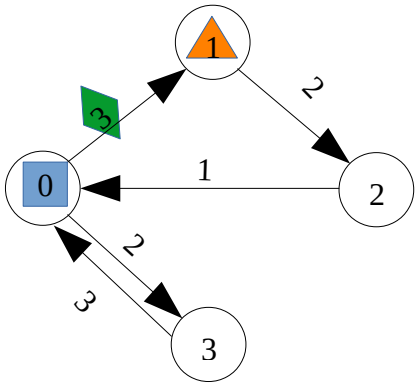
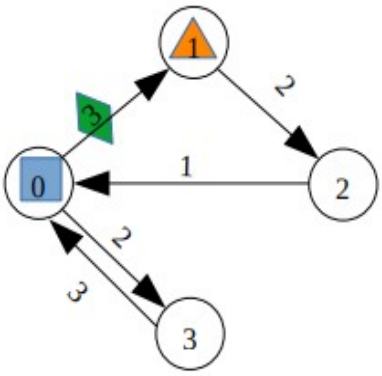
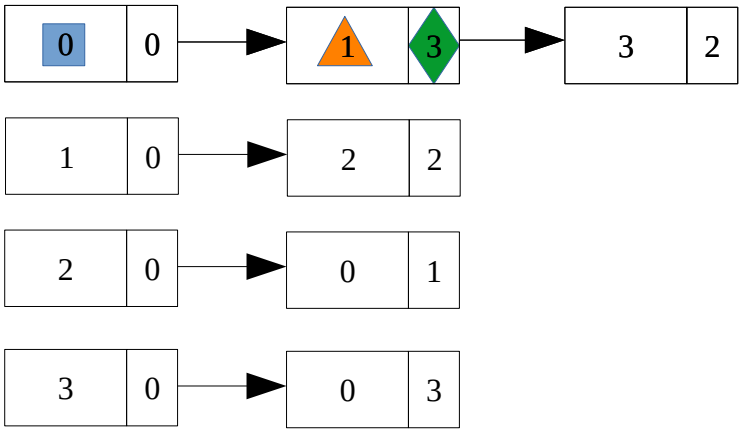
Grafos – Matriz de Adjacência



Vertices	0	1	2	3
0	0	3	0	2
1	0	0	2	0
2	1	0	0	0
3	3	0	0	0

Grafos – Lista Ligada





Algoritmo de Dijkstra

Pseudocódigo

```
Function Dijkstra(G,source, target):
    for each vertex v in G
        dist[v] = infinity
    dist[source] = 0
    Q has the set of all nodes in G
    while Q is not empty:
        u = vertex in Q with smallest dist
        remove u from Q
        if u = target
            break
        for each arc (v,u) in G
            if dist[v] > dist[u] + dist_between(v, u)
                dist[v] = dist[u] + dist_between(v, u)
    return dist
```

Código

```c
void dijkstra(int graph[][MAX_NODES], int num_nodes, int source, int target){
    for (int i=0; i<num_nodes; i++) graph[i][i] = __INT_MAX__;
    graph[source][source] = 0;


    int node_set[num_nodes];
    for (int i=0; i<num_nodes; i++) node_set[i] = 1;

    while (set_is_empty(node_set, num_nodes) != 1){
        int smallest = smallest_dist(graph, node_set, num_nodes);

        node_set[smallest] = -1;

        if (smallest == target) break;

        for (int i=0; i<num_nodes; i++){
            if (graph[smallest][i] != 0 && node_set[i] != -1){
                if(graph[i][i] > graph[smallest][smallest]+graph[smallest][i]
                     && graph[smallest][smallest] != __INT_MAX__
                     && graph[smallest][i] != __INT_MAX__){
                    graph[i][i]=graph[smallest][smallest] + graph[smallest][i];
                }
            }
        }
    }
}

int smallest_dist(int graph[][MAX_NODES], int node_set[], int num_nodes){
    int min = __INT_MAX__, node=-1;
    for (int i=0; i<num_nodes; i++){
        if (node_set[i] != -1){
            if (graph[i][i] < min){
                min = graph[i][i];
                node = i;
            }
        }
    }
    return node;
}

int set_is_empty(int node_set[], int num_nodes){
    int is_empty = 1;
    for (int i=0; i<num_nodes; i++){
        if (node_set[i] != -1){
            return -1;
        }
    }
    return is_empty;
}
```

Algoritmo de Bellman-Ford

Pseudocódigo

```
Function BelmannFord(G,source):
    for each vertex v in G
        dist[v] = infinity
    d[source]=0;

    for(i=0; i<|V|-1; i++)
        for each arc (u,v) in G
            if dist[v] > dist[u]+ dist_between(u, v)
                d[v] = d[u] + dist_between(u, v)

    // Verificação de ciclos negativos
    for each arc (u,v) in G
        if dist[v] > dist[u]+ dist_between(u, v)
            return false   // Ciclo negativo!!
    return true
```

