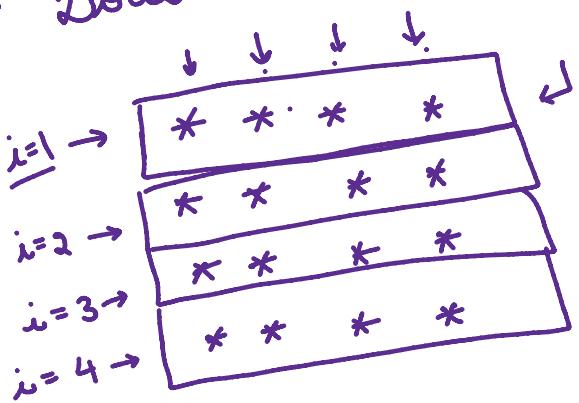


→ Patterns

→ loops (while, Do while)

→ Doubts

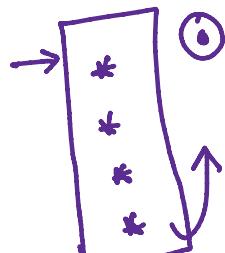
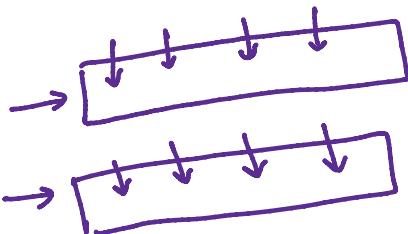


Nested for loop.

Outer Loop → Rows
Inner Loop → Column

```
for (int i = 1; i <= 4; i++) {
    for (int j = 1; j <= 4; j++) {
        cout << "*";
        cout << endl;
    }
}
```

✓
 $i=1 \rightarrow$ 1 1 1 1
 $i=2 \rightarrow$ 2 2 2 2
 3 3 3 3
 4 4 4 4



1. for (int i = 1; i <= 4; i++) {

- n

```

for (int i=1; i<=4; i++) {
    for (int j=1; j<=4; j++) {
        cout << i;
    }
    cout << endl;
}

```

	j=1	j=2	j=3	j=4
i=1	1	2	3	4
i=2	1	2	3	4
i=3	1	2	3	4
i=4	1	2	3	4
.

```

cm >> n;
for (int i=1; i<=n; i++) {
    for (int j=1; j<=n; j++) {
        cout << j;
    }
    cout << endl;
}

```

1234
cout << j

1 2 3 4 cout << j << " ";

$N=4$.

$i=1: i^{\circ} \leq N$

True: j loop.

j = 1: $j \leq N$ j++
True

j = 2: $j \leq N$ j++
True

... : $j = N$: ++

1 2 3 4
1 2 3 4
1 2 3 4
1 2 3 4

1 2 3 4

.

True

j=3 j <= N
True j++

j=4 j <= N
True j++

j=5 j <= N
false

j++

i=2: i <= N
True

j Loop. j=1 j <= N
true j++

j=2 j <= N
true j++

j=3 j <= N
true j++

j=4 j <= N
true j++

j=5 j <= N
false

i++

i=3 i <= N
True j Loop. j=1 j <= N
true j++

j=2 j <= N
true j++

j=3 j <= N
true j++

j=4 j <= N
true j++

$j=5$ $j \leq N$
false
`cout << endl;`

$i++$

$i=4$ $i \leq N$
true

j loop

$j=1$ $j \leq N$
true

$j++$

$j=2$ $j \leq N$
true

$j++$

$j=3$ $j \leq N$
true

$j++$

$j=4$ $j \leq N$
true

$j++$

$j=5$ $j \leq N$
false

`cout << endl;`

$i++$

$i=5$ $i \leq N$
false

$N=4$

1 2 3 4

1 2 3 4

1 2 3 4

1 2 3 4

$N=4$

~~$i=1$ 2 2 2 2~~
 $i=2$ 4 4 4 4

$i=1$
 $i=2 \quad 4 \quad 4 \quad 4 \quad 4$
 $i=3 \quad 6 \quad 6 \quad 6 \quad 6$
 $i=4 \quad 8 \quad 8 \quad 8 \quad 8$

```

for (int i = 1; i <= N; i++) {
    for (int j = 1; j <= N; j++) {
        cout << 2 * ij;
    }
    cout << endl;
}

