CSE 142

Declarations and Scope

Outline for Today

- Goal: present more precisely several things we've dealt with informally up to now
  - Only essential topics for CSE142; won't cover all the technical details
- Scope defined
- Scope for instance variables and methods
  - Public and private
  - Using local methods
  - Accessing instance variables in other objects
  - "this"
- Scope for method parameters and local variables

Declarations

- Everything in a Java program is referenced using an identifier (name)
- New names must be ***declared***
  - Class declarations
  - Method definitions and instance variable declarations in a class
  - Parameter and local variable definitions in methods

Scope

- The ***scope*** of a identifier is the region of the program where that identifier's declaration is in effect
- Answers the question: *where it is legal to use this identifier?*
- Scope limits the range of a declaration
  - Allows sensible reuse of names (identifiers) in different parts of the code

Qualified and Unqualified Names

- If you're at home and mention "Bob", it usually means your Uncle Bob who lives in Aberdeen.
- When your at quiz section and someone says "Bob", they probably are referring to a certain classmate in your section
- If you need to be precise, you can specify "Uncle Bob" or "the Bob in my quiz section"
- "Bob" by itself it an *unqualified* name. Its precise meaning depends on context (where it is used)
- "Uncle Bob" is a *qualified* name. Its precise meaning is much less dependent on context

Qualified and Unqualified Names In Programs

num = myFarm.countSheep( )

This statement contains three identifiers

The Java compiler has to determine exactly what these identifiers refer to.

"num" is unqualified
"countSheep" is qualified by "myFarm"
"myFarm" is unqualified

Three Big Principles

1. Scope is determined at compile-time
   Not at run-time
   We say it is "static" rather than "dynamic"
2. A name must be declared before it can be used
   "Declaration before use" rule
   The rule is bent in a few notable cases
3. Curly braces { } limit scope
   For unqualified names, at least
   A few, but important, exceptions

Summary of Java Scope Rules

- The scope of classes: other classes in the program
- The scope of methods and instance variables: the class containing the declaration and, possibly, other classes
- The scope of parameters and local variables: part or all of the body of the method containing the declaration
  - Minor exception for *for*-loop control variables

- We will look at some of this in a bit more detail now
- The full scope rules for Java are complex and are discussed in increasing detail in 142 and 143.

Methods and Instance Variables

- Declared inside a class
- Scope depends on whether declared ***public*** or ***private***
  - Always accessible inside the class
  - Accessible to clients outside the class if declared public
  - Not accessible to clients if declared private
- Inside the class, local methods and instance variables can be referenced by their simple names
- Always use public or private in CSE142
  - There are rules about what happens if you leave these off; we'll simplify our life by not dealing with them

Example – Tile Class

```
public class Tile {
  private int size;   // tile size

  /** add picture of this tile... */
  public void addTo(...) {
     ...
     display(...);
   }

  // draw a tile at the right place
  private void display(..., Shape s, ...) {
     s.moveBy(...size...);
     ...
  }
```

- Identifiers Tile and addTo are visible inside and outside class Tile
- Identifiers size and display are only visible inside the class

Parameters

- The scope of a parameter declaration is the body of the method or constructor containing the parameter declaration

```
/** deposit amount in this BankAccount */
public void deposit(double amount) {
     …
}
/** Construct new BankAccount with given name and account number */
public BankAccount(int accountNumber, String accountName,) {
     …
}
```

- When the method is called, each parameter is initialized by assigning it the corresponding argument value in the method call

```
BankAccount savings = new BankAccount(12, "D. Warbucks");
savings.deposit(42.17);
```

Nested Scopes

- The scope of a parameter declaration is "nested" inside the scope of instance variables and methods belonging to the class
- The diagrams we use for a method call are designed to show this explicitly
- If a name is referenced in a method, to find the actual thing it refers to
  - First check the method scope
  - Then, if you don't find it, look at the surrounding class (object) scope
  - If still not found, it is not declared – compiler will complain

Nested Scopes Diagramed

- Example

```
BankAccount savings = new BankAccount(567, “Rainy Day”);
savings.deposit(100.00);
```

Nested Scope Pitfall

- Some (buggy) code

```
public class BankAccount {
    private String name;           // name on the account
    /** set the account name */
    public void setName(String name) {
        name = name;
    }
}
```

- What happens if we execute

```
BankAccount credit = new BankAccount(567, “Funny Money”);
credit.setName(“plastic”);
```

Draw the Diagram

Local Variables

- Local variables can be declared inside a method
  - Provides scratch space for temporary values
  - Scope extends to the right brace “}” matching the nearest preceeding left brace “{”

    This can hide a instance variable, parameter, or local variable declared in a surrounding scope – generally bad style; don’t do it
  - Variable no longer exists after leaving the scope

    (in particular, parameters and local variables no longer exists after method execution ends)

