LAPORAN

MODUL 14

GRAPH

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PROGRAM STUDI STRUKTUR DATA
FAKULTAS INFORMATIKA

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A. DASAR TEORI

Struktur data *Graph* adalah tipe struktur data yang tidak berbentuk garis lurus, digunakan untuk menggambarkan hubungan antar data dalam bentuk simpul dan sisi. Setiap simpul mewakili suatu objek, sedangkan sisi menunjukkan hubungan atau koneksi antar objek tersebut. *Graph* bisa berupa graf berarah, di mana arah hubungan antar simpul diatur, atau graf tidak berarah, di mana hubungan tidak memiliki arah. *Graph* juga bisa memiliki bobot, yaitu nilai yang menunjukkan tingkat atau ukuran hubungan antar simpul, atau tidak memiliki bobot tergantung pada kebutuhan masalah yang ingin dipelajari. Dalam penerapannya, graph biasanya disajikan dalam bentuk matriks ketetanggaan atau daftar ketetanggaan. Daftar ketetanggaan lebih efektif digunakan ketika jumlah sisi dalam graph tidak terlalu banyak. Struktur data *Graph* digunakan dalam berbagai situasi nyata seperti jaringan komputer, sistem transportasi, peta, hubungan sosial, dan rekomendasi sistem. Struktur ini juga mendukung berbagai operasi seperti menambah simpul atau sisi, menelusuri *graph,* dan mencari jalur terbaik.

B. GUIDED

a. Source Code

- graf.h

```
#ifndef GRAF_H_INCLUDED
#define GRAF_H_INCLUDED

#include <iostream>
using namespace std;

typedef char infoGraph;

struct ElmNode;
struct ElmEdge;

typedef ElmNode *adrNode;
typedef ElmEdge *adrEdge;

struct ElmNode {
   infoGraph info;
   int visited;
   adrEdge firstEdge;
   adrNode next;
};

struct ElmEdge {
   adrNode node;
   adrEdge next;
};

struct Graph {
   adrNode first;
};

void createGraph(Graph &G);
```

```
        adrNode AllocatedNode(infoGraph X);
        adrEdge AllocatedEdge(adrNode N);

        void insertNode(Graph &G, infoGraph X);
        void FindNode(Graph G, infoGraph X);

        void ConnectNode(Graph &G, infoGraph A, infoGraph B);

        void printInfoGraph(Graph G);

        void ResetVisited(Graph &G);
        void printDFS(Graph &G, adrNode N);
        void printBFS(Graph &G, adrNode N);

#endif
```