```

$N=4$

	$j=1$	2	3	4
$i=2$	2	2	2	2
$i=4$	4	4	4	4
$i=6$	6	6	6	6
$i=8$	8	8	8	8

$2 \times N$

$N=5$

```
for (int i = 2; i <= 2 * N; i += 2)
```

$N = 5$
Rows

$M = 3$
Columns

	$j=1$	2	3
$i=1$	*	*	*
2	*	*	*
3	*	*	*
4	*	*	*
5	*	*	*

$i=2$
 $i=4$
 $i=6$
 $i=8$
 $i=10$

Outer Loop \rightarrow No. of Rows

```
for (int i=1; i<= N; i++) {  
    for (int j=1; j<=M; j++) {  
        cout << "*";  
    }  
    cout << endl;  
}
```

$N=5$

i=1 *
i=2 * *
i=3 * * *
* * * *
* * * * *

i=1 1 star
i=2 2 stars
i=3 3 stars

No. of columns \rightarrow Row No.

j \rightarrow i

```
for (int i=1; i<= N; i++) {  
    for (int j=1; j<=i; j++) {  
        cout << "*";  
    }  
    cout << endl;  
}
```

}

i=1 : j=1

• -1 ?

j=i j<=i
separate lines
or same line
45
45
cin >> a >> b;

$i=1$: $j:$

$i=2 \rightarrow j=1, 2$

$i=3 \rightarrow j=1, 2, 3$

$i=4 \rightarrow j=1, 2, 3, 4$

$i=1 \rightarrow j=1 \checkmark \quad j=1$

$i=2 \rightarrow j=1 \quad j=i X$

~~$N=5$~~

$i=1$	*	*	*	*	*
$i=2$	*	*	*	*	
$i=3$	*	*	*		
$i=4$	*	*			
$i=5$	*				

$N=5$
 $(N-i+1)$ stars

$i=1:$	$5-1+1 = 5$
$i=2:$	$5-2+1 = 4$
$i=3:$	$5-3+1 = 3$
$i=4:$	$5-4+1 = 2$
$i=5:$	$5-5+1 = 1$

for (`int i=1; i<= N; i++`) {

 for (`int j=1; j<= (N-i+1); j++`) {

`cout << "*";`

 }

}

$i=5$ * * * * *
 $i=4$ * * * *
 $i=3$ * * *
 $i=2$ * *
 $i=1$ *

i stars

```

for (int i = N; i >= 1; i--) {
    for (int j = 1; j <= i; j++) {
        cout << "*";
    }
    cout << endl;
}
    
```

$N = 4$

$i=4$ * * * *
 $i=3$ * * *
 $i=2$ * *
 $i=1$ *

$i: 4 \text{ to } 1$

$j: 1 \text{ to } i$

$i = 4$: $i >= 1$ j loop * * * * ↓
 True $j=1$ $j \leq i$ $j++$ * * * * ↓
 true
 $j=2$ $j \leq i$ $j++$ * * ↓
 true
 $j=3$ $j \leq i$ $j++$ * ↓
 true
 $j=4$ $j \leq i$ $j++$ $j=5$

