This is CS50

data structures

abstract data types

queues

FIFO

enqueue

dequeue

```
const int CAPACITY = 50;

typedef struct
{
    person people[CAPACITY];
    int size;
} queue;
```

stacks

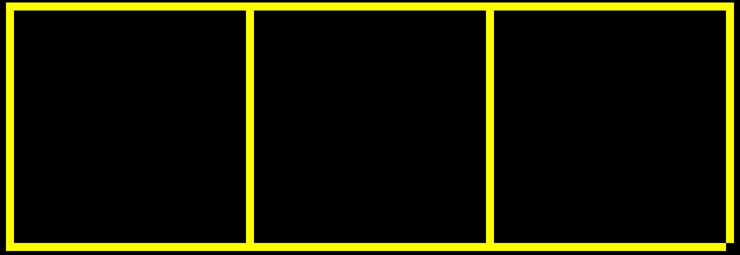
LIFO

push

pop

```
const int CAPACITY = 50;

typedef struct
{
    person people[CAPACITY];
    int size;
} stack;
```

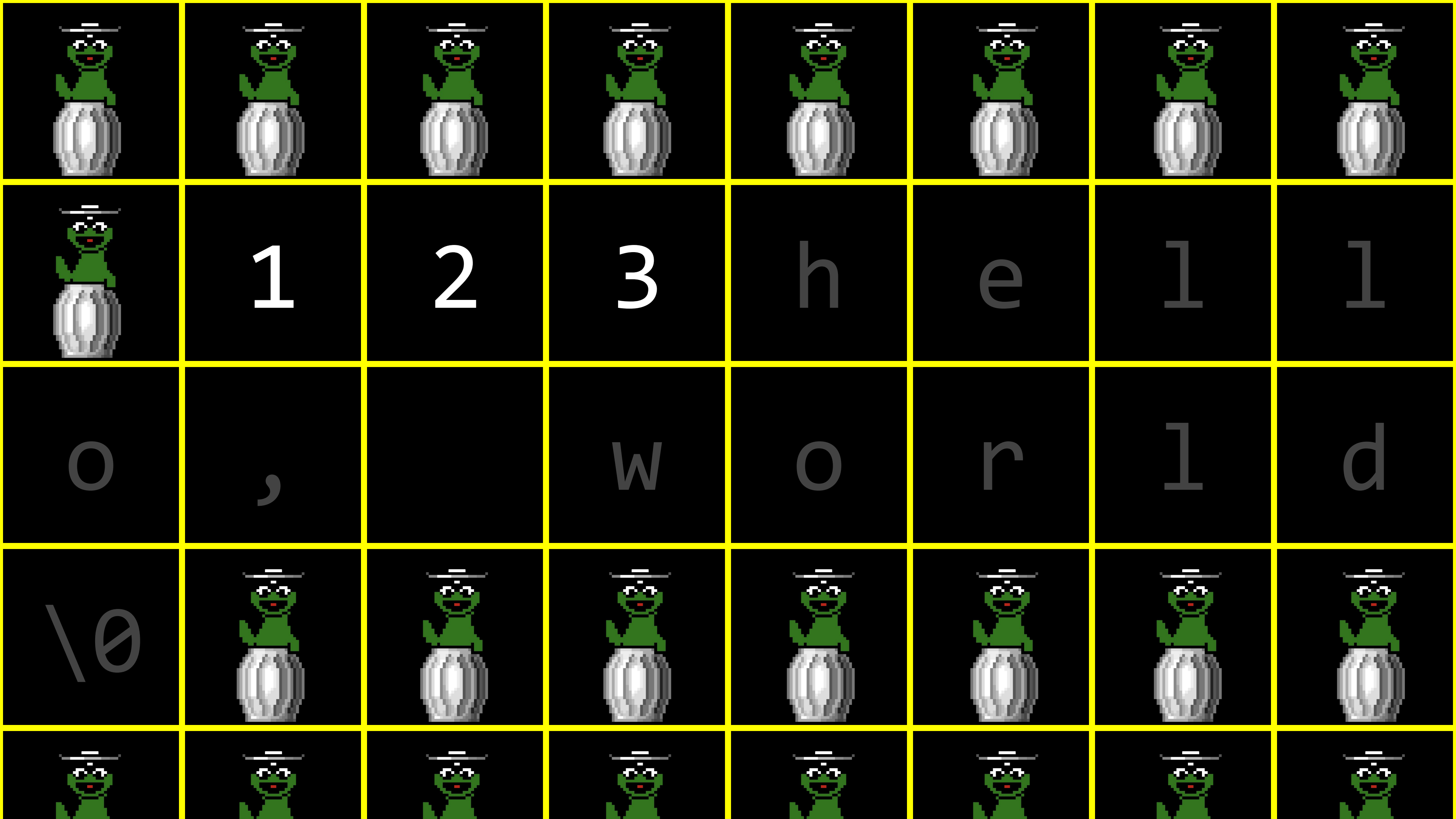
arrays



1	2	3

1	2	3	

	1	2	3				



	1	2	3	h	e	l	l
o	,		w	o	r	l	d
\0							

1	2	3

1	2	3

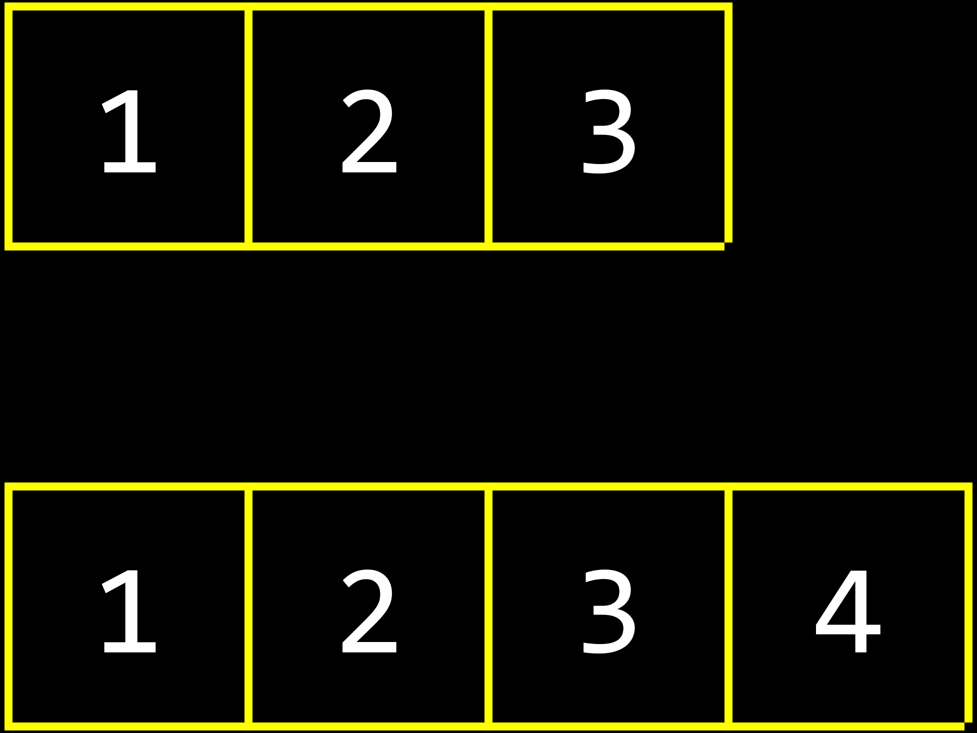
1			

1	2	3

1	2		

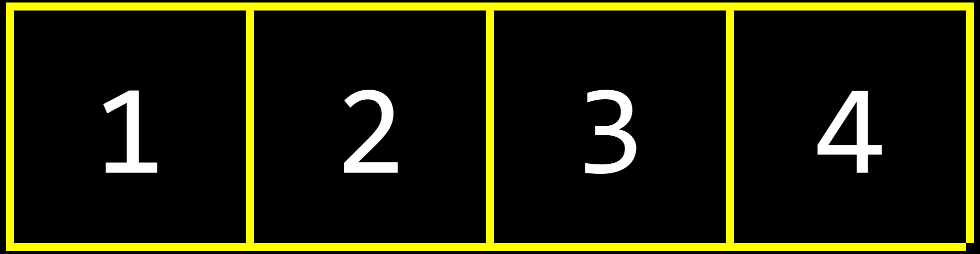
1	2	3

1	2	3	



1	2	3

1	2	3	4



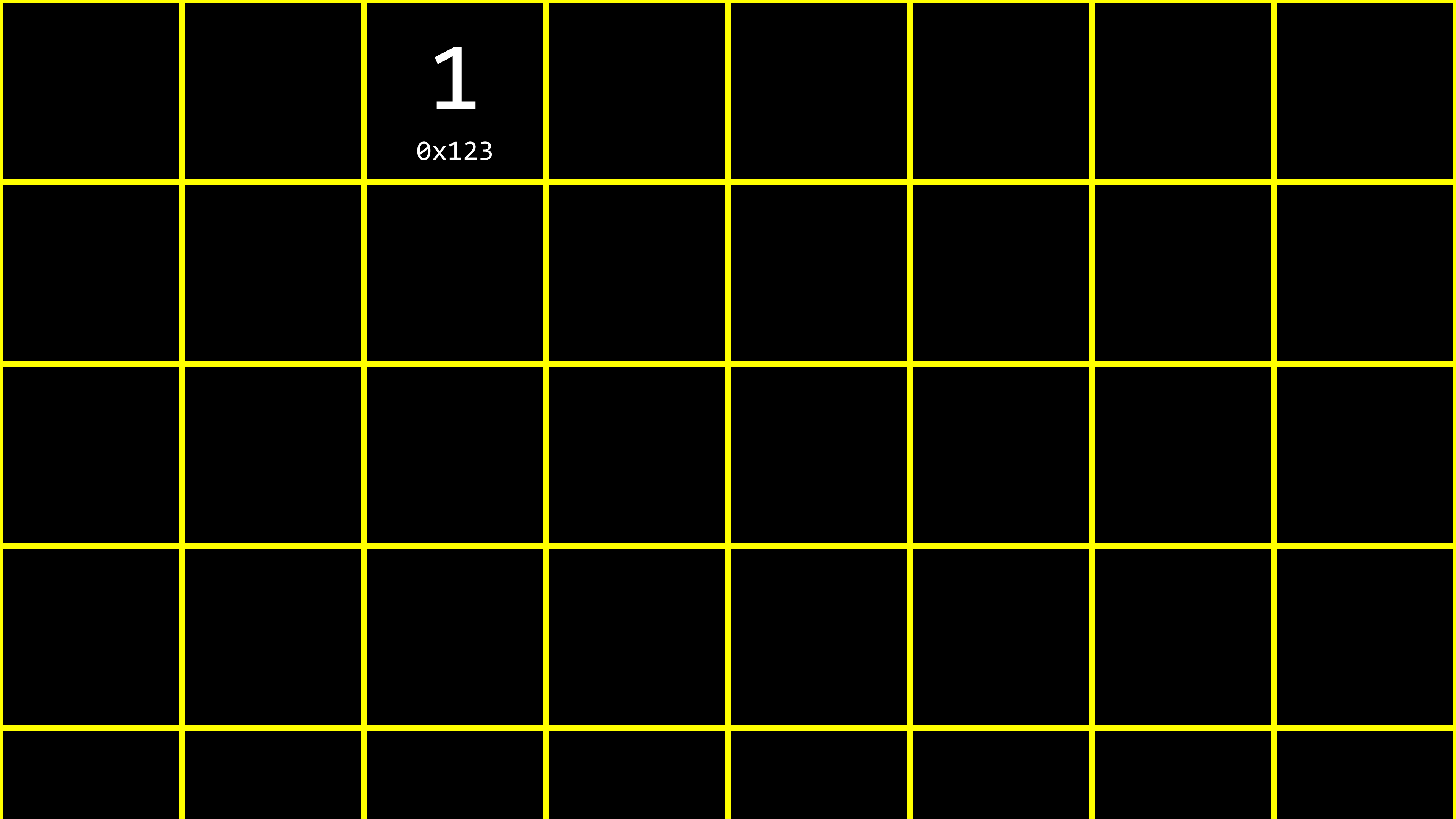
1	2	3	4

data structures

```
struct

.

