

if (n > 0)

$n=3$ $\sqrt{3}$
1 2 1 3 1 2 1

(1) updown(n) ←

(2) print(n)

(3) updown(n-1) →

updown(2)

$n=4$ $\sqrt{4}$

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

1 2 1 3 1 2 1 4 1 2 1 3 1 2 1 5 1 2 1 3 1 2 1 4 1 2 1 3 1 2 1

1 2 3 4 5 4 3 2 1
void DownUp (int n, Mar)

```

{
    if (n > 01)
    {
        print();
        DownUp(n-1);
        print(n);
    }
}

```

5 4 3 2 1 2 3 4 5

```

if (n == 1)
    print n;
else if (n > 1)
{
    print(n);
    DownUp(n-1);
    print(n);
}

```

1 2 3 4 5 4 3 2 1

```

updown(int n)
{
    Aupdown(n, n);
}

```

}

Aupdown (int n, int Max)

{

if (n==1) print(Max);

if (n>1)

{

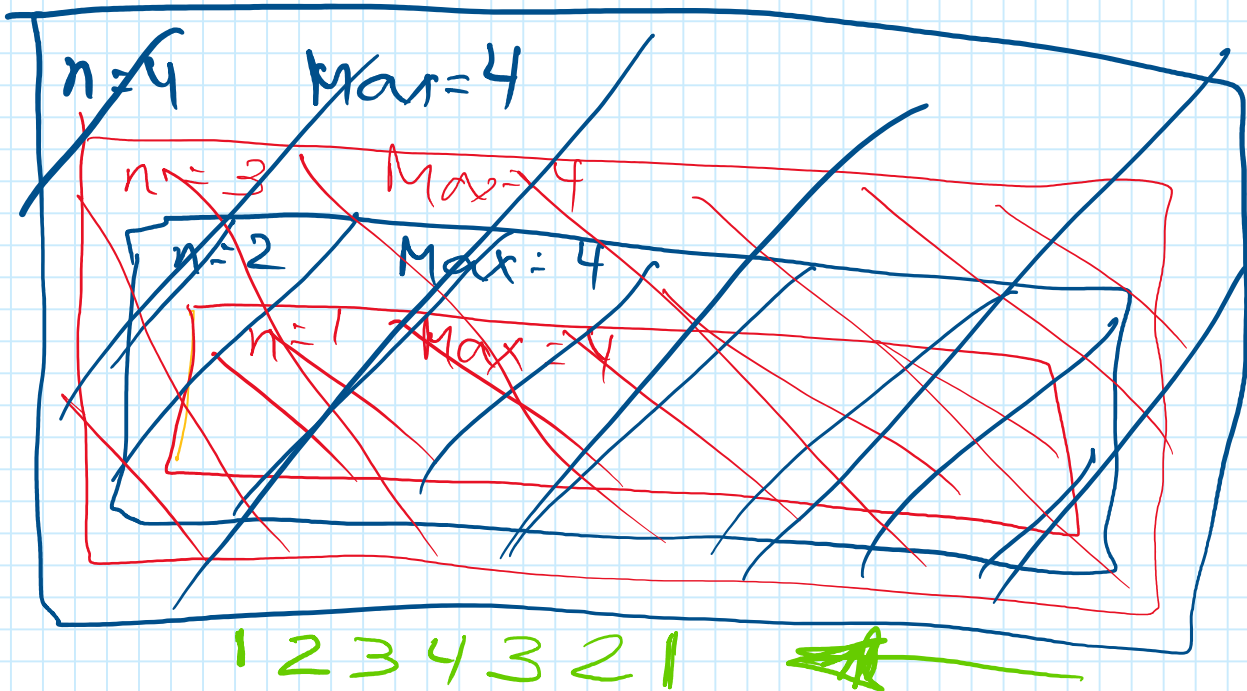
print (Max-n+1)

Aupdown (n-1, Max)

print (Max-n+1)

}

}



updownHelper (int i, int u)

