9/21/17 start

Writing Classes

Chapter 4

5TH EDITION

Lewis & Loftus

java

Software Solutions

Foundations of Program Design

PEARSON Addison Wesley

Writing Classes

- **We've been using predefined classes. Now we will learn to write our own classes to define objects**
- **Chapter 4 focuses on:**
  - **class definitions**
  - **instance data**
  - **encapsulation and Java modifiers**
  - **method declaration and parameter passing**
  - **constructors**
  - **graphical objects**
  - **events and listeners**
  - **buttons and text fields**

Outline

Anatomy of a Class

Encapsulation

Anatomy of a Method

Graphical Objects

Graphical User Interfaces

Buttons and Text Fields

Writing Classes

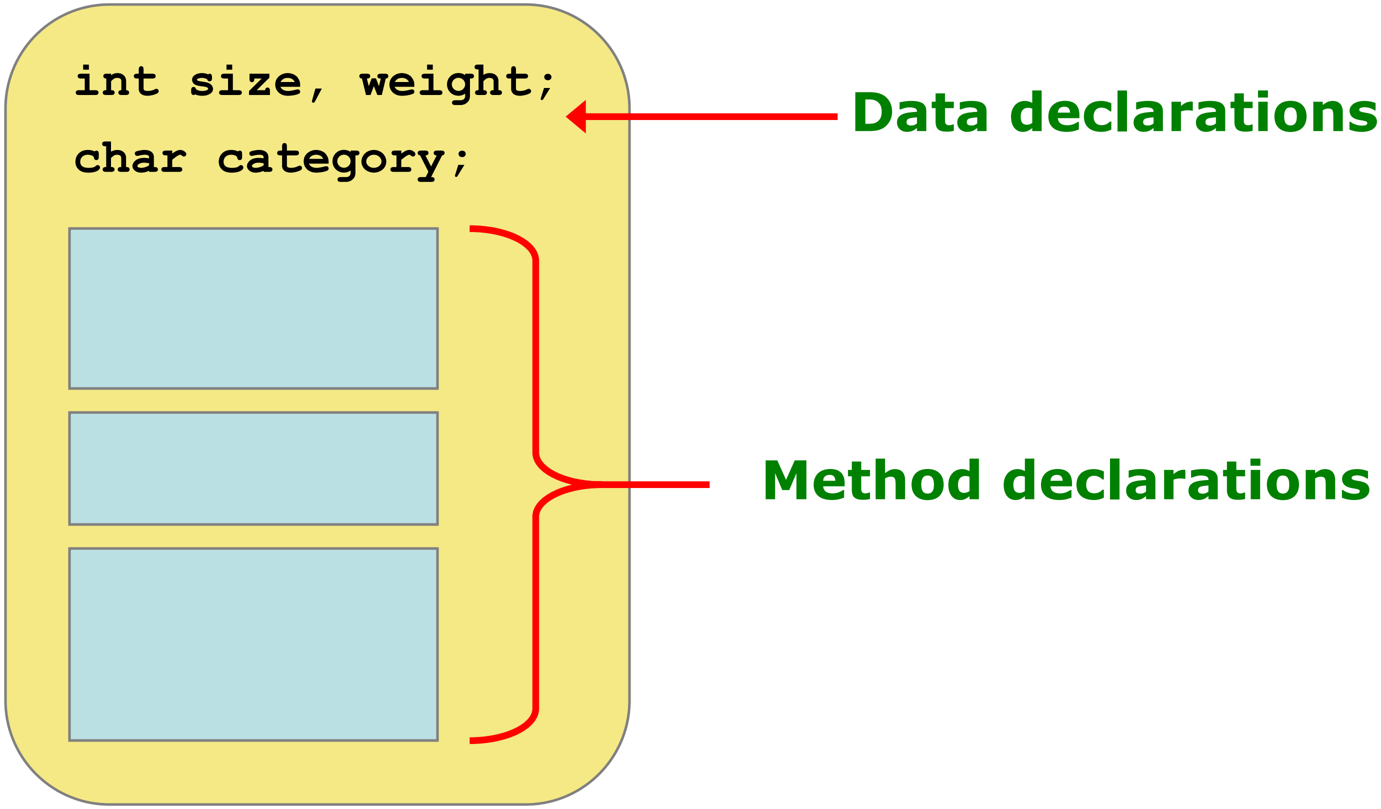
- **The programs we've written in previous examples have used classes defined in the Java standard class library**
- **Now we will begin to design programs that rely on classes that we write ourselves**
- **The class that contains the `main` method is just the starting point of a program**
- **True object-oriented programming is based on defining classes that represent objects with well-defined characteristics and functionality**

Classes and Objects

- **Recall from our overview of objects in Chapter 1 that an object has *state* and *behavior***
- **Consider a six-sided die (singular of dice)**
  - **It's state can be defined as which face is showing**
  - **It's primary behavior is that it can be rolled**
- **We can represent a die in software by designing a class called `Die` that models this state and behavior**
  - **The class serves as the blueprint for a die object**
- **We can then instantiate as many die objects as we need for any particular program**

