Overview of Java's Support for Data & Control Abstraction

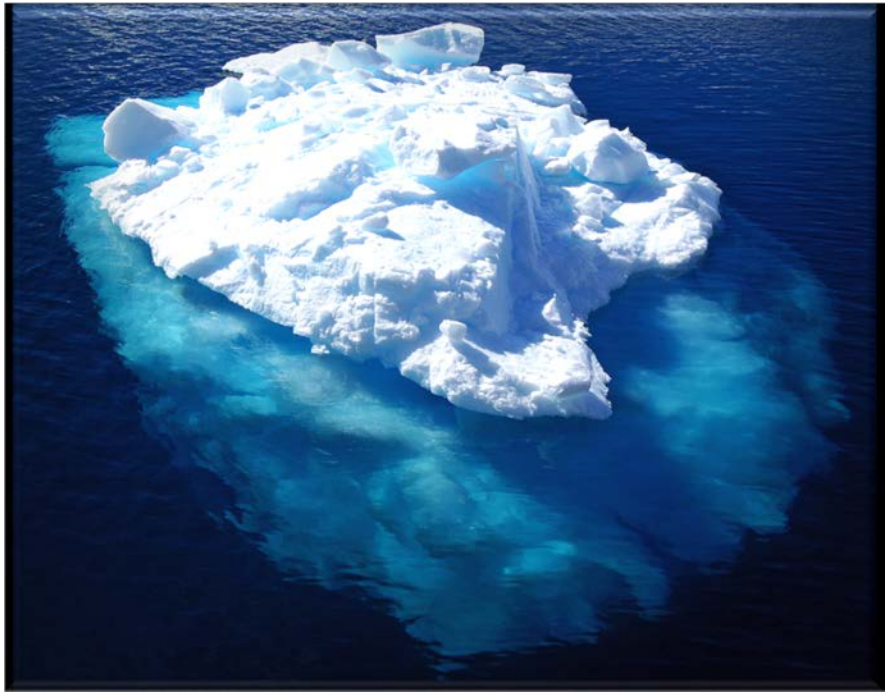
Douglas C. Schmidt
d.schmidt@vanderbilt.edu
www.dre.vanderbilt.edu/~schmidt

Professor of Computer Science

Institute for Software
Integrated Systems
Vanderbilt University
Nashville, Tennessee, USA

Learning Objectives in this Lesson

- Understand what the object-oriented (OO) concept of abstraction means



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- Know the benefits abstraction provides developers of Java apps in Android

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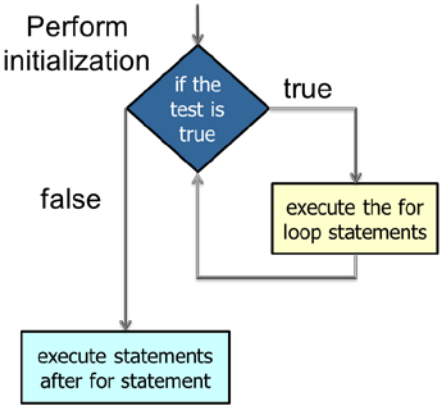
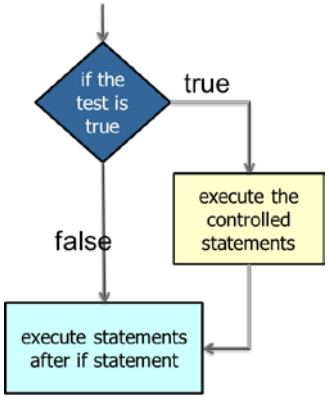
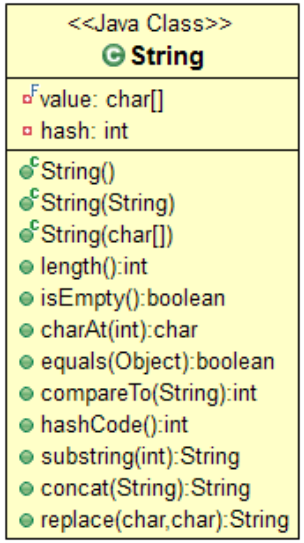
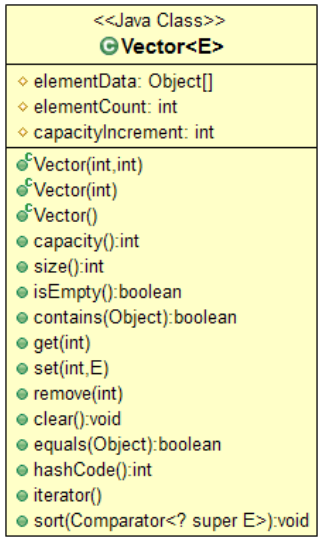
- Identify Java features that implement Java's data & control abstractions



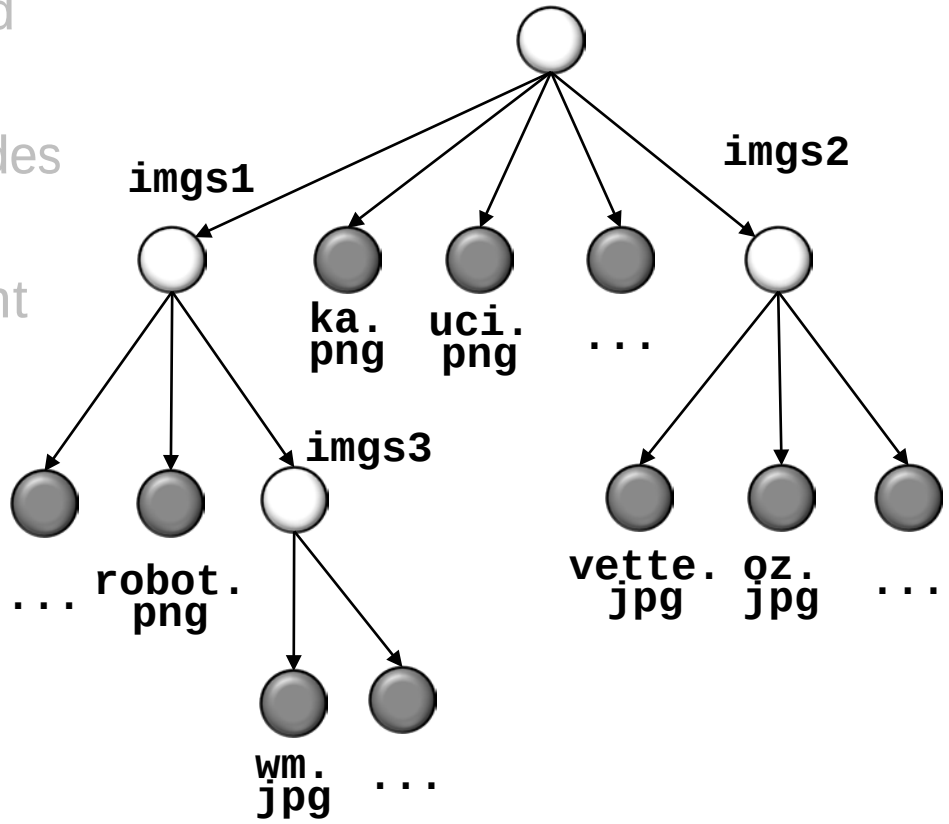






Learning Objectives in this Lesson

- Understand what the object-oriented (OO) concept of abstraction means
- Know the benefits abstraction provides developers of Java apps in Android
- Identify Java features that implement Java's data & control abstractions
- Recognize how to apply these abstractions to count the # of images accessed via a web page



See github.com/douglascraigschmidt/CS891/tree/master/ex/ImageCounter

Overview of Java's Support for Abstraction

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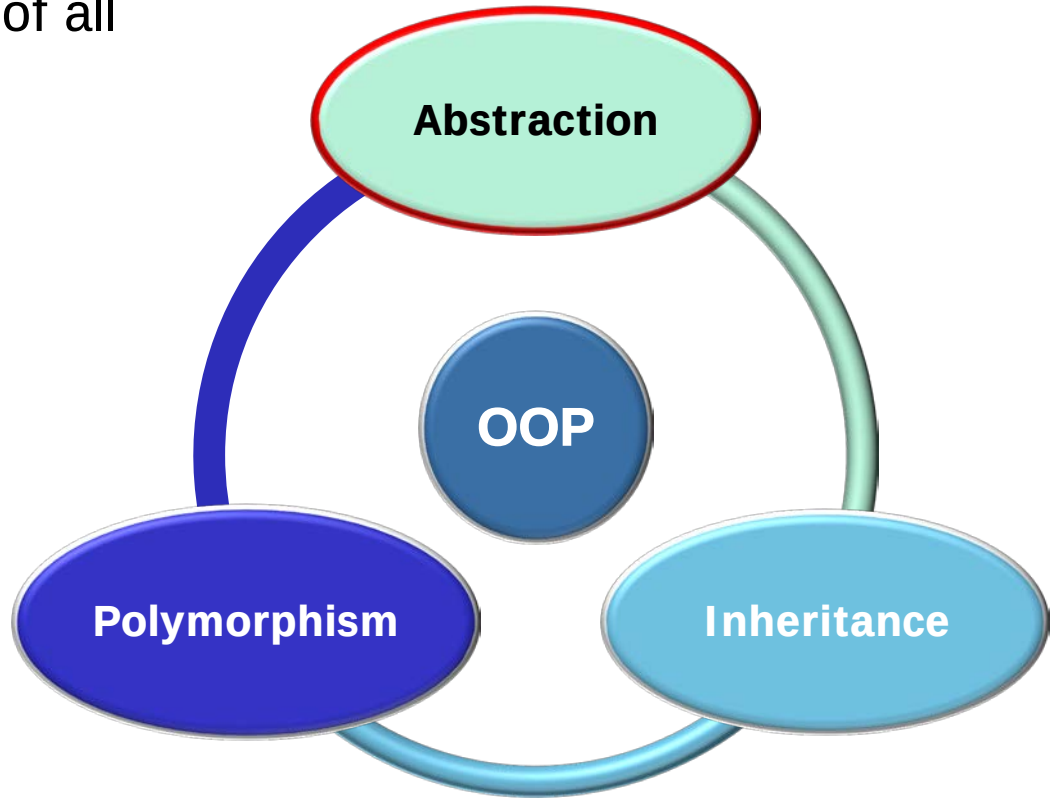
- Abstraction is an essential part of all object-oriented programming languages



See en.wikipedia.org/wiki/Abstraction_(computer_science)

Overview of Java's Support for Abstraction

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  - It emphasizes what's *important* &

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  - It emphasizes what's *important* &
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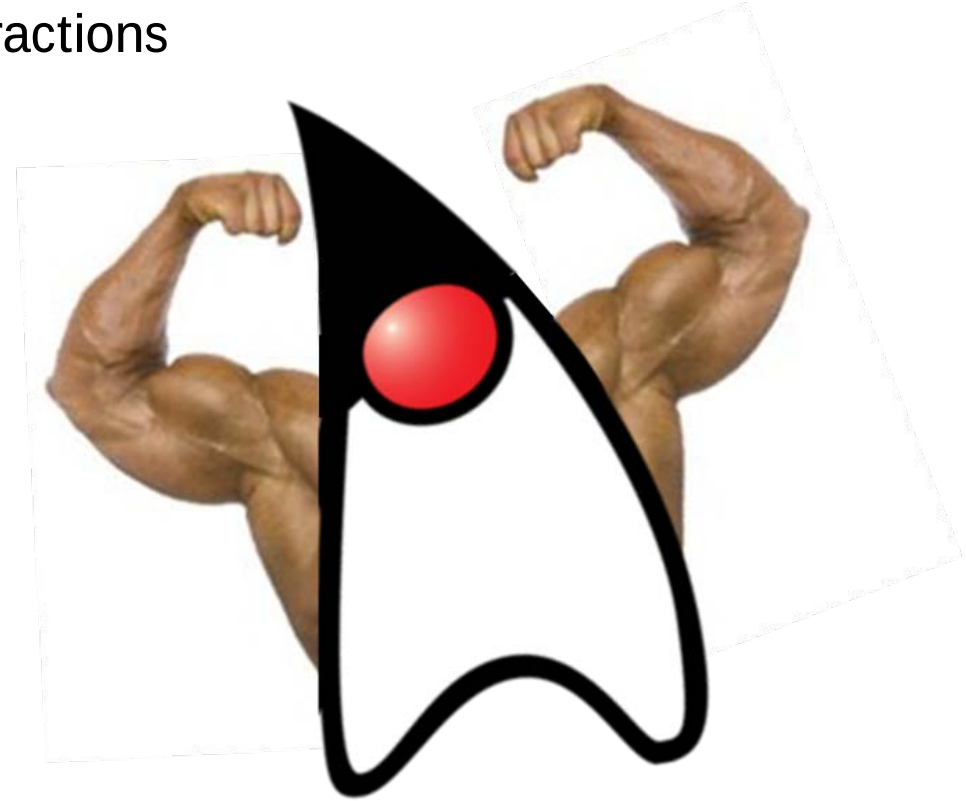
Overview of Java's Support for Abstraction

