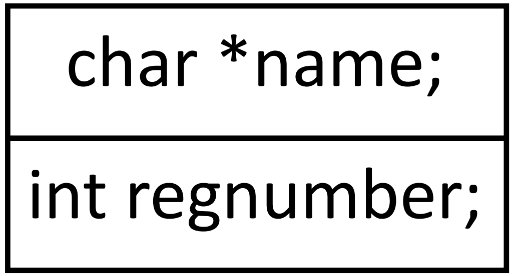
ECS 36A, May 10, 2023

Announcements

1. Everything through today is now on the Canvas and nob web sites
2. On Wednesday, May 10, we will resume in-person classes
3. I will also hold office hours in person beginning then
4. The midterm will be Friday, May 12

Structures

- Data structure used to group elements of a different type together
- Example: student registration number database
  - See element below



type of structure

field

```
struct student {
    char *name;       /* student name */
    int regnumber;  /* registration number */
};
```

Referring to a Structure

Here's how you declare a variable of the structure:

```
struct student xyzzy, *pxyzzy;
```

It's clumsy to write that, so you can define an alias for the type:

```
typedef struct student STUDENT;
```

The latter essentially produces a new type, STUDENT, that can be used wherever struct student can:

STUDENT xyzzy, *pxyzzy;

Another Declarations

```
struct student {
      char *name;        /* student name */
      int regnumber;     /* registration number */
} xyzzy, *pxyzzy;
```

- Declares type `struct student` and 2 variables, `xyzzy` (an instance of `struct student`) and `pxyzzy` (a pointer to an instance of `struct student`)

And Now, With a Typedef

```
typedef struct student {
      char *name; /* student name */
      int regnumber;   /* registration number */
} STUDENT;
STUDENT xyzzy, *pxyzzy;
```

This defines a new type, `STUDENT`, which is the same as the type struct student. Here `xyzzy` is a variable of type `STUDENT` and `pxyzzy` is a pointer to an instance of `STUDENT`.

But Be Careful

- typedef defines an alias for a type
- #define does textual substitution

```
typedef int *PINT;
PINT a, b, c
```

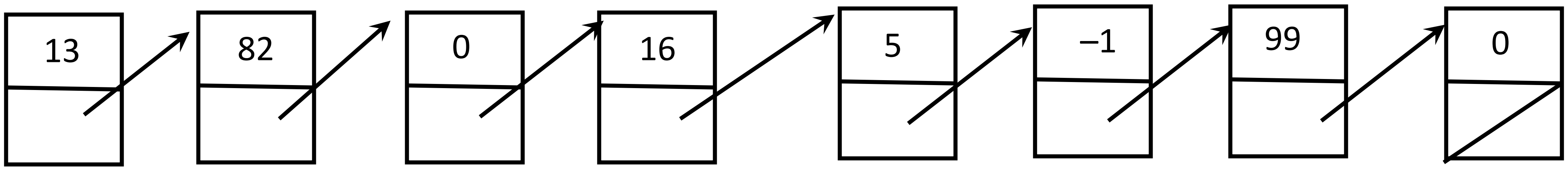
- Now a, b, and c are all pointers to integers

```
#define PINT int *
PINT a, b, c;     /* becomes int * a, b, c; */
```

- Now a is a pointer to an integer, and b and c are integers

Linked List

- A list composed of instantiations of structures
  - One element is whatever is to be sorted (int, for us)
  - Another element is a pointer to the next element; NULL if none



Structure for This List

```
struct node {
     int num;
     struct node *next;
};
struct node *list;
```

