LAPORAN PRAKTIKUM
Modul 13
MULTI LINKED LIST

Disusun Oleh:
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Tujuan Pembelajaran

1. Memahami konsep dan implementasi Multi Linked List
2. Mampu menerapkan Multi Linked List dalam berbagai studi kasus

Ringkasan Konsep Multi Linked List

Definisi: Multi Linked List adalah struktur data yang terdiri dari beberapa list yang saling terhubung, di mana setiap elemen dapat membentuk list tersendiri. Struktur ini biasanya terdiri dari:

- List Induk (Parent List)
- List Anak (Child List)

Komponen Utama:

1. **List Induk:**
   - Menyimpan data utama
   - Memiliki pointer ke list anak
2. **List Anak:**
   - Terhubung dengan elemen induk
   - Dapat memiliki multiple elemen

Operasi Dasar:

1. **Operasi Insert:**
   - Insert Anak:
     - Memerlukan identifikasi elemen induk terlebih dahulu
     - Biasanya menggunakan konsep insert last
   - Insert Induk:
     - Mirip dengan operasi insert pada linked list biasa
2. **Operasi Delete:**
   - Delete Anak:
     - Memerlukan identifikasi induk terlebih dahulu
     - Menghapus elemen anak spesifik
   - Delete Induk:
     - Menghapus elemen induk
     - Otomatis menghapus semua anak yang terkait

Implementasi:

- Menggunakan pointer untuk menghubungkan elemen
- Memiliki struktur data terpisah untuk induk dan anak
- Memerlukan manajemen memori yang baik untuk alokasi dan dealokasi

Kegunaan:

- Manajemen data hierarkis
- Organisasi data yang memiliki relasi parent-child
- Implementasi sistem yang membutuhkan struktur data bertingkat

Contoh Aplikasi:

1. Sistem Manajemen Pegawai dan Proyek
2. Sistem Perpustakaan (Anggota dan Buku)
3. Struktur Organisasi
4. Manajemen Data Mahasiswa

Kelebihan:

- Fleksibel dalam menangani data bertingkat
- Efisien dalam operasi pencarian
- Memudahkan pengelolaan data yang saling berhubungan

Catatan Penting:

- Memerlukan pemahaman yang baik tentang pointer
- Perlu memperhatikan manajemen memori
- Penting untuk menjaga konsistensi antara list induk dan anak

