SHRI VILEPARLE KELAVANI MANDAL'S
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC ACCREDITED with "A" GRADE (CGPA : 3.18)

Department of Information Technology

COURSE CODE: DJS22ITL502 **DATE:** 16-10-24

COURSE NAME: Advanced Data Structures Laboratory **CLASS:** TY B. TECH

NAME: Anish Sharma **ROLL:** I011

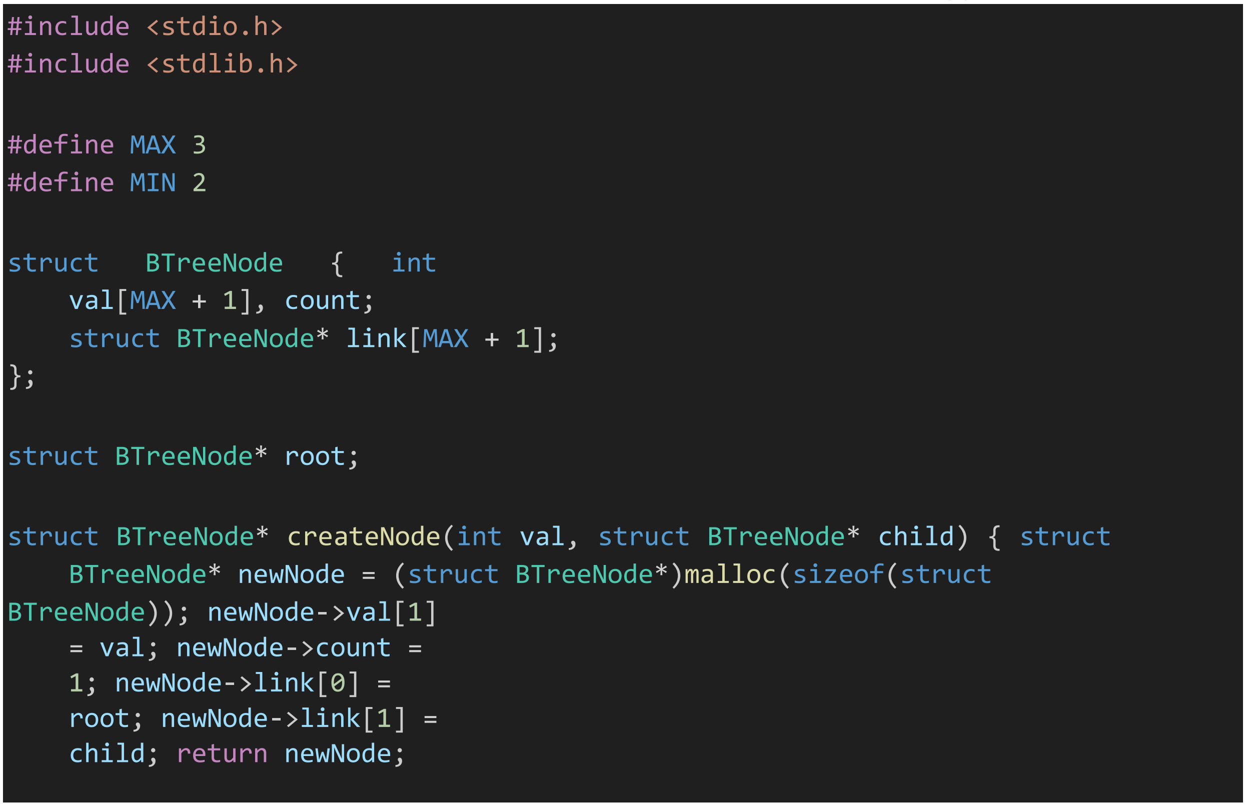
EXPERIMENT NO. 7

CO/LO: Choose appropriate data structure and use it to design algorithm for solving a specific problem

