Day 5

COMP1006/1406

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today's agenda

- assignments
  - Assignment 2 is in
  - Assignment 3 is out
- a quick look back
  - inheritance and polymorphism
- interfaces
  - the `Comparable` interface
- Problem solving
- assignments

last time...

inheritance allows us to reduce duplicate code by sharing code among different classes

- when we `extend` a class we inherit all public/protected attributes and methods from that class
- we can only have one direct parent class (except Object which has no parent)

polymorphism - having multiple forms

- we have seen three kinds of polymorphism
  - method overloading
  - method overriding
  - subtype polymorphism

interfaces

let's first review **abstract classes** in Java

```
public abstract class Insect{
   ...
}
```

- related classes `extend` the same `abstract` class
  - similar (general) behaviour is implemented in the abstract class itself
  - different (specific) behaviour is implemented in overridden methods
- you can only `extend` one single class (abstract or not)
- abstract class can provide a contract between code and users of code
- the abstract class defines what an object **is**
  - name is usually a noun

interfaces

an **interface** in Java is **similar** to an abstract class

```
public iterface Printable{
    ...
}
```

- are valid reference data types
- cannot be instantiated
- intention is for other classes to **implement** it (using `implements`)
  - `public class A extends Q implements B{...}`
  - `public class A implements B{...}`
  - A **is-a** B
- provides a contract between code and users of code

interfaces

an **interface** in Java is **different** from abstract classes

```
public iterface Printable{
   ...
}
```

- classes that implement an interface can be very unrelated
- a class an **implement** any number of interfaces (using `implements`)
  - `public class A extends Q implements B,C,D{...}`
  - A **is-a** B and A **is-a** C and A **is-a** D (and A **is-a** Q)
  - no implicit interface implemented
- interfaces usually define what an object **can do**
  - name is usually an adjective (Comparable, Serielizable)
  - can also define what you are (List, Set) but doesn't specify the data

interfaces

```
public iterface Printable{

   int     MAX_NUM_JOBS = 99;     // constant

   boolean sendToPrint(String);   // abstract
   boolean killPrintJob(int);     // methods

}
```

- can contain abstract method declarations (without definition)
  - are `public` by default (you can omit this)
  - implicitly `abstract` (you do not write this)
- can contain constant class attributes
  - are `public static final` by default (can omit this)
- can have `default` methods and `static` methods (these have definitions) and `enum` types

Comparable

consider the Comparable interface

```
public interface Comparable<Type>{
   int compareTo(Type other);
     // returns an integer X satisfying
     //   X < 0 if this is "less than" other
     //   X = 0 if this is "equal to" other
     //   X > 0 if this is "greater than" other
}
```

- declared like a class, using interface instead
- has a single method called compareTo()
  - by default all methods are public abstract
- uses generics (we'll revisit this in more detail later)
  - allows us to treat types as parameters <type>
  - specifies exactly what we can compare our objects with
  - avoids the messiness we saw with String's equals()

Comparable

using the `Comparable` interface

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

```
public class MyClass implements Comparable<MyClass>{...
```

- class that `implements` the `Comparable` interface either
  - must override (define) the method `compareTo`, or
  - must be `abstract`

```
public interface SomeInterface extends Comparable<T>{...
```

- interfaces can `extends` any number of other interfaces

Comparable

```
public class Student implements Comparable<Student>{
  private String name;
  private int    id;

  @Override
  public static int compareTo(Student other){
     if(other == null){
        return 1;
     }
     return this.getID() - other.getID();
  }

  ...

}
```

```
Student s = new Student("cat", 12);
Student t = new Student("dog", 7);
System.out.println( s.compareTo(t) );
```

Comparable

```
public class Student implements Comparable<Student>{
  private String  name;
  private Integer id;

  @Override
  public static int compareTo(Student other){
     if(other == null){
        return 1;
     }

     /* use built-in compareTo of other objects to help us */
     return this.getID().compareTo(other.getID());
  }

  ...

}
```

```
Student s = new Student("cat", new Integer(-32));
Student t = new Student("dog", new Integer(15));
System.out.println( s.compareTo(t) );
```

example

The `Arrays` class provides static methods to help work with arrays.

toString(...) prints an array nicely (like Python)

```
House[] houses = new House[3]{ ... };
System.out.println(java.util.Arrays.toString(houses));
```

sort(...) sorts the elements in an array

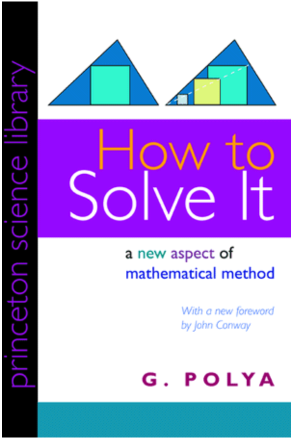
```
java.util.Arrays.sort(houses);
System.out.println(java.util.Arrays.toString(houses));
```

let's take a break...
for 3 minutes

Problem Solving

George Pólya

- How to Solve it
- Terminology: data, unknown, condition



Problem Solving

Using the given **data** to find the **unknown** such that the **condition** is satisfied.

- the data is the information you have.
- the unknown is the information you want.
- the condition is the constraints on the problem.
  These are rules (often implicit) that must be followed.

Alternatively...

Using the given **data** to achieve a **goal** such that the **condition** is satisfied.