Guided

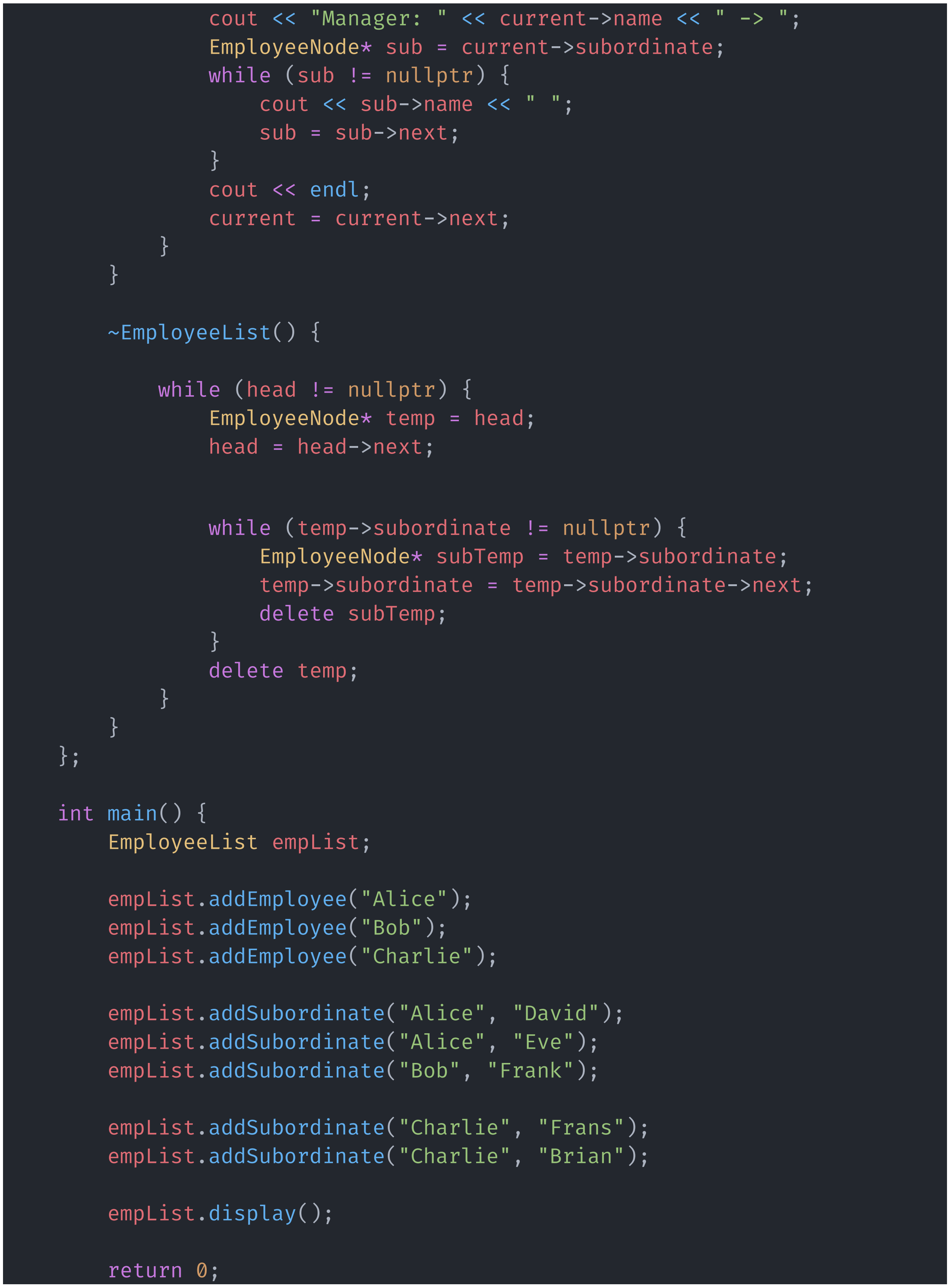
Guided1.cpp

```
#include <iostream>
#include <string>

using namespace std;


struct Node {
    int data;
    Node* next;
    Node* child;
```

```cpp
    Node(int val) : data(val), next(nullptr), child(nullptr) {}
};


class MultiLinkedList {
private:
    Node* head;

public:
    MultiLinkedList() : head(nullptr) {}


    void addParent(int data) {
        Node* newNode = new Node(data);
        newNode->next = head;
        head = newNode;
    }


    void addChild(int parentData, int childData) {
        Node* parent = head;
        while (parent != nullptr && parent->data != parentData) {
            parent = parent->next;
        }
        if (parent != nullptr) {
            Node* newChild = new Node(childData);
            newChild->next = parent->child;
            parent->child = newChild;
        } else {
            cout << "Parent not found!" << endl;
        }
    }


    void display() {
        Node* current = head;
        while (current != nullptr) {
            cout << "Parent: " << current->data << " -> ";
            Node* child = current->child;
            while (child != nullptr) {
                cout << child->data << " ";
                child = child->next;
            }
            cout << endl;
            current = current->next;
        }
    }

    ~MultiLinkedList() {

        while (head != nullptr) {
            Node* temp = head;
            head = head->next;


            while (temp->child != nullptr) {
                Node* childTemp = temp->child;
                temp->child = temp->child->next;
                delete childTemp;
            }
            delete temp;
        }
    }
};

int main() {
    MultiLinkedList mList;

    mList.addParent(1);
    mList.addParent(2);
    mList.addParent(3);

    mList.addChild(1, 10);
    mList.addChild(1, 11);
    mList.addChild(2, 20);
    mList.addChild(2, 20);
    mList.addChild(3, 30);
    mList.addChild(3, 30);
    mList.display();

    return 0;
}
```

