Quad Trees

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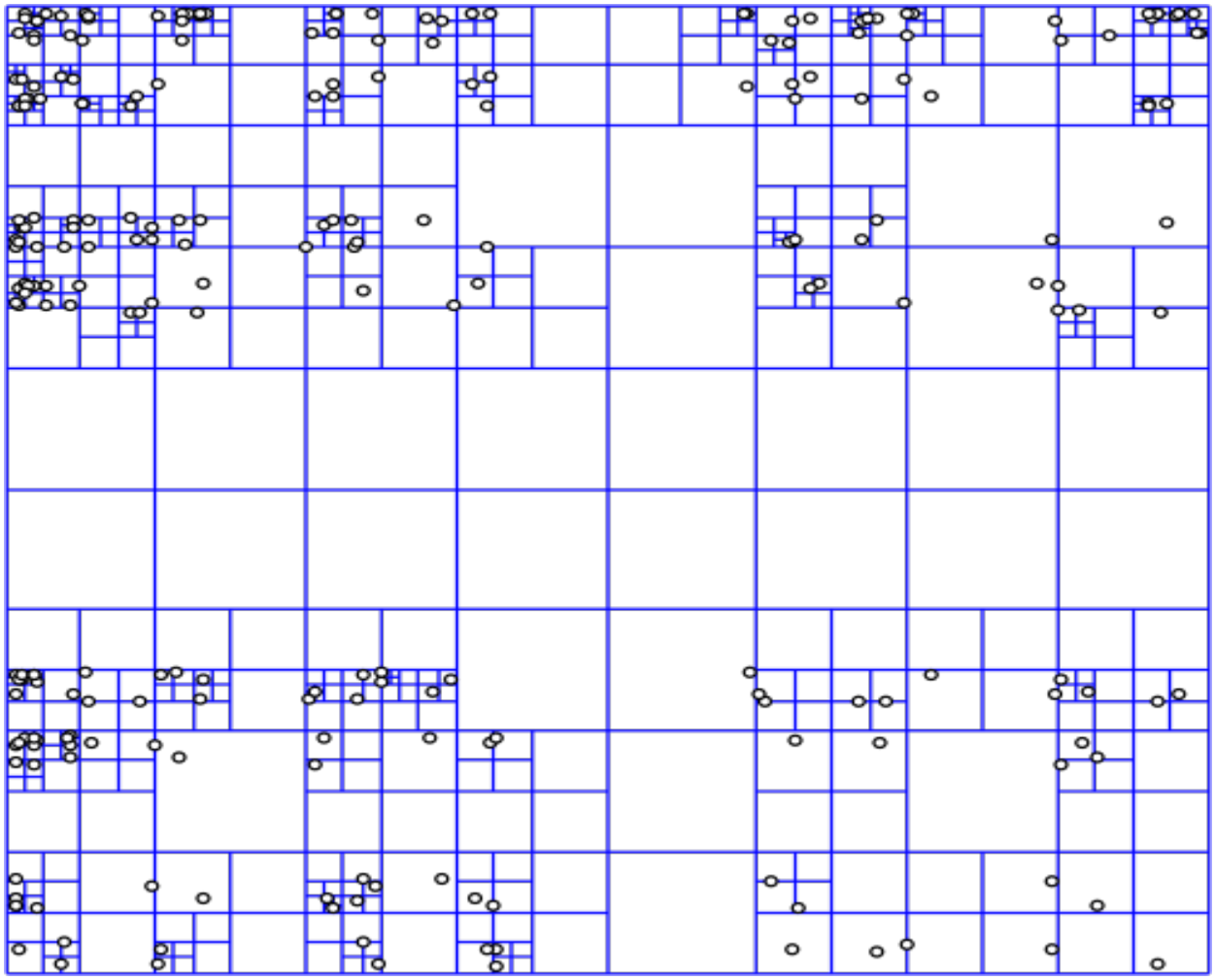


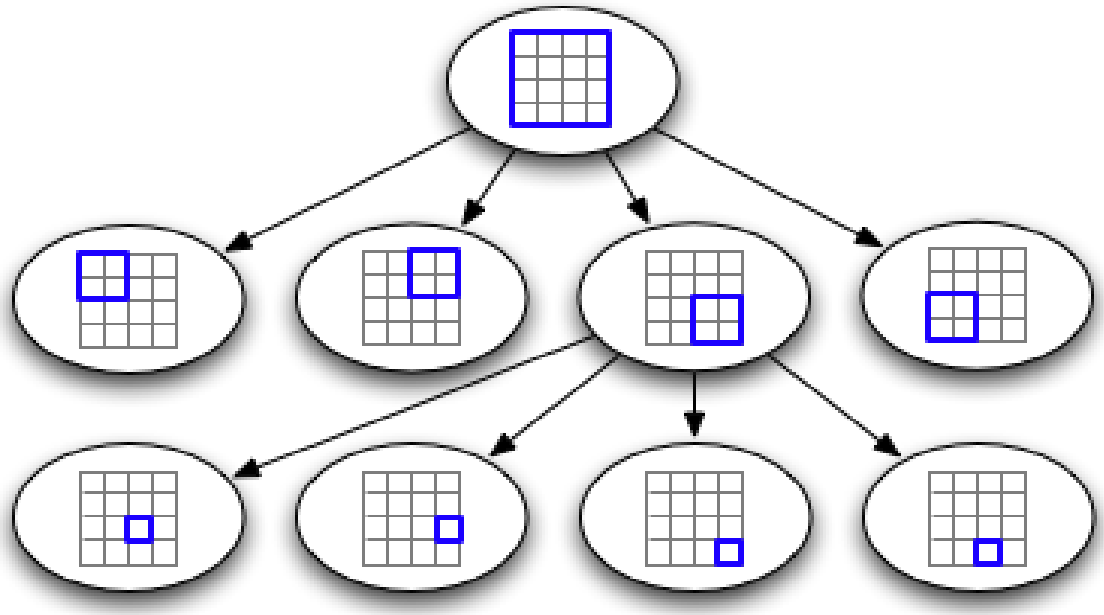
What Are Quad Trees?