Classes

- **A class can contain data declarations and method declarations**



Classes

- **The values of the data define the state of an object created from the class**
- **The functionality of the methods define the behaviors of the object**
- **For our `Die` class, we might declare an integer that represents the current value showing on the face**
- **One of the methods would "roll" the die by setting that value to a random number between one and six**

Classes

```
//********************************************************************
//  Die.java       Author: Lewis/Loftus
//
//  Represents one die (singular of dice) with faces showing values
//  between 1 and 6.
//********************************************************************
```

there is no main - this was a class declaration, it is going to be used by another prograem. it is just a definitioin of another class

- **We'll want to design the `Die` class with other data and methods to make it a versatile and reusable resource**
- **Any given program will not necessarily use all aspects of a given class**
- **See [RollingDice.java](#) (page 163)**
- **See [Die.java](#) (page 164)**

```
//********************************************************************
//  RollingDice.java       Author: Lewis/Loftus
//
//  Demonstrates the creation and use of a user-defined class.
//********************************************************************
public class RollingDice
{
  //-----------------------------------------------------------------
  //  Creates two Die objects and rolls them several times.
  //-----------------------------------------------------------------
  public static void main (String[] args)
  {
    Die die1, die2;
    int sum;
    die1 = new Die();
    die2 = new Die();
    die1.roll();
    die2.roll();
    System.out.println ("Die One: " + die1 + ", Die Two: " + die2);
    die1.roll();
    die2.setFaceValue(4);
    System.out.println ("Die One: " + die1 + ", Die Two: " + die2);
    sum = die1.getFaceValue() + die2.getFaceValue();
    System.out.println ("Sum: " + sum);
    sum = die1.roll() + die2.roll();
    System.out.println ("Die One: " + die1 + ", Die Two: " + die2);
    System.out.println ("New sum: " + sum);
  }
}
```

```
public class Die
{
  private final int MAX = 6;  // maximum face value

  private int faceValue;  // current value showing on the die

  //-----------------------------------------------------------------
  //  Constructor: Sets the initial face value.
  //-----------------------------------------------------------------
  public Die()
  {faceValue = 1;}
  //-----------------------------------------------------------------
  //  Rolls the die and returns the result.
  //-----------------------------------------------------------------
  public int roll()
  {faceValue = (int)(Math.random() * MAX) + 1;
    return faceValue;}
  //-----------------------------------------------------------------
  //  Face value mutator.
  //-----------------------------------------------------------------
  public void setFaceValue (int value)
  {faceValue = value;}
  //-----------------------------------------------------------------
  //  Face value accessor.
  //-----------------------------------------------------------------
  public int getFaceValue()
  {
    return faceValue;
  }

  //-----------------------------------------------------------------
  //  Returns a string representation of this die.
  //-----------------------------------------------------------------
```

The Die Class

if the class is in the same directory as the class that it is calling is in the same directory, it will be able to find it

- **The `Die` class contains two data values**
  - **a constant `MAX` that represents the maximum face value**
  - **an integer `faceValue` that represents the current face value**
- **The `roll` method uses the `random` method of the `Math` class to determine a new face value**
- **There are also methods to explicitly set and retrieve the current face value at any time**

fahrenheitpanel has inner class templistener. the java will create fahrenheitpanel$templistener.class

this is the reason why we dont use $ as variable names because java needs to use it

The toString Method

- All classes that represent objects should define a `toString` method
- The `toString` method returns a character string that represents the object in some way
- It is called automatically when an object is concatenated to a string or when it is passed to the `println` method

when an object is in a string enviroment, their toString method is called
if there is no toString method in the object, then it will just print out the memory location of the object....

it must look like this and return a string:

```
public String toString()
{
   String result = Integer.toString(faceValue);

   return result;
}
```

Constructors

- **As mentioned previously, a *constructor* is a special method that is used to set up an object when it is initially created**
- **A constructor has the same name as the class**
- **The `Die` constructor is used to set the initial face value of each new die object to one**
- **We examine constructors in more detail later in this chapter**

Data Scope

- **The *scope* of data is the area in a program in which that data can be referenced (used)**
- **Data declared at the class level can be referenced by all methods in that class**
- **Data declared within a method can be used only in that method**
- **Data declared within a method is called *local data***
- **In the `Die` class, the variable `result` is declared inside the `toString` method -- it is local to that method and cannot be referenced anywhere else**

Instance Data

- **The `faceValue` variable in the `Die` class is called *instance data* because each instance (object) that is created has its own version of it**

- **A class declares the type of the data, but it does not reserve any memory space for it**

- **Every time a `Die` object is created, a new `faceValue` variable is created as well**

