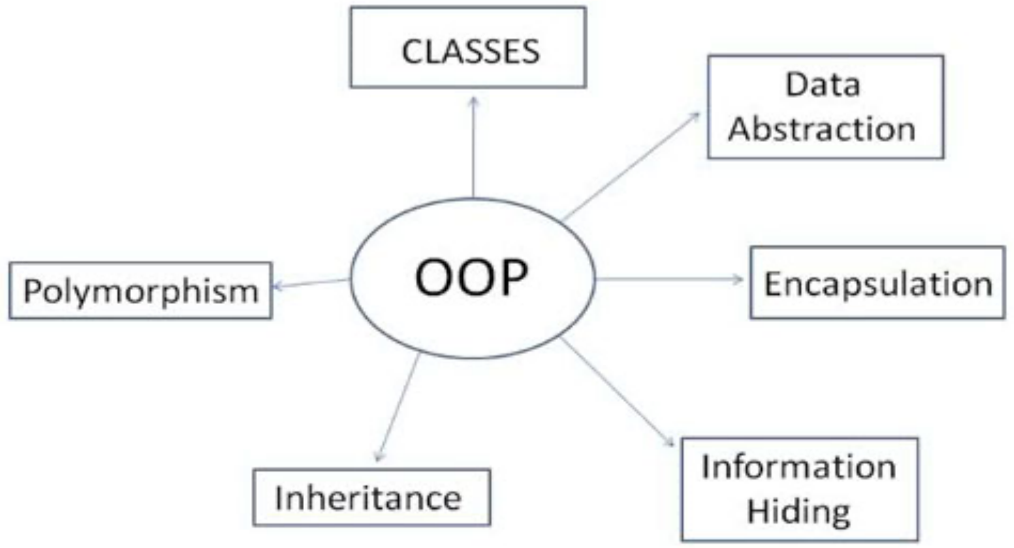
Object Oriented Programming Concept (OOP)

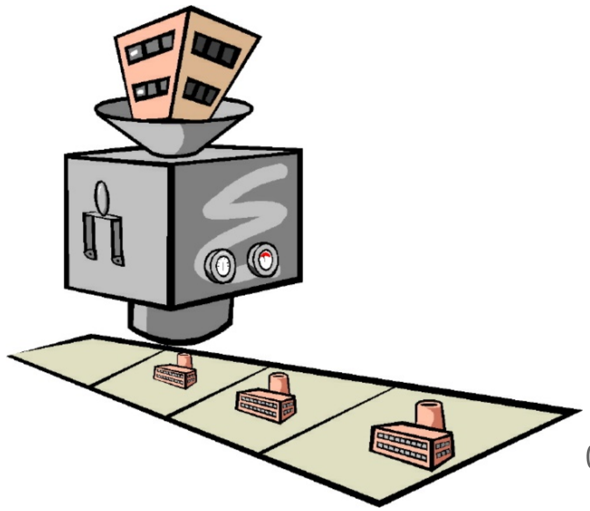


Outlines

- Object Oriented Programming Concept (OOP)
- Class
- Object Instantiation
- Using object data/methods
- Method
- Constructor
- Keywords “this”, “static”, “final”
- Package
- Method in more details
  - Access modifiers, Getter & setters, Passing method arguments
  - toString(), equals()

Object Oriented Programming Concept (OOP)

- An *object* is a data that can contain other data inside.
- An *object-oriented program* works with many objects.
- A *class* is a definition (or blueprint) used to create objects of the same kind.
  - So, an *object* is an instance of a class.
- We ask a class to create an object by using the keyword: *new* ClassName.



A new data of type Car.

```
class Car{
        int speed;
        int acc;
}
```

```
class TransportSim{
    main(){
        Car a = new Car();
        Car b = new Car();
        …
    }
}
```

Used in another program (or another class)

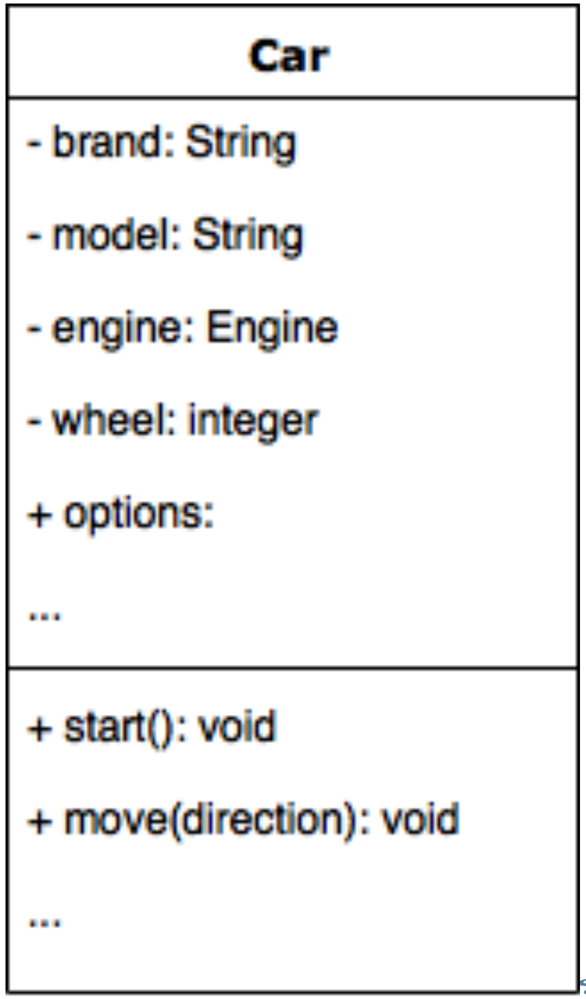
OOP concepts

- View everything as objects and their interactions

- Encapsulation/Information Hiding (Structure)
- Abstraction (Structure)
- Inheritance (Structure)
- Polymorphism (Behavior)

Encapsulation/Information Hiding(Structure)

- Hides all internal implementations from others. (safe from outside manipulation)
- A class can change its internal implementation without effecting outside agents.
  - Outside agents can be forced to use only method(s) of the class
- Accessibility: public, protected, private
- How can we ensure that changing will not hurt? (Unit test)



Not allowed!

```
class Car{
        private int speed;
        private int acc;

        public void pushAcc (){
            speed = speed+acc;
        }
}
```

```
class TransportSim{
    main(){
        Car a = new Car();
        Car b = new Car();
        a.speed = -555;
        a.pushAcc();
    }
}
```

Allowed!

