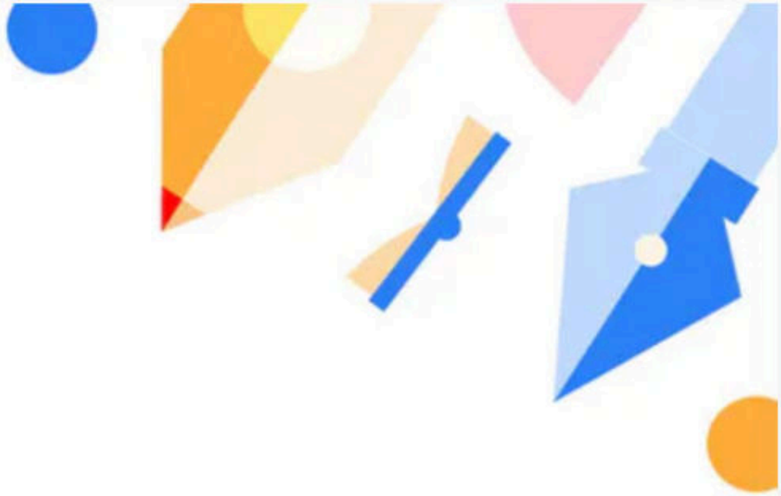

Persistent Data Structures

Special class

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Persistent Data Structures

Course: https://unacademy.com/a/i-p-c-advanced-track

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Objective

- Introduction
  - What is Persistence?
  - Types of Persistence
  - Motivating problem
- Fat Node Persistence
  - Theory Discussion
  - Implementation
- Path Copying
  - Theory Discussion
  - Implementation
- Conclusion

What is Persistence?

- A persistent data structure preserves all versions of itself.
  - Every update to the data structure creates a new version .
  - Update(version, <value>) : returns new version

Types of Persistence

- **Partial Persistence:**
  - Query any version of the data structure
  - Update only the latest version - versions are linearly ordered.

- **Full Persistence:**
  - Query any version of the data structure
  - Update any version - versions form a tree

Motivating Problem (Spoj KQUERY)

- Given an array A with N elements, answers M queries of the form:
  - Range Query: Given L, R, K - Find number of elements in [L, R] which are greater than K
- Ans = Number of numbers > K in [1 .. R] - Number of numbers > K in [1 .. L - 1]

Motivating Problem (Spoj KQUERY)

- Modified Question: Given an index i, query number of elements > K in [1 .. i]

Fat Node Persistence

- Add a vector of (version number, value) to every node of segment tree

Fat Node Persistence - Update

- Add a new (version, value) to every modified internal node - O(logN) time.

Fat Node Persistence - Query

- Visit all O(logN) nodes and do a binary search at every node to get the value corresponding to the correct version -- O(log^2N) per query.

Question

- Is the discussed fat-node method an example of
- A) Partial Persistence
- B) Full Persistence

Path Copying Persistence

- Create a copy for every **affected** node and update necessary links to old / new nodes.

Path Copying Persistence - Update

- For an update, copy every node in the path and create a new root corresponding to a new version - O(logN) per update.

Path Copying Persistence - Query

- For a query, choose the root corresponding to the correct version and do a usual query - O(logN) per query

Question

- Is the discussed path-copying method an example of
- A) Partial Persistence
- B) Full Persistence

Conclusion

- Persistence can be extended to other data structures as well.
- For ex: We will look at Persistent Centroid Tree during our lecture on Centroid Decomposition on Day-2 of the camp.