Guided2.cpp

```
    #include <iostream>
    #include <string>

    using namespace std;
    struct EmployeeNode {
        string name;
        EmployeeNode* next;
        EmployeeNode* subordinate;

        EmployeeNode(string empName) : name(empName), next(nullptr),
subordinate(nullptr) {}
    };


    class EmployeeList {
    private:
        EmployeeNode* head;

    public:
        EmployeeList() : head(nullptr) {}


        void addEmployee(string name) {
            EmployeeNode* newEmployee = new EmployeeNode(name);
            newEmployee->next = head;
            head = newEmployee;
        }


        void addSubordinate(string managerName, string subordinateName) {
            EmployeeNode* manager = head;
            while (manager != nullptr && manager->name != managerName) {
                manager = manager->next;
            }
            if (manager != nullptr) {
                EmployeeNode* newSubordinate = new
EmployeeNode(subordinateName);
                newSubordinate->next = manager->subordinate;
                manager->subordinate = newSubordinate;
            } else {
                cout << "Manager not found!" << endl;
            }
        }


        void display() {
            EmployeeNode* current = head;
            while (current != nullptr) {
```



```cpp
            cout << "Manager: " << current->name << " -> ";
            EmployeeNode* sub = current->subordinate;
            while (sub != nullptr) {
                cout << sub->name << " ";
                sub = sub->next;
            }
            cout << endl;
            current = current->next;
        }
    }

    ~EmployeeList() {

        while (head != nullptr) {
            EmployeeNode* temp = head;
            head = head->next;


            while (temp->subordinate != nullptr) {
                EmployeeNode* subTemp = temp->subordinate;
                temp->subordinate = temp->subordinate->next;
                delete subTemp;
            }
            delete temp;
        }
    }
};

int main() {
    EmployeeList empList;

    empList.addEmployee("Alice");
    empList.addEmployee("Bob");
    empList.addEmployee("Charlie");

    empList.addSubordinate("Alice", "David");
    empList.addSubordinate("Alice", "Eve");
    empList.addSubordinate("Bob", "Frank");

    empList.addSubordinate("Charlie", "Frans");
    empList.addSubordinate("Charlie", "Brian");

    empList.display();

    return 0;
    }
```

