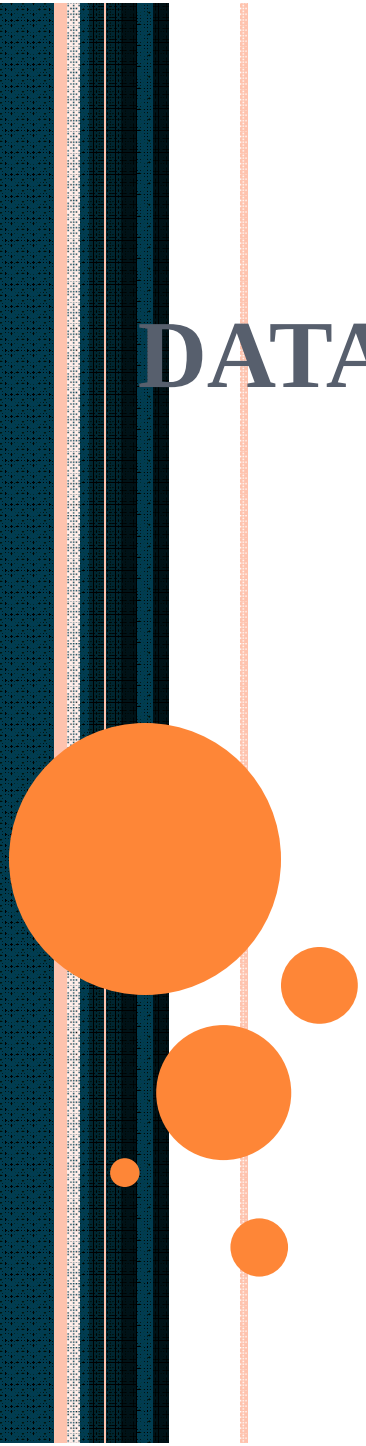
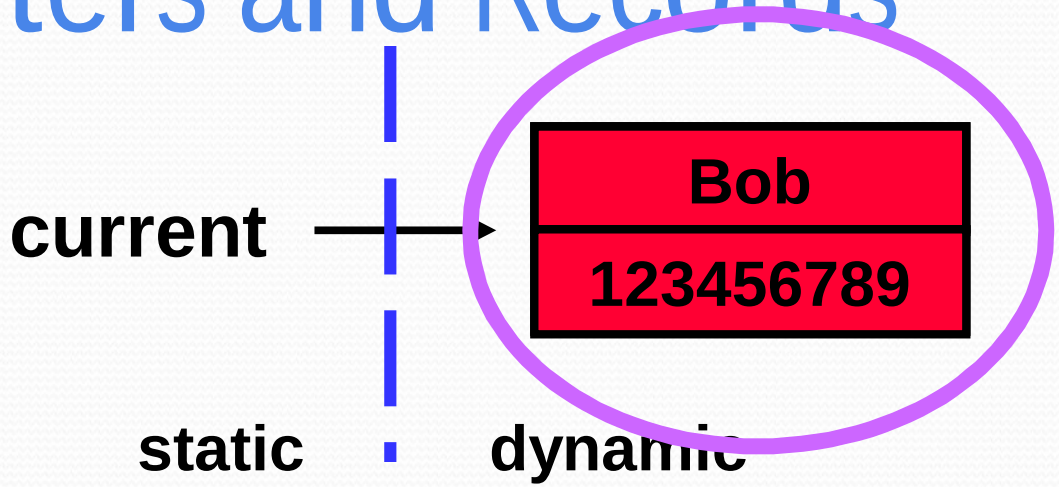
DATA STRUCTURES USING ‘C’