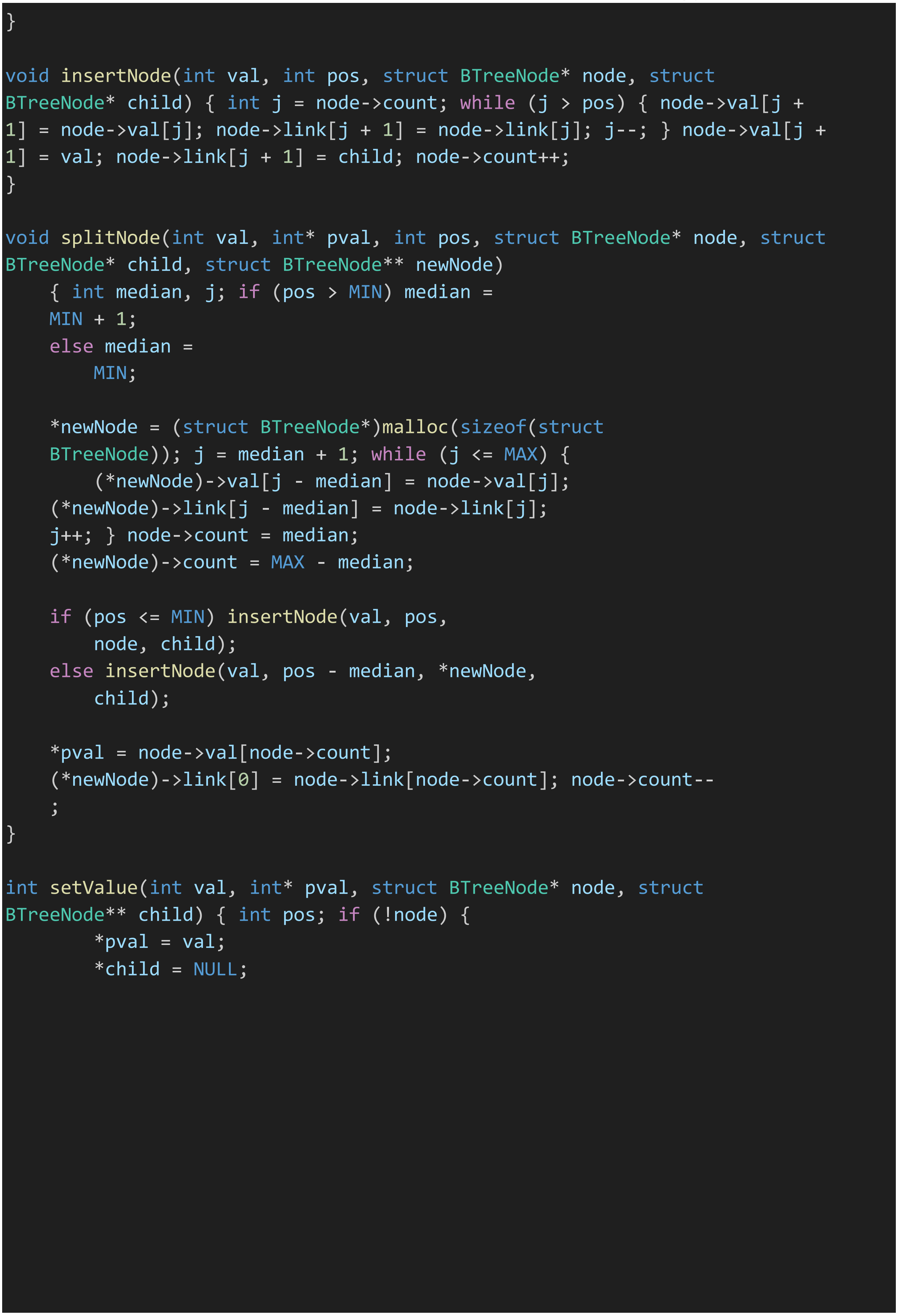
AIM / OBJECTIVE: To implement various operations on a B-Tree.

Properties of B-Tree:
Balanced Tree: B-Trees remain balanced, ensuring that all leaf nodes are at the same level.
M-Way Search Tree: Each node can have multiple keys and children (up to m), reducing tree height.
Efficient Disk Access: Designed for systems with slow disk access by minimizing the number of I/O operations.
Sorted Nodes: Keys within each node are stored in sorted order, making searching efficient.
Variable Node Size: Nodes can grow or shrink as keys are inserted or deleted, within a defined minimum and maximum size.