- graf.cpp

```
        #include "graf.h"
        #include <queue>
        #include <stack>

        void createGraph(Graph &G)
        {
           G.first = NULL;
        }

        adrNode AllocatedNode(infoGraph X)
        {
           adrNode P = new ElmNode;
           P->info = X;
           P->visited = 0;
           P->firstEdge = NULL;
           P->next = NULL;
           return P;
        }

        adrEdge AllocatedEdge(adrNode N)
        {
           adrEdge P = new ElmEdge;
           P->node = N;
           P->next = NULL;
           return P;
        }

        void InsertNode(Graph &G, infoGraph X)
        {
           adrNode P = AllocatedNode(X);
           P->next = G.first;
           G.first = P;
        }
```

```
adrNode findNode(Graph G, infoGraph X)
{
   adrNode P = G.first;
   while (P != NULL) {
      if (P->info == X)
         return P;
      P = P->next;
   }
   return NULL;
}

void ConnectNode(Graph &G, infoGraph A, infoGraph B)
{
   adrNode N1 = findNode(G, A);
   adrNode N2 = findNode(G, B);

   if (N1 == NULL || N2 == NULL) {
      cout << "Node tidak ditemukan!\n";
      return;
   }

   // buat edge dari N1 ke N2
   adrEdge E1 = AllocatedEdge(N2);
   E1->next = N1->firstEdge;
   N1->firstEdge = E1;

   // karena undirected -> buat edge balik
   adrEdge E2 = AllocatedEdge(N1);
   E2->next = N2->firstEdge;
   N2->firstEdge = E2;
}

void printInfoGraph(Graph G)
{
   adrNode P = G.first;
   while (P != NULL)
   {
      cout << P->info << "->";
      adrEdge E = P->firstEdge;
      while (E != NULL)
      {
         cout << E->node->info << " ";
         E = E->next;
      }
      cout << endl;
      P = P->next;
   }
}
```

```
void ResetVisited(Graph &G)
{
   adrNode P = G.first;
   while (P != NULL)
   {
      P->visited = 0;
      P = P->next;
   }
}

void printDFS(Graph &G, adrNode N)
{
   if (N == NULL)
      return;

   N->visited = 1;
   cout << N->info << " ";

   adrEdge E = N->firstEdge;
   while (E != NULL)
   {
      if (E->node->visited == 0)
      {
         printDFS(G, E->node);
      }
      E = E->next;
   }
}

void printBFS(Graph &G, adrNode N)
{
   if (N == NULL)
      return;

   queue<adrNode> Q;
   Q.push(N);

   while (!Q.empty())
   {
      adrNode curr = Q.front();
      Q.pop();

      if (curr->visited == 0)
      {
         curr->visited = 1;
         cout << curr->info << " ";

         adrEdge E = curr->firstEdge;
         while (E != NULL)
         {
```

```
                    if (E->node->visited == 0)
                    {
                        Q.push(E->node);
                    }
                    E = E->next;
                }
            }
        }
}
```

- main.cpp

```
#include "graf.h"
#include "graf.cpp"
#include <iostream>
using namespace std;

int main() {
    Graph G;
    createGraph(G);

    //Tambah node
    InsertNode(G, 'A');
    InsertNode(G, 'B');
    InsertNode(G, 'C');
    InsertNode(G, 'D');
    InsertNode(G, 'E');

    // hubungakan node (graf tidak berarah)
    ConnectNode(G, 'A', 'B');
    ConnectNode(G, 'A', 'C');
    ConnectNode(G, 'B', 'D');
    ConnectNode(G, 'C', 'E');

    cout << "=== Struktur Graph ===" << endl;
    printInfoGraph(G);

    cout << "\n=== Traversal DFS dari node A ===" << endl;
    ResetVisited(G);
    printDFS(G, findNode(G, 'A'));

    cout << "\n\n=== Traversal BFS dari node A ===" << endl;
    ResetVisited(G);
    printBFS(G, findNode(G, 'A'));

    cout << endl;
    return 0;
}
```

b. Screenshot Output

```
=== Struktur Graph ===
E->C
D->B
C->E A
B->D A
A->C B

=== Traversal DFS dari node A ===
A C E B D

=== Traversal BFS dari node A ===
A C B E D
```

c. Deskripsi

Program ini berfungsi untuk mengimplementasikan struktur data graph tidak berarah menggunakan adjacency list serta melakukan traversal DFS dan BFS.

C. UNGUIDED

1. Unguided 1

a. Source Code

- graf.h

```
#ifndef GRAPH_H
#define GRAPH_H

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

```
        typedef char infoGraph;

        struct ElmNode;
        struct ElmEdge;

        typedef ElmNode* adrNode;
        typedef ElmEdge* adrEdge;

        struct ElmNode {
           infoGraph info;
           int visited;
           adrEdge firstEdge;
           adrNode next;
        };

        struct ElmEdge {
           adrNode node;
           adrEdge next;
        };

        struct Graph {
           adrNode first;
        };

        void CreateGraph(Graph &G);
        adrNode AlokasiNode(infoGraph X);
        adrEdge AlokasiEdge(adrNode N);

        void InsertNode(Graph &G, infoGraph X);
        adrNode FindNode(Graph G, infoGraph X);
        void ConnectNode(Graph &G, adrNode N1, adrNode N2);

        void PrintInfoGraph(Graph G);

