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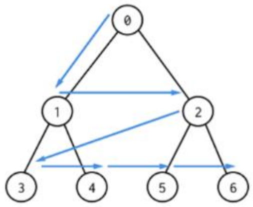
MODUL 9 PRAKTIUKUM STURKTUR DATA

Sekarang, Anda telah memahami cara membuat AVL Tree. Untuk memperdalam pemahaman Anda mengenai AVL Tree, modifikasi BST untuk menyimpan nama mahasiswa yang ada pada program Praktikum8B.c menjadi AVL Tree.

1. Simpan ulang Praktikum9B.c dengan nama Praktikum9B.c, lalu lakukan modifikasi pada fungsi insert dan delete seperti yang kita lakukan pada kegiatan praktikum di atas.
2. Kemudian, tambahkan sebuah fungsi untuk menampilkan nama-nama mahasiswa yang ada pada tree dengan alur.
   Level Order Trasversal :



- **Program**

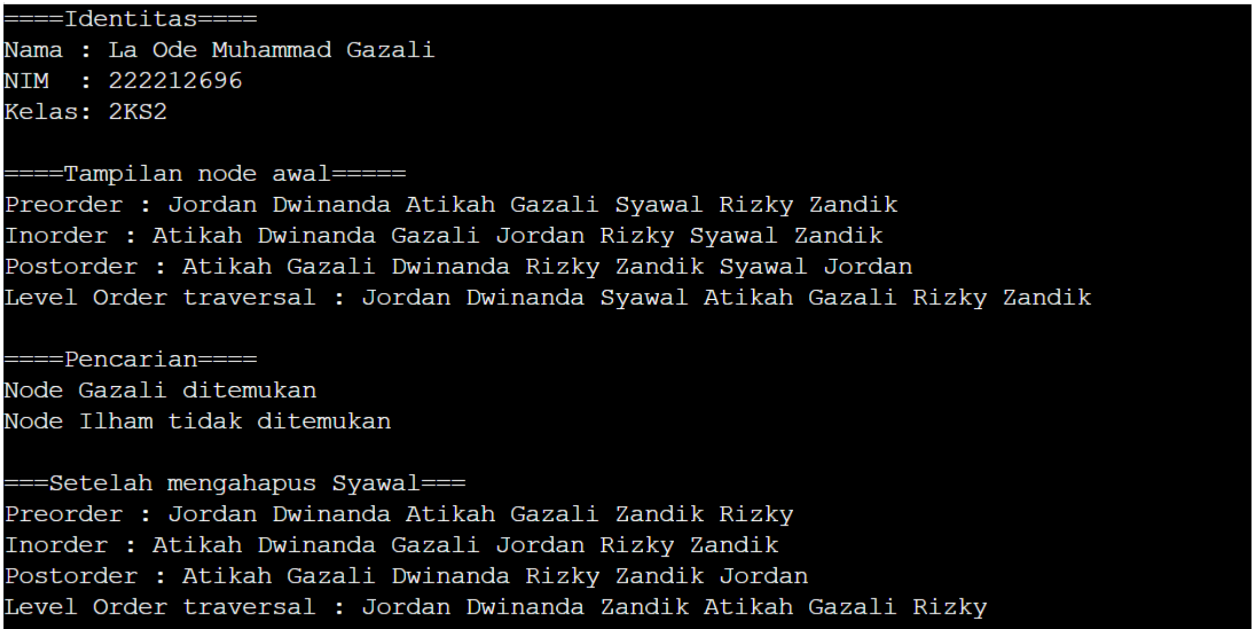
```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

struct node
{
    char data[30];
    struct node *left;
    struct node *right;
    int height;
};

int height(struct node* N)
{
      if (N == NULL)
           return 0;
      return N->height;
}

// Hitung Balance factor untuk node N
int getBalanceFactor(struct node *N)
{
      if (N == NULL)
           return 0;
```

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

int max(int a, int b)
{
     return (a > b)? a : b;
}

struct node *newNode(const char* data)
{
    struct node *new_node = (struct node*)malloc(sizeof(struct node));
    strncpy(new_node->data, data, sizeof(new_node->data));
    new_node->left = NULL;
    new_node->right = NULL;
    new_node->height = 1; // new node is initially added at leaf
    return(new_node);
}

struct node* rightRotate(struct node *y)
{
     struct node *x = y->left;
     struct node *T2 = x->right;

