Recreation

Prove that for every acute angle $\alpha > 0$,

$$\tan \alpha + \cot \alpha \geq 2$$

CS61B Lecture #5: Simple Pointer Manipulation

Announcement

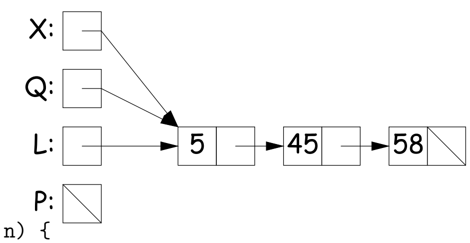
- **Today:** More pointer hacking.
- **Handing in labs and homework:** We'll be lenient about accepting late homework and labs for the first few. Just get it done: part of the point is getting to understand the tools involved. We will *not* accept submissions by email.

Destructive Incrementing

Destructive solutions may modify objects in the original list to save time or space:

```
/** List of all items in P incremented by n. May destroy original. */
static IntList dincrList(IntList P, int n) {
  if (P == null)
    return null;
  else {
    P.head += n;
    P.tail = dincrList(P.tail, n);
    return P;
  }
}
```

```
X = IntList.list(3, 43, 56);
/* IntList.list from HW #1 */
Q = dincrList(X, 2);
```




```
/** List L destructively incremented
 *  by n. */
static IntList dincrList(IntList L, int n) {
  // 'for' can do more than count!
  for (IntList p = L; p != null; p = p.tail)
    p.head += n;
  return L;
}
```


Another Example: Non-destructive List Deletion

If L is the list [2, 1, 2, 9, 2], we want `removeAll(L,2)` to be the new list [1, 9].

```
/** The list resulting from removing all instances of X from L
 *  non-destructively. */
static IntList removeAll(IntList L, int x) {
  if (L == null)
     return null;
  else if (L.head == x)
     return removeAll(L.tail, x);
  else
     return new IntList(L.head, removeAll(L.tail, x));
}
```

Aside: How to Write a Loop (in Theory)

- Try to give a description of how things look on *any arbitrary iteration* of the loop.
- This description is known as a *loop invariant*, because it is true from one iteration to the next.
- The loop body then must
  - Start from any situation consistent with the invariant;
  - Make progress in such a way as to make the invariant true again.

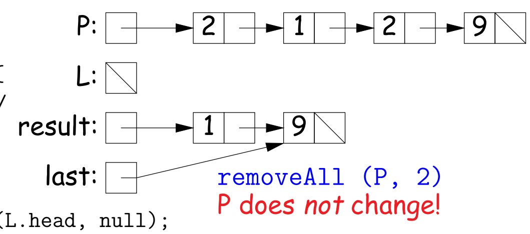
```
while (condition) {
   // Invariant true here
   loop body
   // Invariant again true here
}
// Invariant true and condition false.
```

- So if (*invariant* and not *condition*) is enough to insure we've got the answer, we're done!

Iterative Non-destructive List Deletion

Same as before, but use front-to-back iteration rather than recursion.

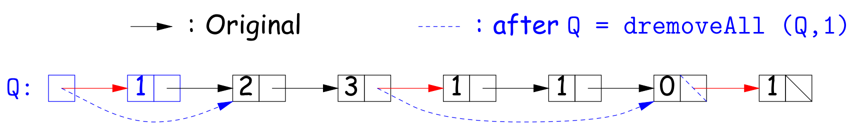
```
/** The list resulting from removing all instances of X from L
 *  non-destructively. */
static IntList removeAll(IntList L, int x) {
  IntList result, last;
  result = last = null;
  for ( ; L != null; L = L.tail) {
    /* L != null and 𝓘 is true. */
    if (x == L.head)
      continue;
    else if (last == null)
      result = last = new IntList(L.head, null);
    else
      last = last.tail = new IntList(L.head, null);
  }
  return result;
}
```



Here, $\mathcal{I}$ is the *loop invariant:*

> Result is all elements of L_0 not equal to x up to and not including L, and last points to the last element of result, if any. We use L_0 here to mean "the original sequence of int values in L."

Destructive Deletion




```
/** The list resulting from removing all instances of X from L.
 *  The original list may be destroyed. */
static IntList dremoveAll(IntList L, int x) {
  if (L == null)
     return null;
  else if (L.head == x)
     return dremoveAll(L.tail, x);
  else {
     L.tail = dremoveAll(L.tail, x);
     return L;
  }
}
```


Iterative Destructive Deletion

```
/** The list resulting from removing all instances of X from L.
 *  Original contents of L may be destroyed. */
static IntList dremoveAll(IntList L, int x) {
  IntList result, last;
  result = last = null;
  while (L != null) {
    IntList next = L.tail;
    if (x != L.head) {
      if (last == null)
        result = last = L;
      else
        last = last.tail = L;
      L.tail = null;
    }
    L = next;
  }
  return result;
}
```