This is CS50

Agenda

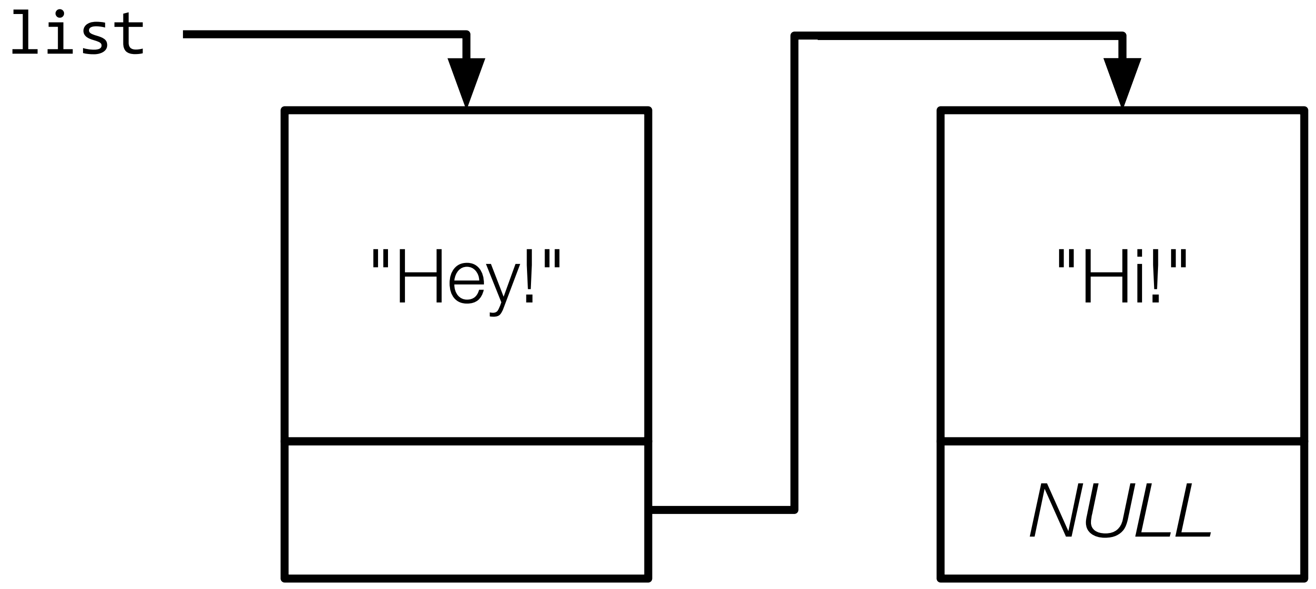
- Data Structures and Trade Offs
- Linked Lists
  - Review
  - Exercise
- Hash Tables
  - Review
  - Hash Function Example
- Inheritance

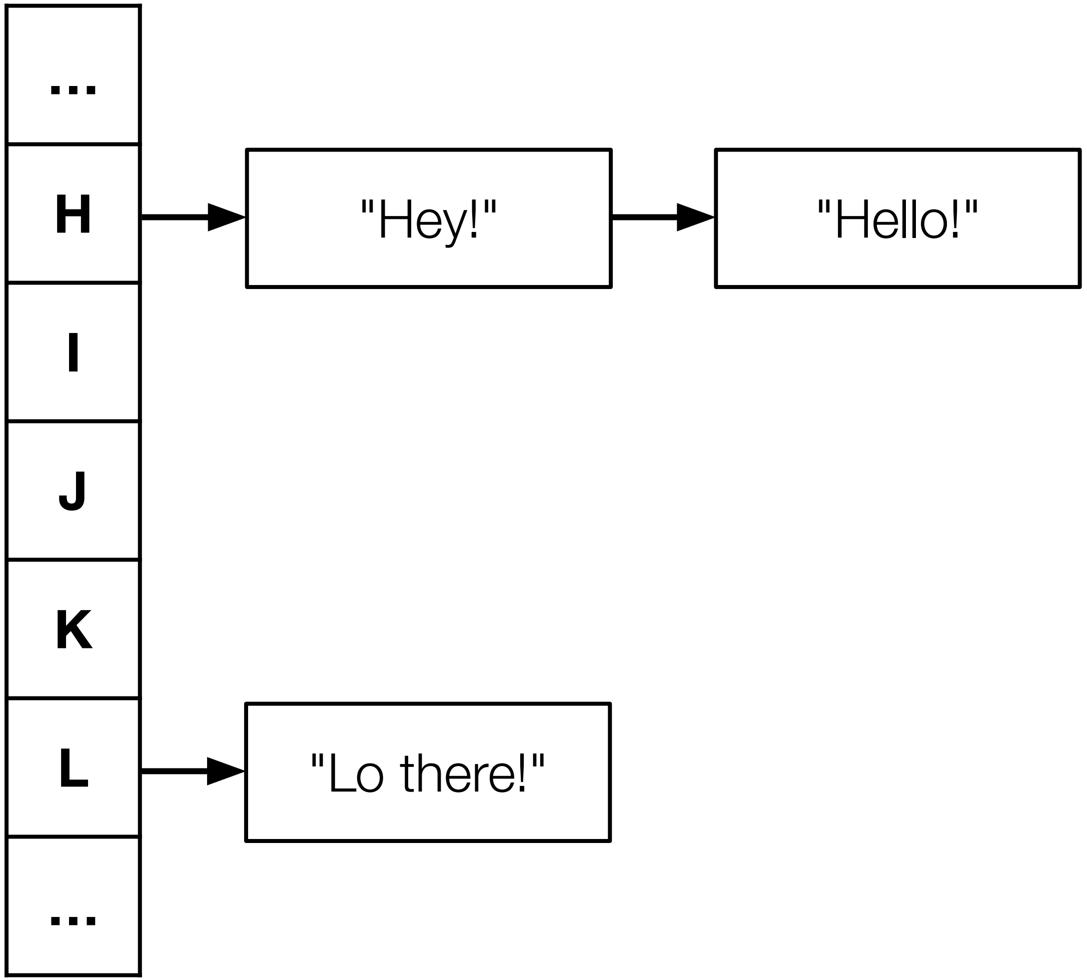
Deletion
Insertion
Search

1. Search
2. Insertion
3. Deletion

1. Insertion
2. Search
3. Deletion

Linked List



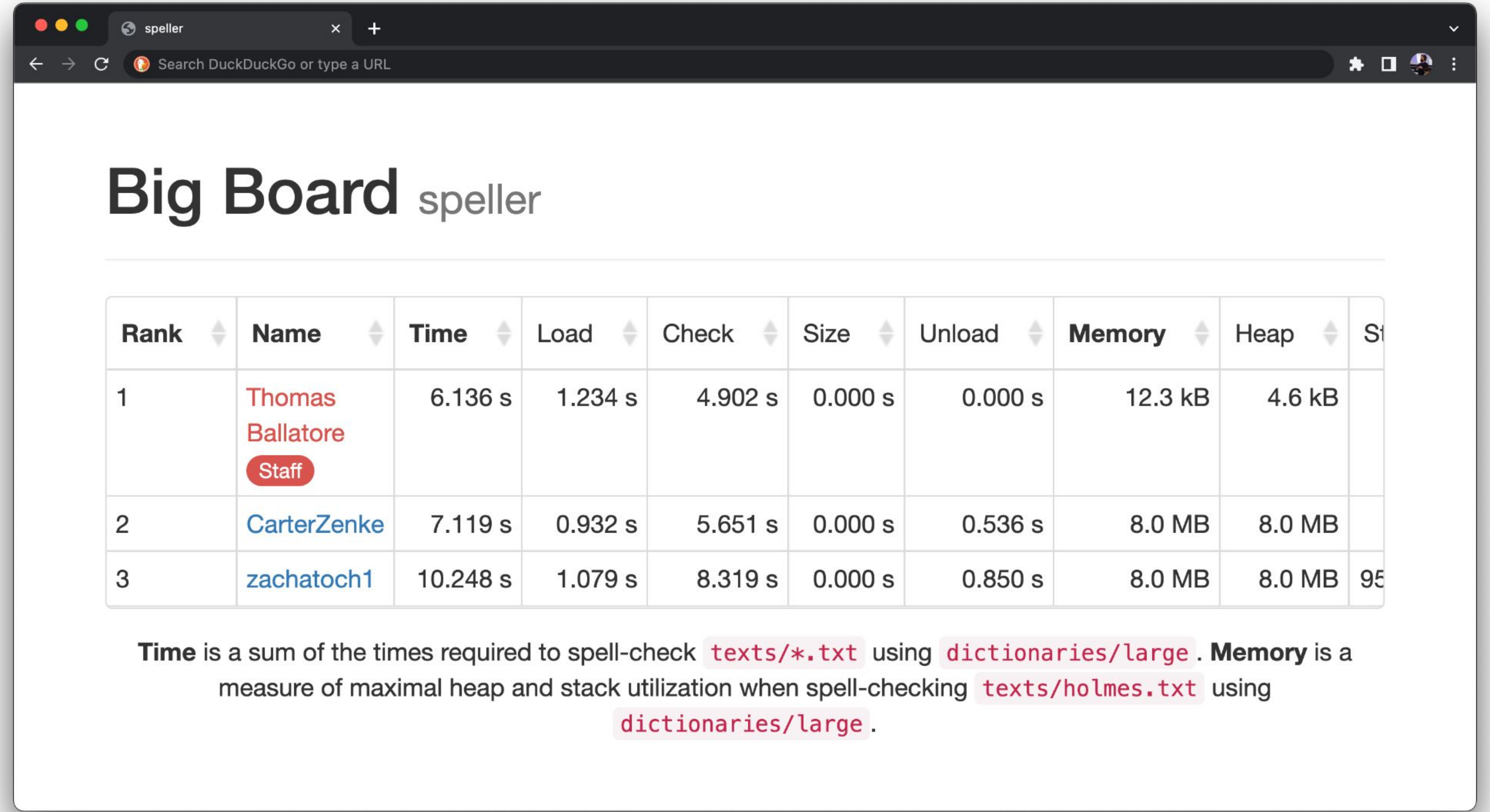


Hash Table

Trie

$$\begin{tikzcd}
 & & L \arrow[r] \arrow[dr] & L \arrow[r] & O \\
H \arrow[r] & E \arrow[ur] \arrow[dr] & & P & \\
 & & Y & &
\end{tikzcd}$$

