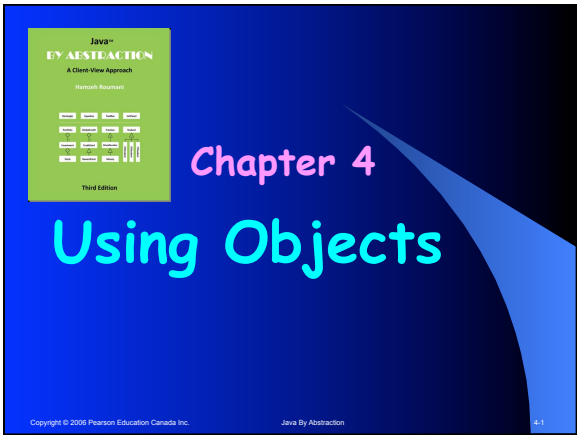
Java
BY ABSTRACTION
A Client-View Approach
Hamish Roumani
Third Edition
Chapter 4
Using Objects
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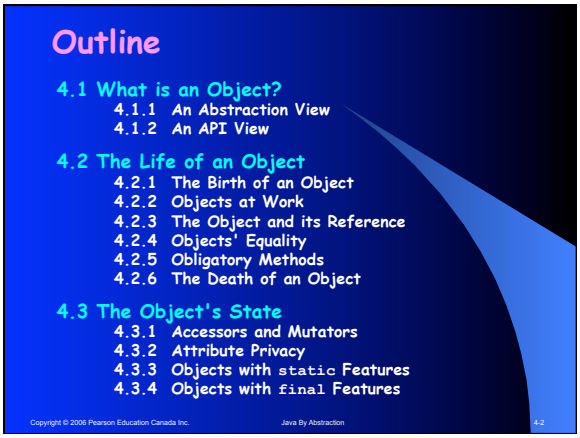
4-1


Outline
4.1 What is an Object?
4.1.1 An Abstraction View
4.1.2 An API View
4.2 The Life of an Object
4.2.1 The Birth of an Object
4.2.2 Objects at Work
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4.3 The Object's State
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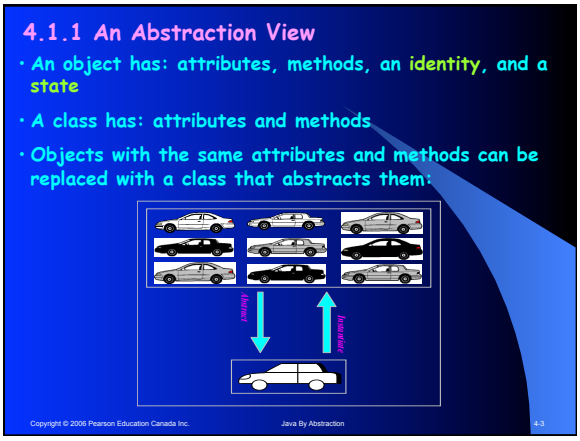
4.1.1 An Abstraction View
• An object has: attributes, methods, an identity, and a state
• A class has: attributes and methods
• Objects with the same attributes and methods can be replaced with a class that abstracts them:
Abstract
Instantiate
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4.1.2 An API View

- The API of an instantiable class has three sections:
  - A Constructor Section
  - A Field Section
  - A Method Section
- Constructors allow us to instantiate the class and get an object; i.e. add identity and state
- A constructor section *looks like* a method but:
  - There is no return column (not even `void`)
  - Constructor name = Class name

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4.2.1 The Birth of an Object

A four-step process:

1. Locate the Class
   ```
   import type.lib.Fraction;
   ```
2. Declare a Reference
   ```
   Fraction f;
   ```
3. Instantiate the Class
   ```
   new Fraction(3, 5)
   ```
4. Assign the Reference
   ```
   f = new Fraction(3, 5);
   ```

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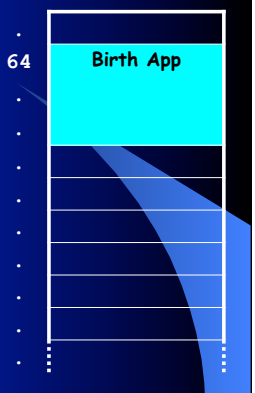
Step #1