*
```

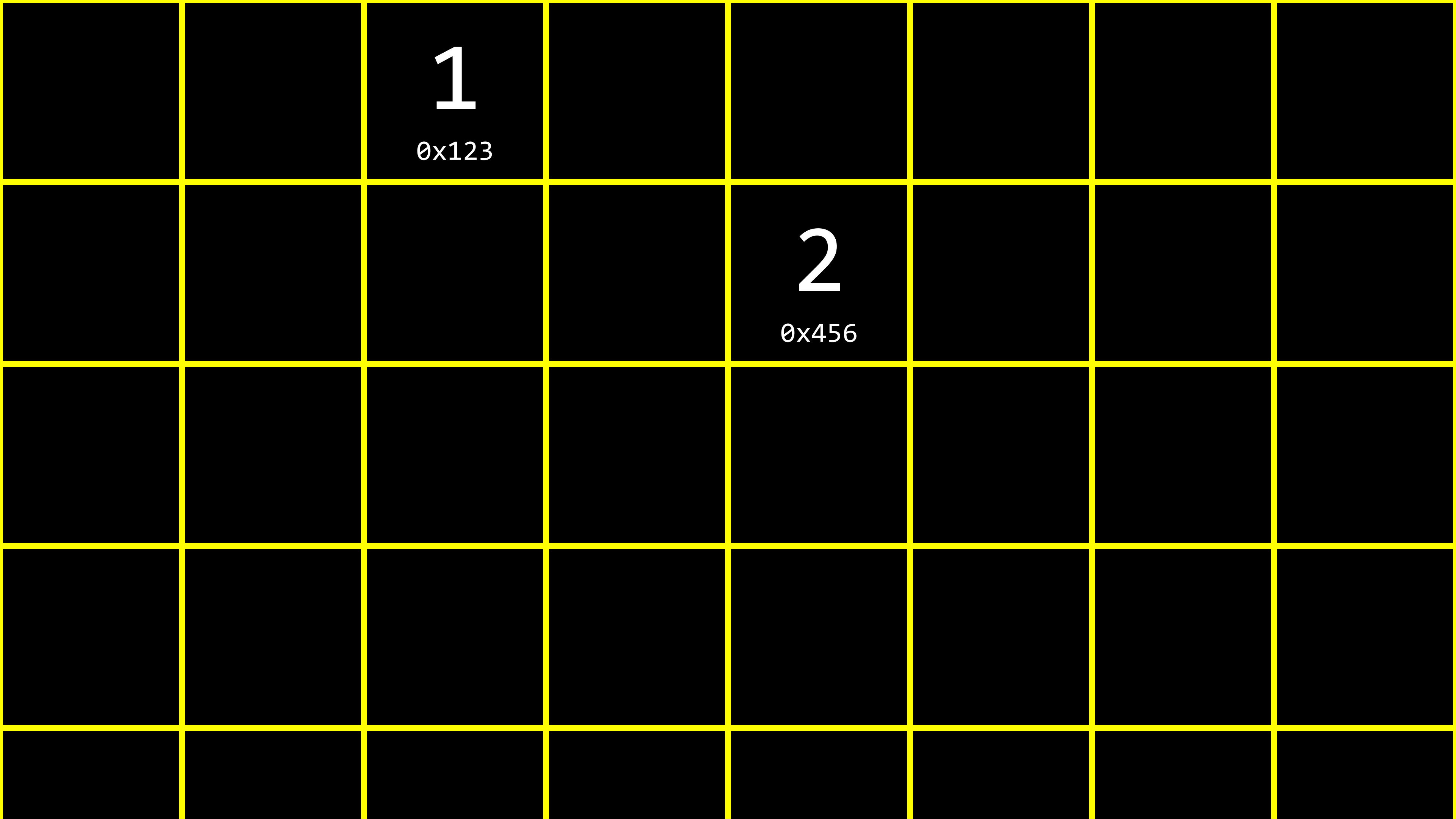
```
struct

->
```

linked lists



1

0x123

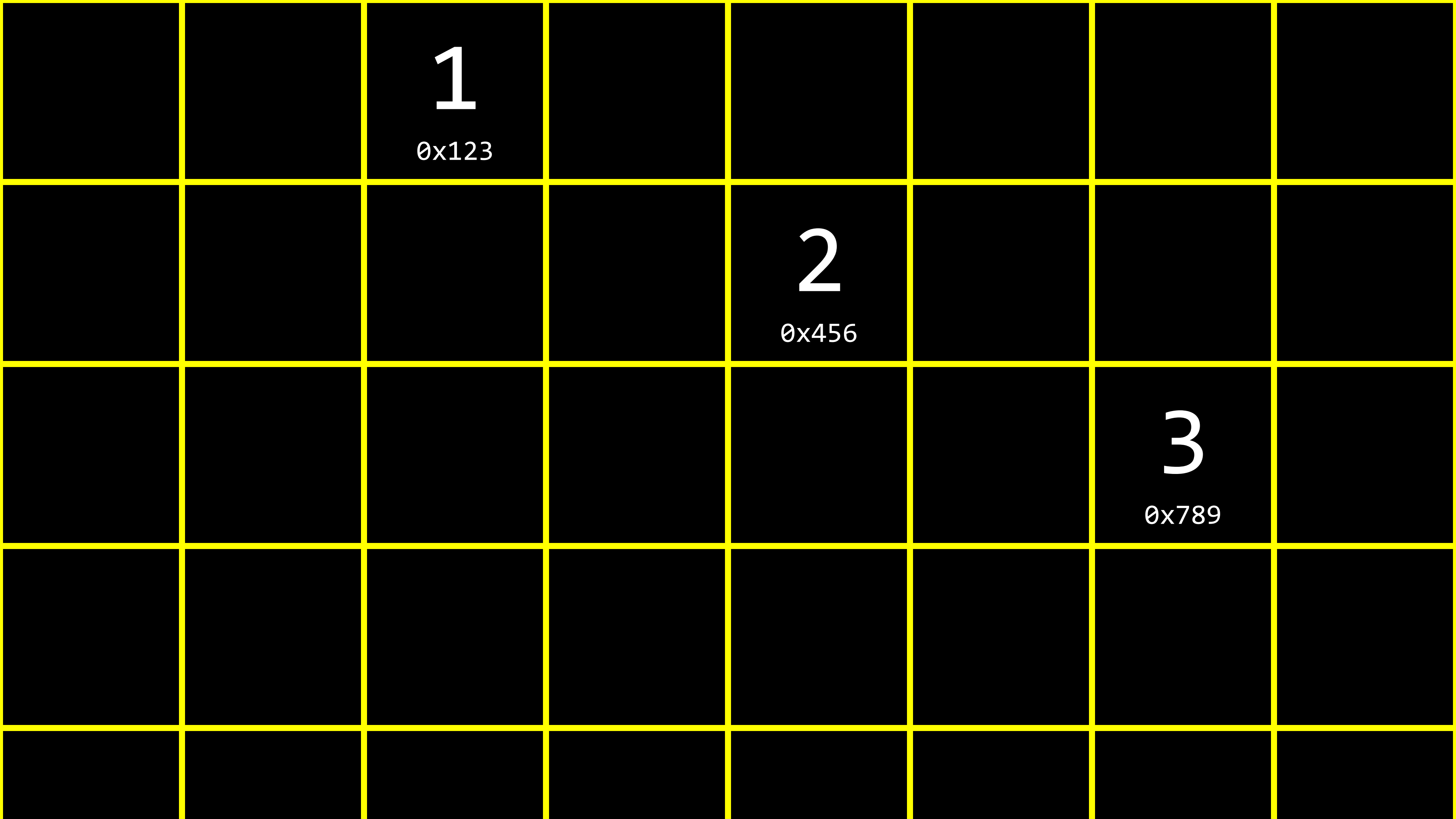


1

0x123

2

0x456



1

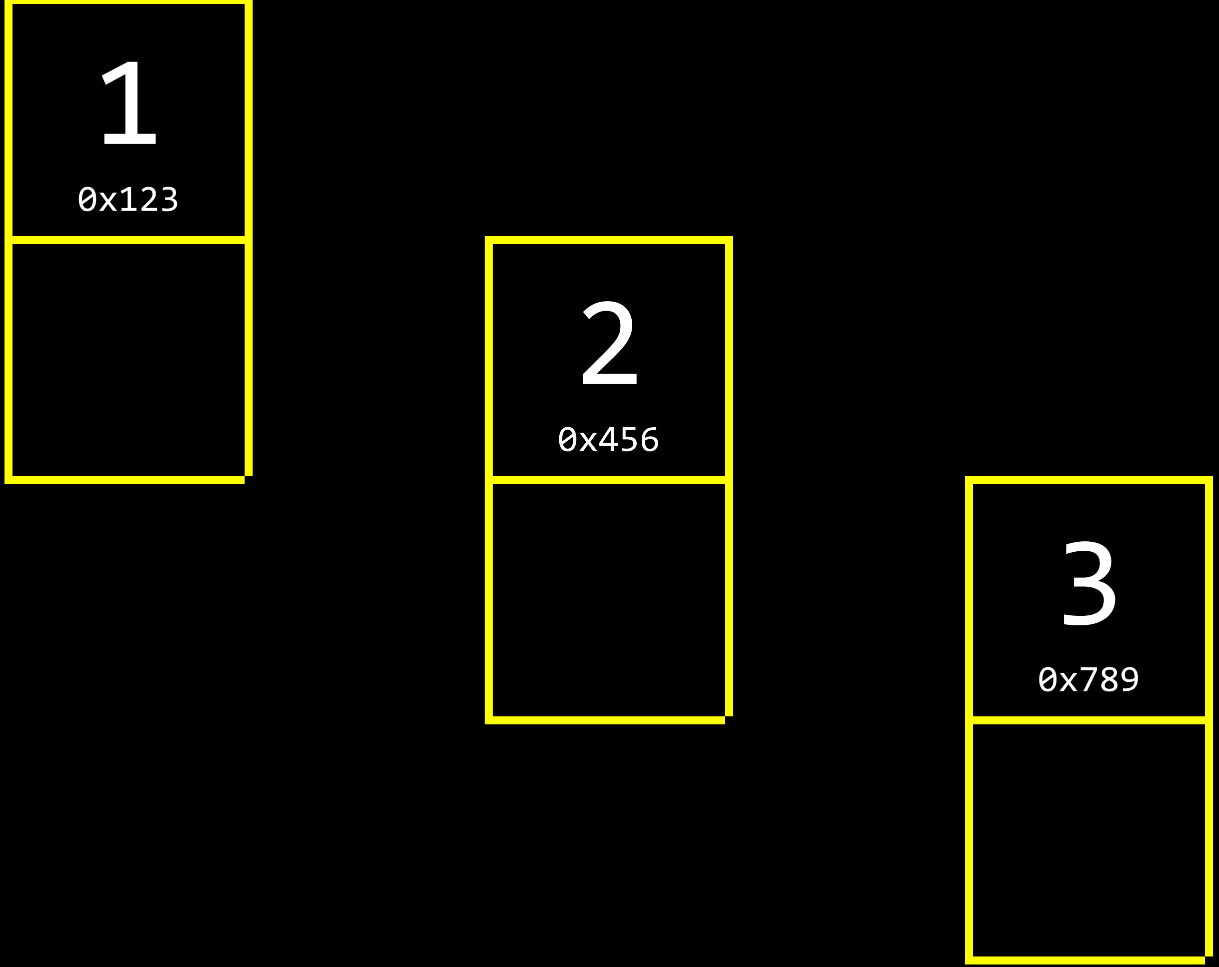
0x123

2

0x456

3

0x789



1

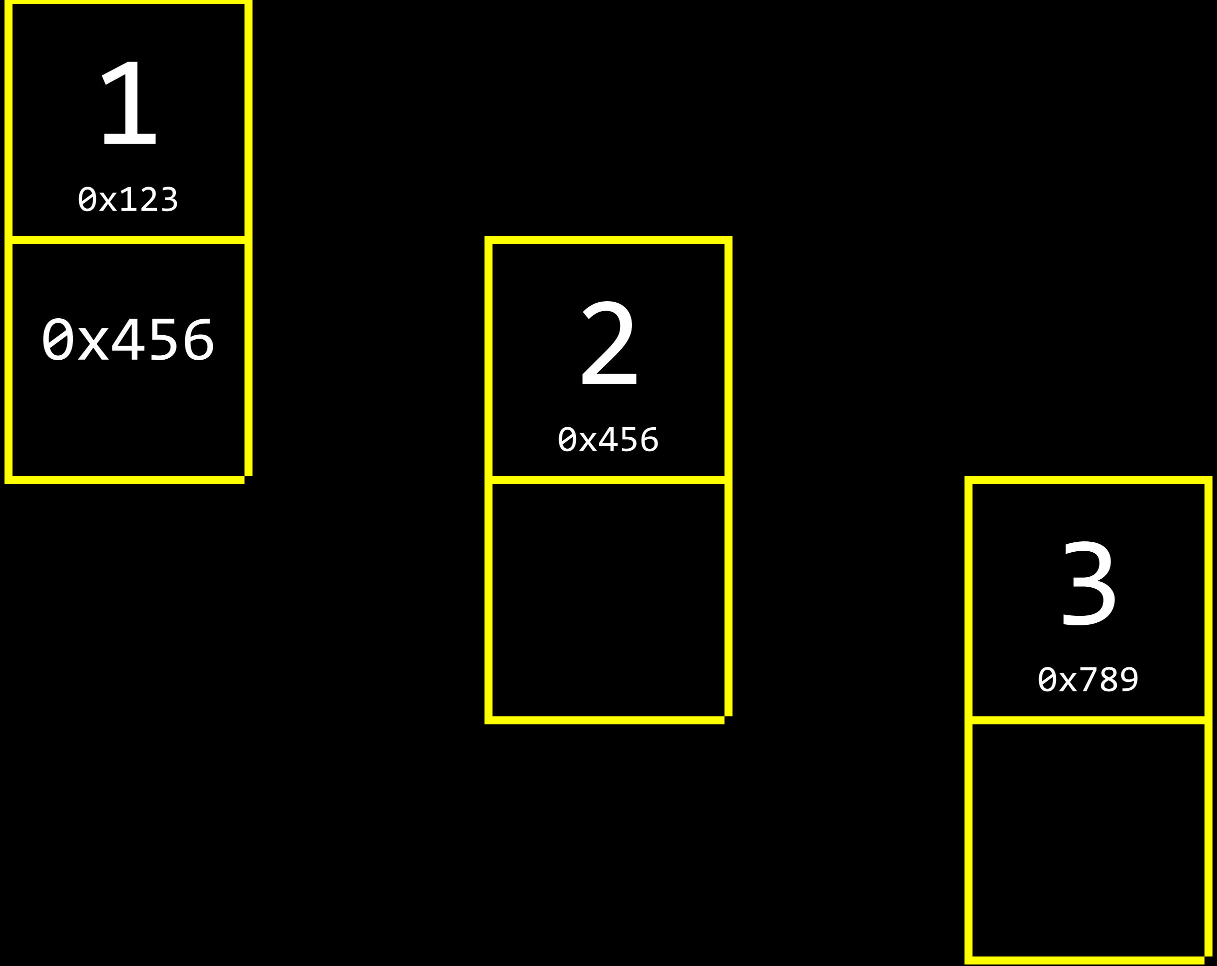
0x123

2

0x456

3

0x789



1

0x123

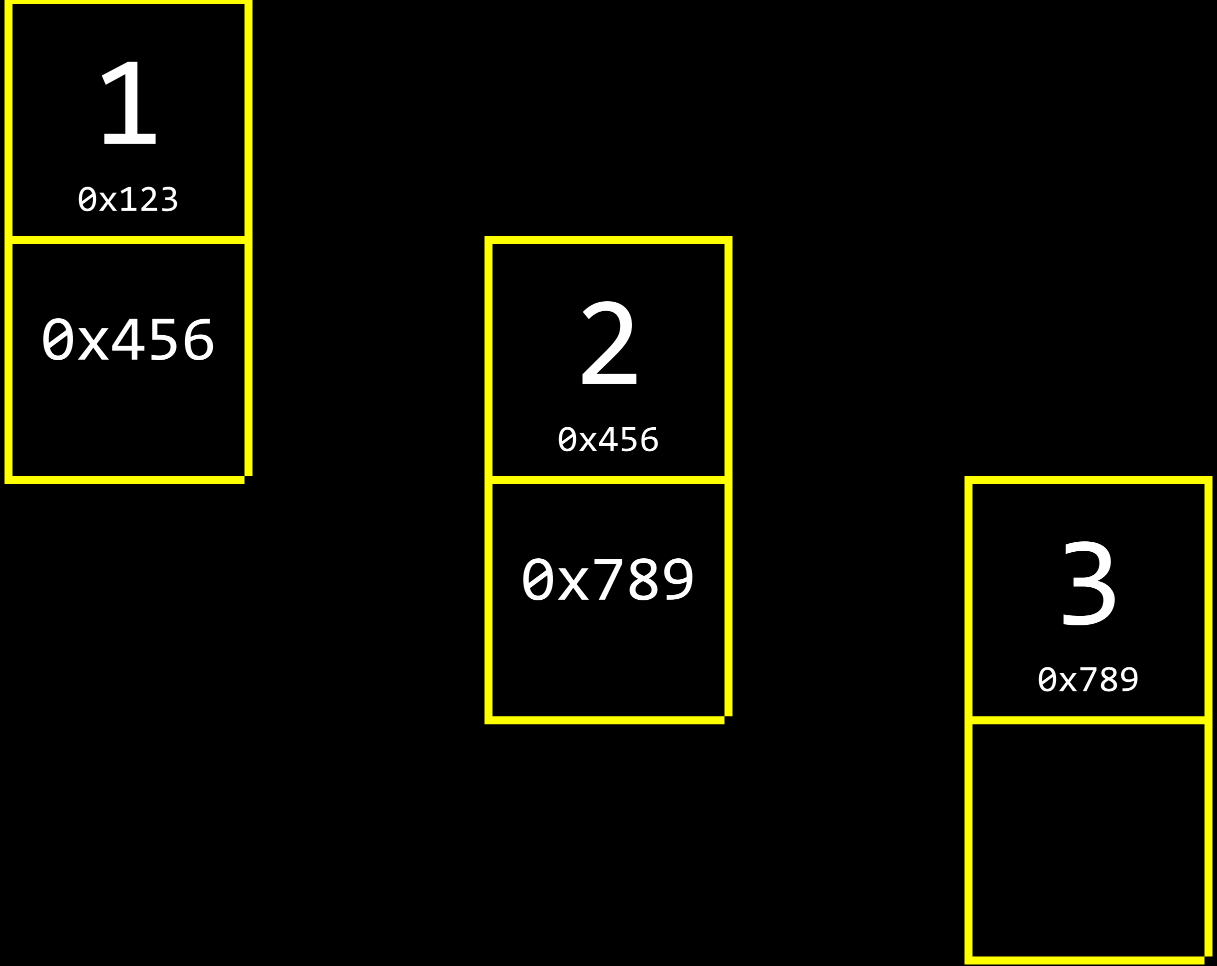
0x456

2

0x456

3

0x789



1

0x123

0x456

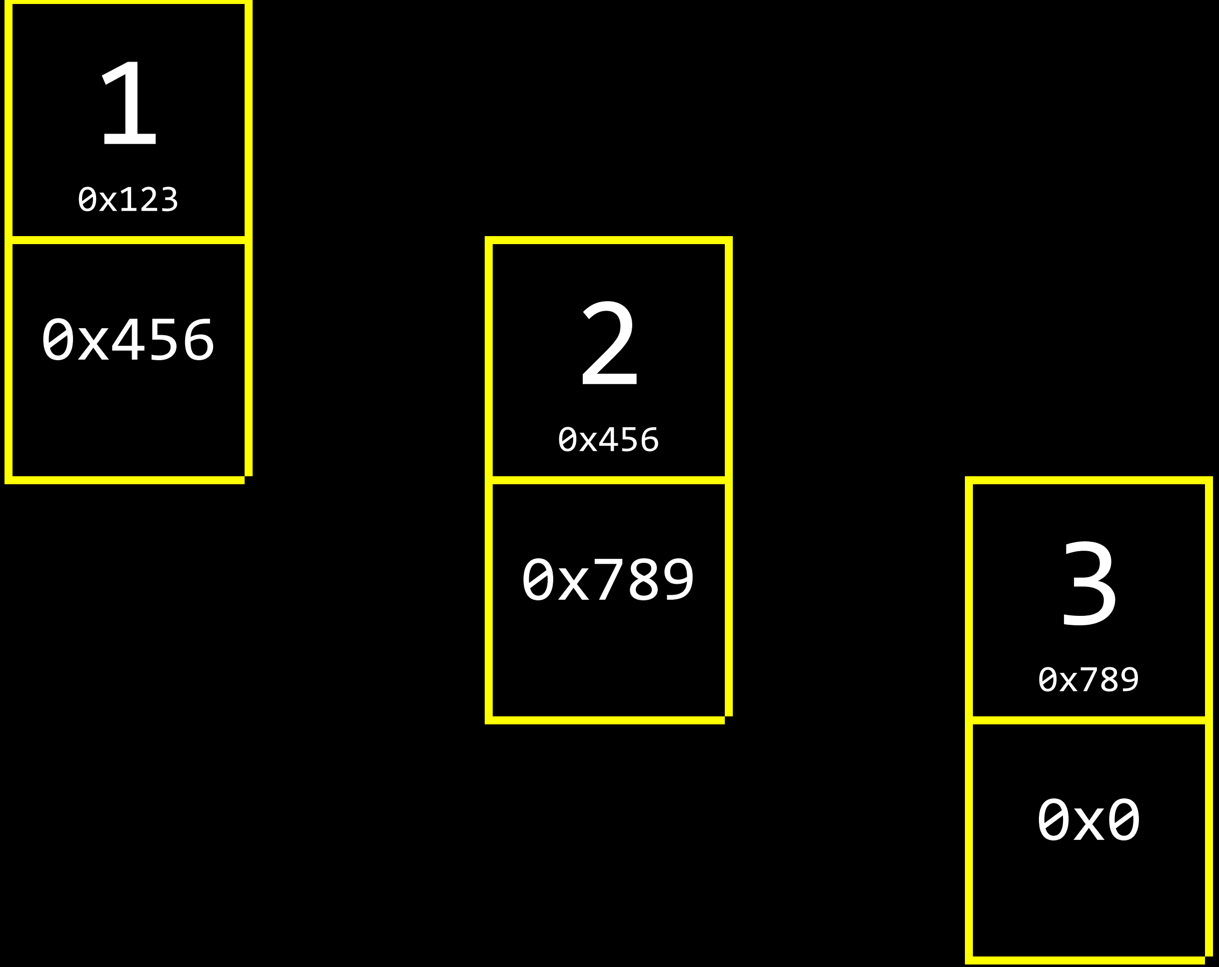
2

0x456

0x789

3

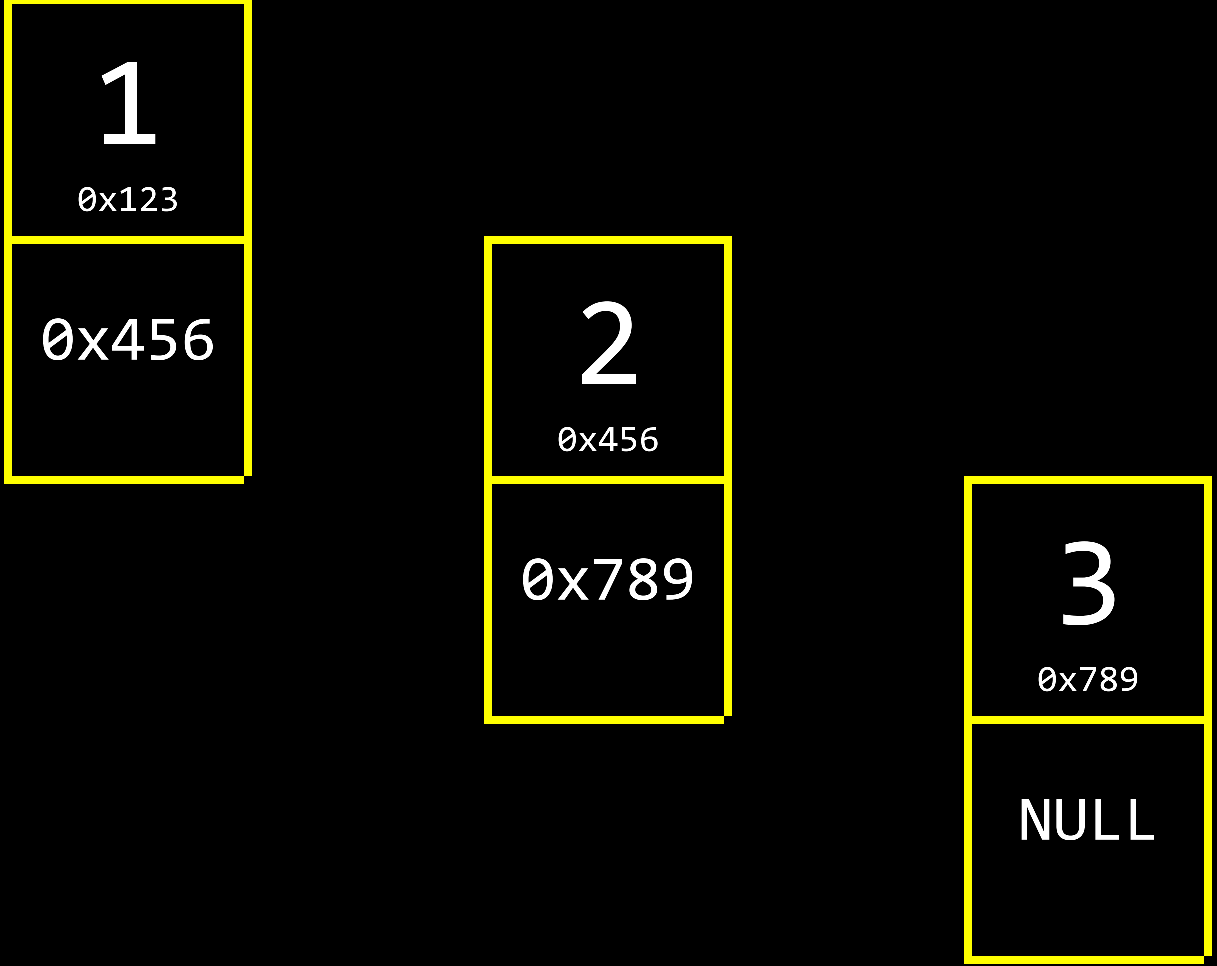
0x789

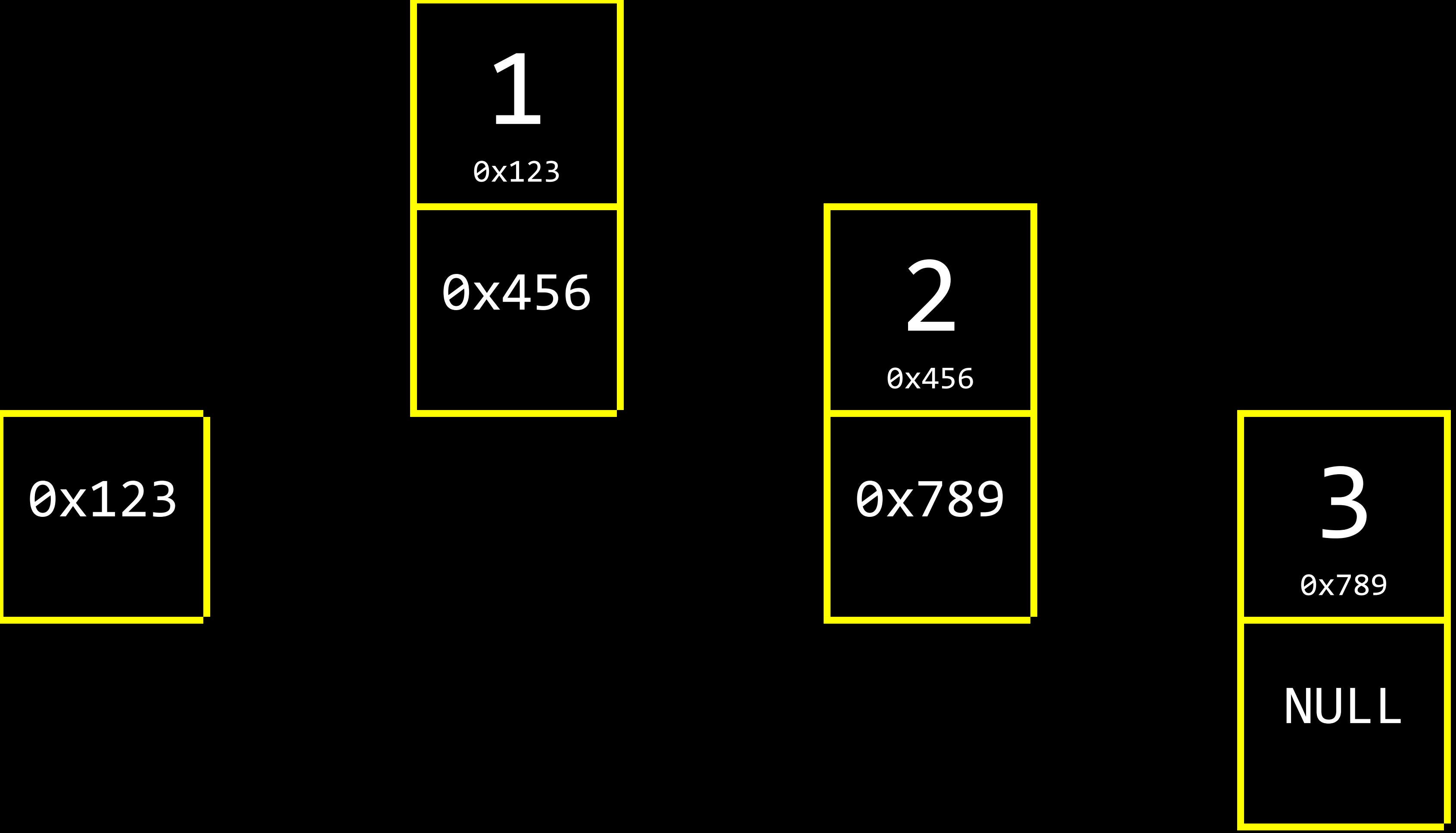


1
0x123
0x456

2
0x456
0x789

3
0x789
0x0


1
0x123
0x456
2
0x456
0x789
3
0x789
NULL



0x123

1

0x123

0x456

2

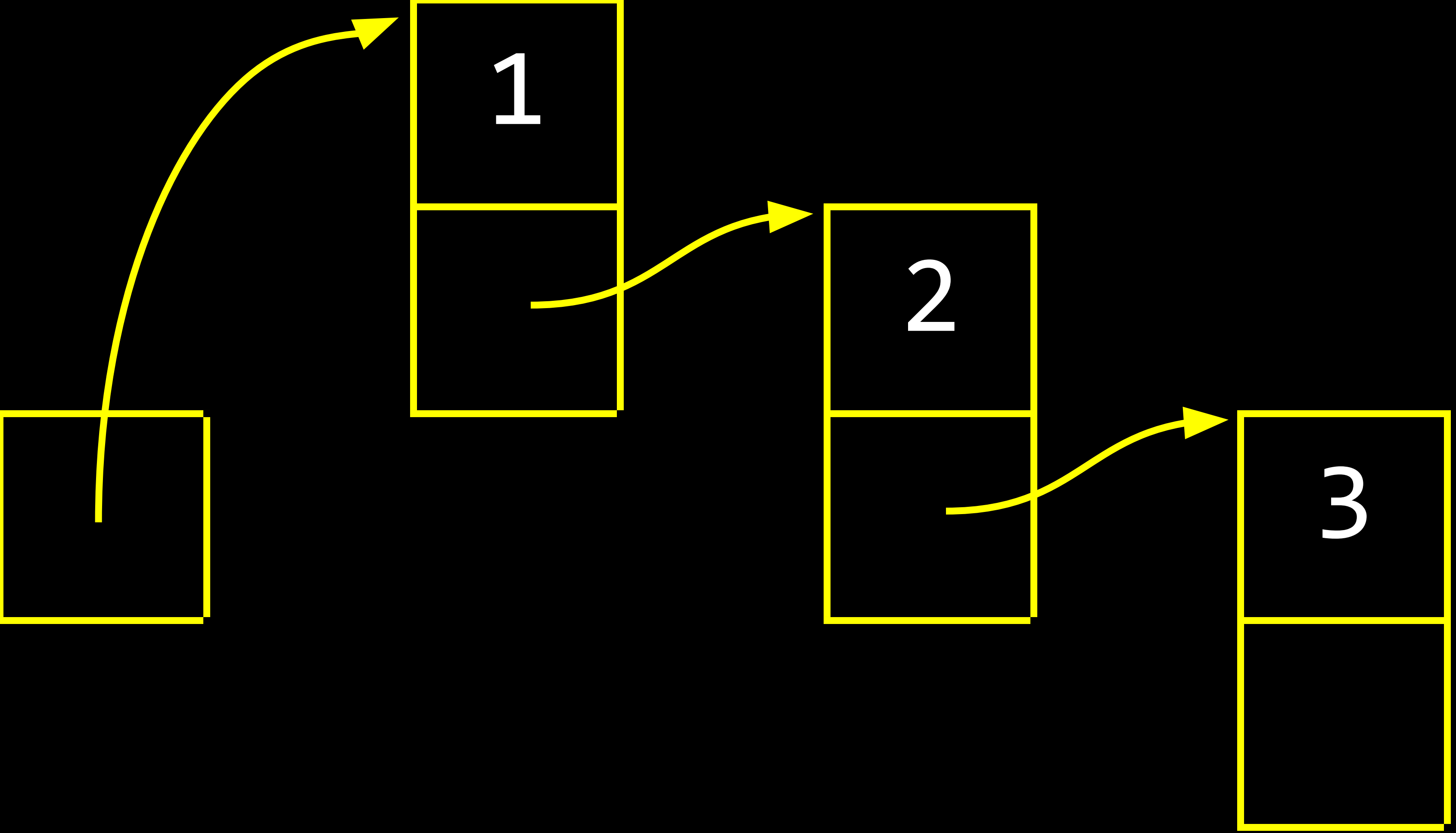
0x456

0x789

3

0x789

NULL


1
2
3

```
typedef struct
{
    string name;
    string number;
} person;
```

```
typedef struct
{
    char *name;
    char *number;
} person;
```

```
typedef struct
{


} person;
```

```
typedef struct
{


} node;
```

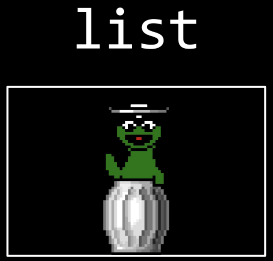
```
typedef struct
{
    int number;

} node;
```

```
typedef struct
{
    int number;
    node *next;
} node;
```

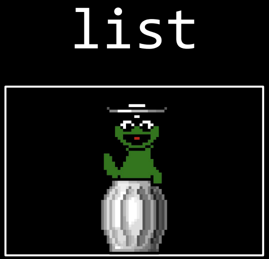
```
typedef struct node
{
    int number;
    node *next;
} node;
```

```
typedef struct node
{
    int number;
    struct node *next;
} node;
```

```
node *list;
node *list;
```

