

Public Service Announcement I

"Do you like working with kids? Do you like making a positive impact on our youth? Do you like meeting amazing and congenial people? Join OASES now!

As an organization of 150 mentors, we tutor elementary school kids in Oakland. This is an fantastic opportunity serve as an important role model for under-resourced children. From playing recess to helping them with homework, every moment makes a difference! You will also meet new and like-minded people eager to mold our youth! Also, you can earn either an Education field studies unit or an Asian American Studies unit!

Drop-in Info-sessions from Tuesday, Sept 5th to Friday, Sept 8th (3:00 PM-6:30 PM at the Free Speech Movement Cafe)

Questions? Contact leadcoords.oases@gmail.com. We're also on Facebook: www.facebook.com/OasesAtUcBerkeley/."

Public Service Announcement II

"Apply to join the Berkeley Political Review! Berkeley Political Review, UC Berkeley's only non-partisan undergraduate political journal, is holding our last info session, next Tuesday September 5th (8pm, location TBD-see FB event for more details). BPR is recruiting writers, business and marketing professionals, tech experts, and designers—come find your place in the BPR family! Applications are due September 7th. Apply online at <https://bpr.berkeley.edu/apply/>."

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.

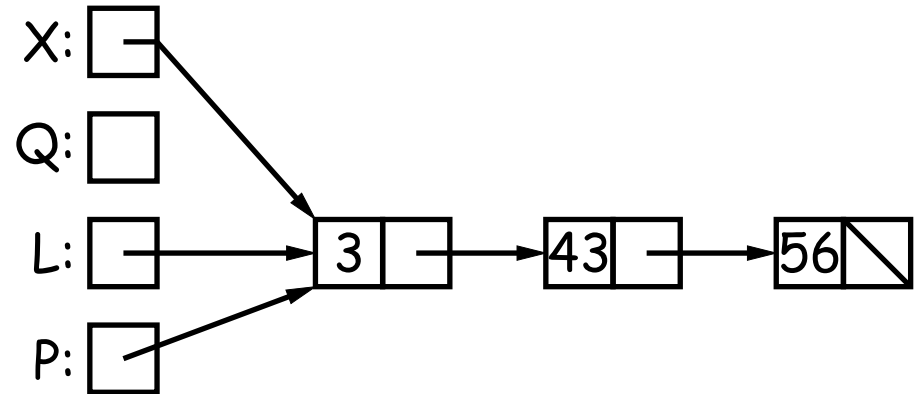
Destructive Incrementing

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

```
/** Destructively add N to L's items. */
static IntList dincrList(IntList P, int n) {
    if (P == null)
        return null;
    else {
        P.head += n;
        P.tail = dincrList(P.tail, n);
        return P;
    }
}
```

```
/** Destructively add N to L's items. */
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;
}
```

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



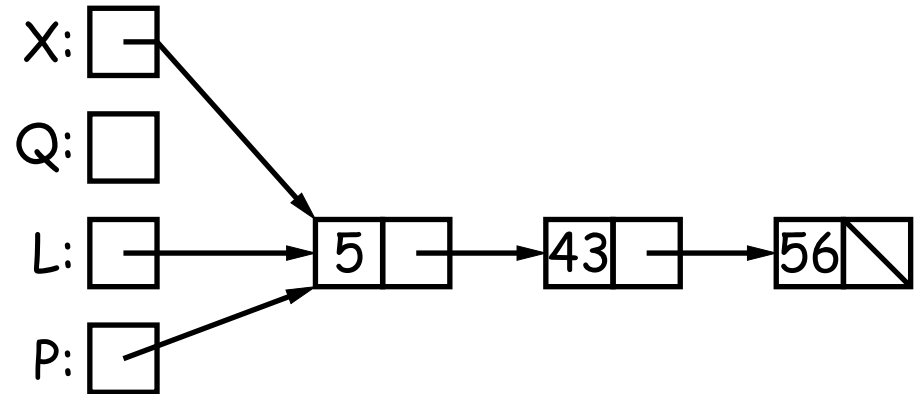
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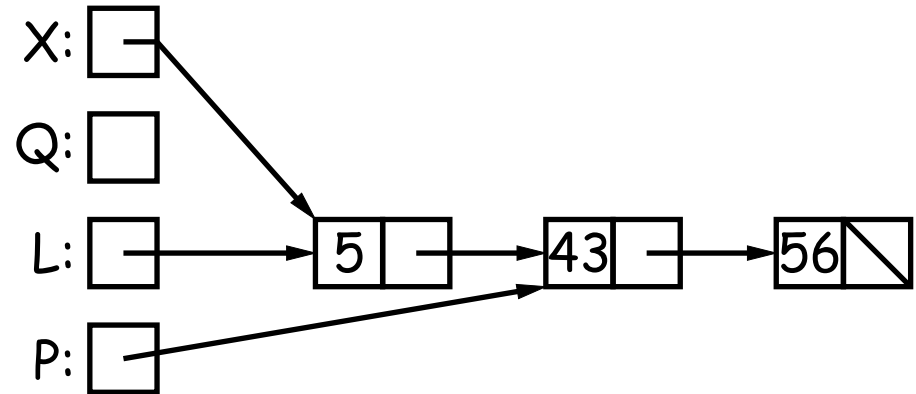
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        return P;
    }
}
```