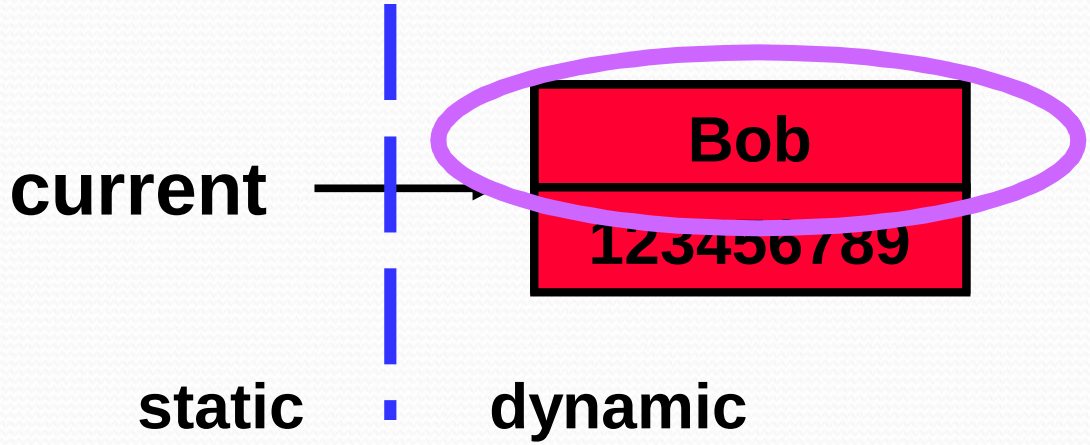
Pointers

Pointers and Records



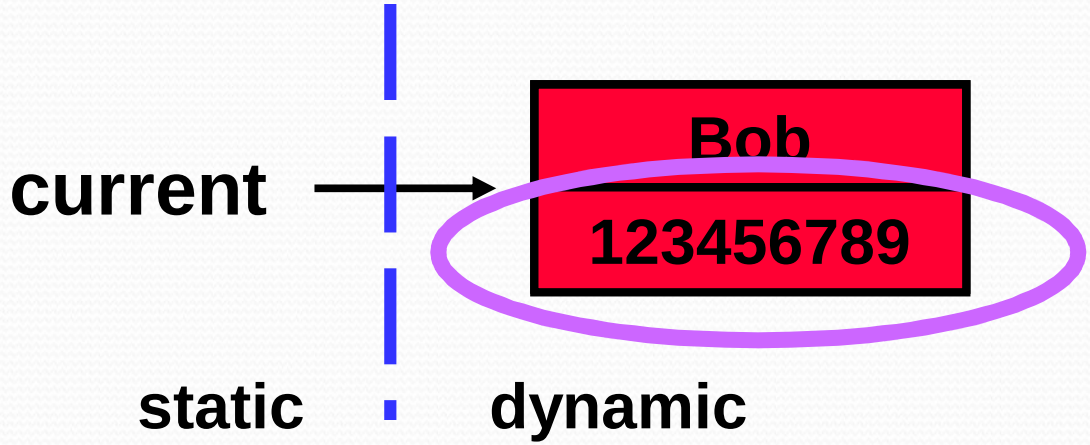
`current^`

Pointers and Records




```
current^.name <- “Bob”
```

Pointers and Records




```
current^.SSN <- 123456789
```

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What's the big deal

- **We already knew about static data**
- **Now we see we can allocate dynamic data but**
- **Each piece of dynamic data seems to need a pointer variable and pointers seem to be static**
- **So how can this give me flexibility**

Questions?