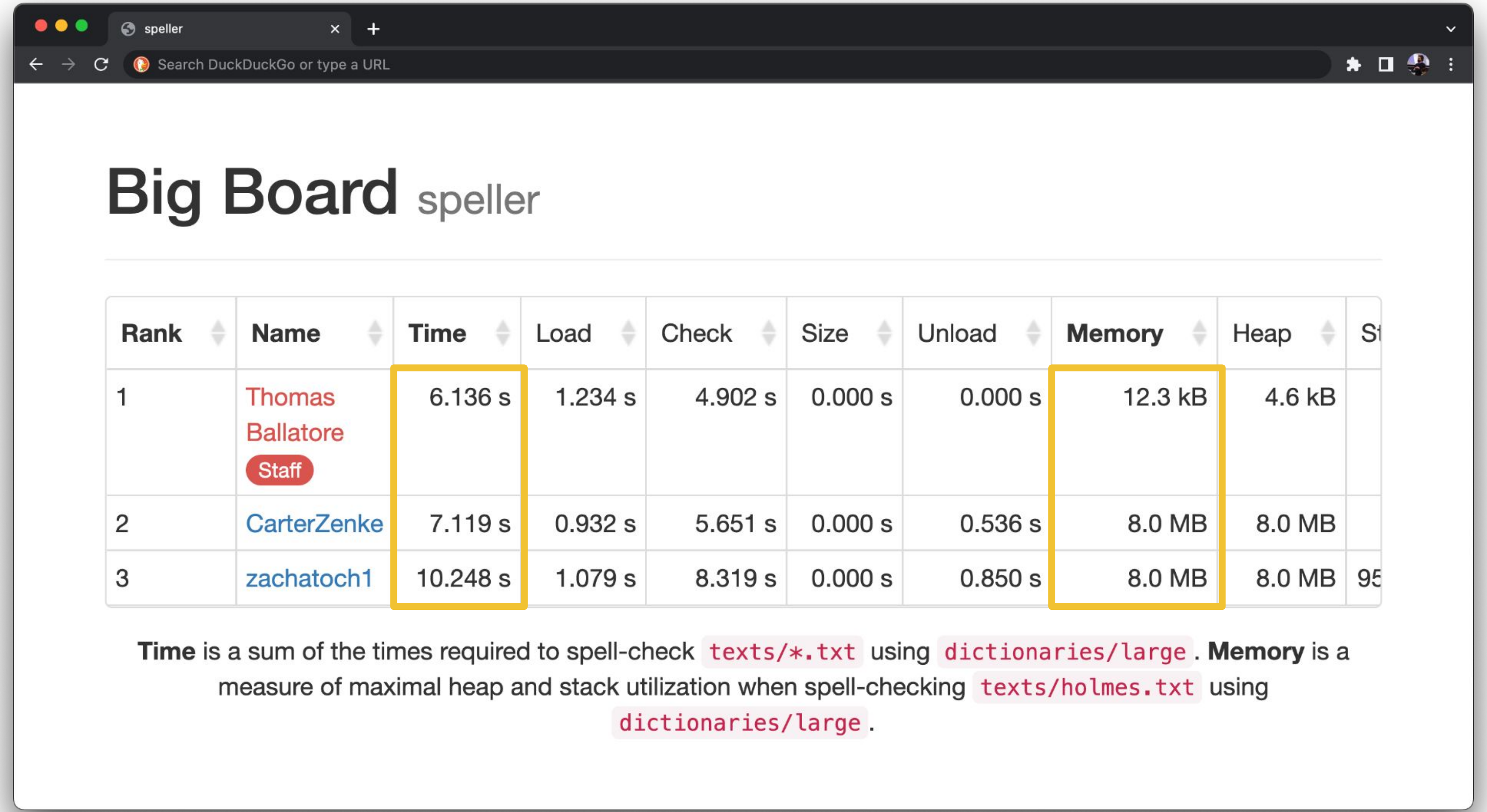
Trade-offs



Big Board speller

Rank	Name	Time	Load	Check	Size	Unload	Memory	Heap	St
1	Thomas Ballatore Staff	6.136 s	1.234 s	4.902 s	0.000 s	0.000 s	12.3 kB	4.6 kB	
2	CarterZenke	7.119 s	0.932 s	5.651 s	0.000 s	0.536 s	8.0 MB	8.0 MB	
3	zachatoch1	10.248 s	1.079 s	8.319 s	0.000 s	0.850 s	8.0 MB	8.0 MB	95

Time is a sum of the times required to spell-check `texts/*.txt` using `dictionaries/large`. **Memory** is a measure of maximal heap and stack utilization when spell-checking `texts/holmes.txt` using `dictionaries/large`.



Big Board speller

Rank	Name	Time	Load	Check	Size	Unload	Memory	Heap	St
1	Thomas Ballatore Staff	6.136 s	1.234 s	4.902 s	0.000 s	0.000 s	12.3 kB	4.6 kB	
2	CarterZenke	7.119 s	0.932 s	5.651 s	0.000 s	0.536 s	8.0 MB	8.0 MB	
3	zachatoch1	10.248 s	1.079 s	8.319 s	0.000 s	0.850 s	8.0 MB	8.0 MB	95

Time is a sum of the times required to spell-check `texts/*.txt` using `dictionaries/large`. **Memory** is a measure of maximal heap and stack utilization when spell-checking `texts/holmes.txt` using `dictionaries/large`.

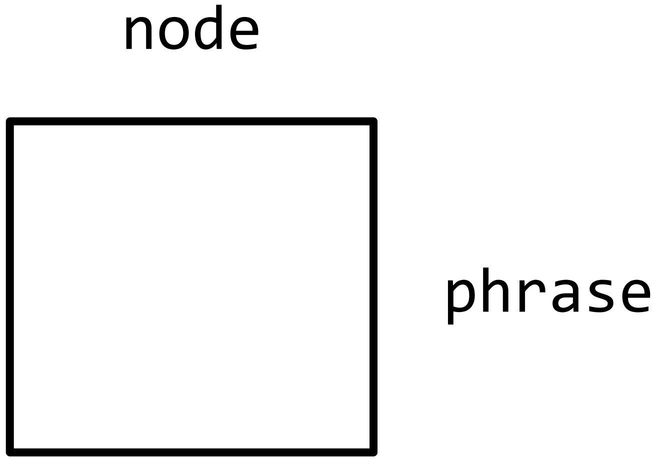
Nodes

```
typedef struct node
{
    string phrase;
    struct node *next;
}
node;
```

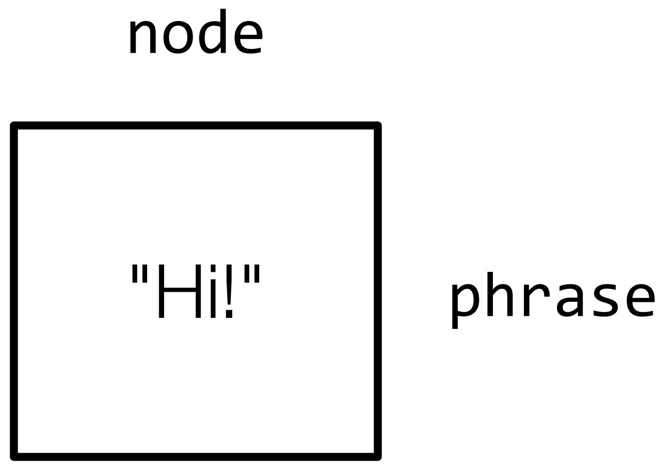
```
typedef struct node
{
    string phrase;
    struct node *next;
}
node;
```

node

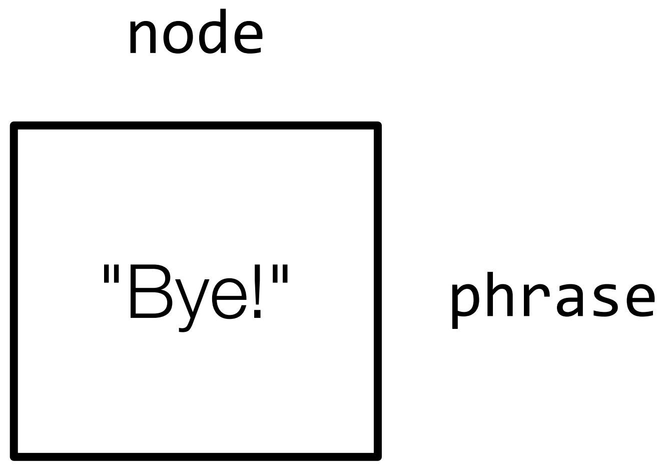
```
typedef struct node
{
    string phrase;
    struct node *next;
}
node;
```



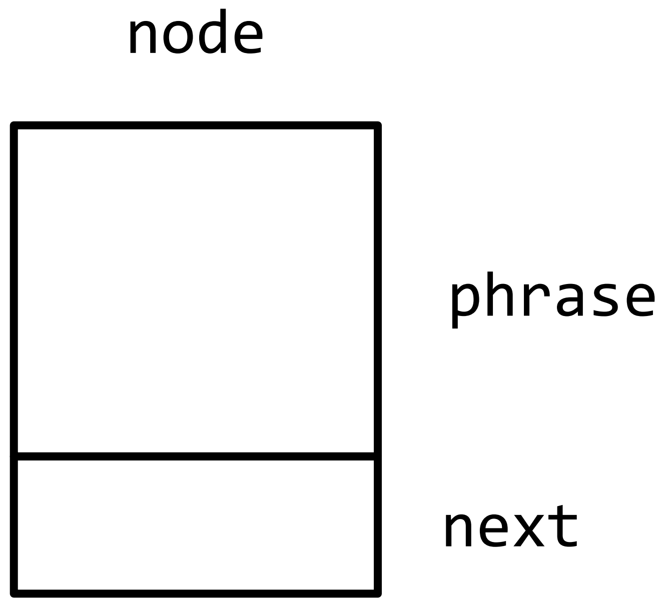
```
typedef struct node
{
    string phrase;
    struct node *next;
}
node;
```



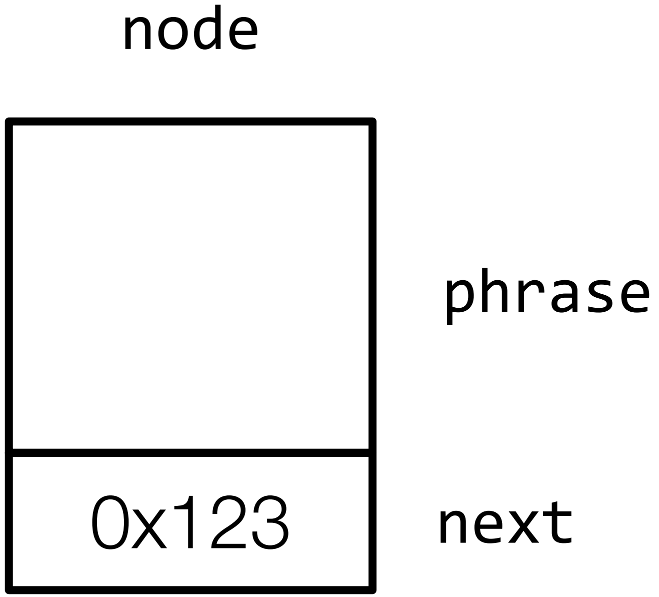
```
typedef struct node
{
    string phrase;
    struct node *next;
}
node;
```



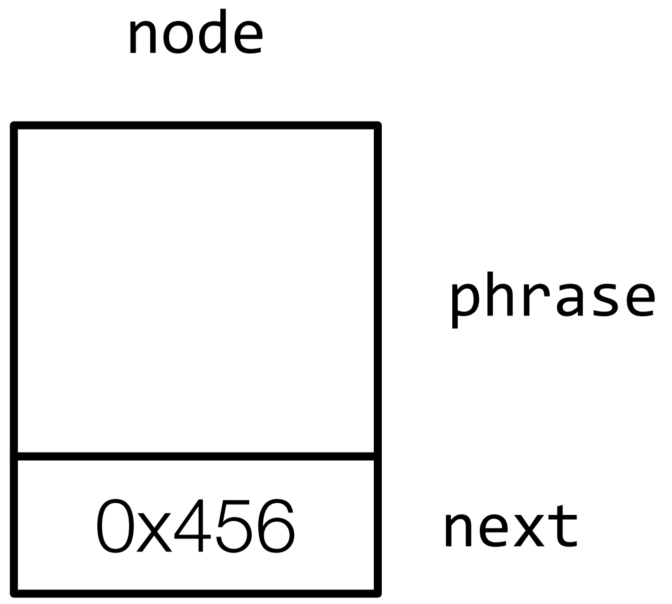
```
typedef struct node
{
    string phrase;
    struct node *next;
}
node;
```



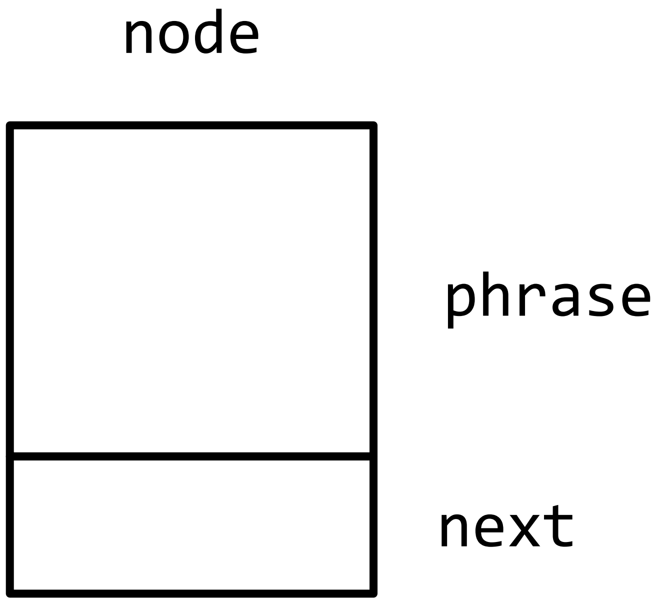
```
typedef struct node
{
    string phrase;
    struct node *next;
}
node;
```



```
typedef struct node
{
    string phrase;
    struct node *next;
}
node;
```