#endif
```

- graf.cpp

```
        #include "graf.h"

        void CreateGraph(Graph &G) {
           G.first = NULL;
        }

        adrNode AlokasiNode(infoGraph X) {
           adrNode P = new ElmNode;
           P->info = X;
           P->visited = 0;
           P->firstEdge = NULL;
           P->next = NULL;
           return P;
```

```
}

adrEdge AlokasiEdge(adrNode N) {
   adrEdge P = new ElmEdge;
   P->node = N;
   P->next = NULL;
   return P;
}

void InsertNode(Graph &G, infoGraph X) {
   adrNode P = AlokasiNode(X);
   P->next = G.first;
   G.first = P;
}

adrNode FindNode(Graph G, infoGraph X) {
   adrNode P = G.first;
   while (P != NULL) {
      if (P->info == X)
         return P;
      P = P->next;
   }
   return NULL;
}

void ConnectNode(Graph &G, adrNode N1, adrNode N2) {
   if (N1 == NULL || N2 == NULL)
      return;

   // edge N1 ke N2
   adrEdge E1 = AlokasiEdge(N2);
   E1->next = N1->firstEdge;
   N1->firstEdge = E1;

   // edge N2 ke N1 (tidak berarah)
   adrEdge E2 = AlokasiEdge(N1);
   E2->next = N2->firstEdge;
   N2->firstEdge = E2;
}

void PrintInfoGraph(Graph G) {
   adrNode P = G.first;
   while (P != NULL) {
      cout << P->info << " -> ";
      adrEdge E = P->firstEdge;
      while (E != NULL) {
         cout << E->node->info << " ";
         E = E->next;
      }
      cout << endl;
```

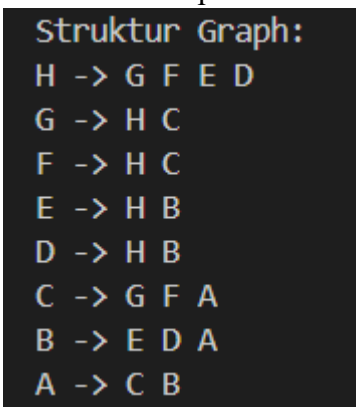
```
            P = P->next;
        }
}
```

- main.cpp

```
#include <iostream>
#include "graf.h"
#include "graf.cpp"

using namespace std;

int main() {
    Graph G;
    CreateGraph(G);

    // Membuat node A sampai H
    InsertNode(G, 'A');
    InsertNode(G, 'B');
    InsertNode(G, 'C');
    InsertNode(G, 'D');
    InsertNode(G, 'E');
    InsertNode(G, 'F');
    InsertNode(G, 'G');
    InsertNode(G, 'H');

    // Ambil alamat node
    adrNode A = FindNode(G, 'A');
    adrNode B = FindNode(G, 'B');
    adrNode C = FindNode(G, 'C');
    adrNode D = FindNode(G, 'D');
    adrNode E = FindNode(G, 'E');
    adrNode F = FindNode(G, 'F');
    adrNode G1 = FindNode(G, 'G');
    adrNode H = FindNode(G, 'H');

    // Hubungan sesuai ilustrasi
    ConnectNode(G, A, B);
    ConnectNode(G, A, C);

    ConnectNode(G, B, D);
    ConnectNode(G, B, E);

    ConnectNode(G, C, F);
    ConnectNode(G, C, G1);

    ConnectNode(G, D, H);
    ConnectNode(G, E, H);
    ConnectNode(G, F, H);
    ConnectNode(G, G1, H);
```

```
        cout << "Struktur Graph:" << endl;
        PrintInfoGraph(G);

        return 0;
}
```

b. Screenshot Output



c. Deskripsi

Program ini dibuat untuk mengimplementasikan struktur data *graph* tidak berarah menggunakan *linked list* sebagai representasi hubungan antar simpul.

2. Unguided 2

a. Source Code

1. graf.h

