Basics on Pointers

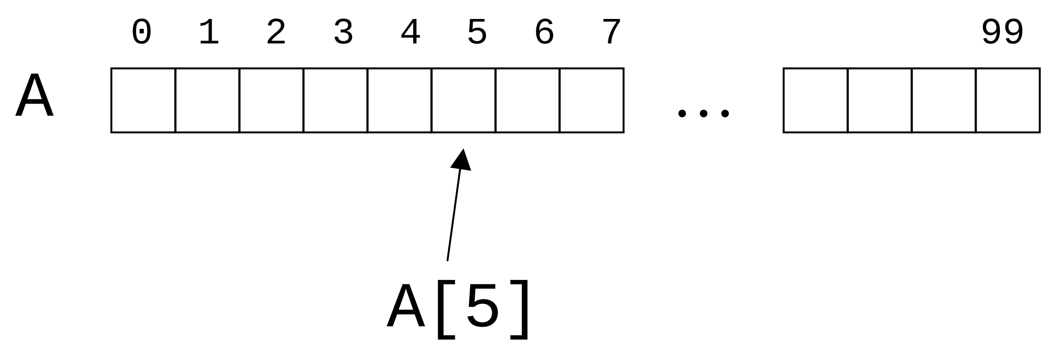
CSE 373

Data Structures

Lecture 2

Basic Types and Arrays

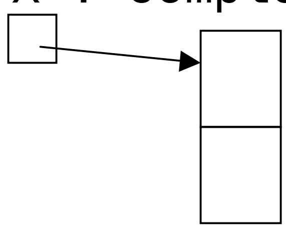
- Basic Types
  - › integer, real (floating point), boolean (0,1), character
- Arrays
  - › A[0..99] : integer array



Records and Pointers

- Record (also called a struct)
  - Group data together that are related

```
X : complex pointer
```



```
real_part : real

imaginary_part : real
```

  - To access the fields we use “dot” notation.

```
X.real_part
X.imaginary_part
```

Record Definition

- Record definition creates a new type

Definition

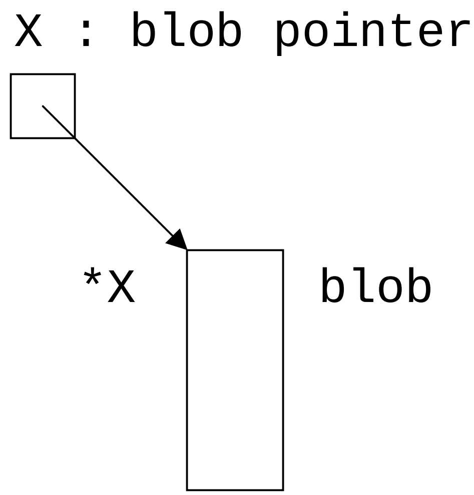
```
record complex : (
  real_part : real,
  imaginary_part : real
)
```

Use in a declaration

```
X : complex
```

Pointer

- A pointer is a reference to a variable or record (or object in Java world).

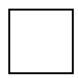


- In C, if X is of type pointer to Y then *X is of type Y

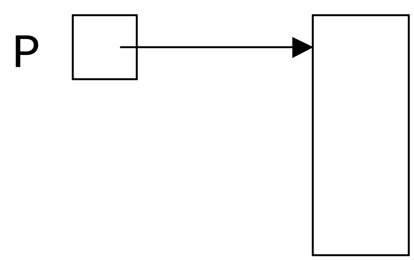
Creating a Record

- We use the “new” operator to create a record.

P : pointer to blob;

P  (null pointer)

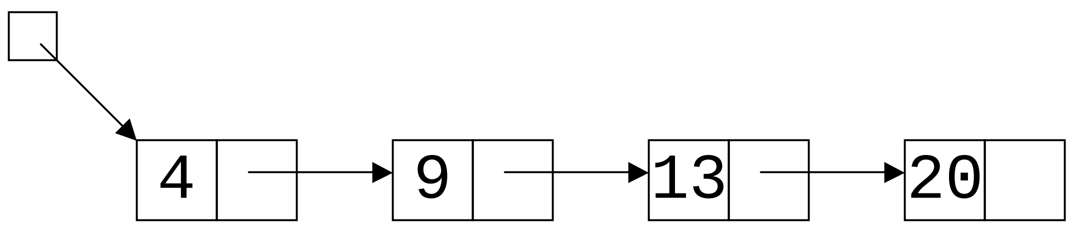
P := new blob;



Simple Linked List

- A linked list
  - › Group data together in a flexible, dynamic way.
  - › We'll describe several list ADTs later.