```
/** Destructively add N to L's items. */
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;
}
```

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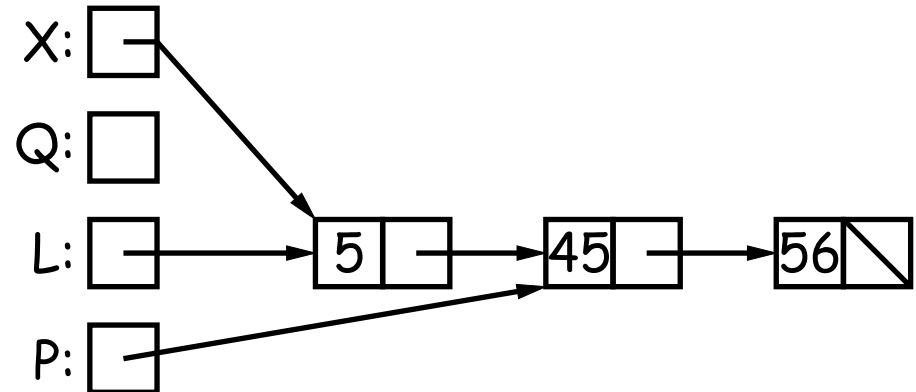
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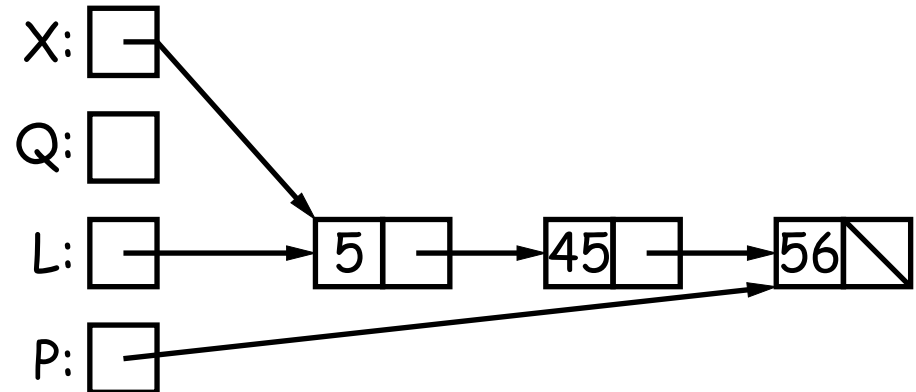
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        p.head += n;
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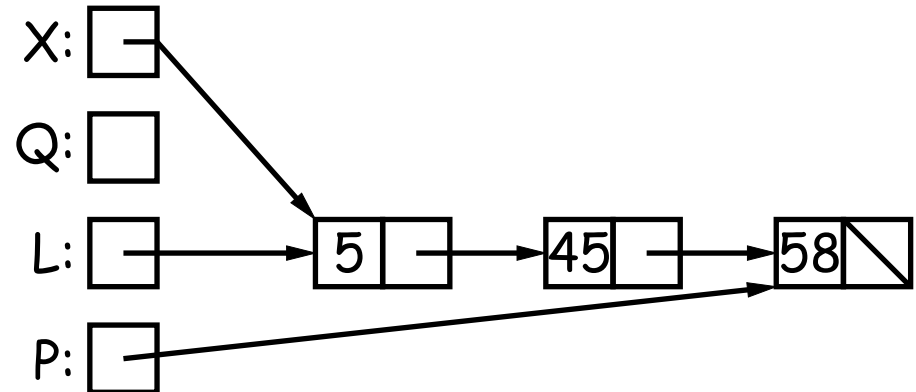
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/** Destructively add N to L's items. */
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{
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    for (IntList p = L; p != null; p = p.tail)
        p.head += n;
    return L;
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```

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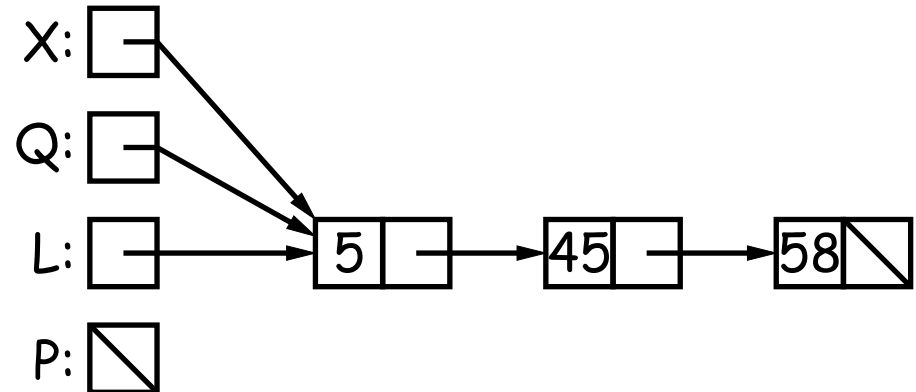
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        return P;
    }
}
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```
/** Destructively add N to L's items. */
static IntList dincrList(IntList L, int n)
{
    // 'for' can do more than count!
    for (IntList p = L; p != null; p = p.tail)
        p.head += n;
    return L;
}
```

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



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 with all x's removed )*/;
    else if (L.head == x)
        return /*( L with all x's removed (L!=null, L.head==x) )*/;
    else
        return /*( L with all x's removed (L!=null, L.head!=x) )*/;
}
```

Another Example: Non-destructive List Deletion

If L is the list $[2, 1, 2, 9, 2]$, we want $\text{removeAll}(L, 2)$ to be the new list $[1, 9]$.

```
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    if (L == null)
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    else
        return /*( L with all x's removed (L!=null, L.head!=x) )*/;
}
```

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```
/** 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 /*( L with all x's removed (L!=null, L.head!=x) )*/;
}
```

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));
}
```

Iterative Non-destructive List Deletion

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

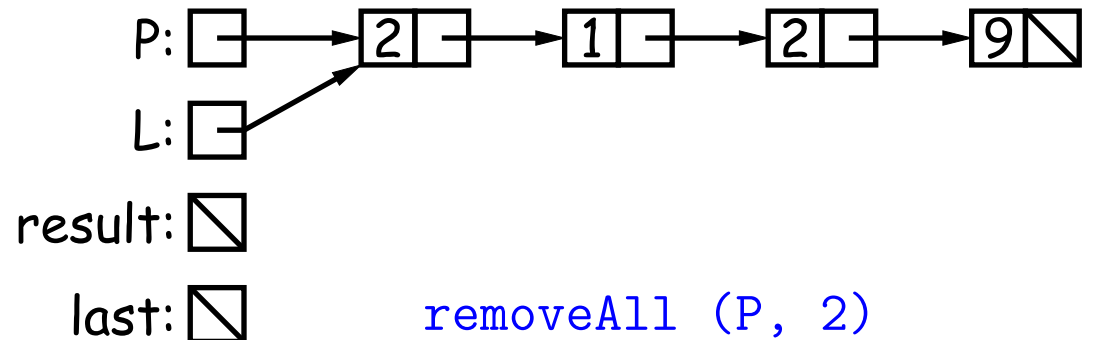
```
/** The list resulting from removing all instances
 * of X from L non-destructively. */
static IntList removeAll(IntList L, int x) {
    IntList result, last;
    result = last = null;
    for ( ; L != null; L = L.tail) {
        if (x == L.head)
            continue;
        else if (last == null)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

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. */
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    IntList result, last;
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        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;
}
```



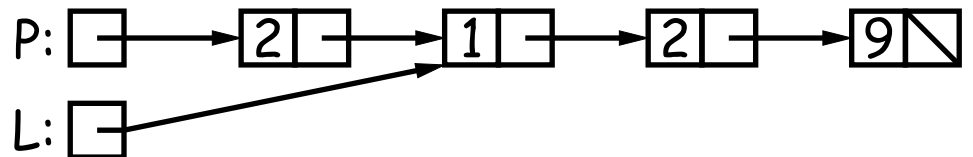
removeAll (P, 2)

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. */
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static IntList removeAll(IntList L, int x) {  
    IntList result, last;  
    result = last = null;  
    for ( ; L != null; L = L.tail) {  
        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;  
}
```



result:

last:

removeAll (P, 2)
P does not change!