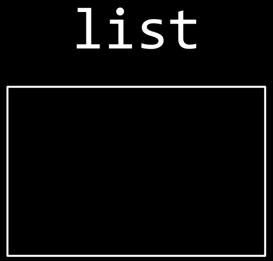


```
node *list = NULL;
```



list

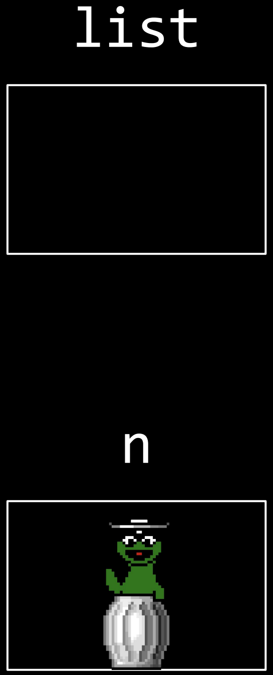
```
node *list = NULL;
```



list

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

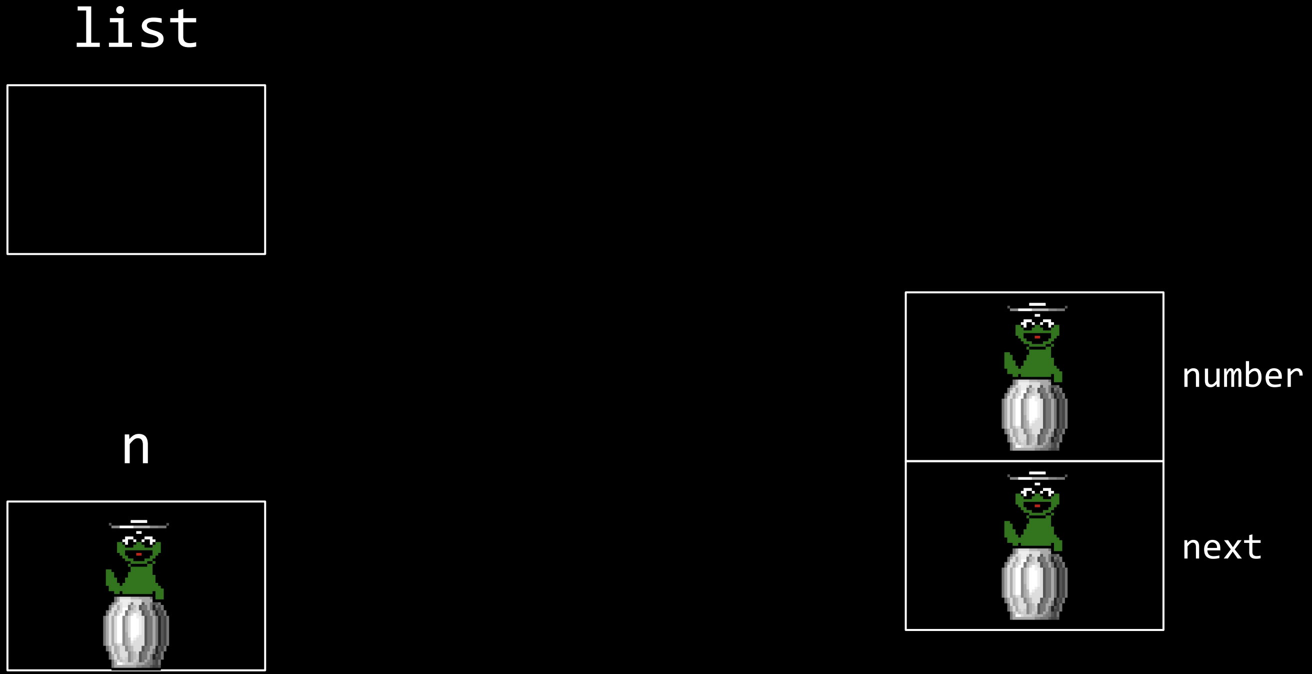
```
node *n = malloc(sizeof(node));
```



list

n

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



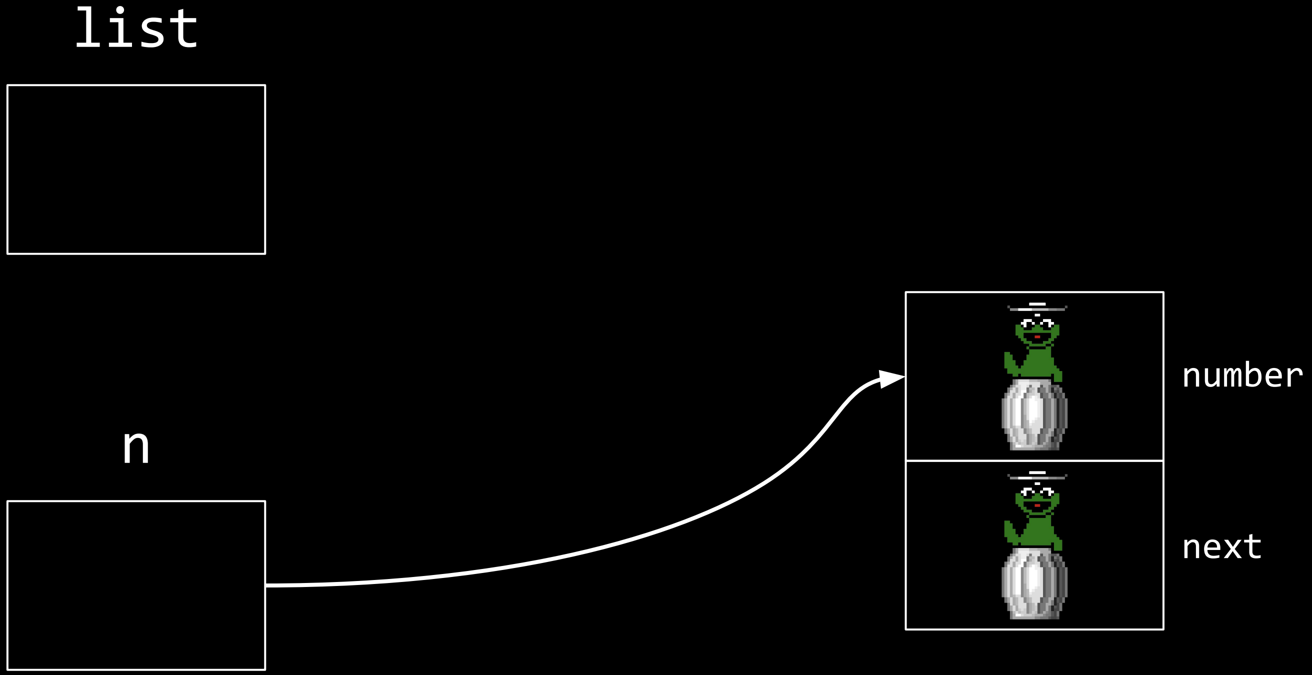
list

n

number

next

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



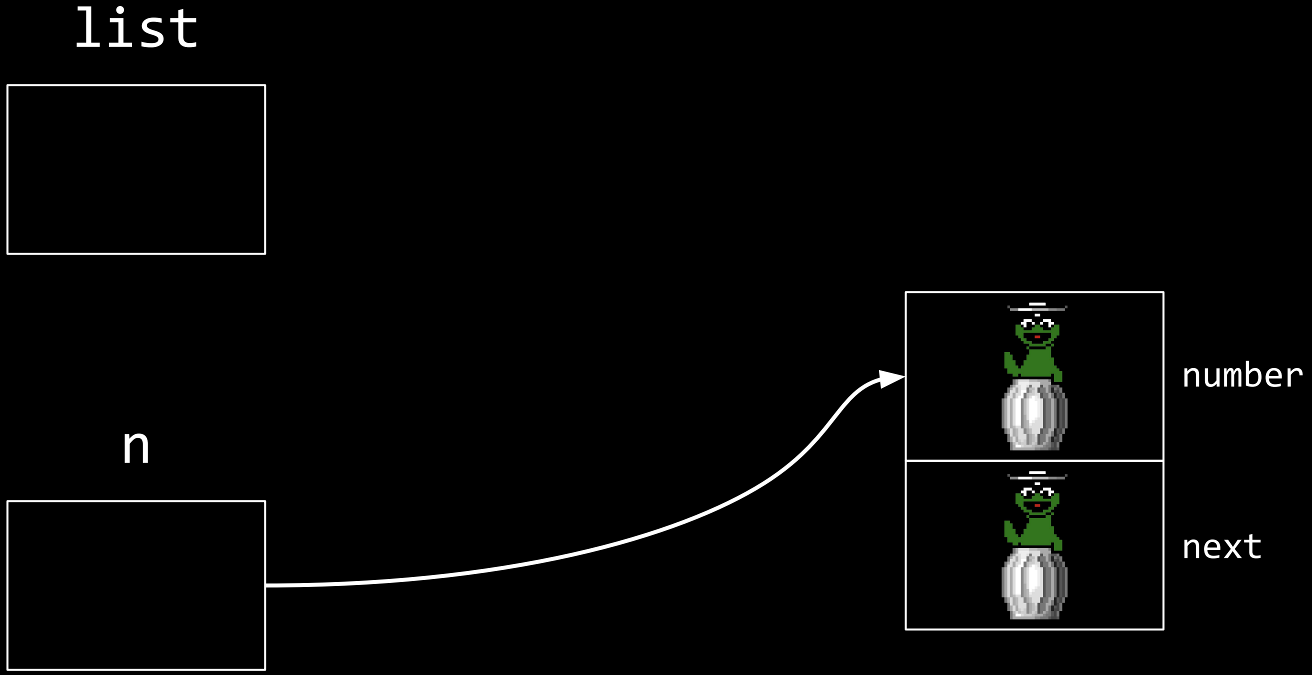
list

n

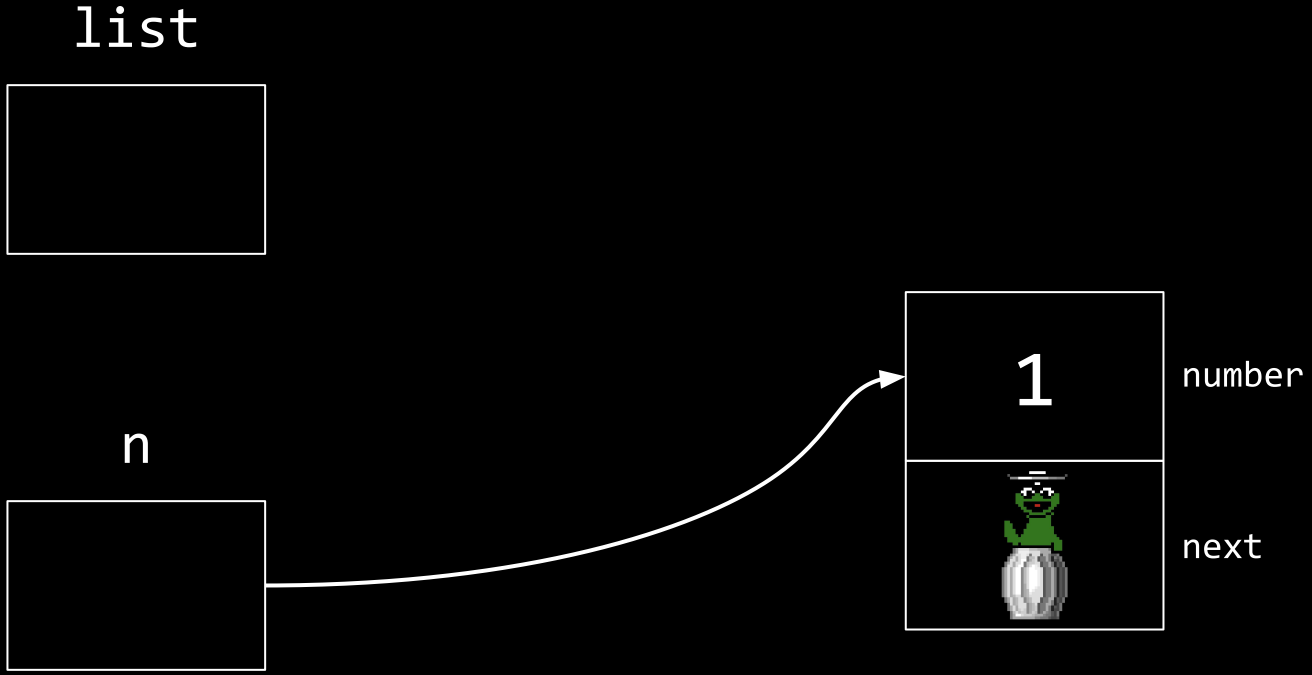
number

next

```
(*n).number = 1;
```



```
(*n).number = 1;
```



list

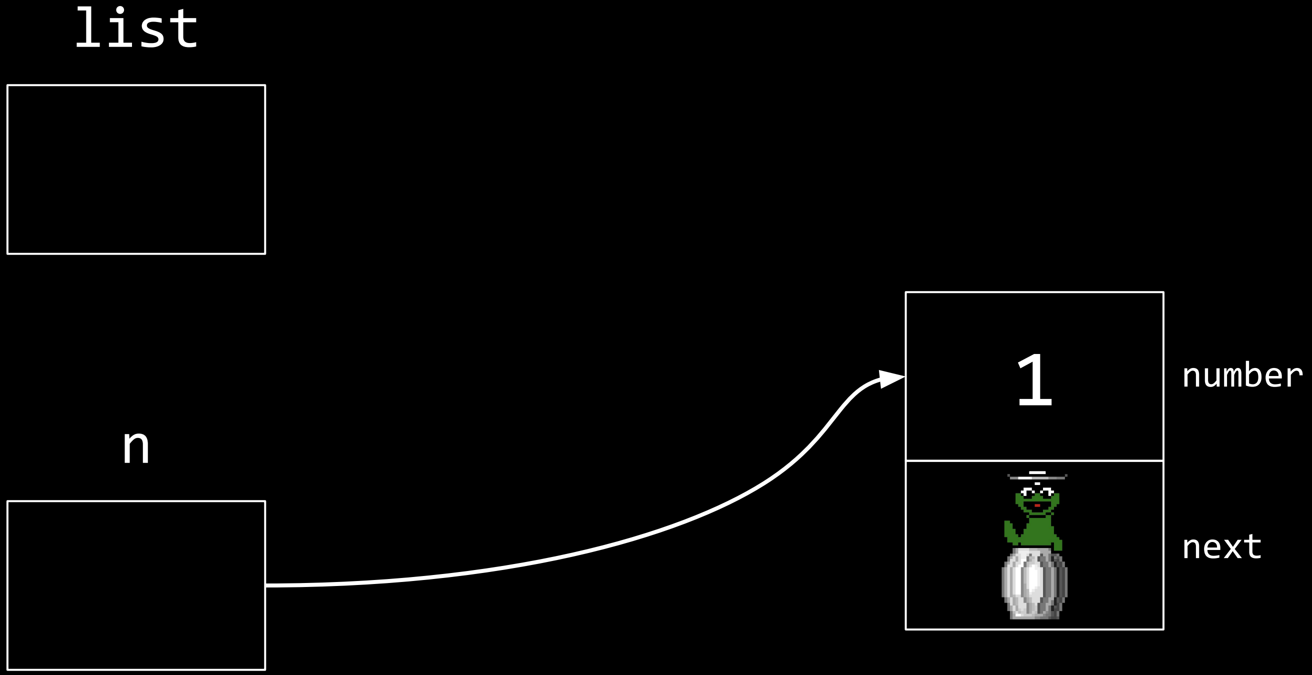
n

1

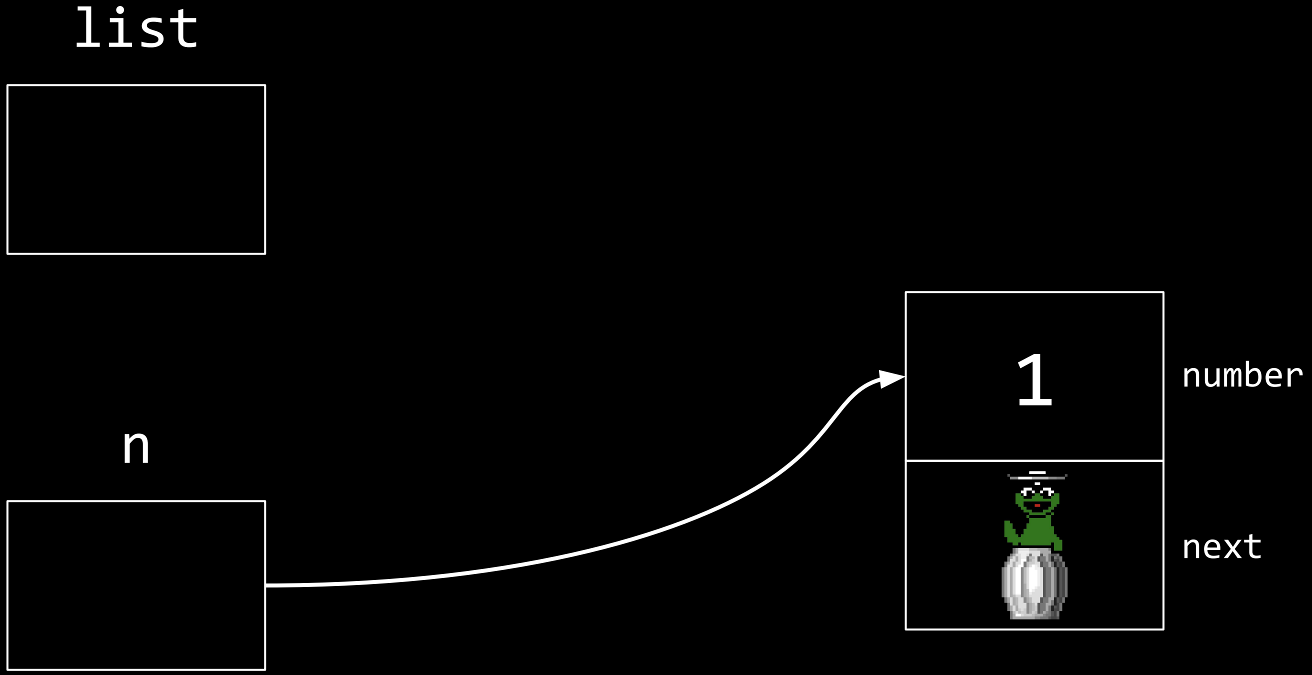
number

next

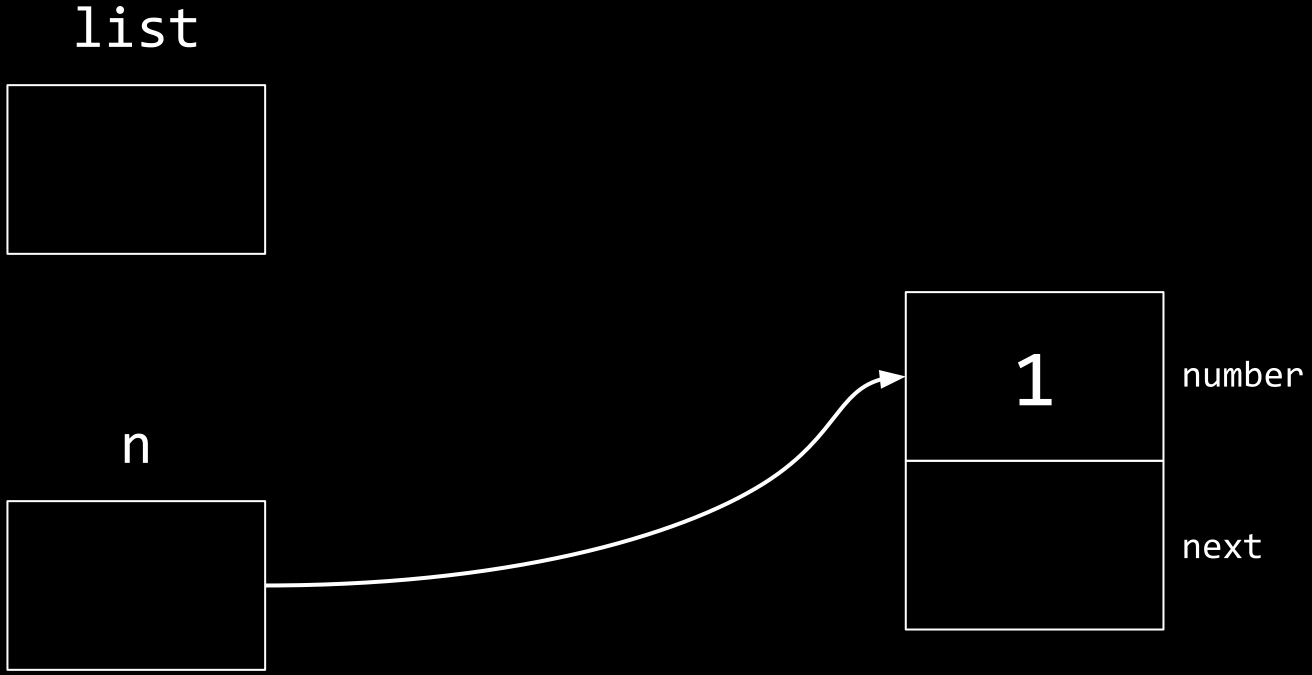
```
n->number = 1;
```



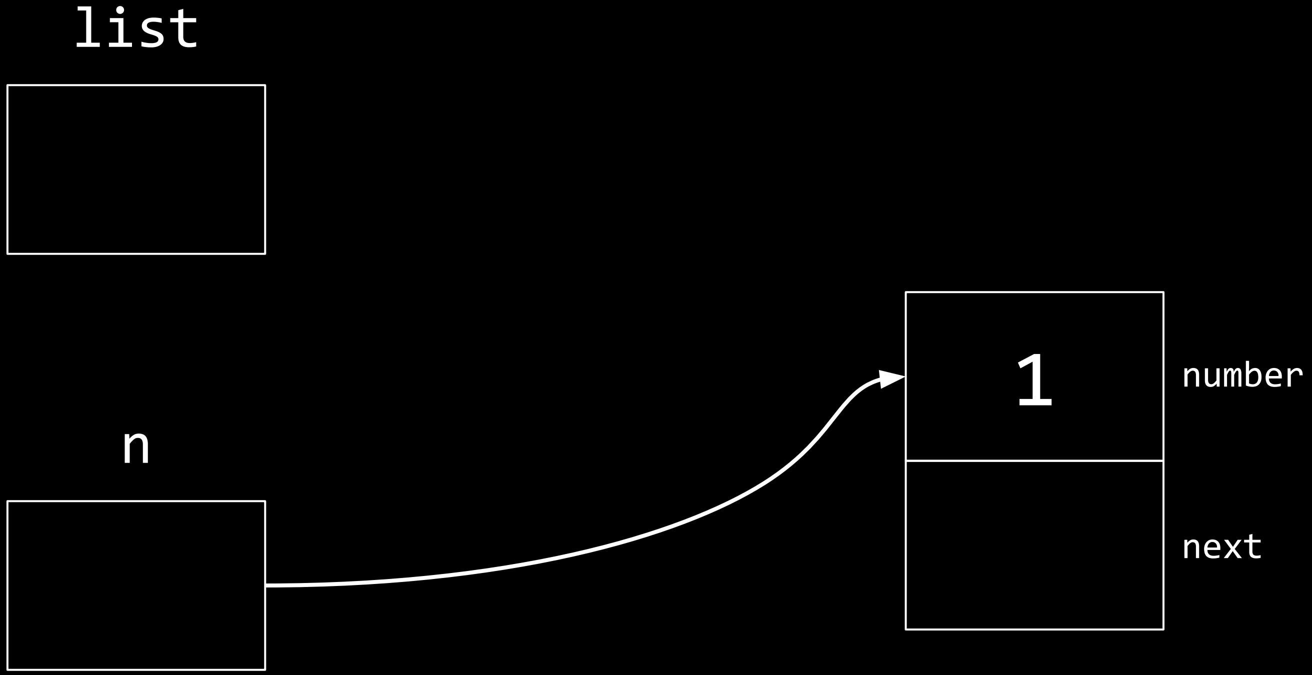
```
n->next = NULL;
```



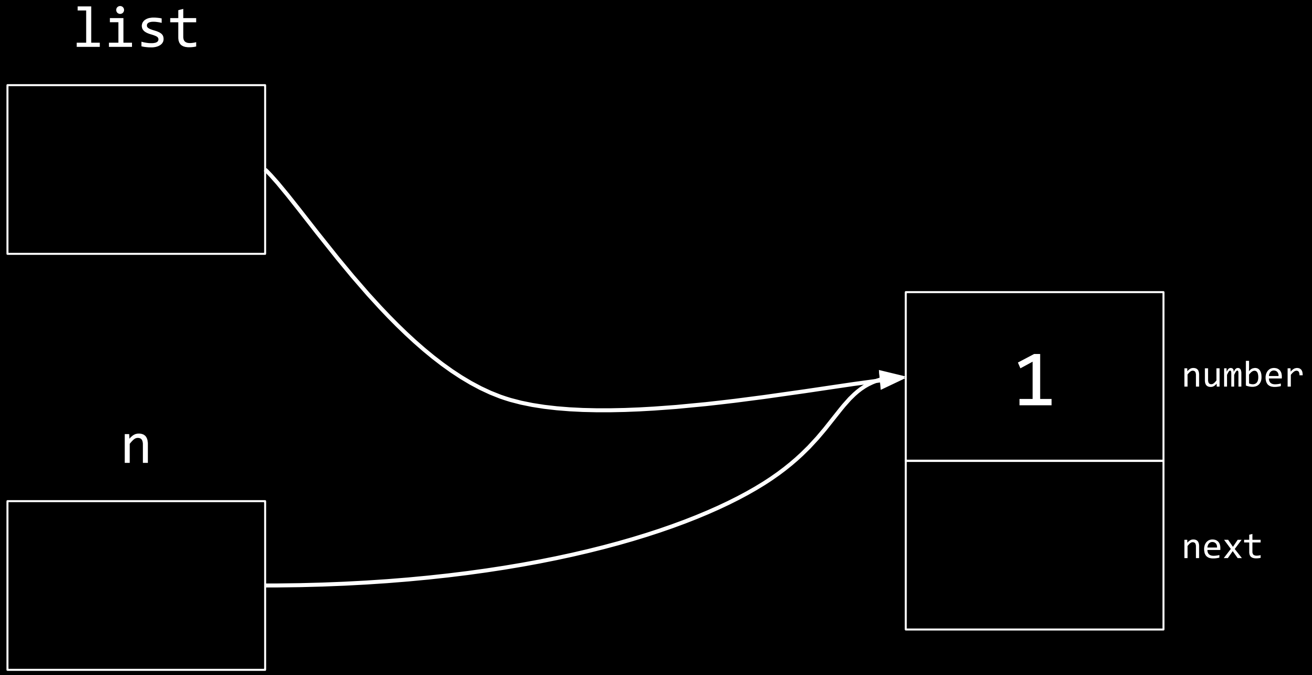
```
n->next = NULL;
```

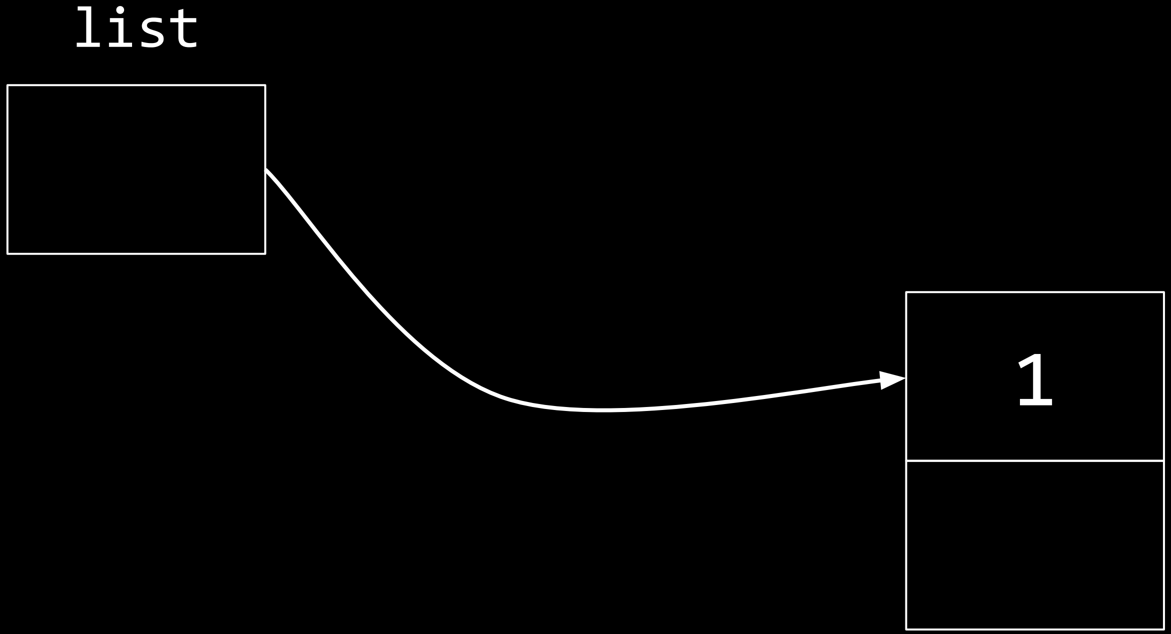


```
list = n;
```



```
list = n;
```