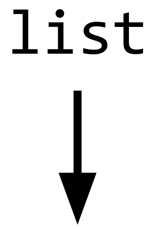


```
typedef struct node
{
    string phrase;
    struct node *next;
}
node;
```

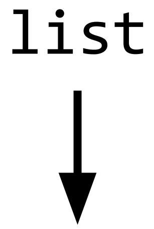


Creating a Linked List

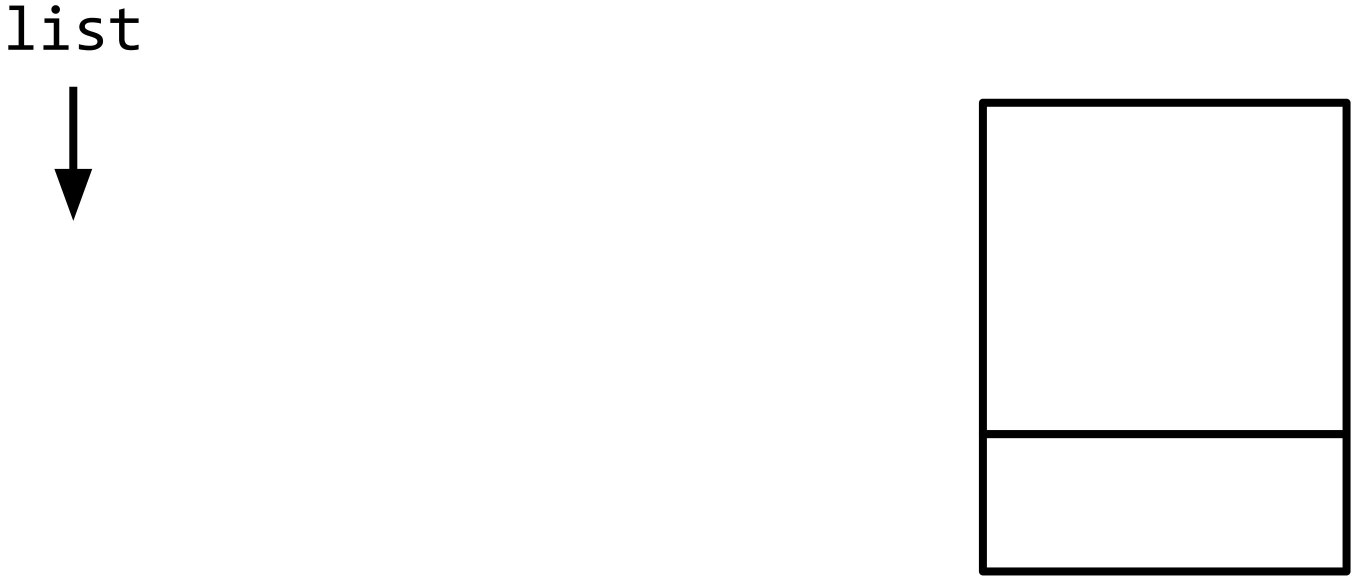
```
node *list = NULL;
```



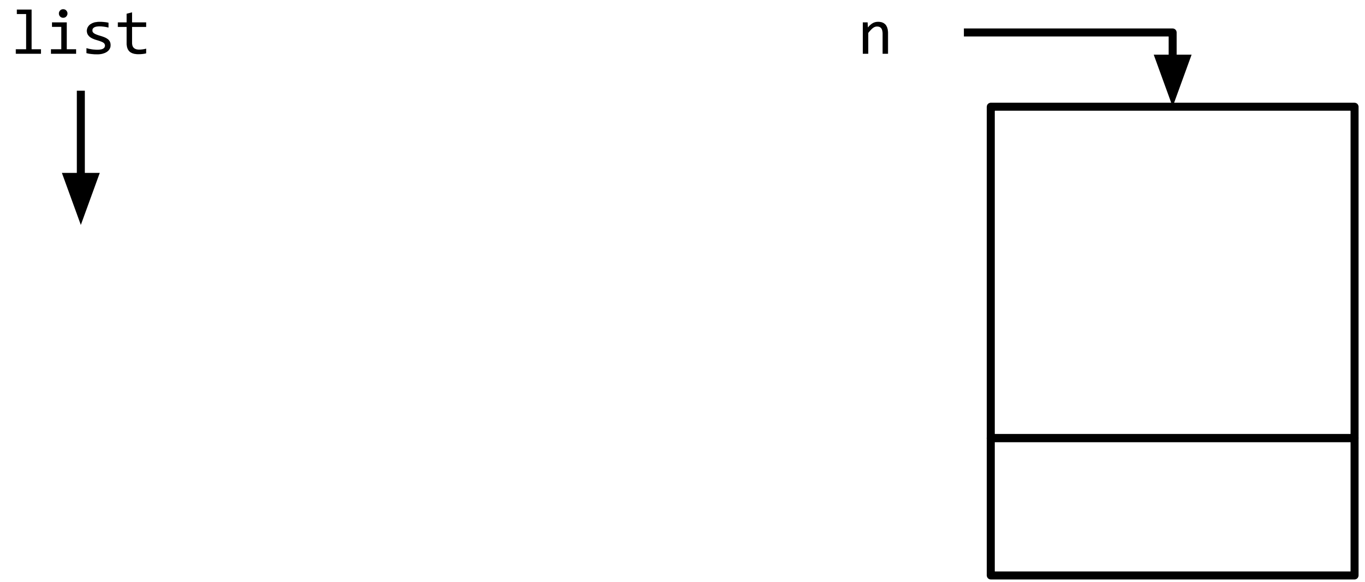
```
node *n = malloc(sizeof(node));
```



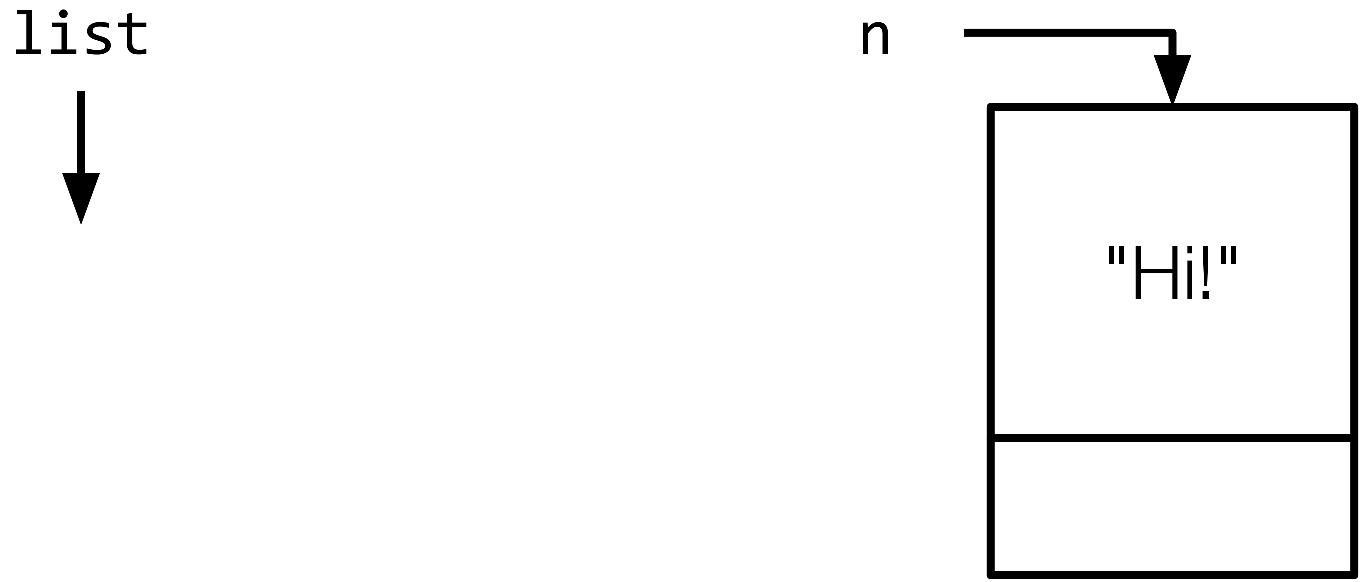
```
node *n = malloc(sizeof(node));
```



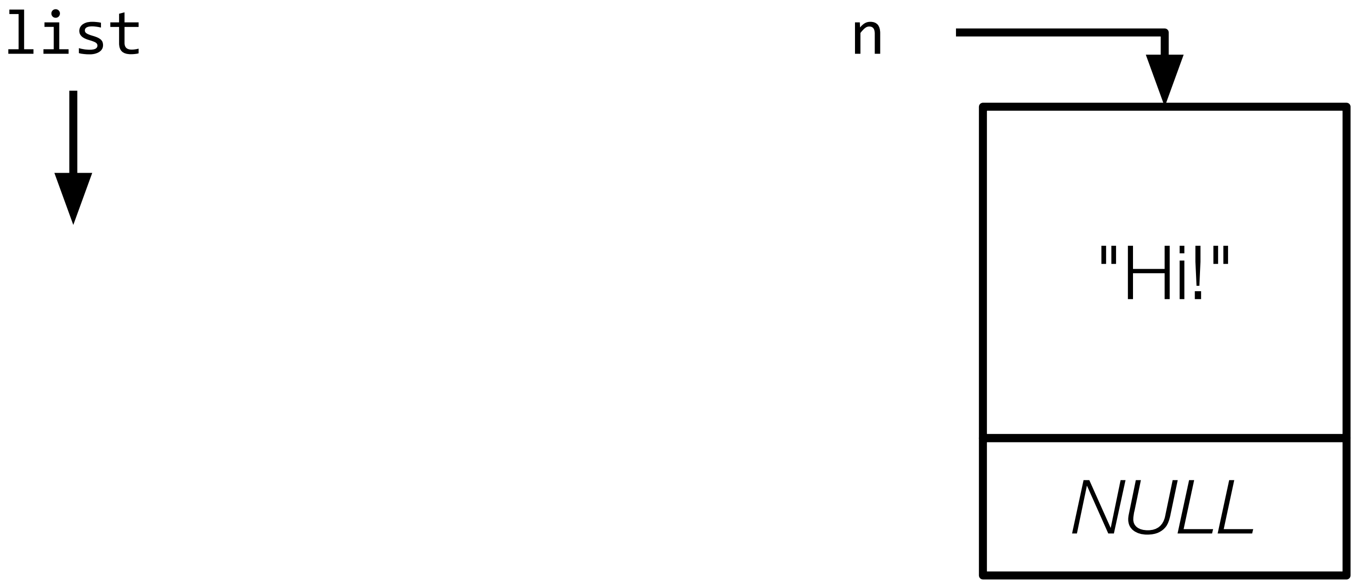
```c
node *n = malloc(sizeof(node));
```



