CS61B Lecture #4: Simple Pointer Manipulation

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

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

Announcements

- **Today:** More pointer hacking.
- **Handing in labs and homework:** We'll be lenient about accepting late homework and labs for lab1, lab2, and hw0. Just get it done: part of the point is getting to understand the tools involved. We will *not* accept submissions by email.
- We will feel free to interpret the absence of a central repository for you or a lack of a lab1 submission from you as indicating that you intend to drop the course.

Small Test of Understanding

- In Java, the keyword **final** in a variable declaration means that the variable's value may not be changed after the variable is initialized.
- Is the following class valid?

```
public class Issue {

    private final IntList aList = new IntList(0, null);

    public void modify(int k) {
        this.aList.head = k;
    }
}
```

Why or why not?

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- In Java, the keyword **final** in a variable declaration means that the variable's value may not be changed after the variable is initialized.
- Is the following class valid?

```
public class Issue {

    private final IntList aList = new IntList(0, null);

    public void modify(int k) {
        this.aList.head = k;
    }
}
```

Why or why not?

Answer: This is *valid*. Although `modify` changes the `head` variable of the object pointed to by `aList`, it does *not* modify the contents of `aList` itself (which is a pointer).

Destructive Incrementing

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

```
/** Destructively add N to P's items.
 *  Return modified list. */
static IntList dincrList(IntList P, int n) {


}
```

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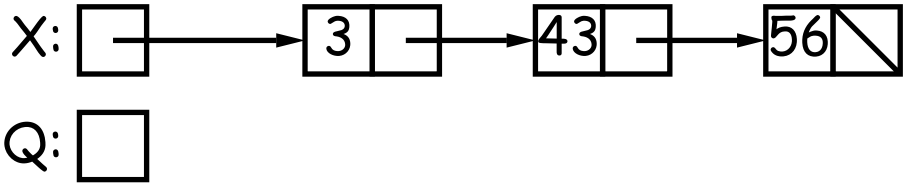

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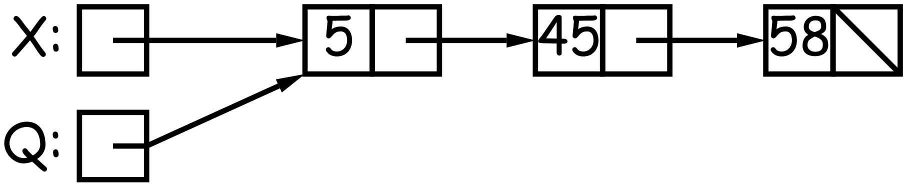

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/** Destructively add N to P's items.
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static IntList dincrList(IntList P, int n) {
  if (P == null)
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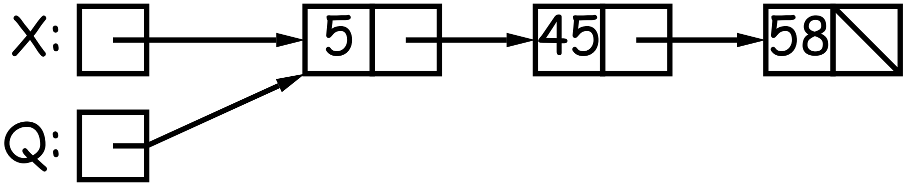

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static IntList dincrList(IntList P, int n) {
  if (P == null)
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  else {
    P.head += n;
    P.tail = dincrList(P.tail, n);
    return P;
  }
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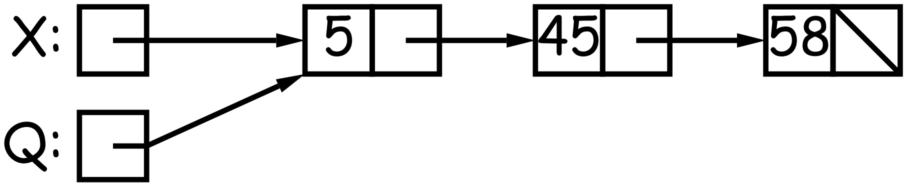

Iterative Destructive Incrementing

Let's try using a **while** loop:

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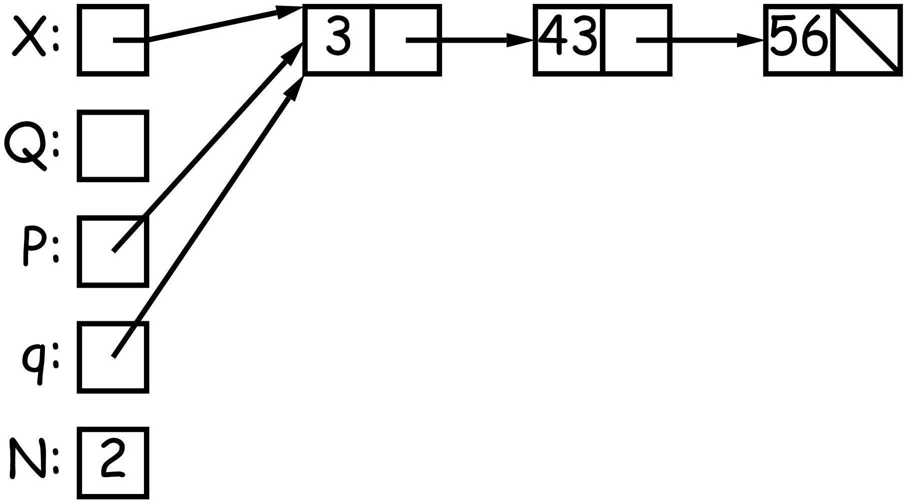

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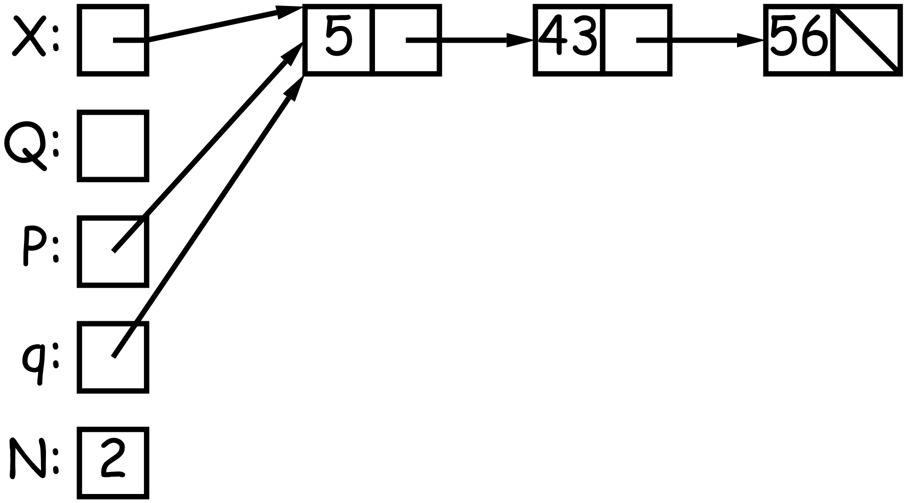

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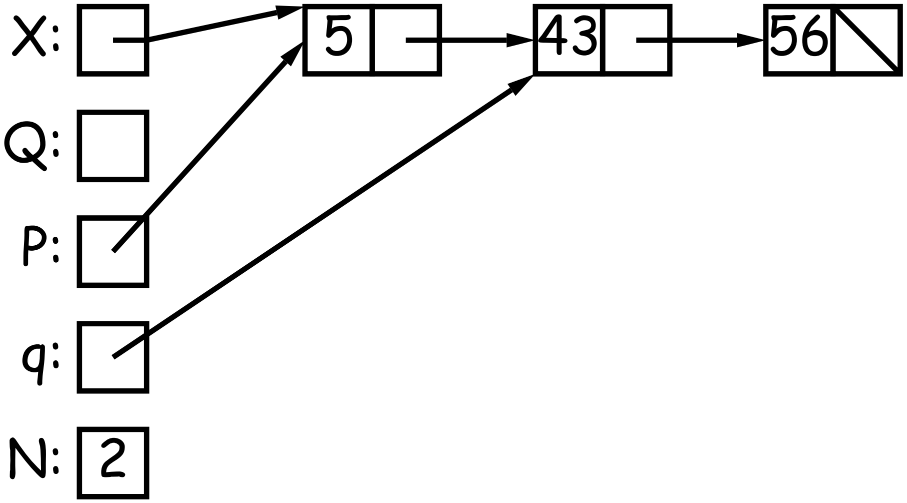

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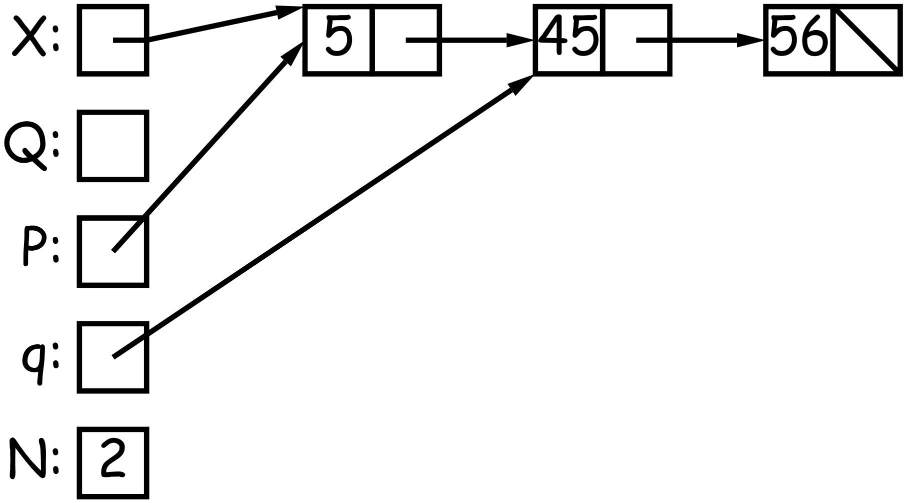