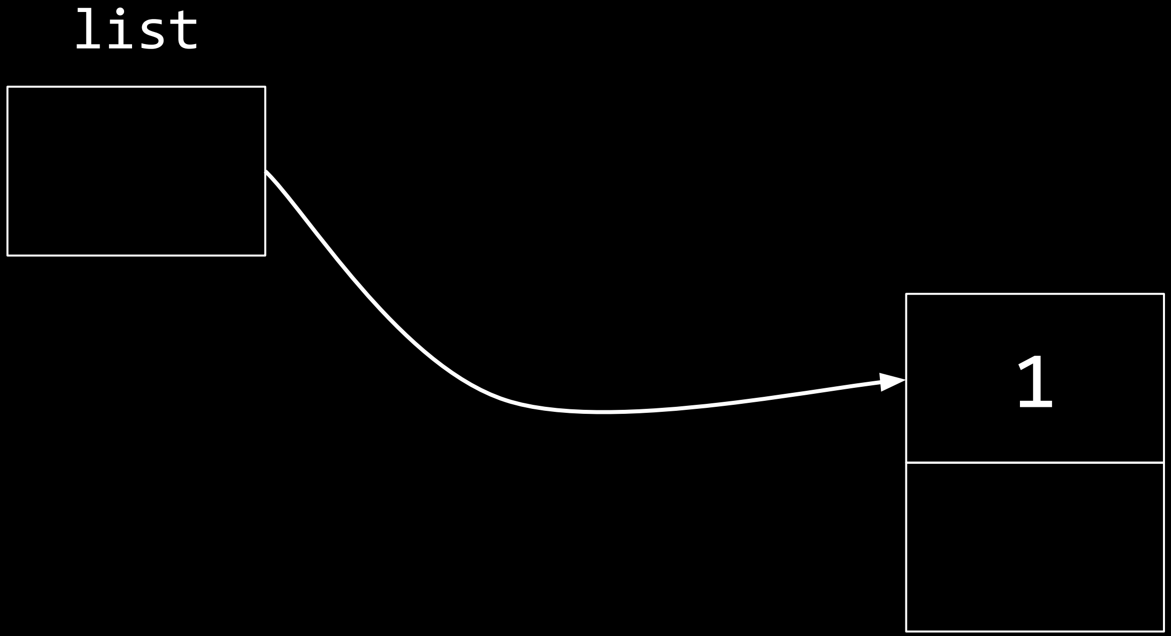




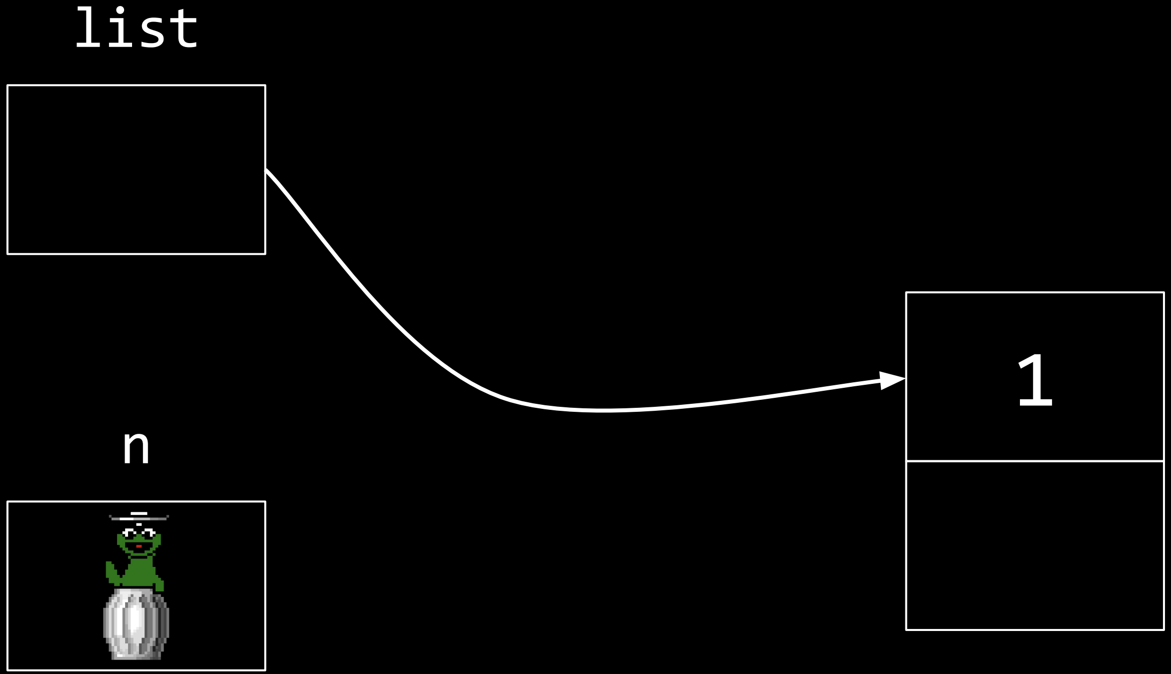
list

1

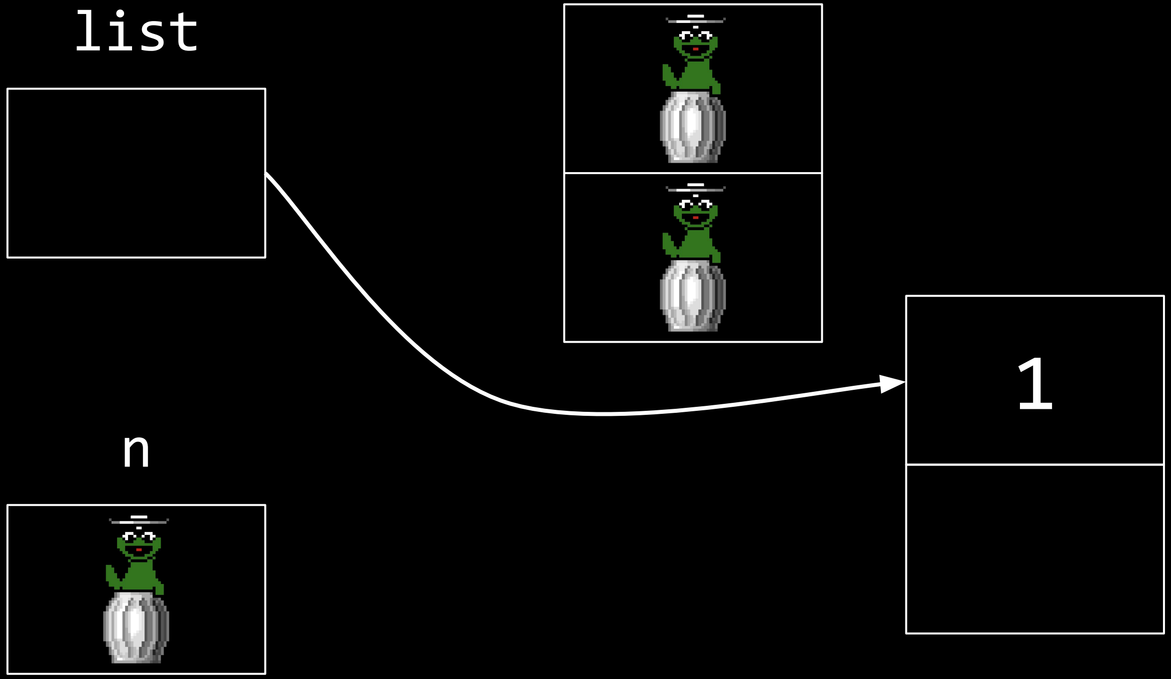
```
node *n = malloc(sizeof(node));
```



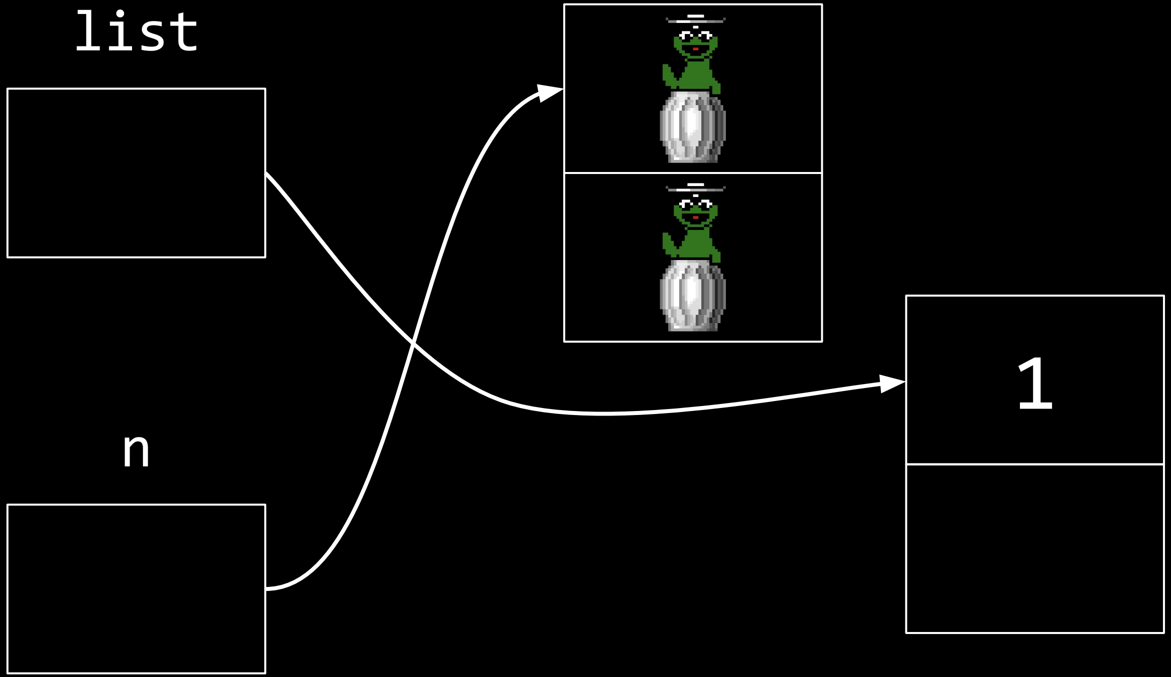
```
node *n = malloc(sizeof(node));
```



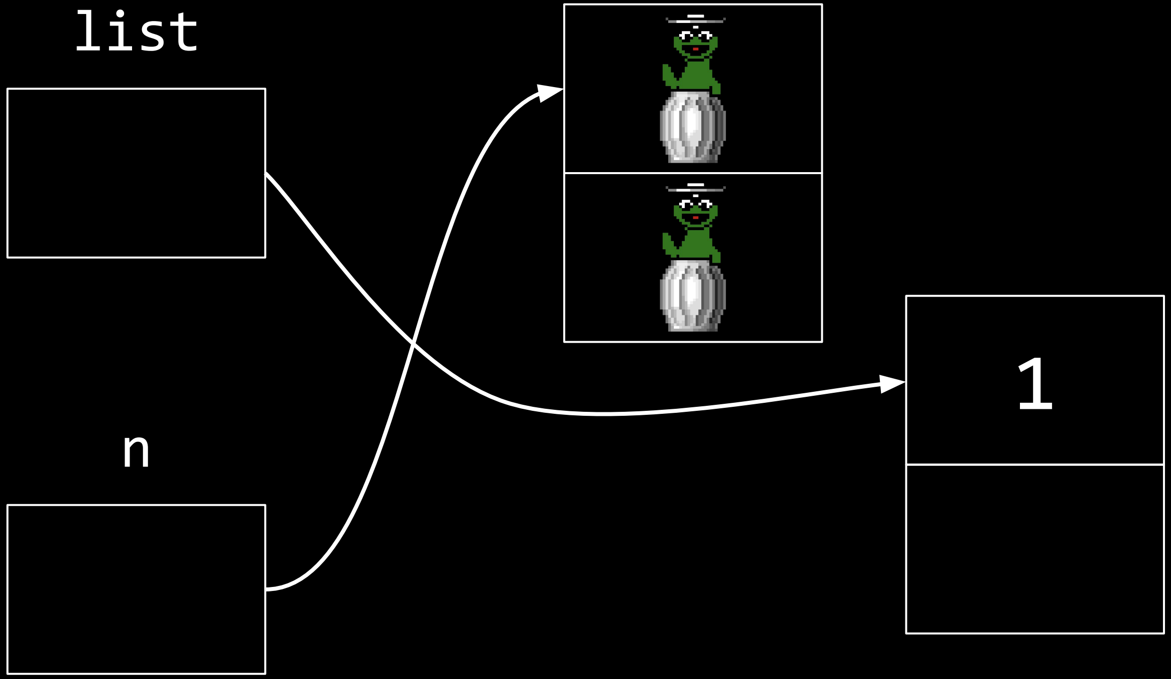
```
node *n = malloc(sizeof(node));
```



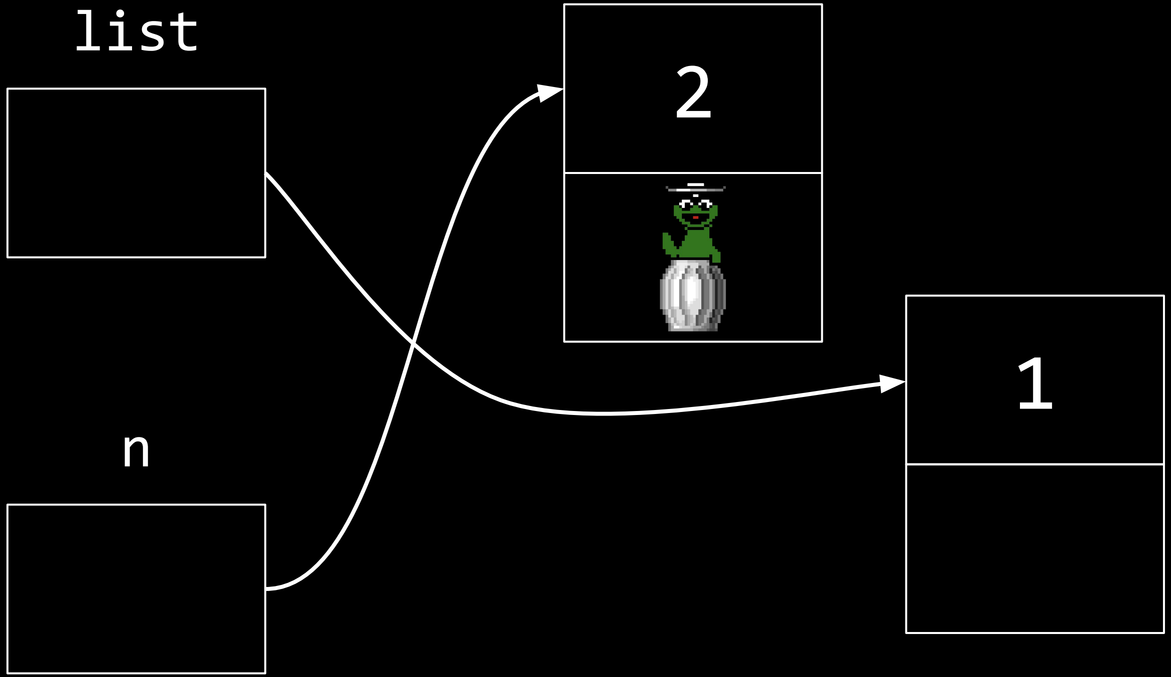
```
node *n = malloc(sizeof(node));
```



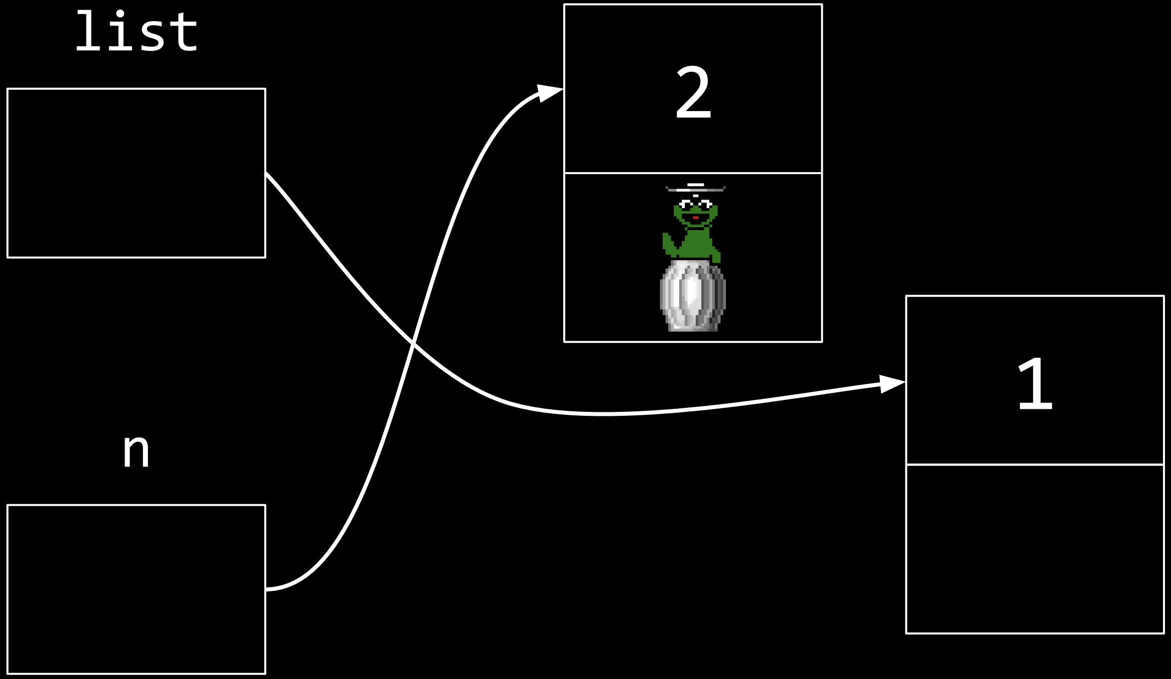
```
n->number = 2;
```



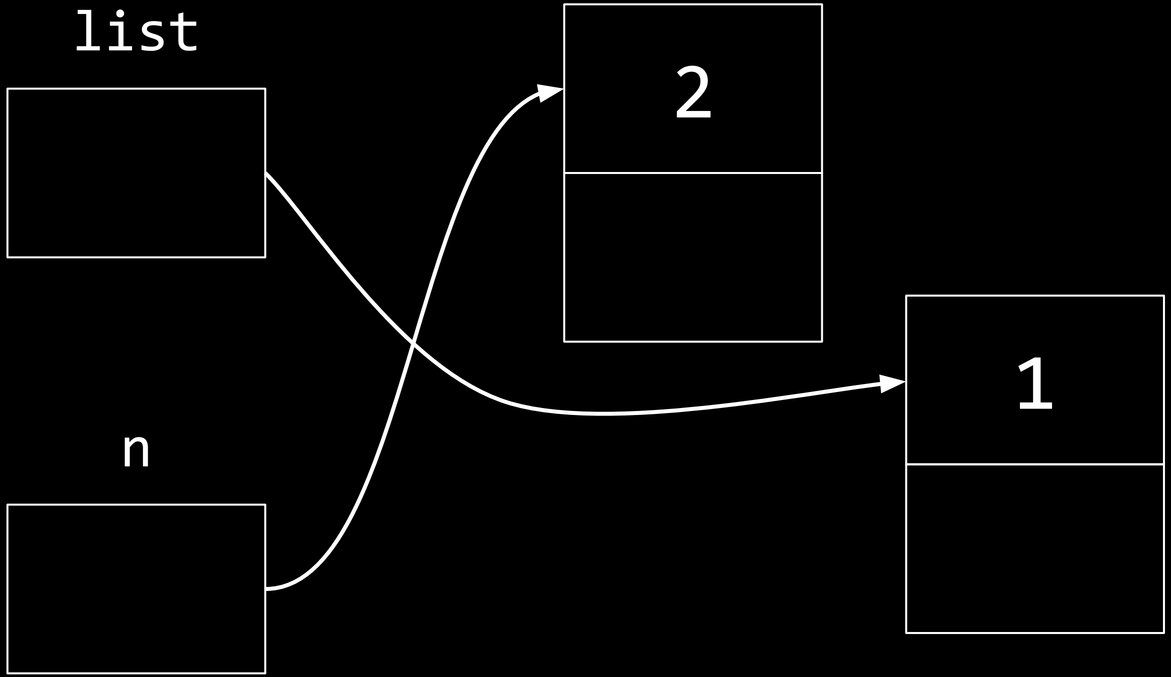
```
n->number = 2;
```

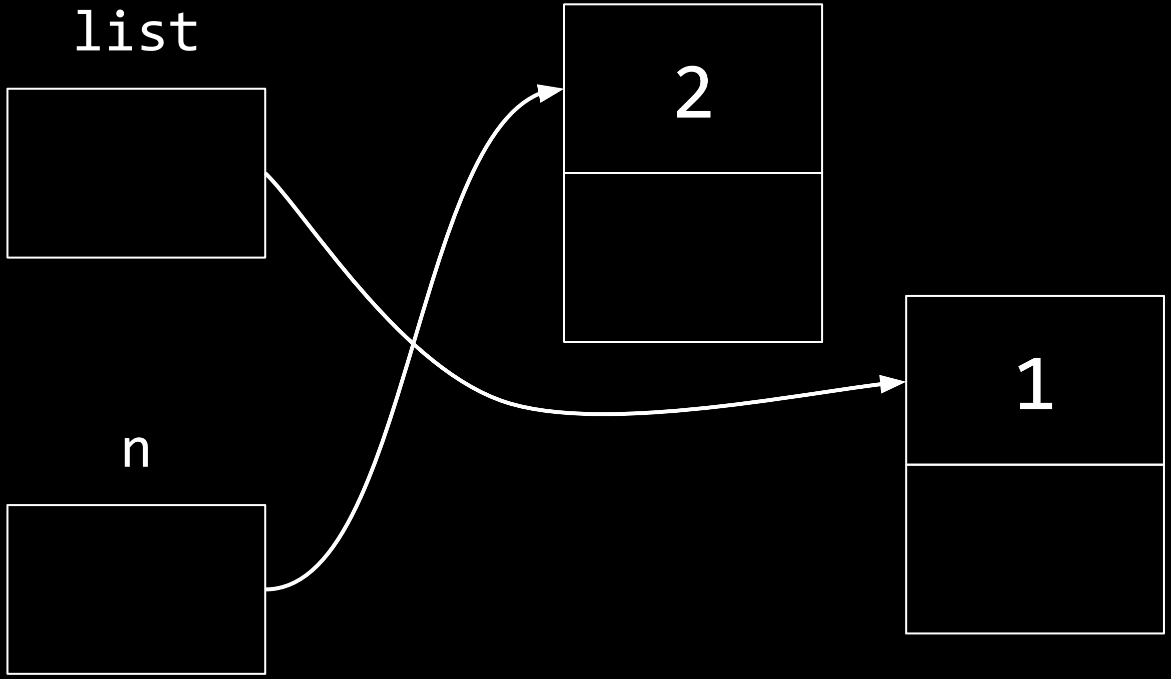


```
n->next = NULL;
```

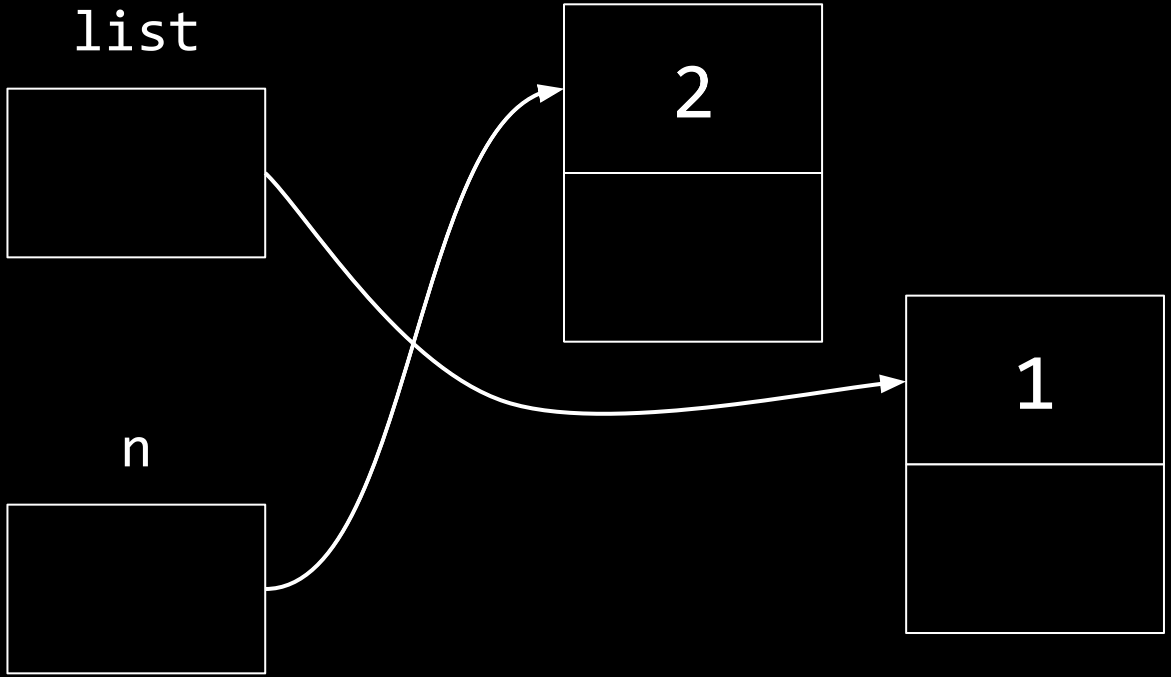


```
n->next = NULL;
```

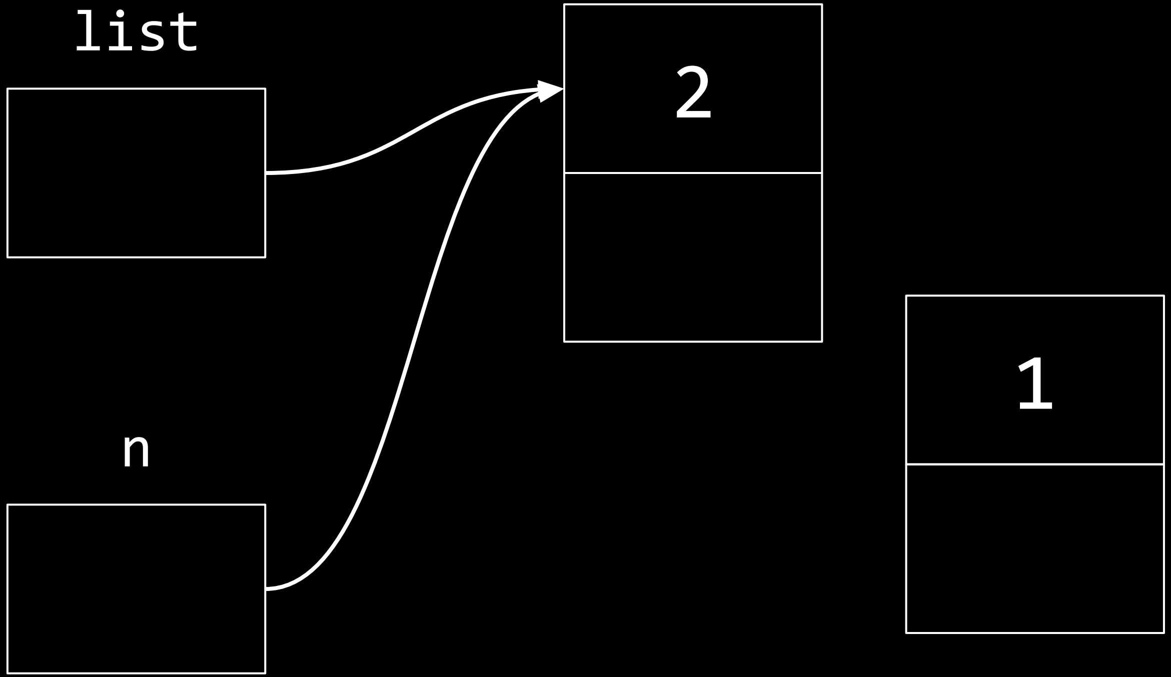



list
n
2
1

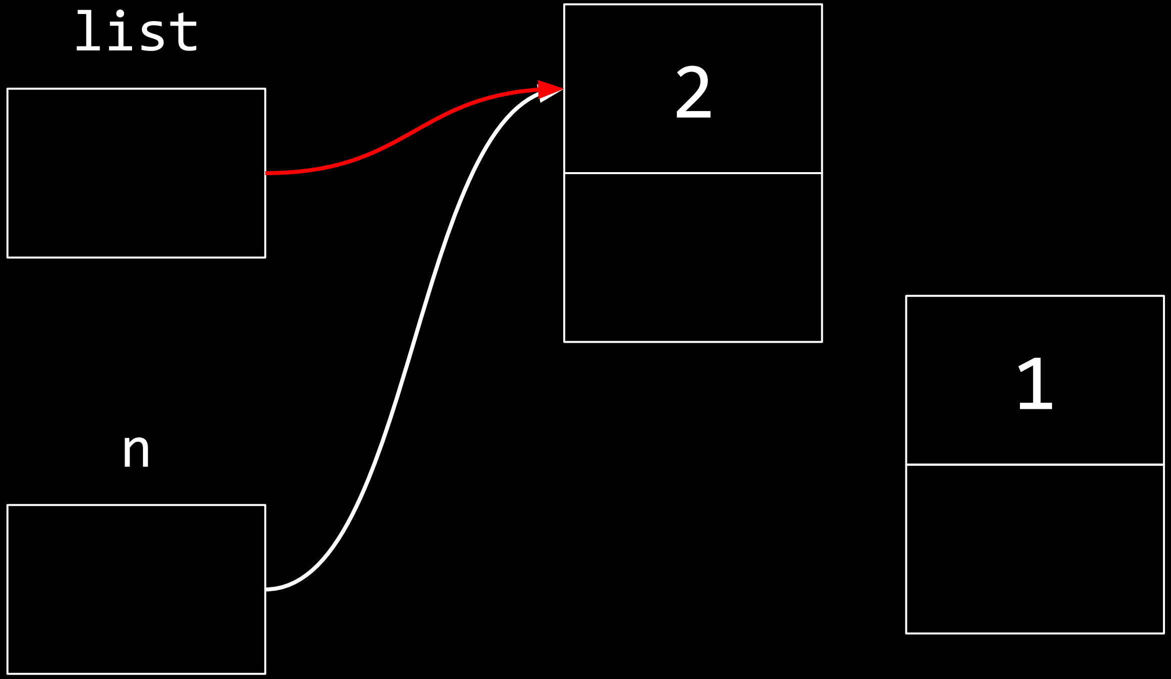
```
list = n;
```

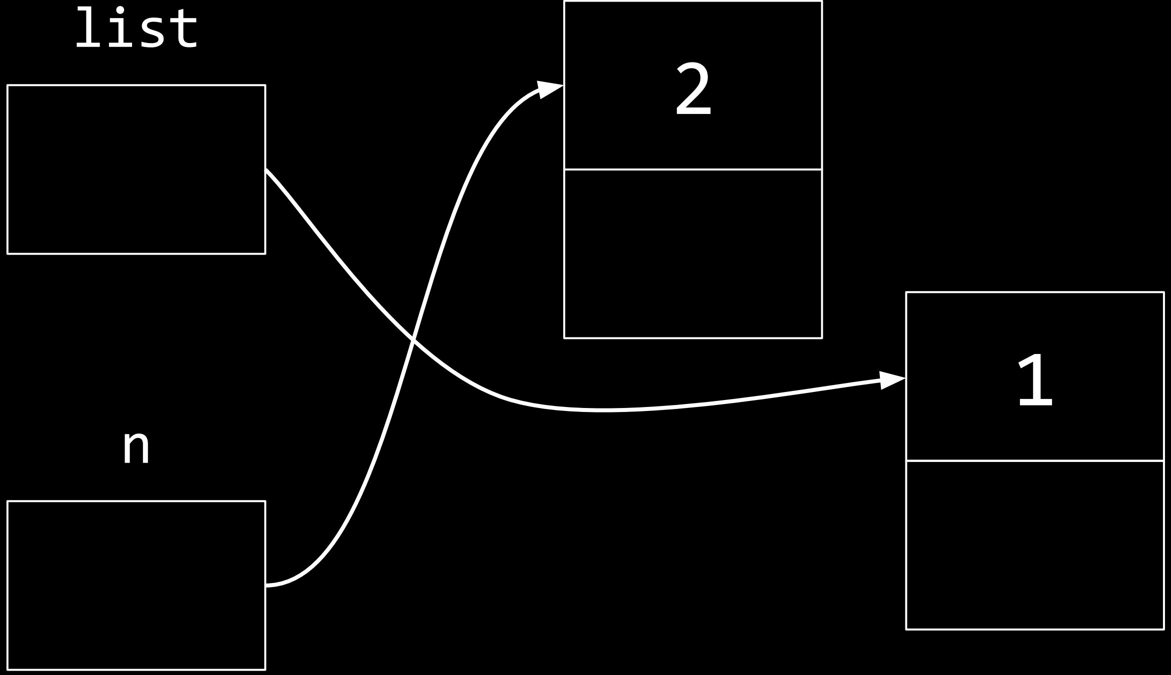


```
list = n;
```



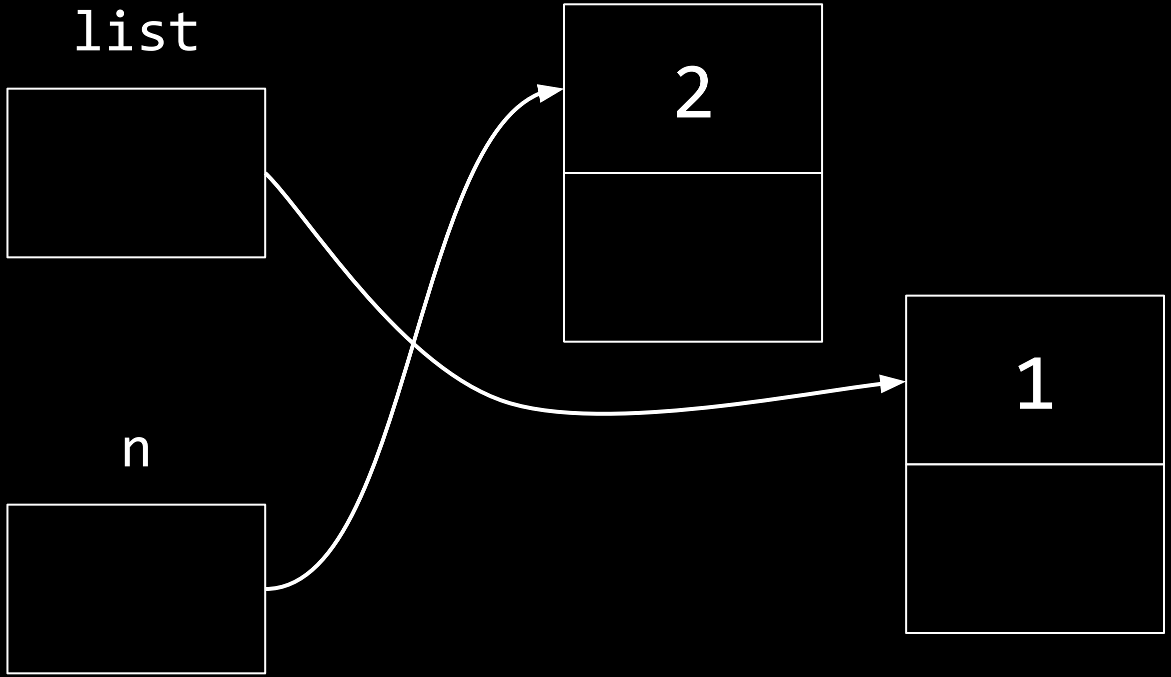
```
list = n;
```



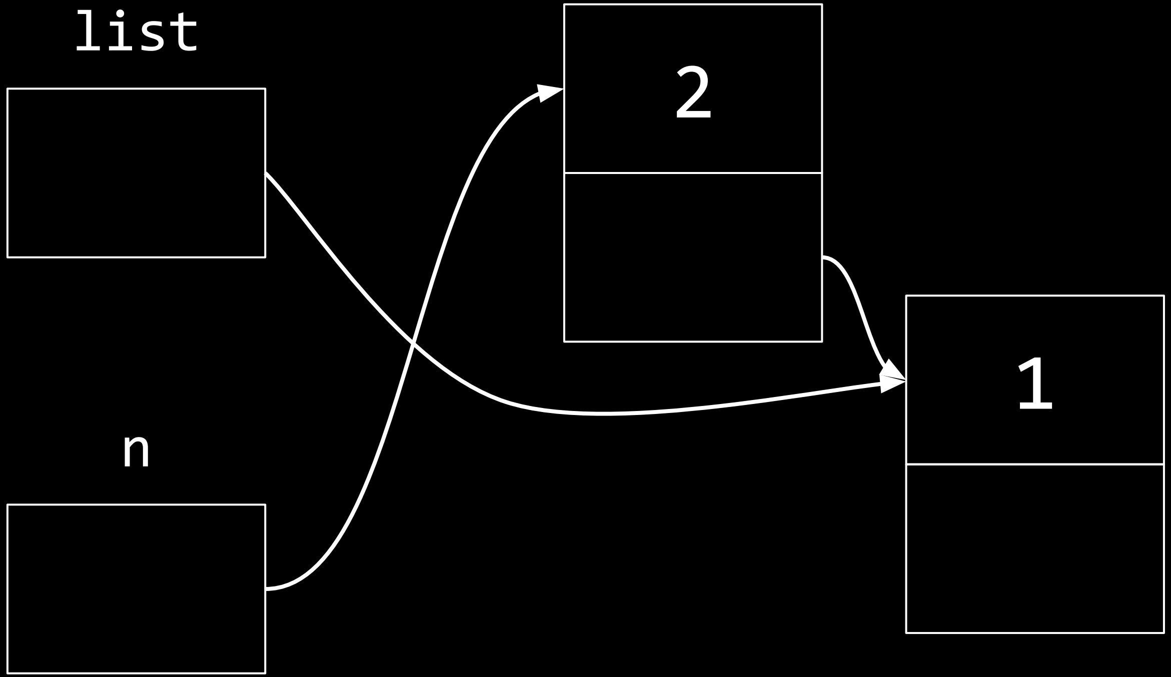


list
2
1
n

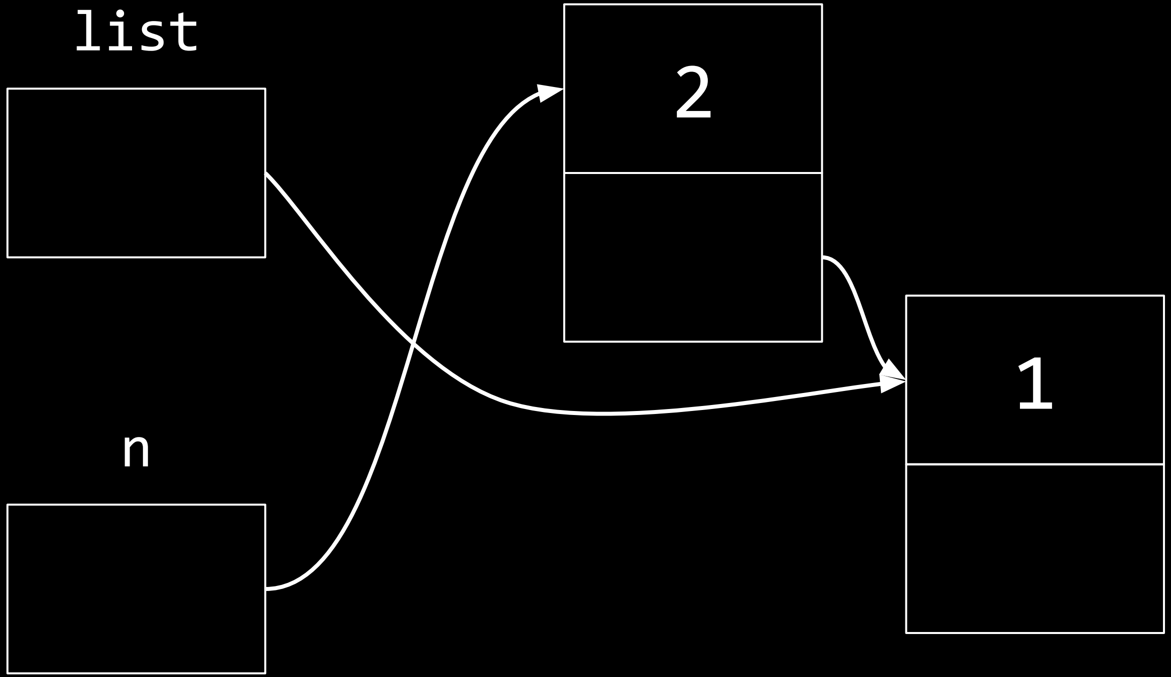
```
n->next = list;
```



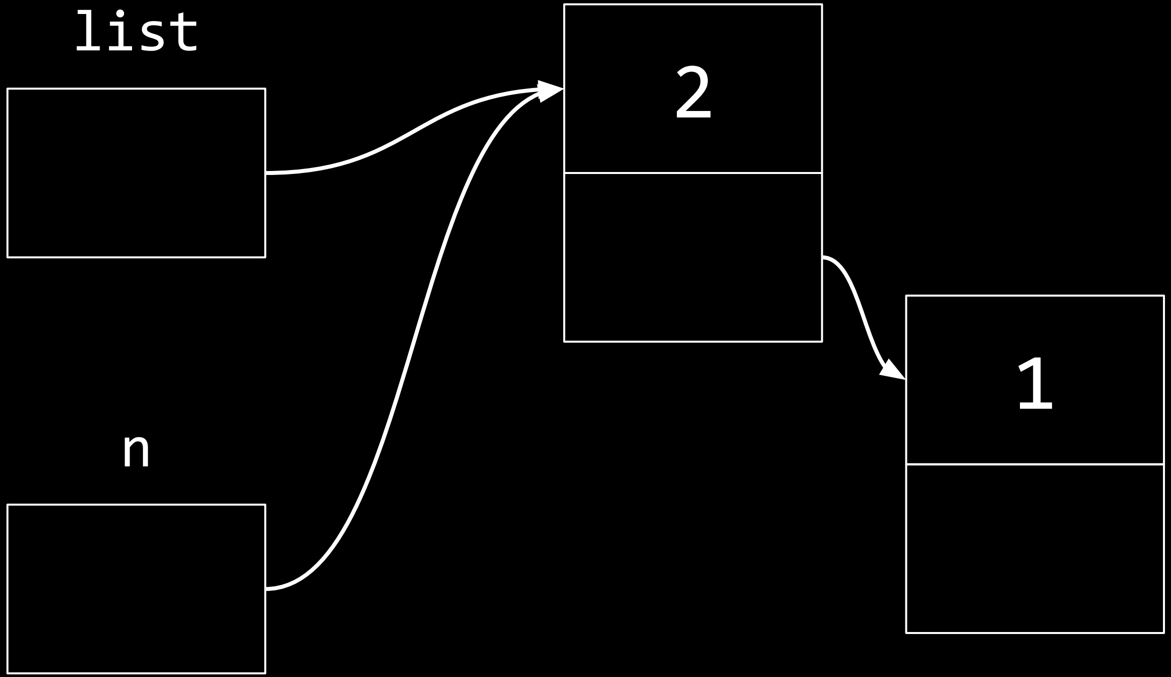