Locate the Class

```
import type.lib.*;
```



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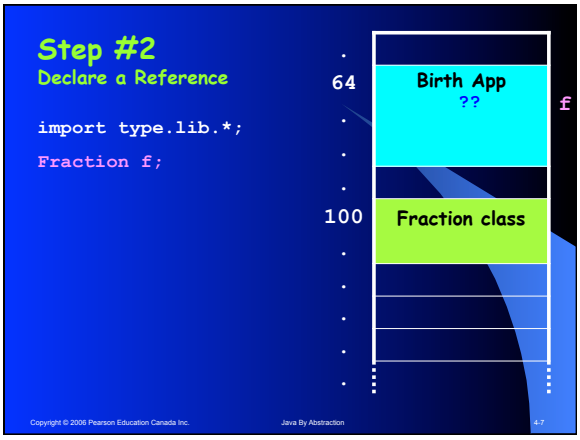
Step #2
Declare a Reference
import type.lib.*;
Fraction f;
64
100
Birth App
??
Fraction class
f
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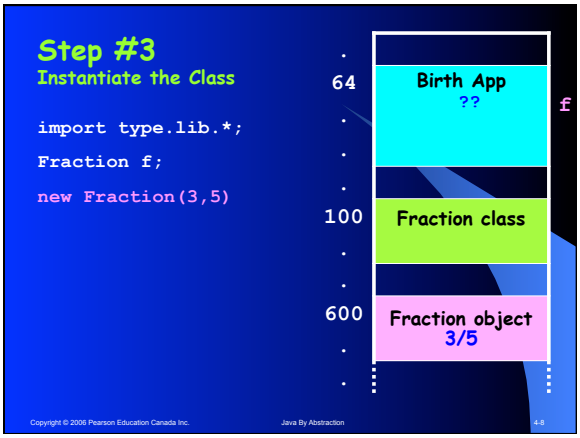
Step #3
Instantiate the Class
import type.lib.*;
Fraction f;
new Fraction(3,5)
64
100
600
Birth App
??
Fraction class
Fraction object
3/5
f
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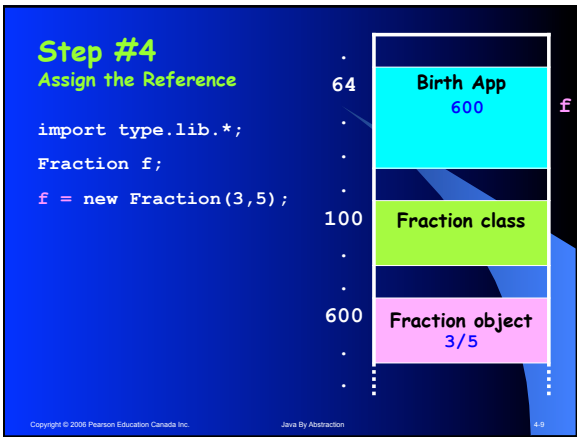
Step #4
Assign the Reference
import type.lib.*;
Fraction f;
f = new Fraction(3,5);
64
100
600
Birth App
600
Fraction class
Fraction object
3/5
f
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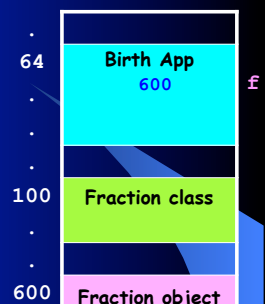
Step #4
Assign the Reference

```
import type.lib.*;
Fraction f;
f = new Fraction(3,5);
```



A reference is a pointer

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4.2.2 Objects at Work

- Accessing Field
  `reference.field`
- Invoking Methods
  `reference.method(…)`

Unlike static/utility classes, we access and invoke on the reference, not on the class.

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Examples

- Create 8/6 and invoke methods
- Note the role of `separator` and `isQuoted`
- Compute:

$$\frac{\frac{5}{3}\times\frac{7}{6}}{\frac{31}{45}}+\frac{3}{4}$$

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4.2.3 The Object Reference

Variables of primitive types hold values:

```
int x = 5;
int y = x;
x = 10;
// at this stage y remains 5
```

Variables of non-primitive types (references) hold addresses of objects, not the objects themselves.

