Agenda.
- → Quad Trees.
- → Design **Uber.**
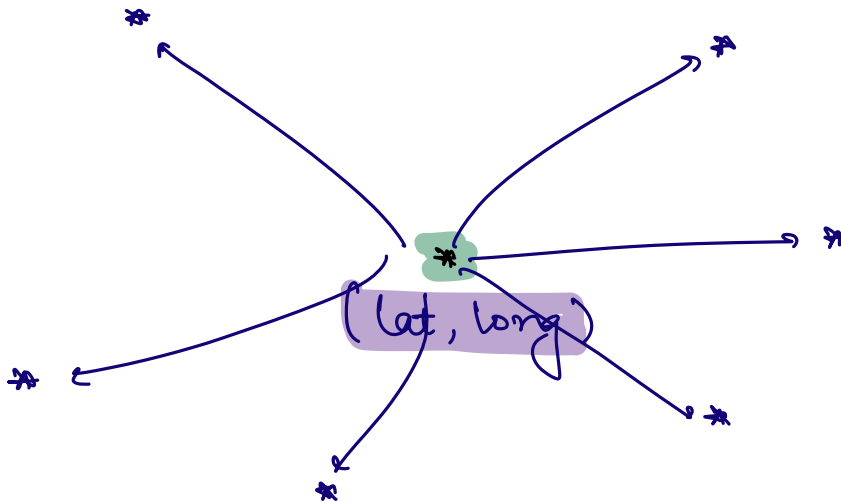   ↓
    Location based searching
    - → Swiggy | Zomato
    - → Google Maps.

Places of **intrest.**
- → Schools
- → Hotels
- → Restaurants
- → Petrol pumps.

(lat, long)

I) Collate all the places of intrest of the entire world with their (x, y) coordinates.
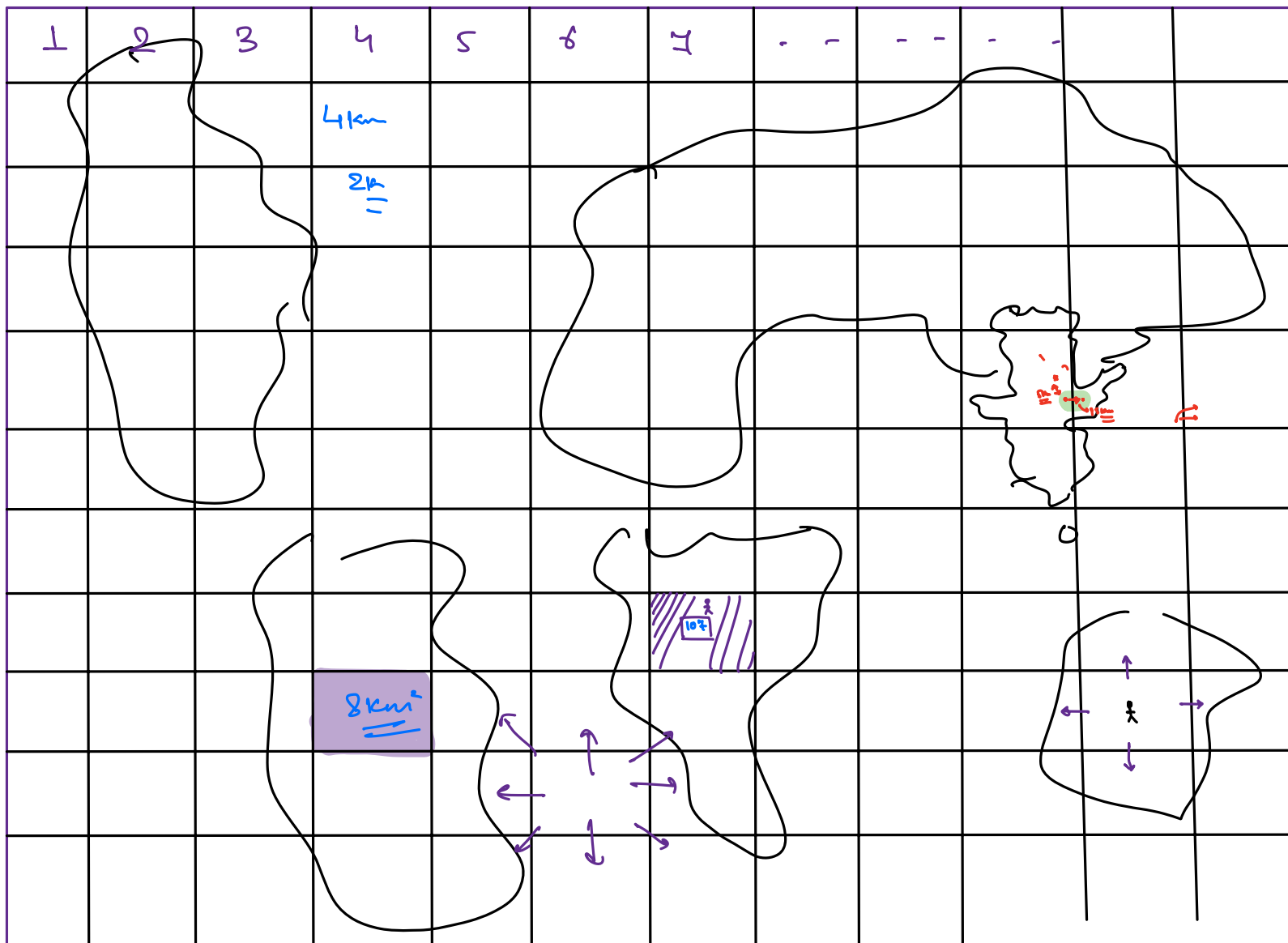
id	name	location	type