Abstraction (Structure)

- We can merge common codes!
  - Combine common characteristics to build class hierarchy
- Reduce duplication

Abstraction

Car

- brand: String
- model: String
- engine: Engine
- wheel: integer
+ options:
...

+ start(): void
+ move(direction): void
...

Truck

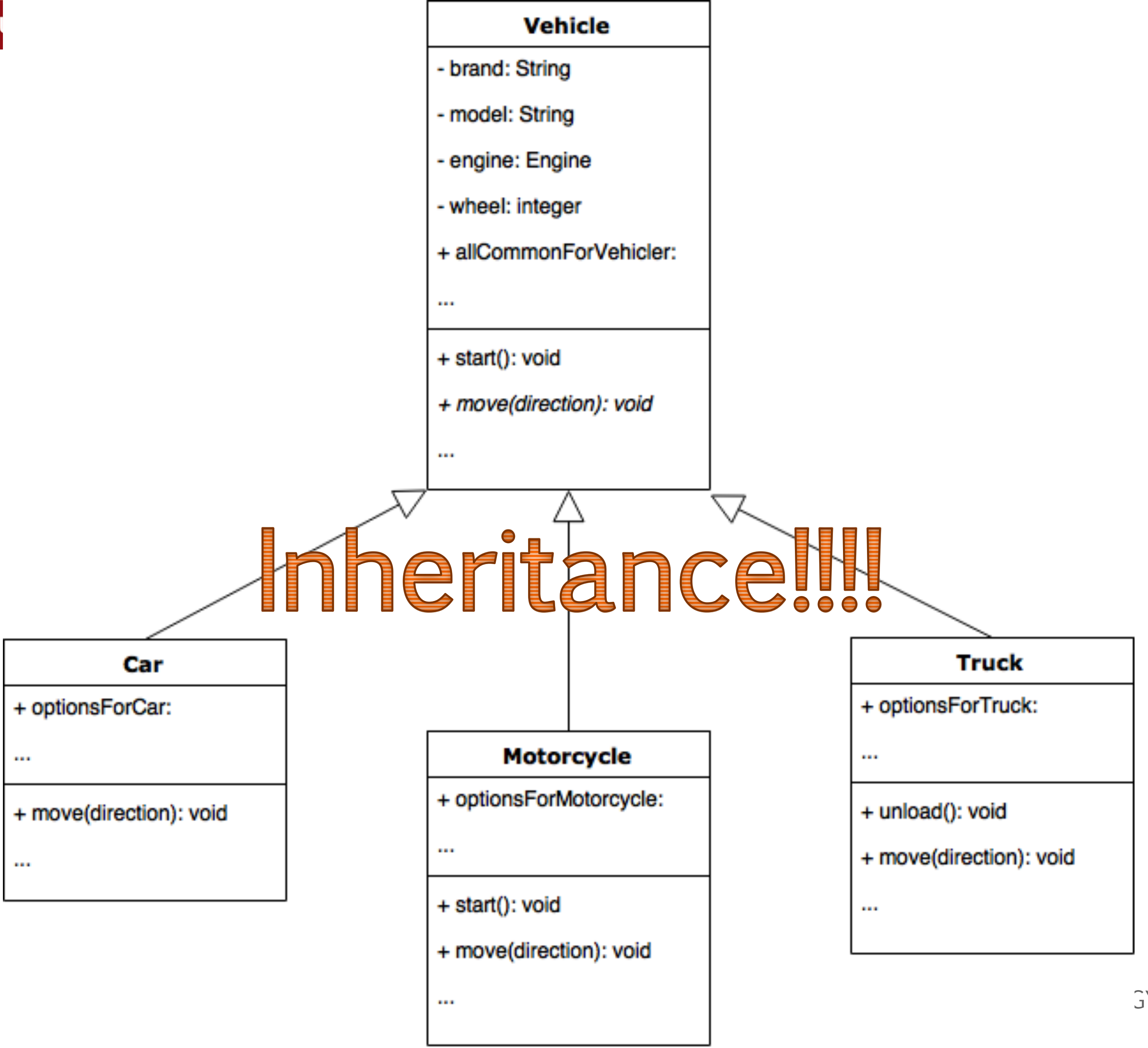
- brand: String
- model: String
- engine: Engine
- wheel: integer
+ optionsForTruck:
...

+ start(): void
+ move(direction): void
...

Motorcycle

- brand: String
- model: String
- engine: Engine
- wheel: integer
+ optionsForMotorcycle:
...

+ start(): void
+ move(direction): void
...


Vehicle
- brand: String
- model: String
- engine: Engine
- wheel: integer
+ allCommonForVehicler:
...
+ start(): void
+ move(direction): void
...
Inheritance!!!!
Car
+ optionsForCar:
...
+ move(direction): void
...
Motorcycle
+ optionsForMotorcycle:
...
+ start(): void
+ move(direction): void
...
Truck
+ optionsForTruck:
...
+ unload(): void
+ move(direction): void
...

