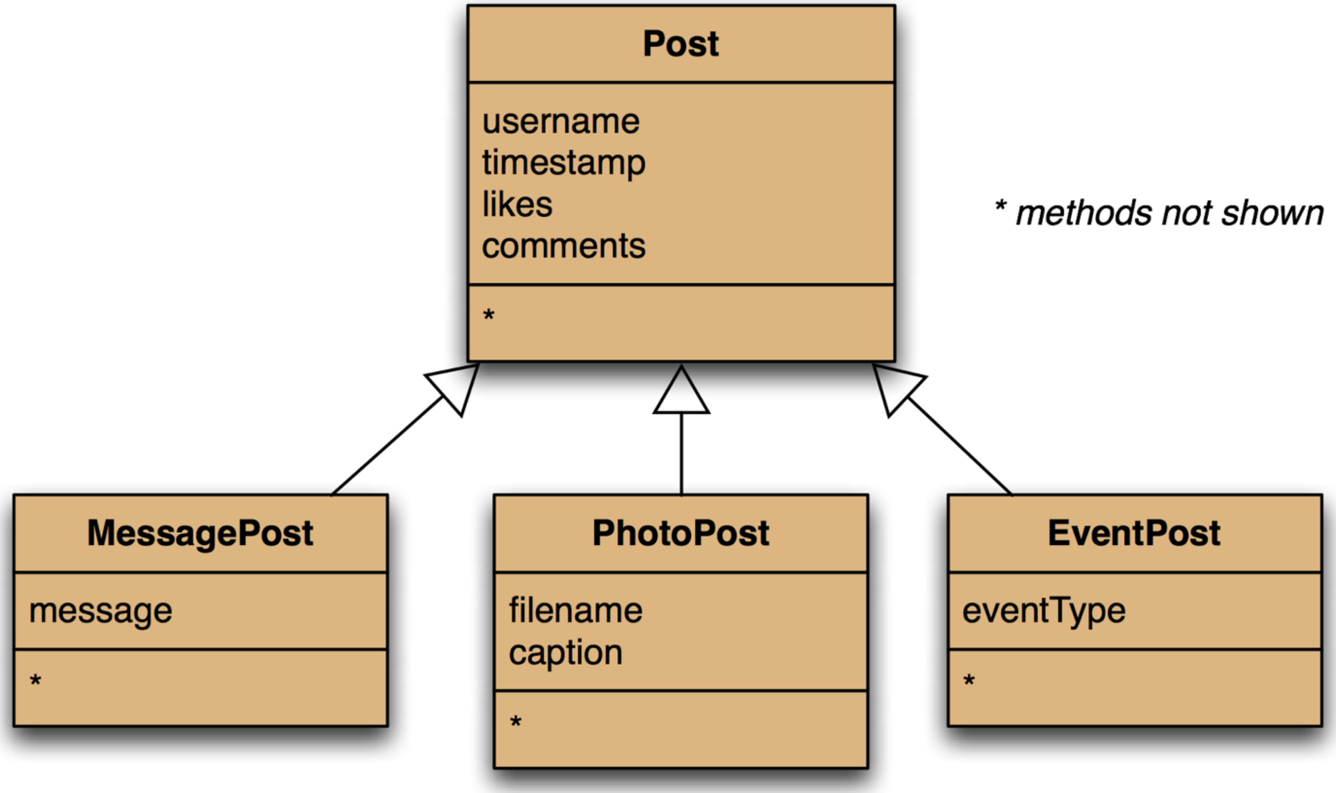
```
public class MessagePost extends Post
{
    private String message;

    /**
     * Constructor for objects of class MessagePost
     */
    public MessagePost(String author, String text)
    {
        super(author);    // MUST be first statement
        message = text;
    }

    // methods omitted
}
```

- Subclass must call superclass constructor!
- Must take values for all fields that we want to initialize!