Millions of entries.

II) find the distance b/w the location of the user & the place of intrest.

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Threshold :
→ 10 km
→ 10 places of intrest.

⇒ Search space is too large.

1	2	3	4	5	6	7	-	-	-	-	-	-

4km

2k

8km²

10%

⇒ Divide the entire into fixed sized grids.

⇒ Assign numbering to grid.

4km | 2km ⇒ 8 Km²

Places.

id	name	location	type	grid_id
1	XYZ School	(L_1, L_2)	Education	102

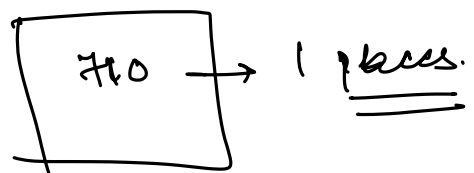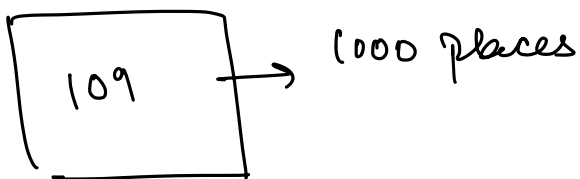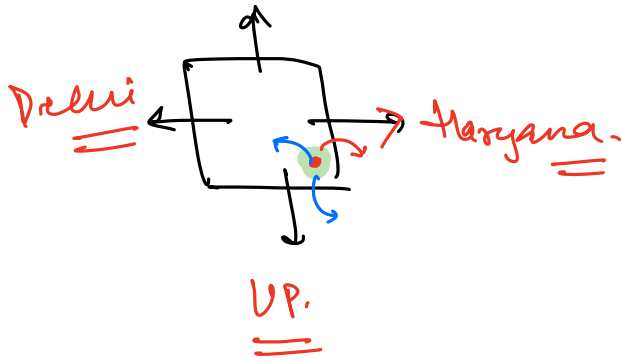To search the places of intrest near to a user, first find the grid_id in which user is present currently.
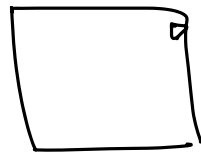
107

→ Get the list of places of intrest in grid_id = 107.

→ fill the nearest ones.

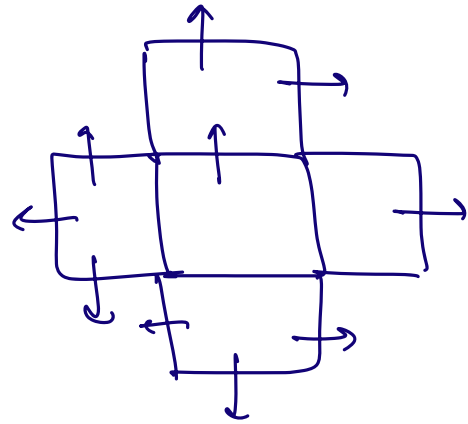Problem : Same sized grid won't be having same no. of places of interest.

109 → 1000 places   710 → 1 places.

Delhi ← | → Haryana.

UP.

⇒ Places of introst are present inside the grids in a non uniform & unorganised way.