- Java supports many powerful abstractions



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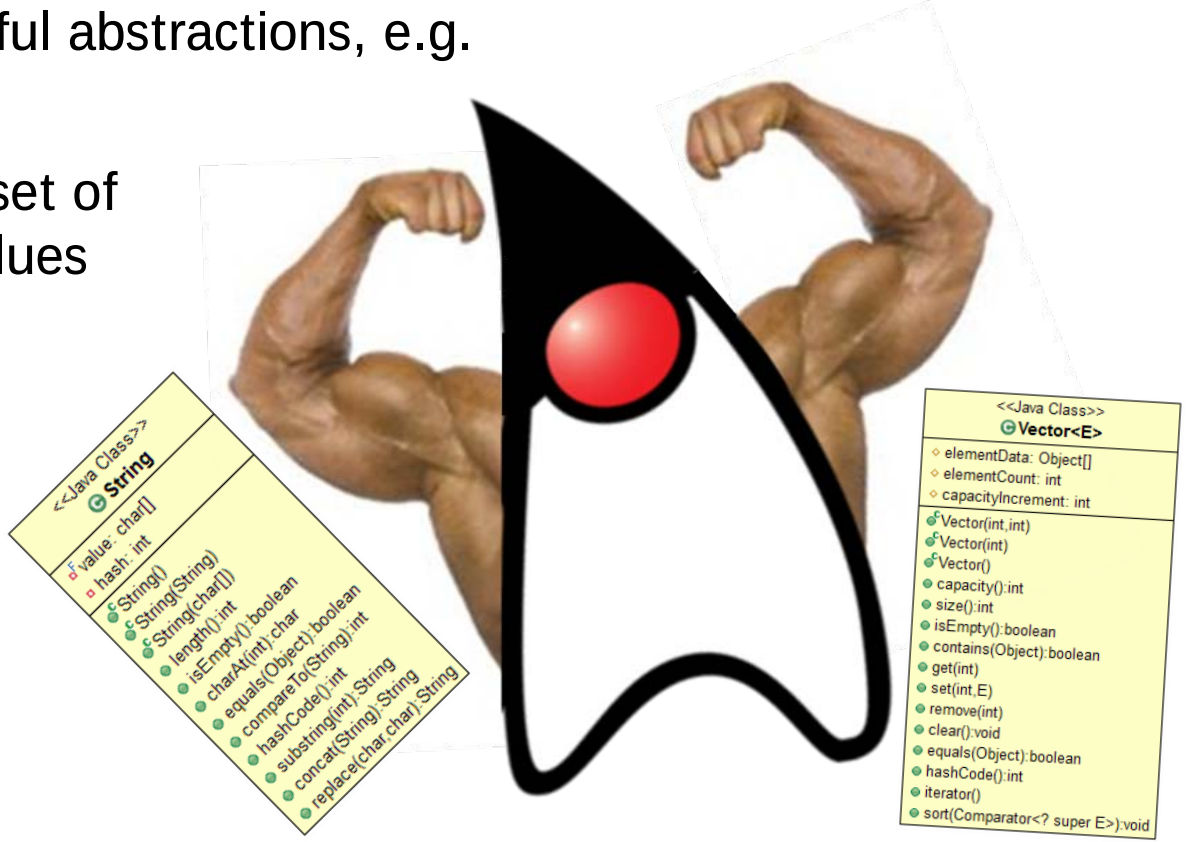
- Java supports many powerful abstractions, e.g.
  - Data abstractions
    - e.g., a set of values & set of operations on those values



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Data should only be accessed via APIs

See en.wikipedia.org/wiki/Application_programming_interface

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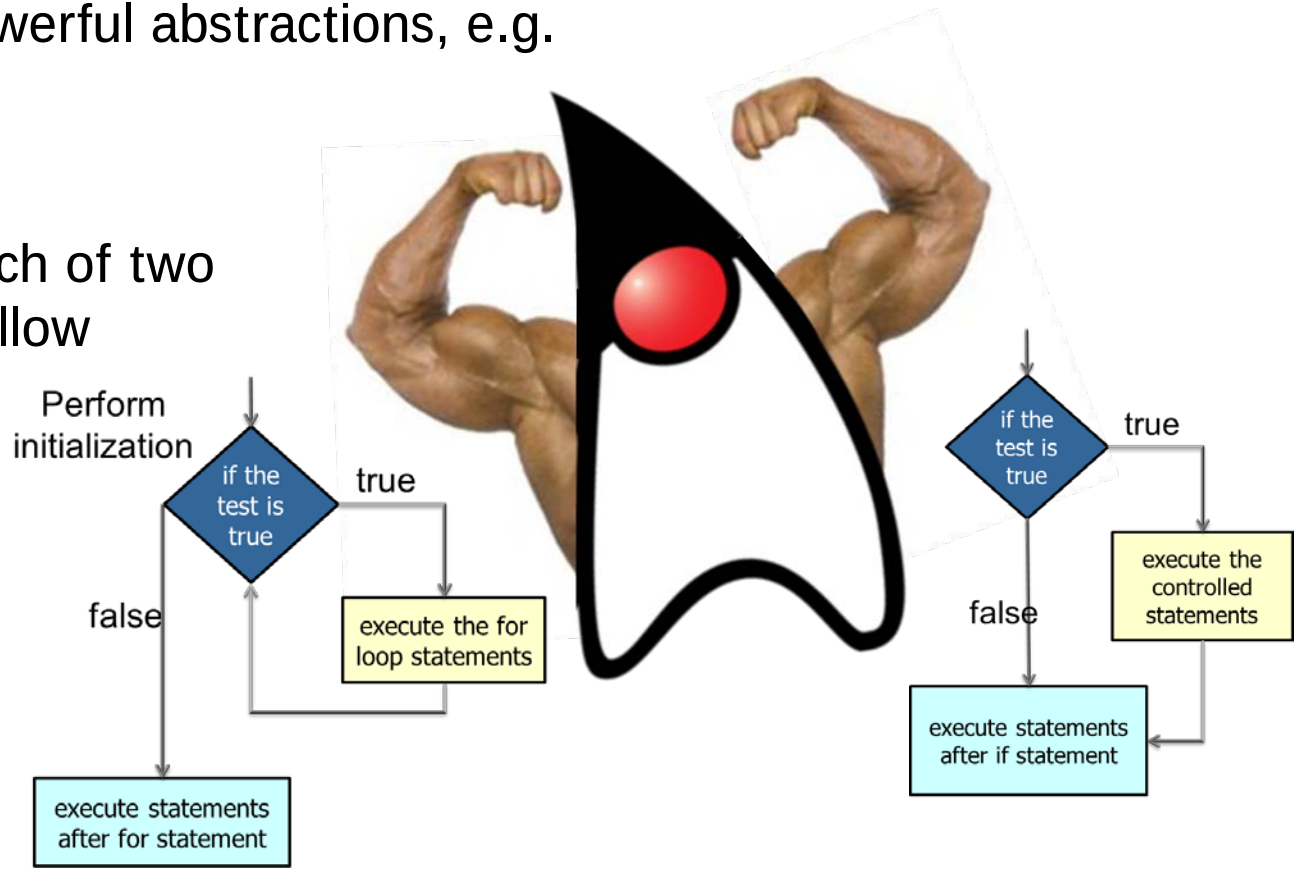
Data should only be accessed via APIs

The goal is to avoid "breaking" code when inevitable changes to data occur..

Overview of Java's Support for Abstraction

- Java supports many powerful abstractions, e.g.
  - Data abstractions
  - Control abstractions
    - e.g., determine which of two or more paths to follow



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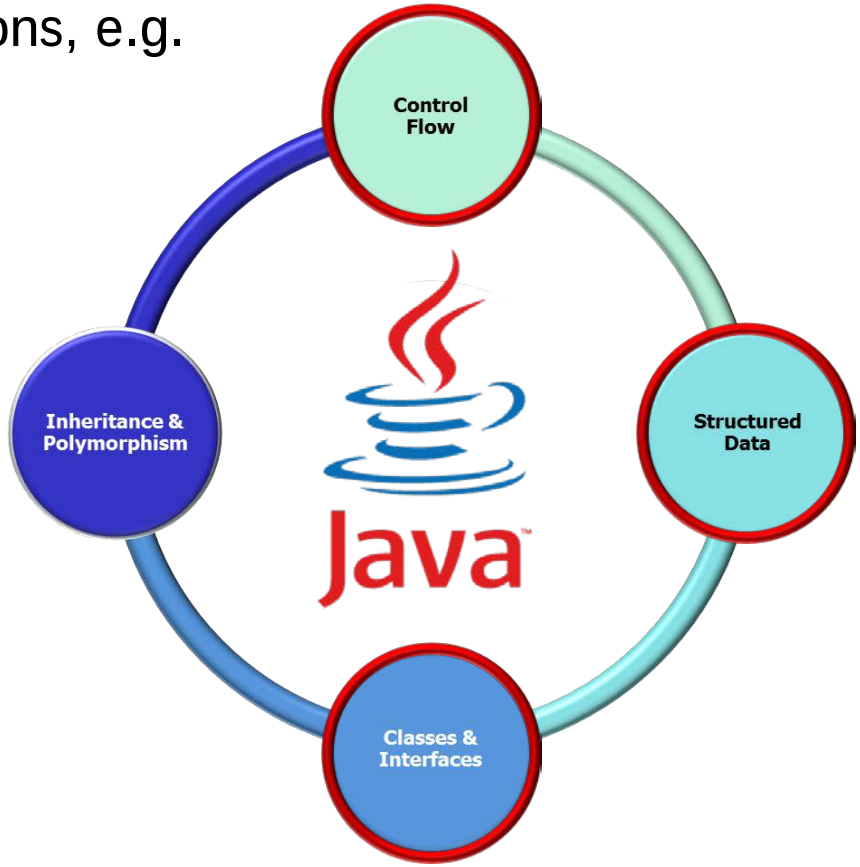

We'll now summarize various data & control abstractions supported by Java

Overview of the Image Counter Example

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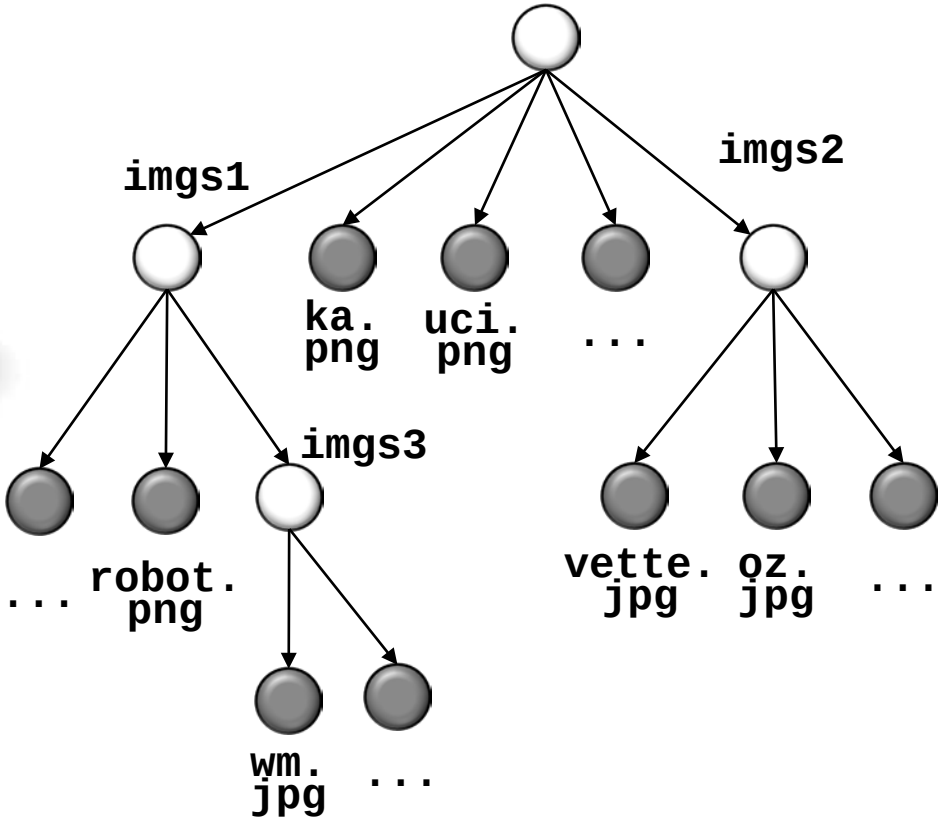
- We show how to apply key Java abstractions in the context of a program that crawls web pages recursively