Superclass constructor call

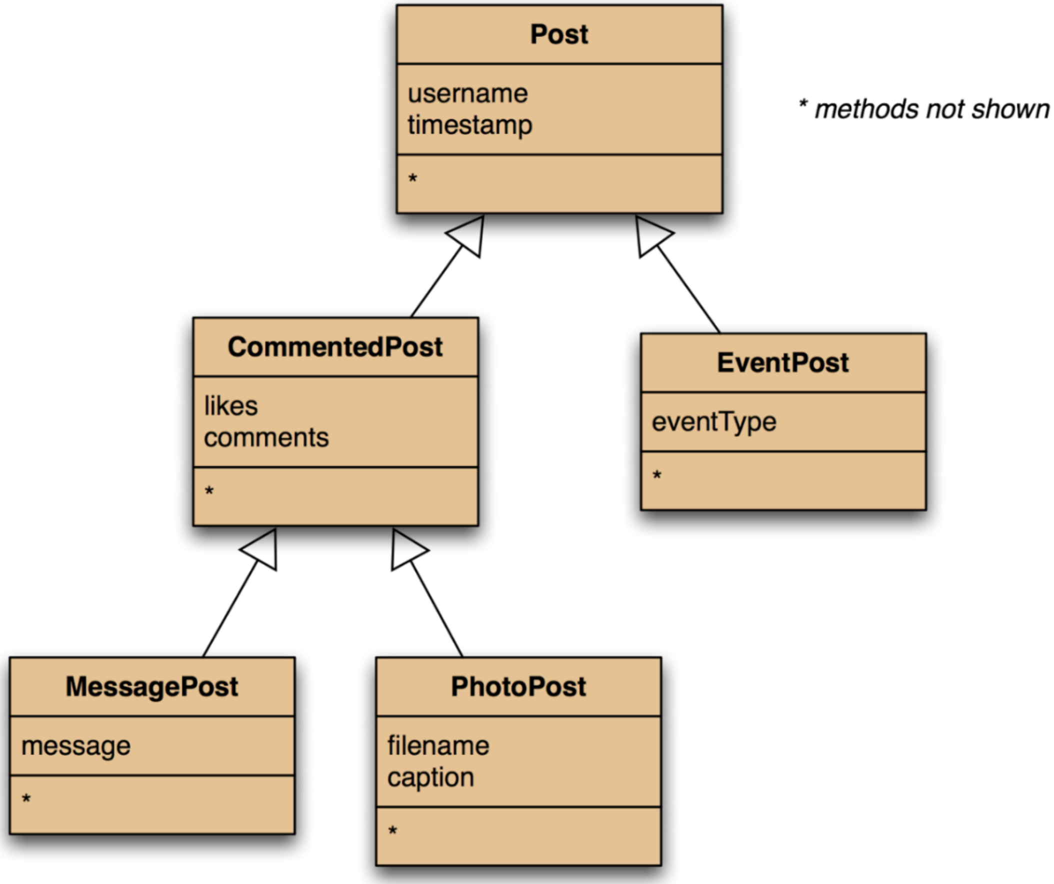
- Subclass constructors must always contain a *super* call
- If none is written, the compiler inserts one (without parameters)
  - only compiles if the superclass has a constructor without parameters
- Must be the first statement in the subclass constructor

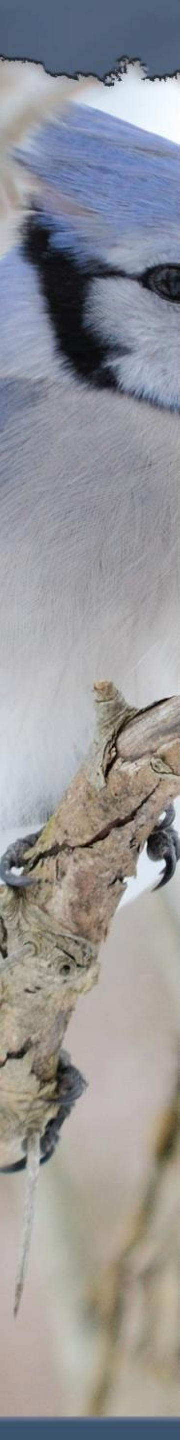
Adding more item types



** methods not shown*

Deeper hierarchies





Review (so far)

Inheritance (so far) helps with:

- Avoiding code duplication
- Code reuse
- Easier maintenance
- Extendibility

```
public class NewsFeed
{
    private ArrayList<Post> posts;

    /**
     * Construct an empty news feed.
     */
    public NewsFeed()
    {
        posts = new ArrayList<Post>();
    }

    /**
     * Add a post to the news feed.
     */
    public void addPost(Post post)
    {
        posts.add(post);
    }
    ...
}
```

Revised NewsFeed source code

avoids code duplication in the client class!