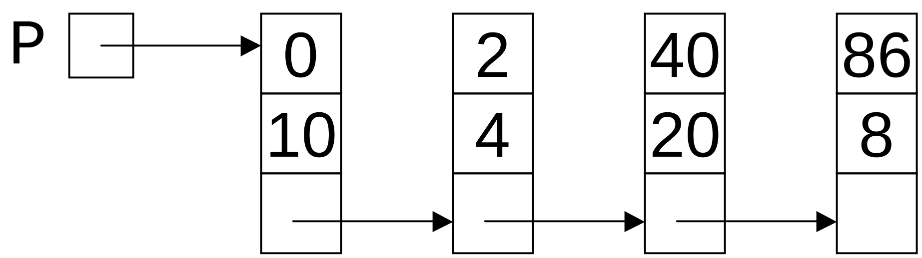
```
L : node pointer
```




```
record node : (
  data : integer
  next : node pointer
)
```

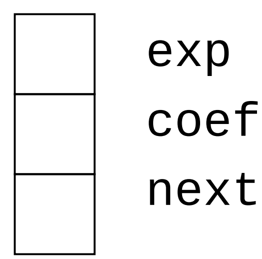
Sparse Polynomials

- $10 + 4\ x^2 + 20\ x^{40} + 8\ x^{86}$

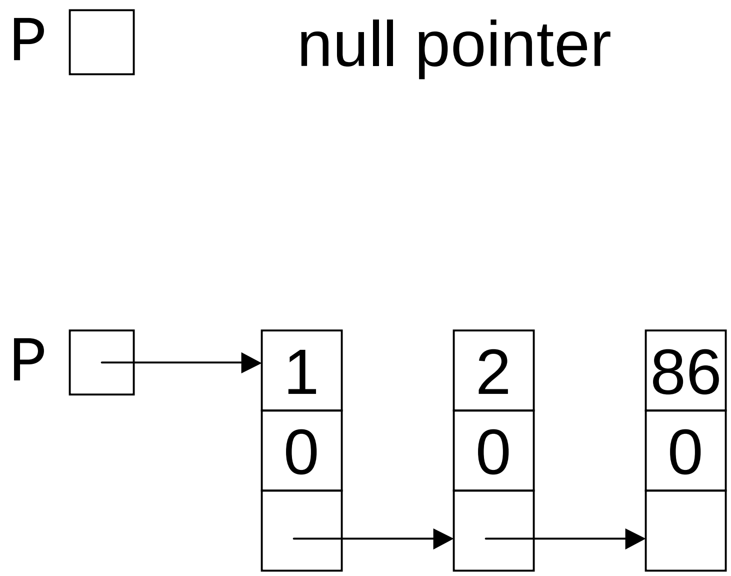


Exponents in Increasing order

```
record poly : (
  exp : integer,
  coef : integer,
  next : poly pointer
)
```