This holds the integer that you read in

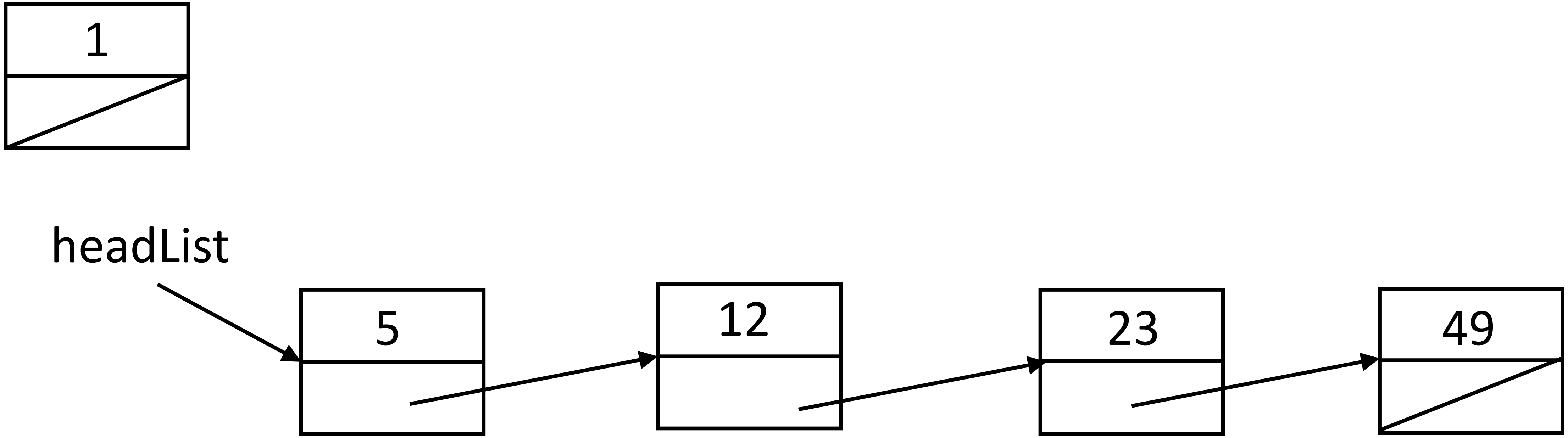
This holds the pointer to the next element in the linked list; it's NULL if it's at the end