Guided3.cpp

```
#include <iostream>
#include <string>

using namespace std;

// Struktur untuk node karyawan
struct EmployeeNode {
    string name; // Nama karyawan
    EmployeeNode* next; // Pointer ke karyawan berikutnya
    EmployeeNode* subordinate; // Pointer ke subordinate pertama

    EmployeeNode(string empName) : name(empName), next(nullptr),
subordinate(nullptr) {}
};

// Kelas untuk Multi-Linked List Karyawan
class EmployeeList {
private:
    EmployeeNode* head; // Pointer ke kepala list

public:
    EmployeeList() : head(nullptr) {}

    // Menambahkan karyawan (induk)
    void addEmployee(string name) {
        EmployeeNode* newEmployee = new EmployeeNode(name);
        newEmployee->next = head; // Menyambungkan ke karyawan sebelumnya
        head = newEmployee; // Memperbarui head
    }

    // Menambahkan subordinate ke karyawan tertentu
    void addSubordinate(string managerName, string subordinateName) {
        EmployeeNode* manager = head;
        while (manager != nullptr && manager->name != managerName) {
            manager = manager->next;
        }
        if (manager != nullptr) { // Jika manajer ditemukan
            EmployeeNode* newSubordinate = new
EmployeeNode(subordinateName);
```

```
            newSubordinate->next = manager->subordinate; // Menyambungkan
ke subordinate sebelumnya
            manager->subordinate = newSubordinate; // Memperbarui
subordinate
        } else {
            cout << "Manager not found!" << endl;
        }
    }

    // Menghapus karyawan (induk)
    void deleteEmployee(string name) {
        EmployeeNode** current = &head;
        while (*current != nullptr && (*current)->name != name) {
            current = &((*current)->next);
        }

        if (*current != nullptr) { // Jika karyawan ditemukan
            EmployeeNode* toDelete = *current;
            *current = (*current)->next;

            // Hapus semua subordinate dari node ini
            while (toDelete->subordinate != nullptr) {
                EmployeeNode* subTemp = toDelete->subordinate;
                toDelete->subordinate = toDelete->subordinate->next;
                delete subTemp;
            }
            delete toDelete;
            cout << "Employee " << name << " deleted." << endl;
        } else {
            cout << "Employee not found!" << endl;
        }
    }

    // Menghapus subordinate dari karyawan tertentu
    void deleteSubordinate(string managerName, string subordinateName) {
        EmployeeNode* manager = head;
        while (manager != nullptr && manager->name != managerName) {
            manager = manager->next;
        }

        if (manager != nullptr) { // Jika manajer ditemukan
            EmployeeNode** currentSub = &(manager->subordinate);
            while (*currentSub != nullptr && (*currentSub)->name !=
subordinateName) {
                currentSub = &((*currentSub)->next);
```

```cpp
            }

            if (*currentSub != nullptr) { // Jika subordinate ditemukan
                EmployeeNode* toDelete = *currentSub;
                *currentSub = (*currentSub)->next; // Menghapus dari list

                delete toDelete; // Menghapus node subordinate
                cout << "Subordinate " << subordinateName << " deleted
from " << managerName << "." << endl;
            } else {
                cout << "Subordinate not found!" << endl;
            }
        } else {
            cout << "Manager not found!" << endl;
        }
    }

    // Menampilkan daftar karyawan dan subordinate mereka
    void display() {
        EmployeeNode* current = head;
        while (current != nullptr) {
            cout << "Manager: " << current->name << " -> ";
            EmployeeNode* sub = current->subordinate;
            while (sub != nullptr) {
                cout << sub->name << " ";
                sub = sub->next;
            }
            cout << endl;
            current = current->next;
        }
    }

    ~EmployeeList() {
        // Destructor untuk membersihkan memori
        while (head != nullptr) {
            EmployeeNode* temp = head;
            head = head->next;

            // Hapus semua subordinate dari node ini
            while (temp->subordinate != nullptr) {
                EmployeeNode* subTemp = temp->subordinate;
                temp->subordinate = temp->subordinate->next;
                delete subTemp;
            }
            delete temp;
        }
    }
};

int main() {
    EmployeeList empList;

    empList.addEmployee("Alice");
    empList.addEmployee("Bob");
    empList.addEmployee("Charlie");

    empList.addSubordinate("Alice", "David");
    empList.addSubordinate("Alice", "Eve");
    empList.addSubordinate("Bob", "Frank");

    cout << "Initial employee list:" << endl;
    empList.display(); // Menampilkan isi daftar karyawan

    empList.deleteSubordinate("Alice", "David"); // Menghapus David dari
Alice
    empList.deleteEmployee("Charlie"); // Menghapus Charlie

    cout << "\nUpdated employee list:" << endl;
    empList.display(); // Menampilkan isi daftar setelah penghapusan

    return 0;
}
```

