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APPLICATIONS OF QUAD TREE: A REVIEW

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Abstract- As we know the computers are widely used in every field either it is of geography, medical, pharmacy, astrology. Astronomy and so on. The ongoing advancements in all these fields require a big database and the place from where this data is retrieved easily to use. The data is some time is in hierarchal format. But the array of memory that we use to save information is in only in 2-D, we have trees for such information in data structure. Q- Tree or Quad tree one of the ways of representing data in the memory. The problem is of representing data in this tree so that one can do searching, insertion and deletion in a fastest manner.

With the increase in traversing and searching the performance of the computer too increases

Keywords

Quad Tree, LEVEL,SW,NW,SE,NE

Introduction

A **quad tree** is a tree data structure in which each internal node has exactly four children. Quad trees are most often used to partition a two-dimensional space by recursively subdividing it into four quadrants or regions. The regions may be square or rectangular, or may have arbitrary shapes.

History

This data structure was named a quad tree by Raphael Finkel and J.L. Bentley in 1974.A similar partitioning is also known as a Q-tree. All forms of quad trees share some common features:They decompose space into adaptable cells.Each cell (or bucket) has a maximum capacity. When maximum capacity is reached, the bucket splits.The tree directory follows the spatial decomposition of the quad tree.

Types of Quad Tree

Quad trees may be classified according to the type of data they represent, including areas, points, lines and curves. Quad trees may also be classified by whether the shape of the tree is independent of the order data is processed. Some common types of quad trees are:

The Region Quad Tree

The region quad tree represents a partition of space in two dimensions by decomposing the region into four equal quadrants, sub quadrants, and so on with each leaf node containing data corresponding to a specific sub region. Each node in the tree either has exactly four children, or has no children (a leaf node). The region quad tree is a type of tree.A region quad tree with a depth of n may be used to represent an image consisting of $2^n \times 2^n$ pixels, where each pixel value is 0 or 1. The root node represents the entire image region. If the pixels in any region are not entirely 0s or 1s, it is subdivided. In this application, each leaf node represents a block of pixels that are all 0s or all 1s.A region quad tree may also be used as a variable resolution representation of a data field. For example, the temperatures in an area may be stored as a quad tree, with each leaf node storing the average temperature over the sub region it represents.If a region quad tree is used to represent a set of point data (such as the latitude and longitude of a set of cities), regions are subdivided until each leaf contains at most a single point.

Point Quad Tree

The point quad tree is an adaptation of a binary tree used to represent two-dimensional point data. It shares the features of all quad trees but is a true tree as the center of a subdivision is always on a point. The tree shape depends on the order in which data is processed. It is often very efficient in comparing two-dimensional, ordered data points, usually operating in O(log n) time.

Node Structure For A Point Quad Tree

A node of a point quad tree is similar to a node of a binary tree, with the major difference being that it has four pointers (one for each quadrant) instead of two ("left" and "right") as in an ordinary binary tree. Also a key is usually decomposed into two parts, referring to x and y coordinates. Therefore a node contains the following information:

- four pointers: quad['NW'], quad['NE'], quad['SW'], and quad['SE']
- point; which in turn contains:
  - key; usually expressed as x, y coordinates
  - value; for example a name

Edge Quad Tree

Edge quad trees are specifically used to store lines rather than points. Curves are approximated by subdividing cells to a very fine resolution. This can result in extremely unbalanced trees which may defeat the purpose of indexing.

Polygonal Map Quad Tree

The polygonal map quad tree (or PM Quad tree) is a variation of quad tree which is used to store collections of polygons that may be degenerate (meaning that they have isolated vertices or edges).There are three main classes of PMQuadtrees, which vary depending on what information they store within each black node. PM3 quad trees can store any amount of non-intersecting edges and at most one point. PM2 quad trees are the same as PM3 quad trees except that all edges must share the same end point. Finally PM1 quad trees are similar to PM2, but black nodes can contain a point and its edges or just a set of edges that share a point, but you cannot have a point and a set of edges that do not contain the point.