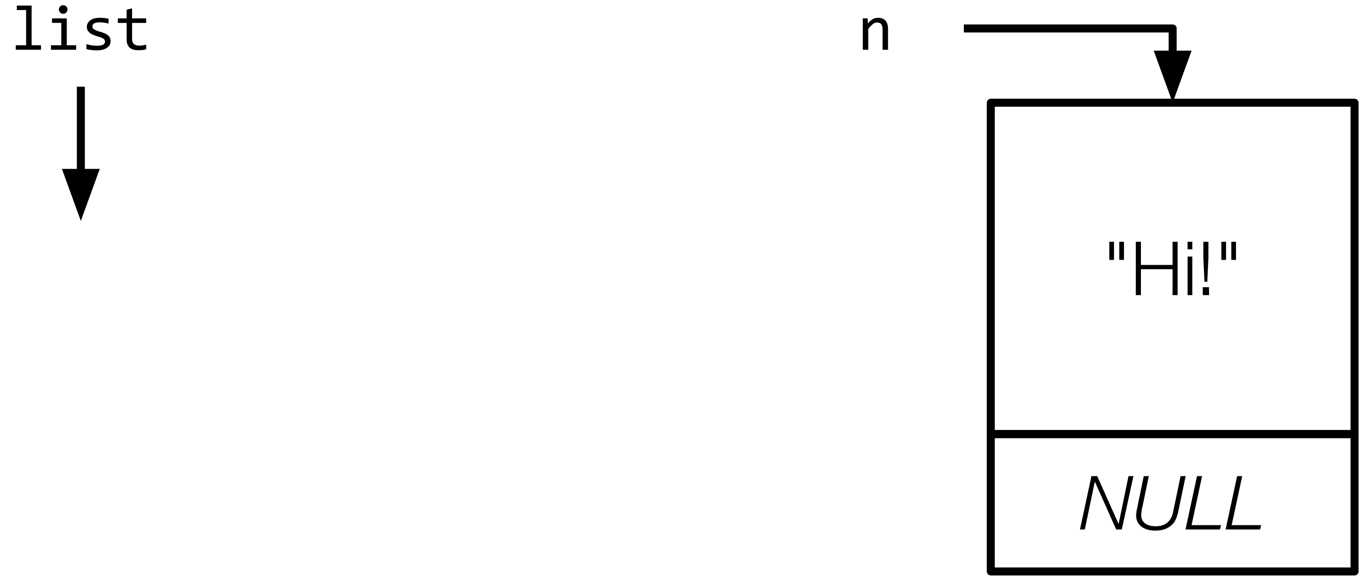
```
node *n = malloc(sizeof(node));
n->phrase = "Hi!";
```



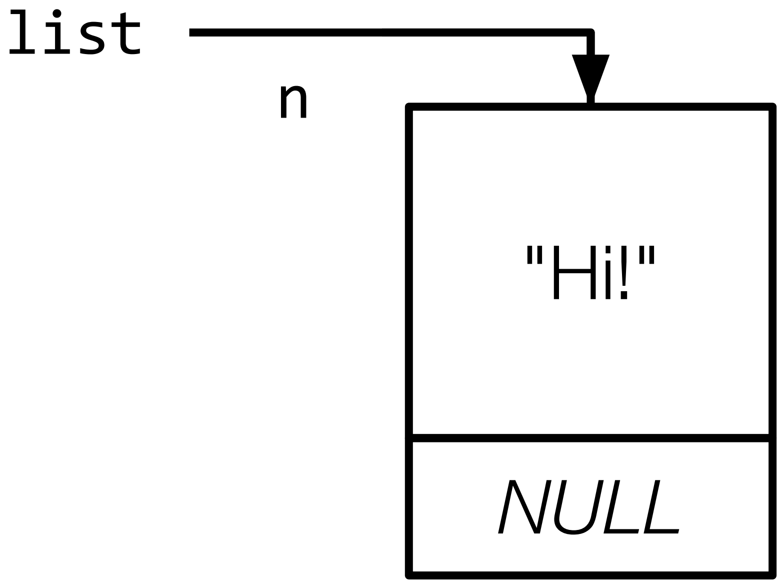
```
node *n = malloc(sizeof(node));
n->phrase = "Hi!";
n->next = NULL;
```



```
list = n;
```

