CS106B Chris Gregg
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# Section Handout #5 Solutions

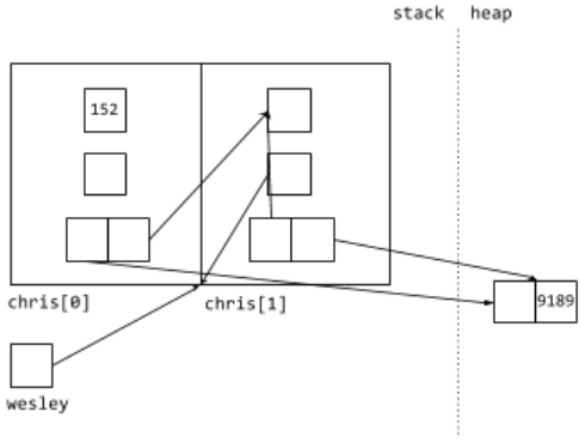
If you have any questions about the solutions to the problems in this handout, feel free to reach out to your section leader, Nick, or Chris for more information.

### 1. A Series of Unfortunate References

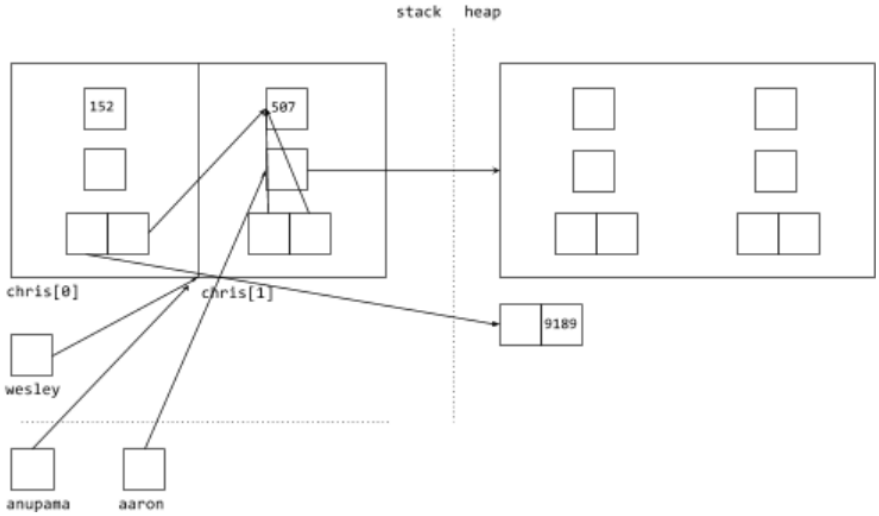
```
1 -84 2
```

### 2. Section Leaders, Then and Now

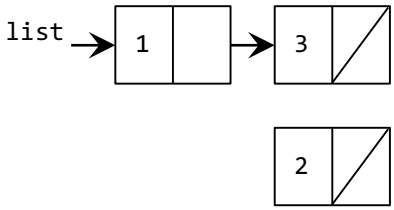
Below is the state of memory just prior to the call to `tyler`:

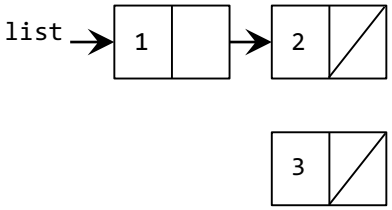



Below is the state of memory just before the call to `tyler` exits:



### 3. What's the Code Do?




### 4. What's the Code?

```
// a)
ListNode *temp = list->next->next;
temp->next = list->next;
list->next->next = list;
list->next->next->next = NULL;
list = temp;
```

```
// b)
list->next->next->next = list;
list = list->next->next;
ListNode *list2 = list->next->next;
list->next->next = NULL;
```

### 5. Is Sorted

```
bool isSorted(ListNode *front) {
  if (front != NULL) {
    ListNode* current = front;
    while (current->next != NULL) {
      if (current->data > current->next->data) {
        return false;
      }
      current = current->next;
    }
  }
  return true;
}
```

### 6. Count Duplicate Strings

```
int countDuplicateStrings(StringNode *front) {
  int count = 0;
  if (front != NULL) {
    StringNode *current = front;
    while (current->next != NULL) {
      if (current->data ==current->next->data) {
        count++;
      }
      current = current->next;
    }
  }
  return count;
}
```

### 7. Remove All Threshold

```
void removeAllThreshold(DoubleNode *&front, double value, double threshold) {
  while (front != NULL && front->data >= value - threshold
                       && front->data <= value + threshold) {
    DoubleNode *trash = front;
    front = front->next;
    delete trash;
  }
  if (front != NULL) {
    DoubleNode *current = front;
    while (current->next != NULL) {
      if (current->next->data >= value - threshold
       && current->next->data <= value + threshold) {
        DoubleNode *trash = current->next;
        current->next = current->next->next;
        delete trash;
      } else {
        current = current->next;
      }
    }
  }
}
```

### 8. Double List

```
void doubleList(ListNode *&front) {
  if (front != NULL) {
    ListNode *half2 = new ListNode(front->data);
    ListNode *back = half2;
    ListNode *current = front;
    while (current->next != NULL) {
      current = current->next;
      back->next = new ListNode(current->data);
      back = back->next;
    }
    current->next = half2;
  }
}
```

