23. BREAK - LOOP CONTROL STATEMENT

EXAMPLE 1

```
$for(int\ i = 1; i \le n; i + +)\{$
        $for(int\ j = 1; j \le n; j + +)\{$
                $if\left(j == \frac{n}{2}\right)\{$
                        $break;$
                $\}$
        $\}$
$\}$
```

SOLUTION

At each $\frac{n}{2}$ *loop statement will break, hence the inner loop will run* $\frac{n}{2} - 1$ *times and outer loop runs n times.*

hence

$$total\ rumtime = \frac{n^2 - 2n}{2} = O(n^2)$$

EXAMPLE 2

```
for(int i = 1; i ≤ n; i + +){
          for(int j = 1; j ≤ n; j + +){
                 print(" * ");
                  break;
              }
}
```

SOLUTION

The inner loop executes only $\boldsymbol{1}$ ***time at each n time of outer loop, hence it run*** $\boldsymbol{1 \times n = n}$ ***times gives*** $\boldsymbol{O(n)}$ ***complexity.***

EXAMPLE 3

```
for(int i = 1; i ≤ n; i + +){
          for(int j = 1; j ≤ n; j + +){
              if(j = 5){
                  break;
              }
          }
}
```

SOLUTION

The inner loop executes only 4 time at each n time of outer loop, hence it run $4 \times n = 4n$ *times gives* $O(n)$ *complexity.*

EXAMPLE 4

```
for(int i = 1; i ≤ n; i + +){
        for(int j = 1; j ≤ n; j + +){
            if $\left(j = \frac{i}{2}\right)$ {
                break;
            }
        print("Hello")
        }
}
```

SOLUTION

The inner most statement executes like =

when $i = 1$, $j = \frac{1}{2} = 0$, *so no break and j runs from* 1 *to n.*

and inner most statement prints 1 *to n. n times*

$\boldsymbol{when\ i = 2\ , j = \frac{2}{2} = 1\ ,}$

$\boldsymbol{so\ no\ print\ of\ inner\ most\ statement\ , as\ break\ statement,}$

$\boldsymbol{executes\ .}$

$\boldsymbol{when\ i = 3\ , j = \frac{3}{2} = 1\ ,}$

$\boldsymbol{so\ no\ print\ of\ inner\ most\ statement\ , as\ break\ statement,}$

$\boldsymbol{executes\ .}$

$\boldsymbol{when\ i = 4\ , j = \frac{4}{2} = 1\ ,}$

$\boldsymbol{print\ of\ inner\ most\ statement\ , executes\ 1\ time\ .}$

$\boldsymbol{It\ looks\ like}$:

$\boldsymbol{n + 0 + 0 + 1 + 1 + 2 + 2 + 3 + 3 + \cdots + k\ times}$

$$\boldsymbol{n + 0 + 0 + \frac{2}{2} + \frac{3}{2} + \frac{4}{2} + \frac{5}{2} + \frac{6}{2} + \frac{7}{2} + \cdots + \frac{n}{2}\ times}$$

$$\boldsymbol{n + 0 + 0 + \sum_{i=2}^{n} \frac{i}{2}}$$

$$\sum_{i=2}^{n}\frac{i}{2}=\sum_{i=1}^{n}\frac{i}{2}-\sum_{i=1}^{1}\frac{i}{2}$$

$$\sum_{i=2}^{n}\frac{i}{2}=\frac{1}{2}\left(\frac{n(n+1)}{2}\right)-\frac{1}{2}$$

$$\sum_{i=2}^{n}\frac{i}{2}=\frac{n^2+n}{4}-\frac{1}{2}$$

$$\sum_{i=2}^{n}\frac{i}{2}=\frac{n^2+n-2}{4}$$

$\boldsymbol{Hence\ if\ we\ exclude\ n = then\ the\ approximate\ time}$

$\boldsymbol{the\ loop\ will\ run}$

$= \left(\left\lfloor\frac{n^2+n-2}{4}\right\rfloor+1\right)$, **note this will give near value or exact number of times the inner most statement will get printed .**

$\boldsymbol{Or\ if\ we\ proceed\ according\ to\ iteration}$:

we get a series like: $\frac{1}{2}+\frac{2}{2}+\frac{3}{2}+\cdots+\frac{n}{2}$

$$\Rightarrow \frac{1}{2}(1+2+3+\cdots+n)$$

$$\Rightarrow \frac{1}{2}\times\left(\frac{n(n+1)}{2}\right)$$

$$\Rightarrow \frac{n^2+n}{4}$$

There fore in both the ways approach is correct .

And Time complexity is : $O(n^2)$.