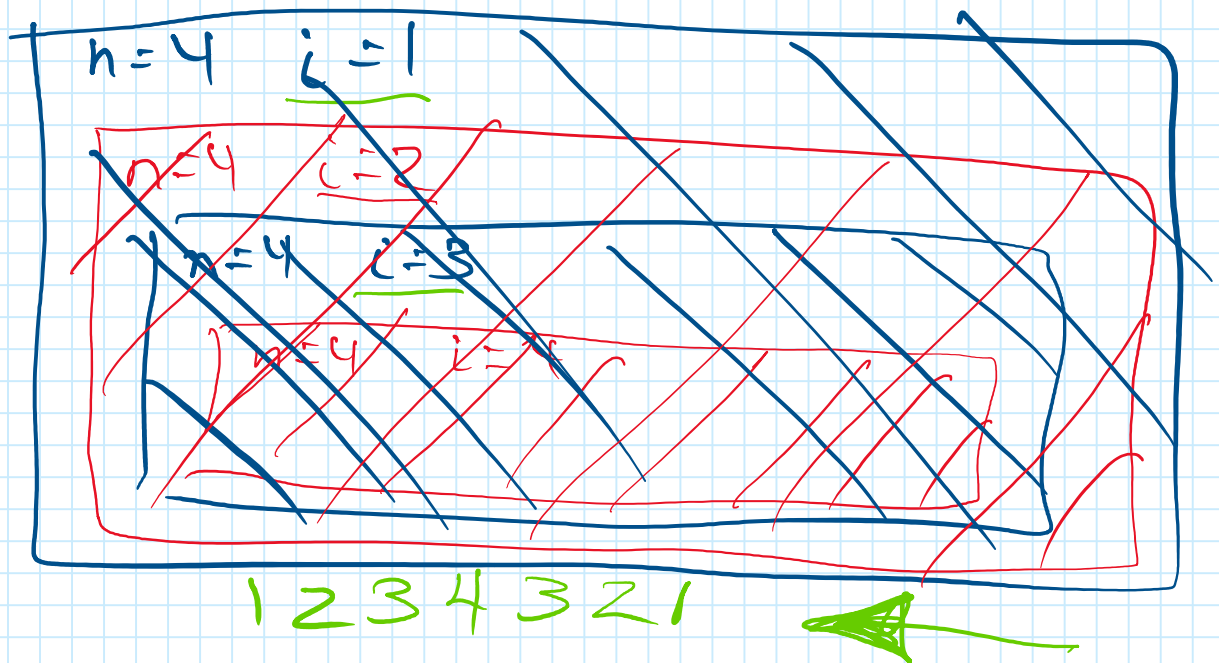
{

```

print(i);
if (i == n) return
updownHelper(i+1, n)
print(i)
}

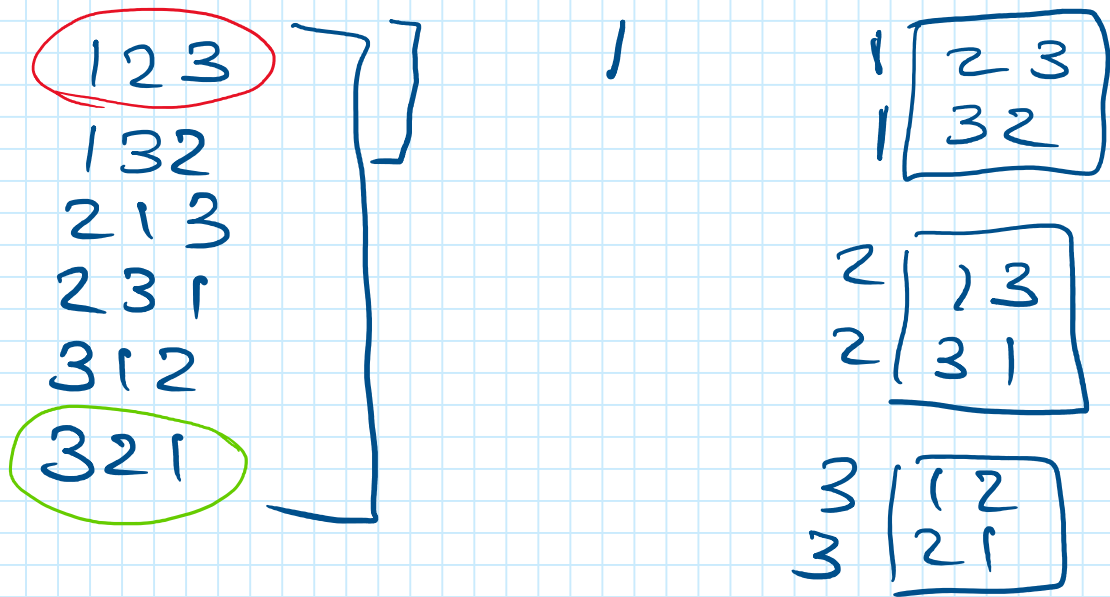
```

updownHelper(1, n);