### 9. Split

```
void split(ListNode *&front) {
  if (front != NULL) {
    ListNode *current = front;
    while (current->next != NULL) {
      if (current->next->data < 0) {
        ListNode *temp = current->next;
        current->next = current->next->next;
        temp->next = front;
        front = temp;
      } else {
        current = current->next;
      }
    }
  }
}
```

```
void split(ListNode *&front) {
  if (front != NULL) {
    ListNode *current = front;
    ListNode *lastNegative = NULL;
    while (current->next != NULL) {
      if (current->next->data < 0) {
        ListNode *temp = current->next;
        current->next = current->next->next;
        if (lastNegative == NULL) {
            lastNegative = temp;
            lastNegative->next = front;
            front = lastNegative;
        } else {
            temp->next = lastNegative->next;
            lastNegative->next = temp;
            lastNegative = temp;
        }
```

```
      } else {
        current = current->next;
      }
    }
  }
}
```

The original solution is on the left, but our amazing SL Norah pointed out that the negative numbers would be printed in reverse instead of the original order. Can you verify if that is true and see why? On the right is an alternate solution which does keep the original order. It keeps track of the last negative number added instead of adding negative numbers to the front of the list. There may be a more elegant solution, and if you find it please let me know! ☺

**10. Reverse Recurse**

```
ListNode *reverse(ListNode *front) {
  if (front == NULL) return NULL;
  if (front->next == NULL) return front;

  ListNode *rest = reverse(front->next); // reverse the whole list but the front
  front->next->next = front;             // update the next pointer of the 2nd element (now
                                         // the second to last element) to point to front
  front->next = NULL;                  // update the next pointer of front (now the
                                         // end of the list) to be NULL

  return rest;
}
```

**11. Merge**

Provided are two solutions for merging lists. The first one is recursive, and the second one is iterative.

```
ListNode *mergeLists(ListNode *one, ListNode *two) {
  if (one == NULL) return two;
  if (two == NULL) return one;

  // got this far? then neither list is empty
  if (one->data <= two->data) {
    one->next = mergeLists(one->next, two);
    return one;
  } else {
    two->next = mergeLists(one, two->next);
    return two;
  }
}
```

```
ListNode *mergeLists(ListNode *one, ListNode *two) {
  ListNode *merge = NULL;
  ListNode **mergePtr = &merge;

  while (one != NULL && two != NULL) {
    if (one->data <= two->data) {
      *mergePtr = one;
      one = one->next;
    } else {
      *mergePtr = two;
      two = two->next;
    }
    mergePtr = &((*mergePtr)->next);
  }

  if (one != NULL) *mergePtr = one;
  else *mergePtr = two;
  return merge;
}
```

Why might you preference one solution over the other? The recursive solution is a bit shorter, and depending on how comfortable you are with recursion versus advanced pointer techniques like double pointers, it might be easier to understand. However, the structure of this problem means you'll make a recursive call for every element in the finished list, which means you could end up with too many stack frames. Oftentimes, when you're doing "tail recursion" (when you make a single recursive call, at the very end of the function), it might actually be better to write an iterative solution, even if it's more complicated.

Note that some programming environments are able to optimize for tail recursion, meaning it's less of a performance hit to use it.

### 12. Draw Polygonal Path

```
void drawPolygonalPath(GWindow &window, PointNode *head) {
  if (head == NULL) {
    return;
  }

  PointNode *current = head;
  window.fillOval(current->x - 1, current->y - 1, 2, 2);

  while (current->next != NULL) {
    window.drawLine(current->x, current->y, current->next->x, current->next->y);
    window.fillOval(current->next->x - 1, current->next->y - 1, 2, 2);
    current = current->next;
    if (current == head) {
      break;
    }
  }
}
```

### 13. Braiding Lists

Provided are two solutions for braiding lists. The first one is iterative, and the second one is recursive.

```
void braid(ListNode *list) {
  ListNode *reverse = NULL;
  for (ListNode *curr = list;
            curr != NULL; curr = curr->next) {
    ListNode *newNode = new ListNode;
    newNode->data = curr->data;
    newNode->next = reverse;
    reverse = newNode;
  }

  // reverse now addresses a memory-independent
  //version of the original list,
  // where all of the nodes are in reverse order.
  ListNode *rest = reverse; //rest addresses part
                            //that has yet to be braided
  for (ListNode *curr = list;
            curr != NULL; curr = curr->next->next) {
    ListNode *next = rest->next;
    rest->next = curr->next;
    curr->next = rest;
    rest = next;
  }
}
```

```
void braid(ListNode *list, Queue<int> &numbers) {
  if (list == NULL) return;
  numbers.enqueue(list->value);
  braid(list->next, numbers);
  ListNode *newNode = new ListNode;
  newNode->data = numbers.dequeue();
  newNode->next = list->next;
  list->next = newNode;
}

void braid(ListNode *list) {
  Queue<int> numbers;
  braid(list, numbers);
}
```

Some of the same considerations apply when choosing between these two solutions as with merging lists. Note that this isn't actually tail recursion, however, it's still "unary recursion" (a single recursive call). Oftentimes problems solved using unary recursion have similarly complex iterative solutions.