

INORDER-TREE-WALK(x, k)

```
if  $x \neq \text{NULL}$ 
    INORDER-TREE-WALK( $left[x]$ )
    print  $key[x]$ 
    INORDER-TREE-WALK( $right[x]$ )
```

TREE-SEARCH(x, k)

```
if  $x = \text{NIL}$  or  $k = key[x]$ 
    then return  $x$ 
if  $k < key[x]$ 
    then return TREE-SEARCH( $left[x], k$ )
    else return TREE-SEARCH( $right[x], k$ )
```

ITERATIVE-TREE-SEARCH(x, k)

```
while  $x \neq \text{NIL}$  and  $k \neq key[x]$ 
    do if  $k < key[x]$ 
        then  $x \leftarrow left[x]$ 
        else  $x \leftarrow right[x]$ 
return  $x$ 
```

TREE-MINIMUM(x)

```
while  $left[x] \neq \text{NIL}$ 
    do  $x \leftarrow left[x]$ 
return  $x$ 
```

TREE-SUCCESSOR(x)

```
if  $right[x] \neq \text{NIL}$ 
    then return TREE-MINIMUM( $right[x]$ )
 $y \leftarrow p[x]$ 
while  $y \neq \text{NIL}$  and  $x = right[y]$ 
    do  $x \leftarrow y$ 
     $y \leftarrow p[y]$ 
return  $y$ 
```

TREE-INSERT(T, z)

```
 $y \leftarrow \text{NIL}$   
 $x \leftarrow \text{root}[T]$   
while  $x \neq \text{NIL}$  do  
     $y \leftarrow x$   
    if  $\text{key}[z] < \text{key}[x]$   
        then  $x \leftarrow \text{left}[x]$   
        else  $x \leftarrow \text{right}[x]$   
 $p[z] \leftarrow y$   
if  $y = \text{NIL}$   
    then  $\text{root}[T] \leftarrow z$   
    else if  $\text{key}[z] < \text{key}[y]$   
        then  $\text{left}[y] \leftarrow z$   
        else  $\text{right}[y] \leftarrow z$ 
```

TREE-DELETE(T, z)

```
if  $\text{left}[z] = \text{NIL}$  or  $\text{right}[z] = \text{NIL}$   
    then  $y \leftarrow z$   
    else  $y \leftarrow \text{TREE-SUCCESSOR}(z)$   
if  $\text{left}[y] = \text{NIL}$   
    then  $x \leftarrow \text{left}[y]$   
    else  $x \leftarrow \text{right}[y]$   
if  $x \neq \text{NIL}$   
    then  $p[x] \leftarrow p[y]$   
if  $p[y] = \text{NIL}$   
    then  $\text{root}[T] \leftarrow x$   
    else if  $y = \text{left}[p[y]]$   
        then  $\text{left}[p[y]] \leftarrow x$   
        else  $\text{right}[p[y]] \leftarrow x$   
if  $y \neq z$   
    then  $\text{key}[z] \leftarrow \text{key}[y]$   
        copy the rest of  $y$  into  $z$   
return  $y$ 
```