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) {
```

```
        if (x == L.head)
```

```
            continue;
```

```
        else if (last == null)
```

```
            result = last = new IntList(L.head, null);
```

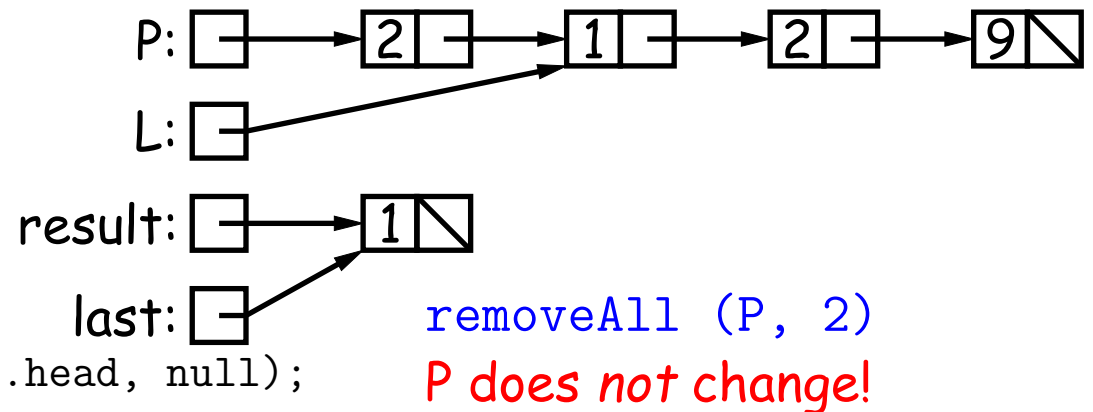
```
        else
```

```
            last = last.tail = new IntList(L.head, null);
```

```
    }
```

```
    return result;
```

```
}
```



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) {
```

```
        if (x == L.head)
```

```
            continue;
```

```
        else if (last == null)
```

```
            result = last = new IntList(L.head, null);
```

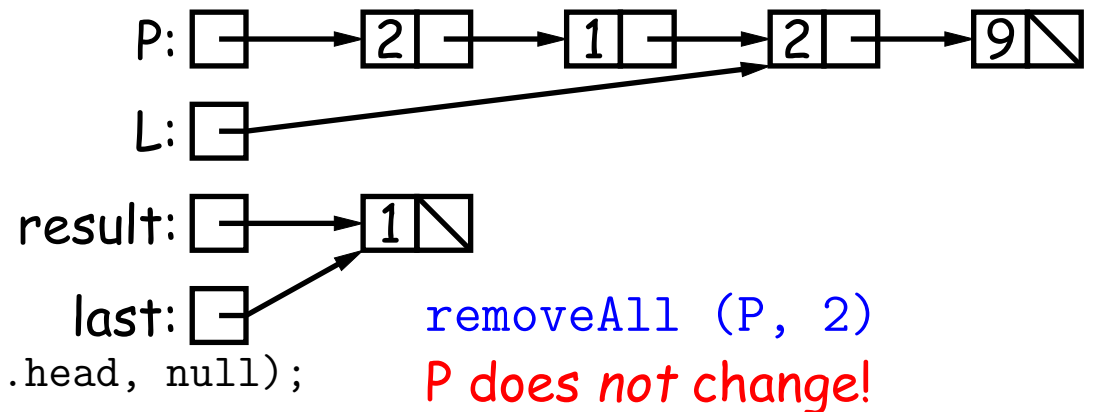
```
        else
```

```
            last = last.tail = new IntList(L.head, null);
```

```
    }
```

```
    return result;
```

```
}
```



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. */
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```
static IntList removeAll(IntList L, int x) {
```

```
    IntList result, last;
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```
    result = last = null;
```

```
    for ( ; L != null; L = L.tail) {
```

```
        if (x == L.head)
```

```
            continue;
```

```
        else if (last == null)
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```
            result = last = new IntList(L.head, null);
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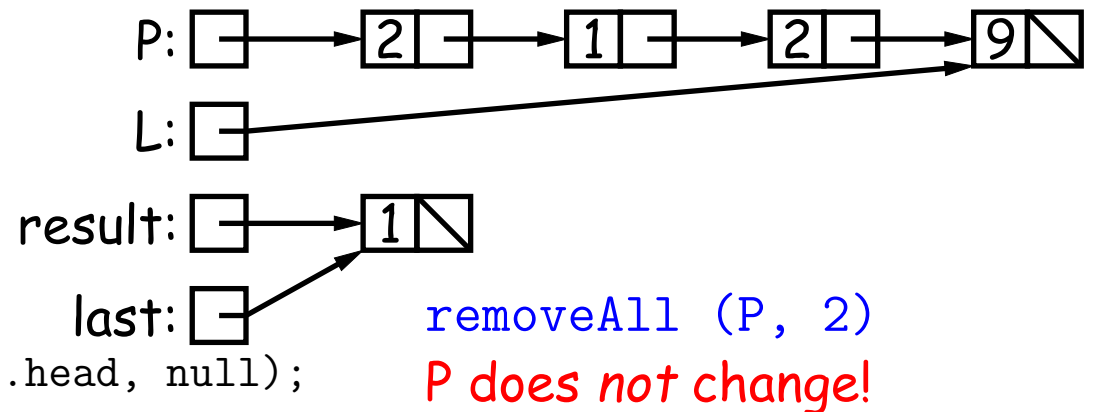
```
        else
```

```
            last = last.tail = new IntList(L.head, null);
```

```
    }
```

```
    return result;
```

```
}
```



Iterative Non-destructive List Deletion

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```
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```

```
    for ( ; L != null; L = L.tail) {
```

```
        if (x == L.head)
```

```
            continue;
```

```
        else if (last == null)
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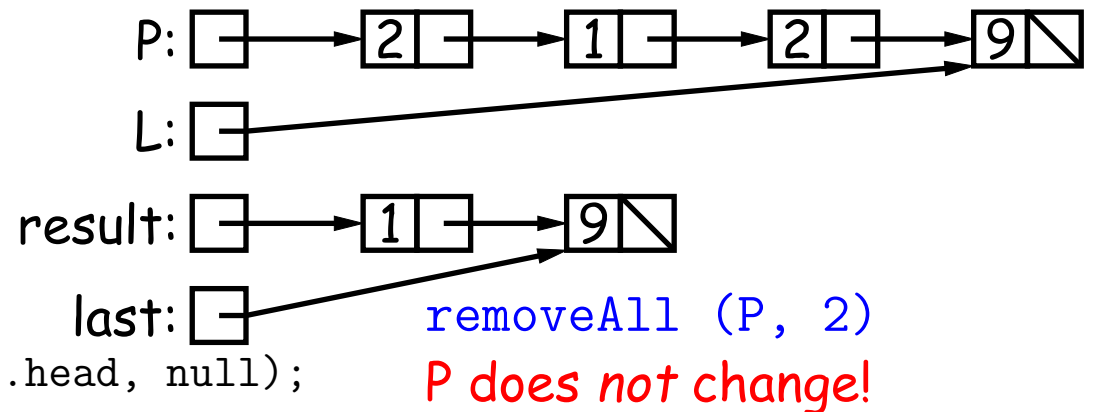
```
        else
```