Inheritance (Structure)

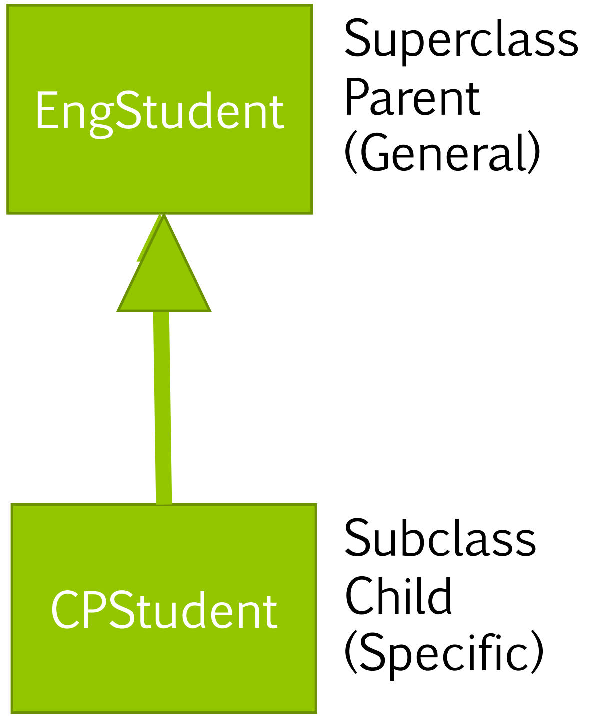
› Define subclasses from existing class

› The subclass object “is-a” or ”is-a-type-of” superclass object

– All Cars are also Vehicles. But a Vehicle does not have to be a Car.

– All CP students are engineer student, but an engineering may be or may not be a CP student.

› Vehicle is reusable as a superclass of future class(es).



Polymorphism (Behavior)

- Different types of objects can receive the same command (method).
- And each of them behave differently according to their actual type.
- We can write a program that correctly works on all of those objects, using the same code.

Meow!
Woof!
Quack!
Animal
Animal
Animal
Polymorphism
speak();
by Sinipull for codecall.net

Image from http://www.c-sharpcorner.com/UploadFile/433c33/polymorphism-in-java/

Classes

- Description of objects that share same attributes/properties/fields (called data members) and actions/behaviors/methods (called member functions)
- Template for creating/instantiating
- Example: Car, Dice

Objects

- instances of classes
- An object has identity, state and behaviors
- Examples:
  - Real world object: Car object, graphic objects (circle, square, ...)
  - Abstract entities: an opened file, a network connection, an object that provides the services for currency conversion

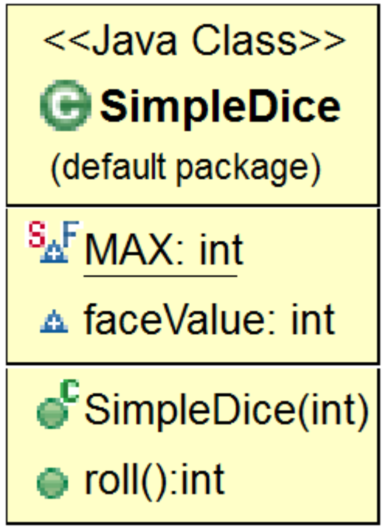
Class

- A class contains 2 main components:
  - data (attributes, properties)
  - methods
    - Constructor is a special method to create class object.

Class “SimpleDice”

```
public class SimpleDice {
    final static int MAX = 6;
    int faceValue;
    public SimpleDice(int faceValue) {
        this.faceValue = faceValue;
    }
    public int roll() {
        faceValue = (int) (Math.random() * MAX) + 1;
        return faceValue;
    }
}
```