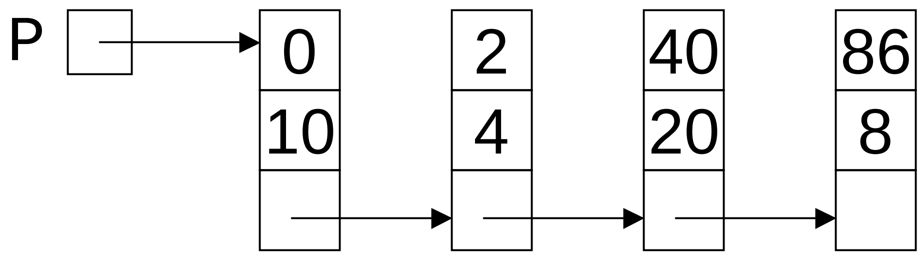


Identically Zero Polynomial

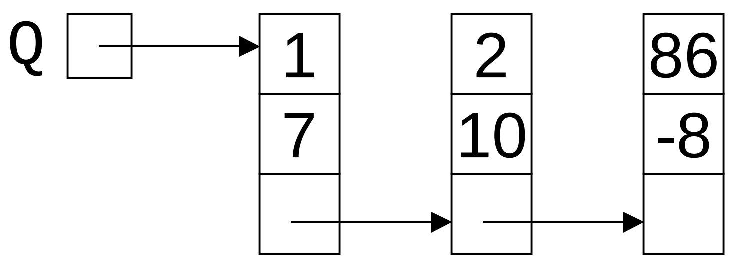


Addition of Polynomials

$10 + 4x^2 + 20x^{40} + 8x^{86}$



$7x + 10x^2 - 8x^{86}$

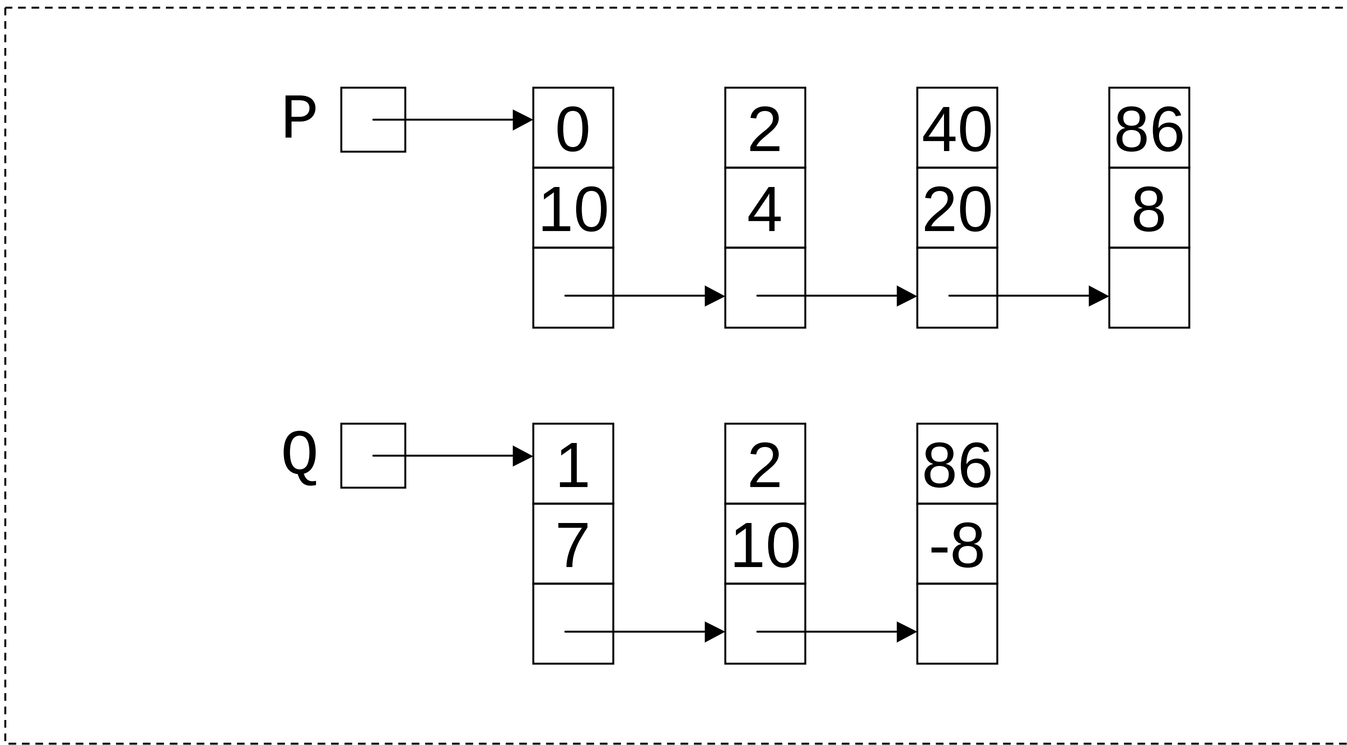


Recursive Addition

```
Add(P, Q : poly pointer): poly pointer{
R : poly pointer
case {
  P = null : R := Q ;
  Q = null : R := P ;
  P.exp < Q.exp : R := P ;
                  R.next := Add(P.next,Q);
  P.exp > Q.exp : R := Q ;
                  R.next := Add(P,Q.next);
  P.exp = Q.exp : R := P ;
                  R.coef := P.coef + Q.coef ;
                  R.next := Add(P.next,Q.next);
}
return R
}
```

