Classes and Objects: Members, Visibility

Lecture 4

Object-Oriented Programming

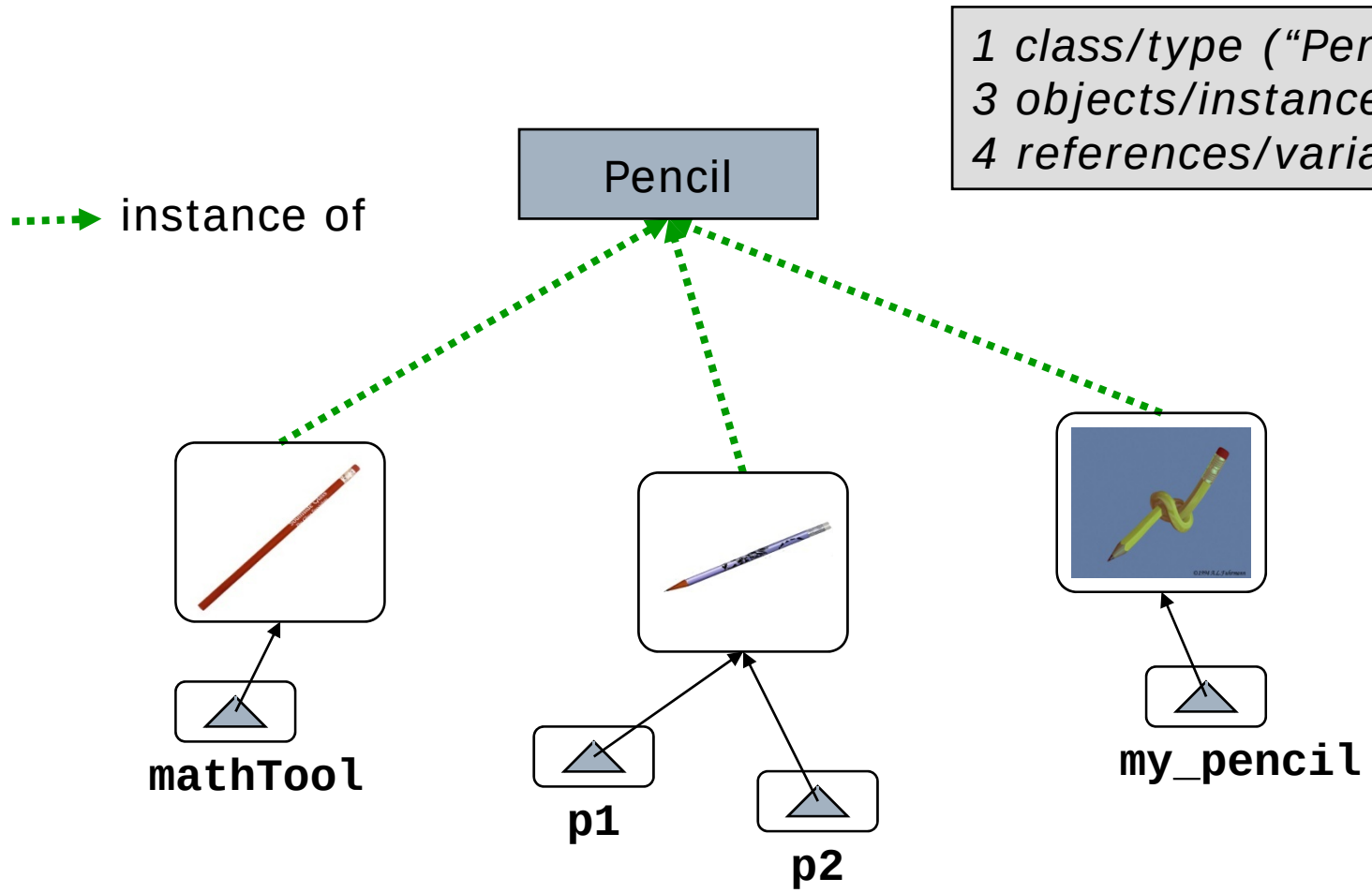
- Fundamental component is an *object*
  - A running program is a collection of objects
- An object encapsulates:
  - State (ie data)
  - Behavior (ie how state changes)
- Each object is an instance of a *class*
  - Class declaration is a blueprint for objects
  - A class is a component type
    - eg Stack, String, Partial_Map, Sorting_Machine
  - An object is an instance of that component
    - Resolve:

```
object Pencil mathTool;
```