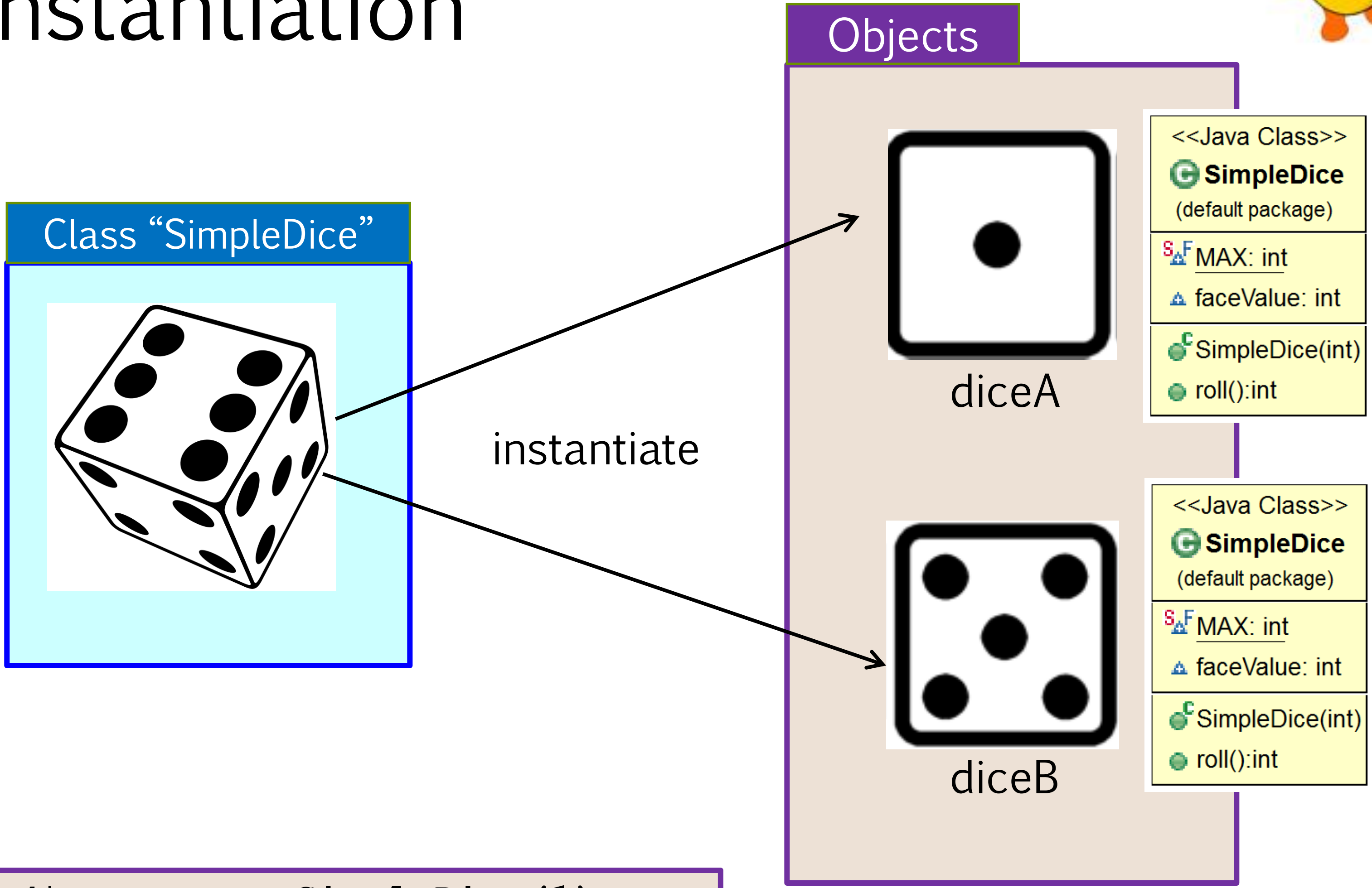
Class “SimpleDice”


<<Java Class>>
SimpleDice
(default package)
MAX: int
faceValue: int
SimpleDice(int)
roll():int

Class UML diagram

Object Instantiation

Important! Each object has its own data and methods.

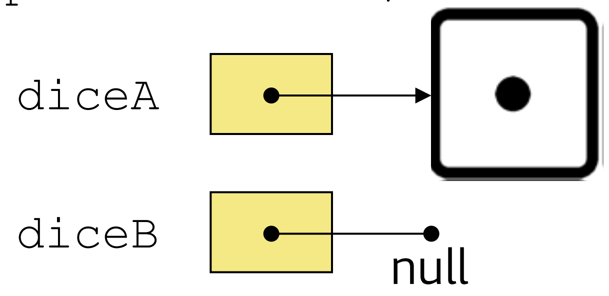


Code

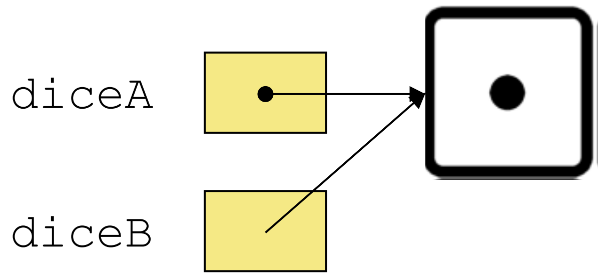
```
SimpleDice diceA = new SimpleDice(1);
SimpleDice diceB = new SimpleDice(5);
```

Object Instantiation (cont.)

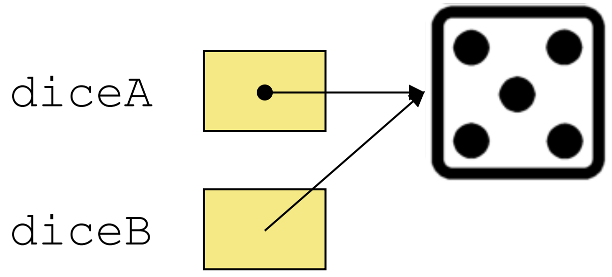
1
```
SimpleDice diceA = new SimpleDice(1);
SimpleDice diceB;
```



2
```
diceB = diceA;
```



3
```
diceB.faceValue = 5;
```



Code
```
SimpleDice diceA = new SimpleDice(1);
SimpleDice diceB;
diceB = diceA;
diceB.faceValue = 5;
System.out.println(diceA.faceValue);
```

What is the result of this program?

Using object data/methods

1. Create new object

```java
SimpleDice diceA = new SimpleDice(1);
```

2. Access an object data

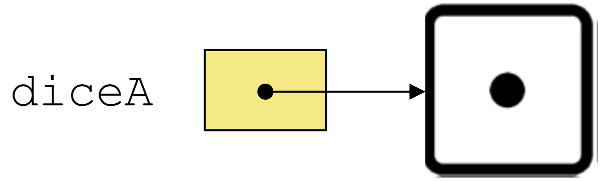
```java
diceA.faceValue = 5;
```

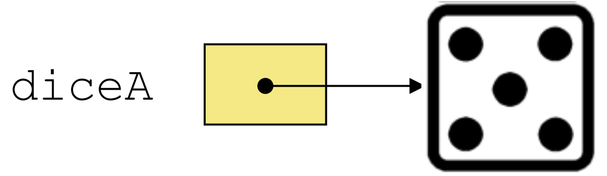
3. Access an object method

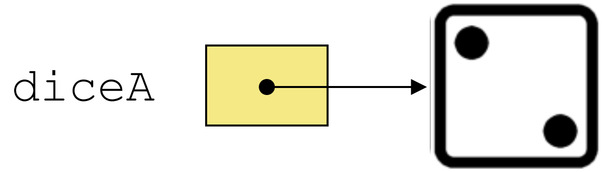
```java
System.out.println( diceA.roll() );
```

