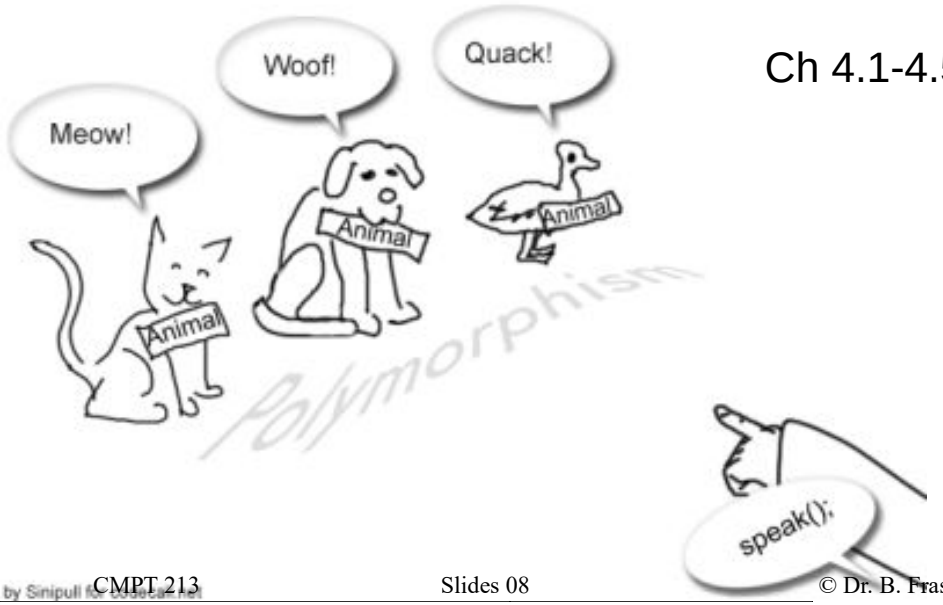
Interface Polymorphism



Ch 4.1-4.5

Topics

1) How can we reduce coupling between classes?
2) How can one piece of code work on different types of objects?

Interface

- An Interface specifies a set of ***public*** methods, but.. does not normally implement them
  - It's a contract for providing methods.

```
public interface LetterGrader {
    String getGrade(double percent);
    double getMinPercentForGrade(String grade);
}
```

- "Interface" can refer to two things:
  - An interface in Java (such as "The LetterGrader interface")
  - The..set of methods of a class (such as "The class's public interface")

Interface Usage

- To implement an interface, a class must both:
  - Say it "implements" the interface
  - implement all methods specified by interface

```
public class EasyLetterGrader implements LetterGrader {
    private static final double BREAK_POINT = 70;

@Override
public String getGrade(double percent) {
    if (percent >= BREAK_POINT) {
        return "A+";
    } else {
        return "B";
    }
    // Code seems incomplete :)
}

@Override
public double getMinPercentForGrade(String grade) {
    if (grade.compareToIgnoreCase("A+") == 0) {
        return BREAK_POINT;
    } else {
        return 0;
    }
}
}
```

@Override is an.. annotation
Tells Java that this method.. must override a method in the base class/interface

Concrete Types

- Concrete Type
  - exact instantiated class of an object
    (not a more general interface or base class).
- Example
  - LetterGrader is an Interface (not instantiatable), so *not* a concrete type.
  - BAD: LetterGrader oops = new LetterGrader();
- Example
  - EasyLetterGrader is an instantiatable class, so.. is a concrete type
  - GOOD: LetterGrader good = new EasyLetterGrader();

Polymorphism

- Polymorphism Example:
  - A variable of type LetterGrade can reference any object of class type which..

    LetterGrader g = new EasyLetterGrader();
    computeClassGrades(g);
    LetterGrader g = new HardLetterGrader();
    computeClassGrades(g);
- Polymorphism definition:
  - The exact method to execute is selected at runtime.
  - Ex: Does g.getGrade() call **EasyLetterGrader**.getGrade(), or **HardLetterGrader**.getGrade() ?

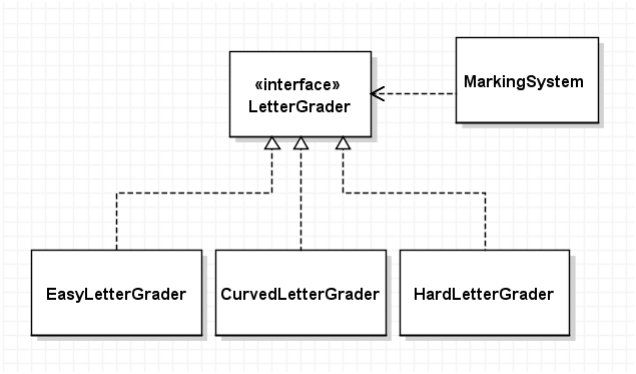
Polymorphism Example

```
class MarkingSystem {
   double[ ] marks = {74, 85, 25, 55, 93, 1};

   void printLetterGrades() {
      LetterGrader grader = new EasyLetterGrader();
      String[] grades = gradeEachStudent(grader);

      for (String grade : grades) {
         System.out.println("Grade: " + grade);
      }
   }

   String[ ] gradeEachStudent(LetterGrader grader) {
      String[ ] letterGrades = new String[marks.length];
      for (int i = 0; i < marks.length; i++) {
         letterGrades[i] = grader.getGrade(marks[i]);
      }
      return letterGrades;
   }
}
```

No idea what type of LetterGrader is passed; just that the object..

