ADJACENCY LIST IN DATA STRUCTURE pdf

1: AdjacencyLists: A Graph as a Collection of Lists

The main operation performed by the adjacency list data structure is to report a list of the neighbors of a given vertex. Using any of the implementations detailed above, this can be performed in constant time per neighbor.

Cells for the edge 2, 5 Edge 1, 3 Cells for the edge 1, 3 The graph presented by example is undirected. It means that its adjacency matrix is symmetric. Indeed, in undirected graph, if there is an edge 2, 5 then there is also an edge 5, 2. This is also the reason, why there are two cells for every edge in the sample. Loops, if they are allowed in a graph, correspond to the diagonal elements of an adjacency matrix. Adjacency matrix is very convenient to work with. Add remove an edge can be done in O 1 time, the same time is required to check, if there is an edge between two vertices. Also it is very simple to program and in all our graph tutorials we are going to work with this kind of representation. Adjacency matrix consumes huge amount of memory for storing big graphs. All graphs can be divided into two categories, sparse and dense graphs. On the other hand, dense graphs contain number of edges comparable with square of number of vertices. Adjacency matrix is optimal for dense graphs, but for sparse ones it is superfluous. Next drawback of the adjacency matrix is that in many algorithms you need to know the edges, adjacent to the current vertex. To draw out such an information from the adjacency matrix you have to scan over the corresponding row, which results in O V complexity. In case, a graph is used for analysis only, it is not necessary, but if you want to construct fully dynamic structure, using of adjacency matrix make it quite slow for big graphs. To sum up, adjacency matrix is a good solution for dense graphs, which implies having constant number of vertices. Adjacency list This kind of the graph representation is one of the alternatives to adjacency matrix. It requires less amount of memory and, in particular situations even can outperform adjacency matrix. For every vertex adjacency list stores a list of vertices, which are adjacent to current one. Let us see an example. Adjacent list allows us to store graph in more compact form, than adjacency matrix, but the difference decreasing as a graph becomes denser. Next advantage is that adjacent list allows to get the list of adjacent vertices in O 1 time, which is a big advantage for some algorithms. This operation stays quite cheap. Adding new vertex can be done in O V , but removal results in O E complexity. To sum up, adjacency list is a good solution for sparse graphs and lets us changing number of vertices more efficiently, than if using an adjacent matrix. But still there are better solutions to store fully dynamic graphs. Code snippets For reasons of simplicity, we show here code snippets only for adjacency matrix, which is used for our entire graph tutorials. Notice, that it is an implementation for undirected graphs.

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2: Adjacency list in Data Structures - Adjacency list in Data Structures () | Wisdom Jobs

(data structure) Definition: A representation of a directed graph with n vertices using an array of n lists of vertices. List i contains vertex j if there is an edge from vertex i to vertex j.

All example graphs can be found here. Note that after loading one of these example graphs, you can further modify the currently displayed graph to suit your needs. There are other less frequently used special graphs: Planar Graph, Line Graph, Star Graph, Wheel Graph, etc, but they are not currently auto-detected in this visualization when you draw them. Usually a Tree is defined on undirected graph. An undirected Tree see above actually contains trivial cycles caused by its bidirectional edges but it does not contain non-trivial cycle. A directed Tree is clearly acyclic. As a Tree only have V-1 edges, it is usually considered a sparse graph. X Esc Prev PgUp Next PgDn Not all Trees have the same graph drawing layout of having a special root vertex at the top and leaf vertices vertices with degree 1 at the bottom. The star graph shown above is also a Tree as it satisfies the properties of a Tree. Tree with one of its vertex designated as root vertex is called a rooted Tree. We can always transform any Tree into a rooted Tree by designating a specific vertex usually vertex 0 as the root, and run a DFS or BFS algorithm from the root. X Esc Prev PgUp Next PgDn In a rooted tree, we have the concept of hierarchies parent, children, ancestors, descendants , subtrees, levels, and height. We will illustrate these concepts via examples as their meanings are as with real-life counterparts: A binary tree is a rooted tree in which a vertex has at most two children that are aptly named: A full binary tree is a binary tree in which each non-leaf also called the internal vertex has exactly two children. The binary tree shown above fulfils this criteria. A complete binary tree is a binary tree in which every level is completely filled, except possibly the last level may be filled as far left as possible. We will frequently see this form especially during discussion of Binary Heap. Usually a Complete graph is denoted with KV. Complete graph is the most dense simple graph. There is no edge between members of the same set. Bipartite graph is also free from odd-length cycle. A Bipartite Graph can also be complete, i. In this visualization, we show three graph data structures: An AM unfortunately requires a big space complexity of O V2 , even when the graph is actually sparse not many edges. Knowing the large space complexity of AM, when is it beneficial to use it? Or is AM always an inferior graph data structure and should not be used at all times? The content of this slide is hidden and only available for legitimate CS lecturer worldwide. Drop an email to visualgo. For weighted graphs, we can store pairs of neighbor vertex number, weight of this edge instead. We use a Vector of Vector pairs for weighted graphs to implement this data structure.

