More About Objects and Methods

Chapter 6

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Objectives

- Define and use constructors
- Write and use static variables and methods
- Use methods from class `Math`
- Use predefined wrapper classes
- Use stubs, drivers to test classes and programs

Objectives

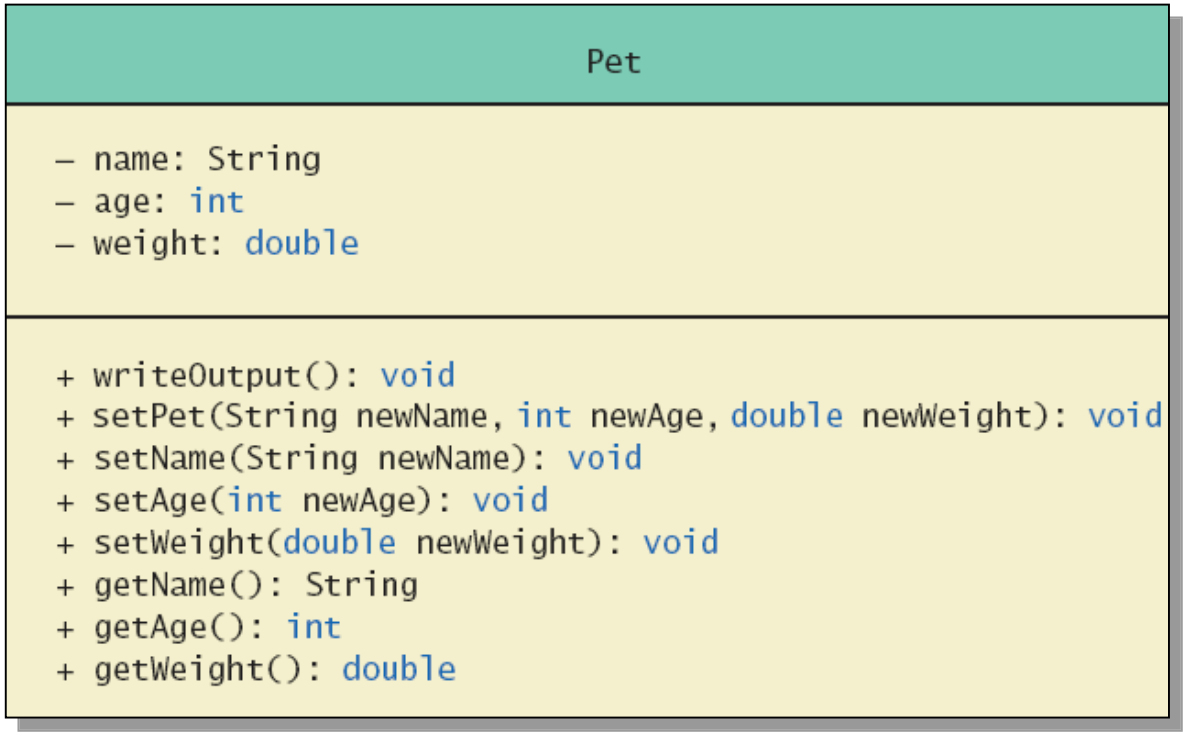
- Write and use **overloaded** methods
- Define and use enumeration methods
- Define and use packages and `import` statements

Defining Constructors

- A special method called when instance of an object created with **new**
  - Create objects
  - Initialize values of instance variables
- Can have parameters
  - To specify initial values if desired
- May have multiple definitions
  - Each with different numbers or types of parameters

Defining Constructors

- Example class to represent pets
- Figure 6.1 Class Diagram for Class `Pet`



Defining Constructors

- `class Pet`
- Note different constructors
  - Default
  - With 3 parameters
  - With String parameter
  - With double parameter
- `class PetDemo`

