CS 61B Spring 2021

Arrays, Linked Lists

Exam Prep Discussion 3: February 1, 2021

1 Fill Grid

Given two one-dimensional arrays `LL` and `UR`, fill in the program on the next page to insert the elements of `LL` into the lower-left triangle of a square two-dimensional array `S` and `UR` into the upper-right triangle of `S`, without modifying elements along the main diagonal of `S`. You can assume `LL` and `UR` both contain at least enough elements to fill their respective triangles. (Spring 2020 MT1)

For example, consider

```
int[] LL = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 0, 0 };
int[] UR = { 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 };
int[][] S = {
    { 0, 0, 0, 0, 0},
    { 0, 0, 0, 0, 0},
    { 0, 0, 0, 0, 0},
    { 0, 0, 0, 0, 0},
    { 0, 0, 0, 0, 0}
};
```

After calling `fillGrid(LL, UR, S)`, `S` should contain

```
{
  { 0, 11, 12, 13, 14 },
  { 1,  0, 15, 16, 17 },
  { 2,  3,  0, 18, 19 },
  { 4,  5,  6,  0, 20 },
  { 7,  8,  9, 10,  0 }
}
```

(The last two elements of `LL` are excess and therefore ignored.)

```
/** Fill the lower-left triangle of S with elements of LL and the
 *  upper-right triangle of S with elements of UR (from left-to
 *  right, top-to-bottom in each case). Assumes that S is square and
 *  LL and UR have at least sufficient elements. */
public static void fillGrid(int[] LL, int[] UR, int[][] S) {
    int N = S.length;
    int kL, kR;
    kL = kR = 0;

    for (int i = 0; i < N; i += 1) {

        ____________________________________________

        ____________________________________________

        ____________________________________________

        ____________________________________________

        ____________________________________________

        ____________________________________________

        ____________________________________________

        ____________________________________________

        ____________________________________________
    }
}
```

Solution:

```
public static void fillGrid(int[] LL, int[] UR, int[][] S) {
    int N = S.length;
    int kL, kR;
    kL = kR = 0;
    for (int i = 0; i < N; i += 1) {
        for (int j = 0; j < N; j += 1) {
            if (i < j) {
                S[i][j] = UR[kR];
                kR += 1;
            } else if (i > j) {
                S[i][j] = LL[kL];
                kL += 1;
            }
        }
    }
}
```

Alternate Solutions:

```
public static void fillGrid(int[] LL, int[] UR, int[][] S) {
    int N = S.length;
    int kL, kR;
    kL = kR = 0;
    for (int i = 0; i < N; i += 1) {
        for (int j = 0; j < i; j += 1) {
            S[i][j] = LL[kL];
            kL += 1;
        }
        for (int j = i + 1; j < N; j += 1) {
            S[i][j] = UR[kR];
            kR += 1;
        }
    }
}
```

```
public static void fillGrid(int[] LL, int[] UR, int[][] S) {
    int N = S.length;
    int kL, kR;
    kL = kR = 0;
    for (int i = 0; i < N; i += 1) {
        System.arraycopy(LL, kL, S[i], 0, i);
        System.arraycopy(UR, KR, S[i], i + 1, N - i - 1);
        kL += i;
        kR += square.length - i - 1; */
    }
}
```

2 Even Odd

Implement the method `evenOdd` by *destructively* changing the ordering of a given `IntList` so that even indexed links **precede** odd indexed links.

For instance, if `lst` is defined as `IntList.list(0, 3, 1, 4, 2, 5)`, `evenOdd(lst)` would modify `lst` to be `IntList.list(0, 1, 2, 3, 4, 5)`.

You may not need all the lines.