This points to the first element of the list

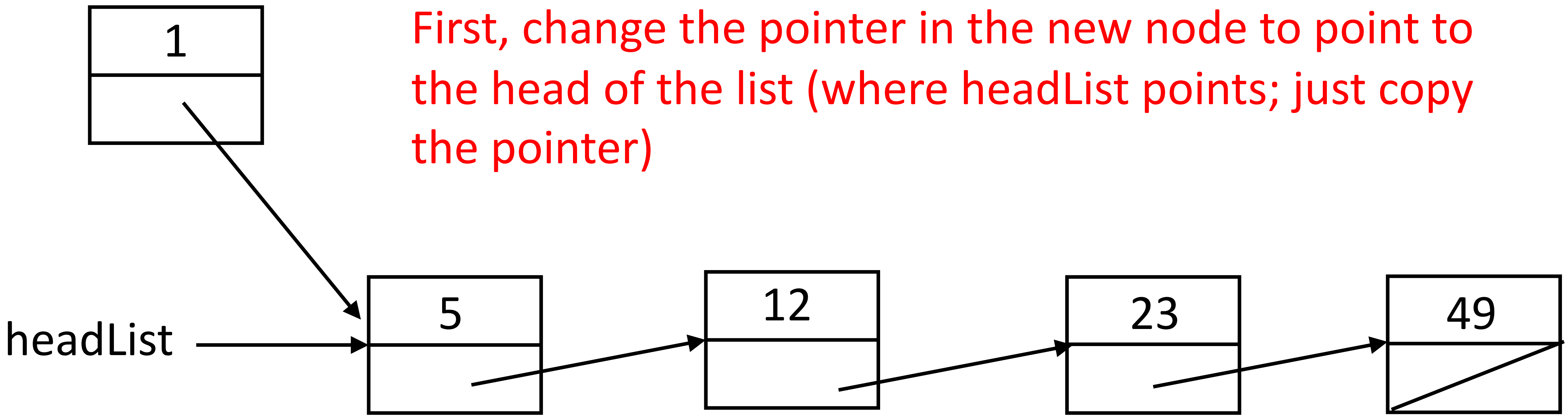
Changing How Memory Is Allocated

- Now you can allocate memory one element (“node”) at a time
- Insertion at beginning is like this (see ”linked.c”, ll. 72–76):
  - new->next = first;
  - list = new;
- Insertion in the middle between prev and succ is (see “linked.c”, ll. 78–97):
  - new->next = succ;
  - prev->next = new;
- Insertion at the end nomore of the list (same as above):
  - nomore->next = new;

Insertion



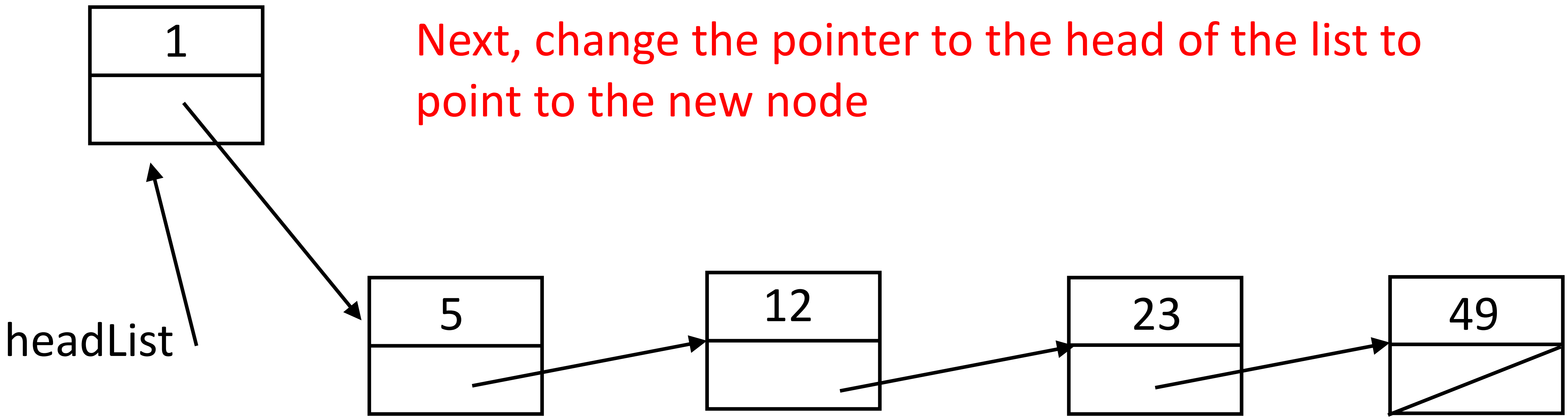
Insertion: At the Beginning of the List



First, change the pointer in the new node to point to the head of the list (where headList points; just copy the pointer)

Insertion: At the Beginning of the List

Next, change the pointer to the head of the list to point to the new node



Code for This

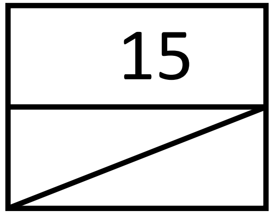
- new is a pointer to the new node, headList points to the head of the list
- First, make new point to the old head. of the list

```
new->next = headList;
```