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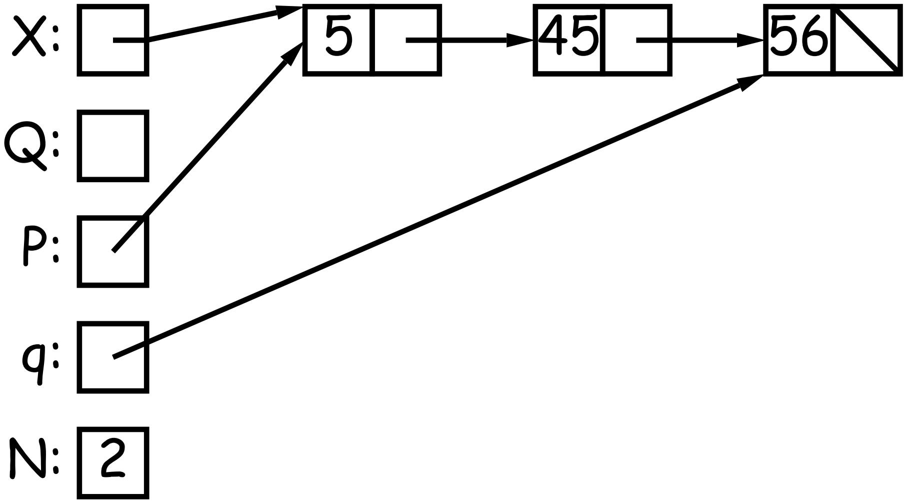

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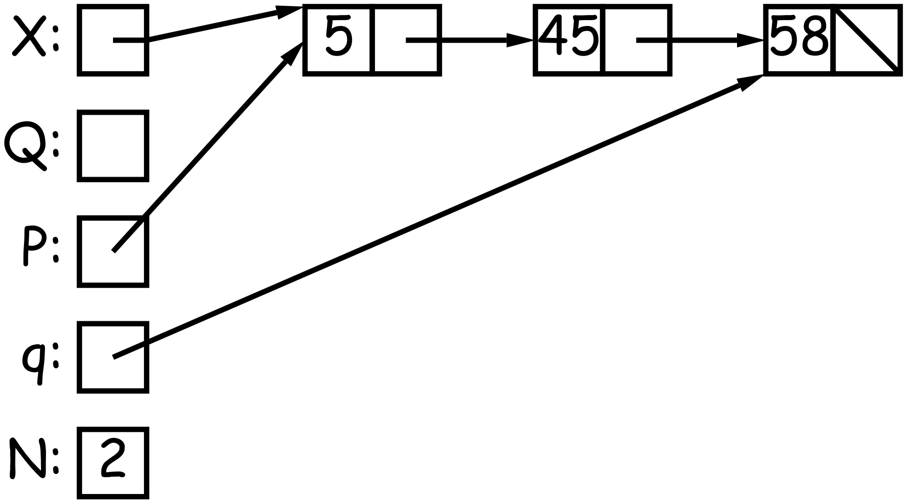

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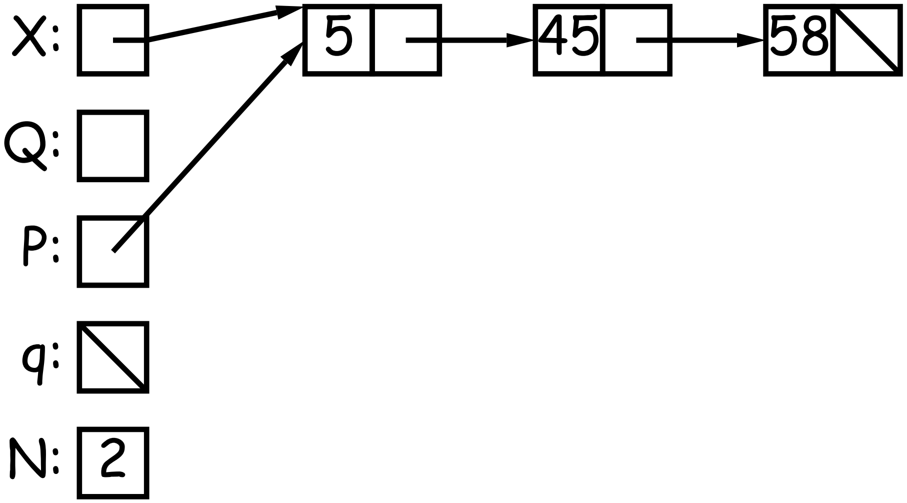

Iterative Destructive Incrementing

Let's try using a **while** loop:

```
/** Destructively add N to P's items.
 *  Return modified list. */
static IntList dincrList(IntList P, int n) {
  IntList q;
  q = P;
  while (?) {
  }
  return ?;
}
```

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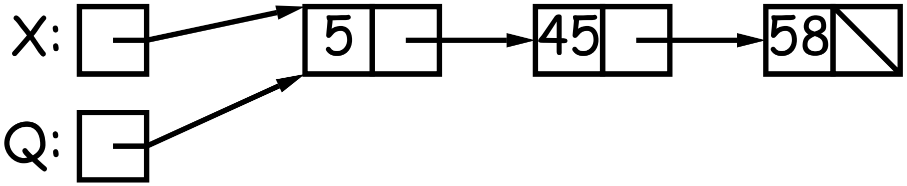

Iterative Destructive Incrementing

Let's try using a **while** loop:

```
/** Destructively add N to P's items.
 *  Return modified list. */
static IntList dincrList(IntList P, int n) {
  IntList q;
  q = P;
  while (q != null) {
    q.head += n;
    q = q.tail;
  }
  return P;
}
```

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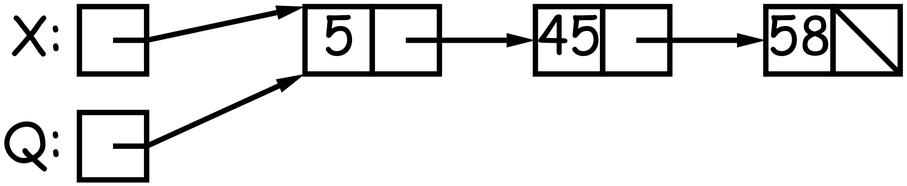

Iterative Destructive Incrementing

Let's try using a **while** loop:

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

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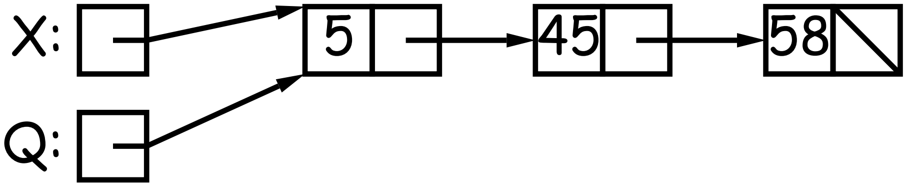

Another Example: Non-destructive List Deletion

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) )*/;
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static IntList removeAll(IntList L, int x) {
  if (L == null)
     return null;
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     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;
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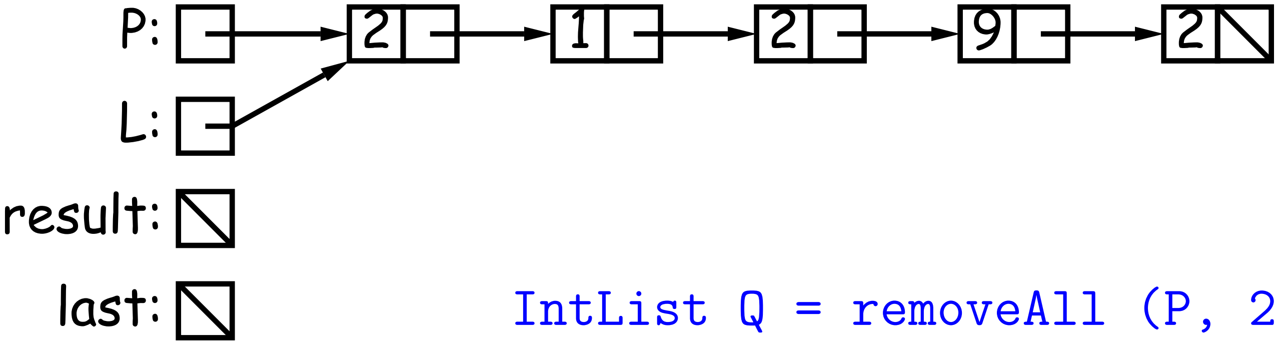

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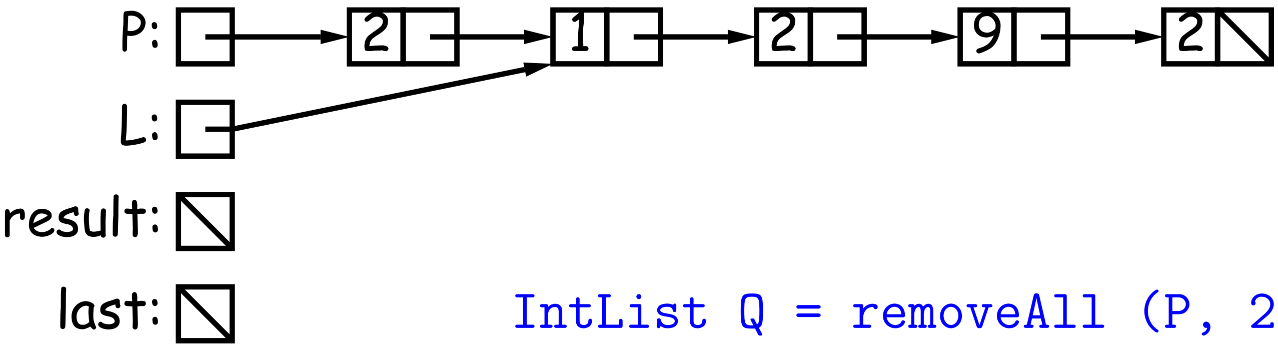