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Overview of the Image Counter Example

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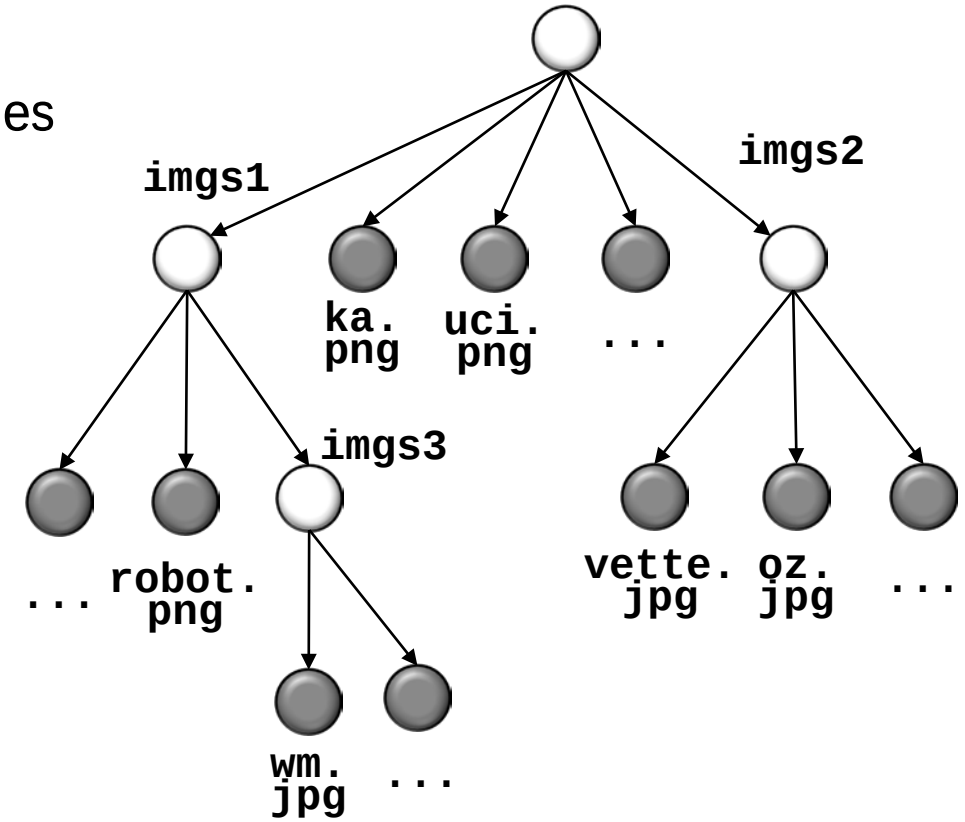
  - This program counts the # of images on each page

```
>> Depth: 1 [index.html](1)
>> Depth: 2 [imgs1/index.html](12)
>> Depth: 2 [imgs1/index.html](12)
Already processed imgs1/index.html
>> Depth: 2 [imgs2/index.html](12)
>> Depth: 3 [imgs3/index.html](13)
Exceeded max depth of 2
there are 21 total image(s)
reachable from index.html
```



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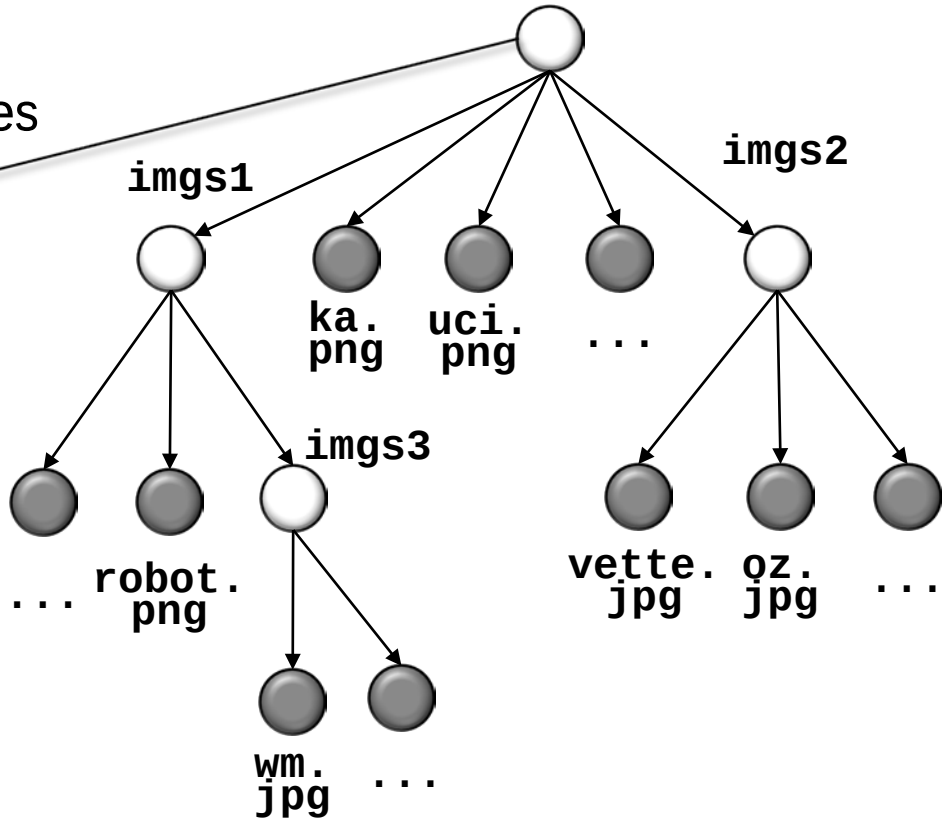
The root folder can either reside locally (filesystem-based) or be accessed remotely (web-based)



Overview of Java's Support for Data Abstraction

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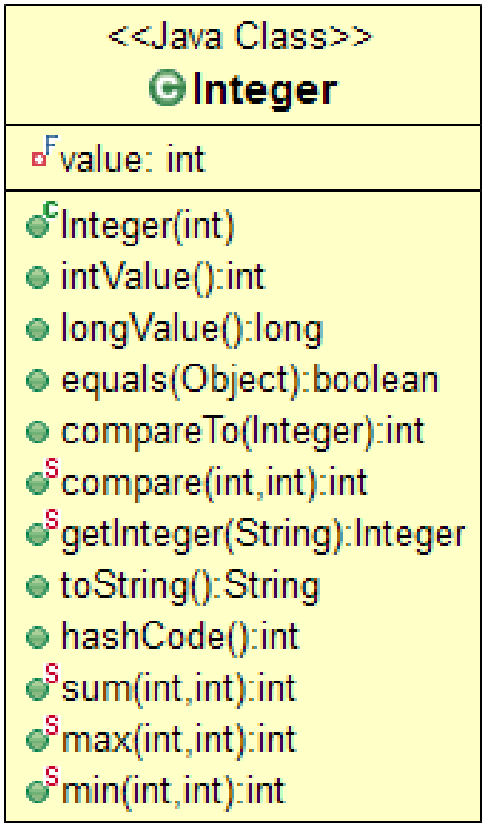
- Java supports data abstraction via Abstract Data Types (ADTs)



See en.wikipedia.org/wiki/Abstract_data_type

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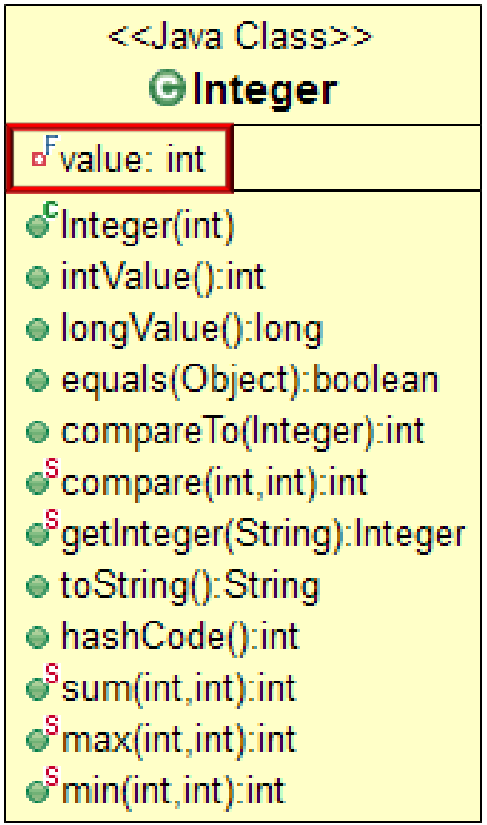

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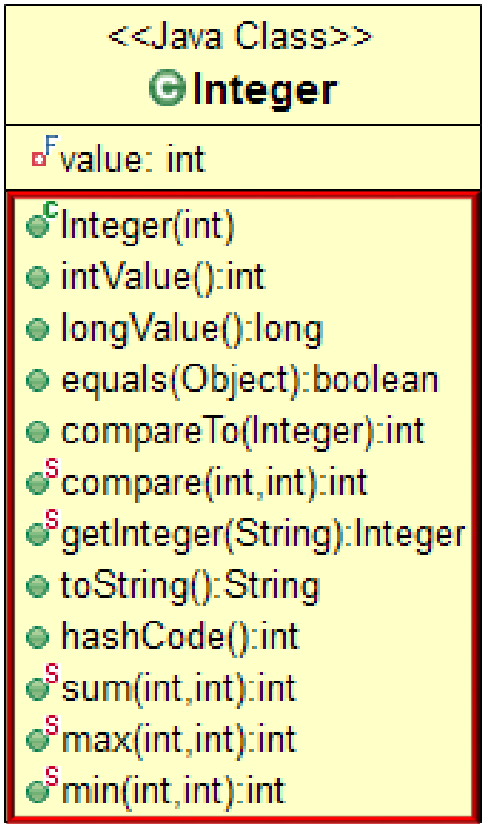

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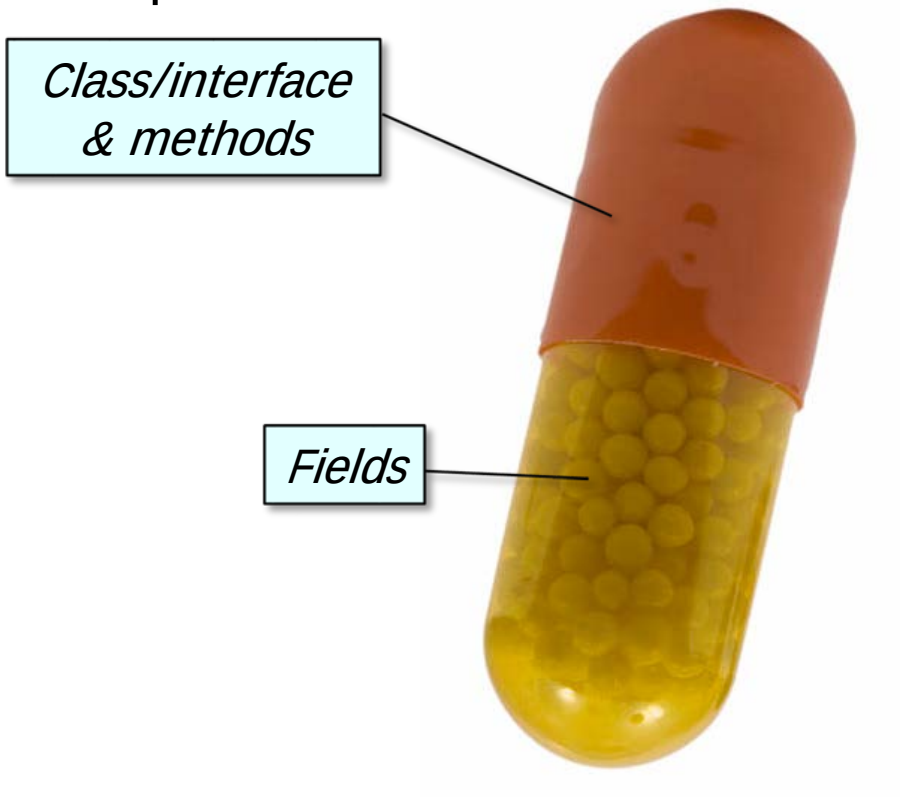
- At the heart of data abstraction is encapsulation



