This is CS50

```
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;
    *y = 13;
}
```

```
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;
    *y = 13;
}
```

```
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;
    *y = 13;
}
```

```c
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;
    *y = 13;
}
```

```
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;
    *y = 13;
}
```

```
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;
    *y = 13;
}
```

```c
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;
    *y = 13;
}
```

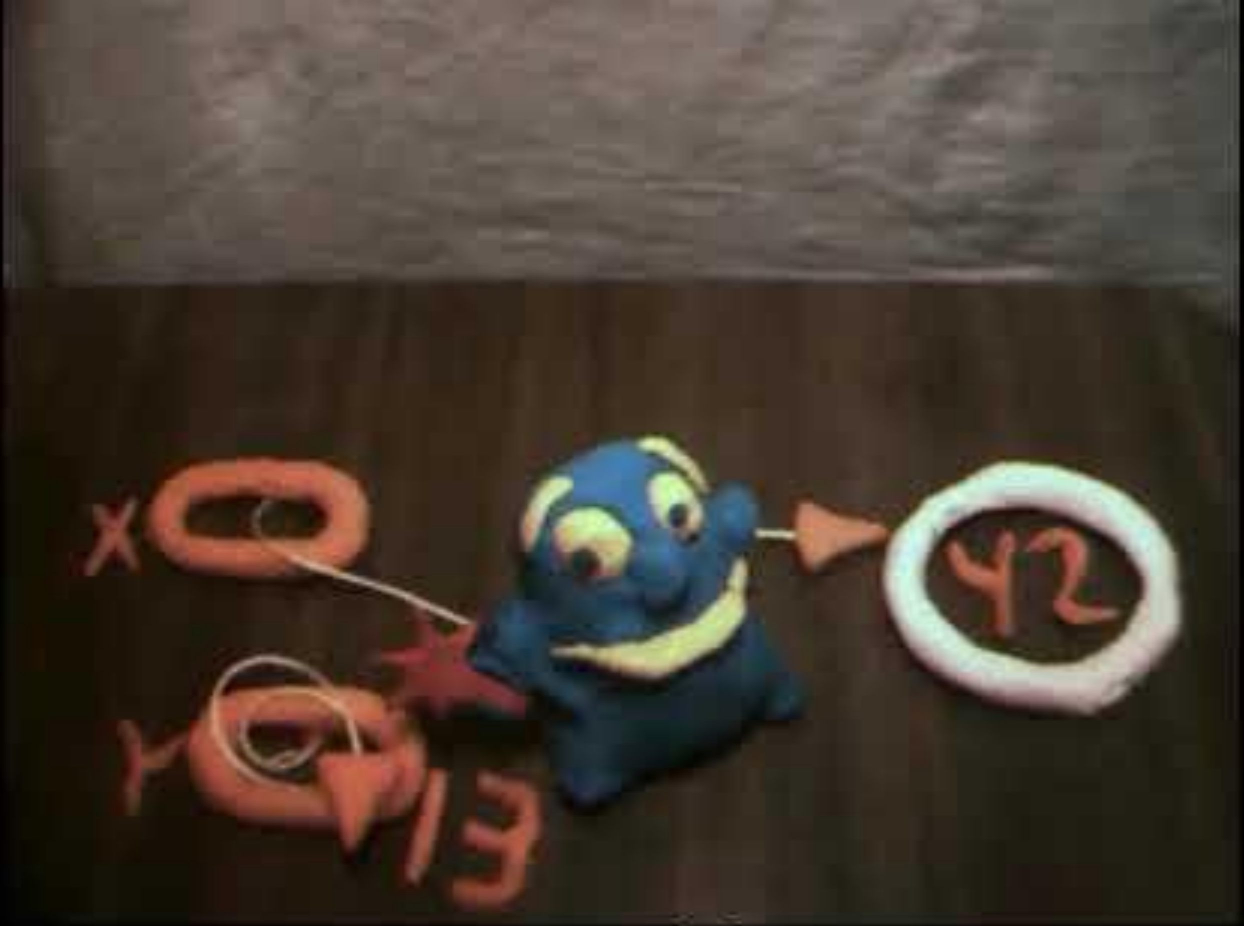
```c
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;




}
```

```
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;

    y = x;

    *y = 13;
}
```

```
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;

    y = x;

    *y = 13;
}
```

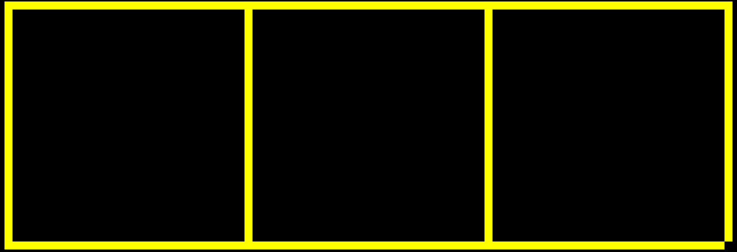
```
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;

    y = x;

    *y = 13;
}
```

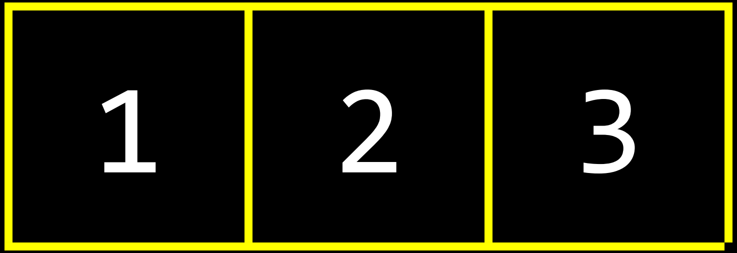
```
int main(void)
{
    int *x;
    int *y;

    x = malloc(sizeof(int));

    *x = 42;

    y = x;

    *y = 13;
}
```

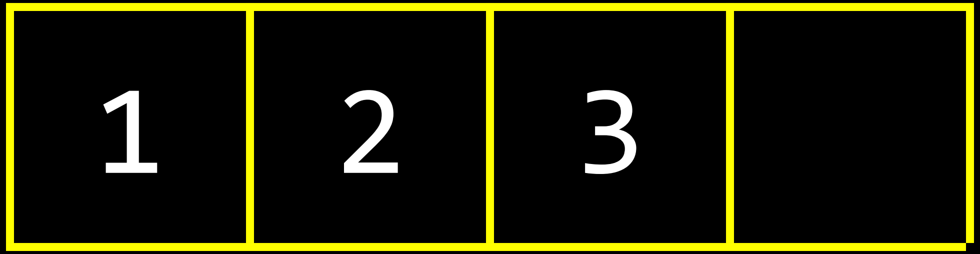


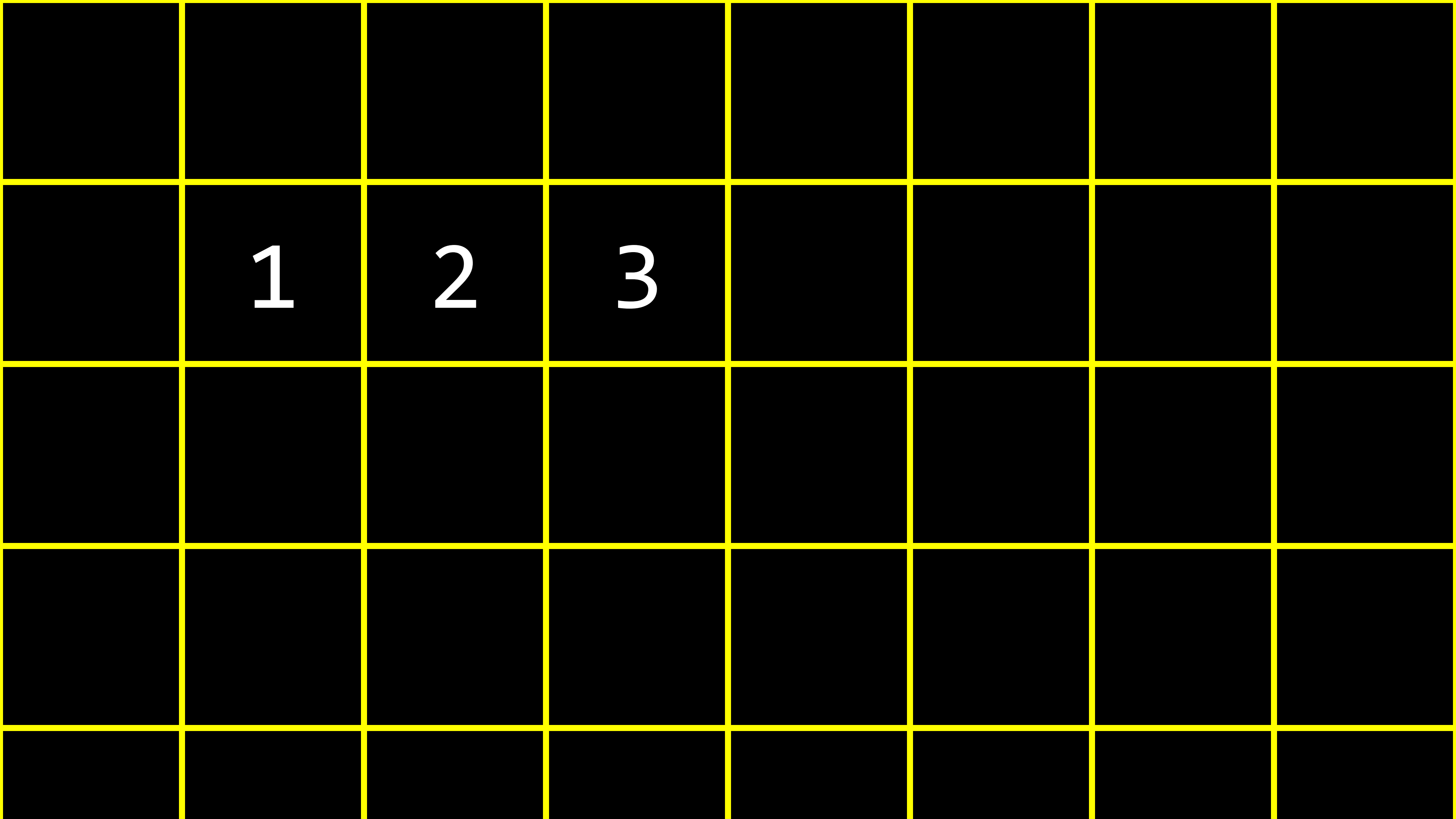
```
*y = 13;
```

arrays

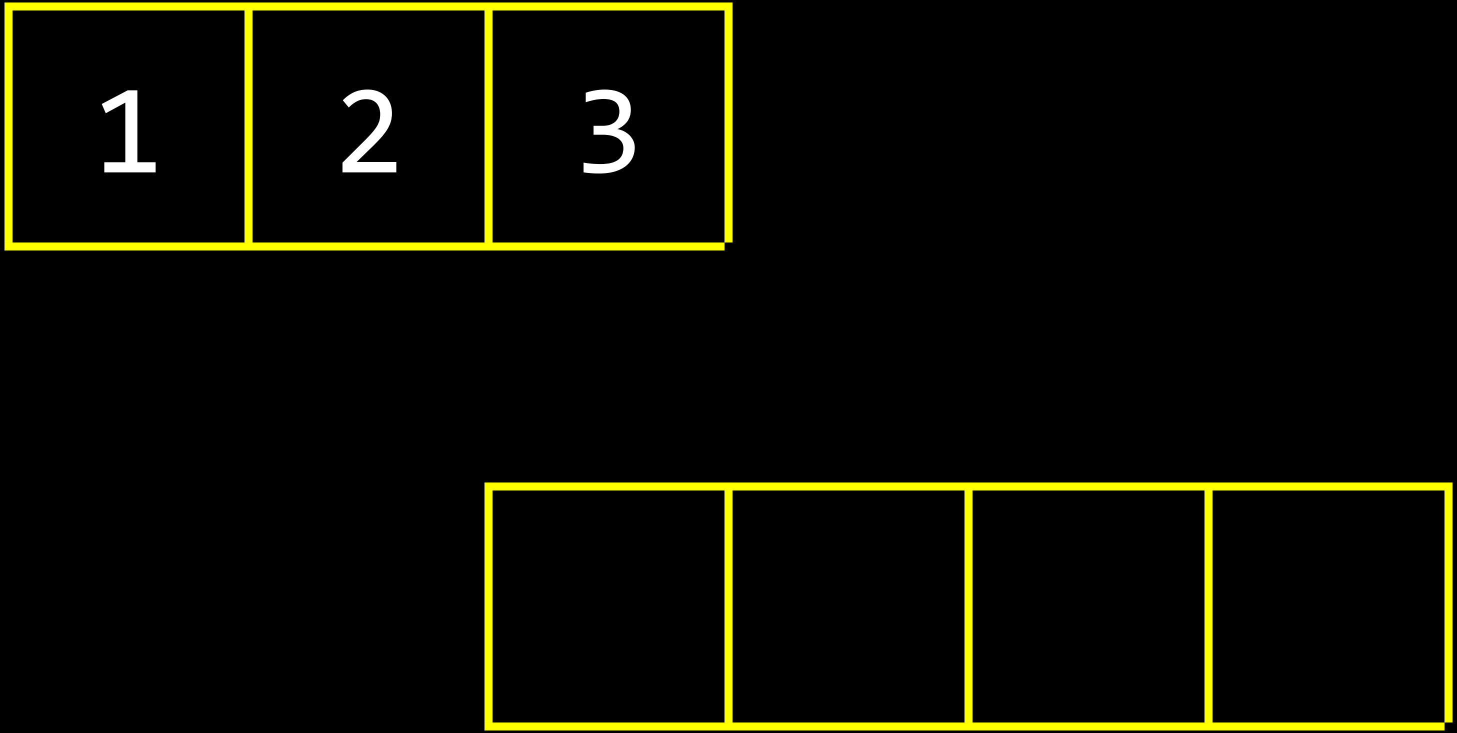


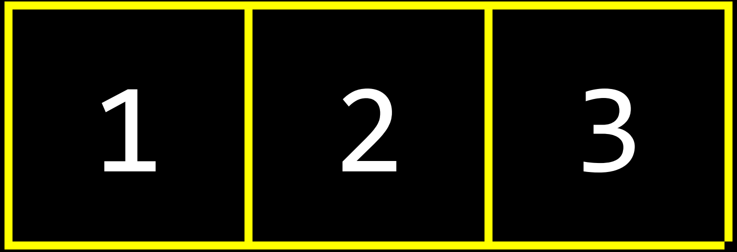
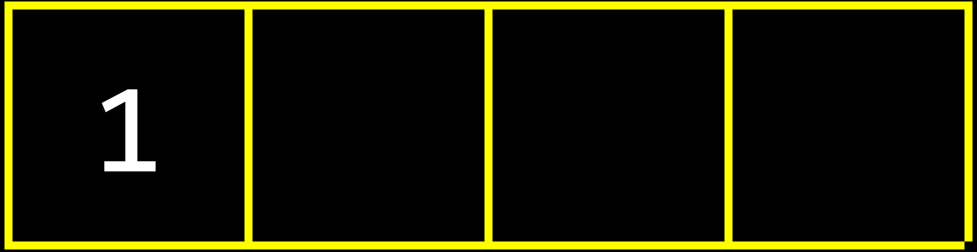

1
2
3

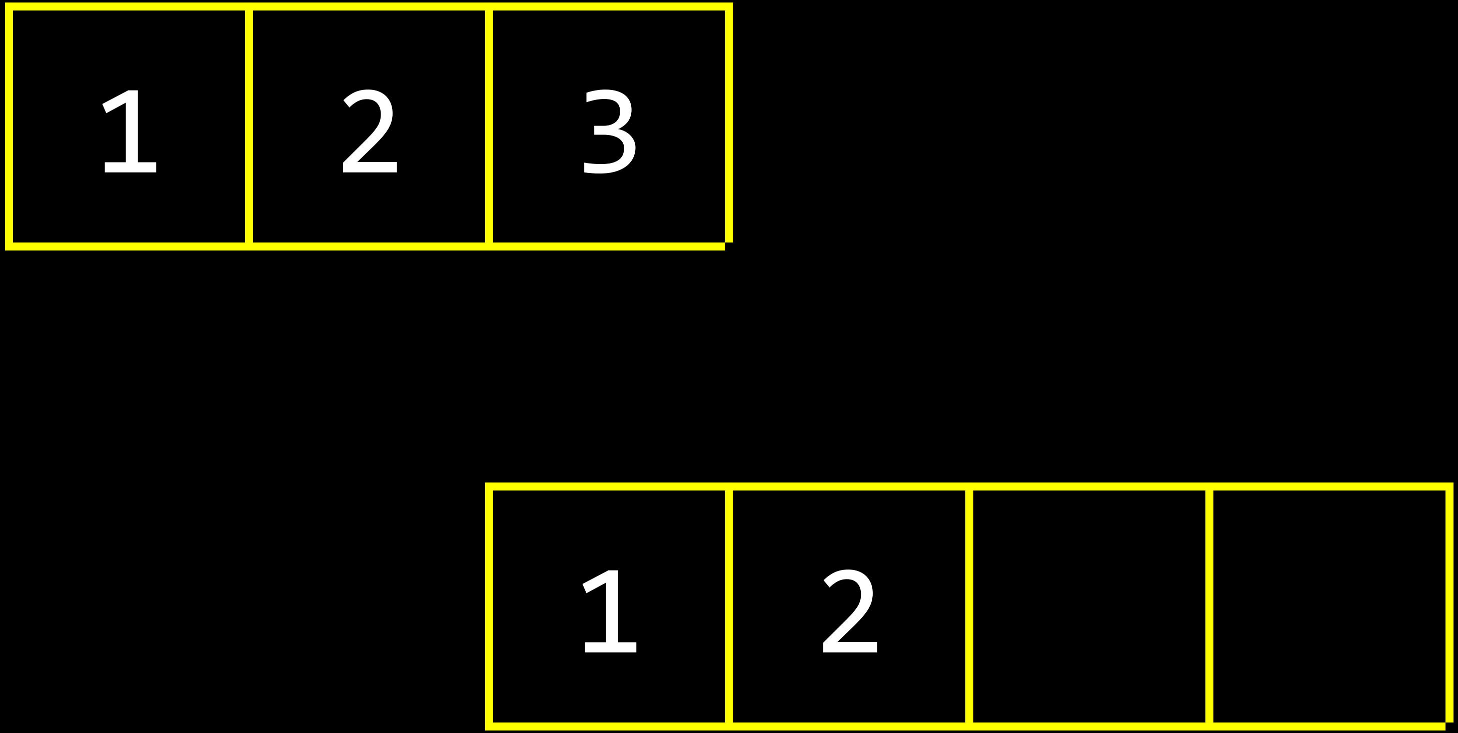

1
2
3

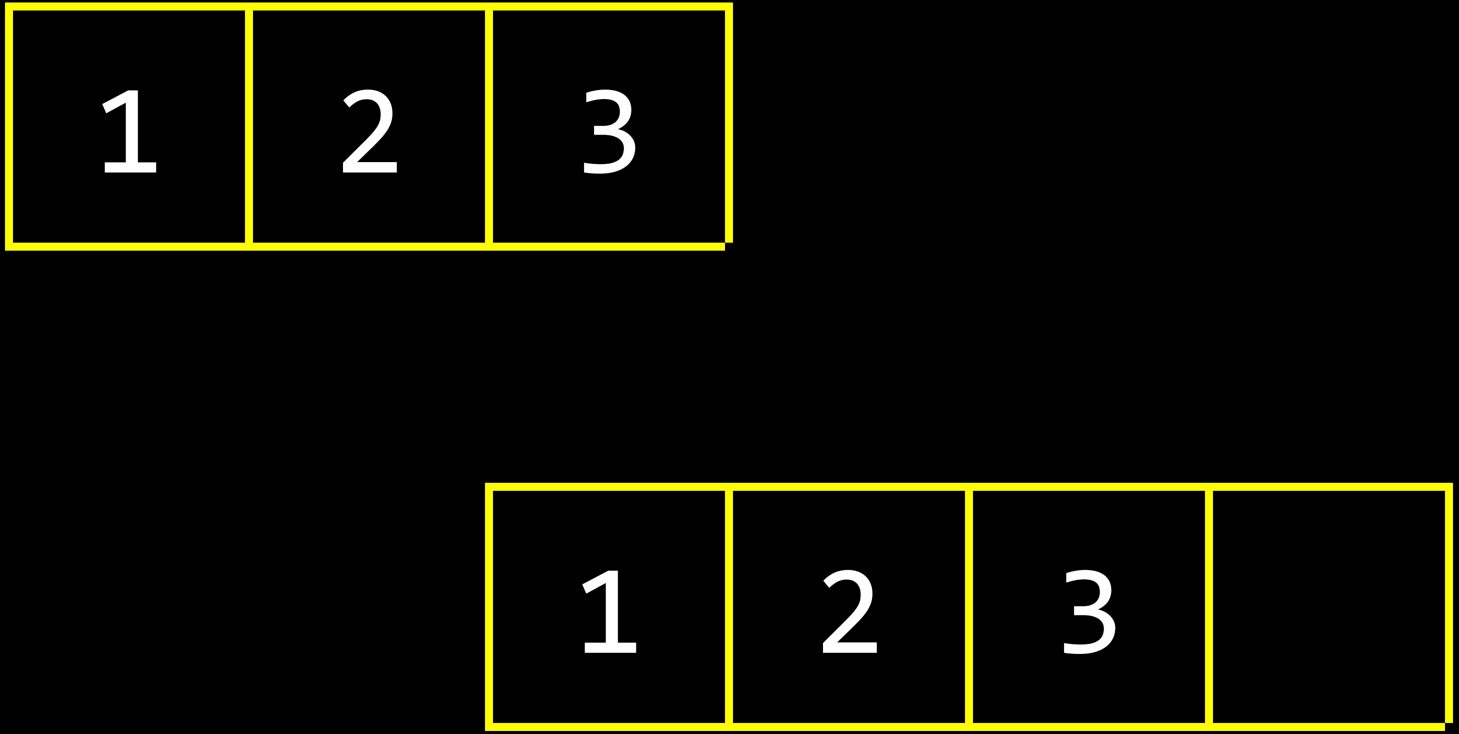

1
2
3

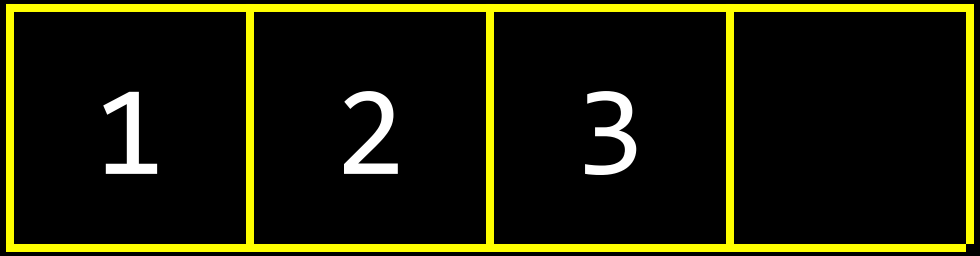
M	M	A	\0	E	M	M	A
\0	1	2	3	E	M	M	A
\0	E	M	M	A	\0	E	M
M	A	\0					

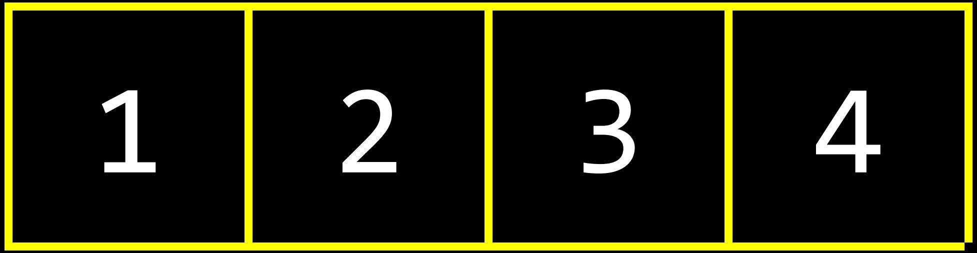

1
2
3


1
2
3

1


1
2
3
1
2


1
2
3
1
2
3


1
2
3


1
2
3
4

$O(n^2)$

$O(n \log n)$

$O(n)$

$O(\log n)$

$O(1)$

$O(n^2)$

$O(n \log n)$

$O(n)$

$O(\log n)$ search

$O(1)$

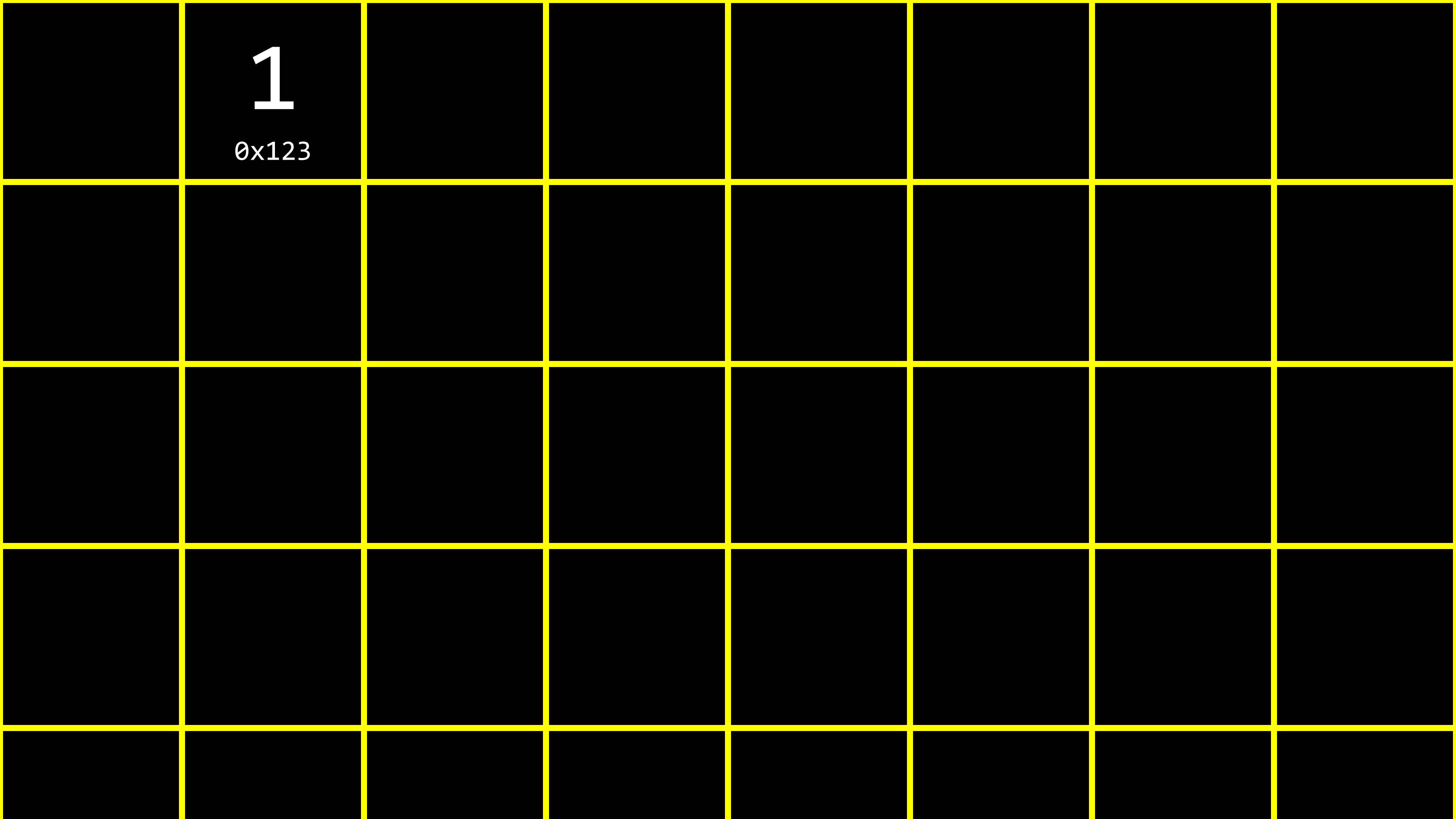
$O(n^2)$	
$O(n \log n)$	
$O(n)$	insert
$O(\log n)$	search
$O(1)$	

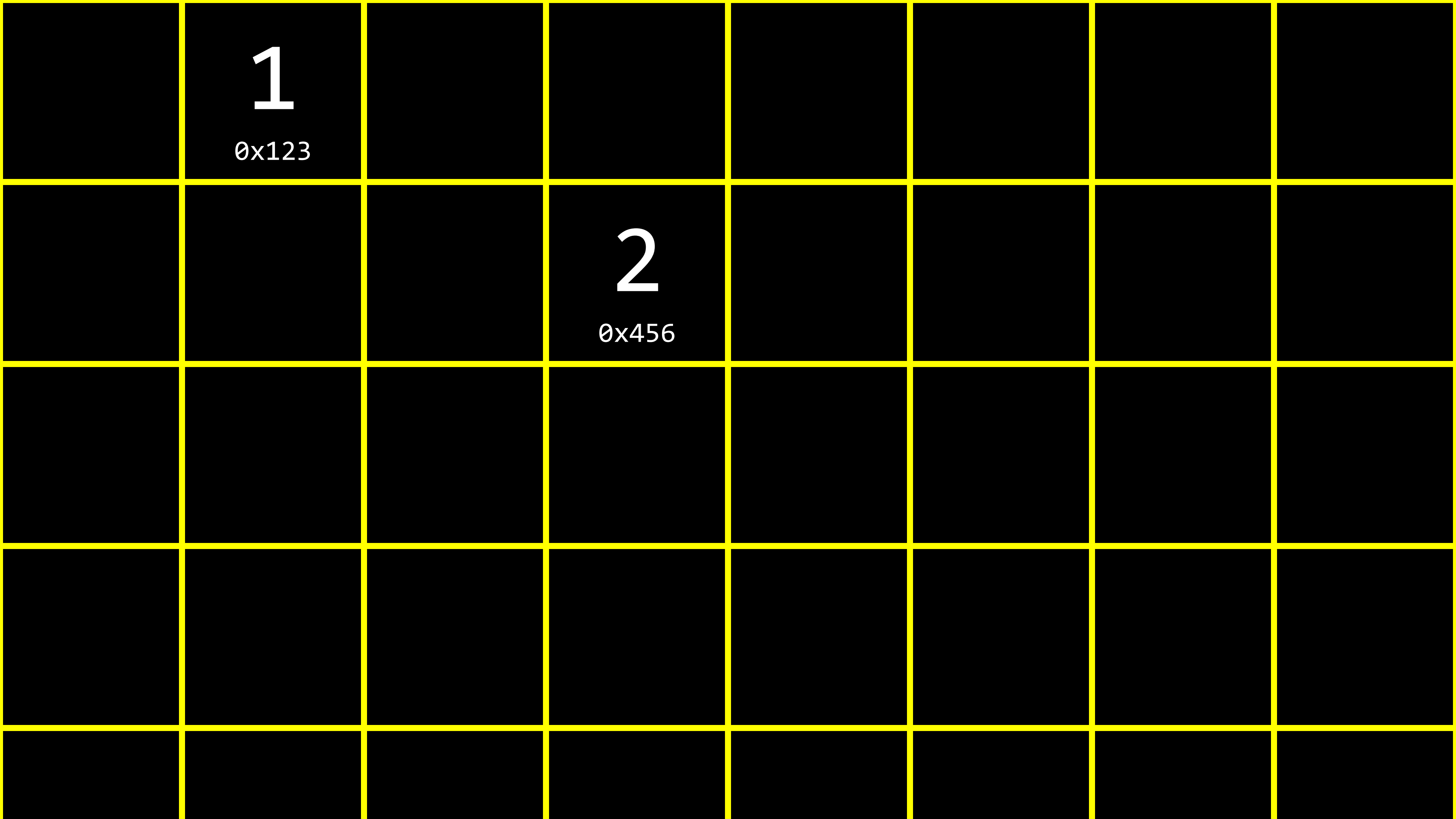
data structures

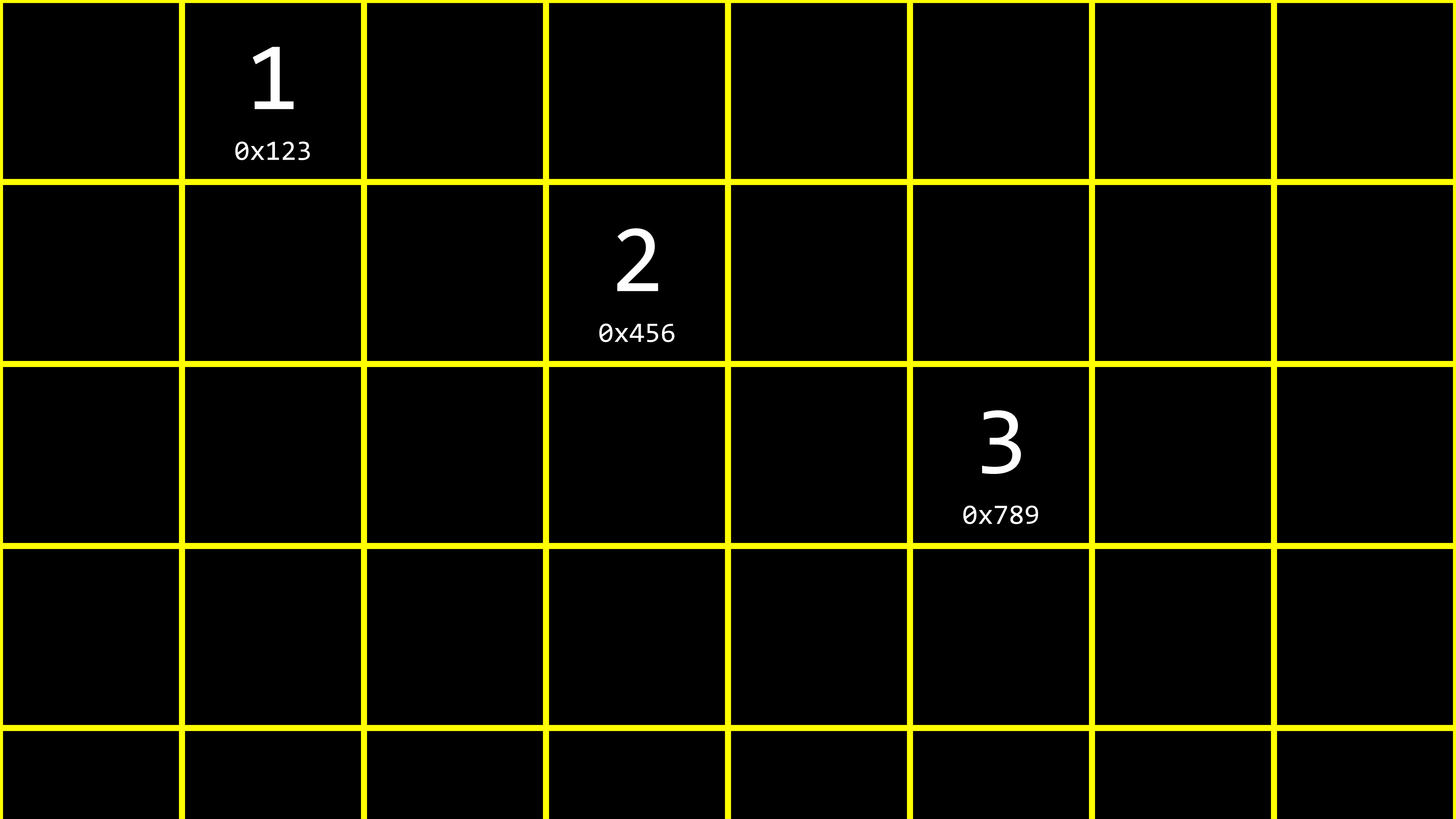
```
struct

.