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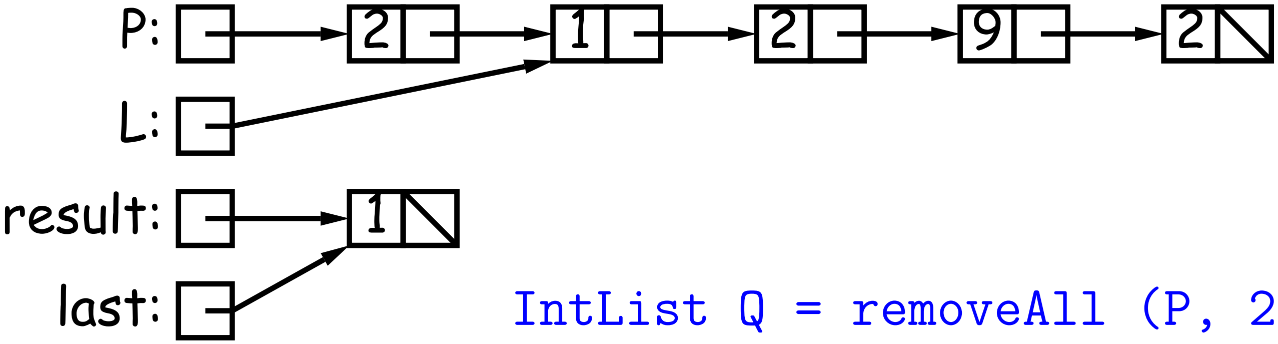

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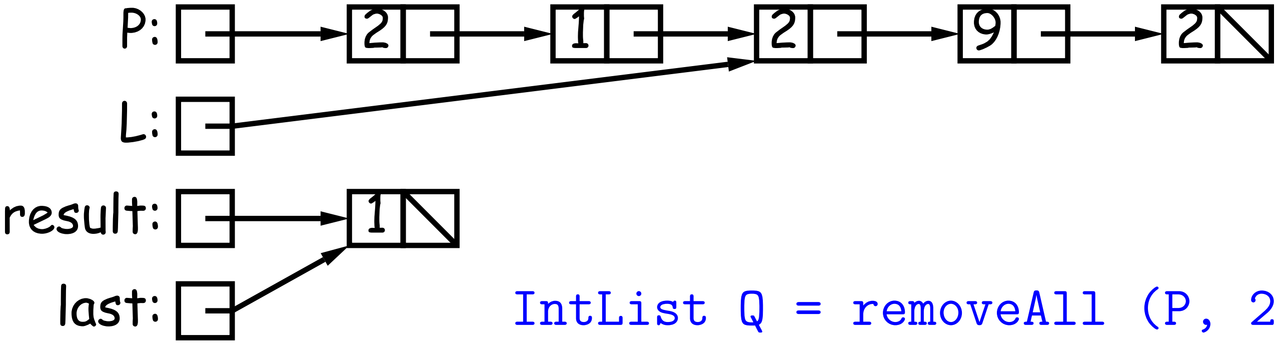

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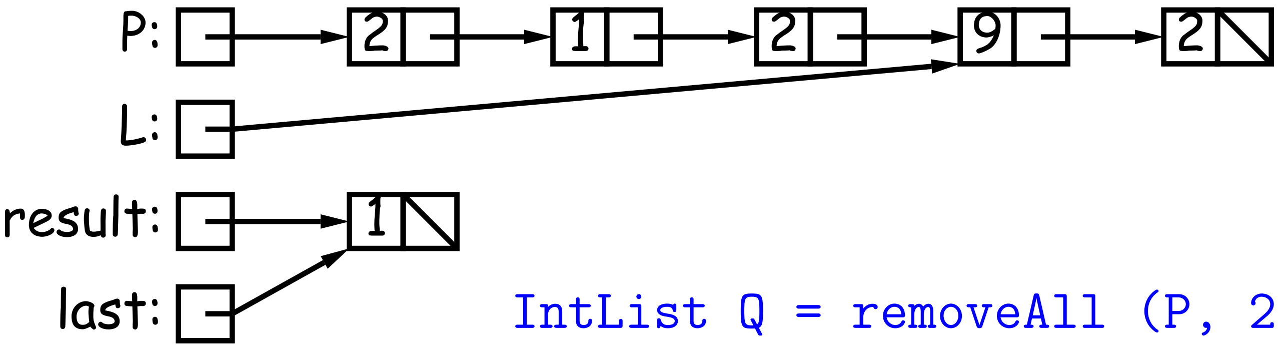

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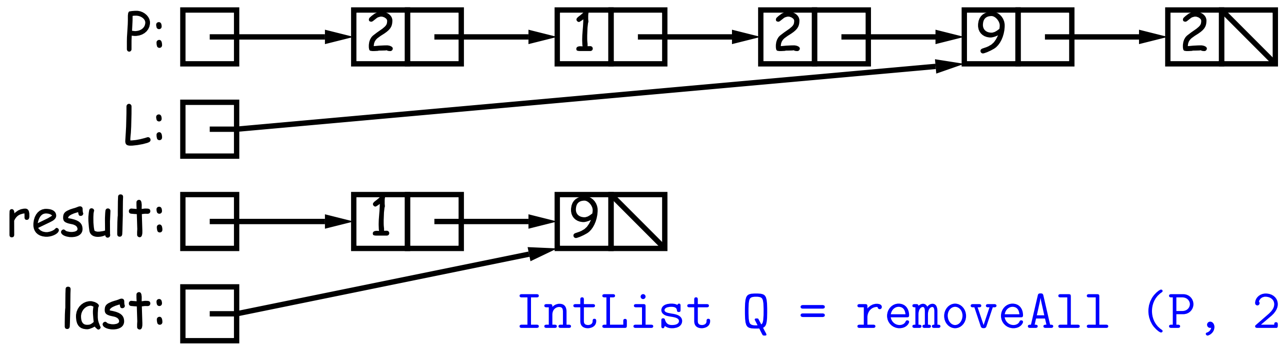

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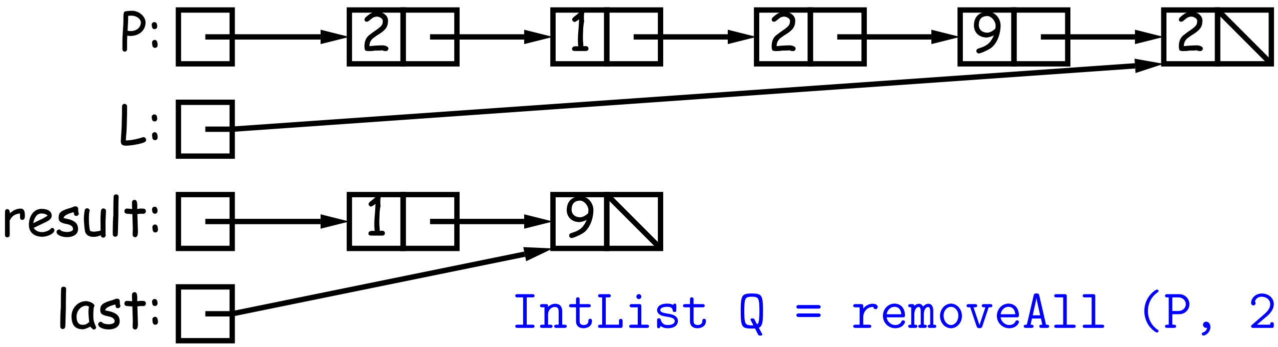

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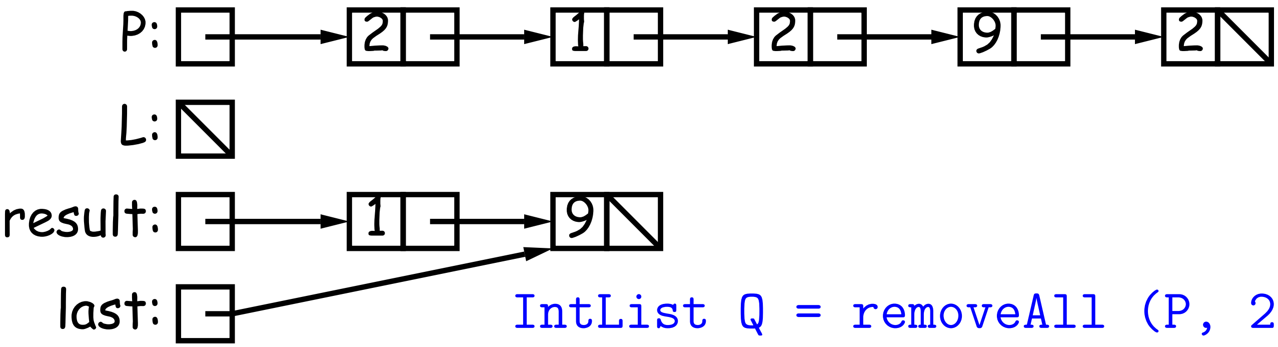