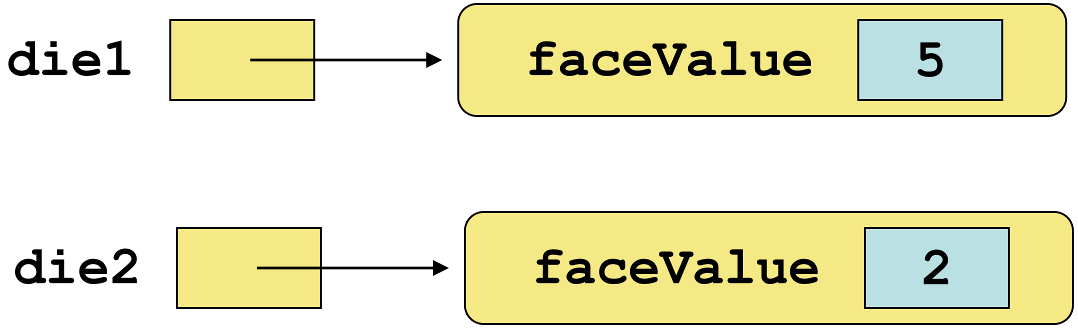
- **The objects of a class share the method definitions, but each object has its own data space**

- **That's the only way two objects can have different states**

Auto memory dynamic
Die1 (room #) -> die: room# max: 6, facevalue: 1
DIe2 (room#2) -> die2: room#2, max: 6, facevaule:1

Instance Data

- We can depict the two `Die` objects from the `RollingDice` program as follows:



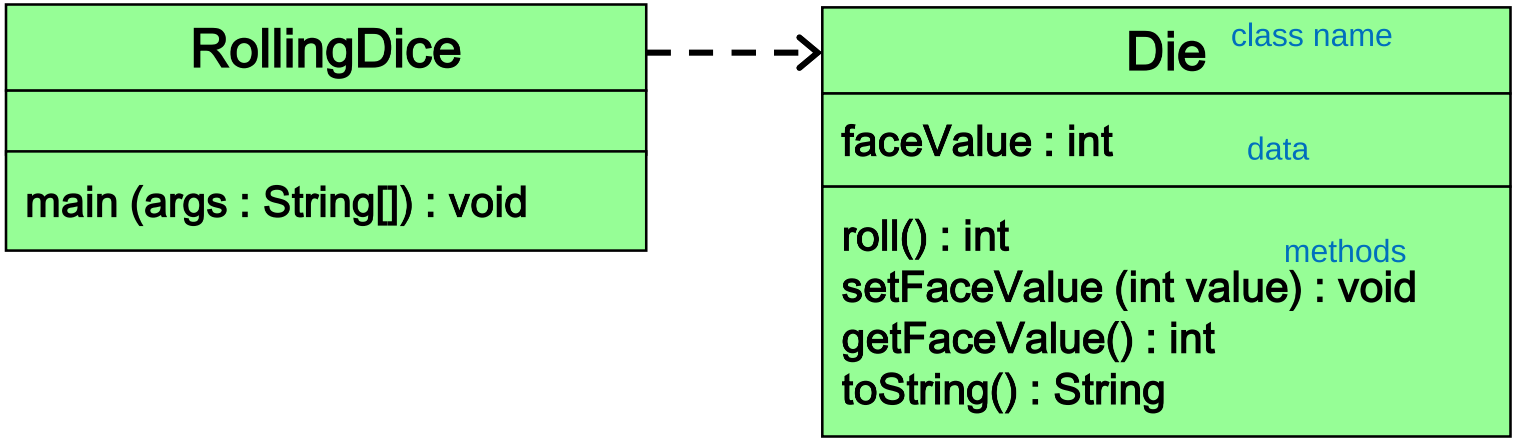
Each object maintains its own `faceValue` variable, and thus its own state

UML Diagrams

- **UML stands for the *Unified Modeling Language***
  what got unified? there were 3 guys
- ***UML diagrams* show relationships among classes and objects**
  rational rose? - came together to create new company
- **A UML *class diagram* consists of one or more classes, each with sections for the class name, attributes (data), and operations (methods)**
- **Lines between classes represent *associations***
- **A dotted arrow shows that one class *uses* the other (calls its methods)**

UML Class Diagrams

- **A UML class diagram for the `RollingDice` program:**



Outline

Anatomy of a Class

Encapsulation

Anatomy of a Method

Graphical Objects

Graphical User Interfaces

Buttons and Text Fields

Encapsulation

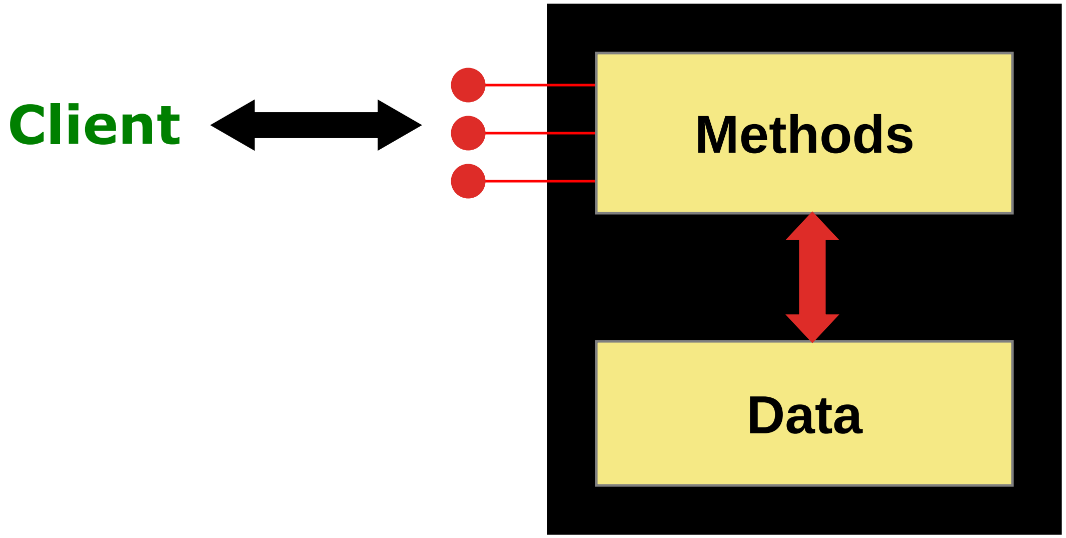
- **We can take one of two views of an object:**
  - **internal - the details of the variables and methods of the class that defines it**
  - **external - the services that an object provides and how the object interacts with the rest of the system**
- **From the external view, an object is an *encapsulated* entity, providing a set of specific services**
- **These services define the *interface* to the object**