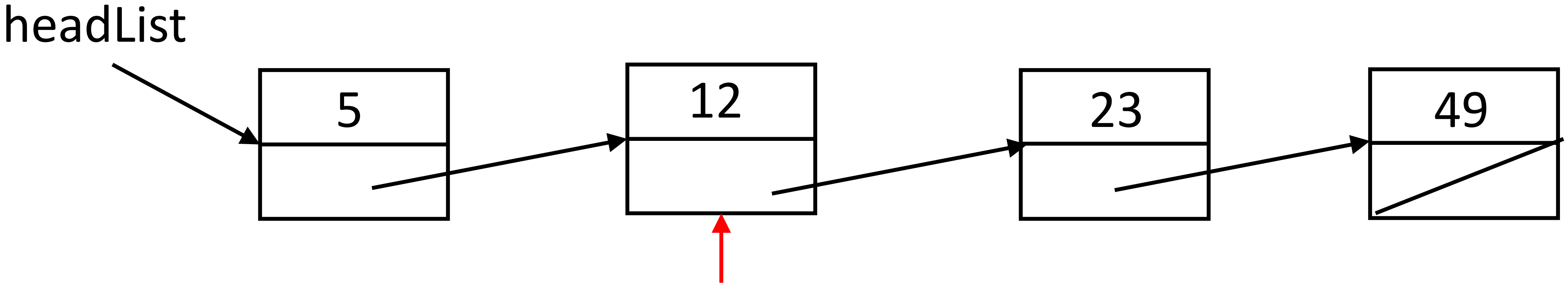
- Next, make the pointer to the head of the list point to new

```
headList = new;
```

Insertion: In the Middle of the List



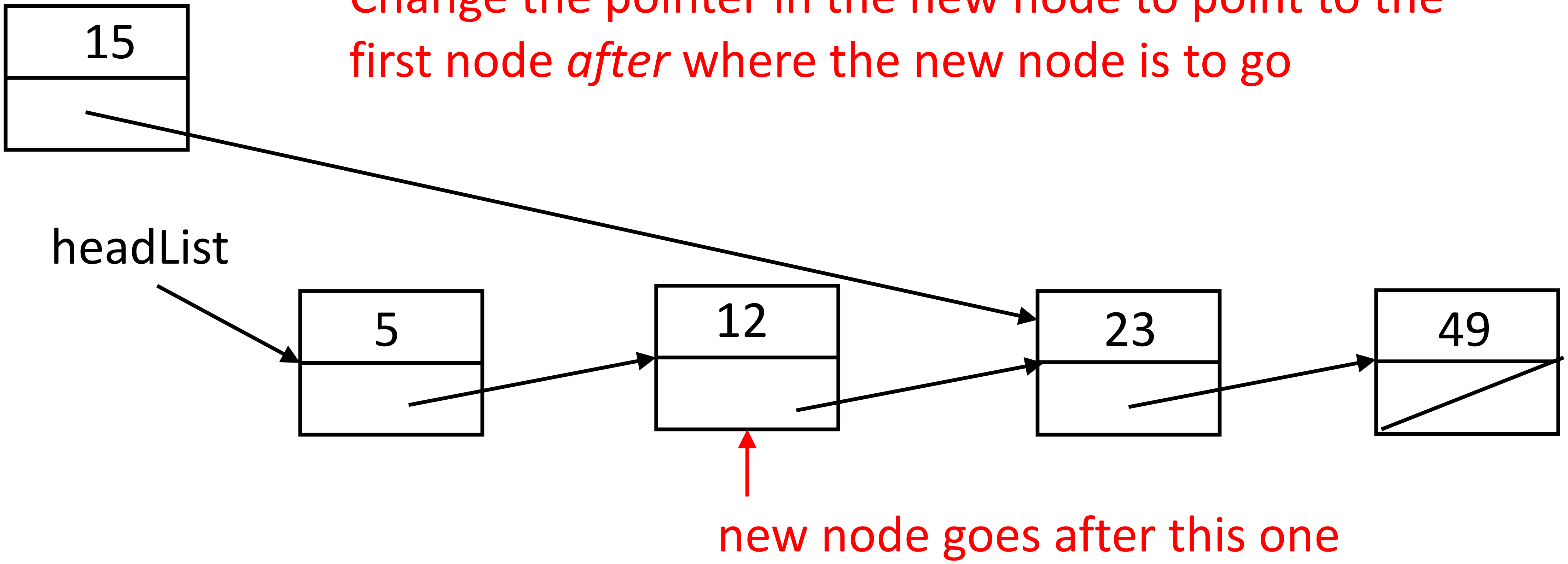
First, scan down the list until you reach the node before which the new node goes.