See en.wikipedia.org/wiki/Encapsulation_(computer_programming)

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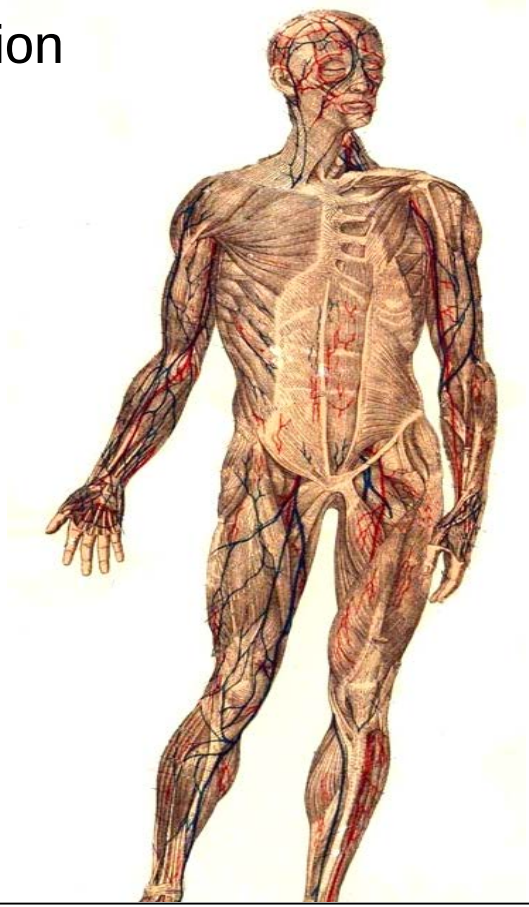

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Encapsulation protects a program from internal implementation changes

Overview of Java's Support for Classes & Interfaces

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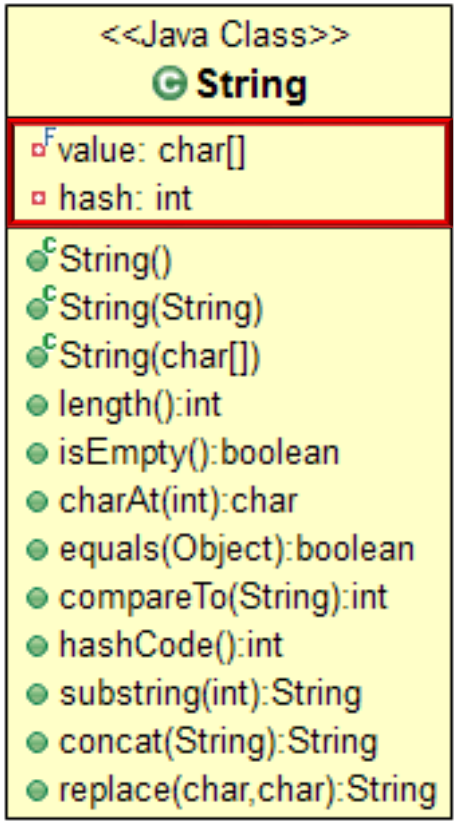
- Java classes provide a blueprint for creating objects

See docs.oracle.com/javase/tutorial/java/javaOO/classes.html

Overview of Java's Support for Classes & Interfaces

- Java classes may contain several entities
  - *Fields*
    - Used to store the state of an object



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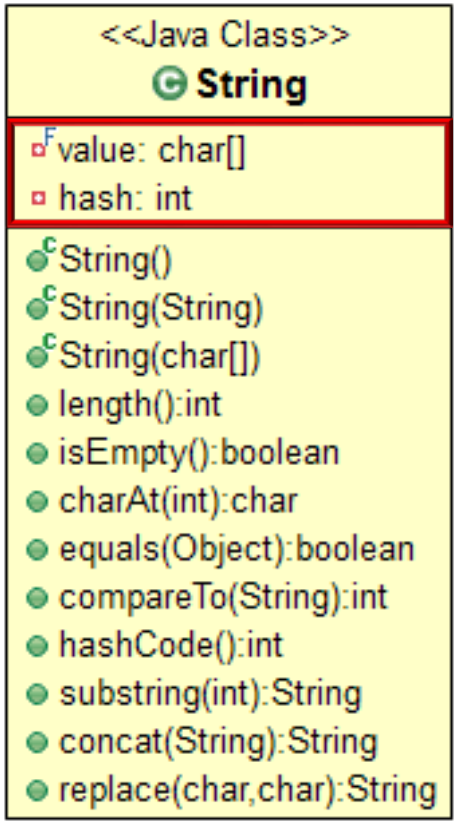
      - e.g., store a sequence of characters, length of this sequence, etc.



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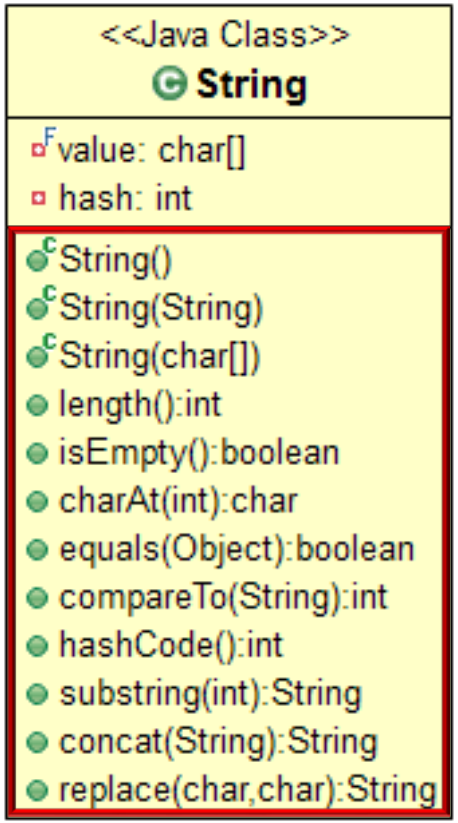

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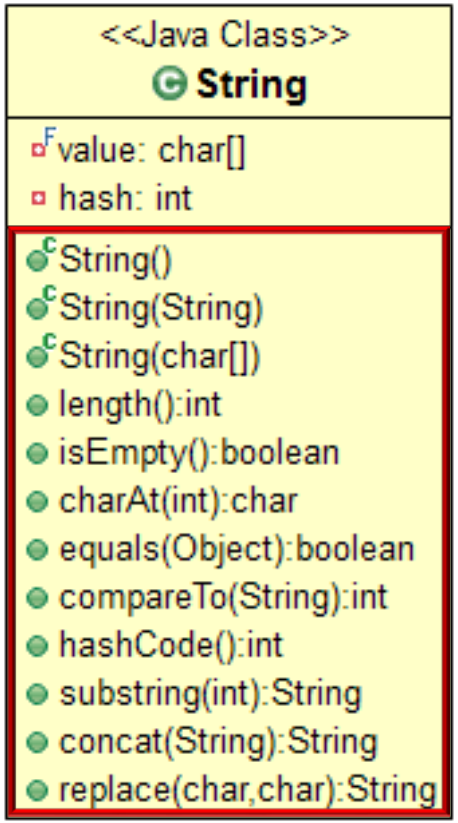
  - *Methods*
    - Used to implement the behaviors of an object
      - e.g., examine individual characters of the sequence, compare strings, search strings, extract substrings, create copies of a string, etc.



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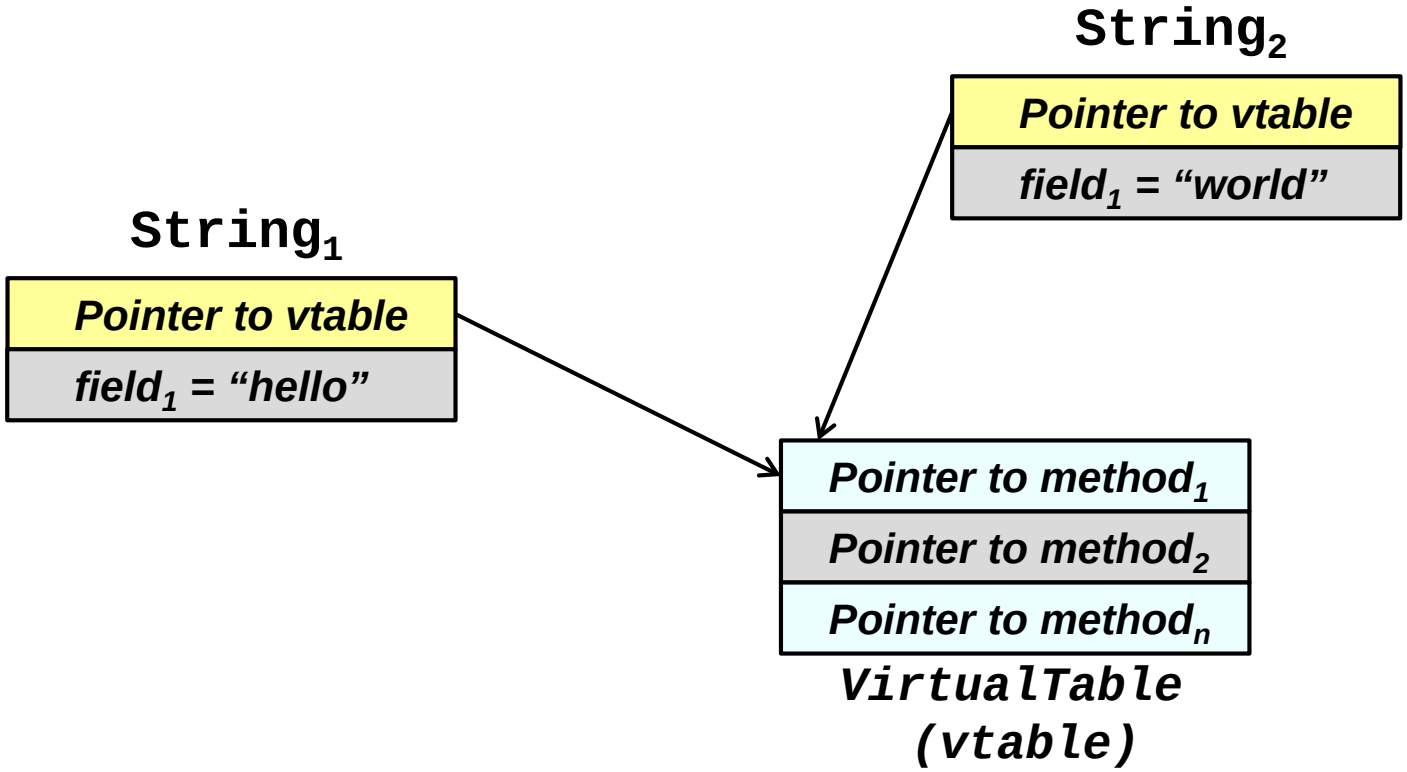
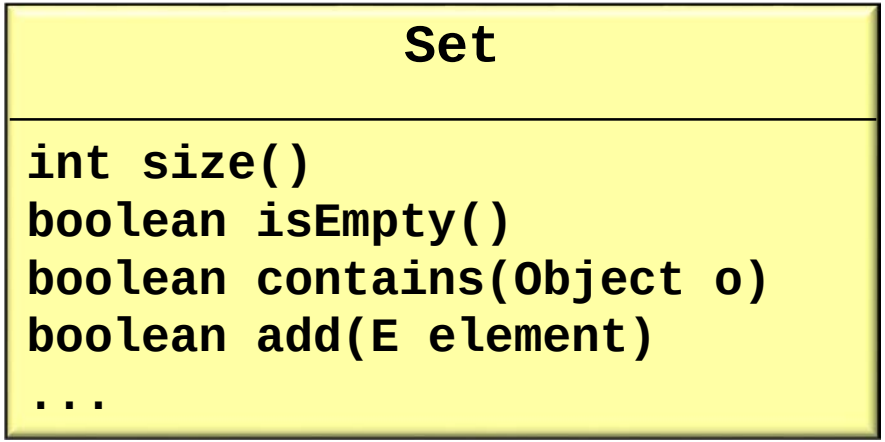
Overview of Java's Support for Classes & Interfaces