```
#ifndef GRAPH_H
#define GRAPH_H

#include <iostream>
using namespace std;

typedef char infoGraph;

struct ElmNode;
struct ElmEdge;

typedef ElmNode* adrNode;
typedef ElmEdge* adrEdge;

struct ElmNode {
   infoGraph info;
   int visited;
   adrEdge firstEdge;
   adrNode next;
};

struct ElmEdge {
   adrNode node;
   adrEdge next;
};

struct Graph {
   adrNode first;
};

void CreateGraph(Graph &G);
adrNode AlokasiNode(infoGraph X);
adrEdge AlokasiEdge(adrNode N);

void InsertNode(Graph &G, infoGraph X);
adrNode FindNode(Graph G, infoGraph X);
void ConnectNode(Graph &G, adrNode N1, adrNode N2);

void PrintInfoGraph(Graph G);

#endif
```

- graf.cpp

```
#include "graf.h"

void CreateGraph(Graph &G) {
   G.first = NULL;
}

adrNode AlokasiNode(infoGraph X) {
```

```
    adrNode P = new ElmNode;
    P->info = X;
    P->visited = 0;
    P->firstEdge = NULL;
    P->next = NULL;
    return P;
}

adrEdge AlokasiEdge(adrNode N) {
    adrEdge P = new ElmEdge;
    P->node = N;
    P->next = NULL;
    return P;
}

void InsertNode(Graph &G, infoGraph X) {
    adrNode P = AlokasiNode(X);
    P->next = G.first;
    G.first = P;
}

adrNode FindNode(Graph G, infoGraph X) {
    adrNode P = G.first;
    while (P != NULL) {
        if (P->info == X)
            return P;
        P = P->next;
    }
    return NULL;
}

void ConnectNode(Graph &G, infoGraph A, infoGraph B) {
    adrNode N1 = FindNode(G, A);
    adrNode N2 = FindNode(G, B);

    if (N1 == NULL || N2 == NULL) return;

    adrEdge E1 = AlokasiEdge(N2);
    E1->next = N1->firstEdge;
    N1->firstEdge = E1;

    adrEdge E2 = AlokasiEdge(N1);
    E2->next = N2->firstEdge;
    N2->firstEdge = E2;
}

void PrintInfoGraph(Graph G) {
    adrNode P = G.first;
    while (P != NULL) {
        cout << P->info << " -> ";
```

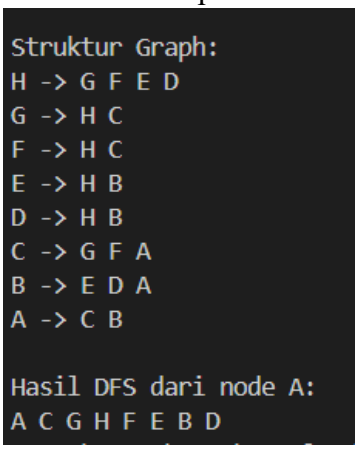
```
            adrEdge E = P->firstEdge;
            while (E != NULL) {
               cout << E->node->info << " ";
               E = E->next;
            }
            cout << endl;
            P = P->next;
         }
      }

      void ResetVisited(Graph &G) {
         adrNode P = G.first;
         while (P != NULL) {
            P->visited = 0;
            P = P->next;
         }
      }

      void PrintDFS(Graph &G, adrNode N) {
         if (N == NULL) return;

         N->visited = 1;
         cout << N->info << " ";

         adrEdge E = N->firstEdge;
         while (E != NULL) {
            if (E->node->visited == 0) {
               PrintDFS(G, E->node);
            }
            E = E->next;
         }
}
```

- main.cpp

```
      #include "graf.h"
      #include "graf.cpp"

      int main() {
         Graph G;
         CreateGraph(G);

         InsertNode(G,'A');
         InsertNode(G,'B');
         InsertNode(G,'C');
         InsertNode(G,'D');
         InsertNode(G,'E');
         InsertNode(G,'F');
         InsertNode(G,'G');
         InsertNode(G,'H');
```