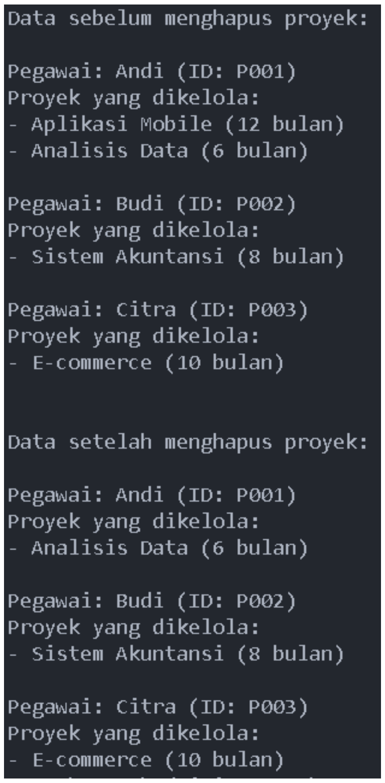
Unguided

unGuided1.cpp

```
#include <iostream>
#include <string>
using namespace std;

// Struktur untuk proyek
struct Project
{
    string name;
```

```cpp
    int duration;
    Project *next;
};

// Struktur untuk pegawai
struct Employee
{
    string name;
    string id;
    Project *firstProject;
    Employee *next;
};

class EmployeeManagement
{
private:
    Employee *head;

public:
    EmployeeManagement()
    {
        head = NULL;
    }

    // Fungsi untuk menambah pegawai baru
    void addEmployee(string name, string id)
    {
        Employee *newEmployee = new Employee;
        newEmployee->name = name;
        newEmployee->id = id;
        newEmployee->firstProject = NULL;
        newEmployee->next = NULL;

        if (head == NULL)
        {
            head = newEmployee;
        }
        else
        {
            Employee *current = head;
            while (current->next != NULL)
            {
                current = current->next;
            }
            current->next = newEmployee;
        }
    }

    // Fungsi untuk menambah proyek ke pegawai
    void addProject(string employeeId, string projectName, int duration)
    {
        Employee *emp = findEmployee(employeeId);
        if (emp != NULL)
        {
            Project *newProject = new Project;
            newProject->name = projectName;
            newProject->duration = duration;
            newProject->next = NULL;

            if (emp->firstProject == NULL)
            {
                emp->firstProject = newProject;
            }
            else
            {
                Project *current = emp->firstProject;
                while (current->next != NULL)
                {
                    current = current->next;
                }
                current->next = newProject;
            }
        }
    }

    // Fungsi untuk mencari pegawai berdasarkan ID
    Employee *findEmployee(string id)
    {
        Employee *current = head;
        while (current != NULL)
        {
            if (current->id == id)
            {
                return current;
            }
            current = current->next;
        }
        return NULL;
    }
    // Fungsi untuk menghapus proyek
    void deleteProject(string employeeId, string projectName)
    {
        Employee *emp = findEmployee(employeeId);
        if (emp != NULL && emp->firstProject != NULL)
        {
            Project *current = emp->firstProject;
            Project *prev = NULL;

            // Jika proyek yang akan dihapus ada di awal
            if (current->name == projectName)
            {
                emp->firstProject = current->next;
                delete current;
                return;
            }

            // Mencari proyek yang akan dihapus
            while (current != NULL && current->name != projectName)
            {
                prev = current;
                current = current->next;
            }

            // Jika proyek ditemukan
            if (current != NULL)
            {
                prev->next = current->next;
                delete current;
            }
        }
    }

    // Fungsi untuk menampilkan semua data
    void displayAll()
    {
        Employee *currentEmp = head;
        while (currentEmp != NULL)
        {
            cout << "\nPegawai: " << currentEmp->name << " (ID: " <<
currentEmp->id << ")" << endl;
            cout << "Proyek yang dikelola:" << endl;

            Project *currentProj = currentEmp->firstProject;
            if (currentProj == NULL)
            {
                cout << "- Tidak ada proyek" << endl;
            }
            while (currentProj != NULL)
            {
                cout << "- " << currentProj->name << " (" << currentProj-
>duration << " bulan)" << endl;
                currentProj = currentProj->next;
            }
            currentEmp = currentEmp->next;
        }
    }
};

int main()
{
    EmployeeManagement em;

    // 1. Menambahkan pegawai
    em.addEmployee("Andi", "P001");
    em.addEmployee("Budi", "P002");
    em.addEmployee("Citra", "P003");

    // 2. Menambahkan proyek ke pegawai
    em.addProject("P001", "Aplikasi Mobile", 12);
    em.addProject("P002", "Sistem Akuntansi", 8);
    em.addProject("P003", "E-commerce", 10);

    // 3. Menambahkan proyek baru untuk Andi
    em.addProject("P001", "Analisis Data", 6);

    cout << "Data sebelum menghapus proyek:" << endl;
    em.displayAll();

    // 4. Menghapus proyek "Aplikasi Mobile" dari Andi
    em.deleteProject("P001", "Aplikasi Mobile");

    cout << "\n\nData setelah menghapus proyek:" << endl;
    em.displayAll();

    return 0;
}
```