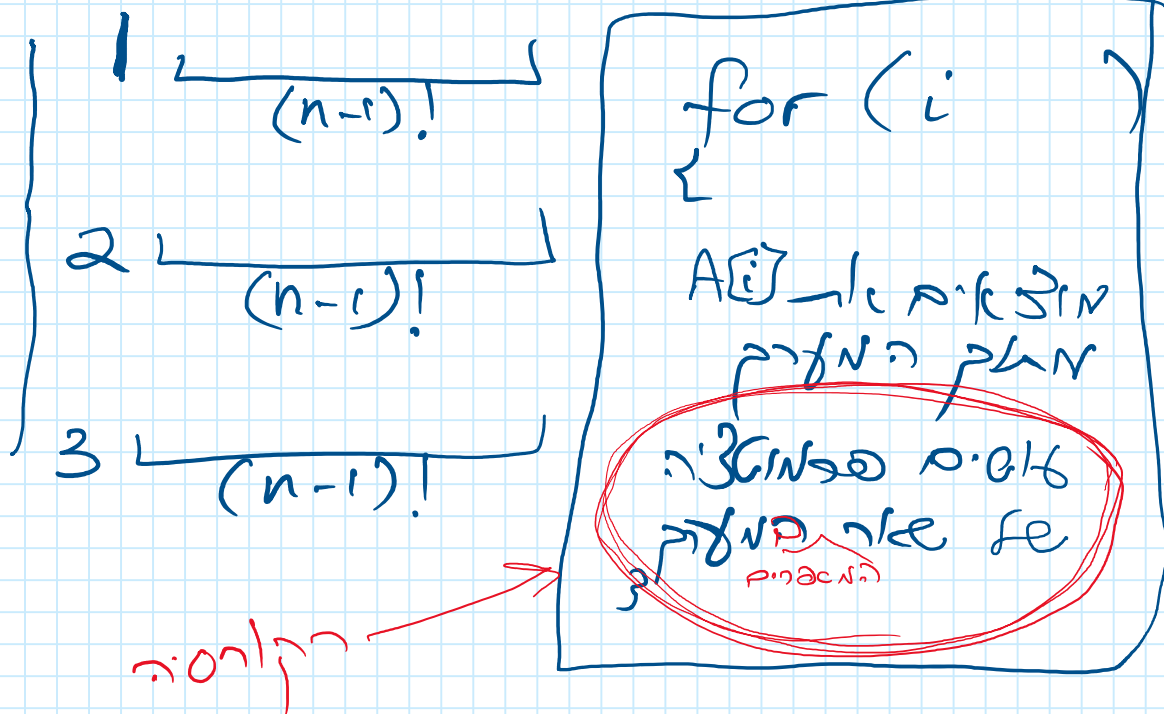


1 2 3

מספרים 3! = 6



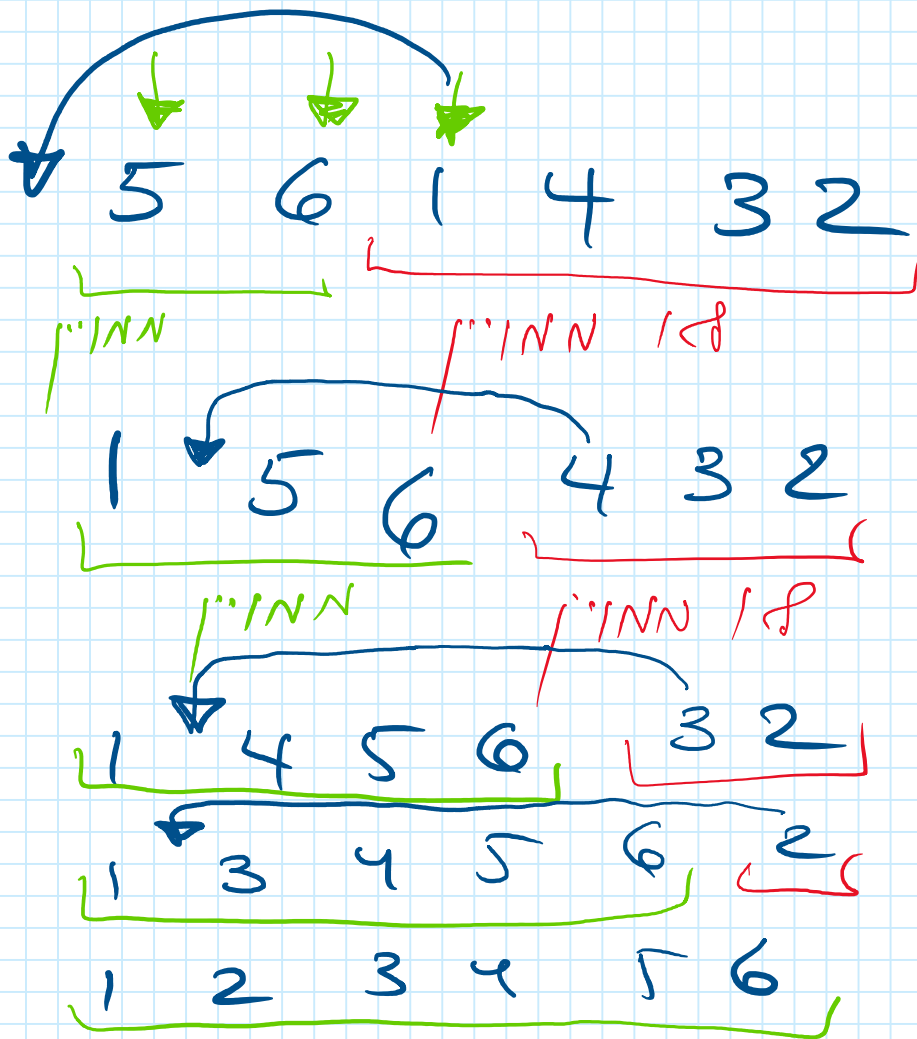
מספרים n - מספרים
מספרים n - מספרים
מספרים n - מספרים



5 6 1 4 3 2

INSERT SORT

דוגמה / N



$$S = 1 + 2 + 3 + \dots + n$$