-Tree Data structure used to represent/partition space

-root will represent the entire space

-In general – each node will have either 4 or 0 children

-General process – split area into 4 quadrants recursively



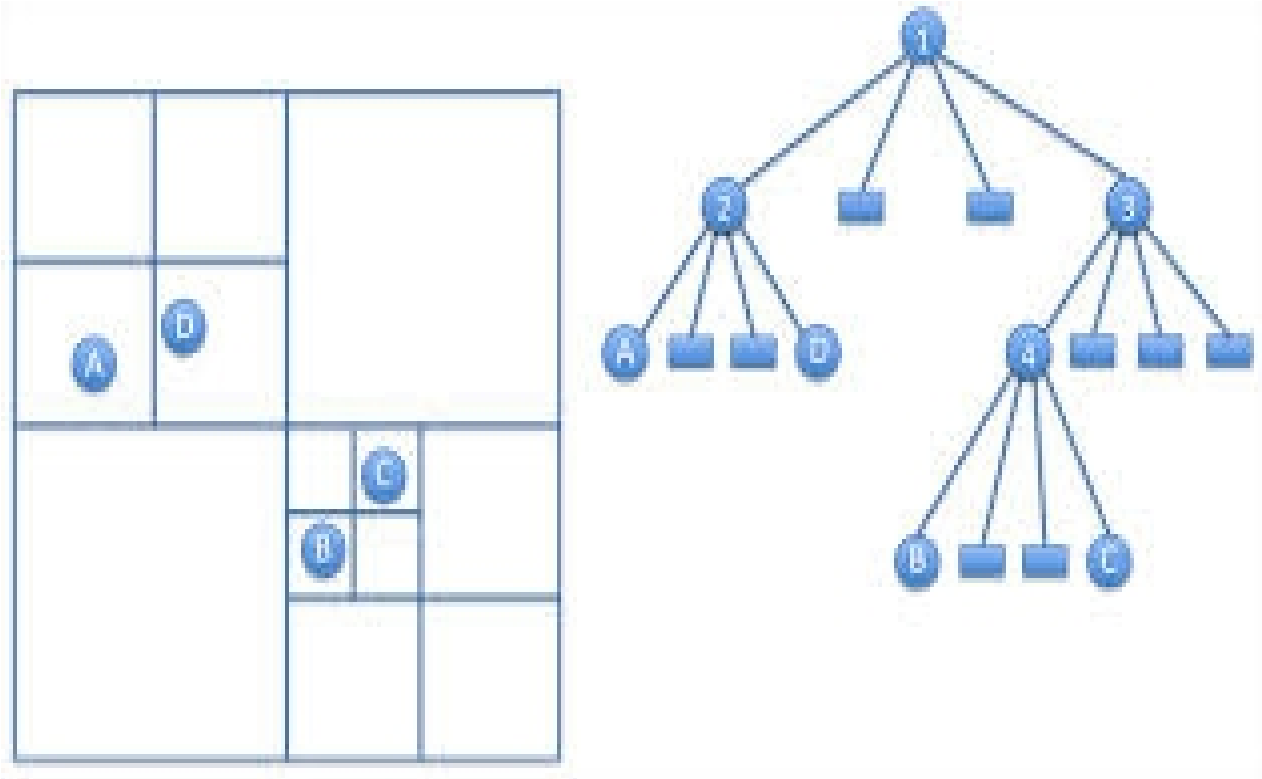
Region Quad Tree

-root is entire space

-4 or 0 children per node

-Objects are stored in the leafs

-Objects in between regions can be stored in parent or as duplicates within leafs



Operations:

Query

-O(h) for traversal

-(n+h) worst case for points – all points may be in same quadrant

Insertion

-From root - traverse through quadrants which hold the point. If leaf, add point to list of points – O(h)

-If you exceed some number of points, split the leaf into quadrants and redistribute the points

Checking Neighbors

-There will be times when you need to check the neighbors of a node

-very simple – traverse up until you find a common ancestor, then traverse back down