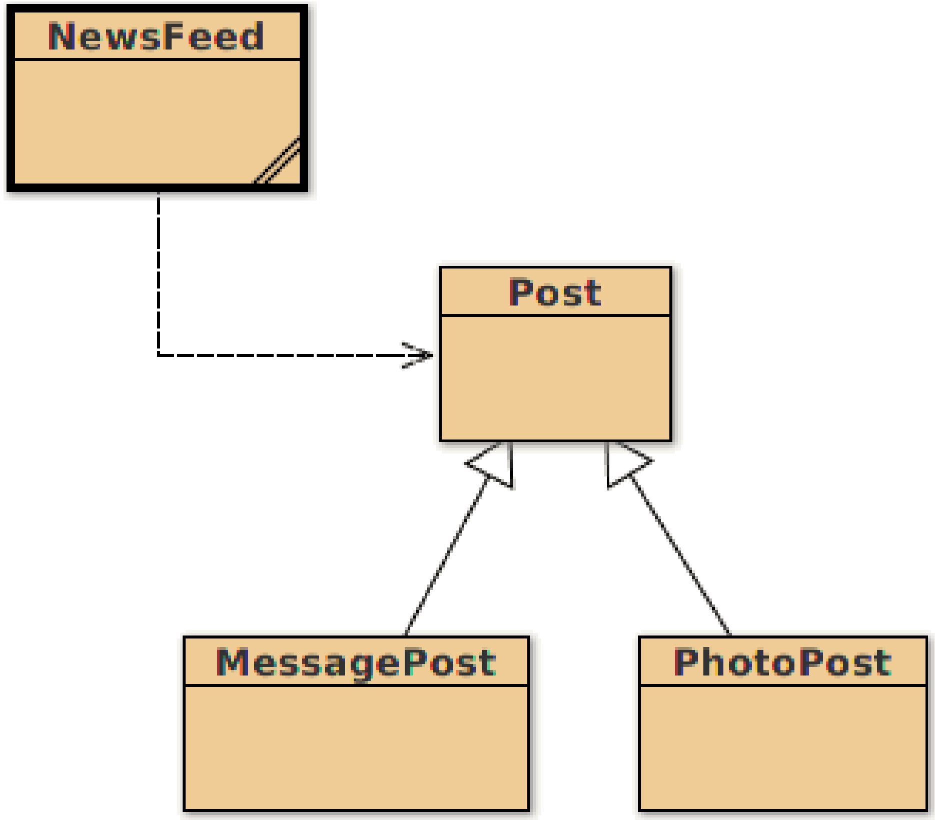
No longer a *messages* AND *photos* ArrayLists!!

New NewsFeed source code

```
/**
 * Show the news feed. Currently: print the
 * news feed details to the terminal.
 * (Later: display in a web browser.)
 */
public void show()
{
   for(Post post : posts) {
       post.display();
       System.out.println(); // Empty line ...
   }
}
```

Now only 1 loop in the show method!!

Improved Class diagram



Subtyping

First, we had:

```
public void addMessagePost(
                MessagePost message)
public void addPhotoPost(
                PhotoPost photo)
```

Now, we have:

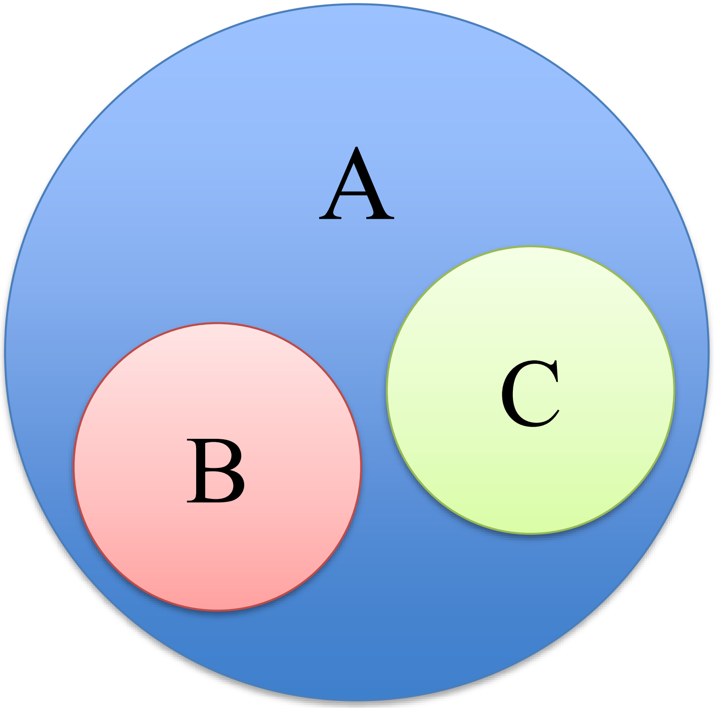
```
public void addPost(Post post)
```

We call this method with:

```
PhotoPost myPhoto = new PhotoPost(...);
feed.addPost(myPhoto);
```

PhotoPost* is a subtype of *Post

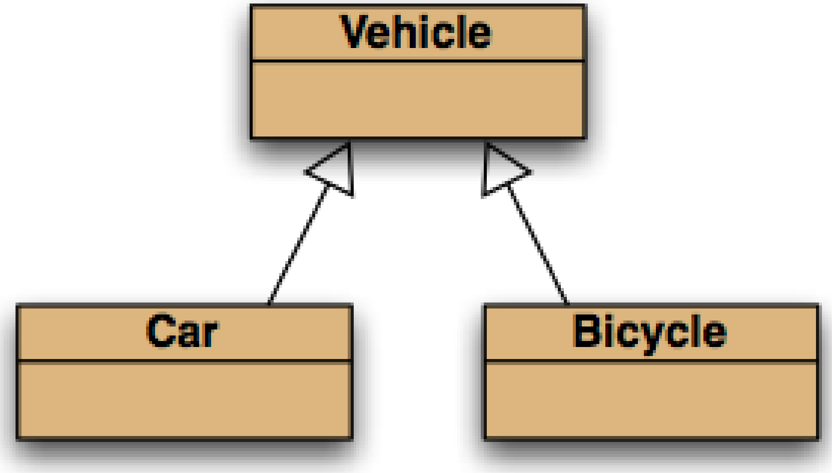
Subclasses and subtyping



Subclasses and subtyping

- Classes define types
- Subclasses define *subtypes*
- Objects of subclasses can be used where objects of supertypes are required.
- (This is called **substitution**.)

Subtyping and assignment



subclass objects may be assigned to superclass variables

```
Vehicle v1 = new Vehicle();
Vehicle v2 = new Car();
Vehicle v3 = new Bicycle();
```

Subtyping

First, we had:

```
public void addMessagePost(
                MessagePost message)
public void addPhotoPost(
                PhotoPost photo)
```

Now, we have:

```
public void addPost(Post post)
```

We call this method with:

```
PhotoPost myPhoto = new PhotoPost(...);
feed.addPost(myPhoto);
```