- Objects of same class share methods, but may store different values in fields



Overview of Java's Support for Classes & Interfaces

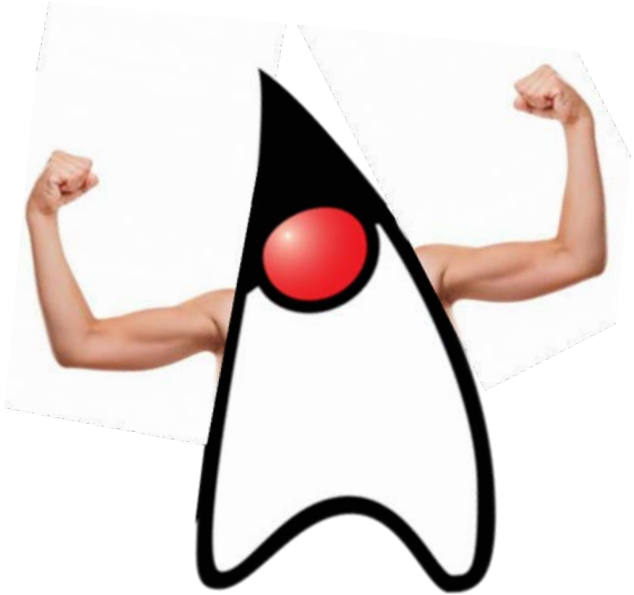
- Java interfaces define a contract specifying methods that classes implementing the interface provide



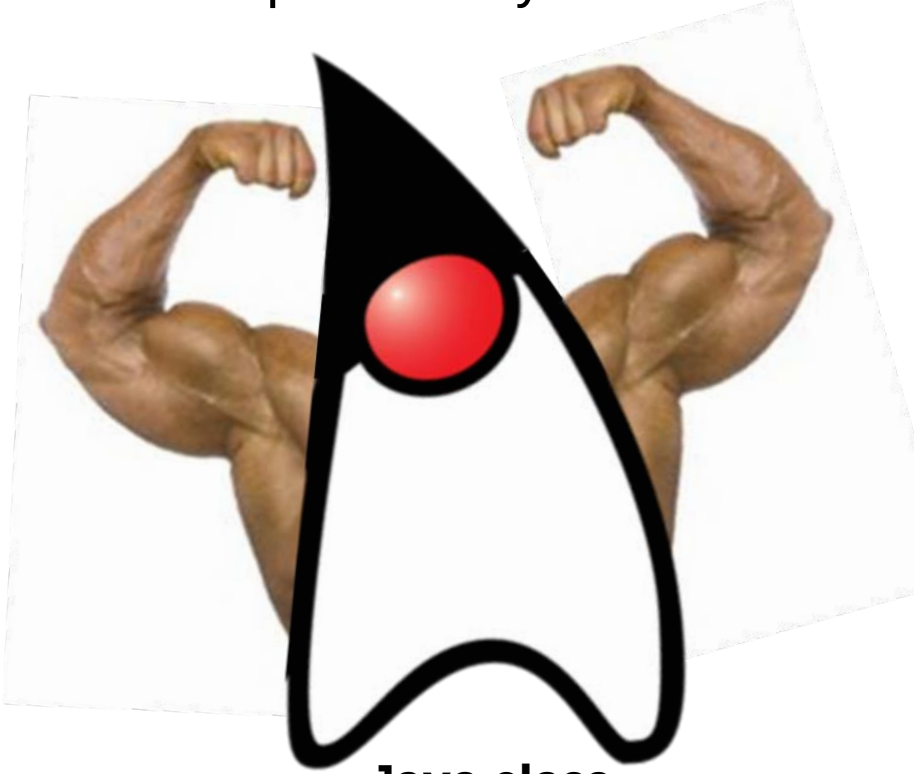
See docs.oracle.com/javase/tutorial/java/concepts/interface.html

Overview of Java's Support for Classes & Interfaces

- A Java interfaces provides a subset of the features provided by a Java class



Java interface



Java class

See www.tutorialspoint.com/java/java_interfaces.htm

Overview of Java's Support for Classes & Interfaces

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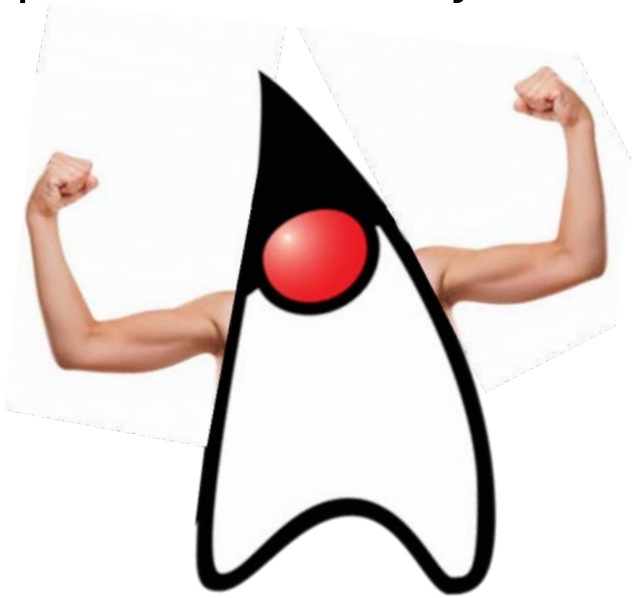
  - e.g., Java <= 7 interfaces have no method implementations, only method signatures



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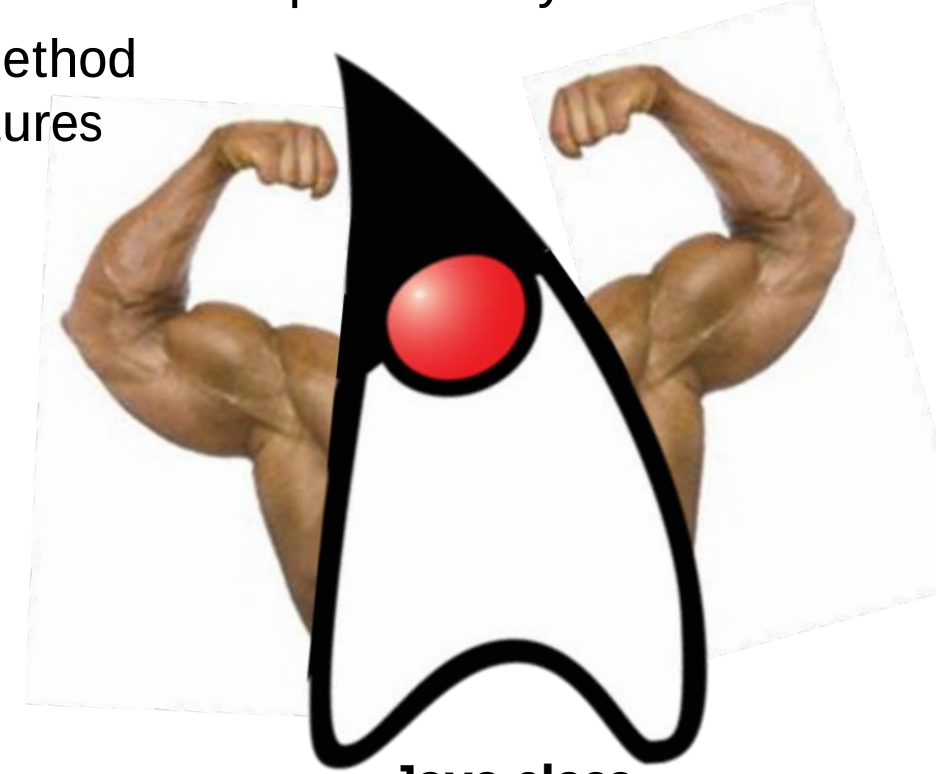

Java class

See en.wikipedia.org/wiki/Type_signature#Java_2

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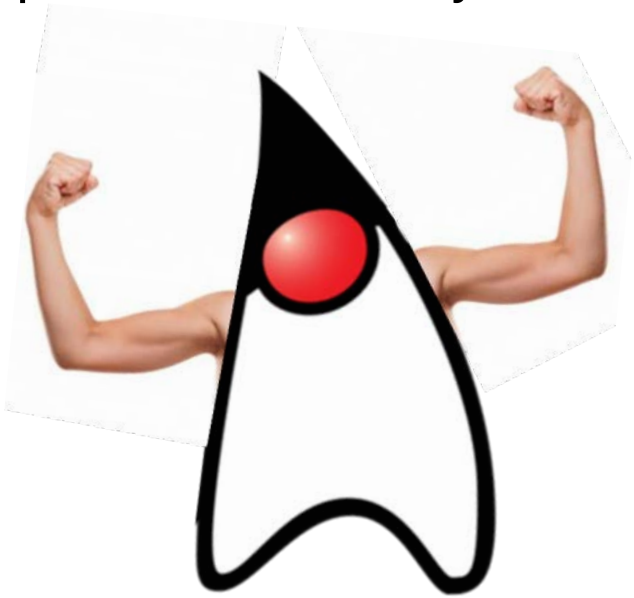

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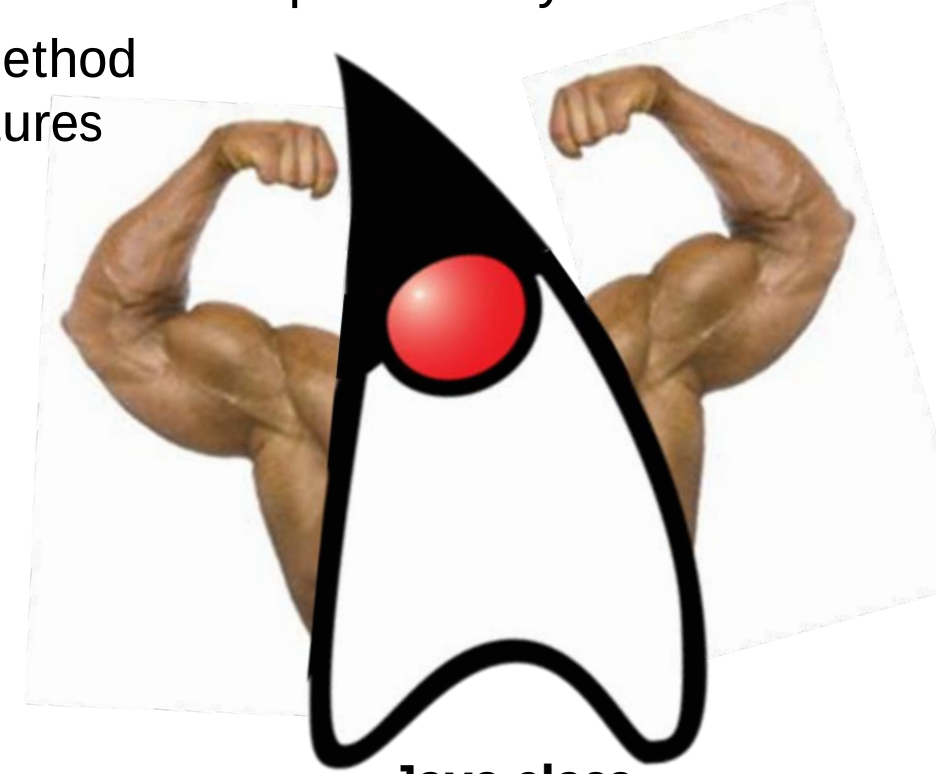

