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CS 106X

Section Handout #5: Linked Lists

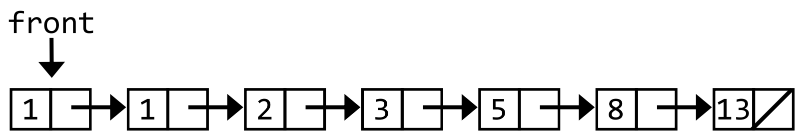
Based on handouts by various current and past CS106B/X instructors and TAs.

Extra practice problems: CodeStepByStep – linked list pointers; Textbook – 11.2, 11.7

Recall our definition of the ListNode structure, which you'll be getting more practice with during this section. For these problems, **do not modify a node's `data` field or use auxiliary structures like Vectors, Stacks, Queues, etc.**

```
struct ListNode {
    int data;
    ListNode* next;
};
```

Also, note that a linked list written as {1, 1, 2, 3, 5, 8, 13}, e.g., really refers to a linked list structed like this:



1. isSorted *(linked lists)*

Write a function called `isSorted` that accepts a pointer to a `ListNode` at the front of a linked list and returns true if the list of integers being passed is in sorted (nondecreasing) order and false otherwise. An empty list is considered to be sorted.

Bonus: Solve this problem both recursively and non-recursively. Which solution do you like better?

2. removeAllThreshold *(linked lists)*

Write a function called `removeAllThreshold` that accepts a pointer to a ListNode at the front of a list and removes all occurrences of a given integer value, plus or minus a provided threshold value, from that list. For example, if `front` points to the first `ListNode` in the following list, then calling `removeAllThreshold(front, 3, 2)` would remove all occurrences of 3 +/- 2 from the list (nodes to be removed are underlined):

`{3, 9, 4, 2, 1, 0, 3, 5, -2, 10} -> {9, 0, -2, 10}`

3. doubleList *(linked lists)*

Write a function `doubleList` that doubles the size of a list of integers by appending a copy of the original sequence to the end of the list. For example, if a list initially stores the sequence below at left, then passing in the front `ListNode` into `doubleList` would result in the list storing the sequence on the right (new nodes underlined):

`{1, 3, 2, 7} -> {1, 3, 2, 7, 1, 3, 2, 7}`

If the original list contains *N* nodes, then you should dynamically allocate exactly *N* new nodes to be added. You may not use any auxiliary data structures to solve this problem (no vector, stack, queue, string, etc.). Your function should run in O(*N*) time, where *N* is the number of nodes in the list.

4. split (*linked lists)*

Write a function `split` that accepts a pointer the front `ListNode` in a linked list as a parameter and rearranges the elements of a list of integers so that all negative values appear before all of the non-negatives, with each group in the same relative order. For example, a call to split would change the list on the left into the list on the right:

```
{8, 7, -4, 19, 0, 43, -8, -7, 2} -> {-4, -8, -7, 8, 7, 19, 0, 43, 2}
```

Do not swap data values or create any new nodes to solve this problem; you must rearrange the list by rearranging the links of the list. Do not use auxiliary structures like arrays, vectors, stacks, queues, etc. to solve this problem.

5a. reverse (*linked lists)*

Write a function called `reverse` that reverses the order of the elements in a linked list. For example, if a list initially stores the sequence of integers below at left, it should store the sequence on the right after your function is called: `{1, 8, 19, 4, 17} -> {17, 4, 19, 8, 1}`

Bonus: Solve this problem without creating any new nodes.

5b. braid (*linked lists)*

Now, write a function `braid` that weaves the reverse of that list into the original. For this problem, you will need to create new nodes. Here are a few examples:

```
          {1, 4, 2}  -> {1, 2, 4, 4, 2, 1}
                {3}  -> {3, 3}
  {1, 3, 6, 10, 15}  -> {1, 15, 3, 10, 6, 6, 10, 3, 15, 1}
```

Bonus: This one also has an interesting recursive solution.

6. drawPolygonalPath (*linked lists)*

```
struct PointNode {
    GPoint data;
    PointNode* next;
}
```

A closed path An open path A single point

Write a function `drawPolygonalPath` that accepts a reference to a `GWindow` object and a pointer to a `PointNode` (see above) that represents the beginning of a "polygonal path," or a series of connected line segments, and draws the path as a series of dots and lines on the window.

The `GPoint` within each `PointNode` contains an *x* and *y* value representing the point along the polygonal path, and the *next* field links to the next point in the path. Each line should be 1 pixel thick and each dot should be 2 pixels wide. Recall the `drawLine` function from the `GWindow` class:

```
gw.drawLine(x1, y1, x2, y2);
```

Note that the polygonal path can be open or closed. In the case of an open polygonal path, the last `PointNode` in the path will have a *next* value of `nullptr`. In the case of a closed polygonal path (in other words, a polygon), the last node in the path will link back to the first node in the path. Note that `drawPolygonalPath` should also be able to draw a single point. Finally, in the case of a null `PointNode` parameter, you should draw nothing. See the above diagrams for examples.