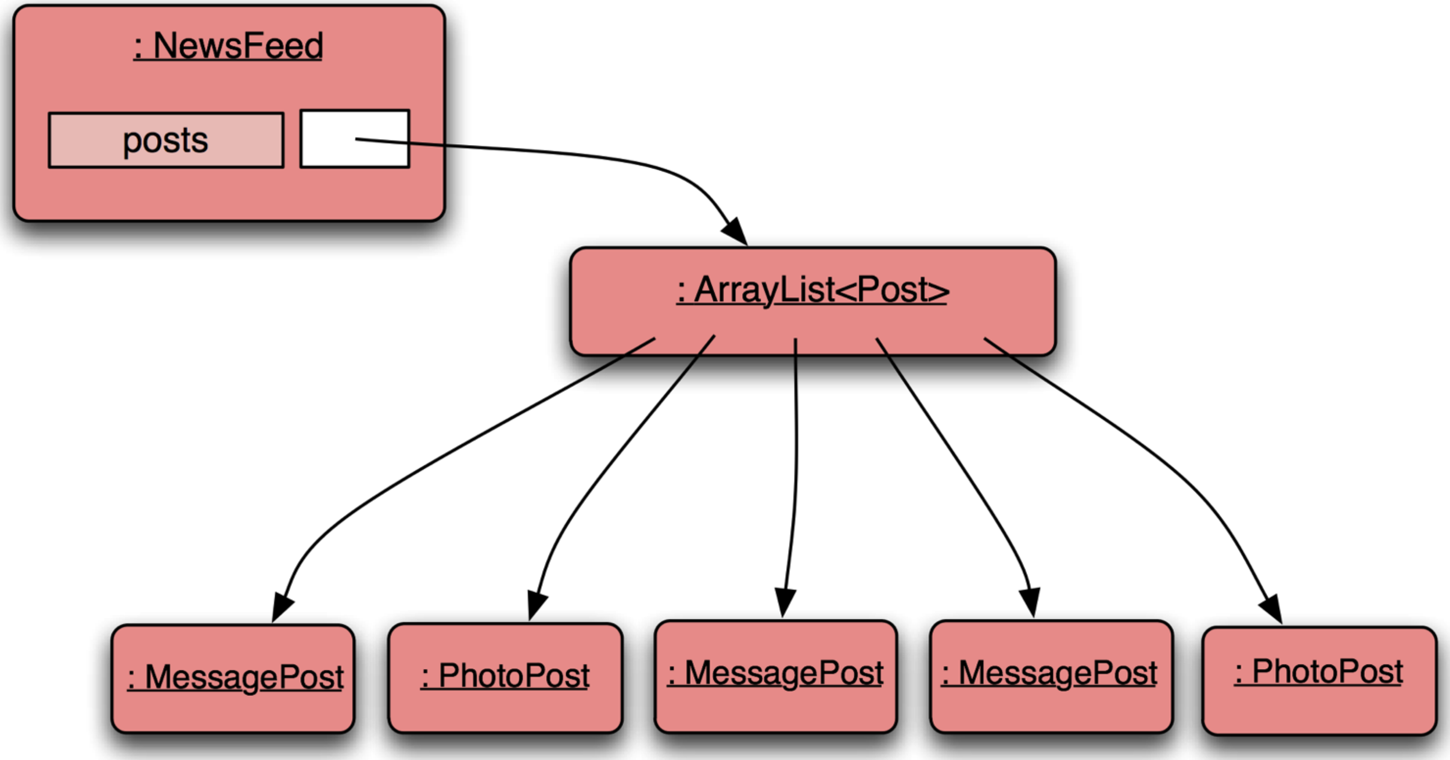
Subtyping and parameter passing

```
public class NewsFeed
{

    public void addPost(Post post)
    {
        ...
    }
}

PhotoPost photo = new PhotoPost(...);
MessagePost message = new MessagePost(...);

feed.addPost(photo);
feed.addPost(message);
```

