08 A: Sorting IV

CS1102S: Data Structures and Algorithms

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1. Bucket Sort

2. Puzzlers

1 Bucket Sort
- Recall: A Counter-Example
- Bucket Sort

2 Puzzlers

Counter-example: Sorting Small Distinct Integers

Input

Array a of N distinct integers from 1 to M

Sorting algorithm

```java
int [] helper = new int [M];
for (int i=0; i<N; i++)
    helper[a[i]] = a[i];
int index = 0;
for (int j=0; j<M; j++)
    if (helper[j]!=0)
        a[index++] = helper[j];
```

Counter-example: Sorting Small Distinct Integers

```java
int[] helper = new int[M];
for (int i=0; i<N; i++)
    helper[a[i]] = a[i];
int index = 0;
for (int j=0; j<M; j++)
    if (helper[j]!=0)
        a[index++] = helper[j];
```

Analysis

Runtime $O(M + N)$

A Couple of Ideas

- We do not have to store the element in the array; boolean values will do
- How can we drop the condition "distinct integers"?
- Instead of boolean values in the array helper, we count the number of occurrences of a given integer

Bucket Sort

```
int [] helper = new int[M];
for (int i=0; i<N; i++)
   helper[a[i]]++;
int index = 0;
for (int j=0; j<M; j++)
   while (helper[j]-- != 0)
      a[index++] = j;
```

Bucket Sort

```
int [] helper = new int [M];
for (int i =0; i <N; i ++)
    helper [a[ i ]]++;
int index = 0;
for (int j =0; j <M; j ++)
    while (helper [ j ]−− != 0)
        a[ index ++] = j ;
```

Analysis

Runtime $O(M + N)$

1 Bucket Sort

2 Puzzlers
- Previous Puzzler: The Last Laugh
- This Week's Puzzler: Printing Money

1 Bucket Sort

2 Puzzlers
- Previous Puzzler: The Last Laugh
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Previous Puzzler: The Last Laugh

What does the following program print?

```java
public class LastLaugh {
    public static void main(String[] args) {
        System.out.println("H" + "a");
        System.out.println('H' + 'a');
    }
}
```

Previous Puzzler: The Last Laugh

What does the following program print?

```java
public class LastLaugh {
    public static void main(String[] args) {
        System.out.println("H" + "a");
        System.out.println('H' + 'a');
    }
}
```

This program prints:

```
Ha
169
```

Why?

- Characters in Java are 16-bit numbers.
- Therefore, 'H' + 'a' performs addition of the corresponding character codes as integers: 72 + 97 = 169.
- What if I want to use characters as strings? Write: "" + 'H' + 'a'
- What does this code print: System.out.println("2 + 2 = " + 2+2);

Summary

Special treatment of +

The + operator performs string concatenation if and only if at least one of its operands is of type String.

New Puzzler: Printing Money

```
class Money {}
class Dollar extends Money {}
class MoneyPrinter {
  public void print(Money x) {
    System.out.println("Money!");
  }
}
class DollarPrinter extends MoneyPrinter {
  public void print(Dollar x) {
    System.out.println("Dollar!");
  }
}
```

New Puzzler: Printing Money

```java
Dollar d = new Dollar();

MoneyPrinter p = new DollarPrinter();
p.print(d);
```