*
```

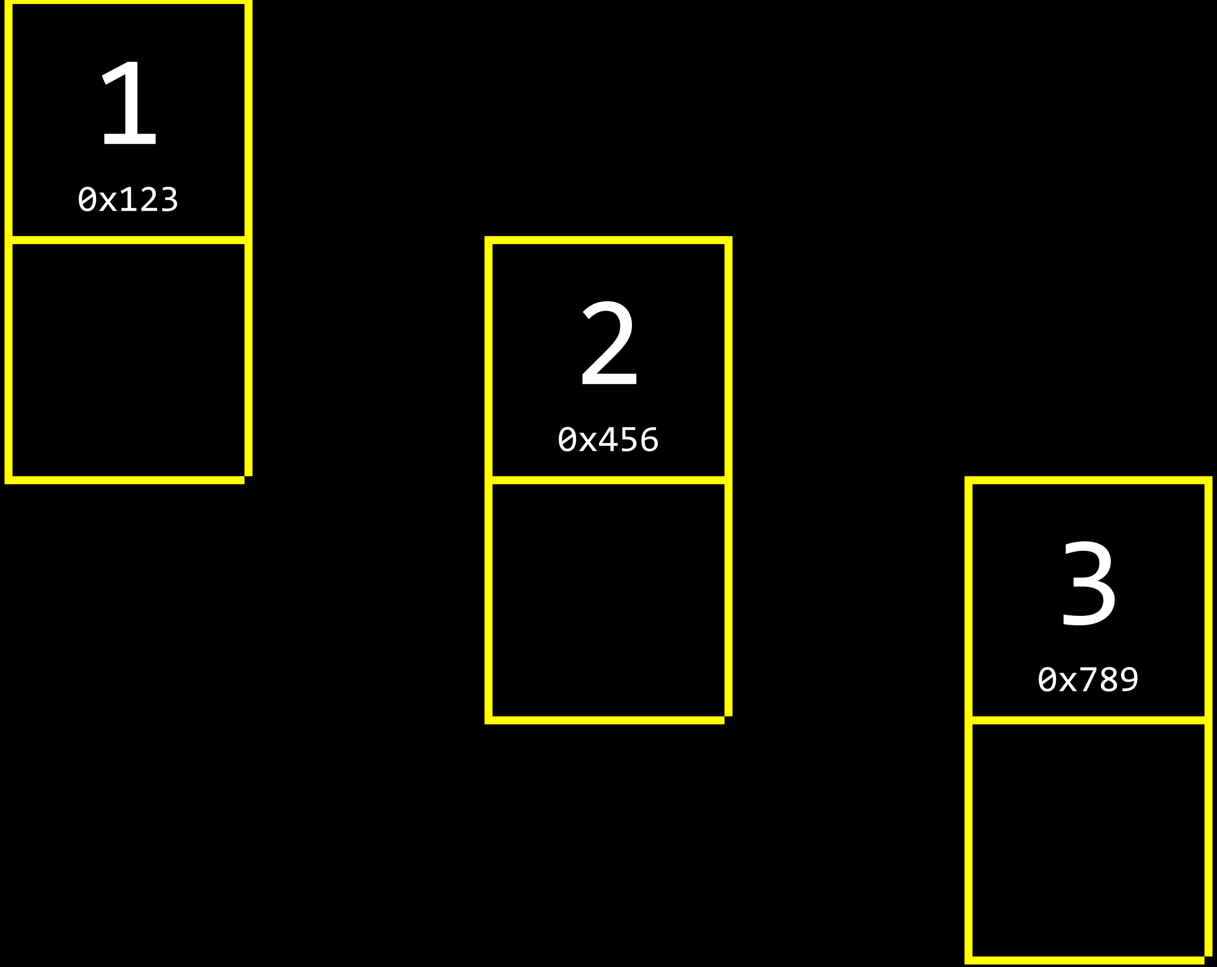
```
struct

->
```

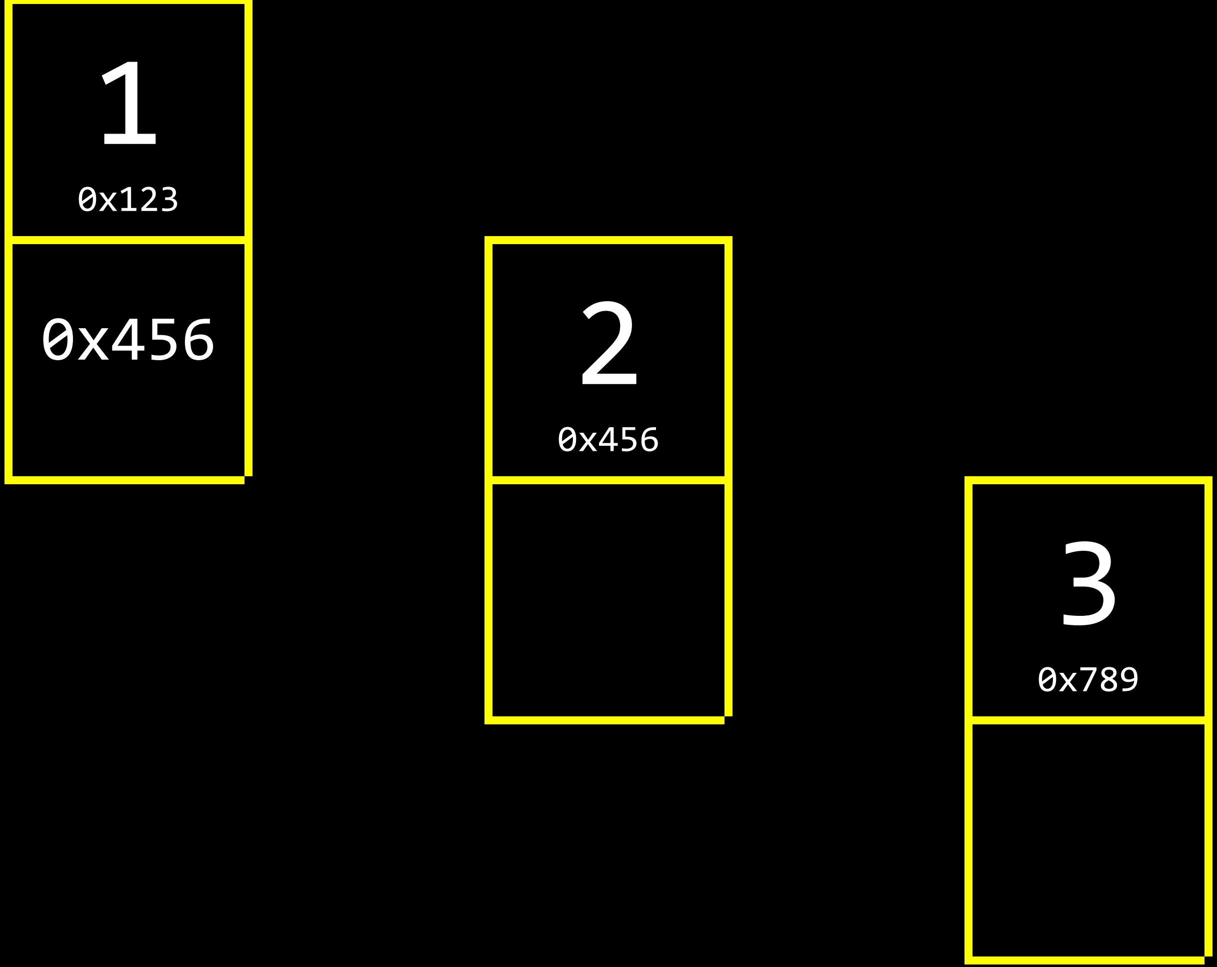
linked lists

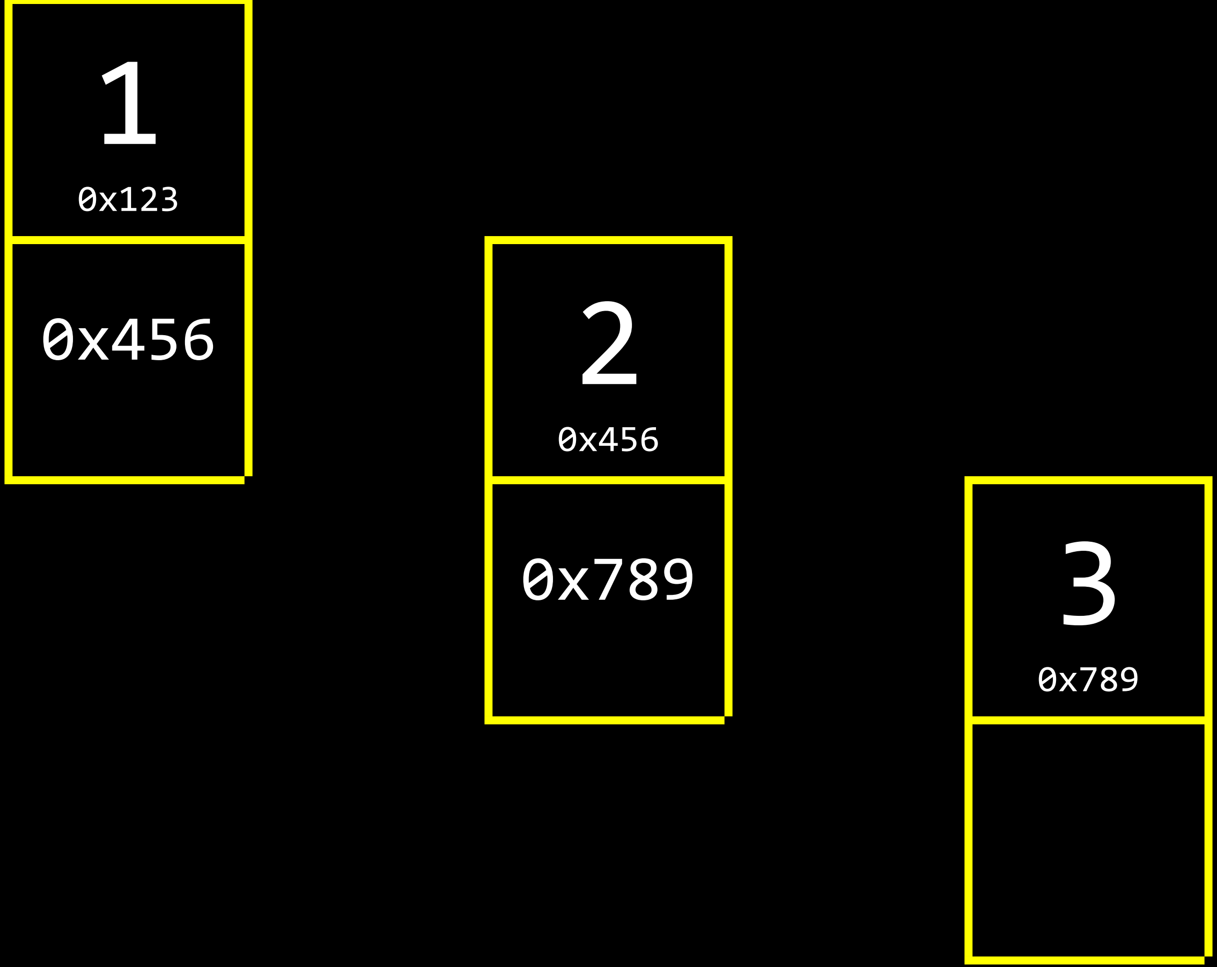

1
0x123

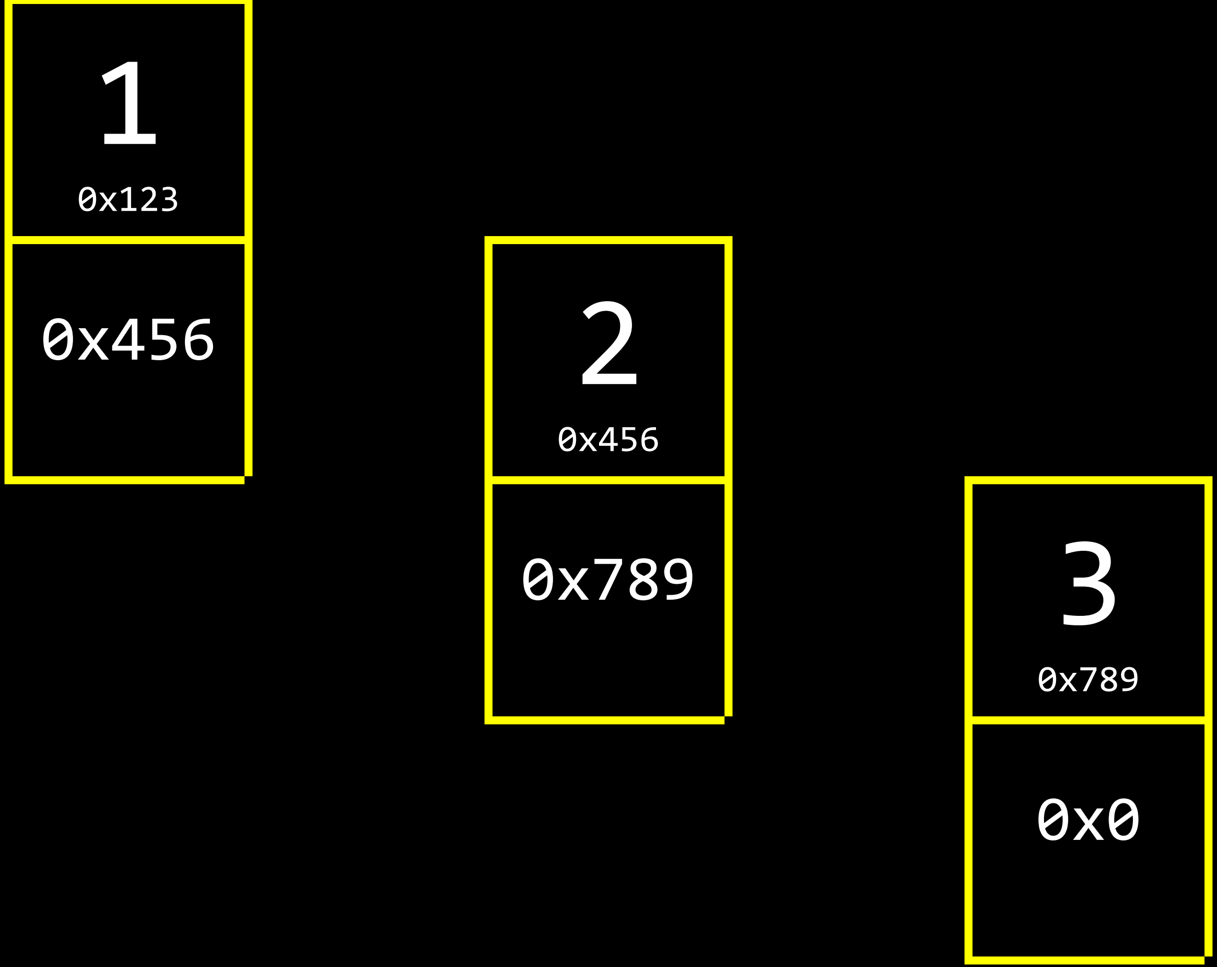

1
0x123
2
0x456

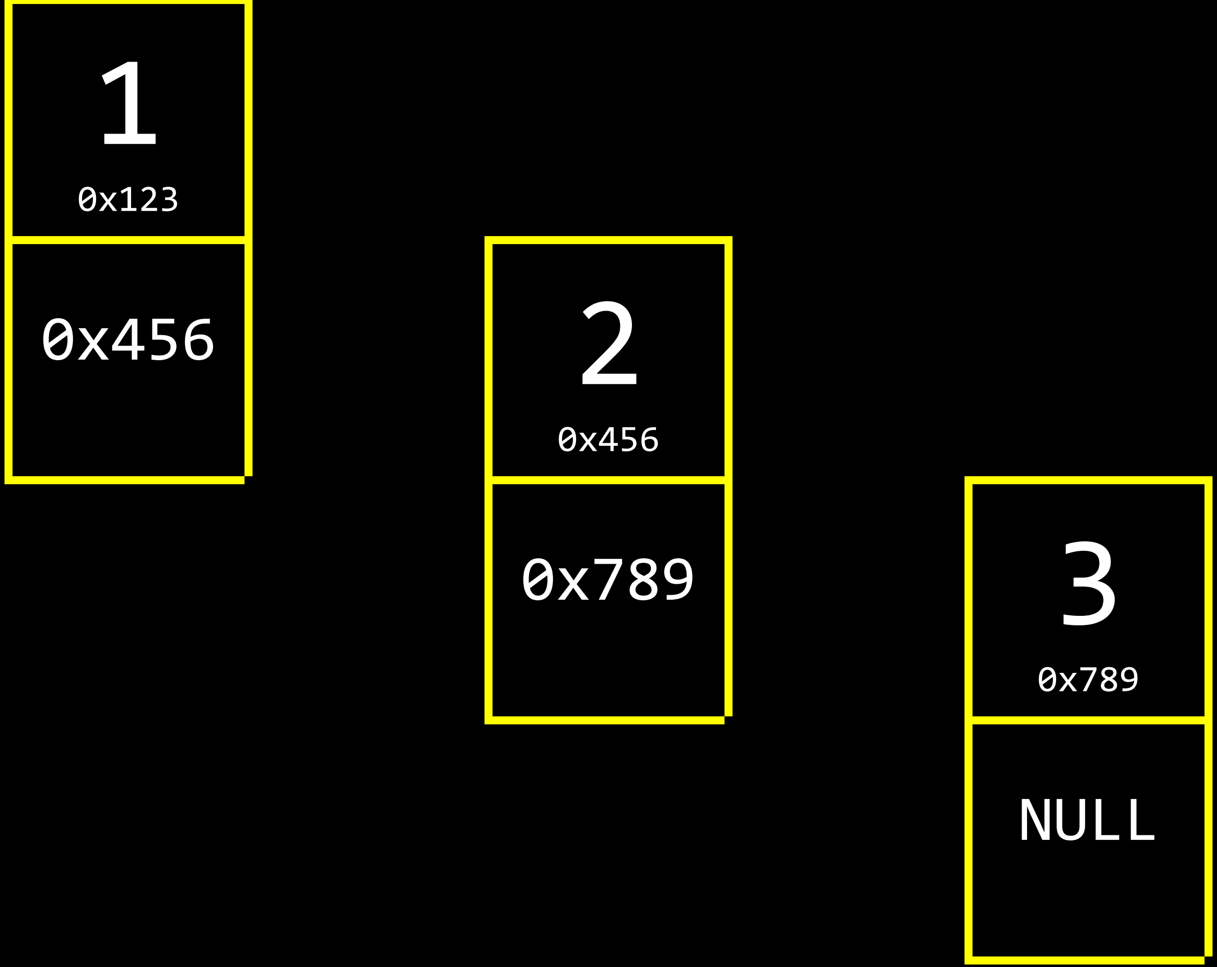

1
0x123
2
0x456
3
0x789

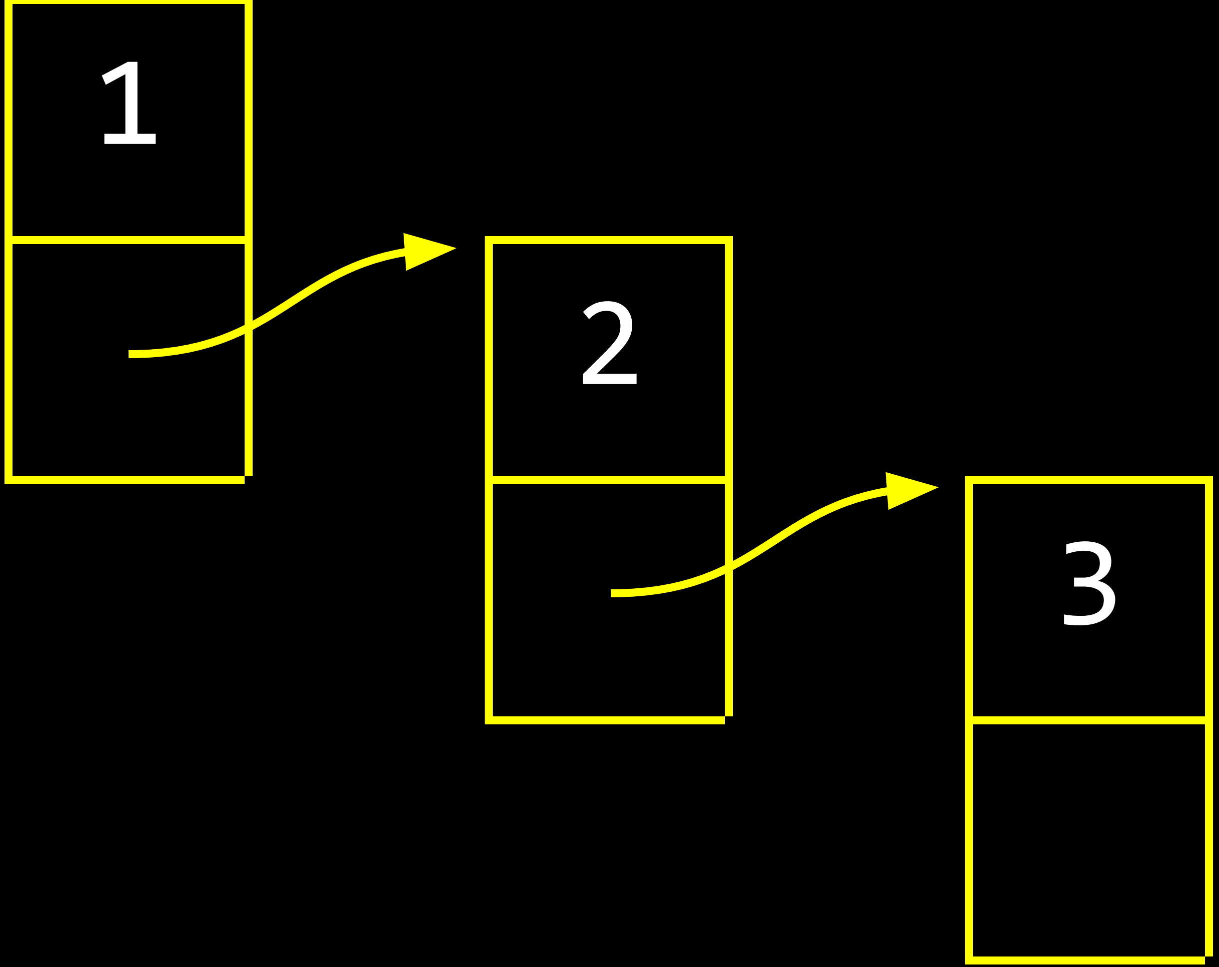

1
0x123
2
0x456
3
0x789


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


1
2
3

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

```
typedef struct
{



}
person;
```

```
typedef struct
{


}
node;
```

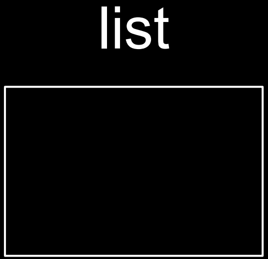
```
typedef struct
{


}
node;
```

```
typedef struct
{
    int number;

}
node;
```

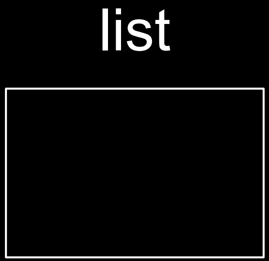
```
typedef struct
{
    int number;
    node *next;
}
node;
```

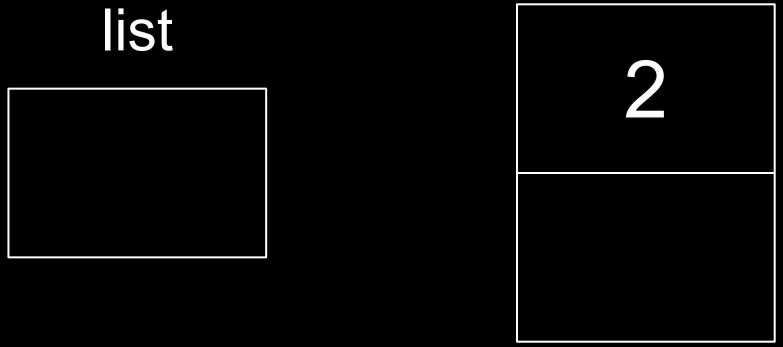
```
typedef struct node
{
    int number;
    node *next;
}
node;
```

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


list

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


list

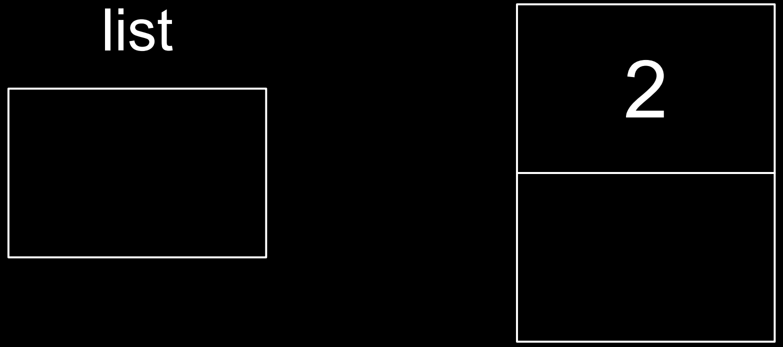

list
2

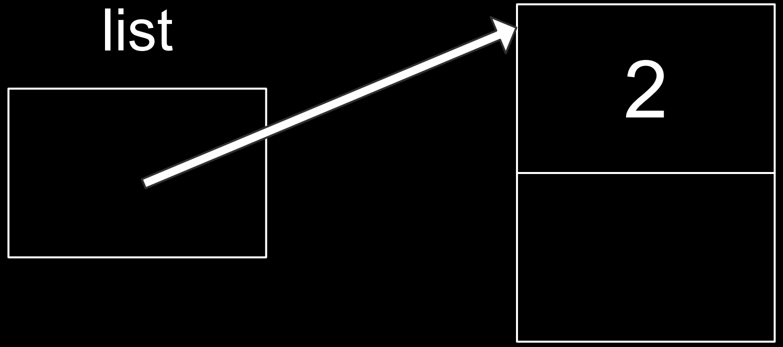
```
node *n = malloc(sizeof(node));
node *n = malloc(sizeof(node));
(*n).number = 2;
```

```
node *n = malloc(sizeof(node));
n->number = 2;
```

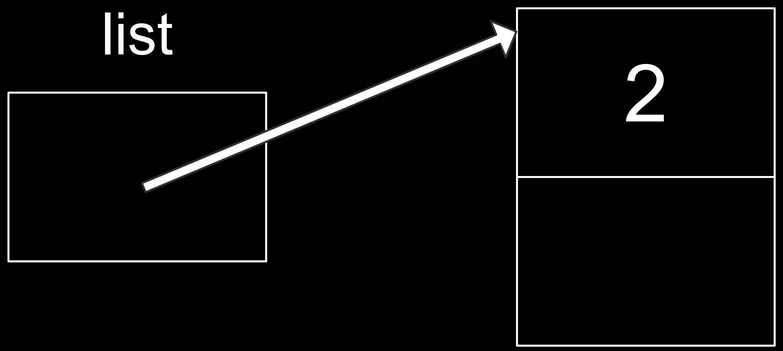
```
node *n = malloc(sizeof(node));
n->number = 2;
n->next = NULL;
```

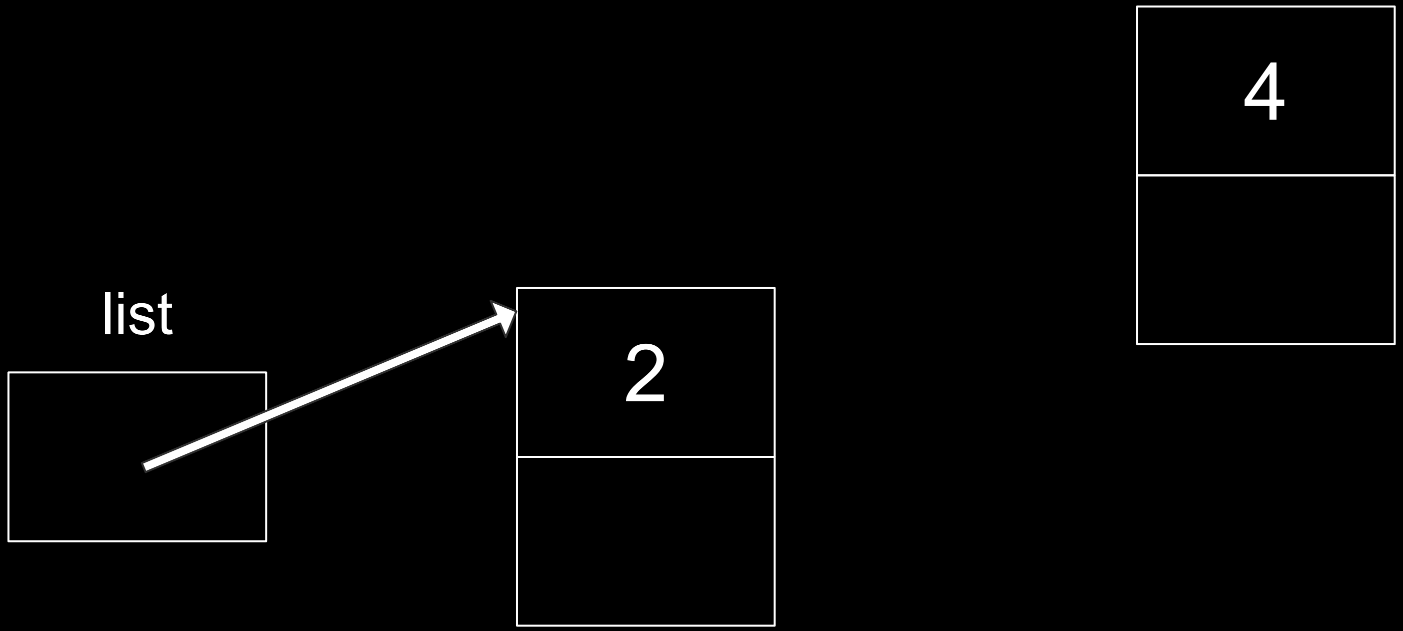
```
node *n = malloc(sizeof(node));
if (n != NULL)
{
    n->number = 2;
    n->next = NULL;
}
```


list
2

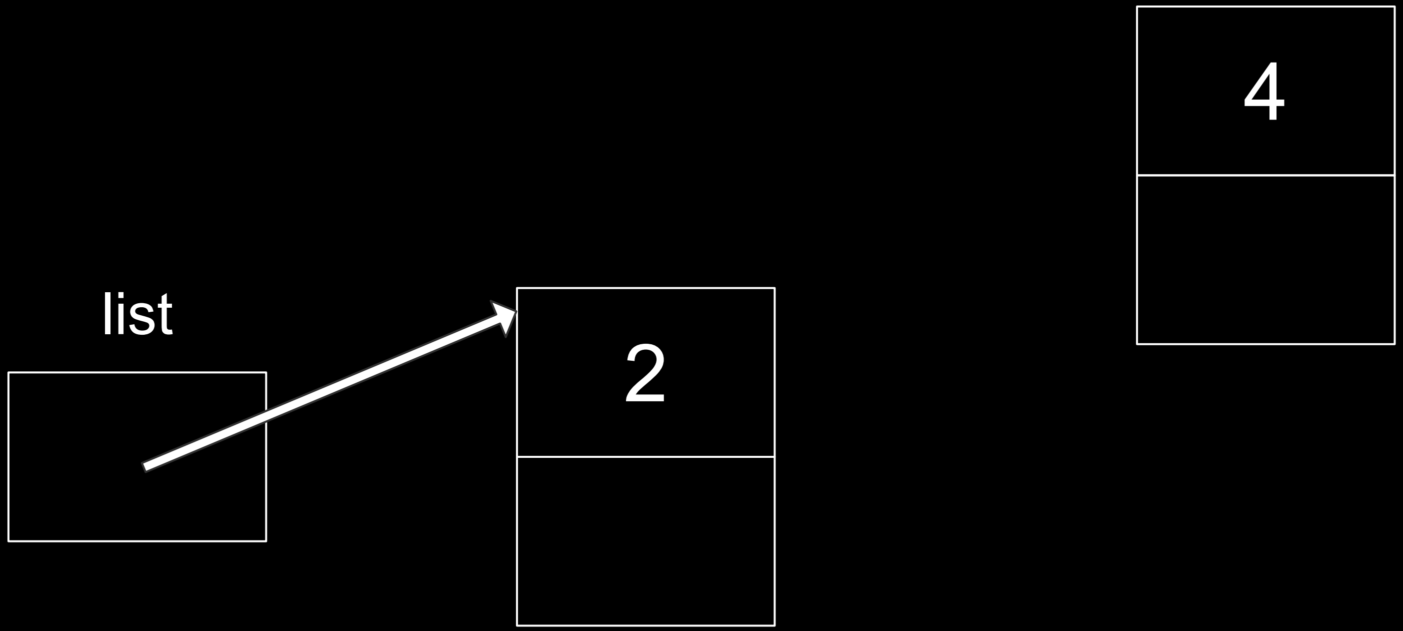

list
2

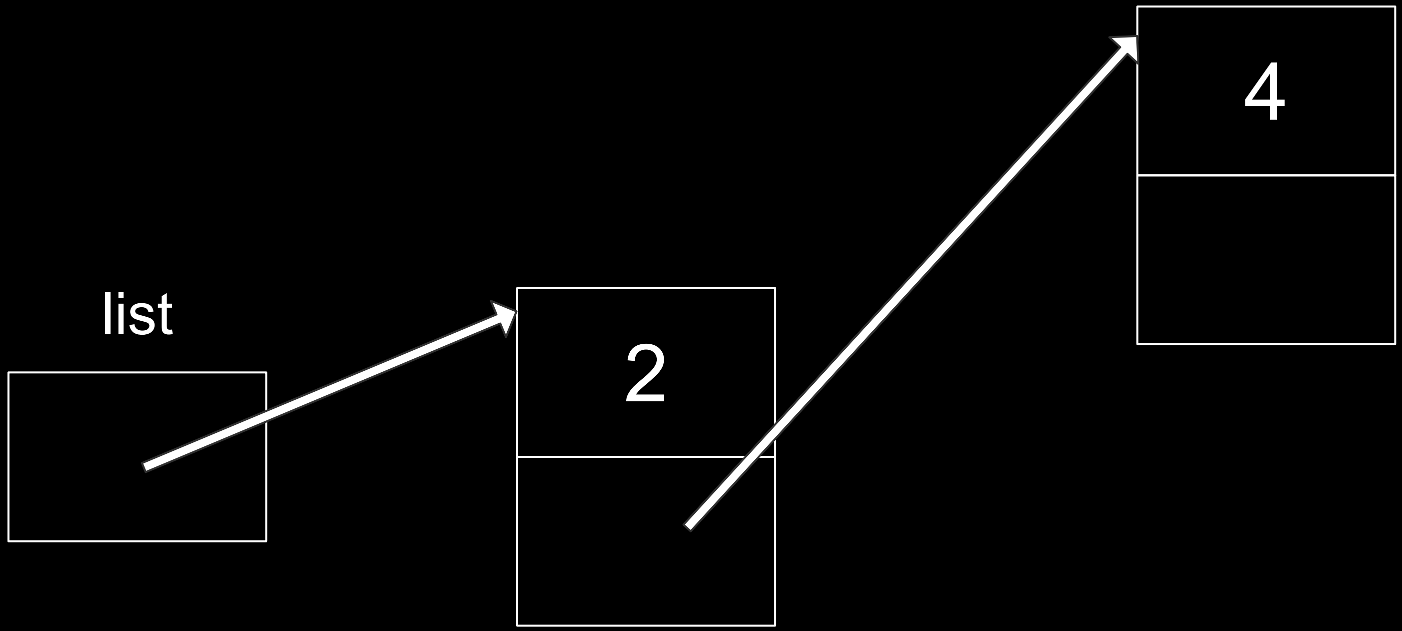
```
list = n;
```


list
2


list
2
4

```
node *n = malloc(sizeof(node));
if (n != NULL)
{
    n->number = 4;
    n->next = NULL;
}
```

