# Algorithms (COT 6405): Solutions 8

**Problem 1**
Give a nonrecursive algorithm that prints all elements of a binary search tree in sorted order.

ITERATIVE-TREE-WALK($T$)
$x \leftarrow$ TREE-MINIMUM($root[T]$)
**while** $x \neq$ NIL
    **do** print $key[x]$
        $x \leftarrow$ TREE-SUCCESSOR($x$)

The running time is $\Theta(n)$, where $n$ is the number of nodes in the tree.

**Problem 2**
Suppose that we have four algorithms, called $A_0$, $A_1$, $A_2$, and $A_3$, whose respective running times are $n$, $n^2$, $\lg n$, and $2^n$. If we use a certain old computer, then the maximal sizes of problems solvable in one hour by these algorithms are $s_0$, $s_1$, $s_2$, and $s_3$. Suppose that we have replaced the old computer with a new one, which is $k$ times faster. Now the maximal size of problems solvable in one hour by $A_0$ is $k \cdot s_0$. What are the maximal problem sizes for the other three algorithms if we run them on the new computer?

**For $A_1$:** On the old computer, $A_1$ solves a problem of size $s_1$ in one hour. The running time of this algorithm on a problem of size $s_1$ is $s_1^2$; hence, $s_1^2 = 1$ hour. The new computer is $k$ times faster, which means that the running time of $A_1$ is $n^2/k$. We denote the size of the largest problem solvable in one hour on the new computer by $v_1$; then, $v_1^2/k = 1$ hour. We conclude that $v_1^2/k = s_1^2$, which implies that $v_1 = s_1 \cdot \sqrt{k}$. Thus, the maximal size of a problem solvable in one hour on the new computer is $s_1 \cdot \sqrt{k}$.

**For $A_2$:** On the old computer, $A_2$ solves a problem of size $s_2$ in one hour, which means that $\lg s_2 = 1$ hour. If we denote the maximal size of a problem solvable in one hour on the new computer by $v_2$, then $\lg v_2/k = 1$ hour. We conclude that $\lg v_2/k = \lg s_2$, which implies that $v_2 = s_2^k$. Thus, the maximal problem solvable in one hour on the new computer is of size $s_2^k$.

**For $A_3$:** We denote the maximal problem solvable by $A_3$ on the new computer by $v_3$, and use a similar reasoning to obtain the equation $2^{v_3}/k = 2^{s_3}$, which implies that $v_3 = s_3 + \lg k$.