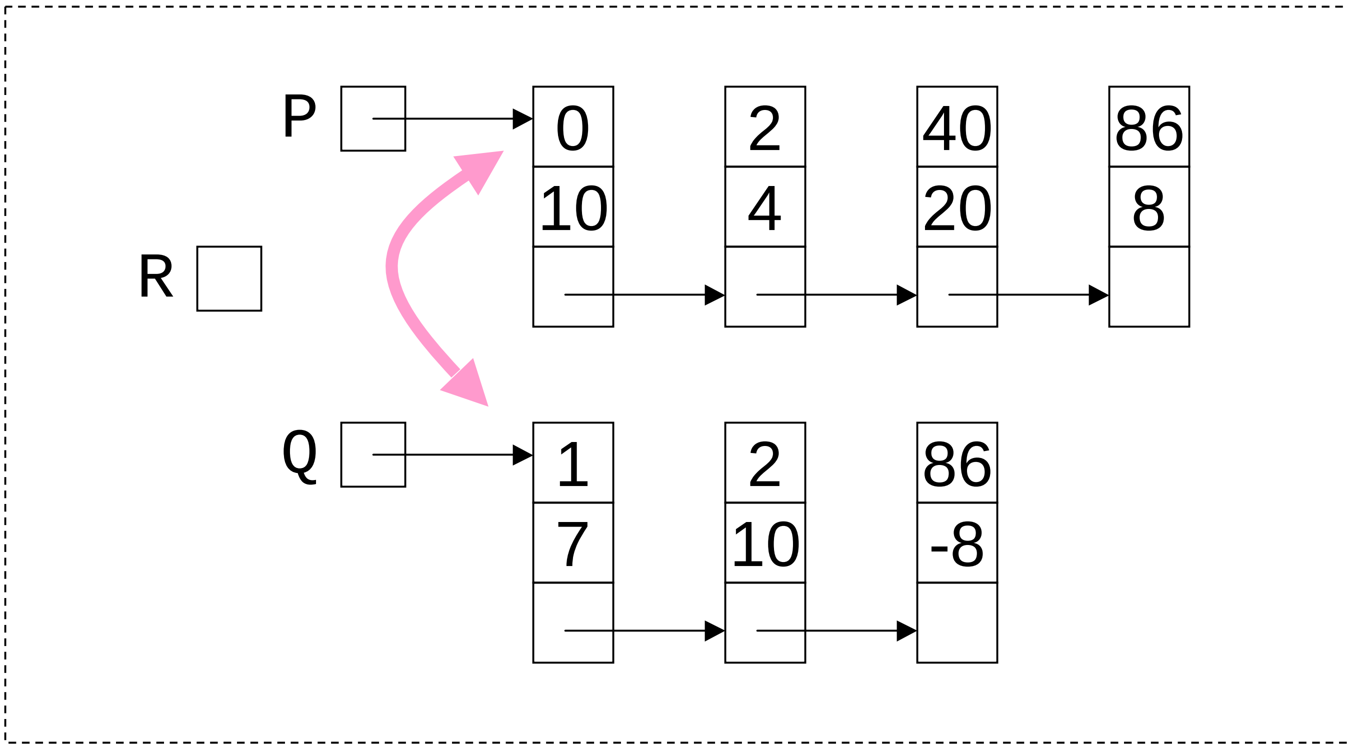
Example

Add

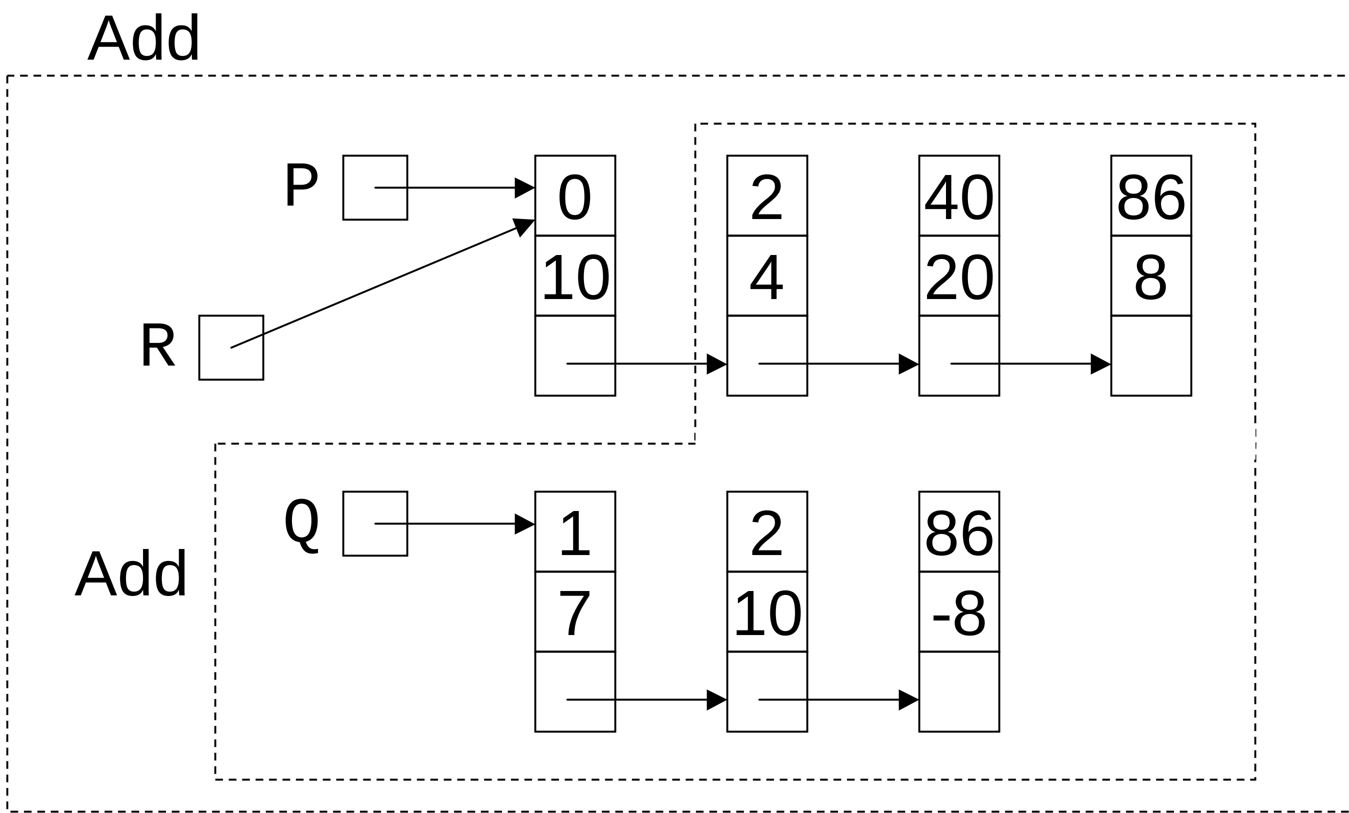


Example

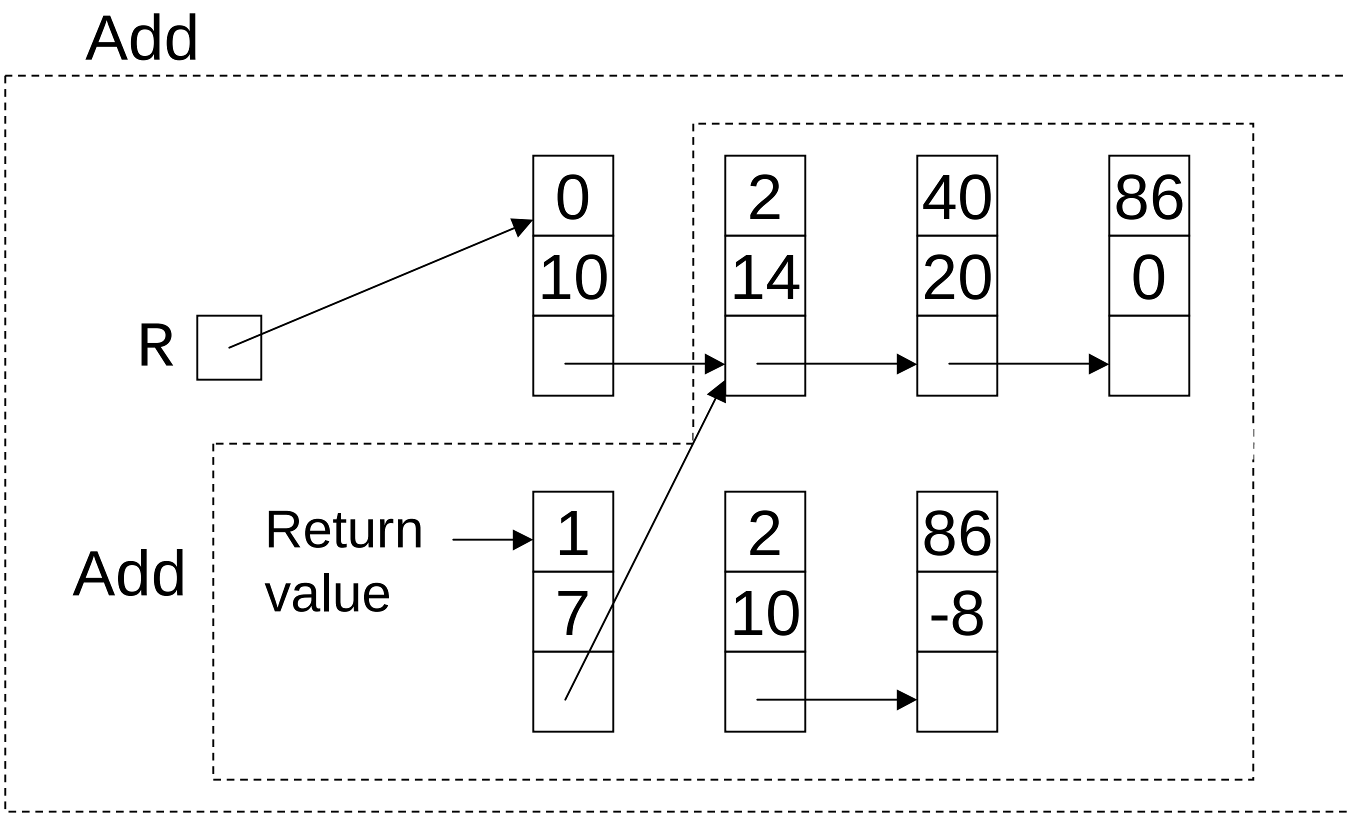
Add



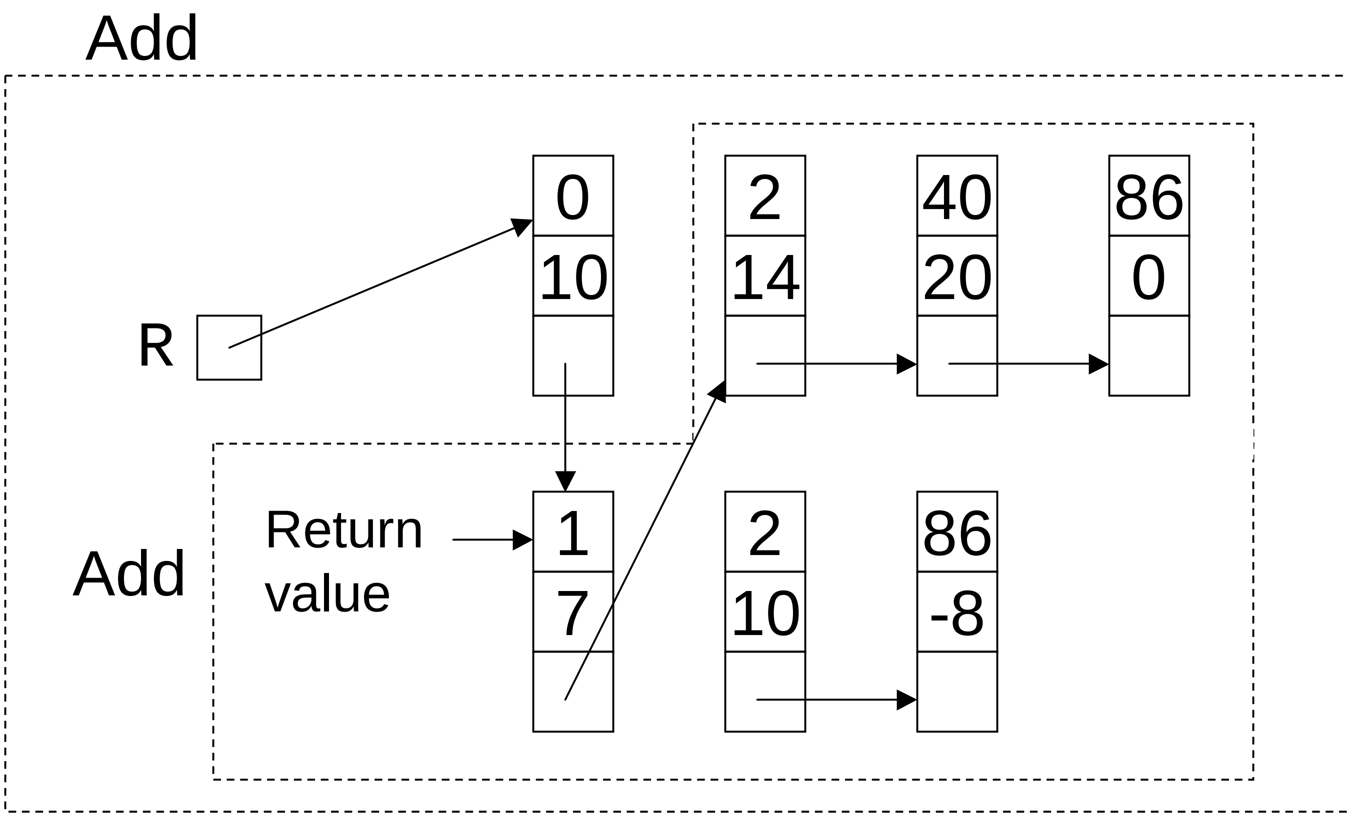
