

Static Members, Enumerations and Packages

Lecture 5

Example Class Declaration

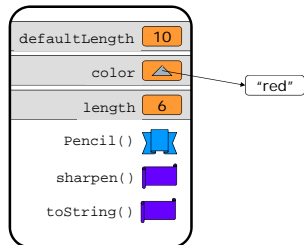
```
public class Pencil {
    private int defaultLength = 10;
    private String color;
    private int length;

    public Pencil (int length) {
        if (length > 0) {
            this.length = length;
        }
        else {
            this.length = defaultLength;
        }
    }

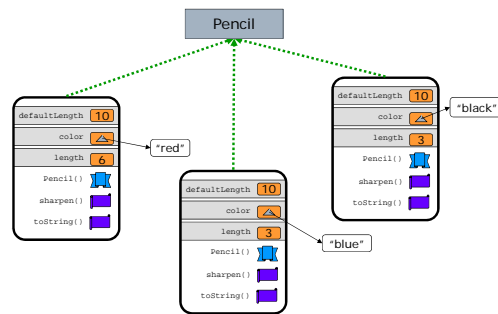
    public int sharpen (int amount) { . . . }

    public String toString () { . . . }
}
```

One Pencil Instance



Multiple Pencil Instances



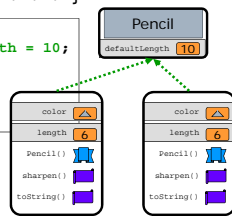
Object vs Class Members

- Class member: only one copy, which is shared by all instances

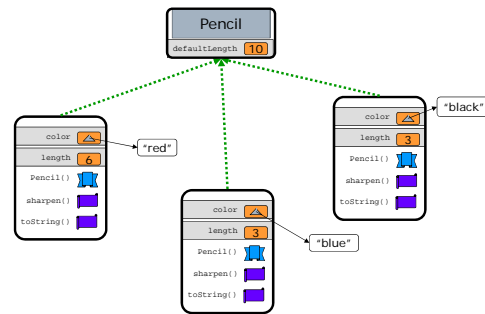
- Keyword: **static**

```
static int defaultLength;
static void reset() { . . . }
```

```
public class Pencil {
    private static int defaultLength = 10;
    private String color;
    private int length;
    . . .
}
```



Multiple Pencil Instances



aka Instance vs Static Members

- ❑ Static members available even before instances (objects) are created!
 - From outside of class: `classname.member`
`Pencil.defaultLength++; //must be public`
 - From inside class: `classname` is optional
 - ❑ Conversely, static members can *not* access instance members
 - ie `this` reference can not be used
- ```
public static void reset () {
 length = defaultLength;
}
```
- Same as this.length  
Compile-time Error

## Good Practice: Static Members

- ❑ Do *not* access static members through object references
- ❑ Use class names instead
  - Do this: `int t = Pencil.defaultLength;`
  - Not this: `int t = p1.defaultLength;`
- ❑ This applies within a class too

```
public class Pencil {
 private static int defaultLength = 10;
 private int length;
 public void reset() {
 length = defaultLength; //correct
 length = Pencil.defaultLength; //better
 }
}
```

## Example: println

- ❑ `System.out.println("Hello");`
  - `System`: A class from Java library
  - See API documentation: `java.lang.System`
- ❑ What is `System`?
  - A class from Java library
  - See API documentation: `java.lang.System`
- ❑ What is `out`?
  - A static field of `System` (available from class)
  - Type: reference to an instance of `PrintStream`
- ❑ What is `println`?
  - An overloaded method in `PrintStream`
  - Different versions for printing `String`, `int`, `boolean`...

## Example: main()

```
public class HelloWorldApp {
 public static void main(String[] args) {
 . . .
 }
}
```

- ❑ `public`: so that JVM can run this method
- ❑ `static`: no instances of class created (yet)
- ❑ `void main(String[])`: required signature
  - JVM looks to invoke the method with this name
- ❑ `args`: array of command-line arguments
  - Any name can be used for formal parameter
  - "args" is just Java convention

## Example

- ❑ See `Artifact.java`
  - Static members
    - ❑ Fields for: class creation time, first instantiation, most recent instantiation, total number of instantiations
    - ❑ Method for getting number of instantiations
  - Instance members
    - ❑ Field holding a float
    - ❑ Method for getting information (`toString`)
  - Constructor
  - Static initialization block (more on that later)
- ❑ See `ArtifactTester.java`
  - Note output showing different times

## Constant Fields: final

- ❑ Modifier `final` on field means it cannot change
  - For primitive type, effectively a constant

```
final int i1 = 53;
final int i2 = (int) (Math.random()*20);
final int i3; //constructor must initialize
. . .
i2++;
```

Compile-time Error
  - For objects, only the *reference* is constant

```
final Pencil p = new Pencil("blue");
. . .
p = new Pencil();
p.sharpen(3);
```

OK

Compile-time Error
- ❑ Often used in conjunction with `static`
  - Class-wide constant value

```
static final int DEFAULT_LENGTH = 10;
```

## Good Practice: No Magic Numbers

- ❑ "Magic Number": a numeric constant in code

```
for (int i=0; i < 365; i++) { ... }
```
- ❑ Some literals are acceptable
  - Booleans and references (`true`, `false`, `null`)
  - Integers: -1, 0, 1, 2
- ❑ The rest should *all* be avoided

```
final int DAYS_PER_YEAR = 365;
for (int i=0; i < DAYS_PER_YEAR; i++) { ... }
```
- ❑ See Java libraries (API, [constant-values](#)):  
`Integer.MAX_VALUE`, `Math.PI`,  
`Float.POSITIVE_INFINITY`, `Thread.MAX_PRIORITY`
- ❑ Important benefits:
  - Single point of control over change
  - Legibility