```
            last = last.tail = new IntList(L.head, null);
```

```
    }
```

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    return result;
```

```
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Iterative Non-destructive List Deletion

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```
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```
        if (x == L.head)
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```
            continue;
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        else if (last == null)
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            result = last = new IntList(L.head, null);
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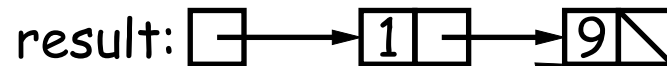
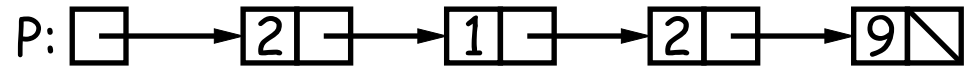
```
        else
```

```
            last = last.tail = new IntList(L.head, null);
```

```
    }
```

```
    return result;
```

```
}
```



removeAll (P, 2)

P does not change!

Destructive Deletion

→ : Original

..... : after Q = dremoveAll (Q,1)

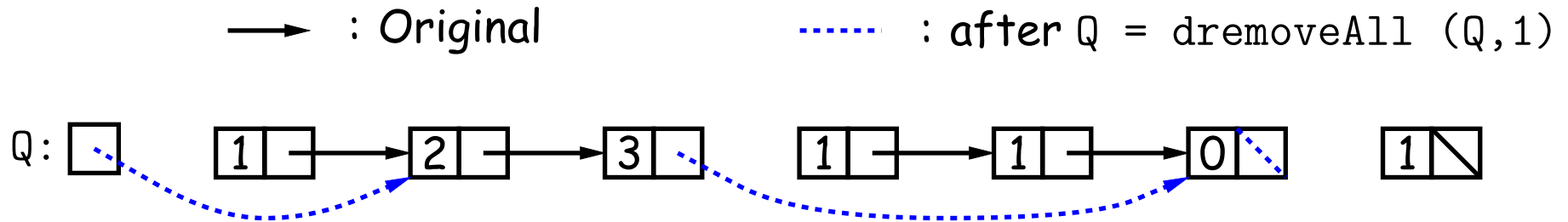


```
/** The list resulting from removing all instances of X from L.
```

```
 * The original list may be destroyed. */
```

```
static IntList dremoveAll(IntList L, int x) {
    if (L == null)
        return /*( null with all x's removed )*/;
    else if (L.head == x)
        return /*( L with all x's removed (L != null) )*/;
    else {
        /*{ Remove all x's from L's tail. }*/;
        return L;
    }
}
```

Destructive Deletion



```

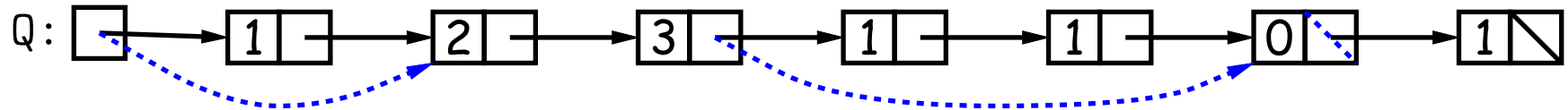
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        /*{ Remove all x's from L's tail. }*/;
        return L;
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}

```


Destructive Deletion

→ : Original

..... : after Q = dremoveAll (Q,1)



```
/** The list resulting from removing all instances of X from L.
```

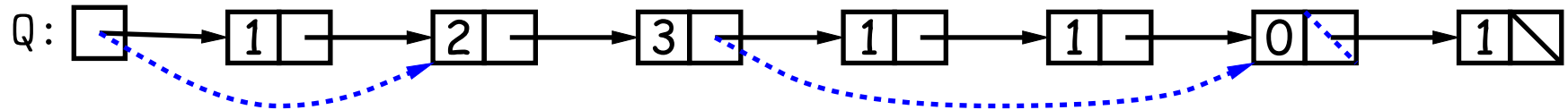
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 * The original list may be destroyed. */
```

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    }  
}
```

Destructive Deletion

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/** The list resulting from removing all instances of X from L.
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```

```
        return /*( L with all x's removed (L != null) )*/;
```

```
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```

```
        /*{ Remove all x's from L's tail. }*/;
```

```
        return L;
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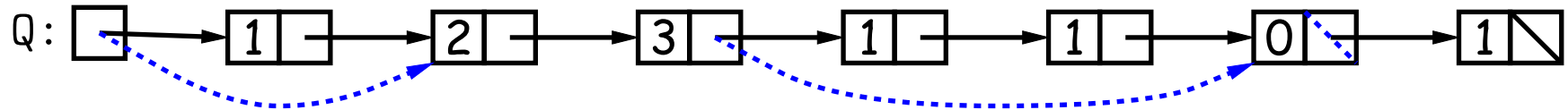
```
    }
```

```
}
```

Destructive Deletion

→ : Original

..... : after Q = dremoveAll (Q,1)



```
/** The list resulting from removing all instances of X from L.
```

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static IntList dremoveAll(IntList L, int x) {
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    if (L == null)
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```
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```

```
        /*{ Remove all x's from L's tail. }*/;
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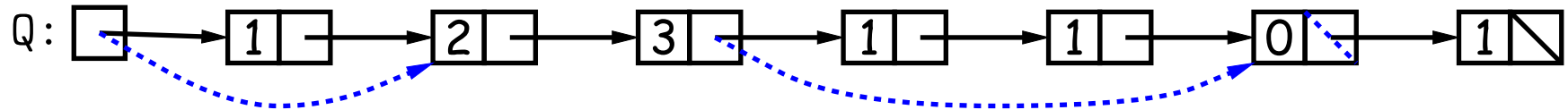
```
    }
```

```
}
```

Destructive Deletion

→ : Original

..... : after Q = dremoveAll (Q,1)



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```

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```

```
static IntList dremoveAll(IntList L, int x) {
```

```
    if (L == null)
```

```
        return
```

```
    else if (L.head == x)
```

```
        return dremoveAll(L.tail, x);
```

```
    else {
```

```
        /*{ Remove all x's from L's tail. }*/;
```

```
        return L;
```

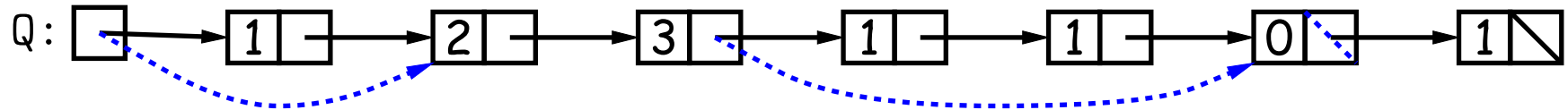
```
    }
```

```
}
```

Destructive Deletion

→ : Original

⋯ : after Q = dremoveAll (Q,1)



```
/** The list resulting from removing all instances of X from L.
```

```
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```