ADJACENCY LIST IN DATA STRUCTURE pdf

3: c# - How to construct BFS-suitable data structure for adjacency list? - Stack Overflow

Adjacency List Structure The simplest adjacency list needs a node data structure to store a vertex and a graph data structure to organize the nodes. We stay close to the basic definition of graph - a collection of vertices and edges {V, E}.

Click on A to make all fonts on the page smaller. Click on A to make all fonts on the page larger. Click on HC to toggle high contrast mode. When you move your mouse over some bold words in high contrast mode, related words are automatically highlighted. Text is shown in black and white. Lesson Objectives After completing this lesson, you will be able to: However, Depth-First Search will not help you compute the shortest path between two vertices. Representing Graph By Adjacency List The SubwayMatrix class you designed in the prior lesson represents a graph using a two-dimensional array known as the adjacency matrix. An alternate representation for graphs is an adjacency list, which is a more efficient data structure to use for sparse graphs. For example, suppose you want to use Breadth-First Search to determine the fewest number of subway stations to visit in the New York City subway system given a source and destination station. Start by constructing a graph where the vertices represent the subway stations if you individually count the subway stations that belong to one of the 32 station complexes. The actual number of station pairings will be much smaller, given the physical reality of subway construction. As graphs become larger and sparser this form of representation will decrease the storage requirements of a graph significantly. Also, instead of being forced to use a for loop to iterate over all possible edges that might exist, code using an adjacency list will only iterate over the existing known neighbors. This class borrows much of the implementation from SubwayMatrix: The index into neighbors is the vertex identifier a number from With this change, the addLine method now invokes the add method to insert each vertex. The same White, Gray, and Black constants are used, in addition to the color and previous arrays. Breadth-First Search While Depth-First Search computes valid paths between two vertices in a connected graph, there is no guarantee that the computed path is the shortest that exists. A Breadth-First Search through a graph starts at a source vertex, s, then proceeds to visit all vertices that are one edge away from s, then vertices no more than two edges away, then vertices no more than three edges away, and so on. The search proceeds methodically from the source vertex, radiating outwards until all vertices in the connected graph are visited. Start by coloring vertex 4 Gray: Now three stations are directly connected to station 4, so they are just one edge away. Record the previous station in the path in this case, station 4 using an arrow for each of these stations: At this point, station 1 is a dead end because it has no unvisited neighbors. However, you can continue to extend the search outwards from stations 2 and 5. Be sure to color stations 2 and 5 Black because they are now fully processed and update previous links for stations 3 and 8: Continue this process until all vertices are colored Black and all previous links are assigned. The fundamental question for implementing Breadth-First Search is how to keep track of the state of the algorithm as it progresses. Depth-First Search maintains only one "current vertex" as it searches through the graph, backtracking to overcome dead ends. However, Breadth-First Search needs to keep track of the Gray vertices that it has identified for exploration. It also must make sure to process the vertices in order. In the subway system above, the shortest path from station 4 to station 9 contains three edges 4, 2, 8, 9 ; another longer path exists 4, 5, 3, 10, 9. Using the terminology from the Java Collections Framework, a Queue is a Collection that supports this behavior: Items are added to the tail of a Queue using the add operation. Items are removed from the head of a Queue using the remove operation. Breadth-First Search uses a Queue to maintain all Gray vertices, which represents the "boundary" of the search radiating outwards from the initial source vertex, s. While this Queue is not empty, there may still be other unvisited vertices to be processed. This pseudocode describes the Breadth-First Search algorithm: Modify the existing SubwayMatrix implementation described in the previous lesson, to convert this pseudocode to Java: Modifications to SubwayMatrix class package subway; import java. It then constructs a Queue of integers starting with s as its initial element. From the pseudocode you saw earlier, observe that any vertex in the Queue is colored Gray. There are many classes in the Java Collections Framework that implement the Queue interface; we chose the LinkedList class because it implements add to the tail of the queue and remove from the head of the queue efficiently. Also, observe a common idiom when

