University of British Columbia
CPSC 111, Intro to Computation
Jan-Apr 2006

Tamara Munzner

Advanced Class Design

Lecture 19, Thu Mar 16 2006

based on slides by Kurt Eiselt

http://www.cs.ubc.ca/~tmm/courses/cpsc111-06-spr

News

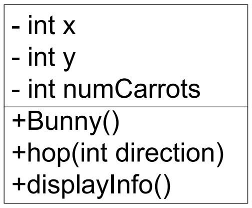
- Midterm 2: Thu Mar 16, 6:30pm (TODAY!)
  - Woodward 2
  - hour-long exam, reserve 6:30-8 time slot
    - for buffer in case of fire alarms etc
- no labs/tutorials this week
  - but one TA will be in lab during normal lab hours to answer questions

Reading

- This week: 9.3-9.4, 9.6-9.8
- Next week: 11.1-11.3

Recap: Bunnies

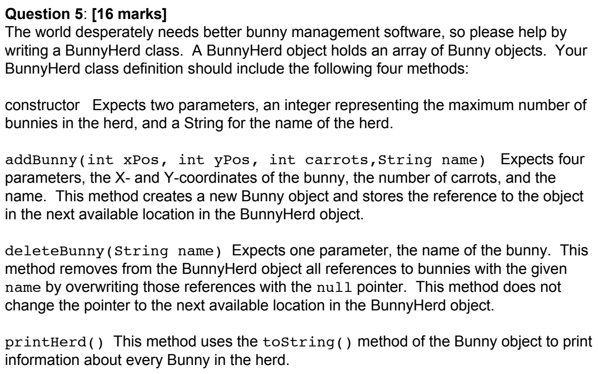
- Bunny.java


- int x
- int y
- int numCarrots
+Bunny()
+hop(int direction)
+displayInfo()

- NamedBunny.java

+Bunny(int x, int y, int numCarrots, String name)

Even More Bunnies


Question 5: **[16 marks]**
The world desperately needs better bunny management software, so please help by writing a BunnyHerd class. A BunnyHerd object holds an array of Bunny objects. Your BunnyHerd class definition should include the following four methods:

constructor Expects two parameters, an integer representing the maximum number of bunnies in the herd, and a String for the name of the herd.

`addBunny(int xPos, int yPos, int carrots,String name)` Expects four parameters, the X- and Y-coordinates of the bunny, the number of carrots, and the name. This method creates a new Bunny object and stores the reference to the object in the next available location in the BunnyHerd object.

`deleteBunny(String name)` Expects one parameter, the name of the bunny. This method removes from the BunnyHerd object all references to bunnies with the given `name` by overwriting those references with the `null` pointer. This method does not change the pointer to the next available location in the BunnyHerd object.

`printHerd()` This method uses the `toString()` method of the Bunny object to print information about every Bunny in the herd.

Even More Bunnies

- BunnyHerd.java

Parameter Passing

Consider the following program:

```
public class ParamTest1
{
  public static void main (String[] args)
  {
    int number = 4;
    System.out.println("main: number is " + number);
    method1(number);
    System.out.println("main: number is now " + number);
  }

  public static void method1(int x)
  {
    System.out.println("method1: x is " + x);
    x = x * x;
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```

What's the flow of control?

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  }
}
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What's printed?

```
main: number is 4
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  }
}
```

What's printed?

```
main: number is 4
method1: x is 4
```

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}
```

What's printed?

```
main: number is 4
method1: x is 4
method1: x is now 16
```

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What's printed?

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What's printed?

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method1: x is now 16
main: number is now 4
```

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5   x = x * x;
6   System.out.println("method1: x is now " + x);
  }
}
```

Why not 16?

```
main: number is 4
method1: x is 4
method1: x is now 16
main: number is now 4
```

Parameter Passing

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```

Because when the value in the `int` variable `number` is passed to `method1`,

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  }
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```

Because when the value in the `int` variable `number` is passed to `method1`, what really happens is that a copy of the value (4) in `number` is assigned to the parameter `x`.

Parameter Passing

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  {
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5   x = x * x;
6   System.out.println("method1: x is now " + x);
  }
}
```

Because when the value in the `int` variable `number` is passed to `method1`, what really happens is that a copy of the value (4) in `number` is assigned to the parameter `x`. It's the value in `x` that's being modified here -- a copy of the value in `number`. The original value in `number` is not affected.

Parameter Passing

Will this program behave differently? Why or why not?

```
public class ParamTest2
{
  public static void main (String[] args)
  {
    int number = 4;
    System.out.println("main: number is " + number);
    method1(number);
    System.out.println("main: number is now " + number);
  }

  public static void method1(int number)
  {
    System.out.println("method1: number is " + number);
    number = number * number;
    System.out.println("method1: number is now " + number);
  }
}
```

What's printed?

Parameter Passing

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  }
}
```

What's printed?

```
main: number is 4
method1: number is 4
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?????????????????????????
```

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    System.out.println("method1: number is " + number);
    number = number * number;
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  }
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```

What's printed?

```
main: number is 4
method1: number is 4
method1: number is now 16
main: number is now 4
```

Parameter Passing

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  }
}
```

Remember that a parameter declared in a method header has local scope, just like a variable declared within that method. As far as Java is concerned, `number` inside of `method1` is unrelated to `number` outside of `method1`. They are not the same variable.

Parameter Passing

Now consider this program.