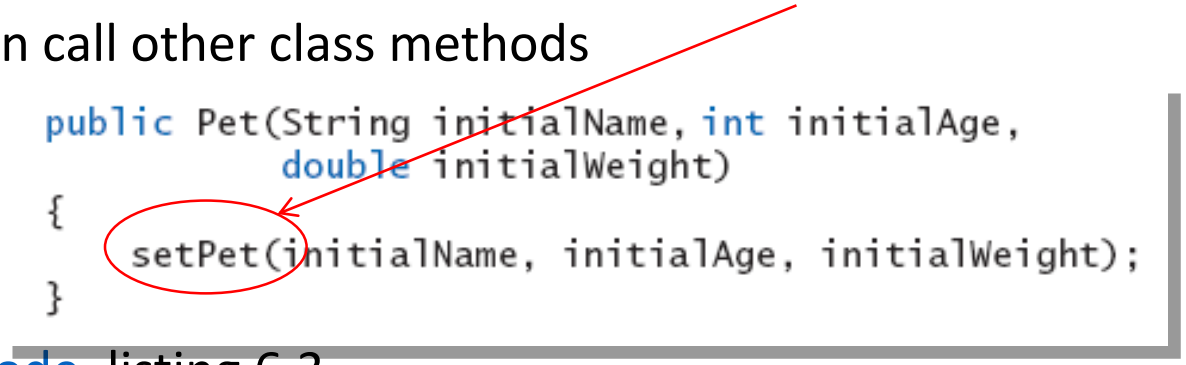
Defining Constructors

```
My records on your pet are inaccurate.
Here is what they currently say:
Name: Jane Doe
Age: 0
Weight: 0.0 pounds
Please enter the correct pet name:
Moon Child
Please enter the correct pet age:
5
Please enter the correct pet weight:
24.5
My updated records now say:
Name: Moon Child
Age: 5
Weight: 24.5 pounds
```

Sample screen output

Calling Methods from Other Constructors

- Constructor can call other class methods



```
public Pet(String initialName, int initialAge,
           double initialWeight)
{
    setPet(initialName, initialAge, initialWeight);
}
```

- View sample code, listing 6.3
  `class Pet2`
  - Note method **`setPet`**
  - Keeps from repeating code

Calling Constructor from Other Constructors

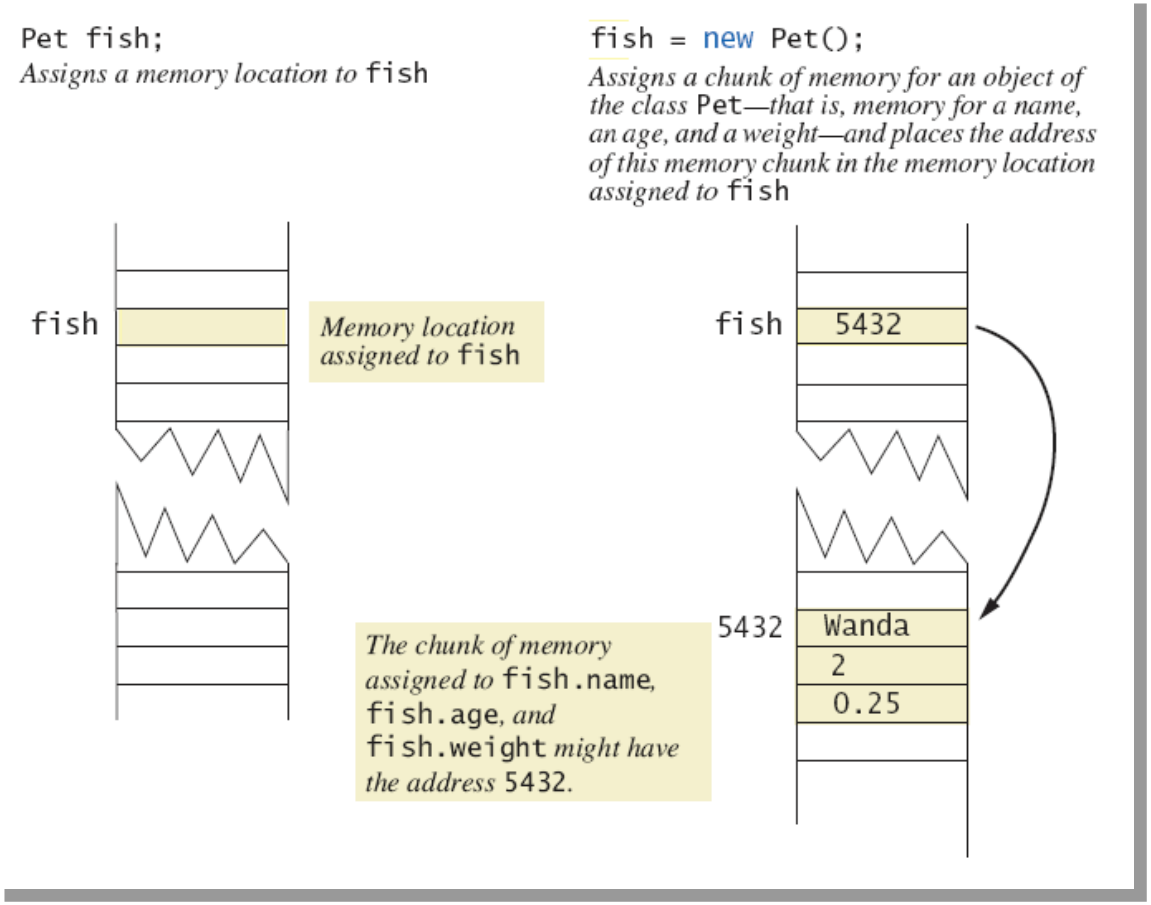
- From listing 6.3 we have the initial constructor and method set
- In the other constructors use the this reference to call initial constructor
- Use `this(<other constructor's params>)` instead of `ClassName(<other constructor's params>)`
- `class Pet3`
  - Note calls to initial constructor