    - Java:

```
Pencil mathTool = new Pencil();
```

Graphical View of Instances



Good Practice: Files and Classes

- Declare one class per file
- Give file the same name as the class declaration it contains
  - class HelloWorldApp declaration appears in HelloWorldApp.java
  - class Pencil is defined in Pencil.java

Example Class Declaration


```
class Pencil {
        boolean hasEraser;
        String color;
        int length;

        int sharpen (int amount) {
                length = length - amount;
                return length;
        }

        String getDescription () {
                if (length < 15) {
                  return “small: ” + color;
                }
                else {
                  return “large: ” + color;
                }
        }
}
```

Members

- Two kinds of members in a class declaration
  - Fields, ie data (determine the *state*)

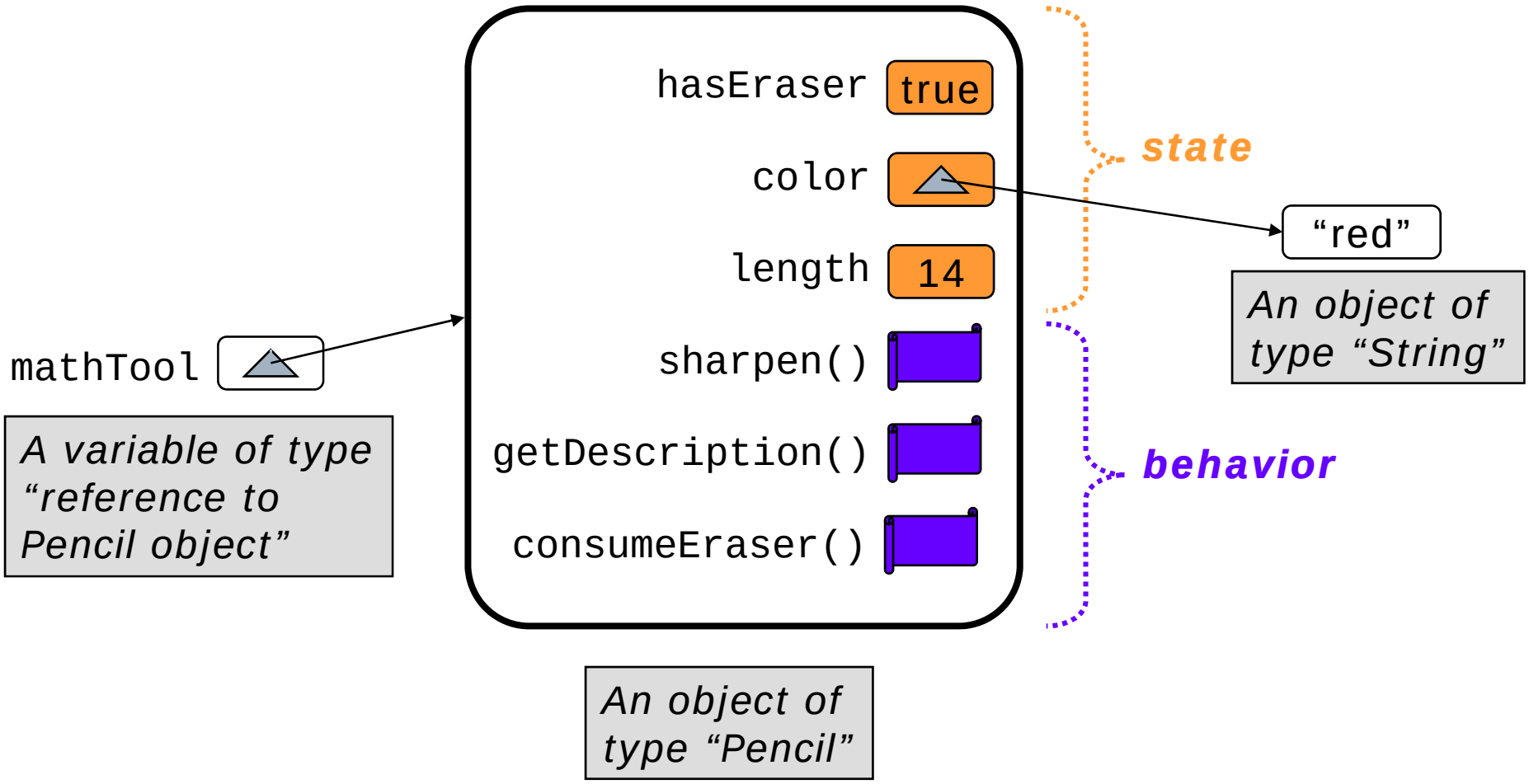
```
boolean hasEraser;
String color;
int length;
```