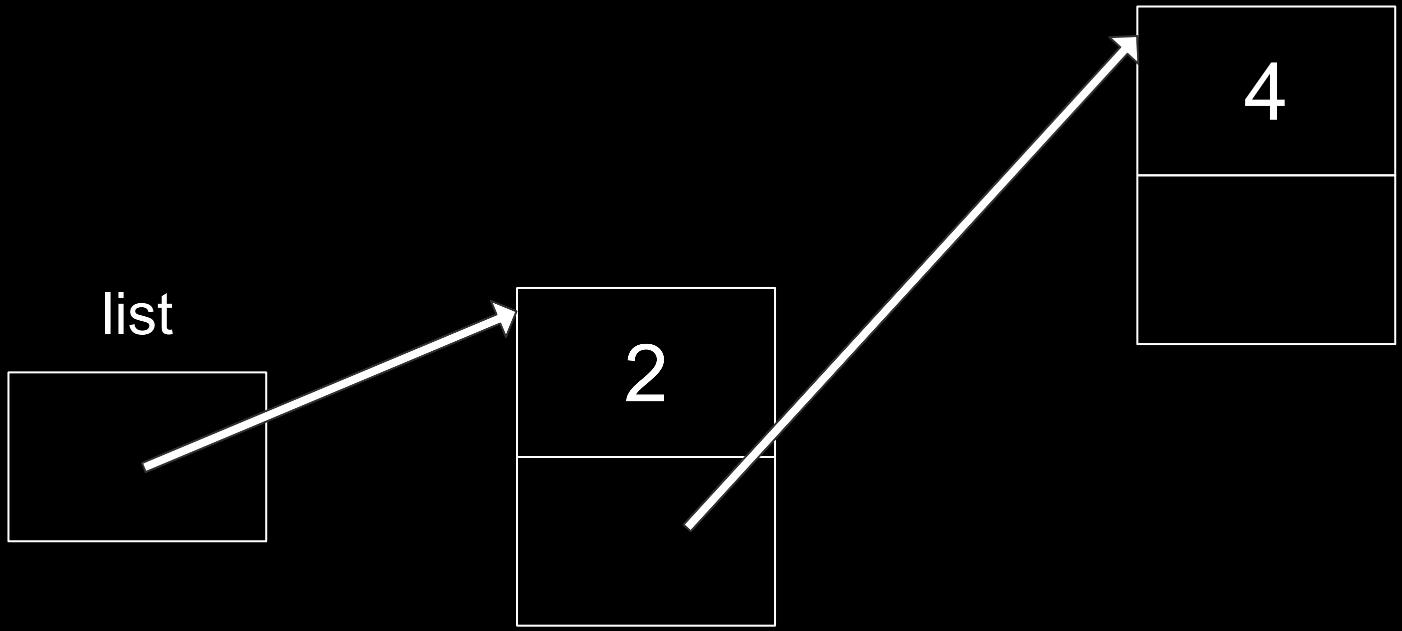

list
2
4

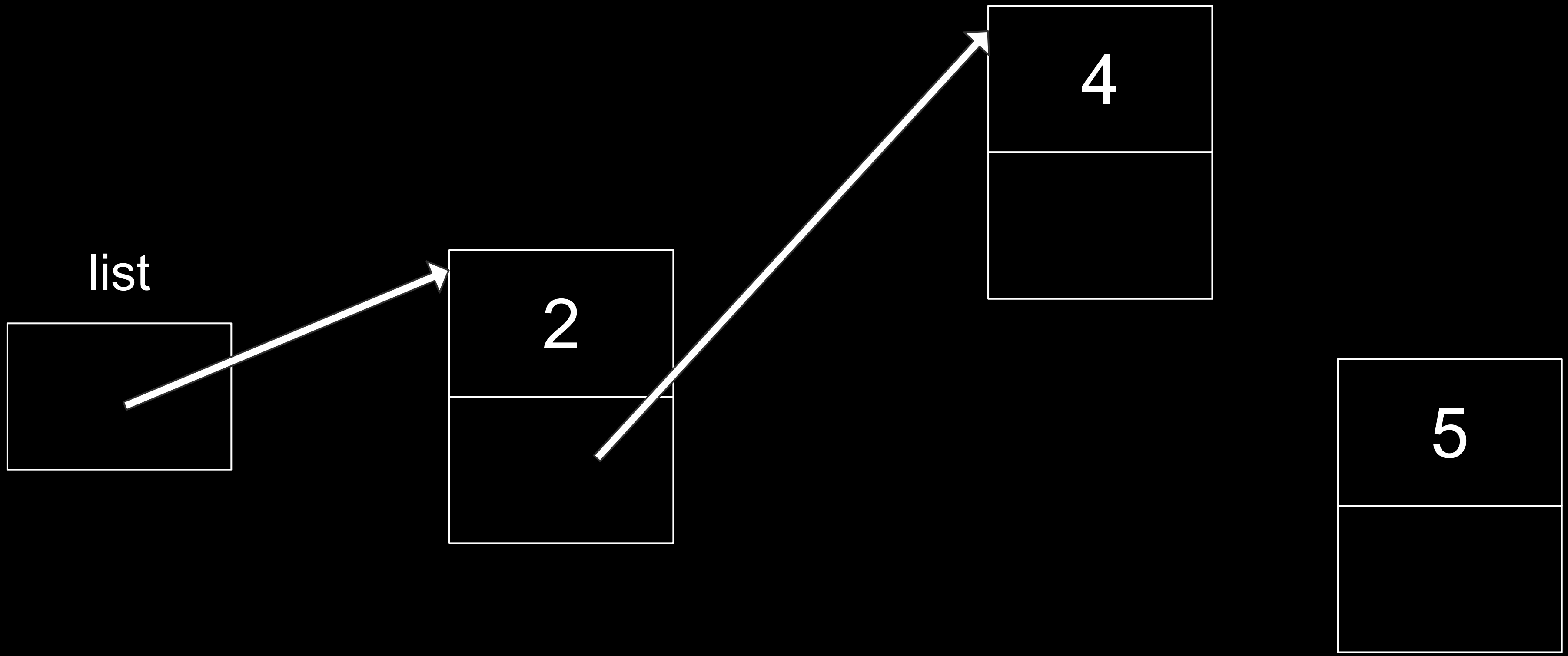

list
2
4

```
node *tmp = list;
node *tmp = list;
while (tmp->next != NULL)
{

}
```

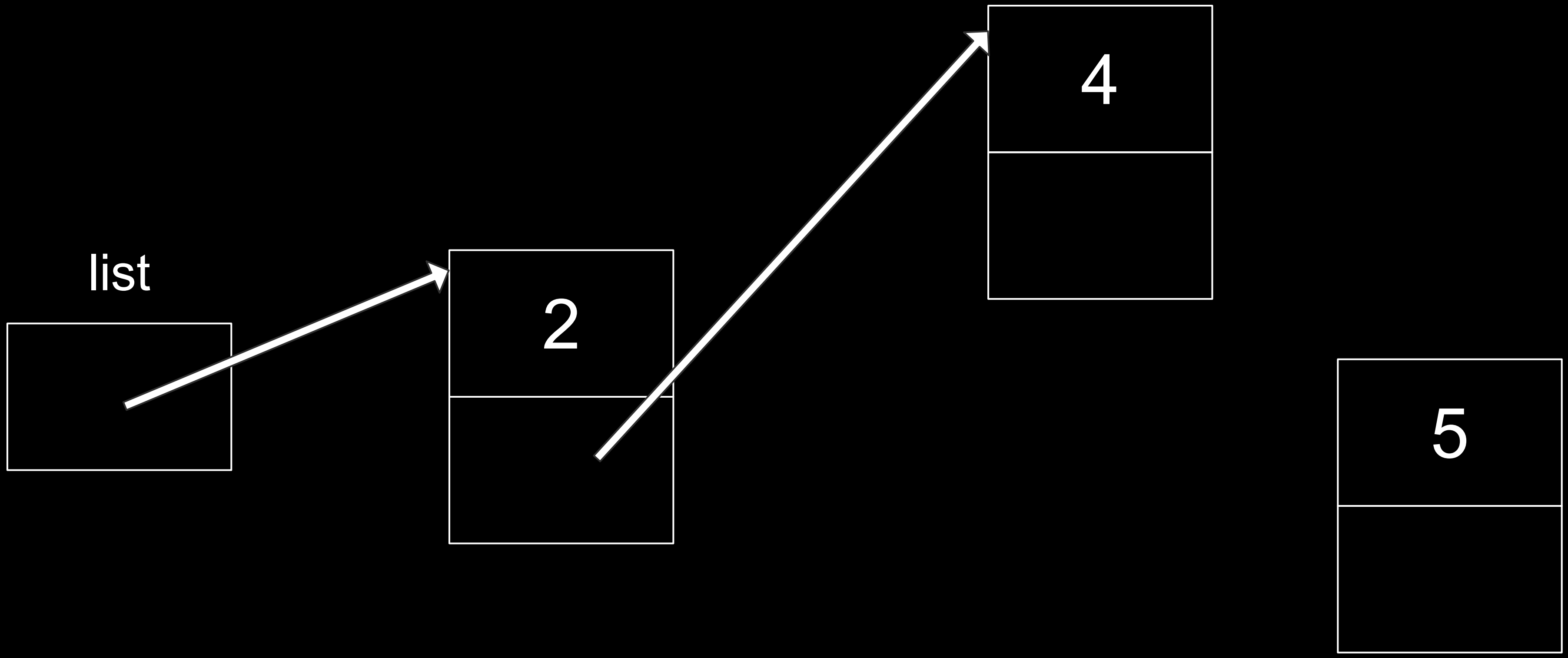
```
node *tmp = list;
while (tmp->next != NULL)
{
    tmp = tmp->next;
}
```

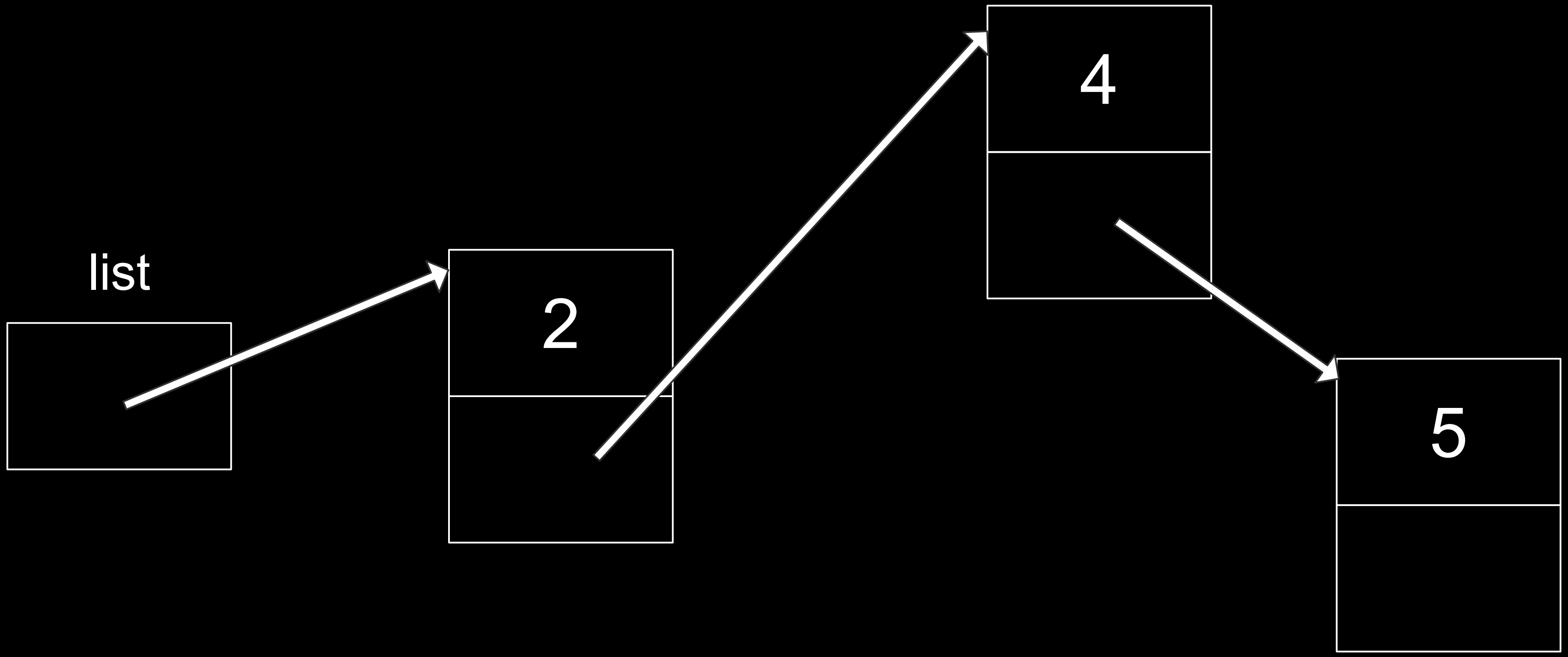
```
node *tmp = list;
while (tmp->next != NULL)
{
    tmp = tmp->next;
}
tmp->next = n;
```


list
2
4

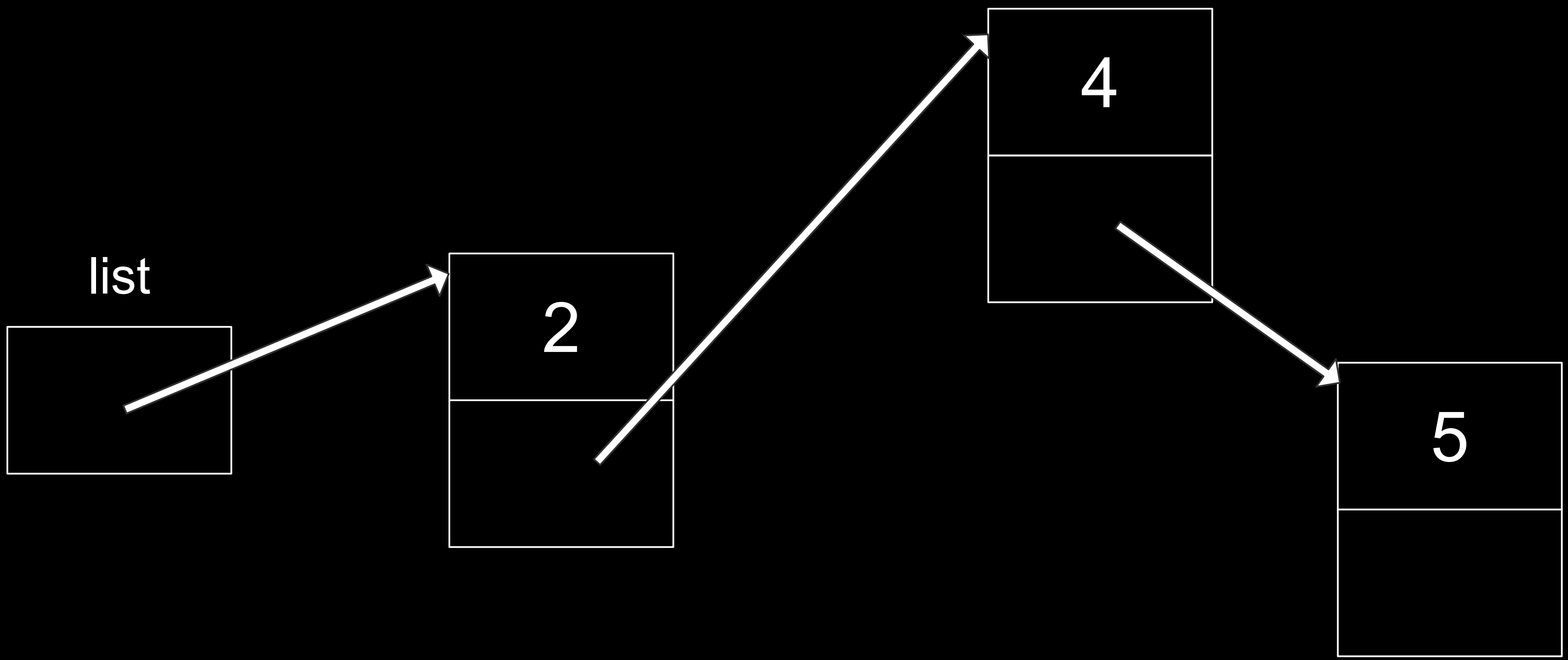

list
2
4
5

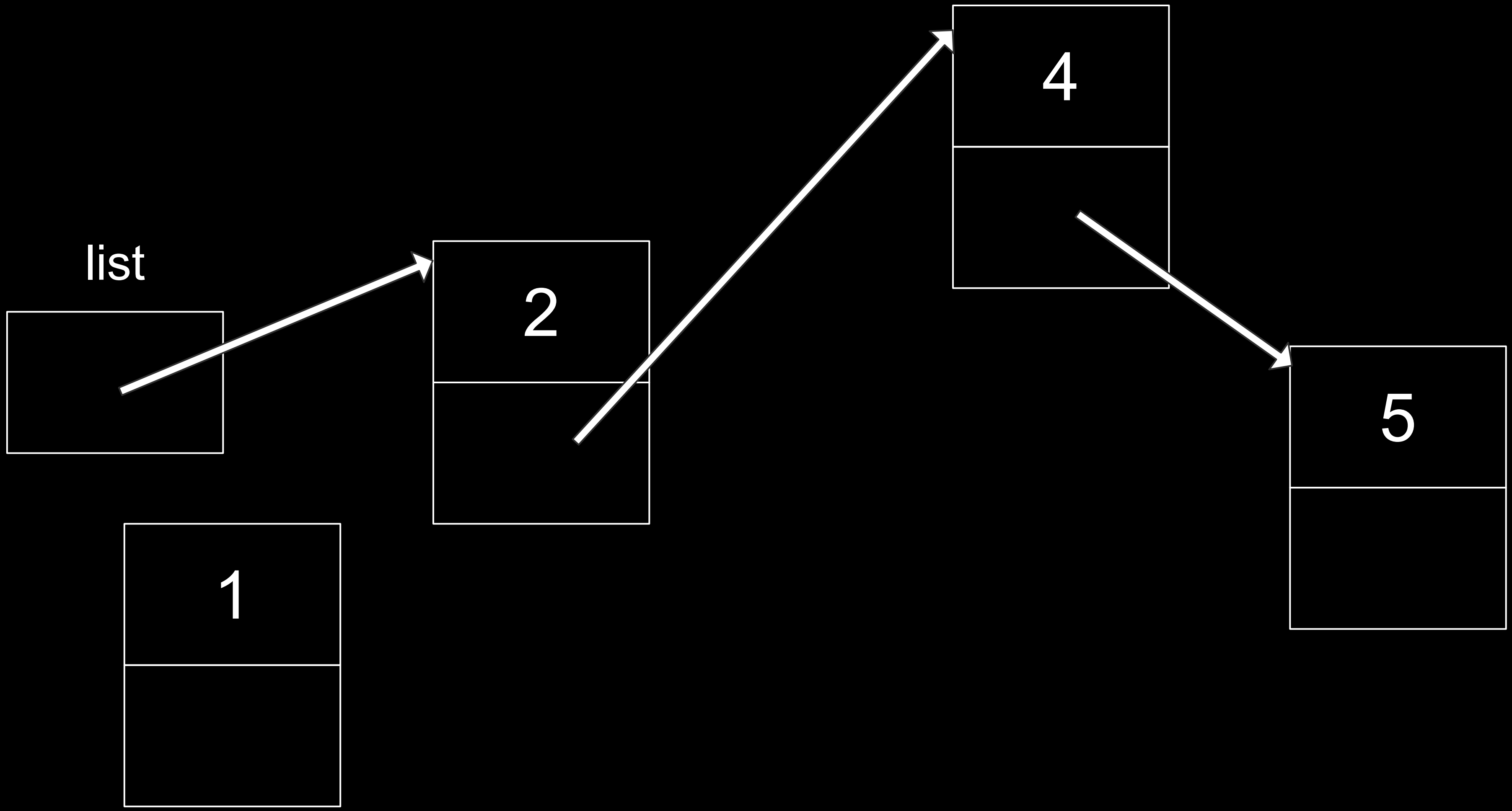
```
node *n = malloc(sizeof(node));
if (n != NULL)
{
    n->number = 5;
    n->next = NULL;
}
```


list
2
4
5

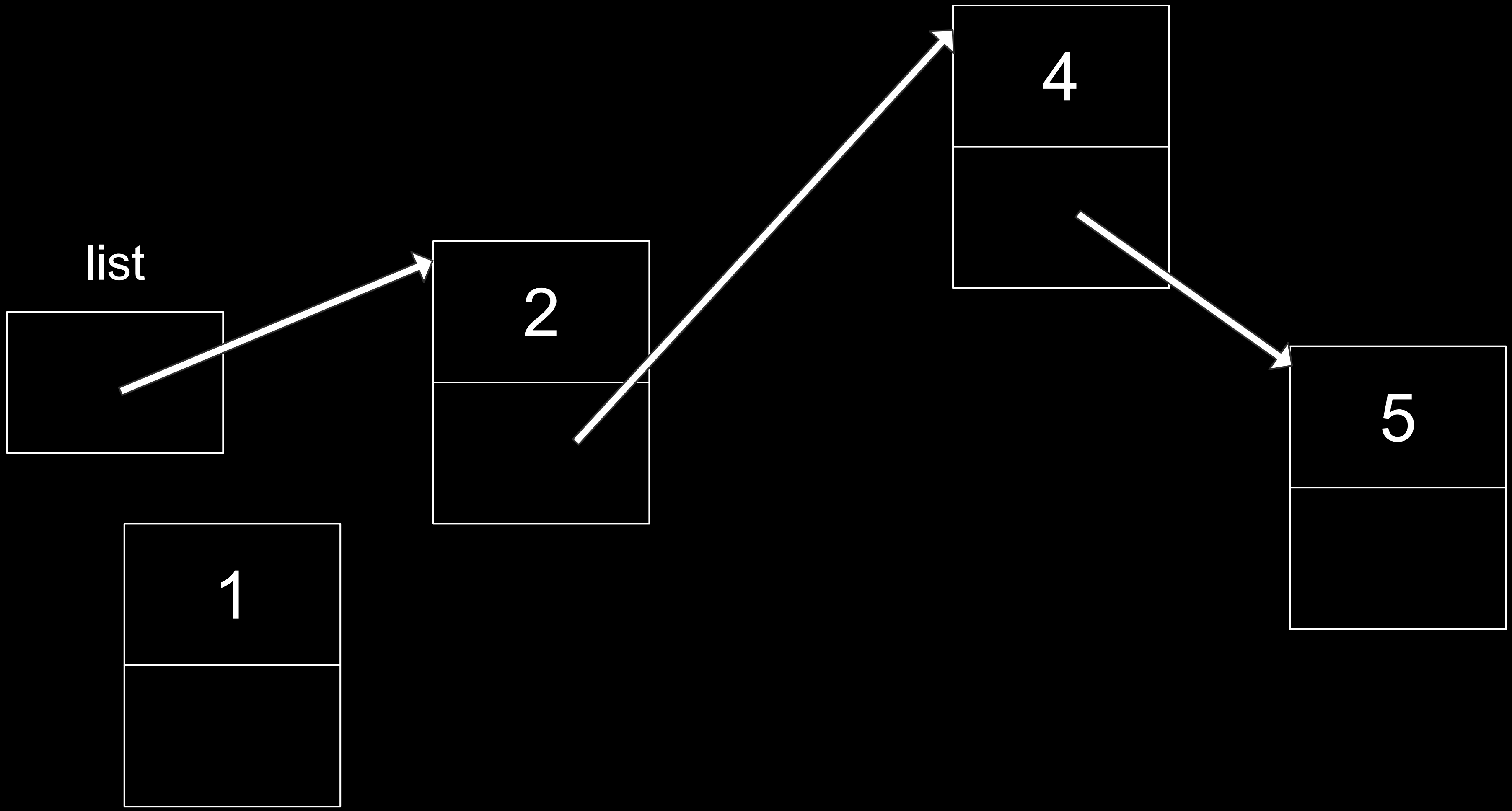

list
2
4
5

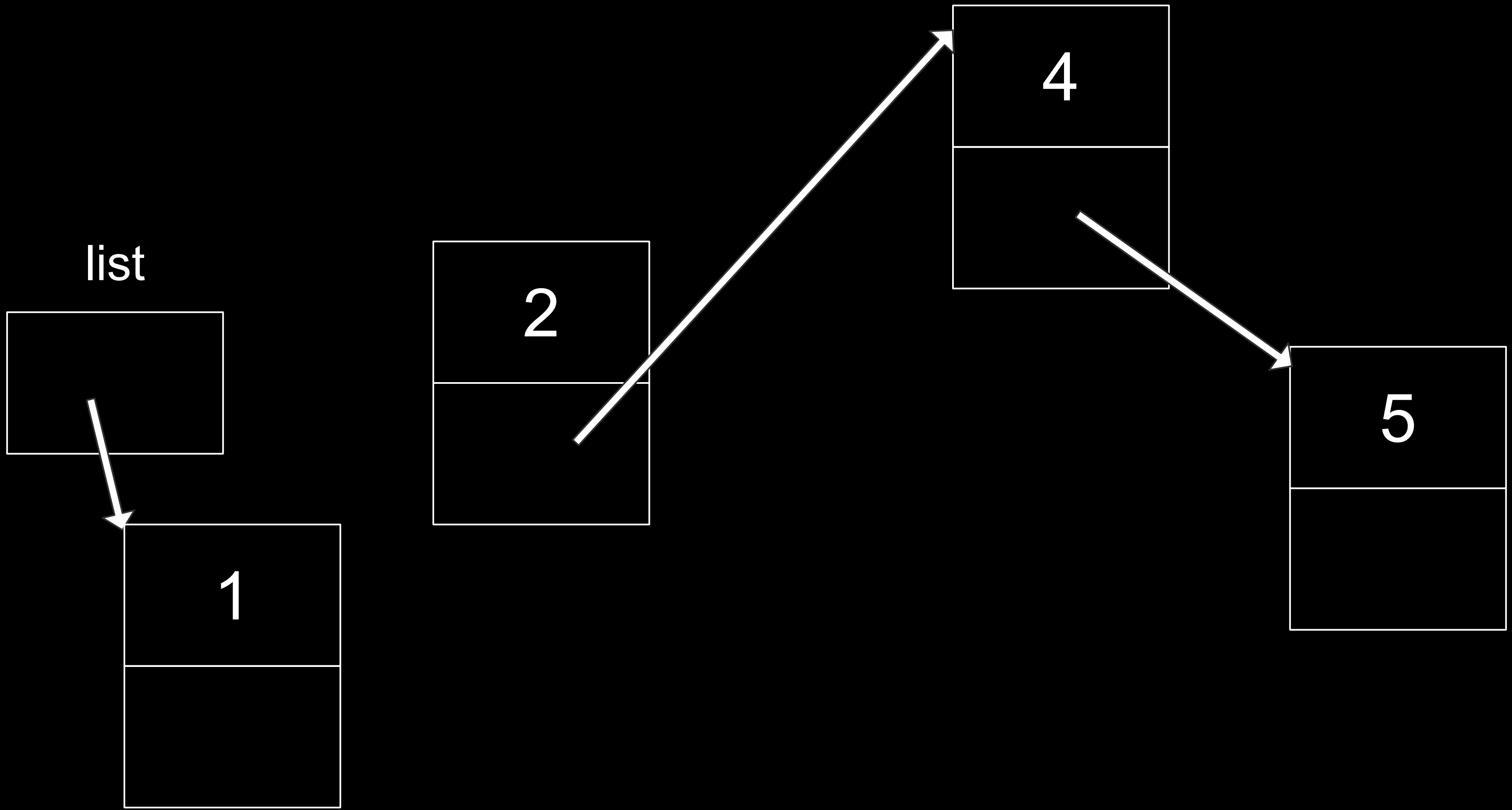
```
node *tmp = list;
while (tmp->next != NULL)
{
    tmp = tmp->next;
}
tmp->next = n;
```

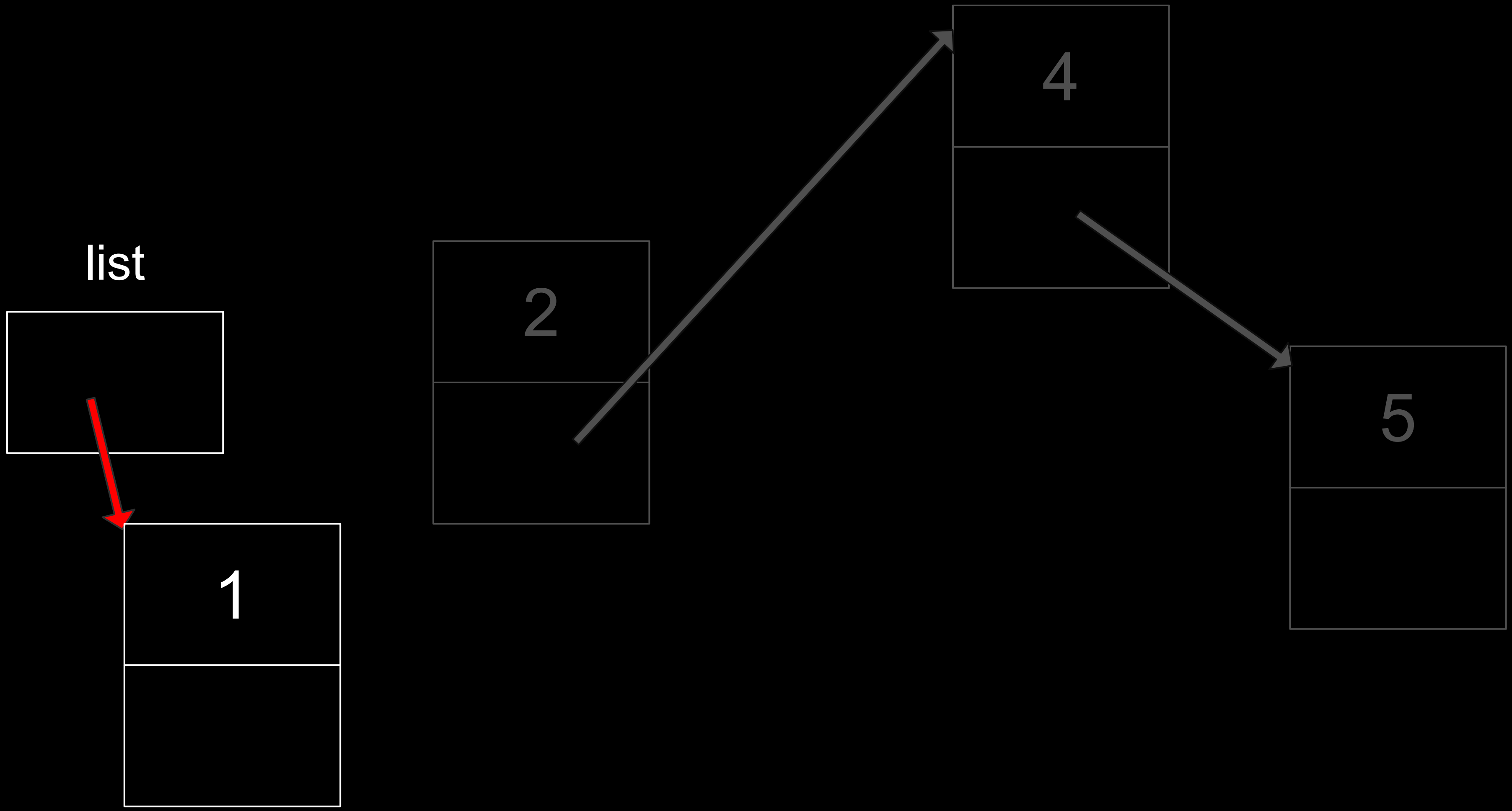

list
2
4
5

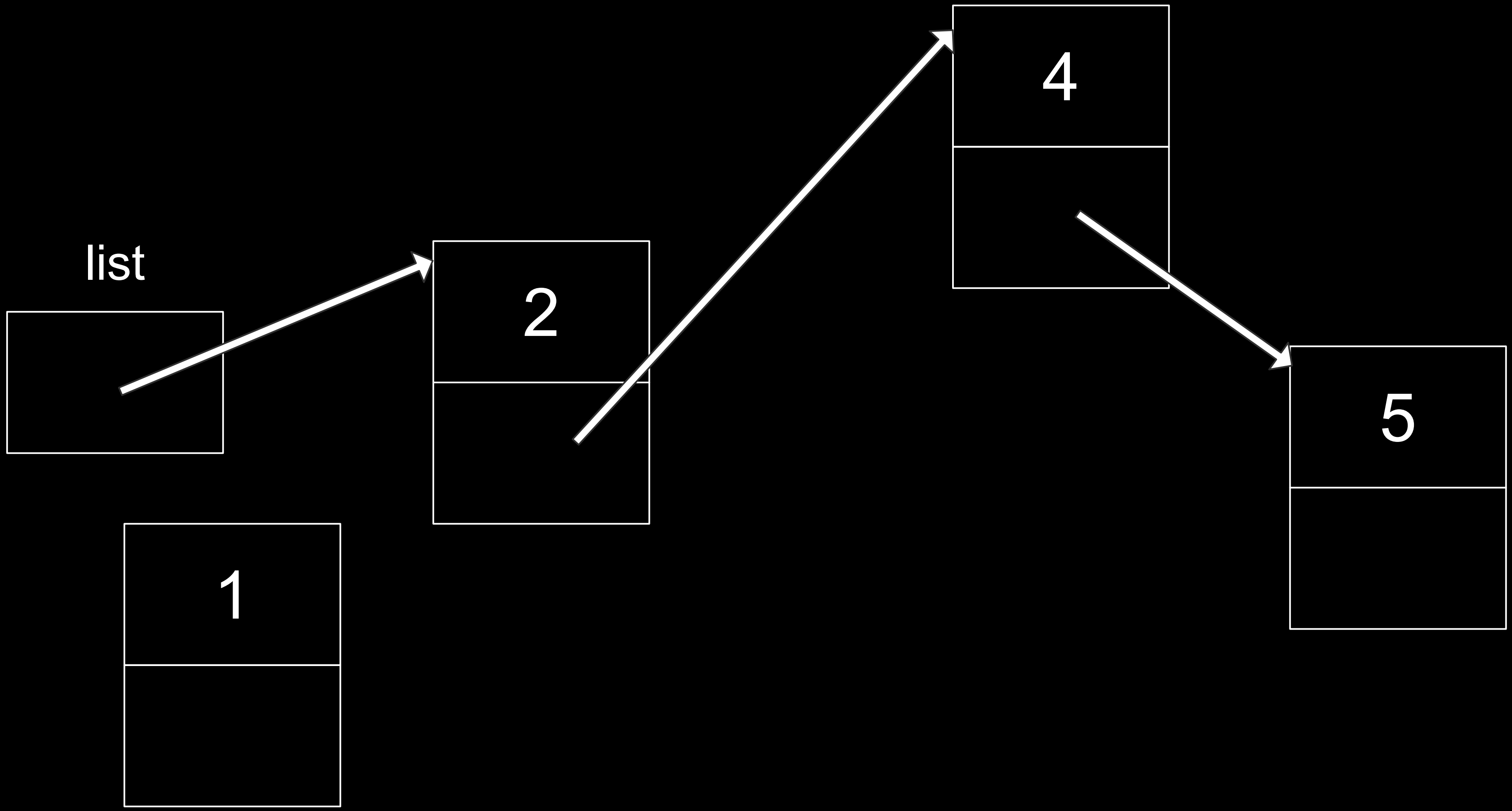

list
2
4
5
1

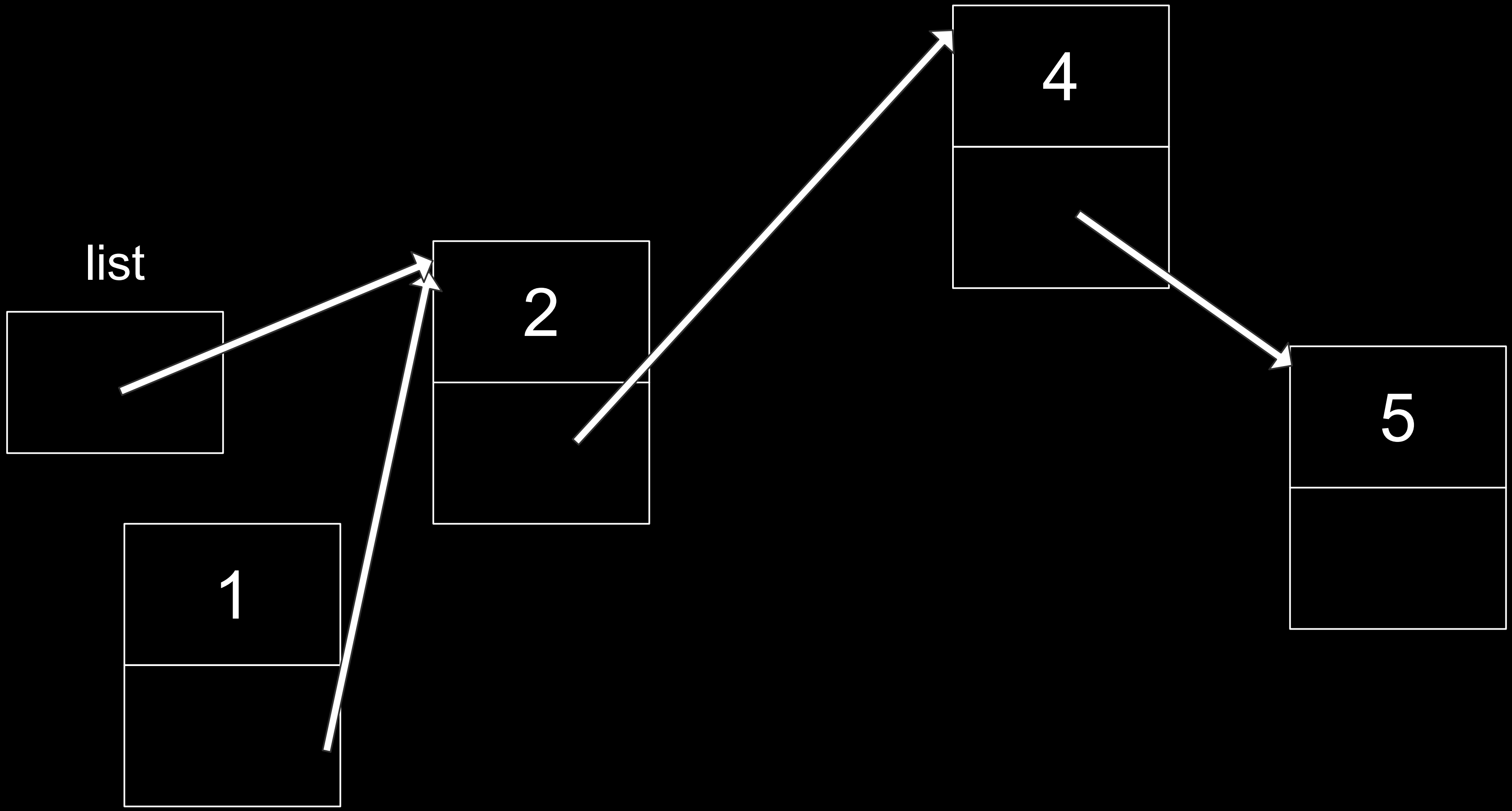
```
node *n = malloc(sizeof(node));
if (n != NULL)
{
    n->number = 1;
    n->next = NULL;
}
```