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static IntList removeAll(IntList L, int x) {
  IntList result, last;
  result = last = null;
  for ( ; L != null; L = L.tail) {
    if (x == L.head)
      continue;
    else if (last == null)
      result = last = new IntList(L.head, null);
    else
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  return result;
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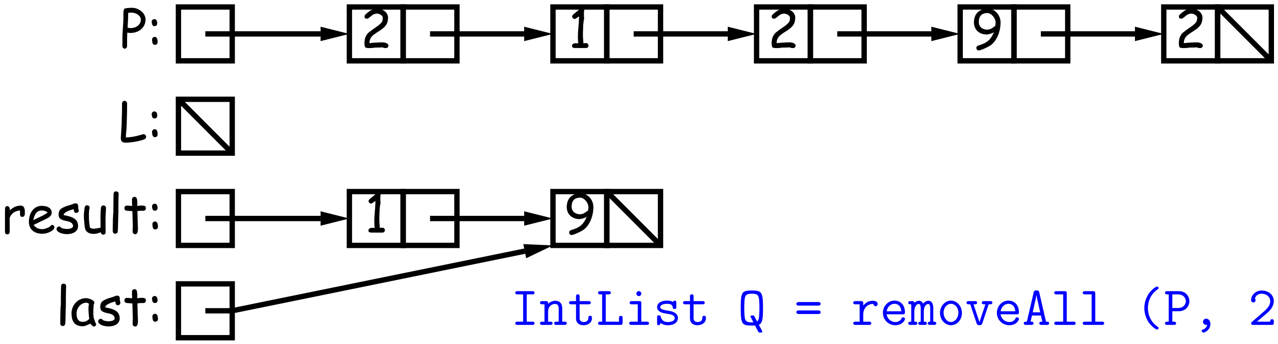

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      continue;
    else if (last == null)
      result = last = new IntList(L.head, null);
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  }
  return result;
}
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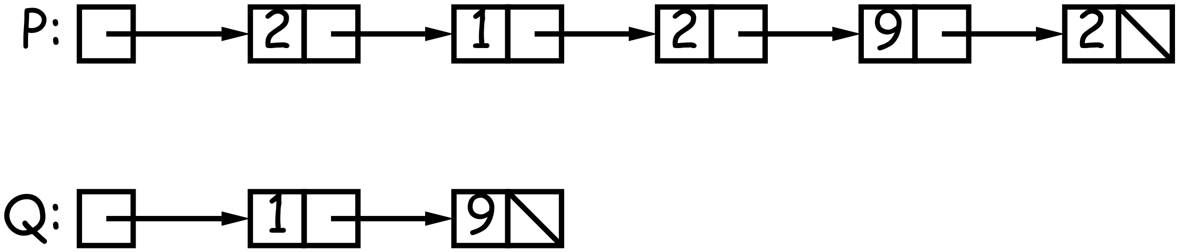

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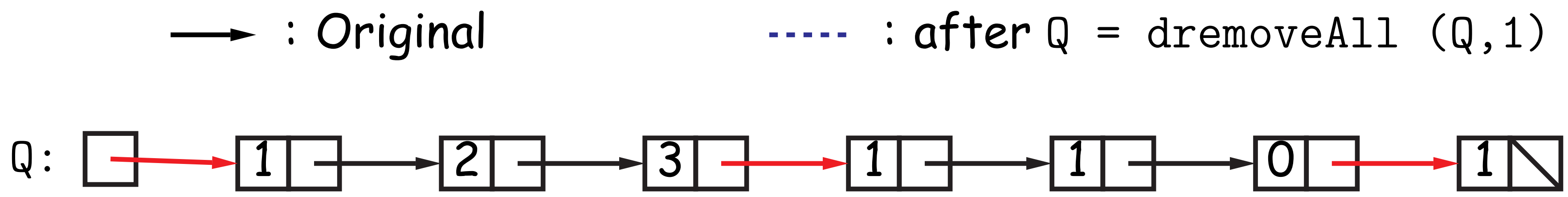
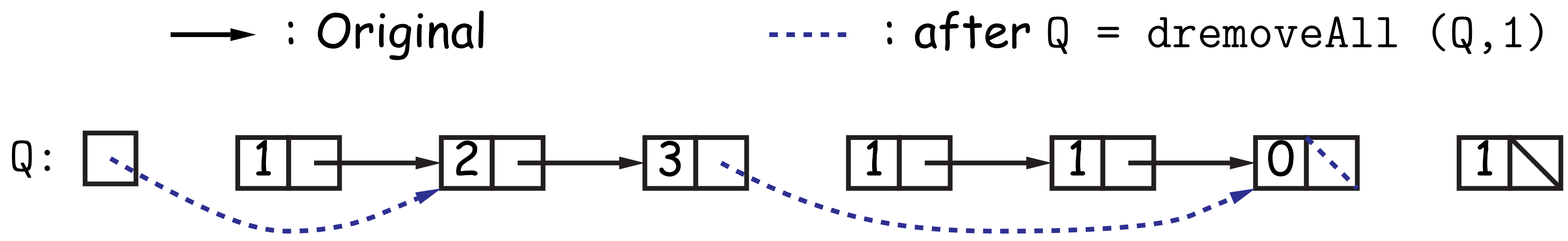
Destructive Deletion



→ : 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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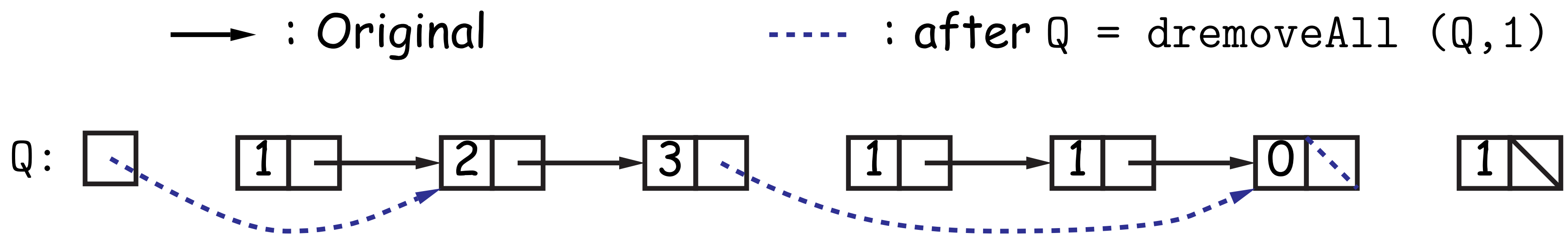

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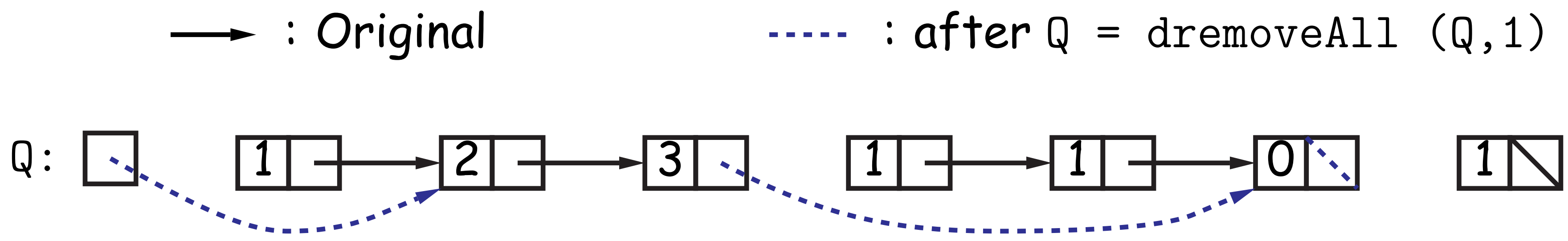

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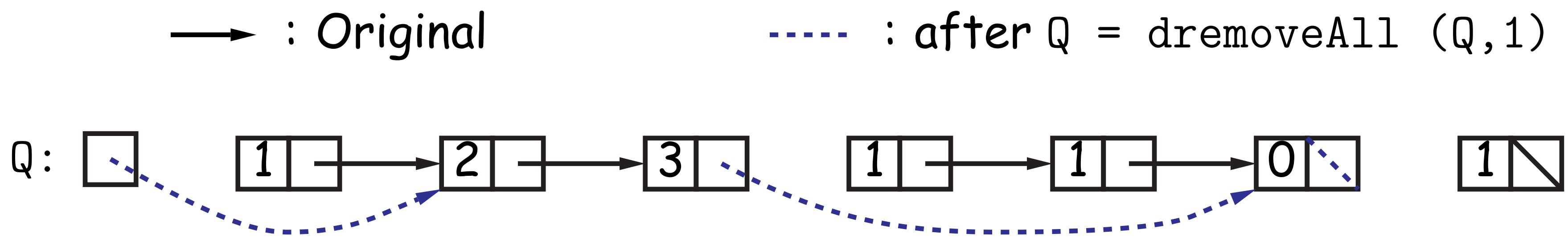

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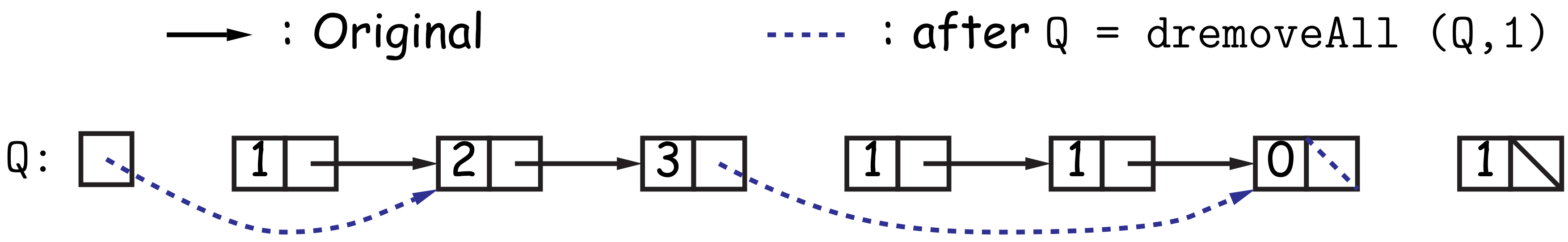
/** The list resulting from removing all instances of X from L.
 *  The original list may be destroyed. */
static IntList dremoveAll(IntList L, int x) {
  if (L == null)
     return null;
  else if (L.head == x)
     return /*( L with all x's removed (L != null) )*/;
  else {
     /*{ Remove all x's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