     // Lakukan rotasi
     x->right = y;
     y->left = T2;

     // Update height
     y->height = max(height(y->left), height(y->right))+1;
     x->height = max(height(x->left), height(x->right))+1;

     // Return root baru
     return x;
}

struct node *leftRotate(struct node *x)
{
     struct node *y = x->right;
     struct node *T2 = y->left;

     // Lakukan rotasi
     y->left = x;
     x->right = T2;

     // Update height
     x->height = max(height(x->left), height(x->right))+1;
     y->height = max(height(y->left), height(y->right))+1;

     // Return root baru
     return y;
}
struct node* insert(struct node* root, const char* newData)
```

```
{
    if (root == NULL) {
        return(newNode(newData));
    }

    int compare = strcmp(newData, root->data);
    if (compare < 0) {
        root->left = insert(root->left, newData);
    }
    else if (compare > 0) {
        root->right = insert(root->right, newData);
    }
    else
        return root;

    // 2. Update height dari node
    root->height = 1 + max(height(root->left), height(root->right));


    // 3. Hitung balance factor untuk menentukan apakah node
unbalanced
      int balance = getBalanceFactor(root);

    // Jika tidak balanced, return hasil rotation
      // Kasus 1: Left Left
      if (balance > 1 && strcmp(newData, root->left->data) < 0)
           return rightRotate(root);

      // Kasus 2: Right Right
      if (balance < -1 && strcmp(newData, root->right->data) > 0)
           return leftRotate(root);

      // Kasus 3: Right Left
      if (balance < -1 && strcmp(newData,root->right->data) < 0)
      {
           root->right = rightRotate(root->right);
           return leftRotate(root);
      }

      // Kasus 4: Left Right
      if (balance > 1 && strcmp(newData,root->left->data)>0)
      {
           root->left = leftRotate(root->left);
           return rightRotate(root);
      }

    return root;
}


struct node * minValueNode(struct node* node) //cari node minimum di
suatu subtree
```

```
{
    struct node* current = node;

    /* loop down to find the leftmost leaf */
    while (current->left != NULL)
        current = current->left;

    return current;
}

void displayPreorder(struct node* node)
{
    if (node == NULL)
        return;

    printf("%s ", node->data); // root
    displayPreorder(node->left); // subtree kiri
    displayPreorder(node->right); // subtree kanan
}

void displayInorder(struct node* node)
{
    if (node == NULL)
        return;

    displayInorder(node->left); // subtree kiri
    printf("%s ", node->data); // root
    displayInorder(node->right); // subtree kanan
}

void displayPostorder(struct node* node)
{
    if (node == NULL)
        return;

    displayPostorder(node->left); // subtree kiri
    displayPostorder(node->right); // subtree kanan
    printf("%s ", node->data); // root
}

void search_node(struct node* root, const char* data)
{
    struct node* cursor = root;

    while (cursor != NULL) {
        int compare = strcmp(data, cursor->data);
        if (compare == 0) {
            printf("\nNode %s ditemukan", data);
            return;
        }
        else if (compare < 0) {
            cursor = cursor->left;
        }
        else {
            cursor = cursor->right;
        }
    }

    printf("\nNode %s tidak ditemukan", data);
}

void levelOrderTraversal(struct node* root) {
    if (root == NULL)
        return;

    int maxNodes = 100;
    struct node* queue[100];
    int front = 0, rear = 0;
    queue[rear++] = root;

    while (front < rear) {
        struct node* current = queue[front++];
        printf("%s ", current->data);

        if (current->left)
            queue[rear++] = current->left;
        if (current->right)
            queue[rear++] = current->right;
    }
}

struct node* delete_node(struct node* root, const char* deletedData)
{
    // 1. Lakukan BST delete biasa
    int compare = strcmp(deletedData, root->data);
    if (root == NULL)
        return root;

    if (compare < 0)
        root->left = delete_node(root->left, deletedData);

    else if(compare > 0)
        root->right = delete_node(root->right, deletedData);

    else
    { //jika ditemukan node yang akan dihapus
        // 1 CHILD atau NO CHILD
       struct node* cursor;
        if (root->left == NULL)
        {
            cursor = root->right;
            free(root);
            root = cursor;
        }
        else if (root->right == NULL)
        {
            cursor = root->left;
            free(root);
            root = cursor;
        }
        //2 CHILDS
        else
        {
            // cari minimum di subtree kanan
            cursor = minValueNode(root->right);
            strncpy(root->data, cursor->data, sizeof(root->data));