The Recursive Call



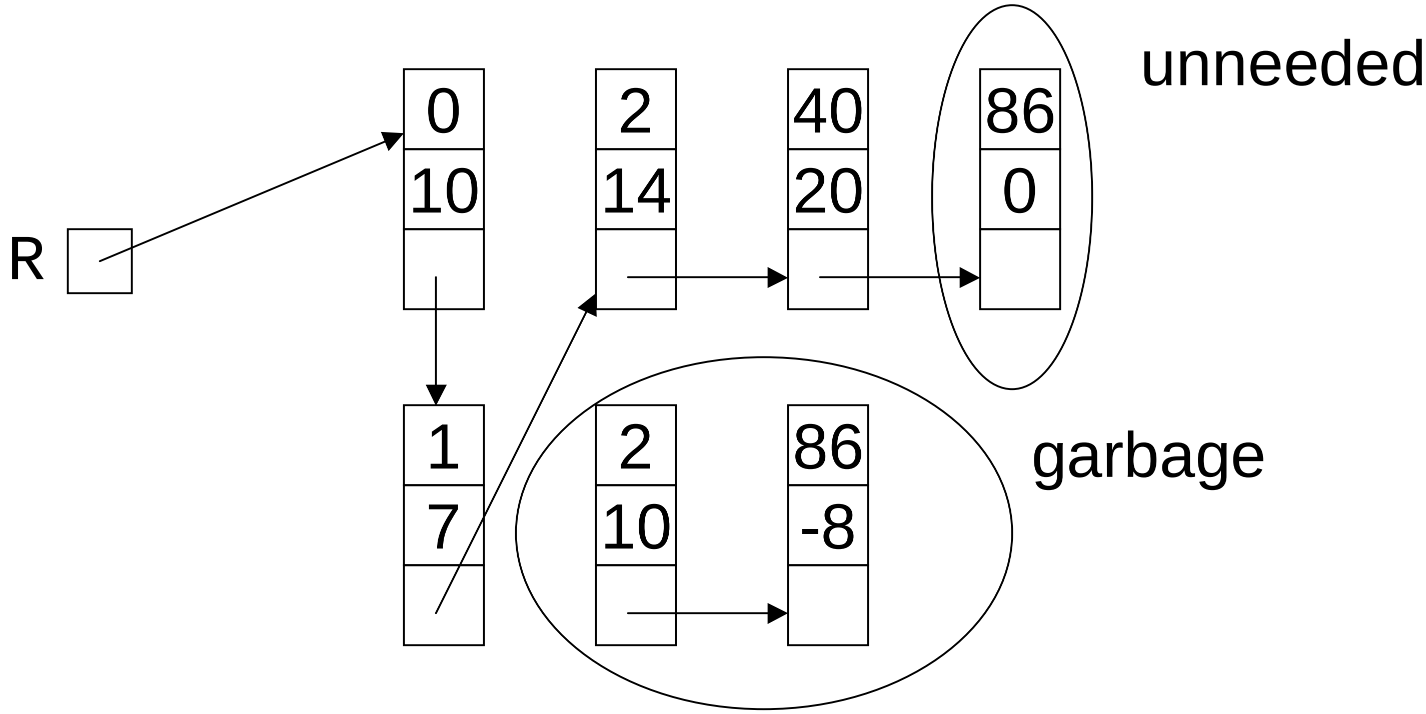
After the Recursive Call



Example



Example



Notes on Addition

- Addition is destructive, that is, the