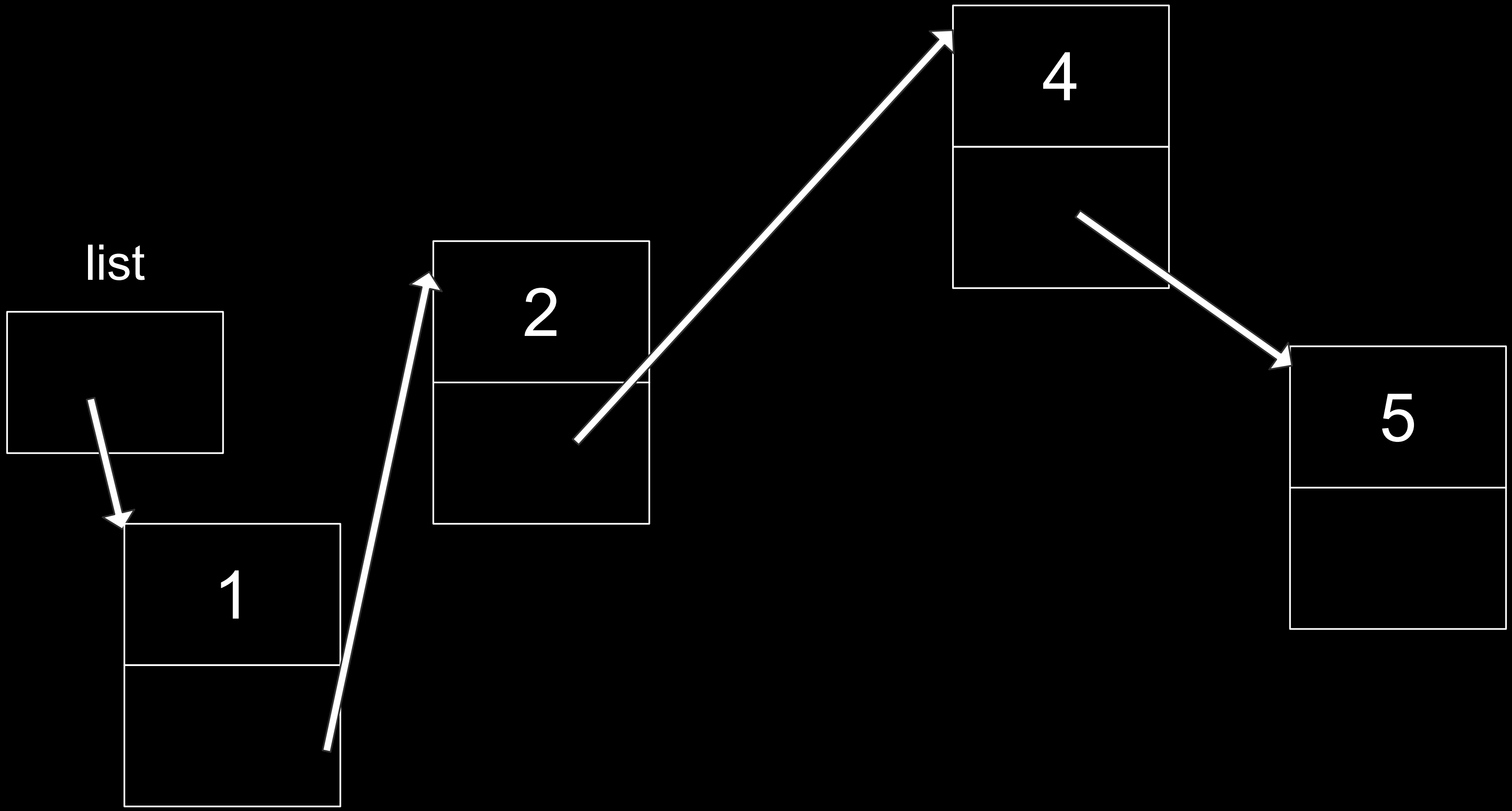

list
2
4
5
1


list
1
2
4
5

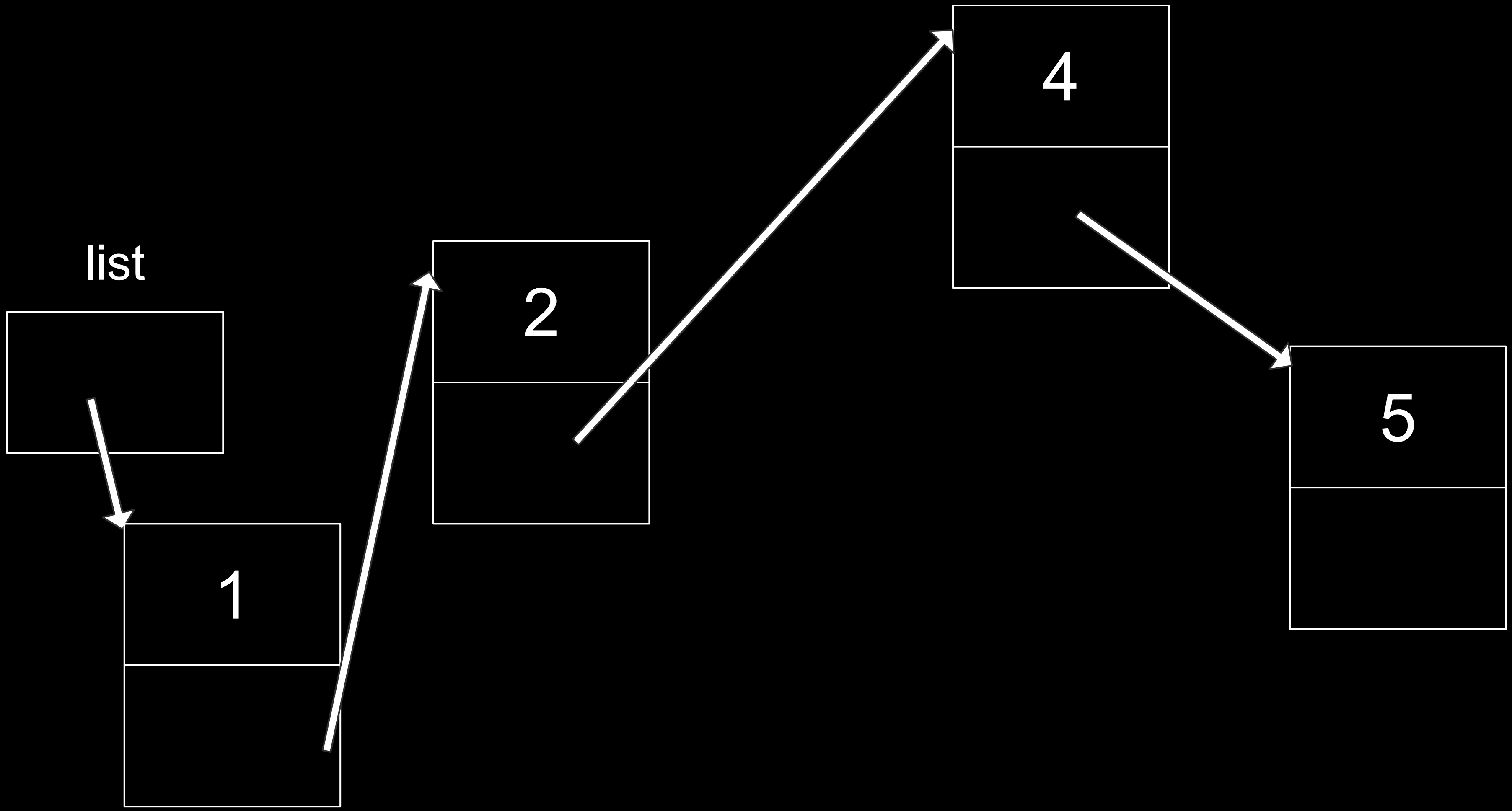

list
1
2
4
5

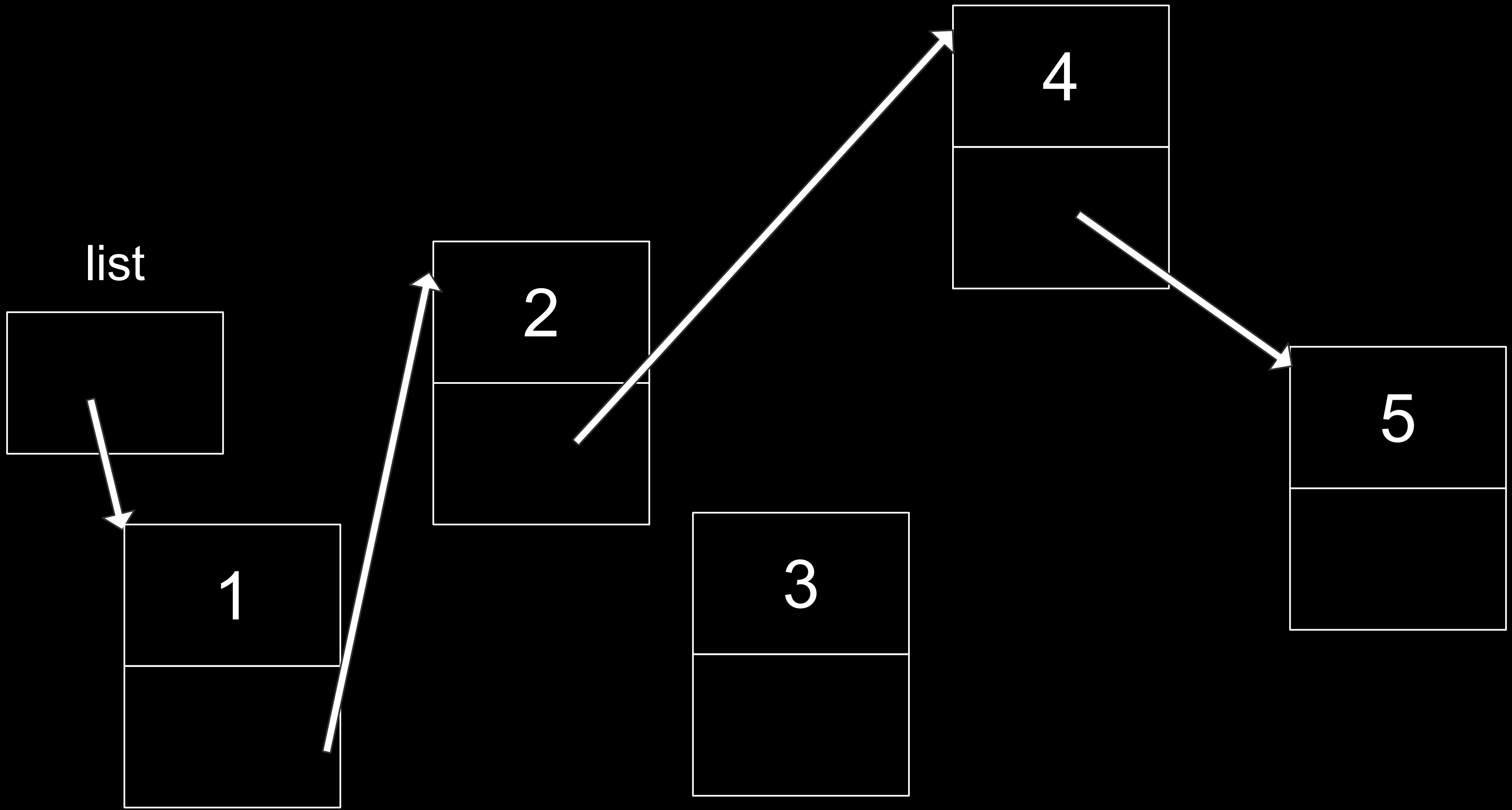

list
2
4
5
1

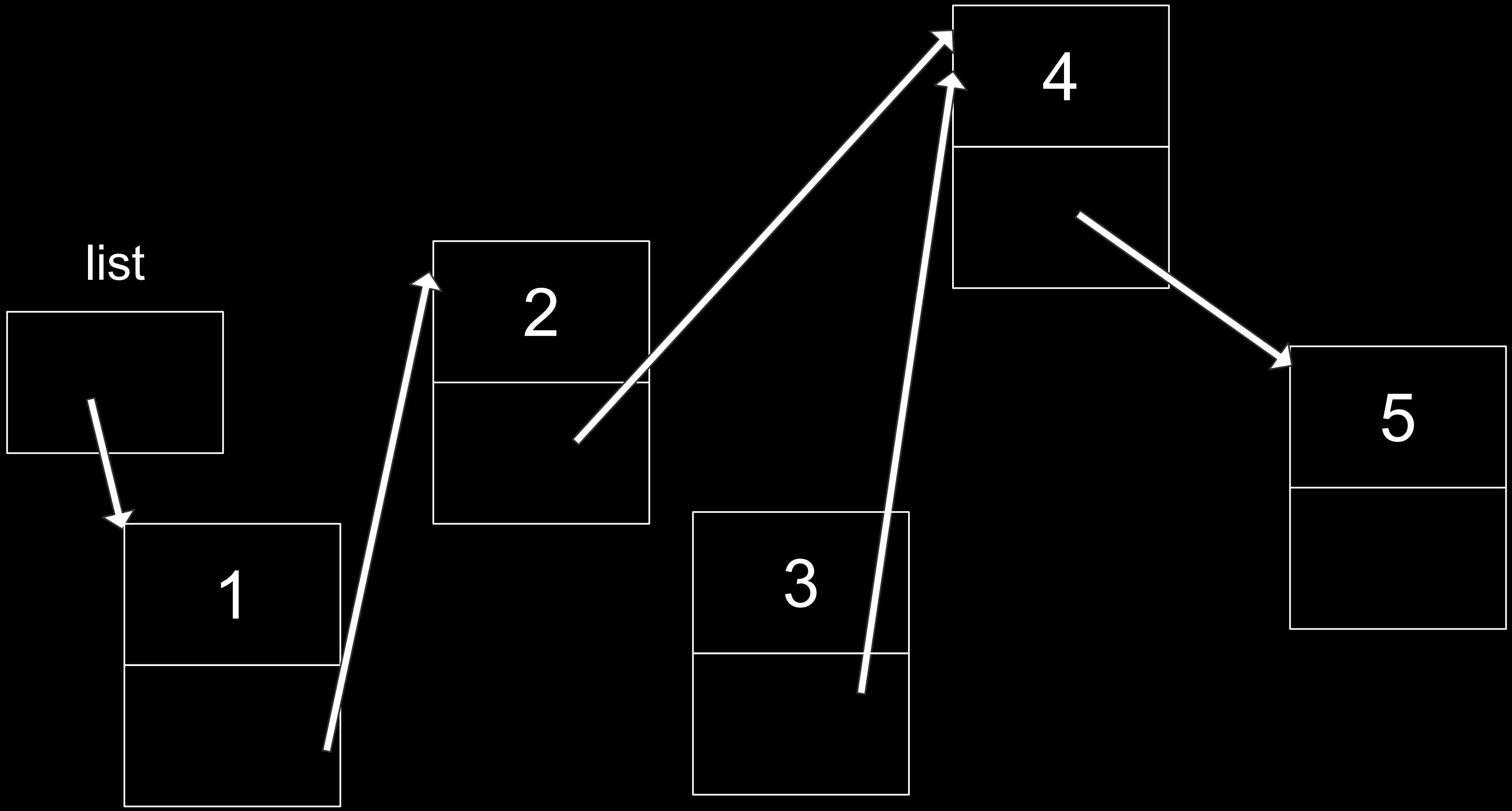

list
1
2
4
5

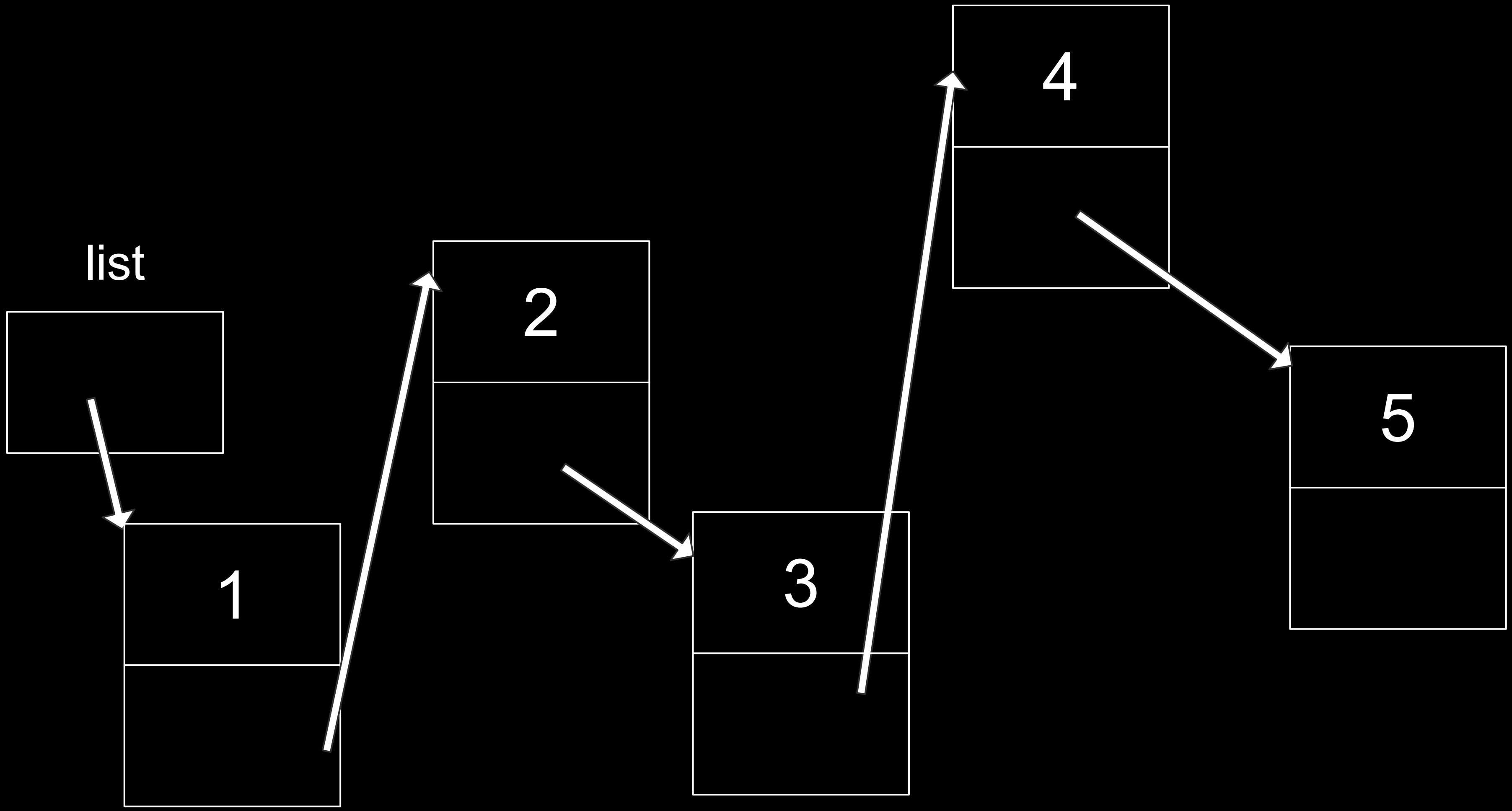

list
1
2
4
5

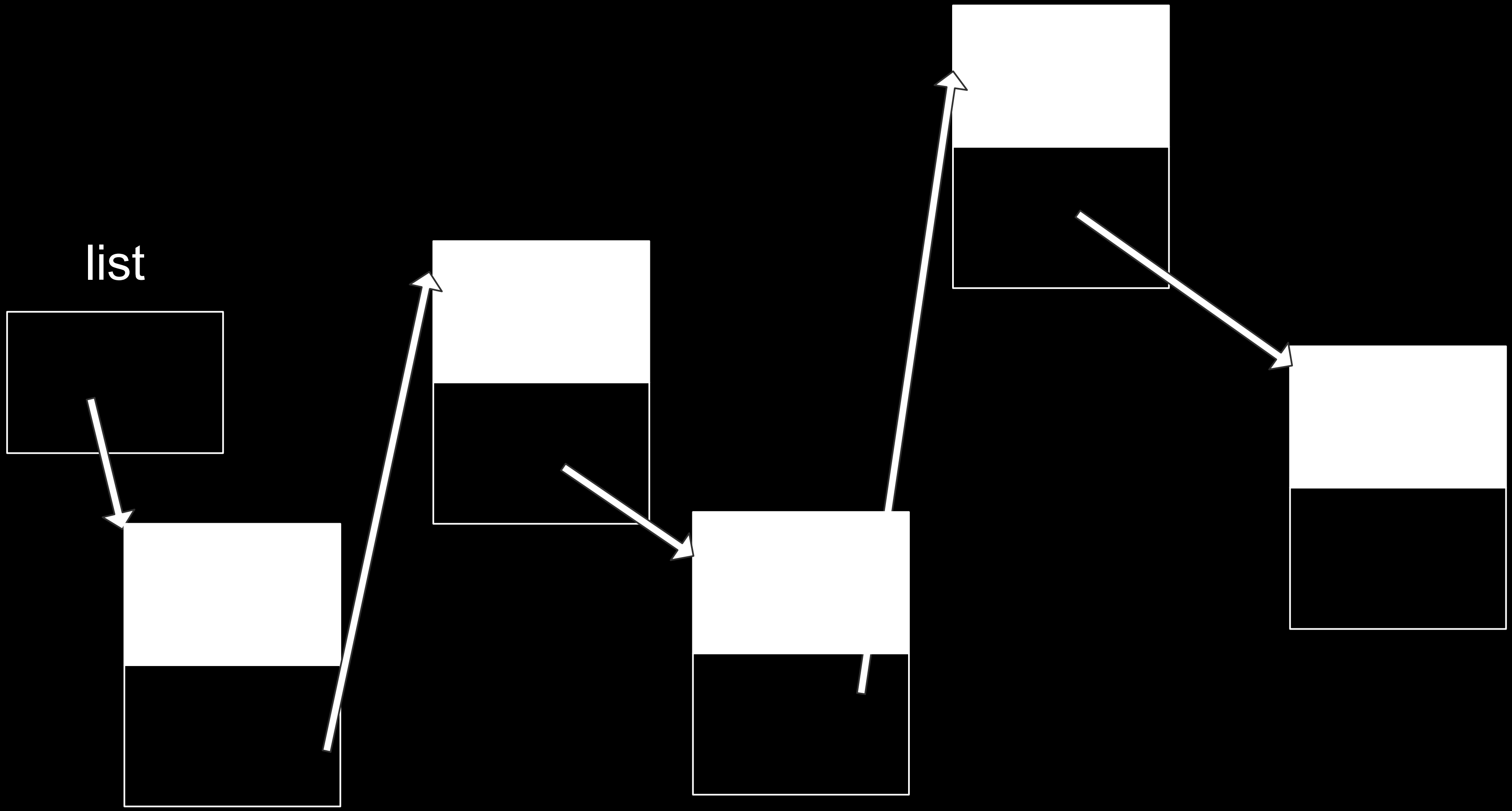
```
n->next = list;
list = n;
```

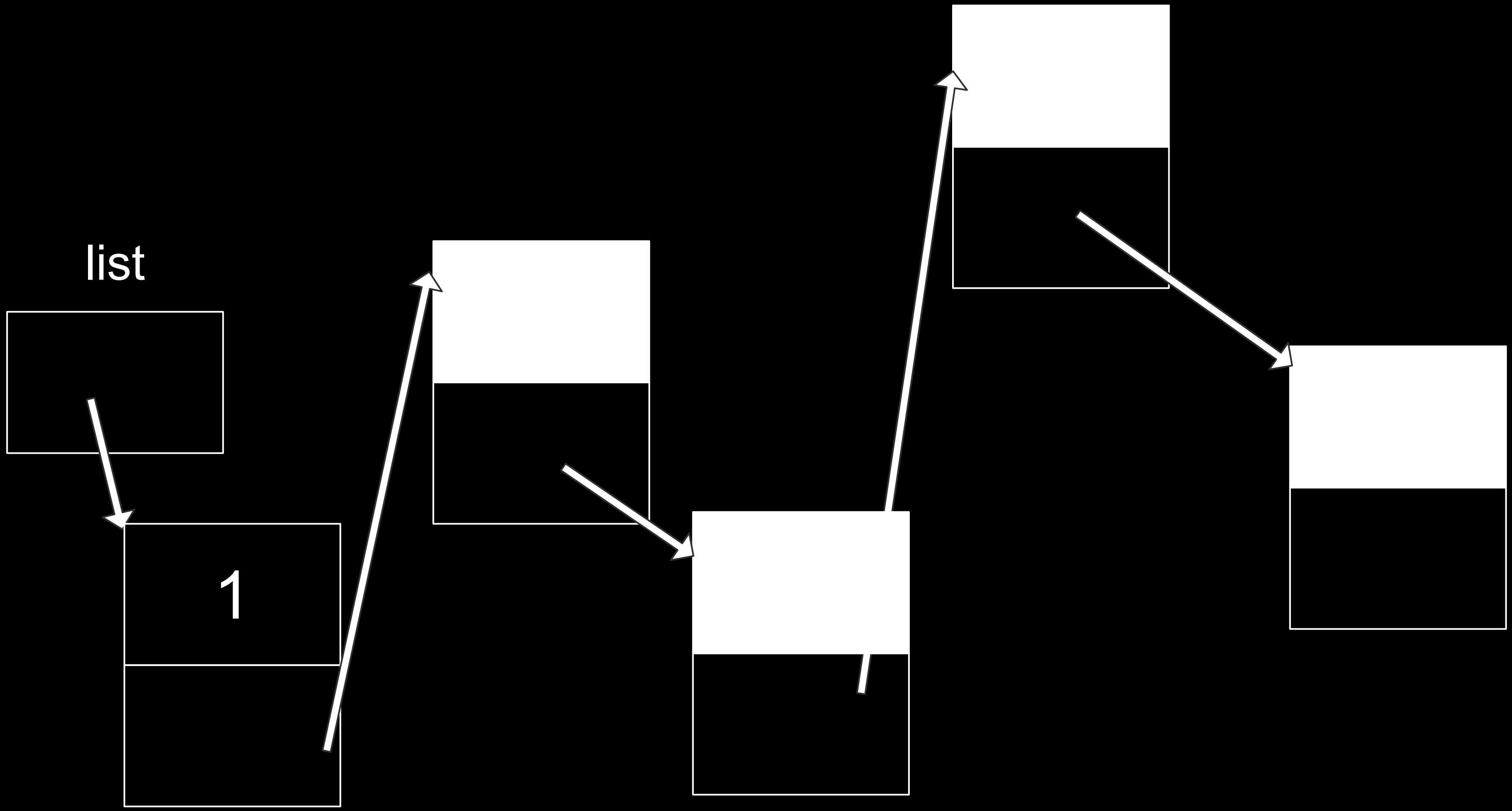

list
1
2
4
5

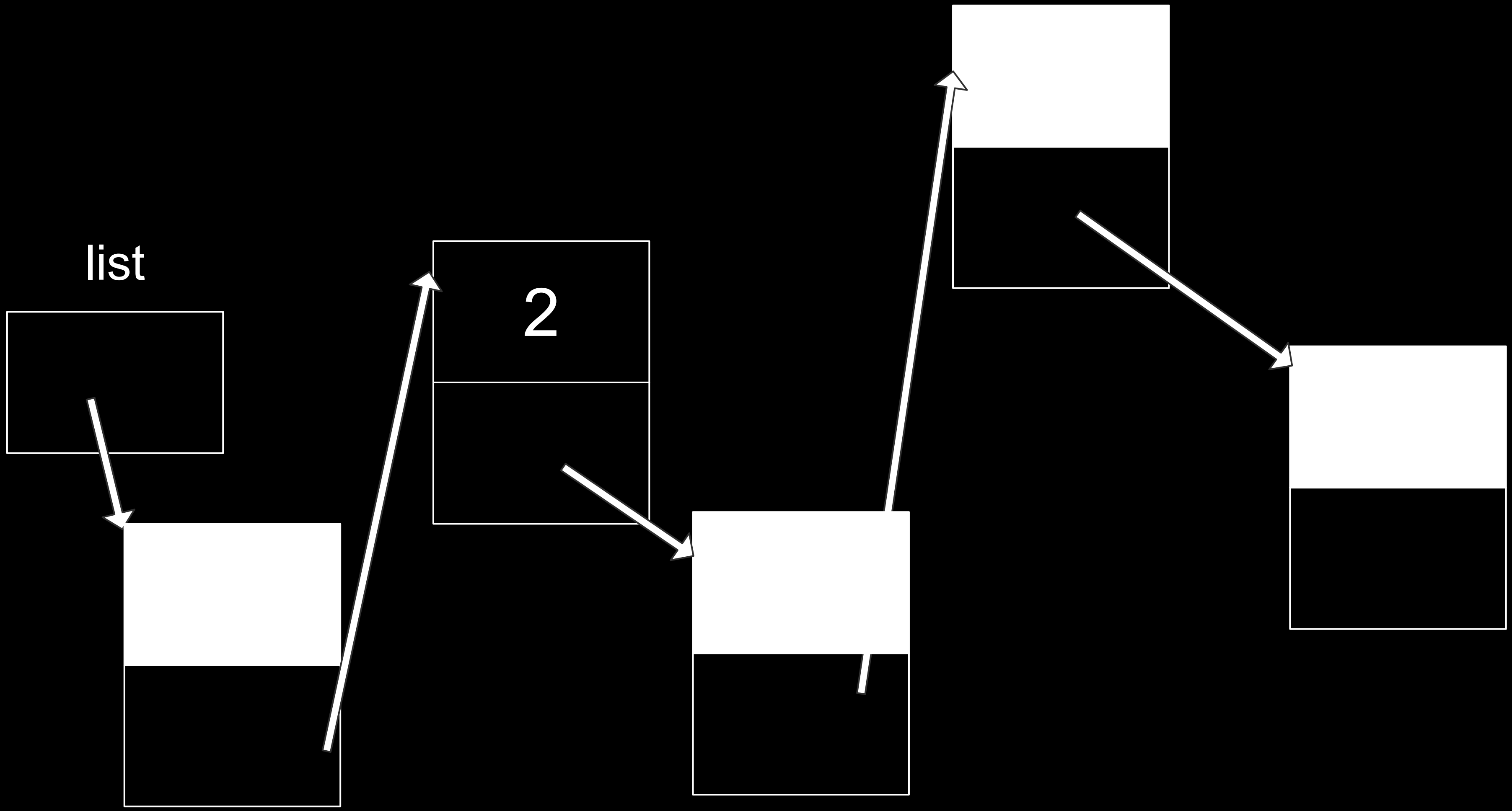

list
1
2
3
4
5

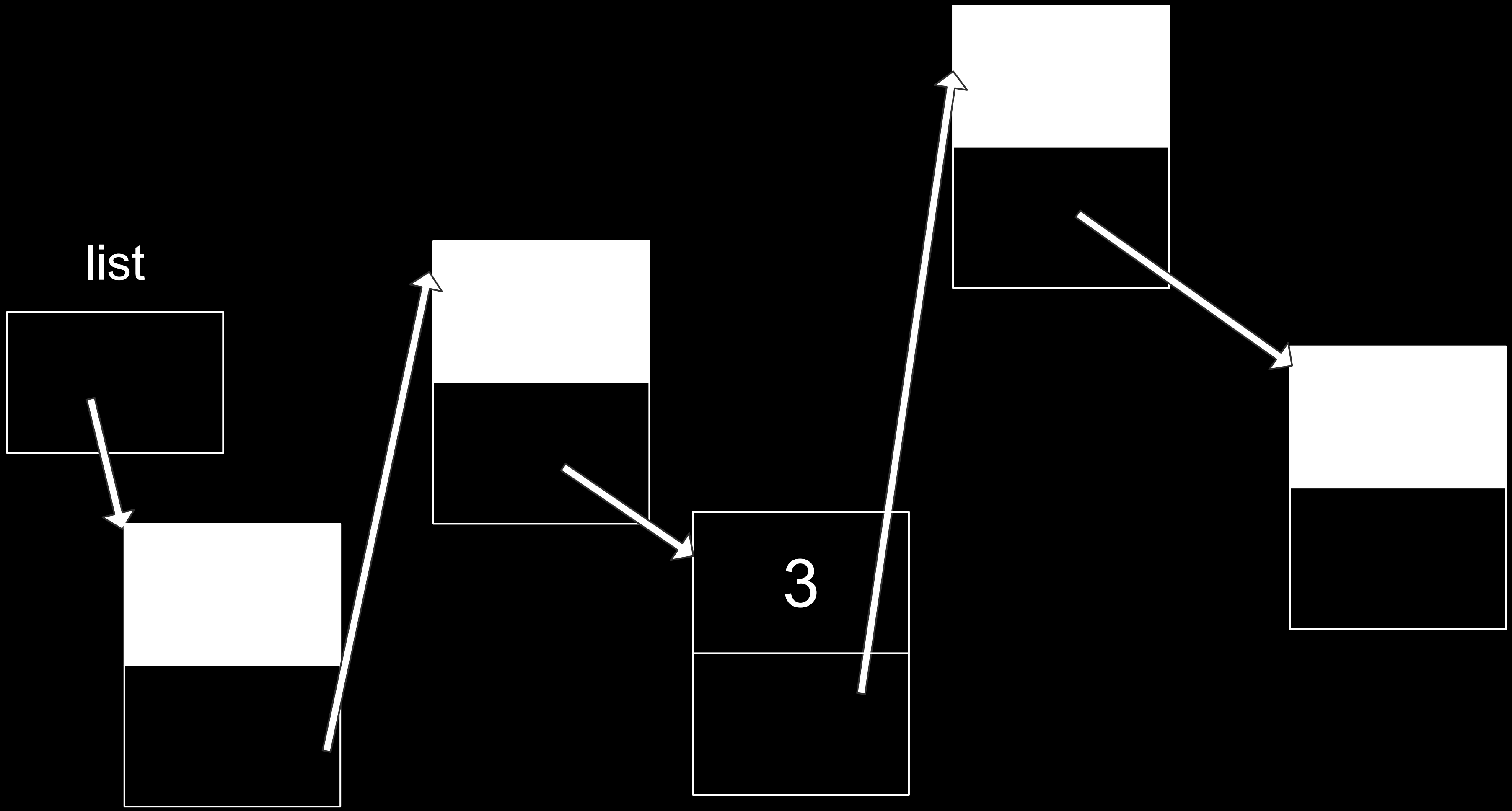

list
1
2
3
4
5

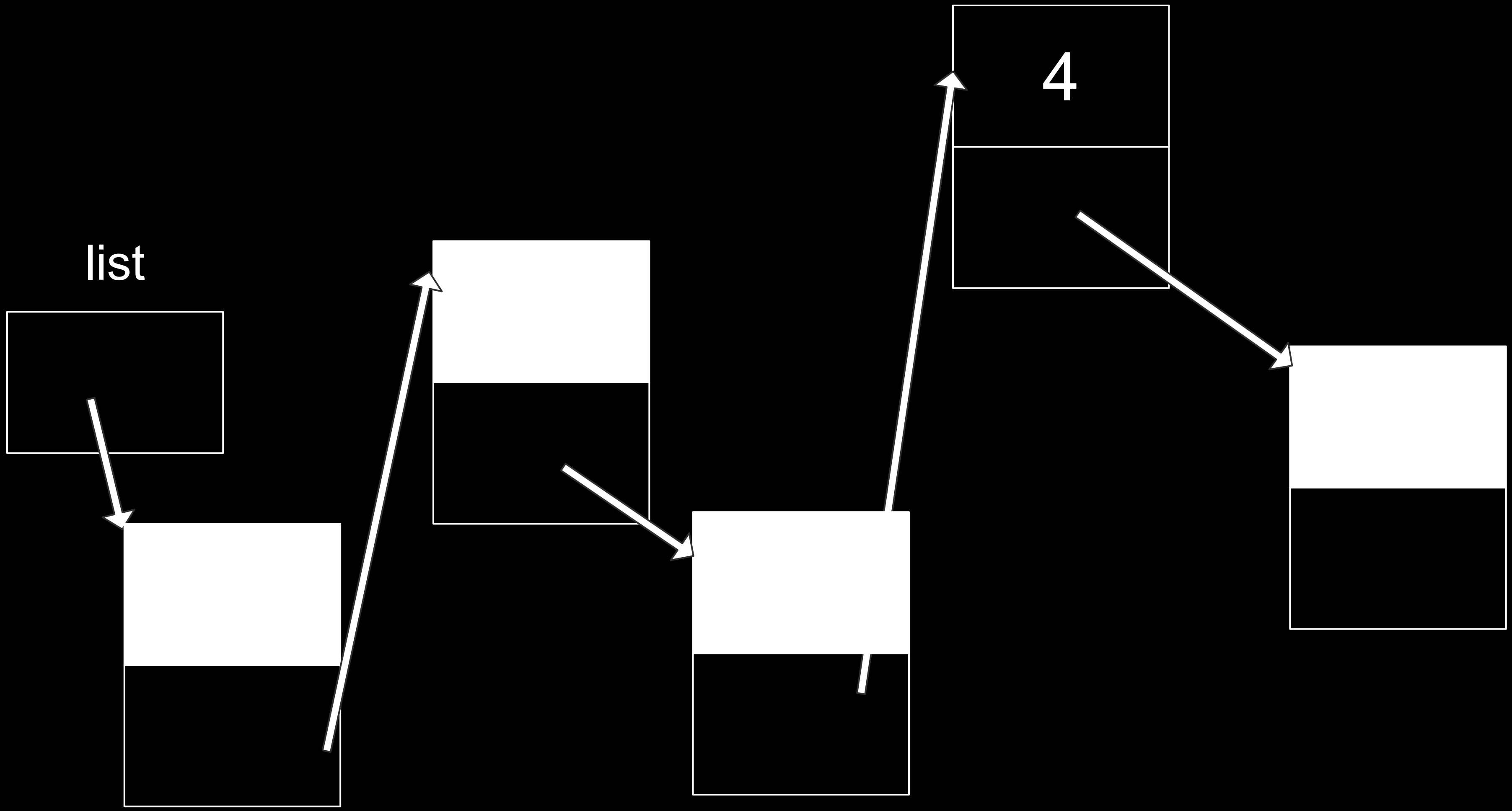

list
1
2
3
4
5

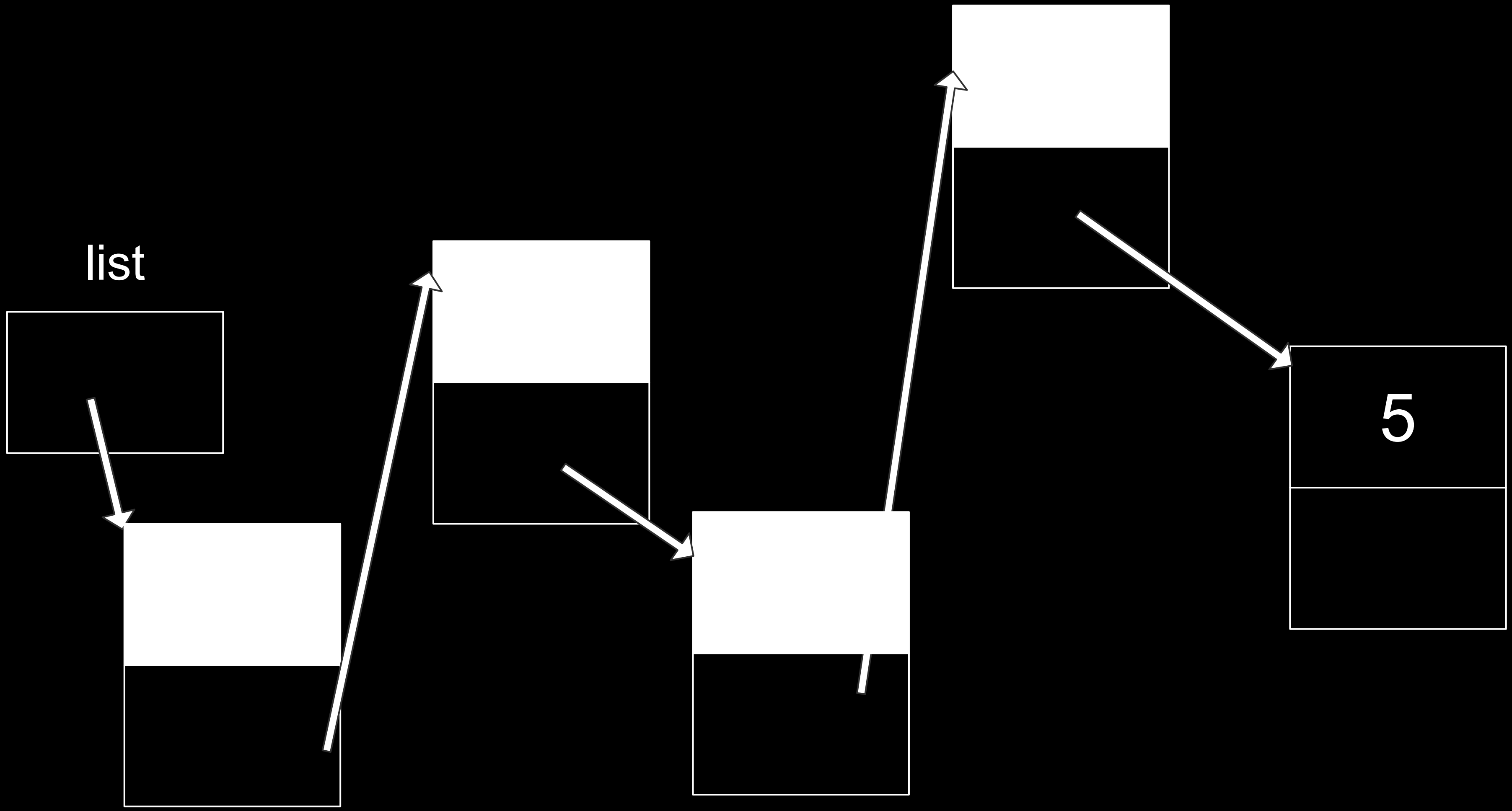

list

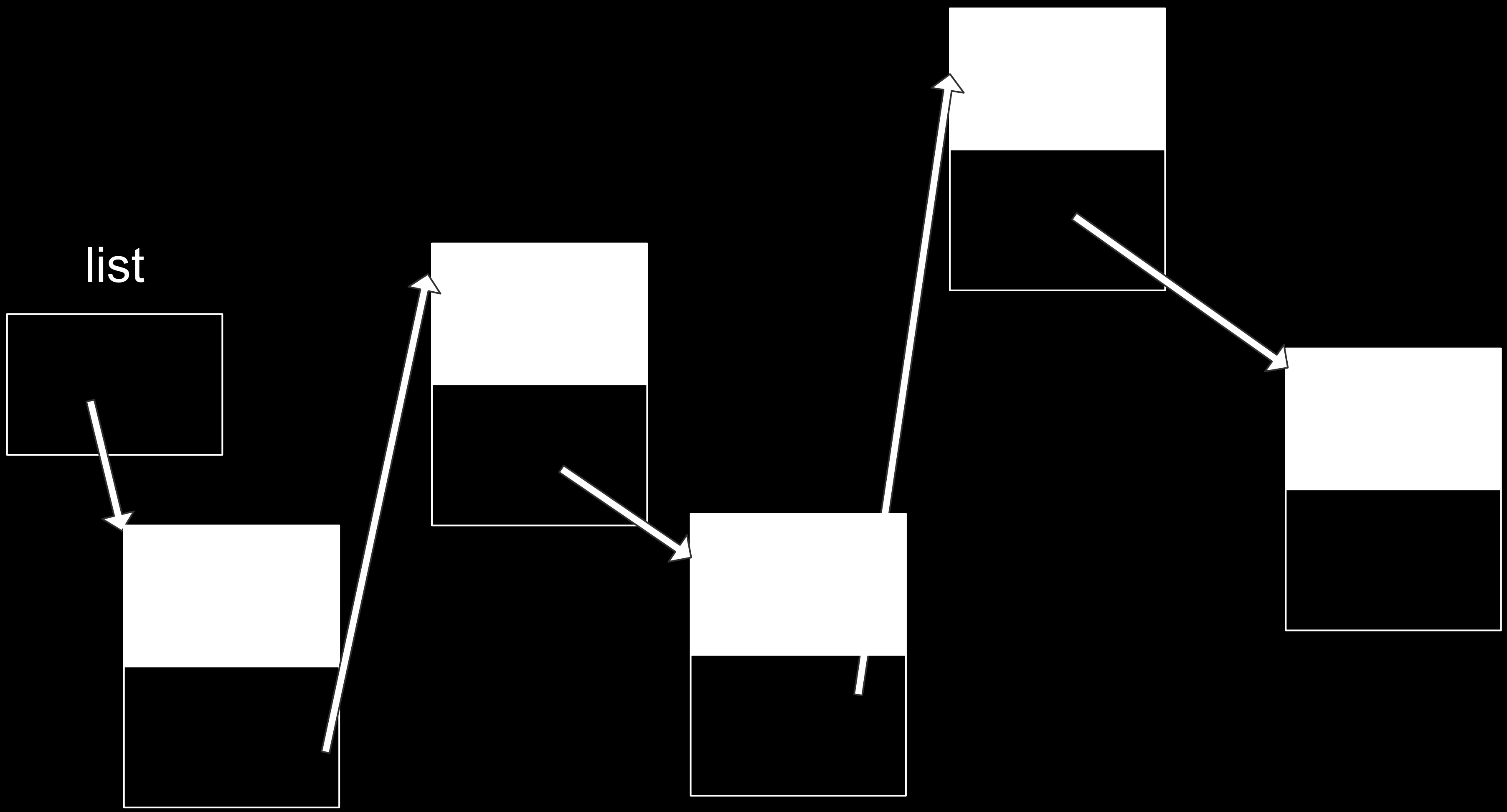

list
1


list
2


list
3


list
4


list
5


list

$O(n^2)$

$O(n \log n)$

$O(n)$

$O(\log n)$

$O(1)$

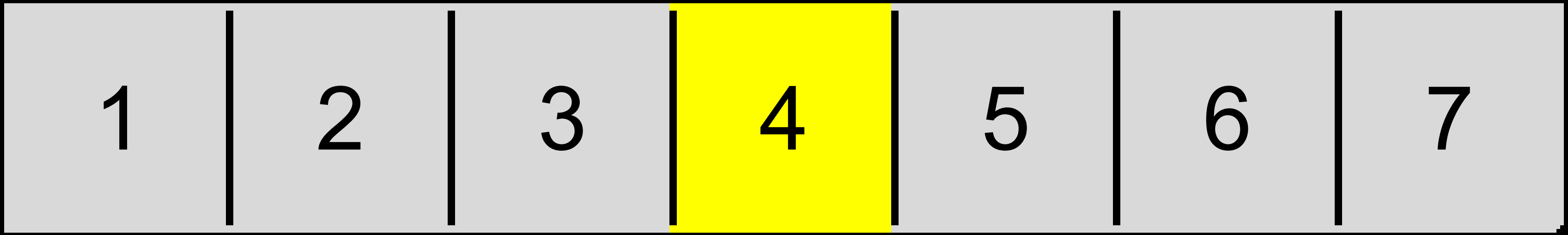
$O(n^2)$	
$O(n \log n)$	
$O(n)$	search
$O(\log n)$	
$O(1)$	

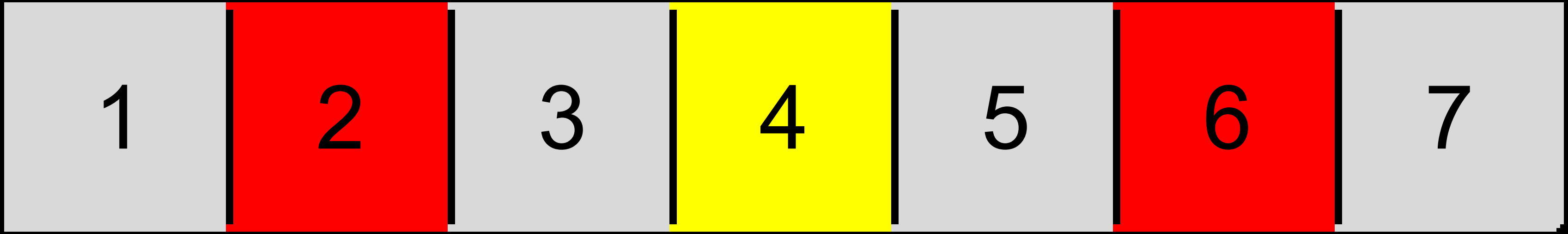
$O(n^2)$	
$O(n \log n)$	
$O(n)$	search, insert
$O(\log n)$	
$O(1)$	

trees

binary search trees

1	2	3	4	5	6	7


1
2
3
4
5
6
7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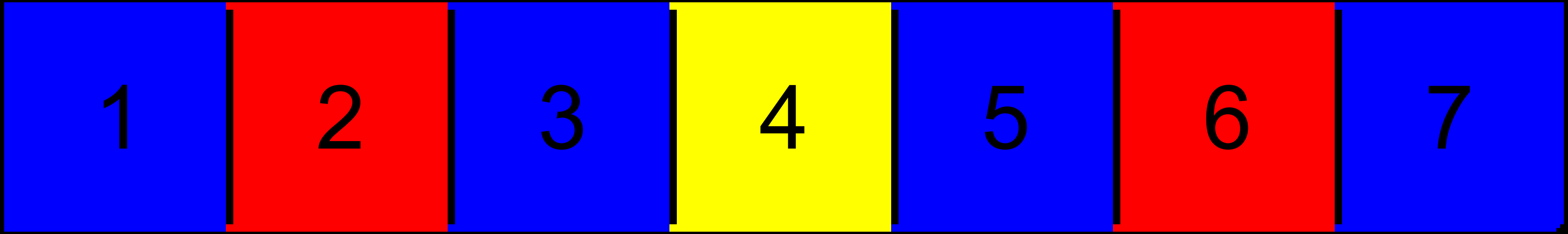
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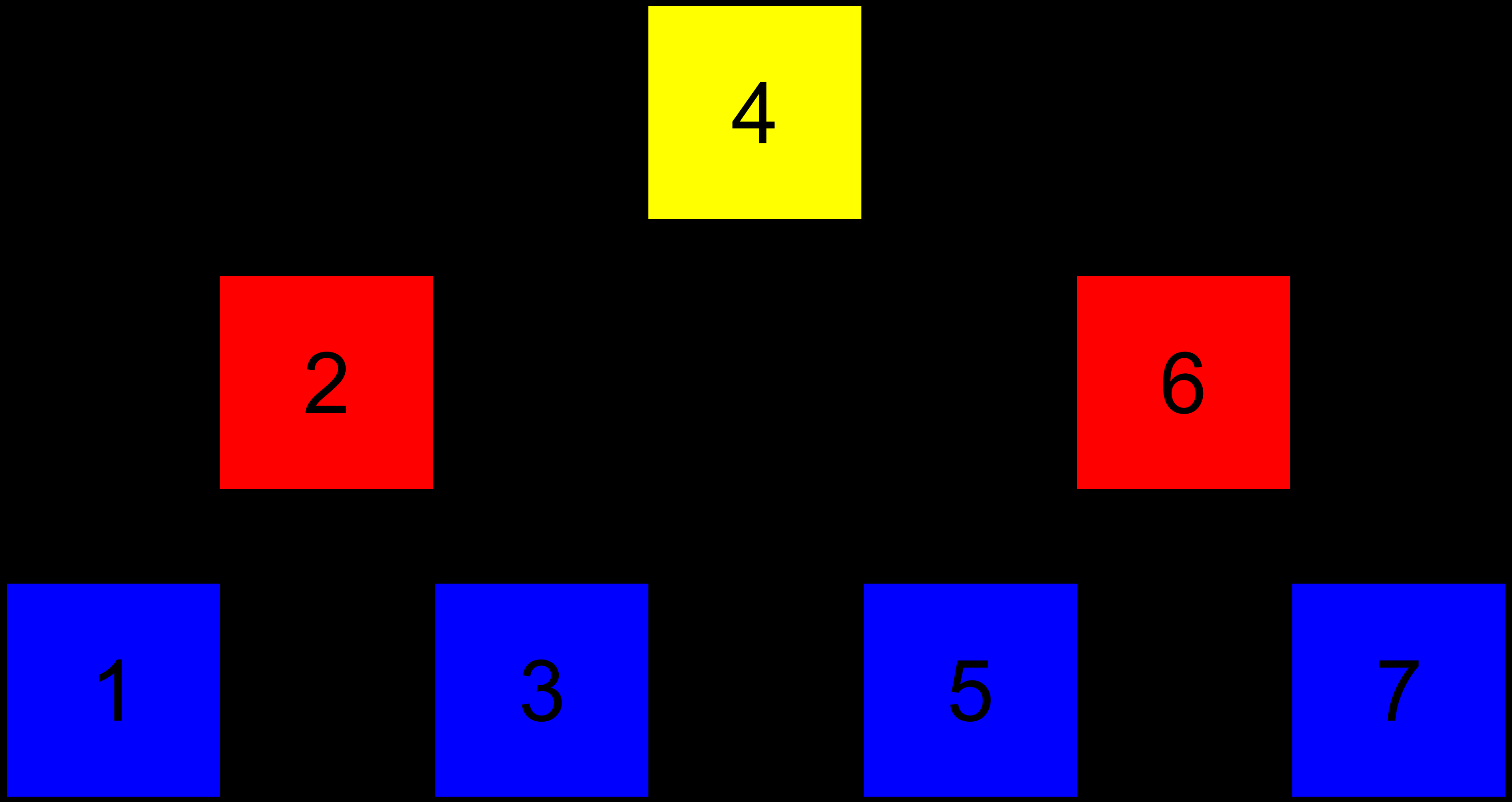
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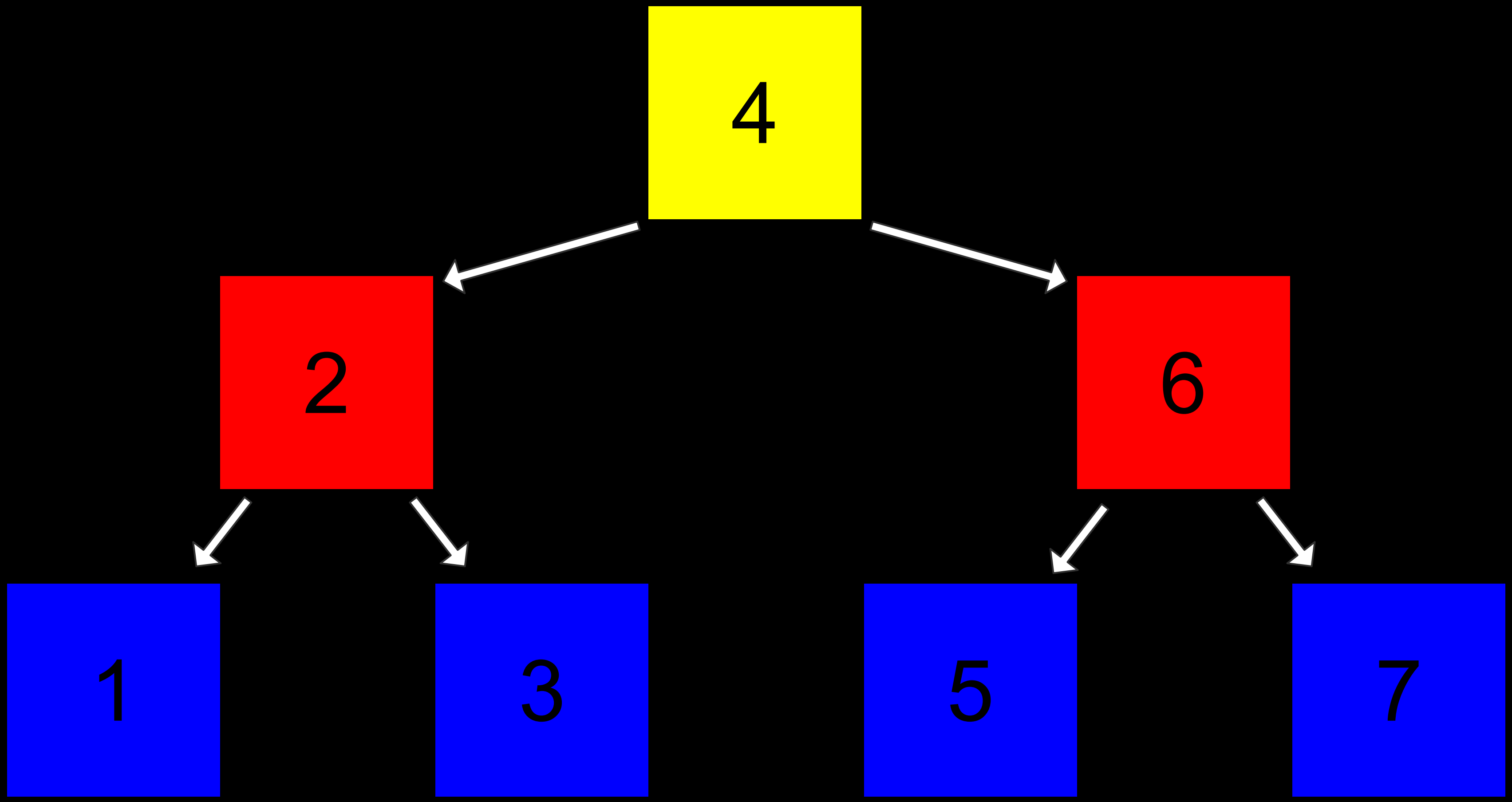