Java class

Java 8 supports default & static methods in interfaces

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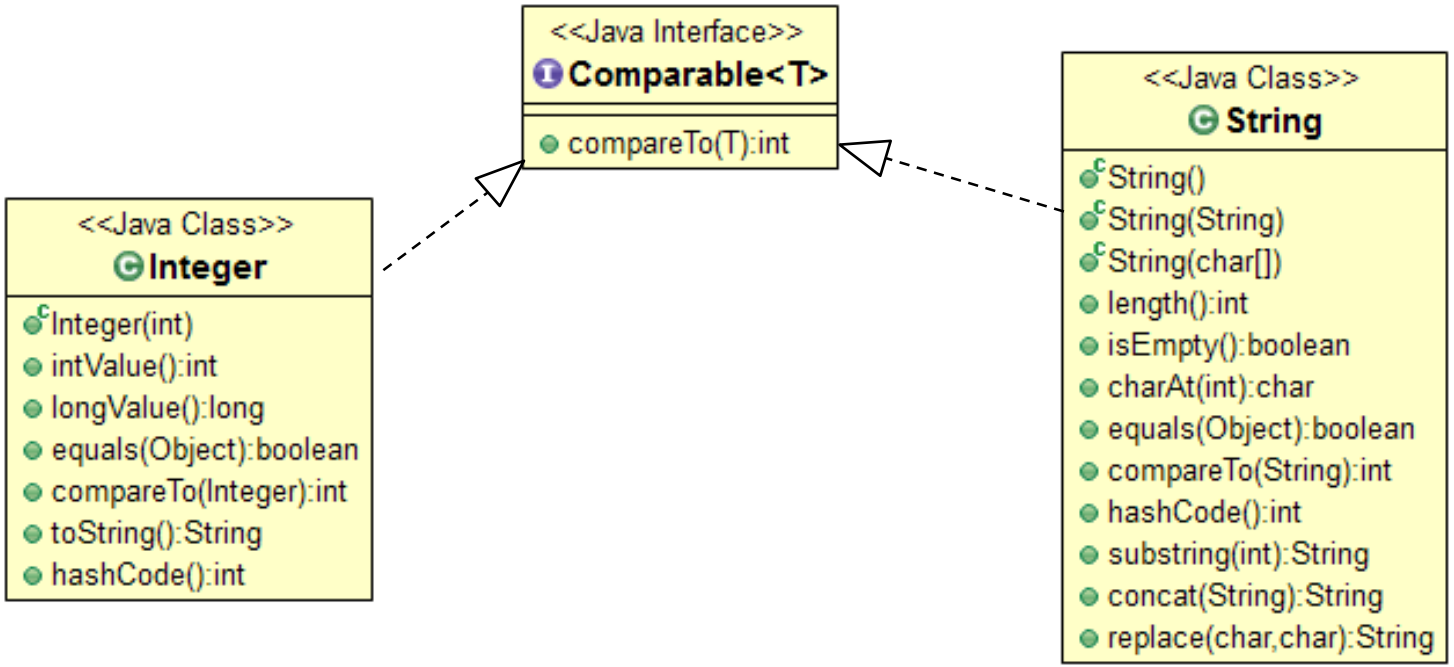

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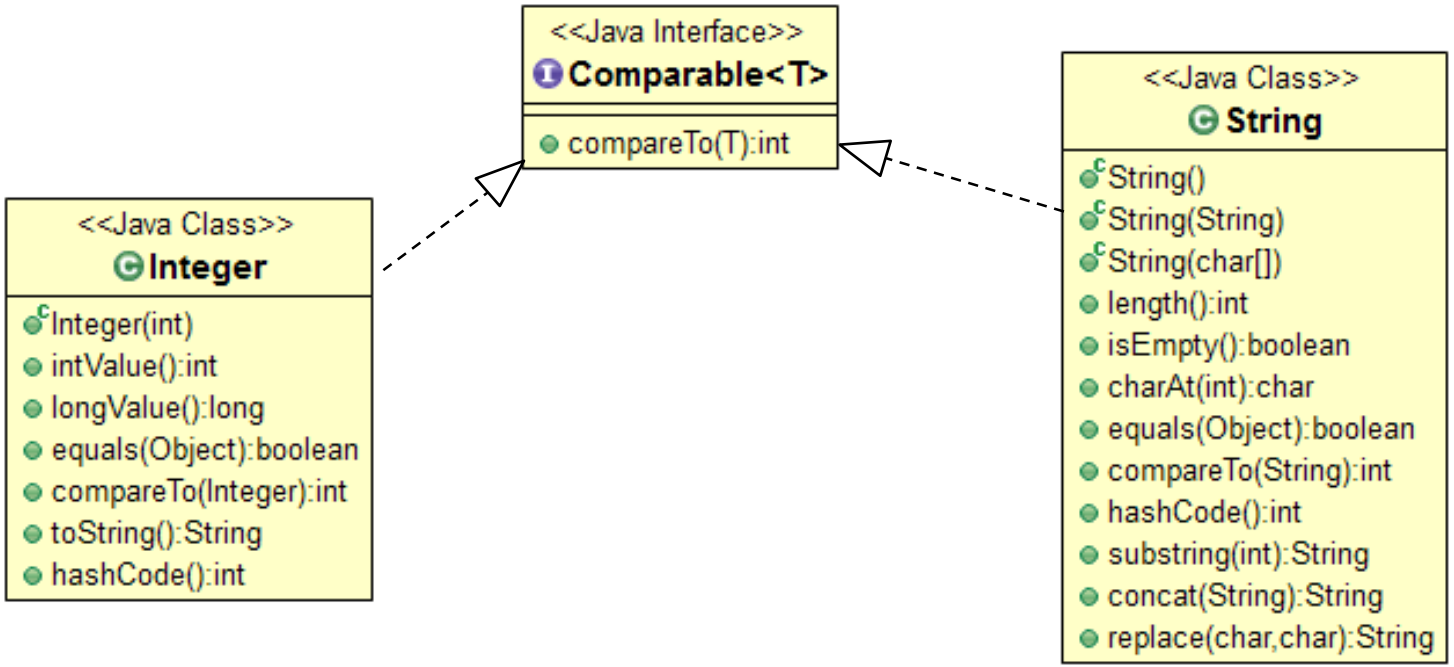

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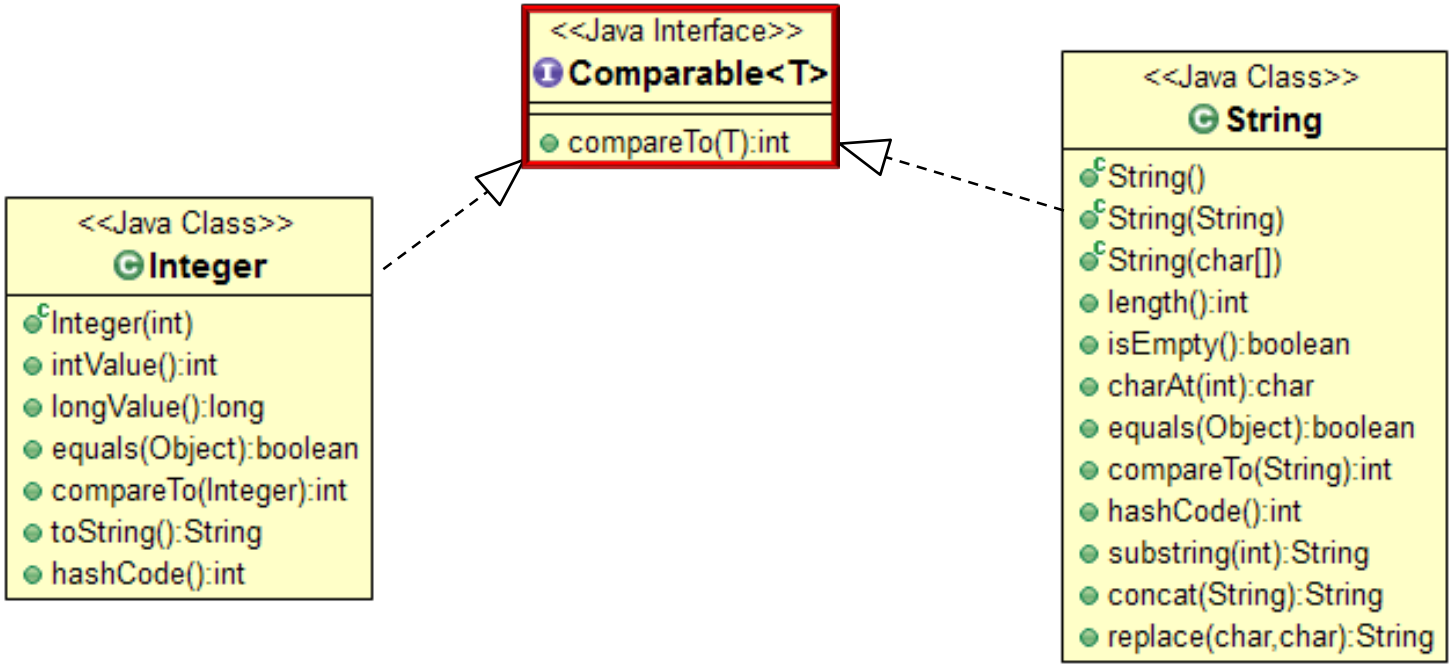

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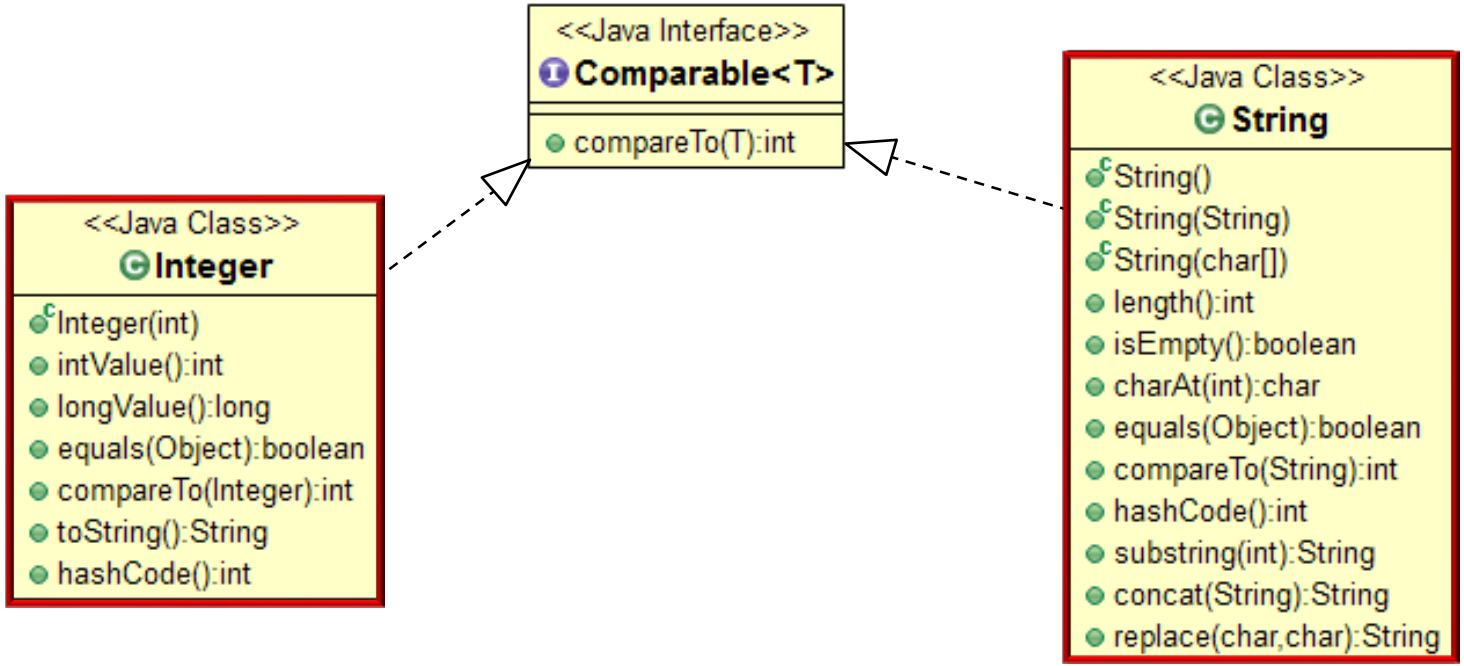