100,000

SOLⁿ : Dynamic Sized grids.
↳ Recursion.

⇒ Assumption :

Entire = One
world   Cell.

⇒ Recursively, we'll keep dividing the grid into smaller grids till the time we have >100 places of interest.

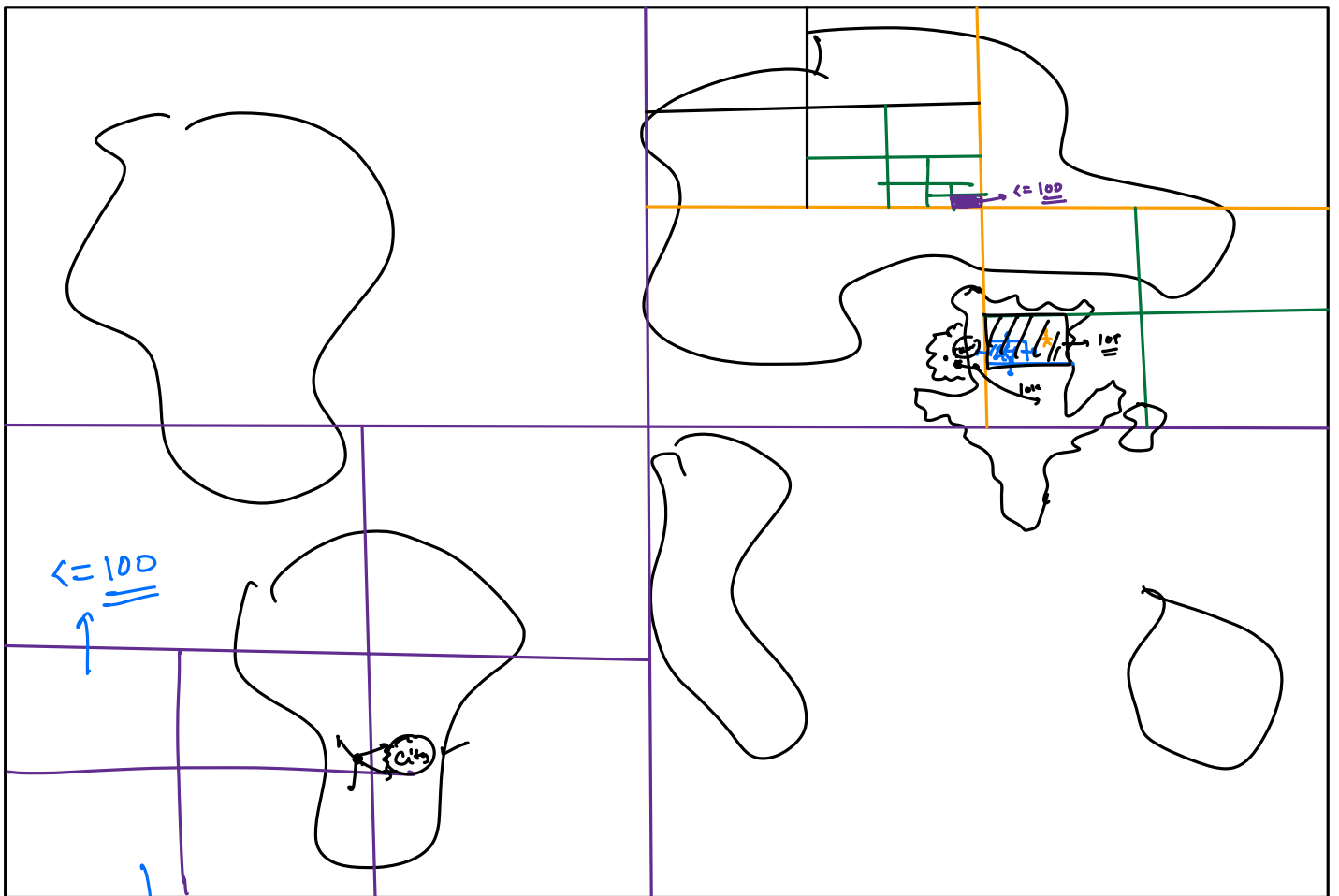if (no. of places in a grid > 100) {
       Divide;
}
else {
    ≡
}

\# of places > 100

⇒ Divide into 4 quadrants.