4
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```
typedef struct node
{
    int number;
    struct node *next;
}
node;
```

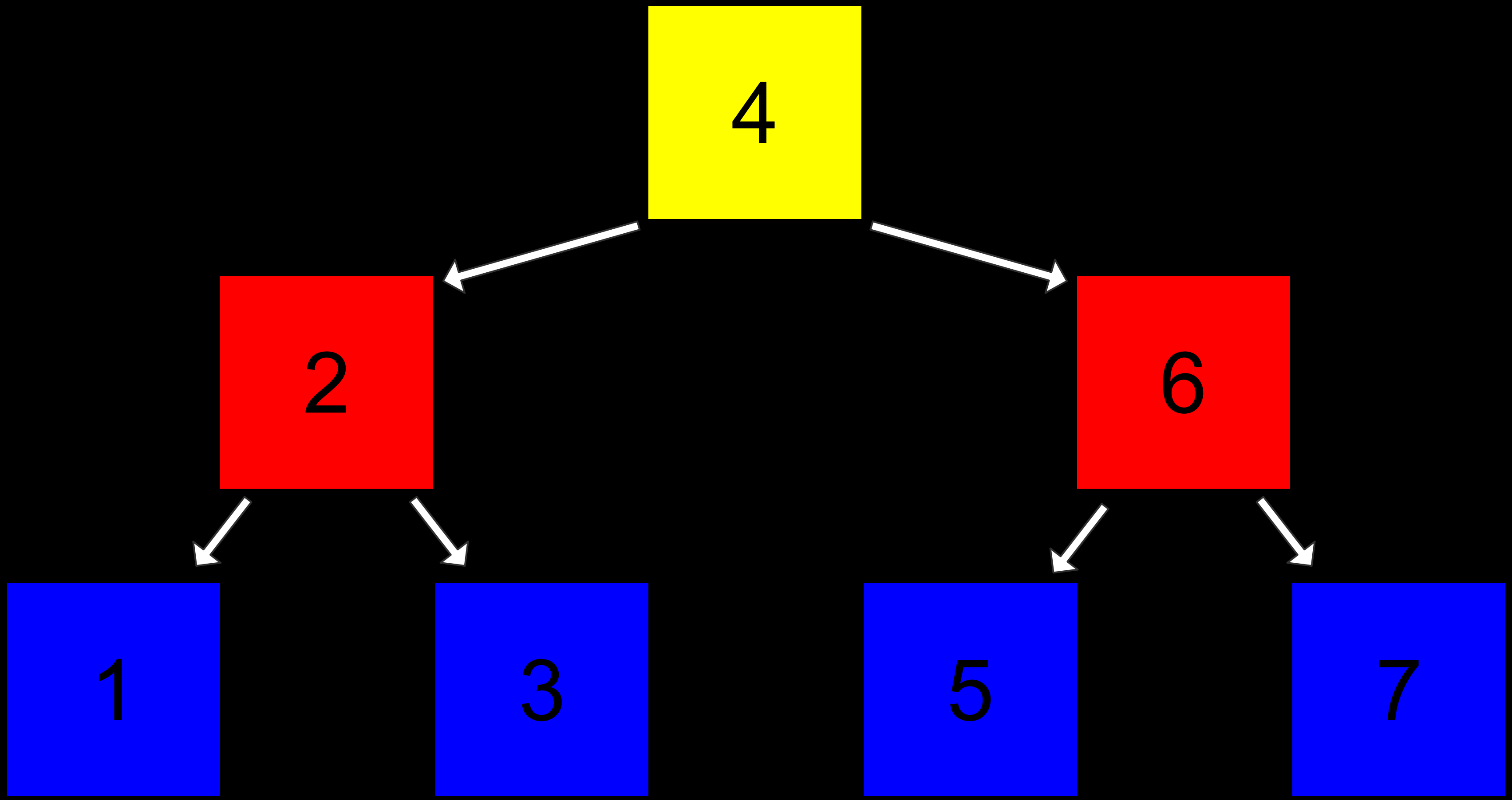
```
typedef struct node
{
    int number;

}
node;
```

```
typedef struct node
{
    int number;


}
node;
```

```
typedef struct node
{
    int number;
    struct node *left;
    struct node *right;
}
node;
```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```
bool search(node *tree)
{





















}
```

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









}
```

```
bool search(node *tree)
{
    if (tree == NULL)
    {
        return false;
    }
    else if (50 < tree->number)
    {
        return search(tree->left);
    }








}
```

```
bool search(node *tree)
{
    if (tree == NULL)
    {
        return false;
    }
    else if (50 < tree->number)
    {
        return search(tree->left);
    }
    else if (50 > tree->number)
    {
        return search(tree->right);
    }




}
```

```
bool search(node *tree)
{
    if (tree == NULL)
    {
        return false;
    }
    else if (50 < tree->number)
    {
        return search(tree->left);
    }
    else if (50 > tree->number)
    {
        return search(tree->right);
    }
    else if (50 == tree->number)
    {
        return true;
    }
}
```

