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Homework 2 Problem 6

Programming Problem 6 (10 points):

We now consider a variation of the Coupon Collector Problem where there are n types of coupons, and each coupon has a value associated with it. The value of a coupon is a random integer between 1 and n. You want to put together a complete set of coupons of *minimum value*, so that of all of the coupons you receive of a certain type c_i, you keep the one of minimum value. You collect coupons until you have a full set of coupons and then you determine the value of the set of coupons.

Your programming assignment is to write a simulator of the Coupon Collector problem with values, and run simulations to see what the average value is for a complete set of coupons. You should run this up to $n = 4,000$. How does this relate to the results of programming problem 5 of homework 1? (Consider both the total value of the coupons V, as well as V/n.)

Answer:

```java
import java.util.Arrays;

class couponCollector{
    public static void main(String[] args){
        for(int i = 500; i <= 5000; i += 500){
            float localSum = 0;
            for(int j = 0; j < 50; j ++)
                localSum += sim(i);
            System.out.printf(
                        "n:%d, "+
                        "avgV:%.2f, "+
                        "V/n:%.2f\n",
                            i,
                            localSum/50,
                            (localSum/50)/i);
        }
    }

    public static float sim(int n) {
        int[] owned = new int[n];
        int[] minVal = new int[n];
```

```
            while (Arrays.stream(owned).sum() != n){
                int idx = (int)(Math.random() * n);
                int val = (int)(Math.random() * n);
                if (owned[idx] == 0) {
                    owned[idx] ++;
                    minVal[idx] = val;
                }
                else{
                    if (minVal[idx] > val) minVal[idx] = val;
                }
            }
            return Arrays.stream(minVal).sum();
    }

}
```

The output of coupon collector:
n:500, avgV:38127.78, V/n:76.26
n:1000, avgV:136683.31, V/n:136.68
n:1500, avgV:286445.03, V/n:190.96
n:2000, avgV:500509.47, V/n:250.25
n:2500, avgV:781876.06, V/n:312.75
n:3000, avgV:1061391.38, V/n:353.80
n:3500, avgV:1494715.88, V/n:427.06
n:4000, avgV:1807960.50, V/n:451.99
n:4500, avgV:2332739.25, V/n:518.39
n:5000, avgV:2730346.25, V/n:546.07

The goodness of w in HW1P5:
n:500, W:39225, W/n:78
n:1000, W:114134, W/n:114
n:1500, W:242898, W/n:161
n:2000, W:459985, W/n:229
n:2500, W:674116, W/n:269
n:3000, W:947377, W/n:315
n:3500, W:1298732, W/n:371
n:4000, W:2206001, W/n:551
n:4500, W:2509572, W/n:557
n:5000, W:2519637, W/n:503

It is easy to spot that the total number of coupons to collected the full set of coupons and goodness of w shared a similar linear function with n, with similar slope of roughly 300000 and interception of 600000.