Simple Traversing Technique Of Quad Tree

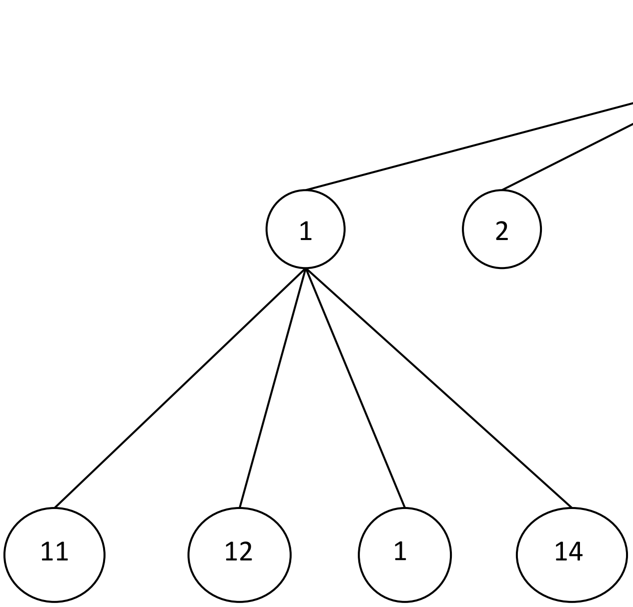
Steps to traverse a quad tree:

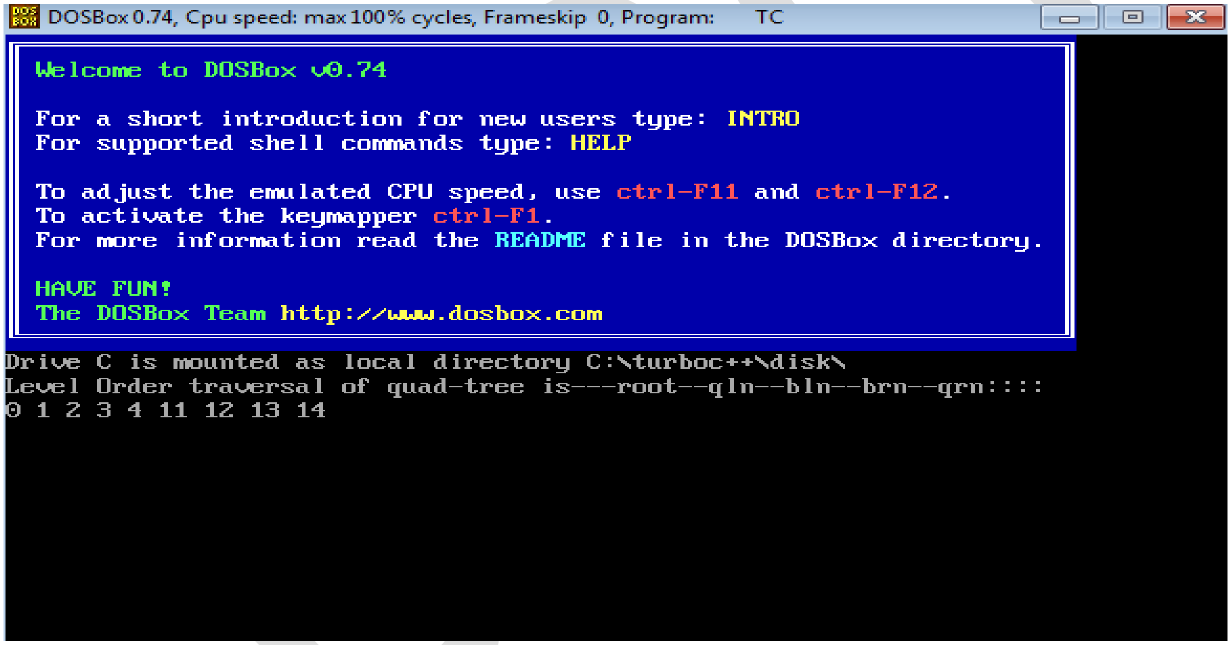
1. begin by moving down the left most branch to the first leaf
2. after processing each leaf in this branch, move back up to the previous branching point, and turn right
3. this will either lead down to another leaf, or back to a previous branching point

LEVEL WISE TRAVERSING

Level wise representation:

There are basically two functions in this method. One is to print all nodes at a given level (printGivenLevel), and other is to print level order traversal of the tree (printLevelorder). printLevelorder makes use of printGivenLevel to print nodes at all levels one by one starting from root.