```
static IntList dremoveAll(IntList L, int x) {
```

```
    if (L == null)
```

```
        return
```

```
    else if (L.head == x)
```

```
        return dremoveAll(L.tail, x);
```

```
    else {
```

```
        L.tail = dremoveAll(L.tail, x);
```

```
        return L;
```

```
    }
```

```
}
```

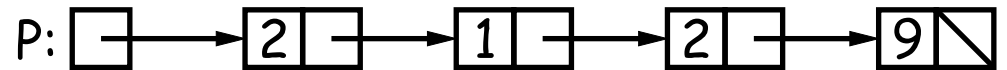
Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
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;
}
```

Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
```

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static IntList dremoveAll(IntList L, int x) {
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                result = last = L;
            else
                last = last.tail = L;
            L.tail = null;
        }
        L = next;
    }
    return result;
}
```



result:

last:

L:

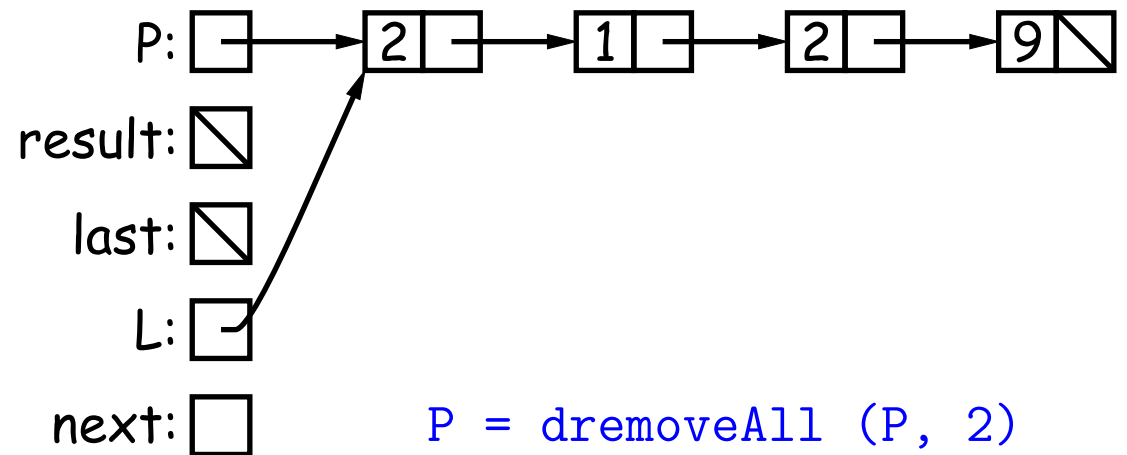
next:

P = dremoveAll (P, 2)

Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
```

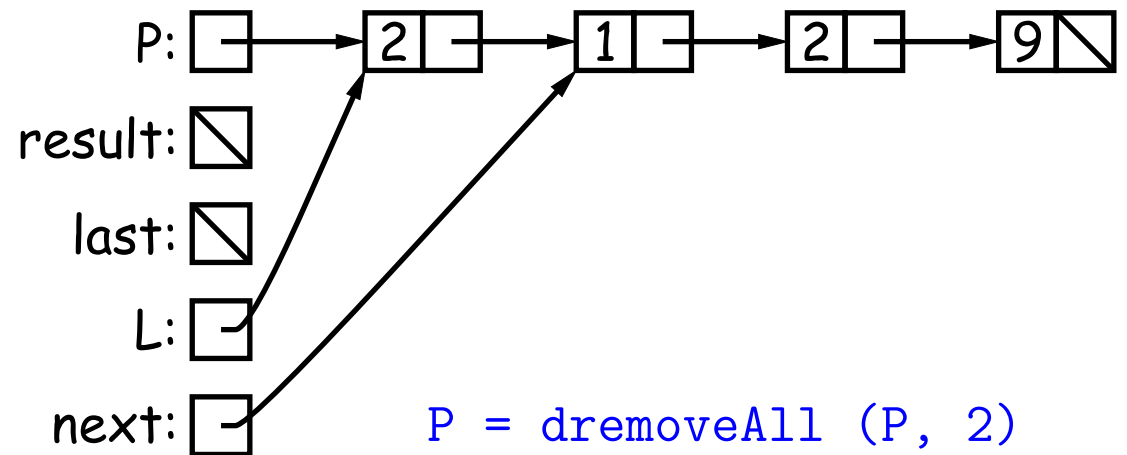
```
static IntList dremoveAll(IntList L, int x) {
    IntList result, last;
    result = last = null;
    while (L != null) {
        IntList next = L.tail;
        if (x != L.head) {
            if (last == null)
                result = last = L;
            else
                last = last.tail = L;
            L.tail = null;
        }
        L = next;
    }
    return result;
}
```



Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
```

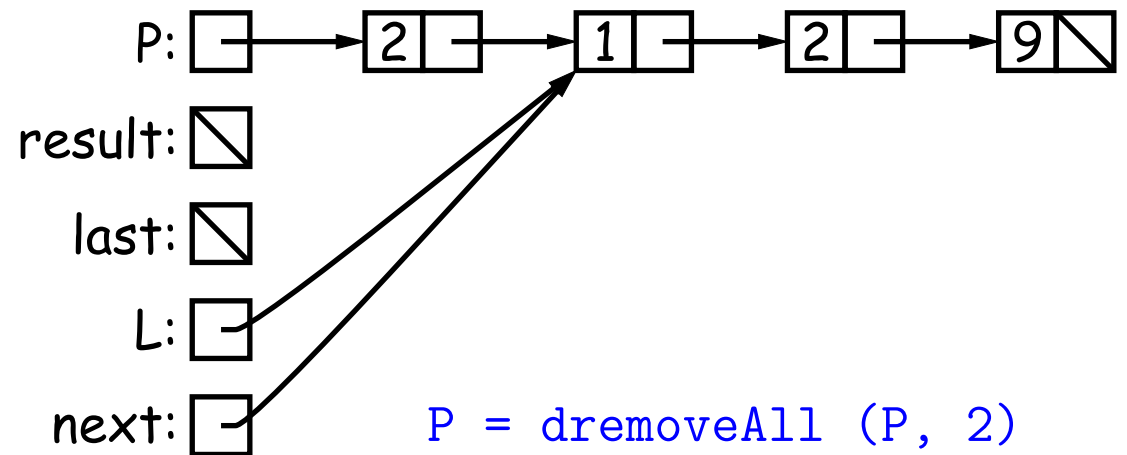
```
static IntList dremoveAll(IntList L, int x) {
    IntList result, last;
    result = last = null;
    while (L != null) {
        IntList next = L.tail;
        if (x != L.head) {
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                result = last = L;
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                last = last.tail = L;
            L.tail = null;
        }
        L = next;
    }
    return result;
}
```