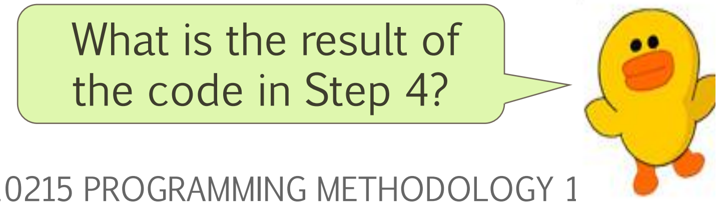
4. Access an object data (again)

```java
System.out.println( diceA.faceValue );
```







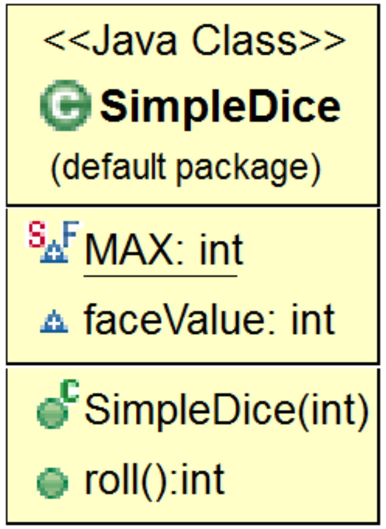


Method

- A *method* is a small, well-defined piece of code that completes a specific task.
- Typically, methods are used to change *variables (data).*
  - For example, the method “roll” changes the value of “faceValue”.

Class “SimpleDice”

```
    public int roll() {
        faceValue = (int) (Math.random() * MAX) + 1;
        return faceValue;
    }
```


<<Java Class>>
SimpleDice
(default package)

MAX: int
faceValue: int

SimpleDice(int)
roll():int

Method Overloading

› A class can have more than one method with the same name but must have unique signature

› Method signature – name + arguments list
  - `add(int m, int n)` → `add(int, int)`
  - `add(double x, double y)` → `add(double, double)`
  - `add(int x, int y, int z)` → `add(int, int, int)`

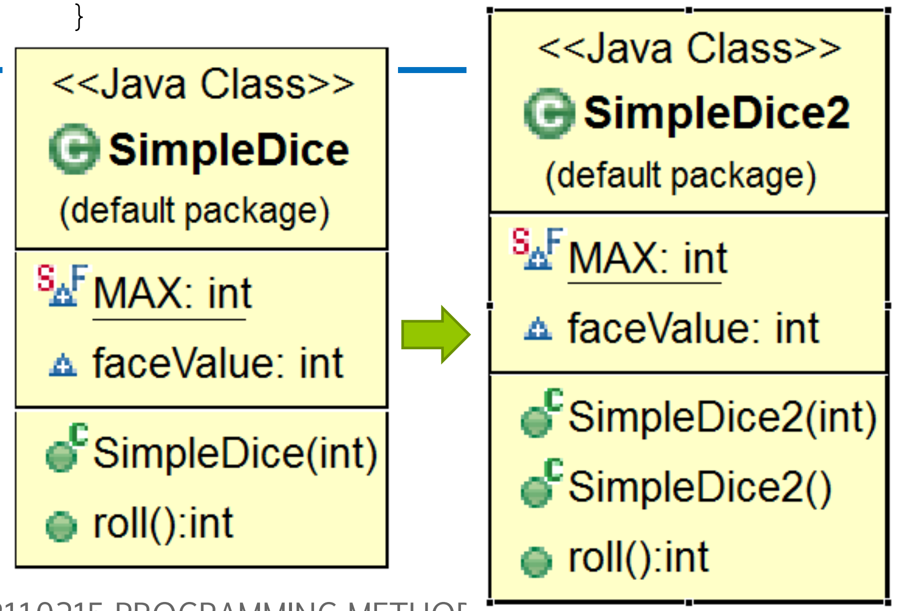
Constructor

- It is a special type of method to define how to create an object.
- It is called once when the object is created (before any other method will be invoked)
- Constructors must:
  - Same name as class
  - Initializes instance variables of a class object
  - Called when program instantiates an object of that class
  - Can take arguments, but *cannot return values*
  - Class can have several constructors, through *overloading*

Class "SimpleDice"

```
public SimpleDice(int faceValue) {
    this.faceValue = faceValue;
}

public SimpleDice() {
    this.faceValue = this.roll();
}
```

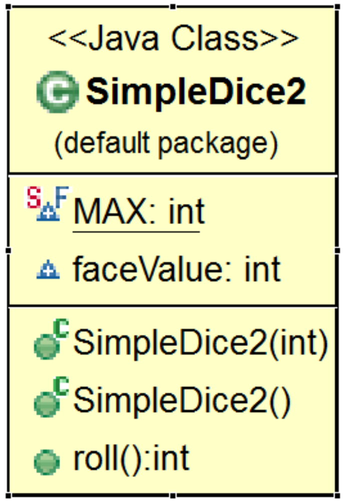


Keyword “this”

- It allows an object to refers to itself.
- It can be used in both class data and methods.
  - this.faceValue, this.roll()
- In Code1, it is necessary to use keyword “this” since the variable names a duplicated.
- In Code2, it is not necessary to use keyword “this”.