```
bool search(node *tree)
{
    if (tree == NULL)
    {
        return false;
    }
    else if (50 < tree->number)
    {
        return search(tree->left);
    }
    else if (50 > tree->number)
    {
        return search(tree->right);
    }
    else
    {
        return true;
    }
}
```

$O(n^2)$

$O(n \log n)$

$O(n)$

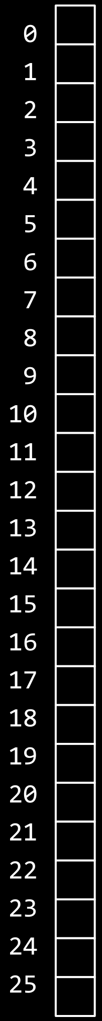
$O(\log n)$

$O(1)$

$O(n^2)$	
$O(n \log n)$	
$O(n)$	
$O(\log n)$	search
$O(1)$	

$O(n^2)$	
$O(n \log n)$	
$O(n)$	
$O(\log n)$	search, insert
$O(1)$	

hash tables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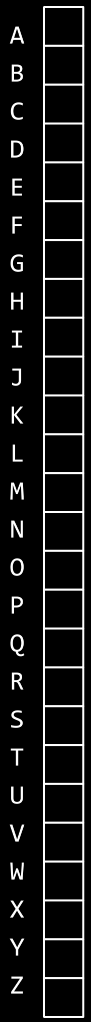
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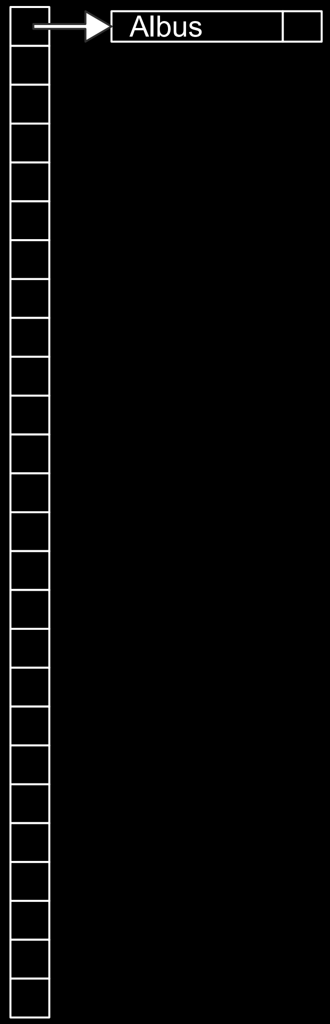
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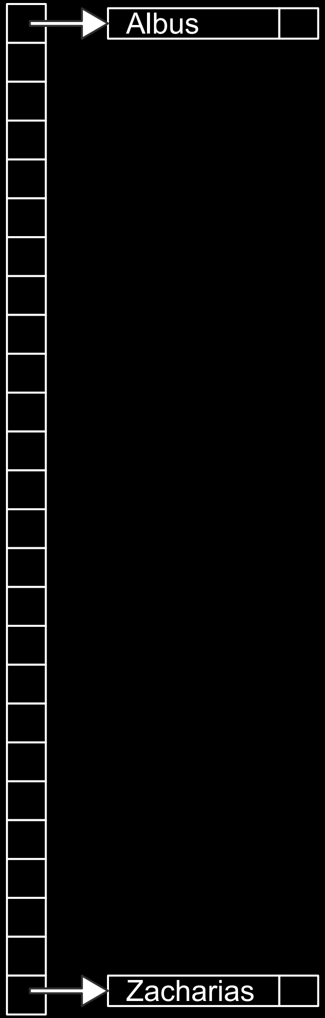
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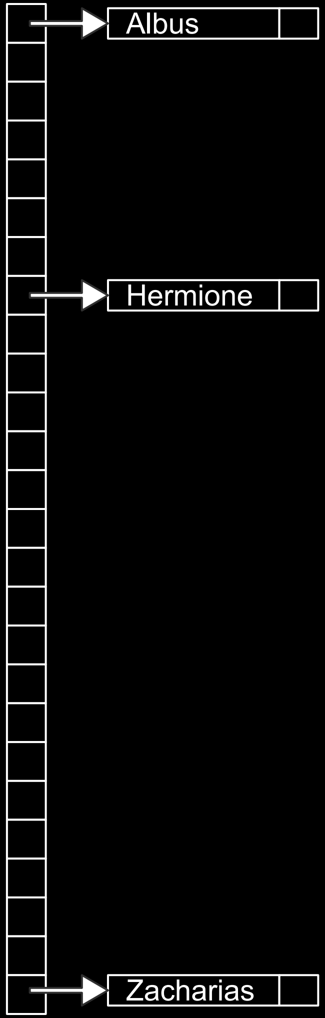
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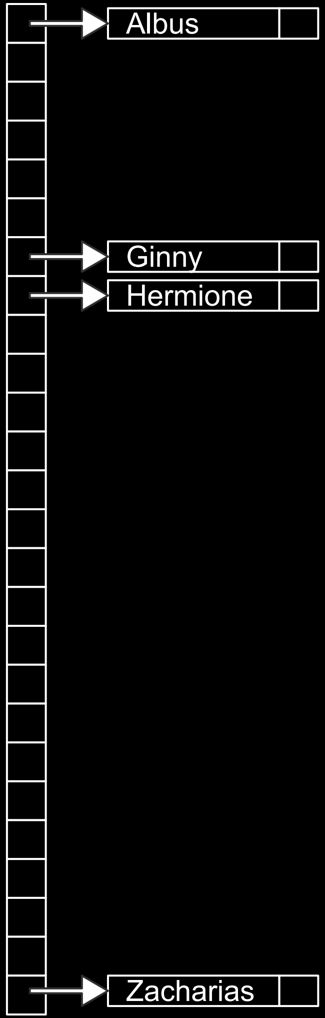
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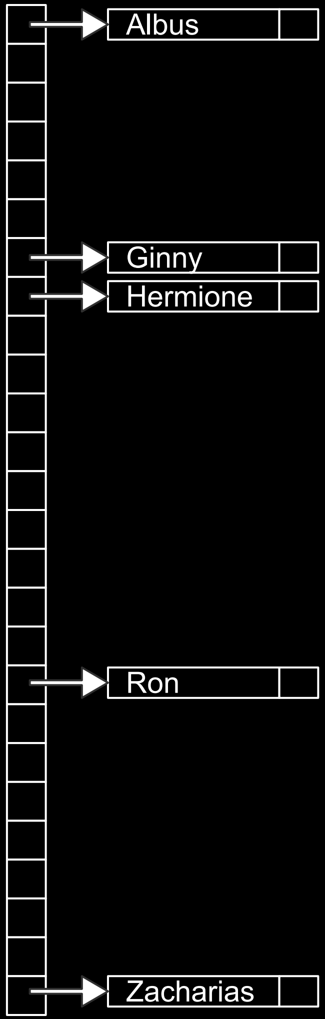
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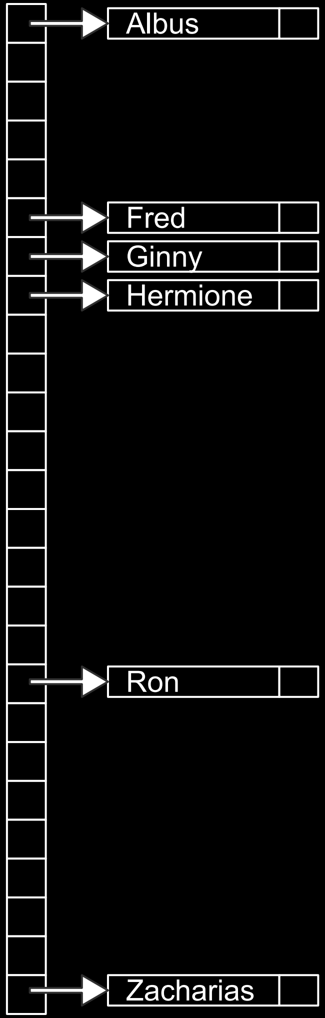
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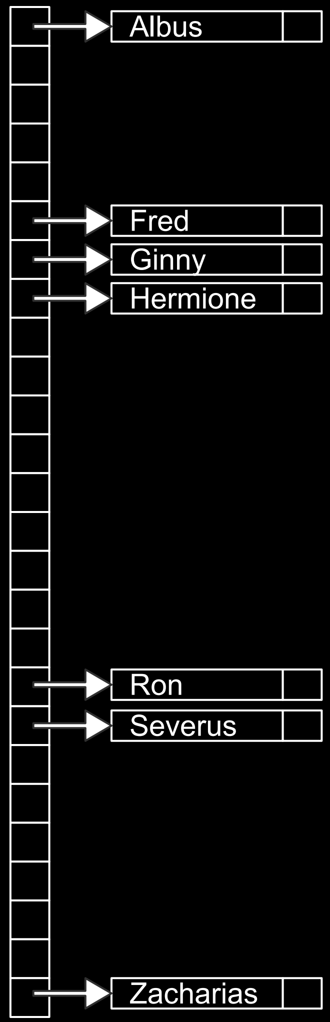
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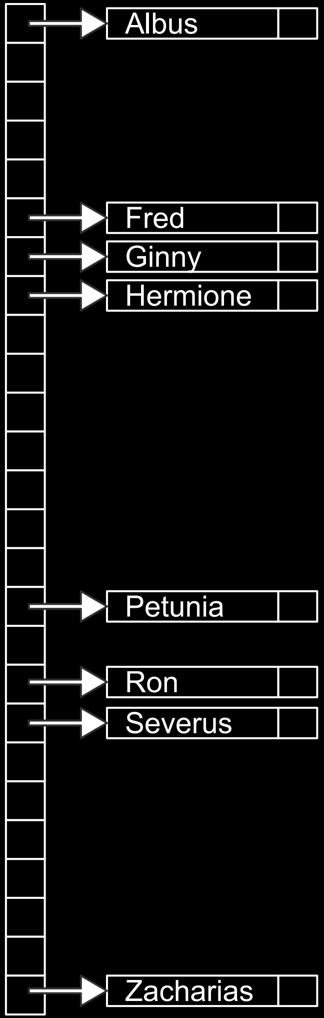

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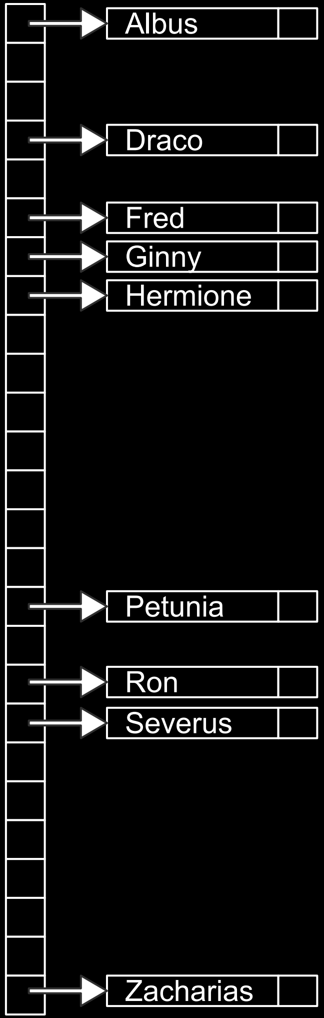
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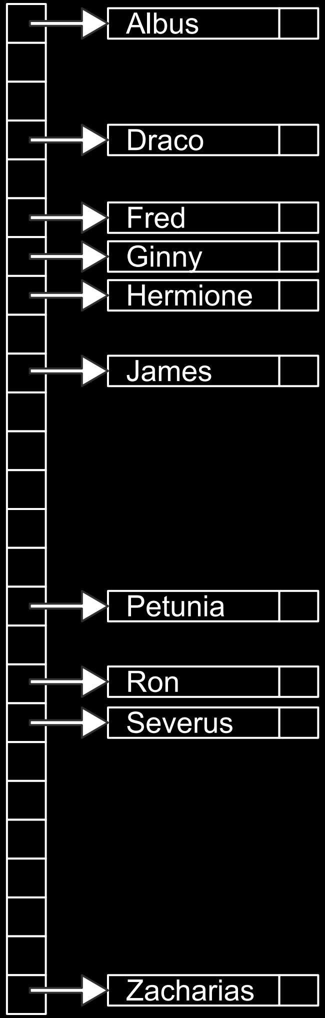
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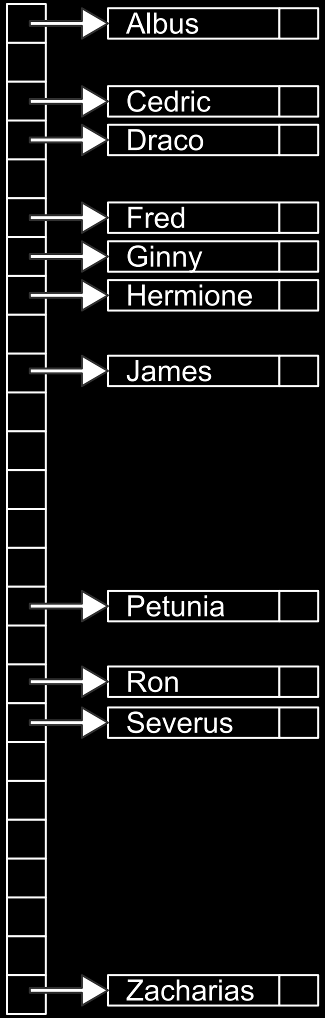
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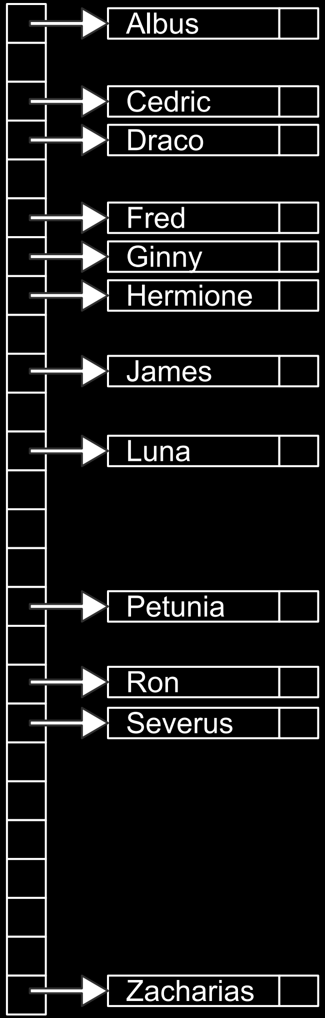
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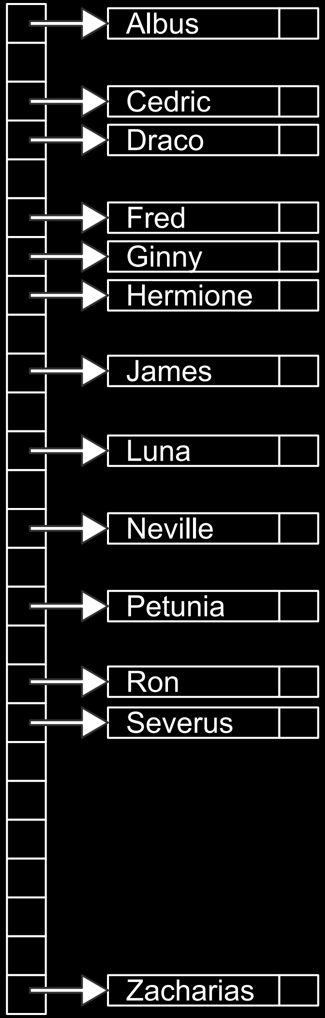
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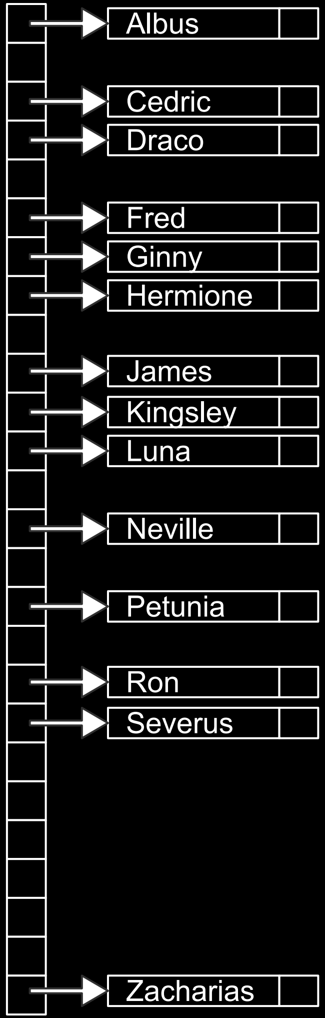
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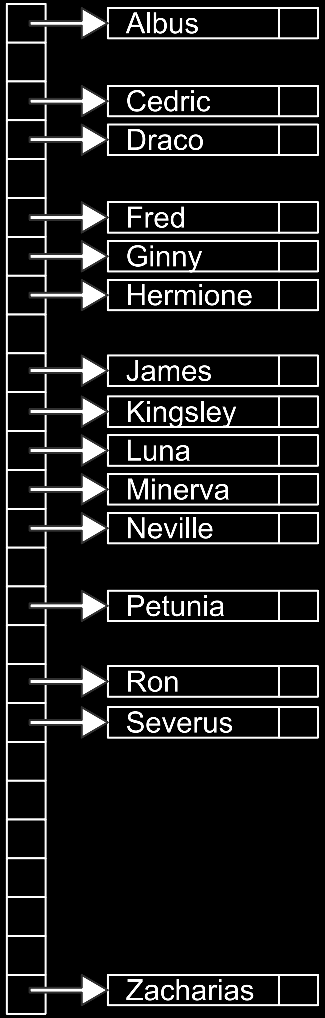
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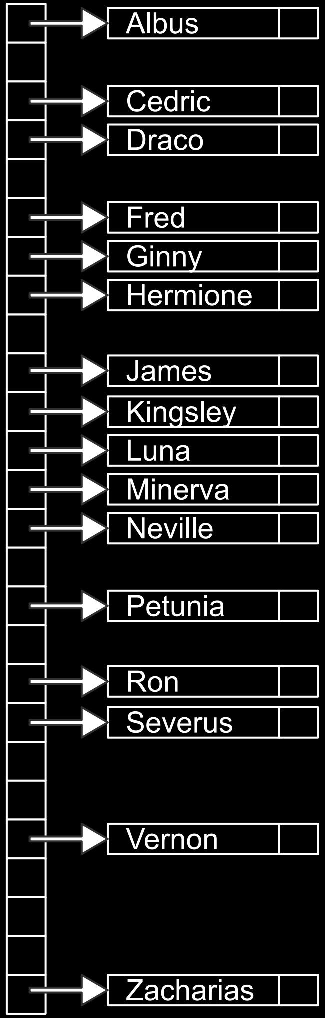
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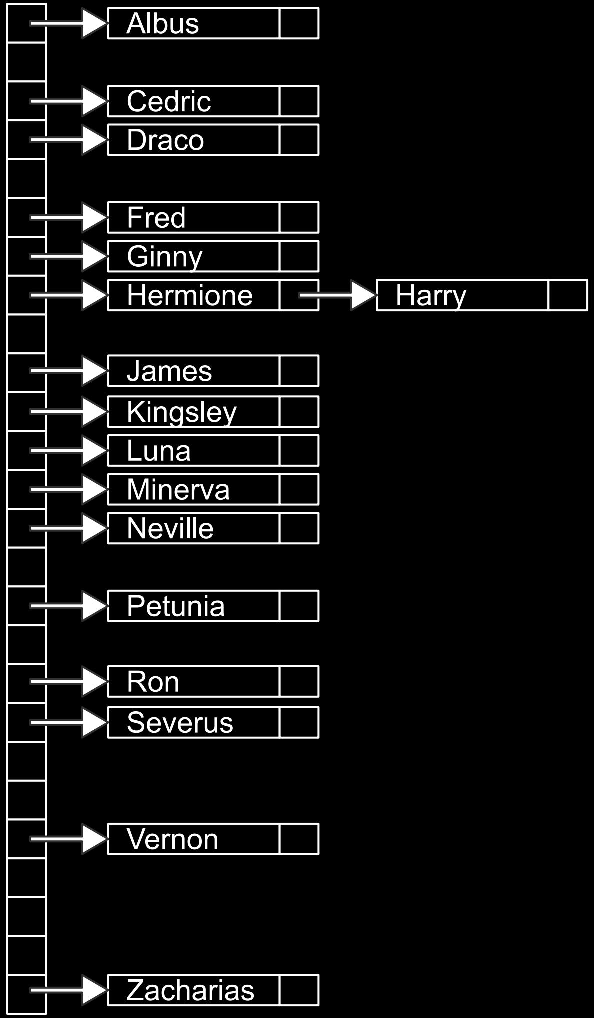
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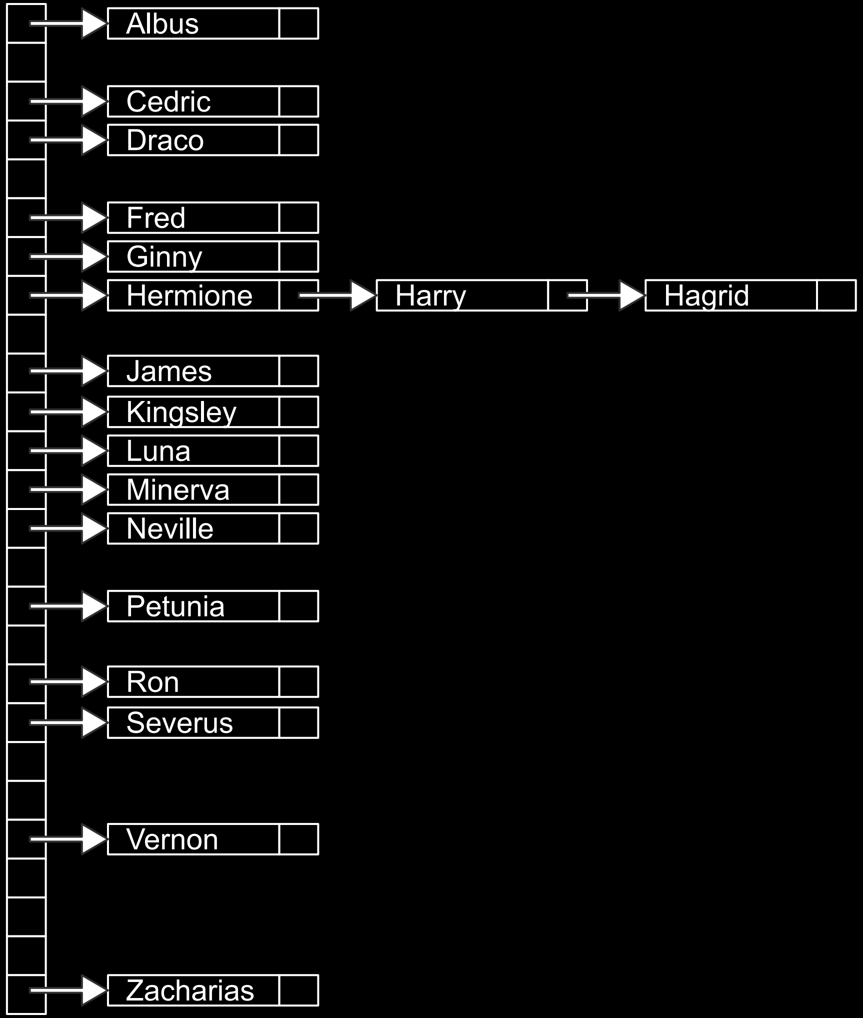
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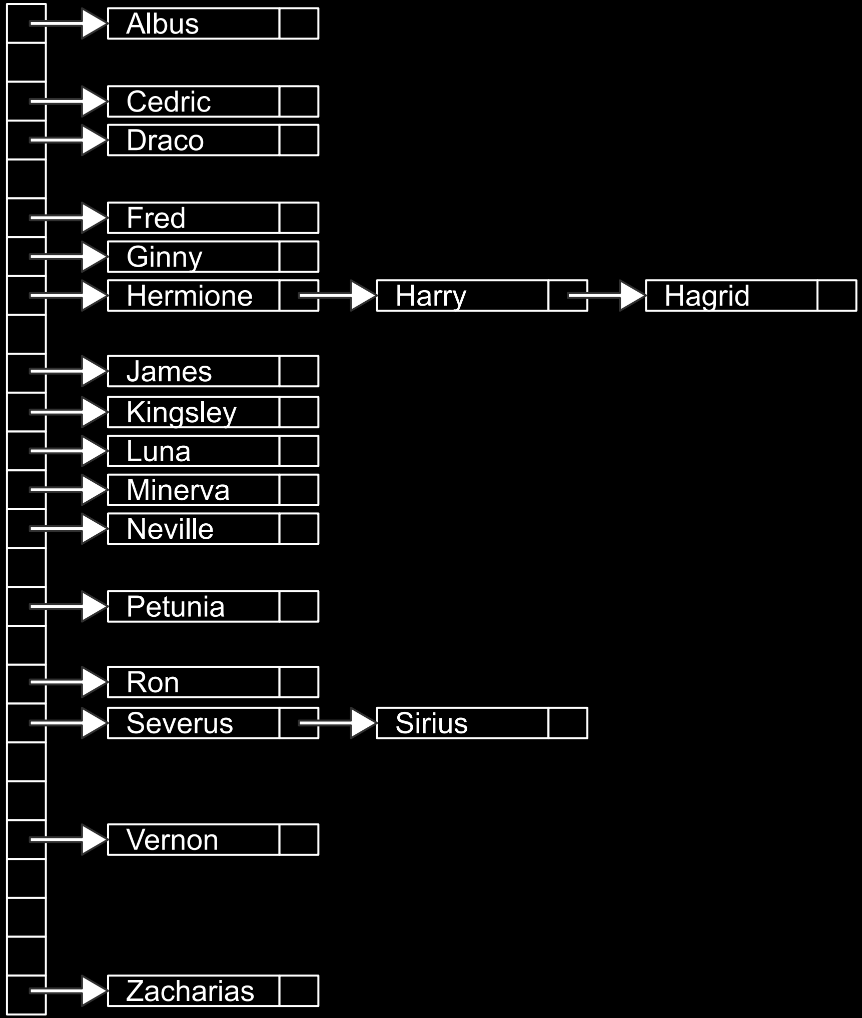
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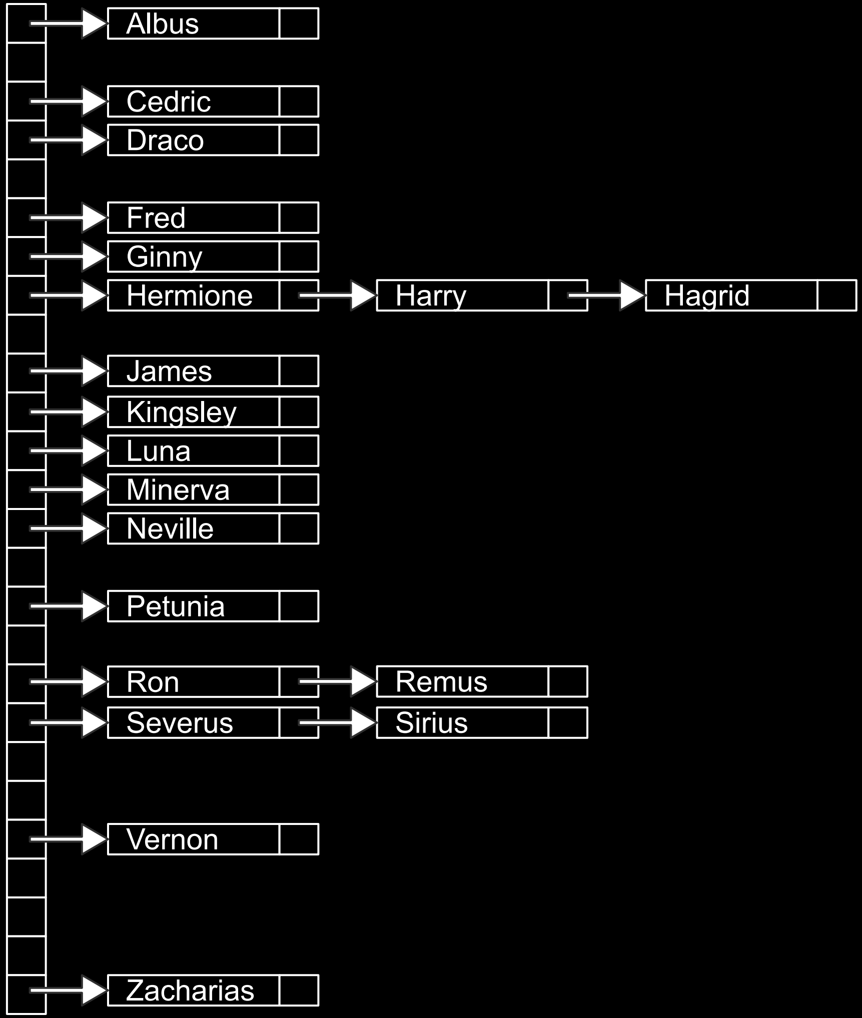
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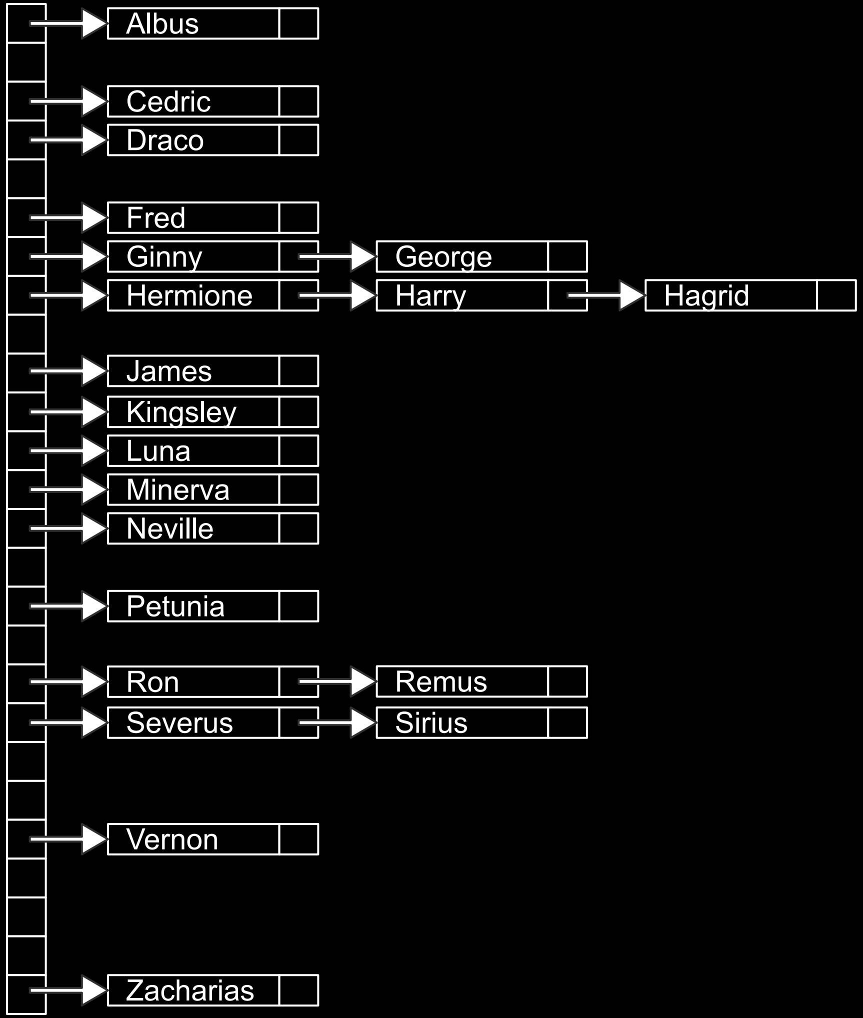
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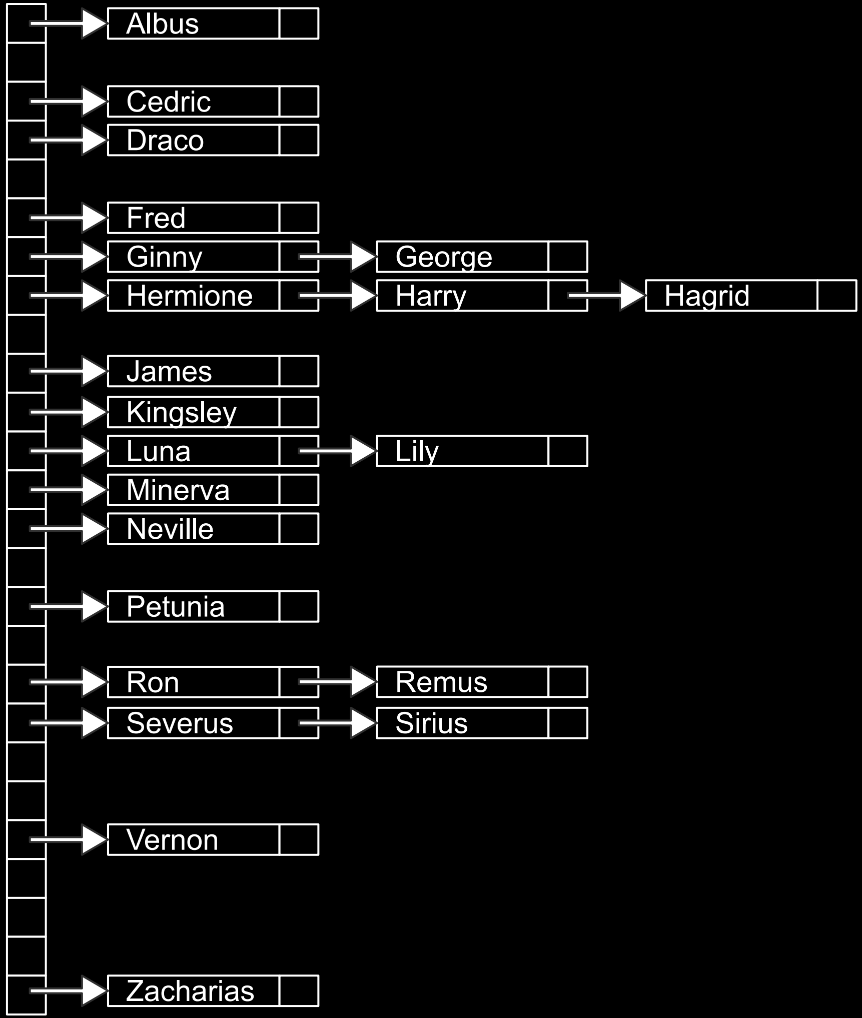
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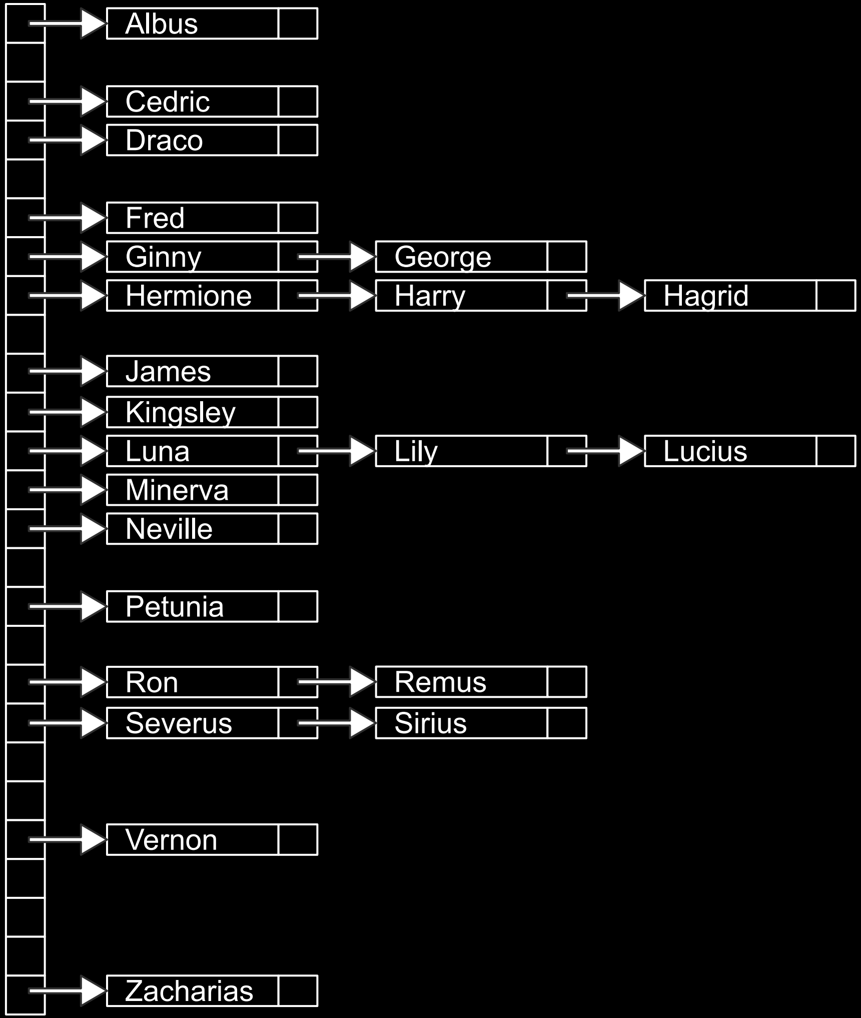
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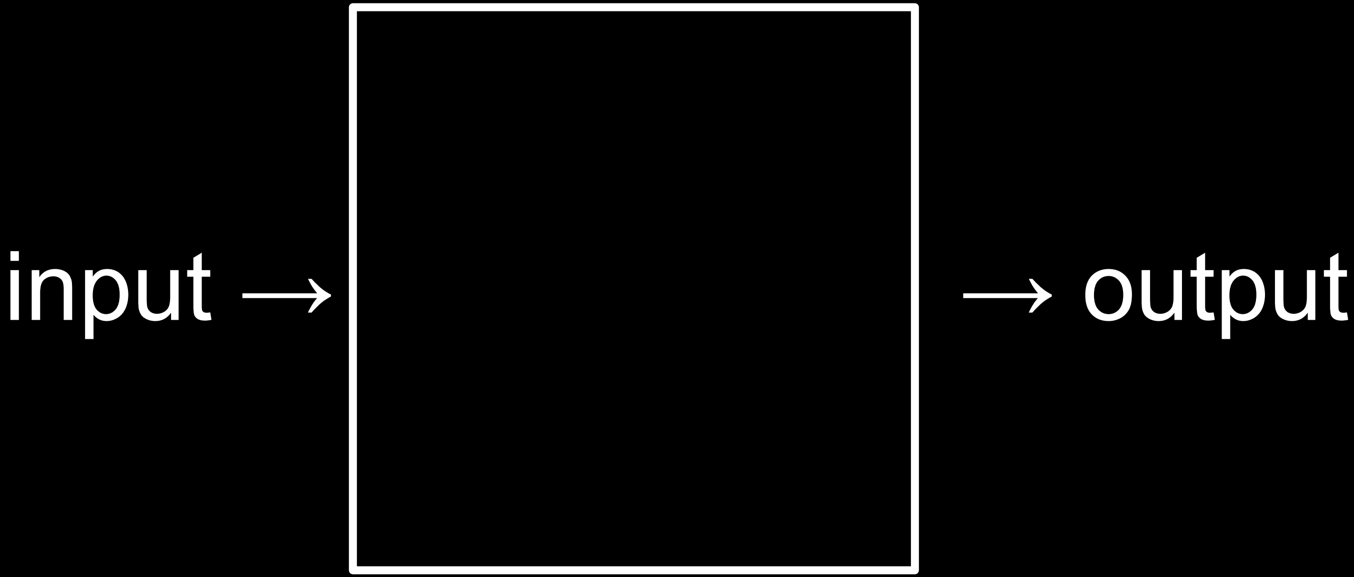
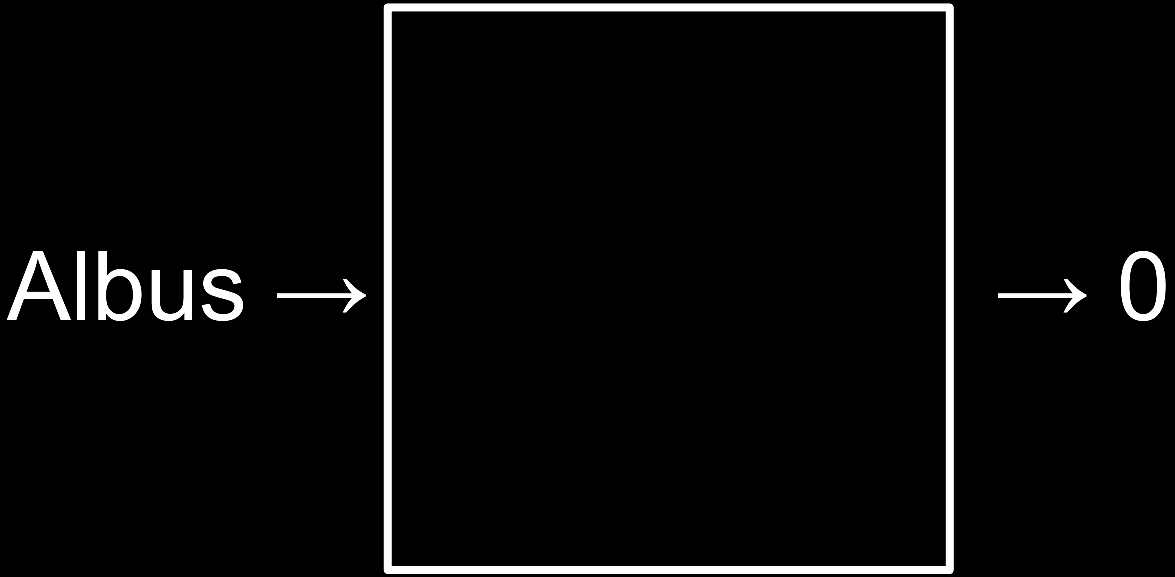

input
output

hash function


Albus
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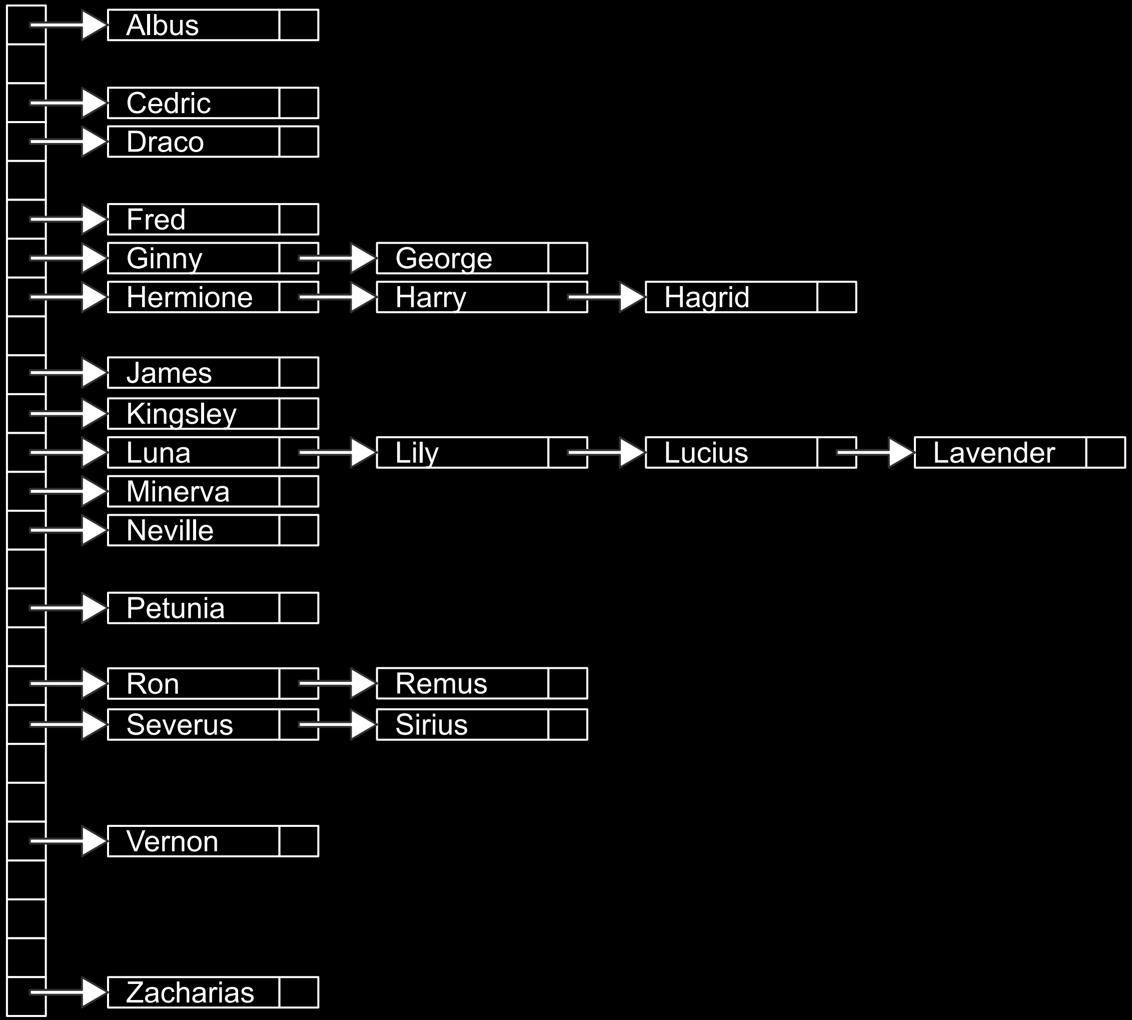