סדרה
arithmetic

$$S = \frac{n(n+1)}{2}$$

★ while for

$$S' = 0 + 1 + 2 + 3 \dots \underline{n-1}$$

$$S' = 1 + 2 + 3 \dots + n-1$$

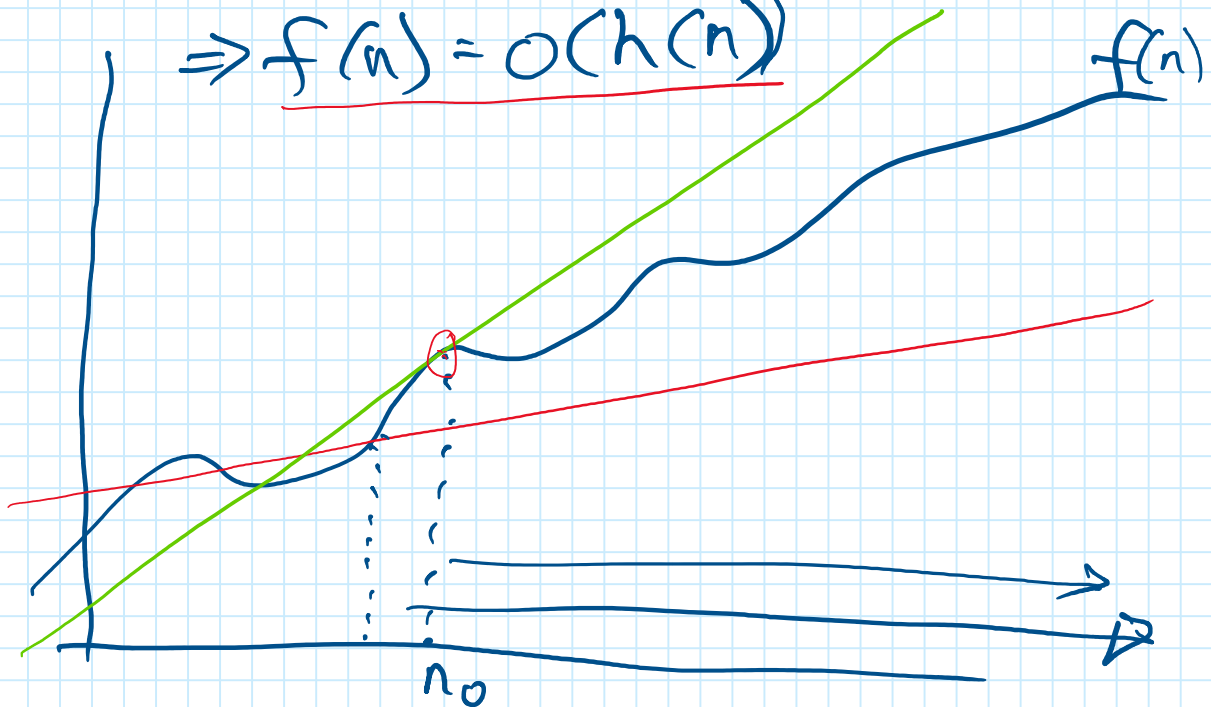
$$= \frac{(n-1)((n-1)+1)}{2} = \frac{n(n-1)}{2}$$