```
n->next = list;
```

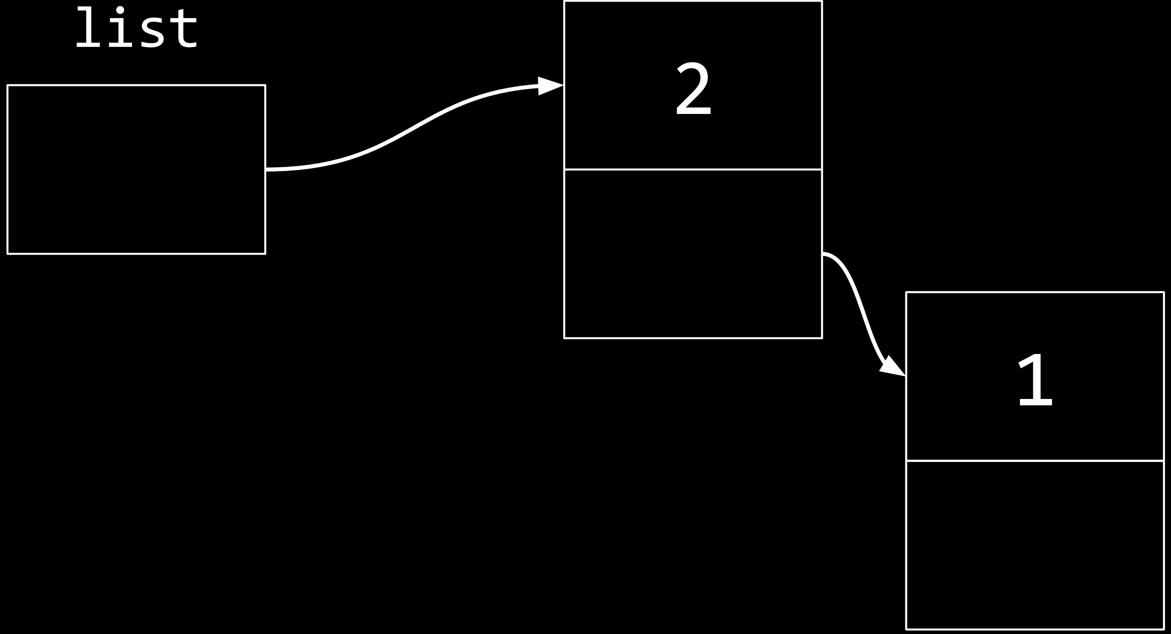


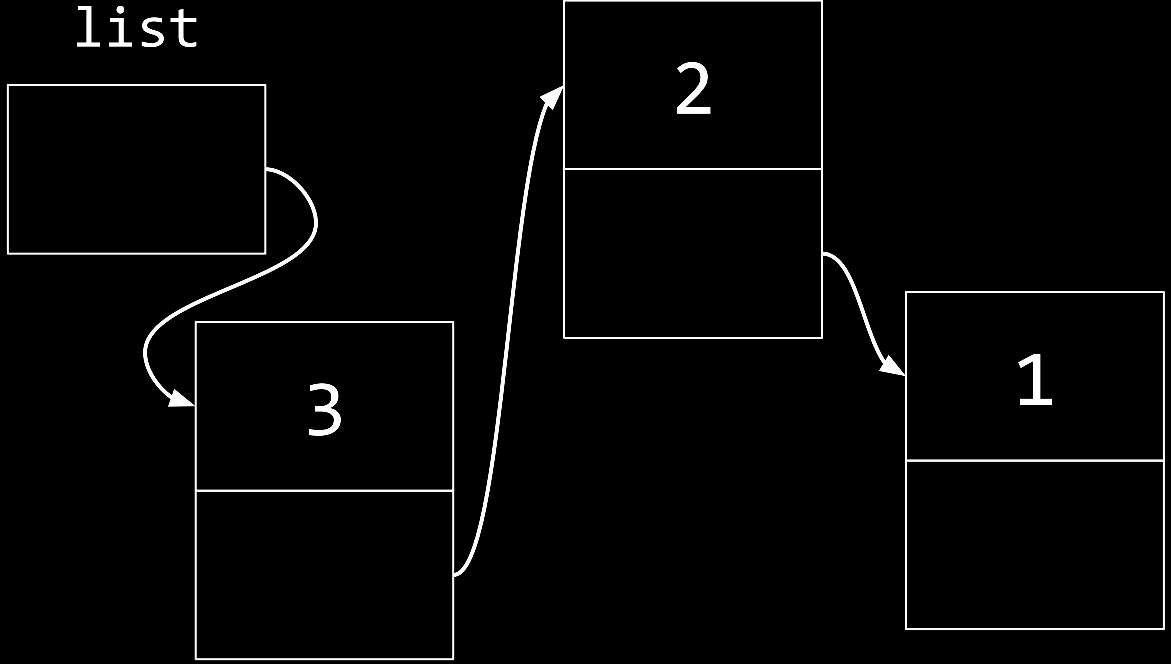
```
list = n;
```

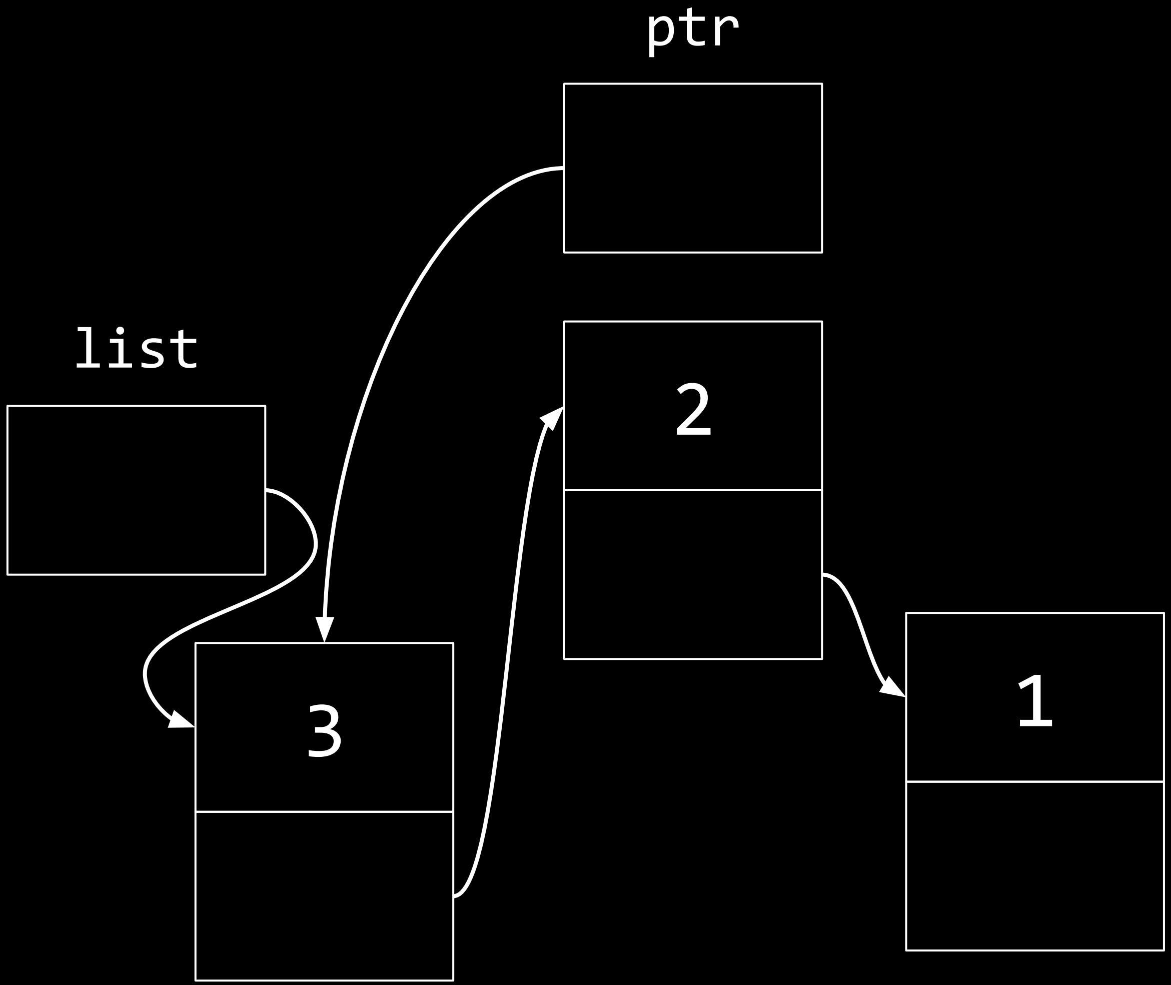


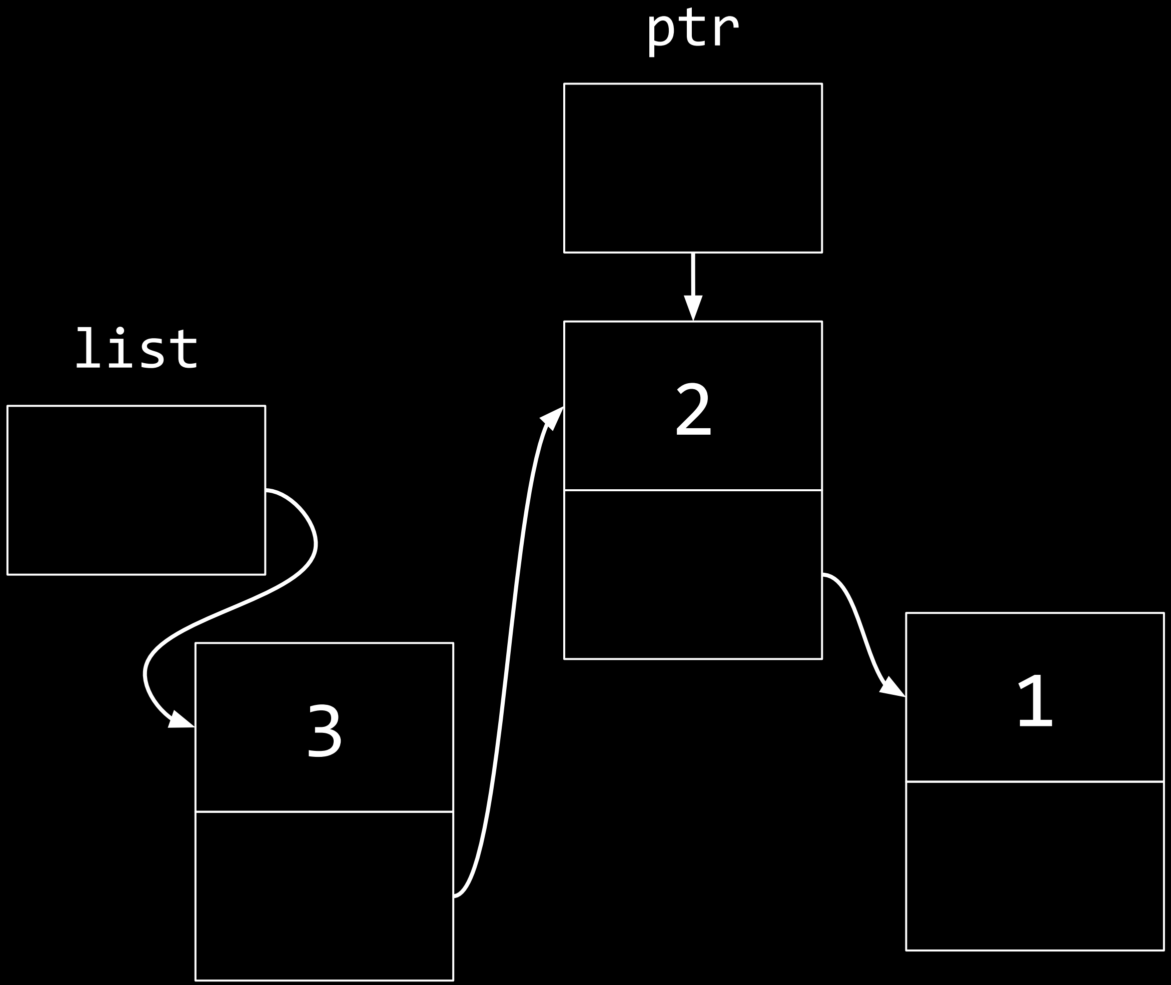
```
list = n;
```

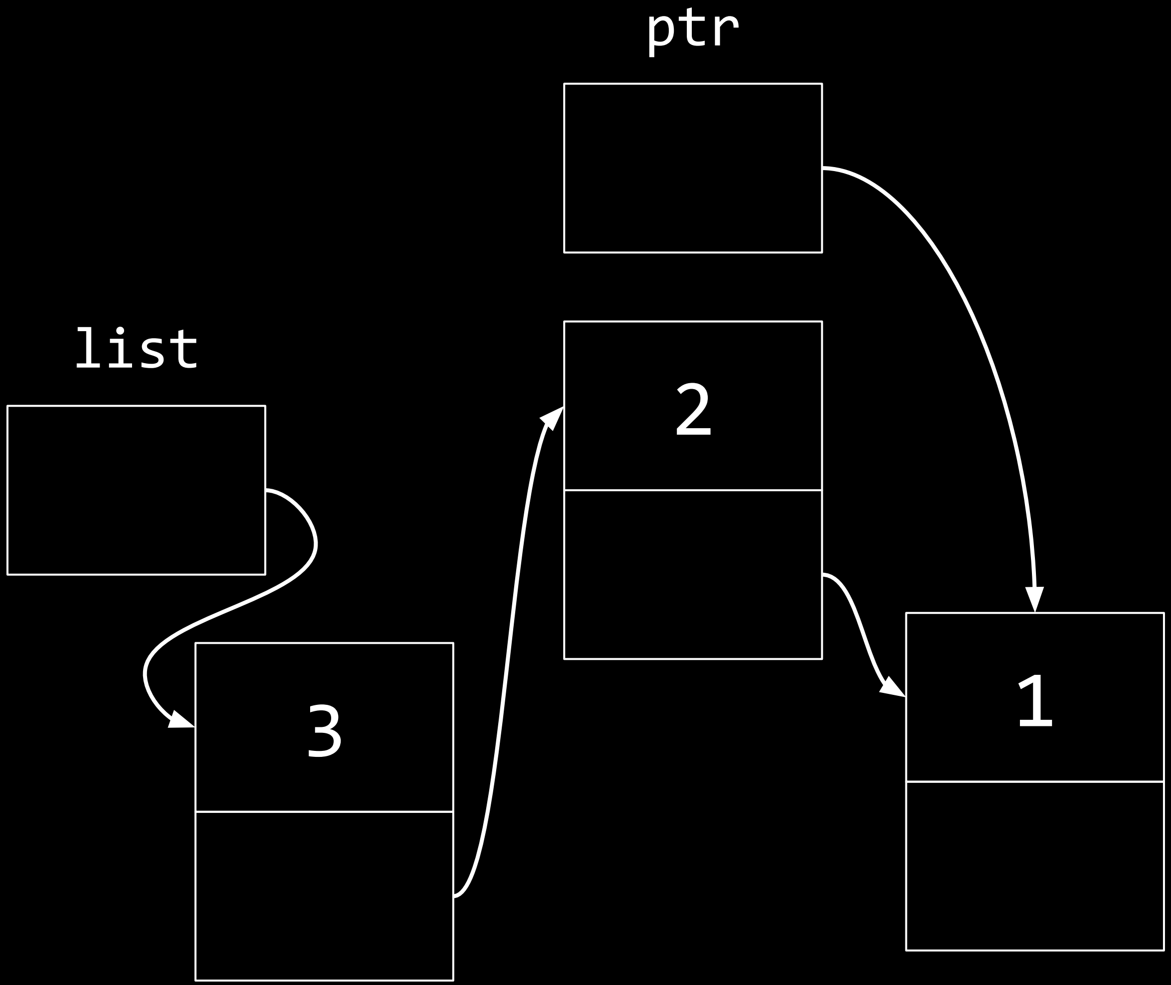


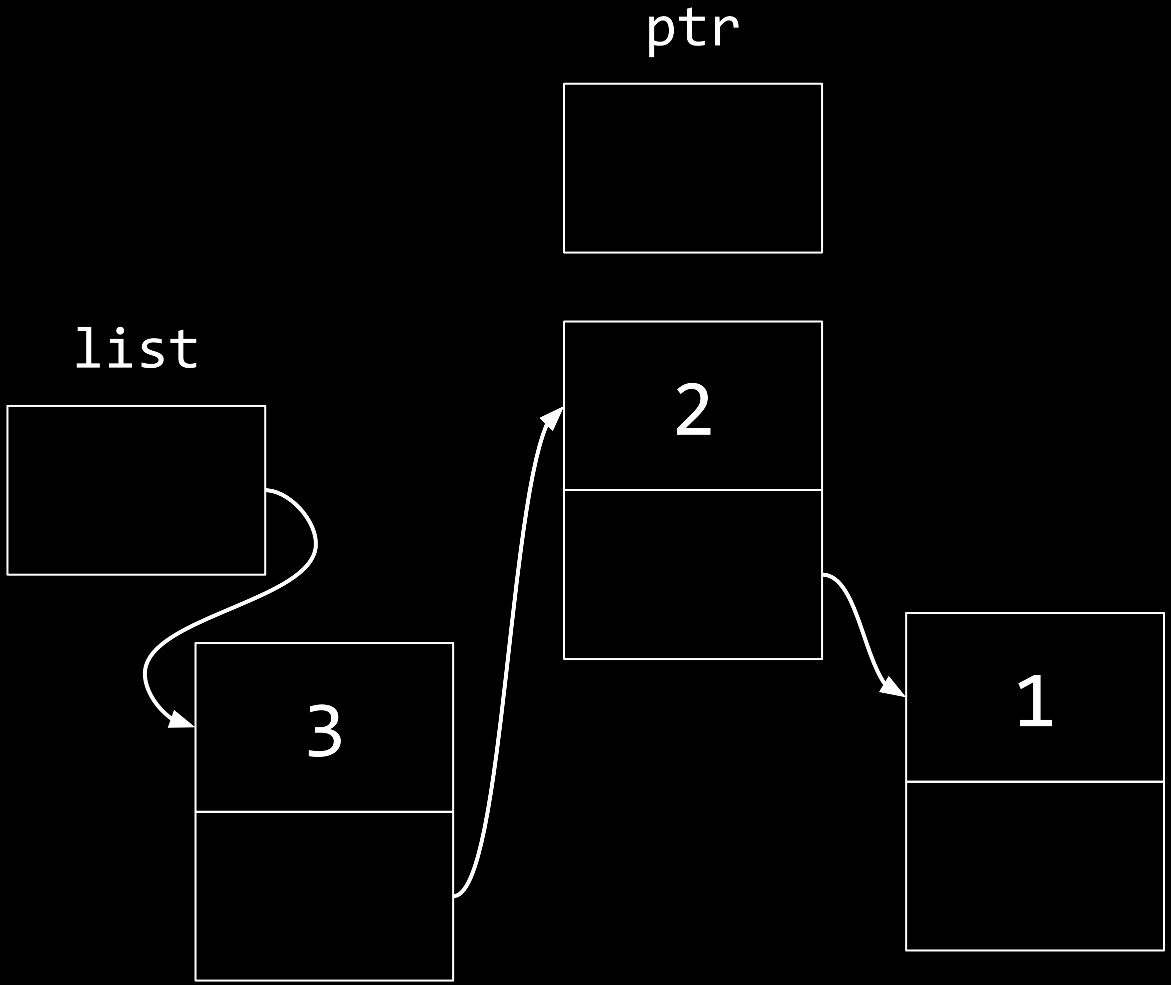

list
2
1

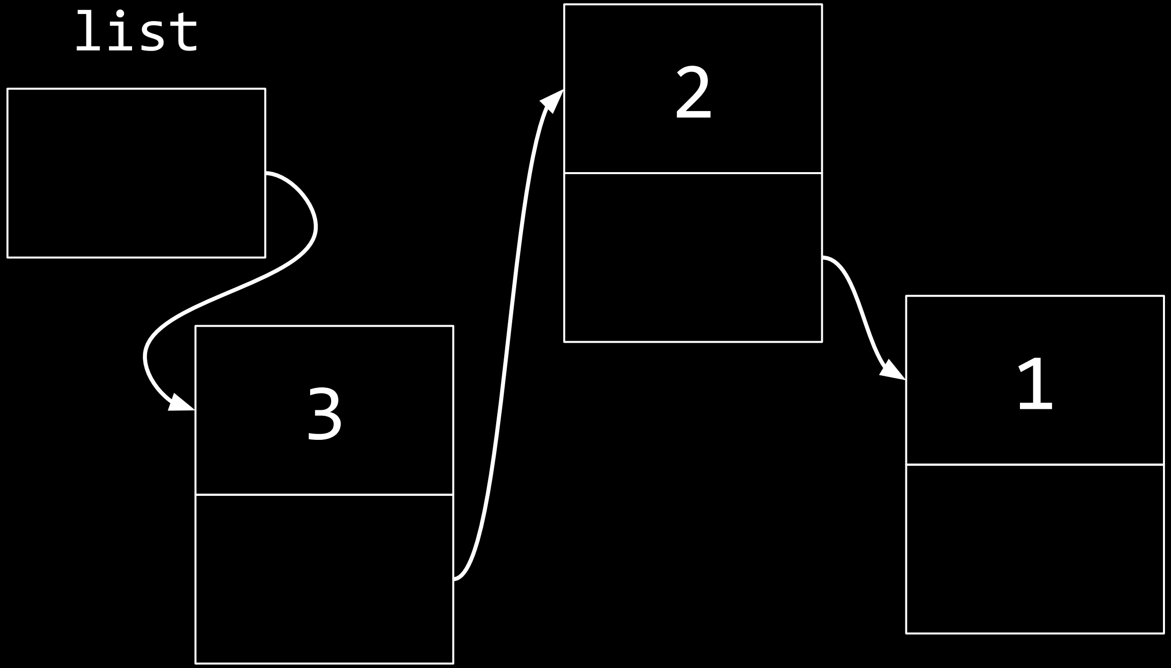

list
3
2
1


ptr
list
2
3
1


ptr
list
2
3
1


ptr
list
2
3
1


ptr
list
2
3
1


list
3
2
1

$O(n^2)$

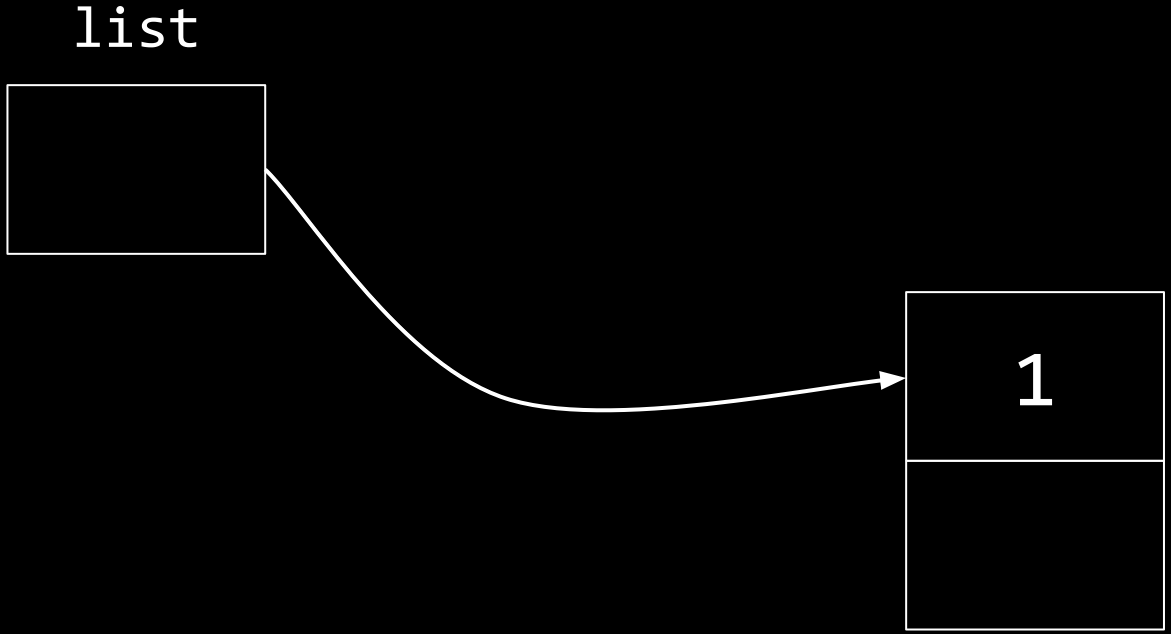
$O(n \log n)$

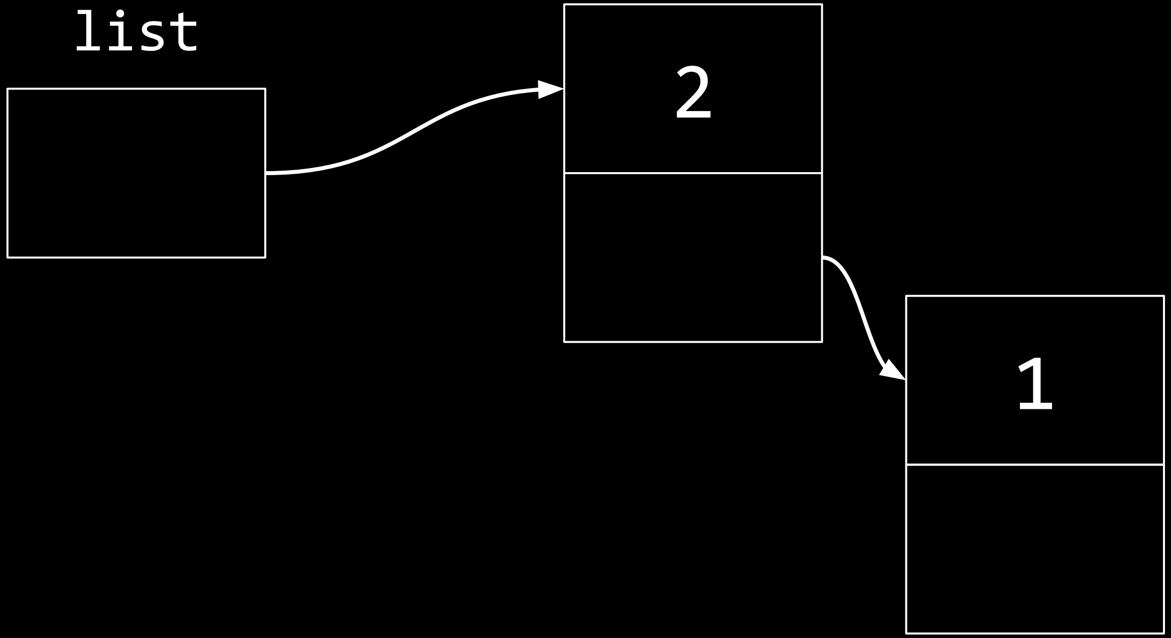
$O(n)$

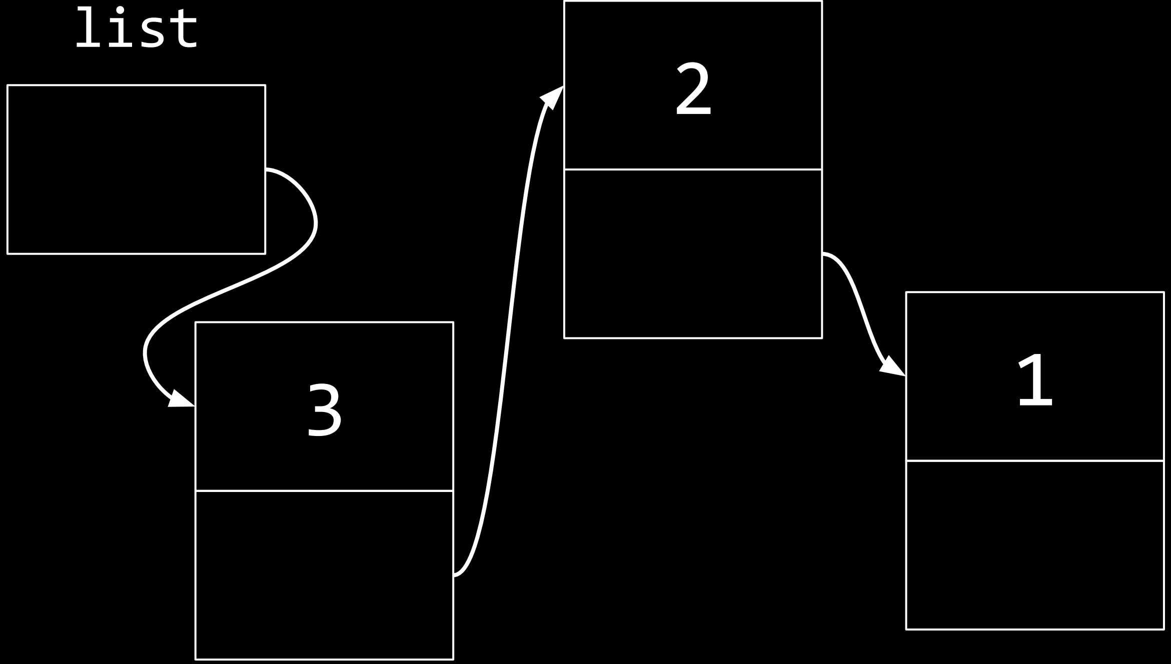
$O(\log n)$

$O(1)$

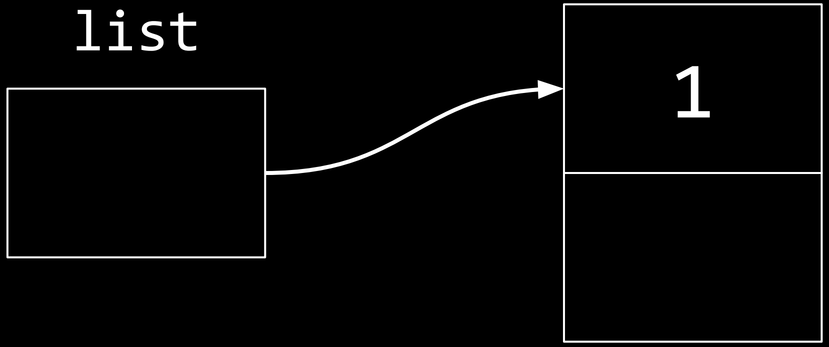
list

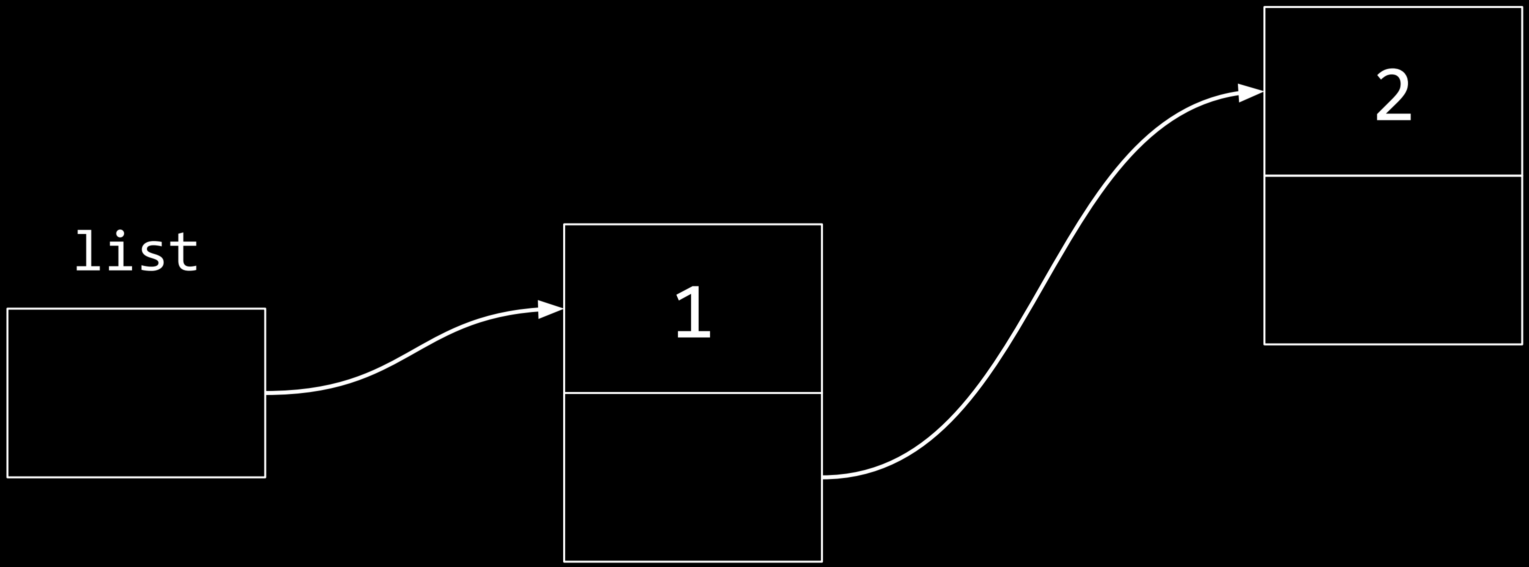

list
1

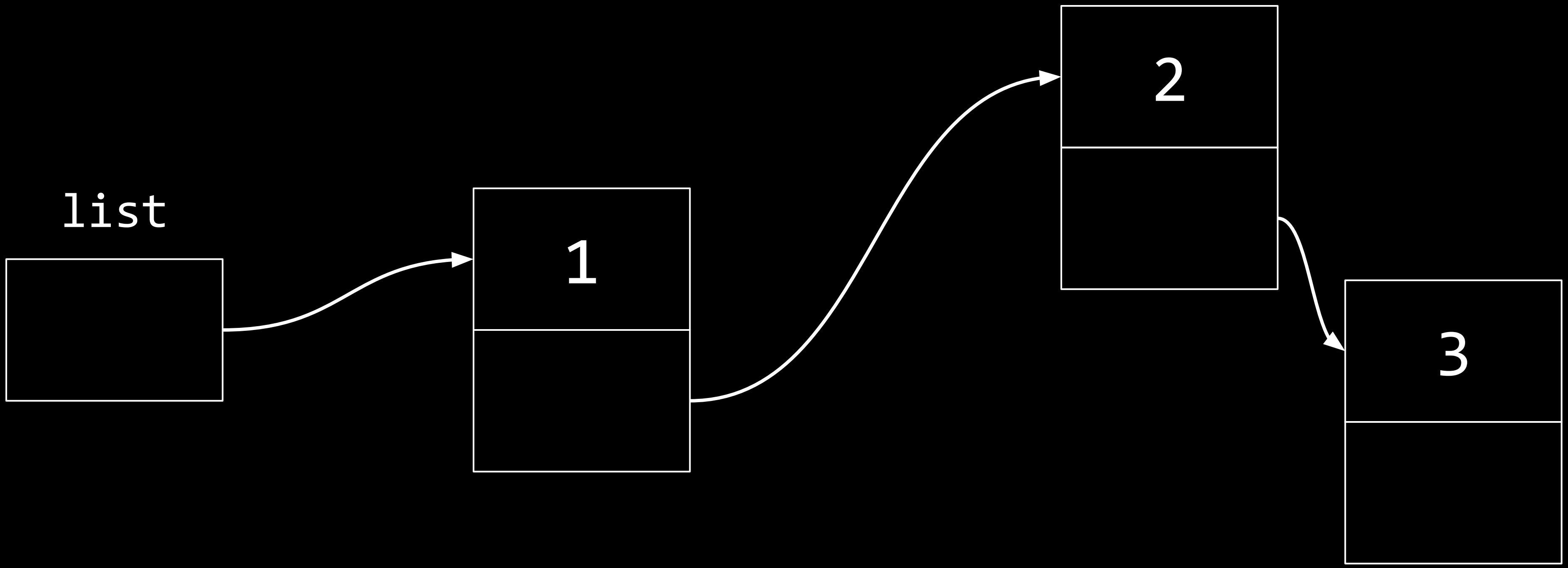

list
2
1


list
3
2
1

list


list
1


list
1
2


list
1
2
3

$O(n^2)$

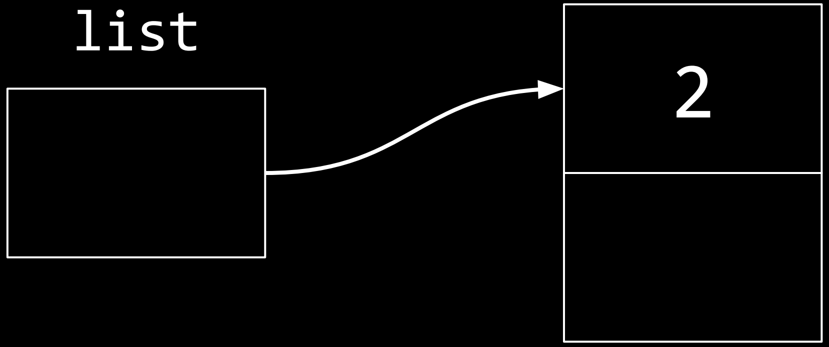
$O(n \log n)$

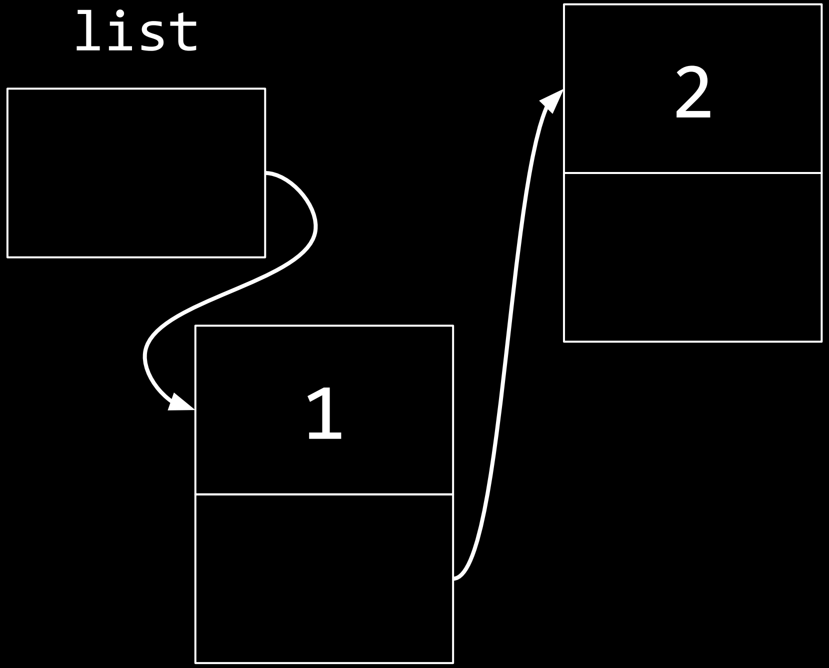
$O(n)$

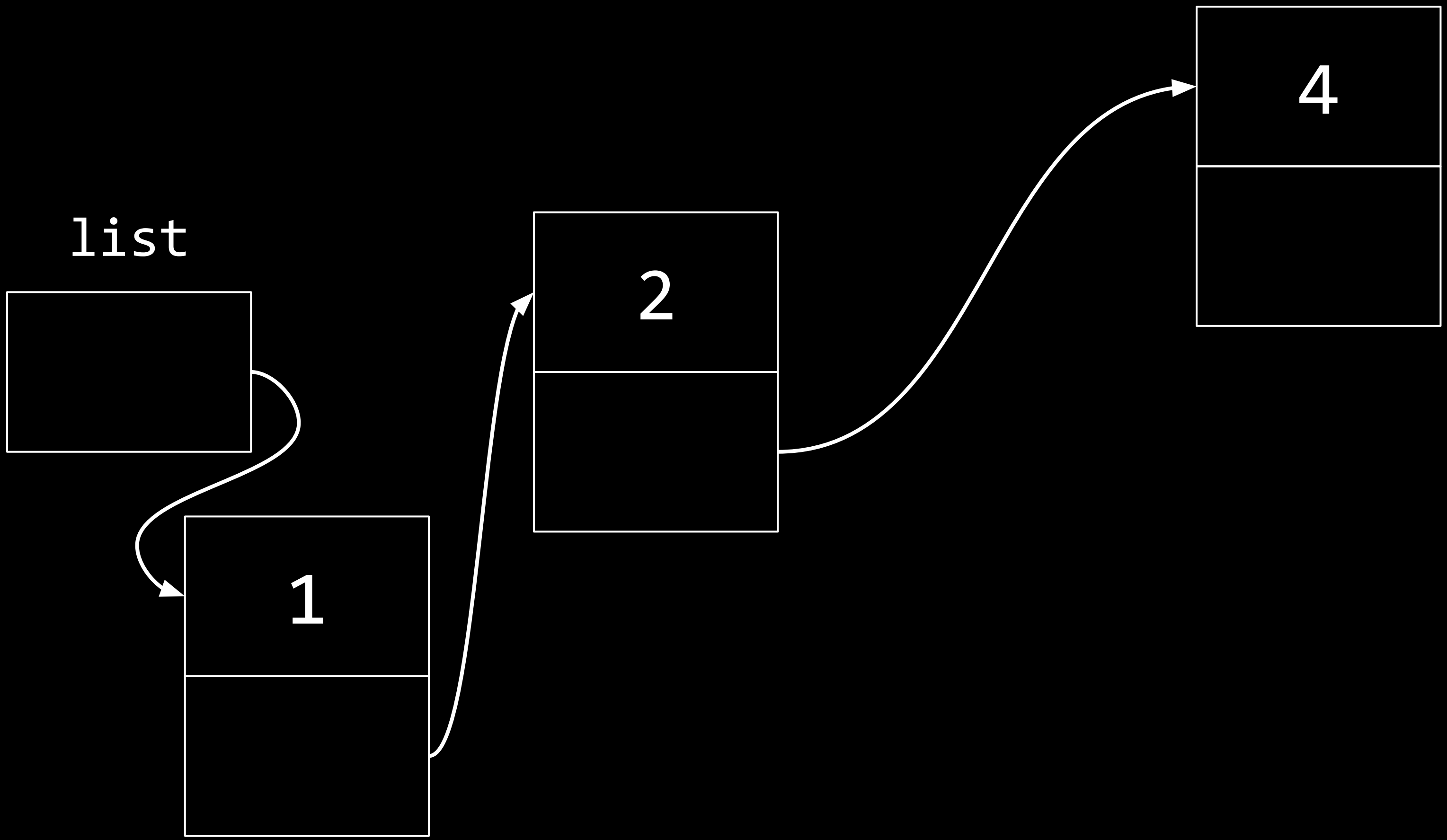
$O(\log n)$

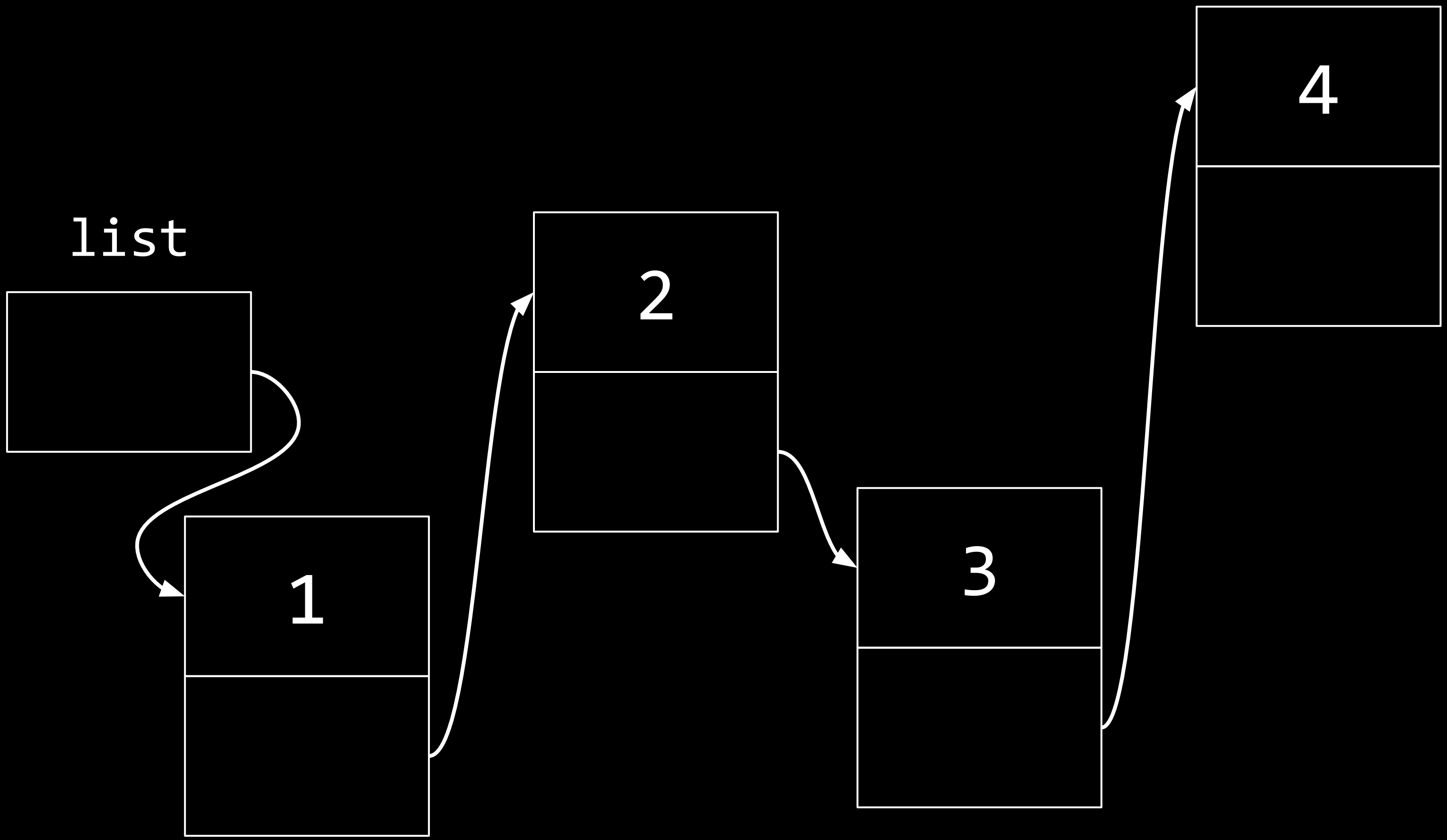
$O(1)$

list


list
2


list
1
2


list
1
2