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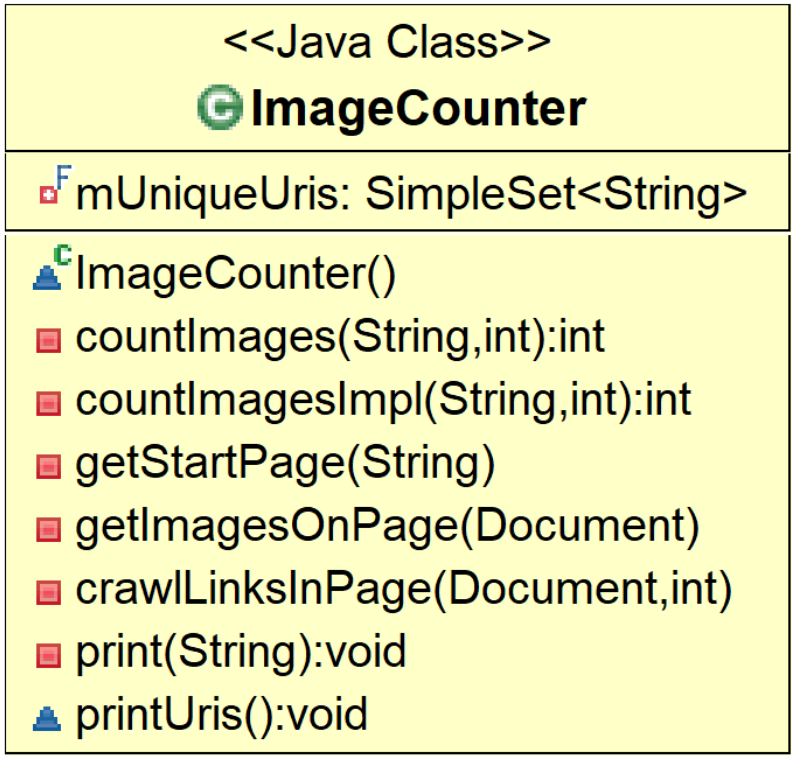

See ImageCounter/src/main/java/ImageCounter.java

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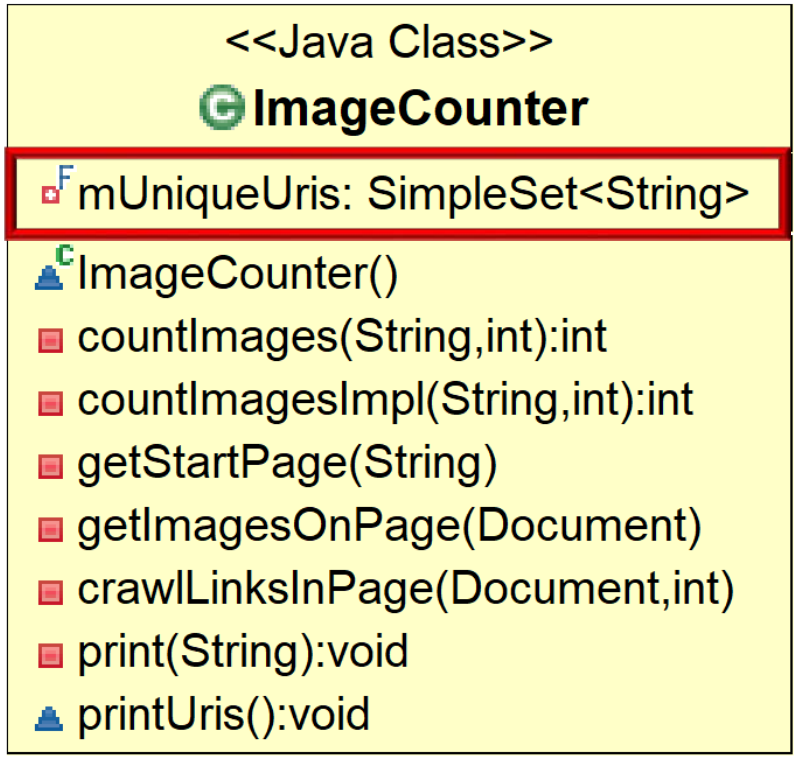

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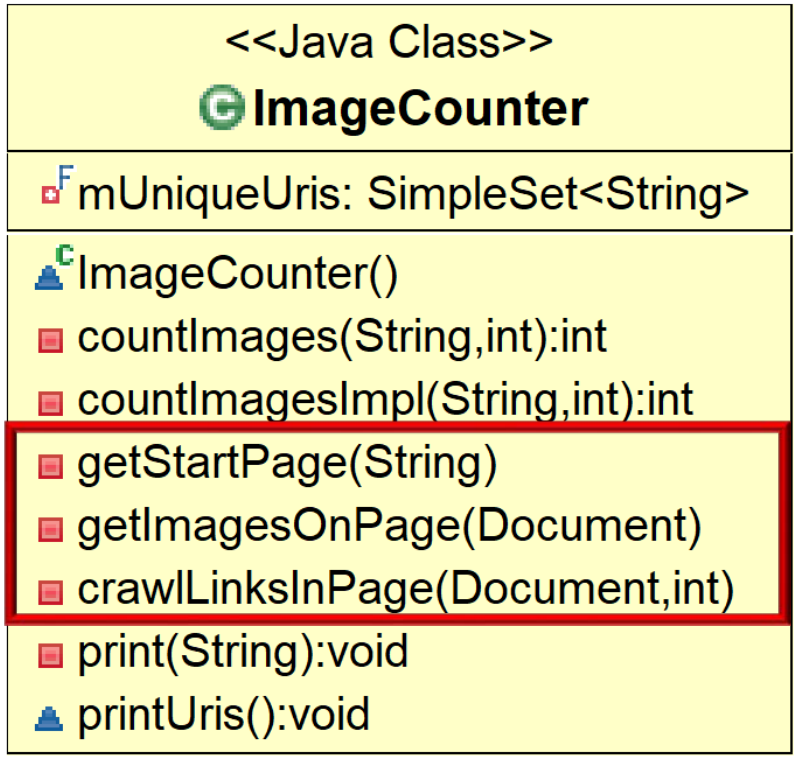

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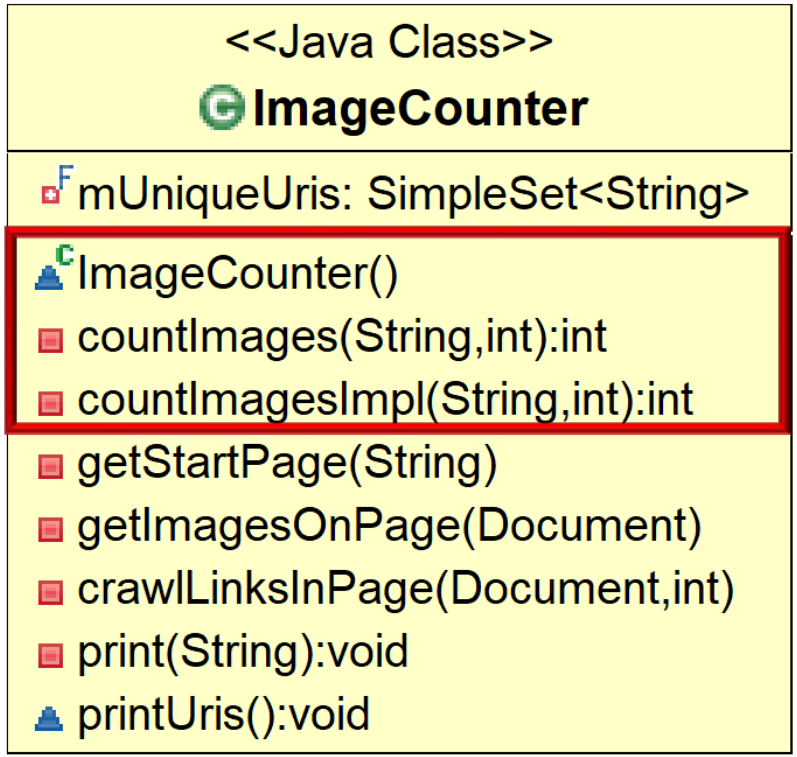

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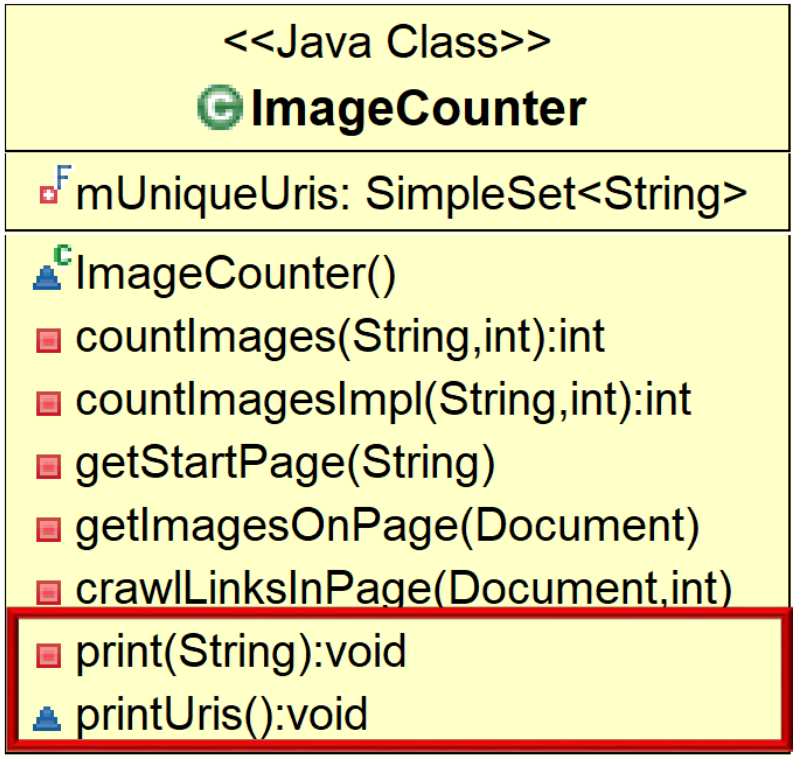
  - Its SimpleSet field caches Uris so they are only visited once
  - Some methods obtain & parse HTML pages
  - Other methods count # of images on a page (recursively)
  - Yet other methods display results to the user



Overview of Java's Support for Generics

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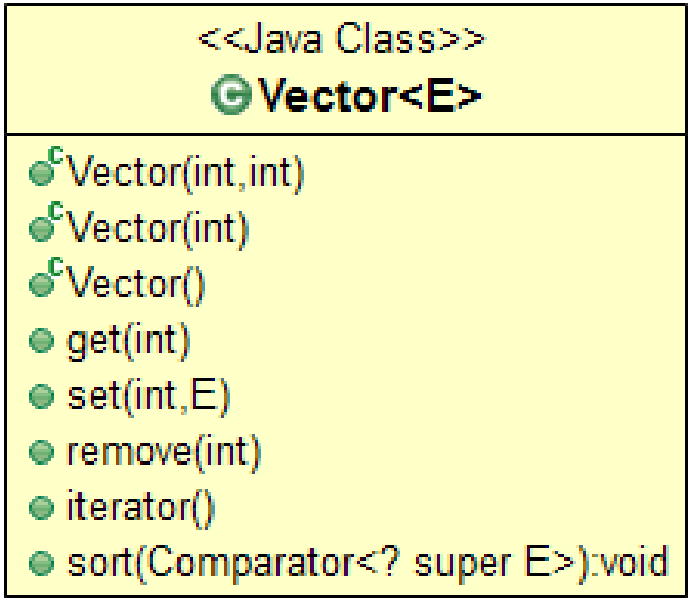
- Java generics enable the passing ADTs as parameters when defining classes, interfaces, & methods

See docs.oracle.com/javase/tutorial/java/generics

Overview of Java's Support for Generics

- Java generics enable the passing ADTs as parameters when defining classes, interfaces, & methods



See docs.oracle.com/javase/8/docs/api/java/util/Vector.html

Overview of Java's Support for Generics

- Java generics not identical to C++ parameterized types (templates)