Destructive Deletion



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  else if (L.head == x)
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  else {
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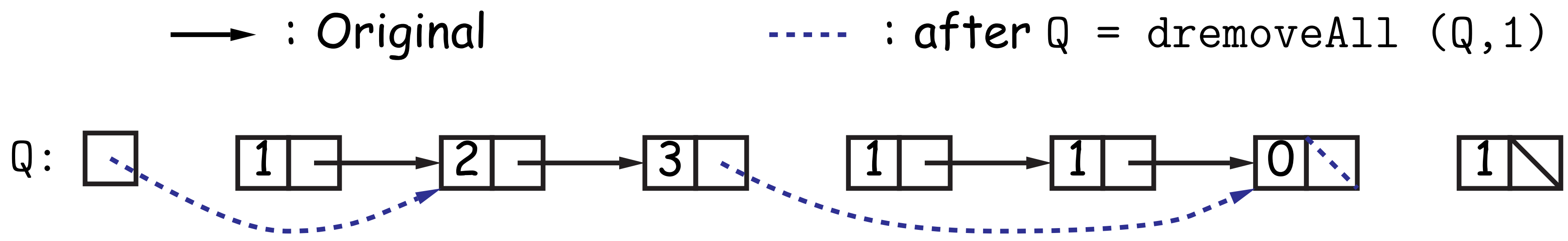
Destructive Deletion



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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, next;
  result = last = null;
  while (L != null) {

    // FIXME

  }
  return result;
}
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Iterative Destructive Deletion

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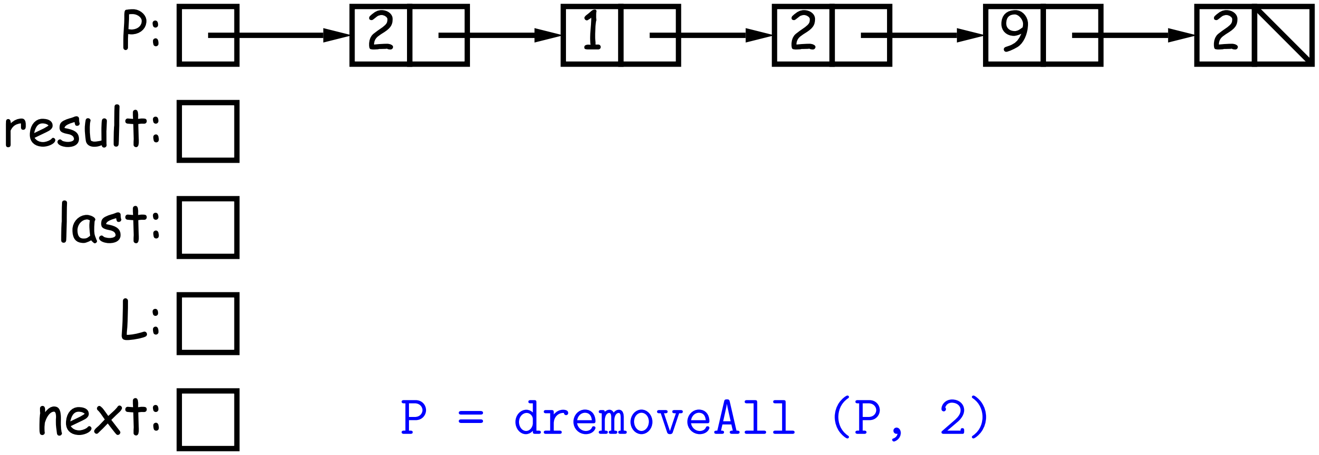

P = dremoveAll (P, 2)

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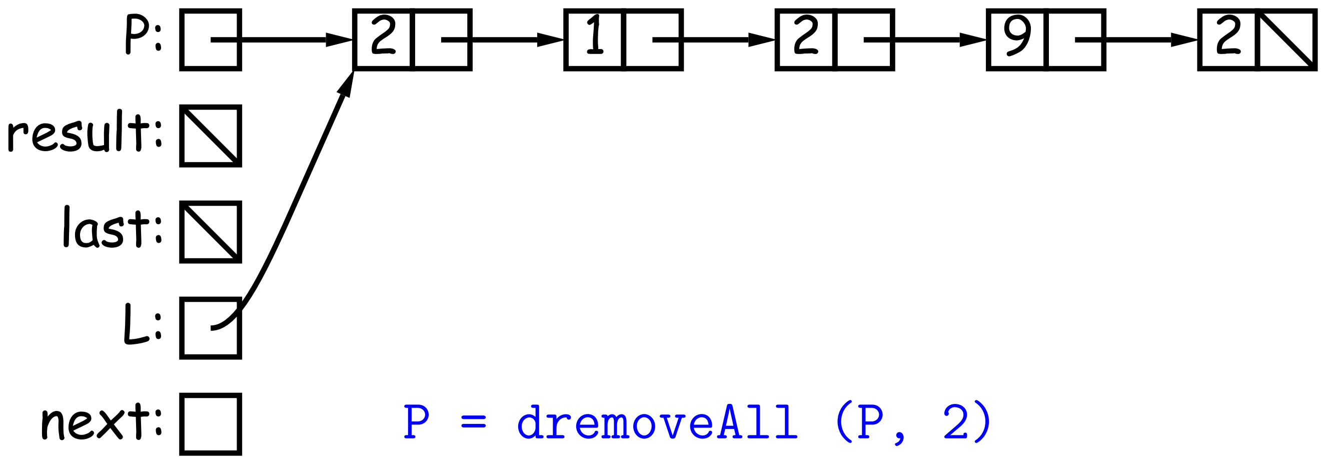

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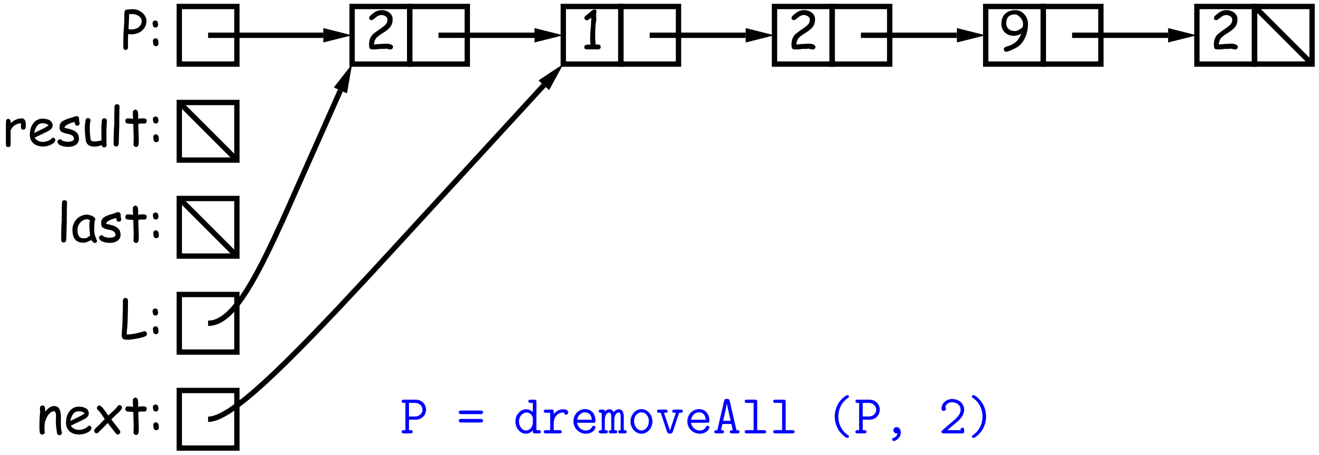

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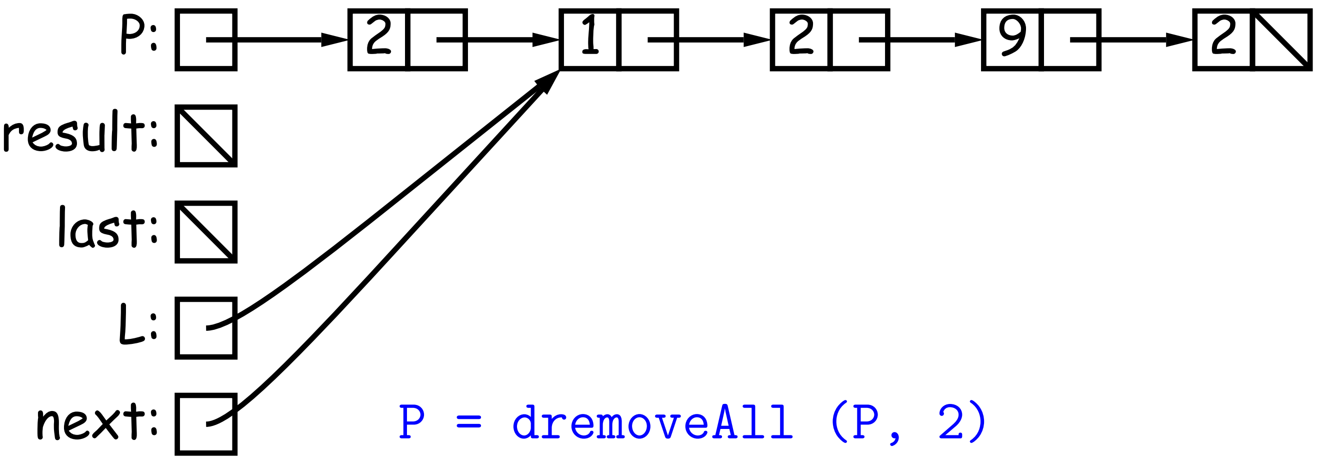