$$\exists c, n_0 \quad \forall n > n_0 \quad f(n) \geq c \cdot g(n)$$

$f(n) = \Omega(g(n))$

$$\underline{\exists c, n_0 \quad \forall n > n_0 \quad f(n) \leq c \cdot h(n)}$$

$$\Rightarrow \underline{f(n) = o(h(n))}$$



$$g(n) = n + k$$

$$\frac{1}{2}g(n) = \frac{n}{2} + \frac{k}{2}$$

$$h(n) = n - t$$

$$4h(n) = \underline{\underline{c}} 4n - 4t \quad f(n) = O(h(n))$$

$$f(n) = 3n + 5$$

$$f(n) = O(n)$$

$$\underline{\exists c, n_0} \quad \forall n > n_0 \quad f(n) \leq c \cdot n$$

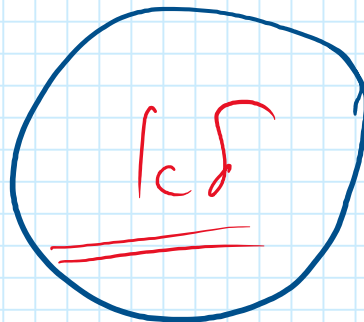
$$c = 2 \quad \text{מנב}$$

$$3n + 5 < 2n$$

n_0 פ'ק מ'כ'ן

$n > n_0$ ל'כ'ל

$$? \quad 3n + 5 < 2n \quad \text{פ'ק מ'כ'ן}$$



$$f(n) = 3n^2 - 5n + 300$$

$$? \quad f(n) = O(n) \quad \text{פ'ק מ'כ'ן}$$

? $f(n) = O(n)$ הלא

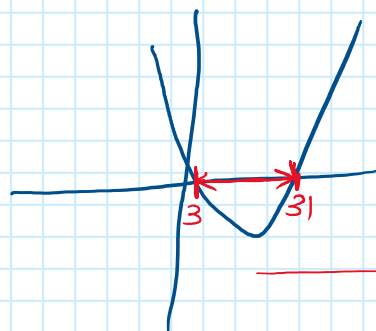
$$\exists c, n_0, \boxed{\forall n > n_0} \quad 3n^2 - 5n + 300 < cn$$

$$c = \underline{100} \quad \text{נבחר}$$

$$3n^2 - 5n + 300 < 100n$$

$$3n^2 - 105n + 300 < 0 \quad \leftarrow$$

לפניו איפה n יש n גדול מ"פ"



נכון לפי n $\frac{n}{31}$

$$f(n) = 3n^2 - 5n + 300$$

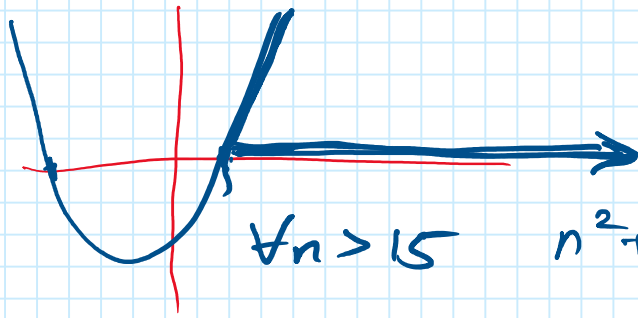
? $f(n) = O(n^2)$ הלא

$$c = 4 \quad \text{נבחר}$$

$$? \quad 3n^2 - 5n + 300 < 4n^2 \quad \text{נ"ח}$$

$$0 < n^2 + 5n - 300$$

$$0 < n^2 + 5n - 300$$



$$\forall n > 15 \quad n^2 + 5n - 300 > 0$$

15 \sim 1348 n \hookrightarrow 1270 n