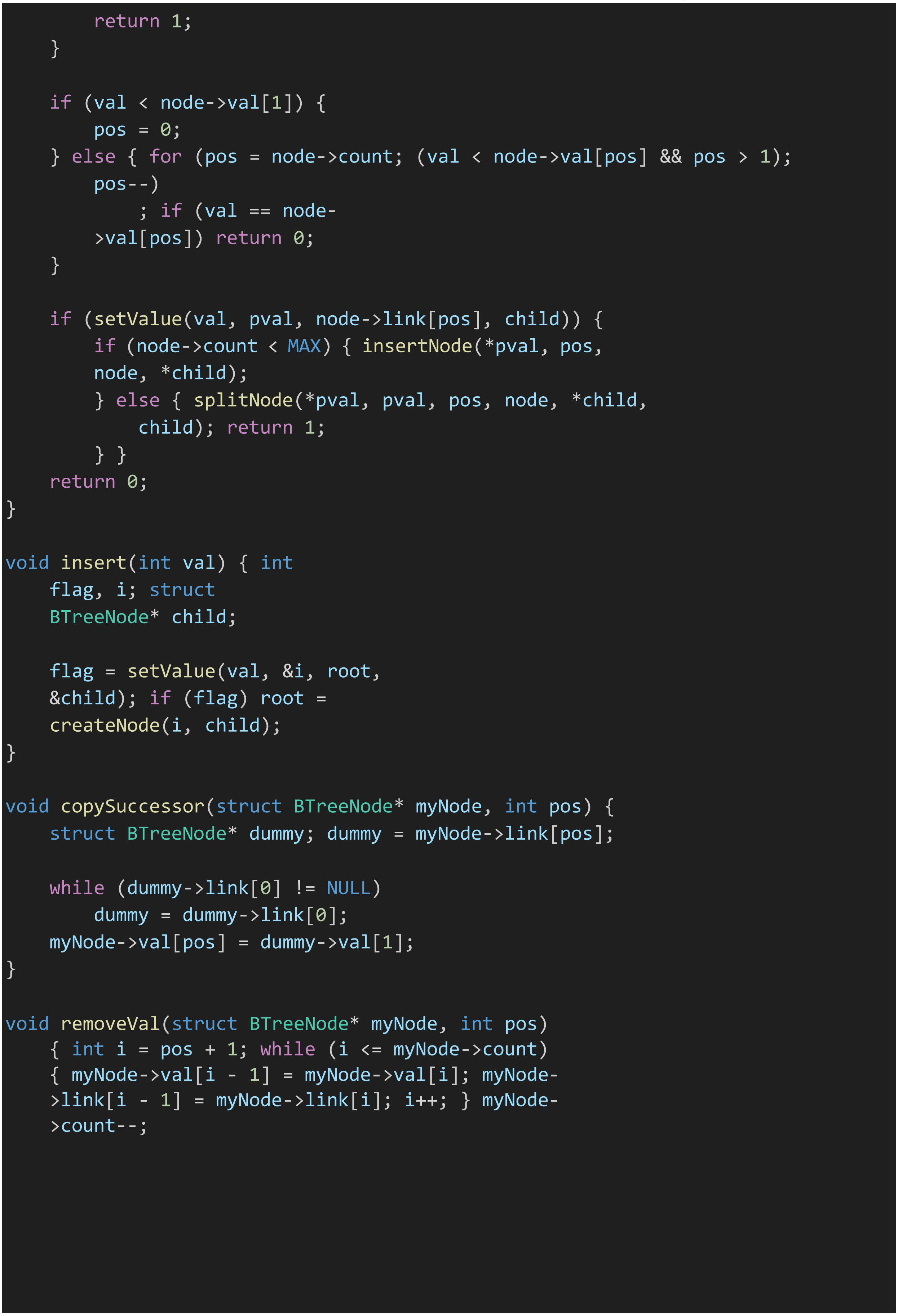
TECHNOLOGY STACK USED: C, C++, JAVA SOURCE CODE:



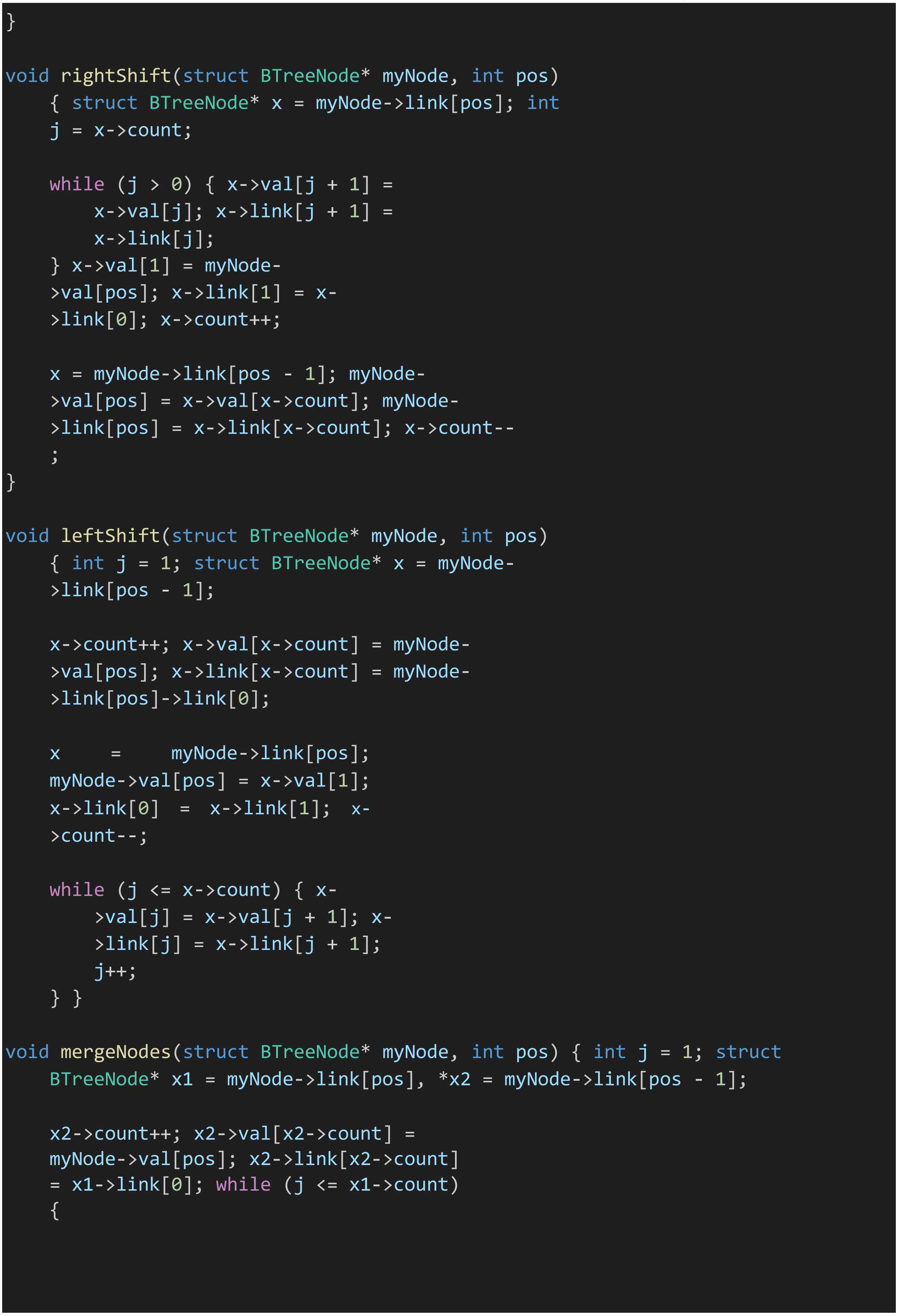
```
#include <stdio.h>
#include <stdlib.h>

#define MAX 3
#define MIN 2

struct   BTreeNode   {   int
    val[MAX + 1], count;
    struct BTreeNode* link[MAX + 1];
};

struct BTreeNode* root;

struct BTreeNode* createNode(int val, struct BTreeNode* child) { struct
    BTreeNode* newNode = (struct BTreeNode*)malloc(sizeof(struct
BTreeNode)); newNode->val[1]
    = val; newNode->count =
    1; newNode->link[0] =
    root; newNode->link[1] =
    child; return newNode;
```