Introduction to Linked Lists

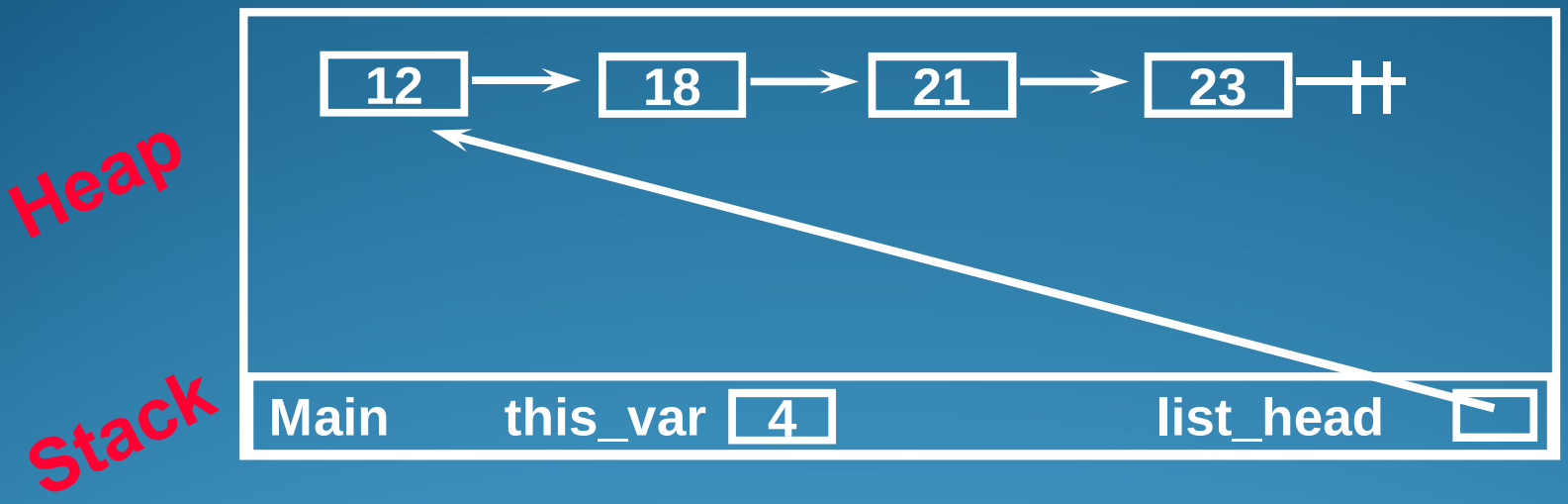
Properties of Lists

- **We must maintain a list of data**
- **Sometimes we want to use only a little memory:**

- **Sometimes we need to use more memory**

- **Declaring variables in the standard way won't work here because we don't know how many variables to declare**
- **We need a way to allocate and de-allocate data dynamically (i.e., on the fly)**

Linked Lists "Live" in the Heap



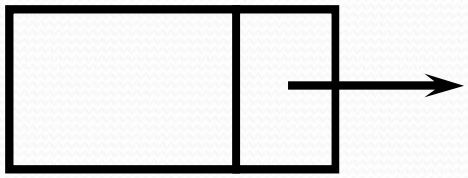
- The heap is memory not used by the stack
- Dynamic variables live in the heap
- We need a pointer variable to access our list in the heap

Linked Lists

With pointers, we can form a "chain" of data structures:


```
List_Node definesa Record
      data isoftype Num
      next isoftype Ptr toa List_Node
endrecord  //List_Node
```

Linked List Record Template



```
<Type Name> definesa record
   data isoftype <type>
   next isoftype ptr toa <Type Name>
endrecord
```

Example:

```
   Char_Node definesa record
      data isoftype char
      next isoftype ptr toa Char_Node
   endrecord
```

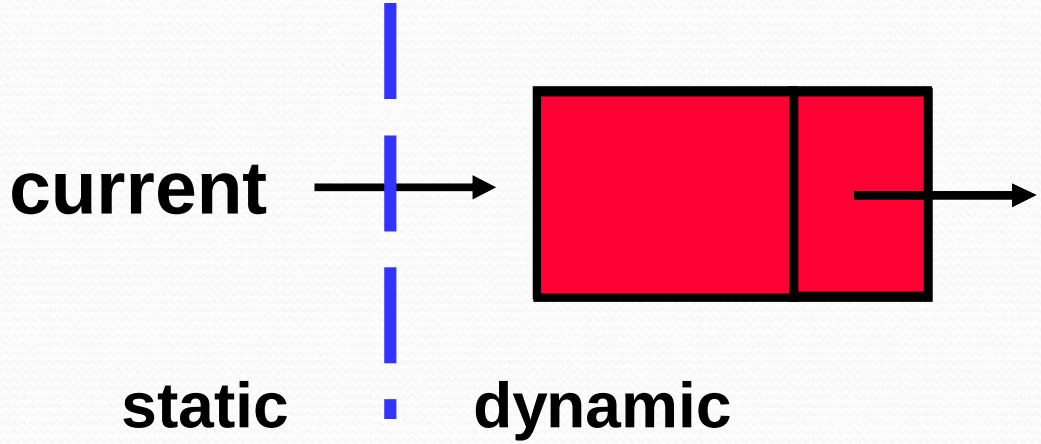
Creating a Linked List Node

```
Node definesa record
   data isoftype num
   next isoftype ptr toa Node
endrecord
```