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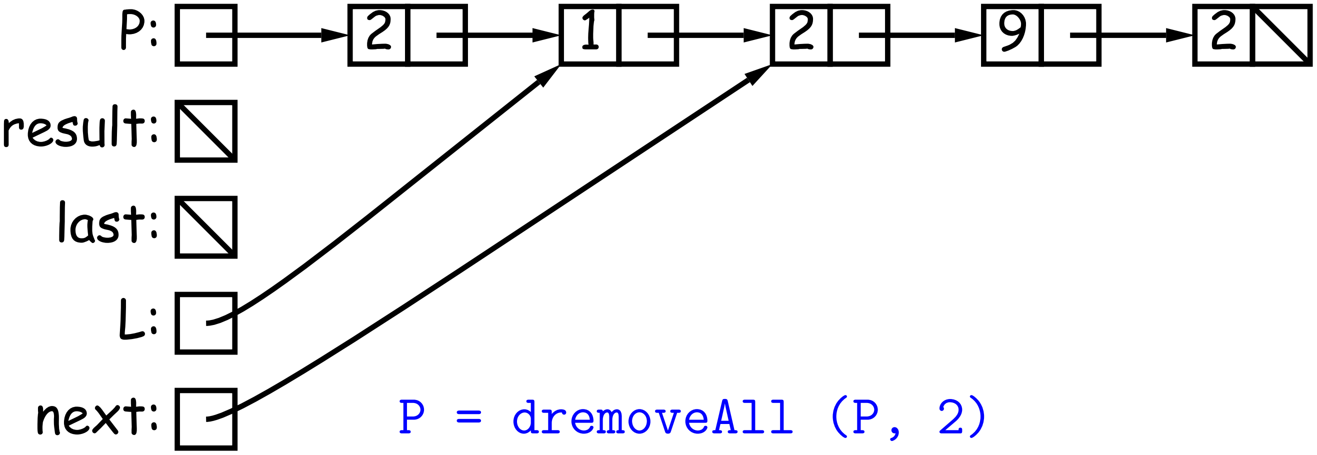

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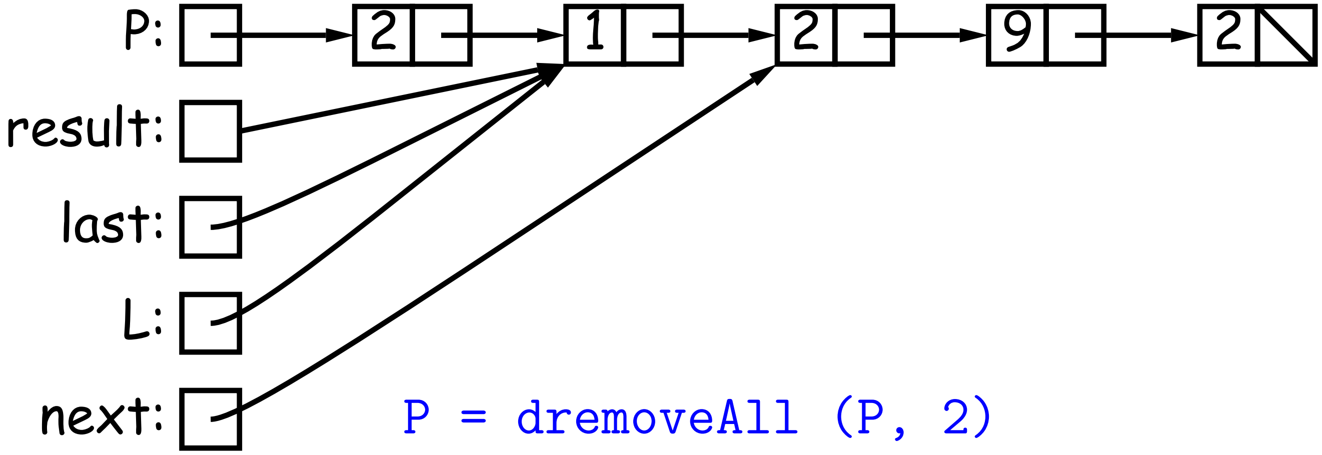

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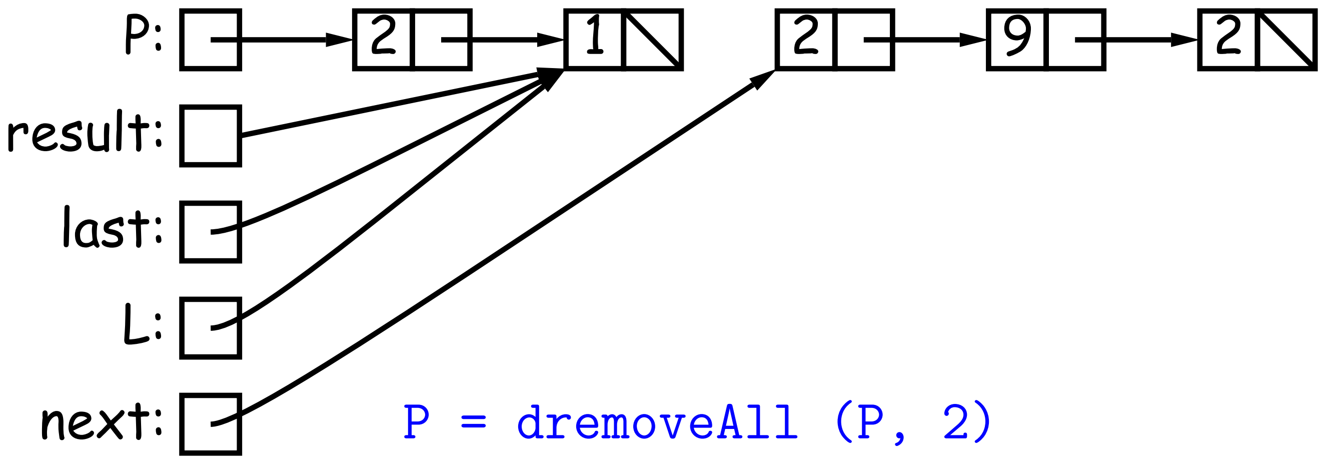

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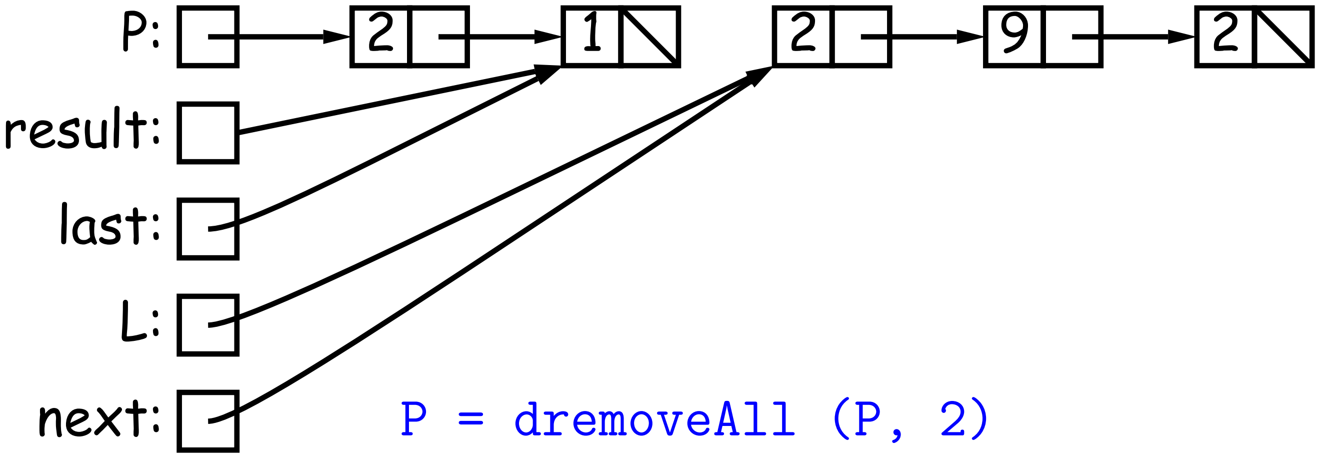