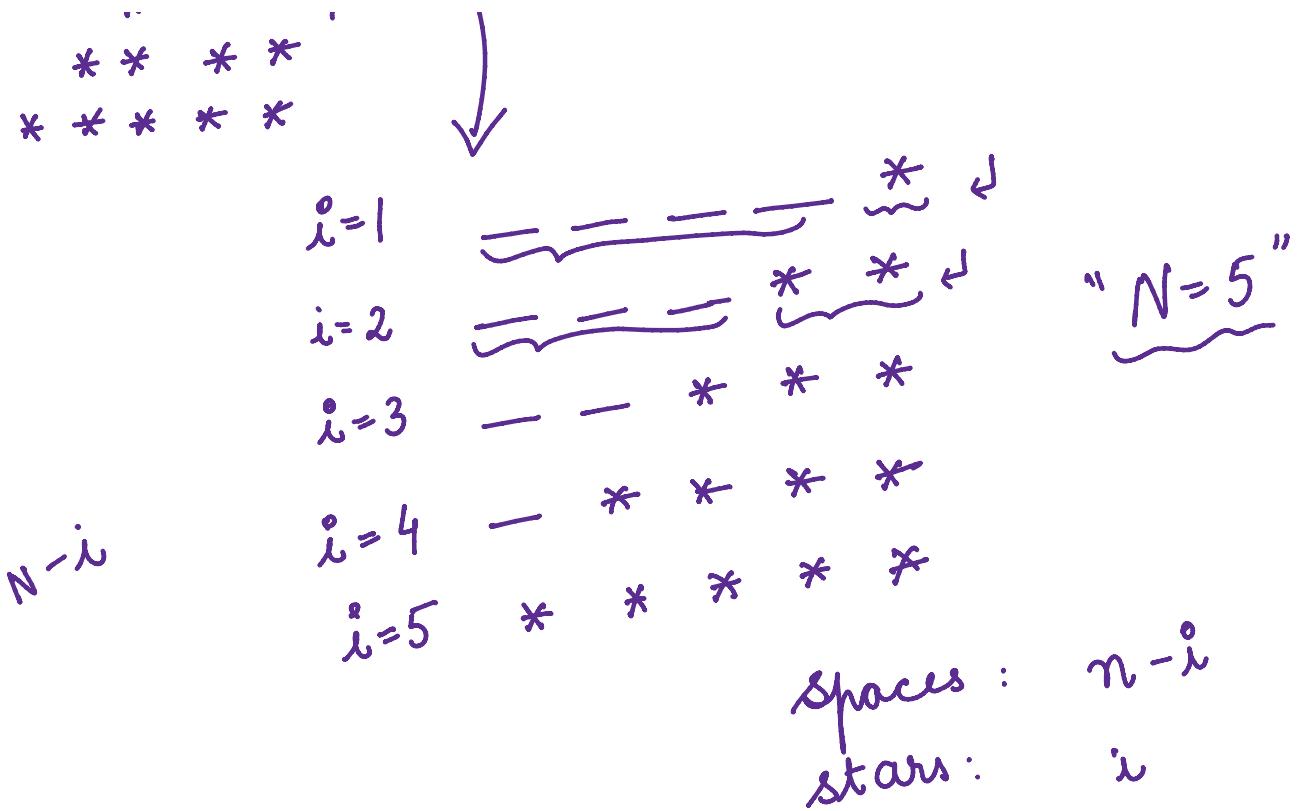
$i = 3$: $i >= 1$
 True j loop: $j = 1$ $j \leq i$ j^{++}
 $j = 2$ $j \leq i$ j^{++}
 $j = 3$ $j \leq i$ j^{++}
 $j = 4$ \circlearrowleft
 $i--$

$i = 2$ $i >= 1$
 True j loop: $j = 1$ $j \leq i$ j^{++}
 $j = 2$ $j \leq i$ j^{++}
 $j = 3$ \circlearrowleft
 $i--$

$i = 1$ $i >= 1$
 True j loop: $j = 1$ $j \leq i$ j^{++}
 $j = 2$ \circlearrowleft
 $i--$

$i = 0$
 $i >= 1$
~~false~~

$N = S$
* * * * *
* * * * *
* * * * *



```

for (int i=1; i<=N; i++) { // Rows.
  for (int k=1; k<=n-i; k++) {
    cout << " ";
  }
  for (int j=1; j<=i; j++) {
    cout << i;
  }
  cout << endl;
}

i=1 { * . .
      ↑ i stars
  