Defining Constructors

- Constructor without parameters is the default constructor
  - Java will define this automatically if the class designer does not define any constructors
  - If you do define a constructor, Java will not automatically define a default constructor
- Usually default constructors not included in class diagram

Defining Constructors

- Figure 6.2 A constructor returning a reference



Static Variables

- Static variables are shared by all objects of a class
  - Variables declared `static final` are considered constants – value cannot be changed
- Variables declared `static` (without `final`) can be changed
  - Only one instance of the variable exists
  - It can be accessed by all instances of the class
- Static variables also called *class variables*
  - Contrast with *instance/member variables*
- Do not confuse class variables with variables of a class type
- Both static variables and instance variables are sometimes called *fields* or *data members*

Static Methods

- Some methods may have no relation to any type of object
- Example
  - Compute max of two integers
  - Convert character from upper to lower case
- Static method declared in a class
  - Can be invoked without using an object
  - Instead use the class name (unnecessary if used in same class defined)
  - Make a method static if the logic
    - Does not use *instance* variables
    - Or, a more specific version of the above, it just takes parameters an just returns a result
      - Example 1: a method that takes two parameters and returns the distance between them
      - Example 2: a utility method such as **print()** or **println()** such as used in class to avoid typing "System.out" every time for print-heavy programs

Static Methods

- View sample class, listing 6.5
  `class DimensionConverter`
- View demonstration program, listing 6.6
  `class DimensionConverterDemo`

```
Enter a measurement in inches: 18
18.0 inches = 1.5 feet.
Enter a measurement in feet: 1.5
1.5 feet = 18.0 inches.
```

Sample screen output

Tasks of `main` in Subtasks

- Program may have
  - Complicated logic
  - Repetitive code
- Create static methods to accomplish subtasks
- Must be static or will require an instance of the class to call – often does not make sense to create an instance of a class just to call a utility method or subtask

Adding Method `main` to a Class

- Method main used so far in its own class within a separate file
- Often useful to include method main within class definition
  - To create objects in other classes
  - To be run as a program
- Note example code, listing 6.11
  a redefined `class Species`
  - When used as ordinary class, method `main` ignored

The `Math` Class

- Provides many standard mathematical methods
  - Automatically provided, no import needed
- Example methods, figure 6.3a

Name	Description	Argument Type	Return Type	Example	Value Returned
pow	Power	double	double	Math.pow(2.0,3.0)	8.0
abs	Absolute value	int, long, float, or double	Same as the type of the argument	Math.abs(-7) Math.abs(7) Math.abs(-3.5)	7 7 3.5
max	Maximum	int, long, float, or double	Same as the type of the arguments	Math.max(5, 6) Math.max(5.5, 5.3)	6 5.5

The `Math` Class

- Example methods, figure 6.3b

Name	Description	Argument Type	Return Type	Example	Value Returned
`min`	Minimum	`int`, `long`, `float`, or `double`	Same as the type of the arguments	`Math.min(5, 6)` `Math.min(5.5, 5.3)`	5 5.3
`round`	Rounding	`float` or `double`	`int` or `long`, respectively	`Math.round(6.2)` `Math.round(6.8)`	6 7
`ceil`	Ceiling	`double`	`double`	`Math.ceil(3.2)` `Math.ceil(3.9)`	4.0 4.0
`floor`	Floor	`double`	`double`	`Math.floor(3.2)` `Math.floor(3.9)`	3.0 3.0
`sqrt`	Square root	`double`	`double`	`sqrt(4.0)`	2.0