DOSBox 0.74, Cpu speed: max 100% cycles, Frameskip 0, Program: TC

```
Welcome to DOSBox v0.74

For a short introduction for new users type: INTRO
For supported shell commands type: HELP

To adjust the emulated CPU speed, use ctrl-F11 and ctrl-F12.
To activate the keymapper ctrl-F1.
For more information read the README file in the DOSBox directory.

HAVE FUN!
The DOSBox Team http://www.dosbox.com
Drive C is mounted as local directory C:\turboc++\disk\
Level Order traversal of quad-tree is---root--qln--bln--brn--qrn::::
0 1 2 3 4 11 12 13 14
```

Neighbor Finding Techniques

One of the ways to traverse quad tree is neighbor finding. We can locate the neighbors in a quad tree either in a vertical direction or in a horizontal direction. Here, again the basic idea is to asset a tree until or unless the desired elements are found in this we can traverse a tree by step by step comparison of elements either by comparing vertical elements with each other or by comparing horizontal elements. The problem is to find out the next node element in a tree. It is done by back tracking back to the previous node and the further previous node and then comparing them and so on.

The data structure was named a quad tree by Raphael Finkel and J.L. Bentley in 1974. After that lot of work has been done on the quad tree on different-different fields.

Haman Samet [1], describe the use of quad tree by using it in image processing. He describes the quad tree traversing technique in the top down manner. instead of only traversing its each nodes either positively on horizontal direction or toward vertical direction it differs in work as it computes diagonal adjacent neighbors rather than computing horizontal and vertical nodes.

Disadvantage:- each node is traversed individually until required node is searched.

Our Focus:- If each node is traversed one by one in horizontally and vertically the number of comparison is more and the time requires searching an item is also large. My aspect is to reduce that time of searching.

Sarah F. Frisken Ronald N. Perry [2], provided methods for point location, region location, and neighbor searching in quad trees that are simple, efficient, inherently non-recursive, and reduces the number of comparisons with poor predictive behavior. The methods are table-free, thereby reducing memory accesses, and generalize easily to higher dimensions.

Disadvantage: In this paper, the search is more focused from point to point and neighbor to neighbor in a region in an image.

Our Focus: - we focus to reduce the time for accessing memory during searching point on an image.

CHI-YEN HUANG AND YU-WEI CHEN [3] , he presents a novel method for building the linear quad tree from a given image. From the theoretical point of view, the time 2N) if the size of the□□complexity for encoding an image is at least of O (2N 2N, since each pixel in the image should be checked regardless of□□image is 2N its color. Both the proposed method and that of belong to this type. Moreover, an algorithm with good empirical performance is required. The proposed method has been indicated to be simple, easy and efficient. Moreover, the image can be encoded in real time. The proposed method does not require a large disk space either to save the input pixels or to maintain a complex data structure.

Patrick R. Brown [4], he introduces a paging in a pointer based quad tree. In his work he creates bags of a quad tree to save it in a memory and then traversing it on the basis of B- tree format to retrieve a page from a memory. This algorithm increases the efficiency and performance of searching in a hierarchal data base.

Disadvantage:-One of the disadvantages of his work that the memory overflow will occurs sometimes without getting an appropriate result.

Our Focus: - In this research, the chances of having an appropriate result is less. This is reduced by this new technique.

Francesco Buccafurri Filippo Fur faro Domenico Sac's [5] A Quad-Tree Based Multiresolution Approach for Two-dimensional data In this paper we restrict our attention to two-dimensional data, which are relevant for a number of applications, and propose a hierarchical summarization technique which is combined with the use of indices, i.e. compact structures providing an approximate description of portions of the original data. Experimental results show that the technique gives approximation errors much smaller than other “general purpose” techniques, such as wavelets and various types of multi-dimensional histogram.

David M. Mark Department of Geography University at Buffalo Buffalo, New York 14260 U.S.A [6]THE USE OF QUADTREES IN GEOGRAPHIC INFORMATION SYSTEMS , Quad trees are very well-suited to many Geographic Information Systems (CIS) applications, chiefly because they represent 2-dimensional (spatial) data in a way which takes advantage of spatial coherence in the phenomenon being represented. This paper has emphasized the handling of diverse types of spatial data in a quad tree environment, strategies for covering very large areas, and the use of quad trees and quad tree-related structures in computational Geometry, spatial search, and spatial modeling.

Our focus:- This research paper is mainly belongs to geographical information system research field. The technique of building quadrants is used from this paper.

