Object Oriented Programming: Class Design

Learning Objectives

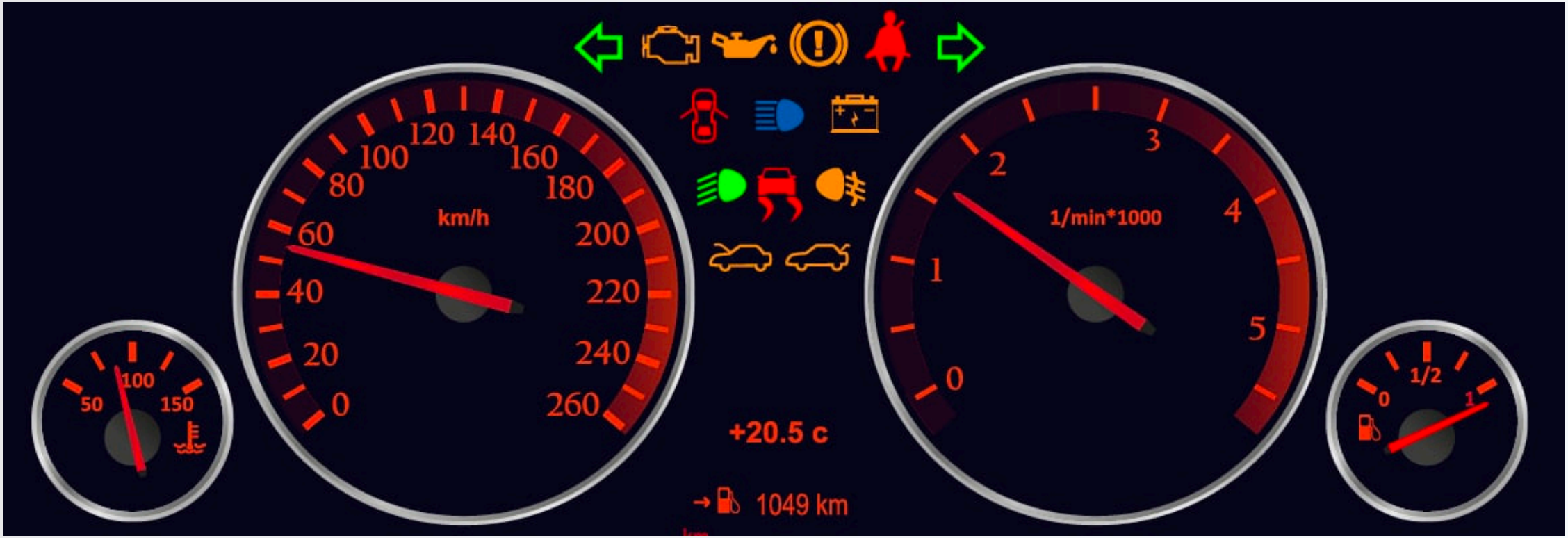
- Create abstractions for entities you want programs to model
- Use encapsulation to define safe ways of using objects you create
- Recognize the public interface created by a class
- Evaluate the effectiveness of a class' design choices

Creating Abstractions

- Objects in Java **know some things** and they can **do some stuff**.
- When designing an object (real or software) for someone to use, the object should include only the properties & behaviors it needs for a given user to use it!

When you drive a car, you're shown information on speed, fuel, and RPMs. You have the choice of actions like *drive*, *park*, *reverse*, etc.

As the driver of a car, you are **not** concerned with the crankshaft & spark plugs & cylinders & valves & ....



Class Design as Abstraction

- Decide what you want a user to be able to do with the objects that you are creating.
  - These will be the methods of the class
- Identify all of the properties such an object must have to be able to implement those desired behaviors
  - These will be the instance variables of the class
  - Some properties can be exposed to the user, some are only necessary for internal use
- Implement the public methods to expose important properties and perform essential behaviors

Bank Account Example

We're tasked with designing a Bank Account object that a team at TD Bank will use in their software systems.

What are the essential operations of a Bank Account object?
What information does a Bank Account need to store in order to perform these operations?

Bank Account Operations

Name	Inputs	Outputs
check balance	none	amount
desposit	amount	none (?)
withdraw	amount	none (?)

Note: it's not that a Bank Account *couldn't* do more. But from our stated problem, this is all a Bank Account must do at a minimum.