```

$i=1$ { *
 2 { * *
 3 { * * *
 4 { * * * *

 $i=3$ { * * *
 2 { * *
 1 { *

i stars

*
* *
* * *
* * *

$$\frac{n}{2}$$

$$\frac{n}{2} + 1$$

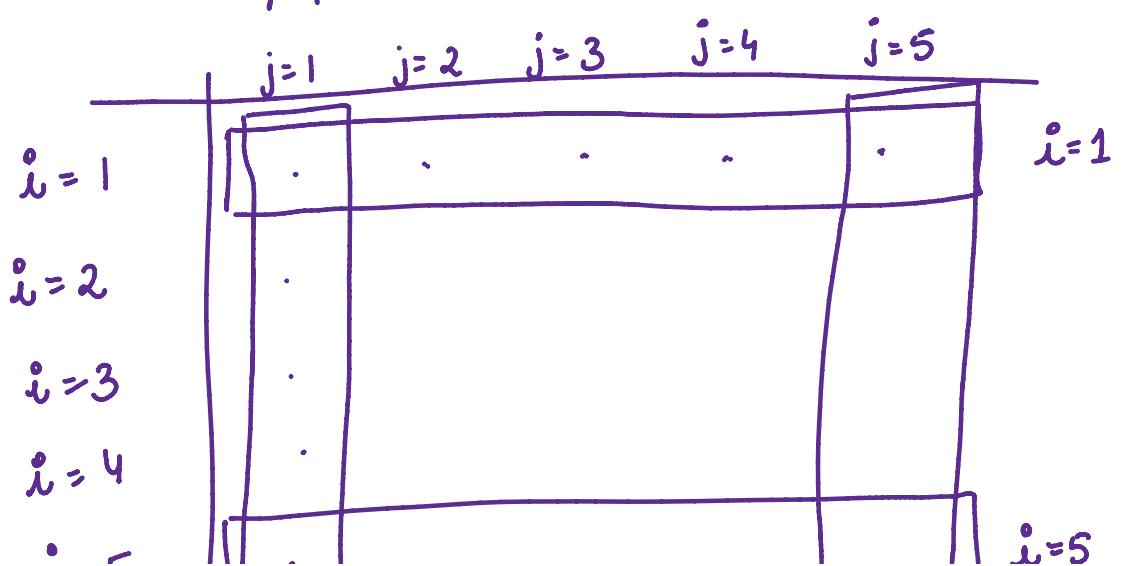
~~$N=5$~~
 $i=1$ $j=1$ 2 3 4 5
 * * * * *
 2 * - - - *
 3 * - - - *
 4 * - - - *
 5 * * * * *

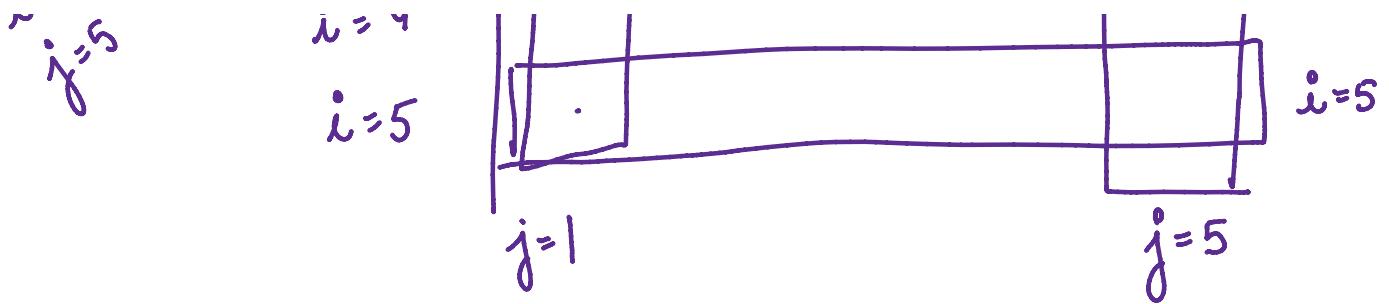
Hollow
square.

Boundary $\rightarrow *$
Otherwise \rightarrow space

Square : 4 sides

Boundary
 $i=1$
 $j=1$
 $i=5$
 $j=5$





```

for (int i=1; i<=5; i++) {
    for (int j=1; j<=5; j++) {
        if (i==1 || j==1 || i==5 || j==5)
            cout << "*";
        else
            cout << " ";
    }
    cout << endl;
}