Código

```
int bellman_ford(int graph[][MAX_NODES], int num_nodes, int source, int target){
    for (int i=0; i<num_nodes; i++) graph[i][i] = __INT_MAX__;

    graph[source][source] = 0;

    /*Iterate |V| - 1, i.e, number of nodes - 1 */
    for (int i=0; i<num_nodes-1; i++){
        for (int j=0; j<num_nodes; j++){
            for (int k=0; k<num_nodes; k++){
                if (k==j || graph[j][k] == 0) continue;
                if (graph[k][k] > graph[j][j] + graph[j][k]
                    && graph[j][j] !=__INT_MAX__ && graph[j][k] =≠ __INT_MAX__){
                    graph[k][k] = graph[j][j] + graph[j][k];
                }
            }
        }
    }

    /*Iteration number |V| serves to detect any negative cycles*/
    for (int j=0; j<num_nodes; j++){
        for (int k=0; k<num_nodes; k++){
            if (k==j || graph[j][k] == 0) continue;
            if (graph[k][k] > graph[j][j] + graph[j][k]
                && graph[j][j] !=__INT_MAX__ && graph[j][k] =≠ __INT_MAX__){
                return -1;
            }
        }
    }

    return 1;
}
```

Algoritmo de Floyd-Warshall

Pseudocódigo

```
Function Floyd-Warshall(G)
    for each edge (u,v)
        dist[u][v] ← w(u,v)  // the weight of the edge (u,v)

    for each vertex v
        dist[v][v] ← 0

    for k from 1 to |V|
        for i from 1 to |V|
            for j from 1 to |V|
                if dist[i][j] > dist[i][k] + dist[k][j]
                    dist[i][j] ← dist[i][k] + dist[k][j]
```

Código

```
void floyd_warshall(int graph[][MAX_NODES], int num_nodes){
    /*Set the diagonal to 0*/
    for (int i=0; i<num_nodes; i++) graph[i][i] = 0;

    /*Set 0 values to infinity (INT_MAX)*/
    for(int i=0; i<num_nodes; i++){
        for(int j=0; j<num_nodes; j++){
            if (i≠j && graph[i][j] == 0) graph[i][j] = __INT_MAX__;
        }
    }

    for (int k=0; k<num_nodes; k++){
        for (int i=0; i<num_nodes; i++){
            for (int j=0; j<num_nodes; j++){
                /*Don't calculate if right side values are INT_MAX, overflow*/
                if (graph[i][j] > graph[i][k] + graph[k][j]
                   && graph[i][k]≠__INT_MAX__ && graph[k][j] ≠ __INT_MAX__)
                    graph[i][j] = graph[i][k] + graph[k][j];
            }
        }
    }
}
```

Algoritmo BFS (Breadth-first Search)

Pseudocódigo

```
Function BFS(G, start_node):
    let S be a queue
    S.enqueue(start_node)
    while S is not empty
        v = S.dequeue()
        if v is the goal:
            return v
        for all edges from v to w in G.adjacentEdges(v) do
            if w is not labeled as discovered:
                label w as discovered
                w.parent = v
                S.enqueue(w)
```

Código

```
void bfs(int graph[][MAX_NODES], int num_nodes, int current, int target, int
visited[], int previous[]){
    /*Queue that holds neighbor nodes of current that haven't yet been visited*/
    queue <int> bfs_queue;
    /*Push the first node (the source node)*/
    bfs_queue.push(current);

    previous[0] = -1;

    /*While stack has nodes to visit*/
    while(!bfs_queue.empty()){
        /*Update current node and pop*/
        current = bfs_queue.front();
        bfs_queue.pop();

        /*We have visited this function node*/
        visited[current] = 1;

        /*For each edge that goes out of current node*/
        for (int j=0; j<num_nodes; j++){
            if (graph[current][j]≠0){
                /*If one of these nodes is our target*/
                if (j==target){
                    previous[j] = current;
                    return;
                }
                /*If we haven't visited node yet*/
                else if(visited[j]==0){
                    previous[j] = current;
                    bfs_queue.push(j);
                }
            }
        }
    }
}
```

Algoritmo DFS (Depth-first Search)

Pseudocódigo

```
Function DFS(G, v):
    if v is the goal:
        exit
    label v as visited
    for each neighbor u of v:
        if u is not labeled as discovered:
            u.parent = v
            DFS(G, u)
```

Código