Encapsulation

- **One object (called the *client*) may use another object for the services it provides**
- **The client of an object may request its services (call its methods), but it should not have to be aware of how those services are accomplished**
- **Any changes to the object's state (its variables) should be made by that object's methods**
- **We should make it difficult, if not impossible, for a client to access an object's variables directly**
- **That is, an object should be *self-governing***

Encapsulation

- An encapsulated object can be thought of as a *black box* -- its inner workings are hidden from the client
- The client invokes the interface methods of the object, which manages the instance data



Visibility Modifiers

- **In Java, we accomplish encapsulation through the appropriate use of *visibility modifiers***
- **A *modifier* is a Java reserved word that specifies particular characteristics of a method or data**
- **We've used the `final` modifier to define constants**
- **Java has three visibility modifiers: `public`,** open to everyone **`protected`, and `private`** only known to class
- **The `protected` modifier involves inheritance, which we will discuss later**

Visibility Modifiers

- **Members of a class that are declared with *public visibility* can be referenced anywhere**

- **Members of a class that are declared with *private visibility* can be referenced only within that class**

- **Members declared without a visibility modifier have *default visibility* and can be referenced by any class in the same package**

- **An overview of all Java modifiers is presented in Appendix E**

use packages or classes in the same directory. if classes are i the same folder, then it is in the same package. these are the default package

Visibility Modifiers

- **Public variables violate encapsulation because they allow the client to “reach in” and modify the values directly**
- **Therefore instance variables should not be declared with public visibility**
- **It is acceptable to give a constant public visibility, which allows it to be used outside of the class**
- **Public constants do not violate encapsulation because, although the client can access it, its value cannot be changed**

Visibility Modifiers

- **Methods that provide the object's services are declared with public visibility so that they can be invoked by clients**

- **Public methods are also called *service methods***

- **A method created simply to assist a service method is called a *support method***

- **Since a support method is not intended to be called by a client, it should not be declared with public visibility**

Visibility Modifiers

usually public methods, private data

	`public`	`private`
Variables	**Violate encapsulation**	**Enforce encapsulation**
Methods	**Provide services to clients**	**Support other methods in the class**

Accessors and Mutators

- **Because instance data is private, a class usually provides services to access and modify data values**

- **An *accessor method* returns the current value of a variable**
  like getFaceValue. as a convention, getters never update data

- **A *mutator method* changes the value of a variable**
  mutator method can change data - like setFaceValue

- **The names of accessor and mutator methods take the form `getX` and `setX`, respectively, where `X` is the name of the value**

- **They are sometimes called "getters" and "setters"**

Mutator Restrictions

- **The use of mutators gives the class designer the ability to restrict a client's options to modify an object's state**
- **A mutator is often designed so that the values of variables can be set only within particular limits**
- **For example, the `setFaceValue` mutator of the `Die` class should have restricted the value to the valid range (1 to `MAX`)**
- **We'll see in Chapter 5 how such restrictions can be implemented**