4


list
1
2
3
4

$O(n^2)$

$O(n \log n)$

$O(n)$

$O(\log n)$

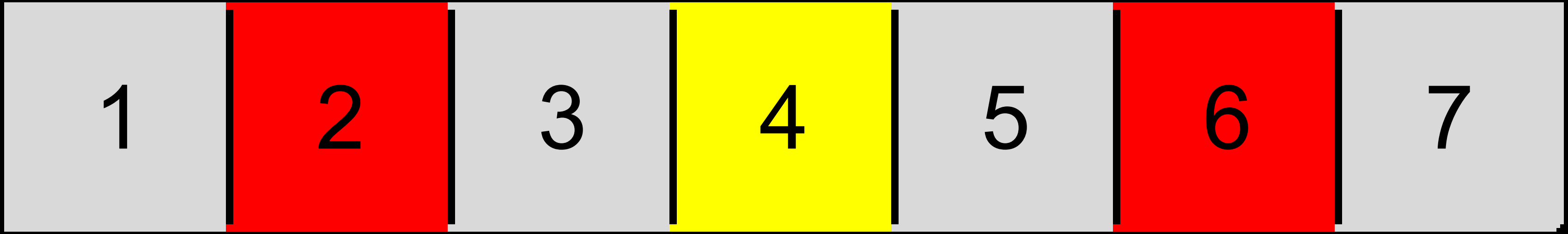
$O(1)$

trees

binary search trees

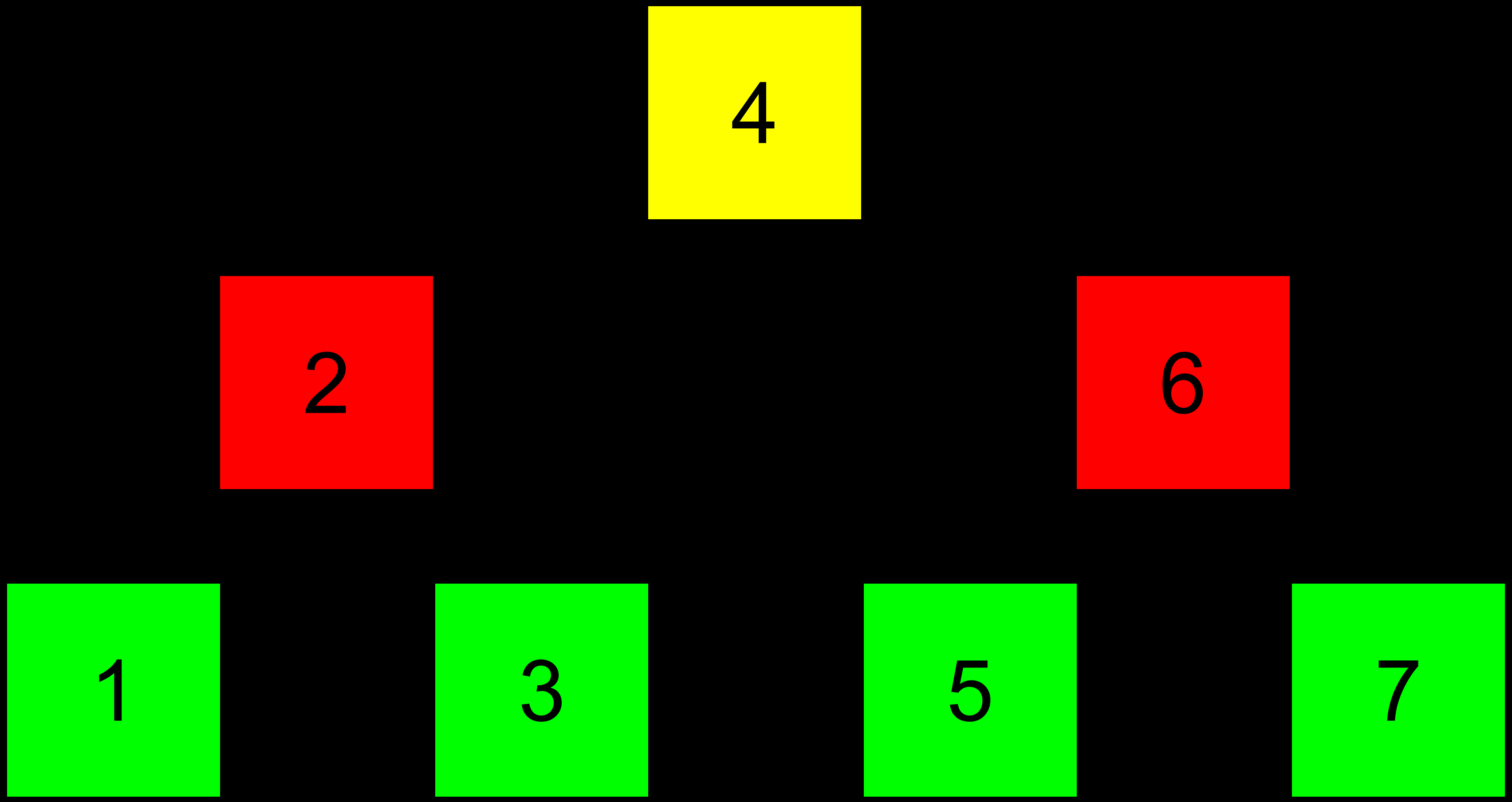
1	2	3	4	5	6	7

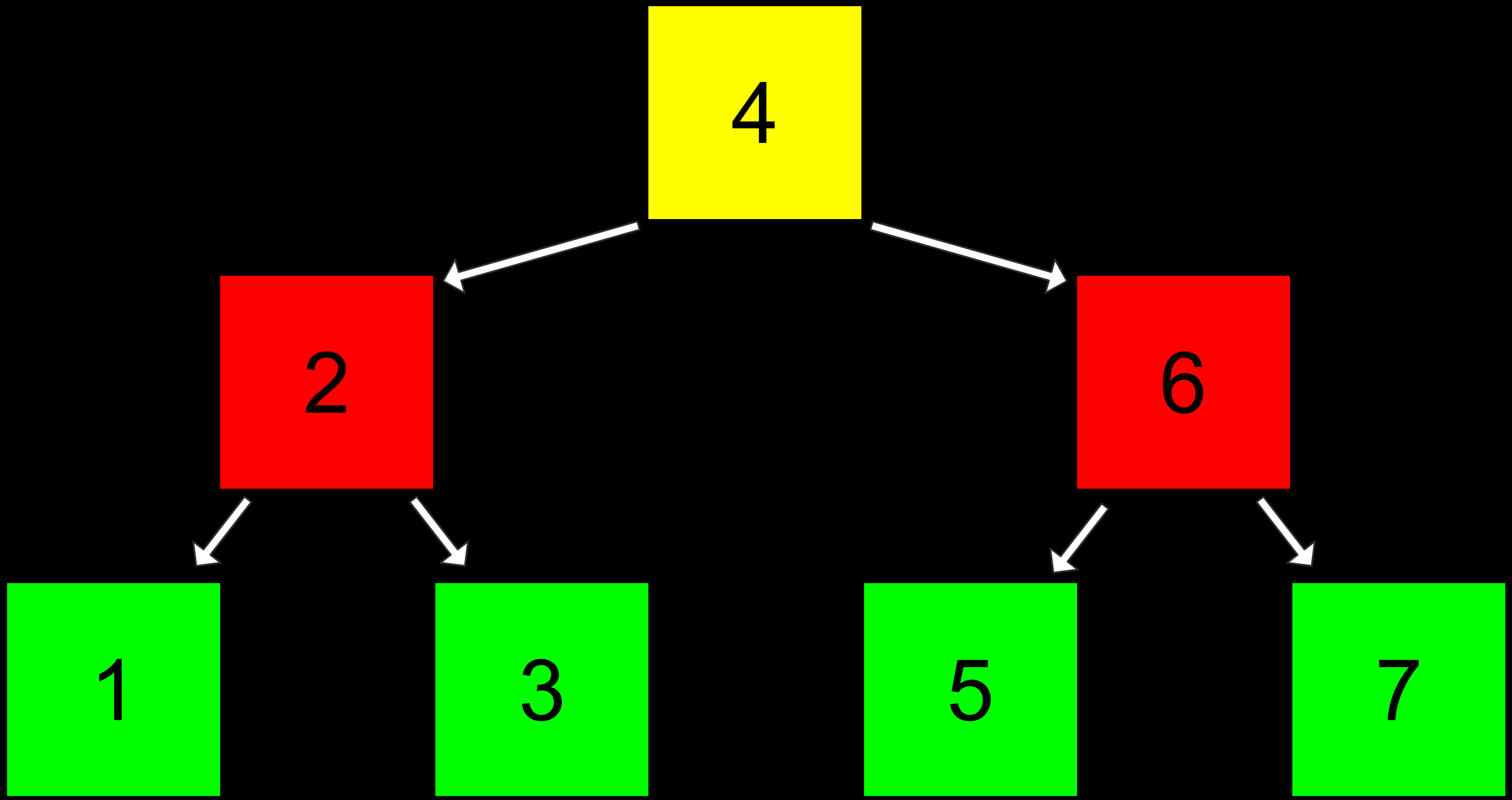
1	2	3	4	5	6	7



1	2	3	4	5	6	7

🟩 1	🟥 2	🟩 3	🟨 4	🟩 5	🟥 6	🟩 7


4
2
6
1
3
5
7

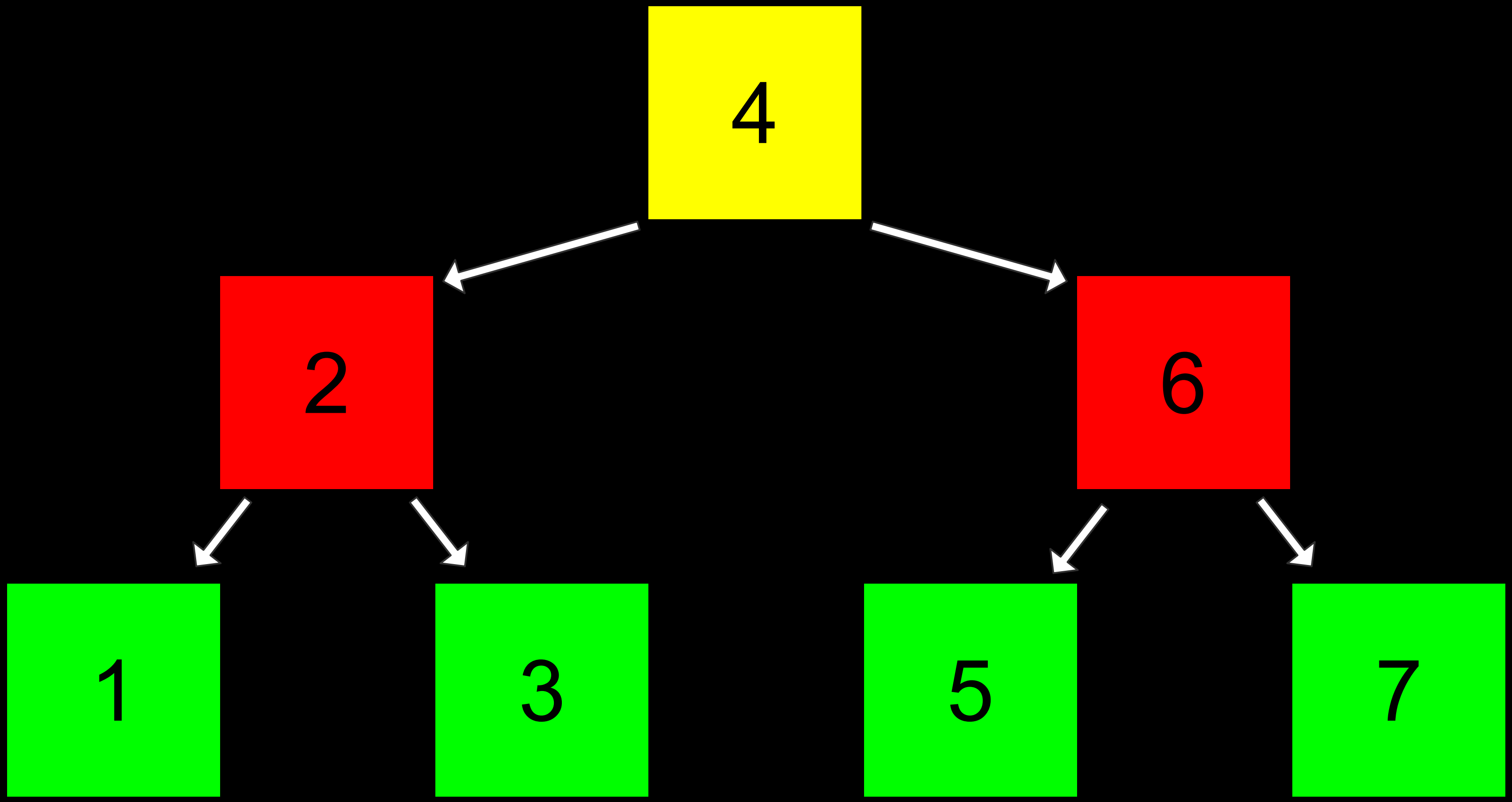

4
2
6
1
3
5
7

```
typedef struct node
{
    int number;
    struct node *next;
} node;
```

```
typedef struct node
{
    int number;

} node;
```

```
typedef struct node
{
    int number;


} node;
```

```
typedef struct node
{
    int number;
    struct node *left;
    struct node *right;
} node;
```


4
2
6
1
3
5
7

```
bool search(node *tree, int number)
{















}
```

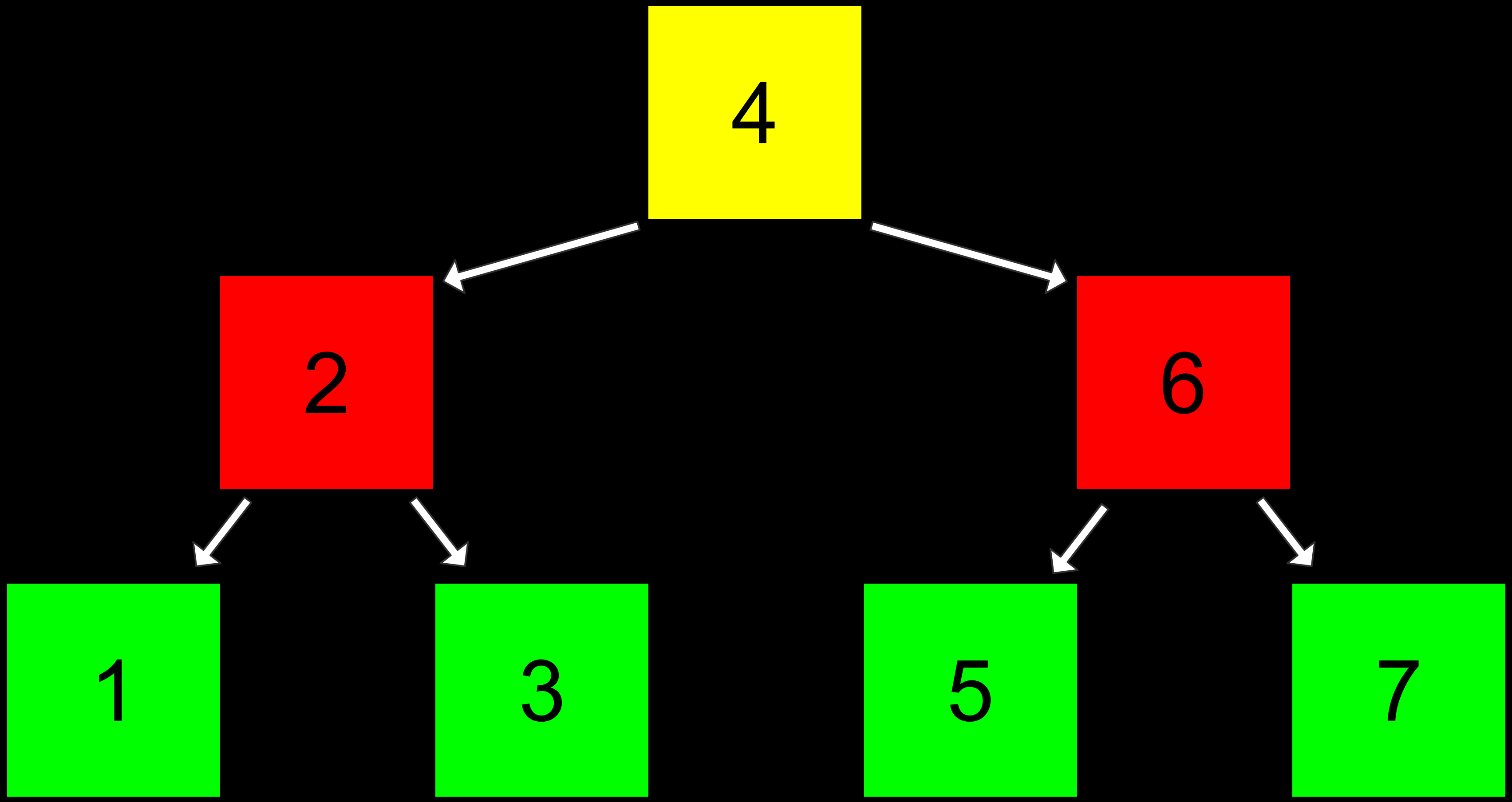
```
bool search(node *tree, int number)
{
    if (tree == NULL)
    {
        return false;
    }



}
```

```
bool search(node *tree, int number)
{
    if (tree == NULL)
    {
        return false;
    }
    else if (number < tree->number)
    {
        return search(tree->left, number);
    }









}
```

