CT2106
Object Oriented Programming

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Summary of Last Two Lectures

- A class has fields, a constructors and methods
- Encapsulation - each object's data (fields) is protected by its accessor/mutator methods
- If you want to access/change an object's state, you must use its accessor/mutator methods
- The use of the 'private' key word prevents external access to an object's data
- Java is both compiled and Interpreted
- Java uses JVM to execute the same code on multiple platforms/machines

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Today's Lecture

- How to implement a scenario?
- An object can be composed of other objects
- Objects can call each other's methods
- Java uses Reference types as well as primitive types
- What to watch out for in Integer division
- To use double and boolean primitive values
- To use conditional statements

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An Example Problem to Solve/Implement

We wish to be able to create several Car (objects)

Each car object has an Engine

Each Engine has the following properties

- **kpg** (kilometers per gallon)
- **fuel** (amount of fuel in the tank)

Each Car has a **totalDistance** (travelled)

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Problem

Each Car should have a **move method** specifying the distance to be travelled

You may call this method as often as you wish, and the car will print out

- Total distance travelled so far
- Remaining fuel
- Estimated distance left to travel

If you are out of fuel, the car will notify you

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How to Start

Firstly, identify the classes

Code up the basic classes

Remember each class should have

- Fields
- At least one constructor
- Methods

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Linking classes

Each Car object “**has a**”/ “**has an**” Engine

In OOP terms, this means that a Car object relies upon the service of an Engine object

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Is-a vs **has-a** relationships

- Two fundamental relationships between classes in OOP
  - **has-a** (or composition)
  - **is-a** (or inheritance) : we'll encouter this later

- A RacingBike is-a type of Bicycle (Inheritance)
- A RacingBike has-a Wheel (Composition)

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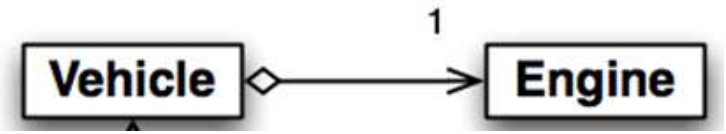
Representing **has-a** relationships

- **has-a** relationship denotes **composition**
- One object is **composed** of another and relies upons its services for its own functionality
- A Vehicle **has-a**(n) Engine; A Bicycle has a wheel

Representing **has-a** relationships

- In OOP class diagrams a diamond shape like this indicates a composition or has-a relationship



- This class diagram tell us that a Vehicle object is composed of a single Engine object

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Realising composition in Java

- To realise a has-a relationship you have to create a link between the participant classes
- You do this using a new type of variable type: **a reference variable type**
- The reference declaration is in the **owner** class
- In our example, the Car class will have reference variable that points to an Engine object

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```
public class Bicycle
{
    // instance variables - replace the example below
    private int speed;
    private int gear;
    private int cadence;
    private Wheel front;
    private Wheel back;

    /**
     * Constructor for objects of class Bicycle
     */
    public Bicycle(int speed, int gear, int cadence)
    {
        // initialise instance variables
        this.speed = speed;
        this.gear = gear;
        this.cadence = cadence;
        front = new Wheel(5);
        back = new Wheel (5);
    }
```

Two reference variable of type Wheel are declared

The variables are initialised in the constructor

Wheel Class

```
public class Wheel
{
    // instance variables - replace the example below with
    private int radius;

    /**
     * Constructor for objects of class Wheel
     */
    public Wheel(int radius)
    {
        // initialise instance variables
        this.radius = radius;
    }   }
```

Following this example, you can create a link between Car and Engine

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Information Required

- What information does the Car object require from Engine object?
  - "Each car should have a **move method** specifying the distance to be travelled"

- You may call this method as often as you wish and the Car will print out:
  - Total distance travelled so far
  - Remaining fuel
  - Estimated distance left to travel

  "If you are out of fuel, the car will notify you"

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Objects Communicating

- What information does the Car object require from Engine object?
-
- We know this
  - Engine object has:
    - ❖ Fuel amount
    - ❖ kpg (the amount of fuel used per distance)

- Car object has
  - The distance amount
  - The total distance travelled amount
  - A move method

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Car to Engine

- Car has no information about fuel levels
- It requires Engine to give it that

Engine to Car

- Engine has no information about distance
- It requires Car to give it this (so that it can calculate fuel consumption)

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go(int distance) method in Engine class

```java
/**
 * go method of the engine calculates the amount of fuel needed to go
 * the distance required. It updates the fuel variable based on this calculation.
 * It returns false if the updated fuel calculation is less than zero.
 * This is a rough and ready way to determine if the fuel level can accomodate the distance required.
 * Can you do better ? For example, if there was fuel for 5 km, but the distance variable was 10km
 * perhaps this method should return the distance that could be travelled, rather
 * than returning false.
 *
 * @param  distance  : the distance required to travel
 * @return  true or false based on whether it is possible or not
 */
public boolean go(int distance)
{
    fuel = fuel - distance/kpg; // integer division problem here. Can you spot it?
    if(fuel >=0){
        return true;
    }

    return false;
}
```

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setFuel(int fuel) from the **Car** class

```
public void setFuel(int fuel){
    engine.setFuel(fuel);
}
```

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move(int distance) from the Car class

```
/**
 * The move method is called whenever a Car object is required to move
 *
 * @param  distance  : the distance the car wishes to move
 * @return   boolean: true or false based on whethe the car moved or not
 */
public boolean move(int distance)
{

    boolean moved = engine.go(distance); //checks to see if engine will allow this distance

    if(moved){
        totalDistance +=distance; //updates distance travelled
    }

    return moved;
}
```

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First Assignment

- Based on this example sand will be posted later today.
- It will be due next Friday.

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