using the Collections Framework: Computing Breadth-First Search while! As long as there are vertices in the Queue that need to be processed, the while loop will remove the head vertex from the Queue. At some point the while loop must terminate because only the unvisited vertices colored White are ever considered for addition to the Queue, and there are a finite number of vertices in the graph. Note that this code maintains the invariant that only Gray vertices are added to the Queue. The add method properly inserts the vertex at the tail to maintain proper ordering of the vertices within the Queue. That is, there is no other Gray or White vertex in the graph that is closer to the source vertex, s. To validate this implementation, write this performance code: Compare Class package subway; import java. As you can see, this code directly compares Breadth-First Search against Depth-First Search on the same subway system and prints only the paths that are shorter when computed by Breadth-First Search. The output below is computed and you can verify that it finds three shorter paths in the graph: Modifications to SubwayList class package subway; import java. In a dense graph, the number of edges can grow proportional to the square of the number of vertices. In a sparse graph, the number of edges grows linearly with the number of vertices. The following performance code generates stylized graphs representing subway lines on which to test these algorithms. The number of edges is roughly n1. Note that the algorithm has not changed, but rather the structural representation of the graph. Lessons Learned Representation of a data structure impacts the performance for an algorithm. Even when you have identified the proper algorithm to use, make sure that you are not using a sub-optimal data structure. The Adjacency List is preferred for sparse graphs while Adjacency Matrix is optimal for dense graphs. Only you know which types of graphs that you intend to process, so choose wisely! Stacks support last-in, first-out while Queues support first-in, first-out. The difference between Depth-First Search and Breadth-First Search can be traced directly to the data structures used to represent the active search. Depth-First Search uses the call stack to store progress, backtracking whenever it hits a dead end; Breadth-first Search uses a queue to methodically search a graph.

ADJACENCY LIST IN DATA STRUCTURE pdf

4: Implement Graph Data Structure in C - Techie Delight

It scans the adjacency list of every vertex, so it takes time. The following theorem summarizes the performance of the above data structure: Theorem 2 The AdjacencyLists data structure implements the Graph interface.