  - Methods, ie procedures (*access*/*modify* the state)

```
int sharpen (int amount) {
  length = length – amount;
  return length;
}
```

- (Much later: nested classes and nested interfaces)

Graphical View of Object



Object Creation and Deletion

- Explicit object creation with ***new()***;

```
java.util.Date d = new java.util.Date();
Integer count = new Integer(34);
Pencil p1 = new Pencil("red");
```

- Unlike C/C++, memory is *not* explicitly freed
  - References just go out of scope ("die")

```
{
   //create a Date object
   java.util.Date d = new java.util.Date();
   . . .
}  //d out of scope, object is unreachable
```

  - *Automatic* garbage collection (eventually) deletes unreachable objects

Initialization of an Object's Fields

- Implicit: Default initial values based on type
  - eg boolean is false, reference type is null

```
boolean hasEraser;  //implicitly false
```

- Explicit: Initialization with field declaration

```
int length = 14;
```

- Special method: "constructor"
  - Syntax: name is same as class, no return type

```
class Pencil {
  String color;
  Pencil (String c) {
    color = c;
  }
}
```

  - Invoked by new(), so can have parameters
  - Runs *after* implicit/explicit field initialization

Default Initial Values

- For fields only
- Does not apply to local variables!!

Type	*Default*
`boolean`	false
`byte`	0
`short`	0
`int`	0
`long`	0L
`float`	0.0f
`double`	0.0d
`char`	'\u0000'
`reference`	null

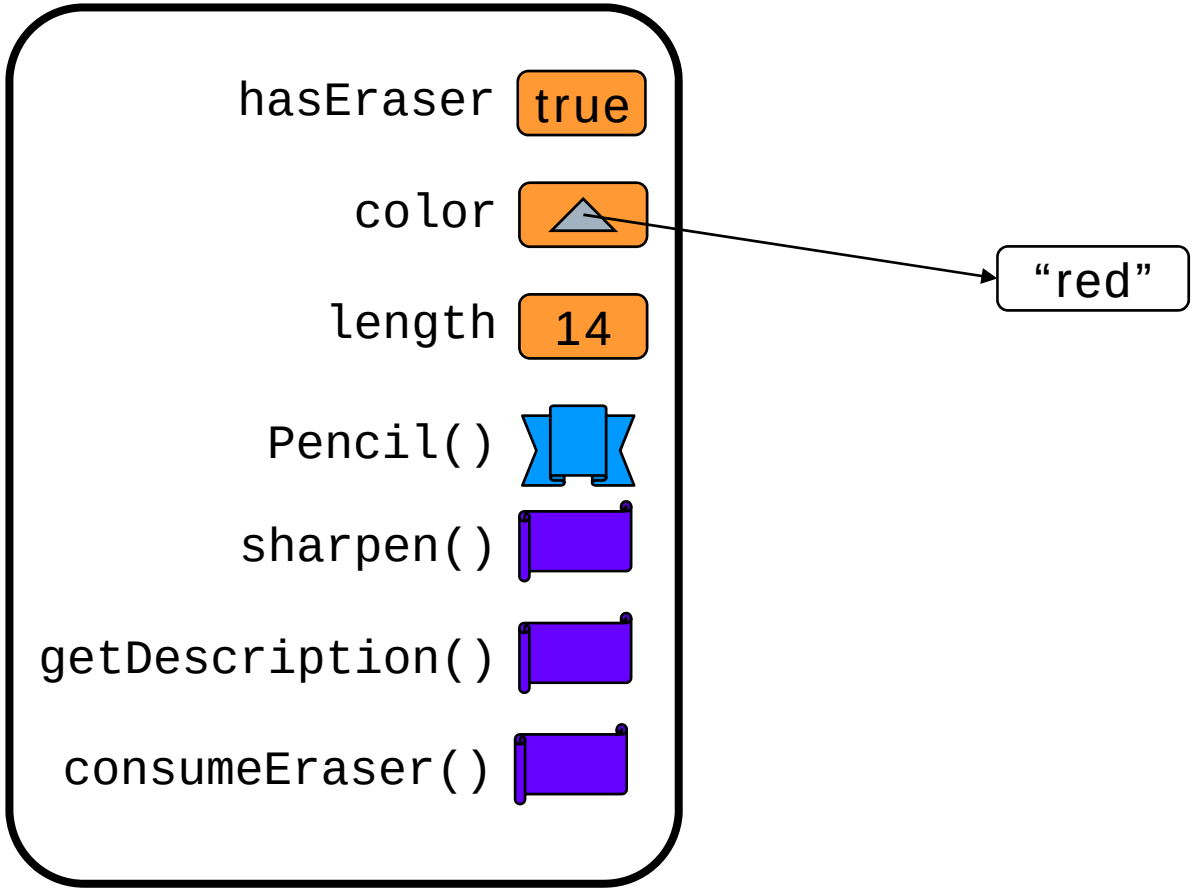
Example Constructor


```
class Pencil {
      boolean hasEraser;
      String color;
      int length = 14;

      Pencil (String c) {
            color = c;
            hasEraser = (length >= 10);
      }

      . . . same methods as before . . .
}
```