new node goes after this one

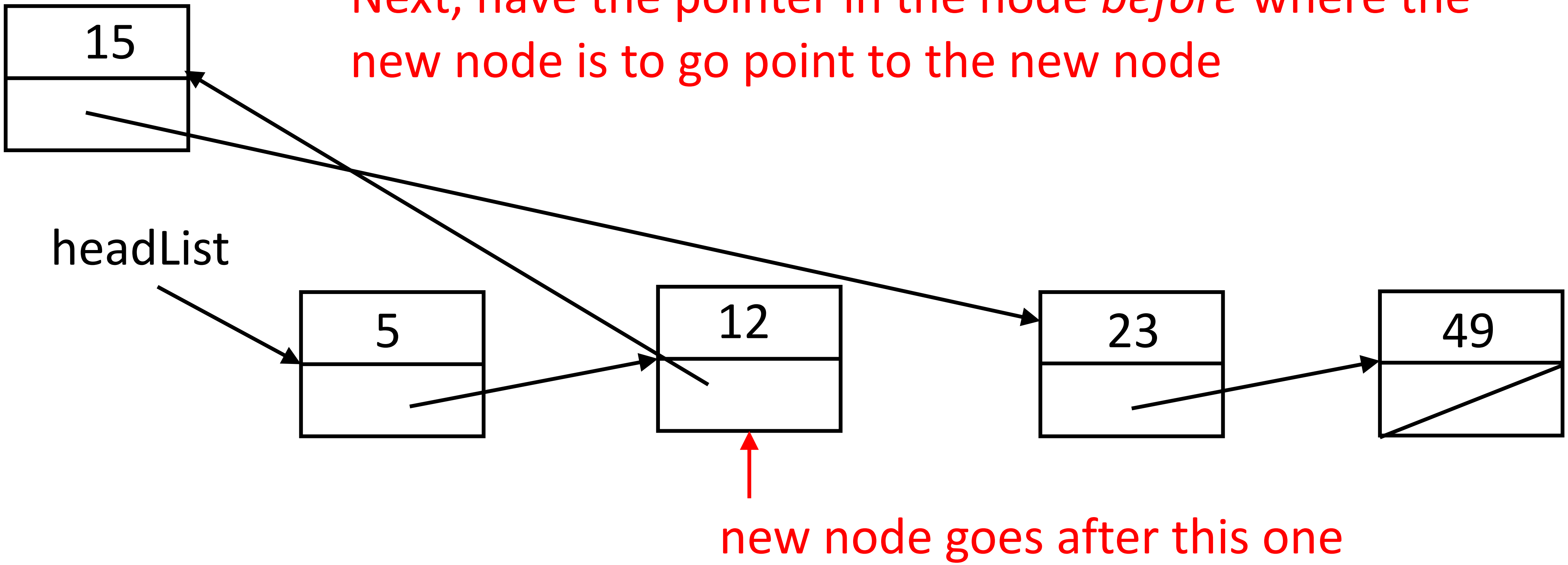
Insertion: In the Middle of the List

Change the pointer in the new node to point to the first node *after* where the new node is to go



Insertion: In the Middle of the List

Next, have the pointer in the node *before* where the new node is to go point to the new node



Code for This

- new is a pointer to the new node, headList points to the head of the list, and p is a pointer to node
- First, find the node that new goes after

```
for(p = headList;
     p != NULL && p->next < new->next;
          p = p->next)
     /* do nothing ;
```

