Analysis of Algorithms: Solutions 1

```
                                         X
                                         X
                                         X
                                         X
                                         X
                                         X
                 X                       X
                 X                       X
number of        X     X                 X
homeworks        X     X  X     X  X     X
                 X     X  X  X  X  X  X  X
                 X     X  X  X  X  X  X  X
                 X  X  X  X  X  X  X  X  X
           --------------------------------
           0  1  2  3  4  5  6  7  8  9  10
                        grades
```

This histogram shows the distribution of grades (from 0 to 10) for the homeworks submitted on time; it does not include the late submissions.

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(1) Give an algorithm that determines the number of *distinct* elements in an array $A[1..n]$.
(2) Estimate the worst-case running time of your algorithm.

DISTINCT-COUNTER(A, n)	*cost*	*times*
counter $\leftarrow 0$	c_1	1
for $j \leftarrow 1$ **to** n	c_2	$n+1$
do $i \leftarrow j+1$	c_3	n
while $i < n+1$ and $A[j] \neq A[i]$	c_4	$\leq \sum_{i=1}^{n}(n-i+1) = \frac{n(n+1)}{2}$
do $i \leftarrow i+1$	c_5	$\leq \sum_{i=1}^{n}(n-i) = \frac{(n-1)n}{2}$
if $i = n+1$	c_6	n
then *counter* $\leftarrow$ *counter* $+1$	c_7	$\leq n$
return *counter*	c_8	1

$$\begin{aligned}
T(n) &\leq c_1 + c_2(n+1) + c_3 n + c_4\frac{n(n+1)}{2} + c_5\frac{(n-1)n}{2} + c_6 n + c_7 n + c_8 \\
&= \left(\frac{c_4}{2} + \frac{c_5}{2}\right)n^2 + \left(c_2 + c_3 + \frac{c_4}{2} - \frac{c_5}{2} + c_6 + c_7\right)n + (c_1 + c_2 + c_8) \\
&= \Theta(n^2)
\end{aligned}$$