

Static Members, Enumerations and Packages

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Lecture 5

Example Class Declaration

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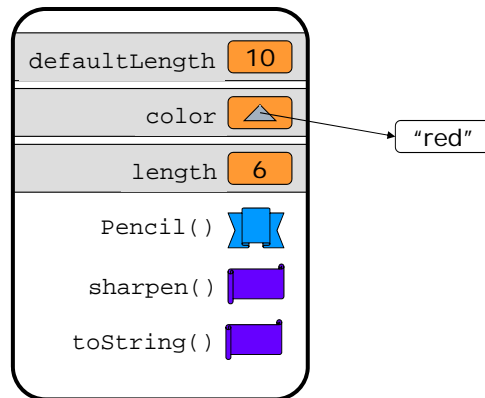
```
public class Pencil {
    private int defaultLength = 10;
    private String color;
    private int length;

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

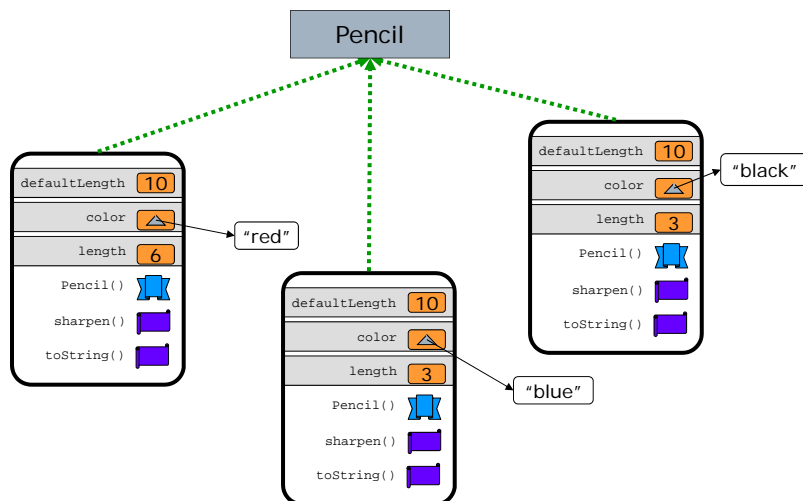
    public int sharpen (int amount) { . . . }

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

One Pencil Instance



Multiple Pencil Instances



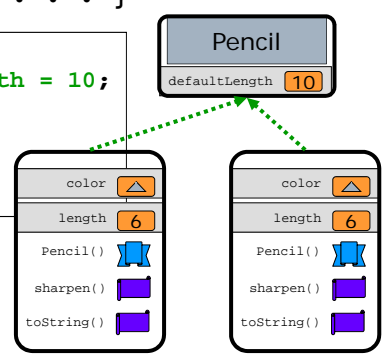
Object vs Class Members

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

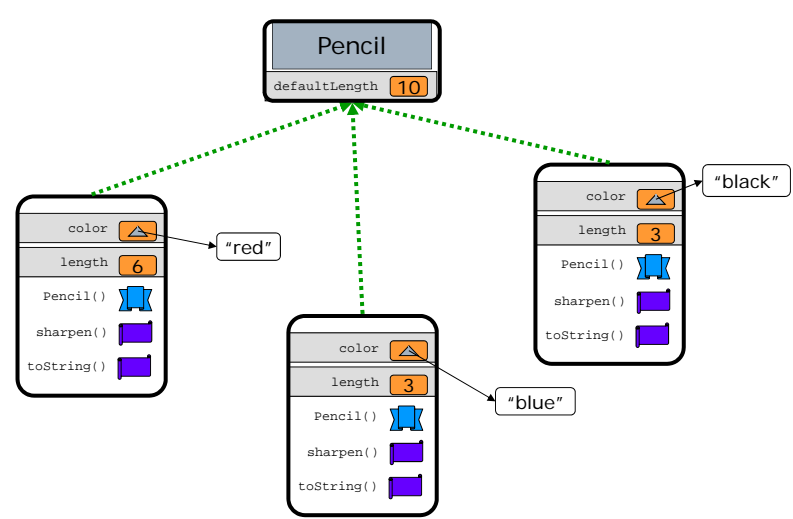
- Keyword: *static*

```
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

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- ❑ 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

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- ❑ 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

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- `System.out.println("Hello");`
 - 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()

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```
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

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- 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

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- 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();
```

 ← Compile-time Error
- OK →

```
p.sharpen(3);
```
- Often used in conjunction with static
 - Class-wide constant value

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

Good Practice: No Magic Numbers

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- ❑ “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

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- ❑ 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

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- 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

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- 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

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- 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

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- 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

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- 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

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- 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

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- 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

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- 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

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- 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