Core Operations → Class Skeleton

```
public class BankAccount {
    public double checkBalance() {
        return 0.0; // TODO
    }

    public void deposit(double amount) {
        // TODO
    }

    public void withdraw(double amount) {
        // TODO
    }
}
```

Adding in the Instance Variables

To check an account's balance, make a deposit to the account, or withdraw an amount from the account, we need to know:

- **the account balance**

That's it! An account could store information about its owner, account type, interest rates, withdrawal limits, etc. But all of that is extraneous for the operations we chose.

Adding in the Instance Variables & Constructor

```
public class BankAccount {
    public double balance; // public for now (bad), but will change!
    public BankAccount(double startingAmount) {
        // TODO
    }
    public double checkBalance() {
        return 0.0; // TODO
    }

    public void deposit(double amount) {
        // TODO
    }

    public void withdraw(double amount) {
        // TODO
    }
}
```

Implementing the Class: a First Pass

Now we can move to implement our methods!

- An important first step is to formalize the requirements by writing some kind of **tests**.
  - unit tests or just rudimentary `main` method tests are both OK
- Writing the tests first requires us to understand what the **expected** behavior should be before we implement the method.
  - Pretty important to know what you intend to do before doing it!
  - (Yes, the tests will fail at first because there is no implementation.)

Writing a User Story Test

A **user story** is a narrativized description of how a user will use the program you're writing.

> "Customers should be able to create a new Bank Account with an initial deposit of $10. They should be able to deposit $20 and see the change reflected in the account afterwards."

Writing a User Story Test (in `main`)

```
public static void main(String[] args) {
    BankAccount harrysAccount = new BankAccount(10.0);
    double startingBalance = harrysAccount.getBalance();
    System.out.println("Harry's new account has a balance of " + startingBalance);
    System.out.println("(Balance should be $10)");

    harrysAccount.deposit(20);
    double newBalance = harrysAccount.getBalance();
    System.out.println("Harry's account has a balance of " + newBalance);
    System.out.println("(Balance should be $30)");
}
```

Writing a User Story Test (in JUnit)

```
@Test
public void testUserStoryOne() {
    BankAccount harrysAccount = new BankAccount(10.0);
    double actualBalance = harrysAccount.getBalance();
    double expectedBalance = 10
    assertEquals(expectedBalance, actualBalance, 0.01);

    harrysAccount.deposit(20);
    actualBalance = harrysAccount.getBalance();
    expectedBalance = 30;
    assertEquals(expectedBalance, actualBalance, 0.01);
}
```

JUnit requires that double comparisons are made with a "DELTA" value that represents an error tolerance.

Other Potential Stories to Test

"Customers should be able to create a new Bank Account with an initial deposit of $10. They should be able to withdraw $3, leaving a balance of $7."

"Customers should be able to create a new Bank Account with an initial deposit of $10. They may attempt to withdraw an amount greater than their balance, but this attempt should have no effect"

"Customers should be able to attempt to withdraw or deposit a negative amount, but these attempts should have no effect on their account balances"

```java
@Test
public void testUserStoryTwo() {
    BankAccount harrysAccount = new BankAccount(10.0);
    harrysAccount.withdraw(3);
    double actualBalance = harrysAccount.getBalance();
    double expectedBalance = 7;
    assertEquals(expectedBalance, actualBalance, 0.01);
}

@Test
public void testUserStoryThree() {
    BankAccount harrysAccount = new BankAccount(10.0);
    harrysAccount.withdraw(11);
    double actualBalance = harrysAccount.getBalance();
    double expectedBalance = 10;
    assertEquals(expectedBalance, actualBalance, 0.01);
}
```

```java
@Test
public void testUserStoryFour() {
    BankAccount harrysAccount = new BankAccount(10.0);
    harrysAccount.withdraw(-3);
    double actualBalance = harrysAccount.getBalance();
    double expectedBalance = 10;
    assertEquals(expectedBalance, actualBalance, 0.01);

    harrysAccount.deposit(-1000);
    actualBalance = harrysAccount.getBalance();
    expectedBalance = 10;
    assertEquals(expectedBalance, actualBalance, 0.01);
}
```

Writing Methods

```
public class BankAccount {
    public double balance; // public for now (bad), but will change!
    public BankAccount(double startingAmount) {
        if (startingAmount < 0) {
            balance = 0;
        } else {
            balance = startingAmount;
        }
    }
    public double checkBalance() {
        return balance
    }

    ...
}
```

Writing Methods

```
public class BankAccount {
    ...

    public void deposit(double amount) {
        if (amount < 0) {
            return;
        }
        balance += amount;
    }

    public void withdraw(double amount) {
        if (amount < 0 || amount > balance) {
            return;
        }
        balance -= amount;
    }
}
```

Encapsulation

Encapsulation refers to the process of hiding the data from the user and using methods to provide data access.