Conclusion Introduction Part 1 and Part 2 of this article series focused on linear data structuresâ€”the array, the List, the Queue, the Stack, the Hashtable, and the Dictionary. In Part 3 we began our investigation of trees. Recall that trees consist of a set of nodes, where all of the nodes share some connection to other nodes. These connections are referred to as edges. As we discussed, there are numerous rules spelling out how these connections can occur. For example, all nodes in a tree except for oneâ€”the rootâ€”must have precisely one parent node, while all nodes can have an arbitrary number of children. These simple rules ensure that, for any tree, the following three statements will hold: Starting from any node, any other node in the tree can be reached. There are no cycles. A cycle exists when, starting from some node v, there is some path that travels through some set of nodes v1, v2, The number of edges in a tree is precisely one less than the number of nodes. In Part 3 we focused on binary trees, which are a special form of trees. Binary trees are trees whose nodes have at most two children. Graphs are composed of a set of nodes and edges, just like trees, but with graphs there are no rules for the connections between nodes. With graphs there is no concept of a root node, nor is there a concept of parents and children. Rather, a graph is just a collection of interconnected nodes. A tree is a special case of a graph, one whose nodes are all reachable from some starting node and one that has no cycles. Figure 1 shows three examples of graphs. Notice that graphs, unlike trees, can have sets of nodes that are disconnected from other sets of nodes. For example, graph a has two distinct, unconnected set of nodes. Graphs can also contain cycles. Graph b has several cycles. One such is the path from v1 to v2 to v4 and back to v1. Another one is from v1 to v2 to v3 to v5 to v4 and back to v1. There are also cycles in graph a. Graph c does not have any cycles, as one less edge than it does number of nodes, and all nodes are reachable. Therefore, it is a tree. Three examples of graphs Many real-world problems can be modeled using graphs. For example, search engines model the Internet as a graph, where Web pages are the nodes in the graph and the links among Web pages are the edges. Programs like Microsoft MapPoint that can generate driving directions from one city to another use graphs, modeling cities as nodes in a graph and the roads connecting the cities as edges. Examining the Different Classes of Edges Graphs, in their simplest terms, are a collection of nodes and edges, but there are different kinds of edges: Directed versus undirected edges Weighted versus unweighted edges When talking about using graphs to model a problem, it is usually important to indicate what class of graph you are working with. Is it a graph whose edges are directed and weighted, or one whose edges are undirected and weighted? Directed and Undirected Edges The edges of a graph provide the connections between one node and another. By default, an edge is assumed to be bidirectional. That is, if there exists an edge between nodes v and u, it is assumed that one can travel from v to u and from u to v. Graphs with bidirectional edges are said to be undirected graphs, because there is no implicit direction in their edges. For some problems, though, an edge might infer a one-way connection from one node to another. For example, when modeling the Internet as a graph, a hyperlink from Web page v linking to Web page u would imply that the edge between v to u would be unidirectional. That is, that one could navigate from v to u, but not from u to v. Graphs that use unidirectional edges are said to be directed graphs. When drawing a graph, bidirectional edges are drawn as a straight line, as shown in Figure 1. Unidirectional edges are drawn as an arrow, showing the direction of the edge. Figure 2 shows a directed graph where the nodes are Web pages for a particular Web site and a directed edge from u to v indicates that there is a hyperlink from Web page u to Web page v. Notice that both u links to v and v links to u, two arrows are usedâ€”one from v to u and another from u to v. Model of pages making up a website Weighted and Unweighted Edges Typically graphs are used to model a collection of "things" and their relationship among these "things. Sometimes, though, it is important to associate some cost with the connection from one node to another. A map can be easily modeled as a graph, with the cities as nodes and the roads connecting the cities as edges. If we wanted to determine the shortest distance and route from one city to another, we first need to assign a cost from traveling from one city to

