DSA PROJECT

TOPIC: GEOHEALTH

***Objective*** –

Develop a comprehensive hospital system using advanced data structures (R-Tree, Trie, and Heap) to efficiently manage and search for hospitals based on various criteria such as name, location, and ratings. The system should support adding, deleting, and retrieving hospital information while maintaining a search history for user reference. The goal is to enhance user experience by providing quick access to hospital data and enabling efficient location-based searches, particularly for emergency situations

***Justification of use of data structures and their time complexities –***

1. **R-Tree**:

* **Use**: R-Trees are designed for spatial access methods, making them ideal for indexing multi-dimensional information such as geographical locations of hospitals.
* **Time Complexity**:
  + **Insertion**: O (log n) - Efficiently organizes hospitals based on their spatial coordinates.
  + **Deletion**: O (log n) - Allows quick removal of hospitals while maintaining the structure.
  + **Search (nearest neighbours)**: O (log n + k) - Quickly retrieves hospitals within a specified range, crucial for location-based queries.

1. **Maxheap**:

* **Use**:  Allows for easy updates and changes in hospital ratings, crucial in healthcare scenarios. Ideal for applications where prioritizing the highest-rated hospitals is essential, such as emergency services or patient referrals.
* **Time Complexity**:
*  **Insertion**: O(log n) - Adds a hospital while maintaining the heap structure.
*  **Extraction**: O(log n) - Retrieves and removes the highest-rated hospital efficiently.
*  **Maximum Retrieval**: O(1) - Accesses the highest-rated hospital instantly.

1. Trie:

* Use:Allows for quick lookups, particularly useful for prefix-based searches (e.g., finding hospitals by name or address). Enables retrieval of all hospitals matching a given prefix, enhancing user experience for autocomplete features.Although it may use more memory than other structures for small datasets, it becomes space-efficient for large datasets with shared prefixes.
* Time complixiety :

 **Insertion**: O(m) – Inserts a hospital based on the key (name or address).

 **Search**: O(m) – Searches for hospitals matching a partial key.

 **Collection of Hospitals**: O(n) – Collects all hospitals from a node and its descendants, where n is the total number of hospitals at or below that node.

 **Deletion**: O(m) – Deletes a hospital entry by traversing the key.

1. Stack :

* Use: LIFO(last in first out property) A stack is ideal for maintaining a search history because it naturally supports the most recent searches being accessible first. This aligns with typical user behavior, where users are likely to revisit their last searches. Both operations are executed in constant time, O(1), allowing for fast insertion and retrieval of search history.
* Time complixiety :

 **Push**: O(1) – Adding a new search detail to the top of the stack.

 **Pop**: O(1) – Removing the most recent search detail from the top of the stack.

 **Peek**: O(1) – Viewing the top search detail without removal.

 **View History**: O(n) – Traversing the stack to collect all search details, where n is the number of searches in the stack.

 **Get Last Search**: O(1) – Accessing the last search detail without modifying the stack.

R TREE STRUCTURE

Root (Internal Node) [Bounding Box: (40.7242, -74.0049) - (40.758896, -73.9176)]

|-- Internal Node 1 [Bounding Box: (40.7242, -74.0049) - (40.7373, -73.9352)]

| |-- Leaf Node 1

| | |-- City Hospital (40.73061, -73.935242)

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| | |-- St. Peter's Hospital (40.7306, -73.9352)

| | |-- Downtown Medical Center (40.7242, -74.0049)

| |-- Leaf Node 2

| |-- Metro (40.730610, -73.935242)

| |-- Sunshine Medical Clinic (40.730610, -73.935242)

| |-- Harbor Medical Center (40.7331, -73.9580)

| |-- Eastside Medical Center (40.7312, -73.9998)

|

|-- Internal Node 2 [Bounding Box: (40.7357, -74.0031) - (40.758896, -73.9744)]

| |-- Leaf Node 3

| | |-- Northside Hospital (40.7357, -73.9918)

| | |-- Westside Hospital (40.7373, -74.0031)

| | |-- Southview Hospital (40.7367, -73.9722)

| | |-- East River Hospital (40.7394, -73.9744)

| |-- Leaf Node 4

| |-- Green Valley Hospital (40.758896, -73.985130)

| |-- General Hospital (40.7580, -73.9855)

| |-- Lakeside Medical Clinic (40.7402, -73.9823)

| |-- Community Health Center (40.7408, -73.9176)