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Aliases

Many variables can point at the same object:

```
Fraction f1;
f1 = new Fraction(3, 5);
Fraction f2;
f2 = f1;
```

If the object is changed through `f1`, the change will be seen by `f2`.

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Example

```
Fraction f1;
f1 = new Fraction(3, 5);
Fraction f2;
f2 = f1;
f1.separator = "|";
System.out.println(f2.toString());
```

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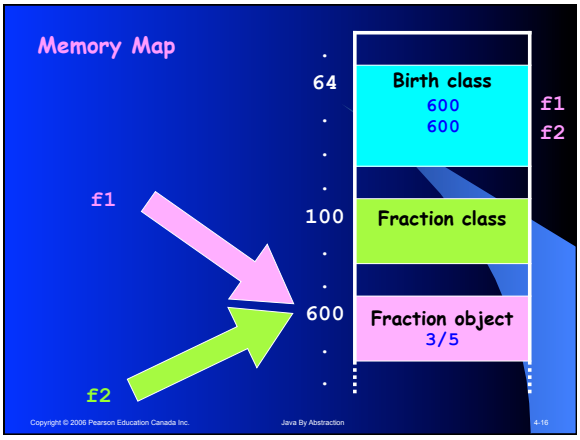

Null References and Orphans

```
Fraction f1;
f1 = new Fraction(3, 5);
Fraction f2;
f2 = f1;
f1 = null;
System.out.println(f1.toString());
System.out.println(f2.toString());
f2 = null;
```

Note that `null` is a literal (just like `true` and `false`) whose type is compatible with any non-primitive type.

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4.2.4 Object Equality

The == operator determines whether two object references are pointing at the same memory block:

```
Fraction f1 = new Fraction(3, 5);
Fraction f2 = f1;
Fraction f3 = new Fraction(2, 7);
Fraction f4 = new Fraction(6, 10);
Fraction f5 = f4;
System.out.println(f1 == f2);
System.out.println(f4 == f5);
System.out.println(f4 == f1);
```

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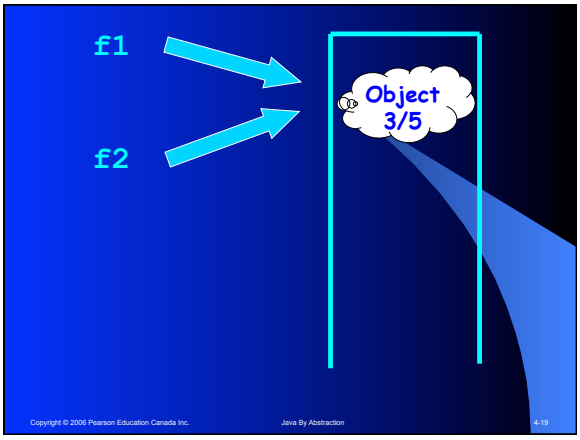