another. The logical solution would be to give each edge a weight, such as how many miles it is from one city to another. Figure 3 shows a graph that represents several cities in southern California. The cost of any particular path from one city to another is the sum of the costs of the edges along the path. The shortest path, then, would be the path with the least cost. The shortest trip, however, is to drive miles to Los Angeles, and then another 30 up to Santa Barabara. Graph of California cities with edges valued as miles Realize that directionality and weightedness of edges are orthogonal. That is, a graph can have one of four arrangements of edges: Figure 2 had directed, unweighted edges, and Figure 3 used undirected, weighted edges. Sparse Graphs and Dense Graphs While a graph could have zero or a handful of edges, typically a graph will have more edges than it has nodes. It depends on whether the graph is directed or undirected. If the graph is directed, then each node could have at an edge to every other node. In general, though, graphs allow for an edge to exist from a node v back to node v. If self-edges are allowed, the total number of edges for a directed graph would be n2. If the graph is undirected, then one node, call it v1, could have an edge to each and every other node, or n â€" 1 edges. The next node, call it v2, could have at most n â€" 2 edges, because there already exists an edge from v2 to v1. The third node, v3, could have at most n â€" 3 edges, and so forth. If a graph has significantly less than n2 edges, the graph is said to be sparse. For example, a graph with n nodes and n edges, or even 2n edges would be said to be sparse. A graph with close to the maximum number of edges is said to be dense. When using graphs in an algorithm it is important to know the ratio between nodes and edges. Creating a Graph Class While graphs are a very common data structure used in a wide array of different problems, there is no built-in graph data structure in the. Part of the reason is because an efficient implementation of a Graph class depends on a number of factors specific to the problem at hand. For example, graphs are typically modeled in either one of two ways: As an adjacency list As an adjacency matrix These two techniques differ in how the nodes and edges of the graph are maintained internally by the Graph class. Because a each node in a graph has an arbitrary number of neighbors, it might seem plausible that we can simply use the base Node class to represent a node in the graph, because the Node class consists of a value and an arbitrary number of neighboring Node instances. However, while this base class is a step in the right direction, it still lacks needed features, such as a way to associate a cost between neighbors. One option, then, is to create a GraphNode class that derives from the base Node class and extends it to include the required additional capabilities. The Graph class contains a NodeList holding the set of GraphNodes that constitute the nodes in the graph. That is, a graph is represented by a set of nodes, and each node maintains a list of its neighbors. Such a representation is called an adjacency list, and is depicted graphically in Figure 4. Adjacency list representation in graphical form Notice that with an undirected graph, an adjacency list representation duplicated the edge information. For example, in adjacency list representation b in Figure 4, the node a has b in its adjacency list, and node b also has node a in its adjacency list. Each node has precisely as many GraphNodes in its adjacency list as it has neighbors. Therefore, an adjacency list is a very space-efficient representation of a graphâ€"you never store more data than needed. While Figure 4 does not show it, adjacency lists can also be used to represent weighted graphs. For dense graphs, u will likely have many GraphNodes in its adjacency list. Determining if there is an edge between two nodes, then, takes linear time for dense adjacency list graphs. Representing a Graph Using an Adjacency Matrix An alternative method for representing a graph is to use an adjacency matrix. For a graph with n nodes, an adjacency matrix is an n x n two-dimensional array. For weighted graphs the array element u, v would give the cost of the edge between u and v or, perhaps -1 if no such edge existed between u and v. For an unweighted graph, the array could be an array of Booleans, where a True at array element u, v denotes an edge from u to v and a False denotes a lack of an edge. Figure 5 depicts how an adjacency matrix representation in graphical form. That is, if there is an edge from u to v in an undirected graph then there will be two corresponding array entries in the adjacency matrix, u, v and v, u. Because determining if an edge exists between two nodes is simply an array lookup, this can be determined in constant time. The downside of adjacency matrices is that they are space inefficient. An adjacency matrix requires an n2 element array, so for sparse graphs much of the adjacency matrix will be empty. Also, for undirected graphs half of the graph is just repeated information. Creating the GraphNode Class The GraphNode class represents a single node in the graph, and is derived from the base Node class we examined in Part 3 of this

article series. The GraphNode class extends its base class by providing public access to the Neighbors property, as well as providing a Cost property. Building the Graph Class Recall that with the adjacency list technique, the graph maintains a list of its nodes.

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5: Adjacency List (With Code in C, C++, Java and Python)

An Adjacency ListÂ¶. A more space-efficient way to implement a sparsely connected graph is to use an adjacency list. In an adjacency list implementation we keep a master list of all the vertices in the Graph object and then each vertex object in the graph maintains a list of the other vertices that it is connected to.

Practice Test In graph theory, an adjacency list is the representation of all edges or arcs in a graph as a list. If the graph is undirected, every entry is a set or multiset of two nodes containing the two ends of the corresponding edge; if it is directed, every entry is a tuple of two nodes, one denoting the source node and the other denoting the destination node of the corresponding arc. Typically, adjacency lists are unordered. Application in computer science In computer science, an adjacency list is a data structure for representing graphs. For instance, the representation suggested by van Rossum, in which a hash table is used to associate each vertex with an array of adjacent vertices, can be seen as an example of this type of representation. Another example is the representation in Cormen et al. One difficulty with the adjacency list structure is that it has no obvious place to store data associated with the edges of a graph, such as the lengths or costs of the edges. To remedy this, some texts, such as that of Goodrich and Tamassia, advocate a more object oriented variant of the adjacency list structure, sometimes called an incidence list, which stores for each vertex a list of objects representing the edges incident to that vertex. To complete the structure, each edge must point back to the two vertices forming its endpoints. The extra edge objects in this version of the adjacency list cause it to use more memory than the version in which adjacent vertices are listed directly, bnut these extra edges are also a convenient location to store additional information about each edge e. Trade-offs The main alternative to the adjacency list is the adjacency matrix. For a graph with a sparse adjacency matrix an adjacency list representation of the graph occupies less space, because it does not use any space to represent edges that are not present. Using a naive array implementation of adjacency lists on a bit computer, an adjacency list for an undirected graph requires about 8e bytes of storage, where e is the number of edges: Besides just avoiding wasted space, this compactness encourages locality of reference. Thus a graph must be very sparse for an adjacency list representation to be more memory efficient than an adjacency matrix. However, this analysis is valid only when the representation is intended to store the connectivity structure of the graph without any numerical information about its edges. Besides the space trade-off, the different data structures also facilitate different operations. It is easy to find all vertices adjacent to a given vertex in an adjacency list representation; you simply read its adjacency list. With an adjacency matrix you must instead scan over an entire row, taking O n time. If you, instead, want to perform a neighbor test on two vertices i. However, this neighbor test in an adjacency list requires time proportional to the number of edges associated with the two vertices.