Iterative Destructive Deletion

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/** The list resulting from removing all X's from L
 * destructively. */
```

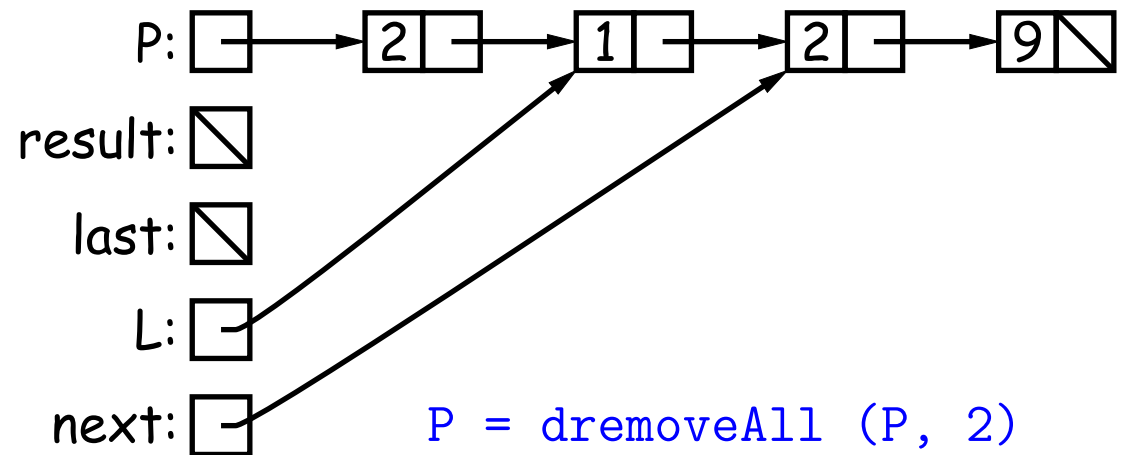
```
static IntList dremoveAll(IntList L, int x) {
    IntList result, last;
    result = last = null;
    while (L != null) {
        IntList next = L.tail;
        if (x != L.head) {
            if (last == null)
                result = last = L;
            else
                last = last.tail = L;
            L.tail = null;
        }
        L = next;
    }
    return result;
}
```



Iterative Destructive Deletion

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                result = last = L;
            else
                last = last.tail = L;
            L.tail = null;
        }
        L = next;
    }
    return result;
}
```

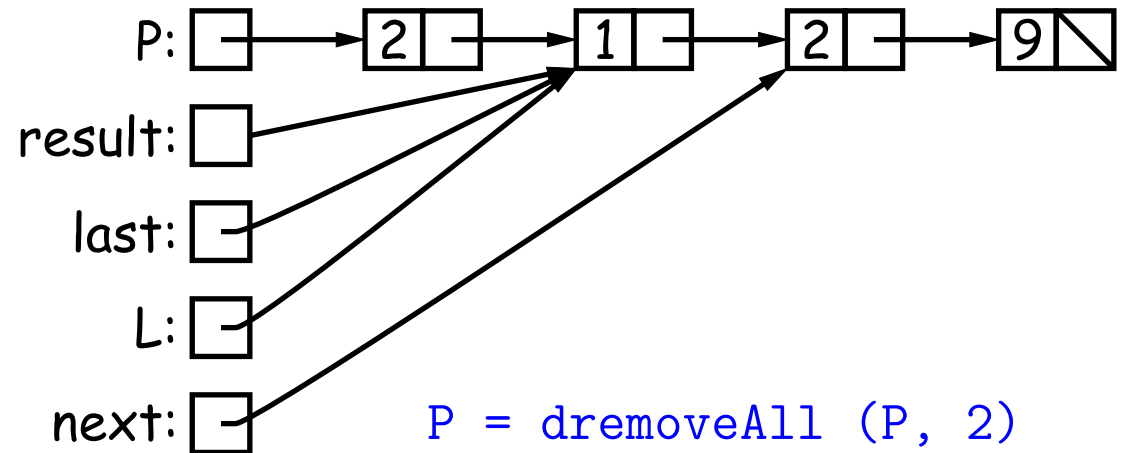


`P = dremoveAll (P, 2)`

Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
```

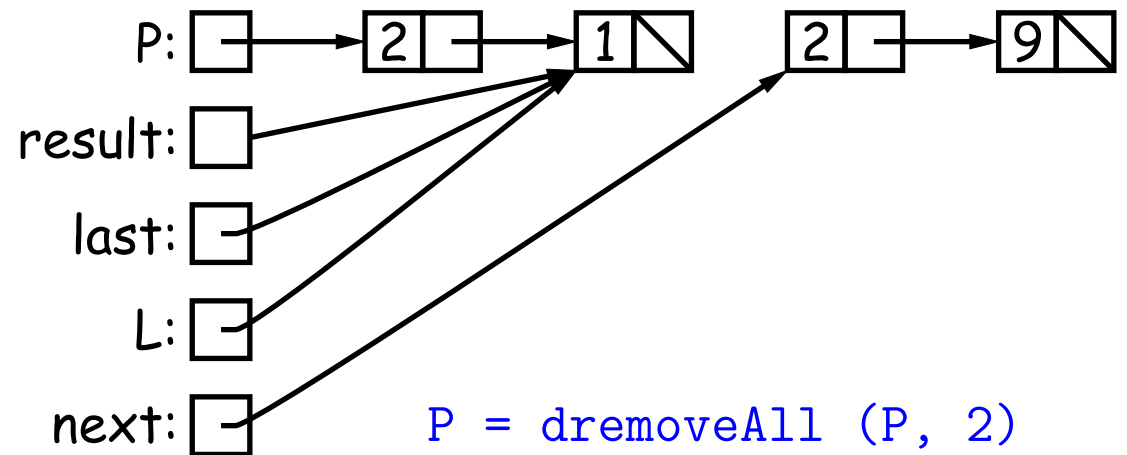
```
static IntList dremoveAll(IntList L, int x) {
  IntList result, last;
  result = last = null;
  while (L != null) {
    IntList next = L.tail;
    if (x != L.head) {
      if (last == null)
        result = last = L;
      else
        last = last.tail = L;
      L.tail = null;
    }
    L = next;
  }
  return result;
}
```



Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
```