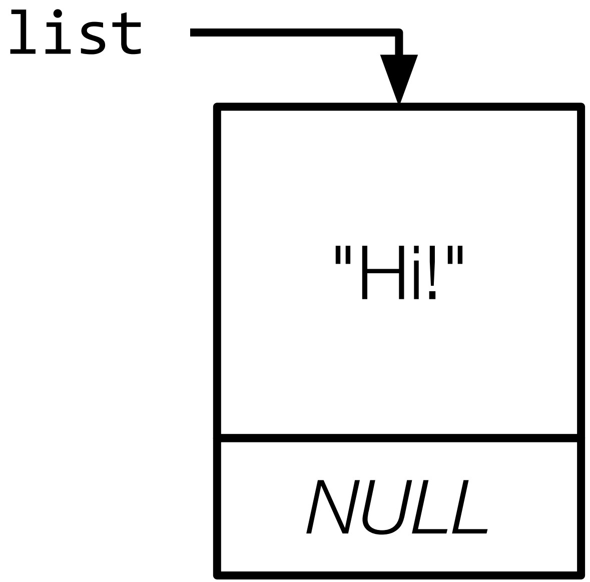


```
list = n;
```

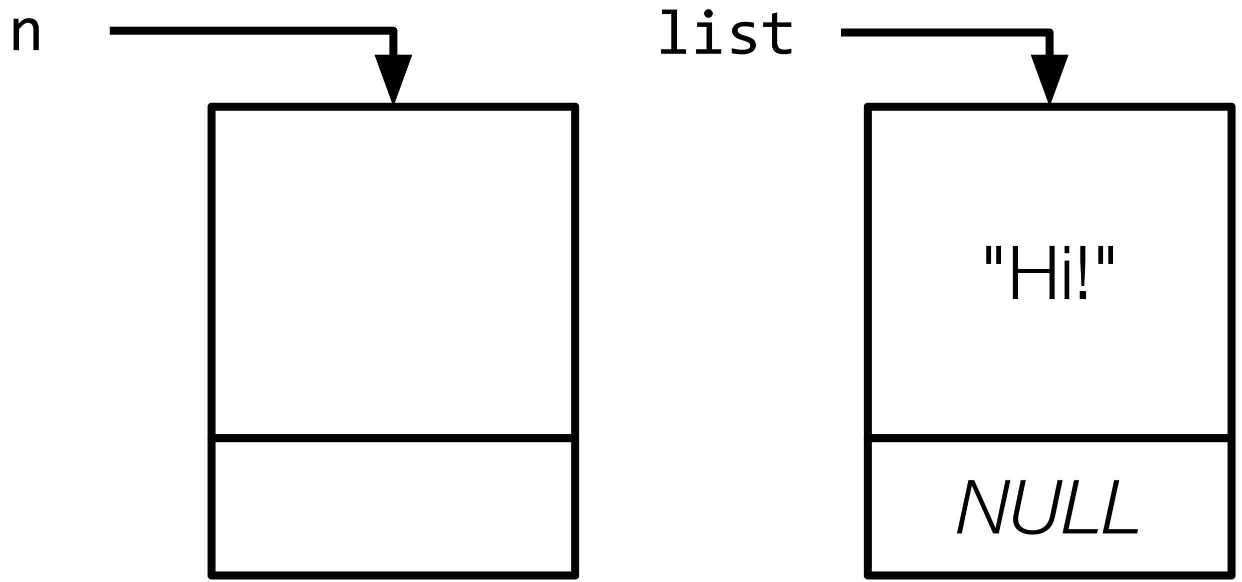


Inserting Nodes

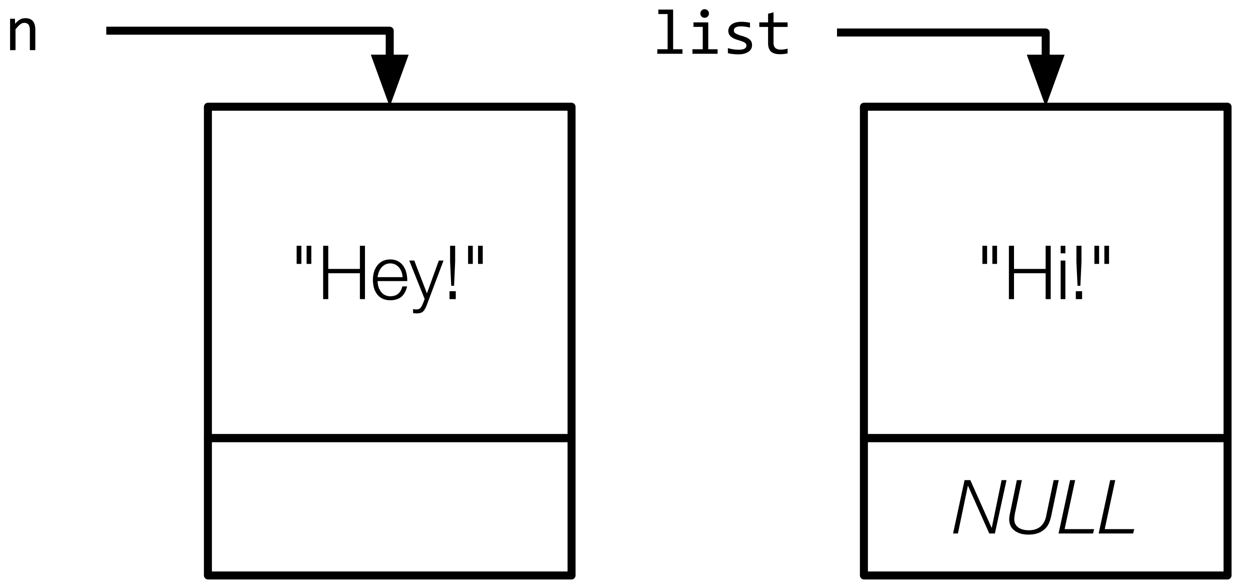
```
n = malloc(sizeof(node));
```



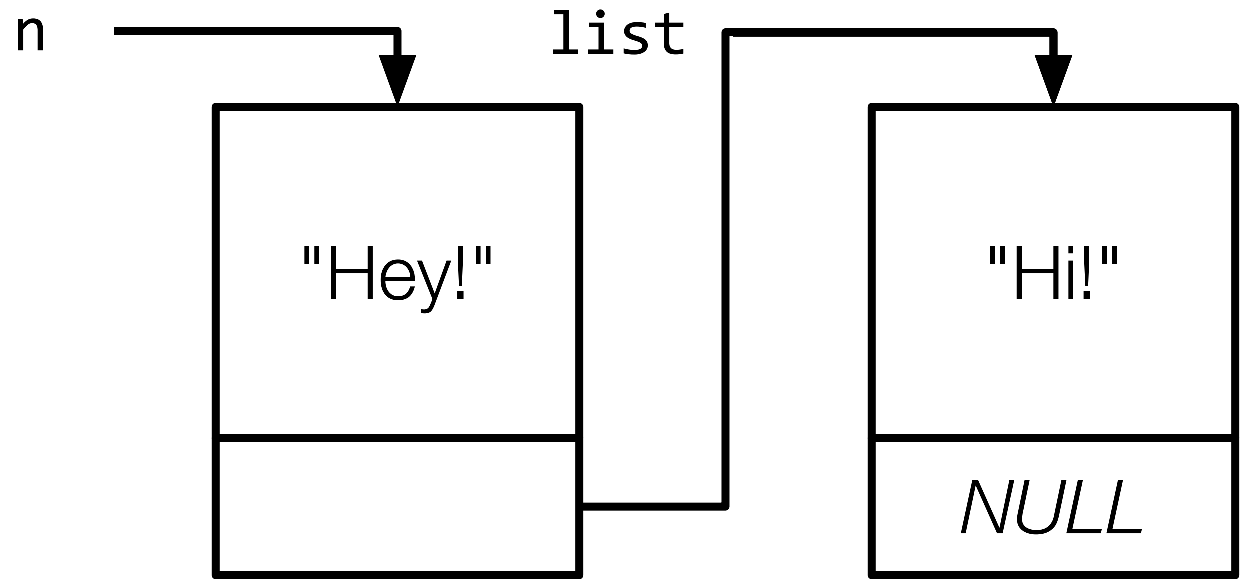
```
n = malloc(sizeof(node));
```



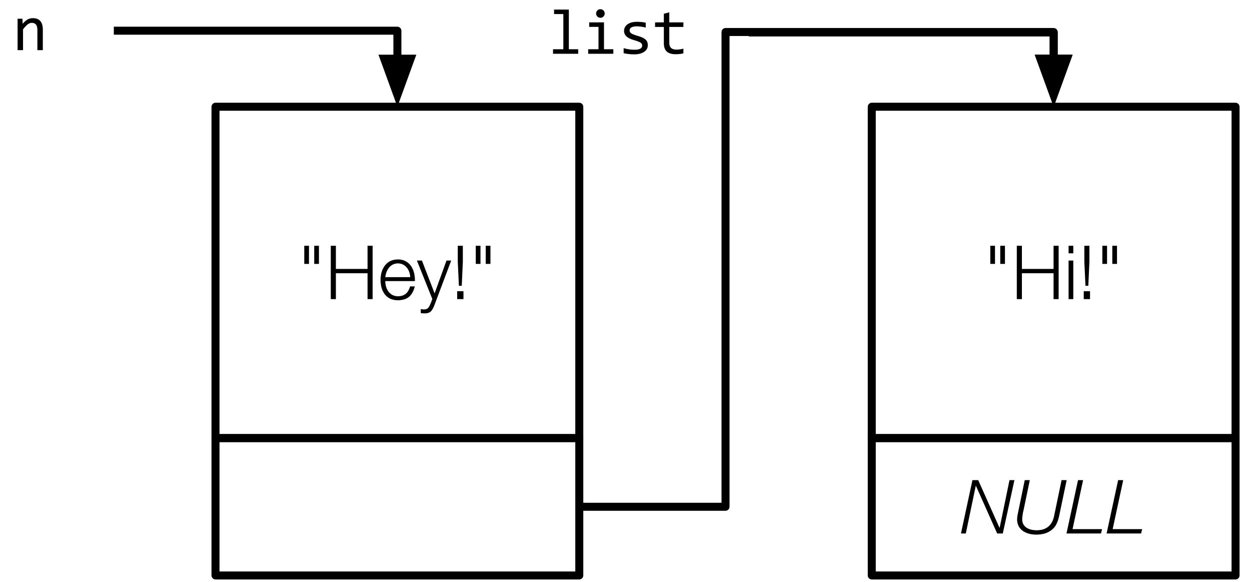
```c
n = malloc(sizeof(node));
n->phrase = "Hey!";
```



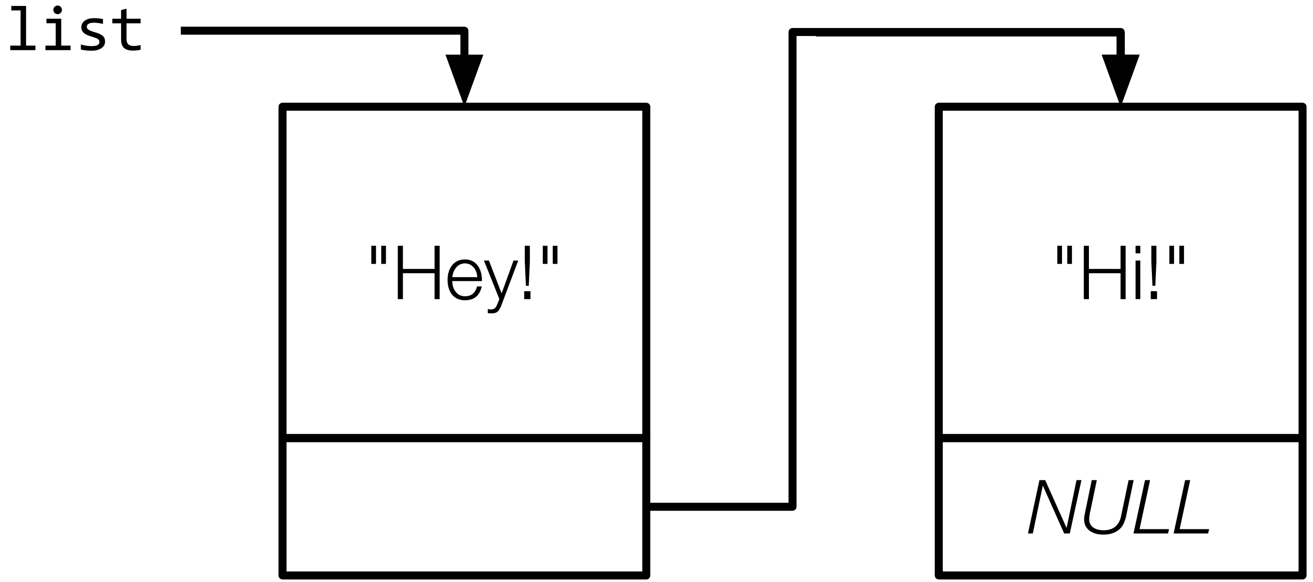
```
n = malloc(sizeof(node));
n->phrase = "Hey!";
n->next = list;
```

