

```
#include <stdio.h>
```

```
#include <stdlib.h>
```

```
struct Node {
```

```
int key;
```

```
struct Node *left;
```

```
struct Node *right;
```

```
int height;
```

```
};
```

```
int max(int a, int b);
```

```
int height(struct Node *N) {
```

```
if (N == NULL)
```

```
return 0;
```

```
return N->height;
```

```
}
```

```
int max(int a, int b) {
```

```
return (a > b) ? a : b;
```

```
}
```

```
struct Node *newNode(int key) {
```

```
struct Node *node = (struct Node *)
```

```
malloc(sizeof(struct Node));
```

```
node->key = key;
```

```
node->left = NULL;
```

```
node->right = NULL;
```

```
node->height = 1;
```

```
return (node);
```

```
}
```

```
struct Node *rightRotate(struct Node *y) {
```

```
struct Node *x = y->left;
```

```
struct Node *T2 = x->right;
```

```
x->right = y;
```

```
y->left = T2;
```

```
y->height = max(height(y->left), height(y->right)) + 1;
```

```
x->height = max(height(x->left), height(x->right)) + 1;
```

```
return x;
```

```
}
```

```
struct Node *leftRotate(struct Node *x) {
```

```
    struct Node *y = x->right;
```

```
    struct Node *T2 = y->left;
```

```
    y->left = x;
```

```
    x->right = T2;
```

```
    x->height = max(height(x->left), height(x->right)) + 1;
```

```
    y->height = max(height(y->left), height(y->right)) + 1;
```

```
    return y;
```

```
}
```

```
int getBalance(struct Node *N) {
```

```
    if (N == NULL)
```

```
        return 0;
```

```
return height(N->left) - height(N->right);
```

```
}
```

```
struct Node *insertNode(struct Node *node, int key) {
```

```
if (node == NULL)
```

```
return (newNode(key));
```

```
if (key < node->key)
```

```
node->left = insertNode(node->left, key);
```

```
else if (key > node->key)
```

```
node->right = insertNode(node->right, key);
```

```
else
```

```
return node;
```

```
node->height = 1 + max(height(node->left),
```

```
height(node->right));
```

```
int balance = getBalance(node);
```

```
if (balance > 1 && key < node->left->key)
```

```
return rightRotate(node);
```

```
if (balance < -1 && key > node->right->key)
```

```
return leftRotate(node);
```

```
if (balance > 1 && key > node->left->key) {
```

```
node->left = leftRotate(node->left);
```

```
return rightRotate(node);
```

```
}
```

```
if (balance < -1 && key < node->right->key) {
```

```
node->right = rightRotate(node->right);
```

```
return leftRotate(node);
```

```
}
```

```
return node;
```

```
}
```

```
struct Node *minValueNode(struct Node *node) {
```

```
struct Node *current = node;
```

```
while (current->left != NULL)
```