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6: Representing graphs (article) | Algorithms | Khan Academy

So I have to get the list of neighbors of v by using that mapped data structure, so I'm going to get the object associated with the key v. And then that object, which is a list, I'm going to add to it the new neighbor.

For simplicity, we will only consider simple graphs i. Adjacency Matrix[edit] The first method of storing graphs is through the means of an adjacency matrix. This simply means we have an matrix where each cell contains a 0 if there is no edge running from one vertex to another, otherwise we will have either a 1 or a positive value for weighted graphs. So for example, if we had a graph that had an edge from vertex 2 to vertex 5, then the cell of [2,5] would contain a 1. If the edge was weighted with say 3, we would mark the cell of [2,5] with 3. Note that this notation supports both undirected and directed graphs. Note that for particularly sparse graphs, there is a considerable amount of wasted space. However, what we gain from this representation is speed and simplicity when determining whether there is an edge going from vertex to vertex since we just merely have to lookup the appropriate cells a constant time operation. See also Adjacency Matrix for a neat algebraic property of this data structure. After we have inserted the edges into the graph representation, we will print out all the adjacent vertices with their corresponding weights. This data structure is called an adjacency list. An adjacency list basically has linked lists, with each corresponding linked list containing the elements that are adjacent to a particular vertex. So given the example we used earlier, we would have a linked list in cell 2 that contains a single element of 5. If vertex 2 was also adjacent to vertex 6 then the linked list in cell 2 would contain two elements, 5 and 6 and so forth. The space requirements grow in proportion to the number of edges plus the number of vertices, i. If the graph was weighted, then we would need to create an abstraction of each node of the linked list. Instead of merely having a numerical value representing which vertices it was adjacent to, each node needs to have another field containing the weight of the edge. Using the same restrictions and objectives as the adjacency matrix implementation, the adjacency list implementation follows: Each vertex has list of pointers to edges to which it is incident. Advantage of this is that two vertices that are adjacent to this edge share the same instance of edge, so when you want to manipulate with edge data, for example flow or cost, you only change data in one object. You also modify neighbor function to make your graph directed, or mixed. Imagine how easy it would be to change the orientation of the edge with this data structure.

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7: Graph Representation: Adjacency Matrix and Adjacency List

This set of Data Structure Multiple Choice Questions & Answers (MCQs) focuses on "Adjacency List". 1. Space complexity for an adjacency list of an undirected graph having large values of V (vertices) and E (edges) is _____.