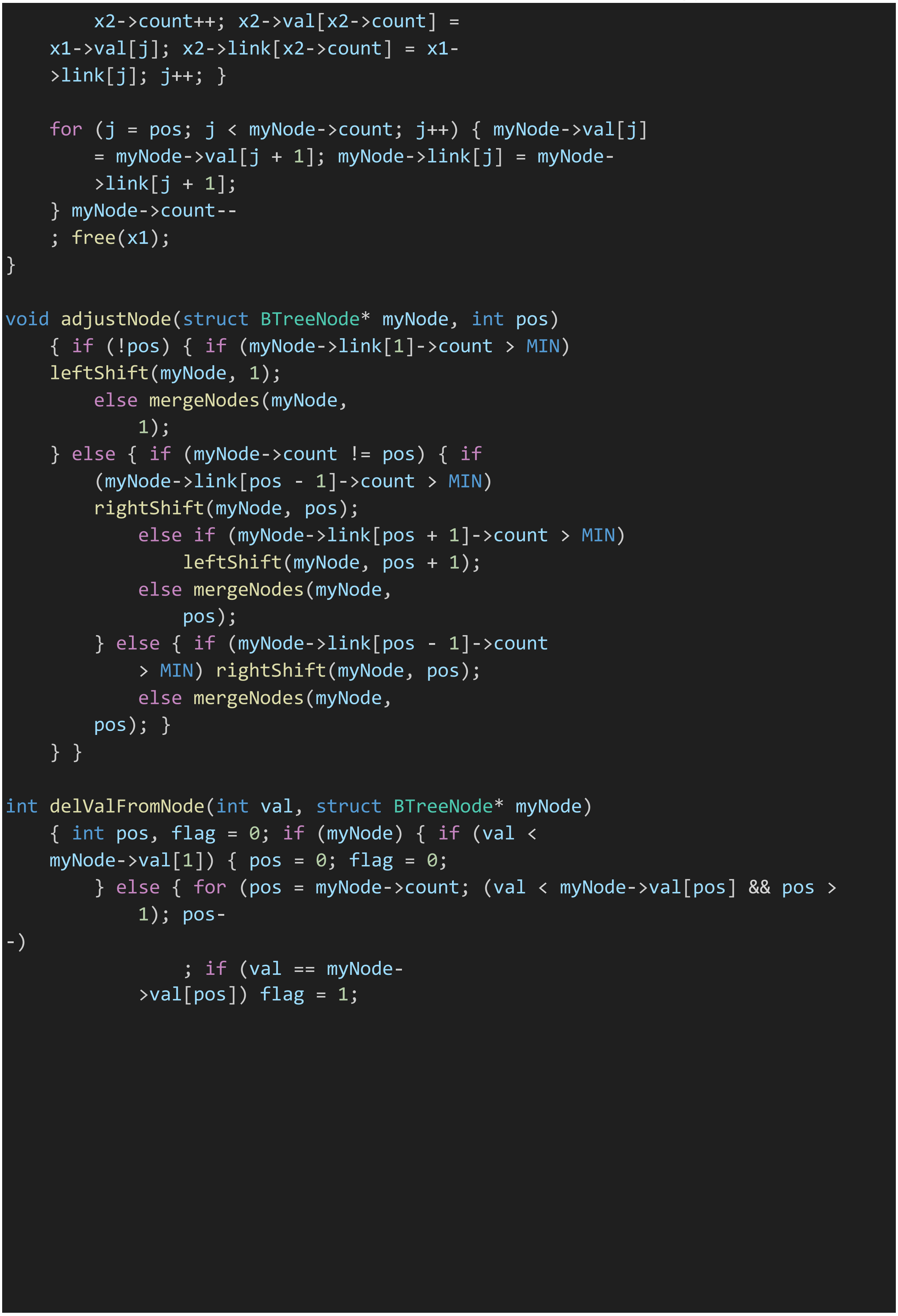
```
}

void insertNode(int val, int pos, struct BTreeNode* node, struct
BTreeNode* child) { int j = node->count; while (j > pos) { node->val[j +
1] = node->val[j]; node->link[j + 1] = node->link[j]; j--; } node->val[j +
1] = val; node->link[j + 1] = child; node->count++;
}

void splitNode(int val, int* pval, int pos, struct BTreeNode* node, struct
BTreeNode* child, struct BTreeNode** newNode)
    { int median, j; if (pos > MIN) median =
    MIN + 1;
    else median =
        MIN;

    *newNode = (struct BTreeNode*)malloc(sizeof(struct
    BTreeNode)); j = median + 1; while (j <= MAX) {
        (*newNode)->val[j - median] = node->val[j];
    (*newNode)->link[j - median] = node->link[j];
    j++; } node->count = median;
    (*newNode)->count = MAX - median;

    if (pos <= MIN) insertNode(val, pos,
        node, child);
    else insertNode(val, pos - median, *newNode,
        child);

    *pval = node->val[node->count];
    (*newNode)->link[0] = node->link[node->count]; node->count--
    ;
}

int setValue(int val, int* pval, struct BTreeNode* node, struct
BTreeNode** child) { int pos; if (!node) {
        *pval = val;
        *child = NULL;
```