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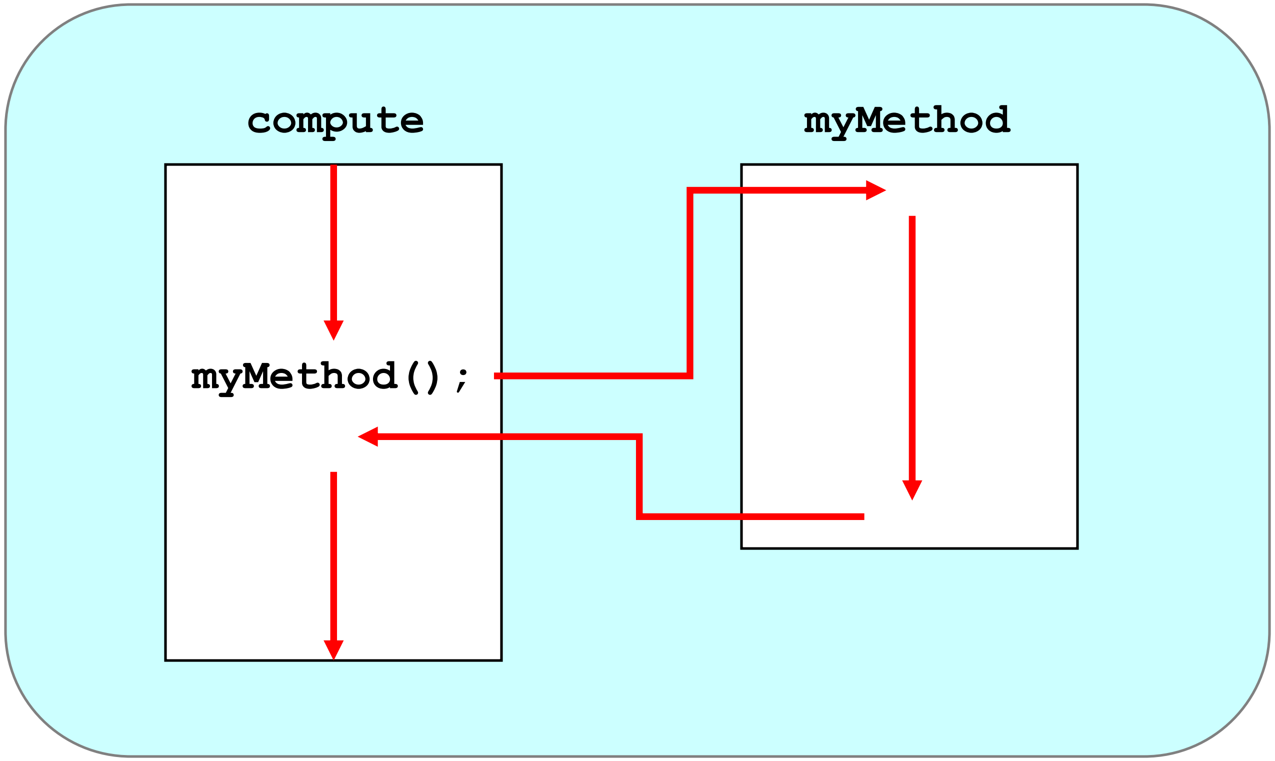
Method Declarations

- **Let's now examine method declarations in more detail**
- **A *method declaration* specifies the code that will be executed when the method is invoked (called)**
- **When a method is invoked, the flow of control jumps to the method and executes its code**
- **When complete, the flow returns to the place where the method was called and continues**
- **The invocation may or may not return a value, depending on how the method is defined**