subclass objects may be used as actual parameters for the superclass

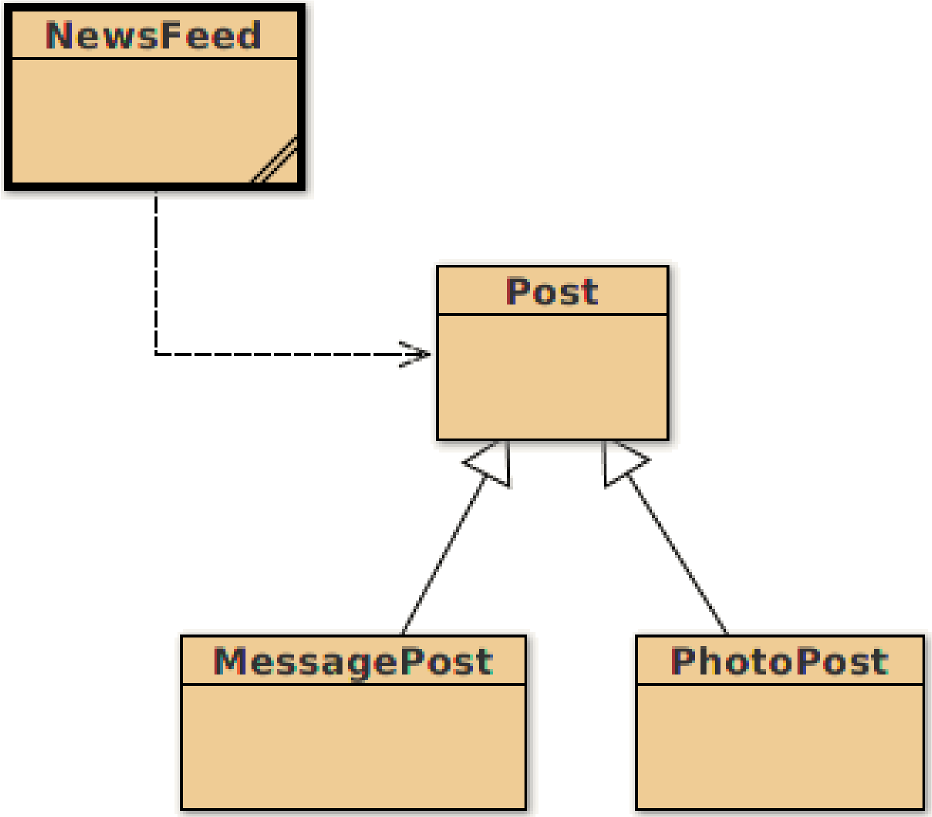
PhotoPost* & *MessagePost* are both subtypes of *Post

Object diagram

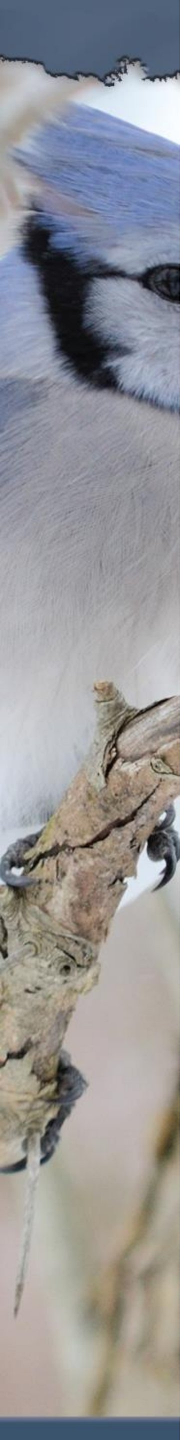


***NewsFeed* object can hold a single or mixed collection of supertype *Post* and subtypes PhotoPost/MessagePost**

Class diagram



***NewsItem* now only knows about *Post* rather than the subclasses**



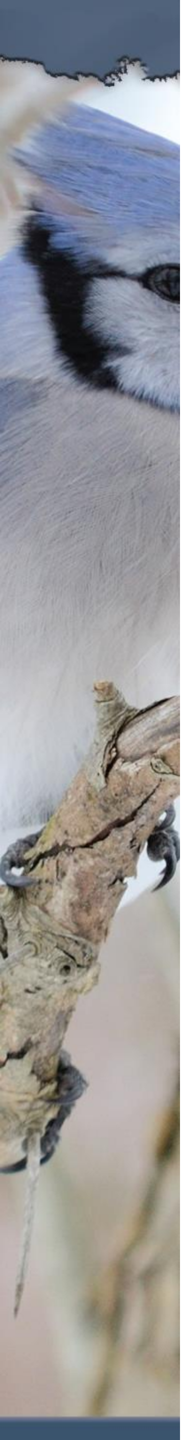
Polymorphic variables

- Object variables in Java are **polymorphic** (many shapes)
  - Can hold objects of more than one type

- Can hold objects of the declared type, or of subtypes of the declared type

```
for(Post post : posts)
{
        post.display();
        System.out.println();
}
```