```

$N=6$

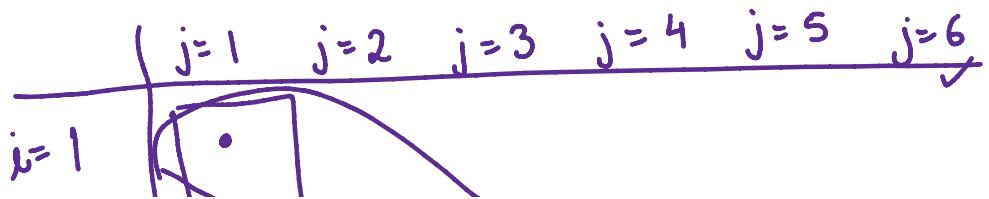
Hollow Triangle.

```

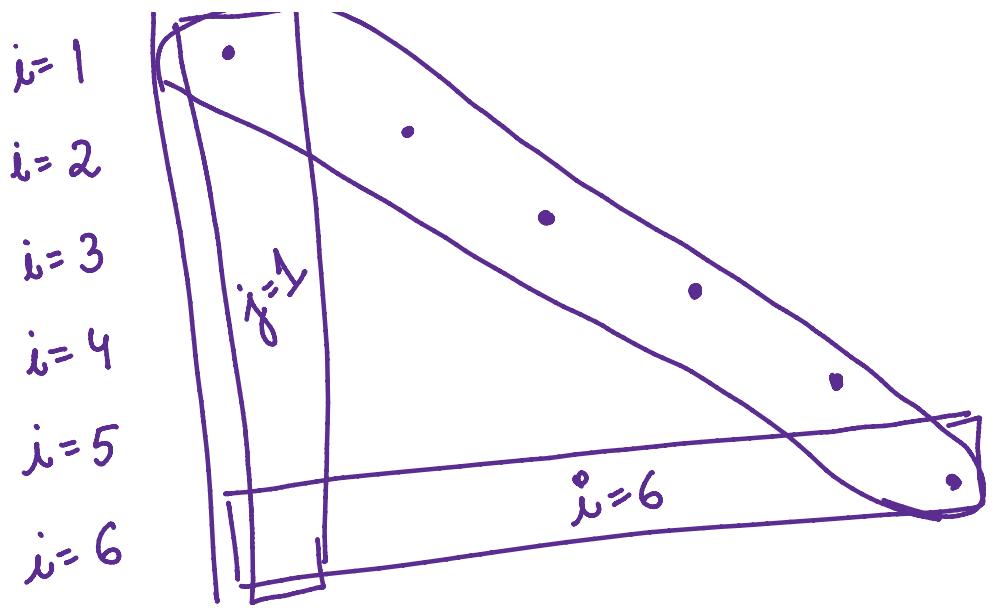
* *
* - *
* - - *
* - - - *
* * * * *

```

|



Boundaries:



```

for (int i= 1; i<= N; i++) {
    for (int j= 1; j<= i; j++) {
        if ((i==N || j==1 || i==j))
            cout << "*";
        else
            cout << " ";
    }
}

```

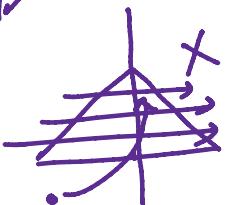
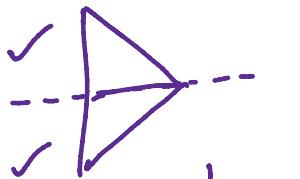
}

}

}

$N=4$

- - - * * * * *
- - * * * * * *
- * * * * * * *
- - - - - - - -



• 71

$N = 4$ (Rows)

	- - - -	*	*	*	*	*	*
	- - - -	*	*	*	*	*	*
	- - - -	*	*	*	*	*	*
	- - - -	*	*	*	*	*	*

$N = 4$

$i = 1$	- - - -	*						
$i = 2$	- - - -	*	*	*				
$i = 3$	- - - -	*	*	*	*	*		
$(N-i)$ spaces	$i = 4$	*	*	*	*	*	*	*

```

for (int i=1; i<=N; i++) {
    for (int k=1; k<=N-i; k++) {
        cout << " ";
    }
    for (int j=1; j<=2*i-1; j++) {
        cout << "*";
    }
    cout << endl;
}

```

$N = 4 . \quad 2 \ 3 \ 4 \ 5$

~~N=4~~

	2	3	4	5
	3	4	5	6
	4	5	6	7
	5	6	7	8

	j=1	j=2	j=3	j=4
i+j	2	3	4	5
i*j	3	4	5	6
2*i+j	4	5	6	7
i=4	5	6	7	8

~~N=4
Rough~~

```

for (int i=1; i<=N; i++) {
    for (int j=1; j<=N; j++) {
        cout << i+j;
    }
}

```

}