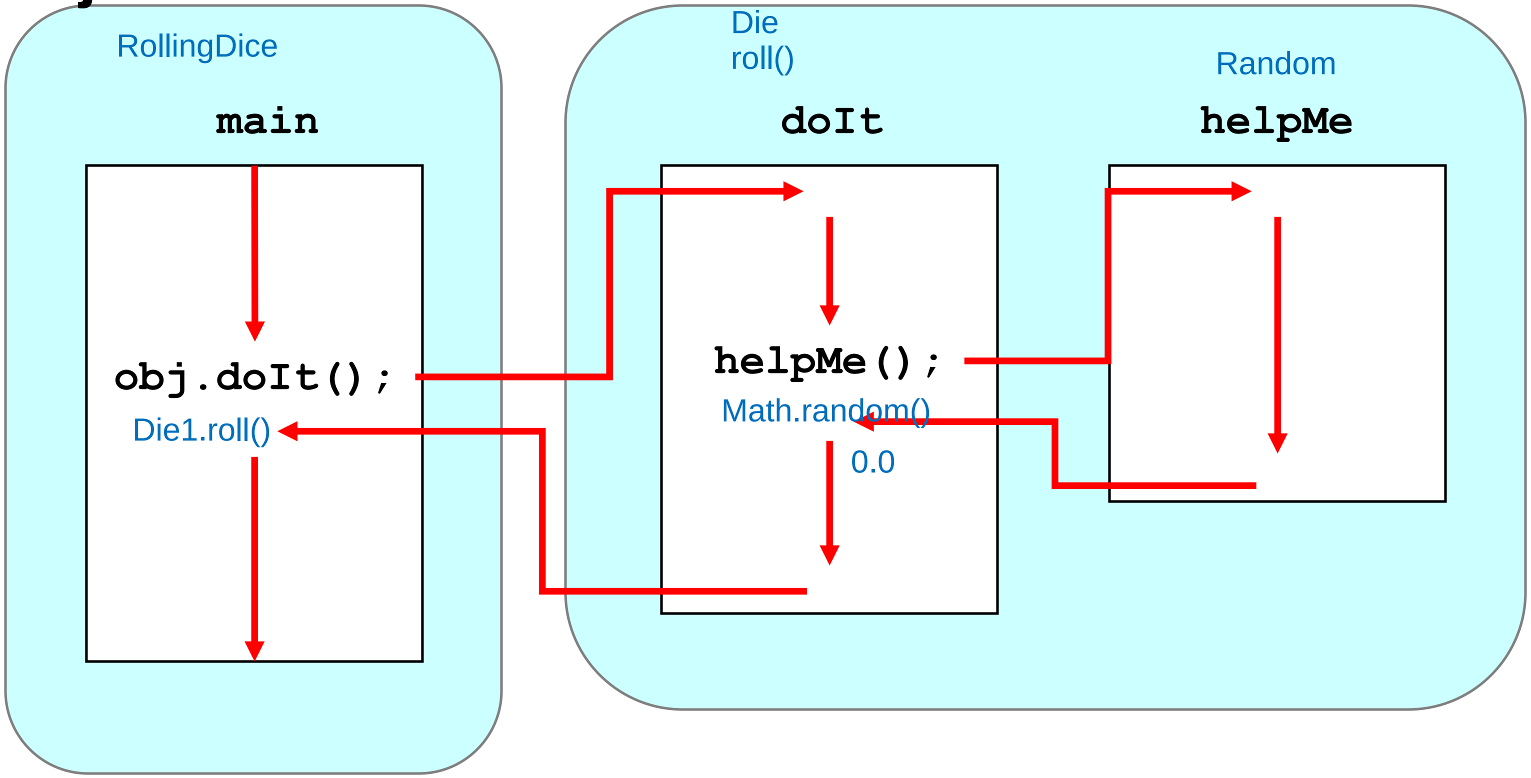
Method Control Flow

- **If the called method is in the same class, only the method name is needed**



Method Control Flow

- **The called method is often part of another class or object**



Method Header

- **A method declaration begins with a *method header***

```
char calc (int num1, int num2, String message)
```

method name

parameter list

return type

The parameter list specifies the type and name of each parameter

The name of a parameter in the method declaration is called a *formal parameter*

Method Body

- **The method header is followed by the *method body***

```
char calc (int num1, int num2, String message)

{
   int sum = num1 + num2;
   char result = message.charAt (sum);

   return result;
}
```

isntance variables

The return expression must be consistent with the return type

`sum` and `result` are local data

They are created each time the method is called, and are destroyed when it finishes executing

The return Statement

- **The *return type* of a method indicates the type of value that the method sends back to the calling location**

- **A method that does not return a value has a `void` return type**

- **A *return statement* specifies the value that will be returned**

void has no return

```
return expression;
```

- **Its expression must conform to the return type**

Parameters

- When a method is called, the *actual parameters* in the invocation are copied into the *formal parameters* in the method header

use 2 1

```
ch = obj.calc (25, count, "Hello");
```

"Hello"

2 1

```
char calc (int num1, int num2, String message)
{
   int sum = num1 + num2;
   char result = message.charAt (sum);

   return result;
}
```

2 1

"Hello".charAt(3)

Local Data

- **As we've seen, local variables can be declared inside a method**
- **The formal parameters of a method create *automatic local variables* when the method is invoked**
- **When the method finishes, all local variables are destroyed (including the formal parameters)**
- **Keep in mind that instance variables, declared at the class level, exists as long as the object exists**