            // Delete data yang telah dipindahkan sebagai root
            root->right = delete_node(root->right, cursor->data);
        }
    }

    // Jika setelah dilakukan delete, tree kosong maka return root
    if (root == NULL)
      return root;

    // 2. Update height dari node
    root->height = 1 + max(height(root->left), height(root->right));


    //3. Hitung balance factor untuk menentukan apakah root unbalanced
    int balance = getBalanceFactor(root);

    // Jika tidak balanced, return hasil rotation
     // Kasus 1: Left Left
    if (balance > 1 && getBalanceFactor(root->left) >= 0)
        return rightRotate(root);

    // Kasus 2: Right Right
    if (balance < -1 && getBalanceFactor(root->right) <= 0)
        return leftRotate(root);

    // Kasus 3: Right Left
    if (balance < -1 && getBalanceFactor(root->right) > 0)
    {
        root->right = rightRotate(root->right);
        return leftRotate(root);
    }

    // Kasus 4: Left Right
    if (balance > 1 && getBalanceFactor(root->left) < 0)
    {
        root->left =  leftRotate(root->left);
        return rightRotate(root);
    }
    // return root jika balanced
    return root;
}

int main()
{
    printf("====Identitas====\n");
    printf("Nama : La Ode Muhammad Gazali\n");
    printf("NIM  : 222212696\n");
    printf("Kelas: 2KS2\n\n");

    struct node* root = newNode("Jordan");
    root = insert(root, "Dwinanda");
    root = insert(root, "Atikah");
    root = insert(root, "Gazali");
    root = insert(root, "Syawal");
    root = insert(root, "Rizky");
    root = insert(root, "Zandik");

    printf("====Tampilan node awal=====");
    printf("\nPreorder : "); displayPreorder(root);
    printf("\nInorder : "); displayInorder(root);
    printf("\nPostorder : "); displayPostorder(root);
    printf("\nLevel Order traversal : ");levelOrderTraversal(root);

    printf("\n\n====Pencarian====");
    search_node(root, "Gazali");
    search_node(root, "Ilham");
    root = delete_node(root, "Syawal");

    printf("\n\n===Setelah mengahapus Syawal===\n");
    printf("Preorder : "); displayPreorder(root);
    printf("\nInorder : "); displayInorder(root);
    printf("\nPostorder : "); displayPostorder(root);
    printf("\nLevel Order traversal : ");levelOrderTraversal(root);

    return 0;
}
```

- **Output**



```
====Identitas====
Nama : La Ode Muhammad Gazali
NIM  : 222212696
Kelas: 2KS2

====Tampilan node awal=====
Preorder : Jordan Dwinanda Atikah Gazali Syawal Rizky Zandik
Inorder : Atikah Dwinanda Gazali Jordan Rizky Syawal Zandik
Postorder : Atikah Gazali Dwinanda Rizky Zandik Syawal Jordan
Level Order traversal : Jordan Dwinanda Syawal Atikah Gazali Rizky Zandik

====Pencarian====
Node Gazali ditemukan
Node Ilham tidak ditemukan

===Setelah mengahapus Syawal===
Preorder : Jordan Dwinanda Atikah Gazali Zandik Rizky
Inorder : Atikah Dwinanda Gazali Jordan Rizky Zandik
Postorder : Atikah Gazali Dwinanda Rizky Zandik Jordan
Level Order traversal : Jordan Dwinanda Zandik Atikah Gazali Rizky
```

AVL Tree sebelum delete Syawal

```
                    Jordan

                    /       \

          Dwinanda      Syawal

             /      \          /        \

  Atikah    Gazali    Rizky    Zandik
```

AVL Tree setelah delete Syawal

```
                    Jordan

                    /      \

          Dwinanda      Zandik

             /      \            /

  Atikah    Gazali     Rizky
```