Selection Sort

A simple $O(n^2)$ sorting algorithm is selection sort.

Sweep through all the elements to find the smallest item, then the smallest remaining item, etc. until the array is sorted.

Selection-sort($A$)
  for $i = 1$ to $n$
    for $j = i + 1$ to $n$

It is clear this algorithm must be correct from an inductive argument, since the $i$th element is in its correct position.

It is clear that this algorithm takes $O(n^2)$ time.

It is clear that the analysis of this algorithm cannot be improved because there will be $n/2$ iterations which will require at least $n/2$ comparisons each, so at least $n^2/4$ comparisons will be made. More careful analysis doubles this.

Thus selection sort runs in $\Theta(n^2)$ time.