```
current = current->left;
```

```
return current;
```

```
}
```

```
struct Node *deleteNode(struct Node *root, int key) {
```

```
if (root == NULL)
```

```
return root;
```

```
if (key < root->key)
```

```
root->left = deleteNode(root->left, key);
```

```
else if (key > root->key)
```

```
root->right = deleteNode(root->right, key);
```

```
else {
```

```
if ((root->left == NULL) || (root->right == NULL)) {
```

```
struct Node *temp = root->left ? root->left : root->right;
```

```
if (temp == NULL) {
```

```
temp = root;
```

```
root = NULL;
```

```
} else
```

```
*root = *temp;
```

```
free(temp);
```

```
} else {
```

```
struct Node *temp = minValueNode(root->right);
```

```
root->key = temp->key;
```

```
root->right = deleteNode(root->right, temp->key);
```

```
}
```

```
}
```

```
if (root == NULL)
```

```
return root;
```

```
root->height = 1 + max(height(root->left),
```

```
height(root->right));
```

```
int balance = getBalance(root);
```

```
if (balance > 1 && getBalance(root->left) >= 0)
```

```
return rightRotate(root);
```

```
if (balance > 1 && getBalance(root->left) < 0) {
```

```
    root->left = leftRotate(root->left);
```

```
    return rightRotate(root);
```

```
}
```

```
if (balance < -1 && getBalance(root->right) <= 0)
```

```
    return leftRotate(root);
```

```
if (balance < -1 && getBalance(root->right) > 0) {
```

```
    root->right = rightRotate(root->right);
```

```
    return leftRotate(root);
```

```
}
```

```
return root;
```

```
}
```

```
void printPreOrder(struct Node *root) {
```

```
    if (root != NULL) {
```

```
        printf("%d ", root->key);
```



```
printPreOrder(root->left);
```

```
printPreOrder(root->right);
```

```
}
```

```
}
```

```
int main() {
```

```
    struct Node *root = NULL;
```

```
    root = insertNode(root, 2);
```

```
    root = insertNode(root, 1);
```

```
    root = insertNode(root, 7);
```

```
    root = insertNode(root, 4);
```

```
    root = insertNode(root, 5);
```

```
    root = insertNode(root, 3);
```

```
    root = insertNode(root, 8);
```

```
    printPreOrder(root);
```

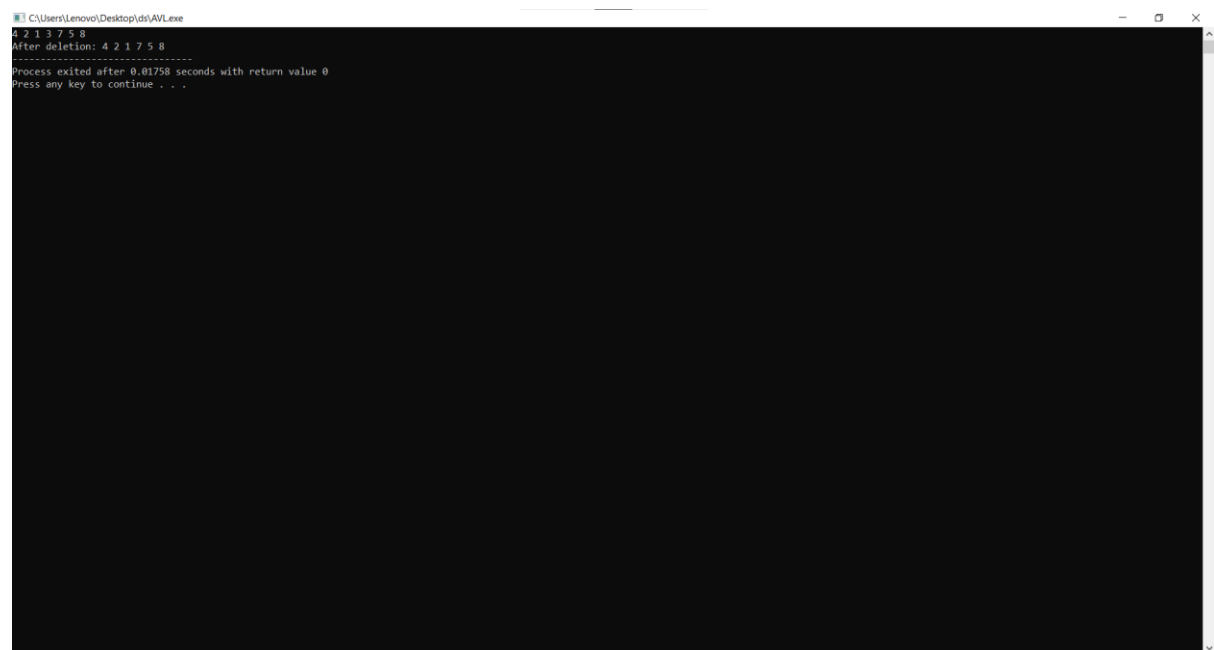
```
    root = deleteNode(root, 3);
```

```
printf("\nAfter deletion: ");
```

```
printPreOrder(root);
```

```
return 0;
```

```
}
```



The screenshot shows a Windows command prompt window with the title bar "C:\Users\Lenovo\Desktop\ds\AVL.exe". The window contains the following text:

```
4 2 1 3 7 5 8
After deletion: 4 2 1 7 5 8
-----
Process exited after 0.01758 seconds with return value 0
Press any key to continue . . .
```