Why is this important?

```
public static void main(String[] args) {
    BankAccount harrysAccount = new BankAccount(10);
    BankAccount enemysAccount = new BankAccount(100);
    harrysAccount.balance = 10000000000
    enemysAccount.balance = -999999999
}
```

Public Instance Variables Violate Encapsulation

Make instance variables private in order to regulate access to important information!

Write getters & setters & other public methods that allow mediated access.

```
public static void main(String[] args) {
    BankAccount harrysAccount = new BankAccount(100);
    harrysAccount.withdraw(999999999); // refused!
}
```

Saved by a public method!

The Public Interface

An **interface** between two objects is the point at which they meet and interact.

- In Java, we'll see that the word has another meaning later

A class' **public interface** refers to the sum of all public instance variables and methods that can be interacted with in other classes.

- Effective class design exposes all necessary behaviors in the public interface
- Poor class design exposes unnecessary methods and sensitive data

```
te boolean isInvalidAmount(double amount) {
    return amount < 0;
}
```

Keep helper methods private!

- These are not intended for outside use, so nobody will miss them when using your object
- More public methods → more clutter for people trying to understand your classes---

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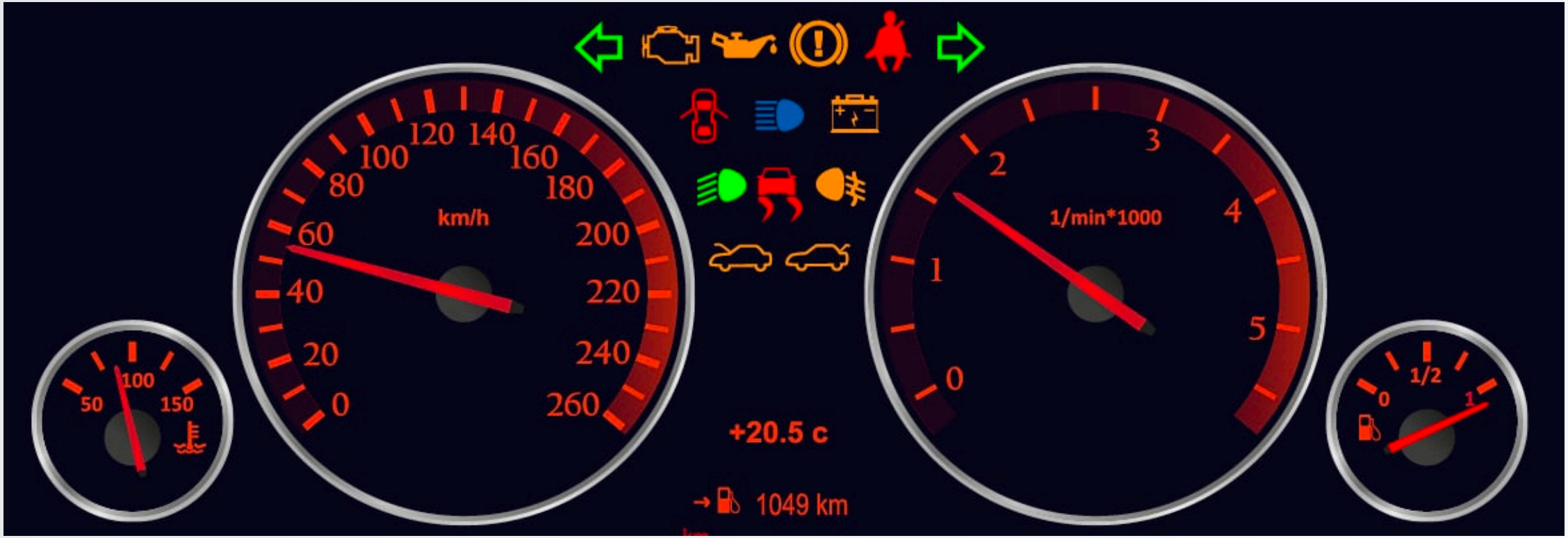

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Helper Methods & Public Interface

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