# CH. 2 OBJECT-ORIENTED PROGRAMMING

ACKNOWLEDGEMENT: THESE SLIDES ARE ADAPTED FROM SLIDES PROVIDED WITH DATA STRUCTURES AND ALGORITHMS IN JAVA, GOODRICH, TAMASSIA AND GOLDWASSER (WILEY 2016)

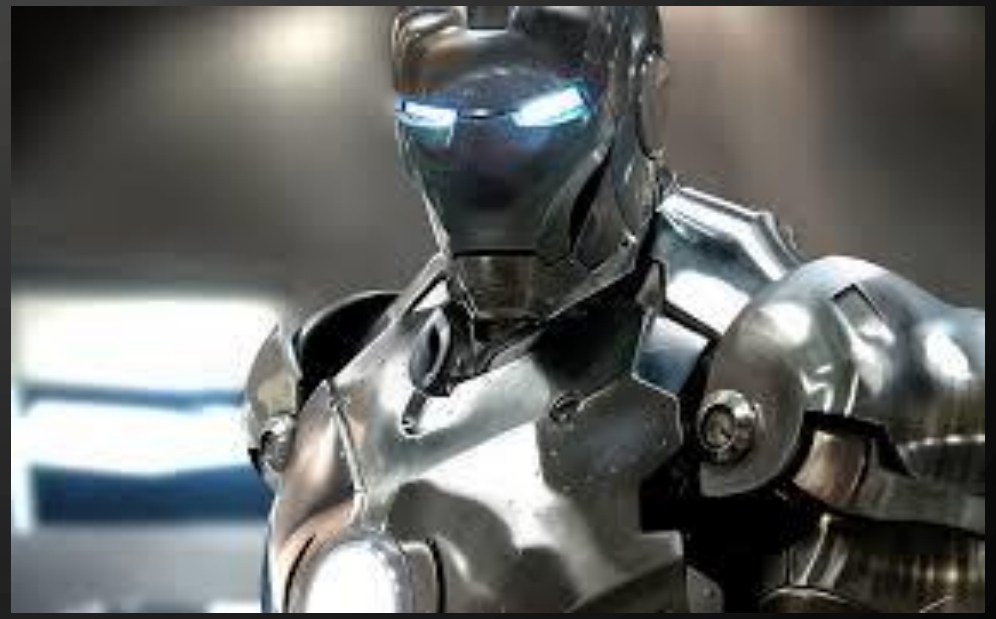
# INTERFACES

# INTERFACES AND ABSTRACT CLASSES

- The main structural element in Java that enforces an application programming interface (API) is an interface.
- An **interface** is a collection of method declarations with no data and no bodies.
- Interfaces do not have constructors and they cannot be directly instantiated.
  - When a class **implements** an interface, it must implement all of the methods declared in the interface.
- An abstract class also cannot be instantiated, but it can define one or more common methods that all implementations of the abstraction will have.

# INTERFACE EXAMPLE

```
1.public interface Robot {
2.    void sense(World w);
3.    void plan();
4.    void act(World w);
5.}
```



# USE IMPLEMENTS TO ENFORCE THE INTERFACE

```
1. public class Roomba implements Robot {
2.   /* code specific to Roomba */
3.   public void sense(World w) {/* Roomba's don't sense */}
4.   public void plan() {/* code for Roomba's actions */}
5.   public void act(World w) {/* code to power motors */}
6.   /* code specific to Roomba */
7. }
```

# ENFORCES?

- In this context, enforce means required by the compiler. A good example is sorting algorithms. In order to sort two things must be comparable. So Java offers a comparable interface so that your own objects can fit into this framework.
- Interfaces are also an example of inheritance. They are "weakly" inherited by implementing classes. So the rules of polymorphism also apply, i.e., an object can be converted to a variable of the interface:

```
Robot r = new Roomba();
```

# GENERIC PROGRAMMING

JAVA GENERICS

# GENERIC PROGRAMMING

- **Generic Programming** is a programming paradigm where the programmer programs interfaces and algorithms without a specific object hierarchy in mind. Rather the programmer only worries about operations (methods) needed to support an interface or perform an algorithm

# HOW DO WE PROGRAM GENERICALLY?

1. Convert things to raw memory, after all it is all 0's and 1's to the computer
2. Inheritance/polymorphism – Treat everything as an Object, or use very deep class hierarchies in combination with polymorphism
3. Generics/templates – A programming technique where we program without any specific type. Then when we instantiate a generic class/function the types becomes known

- (1) is outdated and for pure C programming (2) is done with polymorphism and (3) is done with **Java Generics**
- In all honesty though, we use (2) and (3) in combination.

# SYNTAX FOR GENERIC OBJECTS

- Types can be declared using generic names:

```
1.public class Array<E> {
2.   private E e[];
3.   /* Rest of class */
4.}
```

- They are then instantiated using actual types:
  - `Array<String> arr = new Array<>();`
- There is not much to it actually, but it is a very strange thought process that you do not know what E is as you write it.

# GENERIC OBJECTS

- You may have one or more generic types. This class, we will have at most two
  - `public class Map<Key, Value> { }`
  - `Map<Integer, String>`
- **Generic types must be Java Objects**, so you can use any class that inherits from Java Object, i.e., unfortunately you have to use **`Integer`** or **`Float`** instead of `int` or `float`.
- Many other quirks and oddities that will be experienced as we go!
- All code examples in the book and programming assignments involve this form of programming actually.

# GENERIC FUNCTIONS

- Can also be used in functions:

```
1.public static <T, S> String concat(T t, S s) {
2.   return t.toString() + s.toString();
3.}
```

- Used like:

```
1.MyObject1 a;
2.MyObject2 b;
3.String c = concat(a, b);
```

# JAVA GENERICS
## ADVANCED

- We can specify constraints on the generic parameters through interfaces to only accept certain types in generic classes/functions

```
public <T extends Comparable<T>> int compareTwo(T a, T b) {
   return a.compareTo(b); // Comparable<T> enforces
                          // having the compareTo function
}
```

- **extends** is always used, it generally refers to **extends** or **implements** in this context

# EXERCISE

- With your team. Create a generic interface called **`Addable`** with one function `add`
- Create two classes that implement **`Addable`**: **`MyString`** and **`Point`**.
  - `MyString` owns a single string and uses concatenation for adding
  - `Point` should be a 2D point in the Cartesian plane. Adding will be the sum of components.
- Create a generic function `sum` that sums an array of **`Addable`** objects
- Test your function in `main` with both random **`MyString`**s and **`Point`**s