Kasturi Varadarajan May 2, 2013 [7] Given a set of n points in *k*-dimensional space, and an L_q-metric (Minkowski metric), the all-nearest-neighbors problem is defined as follows: for each point *p* in *V*, find all those points in $V-\{p\}$ that are closest to*p* under the distance metric L_q. We give an O (n log n) algorithm for the all-nearest-neighbors problem, for fixed dimension *k* and fixed metric L_q. Since there is an $\Theta(n \log n)$ lower bound, in the algebraic decision-tree model of computation, on the time complexity of any algorithm that solves the all-nearest-neighbors problem (for*k*=1), the running time of our algorithm is optimal up to a constant factor.

H.Samet, C A Shaffer, R C Neison , Y. G huang , K . Fujimura and A hosenfeld [8] The status of an ongoing research effort to develop a geographic information system based on a variant of the linear quad tree is presented. This system uses quad tree encodings for storing area, point and line features. Recent enhancements to the system are presented in detail. This includes a new hierarchical data structure for storing linear features that represents straight lines exactly and permits updates to be performed in a consistent manner. The memory management system was modified to enable the representation of an image as large as 16 384 x 16 384 pixels. Improvements were also made to some basic area map algorithms which yield significant efficiency speedups by reducing node accesses. These include windowing, set operations with unaligned images, a polygon expansion function, and an optimal quad tree building algorithm which has an execution time that is proportional to the number of blocks in the image instead of the number of pixels.

Disadvantage:-The quad tree memory management is describe in the phase II of the project. In which the leaf node make up in the quad tree are store in the form of list. Each list entry of leaf node contains a word of 32 bit. The first portion consists key which is used to sort nodes in a list and other contains a information.

Our focus:- In this paper the list is created to store quad tree. We use this list technique to save information.

Ivan ·Sime·cek[9] Computations with sparse matrices are used in the wide range of science projects. But suitable formats for storing sparse matrices are still under development, because the computation using widely-used formats (like XY or CSR) are slow and specialized and enceinte formats (like CARB) have a large transformation overhead. In this paper, we represent some improvements to the quad tree storage format. We also compare the performance during the execution of some basic routines from the linear algebra using widely-used formats and the
quad tree storage format.

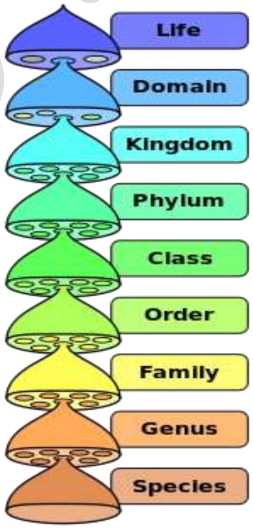
P. Barrett [10] *Quad trees have a wide range of applications, from graphics to image processing to spatial information systems. The use of linear quad trees to represent spatial information has been widely used in geography, but rarely in astronomy. With the advent of the Guide Star Catalog and other large astronomical source lists, an efficient method of storing and accessing such spatial data is necessary. We show that encoding astronomical coordinates as a linear quad tree, instead of right ascension and declination as is typically done, can provide significant improvements in efficiency when accessing sources near a given spatial direction. We also discuss how the linear quad tree can aid in the correlation of source positions from different astronomical catalogs and how it can be applied to relational databases.*

Research objective

The tree is term used to describe a class of hierarchal data structure whose common property is that they are based on the principle of regular decomposition such data structure are becoming increasingly important as representation in the fields of image processing , computer graphics, climatic study , geographical area study , study of mutation rate with a change of environment. It means that the tree is very help full for data which is extracted from a parameters and then there sub parameters and so on.

EXAMPLE 1

One of the example of such kind of data is a classification system in a biology (refer Fig)



In the diagram kingdoms which may be of either like animalia ,plantae, fungi, Protista, monera, and bacteria are either depends on various phylum and this process continue till species.