original polynomial are gone after the operation.
- We don’t salvage “garbage” nodes. We’ll talk about this later.
- We don’t consider consider the case when the coefficients cancel. We’ll talk about that later.

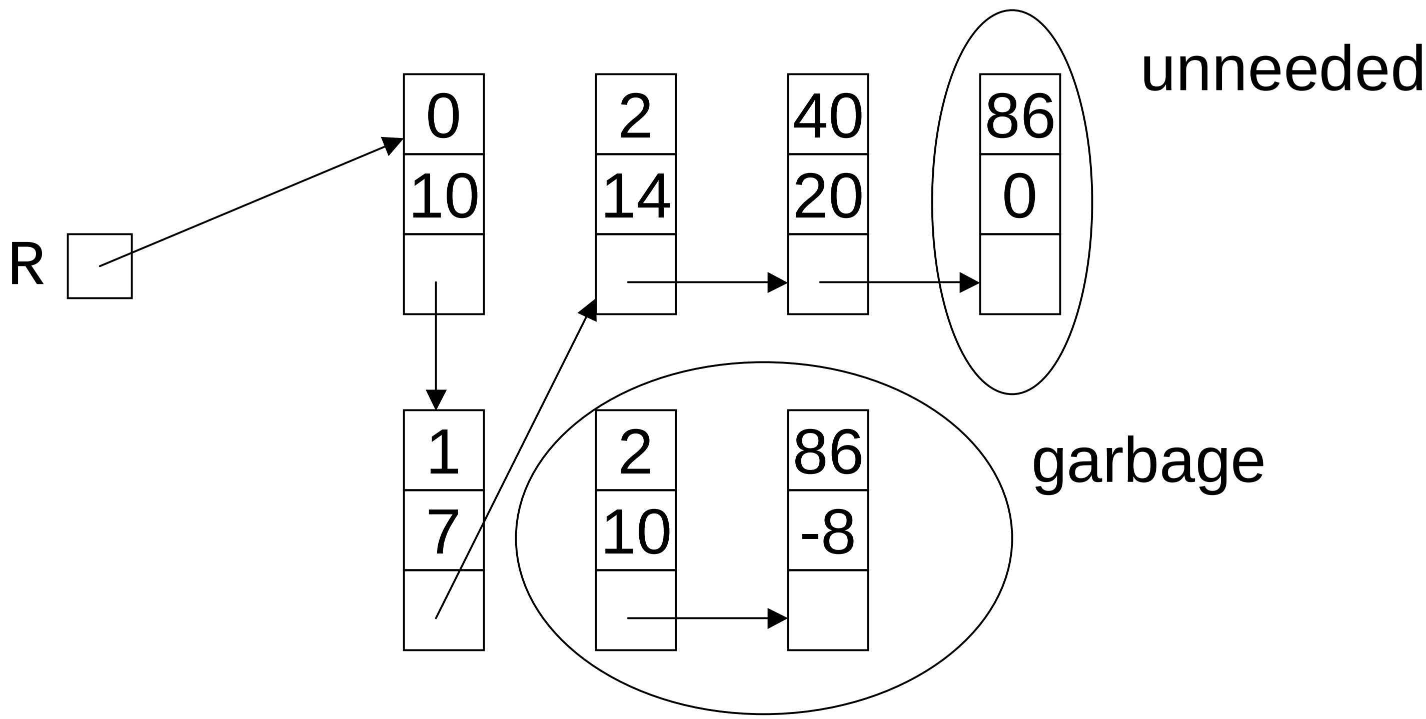
Unneeded to Garbage

- Class participation
- How would you force the unneeded node to be garbage in the code on slide 11?