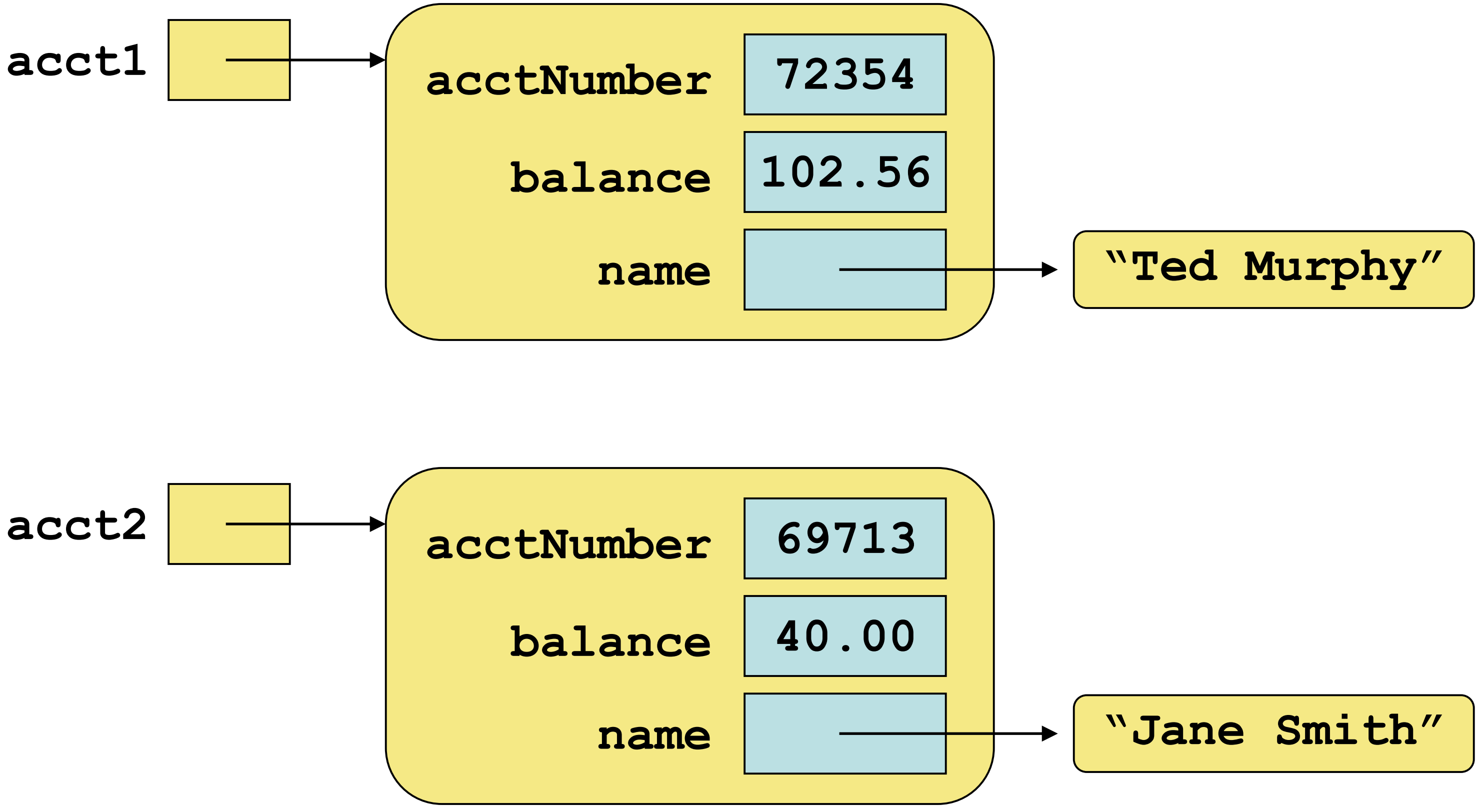
Bank Account Example

- **Let's look at another example that demonstrates the implementation details of classes and methods**
- **We'll represent a bank account by a class named `Account`**
- **It's state can include the account number, the current balance, and the name of the owner**
- **An account's behaviors (or services) include deposits and withdrawals, and adding interest**

Driver Programs

- A *driver program* drives the use of other, more interesting parts of a program
- Driver programs are often used to test other parts of the software
- The `Transactions` class contains a `main` method that drives the use of the `Account` class, exercising its services
- See Transactions.java (page 177)
- See Account.java (page 178)

Bank Account Example



Bank Account Example

- **There are some improvements that can be made to the `Account` class**
- **Formal getters and setters could have been defined for all data**
- **The design of some methods could also be more robust, such as verifying that the `amount` parameter to the `withdraw` method is positive**

Constructors Revisited

- **Note that a constructor has no return type specified in the method header, not even `void`**
- **A common error is to put a return type on a constructor, which makes it a "regular" method that happens to have the same name as the class**
- **The programmer does not have to define a constructor for a class**
- **Each class has a *default constructor* that accepts no parameters**

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Graphical Objects

- **Some objects contain information that determines how the object should be represented visually**
- **Most GUI components are graphical objects**
- **We can have some effect on how components get drawn**
- **We did this in Chapter 2 when we defined the `paint` method of an applet**
- **Let's look at some other examples of graphical objects**

Smiling Face Example

- **The `SmilingFace` program draws a face by defining the `paintComponent` method of a panel**
- **See SmilingFace.java (page 182)**
- **See SmilingFacePanel.java (page 183)**
- **The `main` method of the `SmilingFace` class instantiates a `SmilingFacePanel` and displays it**
- **The `SmilingFacePanel` class is derived from the `JPanel` class using inheritance**

Smiling Face Example

- **Every Swing component has a `paintComponent` method**
- **The `paintComponent` method accepts a `Graphics` object that represents the graphics context for the panel**
- **We define the `paintComponent` method to draw the face with appropriate calls to the `Graphics` methods**
- **Note the difference between drawing on a panel and adding other GUI components to a panel**

Splat Example

- **The `Splat` example is structured a bit differently**
- **It draws a set of colored circles on a panel, but each circle is represented as a separate object that maintains its own graphical information**
- **The `paintComponent` method of the panel "asks" each circle to draw itself**
- **See Splat.java (page 185)**
- **See SplatPanel.java (page 187)**
- **See Circle.java (page 188)**

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Graphical User Interfaces

- **A Graphical User Interface (GUI) in Java is created with at least three kinds of objects:**
  - **components**
  - **events**
  - **listeners**
- **We've previously discussed *components*, which are objects that represent screen elements**
  - **labels, buttons, text fields, menus, etc.**
- **Some components are *containers* that hold and organize other components**
  - **frames, panels, applets, dialog boxes**

