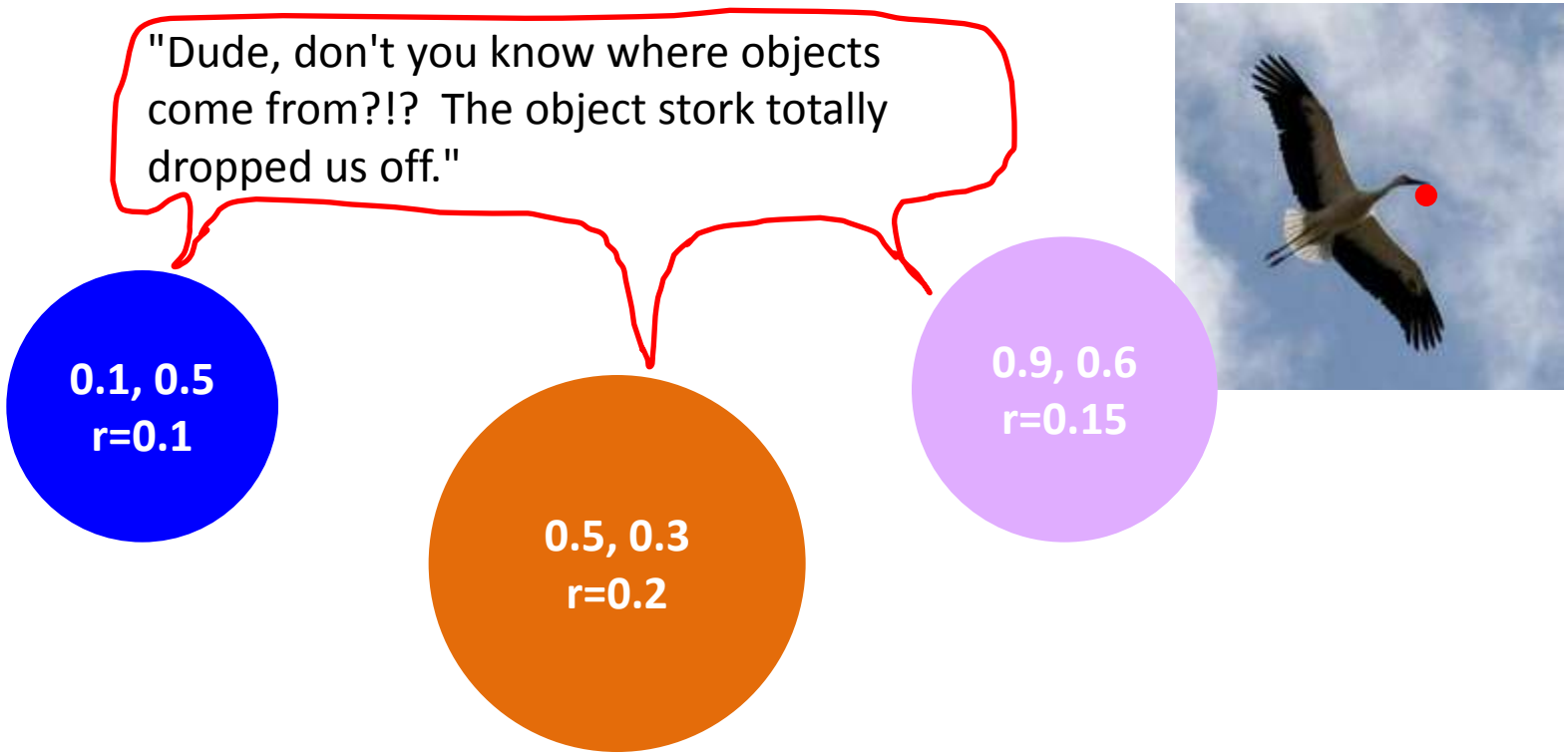
Building a fraction class

Overview

- Object oriented techniques
  - Constructors
  - Methods that take another object of same type
  - Private helper methods
- Fraction class
  - Create a class to represent fractions

Hey objects, where did you come from?




```
public Ball(double x, double y, double r)
{
    posX   = x;
    posY   = y;
    radius = r;
}
```