And a pointer to a Node record:

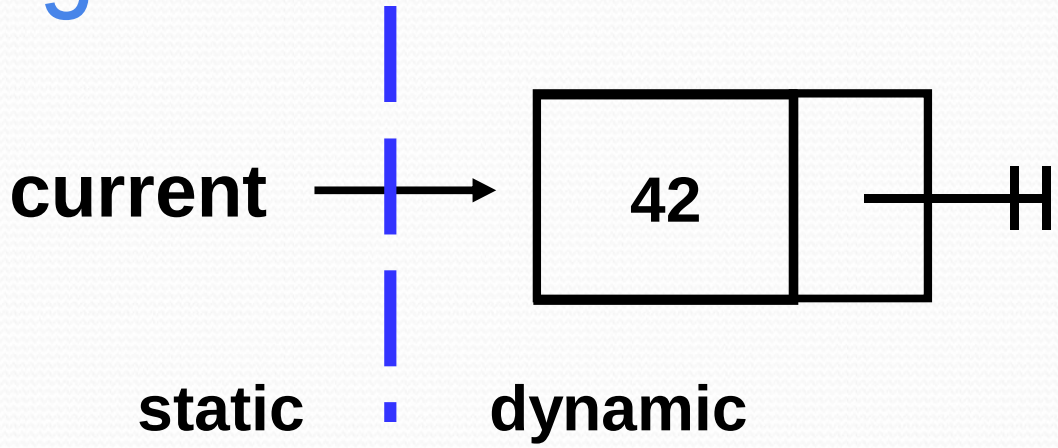
```
current isoftype ptr toa Node
current <- new(Node)
```

Pointers and Linked Lists



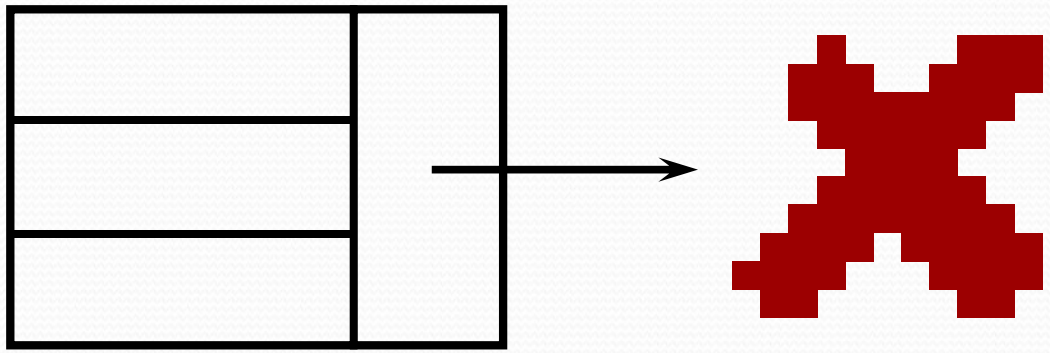

```
current^
current^.data
current^.next
```