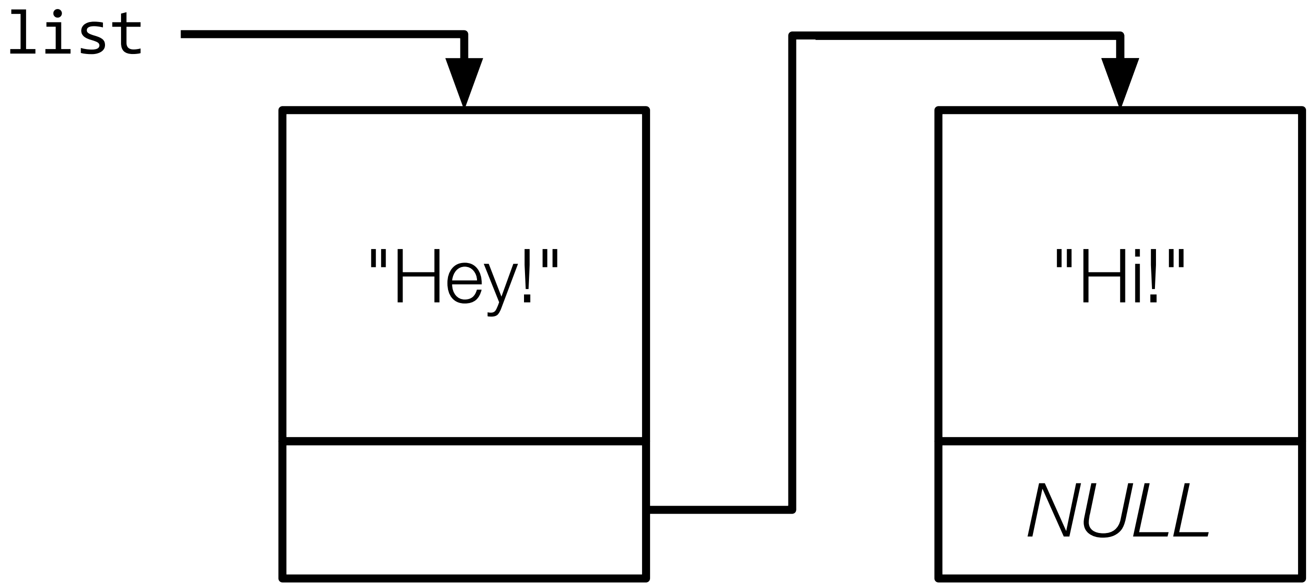


```
list = n;
```

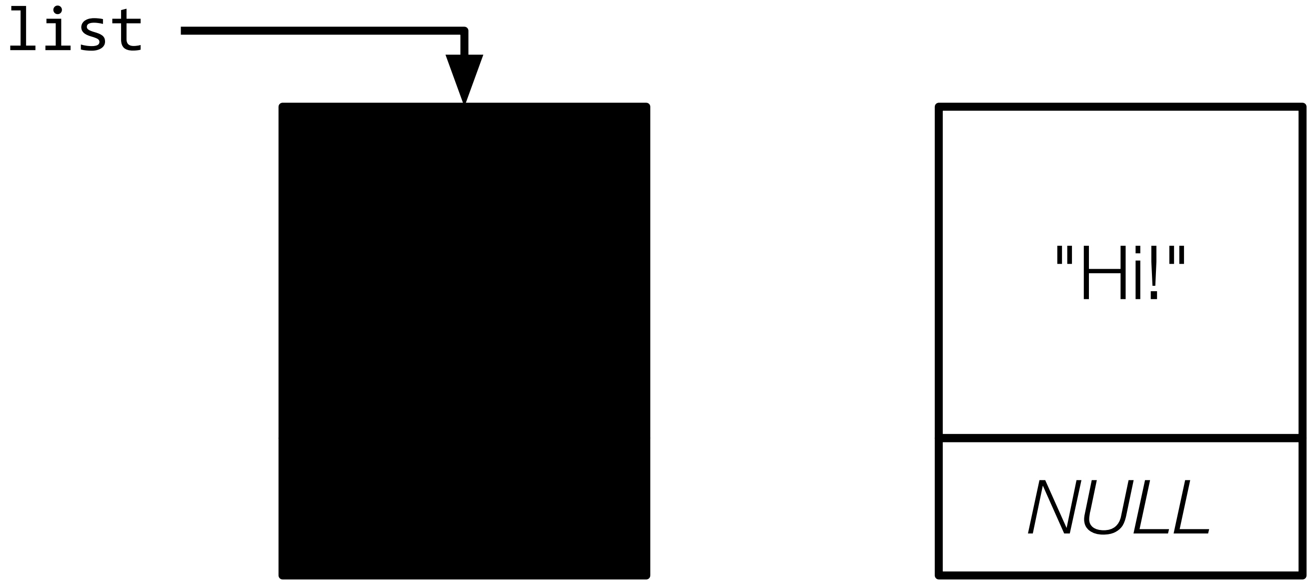


```
list = n;
```

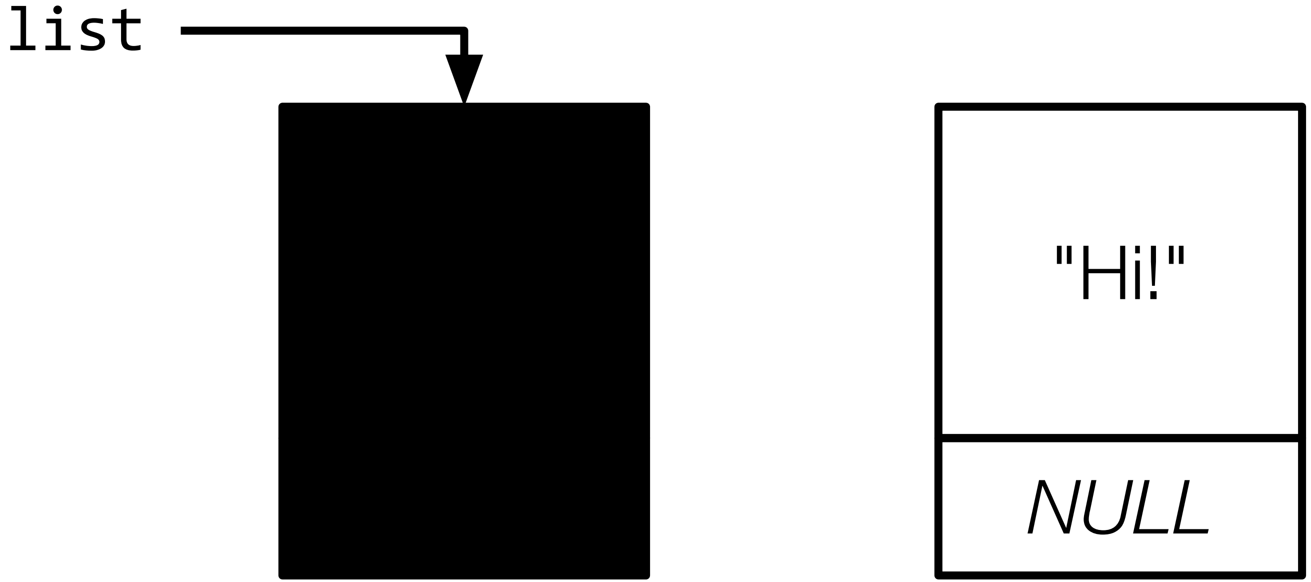


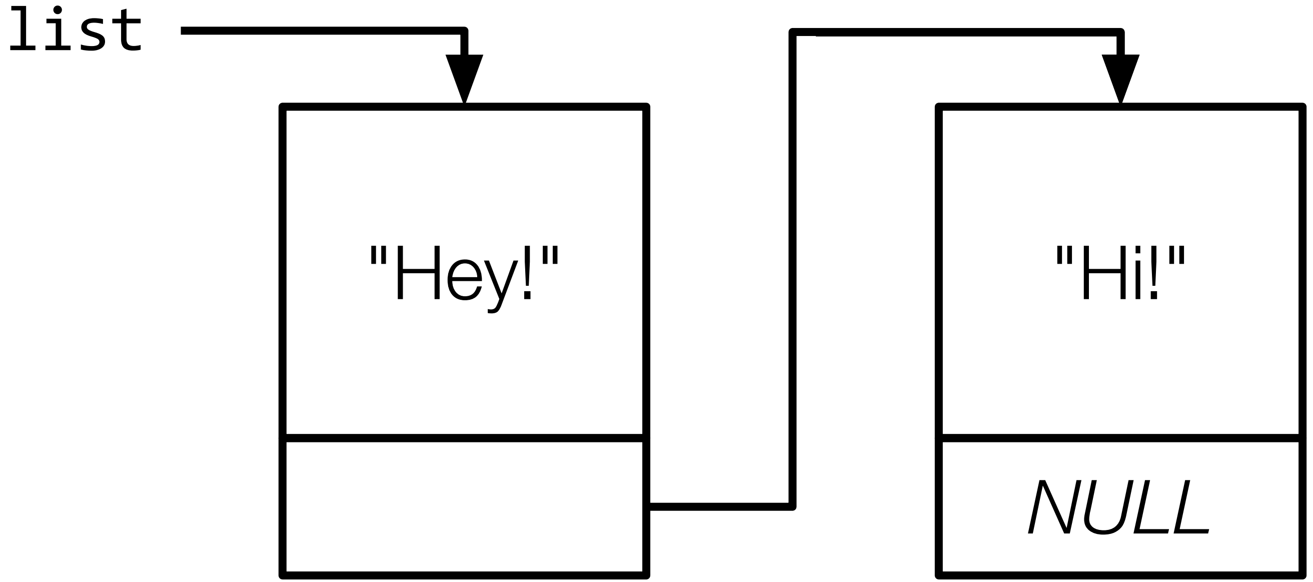

list
"Hey!"
"Hi!"
NULL

```
free(list);
```

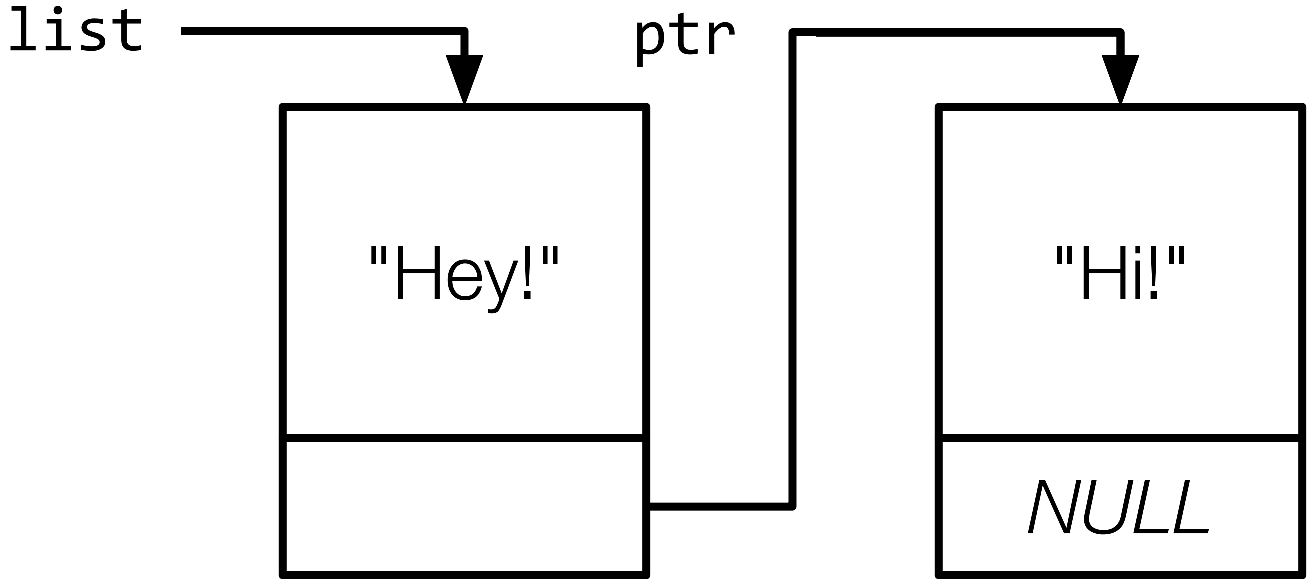


```
free(list);
```

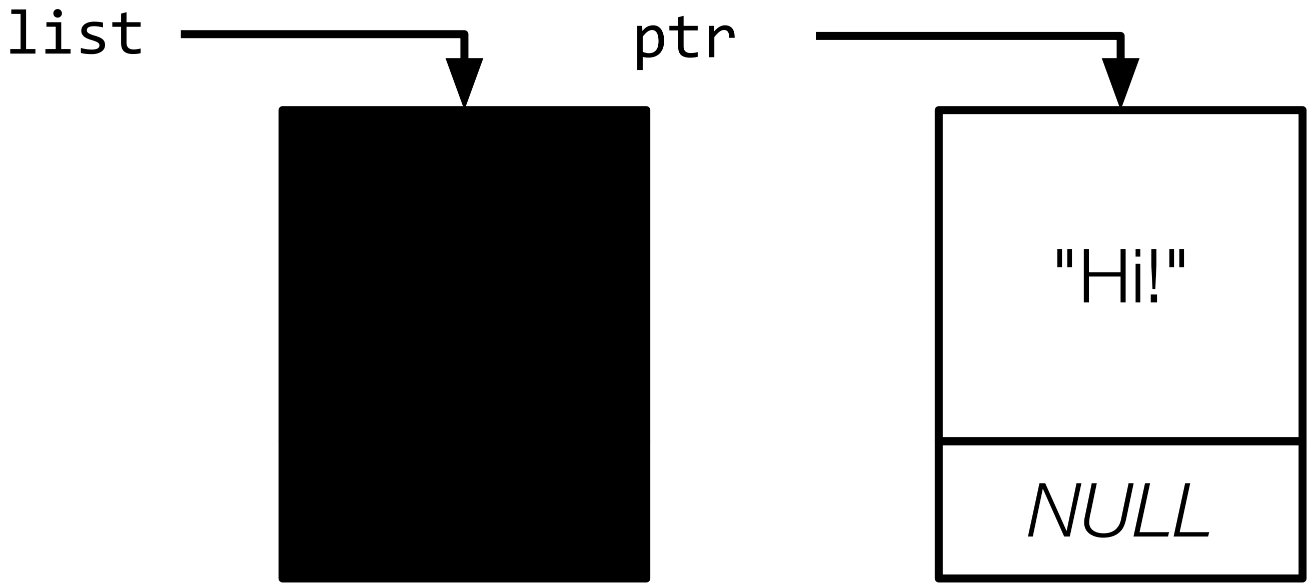



list
"Hey!"
"Hi!"
NULL

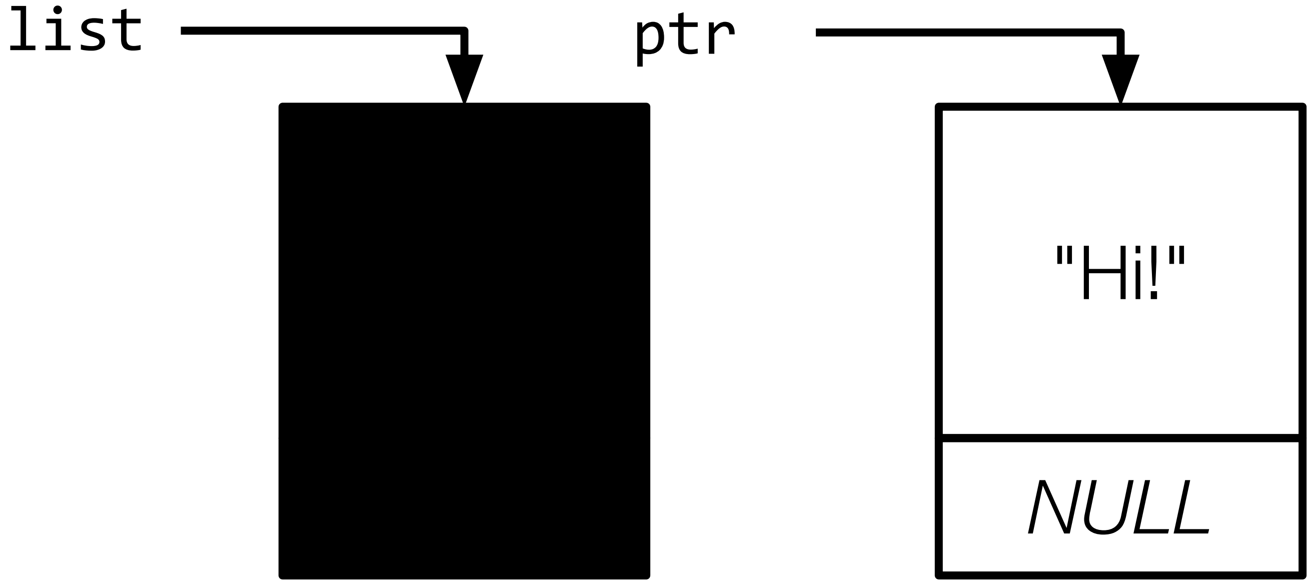