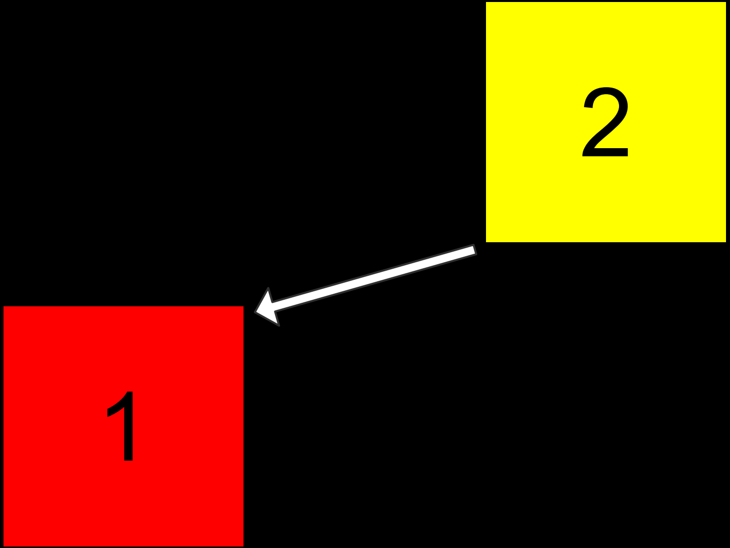
```
bool search(node *tree, int number)
{
    if (tree == NULL)
    {
        return false;
    }
    else if (number < tree->number)
    {
        return search(tree->left, number);
    }
    else if (number > tree->number)
    {
        return search(tree->right, number);
    }




}
```

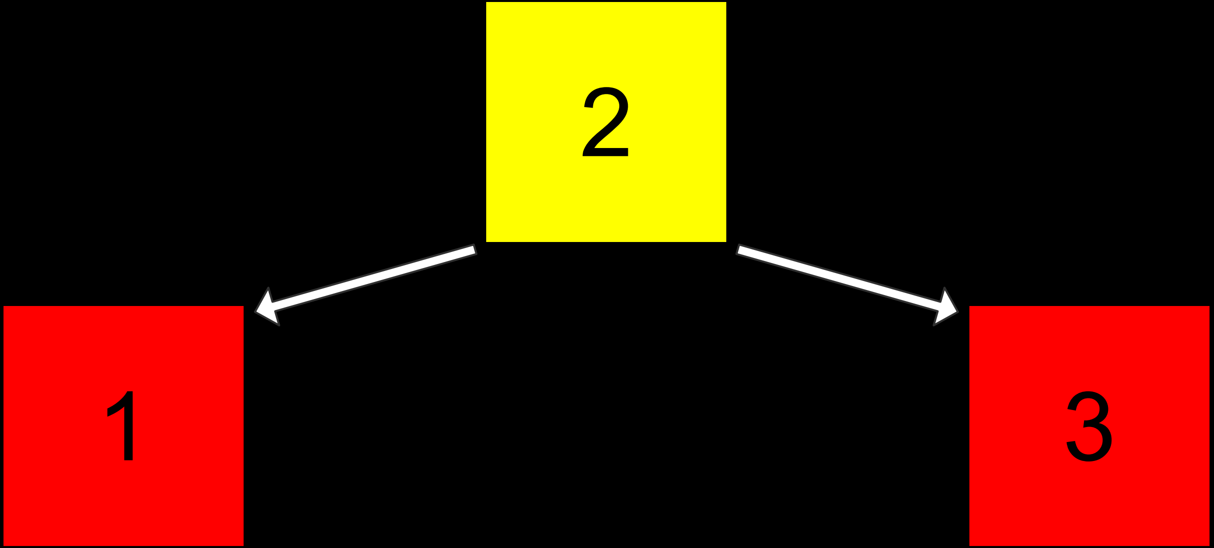
```
bool search(node *tree, int number)
{
    if (tree == NULL)
    {
        return false;
    }
    else if (number < tree->number)
    {
        return search(tree->left, number);
    }
    else if (number > tree->number)
    {
        return search(tree->right, number);
    }
    else if (number == tree->number)
    {
        return true;
    }
}
```

```
bool search(node *tree, int number)
{
    if (tree == NULL)
    {
        return false;
    }
    else if (number < tree->number)
    {
        return search(tree->left, number);
    }
    else if (number > tree->number)
    {
        return search(tree->right, number);
    }
    else
    {
        return true;
    }
}
```

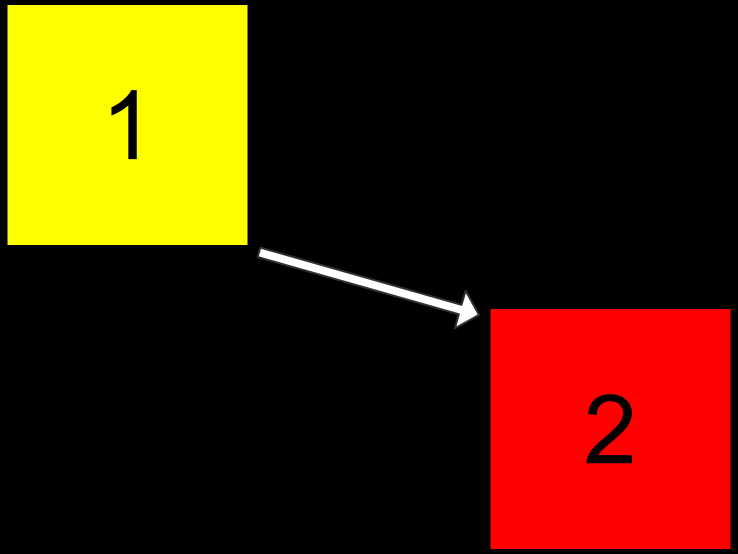

4
2
6
1
3
5
7

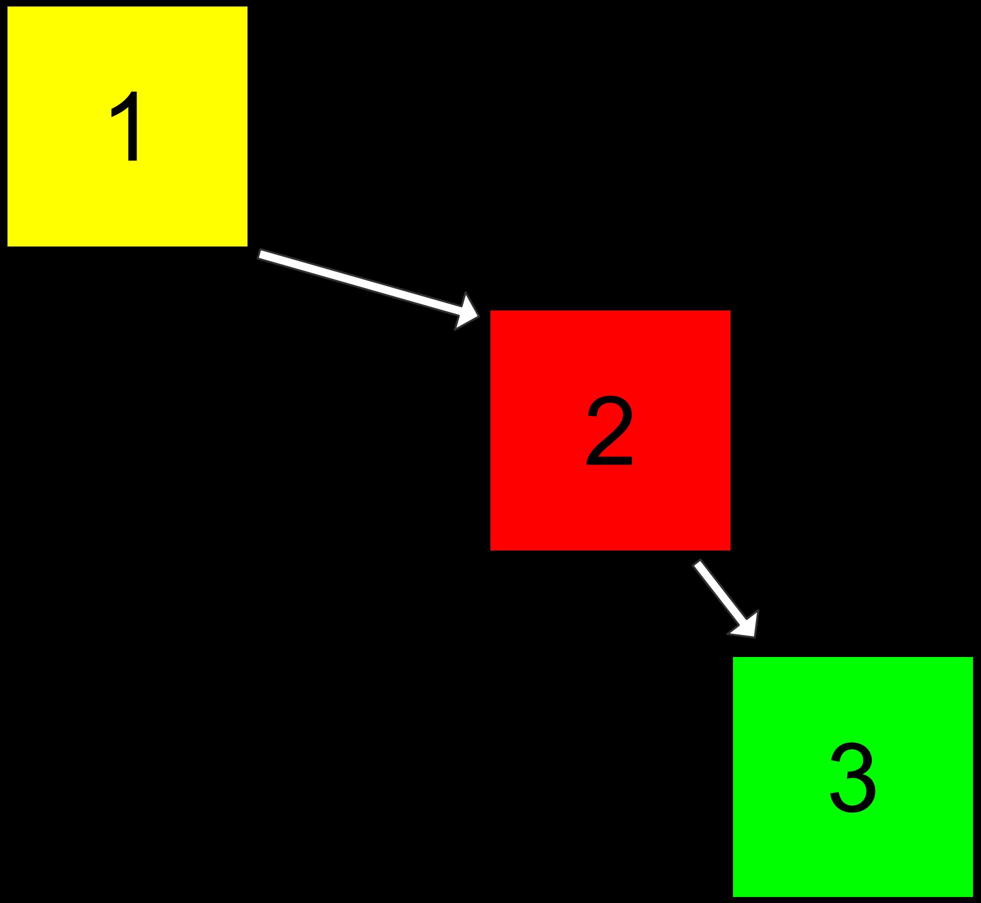
2


2
1


2
1
3

1


1
2



1

2

3

$O(n^2)$

$O(n \log n)$

$O(n)$

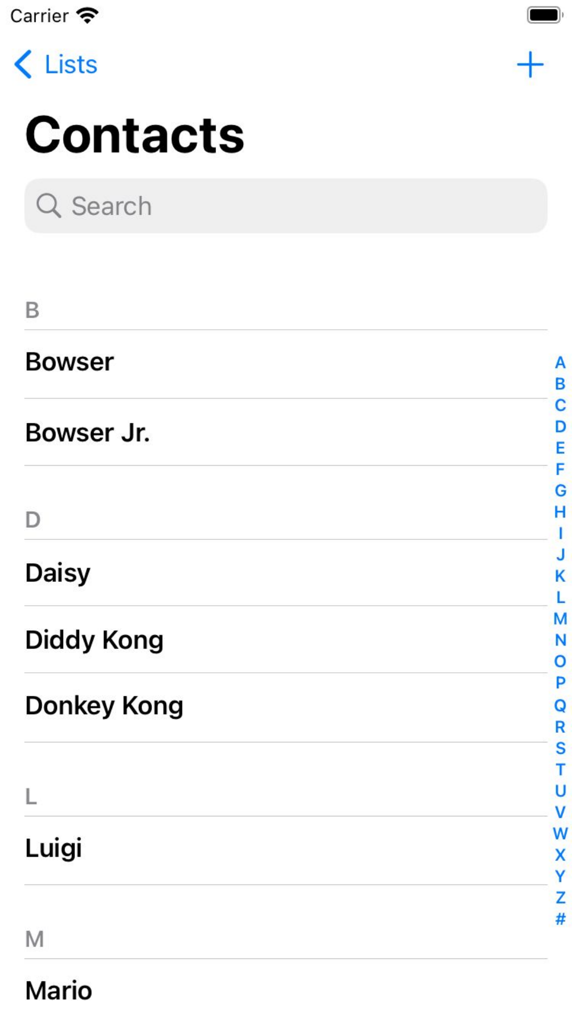
$O(\log n)$

$O(1)$

dictionaries

word	definition

key	value



Contacts

B

Bowser

Bowser Jr.

D

Daisy

Diddy Kong

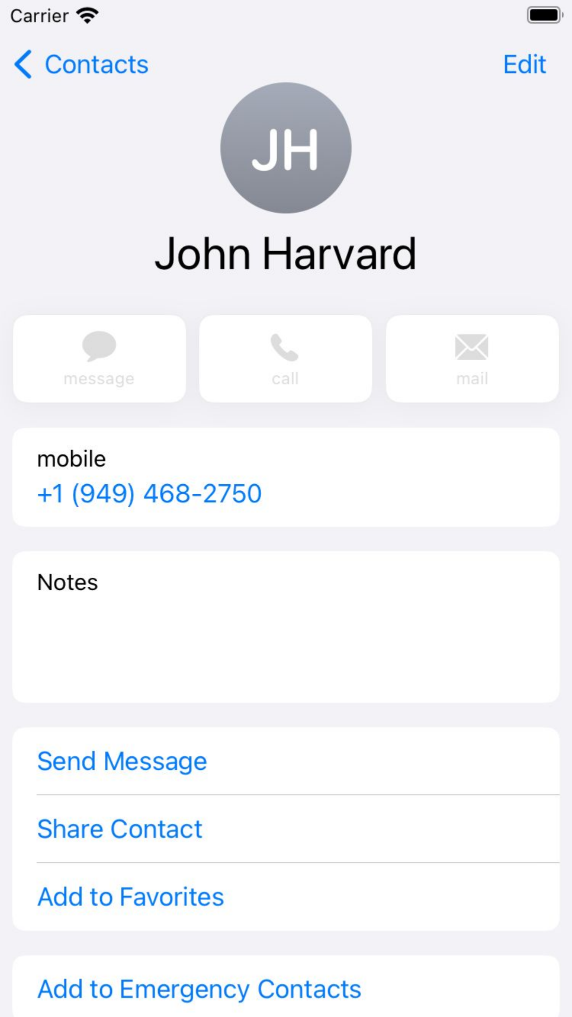
Donkey Kong

L

Luigi

M

Mario

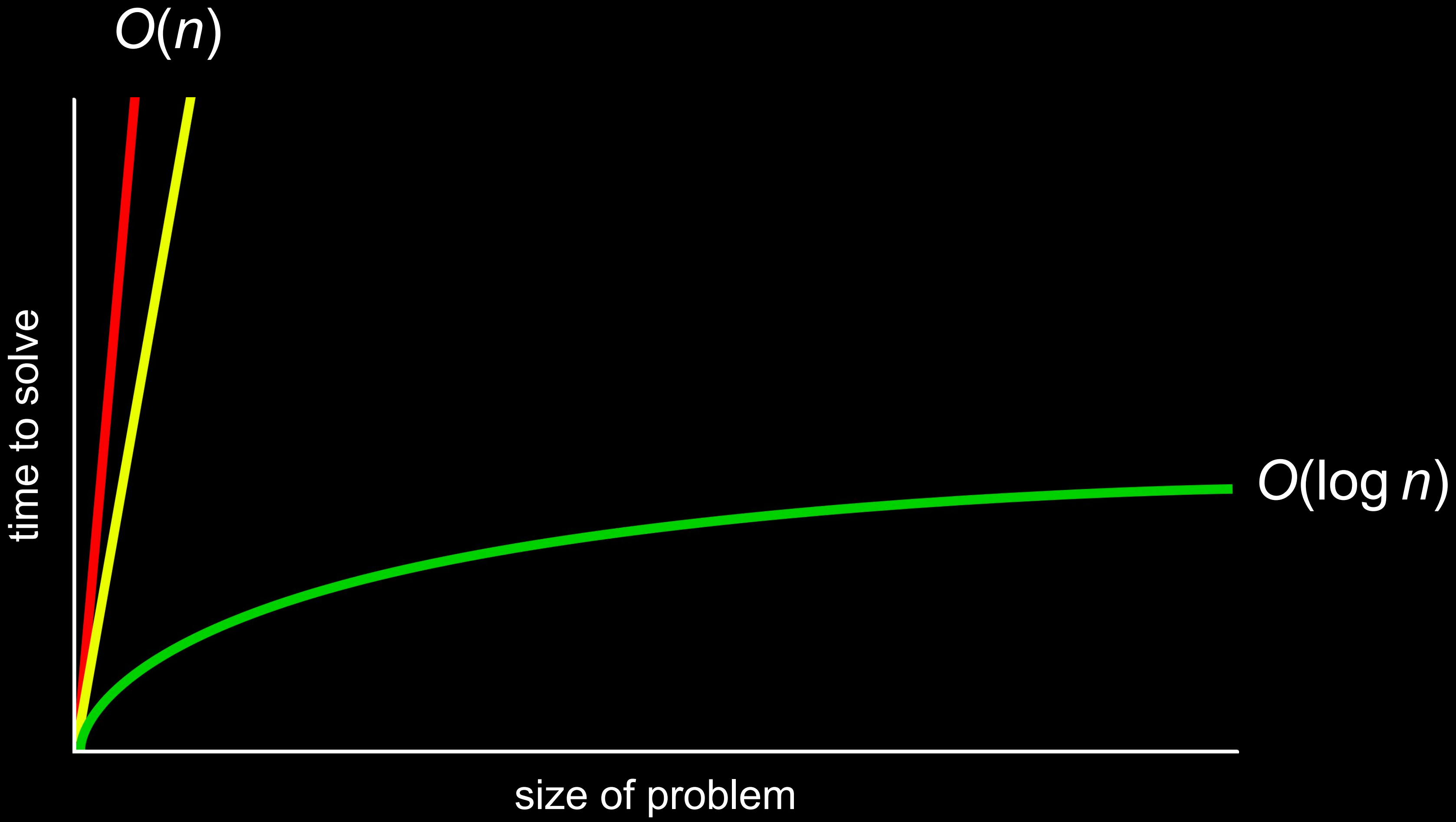


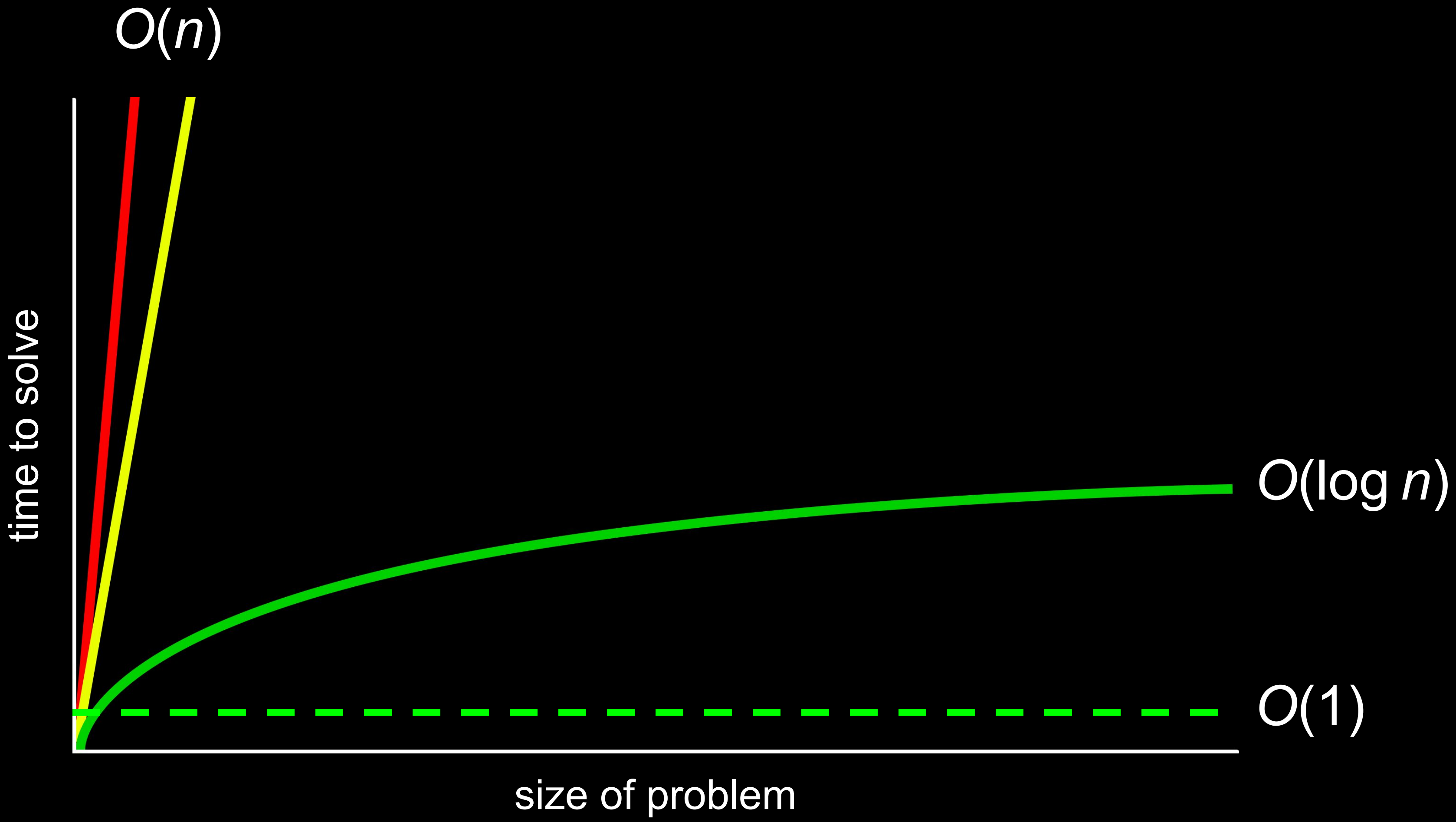
John Harvard

mobile
+1 (949) 468-2750

Notes

name	number

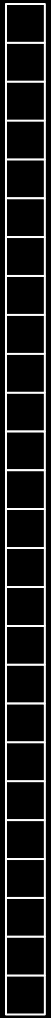

$O(n)$
$O(\log n)$
time to solve
size of problem


$O(n)$
time to solve
$O(\log n)$
$O(1)$
size of problem

hashing

hash function

hash tables



0	
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8	
9	
10	
11	
12	
13	
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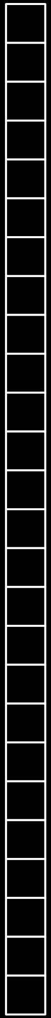
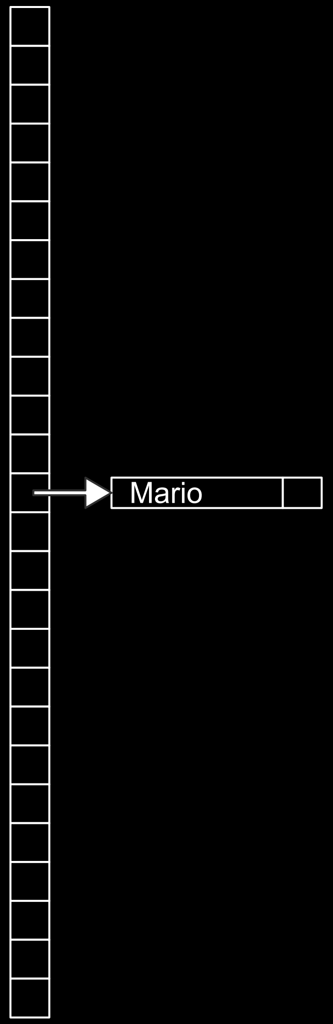
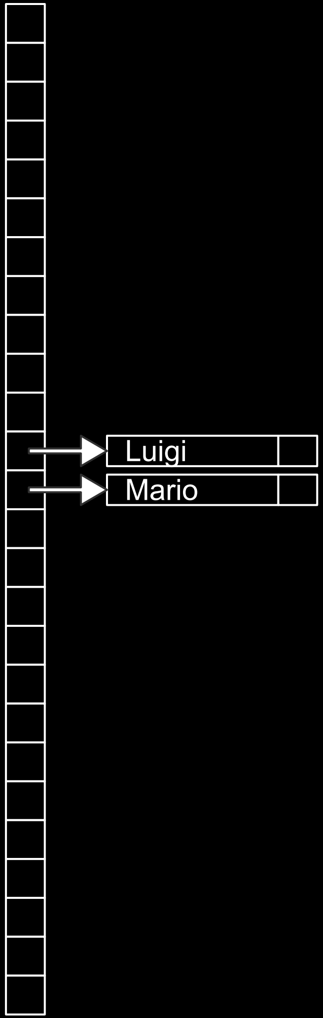
25	

A	
B	
C	
D	
E	
F	
G	
H	
I	
J	
K	
L	
M	
N	
O	
P	
Q	
R	
S	
T	
U	
V	
W	
X	
Y	
Z	

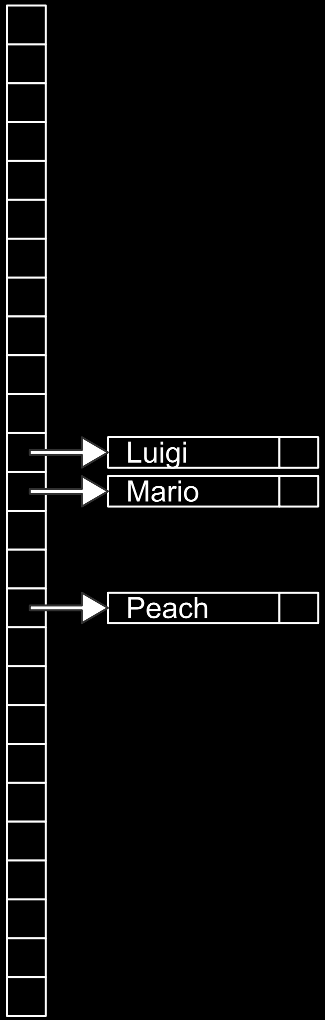


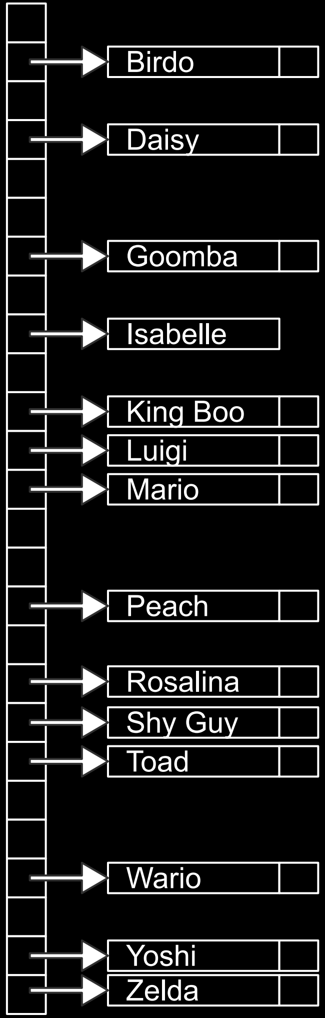


Mario



Luigi
Mario


Luigi
Mario
Peach



Birdo

Daisy

Goomba

Isabelle

King Boo

Luigi

Mario

Peach

Rosalina

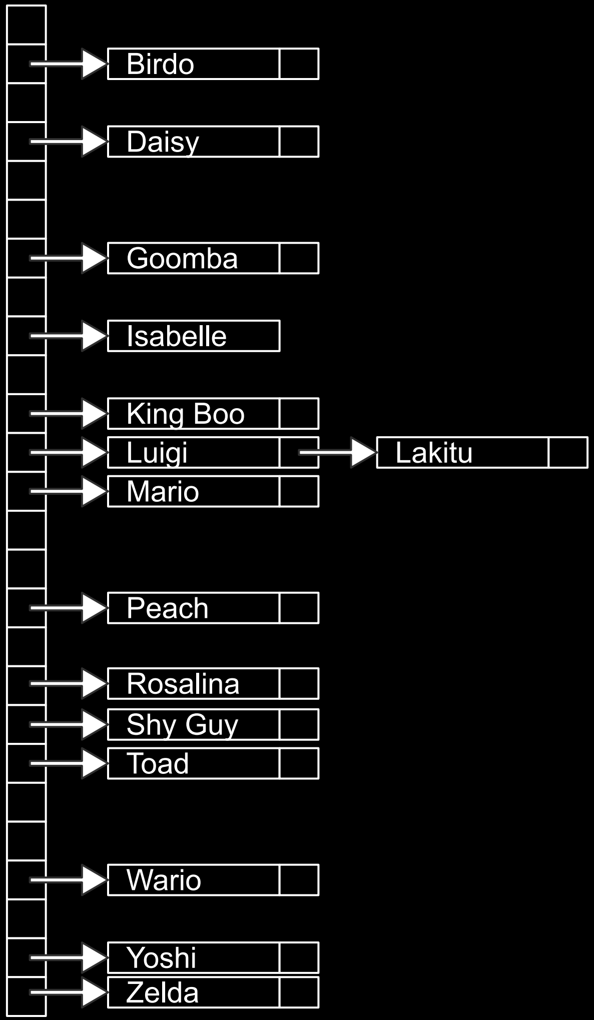
Shy Guy

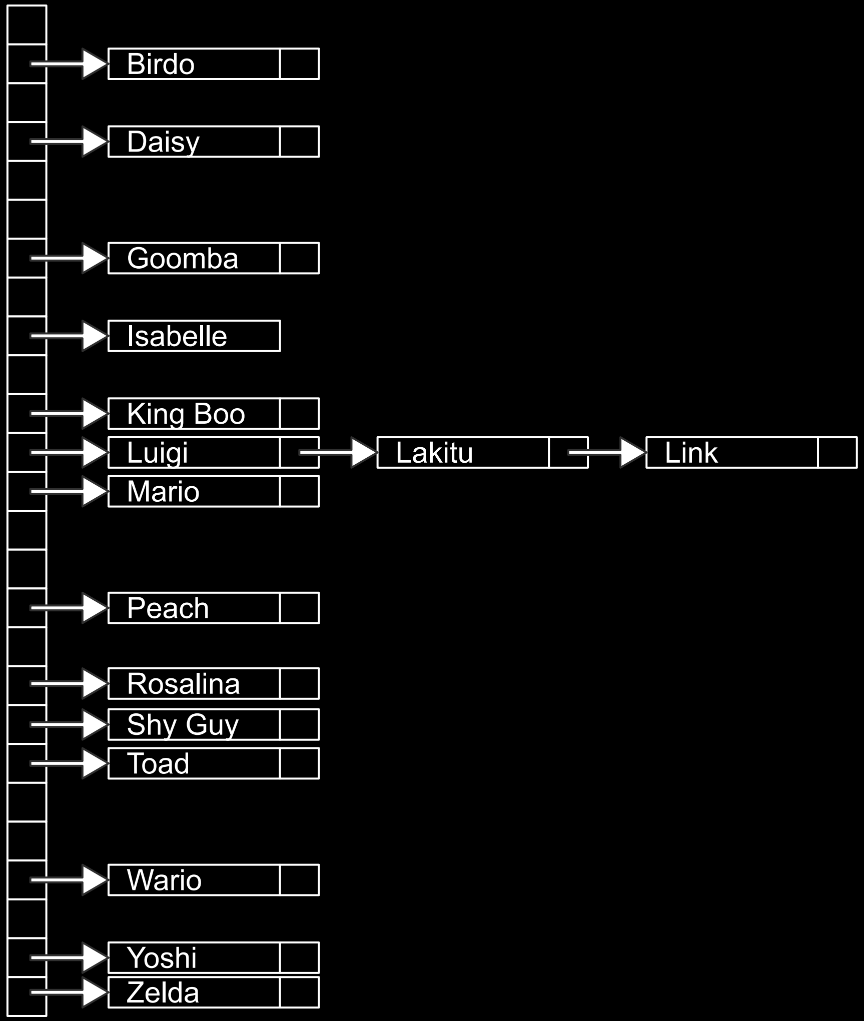
Toad

Wario

Yoshi

Zelda

Birdo
Daisy
Goomba
Isabelle
King Boo
Luigi
Lakitu
Mario
Peach
Rosalina
Shy Guy
Toad
Wario
Yoshi
Zelda



Birdo

Daisy

Goomba

Isabelle

King Boo

Luigi

Lakitu

Link

Mario

Peach

Rosalina

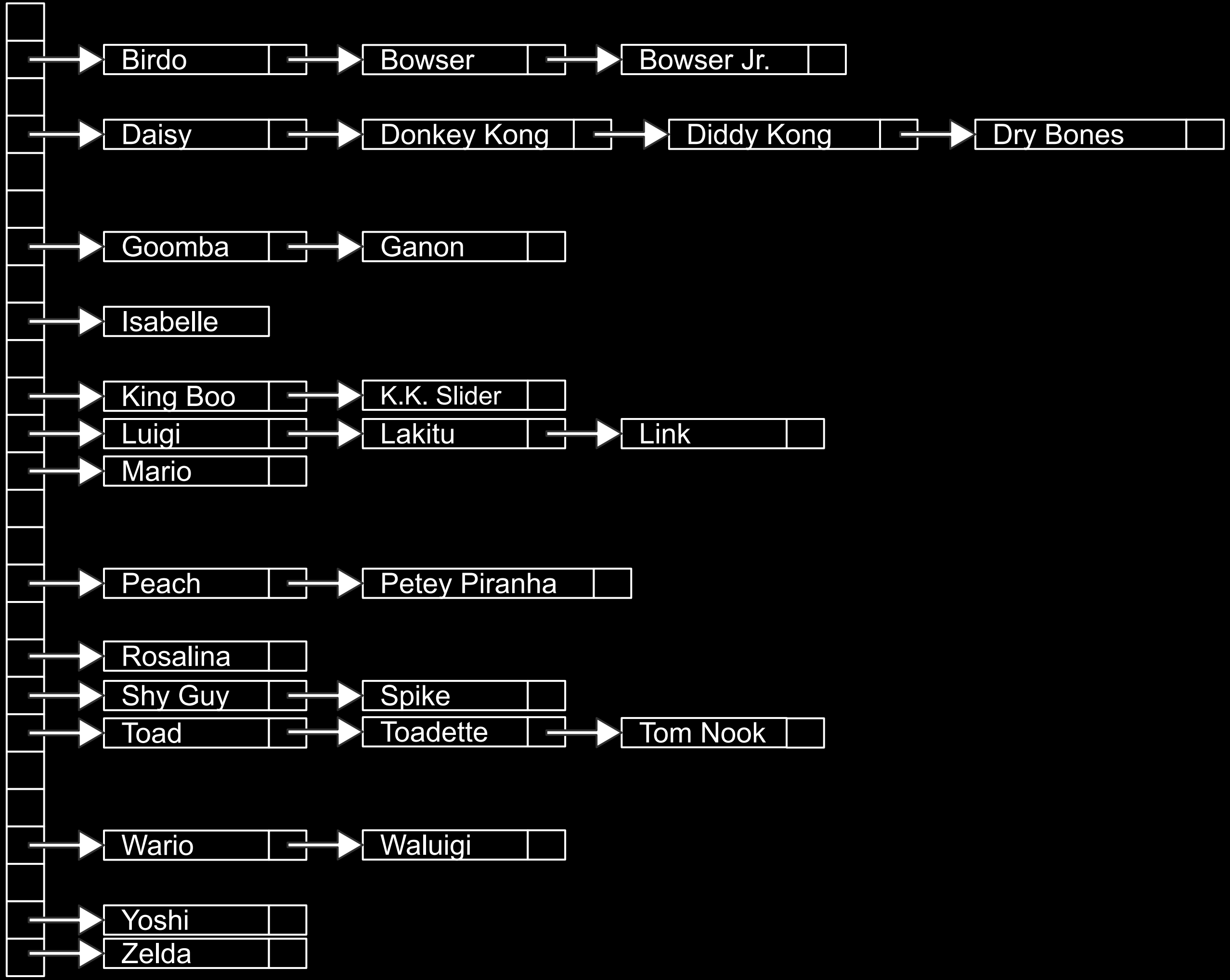
Shy Guy

Toad

Wario

Yoshi

Zelda



Birdo → Bowser → Bowser Jr.