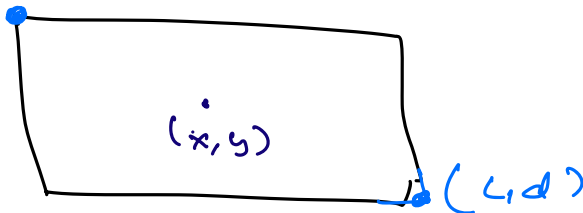⇒ Division of the world in grids ⇒ One time preprocessing task.
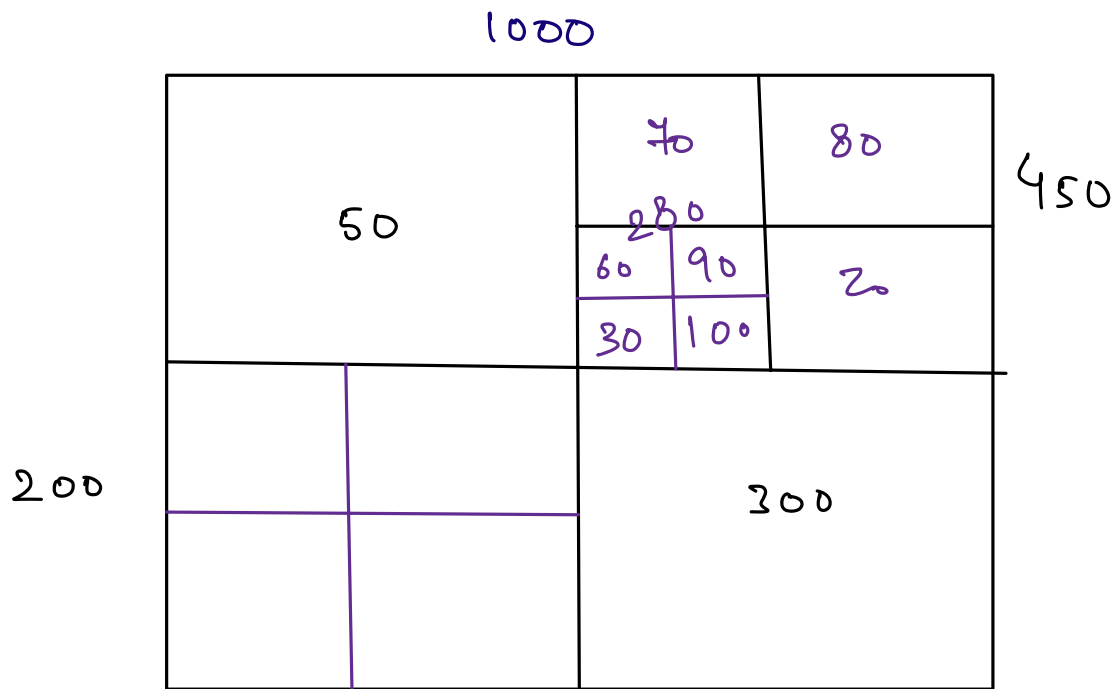
\# Select * from places where grid_id = 105

70

$\Downarrow$

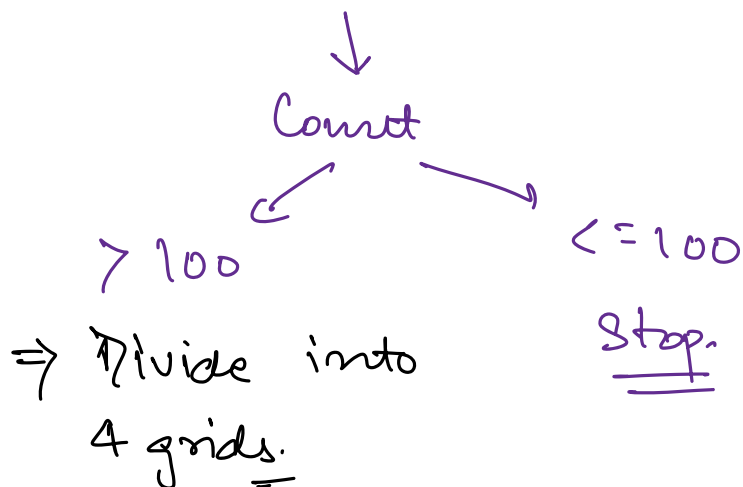10 restaurants.

$\boxed{////}$ → 10K.

(a,b)

(x,y)

(c,d)

⇒ Pre-processing Step: Quad Tree.

⇒ Using recursive algo.

1000

50	70	80	450
	280 60 90		
	30 100	20	

200 | | | 300

⇒ Initially assume that the entire world is a single grid.