Output

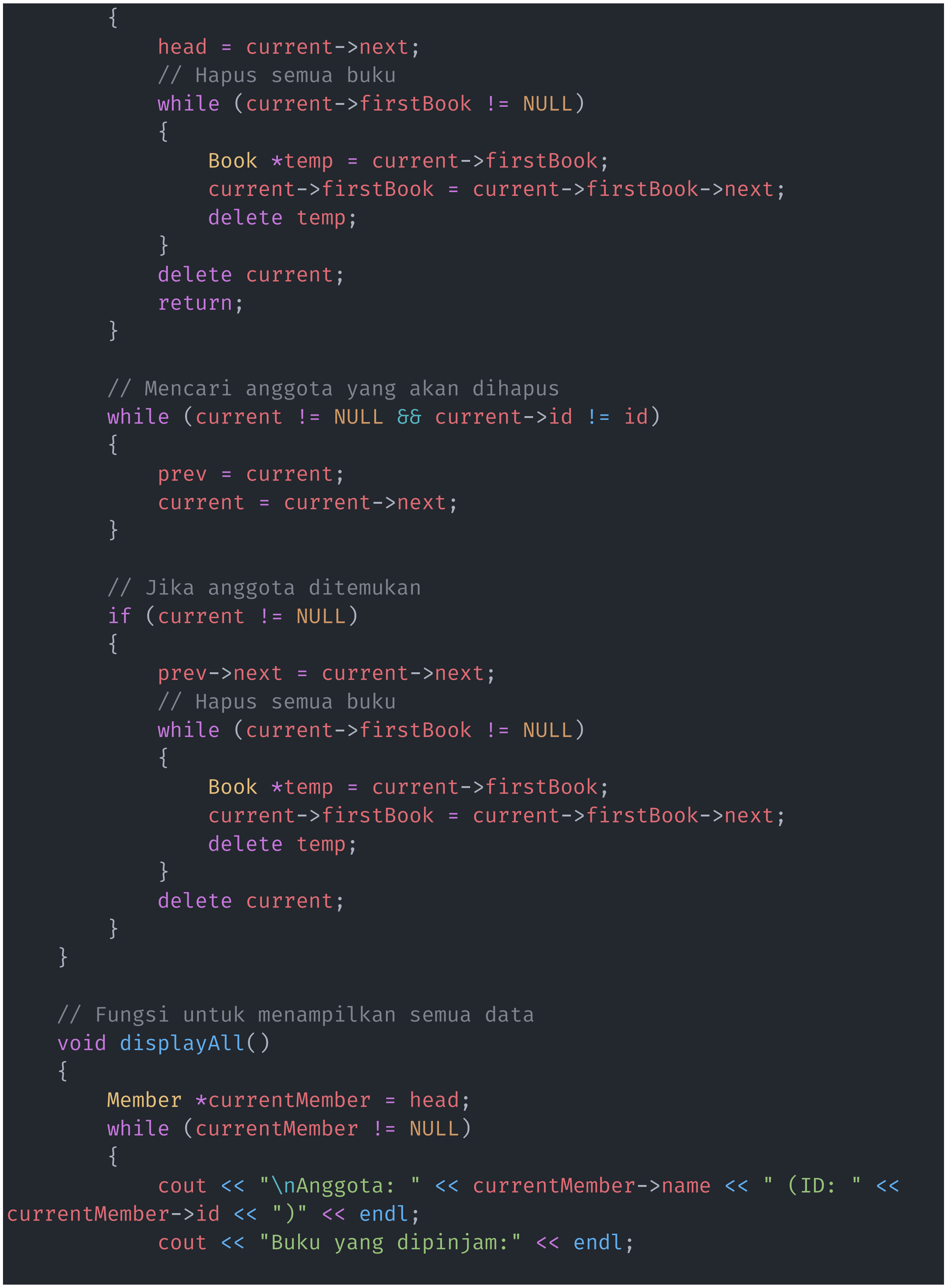


```
Data sebelum menghapus proyek:

Pegawai: Andi (ID: P001)
Proyek yang dikelola:
- Aplikasi Mobile (12 bulan)
- Analisis Data (6 bulan)

Pegawai: Budi (ID: P002)
Proyek yang dikelola:
- Sistem Akuntansi (8 bulan)

Pegawai: Citra (ID: P003)
Proyek yang dikelola:
- E-commerce (10 bulan)


Data setelah menghapus proyek:

Pegawai: Andi (ID: P001)
Proyek yang dikelola:
- Analisis Data (6 bulan)

Pegawai: Budi (ID: P002)
Proyek yang dikelola:
- Sistem Akuntansi (8 bulan)

Pegawai: Citra (ID: P003)
Proyek yang dikelola:
- E-commerce (10 bulan)
```