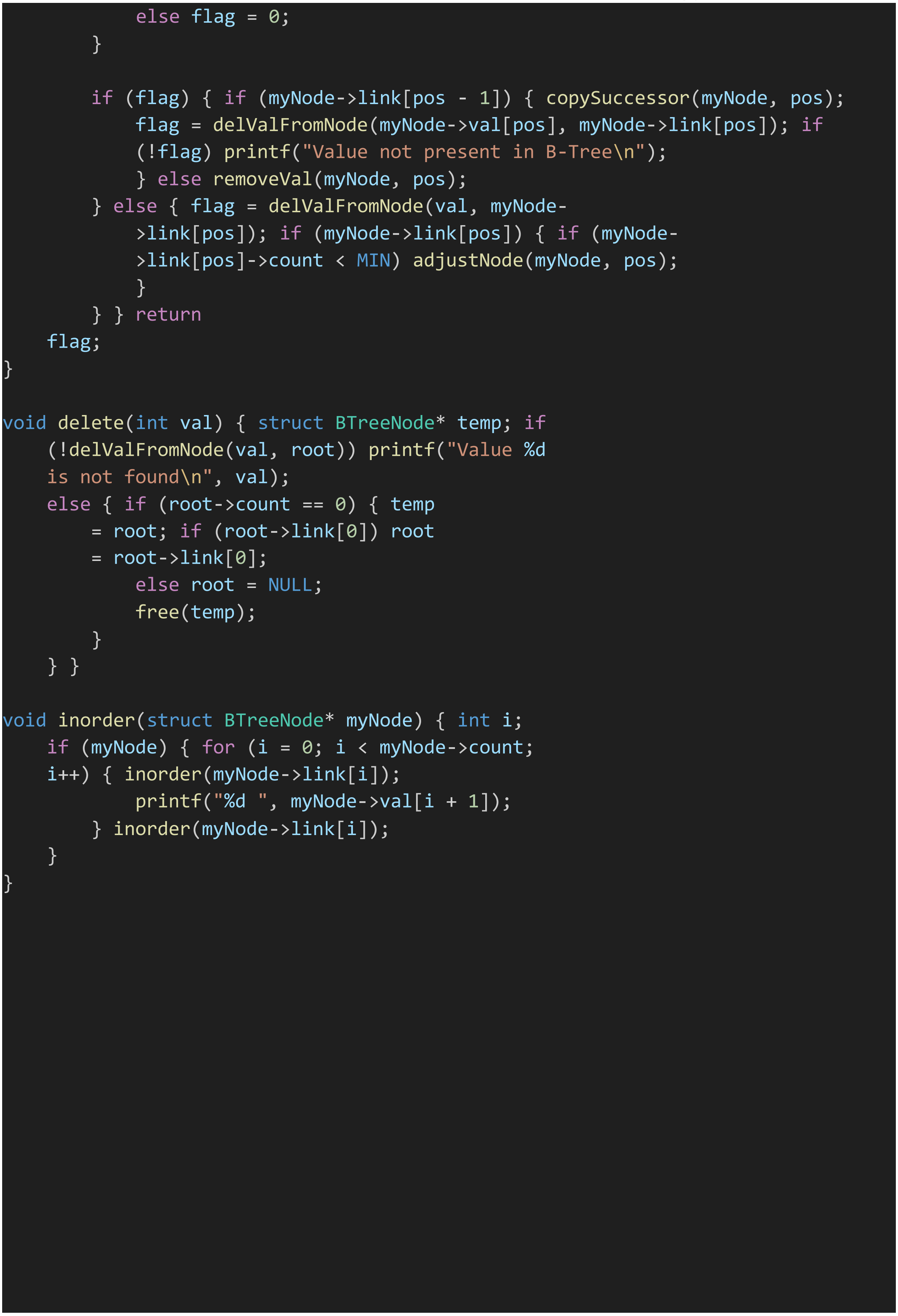
```
        return 1;
    }

    if (val < node->val[1]) {
        pos = 0;
    } else { for (pos = node->count; (val < node->val[pos] && pos > 1);
        pos--)
            ; if (val == node-
        >val[pos]) return 0;
    }

    if (setValue(val, pval, node->link[pos], child)) {
        if (node->count < MAX) { insertNode(*pval, pos,
        node, *child);
        } else { splitNode(*pval, pval, pos, node, *child,
            child); return 1;
        } }
    return 0;
}

void insert(int val) { int
    flag, i; struct
    BTreeNode* child;

    flag = setValue(val, &i, root,
    &child); if (flag) root =
    createNode(i, child);
}

void copySuccessor(struct BTreeNode* myNode, int pos) {
    struct BTreeNode* dummy; dummy = myNode->link[pos];

    while (dummy->link[0] != NULL)
        dummy = dummy->link[0];
    myNode->val[pos] = dummy->val[1];
}

void removeVal(struct BTreeNode* myNode, int pos)
    { int i = pos + 1; while (i <= myNode->count)
    { myNode->val[i - 1] = myNode->val[i]; myNode-
    >link[i - 1] = myNode->link[i]; i++; } myNode-
    >count--;
```



