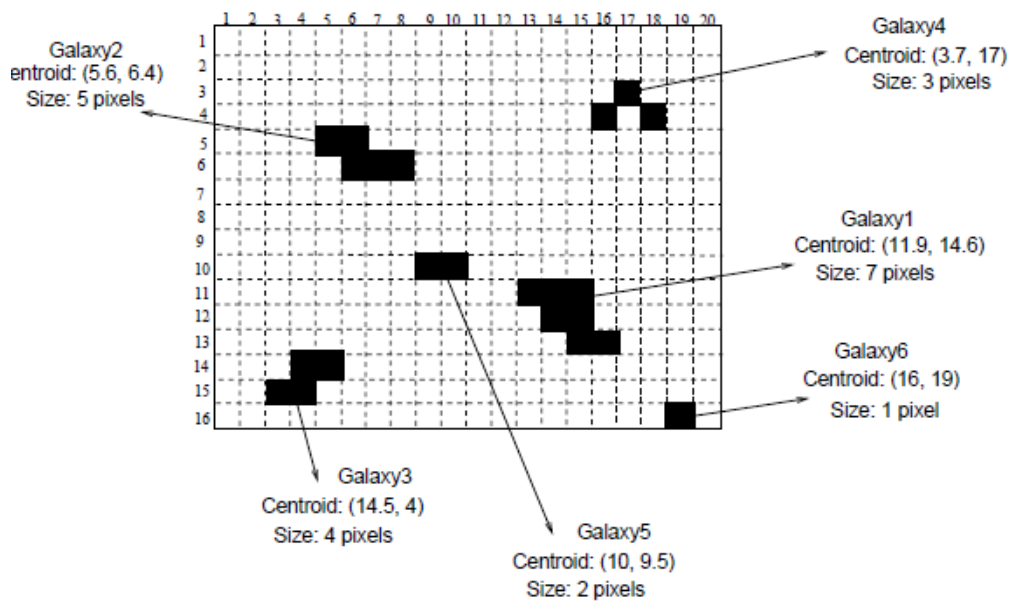


**CS302 Data Structures**  
**Spring 2012 – Dr. George Bebis**  
**Programming Assignment 5 – Extra Credit**  
**Due Date: 5/8/2012**

**Goal:** The goal of this assignment is to familiarize you with the quadtree data structure. Specifically, you will write code that uses the quadtree data structure to find the “k” nearest galaxies to a user specified location where k is specified by the user. For example, consider the arrangement of galaxies shown in the figure below. Assuming that the user specified location is (10, 12) and k=2, your program should return galaxies 1 and 5.



**Quadtree construction:** From assignment 3, you have stored the galaxies in a sorted list. Use the algorithm below to store the galaxies in a quadtree based on their location (i.e., centroid). The “spitting” strategy should be based on the “median” x and y values (i.e., see slide #94). Each internal node should store the “splitting” value and four pointers (i.e., children) corresponding to the four directions: North-East (NE), North-West (NW), South-West (SW), and South-East (SE). The children should be placed in the tree according to the spatial relationship with respect to the parent. The galaxies should be stored at the leaves (i.e., only the centroid needs to be stored); each leaf should store no more than m galaxies where m is a user-specified parameter.

*Input: Point set P (i.e., galaxy centroids)*  
**while** Some cell C contains more than “m” galaxies **do**  
    Split cell C

**Quadtree searching:** to find the closest galaxy to a user specified location, use the algorithm below (i.e., see slide #99). Think of the search region as a circle of radius r.

*Initialize  $r$  to a large value (e.g.,  $\sqrt{2} N$  for an  $N \times N$  image)*

*Put the root on a stack*

**Repeat**

*Pop the next node  $T$  from the stack*

*For each child  $C$  of  $T$*

*if  $C$  intersects with a circle (ball) of radius  $r$  around  $q$ , add  $C$  to the stack*

*if  $C$  is a leaf, examine point(s) in  $C$  and update  $r$*

**Coding:** Implement a generic quadtree data structure with functions to (i) create a quadtree from a set of points  $P$  and (ii) search for the “ $k$ ” nearest points to a given location. You should enhance driver.cpp to allow the user to specify an image location when needed and the number of “ $k$ ” nearest galaxies to be retrieved. Your program should show an image with the retrieved galaxies and report the total number of nodes of the quadtree as well as the number of nodes examined in finding the “ $k$ ” nearest galaxies.

**Instructions**

Each function should be discussed in a separate section with the name of the section being the same as the name of the function. Functions that you have implemented in previous assignments do not need to be described again (only if you have made significant modifications). The sections should be clearly separated from each other.