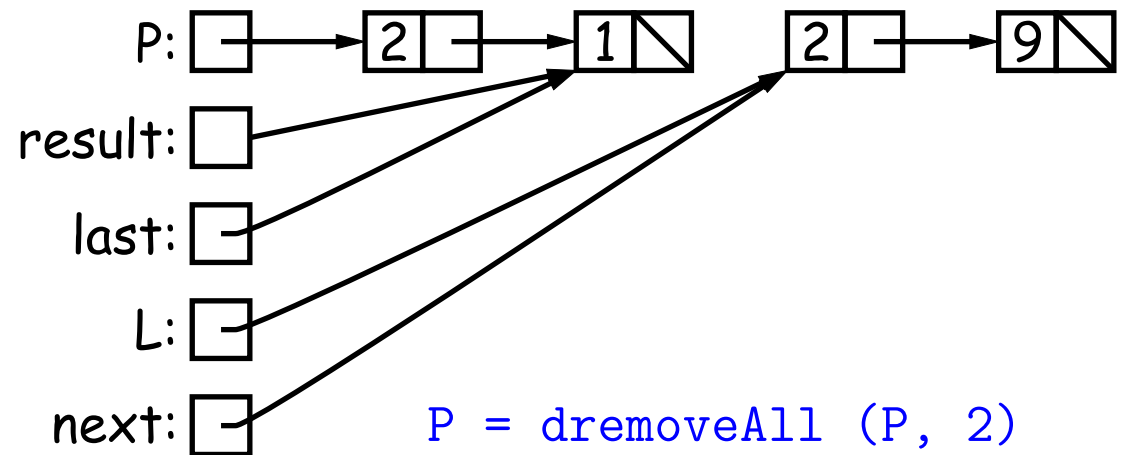
```
static IntList dremoveAll(IntList L, int x) {
  IntList result, last;
  result = last = null;
  while (L != null) {
    IntList next = L.tail;
    if (x != L.head) {
      if (last == null)
        result = last = L;
      else
        last = last.tail = L;
      L.tail = null;
    }
    L = next;
  }
  return result;
}
```



Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
```

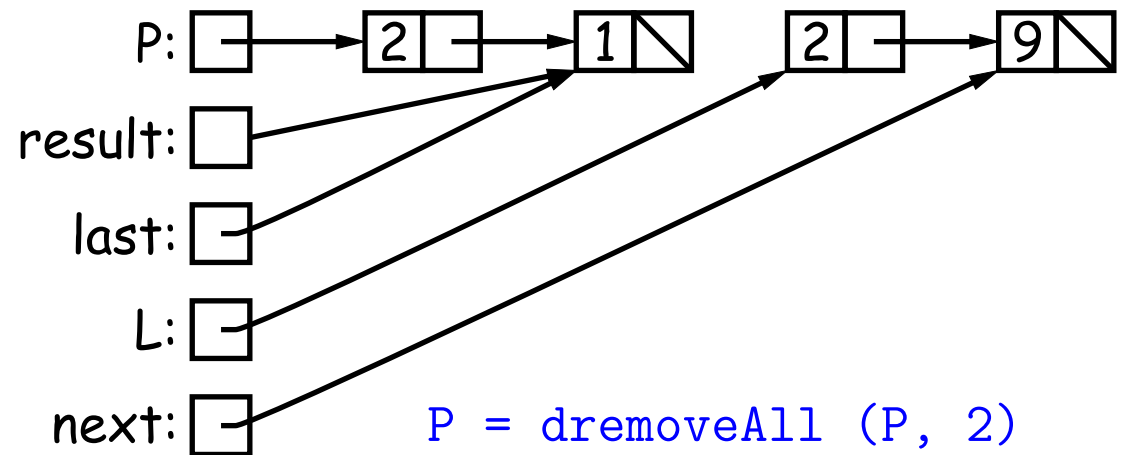
```
static IntList dremoveAll(IntList L, int x) {
  IntList result, last;
  result = last = null;
  while (L != null) {
    IntList next = L.tail;
    if (x != L.head) {
      if (last == null)
        result = last = L;
      else
        last = last.tail = L;
      L.tail = null;
    }
    L = next;
  }
  return result;
}
```



Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
```

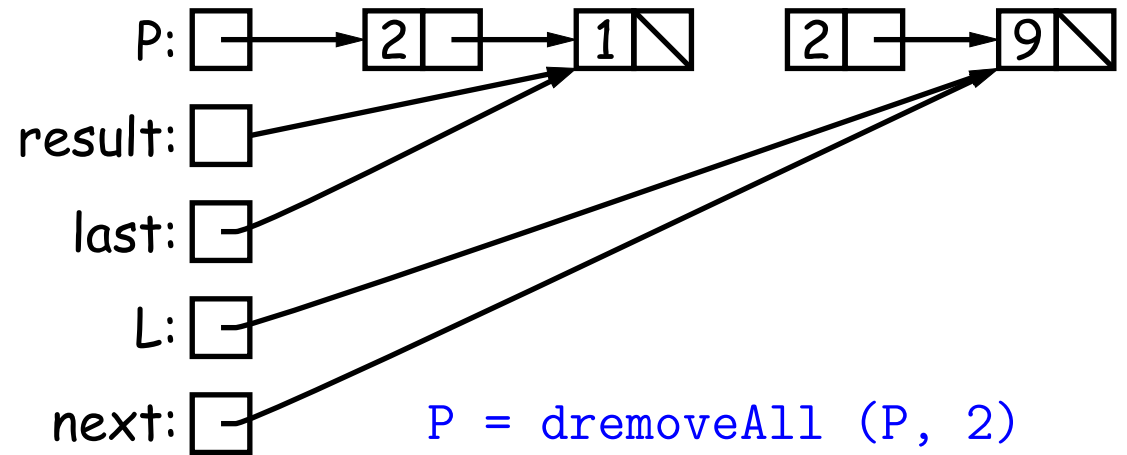
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  IntList result, last;
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    if (x != L.head) {
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        last = last.tail = L;
      L.tail = null;
    }
    L = next;
  }
  return result;
}
```



Iterative Destructive Deletion

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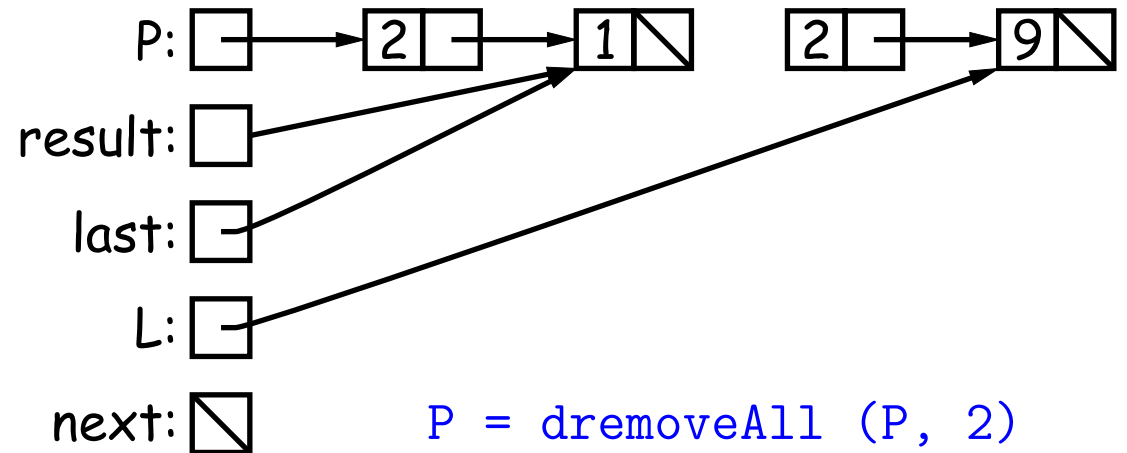
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        last = last.tail = L;
      L.tail = null;
    }
    L = next;
  }
  return result;
}
```



Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
```

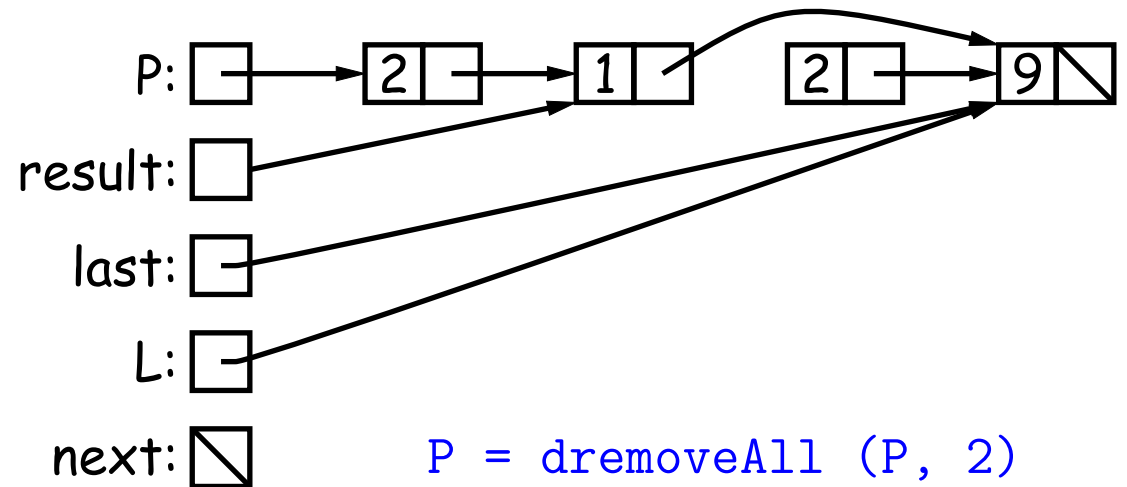
```
static IntList dremoveAll(IntList L, int x) {
  IntList result, last;
  result = last = null;
  while (L != null) {
    IntList next = L.tail;
    if (x != L.head) {
      if (last == null)
        result = last = L;
      else
        last = last.tail = L;
      L.tail = null;
    }
    L = next;
  }
  return result;
}
```



Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
```

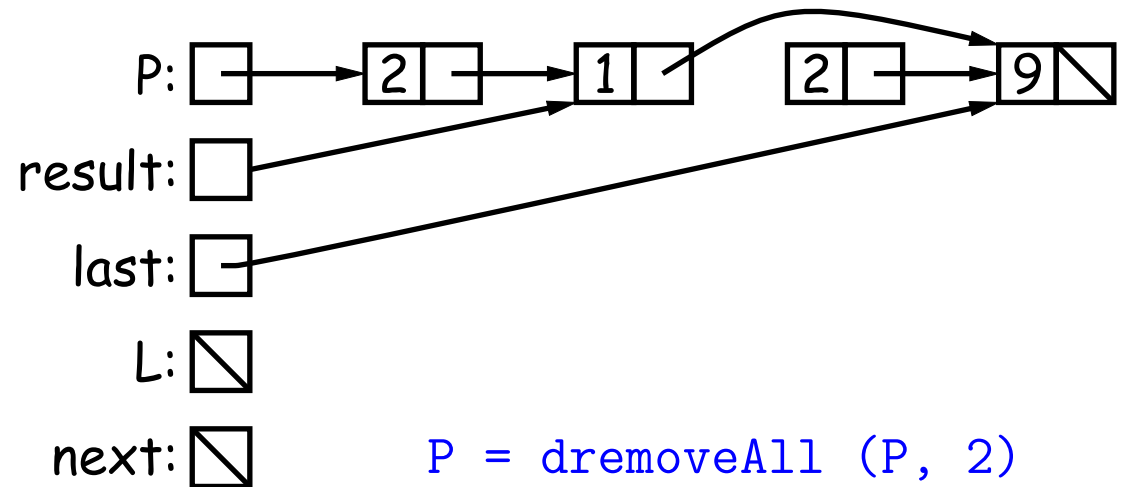
```
static IntList dremoveAll(IntList L, int x) {
  IntList result, last;
  result = last = null;
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    if (x != L.head) {
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        last = last.tail = L;
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    }
    L = next;
  }
  return result;
}
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            else
                last = last.tail = L;
            L.tail = null;
        }
        L = next;
    }
    return result;
}
```

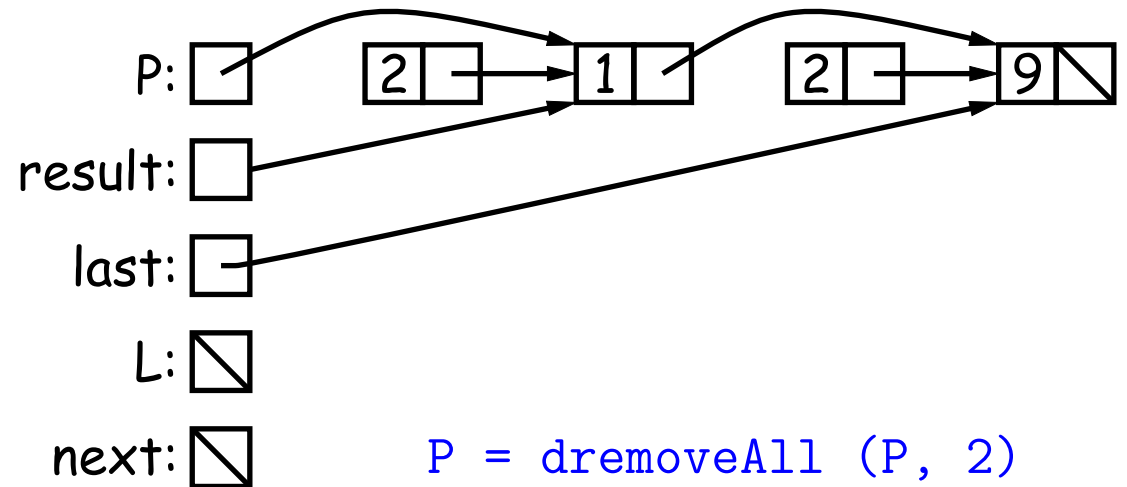


`P = dremoveAll (P, 2)`

Iterative Destructive Deletion

```
/** The list resulting from removing all X's from L
 * destructively. */
```

```
static IntList dremoveAll(IntList L, int x) {
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                last = last.tail = L;
            L.tail = null;
        }
        L = next;
    }
    return result;
}
```



`P = dremoveAll (P, 2)`