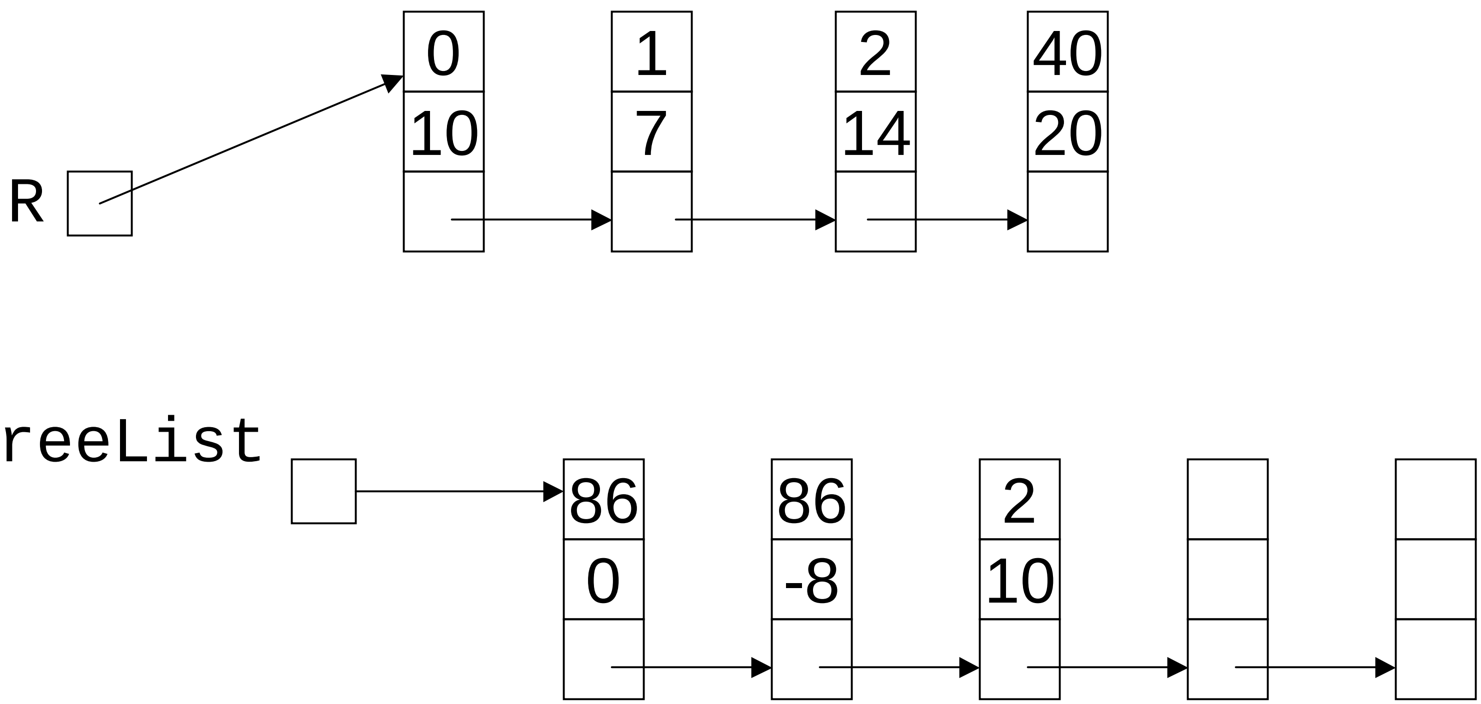
Memory Management – Private Store

- Private store – get blocks from a private store when possible and return them when done.
  - \+ Efficiently uses blocks of a specific size
  - \- The list of unused blocks can build up eventually using too much memory.

Private Store



Private Store



Memory Management – Global Allocator

- Global Allocator's store – always get and return blocks to global allocator
  - + Necessary for dynamic memory.
  - + Blocks of various sizes can be merged if they reside in contiguous memory.
  - - Allocator may not handle blocks of different sizes well.
  - - Allocator may be slower than a private store.

Memory Management – Garbage Collection

- Garbage collection – run time system recovers inaccessible blocks from time-to-time. Used in Lisp, Smalltalk, Java.
  + No need to return blocks to an allocator or keep them in a private store.
  - Care must be taken to make unneeded blocks inaccessible.
  - When garbage collection kicks in there may be undesirable response time.

Solution to Class Work

```
P.exp = Q.exp : R := P ;
                R.coef := P.coef + Q.coef ;
                if R.coef = 0 then
                    R := Add(P.next,Q.next);
                else
                    R.next := Add(P.next,Q.next);
}
```

Use of Private Store or Global Allocator

```
P.exp = Q.exp : R := P ;
                R.coef := P.coef + Q.coef ;
                if R.coef = 0 then
                    R := Add(P.next,Q.next);
                    Free(P); Free(Q);
                else
                    R.next := Add(P.next,Q.next);
                    Free(Q);
}
```