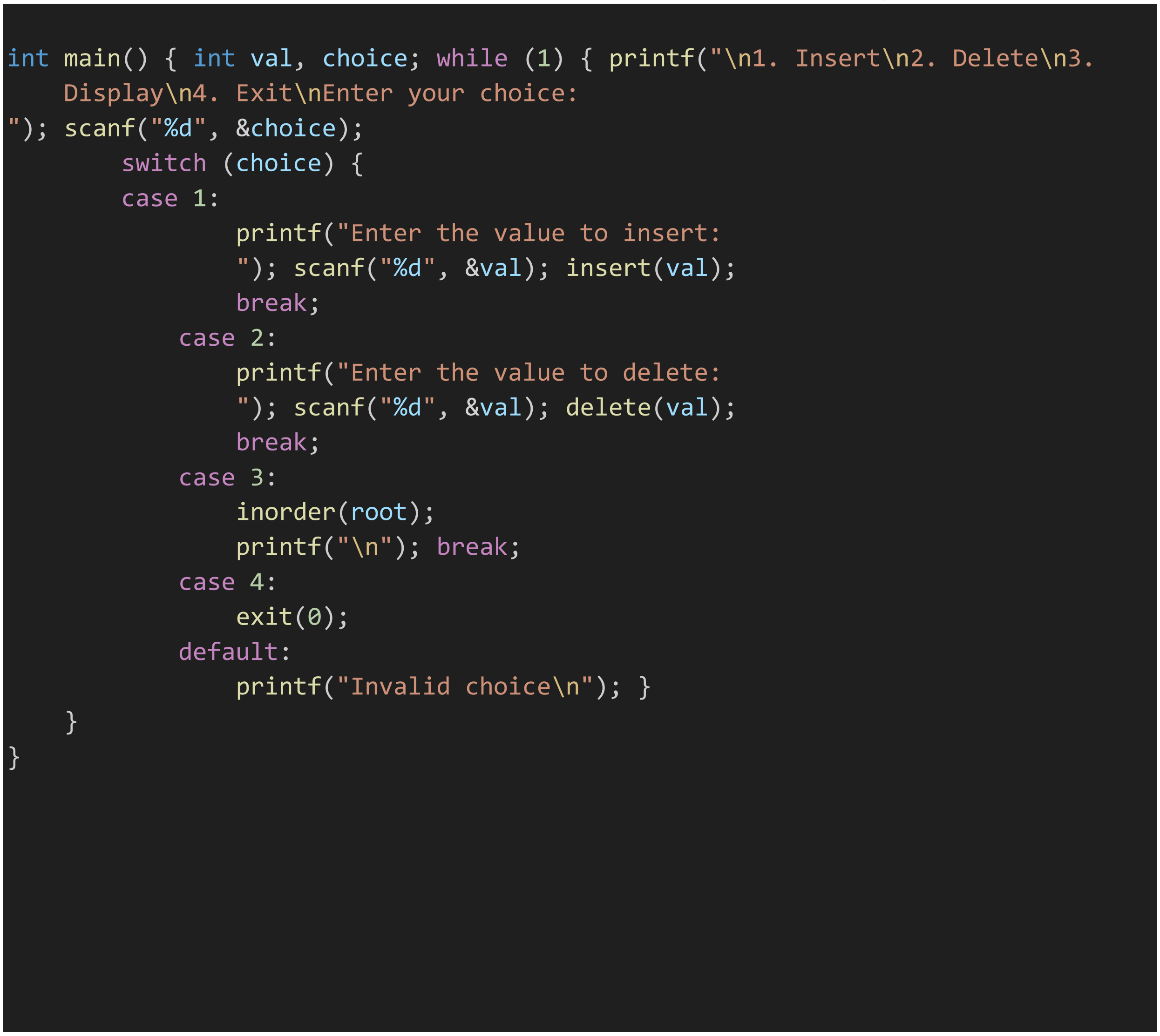
```
}

void rightShift(struct BTreeNode* myNode, int pos)
    { struct BTreeNode* x = myNode->link[pos]; int
    j = x->count;

    while (j > 0) { x->val[j + 1] =
        x->val[j]; x->link[j + 1] =
        x->link[j];
    } x->val[1] = myNode-
    >val[pos]; x->link[1] = x-
    >link[0]; x->count++;

    x = myNode->link[pos - 1]; myNode-
    >val[pos] = x->val[x->count]; myNode-
    >link[pos] = x->link[x->count]; x->count--
    ;
}

void leftShift(struct BTreeNode* myNode, int pos)
    { int j = 1; struct BTreeNode* x = myNode-
    >link[pos - 1];

    x->count++; x->val[x->count] = myNode-
    >val[pos]; x->link[x->count] = myNode-
    >link[pos]->link[0];

    x     =     myNode->link[pos];
    myNode->val[pos] = x->val[1];
    x->link[0]  =  x->link[1];  x-
    >count--;

    while (j <= x->count) { x-
        >val[j] = x->val[j + 1]; x-
        >link[j] = x->link[j + 1];
        j++;
    } }

void mergeNodes(struct BTreeNode* myNode, int pos) { int j = 1; struct
    BTreeNode* x1 = myNode->link[pos], *x2 = myNode->link[pos - 1];

    x2->count++; x2->val[x2->count] =
    myNode->val[pos]; x2->link[x2->count]
    = x1->link[0]; while (j <= x1->count)
    {
```



```
        x2->count++; x2->val[x2->count] =
    x1->val[j]; x2->link[x2->count] = x1-
    >link[j]; j++; }

    for (j = pos; j < myNode->count; j++) { myNode->val[j]
        = myNode->val[j + 1]; myNode->link[j] = myNode-
        >link[j + 1];
    } myNode->count--
    ; free(x1);
}

void adjustNode(struct BTreeNode* myNode, int pos)
    { if (!pos) { if (myNode->link[1]->count > MIN)
    leftShift(myNode, 1);
        else mergeNodes(myNode,
            1);
    } else { if (myNode->count != pos) { if
        (myNode->link[pos - 1]->count > MIN)
        rightShift(myNode, pos);
            else if (myNode->link[pos + 1]->count > MIN)
                leftShift(myNode, pos + 1);
            else mergeNodes(myNode,
                pos);
        } else { if (myNode->link[pos - 1]->count
            > MIN) rightShift(myNode, pos);
            else mergeNodes(myNode,
        pos); }
    } }

int delValFromNode(int val, struct BTreeNode* myNode)
    { int pos, flag = 0; if (myNode) { if (val <
    myNode->val[1]) { pos = 0; flag = 0;
        } else { for (pos = myNode->count; (val < myNode->val[pos] && pos >
            1); pos-
-)
                ; if (val == myNode-
            >val[pos]) flag = 1;
```