Accessing the Data Field of a Node

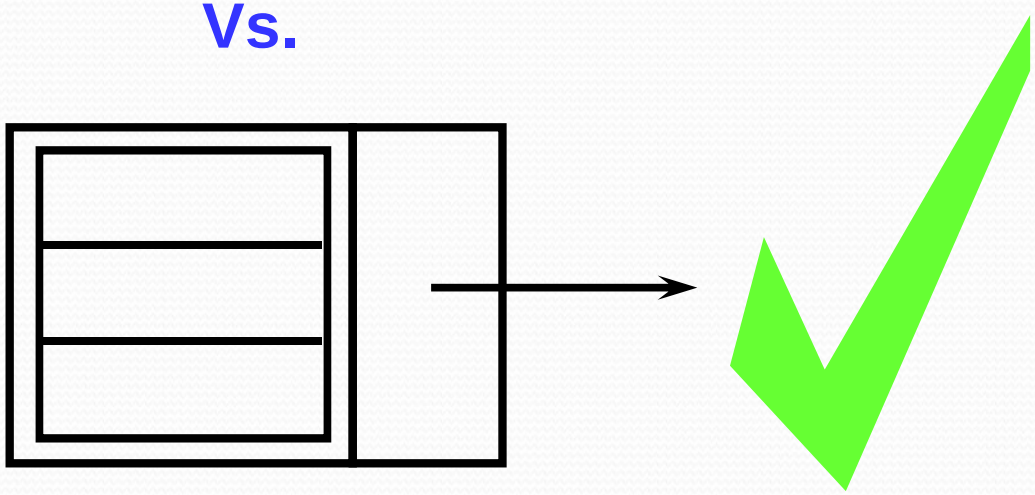



```
current^.data <- 42
current^.next <- NIL
```

Proper Data Abstraction



Vs.



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Complex Data Records and Lists

The examples so far have shown a single num variable as node data, but in reality there are usually more, as in:

```
Node_Rec_Type definesa record
   this_data isoftype Num
   that_data isoftype Char
   other_data isoftype Some_Rec_Type
   next isoftype Ptr toa Node_Rec_Type
endrecord // Node_Rec_Type
```

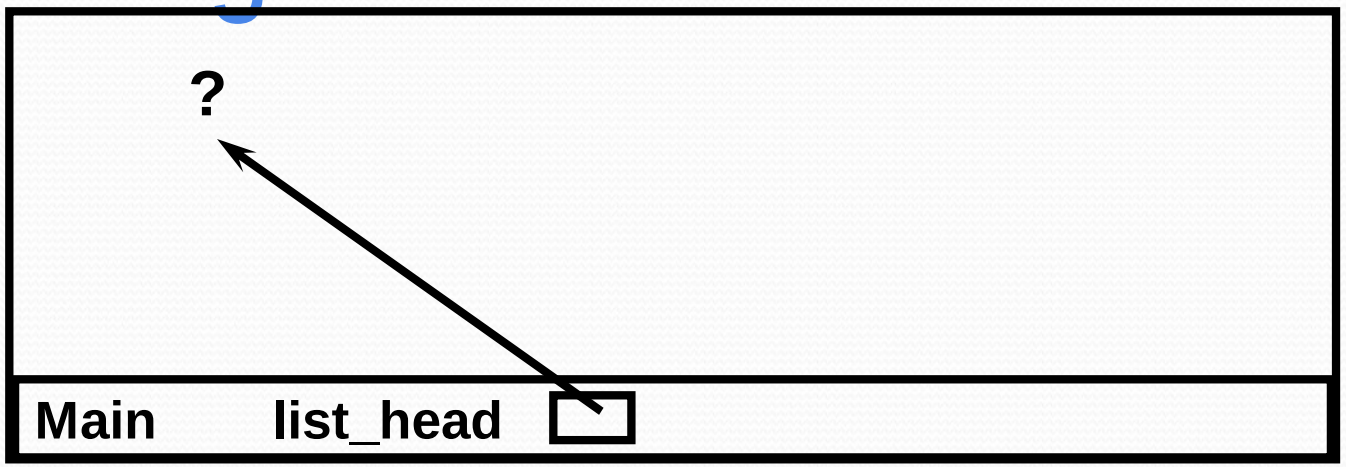
A Better Approach with Higher Abstraction