$$\text{Zacharias} \rightarrow \boxed{} \rightarrow 25$$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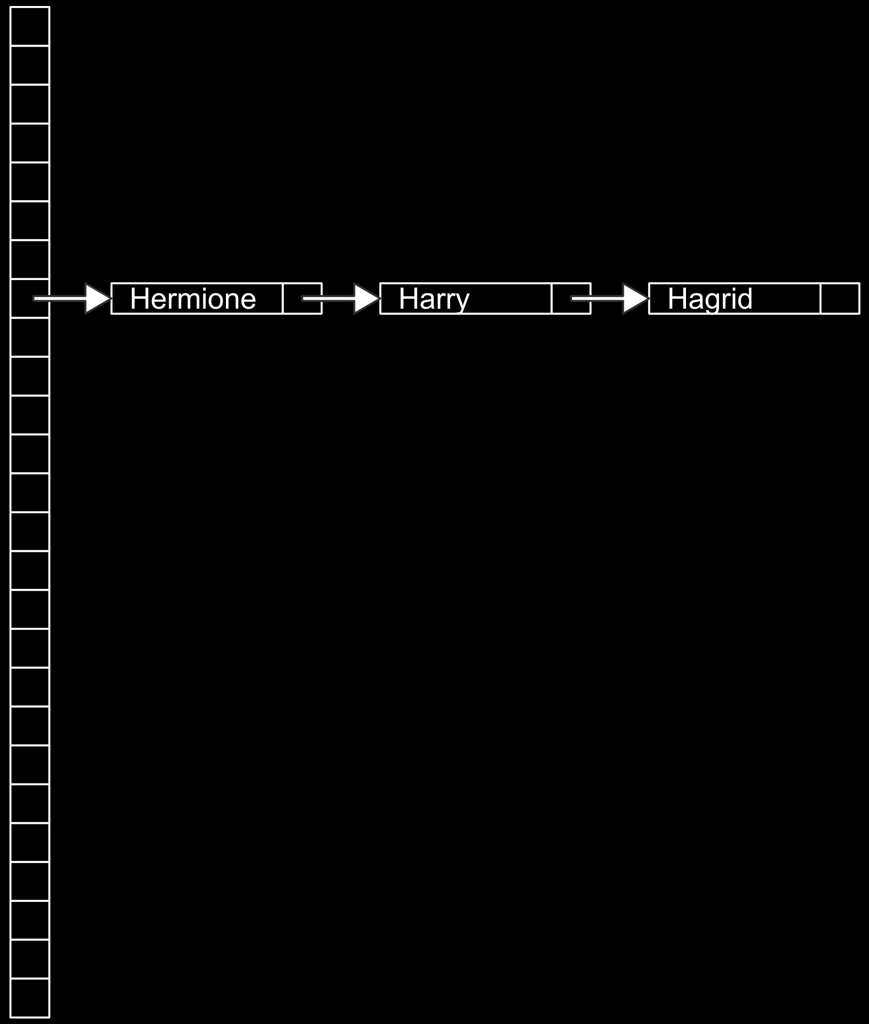
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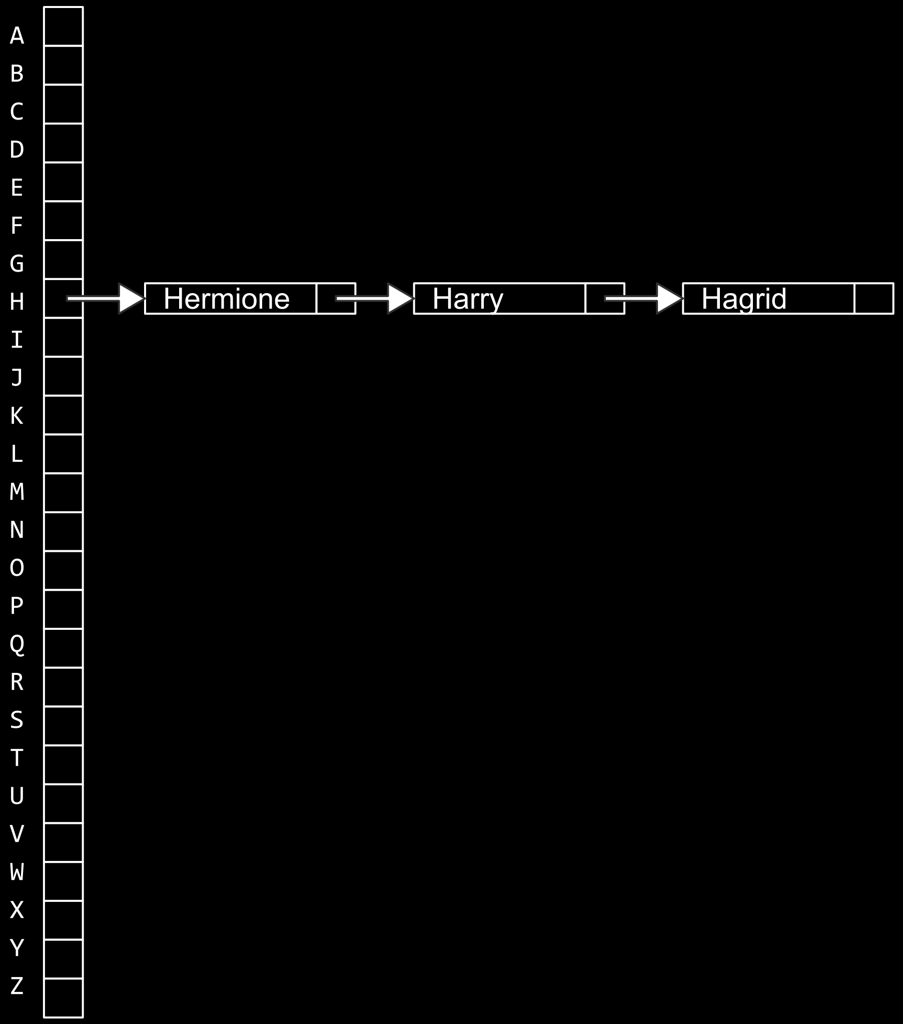
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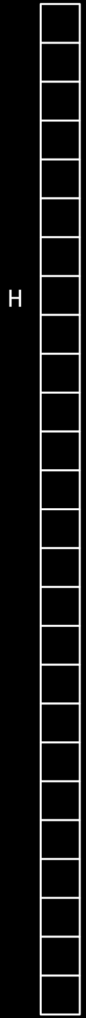
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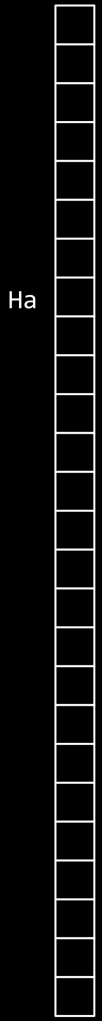
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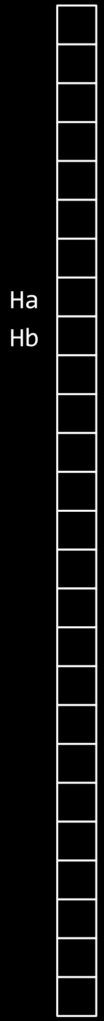
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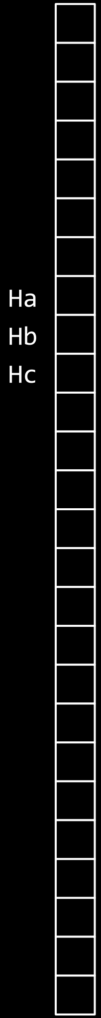
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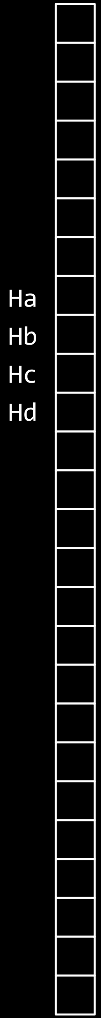
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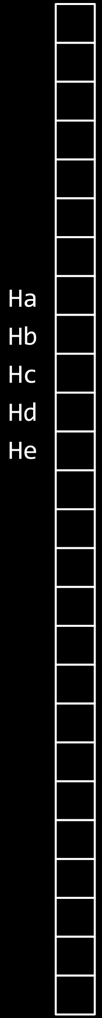
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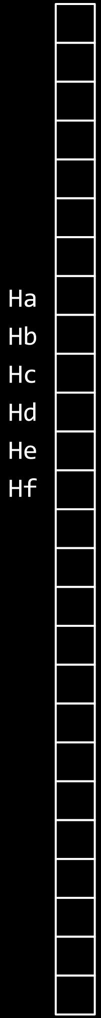
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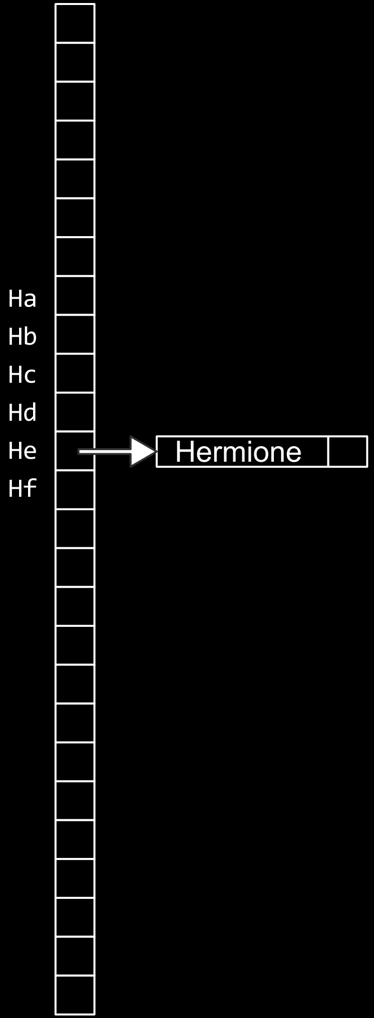
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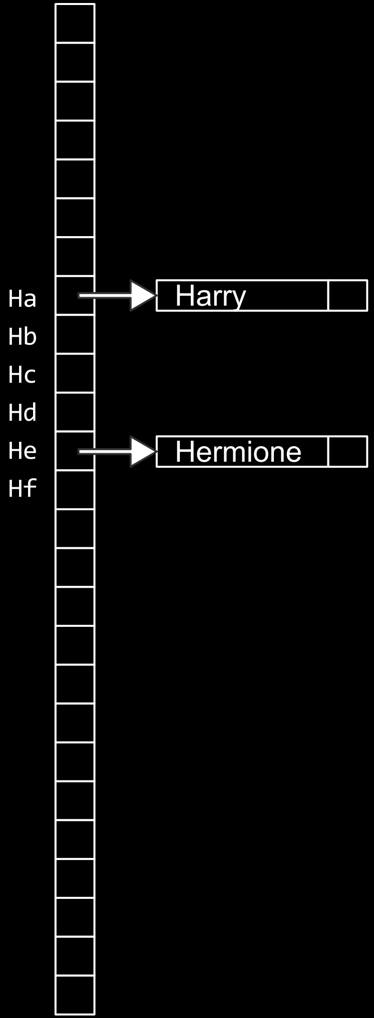
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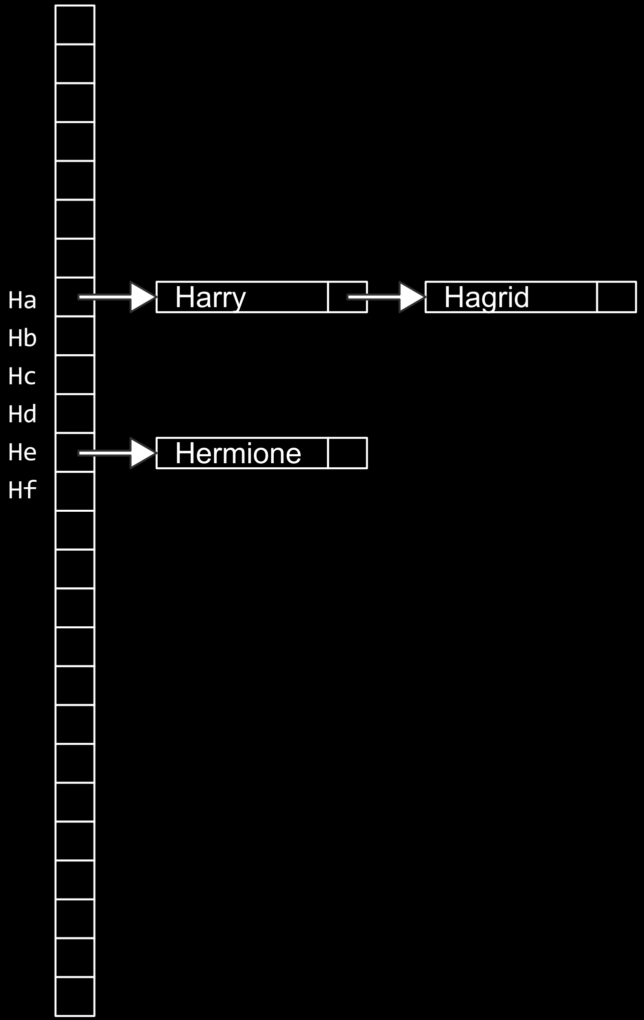
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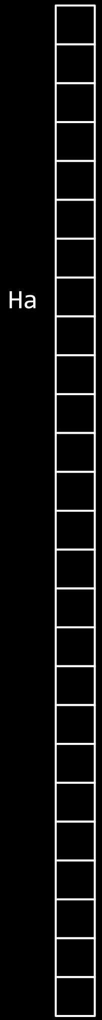
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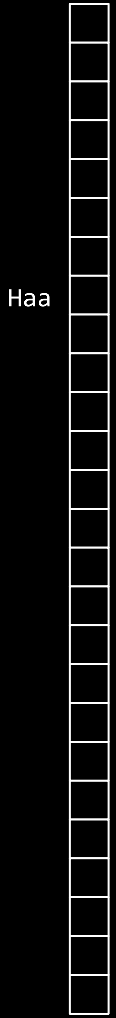
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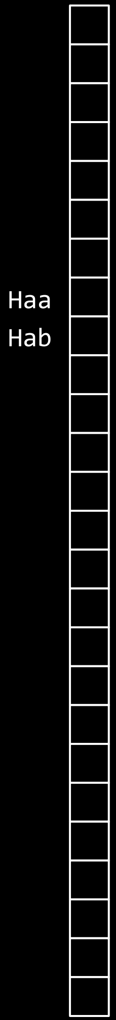
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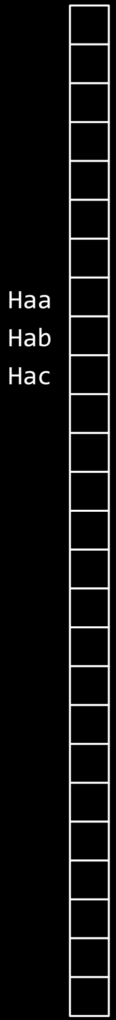
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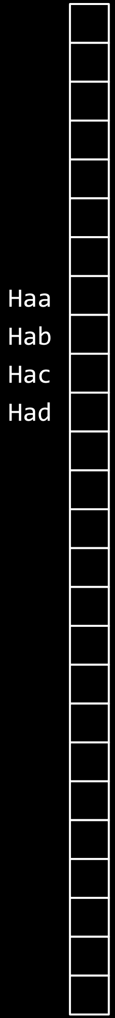
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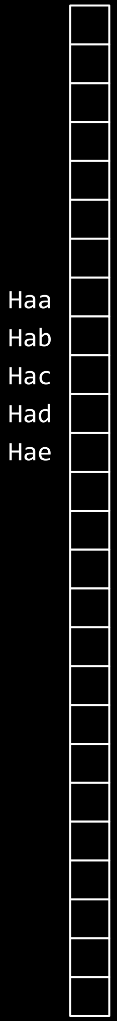
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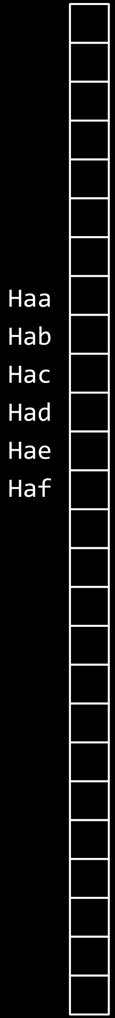
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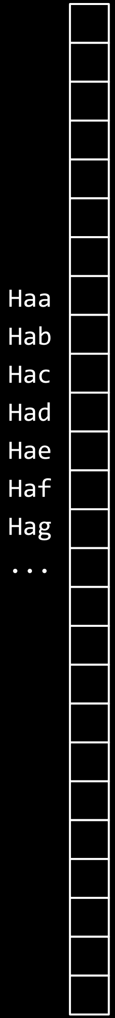
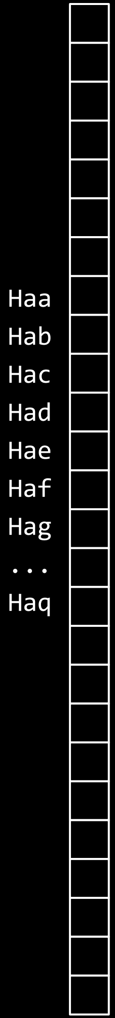
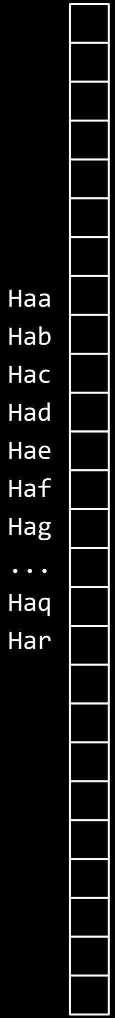
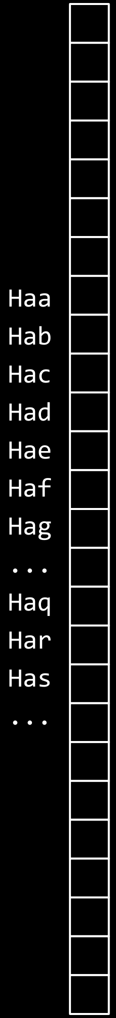
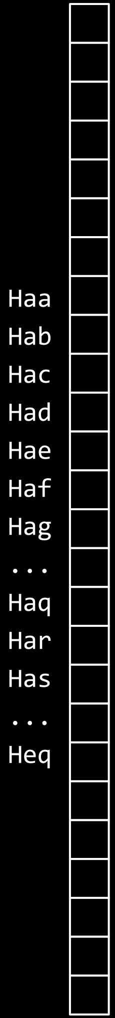
Hae
Haf

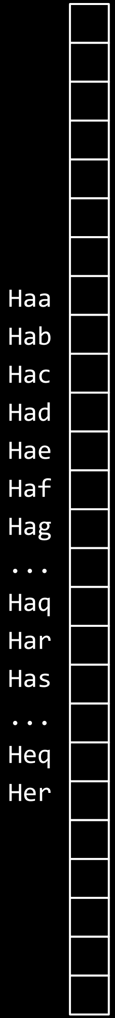

Haa
Hab
Hac
Had
Hae
Haf
Hag
...

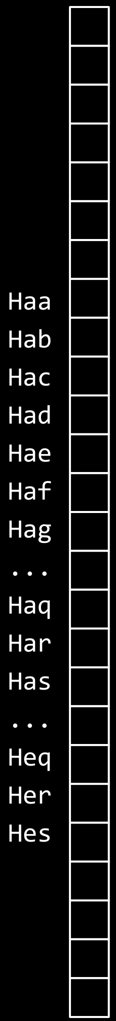

Haa
Hab
Hac
Had
Hae
Haf
Hag
...
Haq

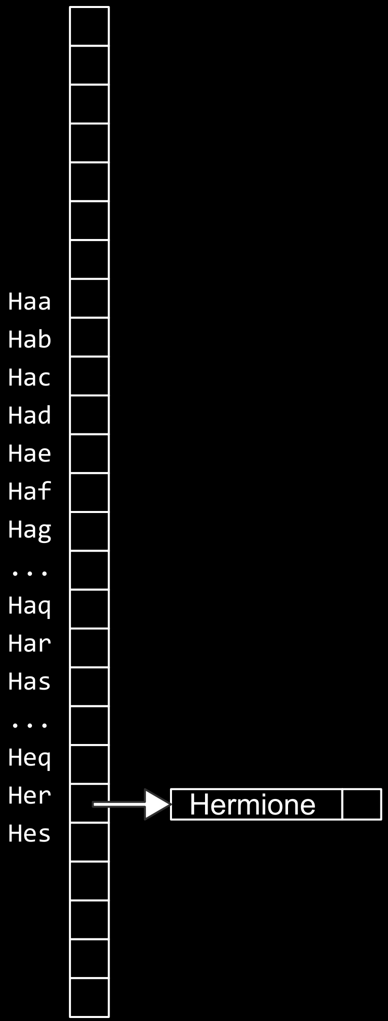

Haa
Hab
Hac
Had
Hae
Haf
Hag
...
Haq
Har

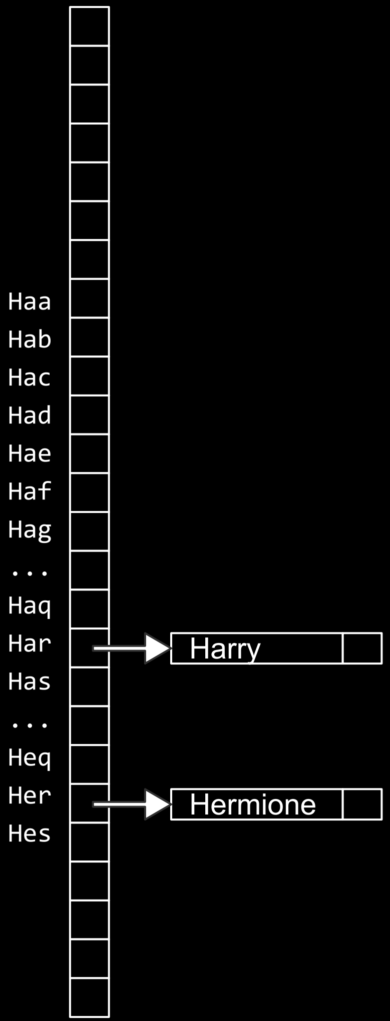

Haa
Hab
Hac
Had
Hae
Haf
Hag
...
Haq
Har
Has
...

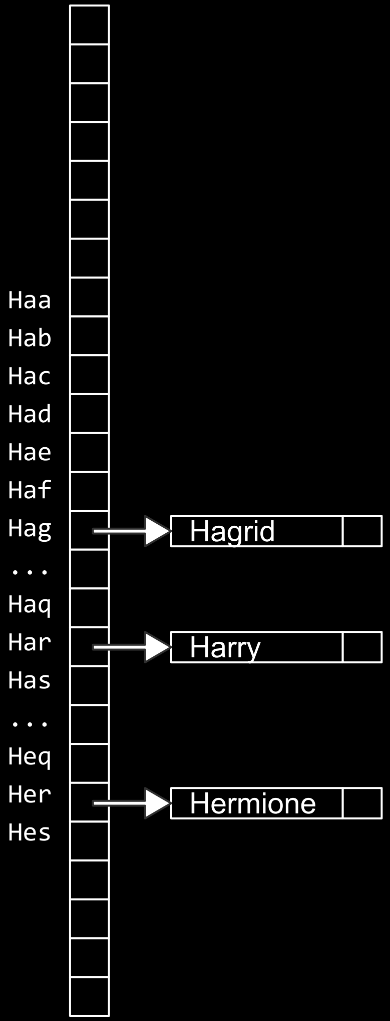

Haa
Hab
Hac
Had
Hae
Haf
Hag
...
Haq
Har
Has
...
Heq


Haa
Hab
Hac
Had
Hae
Haf
Hag
...
Haq
Har
Has
...
Heq
Her


Haa
Hab
Hac
Had
Hae
Haf
Hag
...
Haq
Har
Has
...
Heq
Her
Hes


Haa
Hab
Hac
Had
Hae
Haf
Hag
...
Haq
Har
Has
...
Heq
Her
Hes
Hermione


Haa
Hab
Hac
Had
Hae
Haf
Hag
...
Haq
Har
Has
...
Heq
Her
Hes
Harry
Hermione


Haa
Hab
Hac
Had
Hae
Haf
Hag
...
Haq
Har
Has
...
Heq
Her
Hes
Hagrid
Harry
Hermione

$O(n^2)$

$O(n \log n)$

$O(n)$

$O(\log n)$

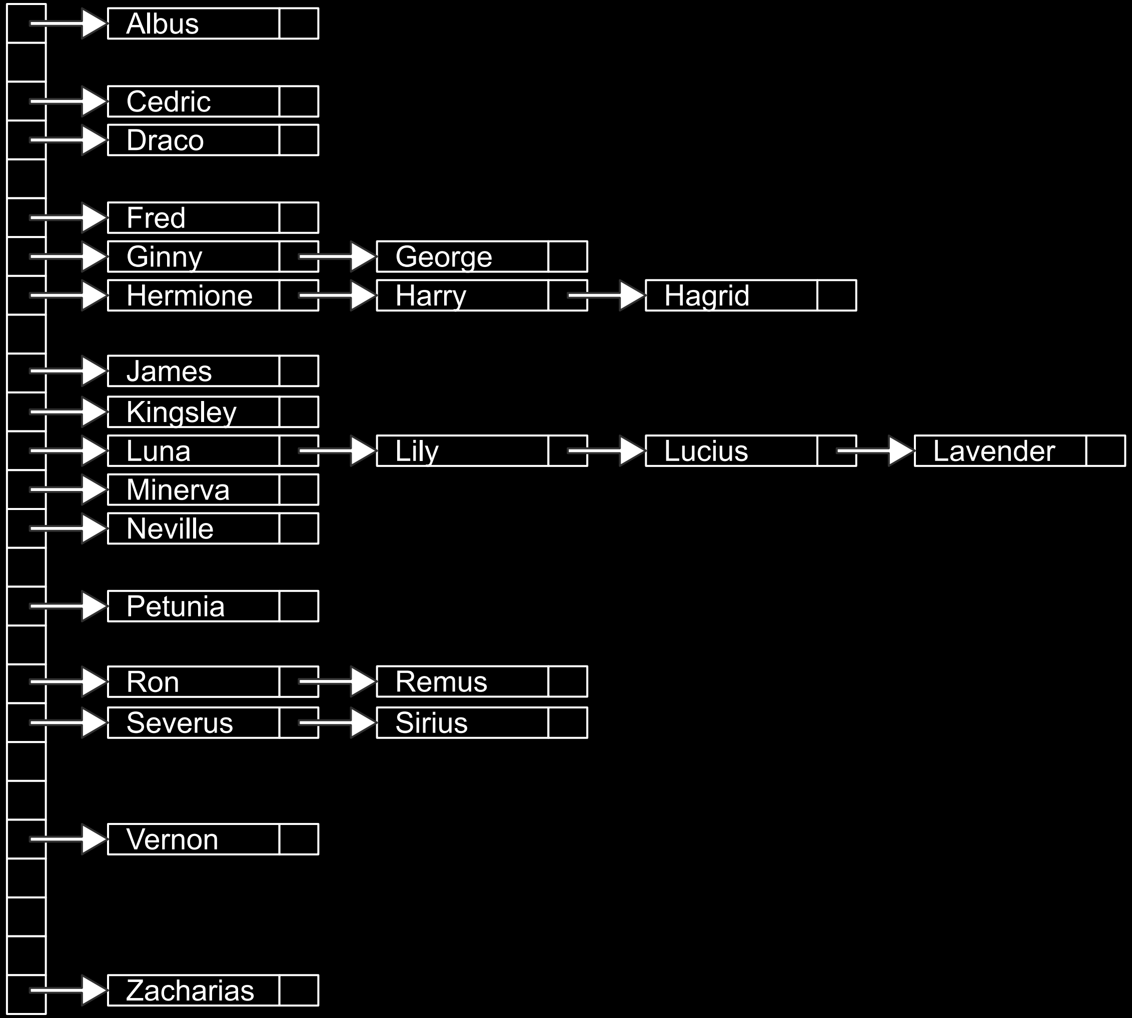
$O(1)$

$O(n^2)$	
$O(n \log n)$	
$O(n)$	
$O(\log n)$	
$O(1)$	search

$O(n^2)$	