Class “SimpleDice”

```
    public SimpleDice(int faceValue) {
        this.faceValue = faceValue;
    }
    public SimpleDice() {
        this.faceValue = this.roll();
    }
```



Code1

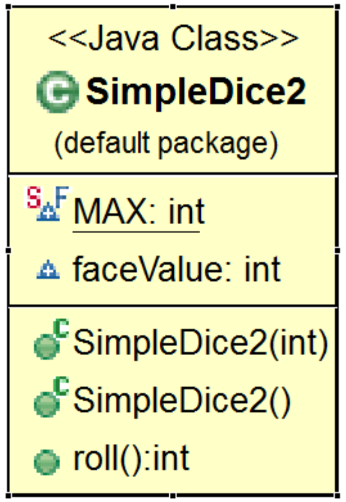
```
    public SimpleDice(int faceValue) {
        this.faceValue = faceValue;
    }
```

Code2

```
    public SimpleDice(int val) {
        // faceValue = val
        this.faceValue = val;
    }
```

Keyword "this"

› "this" as a method is a way to let a constructor calling other constructor.


<<Java Class>>
SimpleDice2
(default package)

MAX: int
faceValue: int

SimpleDice2(int)
SimpleDice2()
roll():int

Class "SimpleDice"

```
    public SimpleDice(int faceValue) {
        this.faceValue = faceValue;
    }
    public SimpleDice() {
        this.faceValue = this.roll();
    }
```

Class "SimpleDice"

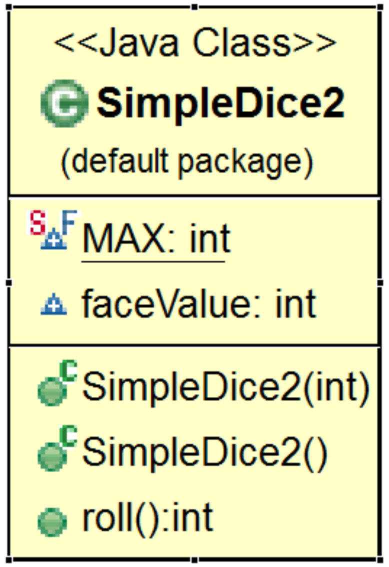
```
    public SimpleDice(int faceValue) {
        this.faceValue = faceValue;
    }
    public SimpleDice() {
        this(this.roll());
    }
```

Keyword "static"

› The static keyword is used when a member variable of a class has to be shared between all the instances of the class.

› It can be used at any levels: data/methods, class, and blocks

› All static variables and methods belong to the class and not to any instance of the class
  – So, they can be directly invoked from "class".



Example1: class "SimpleDice"

```
SimpleDice diceA = new SimpleDice(1);
System.out.println( diceA.MAX );
System.out.println( SimpleDice.MAX );
```

Example2: class "Math"

```
System.out.println( Math.PI );
System.out.println( Math.random() );
System.out.println( Math.floor(1.2) );
```

Class "SimpleDice"

```
public class SimpleDice {
    final static int MAX = 6;
    int faceValue;
}
```

Keyword “final”

- Specifies that a variable is not modifiable (is a constant)
- It can be used at any levels: data/methods, class, and blocks
  - Final data: It means data cannot be modified or changed its value.
  - Final method: It means method cannot be overridden by subclasses.
  - Final class: It means class cannot be inherited.
- For a constant value, it is commonly applied “final static”
  - For example, the variable “MAX” in the class “SimpleDice”

Class “SimpleDice”

```java
public class SimpleDice {
    final static int MAX = 6;
    int faceValue;
}
```

How to load class objects

1 · Class Loaded

2 · Static variables are available

3 · Constructor called and “instance created”

4 · Non-static variables are available

- Step1: Class is loaded by JVM
- Step2: Static variable and methods are loaded and initialized and available for use
- Step3: Constructor is called to instantiate the non static variables
- Step4: Non-static variables and methods are now available

Package

› A *package* is a collection of related classes and interfaces providing access protection and namespace management.

› Java classes and interfaces are members of various packages that bundle classes by function:
  – fundamental classes are in **`java.lang`**,
  – classes for reading and writing (input and output) are in **`java.io`**,
  – etc.

› Avoid namespace conflict

* The source is from Prof. Chate Patanothai

Package (cont.)

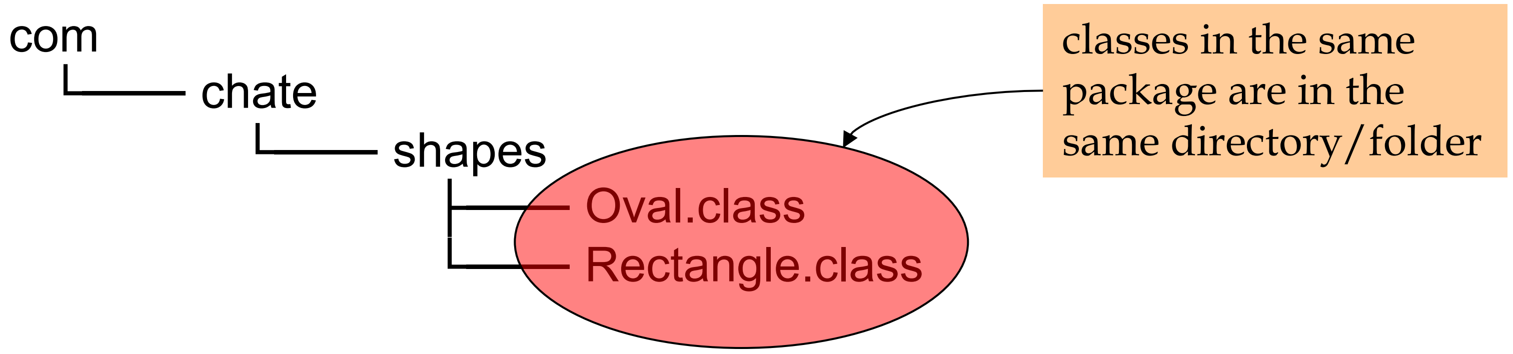
› Use a **package** statement at the top of the source file in which the class or the interface is defined.

```
package com.chate.shapes;

public class Oval {
  // . . .
}
```

```
package com.chate.shapes;

public class Rectangle {
  // . . .
}
```


com
chate
shapes
Oval.class
Rectangle.class
classes in the same package are in the same directory/folder

* The source is from Prof. Chate Patanothai

Package (cont.)