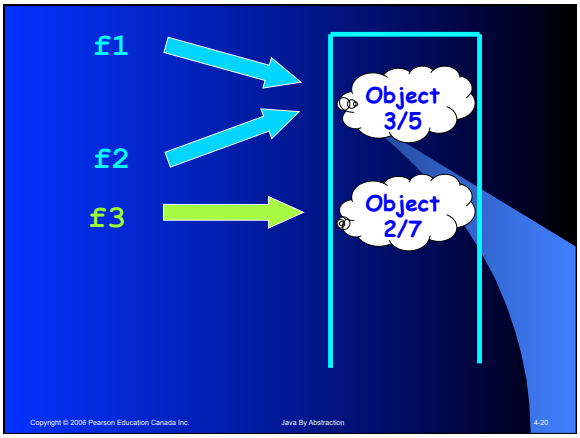

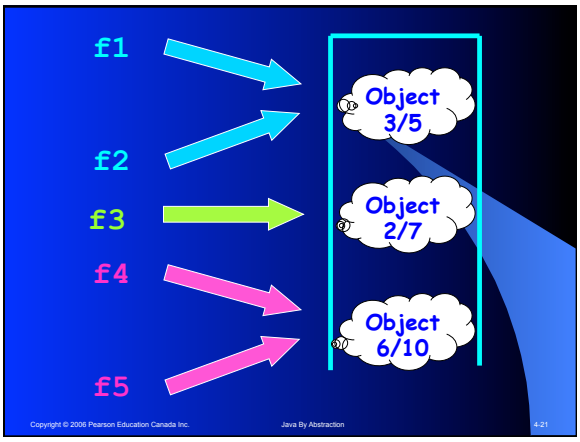

== versus equals

```
Fraction f1 = new Fraction(3, 5);
Fraction f2 = f1;
Fraction f3 = new Fraction(2, 7);
Fraction f4 = new Fraction(6, 10);
Fraction f5 = f4;
System.out.println(f1 == f2);
System.out.println(f4 == f5);
System.out.println(f4 == f1);

System.out.println(f4.equals(f1));
```

The `equals` method determines whether two objects are equal in the eyes of their class.

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Java provides a default equals method for classes that do not have one of their own. This "default" equals method behaves the same as ==:

```
FractionNS x = new FractionNS(4, 5);
FractionNS y = new FractionNS(4, 5);

boolean equalRef = (x == y);
boolean equalObj = x.equals(y);
```

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4.2.5 Obligatory Methods

Certain methods are available in all classes, either directly (provided by the class itself) or indirectly (provided by Java). Two such methods are:

toString
- -Default behaviour: same as ==
- -Auto-invoked by output methods

equals
- -Default behaviour: class name and the object's memory address in hex.

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4.2.6 The Death of an Object

Destroy the object-reference connection by:

- Exiting the scope of the reference
- Setting the reference to null
- Pointing the reference elsewhere

```
Fraction x = new Fraction(3, 5);
Fraction y = x;
Fraction z = x;
{
   Fraction t = x;
}
y = null;
z = new Fraction(4, 7);
```

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We can destroy the object itself (indirectly) by orphaning it:

```
Fraction x = new Fraction(3, 5);
Fraction y = x;
Fraction y = new Fraction(4, 7);
x = null;
```

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4.3.1 Accessors and Mutators

Key points to remember:

- A class has attributes and methods
- The object's state is held in the attributes
- Implementers make all non-final attributes private and provide accessors and mutators to enable clients to access the state.
- Accessors provide read-only access
- Mutators allow clients to mutate the state

See the `type.lib.Item` class

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4.3.2 Objects with `static` features

Some features (attributes and/or methods) in a class can be `static`. Such features:

- stay in the class
- Are shared by all instances
- Should be invoked on the class, *not* on the object reference (even though the compiler tolerates the latter).

See `isQuoted` in `type.lib.Fraction`.

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```
Fraction f = new Fraction(3, 2);
System.out.println(f.toProperString());
f.isQuoted = false;
System.out.println(f.toProperString());
```

The output:

```
"1 1/2"
1 1/2
```

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```
Fraction f = new Fraction(3, 2);
f.isQuoted = true;

Fraction g = new Fraction(5, 2);
g.isQuoted = false;

System.out.println(f.toProperString());
System.out.println(g.toProperString());
```

The output:

```
1 1/2
2 1/2
```

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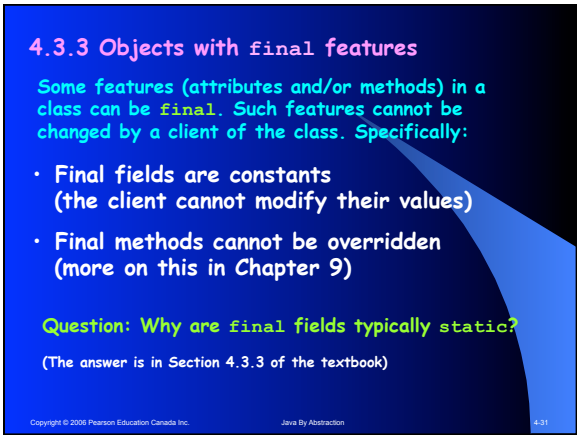
4.3.3 Objects with final features
Some features (attributes and/or methods) in a class can be final. Such features cannot be changed by a client of the class. Specifically:
• Final fields are constants (the client cannot modify their values)
• Final methods cannot be overridden (more on this in Chapter 9)
Question: Why are final fields typically static?
(The answer is in Section 4.3.3 of the textbook)
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