Using the given **data** to create an **algorithm/program** that achieves a **goal** such that the **constraints** are satisfied.

Problem Solving

The four phases of problem solving

1. Understand the problem.
    - identify the data/unknown/condition
2. Devise a plan.
    - choose a technique/heuristic/approach
    - start over if needed
3. Carry out the plan.
    - execute your plan
    - check each step
    - start over if needed
4. Look back.
    - reflect on what you did
    - start over if needed

Problem Solving

General strategies

- Related problems
  - transform the problem into one you already know how to solve
- Abstraction
  - remove details that are not relevant to the problem
- Divide and Conquer
  - break the problem into (smaller) sub-problems
- Backward Chaining
  - start from the solution and work backwards

Problem Solving

General strategies (from Think Like a Programmer, V. A. Spraul)

- Always have a plan
- Restate the problem
- Break the problem down
- Start with what you know
- Reduce the problem
- Look for analogies
- Experiment
- Don't get frustrated!

Problem Solving

General strategies (from Think Like a Programmer, V. A. Spraul)

- Always have a plan
  - Aimless wandering wastes time.
  - Without a plan, you are hoping for a lucky break.
  - Plans give you intermediate goals.
  - Plans can change.
- Restate the problem
  - Check out the problem from every angle before starting.
  - We may find the goal is not what we thought.
  - Use restatement to confirm understanding.
- Break the problem down
  - Divide the problem into steps or phases.
  - Difficulty for each phase can be an order of magnitude lower.
  - Sometimes the sub-problems are hidden.

Problem Solving

General strategies (from Think Like a Programmer, V. A. Spraul)

- Start with what you know
  - Fully investigate a problem with the skills you have first.
  - Build confidence and momentum towards your goal.
  - You may learn more about the problem this way.
- Reduce the problem
  - Reduce scope by adding or removing constraints.
  - Work on a simpler problem that isn't easily divided.
  - Pinpoint where remaining difficulties lie.
- Look for analogies
  - Look for similarities to problems you've already solved.
  - Recognizing analogies improves speed and skill.
  - You need to build up a store of prior problems before you can find analogies.

Problem Solving

General strategies (from Think Like a Programmer, V. A. Spraul)

- Experiment
  - Try things and observe the results (this is not guessing!).
  - Trial-and-error is a valid approach to problem solving (not to be confused with guessing)
  - Make small test programs.
- Don't get frustrated
  - Everything will seem to take longer and be harder!
  - Avoiding frustration is a decision you make.
  - Go back to the plan, work on a different problem, or take a break.

Problem Solving

General strategies (from Think Like a Programmer, V. A. Spraul)

- Experiment
  - Try things and observe the results (this is not guessing!).
  - Trial-and-error is a valid approach to problem solving (not to be confused with guessing)
  - Make small test programs.
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  - Everything will seem to take
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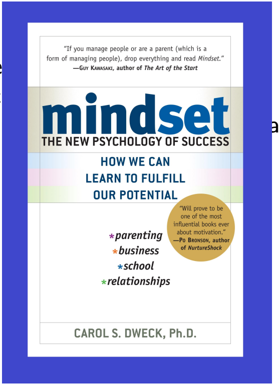
  - Go back to the plan, work o ake a break.



reflection...

Questions to ask yourself about assignment 1

- did I understand the questions?
  - what was given?
  - what was needed to be done?
  - what were the constraints?
- did I test my code?
  - did I verify any given example code?
  - did I generate test cases to extensively test my code
- how did I try to get help if I didn't understand the questions?
- did I give myself enough time to complete the assignment?

let's take a break...
for 3 minutes

some review slides
(in progress)

abstract...

- **abstract methods**
  - a method declared without a definition
  - `public abstract int foo(String[] in);`
  - forces the class to be abstract as well
  - cannot be `final`
- **abstract classes**
  - cannot be instantiated
  - may or may not contain abstract methods
  - are valid reference types and can be subclassed
  - cannot be `final`
- **concrete classes**
  - all methods (declared or inherited) must be defined
  - can be instantiated (all objects other than arrays are instantiations of concrete classes)
  - is a valid data reference type

final...

- **final attributes**
  - value cannot be changed once it is defined
  - must be defined in constructor or initialization block
  - primitive data types, strings and immutable data types are **constants**
- **final methods**
  - cannot be overridden
  - cannot be `abstract`
- **final classes**
  - cannot be extended
  - cannot be `abstract`

access modifiers...

modifier	class	package	subclass	world
`public`	✓	✓	✓	✓
`protected`	✓	✓	✓	✗
none (default)	✓	✓	✗	✗
`private`	✓	✗	✗	✗

- everything is accessible from within the class
- a class in the same package has access to everything except private members
- a subclass has access to public and protected members
- everyone else only has access to public members

arrays...

an **array** is a container that store a collection of items of the same type

```
int[] intArray;               // variable declaration

intArray = new intArray[12];  // allocation of memory in heap for array

intArray[0] = 13;             //
...                           // population of the array with data
intArray[11] = 163;           //
```

When you declare an array variable you can also initialize it using `{...}`. This only works when you declare the variable.

```
/* array declaration, allocation and initialization */
int[] intArray = {1,3,5,7,9};

/* all of these are equivalent */
String[] words = {"cat", "dog", "eel"};
String[] words = new String[]{"cat", "dog", "eel"};
String[] words = new String[3]{"cat", "dog", "eel"};
```