Random Numbers

- **`Math.random()`** returns a random double that is greater than or equal to zero and less than 1
- Java also has a **`Random`** class to generate random numbers
- Can scale using addition and multiplication; the following simulates rolling a six sided die

```
int die = (int) (6.0 * Math.random()) + 1;
```

Wrapper Classes

- Recall that arguments of primitive type treated differently from those of a class type
  - May need to treat primitive value as an object occasionally
- Java provides *wrapper classes* for each primitive type
  - Methods provided to act on values (generally useful)

Wrapper Classes

- Allow programmer to have an object that corresponds to value of primitive type
- Contain useful predefined constants and methods
  - Double.MAX_VALUE
- Wrapper classes have no default constructor
  - Programmer must specify an initializing value when creating new object
- Wrapper classes have no `set` methods – they are *immutable*, like **String**s

Wrapper Classes

- Figure 6.4a Static methods in class **`Character`**

Name	Description	Argument Type	Return Type	Examples	Return Value
`toUpperCase`	Convert to uppercase	`char`	`char`	`Character.toUpperCase('a')` `Character.toUpperCase('A')`	`'A'` `'A'`
`toLowerCase`	Convert to lowercase	`char`	`char`	`Character.toLowerCase('a')` `Character.toLowerCase('A')`	`'a'` `'a'`
`isUpperCase`	Test for uppercase	`char`	`boolean`	`Character.isUpperCase('A')` `Character.isUpperCase('a')`	`true` `false`

Wrapper Classes

- Figure 6.4b Static methods in class **`Character`**

Name	Description	Argument Type	Return Type	Examples	Return Value
`isLowerCase`	Test for lowercase	`char`	`boolean`	`Character.isLowerCase('A')` `Character.isLowerCase('a')`	`false` `true`
`isLetter`	Test for a letter	`char`	`boolean`	`Character.isLetter('A')` `Character.isLetter('%')`	`true` `false`
`isDigit`	Test for a digit	`char`	`boolean`	`Character.isDigit('5')` `Character.isDigit('A')`	`true` `false`
`isWhitespace`	Test for whitespace	`char`	`boolean`	`Character.isWhitespace(' ')` `Character.isWhitespace('A')`	`true` `false`

Whitespace characters are those that print as white space, such as the blank, the tab character (`'\t'`), and the line-break character (`'\n'`).

Writing Methods: Outline

- Case Study: Formatting Output
- Decomposition
- Addressing Compiler Concerns
- Testing Methods

Formatting Output

Algorithm to display a double amount as dollars and cents (corrected)

0. get total number of cents (rounded)
1. `dollars` = the number of whole dollars in total cents amount.
2. `cents` = the number of remaining cents in amount. ~~Round if there are more than two digits after the decimal point.~~
3. Display a dollar sign, `dollars`, and a decimal point.
4. Display `cents` as a two-digit integer.

Formatting Output

```
Testing DollarFormatFirstTry.write:
Enter a value of type double:
1.2345
$1.23
Test again?
yes
Enter a value of type double:
1.235
$1.24
Test again?
yes
Enter a value of type double:
9.02
$9.02
Test again?
yes
Enter a value of type double:
-1.20
$-1.0-20
Test again?
no
```

Oops. There's a problem here.

Sample screen output

Decomposition

- Recall pseudocode from previous slide
- With this pseudocode we *decompose* the task into subtasks
  - Then solve each subtask
  - Combine code of subtasks
  - Place in a method

Addressing Compiler Concerns

- Compiler ensures necessary tasks are done
  - Initialize variables
  - Include `return` statement
- Rule of thumb: believe the compiler
  - Change the code as requested by compiler
  - It is most likely correct

Testing Methods

- To test a method use a driver program (or use unit tests…)
- Every method in a class should be tested – not just that a method was called but that all code paths tested too… still not perfect
- Bottom-up testing
  - Test lowest levels first
  - Failed tests at lower levels generally suggest to work on the lower level before the higher level
- Can do Top-Down also by using a stub – simplified version of a method for testing purposes – for the lower levels. Examples:
  - Stub for Database/Network: may just return answers without querying database or making internet connection
  - Stub for video camera input: may just read a given video

Overloading: Outline

- Overloading Basics
- Overloading and Automatic Type Conversion
- Overloading and the Return Type

Overloading Basics

- When two or more methods have same name within the same class
- Java distinguishes the methods by number and types of parameters
  - If it cannot match a call with a definition, it attempts to do type conversions
  - **return** type is not considered
- A method's name and number and type of parameters is called the *signature*