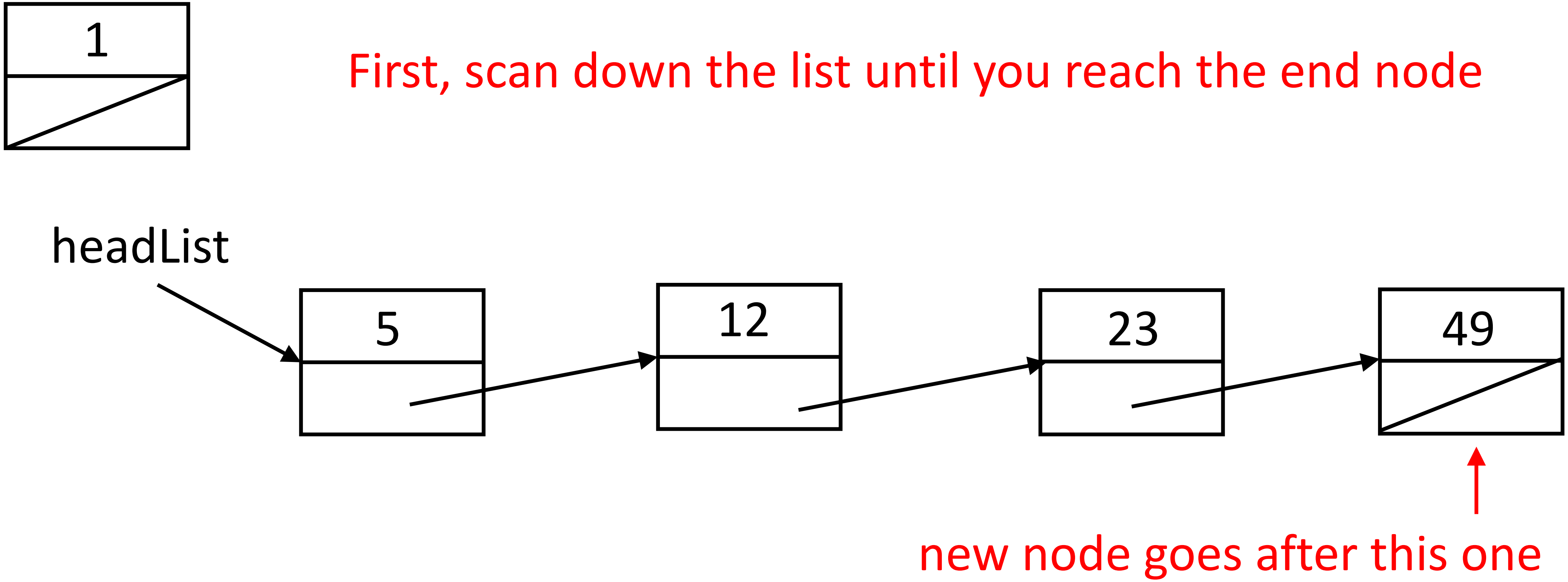
- Next, change the pointer in new to point to the node *after* where this one goes

```
new->next = p->next;
```