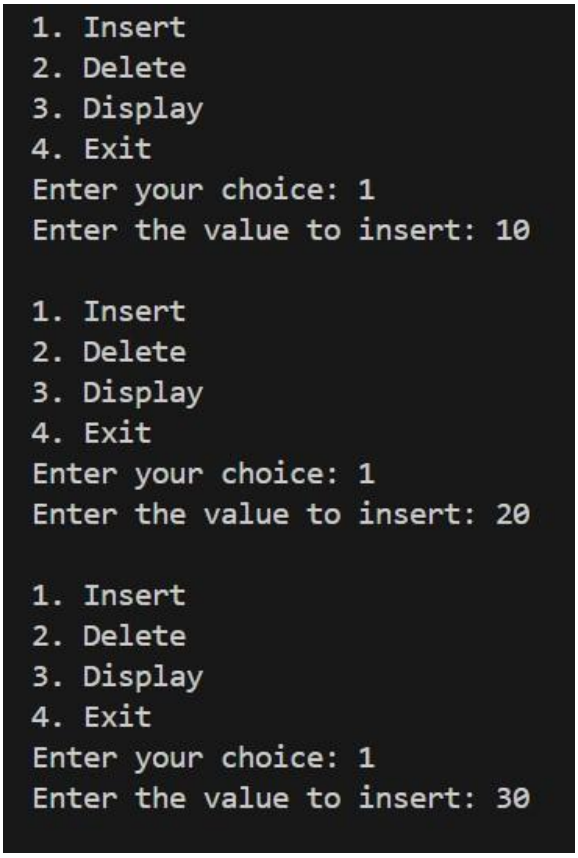


```
            else flag = 0;
        }

        if (flag) { if (myNode->link[pos - 1]) { copySuccessor(myNode, pos);
            flag = delValFromNode(myNode->val[pos], myNode->link[pos]); if
            (!flag) printf("Value not present in B-Tree\n");
            } else removeVal(myNode, pos);
        } else { flag = delValFromNode(val, myNode-
            >link[pos]); if (myNode->link[pos]) { if (myNode-
            >link[pos]->count < MIN) adjustNode(myNode, pos);
            }
        } } return
    flag;
}

void delete(int val) { struct BTreeNode* temp; if
    (!delValFromNode(val, root)) printf("Value %d
    is not found\n", val);
    else { if (root->count == 0) { temp
        = root; if (root->link[0]) root
        = root->link[0];
            else root = NULL;
            free(temp);
        }
    } }

void inorder(struct BTreeNode* myNode) { int i;
    if (myNode) { for (i = 0; i < myNode->count;
    i++) { inorder(myNode->link[i]);
            printf("%d ", myNode->val[i + 1]);
        } inorder(myNode->link[i]);
    }
}
```