```
public class Ptest
{
  public static void main(String[] args)
  {
    int[] foo = new int[1];
    foo[0] = 4;
    System.out.println("main: foo is now: " + foo[0]);
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  }

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main: foo is now: 16
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Why not 4?

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method1: x is now: 4
method1: x is now: 16
main: foo is now: 16
```

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What's in `foo`? Is it the `int[]` array object?

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What's in `foo`? Is it the `int[]` array object? No, it's the reference, or pointer, to the object.

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    System.out.println("method1: x is now: " + x[0]);
  }
}
```

What's in `foo`? Is it the `int[]` array object? No, it's the reference, or pointer, to the object. A copy of that reference is passed to `method1` and assigned to `x`. The reference in `foo` and the reference in `x` both point to the same object.

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    System.out.println("main: foo is now: " + foo[0]);
  }

  public static void method1(int[] x)
  {
    System.out.println("method1: x is now: " + x[0]);
    x[0] = x[0] * x[0];
    System.out.println("method1: x is now: " + x[0]);
  }
}
```

When the object pointed at by `x` is updated, it's the same as updating the object pointed at by `foo`. We changed the object that was pointed at by both `x` and `foo`.

Parameter Passing

- Passing primitive types (int, double, boolean) as parameter in Java
  - "pass by value"
  - value in variable is copied
  - copy is passed to method
  - modifying copy of value inside called method has no effect on original value outside called method
    - modifying aka mutating

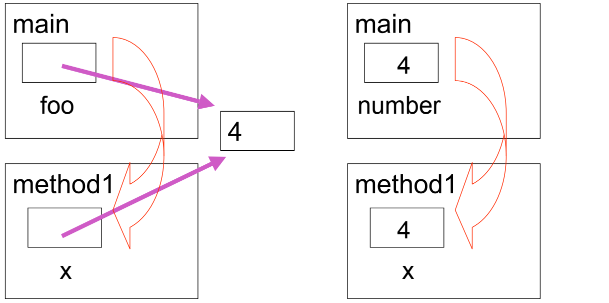
Parameter Passing

- Passing object as parameter in Java
  - "pass by reference"
  - objects could be huge, so do not pass copies around
  - pass copy of the object reference
    - object reference aka pointer
  - modifying object pointed to by reference inside calling method **does** affect object pointed to by reference outside calling method
    - both references point to **same object**

Parameter Passing Pictures

object as parameter:
copy of pointer made

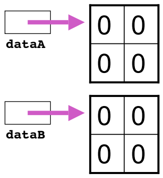
prim as parameter:
copy of value



Midterm Q4 from 04W2

```
int[][] dataA = { { 0, 0 }, { 0, 0 } };
int[][] dataB = { { 0, 0 }, { 0, 0 } };
process( dataA, dataB );
```

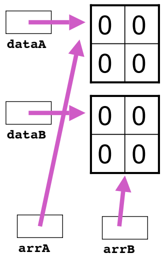
```
public void process( int[][] arrA, int[][] arrB )
{
   int row;
   int col;
   int[][] arrC = { { 1, 1, 1 }, { 1, 1, 1 } };
   arrA = arrC;
   for( row = 0; row < arrB.length; row++ )
   {
      for( col = 0; col < arrB[ row ].length; col++
   )
      {
         arrB[ row ][ col ] = row + col;
      }
   }
}
```



Midterm Q4 from 04W2

```
int[][] dataA = { { 0, 0 }, { 0, 0 } };
int[][] dataB = { { 0, 0 }, { 0, 0 } };
process( dataA, dataB );
```

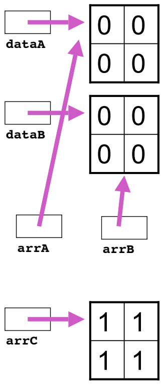
```
public void process( int[][] arrA, int[][] arrB )
{
   int row;
   int col;
   int[][] arrC = { { 1, 1, 1 }, { 1, 1, 1 } };
   arrA = arrC;
   for( row = 0; row < arrB.length; row++ )
   {
      for( col = 0; col < arrB[ row ].length; col++
   )
      {
         arrB[ row ][ col ] = row + col;
      }
   }
}
```



Midterm Q4 from 04W2