Constructor = the object stork

Automatic default constructors

- Rule 1: If you do not create a constructor one will be automatically created for you
  - Default no-arg constructor
  - Doesn't do anything, all instance variable are whatever you initialized them to (or their default value)

```
public class Fraction
{
   private int num;          // numerator (upstairs)
   private int denom;        // denominator (downstairs)
}
```

Creating with default constructor

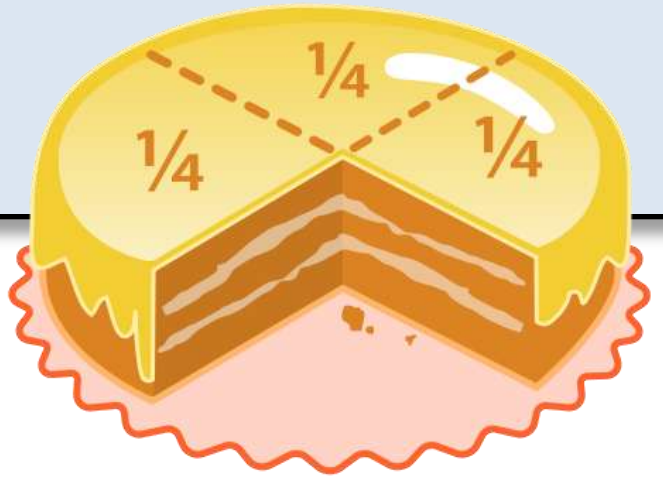
- To create object using no-arg constructor
  - Use empty ()'s after the new
  - Parameters always sent when new'ing an object, Java needs to know which constructor to run

```
public class FractionClient
{
   public static void main(String [] args)
   {
      Fraction a = new Fraction();

      Fraction [] fracs = new Fraction[2];
      fracs[0] = new Fraction();
      fracs[1] = new Fraction();

      ArrayList<Fraction> list = new ArrayList<Fraction>();
      list.add(new Fraction());
   }
}
```

Declaring your own constructor

- Rule 2: If you declare any constructor, a default one will not be automatically created

```
public class Fraction
{
    private int num;          // numerator (upstairs)
    private int denom;        // denominator (downstairs)

    public Fraction(int n, int d)
    {
        num   = n;
        denom = d;
    }
}
```



Creating with default constructor

```
public class FractionClient
{
   public static void main(String [] args)
   {
      Fraction a = new Fraction();

      Fraction [] fracs = new Fraction[2];
      fracs[0] = new Fraction();
      fracs[1] = new Fraction();

      ArrayList<Fraction> list = new ArrayList<Fraction>();
      list.add(new Fraction());
   }
}
```

We broke all the calls to create a `Fraction` object since there no longer exists a no-arg version of the constructor.

Constructor overloading

- Rule 3: You can declare as many constructor versions as you need

Hooray! Now our code using a no-arg constructor will work again.

```
public class Fraction
{
   private int num;         // numerator (upstairs)
   private int denom;       // denominator (downstairs)

   public Fraction()
   {
   }

   public Fraction(int n, int d)
   {
      num   = n;
      denom = d;
   }
}
```

Parameters of your own type

- Create a new object based on another instance of the same type

```
public class Fraction
{
   private int num;        // numerator (upstairs)
   private int denom;      // denominator (downstairs)

   // Create a new Fraction object that has the same
   // values as some other fraction object.
   public Fraction(Fraction other)
   {
      num   = other.num;
      denom = other.denom;
   }
}
```

You can access private instance variables of another object of the same type inside a method of that type.

Multiplying fractions

- Goal: Given two fraction objects, return a new fraction that is the multiplication of the two

```
public class FractionClient
{
   public static void main(String [] args)
   {
      Fraction a = new Fraction(1, 2);
      Fraction b = new Fraction(2, 3);

      Fraction c = a.multiply(b);

      System.out.println(a + " * " + b + " = " + c);
   }
}
```

```
% java FractionClient
1/2 * 2/3 = 1/3
```

Multiply method

```
public class Fraction
{
   private int num;        // numerator (upstairs)
   private int denom;      // denominator (downstairs)

   ...

   public Fraction multiply(Fraction other)
   {
      Fraction result = new Fraction(num   * other.num,
                                     denom * other.denom);
      return result;
   }
}
```

Denominator of the object that called multiply (before the dot).