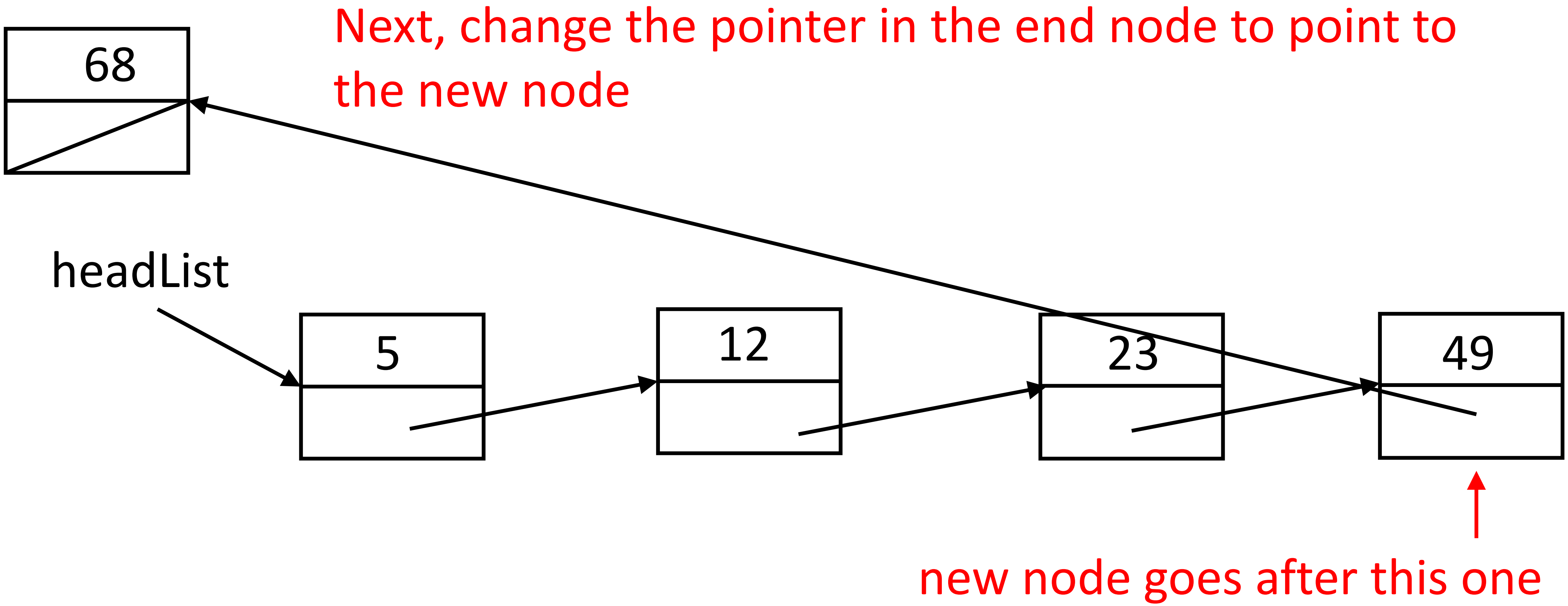
- Finally, make the node p points to point to new

```
p->next = new;
```

Insertion: At the End of the List



Insertion: At the End of the List



Code for This

- new is a pointer to the new node, headList points to the head of the list, and p is a pointer to node
- First, find the node at the end

```
for(p = headList;
     p != NULL && p->next != NULL;
          p = p->next)
     /* do nothing */;
```

- Next, change the pointer in what p points to to point to new

```
p->next = new;
```

- This may be an excess, but make sure new’s pointer field is NULL

```
new->next = NULL;
```

Multiple Arrays

- Need to store several data of different types about something
- Example: sort planets by their diameters
- Use 2 arrays
  - char *names[9]
  - int diameters[9]
- When sorting, need to keep both arrays aligned
  - So when swapping 2 elements of array diameter, the corresponding elements of array names must also be swapped
- Alternate approach: use structures!

Same with Structures

- Instead of 2 arrays, combine into one structure for each element, and use an array of structures

```
struct celestial {
    char *name;    /* pointer to name of planet */
    int diameter; /* diameter of planet in km */
} planets[9];
```

- This allocates space for 9 planets
- When you swap elements, you only need to swap one, not two, as in the parallel arrays case

And now a Word About argv

```
void main(int argc, char *argv[])
```

- Program name is `argv[0]`
- One way to go down the arguments (`j` is declared as `int j`):

```
for(j = 1; j < argc; i++)
     printf("Argument: %s\n", argv[1]);
```

- And the same thing, but using pointers (`a` is declared as `char **a`):

```
for (a = argv+1; *a; a++)
     printf("Argument: %s\n", *a);
```