$O(n \log n)$	
$O(n)$	search
$O(\log n)$	
$O(1)$	

$O(n^2)$	
$O(n \log n)$	
$O(n)$	search, insert
$O(\log n)$	
$O(1)$	

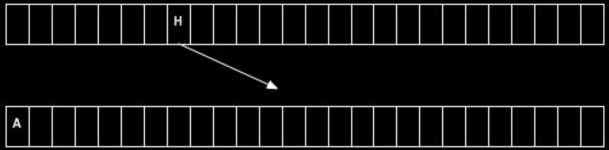
$O(n^2)$	
$O(n \log n)$	
$O(n)$	search
$O(\log n)$	
$O(1)$	insert

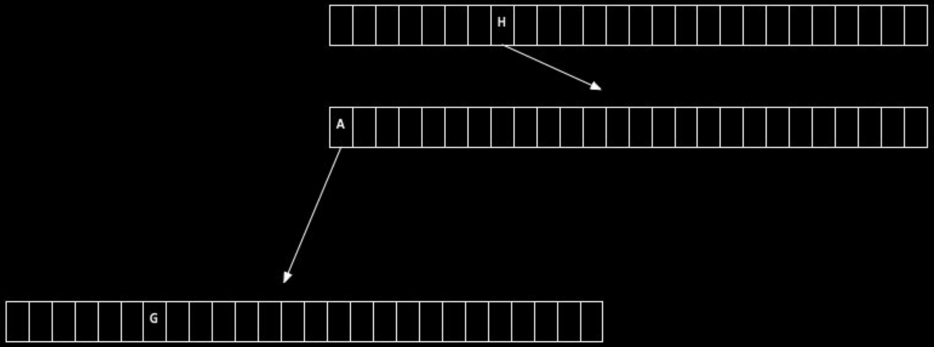

Albus
Cedric
Draco
Fred
Ginny
George
Hermione
Harry
Hagrid
James
Kingsley
Luna
Lily
Lucius
Lavender
Minerva
Neville
Petunia
Ron
Remus
Severus
Sirius
Vernon
Zacharias

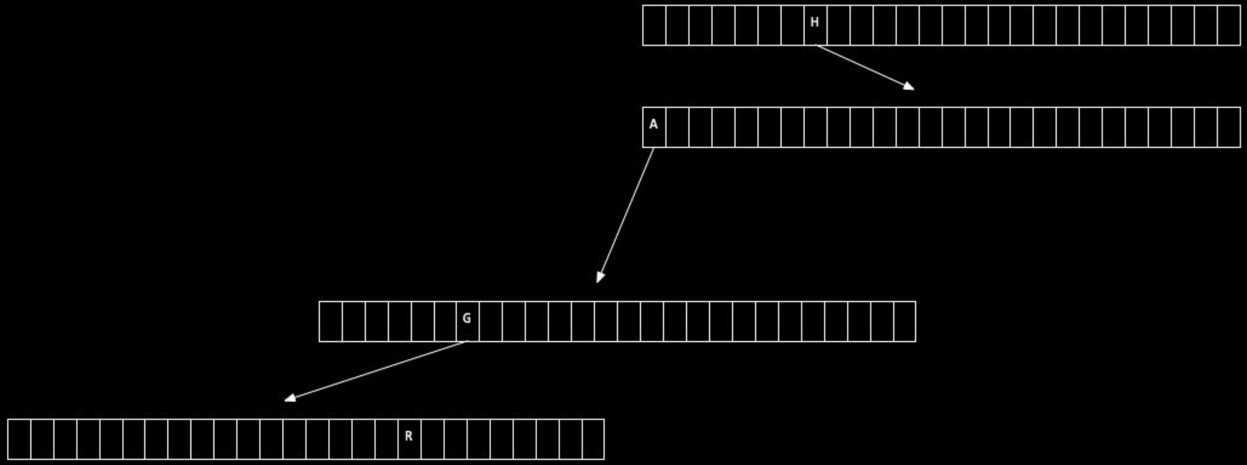
tries

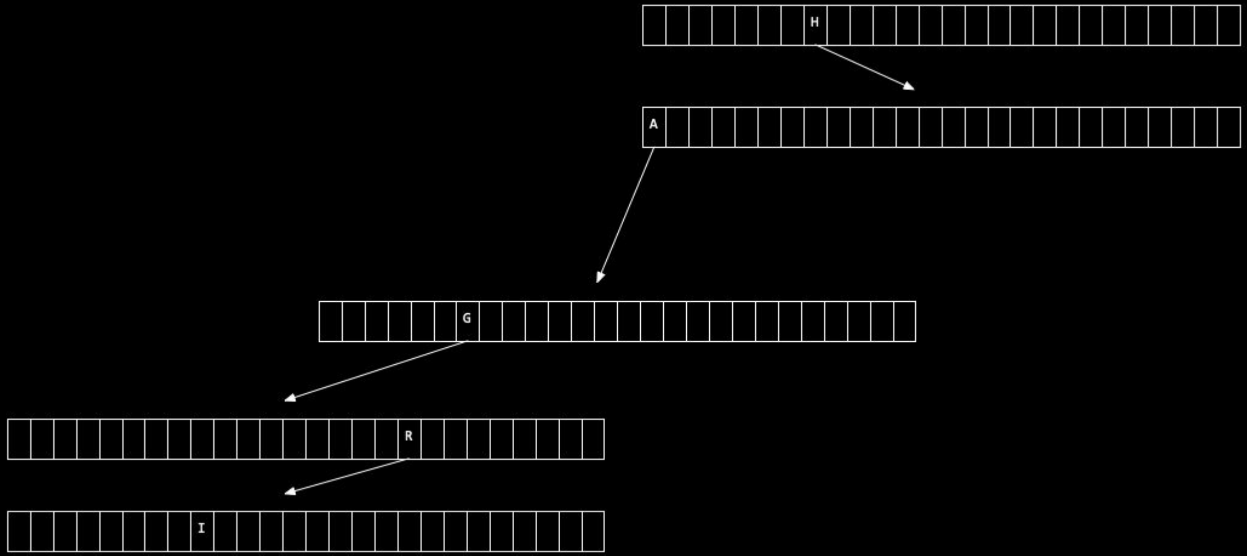
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

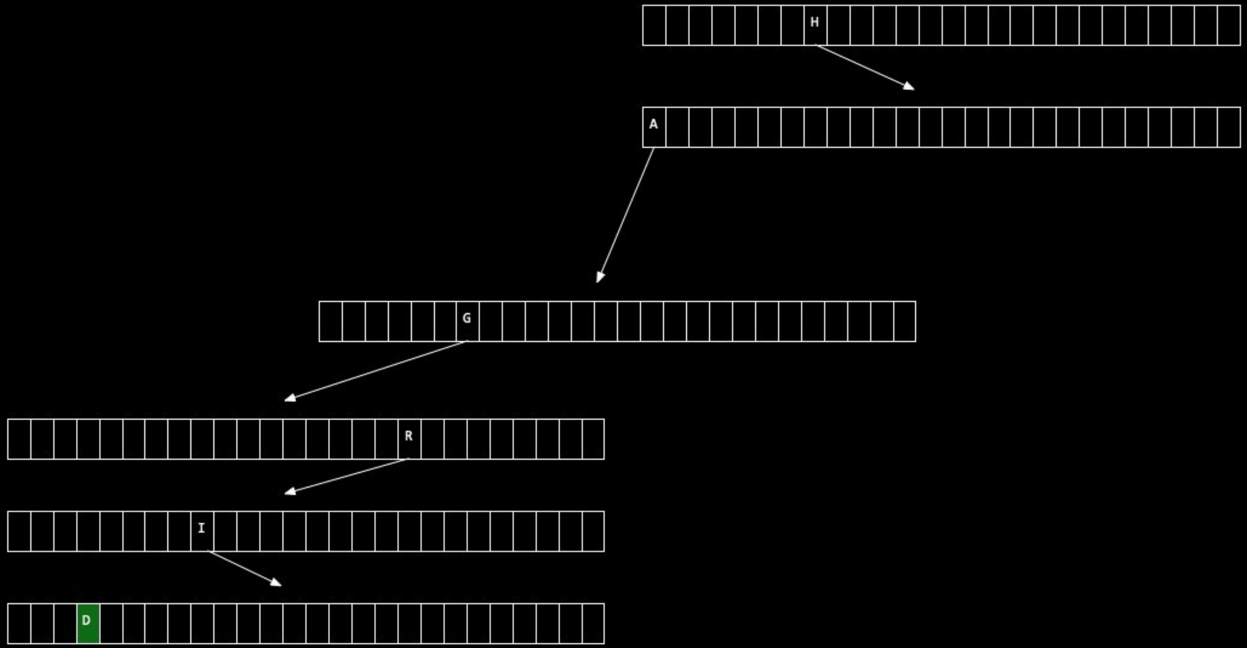
							H																		


H
A


H
A
G


H
A
G
R


H
A
G
R
I


H
A
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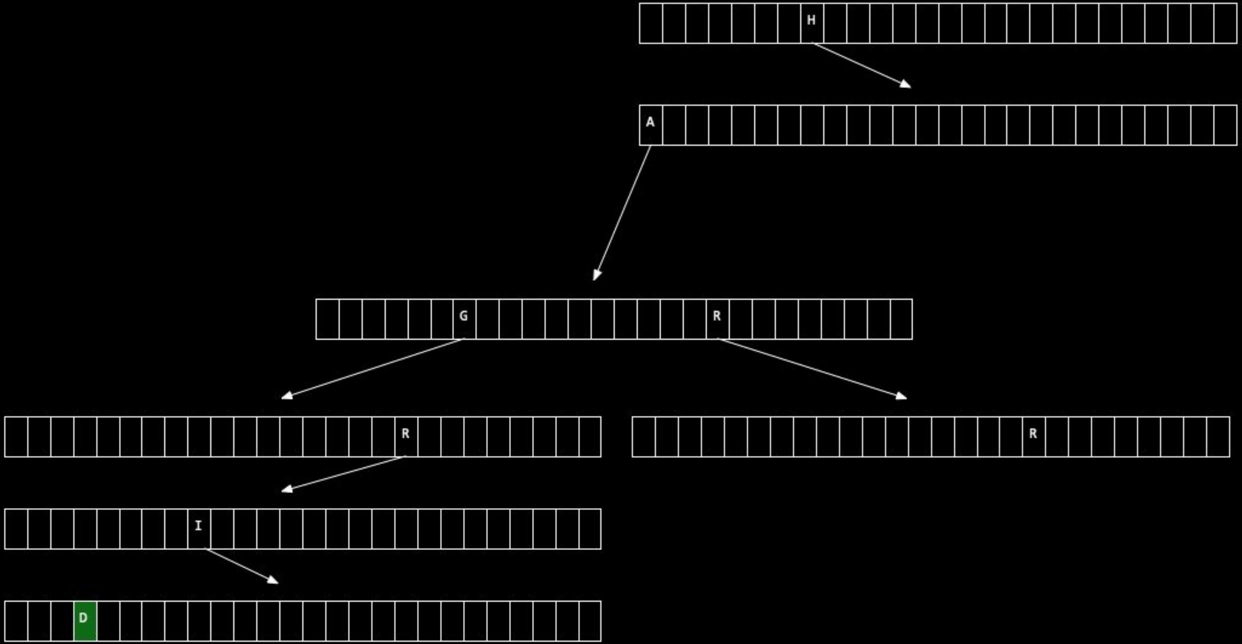
D


H
A
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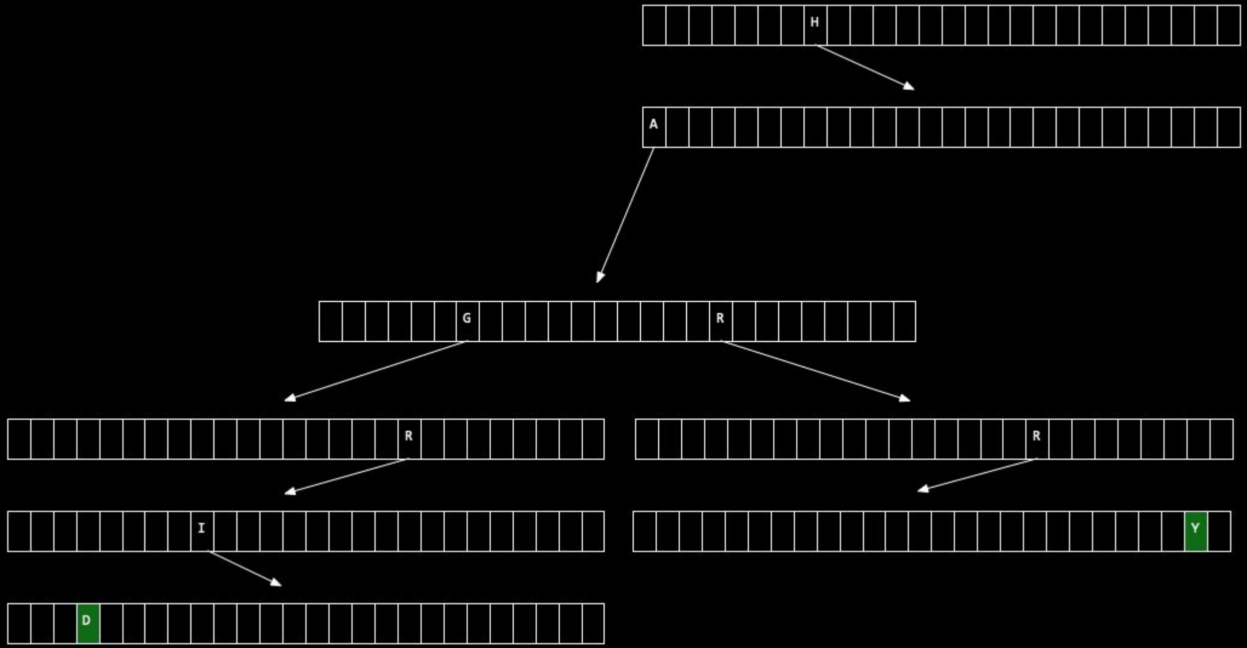
R
R
I
D


H
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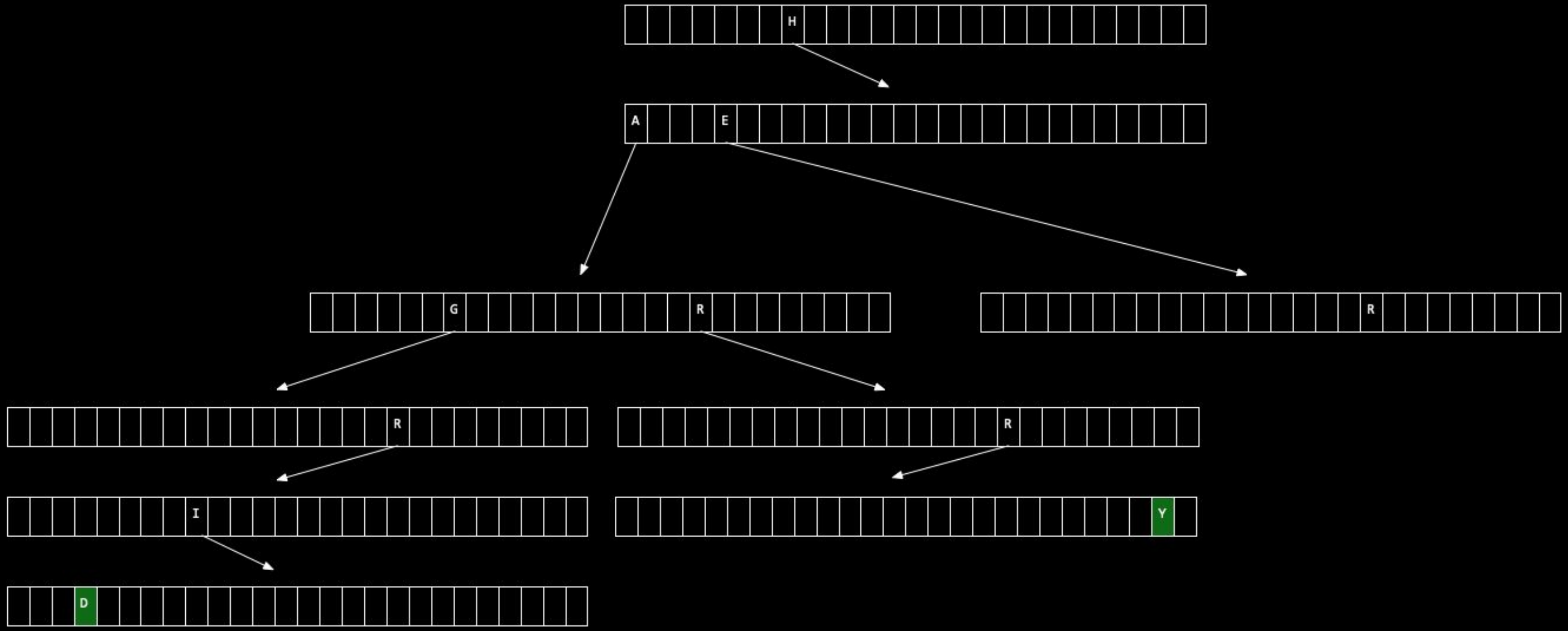
Y
D


H
A
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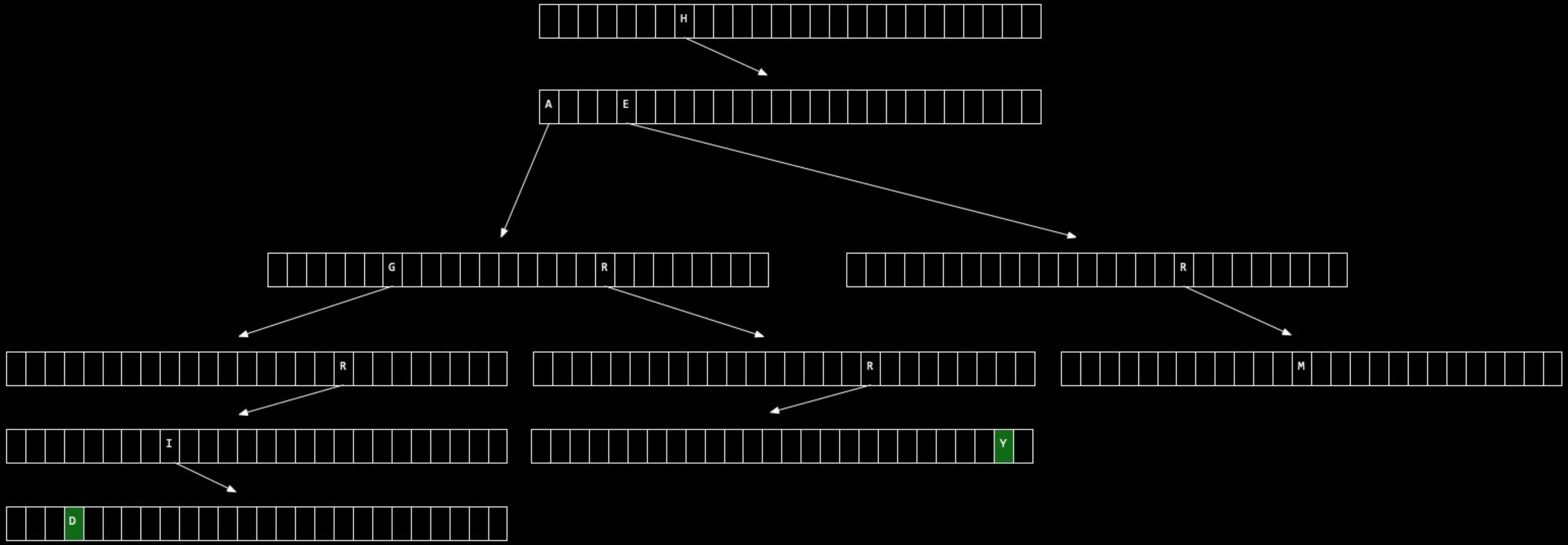
D


H
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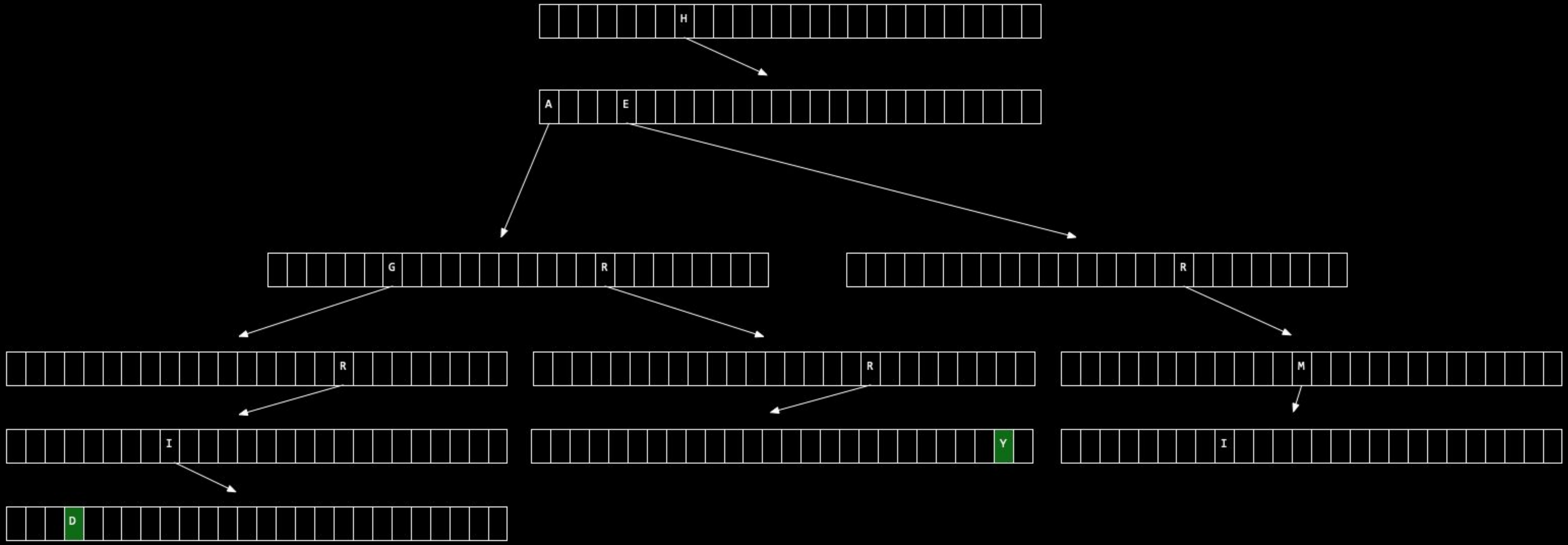
H
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R
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M
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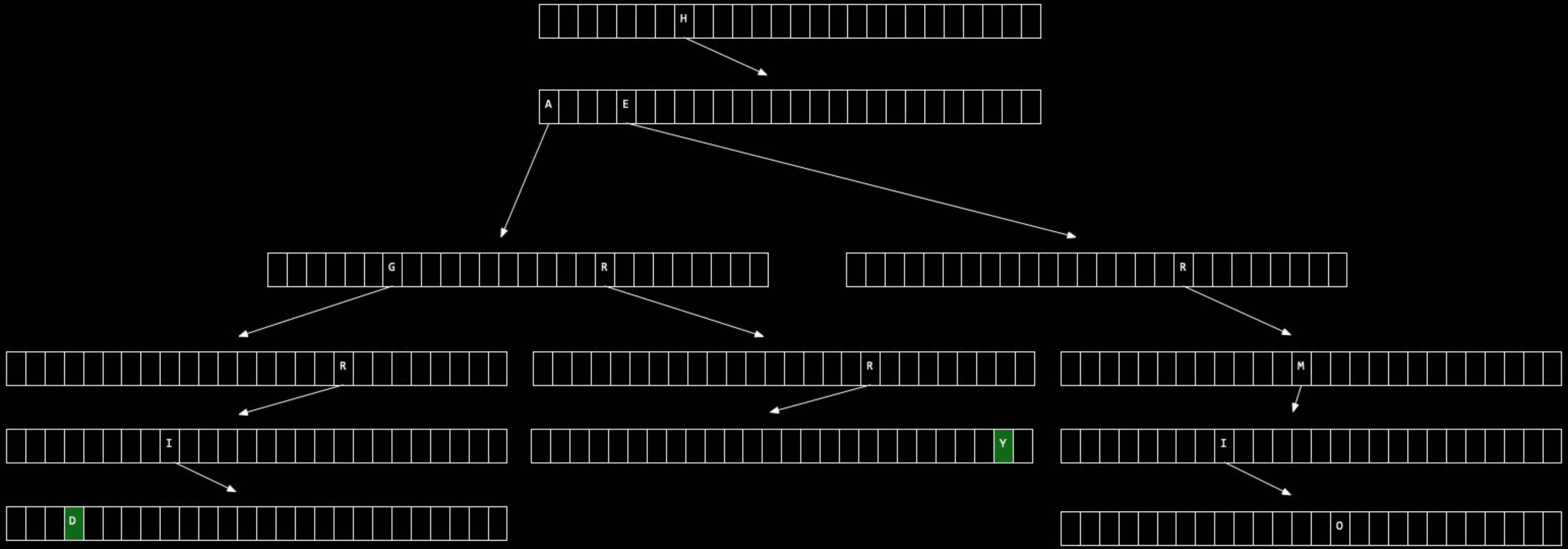
Y
I
D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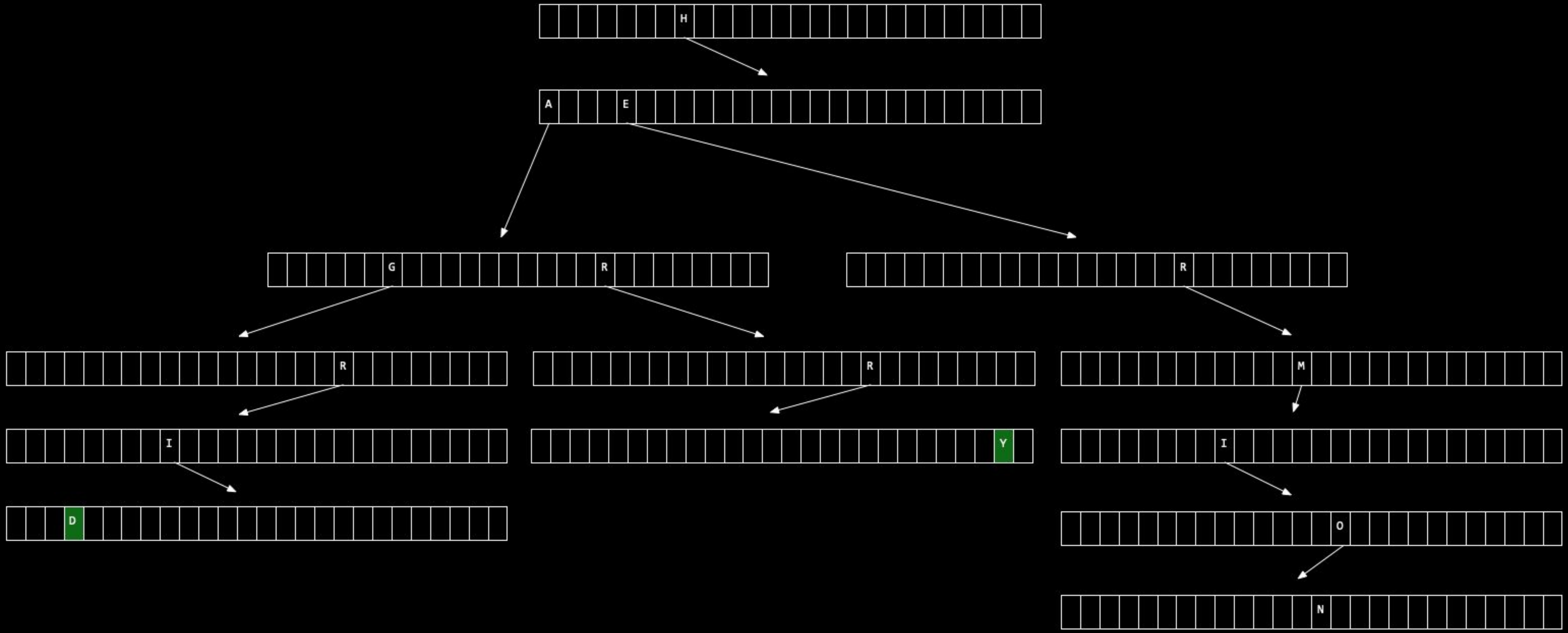
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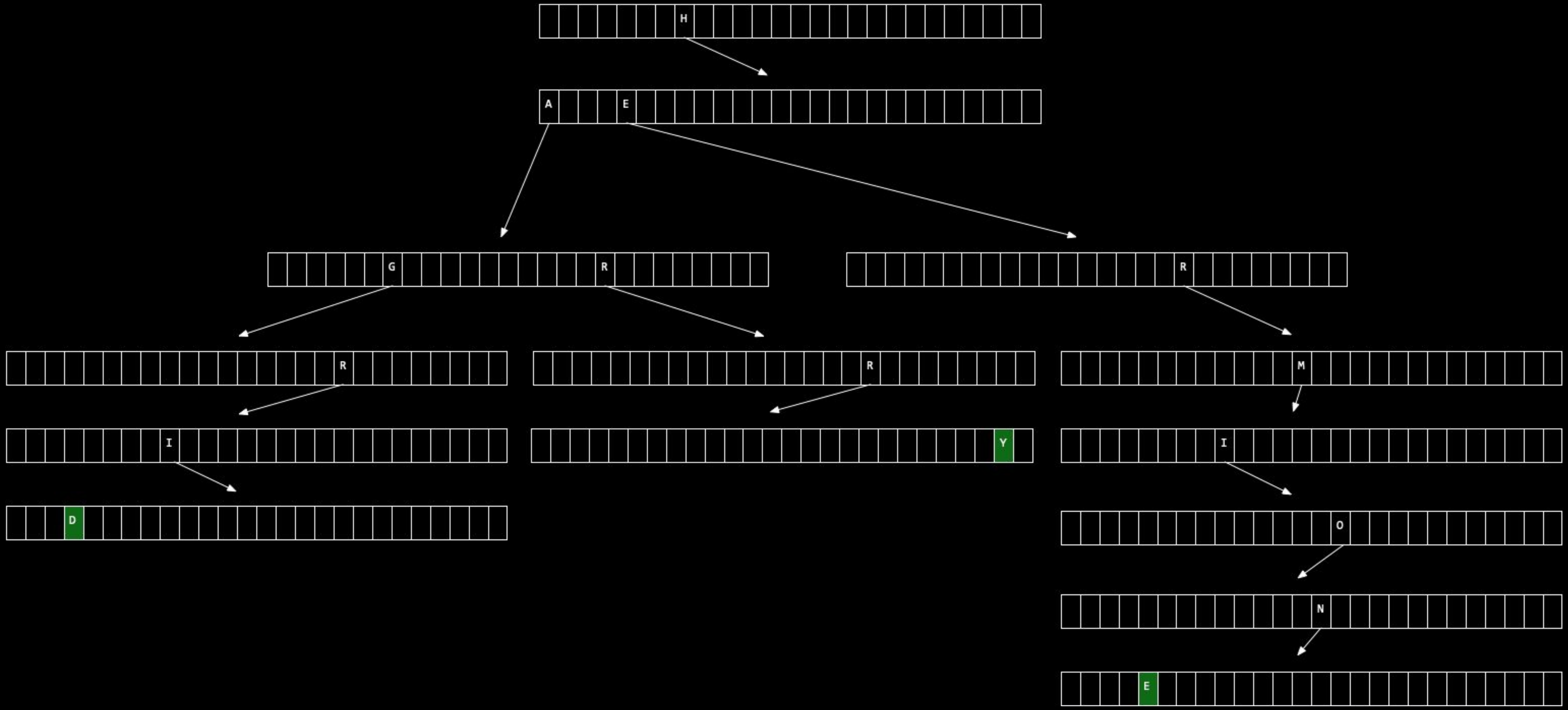
H
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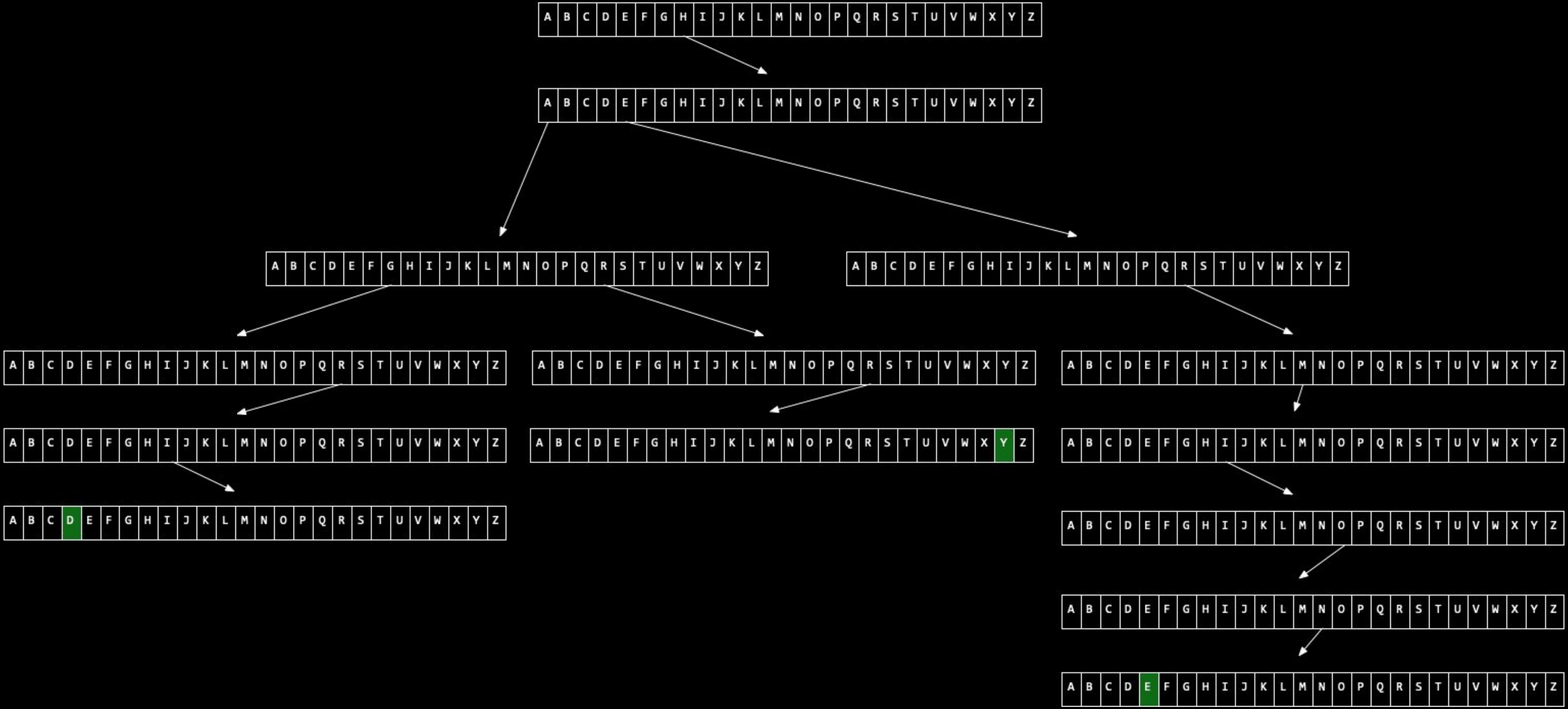

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
A B C D E F G H I J K L M N O P Q R S T U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

$O(n^2)$

$O(n \log n)$

$O(n)$

$O(\log n)$

$O(1)$

$O(k)$ search

$O(k)$ search, insert

$O(1)$ search, insert

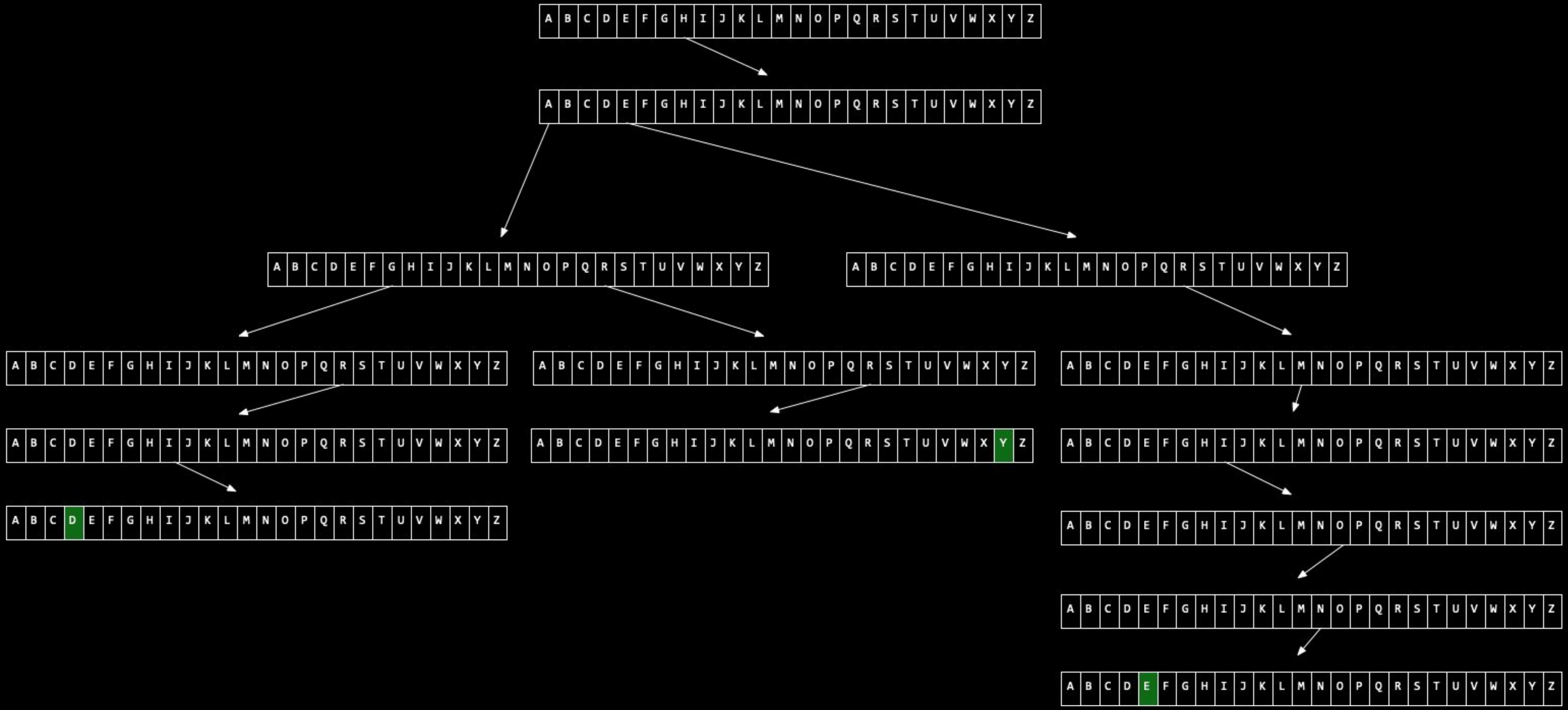
$O(n^2)$

$O(n \log n)$

$O(n)$

$O(\log n)$

$O(1)$	search, insert


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
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
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
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
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
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
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
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
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
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
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
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
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
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
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

abstract data structures

queues

enqueue

dequeue

FIFO

stacks

push

pop

LIFO

dictionaries

ICK ME UP
CHOKIN
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This is CS50