How quadtree works

ALEX XU
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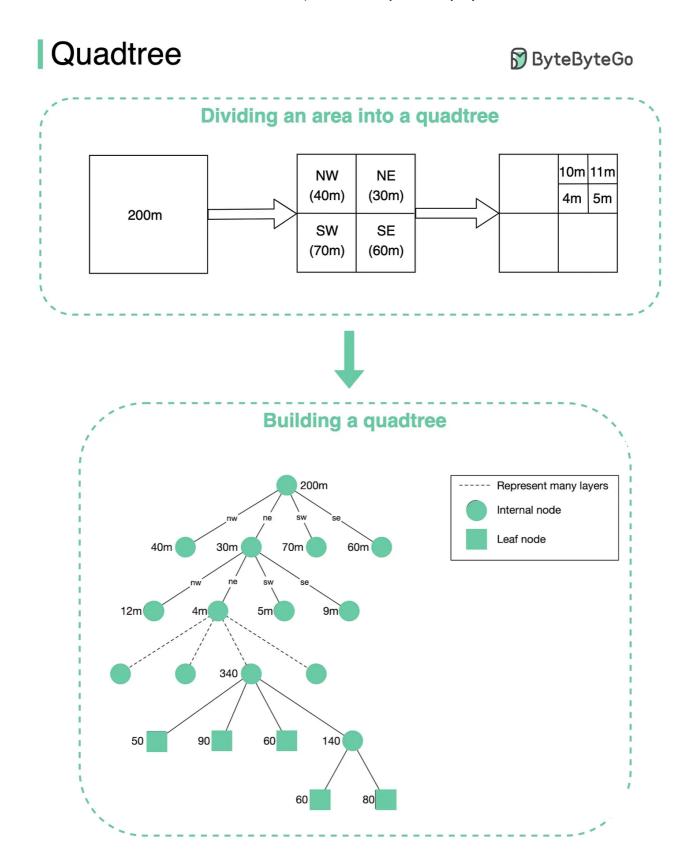
In this post, let's explore another data structure to find nearby restaurants on Yelp or Google Maps.

A quadtree is a data structure that is commonly used to partition a two-dimensional space by recursively subdividing it into four quadrants (grids) until the contents of the grids meet certain criteria (see the first diagram).

Quadtree

ByteByteGo

Dividing an area into a quadtree

NW (40m)	NE (30m)
SW (70m)	SE (60m)

10m	11m
4m	5m

200m

Building a quadtree

- - - - - Represent many layers
- ⬤ Internal node
- ⬛ Leaf node

A quadtree is an **in-memory data structure** and it is not a database solution. It runs on each LBS (Location-Based Service, see last week's post) server, and the data structure is built at server start-up time.

The second diagram explains the quadtree building process in more detail. The root

node represents the whole world map. The root node is recursively broken down into 4 quadrants until no nodes are left with more than 100 businesses.

How to get nearby businesses with quadtree?
- Build the quadtree in memory.

- After the quadtree is built, start searching from the root and traverse the tree, until we find the leaf node where the search origin is.

- If that leaf node has 100 businesses, return the node. Otherwise, add businesses from its neighbors until enough businesses are returned.

Update LBS server and rebuild quadtree
- It may take a few minutes to build a quadtree in memory with 200 million businesses at the server start-up time.

- While the quadtree is being built, the server cannot serve traffic.

- Therefore, we should roll out a new release of the server incrementally to a small subset of servers at a time. This avoids taking a large swathe of the server cluster offline and causes service brownout.
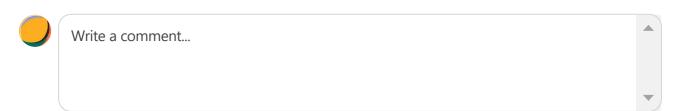
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