1. Full qualified name

```
com.chate.shapes.Oval o = new Oval();

com.chate.shapes.Rectangle r = new Rectangle();
```

2. With import

```
import com.chate.shapes.Oval;

import com.chate.shapes.Rectagle;

// to import all members

// import com.chate.shapes.*;

Oval o = new Oval();

Rectangle r = new Rectangle();
```

* The source is from Prof. Chate Patanothai

Method in more details

› Access modifiers
› Getter & setters
› toString & equals
› Passing method arguments

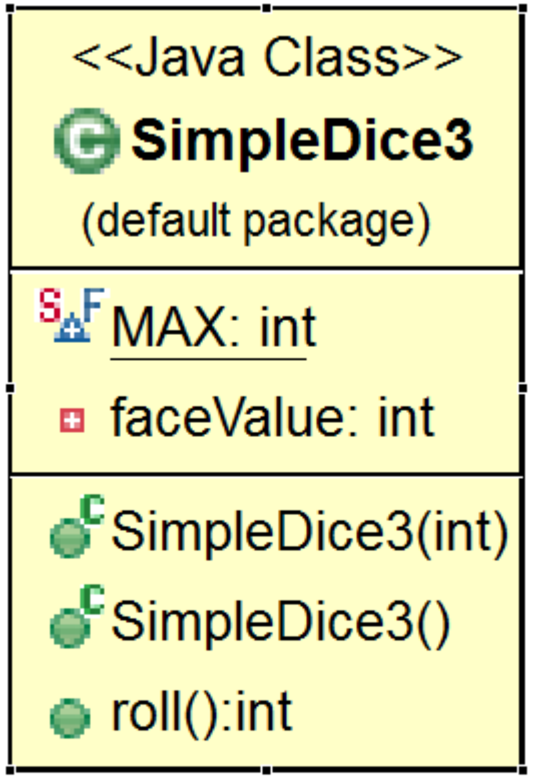
Access modifiers

Specifier	Class	Package	Subclass	World	UML Symbol
`private`	✓				-
`package` (default)	✓	✓			~
`protected`	✓	✓	✓		#
`public`	✓	✓	✓	✓	+

Class “Dice” with Encapsulation Concept

Class “Dice”

```
public class SimpleDice {
    public final static int MAX = 6;
    private int faceValue;
    public SimpleDice(int faceValue) {
        this.faceValue = faceValue;
    }
    public SimpleDice(int faceValue) {
        this.faceValue = faceValue;
    }
    public int roll() {
        faceValue = (int) (Math.random() * MAX) + 1;
        return faceValue;
    }
}
```



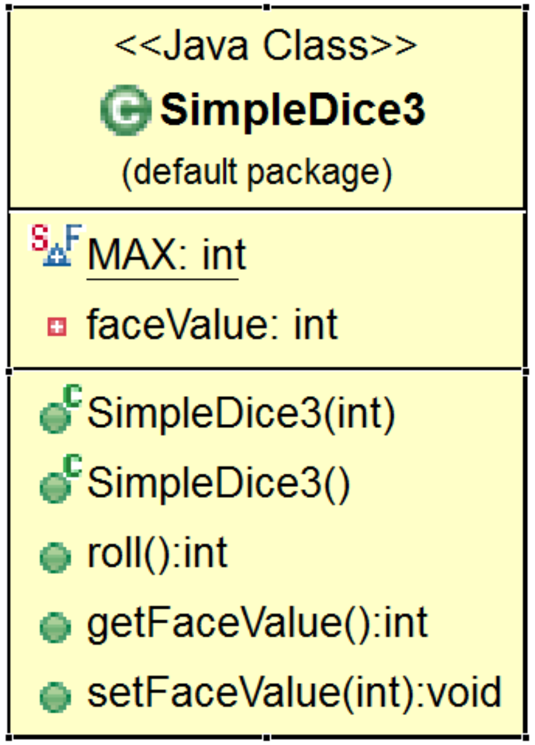
- How can we access class data?
- Getter & Setter

Getters & Setters

Class "Dice"

```
public class SimpleDice {
    public final static int MAX = 6;
    private int faceValue;
    public void setFaceValue(int value) {
        faceValue = value;
    }
    public int getFaceValue() {
        return faceValue;
    }
    ...
}
```

- Getters
  - public method
  - Allow clients to read `private` data
- Setters
  - public method
  - Allow clients to modify `private` data



<<Java Class>>
SimpleDice3
(default package)

MAX: int
faceValue: int

SimpleDice3(int)
SimpleDice3()
roll():int
getFaceValue():int
setFaceValue(int):void

Basic methods

› toString()
  – Convert object to a String representation

› Identity test
  – Test whether two objects/references are the same actual object. (default test when use "==")

