

CSCI 136:
Data Structures
and
Advanced Programming

Lecture 13

Sorting

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Announcements

- If you are not feeling well, let Bill J or me know, and please stay home.
- Remember: wash your hands frequently, cough into a sleeve, etc.
- Be cool.

Outline

1. Practice Quiz
2. Induction activity
3. Sorting algorithms

Practice Quiz

Like recursion, there is an analogy



Remember the template!

Step 1: Prove **P(a)**

Step 2: Prove **P(k) ⇒ P(k+1)**

Therefore, **P(n)**, for all $n \geq 1$, is **true**.

Activity

Prove: n cents can be obtained by using only 3-cent and 8-cent coins, for all $n \geq 15$.

Proof sketch

a = 15; P(15): is 5 x 3 cents. **True.**

P(k) ⇒ P(k+1) True.

Assume **P(k)** is **true**.

Case 1: P(k) has at least one 8-cent coin.

Then we can produce the value $k+1$ by replacing an 8-cent coin with 3 x 3 cent coins.

Case 2: P(k) has no 8-cent coin.

Then we can produce the value $k+1$ by replacing 5 x 3 cents coins with 2 x 8 cent coins. This is OK because $k > 15$.

Therefore we can find change for all $n \geq 15$. **True.**

Code

Let's write a program that gives you the correct change for all $n \geq 15$.

Sorting algorithms

Sorting algorithm

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

Bubble sort

6 5 3 1 8 7 2 4

Bubble sort

Bubble sort is a **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 complexity

Bubble sort is an **$O(n^2)$** sorting algorithm in the **worst case**. The naive algorithm is also **$O(n^2)$** in the **best case**. With a small modification, bubble sort is **$O(n)$** in the best case (i.e., where the array is already sorted).

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 we learned:

- More induction
- Bubble sort

Next class:

- More sorting algorithms
- Comparators