Events

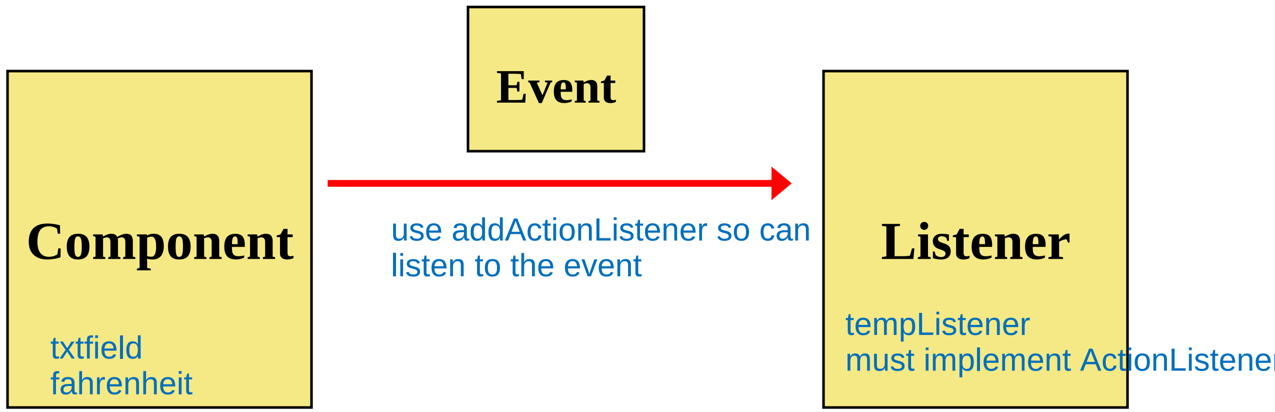
- **An *event* is an object that represents some activity to which we may want to respond**
- **For example, we may want our program to perform some action when the following occurs:**
  - **the mouse is moved**
  - **the mouse is dragged**
  - **a mouse button is clicked**
  - **a graphical button is clicked**
  - **a keyboard key is pressed**
  - **a timer expires**
- **Events often correspond to user actions, but not always**

Events and Listeners

- **The Java standard class library contains several classes that represent typical events**
- **Components, such as a graphical button, generate (or fire) an event when it occurs**
- **A *listener* object "waits" for an event to occur and responds accordingly**
- **We can design listener objects to take whatever actions are appropriate when an event occurs**

Events and Listeners

when press enter - generates action event object



A component object may generate an event

A corresponding listener object is designed to respond to the event

When the event occurs, the component calls the appropriate method of the listener, passing an object that describes the event

the labels and objects always try to preserve its relation to each other

GUI Development

- **Generally we use components and events that are predefined by classes in the Java class library**
- **Therefore, to create a Java program that uses a GUI we must:**
  - **instantiate and set up the necessary components**
  - **implement listener classes for any events we care about**

we dont listen for mouse events because we dont really care about those

  - **establish the relationship between listeners and components that generate the corresponding events**

there is no input for label

- **Let's now explore some new components and see how this all comes together**

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Buttons

- **A *push button* is a component that allows the user to initiate an action by pressing a graphical button using the mouse**
- **A push button is defined by the `JButton` class**
- **It generates an *action event***
- **The `PushCounter` example displays a push button that increments a counter each time it is pushed**
- **See PushCounter.java (page 192)**
- **See PushCounterPanel.java (page 193)**

Push Counter Example

- **The components of the GUI are the button, a label to display the counter, a panel to organize the components, and the main frame**
- **The `PushCounterPanel` class is represents the panel used to display the button and label**
- **The `PushCounterPanel` class is derived from `JPanel` using inheritance**
- **The constructor of `PushCounterPanel` sets up the elements of the GUI and initializes the counter to zero**

Push Counter Example

- **The `ButtonListener` class is the listener for the action event generated by the button**
- **It is implemented as an *inner class*, which means it is defined within the body of another class**
- **That facilitates the communication between the listener and the GUI components**
- **Inner classes should only be used in situations where there is an intimate relationship between the two classes and the inner class is not needed in any other context**

Push Counter Example

- **Listener classes are written by implementing a *listener interface***
- **The `ButtonListener` class implements the `ActionListener` interface**
- **An interface is a list of methods that the implementing class must define**
- **The only method in the `ActionListener` interface is the `actionPerformed` method**
- **The Java class library contains interfaces for many types of events**
- **We discuss interfaces in more detail in Chapter 6**

Push Counter Example

- **The `PushCounterPanel` constructor:**
  - **instantiates the `ButtonListener` object**
  - **establishes the relationship between the button and the listener by the call to `addActionListener`**
- **When the user presses the button, the button component creates an `ActionEvent` object and calls the `actionPerformed` method of the listener**
- **The `actionPerformed` method increments the counter and resets the text of the label**

Text Fields

- **Let's look at another GUI example that uses another type of component**

- **A *text field* allows the user to enter one line of input**

- **If the cursor is in the text field, the text field component generates an action event when the enter key is pressed**

- **See Fahrenheit.java (page 196)**
- **See FahrenheitPanel.java (page 197)**

Fahrenheit Example

- **Like the `PushCounter` example, the GUI is set up in a separate panel class**
- **The `TempListener` inner class defines the listener for the action event generated by the text field**
- **The `FahrenheitPanel` constructor instantiates the listener and adds it to the text field**
- **When the user types a temperature and presses enter, the text field generates the action event and calls the `actionPerformed` method of the listener**
- **The `actionPerformed` method computes the conversion and updates the result label**

Summary

- **Chapter 4 focused on:**
  - **class definitions**
  - **instance data**
  - **encapsulation and Java modifiers**
  - **method declaration and parameter passing**
  - **constructors**
  - **graphical objects**
  - **events and listeners**
  - **buttons and text fields**