Application 1:
Collision Detection

-Used in games or in simulations (particle collision)
-Can be used in any dimension – nodes have 2^d pointers(can use a ton of a memory)
-example: 3D – 8 pointers (octo tree)

How to do it:
-Traverse to leaf the same as in insert
-Run collision detection algorithm for all points in that quadrant

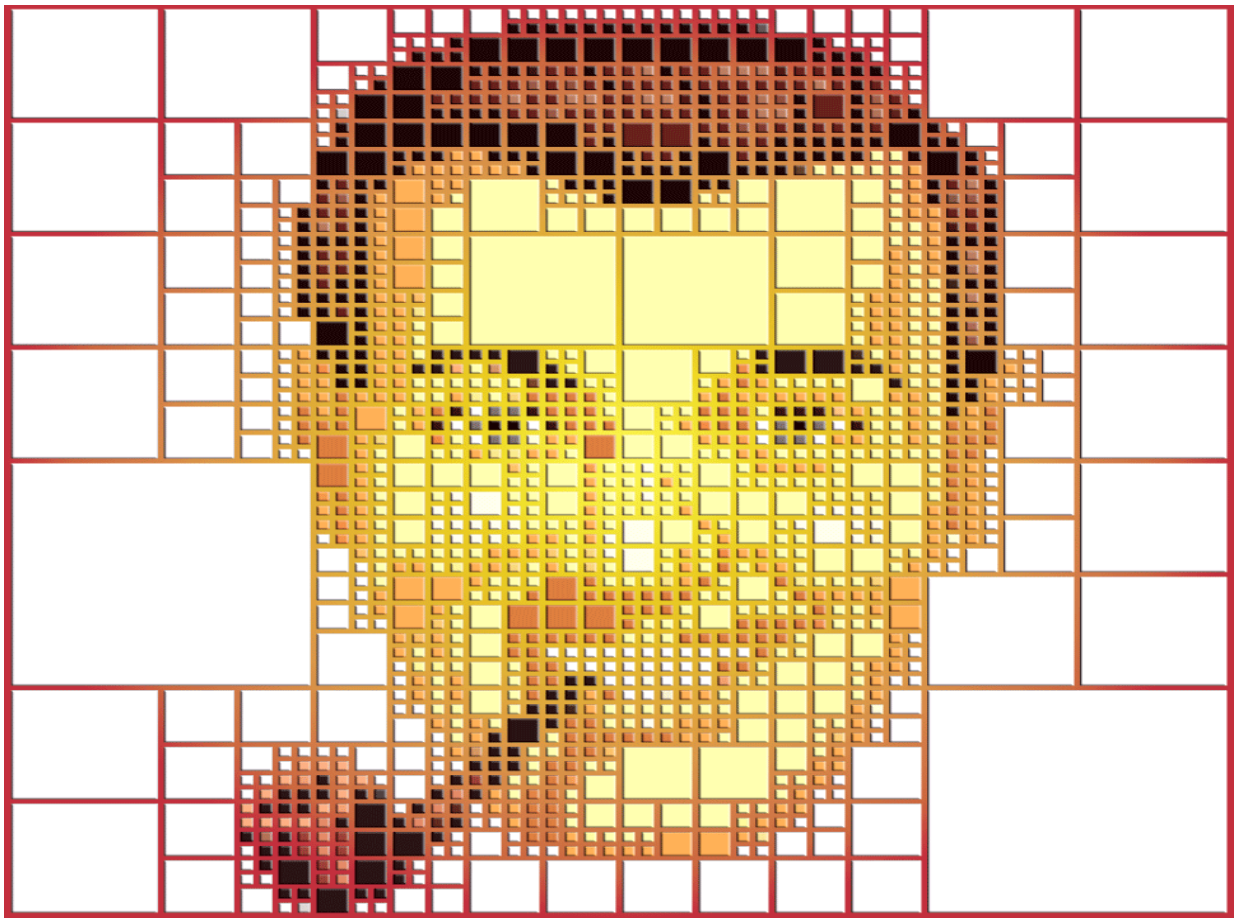
-If storing duplicates – need outside structure

Why this structure is good for collision detection?
-With the way we partition the space, we don't have to run a costly collision algorithm on objects that can't possibly collide

Collision Video 1
Collision Video 2

Application 2: Image

-Can be used to represent an image where the length and width must be powers of two
-root is entire image
-you keep splitting until you reach leaf nodes that only contains 0's or 1's



Other Types:

PR Quad Tree
-very similar to a binary tree
-Balanced – H = log4n
- instead of “left” and “right”, “NW”, “NE”, “SW”, “SE”
-Divide into quadrants until each quadrant holds at most 1 point

Edge Quad Tree
-stores lines instead of points

Others
-There are also many other types such as PM quad trees, MX quad trees, etc...

Thank you for listening

Sources:

Text

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https://wiki.cs.umd.edu/cmsc420/index.php?title=PR_Quadtree
http://stackoverflow.com/questions/4981866/quadtree-for-2d-collision-detection

Videos

https://www.youtube.com/watch?v=7JNsP_vgvp0
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Pictures

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