CSCI 136: Data Structures and Advanced Programming

Lecture 13

Sorting, part 1

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Williams

Topics

- More inheritance
- Comparison sorting

Your to-dos

1. Read **before Mon**: Bailey, Ch 6.4, 6.7-6.9.
2. Quiz 4, **due Saturday by 6pm**.
3. Lab 4, **due Tuesday 10/11 by 10pm**.

Announcements

- TA hours over reading period: **business as usual**
- Kelly: out of town Monday, Dan will fill in for office hours, but **over Zoom**. See help calendar for link.
- Colloquium: **What I Did Last Summer (Industry)**, 2:35pm in Wege Auditorium with **cookies**.

Recall:

Java provides control over **abstractness**, which we can use to enforce behavior to varying degrees.

interface → **fully** abstract

abstract class → **partially** abstract

class → **not** abstract

`Honkable`

Abstract class

An **abstract class** is a partial implementation, mainly used as a **labor-saving device**.

E.g., many **`List`** implementations will implement methods the same way. Why duplicate all that work?

`isEmpty()` can always be implemented by checking that **`size() == 0`**.

`AbstractHonkable`

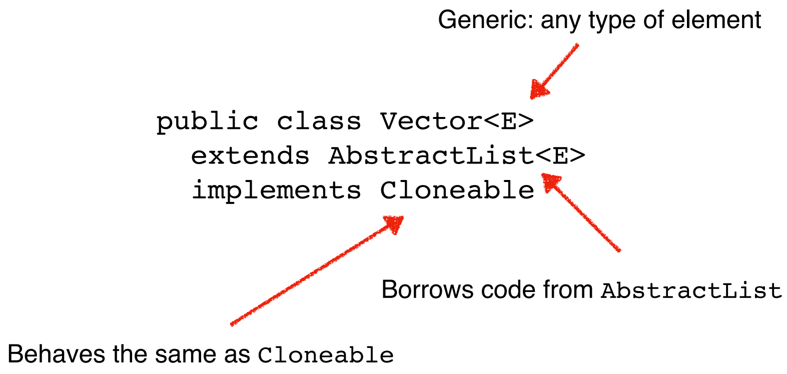
`Car`, etc.

Inheritance

Inheritance is a **mechanism** for defining a class in terms of another class. It is a labor-saving device employed to reduce **code duplication**. Inheritance allows programmers to specify a new implementation while :

1. **maintaining the same behavior**,
2. **reusing code**, and
3. **extending the functionality** of existing software.

How to interpret Javadoc declarations



Generic: any type of element

```
public class Vector<E>
  extends AbstractList<E>
  implements Cloneable
```

Borrows code from `AbstractList`

Behaves the same as `Cloneable`

Sorting algorithms

Sorting algorithm

A **sorting algorithm** is a **procedure** for transforming an unordered set of data into an ordered sequence.

A **comparison sorting algorithm** takes as input a set **S** and a binary relation **<** that defines an **ordering** on **S**.

Example order

Example: **lexicographical order** (aka, "dictionary order"):

Given two different sequences of the same length, $a_1a_2...a_k$ and $b_1b_2...b_k$, the first one is "less than" the second one for the lexicographical order, if $a_i < b_i$, for the first i where a_i and b_i differ.

To compare sequences of different lengths, the shorter sequence is padded at the end with "blanks."

Lexicographic order is a **total order**, meaning that there are **no ties**. A valid comparison sort only needs to be a **weak order** (i.e., **ties are OK**).

In-place sort

An **in-place sort** is a sort that takes an unordered set of elements as an array and **modifies** ("mutates") the original array. Most in-place sort functions return `void`.

In principle, in-place sorts can be **faster** than out-of-place algorithms, since they **do not need to copy data**.

Tradeoff: make sure that you don't need the original, unsorted data!

Bubble sort

6 5 3 1 8 7 2 4

Bubble sort

Bubble sort

Bubble sort is an in-place sorting algorithm in which the largest element "bubbles up" during each pass. Bubble sort makes n-1 passes through the data, performing pairwise comparisons of elements using <.

Bubble sort maintains the invariant (an always-true logical rule) that the rightmost n-numSorted elements are sorted.

I.e., bubble sort builds a sorted order to the right.

Bubble sort: intuition

Bubble sort as a Hungarian dance.

Observe that two things are happening:
1. a comparison, and
2. a swap.

https://bit.ly/3KoPMDX

Bubble sort algorithm

```
public static void bubbleSort(int data[], int n)
// pre: 0 <= n <= data.length
// post: values in data[0..n-1] in ascending order
{
    int numSorted = 0;      // number of values in order
    int index;              // general index
    while (numSorted < n)
    {
        // bubble a large element to higher array index
        for (index = 1; index < n-numSorted; index++)
        {
            if (data[index-1] > data[index])
                swap(data,index-1,index);
        }
        // at least one more value in place
        numSorted++;
    }
}
```

Recap & Next Class

Today:

- Inheritance
- Comparison sorting

Next class:

- More sorts