Graphical View of Object



Good Practice: Establish Invariant

- Ensures clause of a constructor: establishes the convention (representation invariant) for this instance
  - What is true of the state for all instances?
  - eg All long pencils have erasers
    `length >= 10 ==> hasEraser`
  - So the state (false, “green”, 14) is not valid
- A constructor can call other methods of its own object
  - Danger! Convention (representation invariant) might not hold at call point

Visibility

- Members can be private or public
  - member-by-member declaration

```
private String color;
public int length;
public int sharpen (int amount) { . . . }
```

- Private members
  - Can be accessed only by instances of same class
  - Provide concrete implementation / representation
- Public members
  - Can be accessed by any object
  - Provide abstract view (client-side)

Example

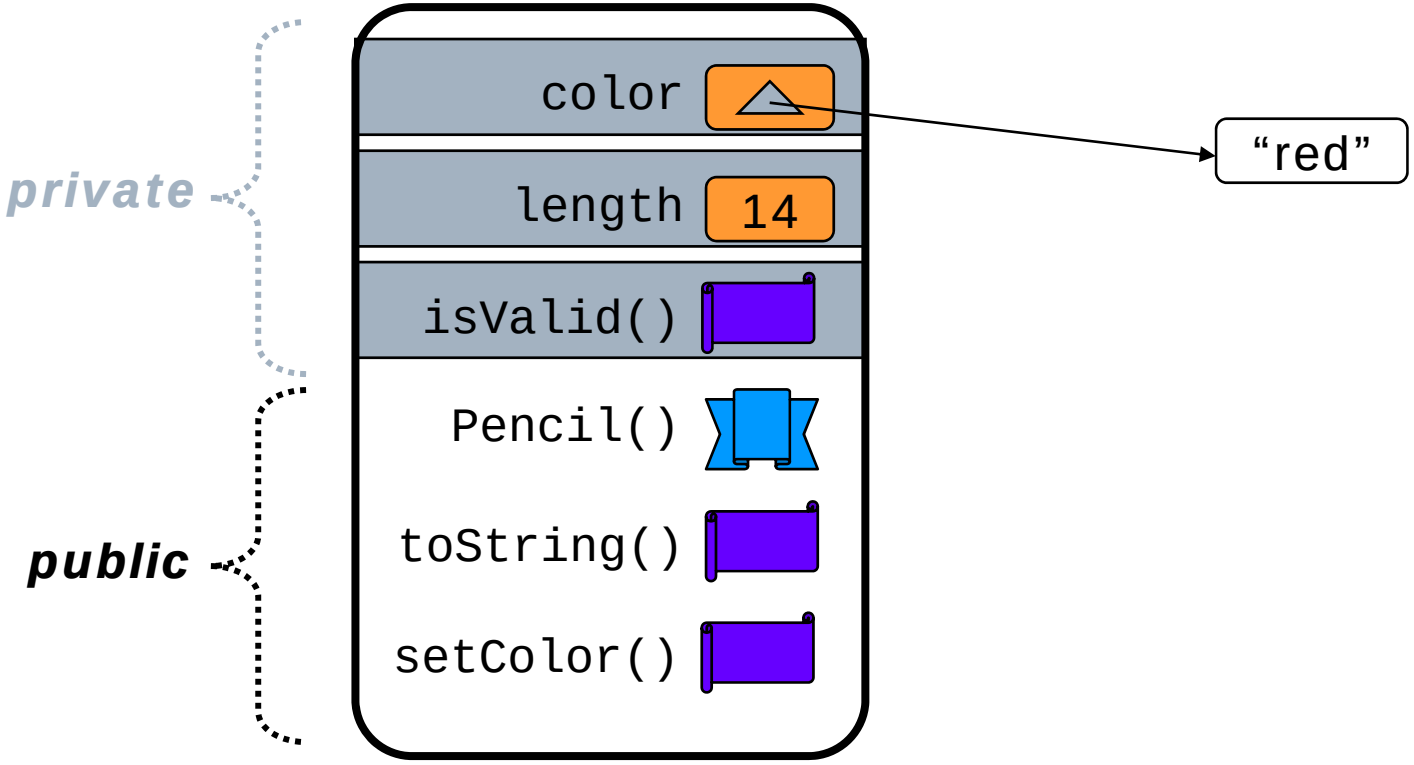

```
class Pencil {
  private String color;
  private int length = 14;
  private boolean isValid(String c) {…}
  public Pencil(String c, int l) {…}
  public String toString() {…}
  public void setColor(String c) {…}
}

class CreatePencil {
  public void m() {
    Pencil p = new Pencil("red", 12);
    p.setColor("blue");
    p.color = "blue";
  }
}
```