```
        ConnectNode(G,'A','B');
        ConnectNode(G,'A','C');
        ConnectNode(G,'B','D');
        ConnectNode(G,'B','E');
        ConnectNode(G,'C','F');
        ConnectNode(G,'C','G');
        ConnectNode(G,'D','H');
        ConnectNode(G,'E','H');
        ConnectNode(G,'F','H');
        ConnectNode(G,'G','H');

        cout << "Struktur Graph:" << endl;
        PrintInfoGraph(G);

        cout << endl << "Hasil DFS dari node A:" << endl;
        ResetVisited(G);
        PrintDFS(G, FindNode(G,'A'));

        cout << endl;
        return 0;
}
```

b. Screenshot Output



c. Deskripsi

Program ini bertujuan untuk mengimplementasikan struktur data *graph tidak berarah* menggunakan representasi *adjacency list*, serta menampilkan hubungan antar simpul dan hasil penelusuran *Depth First Search (DFS)*. Implementasi dibagi ke dalam tiga file utama, yaitu *graf.h*, *graf.cpp*, dan *main.cpp*.

3. Unguided 3

a. Source Code

1. graf.h

```
#ifndef GRAF_H_INCLUDED
#define GRAF_H_INCLUDED

#include <iostream>
using namespace std;

typedef char infoGraph;

struct ElmNode;
struct ElmEdge;

typedef ElmNode* adrNode;
typedef ElmEdge* adrEdge;

struct ElmNode {
   infoGraph info;
   int visited;
   adrEdge firstEdge;
   adrNode next;
};

struct ElmEdge {
   adrNode node;
   adrEdge next;
};
```

```
    struct Graph {
       adrNode first;
    };

    void CreateGraph(Graph &G);
    adrNode AllocatedNode(infoGraph X);
    adrEdge AllocatedEdge(adrNode N);

    void InsertNode(Graph &G, infoGraph X);
    adrNode FindNode(Graph G, infoGraph X);
    void ConnectNode(Graph &G, infoGraph A, infoGraph B);

    void PrintInfoGraph(Graph G);

    void ResetVisited(Graph &G);
    void PrintBFS(Graph &G, adrNode N);

#endif
```

2. graf.cpp

```
    #include "graf.h"
    #include <queue>

    void CreateGraph(Graph &G) {
       G.first = NULL;
    }

    adrNode AllocatedNode(infoGraph X) {
       adrNode P = new ElmNode;
       P->info = X;
       P->visited = 0;
       P->firstEdge = NULL;
       P->next = NULL;
       return P;
    }

    adrEdge AllocatedEdge(adrNode N) {
       adrEdge E = new ElmEdge;
       E->node = N;
       E->next = NULL;
       return E;
    }

    void InsertNode(Graph &G, infoGraph X) {
       adrNode P = AllocatedNode(X);
       P->next = G.first;
       G.first = P;
    }
```

```
adrNode FindNode(Graph G, infoGraph X) {
   adrNode P = G.first;
   while (P != NULL) {
      if (P->info == X)
         return P;
      P = P->next;
   }
   return NULL;
}

void ConnectNode(Graph &G, infoGraph A, infoGraph B) {
   adrNode N1 = FindNode(G, A);
   adrNode N2 = FindNode(G, B);

   if (N1 == NULL || N2 == NULL) {
      cout << "Node tidak ditemukan" << endl;
      return;
   }

   adrEdge E1 = AllocatedEdge(N2);
   E1->next = N1->firstEdge;
   N1->firstEdge = E1;

   adrEdge E2 = AllocatedEdge(N1);
   E2->next = N2->firstEdge;
   N2->firstEdge = E2;
}

void PrintInfoGraph(Graph G) {
   adrNode P = G.first;
   while (P != NULL) {
      cout << P->info << " -> ";
      adrEdge E = P->firstEdge;
      while (E != NULL) {
         cout << E->node->info << " ";
         E = E->next;
      }
      cout << endl;
      P = P->next;
   }
}