Select * from places where grid_id = 1;

↓

Count

> 100   <=100

⇒ Divide into   Stop.
4 grids.

N: No of places in the world.

$\rightarrow O(N)$

$\frac{N}{5} \times 4$

(21)

(N)

(N)

$\left(\log_{4} N\right) \rightarrow K \times O(N)$

$\uparrow$
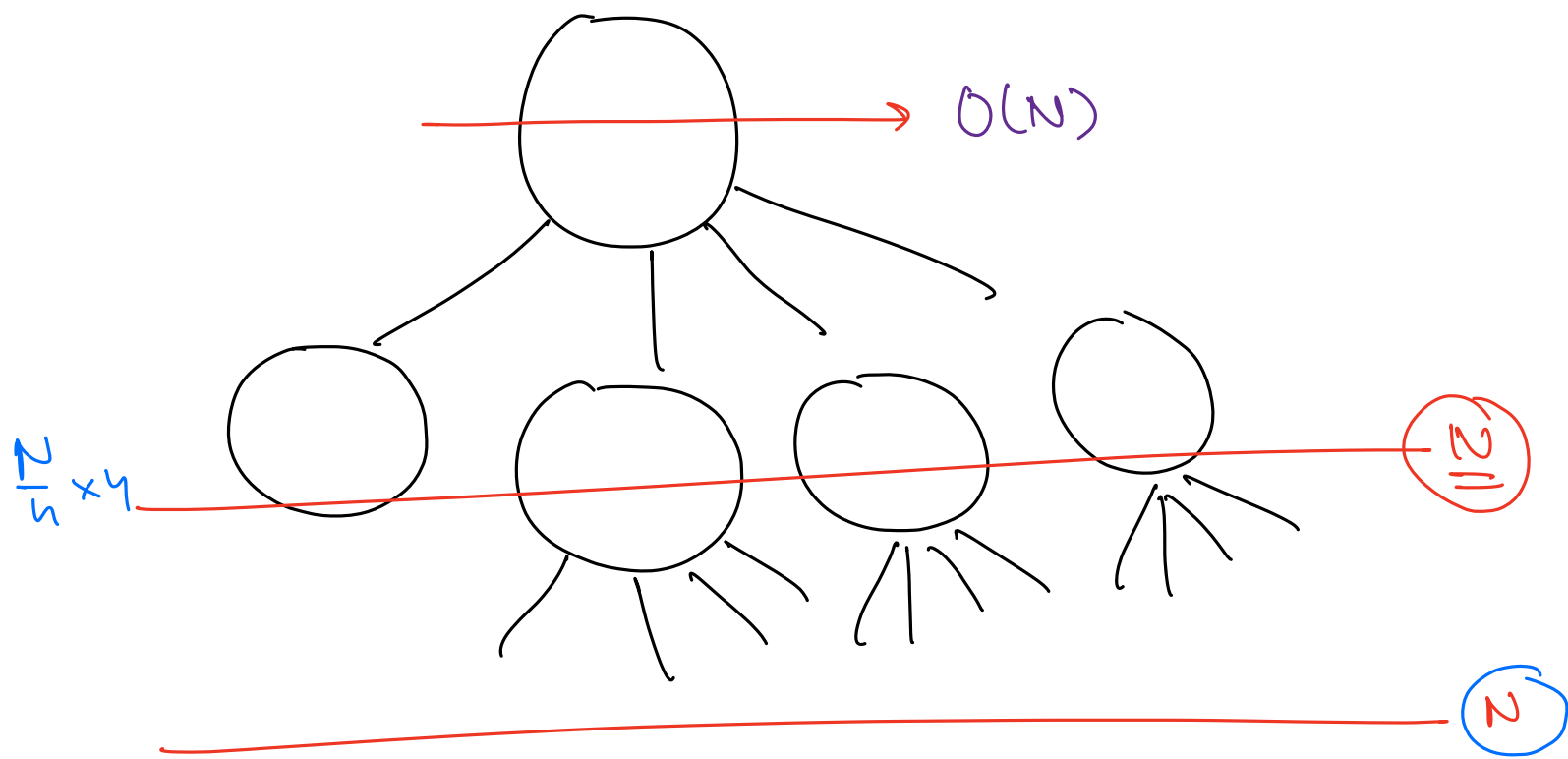
Height of the Quad Tree.