Hint: Make sure your solution works for lists of odd and even lengths.

```
1  public class IntList {
2      public int first;
3      public IntList rest;
4      public IntList (int f, IntList r) {
5          this.first = f;
6          this.rest = r;
7      }
8
9      public static void evenOdd(IntList lst) {
10
11       if (_____________________________________________) {
12           return;
13       }
14
15       ________________________________________________
16
17       ________________________________________________
18
19       while (_____________________________________________) {
20
21           ________________________________________________
22
23           ________________________________________________
24
25           ________________________________________________
26
27           ________________________________________________
28       }
29
30       ________________________________________________
31     }
32 }
```

Solution:

```
public static void evenOdd(IntList lst) {
    if (lst == null || lst.rest == null) {
        return;
    }
    IntList oddList = lst.rest;
    IntList second = lst.rest;
    while (lst.rest != null && oddList.rest != null) {
        lst.rest = lst.rest.rest;
        oddList.rest = oddList.rest.rest;
        lst = lst.rest;
        oddList = oddList.rest;
    }
    lst.rest = second;
}
```

Alternate Solution:

```
public static void evenOdd(IntList lst) {
    if (lst == null || lst.rest == null || lst.rest.rest == null) {
        return;
    }
    IntList second = lst.rest;
    int index = 0;
    while (!(index % 2 == 0 && (lst.rest == null || lst.rest.rest == null))) {
        IntList temp = lst.rest;
        lst.rest = lst.rest.rest;
        lst = temp;
        index++;
    }
    lst.rest = second;
}
```

Explanation: For any linked list, observe that we simply want to change the `rest` attribute of each `IntList` instance to skip an `IntList` instance. Looking at `lst`, we want to link 0 to 1, 3 to 4, and so on. This will constitute the work of the body of the **`while`** loop, so we just to need to figure out how to link the last even indexed `IntList` instance to the first odd indexed `IntList` instance. To keep track of the first odd indexed `IntList` instance, we can use `second`. Now, we just need to exit the **`while`** loop when we are at the last even indexed `IntList` instance. This occurs when the index is even and we are either at the second to last element (`lst.rest.rest == null`) or the last element (`lst.rest == null`).

3 Partition

Implement `partition`, which takes in an `IntList lst` and an integer `k`, and *destructively* partitions `lst` into `k IntLists` such that each list has the following properties:

1. It is the **same** length as the other lists. If this is not possible, i.e. `lst` cannot be equally partitioned, then the later lists should be **one** element smaller. For example, partitioning an `IntList` of length 25 with `k = 3` would result in partitioned lists of lengths 9, 8, and 8.
2. Its ordering is consistent with the ordering of `lst`, i.e. items in earlier in `lst` must **precede** items that are later.

These lists should be put in an array of length `k`, and this array should be returned. For instance, if `lst` contains the elements 5, 4, 3, 2, 1, and `k = 2`, then a **possible** partition (note that there are many possible partitions), is putting elements 5, 3, 2 at index 0, and elements 4, 1 at index 1.

You may assume you have the access to the method `reverse`, which destructively reverses the ordering of a given `IntList` and returns a pointer to the reversed `IntList`. You may not create any `IntList` instances. You may not need all the lines.

Hint: You may find the % operator helpful.

```
1  public static IntList[] partition(IntList lst, int k) {
2      IntList[] array = new IntList[k];
3      int index = 0;
4      IntList L = ____________________________________
5      while (L != null) {
6
7          ____________________________________________
8
9          ____________________________________________
10
11         ____________________________________________
12
13         ____________________________________________
14
15         ____________________________________________
16
17         ____________________________________________
18
19         ____________________________________________
20     }
21     return array;
22 }
```

Solution:

```
public static IntList[] partition(IntList lst, int k) {
    IntList[] array = new IntList[k];
    int index = 0;
    IntList L = reverse(lst);
    while (L != null) {
        IntList prevAtIndex = array[index];
        IntList next = L.rest;
        array[index] = L;
        array[index].rest = prevAtIndex;
        L = next;
        index = (index + 1) % array.length;
    }
    return array;
}
```