OK

Compile-time Error

Graphical View of Member Visibility



Example

- See PencilA.java
  - Concrete state (ie representation) is hidden from clients
  - Abstract state (ie client-side view) is accessed and manipulated through public methods
- See PencilB.java
  - Different representation
  - Exact same behavior as far as the outside world is concerned

Good Practice: Member Declarations

- Group member declarations by visibility
  - Java's convention: private members at top
- No fields should be public
  - Common (bad) idiom: Public "accessor" methods for getting and setting private fields (aka getters/setters)

```
class Pencil {
  private int length;
  public int getLength() { . . . }
  public void setLength(int) { . . . }
}
```

  - Better idiom: Provide public members for observing and controlling *abstract state*
    - Recall from Resolve: "Client view first"
  - Eg PencilA and PencilB should have *exactly the same accessors* (including signatures)

Method Invocation

- Syntax: *objectreference.member*

```
p.color = “red”;
p.toString().length();
```

- Reference is implicit inside a method that was just called on this same object

```
class Pencil {
  private String color;
  public Pencil() {
    color = “red”;
  }}
```

- Explicit reference to same object available as ***this*** keyword (from within the method that was called on this object)

```
this.color = “red”;
```

Good Practice: Formal Parameters

- Constructor formal parameters that are used directly to set object fields can be given the same name as the field
  - Formal argument “hides” class field variable
  - Refer to the field using explicit ***this***

```
class Pencil {
  private int length;
  Pencil(int length) {
    this.length = length;
  }
```

Method Overloading

- A class can have more than one method with the same name as long as they have different *parameter lists*

```
class Pencil {
  . . .
  public void setPrice(float newPrice) {
    price = newPrice;
  }
  public void setPrice(Pencil p) {
    price = p.getPrice();
  }
}
```

- How does the compiler know which method is being invoked?
  - Answer: it compares the number and type of the parameters and uses the matched one

```
p.setPrice(3.4);
```

- Differing *only* in return type is not allowed

Multiple Constructors

- Default constructor: no arguments
  - Fields initialized explicitly in declaration or implicitly to language-defined initial values
  - Provided automatically *only* if no constructor defined explicitly

```
class Pencil {
  String color;    //initialized implicitly to null
  int length = 14; //initialized explicitly
  …
}
```

- Another constructor: one same-class argument

```
Pencil (Pencil p) { . . . }
```

- One constructor can call another with ***this()***
  - If another constructor called, must be the first statement

```
Pencil (Pencil p) {
  this(p.color);  //must be 1st line
  length = 10;
}
```

Summary

- Classes and objects
  - Class declarations and instantiations
- Instance members
  - Fields, ie state
  - Methods, ie behaviors
- Constructors
- Visibility
  - private: Visible only to instances of same class
  - public: Visible to instances of any class
- Overloading
  - Multiple implementations of same method name
  - Distinguished by formal parameter types