## Outdated (bad) Idiom: int enums

- ❑ Enumeration type: legal values a finite set of constants
  - Card suits (clubs, diamonds, hearts, spades)
  - Days of the week (D, M, T, W, R, F, S)
- ❑ This could be done with static final fields

```
public class PlayingCard {
 public static final int CLUBS = 0;
 public static final int DIAMONDS = 1;
 public static final int HEARTS = 2;
 public static final int SPADES = 3;
 . . .
}
```
- ❑ Later, use these named constants

```
int trump = . . . ;
if (trump == PlayingCard.CLUBS) { . . . }
```
- ❑ Problem: no type safety! `trump` is just an int

```
if (trump == 23) { . . . }
```

## Enum Types

- ❑ Declared like a class, keyword `enum`
  - Contains a list of *enum constants*

```
enum Suit {
 CLUBS, DIAMONDS, HEARTS, SPADES
}
```
  - These constants are (implicitly) static fields

```
Suit trump = Suit.SPADES; //do not use new!!
if (trump == Suit.CLUBS) { . . . }
```
- ❑ Can also contain fields & methods (and nested types)
- ❑ Automatically provided (static) methods include:
  - `values()` – returns array of constants  
`Suit.values()[0]` is `Suit.CLUBS`
  - `valueOf(String)` – returns constant with that name  
`Suit.valueOf("CLUBS")` is `Suit.CLUBS`
  - `ordinal()` – returns constant's position in declaration list  
`Suit.CLUBS.ordinal()` is 0

## Packages: Component Catalogs

- ❑ A *package* is a grouping of classes
  - Hierarchical: subpackages within packages
  - Sun standard libraries organized in packages
    - ❑ `java.lang`, `java.util`, `java.util.logging`
    - ❑ see <http://docs.oracle.com/javase/6/docs/api/>
- ❑ A package provides
  - Logical structuring: related classes are bundled
  - Encapsulation: another level of access control
  - Distinct namespace: classes in different packages can have the same name without conflict
    - ❑ *Convention* to guarantee uniqueness of package name: reverse of company's domain name
    - ❑ `org.w3c.dom`, `edu.ohio-state.cse`

## Declaration

- ❑ Use package statement at top of source file
  - Must appear first, before any class declarations

```
package edu.ohio-state.cse;
public class Pencil { . . . }
```
- ❑ This file must be in a directory matching package name
  - `Pencil.java` in `???/edu/ohio-state/cse`
  - Eclipse handles this correspondence for you
- ❑ At most one package declaration in a file
- ❑ If there is no package declaration, class is in unnamed default package
  - This is fine only for very small programs (like the ones you will write for this class)

## Access Control

- ❑ Another level of visibility: package
  - *Default for members (public/private omitted)*
  - Package-visible members are accessible by all classes in the same package

```
package edu.ohio-state.edu;
public class Pencil {
 private String color;
 int length;
 . . .
}
```
- ❑ Classes are public or package (default)
  - Public classes available outside package

```
public class Math { . . . }
```
  - Package classes available only within same package

```
class Pencil { . . . }
```

## Type Imports

- Fully-qualified type name is *package.class*

```
java.util.Date d = new java.util.Date();
```

  - Do not confuse this “.” with member access
- Shorthand: import statement at top of file
  - To import a single *public* type

```
import java.util.Date;
```

`Date d = new Date();`
  - To import all *public* types, use wildcard `*`

```
import java.util.*;
```

`Date d = new Date();`
    - `*` does not import subpackages
- All classes implicitly import `java.lang.*`
- Static members can be explicitly imported

```
import static java.lang.Math.exp;
```

`exp(x); //instead of Math.exp(x)`
  - Can use wildcard `*` as well

## Good Practice: Naming Conventions

- Avoid name conflicts with packages and reserved keywords
- Package names: lowercase letters
  - `java.util`, `java.net`, `java.io`, . . .
- Class names: start with uppercase letter
  - `Math`, `Pencil`, `PriorityQueue`, . . .
- Variable, field and method names: start with lowercase letters
  - `x`, `out`, `myColor`, `abs()`, `getName()`, `isEven()` . . .
- Constant names: all uppercase letters
  - `PI`, `DEFAULT_LENGTH`, `DAY_OF_WEEK` . . .
- Type parameters: single letter upper case
  - `E` (element) `T` (type) `V` (value type)

## Initialization Block

- Statement block outside methods/constructors
- Executed *before* the body of any constructor

*Without initialization block*

```
public class Body {
 private long idNum;
 private String name = "";
 private Star orbits;
 private static long nextID = 0;

 public Body() {
 idNum = nextID++;
 }

 public Body(String name, Star orbits)
 {
 this();
 this.name = name;
 this.orbits = orbits;
 }
}
```

*With initialization block*

```
public class Body {
 private long idNum;
 private String name = "";
 private Star orbits;
 private static long nextID = 0;

 {
 idNum = nextID++;
 }

 public Body(String name, Star orbits)
 {
 this.name = name;
 this.orbits = orbits;
 }
}
```

## Static Initialization Block

- Similar to initialization block, but:
    - Can only reference static members
    - Executed only once, when class is first loaded
- ```
public class Primes {
    private static int[] primes = new int[4];

    static {
        primes[0] = 2;
        for(int i = 1; i < primes.length; i++) {
            primes[i] = nextPrime(i);
        }
    }
    //declaration of static nextPrime(int) . . .
}
```

Summary

- Static members (ie class members)
 - Instance member belongs to one objects
 - Static member is shared amongst instances
- Enumerated types
- Packages (ie component catalogs)
 - Declaration
 - Another level of visibility
 - Import statements
 - Syntactic shorthand for frequent use
 - Static imports
- Initialization blocks, including static initialization