One should separate the data from the structure that holds the data, as in:

```
Node_Data_Type definesa Record
  this_data isoftype Num
  that_data isoftype Char
  other_data isoftype Some_Rec_Type
endrecord // Node_Data_Type


Node_Record_Type definesa Record
  data isoftype Node_Data_Type
  next isoftype Ptr toa Node_Rec_Type
endrecord  // Node_Record_Type
```

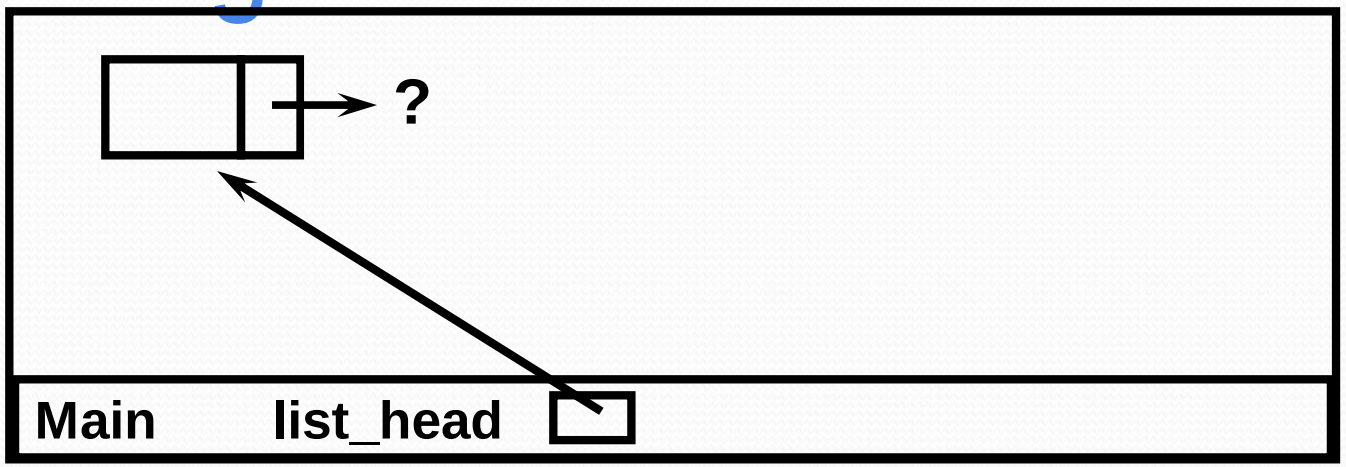
Creating a Pointer to the Heap




```
list_head isoftype ptr toa List_Node
```

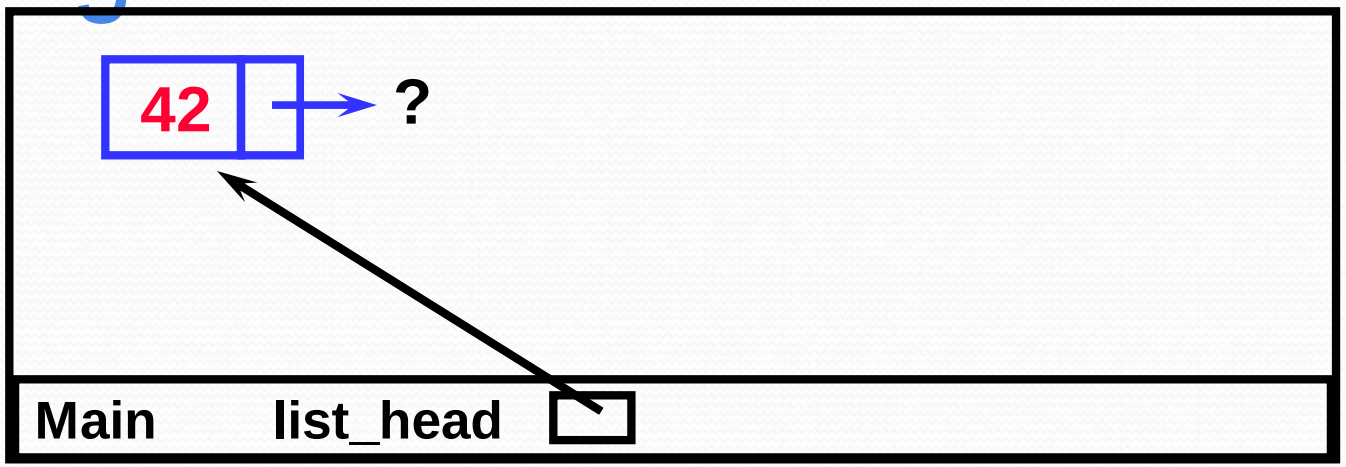
Notice that list_head is not initialized and points to "garbage."