Variables of supertype *Post* may hold objects of subtypes PhotoPost/MessagePost



Casting

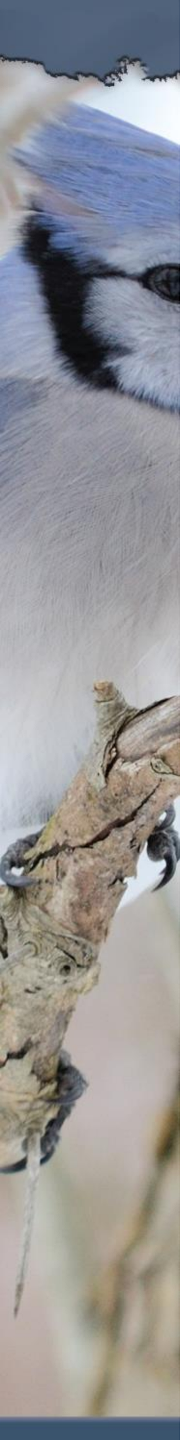
- We can assign subtype to supertype …
- … but we cannot assign supertype to subtype!

```
Vehicle v;
Car c = new Car();
v = c;               // correct
c = v;               // compile-time error!
```

- Casting fixes this:

```
c = (Car) v;
```

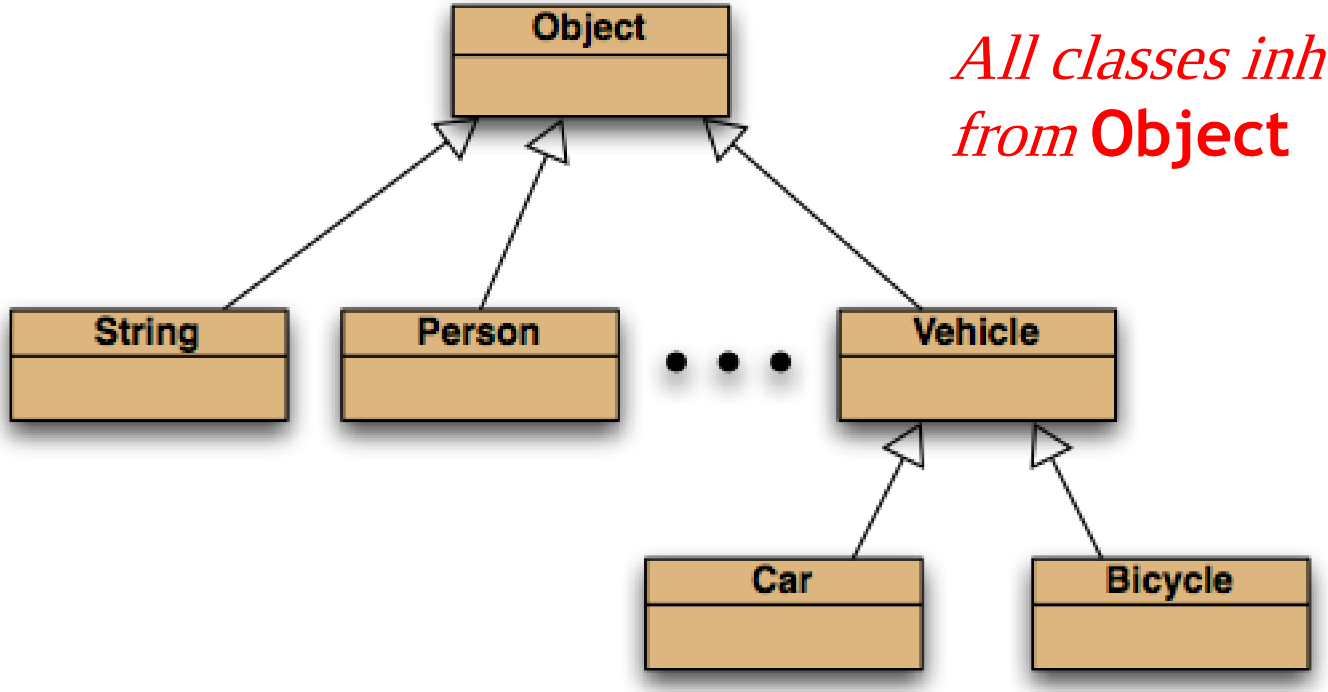
(only ok if the vehicle really is a Car!)