unGuided2.cpp

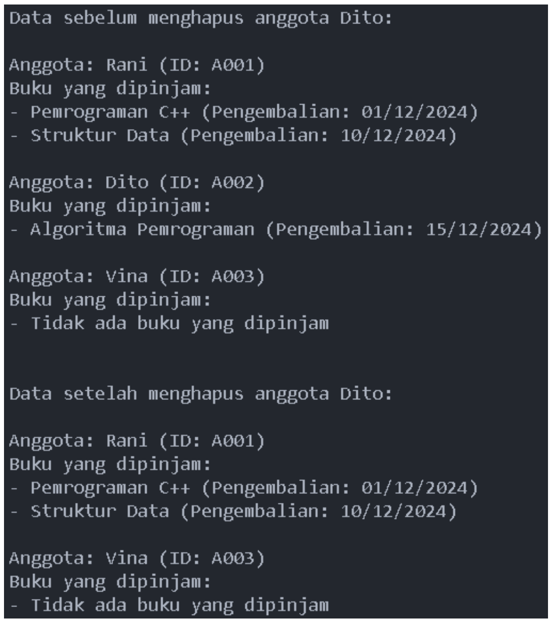
```cpp
#include <iostream>
#include <string>
using namespace std;

// Struktur untuk buku
struct Book
{
    string title;
    string returnDate;
    Book *next;
};

// Struktur untuk anggota
struct Member
{
    string name;
    string id;
    Book *firstBook;
    Member *next;
```

```
};

class LibraryManagement
{
private:
    Member *head;

public:
    LibraryManagement()
    {
        head = NULL;
    }

    // Fungsi untuk menambah anggota baru
    void addMember(string name, string id)
    {
        Member *newMember = new Member;
        newMember->name = name;
        newMember->id = id;
        newMember->firstBook = NULL;
        newMember->next = NULL;

        if (head == NULL)
        {
            head = newMember;
        }
        else
        {
            Member *current = head;
            while (current->next != NULL)
            {
                current = current->next;
            }
            current->next = newMember;
        }
    }

    // Fungsi untuk menambah buku ke anggota
    void addBook(string memberId, string bookTitle, string returnDate)
    {
        Member *member = findMember(memberId);
        if (member != NULL)
        {
            Book *newBook = new Book;
            newBook->title = bookTitle;
            newBook->returnDate = returnDate;
            newBook->next = NULL;

            if (member->firstBook == NULL)
            {
                member->firstBook = newBook;
            }
            else
            {
                Book *current = member->firstBook;
                while (current->next != NULL)
                {
                    current = current->next;
                }
                current->next = newBook;
            }
        }
    }

    // Fungsi untuk mencari anggota berdasarkan ID
    Member *findMember(string id)
    {
        Member *current = head;
        while (current != NULL)
        {
            if (current->id == id)
            {
                return current;
            }
            current = current->next;
        }
        return NULL;
    }

    // Fungsi untuk menghapus anggota beserta bukunya
    void deleteMember(string id)
    {
        if (head == NULL)
            return;

        Member *current = head;
        Member *prev = NULL;

        // Jika anggota yang akan dihapus ada di awal
        if (current != NULL && current->id == id)
```



```
        {
            head = current->next;
            // Hapus semua buku
            while (current->firstBook != NULL)
            {
                Book *temp = current->firstBook;
                current->firstBook = current->firstBook->next;
                delete temp;
            }
            delete current;