Creating a New Node in the List




```
list_head <- new(List_Node)
```

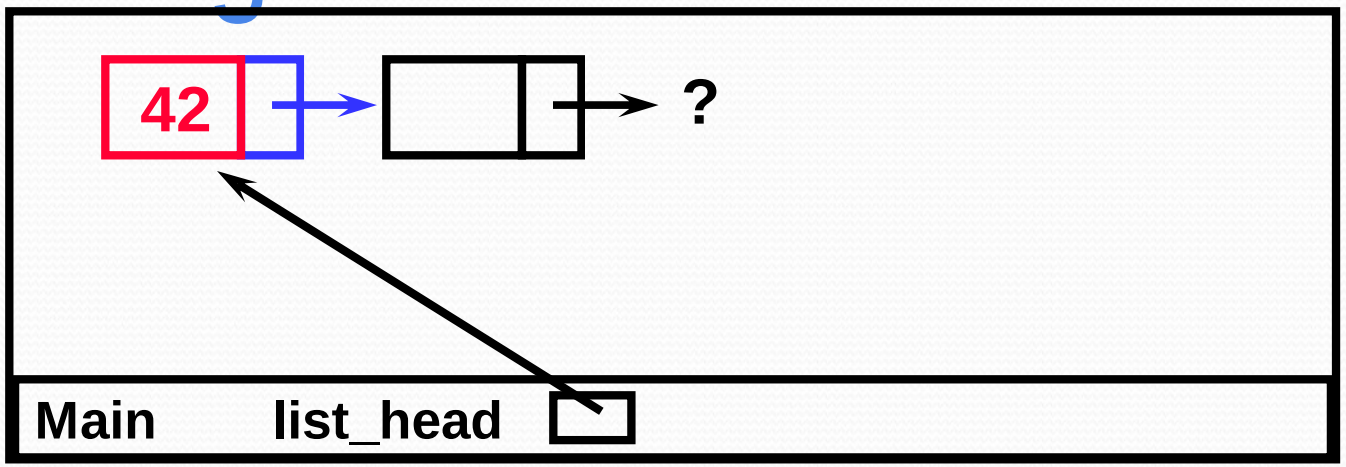
Filling in the Data Field




```
list_head^.data <- 42
```

The ^ operator follows the pointer into the heap.