Overloading Basics

- View example program, listing 6.15
  `class Overload`
- Note overloaded method `getAverage`

```
average1 = 45.0
average2 = 2.0
average3 = b
```

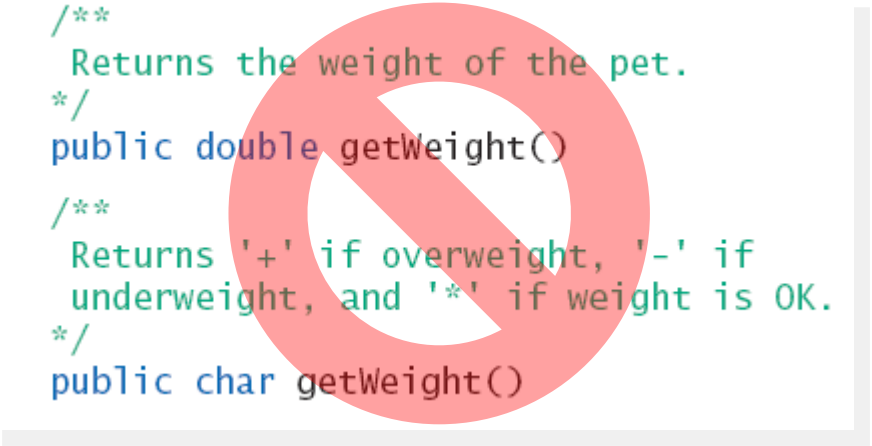
Sample screen output

Overloading and Type Conversion

- Overloading and automatic type conversion can conflict
- Recall definition of Pet class of listing 6.1
  - If we pass an integer to the constructor we get the constructor for age, even if we intended the constructor for weight
- Remember the compiler attempts to overload before it does type conversion
- Use descriptive method names, avoid overloading

Overloading and Return Type

- You must not overload a method where the only difference is the type of value returned -- ambiguous



```
/**
 Returns the weight of the pet.
*/
public double getWeight()

/**
 Returns '+' if overweight, '-' if
 underweight, and '*' if weight is OK.
*/
public char getWeight()
```

Information Hiding Revisited

Privacy Leaks

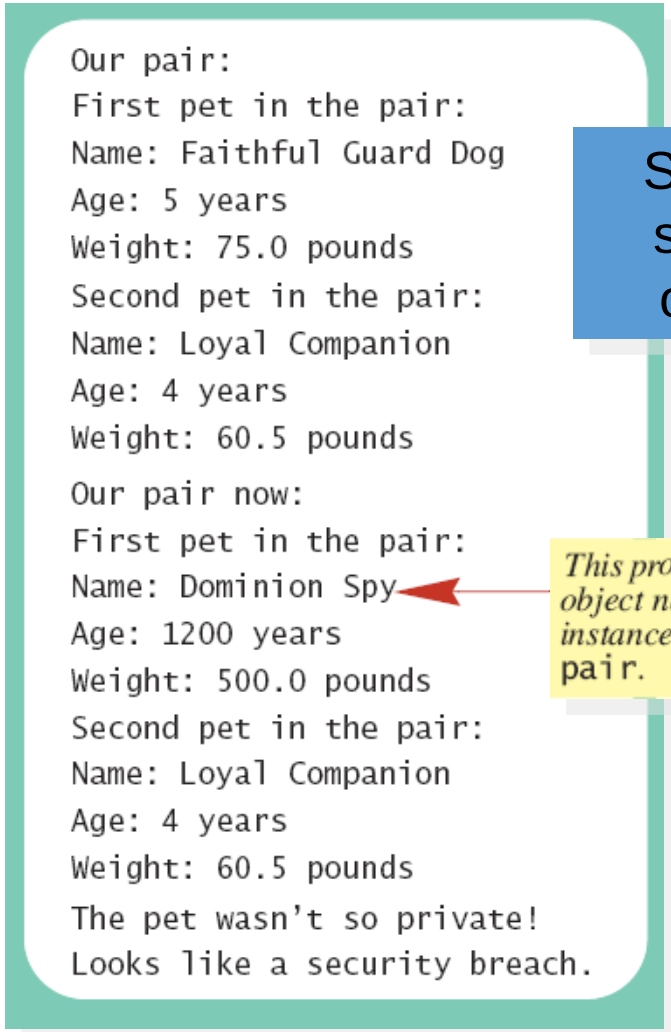
- Instance variable of a class type contain address where that object is stored
- Assignment of class variables results in two variables pointing to same object
  - Use of method to change *either* variable, changes the actual object itself
- View insecure class, listing 6.18

```
class petPair
```