There are many variations of this basic idea, differing in the details of how they implement the association between vertices and collections, in how they implement the collections, in whether they include both vertices and edges or only vertices as first class objects, and in what kinds of objects are used to represent the vertices and edges. An implementation suggested by Guido van Rossum uses a hash table to associate each vertex in a graph with an array of adjacent vertices. In this representation, a vertex may be represented by any hashable object. There is no explicit representation of edges as objects. In this representation, the nodes of the singly linked list may be interpreted as edge objects; however, they do not store the full information about each edge they only store one of the two endpoints of the edge and in undirected graphs there will be two different linked list nodes for each edge one within the lists for each of the two endpoints of the edge. The object oriented incidence list structure suggested by Goodrich and Tamassia has special classes of vertex objects and edge objects. Each vertex object has an instance variable pointing to a collection object that lists the neighboring edge objects. In turn, each edge object points to the two vertex objects at its endpoints. Operations[edit] The main operation performed by the adjacency list data structure is to report a list of the neighbors of a given vertex. Using any of the implementations detailed above, this can be performed in constant time per neighbor. In other words, the total time to report all of the neighbors of a vertex v is proportional to the degree of v. It is also possible, but not as efficient, to use adjacency lists to test whether an edge exists or does not exist between two specified vertices. In an adjacency list in which the neighbors of each vertex are unsorted, testing for the existence of an edge may be performed in time proportional to the minimum degree of the two given vertices, by using a sequential search through the neighbors of this vertex. If the neighbors are represented as a sorted array, binary search may be used instead, taking time proportional to the logarithm of the degree. Trade-offs[edit] The main alternative to the adjacency list is the adjacency matrix , a matrix whose rows and columns are indexed by vertices and whose cells contain a Boolean value that indicates whether an edge is present between the vertices corresponding to the row and column of the cell. For a sparse graph one in which most pairs of vertices are not connected by edges an adjacency list is significantly more space-efficient than an adjacency matrix stored as an array: However, it is possible to store adjacency matrices more space-efficiently, matching the linear space usage of an adjacency list, by using a hash table indexed by pairs of vertices rather than an array. The other significant difference between adjacency lists and adjacency matrices is in the efficiency of the operations they perform. In an adjacency list, the neighbors of each vertex may be listed efficiently, in time proportional to the degree of the vertex. In an adjacency matrix, this operation takes time proportional to the number of vertices in the graph, which may be significantly higher than the degree. On the other hand, the adjacency matrix allows testing whether two vertices are adjacent to each other in constant time; the adjacency list is slower to support this operation. Data structures[edit] For use as a data structure, the main alternative to the adjacency list is the adjacency matrix. Besides avoiding wasted space, this compactness encourages locality of reference. However, for a sparse graph, adjacency lists require less space, because they do not waste any space to represent edges that are not present. Thus a graph must be sparse enough to justify an adjacency list representation. Besides the space trade-off, the different data structures also facilitate different operations. Finding all vertices adjacent to a given vertex in an adjacency list is as simple as reading the list. With an adjacency matrix, an entire row must instead be scanned, which takes O V time. Whether there is an edge between two given vertices can be determined at once with an adjacency matrix, while requiring time proportional to the minimum degree of the two vertices with the adjacency list.

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8: c++ - Implementation of an adjacency list graph representation - Stack Overflow

Graph is a data structure that consists of following two components: 1. A finite set of vertices also called as nodes. 2. A finite set of ordered pair of the form (u, v) called as edge. The pair is ordered because (u, v) is not same as (v, u) in case of a directed graph(di-graph). The pair of the.

If we represent objects as vertices or nodes and relations as edges then we can get following two types of graph: In directed graph, an edge is represented by an ordered pair of vertices i,j in which edge originates from vertex i and terminates on vertex j. Given below is an example of an directed graph. In Undireced graph, edges are represented by unordered pair of vertices. Given below is an example of an undirected graph. Adjacency List Adjacency Matrix Let us consider a graph in which there are N vertices numbered from 0 to N-1 and E number of edges in the form i,j. Where i,j represent an edge originating from ith vertex and terminating on jth vertex. Given below are Adjacency matrices for both Directed and Undirected graph shown above: Adjacency Matix for Directed Graph: Create a matrix A of size NxN and initialise it with zero. Iterate over each given edge of the form u,v and assign 1 to A[u][v]. Also, If graph is undirected then assign 1 to A[v][u]. Where i,j represent an edge from ith vertex to jth vertex. Now, Adjacency List is an array of seperate lists. Each element of array is a list of corresponding neighbour or directly connected vertices. In other words ith list of Adjacency List is a list of all those vertices which is directly connected to ith vertex. Given below are Adjacency lists for both Directed and Undirected graph shown above: Adjacency List for Directed Graph: Create an array A of size N and type of array must be list of vertices. Intially each list is empty so each array element is initialise with empty list. Iterate each given edge of the form u,v and append v to the uth list of array A. Also, If graph is undirected append u to the vth list of array A.

9: Data Structures Tutorial | Implementing Graphs with Adjacency Lists in Java | Code Snipcademy

A Graph is represented in two major data structures namely Adjacency Matrix and Adjacency List. This forms the basis of every graph algorithm. In this article, we have explored the two graph data structures in depth and explain when to use one of them.

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