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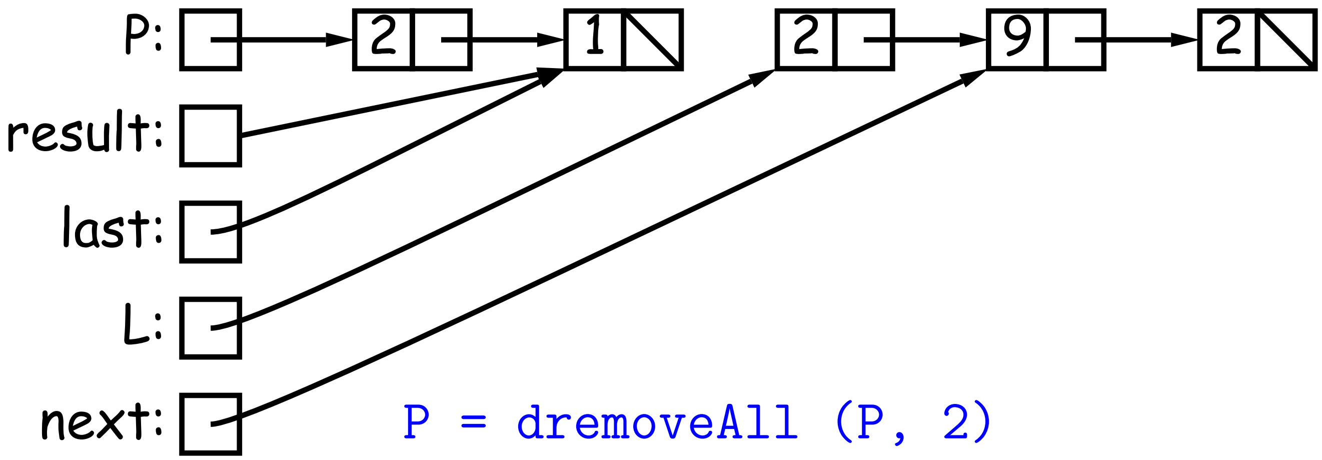

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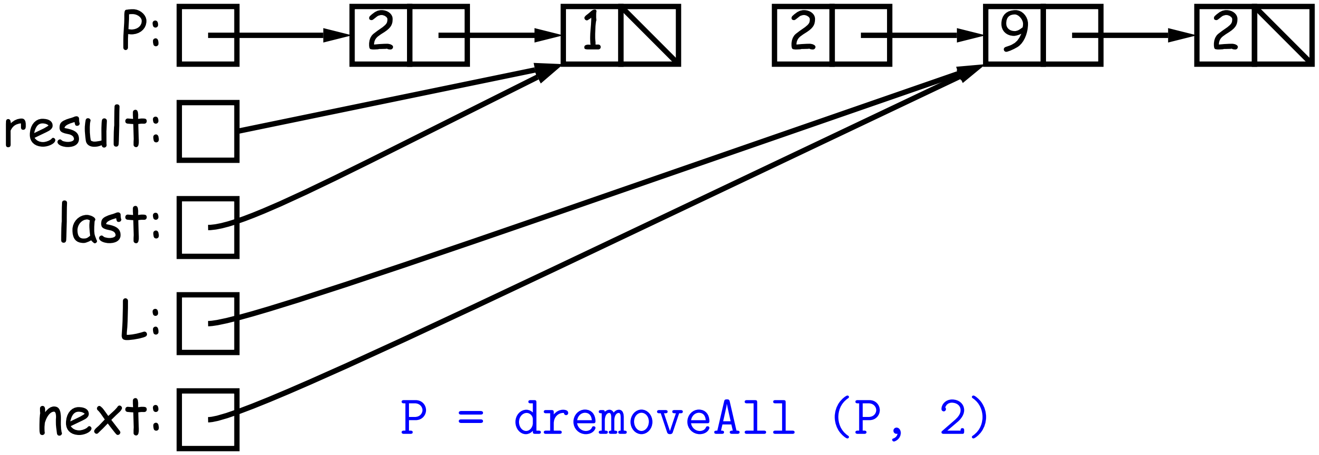

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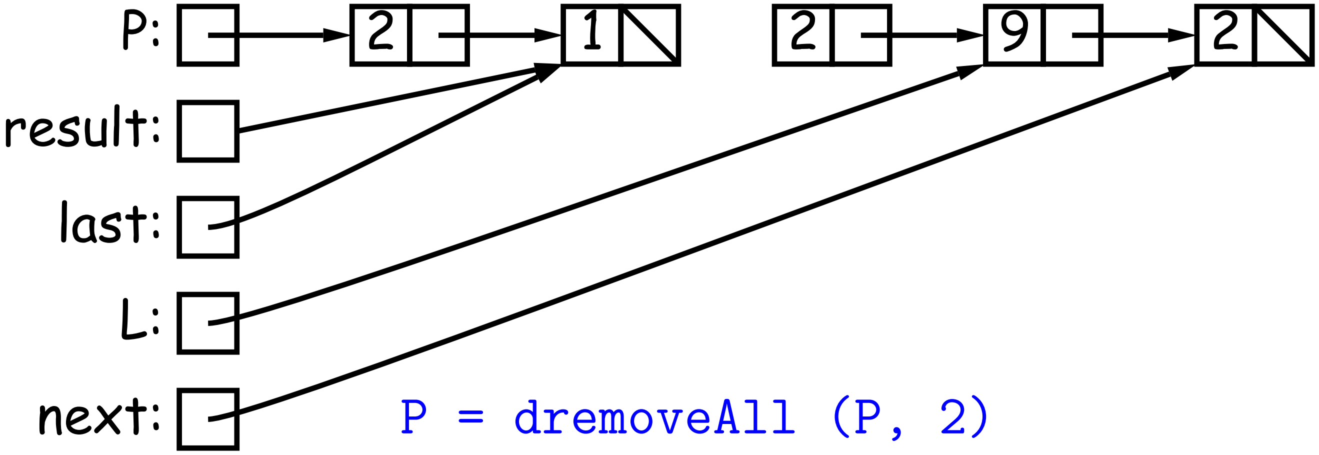

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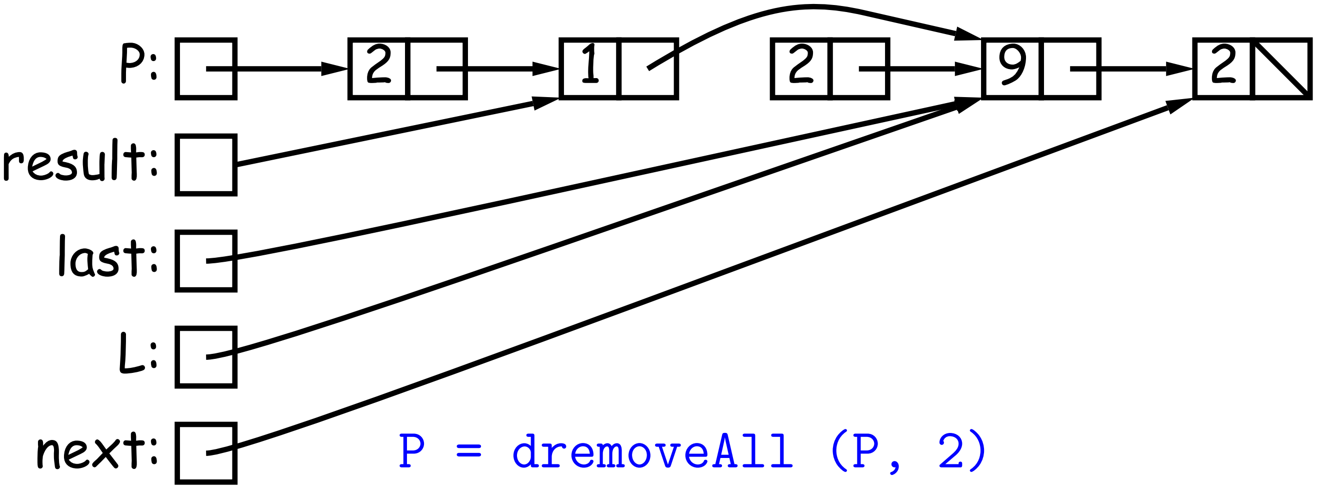

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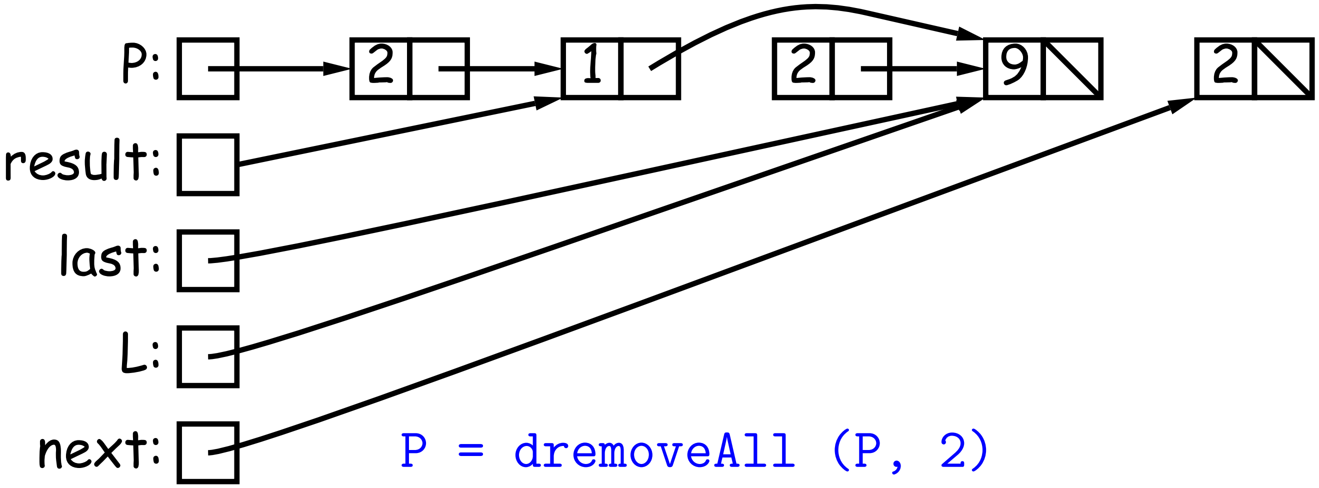