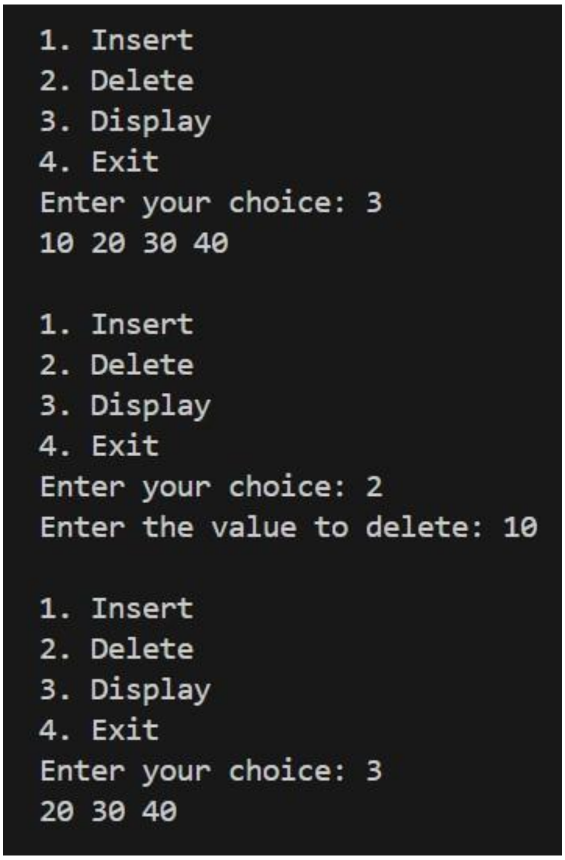


```
int main() { int val, choice; while (1) { printf("\n1. Insert\n2. Delete\n3.
    Display\n4. Exit\nEnter your choice:
"); scanf("%d", &choice);
        switch (choice) {
        case 1:
                printf("Enter the value to insert:
                "); scanf("%d", &val); insert(val);
                break;
            case 2:
                printf("Enter the value to delete:
                "); scanf("%d", &val); delete(val);
                break;
            case 3:
                inorder(root);
                printf("\n"); break;
            case 4:
                exit(0);
            default:
                printf("Invalid choice\n"); }
    }
}
```

OUTPUT:



```
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 10

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 20

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1
Enter the value to insert: 30
```



```
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
10 20 30 40

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2
Enter the value to delete: 10

1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
20 30 40
```

CONCLUSION: In this experiment we implemented various operations on a B-Tree

REFERENCES:

1. Peter Brass, “Advanced Data Structures”, Cambridge University Press, 2008

2. Robert Sedgewick & Kevin Wayne, “Algorithms”, 4th Edition, Addison-Wesley Professional, 2011.