Java generics

- No support for primitives
- Single copy of code exists regardless of the number of type arguments a generic code is used with
- Generified code get compiled as an entity in itself
- Bounded type parameters, possible, unbo unded defaults to Object

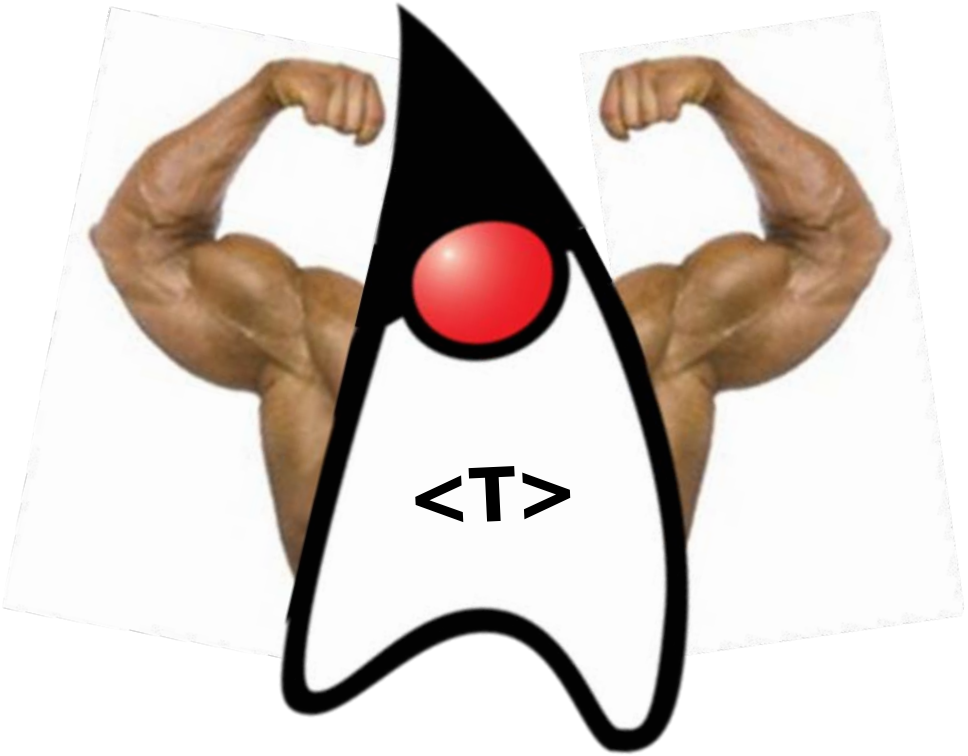
C++ templates

- Supports all types
- One copy of object code for each template instantiation
- Glorified C style marcos, compilation happens once for each expansion; some compilation errors crop up here
- No inheritance family based bounding of type parameters, only explicit specialization is possible

See www.cs.binghamton.edu/~mike/presentations/java-generics-cs580c-fall-2007.pdf

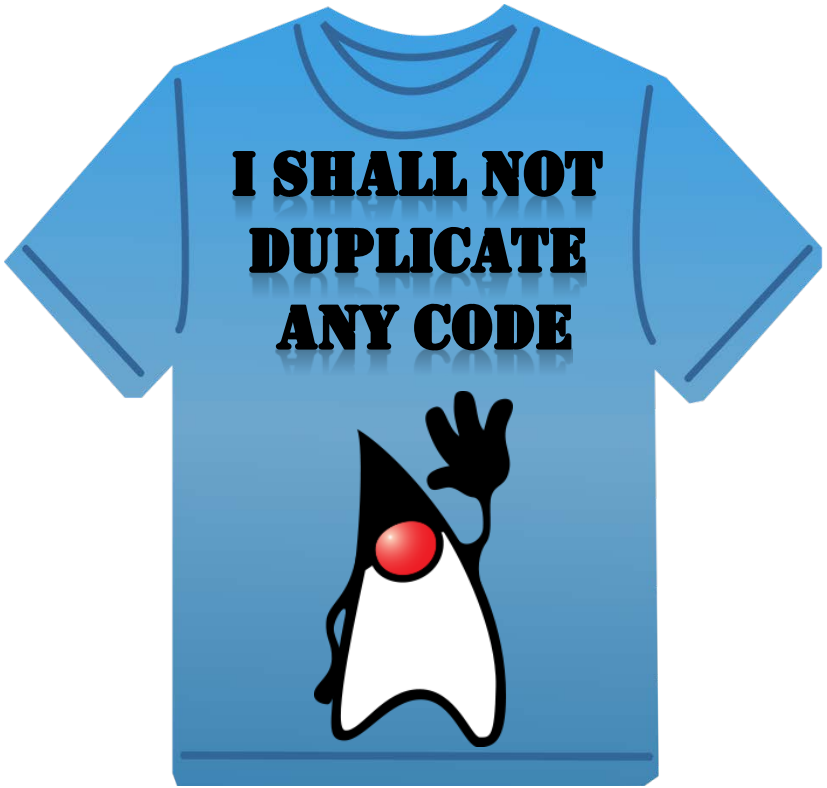
Overview of Java's Support for Generics

- Generics offer several benefits to Java programmers



Overview of Java's Support for Generics

- Generics offer several benefits to Java programmers, e.g.
  - Eliminate unnecessary code duplication



See en.wikipedia.org/wiki/Don't_repeat_yourself

Overview of Java's Support for Generics

- Generics offer several benefits to Java programmers, e.g.
  - Eliminate unnecessary code duplication
  - Ensure compile-time type safety when operating on different ADTs

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package java.util;

public class Vector<E> ... {
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Vector<Integer> vi = new
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vi.set(0, 10);   // Works
vi.set(0, 10.0); // Fails
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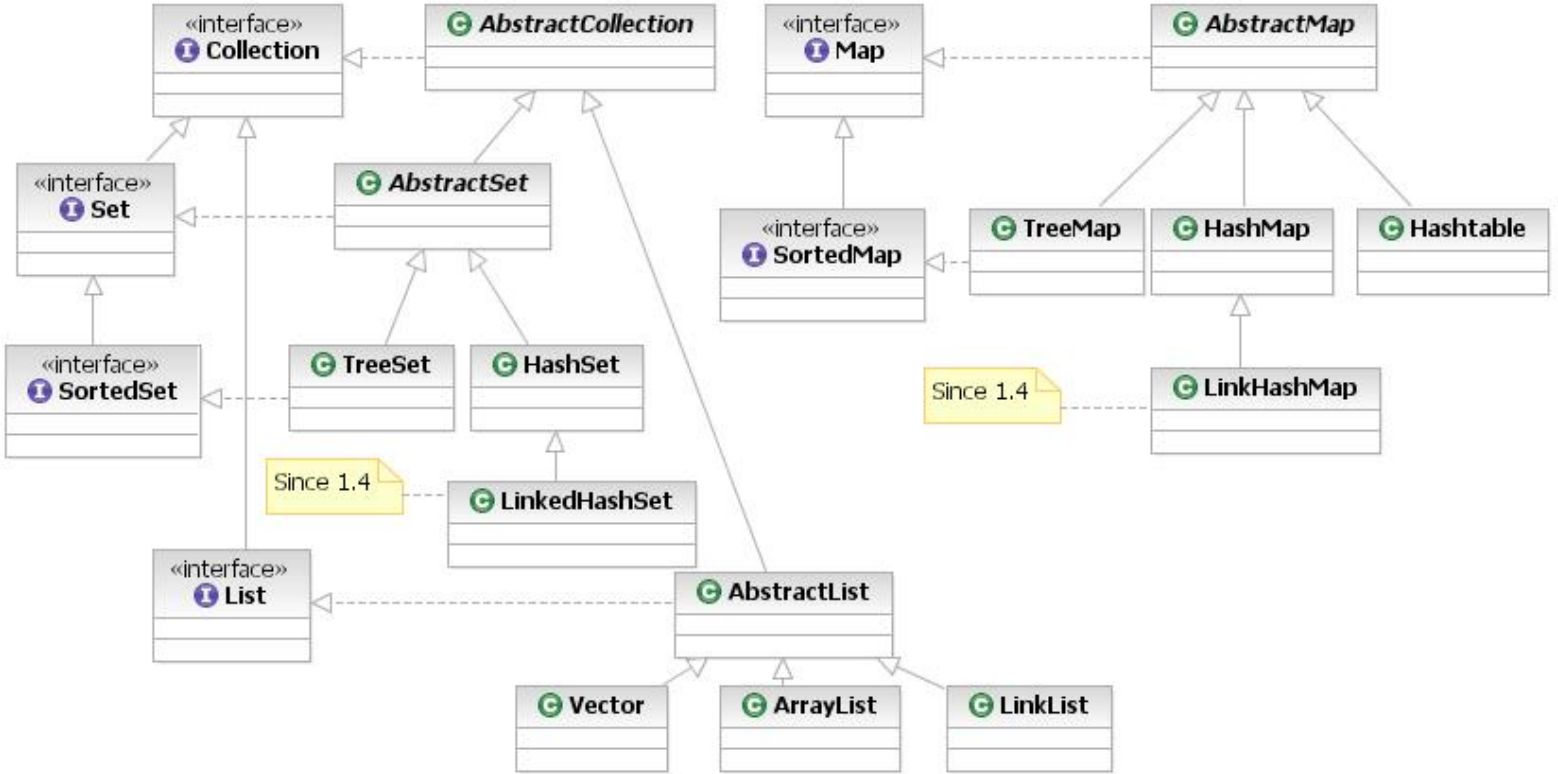
Overview of Java's Support for Generics

- The Java Collections Framework uses generic classes & interfaces extensively



See en.wikipedia.org/wiki/Java_collections_framework

Image Counter Example of Java Generics

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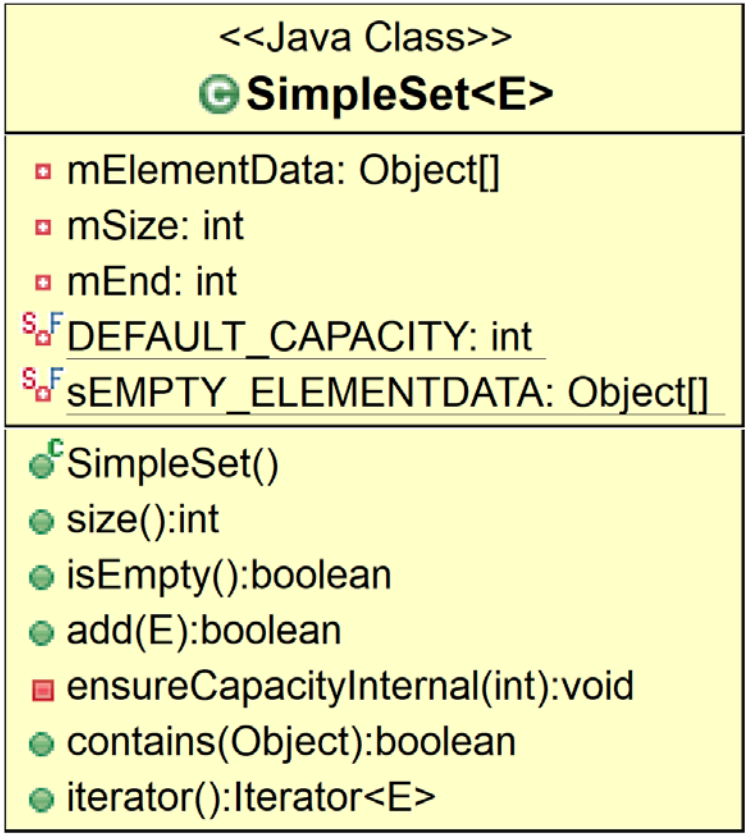
- SimpleSet defines a generic set that's implemented using a simple built-in array



See ImageCounter/src/main/java/utils/SimpleSet.java

Image Counter Example of Java Generics

- SimpleSet.add() adds the specified element to this set

```
class SimpleSet<E> ... {
  ...
  boolean add(E e) {
    if (contains(e))
      return false;

    ensureCapacityInternal
      (mSize + 1);

    mElementData[mEnd] = e;

    mEnd++;
    mSize++;
    return true;
  } ...
```

Note how the implementation of SimpleSet doesn't depend on the type of E