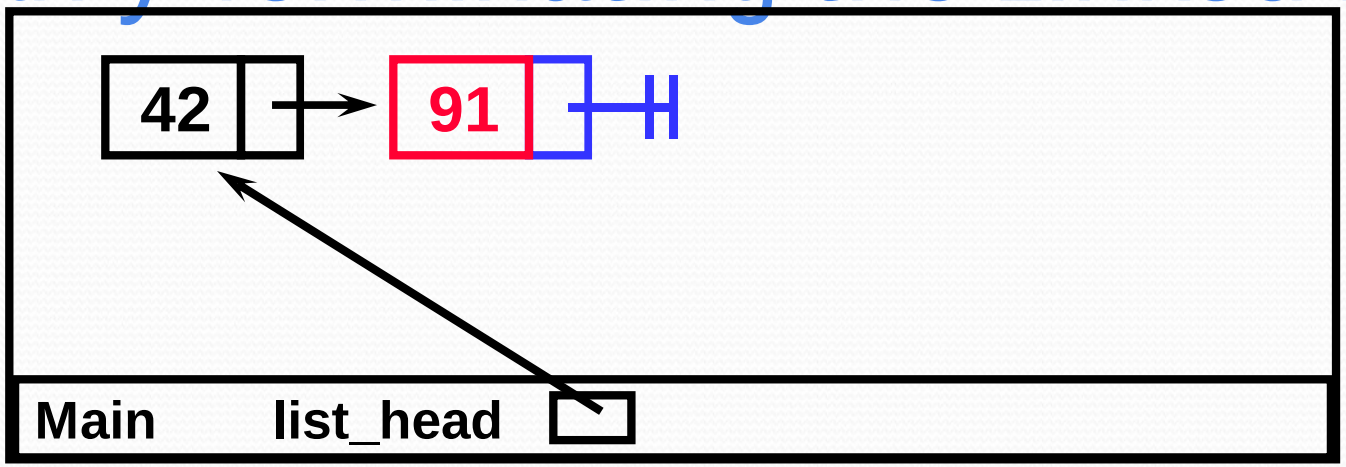
Creating a Second Node




```
list_head^.data <- 42
list_head^.next <- new(List_Node)
```

The "." operator accesses a field of the record.

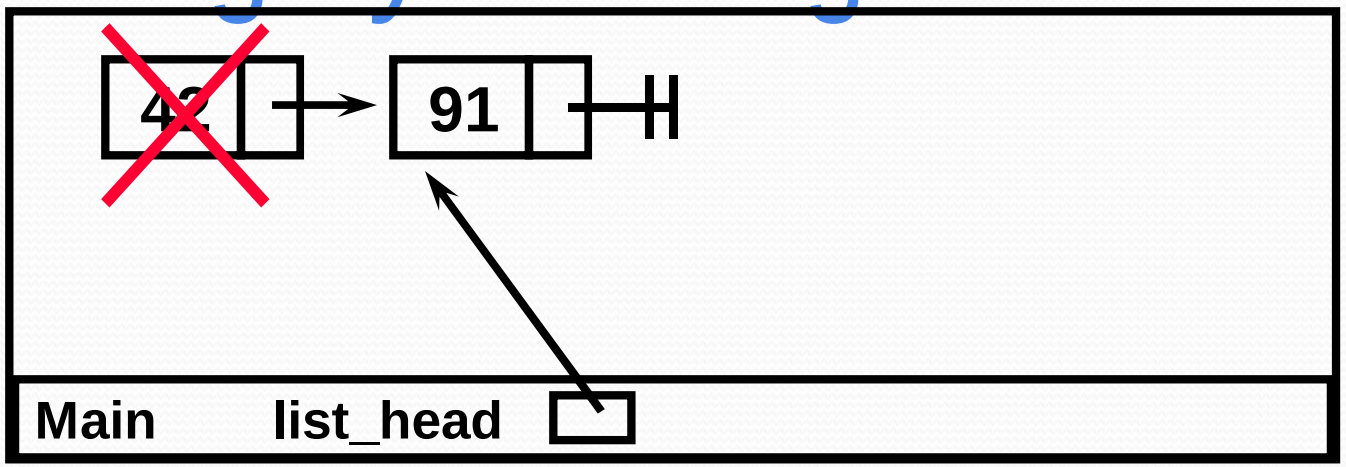
Cleanly Terminating the Linked List




```
list_head^.next^.data <- 91
list_head^.next^.next <- NIL
```

We terminate linked lists “cleanly” using NIL.

Deleting by Moving the Pointer



If there is nothing pointing to an area of memory in the heap, it is automatically deleted.

```
list_head <- list_head^.next
```