```
int[][] dataA = { { 0, 0 }, { 0, 0 } };
int[][] dataB = { { 0, 0 }, { 0, 0 } };
process( dataA, dataB );
```

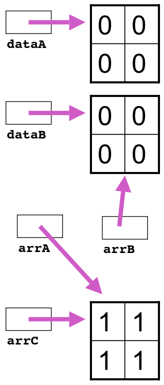
```
public void process( int[][] arrA, int[][] arrB )
{
   int row;
   int col;
   int[][] arrC = { { 1, 1, 1 }, { 1, 1, 1 } };
   arrA = arrC;
   for( row = 0; row < arrB.length; row++ )
   {
      for( col = 0; col < arrB[ row ].length; col++
   )
      {
         arrB[ row ][ col ] = row + col;
      }
   }
}
```



Midterm Q4 from 04W2

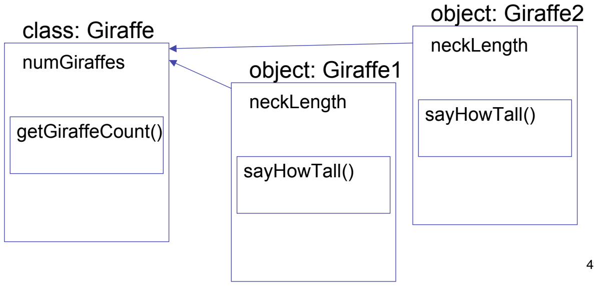
```
int[][] dataA = { { 0, 0 }, { 0, 0 } };
int[][] dataB = { { 0, 0 }, { 0, 0 } };
process( dataA, dataB );
```

```
public void process( int[][] arrA, int[][] arrB )
{
   int row;
   int col;
   int[][] arrC = { { 1, 1, 1 }, { 1, 1, 1 } };
   arrA = arrC;
   for( row = 0; row < arrB.length; row++ )
   {
      for( col = 0; col < arrB[ row ].length; col++
   )
      {
         arrB[ row ][ col ] = row + col;
      }
   }
}
```



Review: Static Fields/Methods

- Static fields belong to whole class
  - nonstatic fields belong to instantiated object
- Static methods can only use static fields
  - nonstatic methods can use either nonstatic or static fields



Review: Variable Scope

- Scope of a variable (or constant) is that part of a program in which value of that variable can be accessed

Variable Scope

```
public class CokeMachine4
{
  private int numberOfCans;

  public CokeMachine4()
  {
    numberOfCans = 2;
    System.out.println("Adding another machine to your empire");
  }

  public int getNumberOfCans()
  {
    return numberOfCans;
  }

  public void reloadMachine(int loadedCans)
  {
    numberOfCans = loadedCans;
  }
```

- numberOfCans variable declared inside class but not inside particular method
  - scope is entire class: can be accessed from anywhere in class

Variable Scope

```
public class CokeMachine4
{
  private int numberOfCans;

  public CokeMachine4()
  {
    numberOfCans = 2;
    System.out.println("Adding another machine to your empire");
  }

  public double getVolumeOfCoke()
  {
    double totalLitres = numberOfCans * 0.355;
    return totalLitres;
  }

  public void reloadMachine(int loadedCans)
  {
    numberOfCans = loadedCans;
  }
```

- totalLitres declared within a method
  - scope is method: can only be accessed from within method
  - variable is local data: has local scope

Variable Scope

```
public class CokeMachine4
{
  private int numberOfCans;

  public CokeMachine4()
  {
    numberOfCans = 2;
    System.out.println("Adding another machine to your empire");
  }

  public int getNumberOfCans()
  {
    return numberOfCans;
  }

  public void reloadMachine(int loadedCans)
  {
    numberOfCans = loadedCans;
  }
```

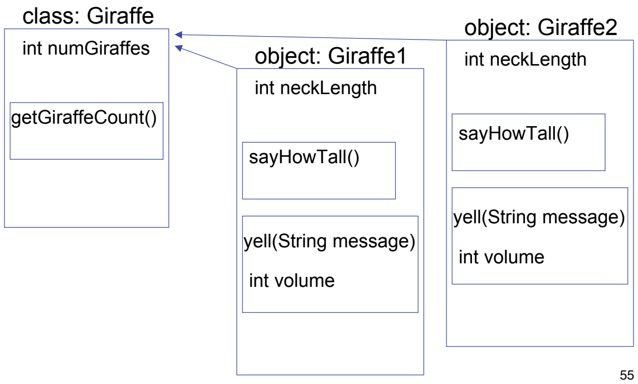
- loadedCans is method parameter
  - scope is method: also local scope
  - just like variable declared within parameter
  - accessed only within that method

Variable Types

- Static variables
  - declared within class
  - associated with class, not instance
- Instance variables
  - declared within class
  - associated with instance
  - accessible throughout object, lifetime of object
- Local variables
  - declared within method
  - accessible throughout method, lifetime of method
- Parameters
  - declared in parameter list of method
  - acessible throughout method, lifetime of method

Variable Types

- Static? Instance? Local? Parameters?



class: Giraffe

int numGiraffes

getGiraffeCount()

object: Giraffe1

int neckLength

sayHowTall()

yell(String message)

int volume

object: Giraffe2

int neckLength

sayHowTall()

yell(String message)

int volume

Questions?