void ResetVisited(Graph &G) {
   adrNode P = G.first;
   while (P != NULL) {
      P->visited = 0;
      P = P->next;
   }
}
```

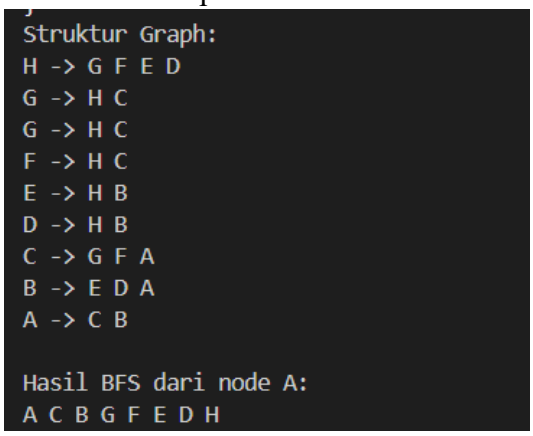
```
void PrintBFS(Graph &G, adrNode N) {
    if (N == NULL) return;

    queue<adrNode> Q;
    Q.push(N);

    while (!Q.empty()) {
        adrNode P = Q.front();
        Q.pop();

        if (P->visited == 0) {
            P->visited = 1;
            cout << P->info << " ";

            adrEdge E = P->firstEdge;
            while (E != NULL) {
                if (E->node->visited == 0) {
                    Q.push(E->node);
                }
                E = E->next;
            }
        }
    }
}
```

3. main.cpp

```
#include <iostream>
#include "graf.h"
#include "graf.cpp"

using namespace std;

int main() {
    Graph G;
    CreateGraph(G);

    InsertNode(G,'A');
    InsertNode(G,'B');
    InsertNode(G,'C');
    InsertNode(G,'D');
    InsertNode(G,'E');
    InsertNode(G,'F');
    InsertNode(G,'G');
    InsertNode(G,'H');

    ConnectNode(G,'A','B');
    ConnectNode(G,'A','C');
    ConnectNode(G,'B','D');
    ConnectNode(G,'B','E');
    ConnectNode(G,'C','F');
```

```
    ConnectNode(G,'C','G');
    ConnectNode(G,'D','H');
    ConnectNode(G,'E','H');
    ConnectNode(G,'F','H');
    ConnectNode(G,'G','H');

    cout << "Struktur Graph:" << endl;
    PrintInfoGraph(G);

    cout << endl << "Hasil BFS dari node A:" << endl;
    ResetVisited(G);
    PrintBFS(G, FindNode(G,'A'));

    cout << endl;
    return 0;
}
```

b. Screenshot Output



c. Deskripsi

Program ini bertujuan untuk mengimplementasikan struktur data Graph tidak berarah menggunakan representasi adjacency list serta menampilkan hasil penelusuran BFS (Breadth First Search). Implementasi dibagi ke dalam beberapa file agar struktur program rapi dan mudah dipahami.

D. KESIMPULAN

Berdasarkan ketiga implementasi yang dibuat, dapat disimpulkan bahwa struktur data *graph tidak berarah* dapat direpresentasikan secara efektif menggunakan *adjacency list* berbasis *linked list*. Implementasi ini memungkinkan pengelolaan node dan edge secara dinamis melalui proses alokasi memori, penyisipan node, serta pembentukan hubungan dua arah antar simpul. Selain menampilkan struktur graph, program juga menunjukkan kemampuan penelusuran graph melalui dua metode, yaitu *Depth First Search (DFS)* dan *Breadth First Search (BFS)*, yang masing-masing memiliki karakteristik penelusuran berbeda. Dengan pembagian program ke dalam file *graf.h*, *graf.cpp*, dan *main.cpp*, struktur kode menjadi lebih terorganisir, mudah dipahami, serta memudahkan pengembangan dan pengujian fitur graph secara bertahap.

E. REFERENSI

- Modul 14 Struktur Data. Graph. Program Studi Teknik Informatika. Universitas Telkom, 2025
- Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. Introduction to Algorithms. MIT Press, 2009.