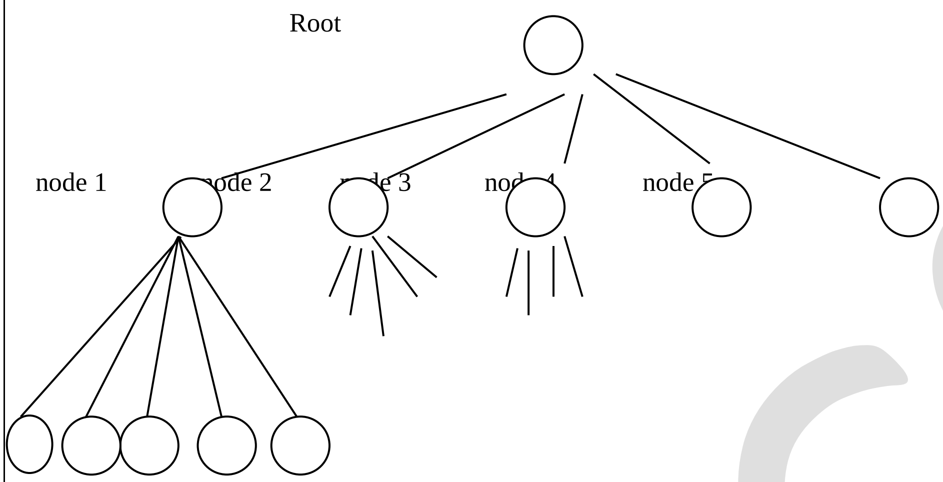


Figure 1

Here, root node has a five child nodes as node 1, node 2, node 3 node 4, and node 5. Each node further has a 5 more sub nodes and so on.

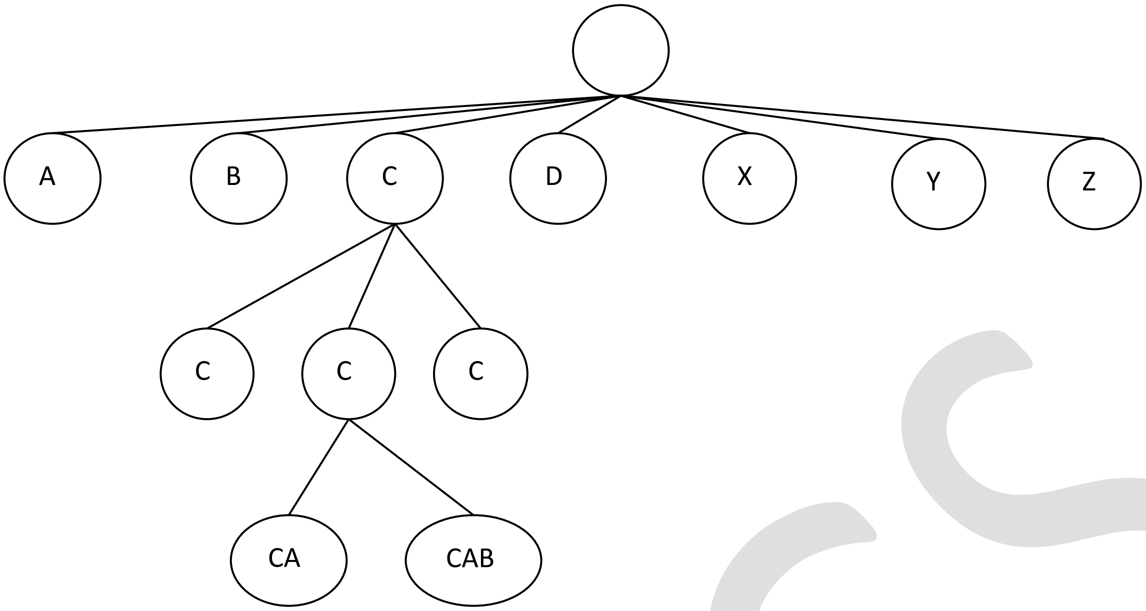
There are many cases where more than 5 nodes are required. In these kinds of data structures to traversing is difficult and time consuming. As in such cases we cannot do in-order, pre-order and post order traversing. So, we require traversing each node. Accordingly there are many trees like ternary tree having 3 nodes, quad tree having 4 nodes, and so on.

Example 2:

The dictionary is also a one example in which we have a big data and the data should present in a well scheduled and when we required to find an element we straightly open dictionary and go to the word initial letter that we want to search and then next letter and so on . this step helps us to find a word in a dictionary. But this process is only useful if we have data in a dictionary in arranged manner. Else it requires a lot of time to search a single word.

A non linear data structure that is required to represent the data structure is called tree. This data structure is manly contains a hierarchal relationship between elements e.g. records, files, family tree and tables.

Following tree shows a dictionary and the data that is saved in a dictionary in tree format.



Future Scope

The quad tree is too can be used for the memory management in a big and hierarichal data base. It is the one of the best technique in which we can use the quad tree and can acess the multiple different data and make the searching efficient and fast.

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