Information Hiding Revisited

- View sample program, listing 6.19

`class Hacker`



Enumeration as a Class

- Consider defining an enumeration for suits of cards

```
enum Suit {CLUBS, DIAMONDS, HEARTS, SPADES}
```

- Compiler creates a class with methods
  - `equals`
  - `compareTo`
  - `ordinal`
  - `toString`
  - `valueOf`

Enumeration as a Class

- View enhanced enumeration, listing 6.20
  `enum Suit`
- Note
  - Instance variables
  - Additional methods
  - Constructor

Packages: Outline

- Packages and Importing
- Package Names and Directories
- Name Clashes

Packages and Importing

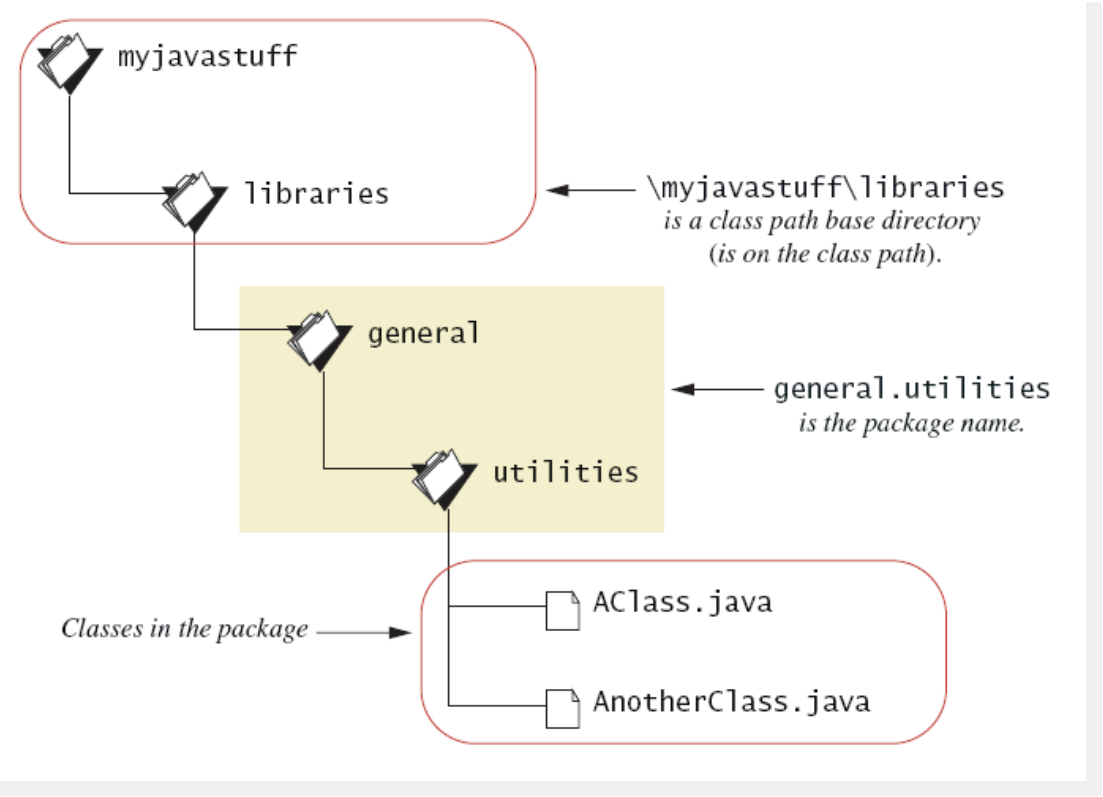
- A package is a collection of classes grouped together into a folder
- Name of folder is name of package
- Each class
  - Placed in a separate file
  - Has this line at the beginning of the file
    package `Package_Name;`
- Classes use packages by use of `import` statement

Package Names and Directories

- Package name tells compiler path name for directory containing classes of package
- Search for package begins in class path base directory
  - Package name uses dots in place of / or \
- Name of package uses relative path name starting from any directory in class path

Package Names and Directories

- Figure 6.5 A package name



Name Clashes

- Packages help in dealing with name clashes
  - When two classes have same name
- Different programmers may give same name to two classes
  - Ambiguity resolved by using the package name