Example

```
/** return the weekly pay of this Employee */
public double getWeeklyPay( ) {
    double basePay;
    double overtimePay;
    if (hours <= 40) {
      basePay = hours * rate;              // hours, rate are instance variables
      overtimePay = 0.0;
    } else {
      basePay = 40 * rate;
      overtimePay = 1.5 * (hours-40) * rate;
    }
    return basePay + overtimePay;
}
```

Trace

```
Employee intern = new Employee(…);
System.out.println(intern.getWeeklyPay());
```

Variable Declaration with Initialization

- A variable declaration can also specify an initial value

```
/** Return the area of the circle with given diameter */
public double area(double diameter ) {
    double radius = diameter / 2.0;
    return 3.14 * radius * radius;
}
```

- Common for temporary quantities used inside a method
  - Can make code easier to read if you name intermediate results by declaring and initializing appropriate local variables
- Not common for instance variables
  - Better style is to put all initializations inside the constructor(s)

Scopes and Initialization

- What happens here?

```
/** return the weekly pay of this Employee */
public double getWeeklyPay( ) {
    if (hours <= 40) {
      double basePay = hours * rate;
      double overtimePay = 0.0;
    } else {
      double basePay = 40 * rate;
      double overtimePay = 1.5 * (hours-40) * rate;
    }
    return basePay + overtimePay;
}
```

  - (Hint: what is the scope of a local variable declaration?)

Scopes and Multiple Objects

- Each object defines a separate scope for its instance variables and methods
- A method or instance variable in another object can be accessed (if it is public or in the same class) by writing
  - *objectName . methodName* (…);
  - or
  - *objectName . variableName*
- When a method executes, its local scope is surrounded by the scope of the corresponding object

Example: BankAccount Transfer

```
class BankAccount {
   …
   /** Transfer given amount from otherAccount */
   public void transferFrom(BankAccount otherAccount, double amount) {
      boolean success = otherAccount.withdraw(amount);
      if (success) {
         balance = balance + amount;
      }
   }
```

Execution Example

```
BankAccount yours = new BankAccount(567, “Moneybags”);
yours.deposit(5000.00);
BankAccount mine = new BankAccount(1234, “Me”);
mine.transferFrom(yours, 2000.00);
```

Another Implementation of Transfer

```
class BankAccount {
   …
   /** Transfer given amount from otherAccount */
   public void transferFrom(BankAccount otherAccount, double amount) {
      if (otherAccount.balance >= amount) {
         otherAccount.balance = otherAccount.balance – amount;
         balance = balance + amount;
      }
   }
```

- Discuss: Is this better or worse than using otherAccount.withdraw(…)? Why or why not?

Method and Instance Variable Names, Revisited

- When we write something like

  name = otherAccount.name;

  - or

  otherAccount.balance = balance;

  the occurrence of "name" or "balance" refers to fields in the current object scope where the method is executing
- But technically, every method or instance variable has a full name which is always ***objectName . fieldName***.
- When we use a simple name like balance by itself, we really mean

  "the current object" . balance

"The Current Object" – this

- Java has a reserved keyword, ***this***, that can be used to explicitly refer to "the current object"
- If we use a field name by itself

  balance = 42.17;

  it is equivalent to writing

  this.balance = 42.17;
- You can write this explicitly if you want. If you don't, Java understands that that is what you mean

A Common Use for this

- Normally instance variables and local variables or parameters should not have the same name

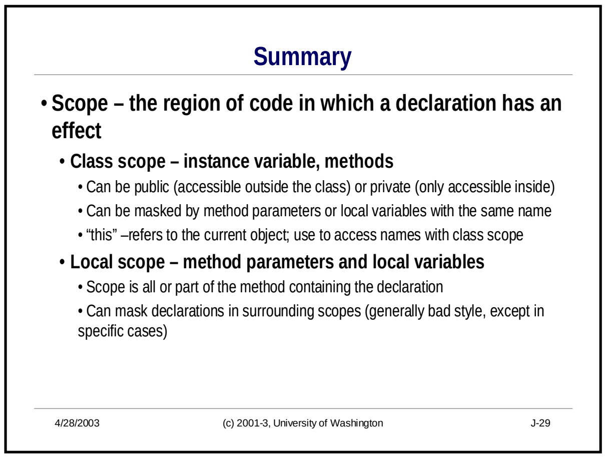
  (Style/readability issue)
- But in constructors, it's often more readable if parameter names are the same as the fields they initialize
- Use "this" to access an instance variable whose scope is masked by a local parameter declaration

```
/** construct a new BankAccount with the given name and number */
public BankAccount(int number, String name) {
    this.number = number;
    this.name = name;
}
```

Scope Rules and This

- Trace execution of

  BankAccount test = new BankAccount(654, "scope demo");


Summary

- Scope – the region of code in which a declaration has an effect
  - Class scope – instance variable, methods
    - Can be public (accessible outside the class) or private (only accessible inside)
    - Can be masked by method parameters or local variables with the same name
    - "this" –refers to the current object; use to access names with class scope
  - Local scope – method parameters and local variables
    - Scope is all or part of the method containing the declaration
    - Can mask declarations in surrounding scopes (generally bad style, except in specific cases)

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