Denominator of the object passed as a parameter to the multiply() method

```
Fraction c = a.multiply(b);
```

Multiplying fractions

- Attempt 1: Hmmmm, we forgot something…

```
public class FractionClient
{
   public static void main(String [] args)
   {
      Fraction a = new Fraction(1, 2);
      Fraction b = new Fraction(2, 3);

      Fraction c = a.multiply(b);

      System.out.println(a + " * " + b + " = " + c);
   }
}
```

```
% java FractionClient
Fraction@164f1d0d * Fraction@23fc4bec = Fraction@8dc8569
```

Multiplying fractions

- Attempt 2: Close, but not in lowest terms…

```
public class Fraction
{
   private int num;        // numerator (upstairs)
   private int denom;      // denominator (downstairs)

   ...

   public String toString()
   {
      return "" + num + "/" + denom;
   }
}
```

```
% java FractionClient
1/2 * 2/3 = 2/6
```

Lowest terms

- Attempt 3: Add code to reduce to lowest terms

```
public class Fraction
{
  ...
   public Fraction multiply(Fraction other)
   {
      Fraction result = new Fraction(num   * other.num,
                                     denom * other.denom);
      int i = Math.min(Math.abs(result.num),
                       Math.abs(result.denom));
      if (i == 0)
         return result;
      while ((result.num % i != 0) || (result.denom % i != 0))
         i--;
      Fraction result2 = new Fraction(result.num   / i,
                                      result.denom / i);
      return result2;
   }
}
```

```
% java FractionClient
1/2 * 2/3 = 1/3
```

Divide method

- Very similar method for division:

```
public class Fraction
{
   ...
    public Fraction divide(Fraction other)
    {
       Fraction result = new Fraction(num    * other.denom,
                                      denom  * other.num);
       int i = Math.min(Math.abs(result.num),
                        Math.abs(result.denom));
       if (i == 0)
          return result;
       while ((result.num % i != 0) || (result.denom % i != 0))
          i--;
       Fraction result2 = new Fraction(result.num    / i,
                                       result.denom  / i);
       return result2;
    }
}
```

Repeated code is evil

```
public Fraction multiply(Fraction other)
{
   Fraction result = new Fraction(num   * other.num,
                                  denom * other.denom);
   int i = Math.min(Math.abs(result.num),
                    Math.abs(result.denom));
   if (i == 0)
      return result;
   while ((result.num % i != 0) || (result.denom % i != 0))
      i--;
   Fraction result2 = new Fraction(result.num   / i,
                                   result.denom / i);
   return result2;
}
```

Where should this code really live? There are a number of choices, but not here for sure.

We'd have to repeat it in the divide(), add(), and subtract() methods as well.

Helper methods

- Add a private helper method, reduce()

```
public class Fraction
{
   private void reduce()
   {
      int i = Math.min(Math.abs(num), Math.abs(denom));
      if (i == 0)
         return;
      while ((num % i != 0) || (denom % i != 0))
         i--;
      num   = num   / i;
      denom = denom / i;
   }
   public Fraction multiply(Fraction other)
   {
      Fraction result = new Fraction(num   * other.num,
                                     denom * other.denom);
      result.reduce();
      return result;
   }
}
```

Because it is a private method, can only be called inside other methods in the Fraction class

Fill in the missing code

```
public class Fraction
{
   public Fraction multiply(Fraction other)
   {
      Fraction result = new Fraction(num   * other.num,
                                     denom * other.denom);
      result.reduce();
      return result;
   }

   public boolean equals(Fraction other)
   {
   }

   public Fraction reciprocal()
   {
   }

   public Fraction add(Fraction other)
   {
   }

   public Fraction subtract(Fraction other)
   {
   }
}
```

Summary

- Objects
  - No-arg default constructors
  - Passing objects of same type to method
  - Private helper methods
- Fraction object
  - Built an object to represent a fraction