            return;
        }

        // Mencari anggota yang akan dihapus
        while (current != NULL && current->id != id)
        {
            prev = current;
            current = current->next;
        }

        // Jika anggota ditemukan
        if (current != NULL)
        {
            prev->next = current->next;
            // Hapus semua buku
            while (current->firstBook != NULL)
            {
                Book *temp = current->firstBook;
                current->firstBook = current->firstBook->next;
                delete temp;
            }
            delete current;
        }
    }

    // Fungsi untuk menampilkan semua data
    void displayAll()
    {
        Member *currentMember = head;
        while (currentMember != NULL)
        {
            cout << "\nAnggota: " << currentMember->name << " (ID: " <<
currentMember->id << ")" << endl;
            cout << "Buku yang dipinjam:" << endl;
            Book *currentBook = currentMember->firstBook;
            if (currentBook == NULL)
            {
                cout << "- Tidak ada buku yang dipinjam" << endl;
            }
            while (currentBook != NULL)
            {
                cout << "- " << currentBook->title << " (Pengembalian: "
<< currentBook->returnDate << ")" << endl;
                currentBook = currentBook->next;
            }
            currentMember = currentMember->next;
        }
    }
};

int main()
{
    LibraryManagement lm;

    // 1. Menambahkan anggota
    lm.addMember("Rani", "A001");
    lm.addMember("Dito", "A002");
    lm.addMember("Vina", "A003");

    // 2. Menambahkan buku yang dipinjam
    lm.addBook("A001", "Pemrograman C++", "01/12/2024");
    lm.addBook("A002", "Algoritma Pemrograman", "15/12/2024");

    // 3. Menambahkan buku baru untuk Rani
    lm.addBook("A001", "Struktur Data", "10/12/2024");

    cout << "Data sebelum menghapus anggota Dito:" << endl;
    lm.displayAll();

    // 4. Menghapus anggota Dito beserta buku yang dipinjam
    lm.deleteMember("A002");

    cout << "\n\nData setelah menghapus anggota Dito:" << endl;
    lm.displayAll();

    return 0;
}
```

Output



```
Data sebelum menghapus anggota Dito:

Anggota: Rani (ID: A001)
Buku yang dipinjam:
- Pemrograman C++ (Pengembalian: 01/12/2024)
- Struktur Data (Pengembalian: 10/12/2024)

Anggota: Dito (ID: A002)
Buku yang dipinjam:
- Algoritma Pemrograman (Pengembalian: 15/12/2024)

Anggota: Vina (ID: A003)
Buku yang dipinjam:
- Tidak ada buku yang dipinjam


Data setelah menghapus anggota Dito:

Anggota: Rani (ID: A001)
Buku yang dipinjam:
- Pemrograman C++ (Pengembalian: 01/12/2024)
- Struktur Data (Pengembalian: 10/12/2024)

Anggota: Vina (ID: A003)
Buku yang dipinjam:
- Tidak ada buku yang dipinjam
```