```
node *ptr = list->next;
```



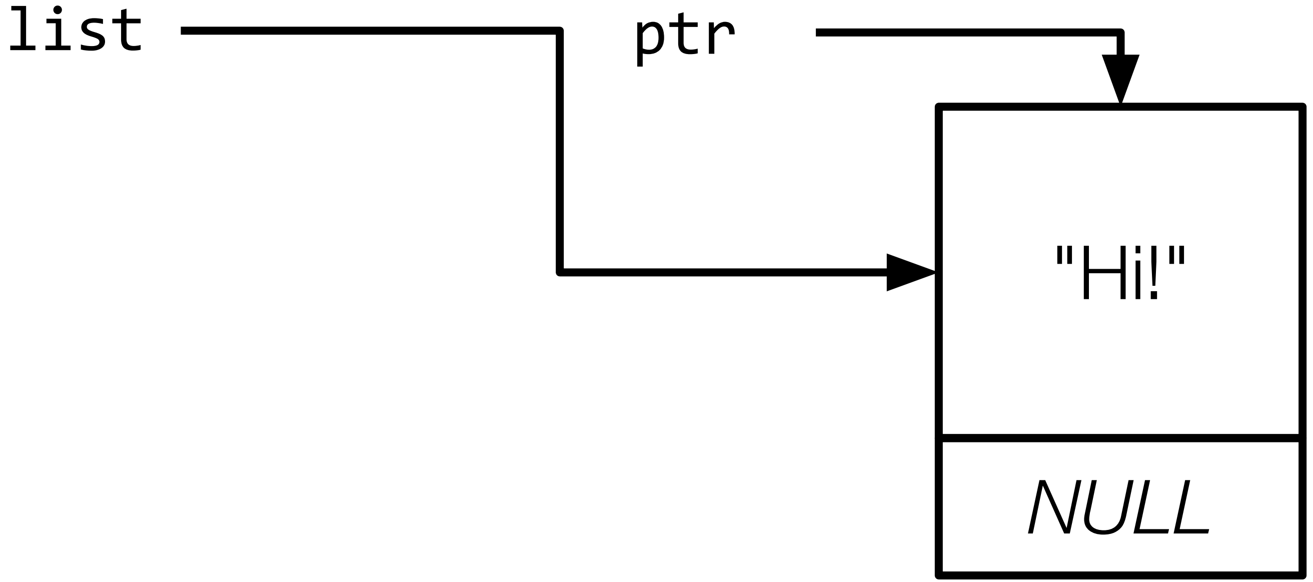
```
free(list);
```



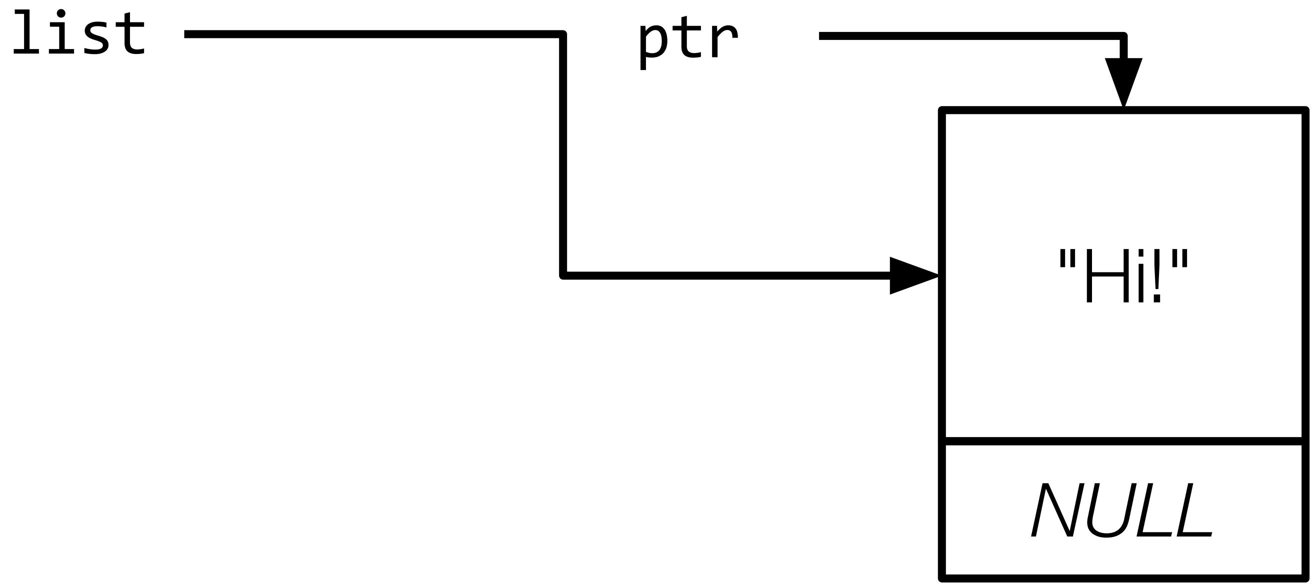
```
list = ptr;
```



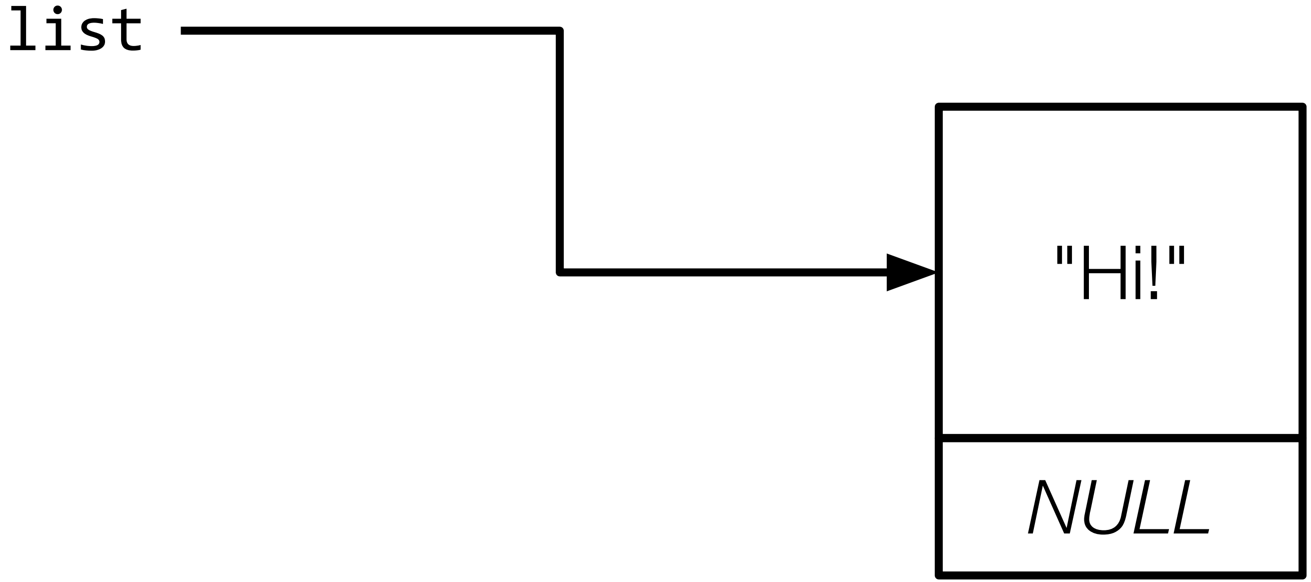
```
list = ptr;
```



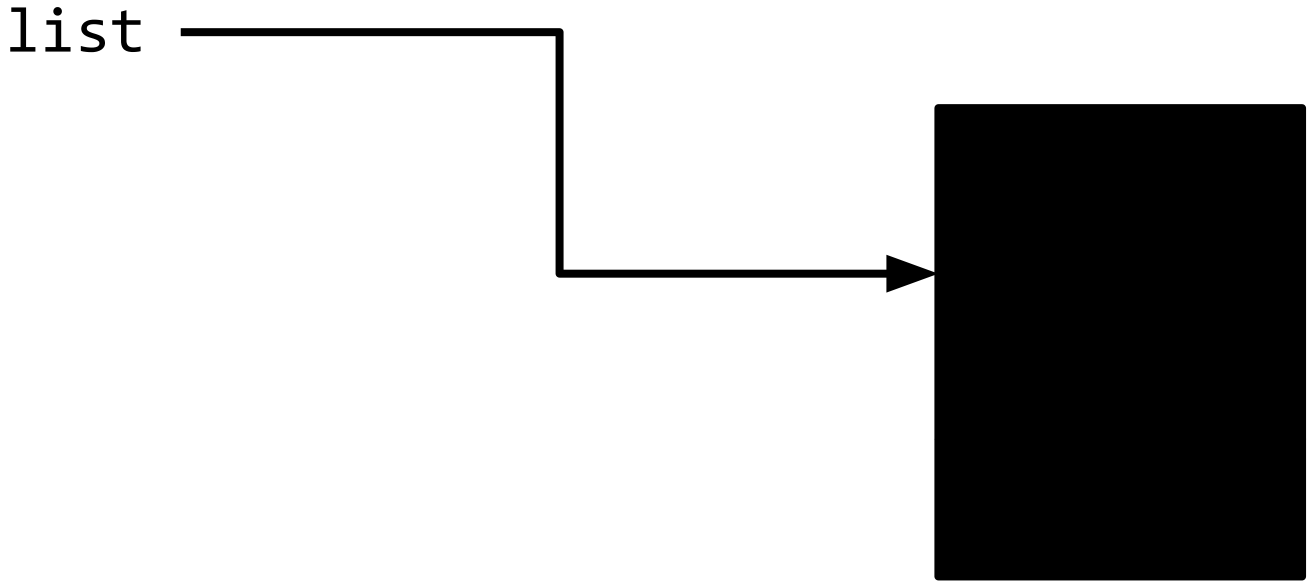
```
ptr = list->next;
```



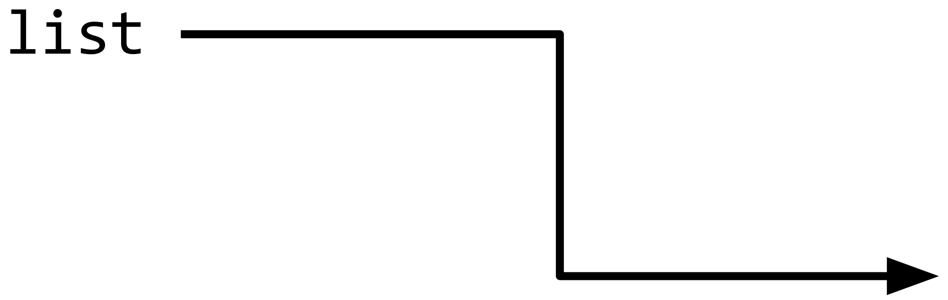
```
ptr = list->next;
```



```c
free(list);
```