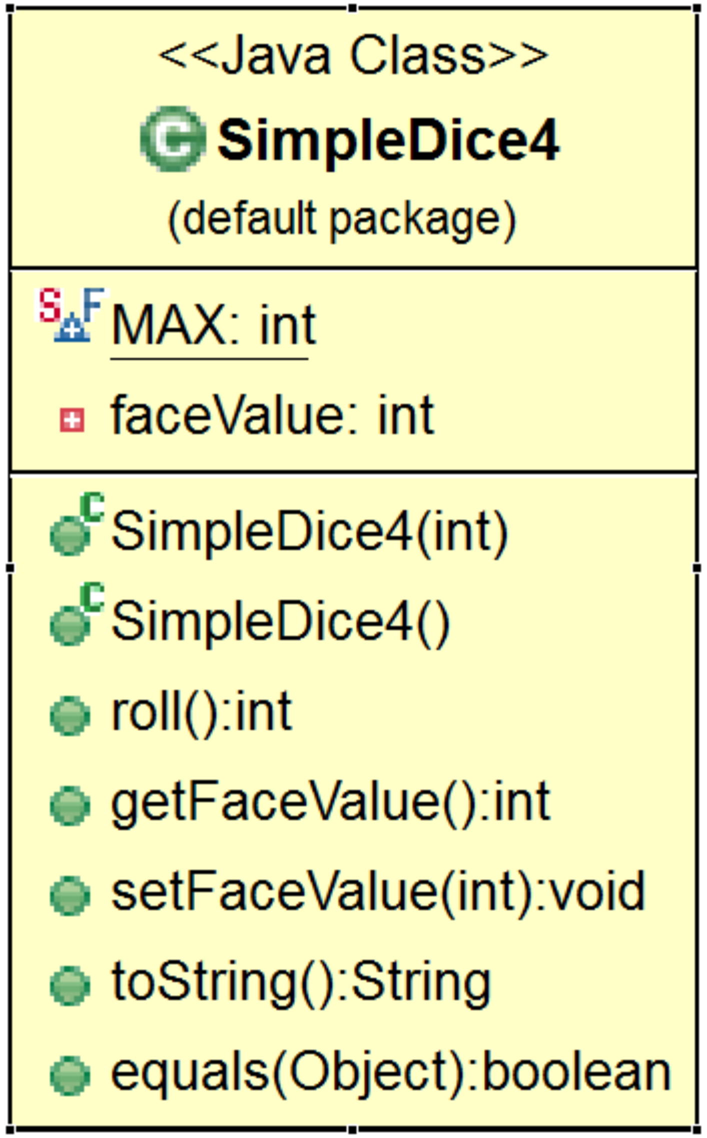
› Equality test
  – Test whether two objects are logically equal.

Method toString() & equals()

Class “Dice”

```java
public class SimpleDice {
   ...
   @Override
   public String toString() {
      return "SimpleDice4 [faceValue=" + faceValue + "]";
   }

   public boolean equals(Object o) {
      Dice otherDice = (Dice) o;
      if (this.getFaceValue() == otherDice.getFaceValue())
         return true;
      else
         return false;
   }
}
```


<<Java Class>>
SimpleDice4
(default package)

MAX: int
faceValue: int

SimpleDice4(int)
SimpleDice4()
roll():int
getFaceValue():int
setFaceValue(int):void
toString():String
equals(Object):boolean

equals()

Is it correct?

```
public boolean equals(Object o) {
    Dice otherDice = (Dice) o;
    if (this.getFaceValue() == otherDice.getFaceValue())
        return true;
    else
        return false;
}
```

```
public boolean equals(Object o) {
    return this.getFaceValue() ==
           ((Dice) o).getFaceValue()
}
```

```
public boolean equals(Object o) {
    Dice otherDice = (Dice) o;
    return this.getFaceValue() ==
           otherDice.getFaceValue()
}
```

Does equals() work as expect?

- Must be conformed with specification.
- The equals method implements an equivalence relation on non-null object references:
  - It is *reflexive*: for any non-null reference value x, `x.equals(x)` should return true.
  - It is *symmetric*: for any non-null reference values x and y, `x.equals(y)` should return true if and only if y.equals(x) returns true.
  - It is *transitive*: for any non-null reference values x, y, and z, if `x.equals(y)` returns true and `y.equals(z)` returns true, then x.equals(z) should return true.
  - It is *consistent*: for any non-null reference values x and y, multiple invocations of `x.equals(y)` consistently return true or consistently return false, provided no information used in equals comparisons on the objects is modified.
  - For any non-null reference value x, `x.equals(null)` should return false.

Testing x.equals(y)

	x	y	Expected result
reflexive	Non-null	-	true
symmetric	Non-null	Non-null	x.equals(y) == y.equals(x)
transitive	Non-null	Non-null	
consistent	Non-null		
x.equals(null)			false

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Passing method arguments

› Primitive type data is passed to a method "by value" (copy), while non-primitive type data is passed to a method "by reference".
  - Pass by value: there is no change in the passing variable.
  - Pass by reference: the change in method affects the value of the passing variable.

Code

```
import java.awt.Point;
public class PassingDataToMethod {
  public static void main(String[] args) {
    int v = 2;
    Point p = new Point(2,2);
    passByValueSetToTen(v);
    passByReferenceSetToTen(p);
    System.out.println("v="+v);
    System.out.println(p.toString());
  }
  public static void passByValueSetToTen(int a){
    a = 10;
  }
  public static void passByReferenceSetToTen(Point a){
    a.x = 10; a.y = 10;
  }
}
```

Result

```
v=2
java.awt.Point[x=10,y=10]
```

Question

```
public class IdentifyMyParts {
    public static int x = 7;
    public int y = 3;
}
```

What are the class variables?

What are the instance variables?

What is the output?

```
IdentifyMyParts a = new IdentifyMyParts();
IdentifyMyParts b = new IdentifyMyParts(); a.y =
5; b.y = 6; a.x = 1; b.x = 2;
System.out.println("a.y = " + a.y);
System.out.println("b.y = " + b.y);
System.out.println("a.x = " + a.x);
System.out.println("b.x = " + b.x);
System.out.println("IdentifyMyParts.x = " +
                           IdentifyMyParts.x);
```