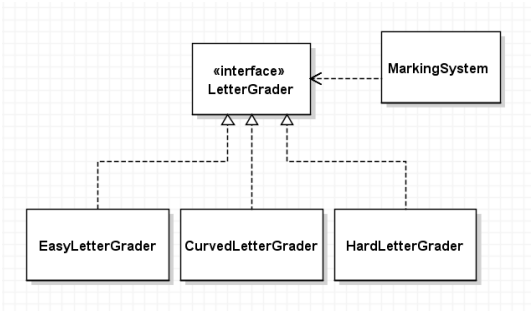
It can only use..

Terminology



Why Use Polymorphism?

- ..
  Exact method (concrete type) determined at runtime.
- ..
  works with any object implementing the Interface so independent of object's concrete type.
- Design Heuristic:
  - Extensible:
    Reuse code without re-write to support new classes.



Interface Details

- Interface methods are ..
  - can provide “default” implementation of function.
- Can declare.. (automatically public static final)

```
public interface CardDeck {
    int NUM_CARDS = 52;
    // ...
}
```


Interface Details

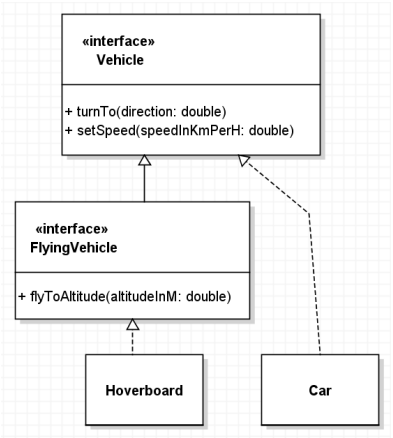
- An Interface can..

```
public interface Vehicle {
    void turnTo(double direction);
    void setSpeed(double speedInKmPerH);
}

public interface FlyingVehicle extends Vehicle {
    void flyToAltitude(double altitudeInM);
}
```

  - A class implementing FlyingVehicle must also implement all of Vehicle's methods too.

Exercise

- Which of the following statements work?




```
public static void main(String[] args) {
    Vehicle v1;
    v1 = new Vehicle();
    v1 = new Car();
    v1 = new Hoverboard();

    FlyingVehicle v2;
    v2 = new Vehicle();
    v2 = new Car();
    v2 = new Hoverboard();

    Car v3;
    v3 = new Vehicle();
    v3 = new Car();
    v3 = new Hoverboard();
}
```

Comparable Review

- Can write algorithms for interface types.

```
interface Comparable<Type> {
    int compareTo(Type obj);
}
```

```
public class InOrder {
    public static void main(String[] args) {
        Long[] data = new Long[5];
        for (int i = 0; i < data.length; i++) {
            data[i] = i;
        }
        System.out.println("In order? "
            + isAscending(data));
    }

    public static boolean
    isAscending(Comparable[] array) {
        for(int i = 0; i < array.length - 1; i++) {
            Comparable first = array[i];
            Comparable second = array[i+1];
            if (first.compareTo(second) > 0) {
                return false;
            }
        }
        return true;
    }
```

This is not quite perfect. Comparable is a generic type, so isAscending() should have the heading

```
public static <T extends Comparable<T>>
    boolean isAscending(T[] array) {
```


Comparator Review

- An idiom is..
- For creating anonymous classes make a function which creates it.

```
public interface FileFilter {
    boolean accept(File path);
}
```

```
private void addFolder(File directory) {
    FileFilter filter = createExtensionFilter();
    File[] files = directory.listFiles(filter);
    //..
}

private FileFilter createExtensionFilter() {
    return new FileFilter() {
        @Override
        public boolean accept(File path) {
            return path.isDirectory()
                    || hasAcceptedExtension(path);
        }
    };
}
```


Review Questions

- Can the full type of an object be just an Interface type?
  - No: An object's concrete type cannot be an Interface. An Interface cannot be instantiated, only implemented by other classes.
- Are the following two ideas identical?
  A class which has the same methods as an Interface
  A class which implements the interface?
  - No: For polymorphism to work, a class must implement the interface as well.

Summary

- Interface: A set of methods & constants.
  - How to define, implement, and use an interface.
- Concrete Type: the instantiated type of an object.
- Example uses for polymorphism.