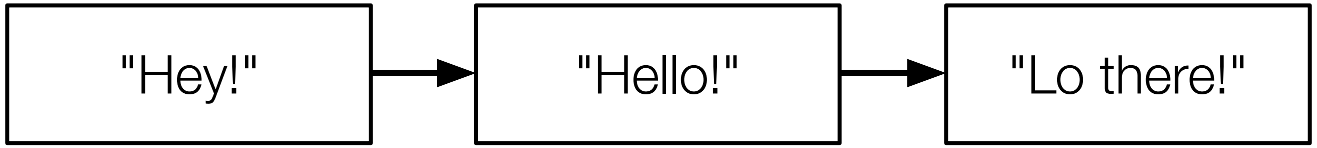
```
list = ptr;
```

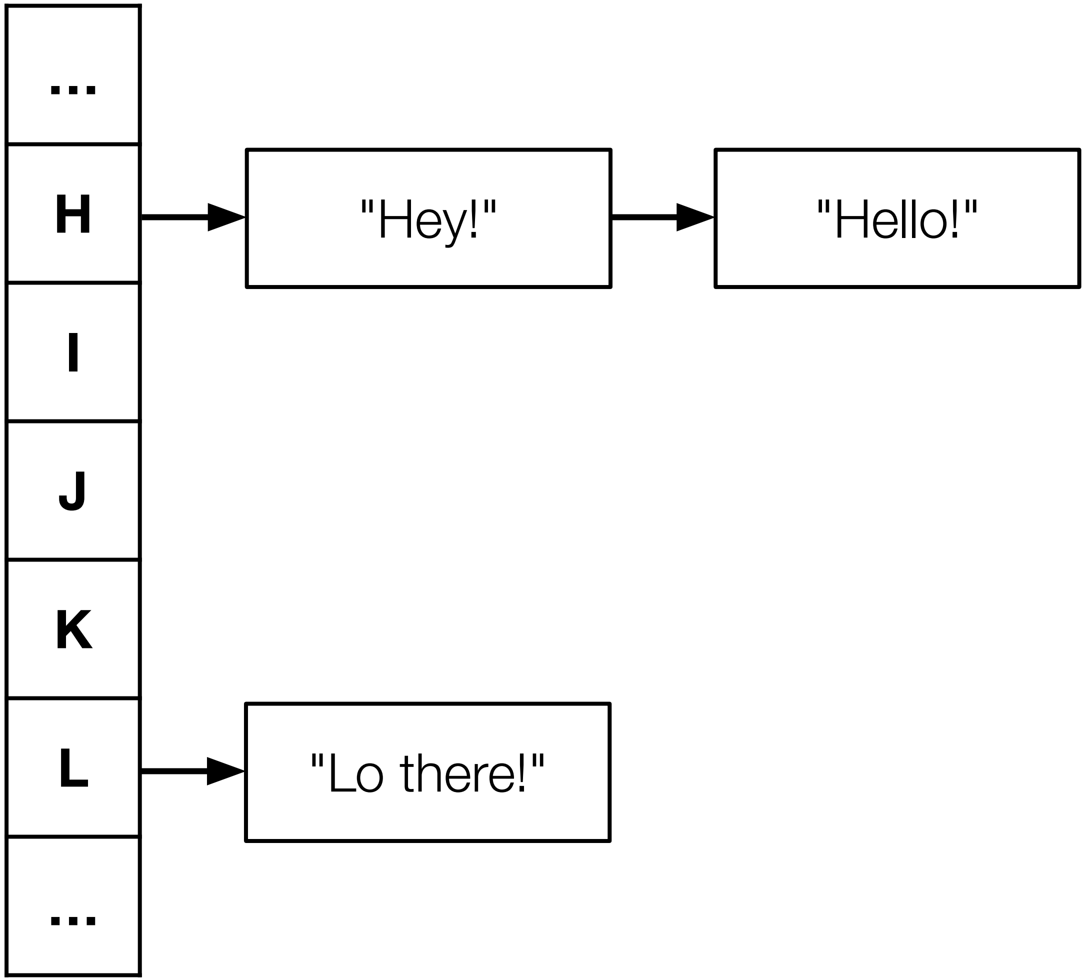


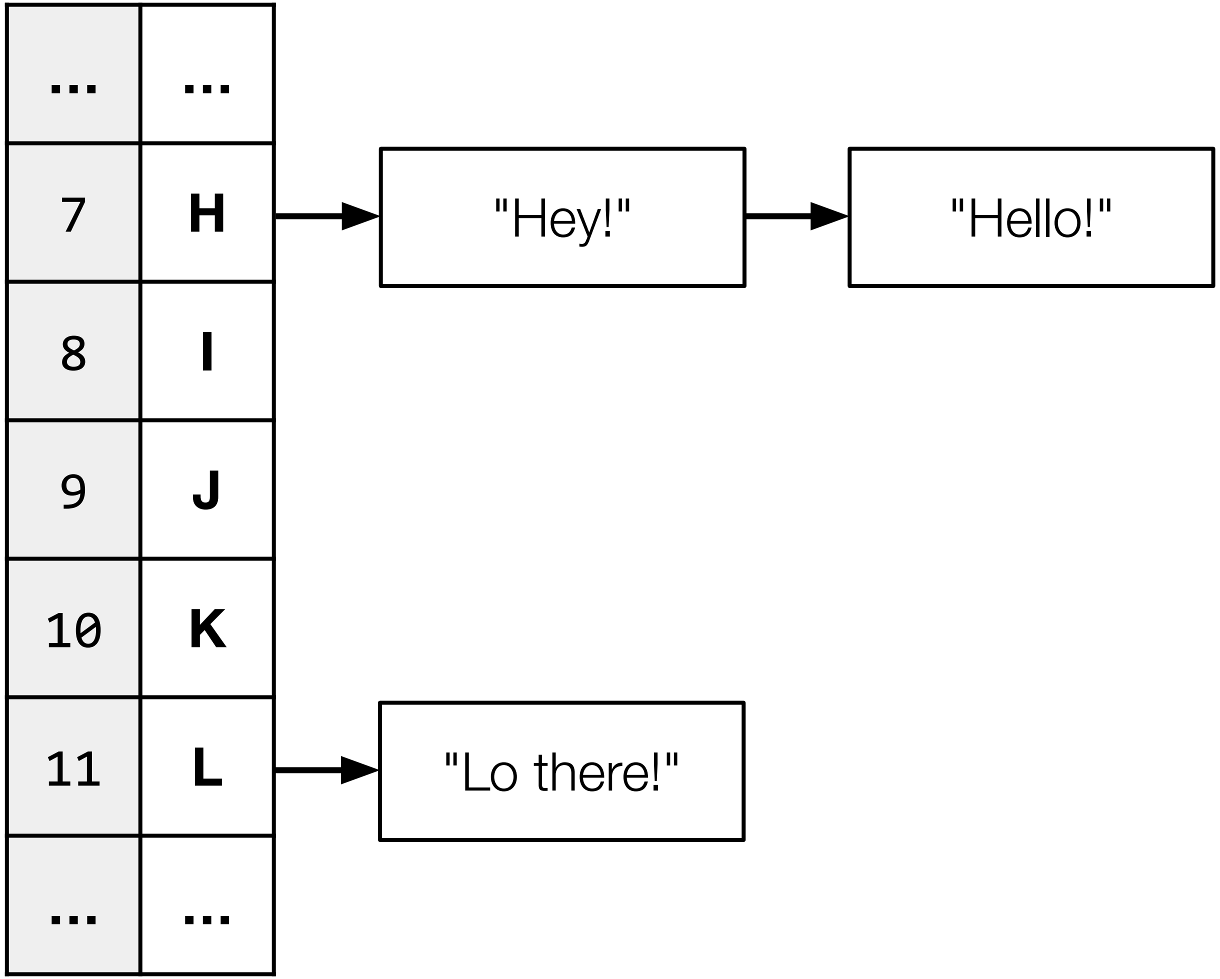
Inserting and Unloading a Linked List

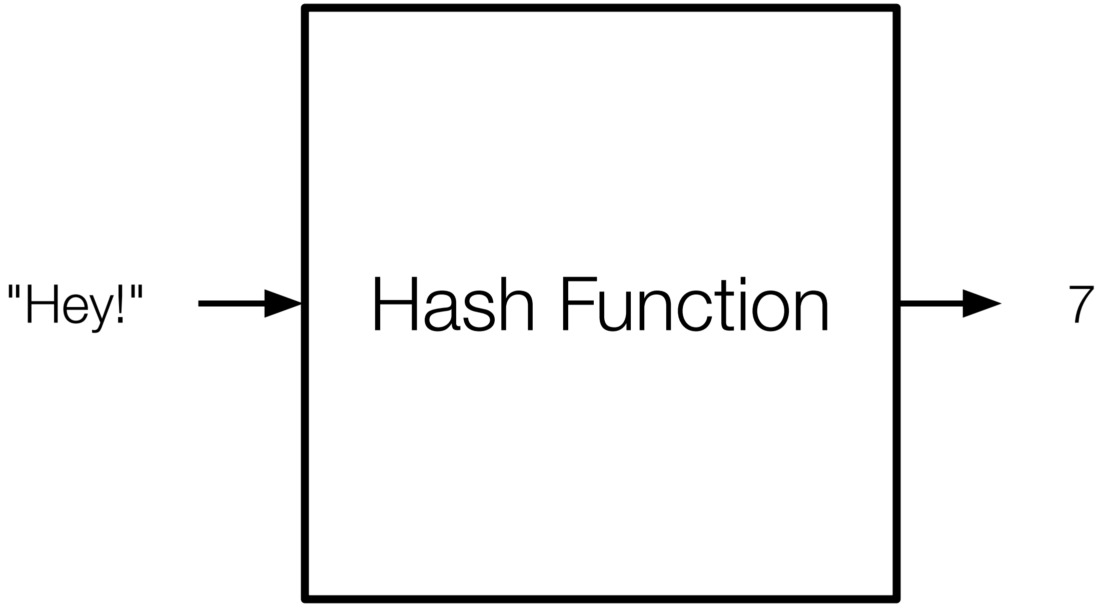
Download and open **list.c** at **cs50.ly/supersection1**.

1. TODO: implement code to add a node to the linked list. Ensure that **list** always points to the head of the linked list. Also ensure your new node contains a phrase.
2. TODO: implement **unload** such that all nodes in the linked list are **free**'d when the function is called. Return **true** when successful.


"Hey!"
"Hello!"
"Lo there!"


...
H
I
J
K
L
...
"Hey!"
"Hello!"
"Lo there!"


...
...
7
H
"Hey!"
"Hello!"
8
I
9
J
10
K
11
L
"Lo there!"
...
...


"Hey!"
Hash Function
7

Hashing

Download and open **table.c** at **cs50.ly/supersection2**.

TODO: complete **hash** to return a number, 0–25, depending on the first character in the word.

We will walk through it together!

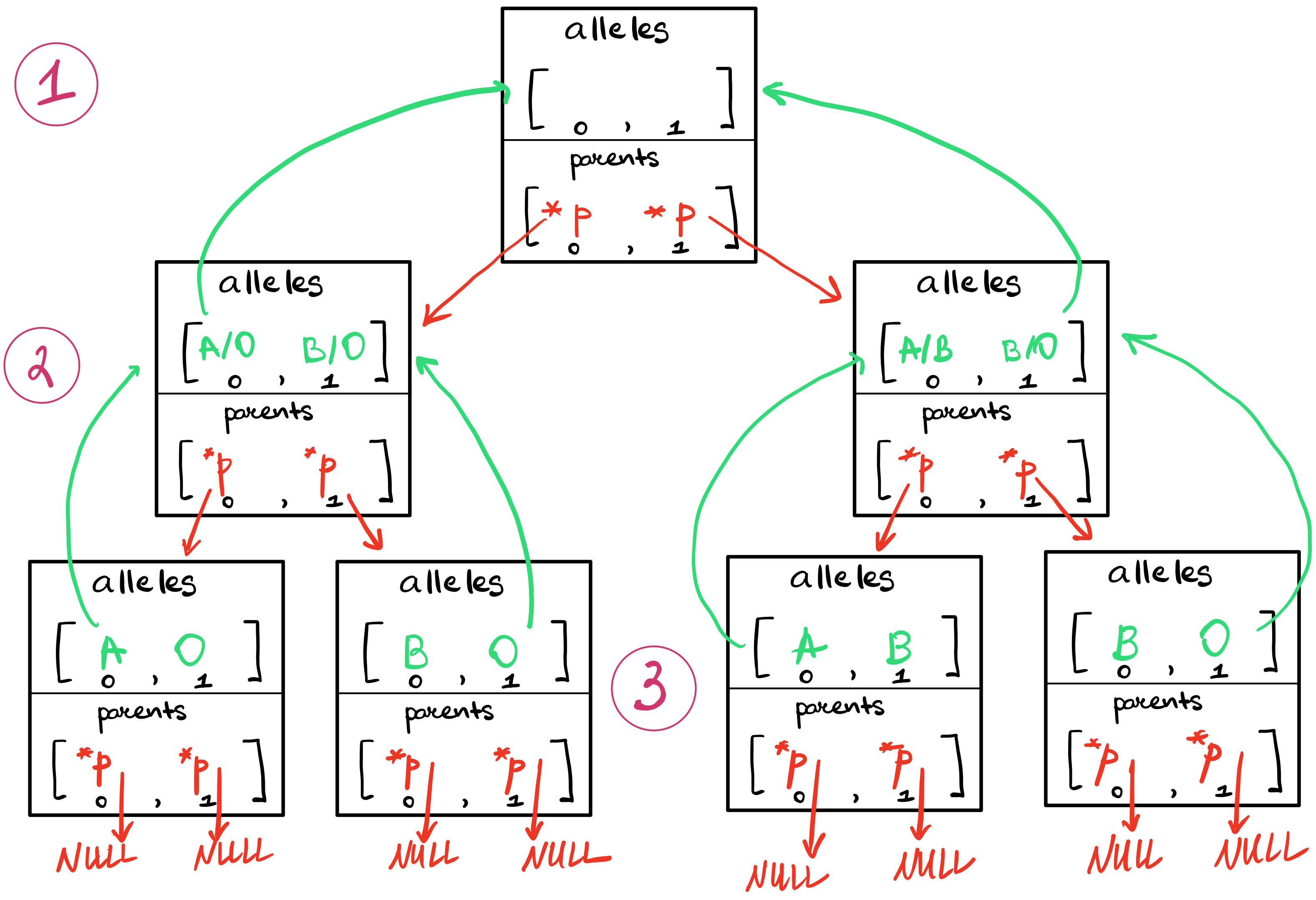
A good hash function…

Always gives you the same value for the same input

Produces an even distribution across buckets

Uses all buckets

Inheritance


1
alleles
[,]
0 , 1
parents
[*p , *p]
2
alleles
[A/O , B/O]
parents
[*p , *p]
alleles
[A/B , B/O]
parents
[*p , *p]
3
alleles
[A , O]
[B , O]
[A , B]
[B , O]
parents
[*p , *p]
NULL

This was CS50