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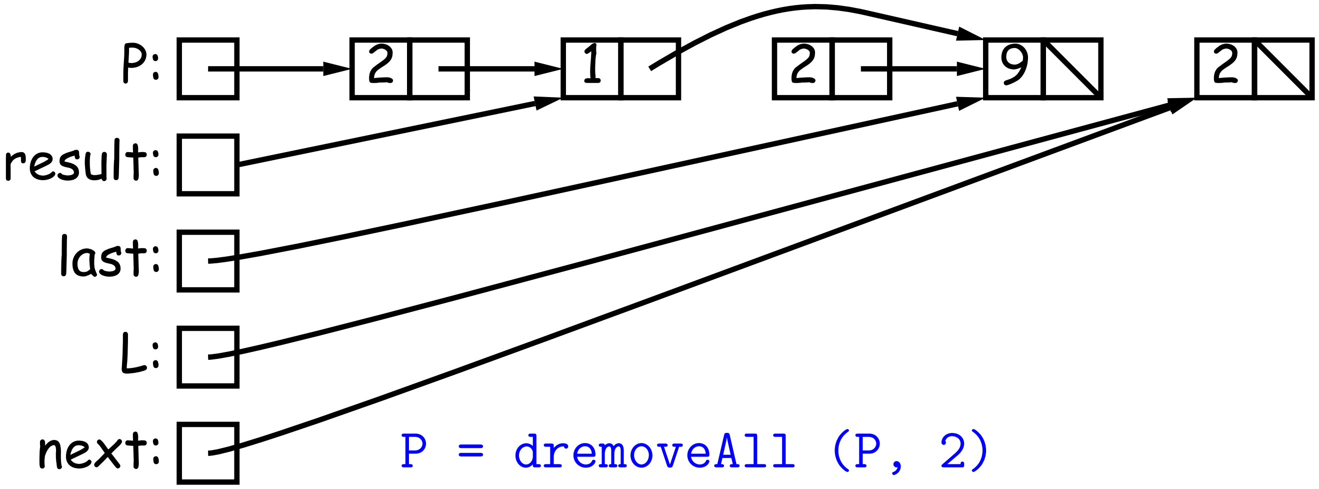

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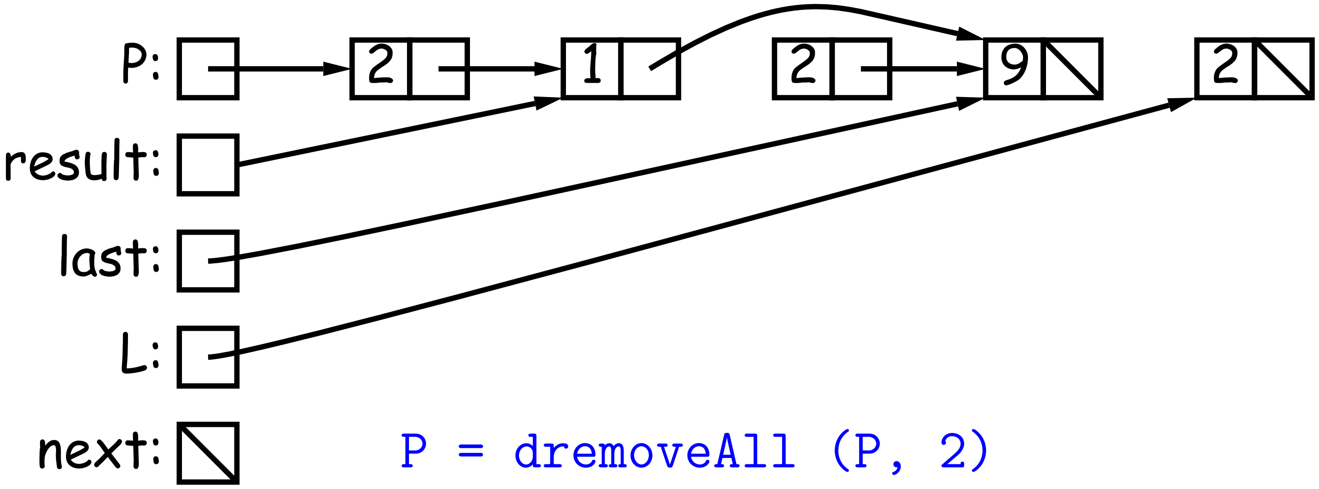

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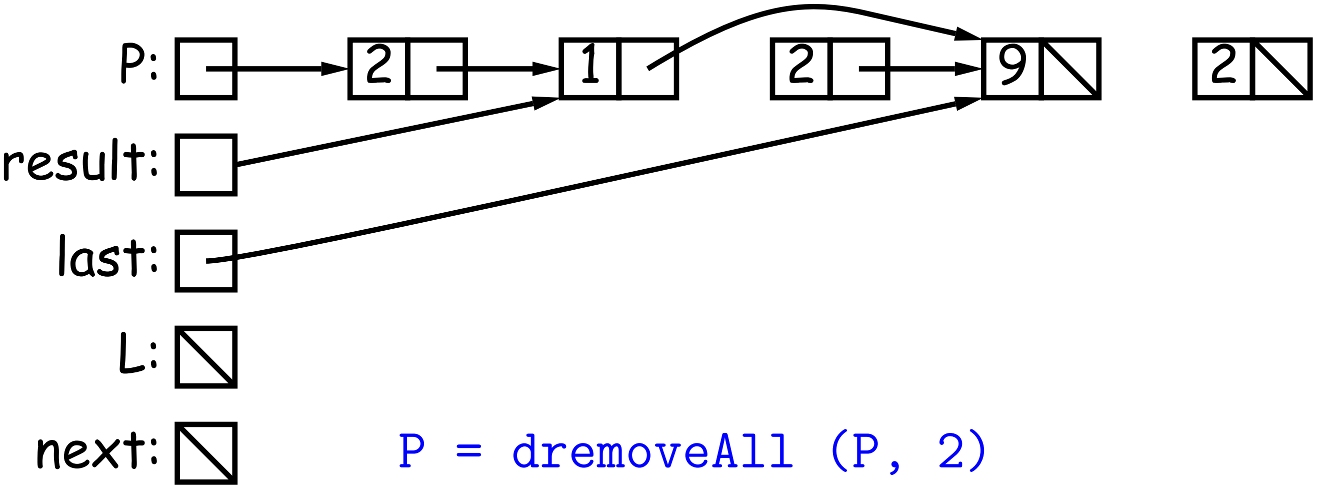

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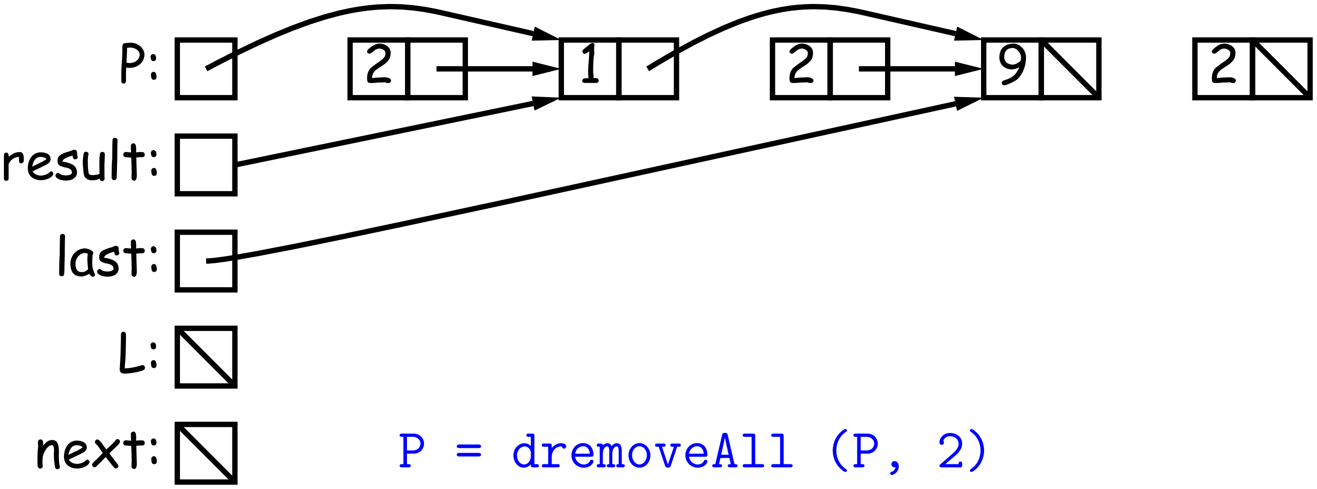

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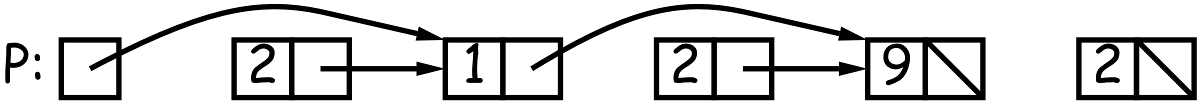

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  IntList result, last, next;
  result = last = null;
  while (L != null) {
    next = L.tail;
    if (x != L.head) {
      if (last == null)
        result = last = L;
      else
        last = last.tail = L;
      L.tail = null;
    }
    L = next;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

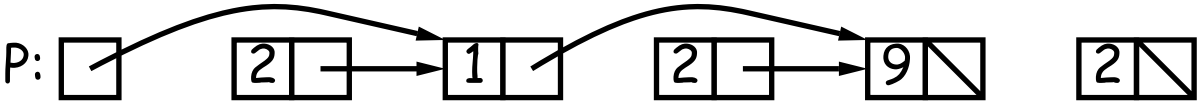

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