$100M$

$= 10^8 - 10^9$

$\Rightarrow$ Preprocessing Step.

Zomato.

→ Restaurants near our location.

→ India.
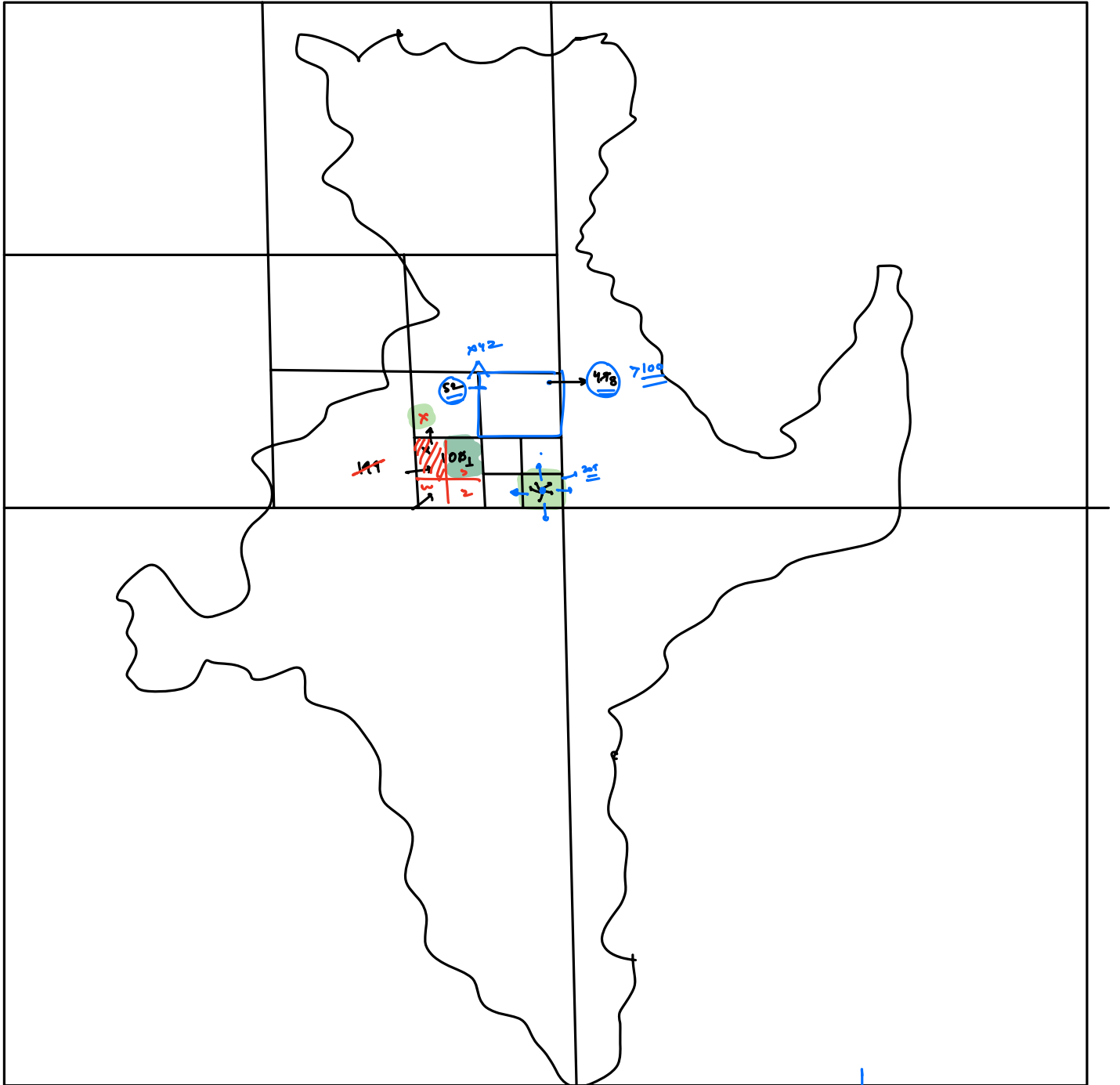
> 100 restaurants.

restaurants.

id	name	type	(x,y)	grid_id.
x				2.0

⇒ 10 nearest restaurants in the same grid.

⇒ When a new is getting added or a place is getting removed, we'll have to update the Quad Tree as well.

↓

This can be done in async.

(May be once in every 24 hrs).

Size of the Quad Tree.

↳ Next Class. (Tuesday)