Daisy → Donkey Kong → Diddy Kong → Dry Bones

Goomba → Ganon

Isabelle

King Boo → K.K. Slider

Luigi → Lakitu → Link

Mario

Peach → Petey Piranha

Rosalina

Shy Guy → Spike

Toad → Toadette → Tom Nook

Wario → Waluigi

Yoshi

Zelda

$O(n^2)$

$O(n \log n)$

$O(n)$

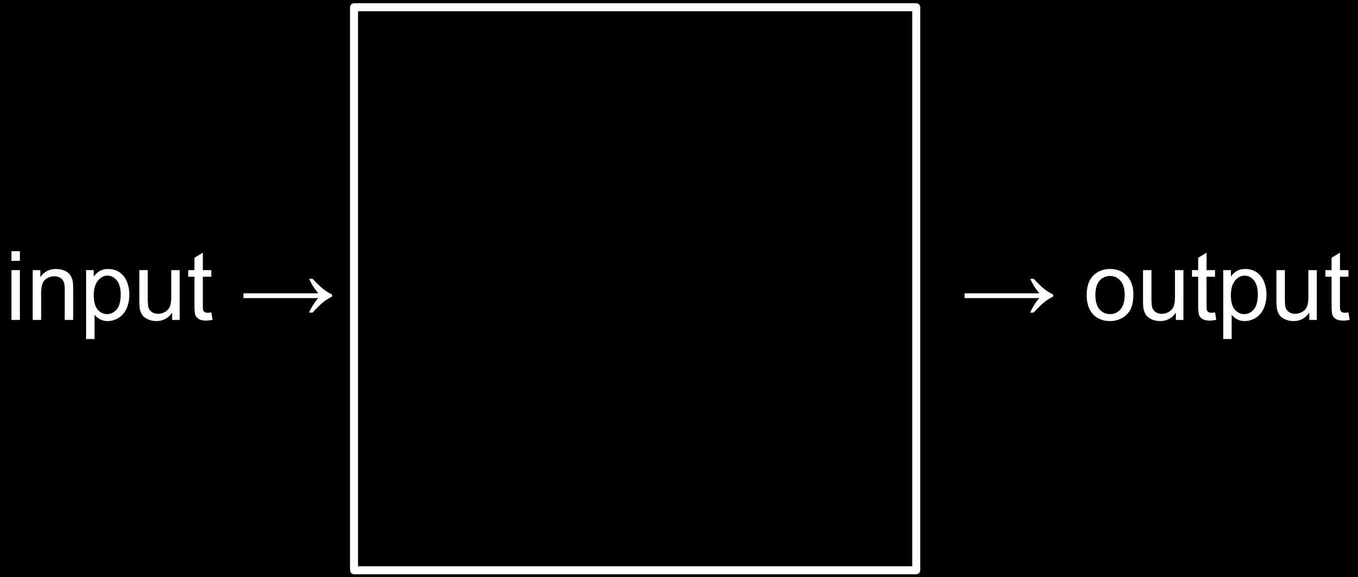
$O(\log n)$

$O(1)$

```
typedef struct
{
    char *name;
    char *number;
} person;
```

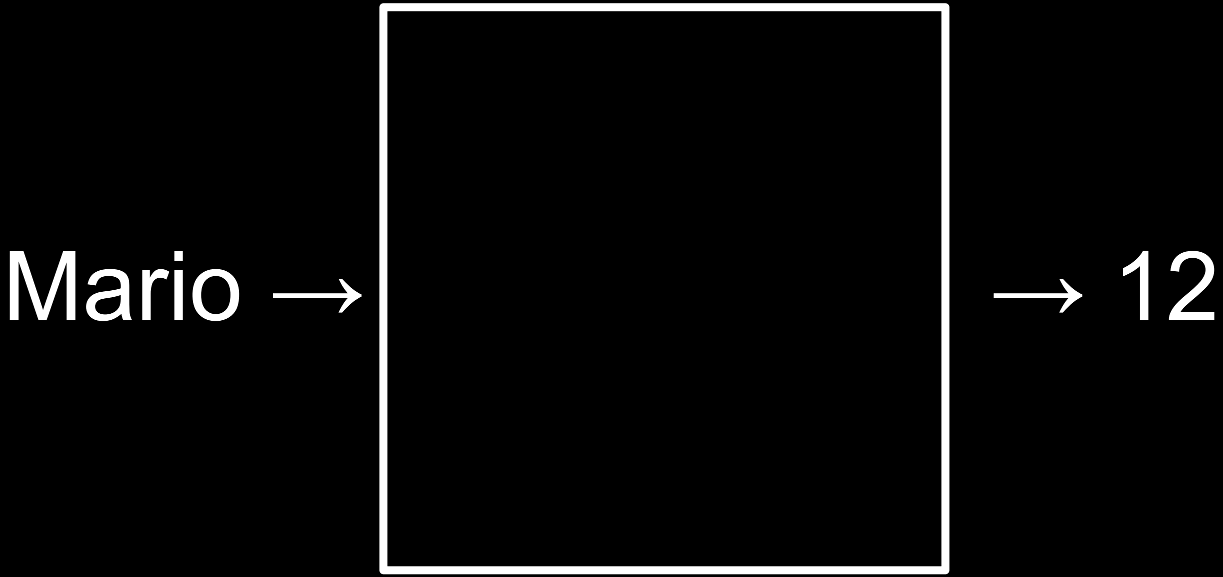
```
typedef struct node
{
    char *name;
    char *number;
    struct node *next;
} node;
```

```
node *table[26];
```



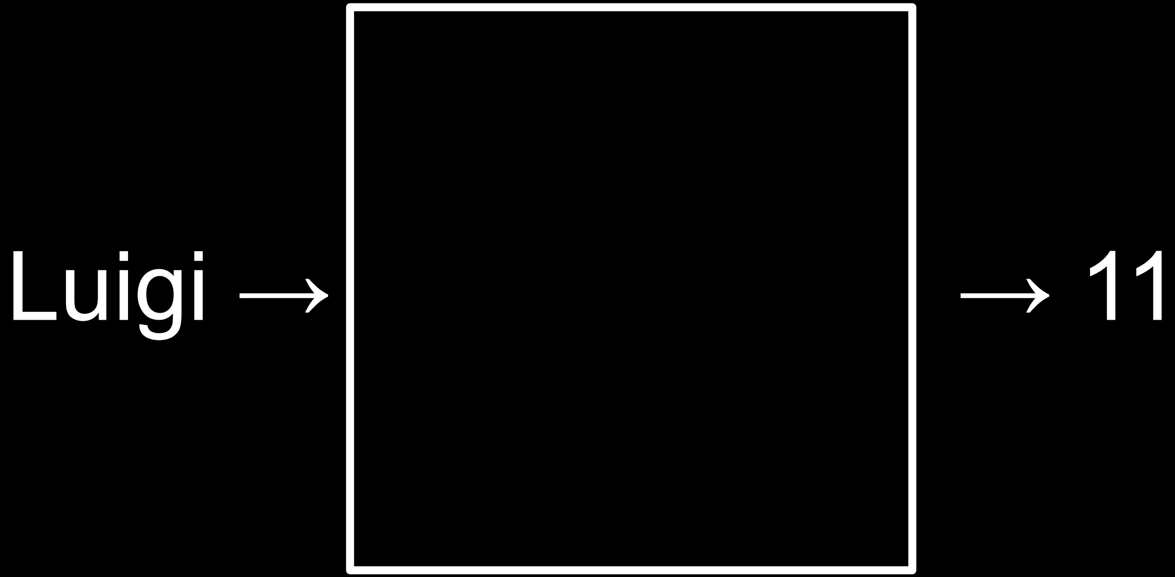
input → → output

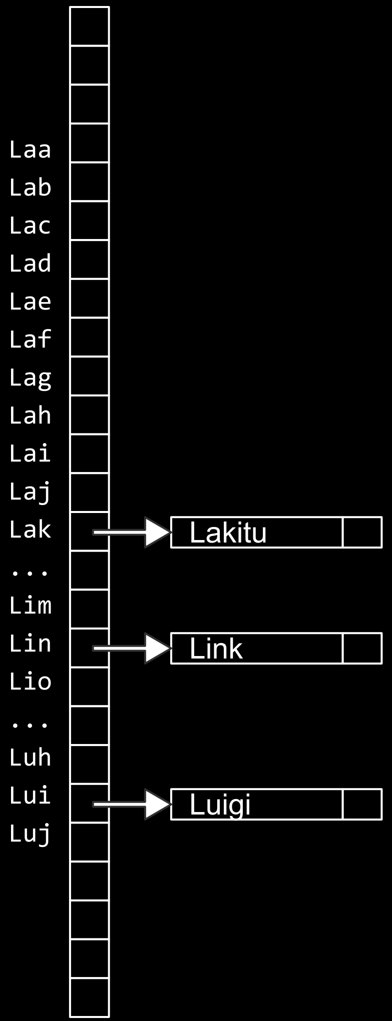
hash function



Mario →

→ 12


Luigi →
→ 11


Laa
Lab
Lac
Lad
Lae
Laf
Lag
Lah
Lai
Laj
Lak
...
Lim
Lin
Lio
...
Luh
Lui
Luj
Lakitu
Link
Luigi

```
#include <ctype.h>

int hash(char *word)
{
    return toupper(word[0]) - 'A';
}
```

```c
#include <ctype.h>

int hash(const char *word)
{
    return toupper(word[0]) - 'A';
}
```

```c
#include <ctype.h>

unsigned int hash(const char *word)
{
    return toupper(word[0]) - 'A';
}
```

$O(n)$

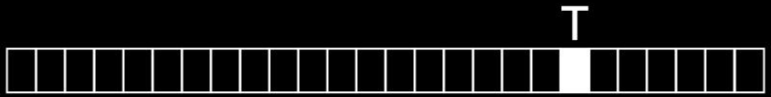
$O(n/k)$

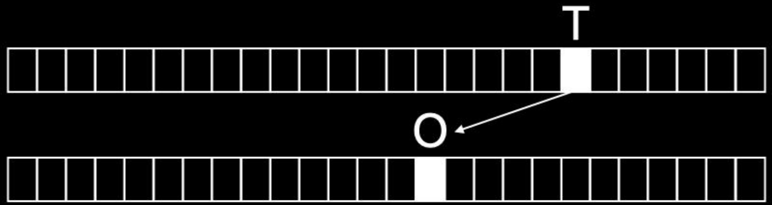
$O(n)$

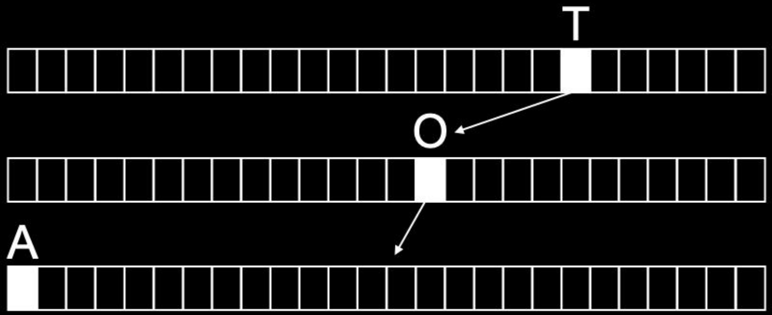
$O(1)$

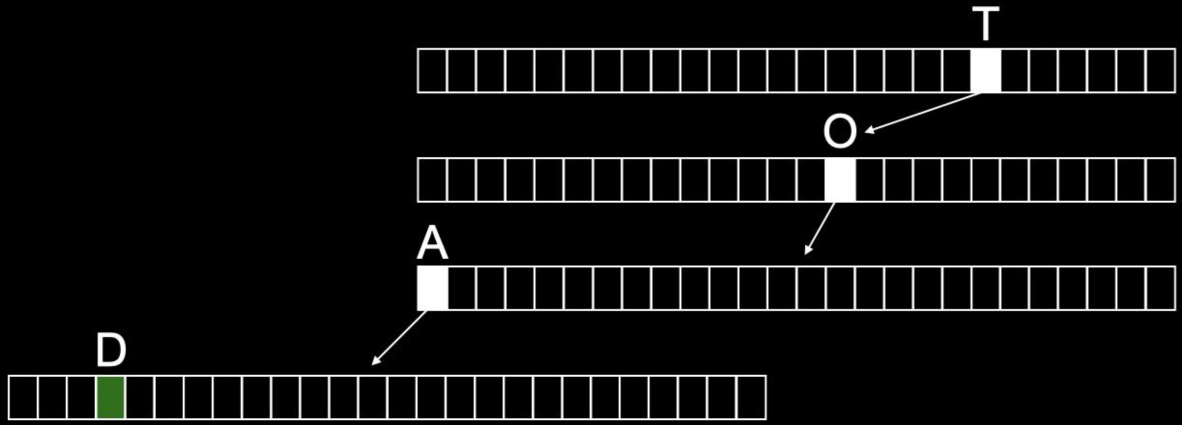
tries

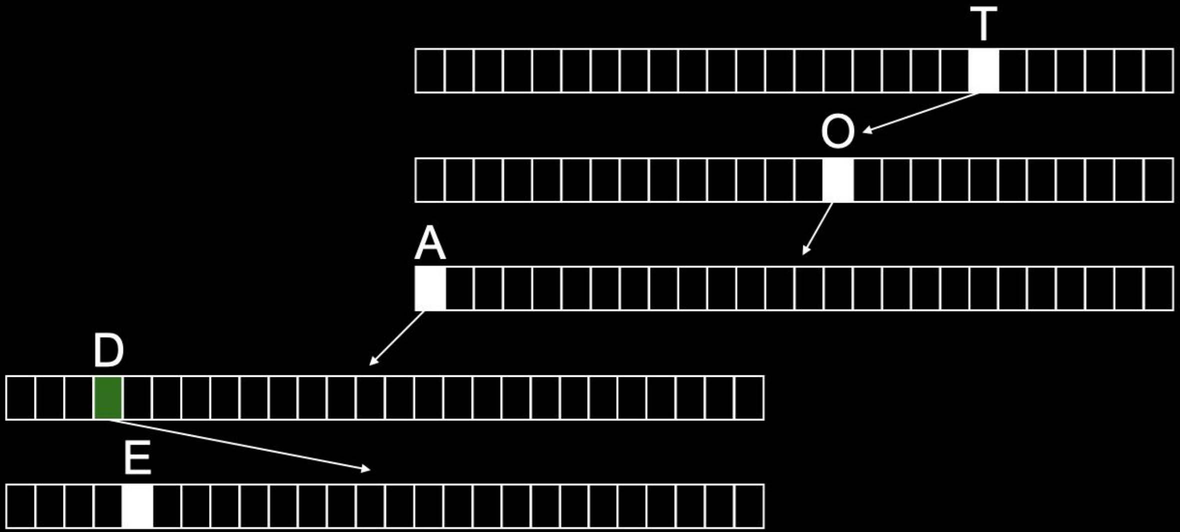
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

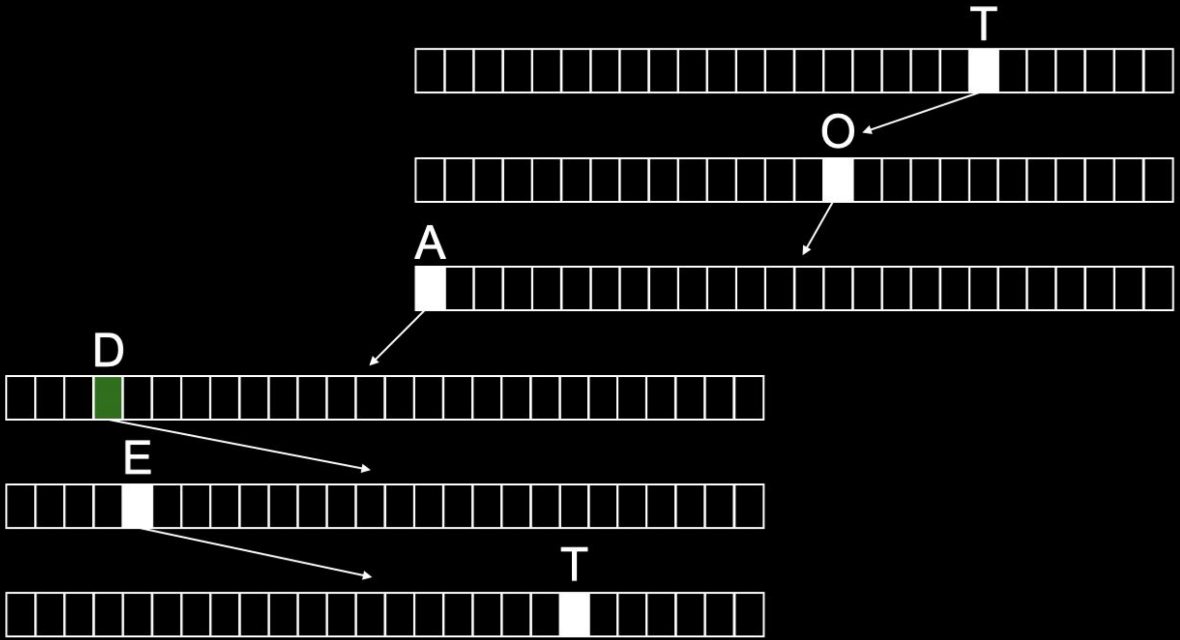

T

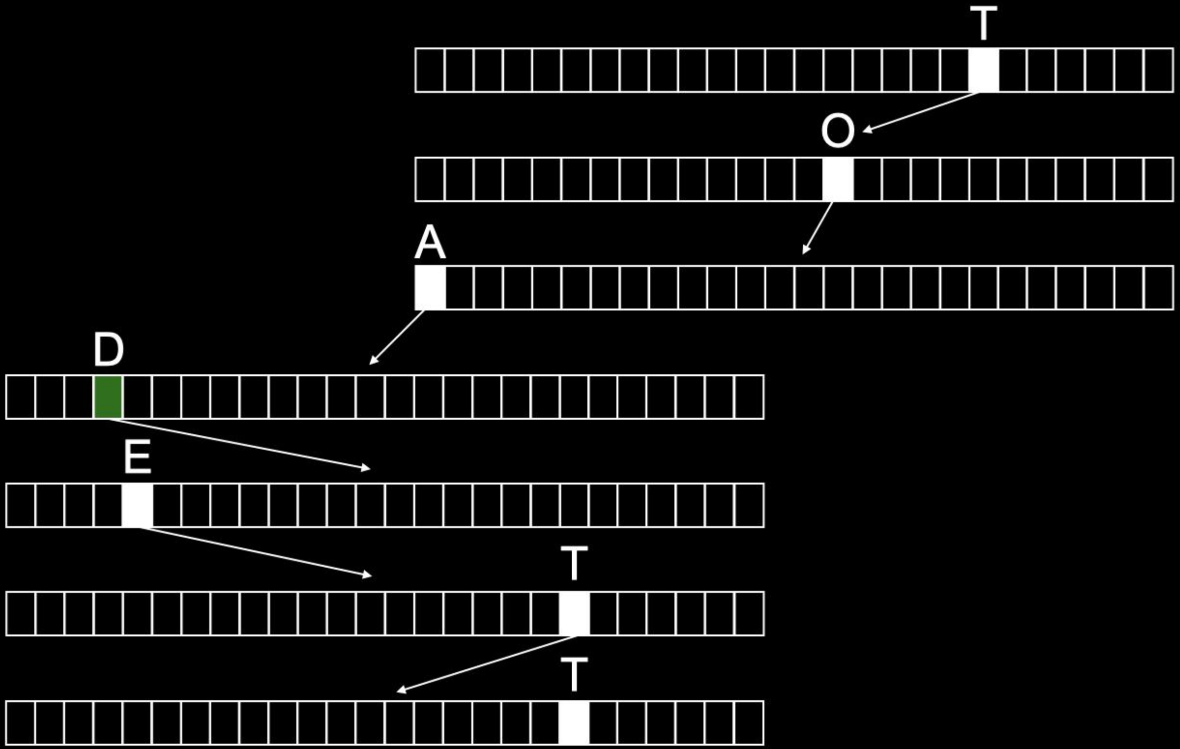

T
O


T
O
A


T
O
A
D


T
O
A
D
E


T
O
A
D
E
T


T
O
A
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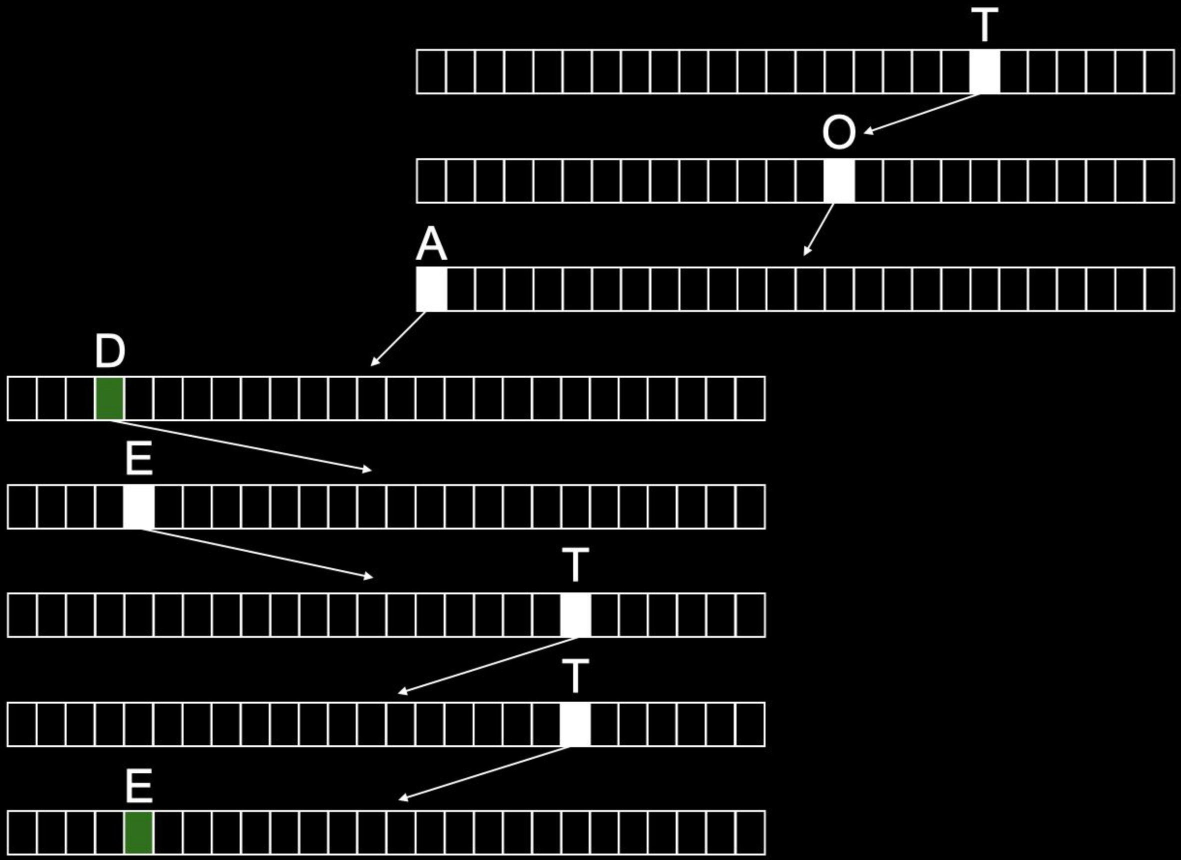
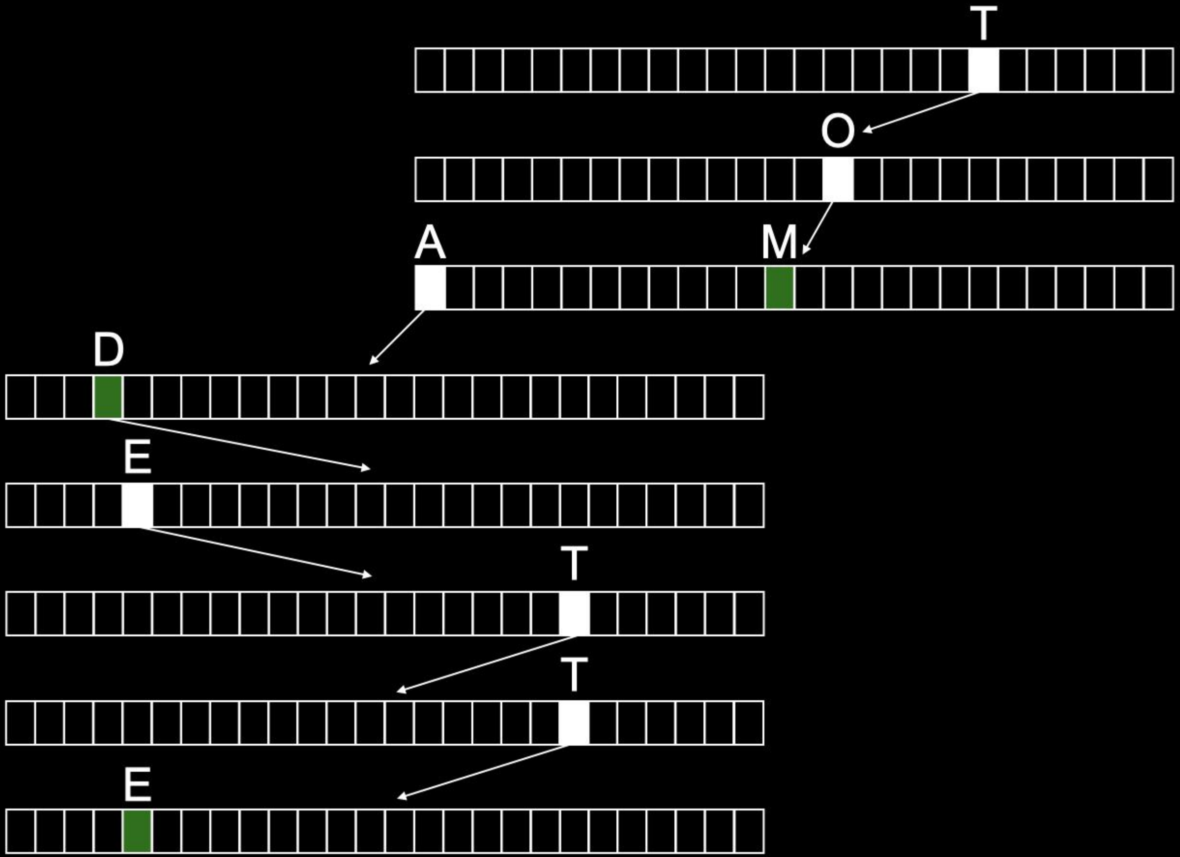
T


T
O
A
D
E
T
T
E


T
O
A
M
D
E
T
T
E

```
typedef struct node
{
    struct node *children[26];
    char *number;
} node;
```

```
node *trie;
```

$O(n^2)$

$O(n \log n)$

$O(n)$

$O(\log n)$

$O(1)$

ICK ME UP
ServSafe
ServSafe
Safety And First-aid Education
FOOD ESTABLISHMENT PERMIT
CHOKING
B
C
D
E
F
G
H
I
K
L
M
N
O
P
Q
R
T
U-
V
W
X
Y
Z

This is CS50