Casting

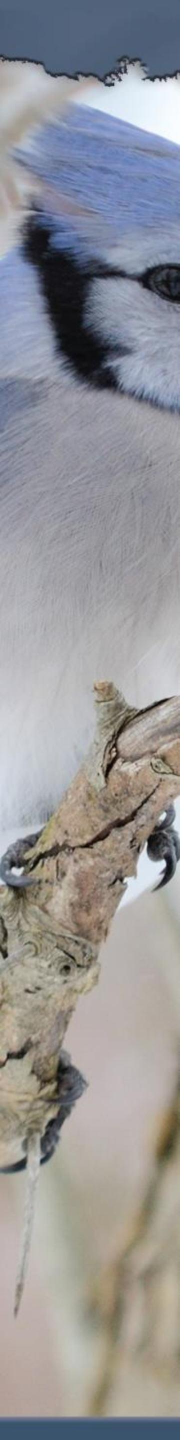
- An object type in parentheses
- Used to overcome 'type loss'
- The object is not changed in any way
- A runtime check is made to ensure the object really is of that type:
  - `ClassCastException` if it isn't!
- Use it sparingly

The Object class



All classes inherit from **Object**

***Object* class from Java standard library**

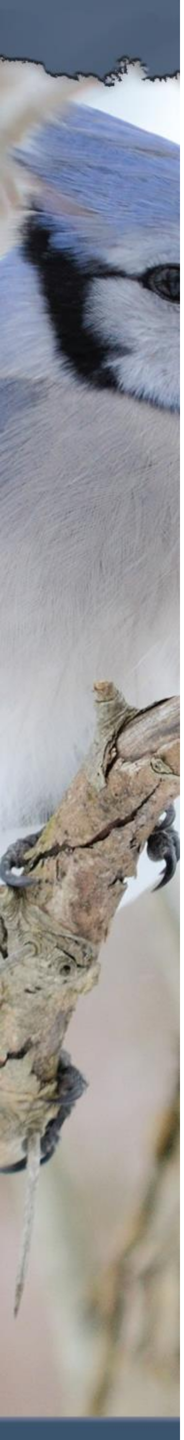


Polymorphic collections

- All collections are polymorphic
- The elements could simply be of type **Object**

```
public void add(Object element)

public Object get(int index)
```

- Usually avoided by using a type parameter with the collection

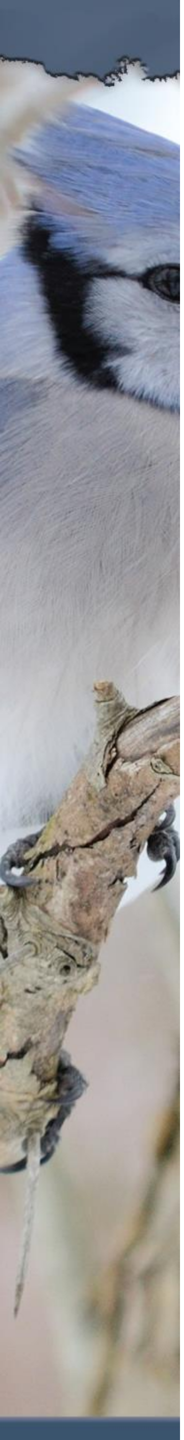


Polymorphic collections

- A type parameter limits the degree of polymorphism:

  `ArrayList<Post>`

- Collection methods are then typed
- Without a type parameter, **`ArrayList<Object>`** is implied
- Likely to get an “*unchecked or unsafe operations*” warning
- More likely to have to use casts



Review

- Inheritance allows the definition of classes as extensions of other classes
- Inheritance
  - avoids code duplication
  - allows code reuse
  - simplifies the code
  - simplifies maintenance and extending
- Variables can hold subtype objects
- Subtypes can be used wherever supertype objects are expected (substitution)